APPENDIX F

TETRA TECH EBA

September 4, 2015

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Attention: David Harpley, VP Environmental & Permitting Affairs

Subject: Addendum and Progress Report to Address Adequacy Review of Developer's Assessment Report for Environmental Assessment, EA1415-01 Proposed All-Season Road Access to Prairie Creek Mine, NT

1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech EBA) completed a geotechnical evaluation in March 2015 to support a regulatory process for a proposed all-season road from Northwest Territories Highway 7 near Nahanni Butte to the Prairie Creek Mine. Our geotechnical report was part of Canadian Zinc Corporation's (CZN's) Developer's Assessment Report (DAR), submitted to the Mackenzie Valley Environmental Impact Review Board (MVEIRB). As a result of MVEIRB's adequacy review (AR) of the DAR dated May 22, 2015, CZN requested Tetra Tech EBA to supplement the information provided in the geotechnical report, as well as enhance the presentation of existing data in graphical form.

This letter provides much of the additional information and commentary as requested in the AR and subsequent MVEIRB letter dated June 24, 2015, respectively. Tetra Tech EBA has also included the locations of this information in the concordance table provided by CZN (presented as Table 1, after the references). In many cases, the requested information exists in our March 2015 report, but needed to be adequately referenced and/or additional graphical presentation to make it more accessible for review. In other cases, additional information was needed to clarify or supplement the provided information. Several sets of maps have now been completed, including slope gradient and slope aspect for the route, surficial geology and geomorphology for the portion of the route where existing mapping is available. Terrain stability mapping for the sections of the route identified as "high-risk" in Tetra Tech EBA's March 2015 report is ongoing, and the results to date are reported in this letter. Confirmatory terrain mapping is also ongoing for a proposed alternative alignment on a portion of the proposed all-season road route. A description of the route and routing decisions made to date is provided herein. The map series and the discussion of the alternative alignment are included as appendices at the end of this letter.

The additional commentary requested in the AR is presented in this letter in essentially the same order as in the AR document. Where additional commentary or clarification was requested in the June 24, 2015 letter, this information is incorporated into the relevant sections.

2.0 ADDITIONAL COMMENTARY FOR MVEIRB QUESTIONS

2.1 General

The following points record the items requested by the AR, along with the method by which Tetra Tech EBA has addressed the requirement, or some additional text to satisfy the requirement. References to the geotechnical report are to Tetra Tech EBA's March 2015 report.

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2.2 Existing Topography – Characterization of Geohazards (AR Section 7.2)

ToR section

5.1.1, item 1 *topography and geology, including key terrain features such as rivers, lakes, karst features and wetlands and other important processes and features*

DAR section

4.1, Appendix 2 *Topography, Terrain, Geology, and Karst Features*

Item Rationale

Insufficient baseline characterization and metrics have been provided to allow for the prediction of quantitative and qualitative effects to the terrain features. This information is required to ensure that safety measures for the all-season road are adequately addressed in the project design. Specifically, the information feeds into the considerations of terrain stability with respect to road construction and the consideration of erosion potential, and for the assessment of the key line of inquiry of the effects of potential accidents and malfunctions.

- ***Descriptions of the variations in the natural slope angle along the alignment:*** Slope angle maps have been generated from the LiDAR survey and the adjacent geobase DEM's within the mapping area. These maps are discussed in Section 3.0 below and are presented in Appendix A. Slope gradient is also reported in the geotechnical report in various locations in the baseline route description, as percent, or as ranges, e.g. gentle, moderately steep, steep, or very steep. Slope gradient ranges are also provided in the surficial geology and geomorphology maps (discussed in Section 5 and attached in Appendix C), and in the terrain stability mapping for any mapped polygons considered unstable or potentially unstable. The terrain stability mapping is discussed in Section 6 of this letter and the mapping results to date are presented in Appendix D.

- ***Descriptions of the variation in slope aspect along the alignment:*** Slope aspect maps are provided for the route in Appendix B, and are discussed in Section 4.0 below. Slope aspect is also discussed in various locations in the baseline route description in the geotechnical report.

- ***An evaluation of the likelihood of the alignment, particularly the bridge sites, being affected by meander mitigations and channel avulsions:*** Previous evaluations using aerial coverage included the 1994 air photos and the 2012 ortho-imagery and LiDAR, along with the 2014 field observations and previous field observations by others. An evaluation of historic air photos has begun for major stream crossings in the route sections identified as "high-risk" in the geotechnical report. Initially, this includes the bridge crossing proposed over Polje Creek at KP053, in order to assess the potential for meandering of the stream in the area of the crossing. The current work incorporates air photo coverage as far back as 1949 and is ongoing. Due to time constraints, it has not yet been included with the terrain stability mapping. For stream crossings not yet evaluated in this manner, or route sections traversing in close proximity to meandering or avulsing channels, it is assumed that terrain that is poorly vegetated is likely to meander/avulse on a regular and continuing basis, whether it is a stream channel or an alluvial fan. Even well-vegetated fans are considered unpredictable. Therefore, the road alignment has currently been located to reduce the likelihood or limit the length of the crossing that could potentially be overrun with debris by skirting the toes of fans, or crossing near the apices, depending on mitigation requirements for other hazards, such as rockfall upslope, or thermokarst downslope. Examples include debris flow fans between about KP029.1 to 32.4. In this section, most of the route skirts just below the toes of the fans, except at the KP031.3 fan, where the route crosses mid-fan. At KP29.1, the debris flow fan has overrun the old winter road. At about KP029.8, the route occupies a narrow corridor between the creek and the toe of another fan, because moving further upslope would put the road too close to the upslope hazards. There is a similar narrow corridor at KP031.6. Similar concerns occur just east of Grainger Gap between about KP124.6 and KP126.2, where a route closer to the toe of the steeper slope was considered to avoid the floodplain and its potential for thermokarst and flooding. However, it was determined that the upslope hazards, rockfall and debris flow terrain, were a greater concern than the downslope issues.

- ***Comprehensive landslide mapping that differentiates the landslide types and shows the locations of past landslides and hazard zones:*** Terrain mapping to date has been in a linear format rather than a mapping format. For example, Appendix C in the geotechnical report records the extensive talus slopes and debris flood/flow channels and fans in the western part of the alignment that the AR indicates could be used as a basis for delineating the extents of rockfall hazard zones. Terrain stability mapping has commenced in the areas indicated as "high-risk" in the geotechnical report, in order to provide a more visual overview of the terrain stability issues potentially affecting the route. The terrain stability mapping is further discussed in Section 6.0 below. Associated maps are attached in Appendix D.
- ***An assessment of the frequency and magnitude of the various natural terrain landslide and snow avalanche hazards along the alignment:*** Snow avalanche hazards were addressed by Alpine Solutions Avalanche Services in their report dated May 26, 2012. The avalanche hazard maps generated were provided in Appendix D of our geotechnical report. For landslide hazards, the AR requested the review of a "suite of years of historic air photos across a time span that is considerably greater than the design life of the project." Previous evaluations using aerial coverage included the 1994 air photos and the 2012 ortho-imagery and LiDAR, along with the 2014 field observations and previous field observations by others, thus encompassing a 20-year timeframe, longer than the proposed mine life (14 years). This timeframe was considered to be the most relevant for recent changes likely to have been induced by climate change. The current terrain stability mapping work (ongoing) incorporates air photo coverage as far back as 1949 for the areas indicated as "high-risk" in the geotechnical report. The work so far has revealed that the thaw slump/flow located near KP054 was not yet present at the time of the 1994 imagery.
- ***A comparison of the present day extents of the areas of large scale slope instability between [KP039] and [KP060] with the extents on older years of air photos:*** We note that some of the obvious slope activity from about KP039 to KP048 is associated with stream meanders. Detailed design will require further investigation in these areas. The route section from about KP048 to KP060 has within it some terrain indicated as "high-risk" in the geotechnical report. Accordingly, this section is part of the terrain stability mapping further discussed in Section 6.0 below. Associated maps are attached in Appendix D.
- ***A detailed characterization of permafrost and karst hazards that have been identified between [KP048] and [KP059]:*** This section is part of the terrain stability mapping further discussed in Section 6.0 below. Associated maps are attached in Appendix D. It is noted that an overlay of previous mapping of karst terrain by others was also presented for this road section in the geotechnical report (Figure 3).
- ***An integration of surficial geology and slope angle data. This is needed in order to analyze the likelihood of landslide occurrence in relation to the proposed road cutting and clearcutting. This information can be presented in the form of terrain stability maps. The analysis could be calibrated by assessing the performance of previous clear cutting operations and road construction in relation to the surficial geology and slope angle:*** "Calibration" efforts are anticipated to be most successful at the west end of the road route, where there is already a partially-built road grade along much of the route, and accordingly we have noted several areas with some apparent performance issues. Golder (2010) describes small-scale rockfall (up to 1 m in diameter) as common along the route from the Mine to Cat Camp, "with some historic evidence of large fragments having reached the valley bottom." Specific areas include prominent ravelling upslope of the road between KP000.1 and KP000.3 at the Mine, ravelling along the road from KP001.1 to KP1.4, KP003.4 to KP004.2, a ravelling cutslope and tension cracks on the fillslope at KP005, three narrow fillslope failures at about KP013.5, possibly due to sidecast fill, a fillslope failure at KP014 (30 m wide and 40 m long) on an active talus slope, and apparent fillslope failures at KP016.25 to KP016.75. From there until Cat Camp, several

sections of road were noted to skirt along the toe of the talus or cut through toes of talus cones. Typical areas include KP017 to KP019.1, KP021.2 to KP021.5, KP021.8 to KP021.9, KP022.2 to KP022.6, KP023.65 to KP024.65, and KP033.3 to KP035. Such areas would need to be dealt with on a site-specific basis in detailed design in order to mitigate the possibility of increased ravelling of cutslopes and additional fillslope failures due to an increased road width. However, it should be noted that an existing all season road bed exists from KP0 to KP017, and a bladed trail on gravel from KP017 to KP033. These have been largely intact for 35 years apart from KP026 to KP028 which crosses ravelling talus, a section which will now be avoided by a southern re-alignment. For much of the remaining route, as we have noted previously, the performance of a winter road is not particularly representative of the performance of an all-season road. As well, past performance is not necessarily representative of future performance, due to the continuing influence of climate change. Terrain stability mapping is currently being carried out for the areas indicated to be "high-risk" in the geotechnical report, and work to date is presented in Section 6.0 and Appendix D.

- ***Details regarding how the road design has been modified to mitigate the rockfall risk (refer to recommendations on Page II-4 of the Golder report):*** Golder recommended this step for detailed design. In the interim, we have recommended various locations where the highest risk areas can be avoided as noted above in the description of routing to mitigate risks due to debris flows, and the route alignment has been changed accordingly by Allnorth. For places where rerouting may not be possible, we have recommended that engineering and/or administrative controls be implemented.

2.3 Unconsolidated Surficial Materials (AR Section 7.3)

ToR section

5.1.1, item 3 *unconsolidated surficial materials and terrain types, including thickness of landforms*

DAR section

4.1, Appendix 2 *Topography, Terrain, Geology, and Karst Features*

Item Rationale

Insufficient baseline characterization and metrics have been provided to allow for the prediction of quantitative and qualitative effects.

- ***An overlay map showing the findings of the published surficial geology mapping (Hawes 1981, Rutter and Boydell 1981) for the alignment:*** Surficial geology and geomorphology overlay maps are attached in Appendix C for the section of the route where existing mapping is available, from about KP064 to KP174.5. These maps are discussed in Section 5.0 below.

- ***Terrain maps for the alignment (terrain mapping is discussed in various sections but the terrain maps are not included):*** Terrain mapping as discussed in the geotechnical report consisted of the confirmation and/or fine-tuning of the existing mapping specific to the proposed road right-of-way, as well as noting specific terrain features as applicable along the route, for example, noting the kilometre post locations of transitions between terrain units, or kilometre post locations and characteristics of such features as sinkholes or slope failures. The terrain was described in Appendix C of the geotechnical report in a linear format with photos along the route, and is now included as geomorphology in the surficial geology and geomorphology overlay mapping noted above. Additional field sites have been mapped to further detail materials and terrain types along the proposed alignment. Terrain stability mapping completed so far for the "high risk" portions of the route is attached in Appendix D.

2.4 Soil Types (AR Section 7.4)

ToR section

5.1.1, item 4	*Soil types, including group, series and type, as applicable*

DAR section

4.1, Appendix 2	*Topography, Terrain, Geology, and Karst Features*

Item Rationale

The types of soils along the various segments of the alignment are described in general terms. What is missing is a description of the predicted spatial extents of the various soil types along with descriptions of their texture. This information is essential for interpreting the erosion potential and permafrost conditions.

- ***A description of the predicted spatial extents of the various soil types along with descriptions of their texture:*** Surficial geology and geomorphology overlay maps are now presented for the section of the route where existing mapping is available, from about KP064 to KP174.5. These maps are discussed in Section 5.0 below and are presented in Appendix C. Some additional field site information is also available to support the mapping, in addition to the information collected in 2014 by Tetra Tech EBA and Allnorth. Permafrost mapping is also being carried out in conjunction with the terrain stability mapping in the areas indicated as "high-risk" in the geotechnical report. This mapping is further discussed in Section 6.0 below. Associated maps are attached in Appendix D.

2.5 Stability of Landforms with Respect to Permafrost (AR Section 7.5)

ToR section

5.1.1, item 14	*permafrost processes, features and landforms and their stability, including slopes, shorelines and stream banks*
5.1.1, item 15	*probable ground ice conditions, temperature and ground thermal regime*
5.1.1, item 18	*thaw slumps in the area*
5.1.1, item 19	*how regional climate variation and documented warming of ground temperatures in the region may affect ground conditions.*

DAR section

4.1, Appendix 2	*Topography, Terrain, Geology, and Karst Features*

Item Rationale

Insufficient baseline characterization and metrics have been provided for the prediction of quantitative and qualitative effects. The information is required to ensure that safety measures are adequately addressed in the project design. In addition, the information feeds into the considerations of terrain stability with respect to road construction and operations, and the assessment of the key line of inquiry of the effects of potential accidents and malfunctions.

- ***An estimation of the retrogression rates of the thaw slides and thaw flows by comparing the present day back scarp locations with historic locations:*** Where slides and flows have been identified on more than one year of aerial coverage, retrogression rates can be estimated. Terrain stability mapping currently being done in the areas indicated as "high-risk" in the geotechnical report will identify such features for further analysis. This mapping is further discussed in Section 6.0 below. Associated maps are attached in Appendix D.

- ***A description of the inferred significance of elevation, slope aspect and slope angle to the ground temperature regime and the presence of permafrost:*** This information is presented and discussed in numerous locations in the geotechnical report as applicable to the typical terrain and range of elevations seen along each road section (Section 5), and also in general terms with respect to elevation (Sections 5.4 and 6). However, the slope aspect and slope gradient maps now available may allow additional correlations to be discerned at a scale more encompassing than merely local or site-specific spot checks and, in any case, can help confirm or refine the data already noted. The slope gradient maps are discussed in Section 3.0, with the maps attached in Appendix A, while the slope aspect maps are discussed in Section 4.0, and the maps are attached in Appendix B. Tetra Tech EBA has also considered the contribution of surficial geology and geomorphology as well as soil types anticipated and encountered along the route, in order to estimate the likely ground temperature regime, for example, the likely ranges of active layer thickness based on the types of soils likely to be encountered in a particular area (granular vs. fine-grained), or the presence or absence of permafrost or the likely active layer thickness based on the types of vegetation seen (black spruce vs. jack pine). The surficial geology and geomorphology maps are discussed in Section 5.0 and the maps are attached in Appendix C.

- ***Consideration of potential climate change effects in relation to variations in the altitude and slope aspect along the alignment:*** As noted in the geotechnical report, Tetra Tech EBA anticipates that trends in climate change effects are likely to be relatively consistent along the route. For example, regional trends in air and ground temperature are likely to be similar at different elevations even if absolute temperatures are quite different (Section 5.3). Similarly, overall trends in temperatures would likely be relatively consistent regardless of slope aspect, even though south-facing aspects are already warmer than north-facing aspects. One possible difference, however, may be seen in the end result of climate change trends, when comparing north- vs. south-facing aspects for sites that might have otherwise similar characteristics. If a slope with a south-facing aspect experiences climate warming, the results of thawing might be less obvious than those experienced by a similar north-facing slope, if the south-facing slope already has less permafrost by virtue of being warmer. On the other hand, if the south-facing slope is closer to thawing temperature, but the amount and characteristics of permafrost are otherwise similar to that in a north-facing slope, the south-facing slope might show obvious results of thawing sooner than the north-facing slope.

2.6 Channel Morphology and Stability (AR Section 7.6)

ToR section

5.1.3, 7 iv	*channel and bed morphology and stability*
5.1.3, 7v	*bank stability and areas of erosion*

DAR section

4.3	*Water Quality and Quantity*

Item Rationale

Preliminary designs for watercourse crossings and riparian road segments are provided in Appendix 1 (Allnorth report). The watercourse crossings were reportedly designed to accommodate the passage of 1:100 year flood flows, as well as debris and ice; however, the designs lacked site-specific information.

Of particular concern were the Casket Creek crossing which is located on an active alluvial fan, crossings of braided streams with wide active channel zones such as Sundog, Tetcela and Grainger, and the proposed re-alignment of the Sundog Creek channel. Concerns included possible channel avulsions and road washouts, encroachment of stream crossings on active channel widths, and the lack of channel stability assessments.

The following point records the terrain-analysis-related items requested in the AR, along with the method by which Tetra Tech EBA would assist CZN in addressing these requirements:

- ***A review of sequential historical air photos to assess lateral channel instability, including channel avulsion frequency on alluvial fans and meander migration rate on floodplains:*** Major stream crossings can be evaluated based on historical air photos. Terrain stability mapping is ongoing for the areas indicated as “high-risk” in the geotechnical report and will identify such features as avulsions and meanders for further analysis. Current terrain stability mapping will include the area of the Polje Creek crossing at KP053, as the crossing is located on a meandering stream that is potentially affected by events in the adjacent "high-risk" areas. This mapping is further discussed in Section 6.0 below. Associated maps are attached in Appendix D.

2.7 Impacts to NNPR (AR Section 8.1)

ToR section

4.1 Impact Assessment Steps
A summary matrix in Appendix B of the ToR is required for all eleven items in section 7.2.3

7.2.3 NNPR Items 1, 2, 7, 8 10, 11 in Section 7.2.3 do not meet conformity requirements with the ToR

DAR section

DAR Section 10 and Appendix 7, Section 6 Impacts to NNPR

Item rationale

Section 4 of the ToR outlined the impact assessment steps methodology to be used for each valued component (see page 2 above). The items in Section 10 of the DAR do not conform with these impact assessment steps.

Required Item

In accordance with the ToR methodology outlined in Section 4.1, 7.1, and ToR Appendix B, please conduct a complete assessment of impacts from the project on the following items as required under the key line of inquiry for Impacts to NNPR, Section 7.2.3 of the ToR:

7. Changes to karst formations

Travelling east from the Mine, the old winter road alignment leaves the Polje Creek valley at approximately KP049 on the all-season alignment, and climbs the Ram Plateau via two switchbacks. Ford (2009) called this portion of the plateau the Suffosion Sinkhole Plain. Numerous sinkholes (and possible kettle holes) are evident just south of the old winter route, and a few sinkholes and block subsidence areas are present north of the route. Due south of the block subsidence areas and the slope failure scarps located between the Second and Third Poljes, and the winter road, the old winter route turns to the north-northeast and then descends the plateau in a series of switchbacks between the Second and First Polje, passing between two more subsidence blocks enroute. From the base of the valley, the old winter road then climbs again, switching back to rejoin the all-season alignment at about KP058.6. Golder (2010) noted the intense karst land centred on the poljes, and recommended a reroute to the north to avoid the suffosion sinkhole area and the poljes, as well as the adjacent slope instabilities.

Golder (2010) also noted the presence of closed depressions near the road alignment across the plateau, and further along the route. Golder stated, "The closed depressions are understood to originate from the loss of ground overlying the Nahanni Limestone Formation into solution cavities within the limestone and are identified in the literature as suffosion sink holes. Some of the closed depression features, particularly within the glacial deposits below approximately elevation 2800 to 3000 feet may be kettle holes. These features form in glacial deposits within which ice has become buried and has subsequently melted." Golder further observed, "Where the access route crosses through the valley that contains the intense karst land […] many sink holes and faulted land exists adjacent to and probably under the route." Outside the polje area, from about KP059 to KP084, Golder further noted that the route crosses no closed depressions, though some do exist "within a few hundred metres of the route. One sink hole into which local drainage flows, exists approximately 300 m to 400 m off the route near Km 65." Golder observed that "[t]he hazard related to the suffosion sink hole features is that renewed subsidence (associated with existing closed depressions) could take place during the life of the road, leading to partial or complete loss of the road grade locally. A remote possibility exists that a completely new feature could show up at the surface. The subsidence that would be associated with renewed activity at existing closed depressions can occur suddenly and without significant prior warning. Renewed activity is generally expected to result in small volume, incremental movement, however, it is possible that vertical displacement could be many metres." However, no evidence of subsidence within the lifetime (28 years at the time of Golder's evaluation) of the existing old winter road was noted at any location along the old winter route. Despite the apparent lack of subsidence activity, Golder recommended re-aligning the route to the north, and recommended that "detailed mapping of all features within approximately 200 metres of the road be undertaken", and "periodic review of these features be carried out to document any changes that may take place." These recommendations are understood to have been included in the approved, revised winter route.

Tetra Tech EBA and Allnorth have refined Golder's proposed reroute (2010), and the revisions subsequently proposed by SNC Lavalin Inc. (SLI) (2012), to improve the grades and to avoid specific terrain hazards.
The development or reactivation of karst features may pose some risks to the integrity of the road bed; however, the road itself is not considered to pose a significant risk to the karst features themselves, especially since re-alignment proposals will result in the road avoiding the intense karst locations. If the road starts to deteriorate due to subsidence, the geotechnical consequence may be only that the road needs to be rebuilt, or re-aligned, in that section. Golder has advised suitable mitigation for the risks to the road. Besides the avoidance of intense karst terrain, and the mapping and review of nearby karst features, Golder noted that remedial action could be planned and undertaken, if deemed necessary according to the nature of changes that might be observed.

SLI noted a doline-like lake along the switchbacks section of the route on the west side of the Silent Hills (SLI 2012a, 2012b). Although this area is not considered to be traditional karst, this large sinkhole (confirmed by Tetra Tech EBA's air photo analysis) was subsequently avoided entirely by a 2015 reroute, and several other suspected sinkhole features near the route were avoided as well, as shown in Figure 11 of Tetra Tech EBA's 2015 geotechnical report. (The sinkhole in this figure is seen superimposed on the marker for BH14, which is located just northwest of this feature.) The route has been shortened by about 300 m in this section, by removing the switchback that led north to the sinkhole. Added benefits of the reroute include reducing the number of debris flow channel crossings and also a reduction in the route's exposure to other slope instabilities in the ascent of the Silent Hills.

The predicted Project-related direct geotechnical effects to karst features after mitigation has been applied (road re-alignment, mapping depressions and annual review) are summarized as follows:

Table 2.7-1: Terms of Reference (ToR) Non-Conformance Items in AR Section 8.1

Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Phase 1	Adverse	Low	Low	High	Moderate	Low	Moderate
Overall Significance							
Low							

Confidence in this assessment is moderate. The measurable parameters are changes to the mapped depressions, and/or the appearance of new depressions. With adherence to mitigation, geotechnical residual effects are considered to be unlikely.

2.8 Terrain, Soils, Permafrost, and Karst Topography (AR Section 10)

The AR provides no specific item rationale for the items discussed in this section; however, Tetra Tech EBA anticipates that some additional discussion and description would assist MVEIRB in evaluating the completeness of baseline characterization and metrics for the prediction of quantitative and qualitative effects (ToR 5.1.1, items 12 and 13) and the potential consequences of thaw-related events on the terrain (ToR 7.3.1, items 5, 7, and 12 through 16). This information contributes to the consideration of terrain stability with respect to road construction and operations, and may assist in the key line of inquiry into the effects of potential accidents and malfunctions.

Table 2.8: Terms of Reference (ToR) Non-Conformance Items in AR Section 10

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
5.1.1, Item 12	Probable permafrost distribution (thickness and lateral extent) on land, water, shoreline and slope crossings	Probable permafrost distribution is discussed in numerous locations in the geotechnical report, however, a few items are worth clarifying here. In warm permafrost, which is expected along the route, permafrost is unlikely to be present under water bodies with unfrozen water year-round, and is more likely to be present in streams that freeze to the bottom every winter. Shorelines and river banks tend to have nearly vertical transitions between no permafrost beneath the water body and permafrost outside the water body. Exceptions can occur in meanders where, for instance, permafrost may still be present beneath outside bends of rivers, while it may still be forming in the deposition areas at inside bends of rivers. In climate-warming conditions in warm permafrost, it is also possible or even likely that permafrost will not reform at the inside bends. Permafrost in the area of the route is mapped as “extensive discontinuous,” indicating it may be present in 50 to 90% of the area. Since there is a significant range in elevation along the route, permafrost may be more likely at higher elevations, and it will be colder if/where present. However, low-elevation, low-lying areas with fine-grained sediments which have developed potentially ice-rich permafrost are also present along the route.
5.1.1, Item 13	Permafrost distribution and stability beneath waterbodies	In warm permafrost, as is expected along the route, permafrost is unlikely to be present under water bodies with unfrozen water year-round. See further discussion in Item 12 above.
7.3.1, Item 5	Snow distribution and consequences on ground thermal regime	The potential consequences of snow drifting and snow plowing are discussed in several places in the geotechnical report, however, a few points are worth emphasizing here. Snow drifting and snow plowing along the road both tend to result in a scoured road surface and greater snow depths along the sideslopes and toes of the embankment. This means that the ground at the middle of the road tends to become colder than conditions without an embankment, while conditions in the areas with extra snow (lower slopes and along toes of the embankment) tend to result in warmer ground than areas without extra snow. The warmer ground is a direct result of the snow insulating the ground and allowing less heat to escape the ground during winter. If the ground continues to be kept warmer than “normal,” year after year, the permafrost may begin to gradually thaw, and ponded water may form along the toes of the embankment, as is seen along sections of Yellowknife Highway 3 where the ground beneath the road has warm ice-rich permafrost.
7.3.1, Item 7	Avalanche risks and the effect of avalanche management on the environment	Avalanches have the effect of redistributing snow. An avalanche management program might be expected to redistribute the snow more often, because the goal of the program is to create avalanches while the snow load is still relatively small, thus reducing the risk to human safety, property and terrain as a result of the avalanche. Smaller avalanches should therefore have less likelihood of reaching the road, so the above-described risks resulting from snow distribution along the road might be reduced compared to letting avalanches run naturally. As noted above, avalanche hazard maps produced by others were included in our geotechnical report.

Table 2.8: Terms of Reference (ToR) Non-Conformance Items in AR Section 10

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
7.3.1, Item 12	Frost heave or frost susceptible soils in thin permafrost as well as seasonally frozen soils	Frost-susceptible soils are also thaw-sensitive soils, meaning that they can heave while freezing and then settle when thawing. Permafrost in fine-grained soils can have an ice content high enough that it will lose its strength and settle significantly or even flow if it thaws. Seasonally-frozen materials can also be susceptible to frost heave and can be thaw-sensitive if they have a high enough moisture content. Permafrost that is more than 100% saturated and/or has visible ice will lose its strength and settle or flow if it thaws. Fine-grained soils are usually more likely to be ice-rich. Ice-rich soils, even if they stay frozen, can creep and deform under very small loads. If permafrost is thin, potentially a larger source of water may be available from the surrounding soils to contribute to frost heave during the freezing season. A layer of permafrost can also be thin if it is gradually thawing. Thawing can occur on both the upper and lower surfaces, with thaw settlement potentially happening above and below the still-frozen layer. Areas of thermokarst, including beaded streams, for example, in the Fishtrap Creek drainage west of the Silent Hills, or just south of Grainger Gap along the route, often suggest the presence of fine-grained ice-rich soils.
7.3.1, Item 13	thaw or settlement-related impacts on drainage and surface hydrology (see also Section 7.3.5 on water and water quality)	One of the consequences of thaw-settlement was noted in the discussion above about the consequences of snow distribution: ponded water along the toe of the road embankment. It follows that if water becomes trapped along the roadside, drainage and surface hydrology will be affected. The ponding of water can also trigger additional permafrost thaw, in a process called thermal erosion. If water drains or flows in a location where it would not ordinarily flow, it can become a trigger for both physical and thermal erosion, again impacting drainage and surface hydrology.
7.3.1, Item 14	shorelines and channels	Where encountered on traverses of the proposed road locations, the characteristics of stream banks and stream beds have been noted. These characteristics can provide clues as to the likelihood of the stream being affected by thermal and/or physical erosion. For example, beaded streams are indicators of thermokarst, creating deep round pools at intervals along the stream, such as along Fishtrap Creek, and south of Grainger Gap. See also notes above on probable permafrost distribution in the vicinity of water bodies.
7.3.1, Item 15	combined impacts of the all season road and fires	Fires and their possible contributions to permafrost thaw and slope instability have been discussed in several locations in the geotechnical report. Fires tend to trigger thermal erosion when the organic layer is burned hot enough or deep enough to change its insulating properties. As well, the terrain loses its normal shade cover for many years if all the trees are burned. These are changes to the surface properties of the ground. Building a road also changes the surface properties of the ground, and even a small change in those properties can change the permafrost regime. For example, compaction of the thick peat just by placing fill on top of it can reduce its insulating properties, as well as its capacity to hold water that might otherwise run off or pond in inconvenient locations, such as along road embankment toes. On the other hand, the presence of a road does offer the possibility for easier staging of fire-fighting crews and equipment should this become necessary to protect personnel, equipment, facilities, or natural features.

Table 2.8: Terms of Reference (ToR) Non-Conformance Items in AR Section 10

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
7.3.1, Item 16	how warming ground temperatures and deepening active layers will affect the all season road and how mitigation measures will remain effective in various climate warming scenarios	Warming ground temperatures and deepening active layers are most likely to affect the route in areas that are thaw-sensitive. It should be noted that thaw-sensitive areas may not necessarily be the first areas to thaw, because thaw-sensitive soils tend to be ice-rich, and ice-rich soils need more energy to thaw than ice-poor soils. Site-specific mitigation measures are designed to be effective over the long-term for an appropriate climate warming scenario, modelled in accordance with documented temperature changes measured locally and regionally. Such measures are designed to mitigate the rate of impact, by managing the rate of thaw and/or the types of potential effects. Embankments will be designed to slow the rate of thaw, and/or have cross-sections that are more forgiving if thaw settlement does occur. For example, thicker embankments can help bridge soft wet areas, as can building the embankment with denser soils. Using corduroy (logs laid side-by-side) also help bridge soft wet areas, including areas that may be starting to thaw and need to be protected from heavy point loads or linear loads such as tire tracks that tend to damage the turf and trigger thaw. Monitoring is needed to prove the effectiveness of such measures, and additional measures applied if/as required to maintain the integrity of the road. Monitoring can be done with visual observations, survey points where suitable benchmarks are also available, and with ground temperature cables.

2.9 Granular Materials (AR Section 11)

The AR provides no specific item rationale for the items discussed in this section; however, Tetra Tech EBA anticipates that some additional discussion and description would assist MVEIRB in evaluating the potential consequences of events related to talus slope instability on the terrain (ToR 7.3.2, Item 5). This information contributes to the consideration of terrain stability with respect to borrow pit construction and operations, and may also be relevant to road construction and operations.

Table 2.9-2: Terms of Reference (ToR) Non-Conformance Items in AR Section 11

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
7.3.2, Item 5	Talus slope stability	Ice content is important both from the viewpoint of ease of extraction and processing for use and in not creating a site that becomes unstable after the material is extracted. The latter possibility comes to mind because some of the most promising sites also have the possibility of excess ice content that could affect stability when the ice thaws. That is, the site looks like a rock glacier and probably behaves like a glacier, so removing the active layer by extracting borrow might result in additional or unexpectedly large movements that potentially affect downslope resources. Therefore, it is prudent to try to avoid borrow sites or areas of proposed borrow sites that are ice-rich. This is a question that would be further evaluated on a site-specific basis depending on the borrow locations, the volume requirements for borrow materials at specific locations on the route, and when further work is done to optimize hauling of optimal materials for a particular road section.

2.10 Water Quantity and Quality (AR Section 14)

The AR provides no specific item rationale for the items discussed in this section; however, Tetra Tech EBA anticipates that some additional discussion and description would assist MVEIRB in evaluating the potential consequences of events related to borrow extraction potentially resulting in permafrost thaw and/or changes to drainage patterns on the terrain (ToR 7.3.5, Item 10). This information also contributes to the consideration of terrain stability with respect to borrow pit construction and operations, and may also be relevant to road construction and operations. The AR also requests further information on changes to surface water drainage patterns and hydrology resulting from road-related impacts (ToR 7.3.5, Item 1), and potential changes to water quality resulting from thaw slope or other slope failures (ToR 7.3.5, Item 8).

Table 2.10-3: Terms of Reference (ToR) Non-Conformance Items in AR Section 14

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
7.3.5, Item 10	Issues related to borrow extraction including melting of ground ice and potential changes to drainage patterns, etc.	Proposed borrow sites potentially a concern with respect to possible ice-rich permafrost based on the 2014 field work have been noted accordingly. Section 8 of the geotechnical report applies to mitigations, with the primary mitigation being the avoidance of ice-rich borrow sites. Further evaluation would be done on a site-specific basis.
7.3.5, Item 1	Changes to surface drainage patterns and surface water hydrology including changes caused by road-related impacts on terrain, soils and permafrost	The main goal of related mitigations is to reduce the likelihood of such changes to surface water drainage/hydrology (Section 8 of geotechnical report). The intent of detailed design would include mitigations to reduce the likelihood of the road becoming an obstacle to drainage, even where direction of flow is not obvious. Culverts would be used to encourage cross-drainage in some areas, while permeable fill at the base of the embankment may be more appropriate in other areas. Consideration of how the road embankment may affect the shape of a permafrost surface may be important in some areas.
7.3.5, Item 8	Changes to water quality due to thaw slumps and other slope instability at water crossing	Primary related mitigations are to reduce likelihood of slumps or instabilities occurring that could be caused or influenced by the road near stream crossings, and by the crossing itself. Appropriate design of approaches and crossings are primary mitigative measures. An SECP is a secondary measure to mitigate changes that might still occur despite the design approach.

2.11 Effects of the Environment on the Project – Fires (AR Section 22.1)

The AR noted the following: *An assessment of how climate change may affect the incidence of forest fires was not discussed in the DAR. The assessment of fires stated that fires are common but do not pose a high risk to the road. Fires would affect the road operation and may affect the maintenance of the road. For example, forest fires may result in road closures and reduce the operating season, thawing of permafrost that may result in subsidence or thaw slumps, or increased risks of landslides.* The following table summarizes the anticipated effects of climate change on permafrost, including considerations for possible changes in fire activity.

Table 2.11-4: Terms of Reference (ToR) Non-Conformance Items in AR Section 22.1

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
8, Item 1	long-term climate change scenarios (e.g., loss of permafrost, increased evaporation and evapotranspiration, greenhouse gas emissions)	Long-term climate change scenarios are discussed in the geotechnical report with respect to permafrost temperatures and gradual thawing of permafrost (Section 6). Gradual reduction of permafrost and possible eventual loss of permafrost may occur. Depending on location along the route, it appears that some areas may be likely to become drier after the permafrost thaws, for example, elevated mounds that are already drier may become even drier, while other areas may become wetter, such as low-lying areas that will settle when the permafrost thaws. Some areas may therefore become more susceptible to fires and some less susceptible to fires.
8, Item 6	Fires	The effects of fires on permafrost are discussed in numerous places in the geotechnical report: in specific road sections and in Section 5.4 Permafrost. Additional observations are recorded in Appendix C of the geotechnical report. Similar observations seem likely in areas that are still prone to fires, or become more prone to fires, with climate changes. Section 2.7 above provides further discussion about fires in relation to the all-season road.

2.12 Effects of the Environment on the Project – Thaw Settlement (AR Section 22.2)

The AR noted the following: *Appendix 2 [Tetra Tech EBA's geotechnical report] adequately outlined that climate change may result in permafrost thaw and associated subsidence. The mitigations described relied on the construction approach. There was no discussion of what mitigations would be taken if the effects of permafrost thaw or subsidence were observed throughout the operation of the project.*

The following table summarizes the anticipated measures that might be required to mitigate the effects of thaw settlement, as well as summarizing currently available data that can be used to delineate areas at high risk of thaw settlement.

Table 2.12-5: Terms of Reference (ToR) Non-Conformance Items in AR Section 22.2

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
8, Item 7	An assessment of the likelihood and severity of each risk identified including: a map of high risk zones; site-specific contingencies for high risk areas	***Provide a map indicating high risk zones for effects from permafrost thaw and subsidence [thaw settlement]:*** Currently, terrain stability mapping is taking place in the areas indicated as "high-risk" in the geotechnical report. In conjunction with that work, mapping of active permafrost terrain is being undertaken so, upon completion of the mapping, it may be possible to identify areas considered to be at higher risk from thaw settlement. Site-specific contingencies for areas at high risk of permafrost thaw and subsidence may include fill-only embankments and "corduroy" log support.

Table 2.12-5: Terms of Reference (ToR) Non-Conformance Items in AR Section 22.2

ToR Section	Description of Item Not in Conformance	Additional Discussion / Description
8, Item 5	Subsidence	***Describe specific mitigations and contingencies that would take place if permafrost thaw and subsidence [thaw settlement] are observed during operation of the road:*** Ideally, the road sections anticipated to be prone to thaw settlement would be adequately designed for a 20-year service life. However, should some of the road sections appear to be under-performing in areas suspected to be experiencing thaw settlement, cost-effective solutions to correct the problem can be considered. Mitigations could include repair and replacements of culverts (a fairly common problem), and over-excavation of thawed and unsupportive subgrade and replacement with competent fill and/or additional “corduroy” log layers to help distribute design loads over a soft subgrade. In particularly problematic locations, other solutions could be considered, such as implementing various methods of keeping the embankment cool and thereby protecting the permafrost, for example, some of the solutions that worked the best from research sponsored by the Government of Yukon along the Alaska Highway at Beaver Creek, YT. Multiple solutions may be considered for complex issues, or to mitigate more than one issue in a problem area.
8, Item 2	How likely changes in permafrost will affect the amount the granular material required for care and maintenance of the all season road	***If the mitigations require additional fill placement, estimate how much additional granular material may be needed:*** Some mitigations may indeed require additional fill. To estimate actual remedial fill requirements before detailed design is probably premature, since that estimate could be out by a factor of 10, or even 100. It is noted that Allnorth have identified a great deal of reserve granular material in numerous sources already that could be used if needed, so acquiring sufficient volume should not be an issue.

3.0 SLOPE GRADIENT MAPS

As requested in the AR, Tetra Tech EBA has produced a series of maps for the route to show the range in slope gradients along the route. The slope gradient mapping data was extracted from the LiDAR DEMs for the project area, as well as from the geobase DEMs for some of the surrounding terrain where it was desirable to extend the boundaries of the area to be evaluated or where the proposed alignment has changed since the acquisition of the LiDAR data. Slope gradient ranges were adapted from the ranges used in Howes and Kenk (1997), but with a bit more detail, as shown in the legend of the maps.

This information can be combined with the slope aspect information and the surficial geology and geomorphology mapping information to provide additional insight into the conditions that may be encountered along the route and the potential for terrain instabilities to occur, including instabilities related to rock slides or rock falls. The maps are provided in Appendix A. The slope gradient ranges on the maps are colour-coded, with the flattest terrain being dark green, and progressively steeper terrain ranging from light green to yellow to orange to red. Terrain features are readily seen, for example, on Figure A09, where the proposed road route can be seen avoiding the steepest terrain.

4.0 SLOPE ASPECT MAPS

As requested in the AR, Tetra Tech EBA has produced a series of maps for the route to show the range in slope aspects along the route. The slope aspect mapping data was extracted from the LiDAR DEMs for the project area, as well as from the geobase DEMs for some of the surrounding terrain where it was desirable to extend the boundaries of the area to be evaluated. The range in aspects was chosen in 45° degree increments, with directions noted as north, northeast, east, southeast, south, southwest, west and northwest. Colour choices to show aspects are intended to be intuitive, with the colder aspects being indicated by “colder” colours, consisting of a range of blues and green, and the warmer aspects being indicated with “warmer” colours, comprising a range of pink, red, orange and yellow.

This information can be combined with the slope gradient information and the surficial geology and geomorphology mapping information to provide additional insight into the conditions that may be encountered along the route and the potential for terrain instabilities to occur, particularly as related to the potential for permafrost along the route. The slope aspect maps are provided in Appendix B. It is noted that due to the very high resolution of the LiDAR data, some noise is introduced, creating a scatter of colour in some of the flatter valley bottoms. However, this high resolution also results in some very clear outlines of such finely-detailed features as the sides of channel braids, debris flow gullies on the fans, and some very narrow slope movements that are not very noticeable with contours or imagery alone. For example, on Figure B09, between about KP057 and KP059, the terraces and ridges north of the route are readily seen in the finer details of the slope aspect model, while the steeper slopes southwest of the route clearly show some larger slope instabilities between the route and the Poljes.

5.0 SURFICIAL GEOLOGY AND GEOMORPHOLOGY MAPS

As requested in the AR, Tetra Tech EBA has produced a series of maps for the route to present the surficial geology and geomorphology along the route. At present, existing information is available from about KP064, just east of the Polje reroute, to the end of the proposed all-season road at its junction with the Nahanni Butte access road. The existing surficial geology and geomorphology maps from Hawes (1980) and Rutter and Boydell (1981) have been superimposed on the CanVec topographic data to produce the maps. It is noted that because the existing maps are at a scale of 1:125,000, and have been superimposed on the CanVec topographic information at a scale of 1:50,000, and finally enlarged to a scale of 1:20,000 for consistency with the terrain stability mapping, there are some unavoidable discrepancies in scaling where some of the features do not precisely line up between the two map sources. Nevertheless, the correspondence is close enough that specific features on each are readily identifiable as being the same (e.g. creeks or lakes).

The surficial geology and geomorphology maps can be combined with the slope aspect information and the slope gradient information to provide additional insight into the conditions that may be encountered along the route and the potential for terrain instabilities to occur. The maps are provided in Appendix C. Figure C01 shows how the mapped escarpments relate to the karst canyons, and small meltwater channels to present-day chains of small lakes, ponds and streams.

6.0 TERRAIN STABILITY MAPS

6.1 General Mapping Description and Tasks

As requested the AR, Tetra Tech EBA has reviewed the availability of additional air photos for the route to assess the possibility of historical review in addition to the 1994 through 2014 data that had been used before. Most of the coverage is very high level coverage with scales of 1:40,000 to 1:60,000 being typical. Coverage down to 1:20,000 is available in some areas of the route and, rarely, coverage at 1:7,000 to 1:15,000 scale is available in very limited areas. Air photos to be used in the current mapping program are listed in the references at the end of this letter, and air photos used to date are shown in the flight indices presented in Appendix D. Tetra Tech EBA is using a technology-intensive mapping method in order to efficiently use the higher level coverage and to create scalable models of the air photo data for analysis.

Terrain stability mapping (TSM) is a synthesis of the slope gradient, slope aspect, and surficial geology and geomorphology mapping information, along with air photo analysis to provide additional insight into the terrain types and conditions that may be encountered along the route and the potential for terrain instabilities to occur.

Currently, TSM is being carried out for the areas identified as “high-risk” in the previous work (Tetra Tech EBA, March 2015). These priority mapping areas are located along the Polje reroute and the Silent Hills and include several different types of slope instabilities. So far, the more recent air photos, dated 1994 and 1982, for the two areas, respectively, have been incorporated in the mapping. Ongoing work will incorporate older photos from 1949 and 1963 for these areas, respectively, according to the coverage available for the areas. The resulting terrain stability maps for the work completed to date are provided in Appendix D. As the mapping progresses, additional review will be carried out to verify consistency and accuracy in the mapping.

6.2 Methods

Air photos were acquired from the National Air Photo Library (NAPL) of Canada in Ottawa, focussing on those photos that cover the areas indicated as “high-risk” sections of the proposed all-season route in the geotechnical report (Tetra Tech EBA 2015). The flight indices for the photos analyzed to date, which show photo roll number, photo number, year, scale, and relationship to each other and the proposed route, are provided in Appendix D.

Upon receipt of the high-resolution digital photo images from NAPL, the photos were sent to a contractor for georeferencing and aerial triangulation. Available hard copy air photos were also scanned at 15 micron resolution and similarly georeferenced and triangulated. The photo images and georeferencing files (models) were loaded into PurVIEW, an add-on software to ArcGIS that allows the mapper to not only view the photos in 3D on a computer screen, but also allows him/her to zoom in and out to delineate otherwise difficult-to-identify features with greater accuracy than would be possible with a standard stereoscope and hard copy air photos.

Mapping was carried out by Shirley McCuaig, Ph.D., P.Geo., in accordance with the guidelines set out by Howes and Kenk (1997), RIC (1996) and Ministry of Forests (1999). TSM was completed at 1:20,000 scale, with helicopter reconnaissance and some ground checking, resulting in a Terrain Survey Intensity Level (TSIL) of D (Ministry of Forests 1999). TSIL D is considered to be reconnaissance mapping. As such, stable areas are not required to be mapped. However, the surficial geology of these areas has been mapped as per the requirements outlined in the AR. If there is no P or U indicating Potentially Unstable or Unstable within a polygon, then the polygon can be assumed to be stable. A numerical range of the dominant slope gradients is listed for all polygons labelled P or U. The slope gradient and aspect maps presented in Appendices A and B were used to guide the TSM in the mapping areas.

The AR requested that photos from different years be examined to determine activity levels of certain geohazards and also requested that channel meanders and avulsions be mapped. These are not a requirement for standard TSM according to the guidelines noted above. Due to time constraints, this work is not yet complete for the mapping areas completed so far and will be included in additional reporting at a later date. Photos from 1994 were analyzed for most of the mapping, in the Polje reroute area, while photos flown in 1982 were interpreted for the easternmost section of mapping. Slides were mapped outside of the map area in some instances where it was warranted. These areas will also be terrain mapped and the associated reporting will follow.

Field checking was done by Shirley McCuaig on July 7 and 8, 2015 in accordance with the requirement for the mapper to complete fieldwork (Ministry of Forests 1999). Additional information was also incorporated to help confirm the mapping, including fieldwork completed by and field photos taken by Rita Kors-Olthof, P.Eng., P.E., and by Allnorth Consultants Ltd. (Allnorth) in 2014. These studies are considered Terrain Stability Field Assessments (TSFAs) and can be considered part of the field-checking requirement. This information, along with available testpit and borehole information, was added to ArcGIS for reference while mapping. The resulting number of field checks was nine, giving a final amount of 12% of the 73 polygons mapped having been checked (TSIL D). Of the polygons checked, eight included ground sites and one was an air call. In some instances, there are several checks in one polygon, for example, where a field traverse on foot was done; these count as one check per polygon since only one polygon was confirmed.

6.3 Mapping Results

The results of the mapping are given in Appendix D. The findings in the three high-risk areas are described in the following sections.

6.3.1 KP048.8 to KP051 (West End of Polje Reroute)

The valley in this area is about 1 km wide, but tributary valleys are present on its western side (Figure 1 in Appendix D). The Polje Creek tributary meanders across its entire floodplain, locally eroding the valley slope sediments on its outer bends. Several small debris slides, including one active one below TFSA Site 29, have formed by this process near KP50. Relocating the proposed alignment to higher ground in this location is warranted, but it still may be affected by the larger slide movements described below. There is no alternative superior location, however, so it is suggested that the road remain in this approximate location, but higher up on the glaciofluvial terraces.

Colluvium forms stepped topography in this area that is clearly visible on the air photos. The stepped features are better developed on the eastern slopes and a couple of small slides have developed within the larger failures there. On the western slopes, the slide blocks appear more like small individual knolls. The slide blocks appear to be developed in glaciofluvial terrace material, but this is not a common manner in which loose sandy or gravelly material generally fails. It is more likely that the failures occurred in bedrock and that the overlying glaciofluvial material was carried along with many slide blocks as they moved. As a result, the field test pits and boreholes show mainly sand in the upper 2 m of these failures.

The movement of the slide blocks is suspected to be slow, with the bedrock failing under its own weight after support was removed by glacial and modern river erosion within the valley. Lack of major disruption of the glaciofluvial material on the surface of the slide blocks appears to support this interpretation, but analysis of the older air photos may confirm or disprove this contention. Movement appears to be mostly translational. Similar failures with larger and more discontinuous slide blocks are evident in the tributary valleys to the west. Some of these slides may be rotational, as a number of slide blocks form arcuate ridges. All are generally failing toward the centre of the tributary valleys and thus do not affect the main valley at present. However, some of the failures on the higher, southeastern-facing slopes have formed steep head scarps from which debris slides appear to have formed in the past. A few of these have long runout zones. Debris slides entering the creeks could potentially lead to debris flows in these two tributary valleys. One of the steep scarps northwest of KP50.4 has slide material forming a hummocky terrace 20 m above the tributary valley floor. Reactivation of this slide would likely be rapid as there is no supporting slide block material below it. The slide would affect only the upper part of the tributary valley but could lead to debris flows in the tributary creek. Although there is no obvious evidence of former debris flows in this small valley, the creek in this location has built out an alluvial fan that is more than three times larger than its counterpart draining the tributary valley to the south, but this could be due simply to the larger size of its valley.

Gullies are developed locally in areas of water flow concentration. Only one of these affects the road. It is located at KP49.9 and will be avoided if the alignment is moved to higher ground.

Fieldwork evidence shows that seepage is common on the slopes covered with colluvium (material formed by mass movement), at least on the western side of the valley. No evidence of permafrost was found. The boreholes and test pits on the slopes in this area reach a maximum of 1.2 m, so permafrost potentially could be present at greater depths. The seepage could also be caused by drainage disruptions caused by the failures.

If permafrost is present, climate change could have the potential to reactivate or accelerate the movement of the large slides. It is recommended that determination of the presence or absence of permafrost be undertaken in this area during detailed design. No permafrost features were identified either on the air photos or in the field, unless the seepage on the slopes is caused by the presence of a permafrost table.

6.3.2 KP053.7 to KP059.9 (East End of Polje Reroute)

From KP053.7 to KP054.6, permafrost processes are evident (Figure 2 in Appendix D). A thaw slump/flow that is evident in the field and on the LiDAR bare earth image was not present on the 1994 photos. Such slides generally retrogress (expand upslope) as freshly-exposed permafrost melts. However, the adjacent mapped polygon does not appear to have permafrost near the surface as tree growth is quite consistent there. If that is the case, then the slide could grow no more than about 50 m upslope and would not affect the proposed route alignment.

At KP054.8 to KP054.9, older rockfalls or possibly debris slides are present above the proposed alignment. Slide management measures may be required in this location. A large alluvial fan is present to the east. A possible karst depression with a pond near KP056 may actually be a thermokarst depression as the edges are folding over and it looks quite shallow (Allnorth Photos SAM_6375 and 6376). Lineations seen on the fan near the depression could either be indications of karst subsidence or thermokarst; however, the LiDAR at its present resolution (1 m pixels) does not allow the determination of the amount of possible subsidence, or to confirm whether or not there is in fact subsidence. In its lower reaches, the alluvial fan is affected by karst processes in the bedrock beneath it. Visible features are about 230 m southwest of KP55.3 and 275 m south of KP55.7.

The route crosses slide material of low slope angles between KP055.9 and KP056.3 and between KP056.9 and KP057.3. The former is a large hummocky deposit formed by slides, possibly in bedrock. The latter are minor movements of surficial material down the slope that can likely be managed with mitigation. Between these two locations (KP056.3 to KP056.9) is some angular hummocky topography that also comprises older slide material. The road crosses through the centre of this material. However, the chosen alignment appears to be the best location locally. An alignment that crosses the alluvial fan is not preferred because the fan is more likely to have ongoing debris flow/flood issues, whereas the hummocky slide material probably reached equilibrium at some point in the past. Analysis of older air photos should confirm/disprove this assumption.

The area from KP057.3 to KP059.9 has some terrain issues. Glaciofluvial terraces in the east may be thinner than expected, as bedrock appears to be near the surface in some areas. The two poljes have affected the surficial sediments south of the proposed alignment (indicated with –K in the polygon labels). The loss of underlying bedrock has caused failures in the bedrock and surficial sediments above. These are below the alignment but become close to it in the KP058 to KP059 area (10 m away from KP058 and 20 m away from KP058.7 at the closest points). Moving the route further north in these locations is prudent as more karst activity could lead to enlargement of these slides. One large and two small possible sinkholes or kettles were identified in the glaciofluvial terrace deposits on which the route is located. The gradually-sloping sides are more indicative of kettles than sinkholes; however, these features could be related to karst activity if bedrock is close to surface in these locations. Golder also mapped the larger feature just northwest of KP59 as a sinkhole (Figure 2 in Appendix D). If bedrock is not shallow, these features may be safely assumed to be kettles and not a problem for the all-season road. Otherwise, avoidance is a good strategy for aligning the route.

6.3.3 KP115 to KP116.5 (East Side of Silent Hills)

This area could potentially be affected by debris flows originating in a gully uphill (Figure 3 in Appendix D). A fresh rock face on the west slope of the gully in the 1982 photos shows that rockfall activity was fairly fresh at that time. Rockfall material and surficial debris entering the gully could potentially produce a debris flow where the road crosses the creek that drains the gully. However, there is no obvious debris flow evidence in this area, so the ongoing rockfall activity may be minimal or produces large enough material that it does not get carried very far downstream.

7.0 ALTERNATIVE ALIGNMENT (KP103.4 TO KP124)

Confirmatory terrain mapping is ongoing for a proposed alternative alignment on a portion of the proposed all-season road route between KP103.4 and KP124. A description of the route and routing decisions made to date is provided.

7.1 General

Several alternative routes were proposed for this area. Allnorth and Tetra Tech EBA accompanied CZN on helicopter-supported fieldwork for this area on July 8, 2015. After the fieldwork, a preferred route was chosen from the alternatives. This route will be described as “selected alternative alignment” and the others will be referred to as “alternative alignment options”. Tetra Tech EBA understands that CZN wished to investigate an alternative route in this area, in the event that it could offer some advantages over the current proposed route, including a shorter road length and the avoidance of two fish-bearing stream crossings of Grainger River (KP122.1 and KP123.1).

7.2 Geology

The geology of the area is summarized from Douglas and Norris (1977). Bedrock in this road section is part of the Yohin Syncline. The first 500 m of the route crosses Upper Devonian black shale, mudstone and limestone that may be partly Mississippian in age. The area from KP103.8 to KP104.5 and the area from KP105.3 to KP105.7 overlie Upper Devonian mudstone and calcareous siltstone.

Most of the remainder of the alternative alignment areas, including the selected alternative alignment, are underlain by the Fort Simpson Formation, which comprises shale and thinly bedded siltstone that is also Upper Devonian in age.

The older Nahanni Formation is found in three locations: an area immediately east of a pond in the centre of the valley between the two KP116 locations (current and selected alternative alignments), an area east of KP116 on the alternative alignment that crosses a small ridge that forms part of the Nahanni Range, and from KP120.3 to KP120.7 on the selected alternative alignment. These areas coincide with linear bedrock ridges that form small anticlines. The Nahanni Formation consists of limestone and dolomite and is Middle Devonian in age.

The last 200 m of the selected alternative alignment and a 200 m section of the adjacent alternative alignment option cross a north/south trending limestone unit of the Landry Formation. The terminal 400 m of the alternative alignment option that ends at about KP124.3 is underlain by banded and partly brecciated dolomite of the Arnica Formation. Both of these formations are Middle Devonian in age.

Depths to bedrock are unknown, but can be assumed to be less than 1 m in areas mapped as veneers on the surficial geology maps.

7.2.1.1 Surficial Materials and Soils

Surficial deposits in the area are summarized from Rutter and Boydell (1981) and Rutter (1993).

Briefly, bedrock and colluvial deposits flank the valley in which the alternative alignments lie. The north central portion is a wet area, with numerous wetlands and some fluvial deposits overlying till. Glaciofluvial sand and gravel are found in the south, some of which is contained within large meltwater channels. Coalescing alluvial fans and colluvium have formed on the west slope of the Nahanni Range, which is a bedrock upland. Till veneer is present locally and fluvial gravels flank the Grainger River within Grainger Gap. The deposits are described in detail in Table E1, presented in Appendix E, along with Figure E1 which shows the field site locations visited by air or ground to evaluate the route. Photos of the various sites are presented in the table.

8.0 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 F of this report.

9.0 CLOSURE

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

Respectfully submitted,
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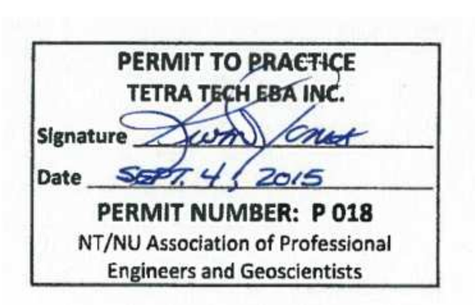

PERMIT TO PRACTICE
TETRA TECH EBA INC.
Signature ______
Date SEPT. 4, 2015
PERMIT NUMBER: P 018
NT/NU Association of Professional Engineers and Geoscientists

REFERENCES

Aerial photographs:

________________________________, 1994. Roll A28094 – Line 7, Photos 270-274; Line 8, Photos 217-224; Line 9, Photos 196-197. Approximate scale 1:20,000. Black and white. Date: 1994-06-16.

________________________________, 1982. Roll A26165 – Photos 22-25. Approximate scale 1:20,000. Black and white. Date: 1982-08-26.

________________________________, 1963. Roll A18041 – Photos 19-21. Approximate scale 1:60,000. Black and white. Date: 1963-06-15.

________________________________, 1949. Roll A12034 – Photos 353-356. Approximate scale 1:40,000. Black and white. Date: 1949-06-29.

________________________________, 1949. Roll A12106 – Photos 353-3529-316. Approximate scale 1:40,000. Black and white. Date: 1949-07-11.

Bing, 2014. Microsoft Bing Maps Imagery Service for ArcGIS. 2014.

British Columbia Ministry of Forests, Lands and Natural Resource Operations (BCMF), 2014a. Reports and Publications. http://www.for.gov.bc.ca/pscripts/pab/whatsnew/index.asp. Various dates of publication. Access date: January 23, 2015.

BCMF, 2014b. Forest Practices Code Guidebooks. http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm. Various dates of publication. Access date: January 23, 2015.

BCMF, 2013. Engineering Manual. Prepared by British Columbia Forest Service, Engineering Branch. http://www.for.gov.bc.ca/hth/engineering/documents/publications_guidebooks/manuals_standards/eng-manual.pdf. Revision date: November 15, 2013. Access date: January 23, 2015.

BCMF, 2003. Karst Management Handbook for British Columbia. British Columbia Ministry of Forests. ISBN 0-7726-4922-7. http://www.for.gov.bc.ca/hfp/publications/00189/Karst-Mgmt-Handbook-web.pdf. May 2003. Access date: January 23, 2015.

Canadian Standards Association (CSA), 2010. Technical Guide – Infrastructure in Permafrost. A Guideline for Climate Change Adaptation. CSA Reference Number: Plus 4011-10.

D. Mollard and Associates Ltd., 1995. Remotely Sensed Terrain Analysis and Assessed Impact of the Existing Roadway along and near the 185-km-Long Prairie Creek Existing Winter Haul Route from 1:20,000 Scale Stereoscopic Airphotos. Prepared for Bruce Geotechnical Consulting Inc. and J.D. Mollard and Associates Ltd. September 1995.

Douglas, R.J.W. and Norris, D.K., 1977a. Geology, Sibbeston Lake, District of Mackenzie. Geological Survey of Canada, "A" Series Map 1377A, scale 1:250,000. GSC Library date 1977, compiled 1960, 1974.

Douglas, R.J.W. and Norris, D.K., 1977b. Geology, Virginia Falls, District of Mackenzie. Geological Survey of Canada, "A" Series Map 1378A, scale 1:250,000. GSC Library date 1977, compiled 1960, 1974.

Duk-Rodkin, A., Huntley, D., and Smith, R., 2007. Quaternary geology and glacial limits of the Nahanni National Park Reserve and adjacent areas, Northwest Territories, Canada, *in* Mineral and Energy Resource

Assessment of the Greater Nahanni Ecosystem Under Consideration for the Expansion of the Nahanni National Park Reserve, Northwest Territories, (ed.) D.F. Wright, D. Lemkow, and J.R. Harris. Geological Survey of Canada, Open File 5344, p. 125-129.

EBA, 2011a. Slope Stabilization at Liard Highway No. 7, km 5.9, NT. Prepared for the Government of the Northwest Territories, Department of Transportation. (EBA File: Y14101311.)

Ford, D., 2009. Mapping Known and Potential Karst Areas in the Northwest Territories, Canada. Prepared for Government of the Northwest Territories, Environment and Natural Resources. August 2009. Accompanying Maps of Karst Features in the NWT. http://www.nwtpas.ca/science-karst.asp. Access date: December 4, 2014.

Ford, D.C, 2006. Karst Landform. Prepared for *The Canadian Encyclopedia*, Historica Foundation. http://www.thecanadianencyclopedia.ca/en/article/karst-landform/. Last revised March 6, 2015. Access date: March 10, 2015.

Golder Associates Ltd. (Golder), 2010a. Terrain Assessment Report, Prairie Creek Mine, Northwest Territories. Prepared for Canadian Zinc Corporation. March 2010. Golder File: 0913761009.

Google, 2014. Google Earth imagery. August 16, 2007 and April 9, 2013.

Hawes, R.J. et al, 1980. Surficial Geology and Geomorphology, Fort Liard, District of Mackenzie. Geological Survey of Canada, Preliminary Map 11-1979, scale 1:125,000. GSC Library date 1980, compiled date 1975.

Heginbottom, J.A., Dubreuil, M.A., and Harker, P.A., 1995. Canada - Permafrost. National Atlas of Canada, 5th Edition, National Atlas Information Service, Natural Resources Canada, Ottawa, Plate 2.1, MCR 4177.

Indian and Northern Affairs Canada (INAC), 2010a. Northern Land Use Guidelines, Roads and Trails. Prepared by INAC (now Aboriginal Affairs and Northern Development Canada). ISBN: 978-1-100-14743-7. https://www.aadnc-aandc.gc.ca/eng/1100100023568/1100100023583. Access date: January 23, 2015.

INAC, 2009. Northern Land Use Guidelines, Pit and Quarries. Prepared by INAC. ISBN: 978-1-100-14254-8. https://www.aadnc-aandc.gc.ca/eng/1100100023585/1100100023587. Access date: January 23, 2015.

J.D. Mollard and Associates Ltd. (JDMA), 1984. Office Airphoto Search for Foundation and Surfacing Materials for Nahanni Butte Airstrip, Vicinity Nahanni Butte Settlement, N.W.T. Prepared for Government of the Northwest Territories, Public Works – Highways Division. March, 1984.

Kors-Olthof, R.I., Hoeve, T.E., and Patrick, R.A., 2014. Evaluation and Stabilization of a Slope Failure at Liard Highway No. 7, km 5.9 (Case Study). Paper prepared for and presented at GeoRegina, 2014; also presented at the 2014 Yellowknife Geoscience Forum. September 2014.

McElhanney, 2012. Orthoimagery and LiDAR for Prairie Creek Winter Road. 2012.

Rutter, N.W., Boydell, A.N., 1981. Surficial Geology and Geomorphology, Sibbeston Lake, District of Mackenzie. Geological Survey of Canada (GSC), Preliminary Map 10-1979, scale 1:125,000. GSC Library date 1981, compiled date 1975.

Rutter, N.W., Hawes, R.J., Catto, N.R., 1993. Surficial Geology, Southern Mackenzie River Valley, District of Mackenzie, Northwest Territories, “A” Series Map 1693A. Geological Survey of Canada. 1993.

SNC Lavalin Inc. (SLI), 2012a. Prairie Creek Access Road – Geotechnical Investigation. Prepared for Canadian Zinc Corporation. November 2012. SLI File No. 610984-8000-4GER-0002.

SLI, 2012b. Preliminary Geotechnical Site Reconnaissance, Prairie Creek Mine Winter Road, Bridge Crossings and Transfer Station Location – July 2012. Prepared for Canadian Zinc Corporation. August 2012. SLI File No. 334518-8000-4GCB-0001.

Transportation Association of Canada (TAC), 2010. Development and Management of Transportation Infrastructure in Permafrost Regions.

TAC, 2005. National Guide to Erosion and Sediment Control on Roadways Projects.

Tetra Tech EBA, 2015. Geotechnical Evaluation and Developer's Assessment Report Sections for Proposed Prairie Creek All-Season Road, Near Nahanni Butte, Northwest Territories. Prepared for Canadian Zinc Corporation. March 2015. Tetra Tech EBA File: Y14103320.01-001.

Tetra Tech EBA, 2014. Stream Crossing Design Water Levels for Prairie Creek Mine Access Road, Northwest Territories. Prepared for Canadian Zinc Corporation. December 2014. Tetra Tech EBA File: ENVMIN03009-01.

TABLES

	A	B	C	D	E
1	**Table 1**				
2	**Concordance Table**				
3	**Terms of Reference**			**Location**	
4	**Sub-Sec.**	**Item**	**Description**	**DAR Section**	**Additional Reference**
5	5.1.1 Terrain, Geology, Soils, and Permafrost	1	topography and geology, including key terrain features such as rivers, lakes, karst features and wetlands and other important processes and features		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63). Tetra Tech EBA August 2015 Addendum (p.2-3).
6		2	bedrock type and depth		item withdrawn
7		3	unconsolidated surficial materials and terrain types, including thickness of landforms		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63); Tetra Tech EBA August 2015 Addendum (p.4).
8		4	soil types, including group, series and type, as applicable		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5 and Appendix B, organized by road section (p.17-63). Tetra Tech EBA August 2015 Addendum (p.4-5).
9		10	probable existence and extent of ice rich permafrost areas that may be excavated		DAR Appendix 2, Tetra Tech EBA March 2015 report, Sections 6 (p.63-65) and 8.2 (p. 79-81). Tetra Tech EBA August 2015 Addendum (p.3).
10		12	probable permafrost distribution (thickness and lateral extent) on land, water, shoreline and slope crossings		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63); general discussion in Section 5.4 on p. 62-63. Tetra Tech EBA August 2015 Addendum (p.7).
11		13	permafrost distribution and stability beneath waterbodies		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63); general discussion in Section 5.4 on p. 62-63. Tetra Tech EBA August 2015 addendum (p.7).
12		14	permafrost processes, features and landforms and their stability, including slopes, shorelines and stream banks		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63); general discussion in Section 5.4 on p. 62-63. Tetra Tech EBA August 2015 Addendum (p.5-6).
13		15	probable ground ice conditions, temperature and ground thermal regime		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63); general discussion in Section 5.4 on p. 62-63. Tetra Tech EBA August 2015 Addendum (p.5-6).

	A	B	C	D	E
3	Terms of Reference			Location	
4	**Sub-Sec.**	**Item**	**Description**	**DAR Section**	**Additional Reference**
14		16	probable active layer thickness, seasonal frost, penetration, thaw sensitivity and frost susceptibility		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63); general discussion in Section 5.4 on p. 62-63. Tetra Tech EBA August 2015 Addendum (p.5, 8).
15		17	how fires may affect ground temperature regimes and permafrost		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); general discussion in Section 5.4 on p. 63. Site-specific observations in Appendix C. Tetra Tech EBA August 2015 Addendum (p.8, 10-11).
16		18	thaw slumps in the project area		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section (p.17-63). Tetra Tech EBA August 2015 Addendum (p.10).
17		19	how regional climate variation and documented warming of ground temperatures in the region may affect ground conditions.		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 6 (p.63-65).
18	5.1.2 Climate	1	the location of recording stations, length of record for any meteorological data presented, and the quality of the data		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5.3 (p.61-62).
19		2	prevailing climatic conditions, seasonal variations, predominant winds including direction and velocity, temperature and precipitation (snowfall, snow depth, rain, fog, wind)		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5.3 (p.61-62).
20		3	spatial and temporal boundaries for the description of climate		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5.3 (p.61-62).
21		5	define the variability and trends within the "current" climate normal period and within the historical period of instrumental record		DAR Appendix 2, Tetra Tech EBA March 2015 report, Sections 5.3 and 6.0 (p.61-65). CSA Plus 4011-10.
22		6	discuss the contribution of traditional knowledge to the understanding of climate conditions and variability		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5.3 (p.62).

	A	B	C	D	E
3	Terms of Reference			Location	
4	**Sub-Sec.**	**Item**	**Description**	**DAR Section**	**Additional Reference**
23	5.1.3 Water Quality and Quantity	7iv	channel and bed morphology and stability		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63), and Appendix C of report. Tetra Tech EBA August 2015 Addendum (p.6).
24		7v	bank stability and areas of erosion		Tetra Tech EBA August 2015 Addendum (p.6).
25	6.1 Project Components and Activities	4	road construction methods		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8.1.3 Mitigative Measures (p.79-81). Tetra Tech EBA August 2015 Addendum (p.11-12).
26	6.2 Road Design Consideration s	10	geotechnical stability		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8.1.3 Mitigative Measures (p.79-81). Tetra Tech EBA August 2015 Addendum (p.11-12).
27	6.3 Construction Phases and Schedule	1			DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8.1.3 Mitigative Measures (p.79-81).
28	7.2.2 Effects of Potential Accidents and Malfunctions	7i	how flooding may contribute to potential accidents, malfunctions, and spills		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.1 Environmental Causes (p.65-68).
29		7ii	how overland flow may contribute to potential accidents, malfunctions, and spills		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.1 Environmental Causes (p.65-68).
30		7iii	how landslides may contribute to potential accidents, malfunctions, and spills		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.1 Environmental Causes (p.65-68).
31		7iv	how seismic activity may contribute to potential accidents, malfunctions, and spills		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.1 Environmental Causes (p.65-68).
32		7v	how avalanche activity may contribute to potential accidents, malfunctions, and spills		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.1 Environmental Causes (p.65-68).
33		8	A risk assessment using best practices for the Project including components, systems, hazards, and failure modes		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.2 Qualitative Risk Assessments (p.68-74). Aspects/risks related to terrain, soils, permafrost and karst topography.

	A	B	C	D	E
3	Terms of Reference			Location	
4	**Sub-Sec.**	**Item**	**Description**	**DAR Section**	**Additional Reference**
34		9i	A map of high risk zones		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.2 Qualitative Risk Assessments in tabulated form (p.71-73). Aspects/risks related to terrain, soils, permafrost and karst topography. Tetra Tech EBA August 2015 Addendum (p.13-16).
35		9ii	Site-specific contingencies for high risk areas		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.3 Mitigation and Residual Effects (p.74-76); Section 7.3.3 Residual Effects and Site-Specific Contingencies for High-Risk Zones. Contingencies related to terrain, soils, permafrost and karst topography.
36	7.2.3 Impacts to NNPR	7	changes to the karst formations		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 8.1.3 Mitigative Measures (p. 79-81). Tetra Tech EBA August 2015 Addendum (p.3, 6-7).
37		1	slope and soil stability, erosion and subsidence		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 8 (p. 77-81).
38		2	the effect of changes in road bed weight relative to the winter road, drainage, traffic volume, traffic speed, and borrow site development on karst topography		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 8.1.3 Mitigative Measures (p. 79-81). Tetra Tech EBA August 2015 Addendum (p.3, 6-7).
39		3	the effects on wetlands with particular attention to the wetland areas		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 8 (p. 77-81).
40		4	thaw slumps, compaction of organic peat lands, and potential for melt of ice rich ground		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 8 (p. 77-81).

	A	B	C	D	E
3	Terms of Reference			Location	
4	Sub-Sec.	Item	Description	DAR Section	Additional Reference
41	7.3.1 Terrain, Soils, Permafrost and Karst Topography	5	snow distribution and consequences on ground thermal regime		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.7).
42		6	drainage beside and beneath the road, channelization and non-channelization flow and permafrost degradation		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7 (p.65-76); Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.8).
43		7	avalanche risks and the effect of avalanche management on the environment.		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7 (p. 65-76). Tetra Tech EBA August 2015 Addendum (p.7-8).
44		8	permafrost as a design feature in the road bed, failure modes analysis and associated contingency plans		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8 (p. 77-81). Because the permafrost is so warm, it is not being considered as a long-term design feature, only as a potential factor that may require mitigation in design.
45		10	thermal conditions, active layer thickness, thaw depth, distribution and stability		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section, beginning on p.17; Section 6 (p. 63-65), Section 8 (p. 77-81).
46		11	ice rich soils (thaw settlement, thermokarst) permafrost thaw and related settlement		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.8-10).
47		12	frost heave or frost susceptible soils in thin permafrost as well as seasonally frozen soils		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.8).

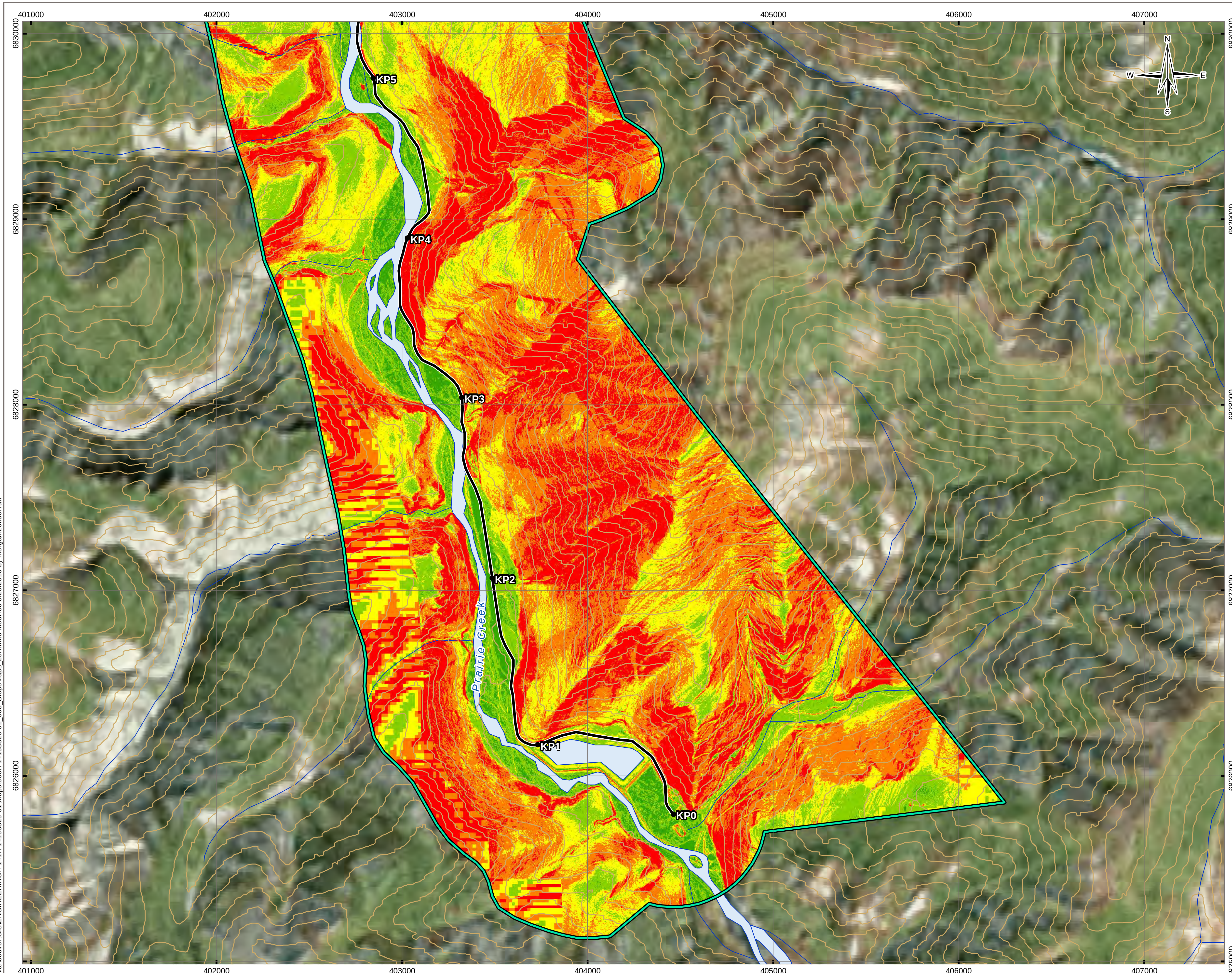
	A	B	C	D	E
3	Terms of Reference			Location	
4	Sub-Sec.	Item	Description	DAR Section	Additional Reference
48		13	thaw or settlement-related impacts on drainage and surface hydrology		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.8).
49		14	shorelines and channels		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63). Tetra Tech EBA August 2015 Addendum (p.8).
50		15	combined impacts of the all season road and fires		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 5.4 Permafrost (p.62-63) includes text specific to fires; Section 6 (p. 63-65), Section 8 (p. 77-81). Site-specific observations in Appendix C. Tetra Tech EBA August 2015 Addendum (p.8).
51		16	how warming ground temperatures and deepening active layers will affect the all season road and how mitigation measures will remain effective in various climate warming scenarios.		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Section 5.4 Permafrost (p.62-63); Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.8-9).
52	7.3.2 Granular Materials	3	measures to limit the effect on the surrounding environment		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8 (p. 77-81). Contributions to Allnorth's recommendations in their DAR supplement (acknowledged as noted therein.)
53		4	excavation requirements		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8 (p. 77-81). Contributions to Allnorth's recommendations in their DAR supplement (acknowledged as noted therein.)
54		5	talus slope stability		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63). Tetra Tech EBA August 2015 Addendum (p.9).

	A	B	C	D	E
3	Terms of Reference			Location	
4	Sub-Sec.	Item	Description	DAR Section	Additional Reference
55	7.3.5 Water Quality and Quantity	1	changes to surface drainage patterns and surface water hydrology including changes caused by road-related impacts on terrain, soils and permafrost		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.10).
56		8	changes to water quality due to thaw slumps and other slope instability at water crossing		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.10).
57		9	changes to snow distribution and potential impacts on drainage		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5.3 (p.62); Section 6 (p. 63), Section 7 (p.66), Section 8 (p. 78-80). Tetra Tech EBA August 2015 Addendum (p.7).
58		10	issues related to borrow extraction including melting of ground ice and potential changes to drainage patterns etc.		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section (p.17-63); Tetra Tech EBA August 2015 Addendum (p.7).
59		1	long-term climate change scenarios (e.g., loss of permafrost, increased evaporation and evapotranspiration, greenhouse gas emissions)		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 6 (p. 63-65). Tetra Tech EBA August 2015 Addendum (p.11).
60		2	how likely changes in permafrost will affect the amount the granular material required for care and maintenance of the all season road		DAR Appendix 2, Tetra Tech EBA March 2015 report; Section 5.4 (p. 62-63), Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.11-12).
61		3	short-term climatic and extreme weather events (e.g., major precipitation, wind, fog, drought)		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.1 Environmental Causes (p.65-68), 7.3 Mitigations and Residual Effects (p.74-76), as applicable to climate- or weather-related events.
62		4	changes in permafrost regime		DAR Appendix 2, Tetra Tech EBA March 2015 report; Section 5.4 (p. 62-63), Section 6 (p. 63-65), Section 8 (p. 77-81). Tetra Tech EBA August 2015 Addendum (p.8-9).

	A	B	C	D	E
3	Terms of Reference			Location	
4	**Sub-Sec.**	**Item**	**Description**	**DAR Section**	**Additional Reference**
63	8 Effects of the Environment on the Project	5	subsidence		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section, beginning on p.17; Section 8.1.3 Mitigative Measures (p. 79-81). Tetra Tech EBA August 2015 Addendum (p.11-12).
64		6	fires		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 5, organized by road section if/as applicable to specific road section, beginning on p.17; general discussion in Section 5.4 on p. 63. Site-specific observations in Appendix C. Tetra Tech EBA August 2015 Addendum (p.11).
65		7i	map of high risk zones		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.2 Qualitative Risk Assessments in tabulated form (p.71-73). Aspects/risks related to terrain, soils, permafrost and karst topography. Tetra Tech EBA August 2015 Addendum (p.13-16).
66		7ii	site-specific contingencies for high risk areas		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.3 Mitigation and Residual Effects (p.74-76); Section 7.3.3 Residual Effects and Site-Specific Contingencies for High-Risk Zones. Contingencies related to terrain, soils, permafrost and karst topography.
67		4	a risk assessment using best practices for the project including components, systems, hazards, and failure modes		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.2 Qualitative Risk Assessments (p.68-74), risks related to terrain, soils, permafrost and karst topography, as applicable to environmental causes (described in Section 7.1). Tetra Tech EBA August 2015 Addendum (p.12-16).
68		5	assessment of the likelihood and severity of each risk identified		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.2 Qualitative Risk Assessments (p.68-74), risks related to terrain, soils, permafrost and karst topography, as applicable to environmental causes (described in Section 7.1).

	A	B	C	D	E
3	Terms of Reference			Location	
4	Sub-Sec.	Item	Description	DAR Section	Additional Reference
69		6	a description of contingency plans for accidents, malfunctions, or unforeseen impacts of the environment on the development and the development on the environment		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 7.3 Mitigation and Residual Effects (p.74-76); Section 7.3.3 Residual Effects and Site-Specific Contingencies for High-Risk Zones. Aspects related to terrain, soils, permafrost and karst topography for input into plans.
70	10 Cumulative Effects	1	identify the valued components, or their indicators, on which the cumulative effects 1.assessment is focused, including the rationale for their selection. These are valued components affected by the all season road in combination with other past, present or reasonably foreseeable future human activities and developments. Present spatial and temporal boundaries for the cumulative effect assessment for each valued component selected. Emphasize valued components with special environmental sensitivities or where significant risks could be involved.		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 9.0 Cumulative Effects. Aspects related to terrain, soils, permafrost and karst topography.
71		2	identify the sources of potential cumulative effects. Specify other past, present or reasonably foreseeable future human activities and developments that may substantially affect the valued components identified above. These may be in the vicinity of the road or may affect a mobile resource that moves into its vicinity (like a river or a caribou herd).		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 9.0 Cumulative Effects. Aspects related to terrain, soils, permafrost and karst topography.
72		3	predict the combined effects of the road and the other activities identified above.		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 9.0 Cumulative Effects. Aspects related to terrain, soils, permafrost and karst topography.
73		4	identify how the developer or others will mitigate the identified cumulative impacts		DAR Appendix 2, Tetra Tech EBA March 2015 report, Section 9.0 Cumulative Effects. Aspects related to terrain, soils, permafrost and karst topography.

APPENDIX A
SLOPE GRADIENT MAPS

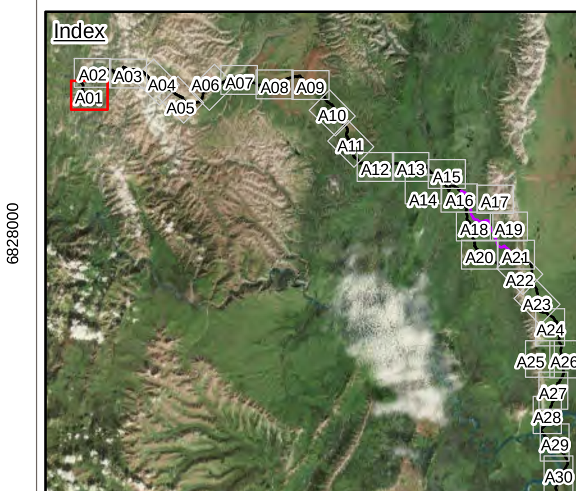


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A01

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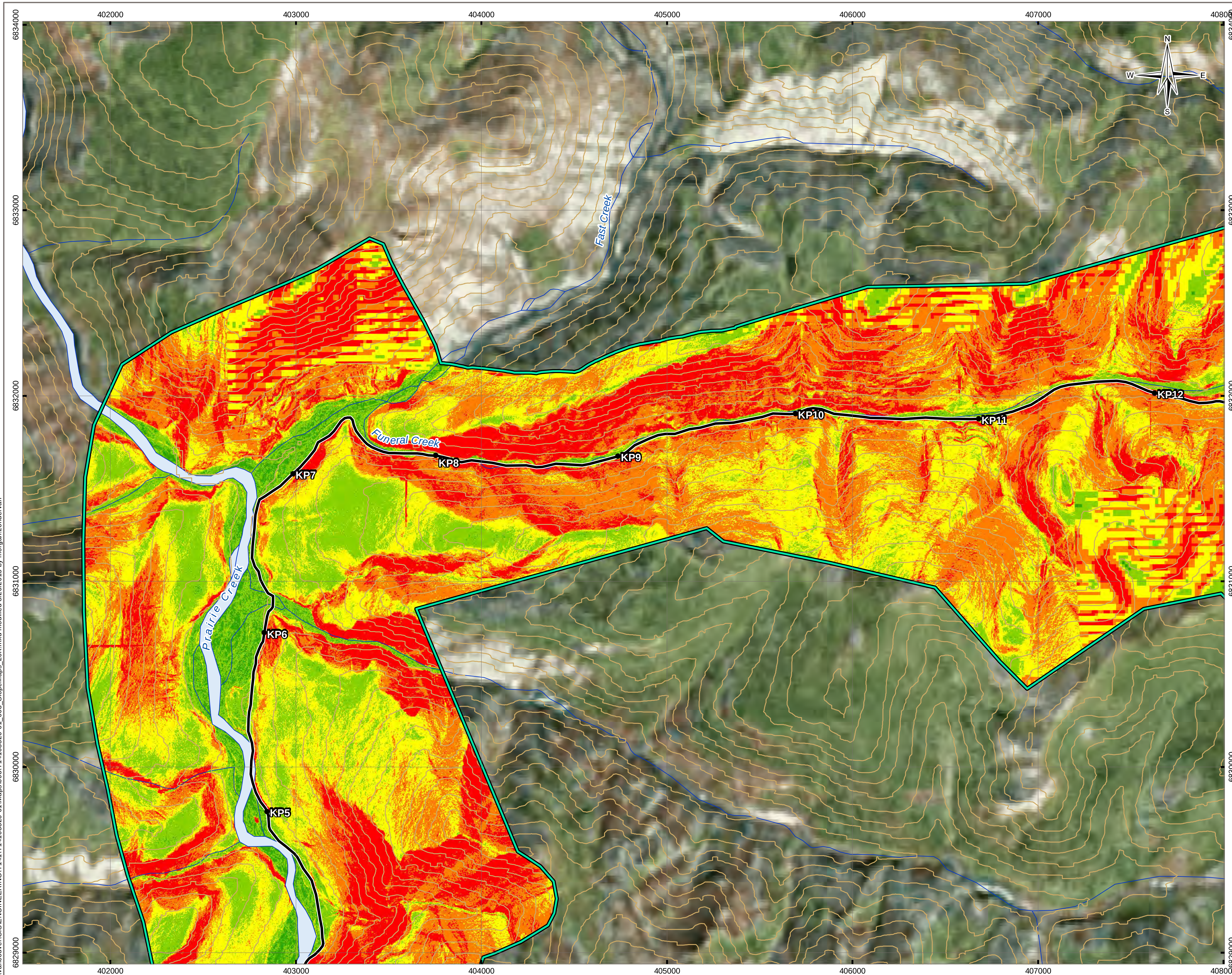

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LEGEND

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- Watercourse
- Waterbody

Slope Gradient

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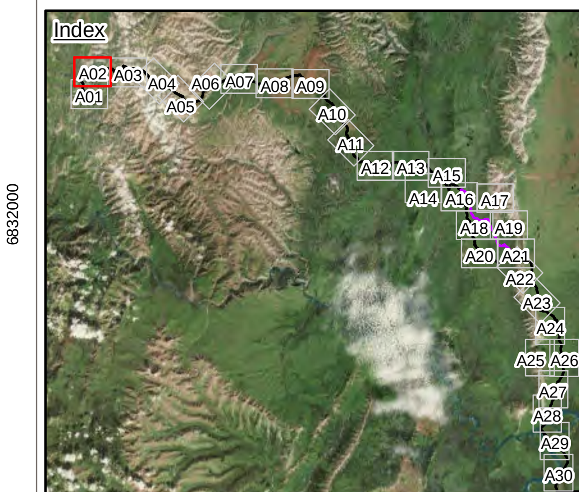
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

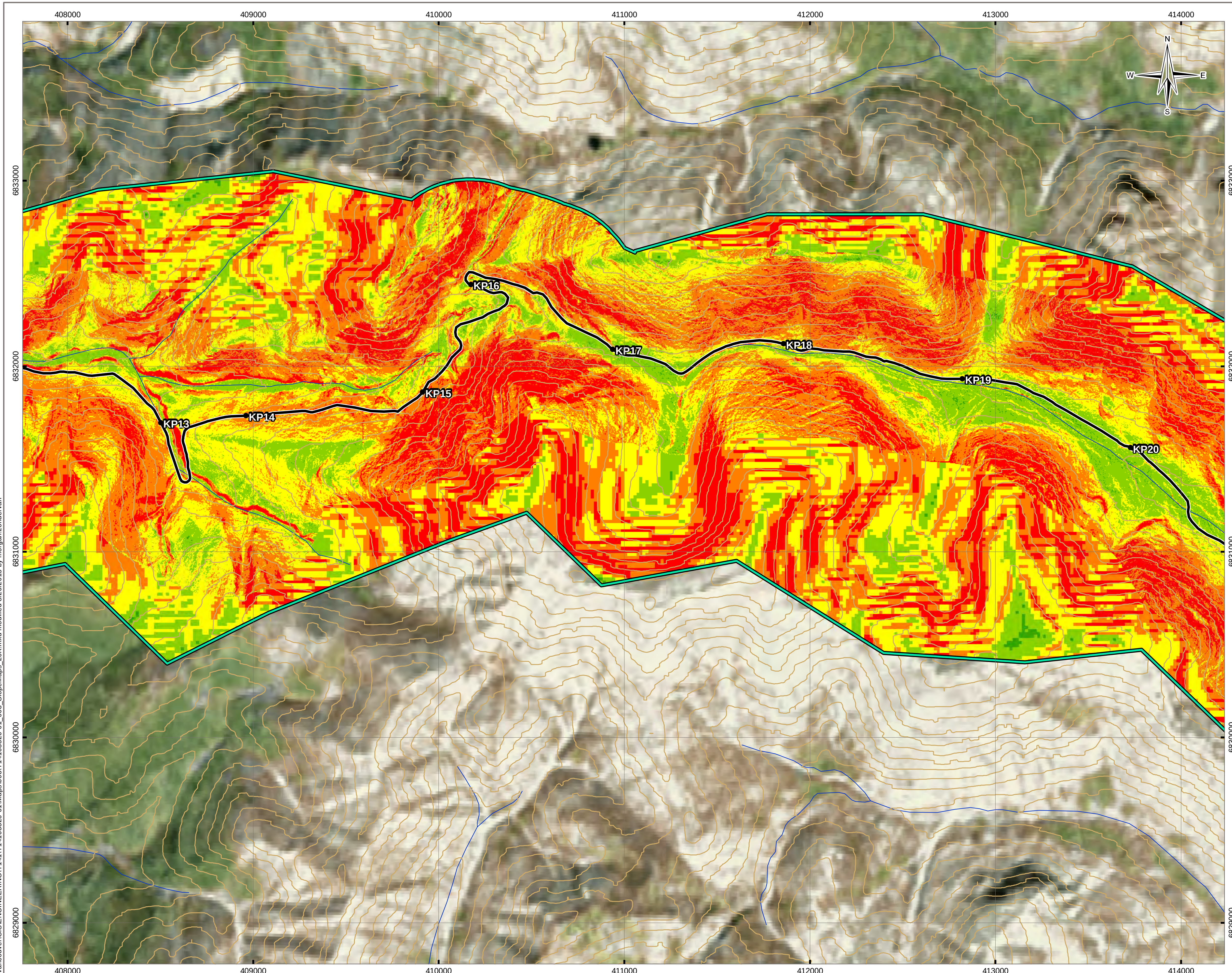
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A02



LEGEND

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- Alternative Alignment (July 30, 2015)
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- Watercourse
- Waterbody

Slope Gradient

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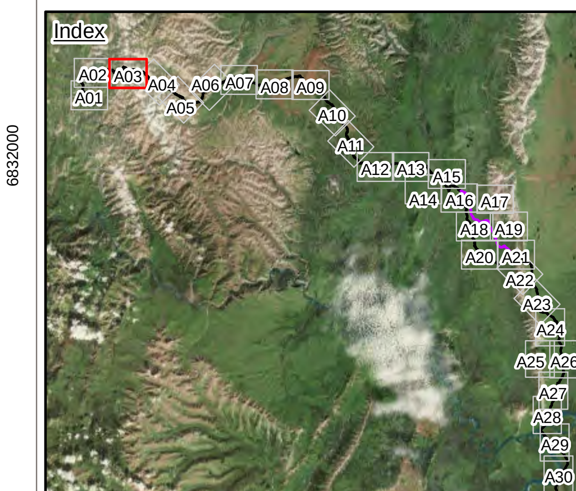

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A03

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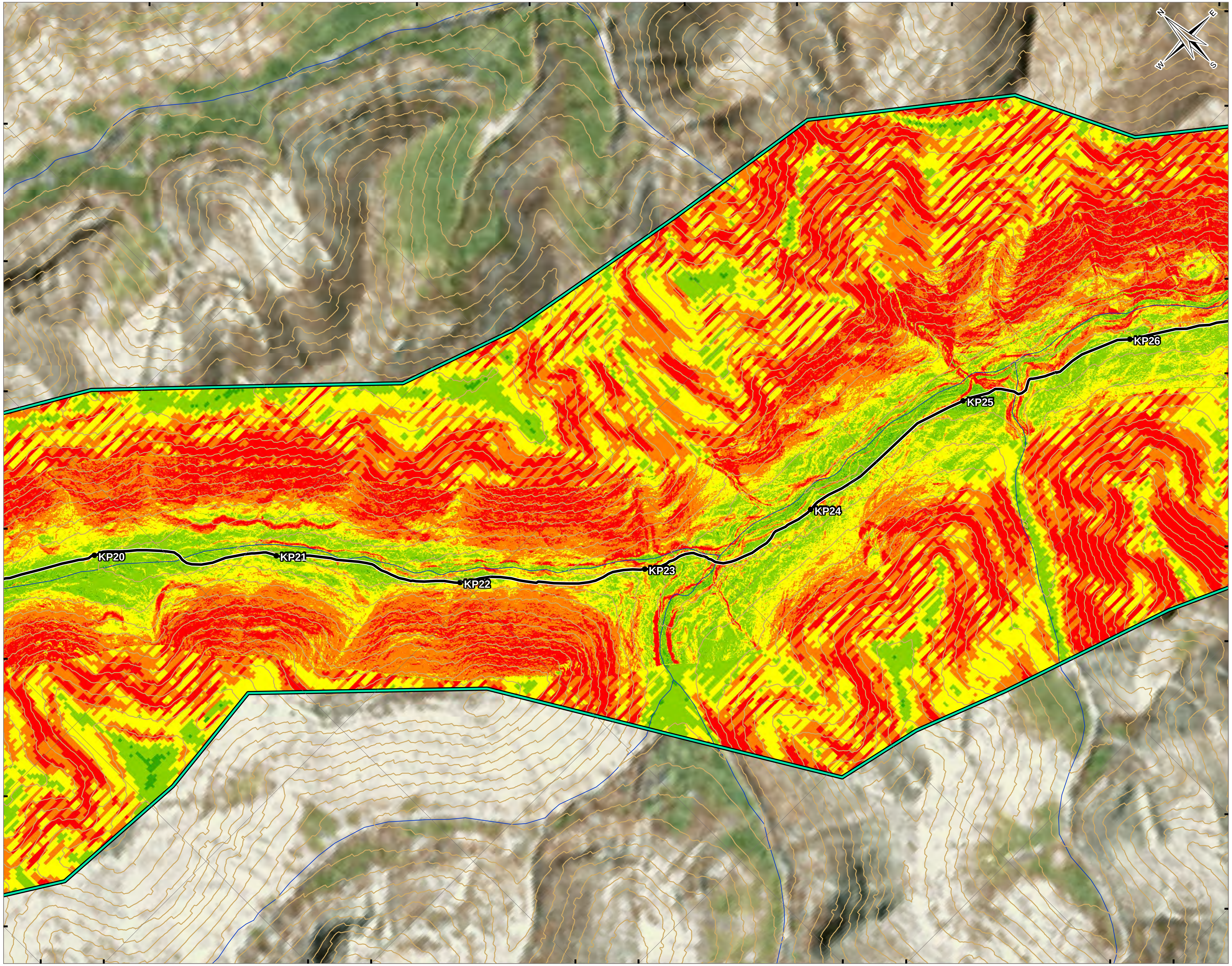

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

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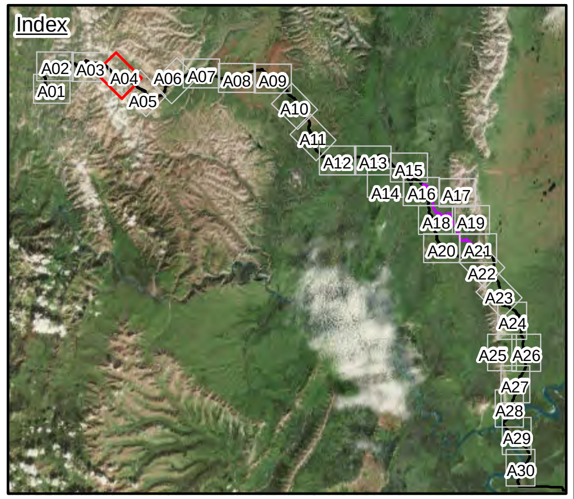
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A04

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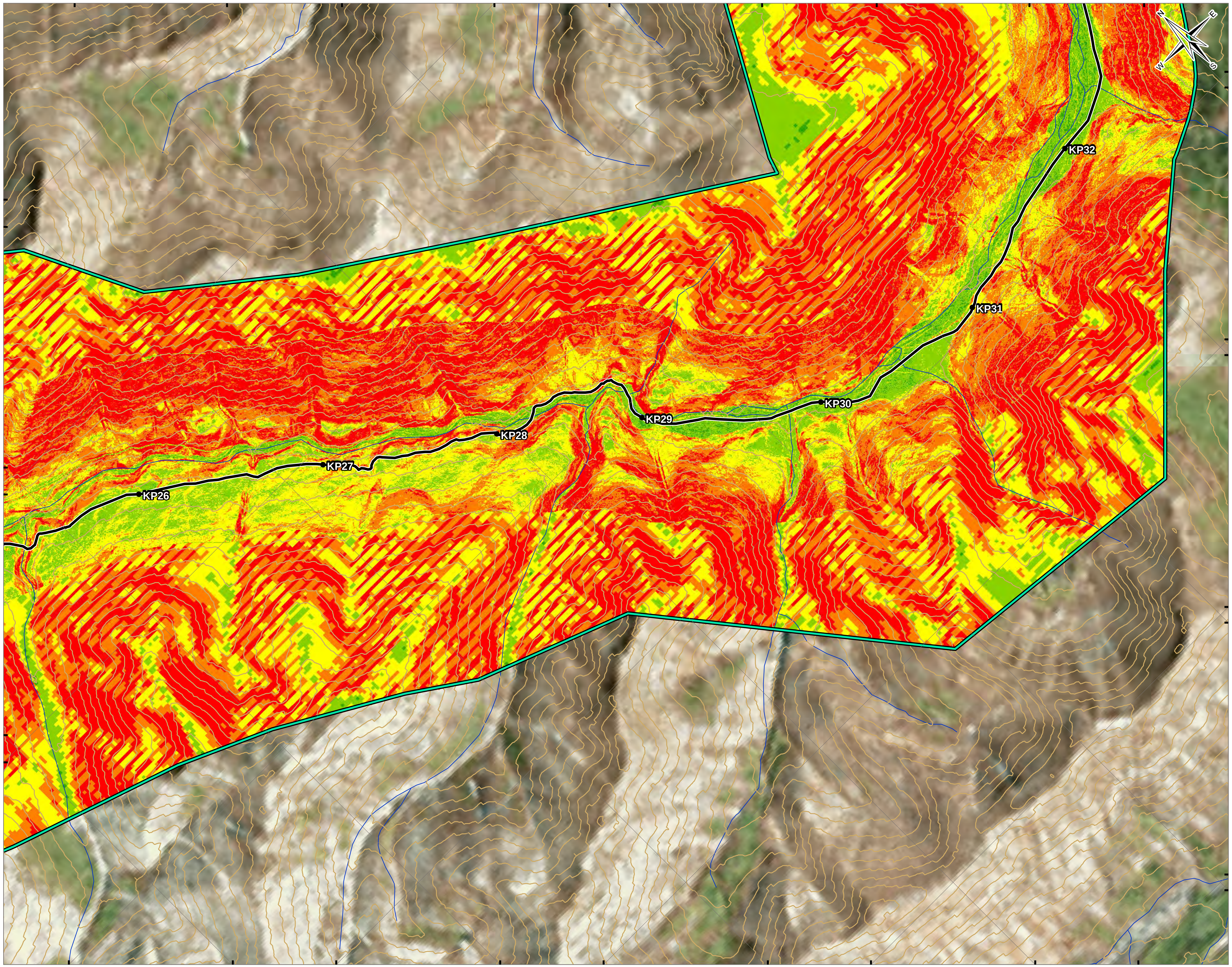
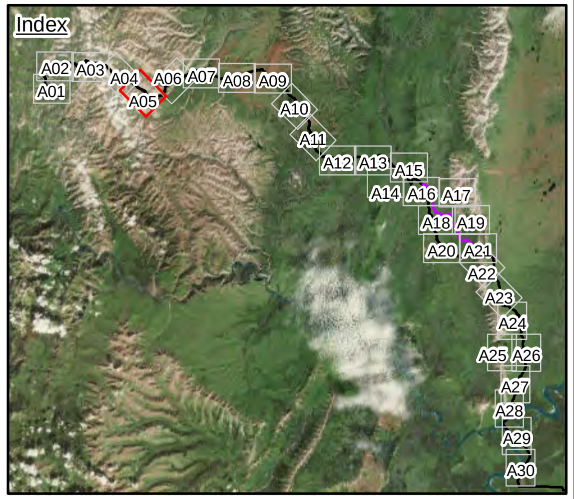


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000 (400 200 0 400 Metres)

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SlopeMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	1
OFFICE	**DATE**			
Tt EBA-VANC	August 26, 2015			

Figure A05

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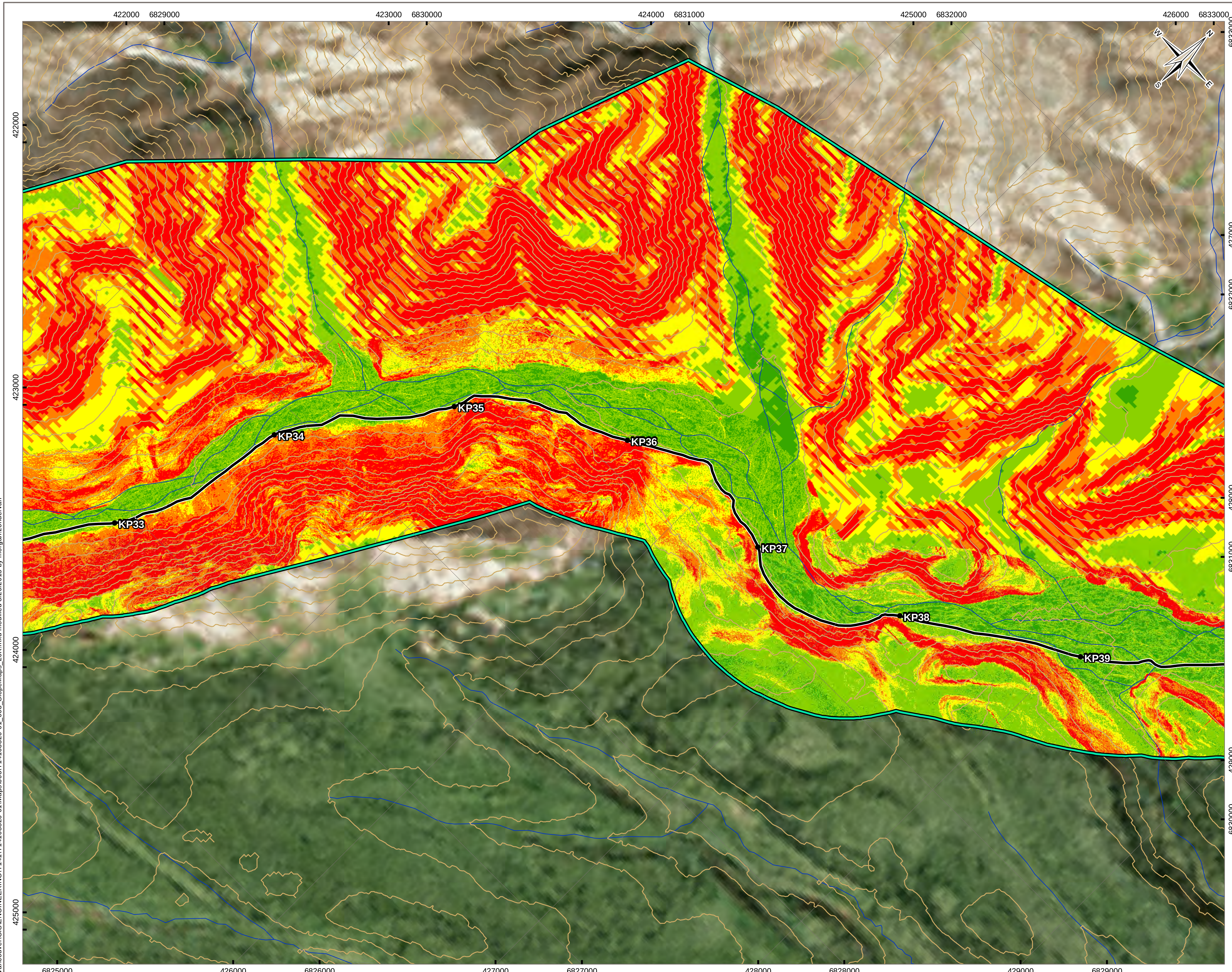

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
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- > 70% (steep)

NOTES
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LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A06

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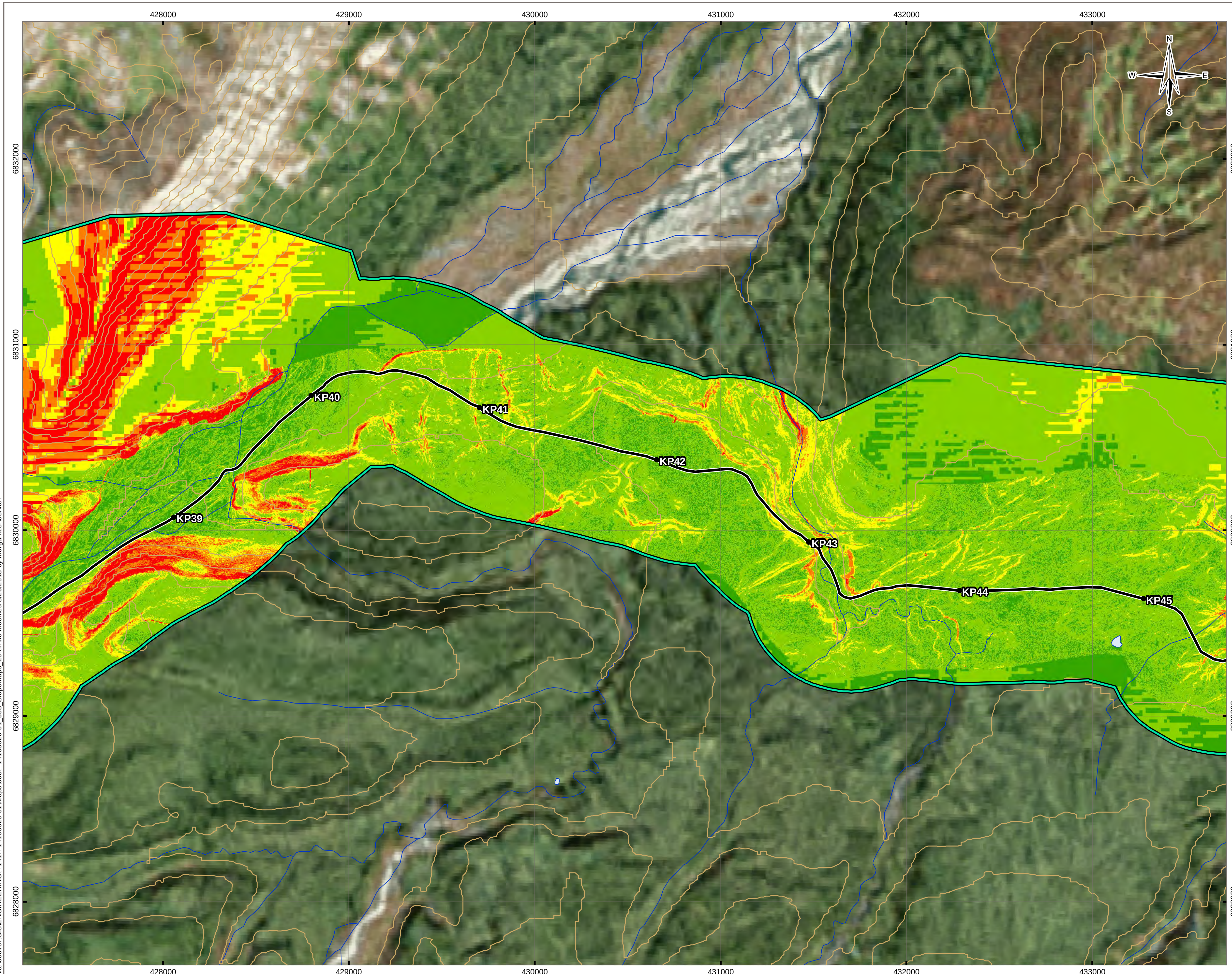

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

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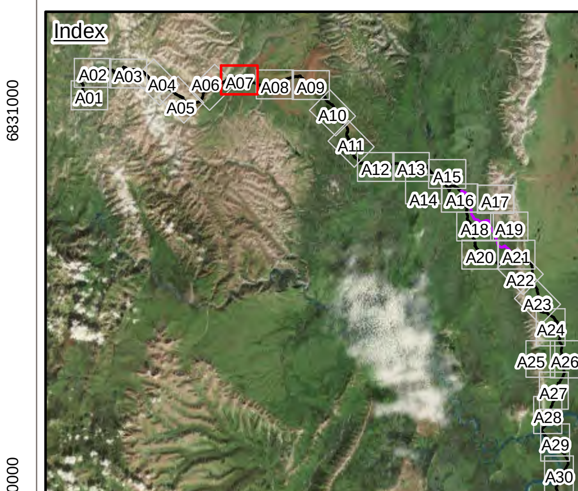

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A07

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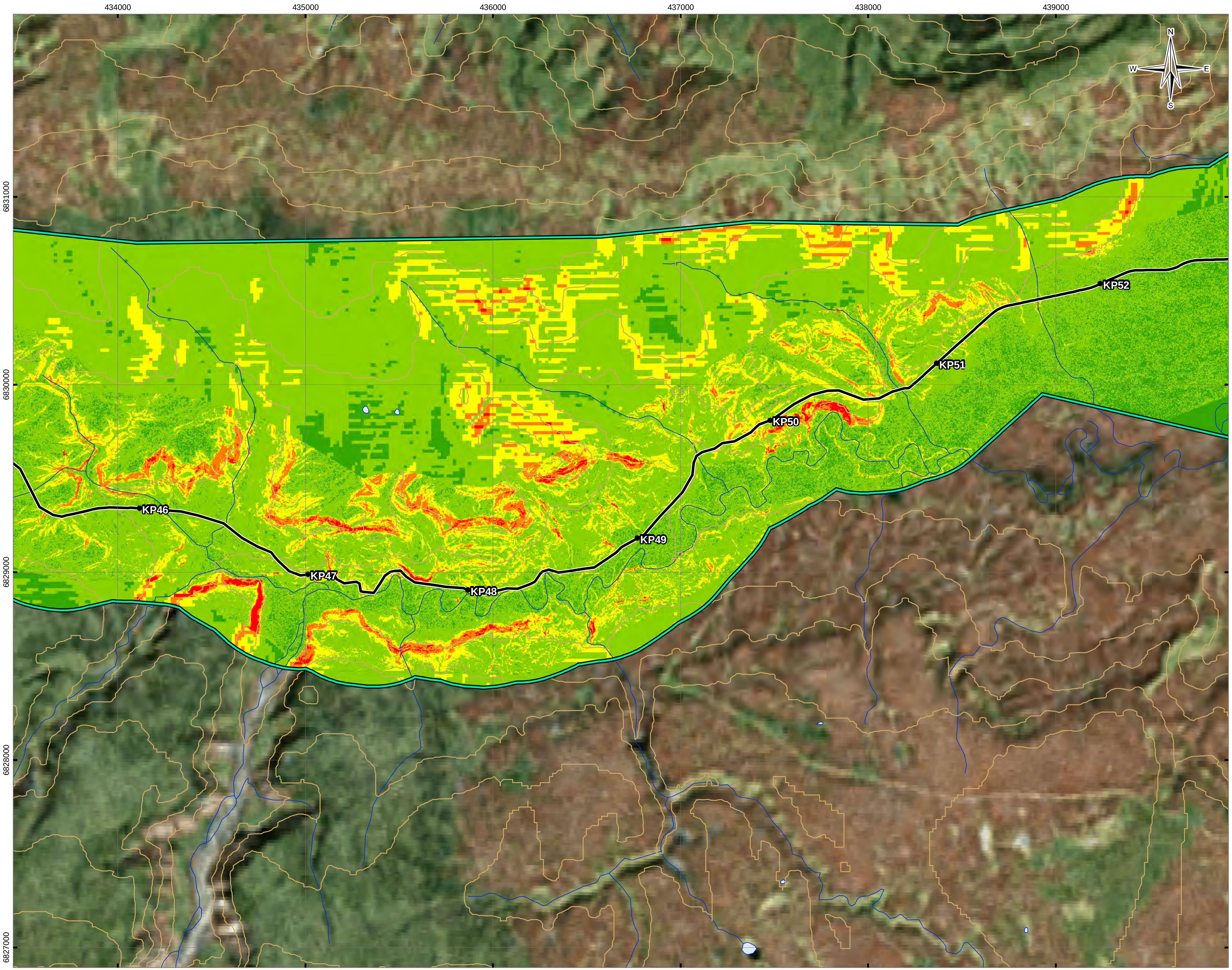

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LEGEND

- 1 km Buffer (+ additional areas)
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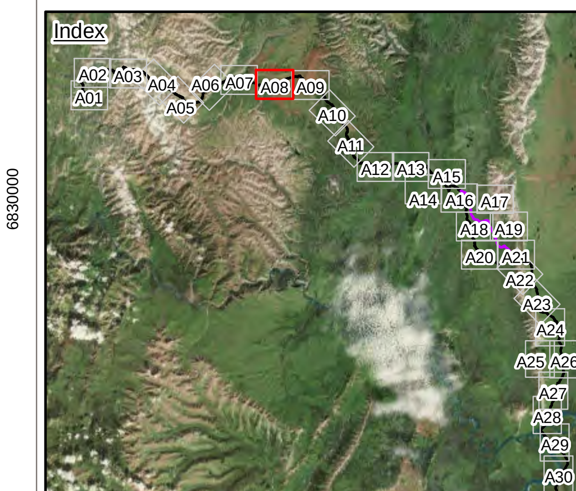


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

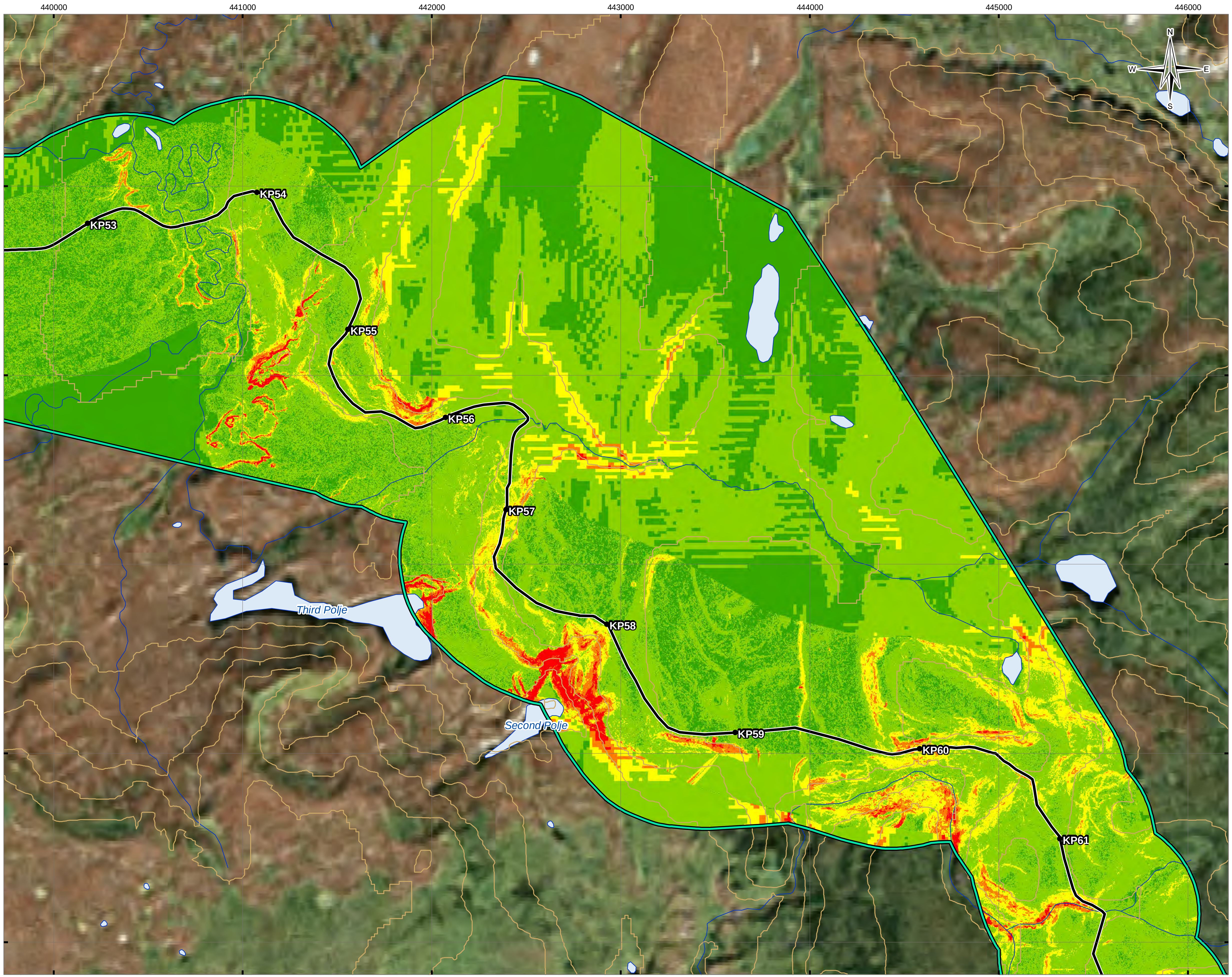
PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.				
Y14103320-01_003_SlopeMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	1
OFFICE	**DATE**			
Tt EBA-VANC	August 26, 2015			

TETRA TECH EBA

Figure A08



LEGEND

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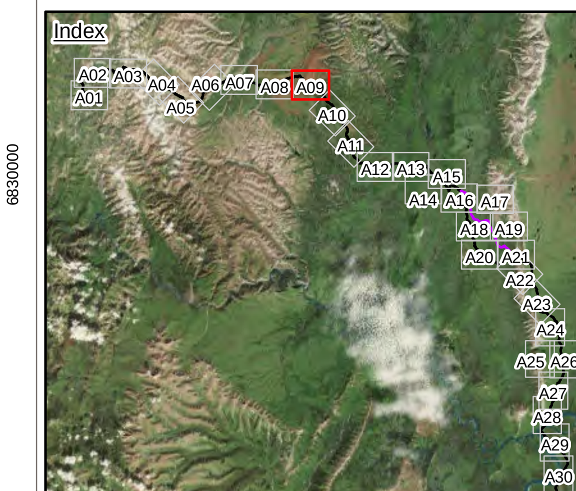

NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
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Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A09

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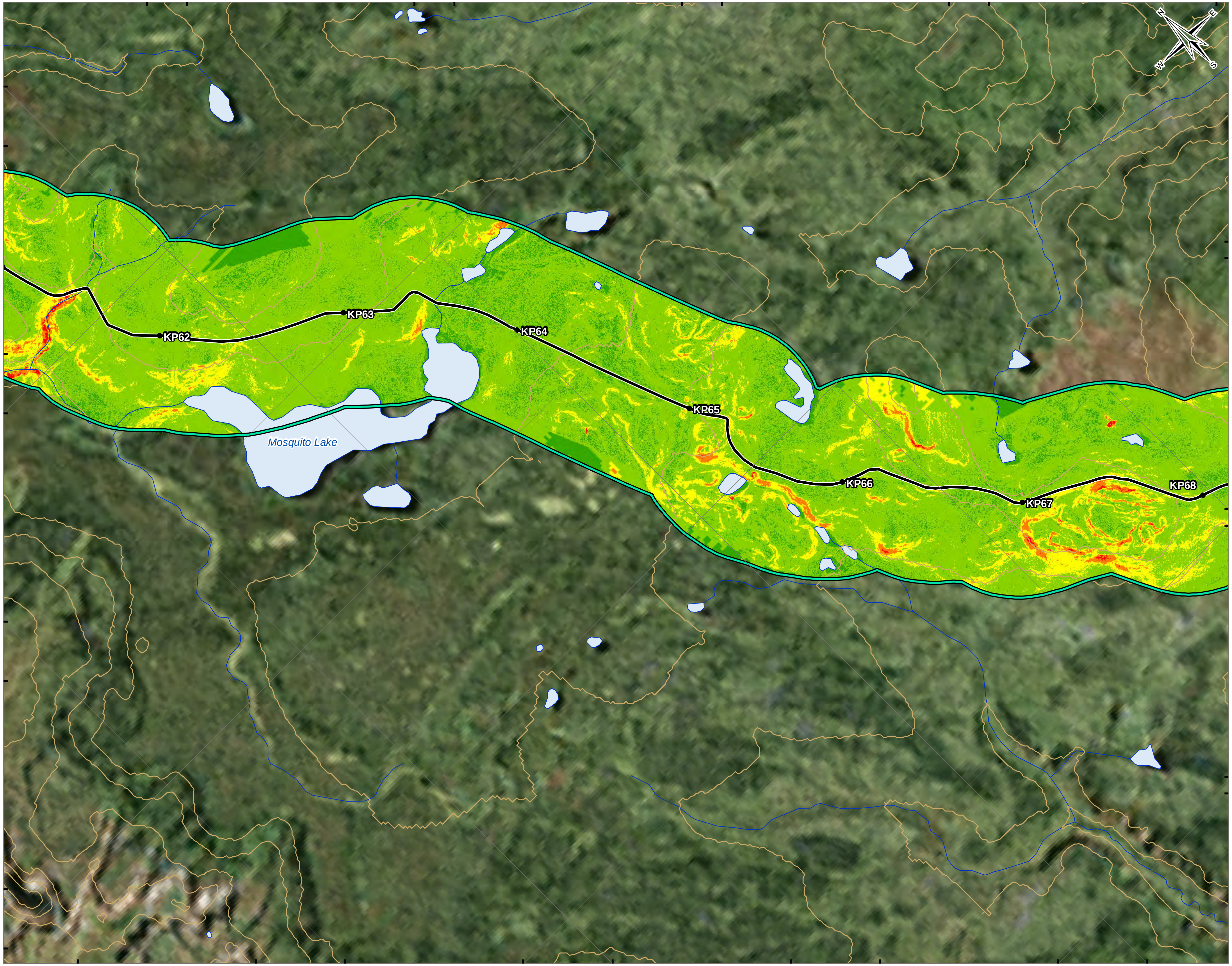

LEGEND

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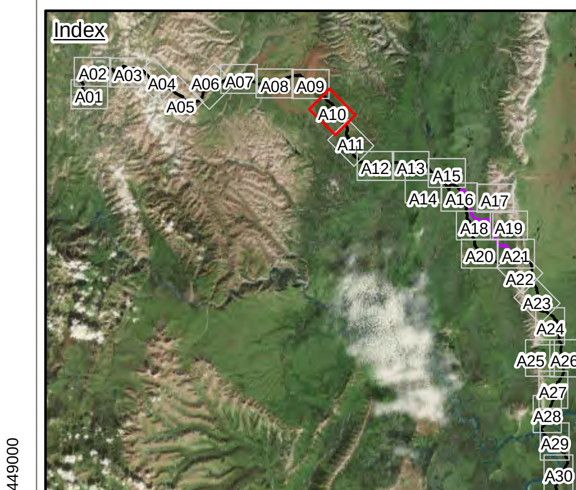

NOTES
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LiDAR provided by McElhanney (2012).
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STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A10

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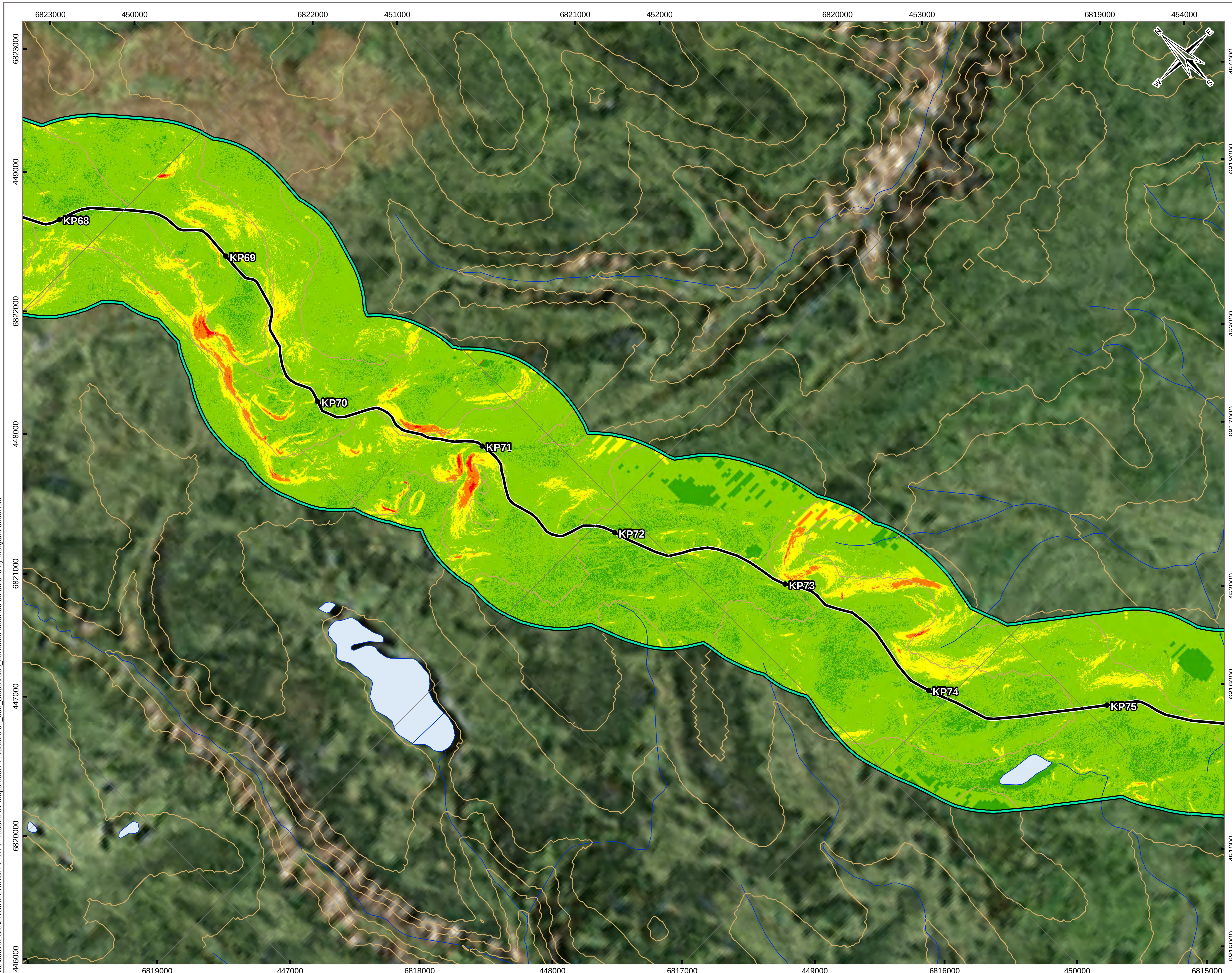

LEGEND

1 km Buffer (+ additional areas)
Prairie Creek Access Road (Feb 24, 2015)
Alternative Alignment (July 30, 2015)
Contour (40 m)
Watercourse
Waterbody

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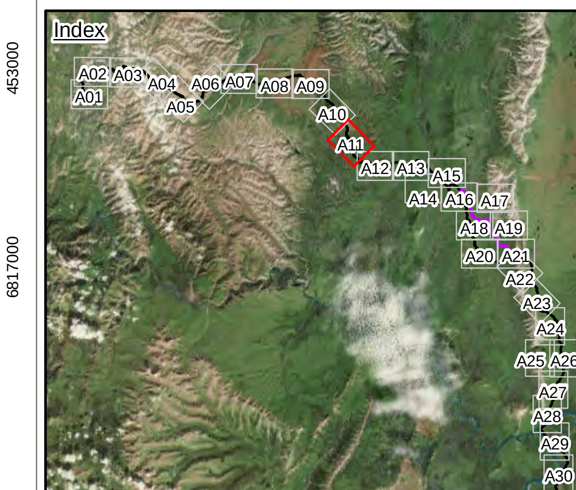

NOTES
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LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A11

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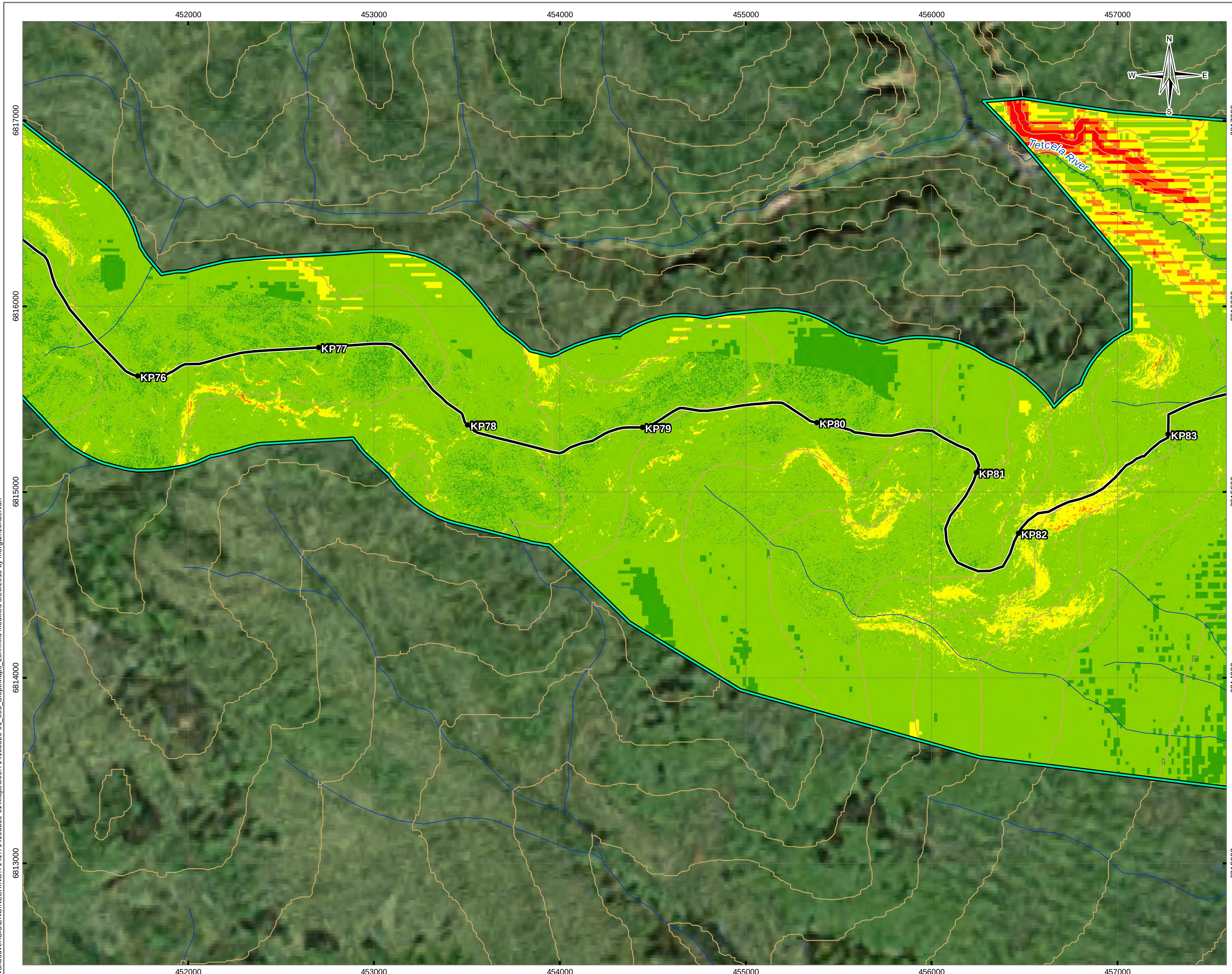


Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)

NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

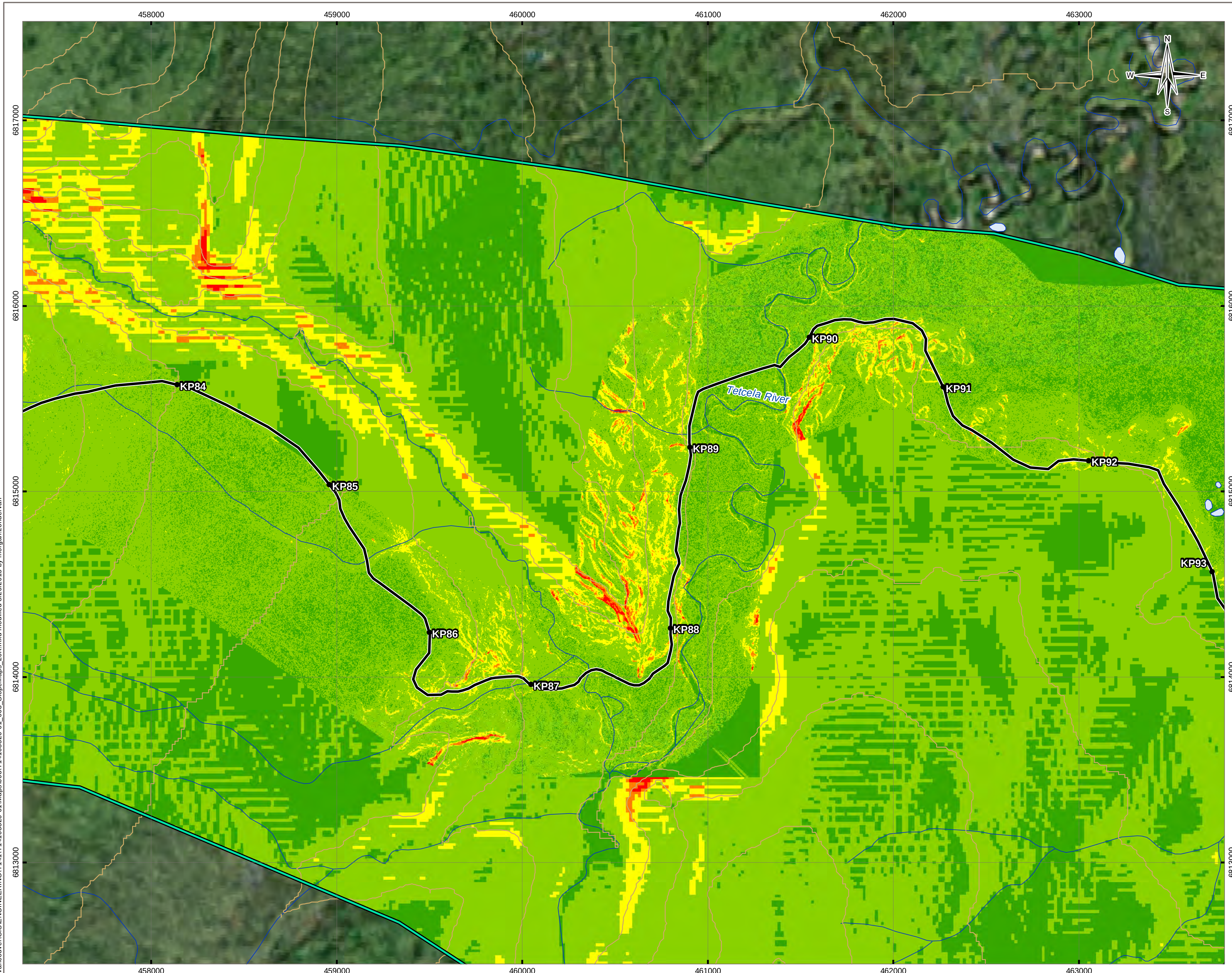
400 200 0 400

Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SlopeMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	1
OFFICE	**DATE**			
Tt EBA-VANC	August 26, 2015			

Figure A12

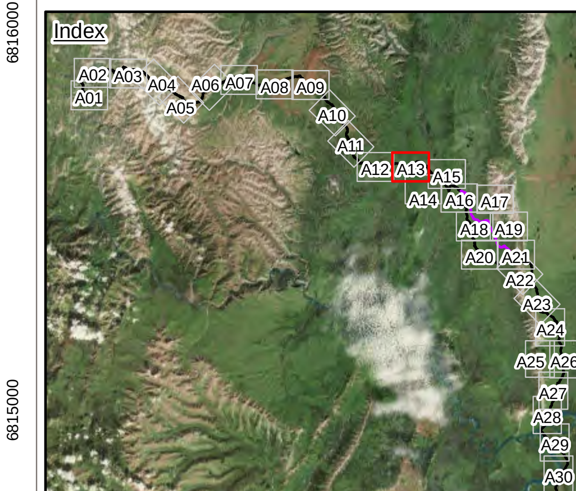


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION
Scale: 1:20,000 (400 200 0 400 Metres)		TETRA TECH EBA

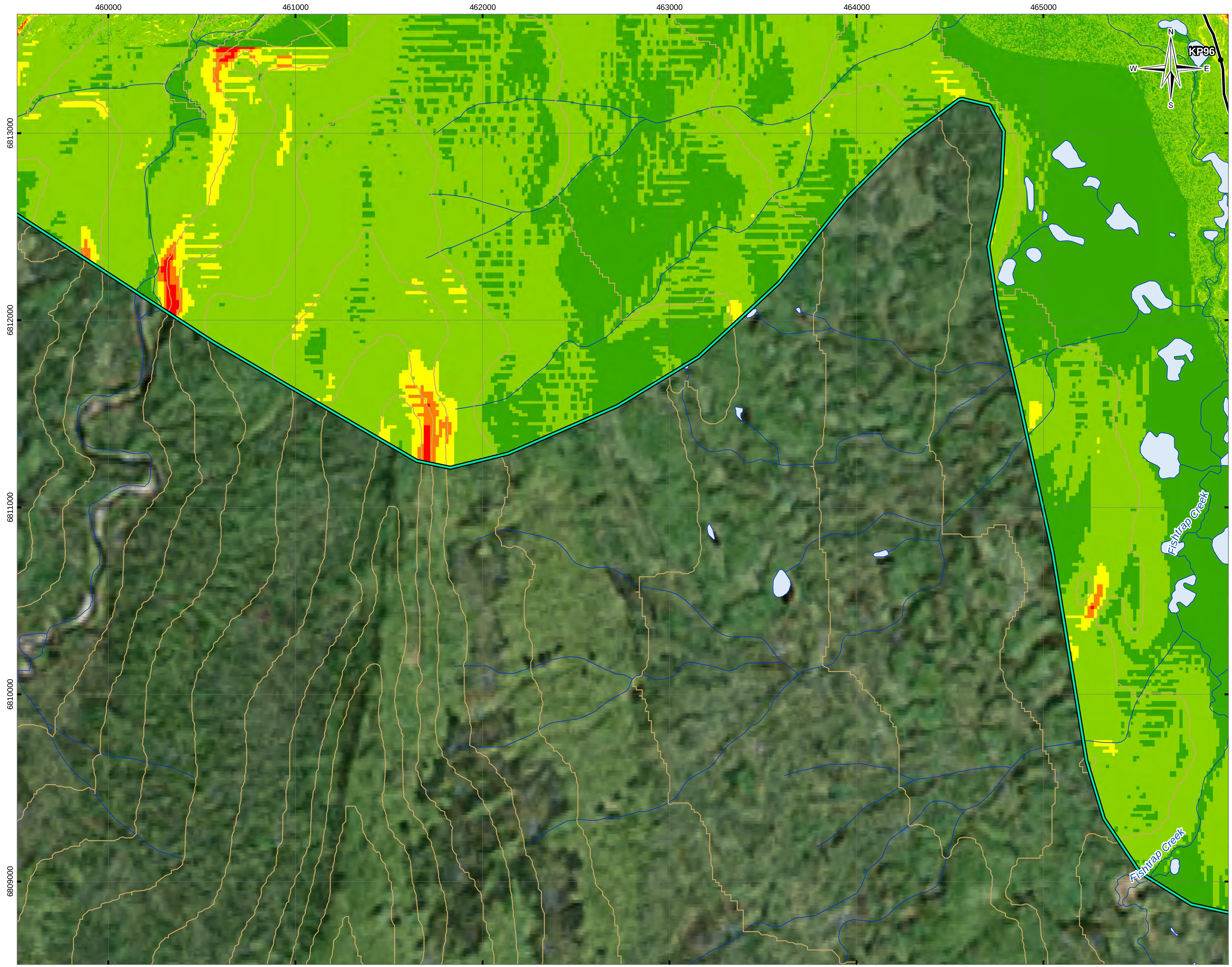
FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A13

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan

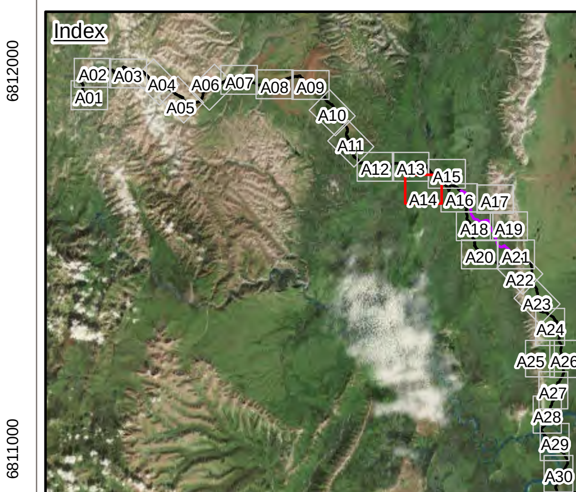


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

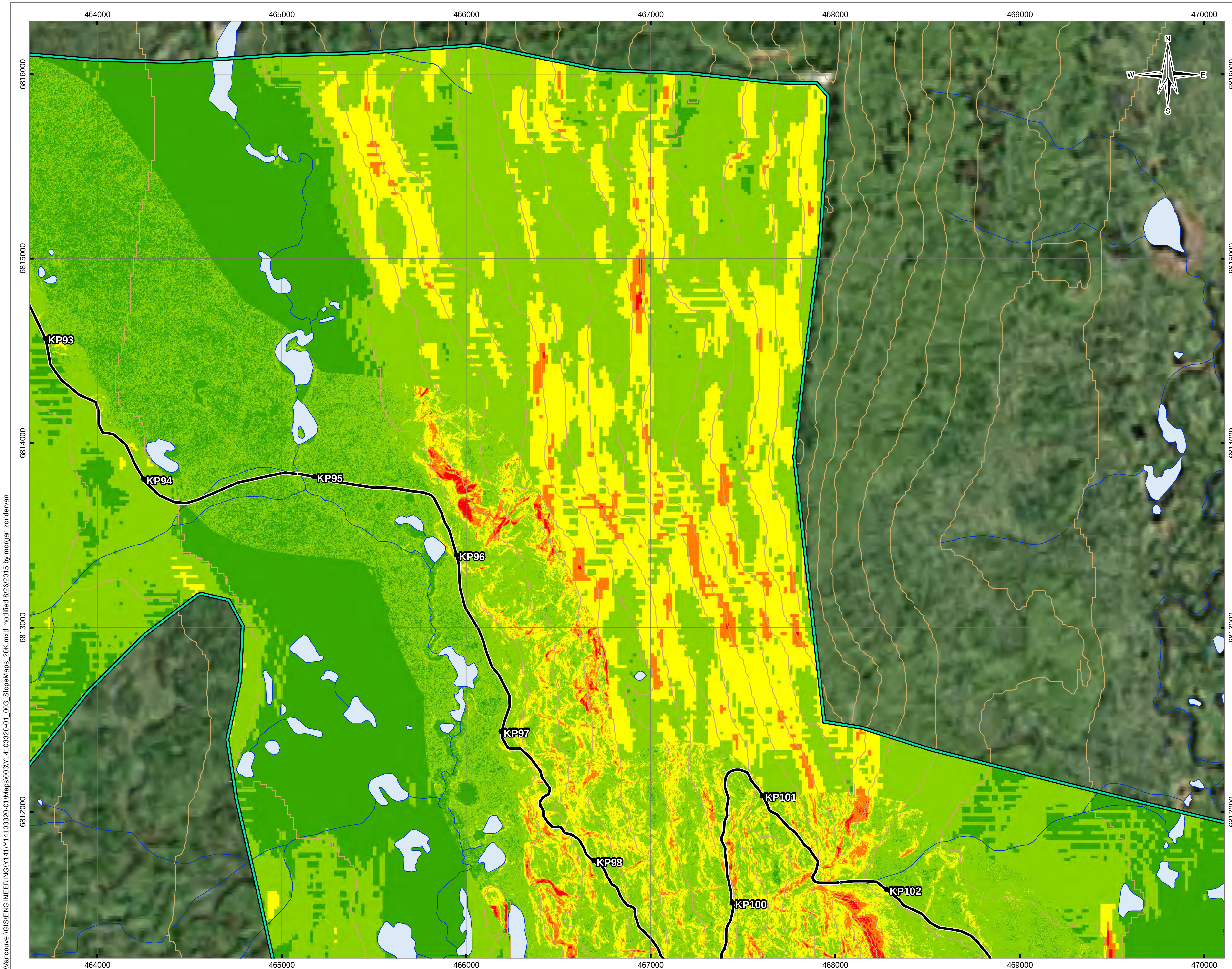
FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A14

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

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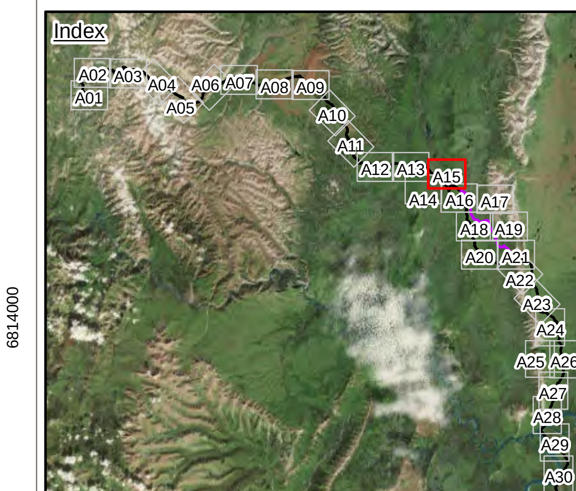


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

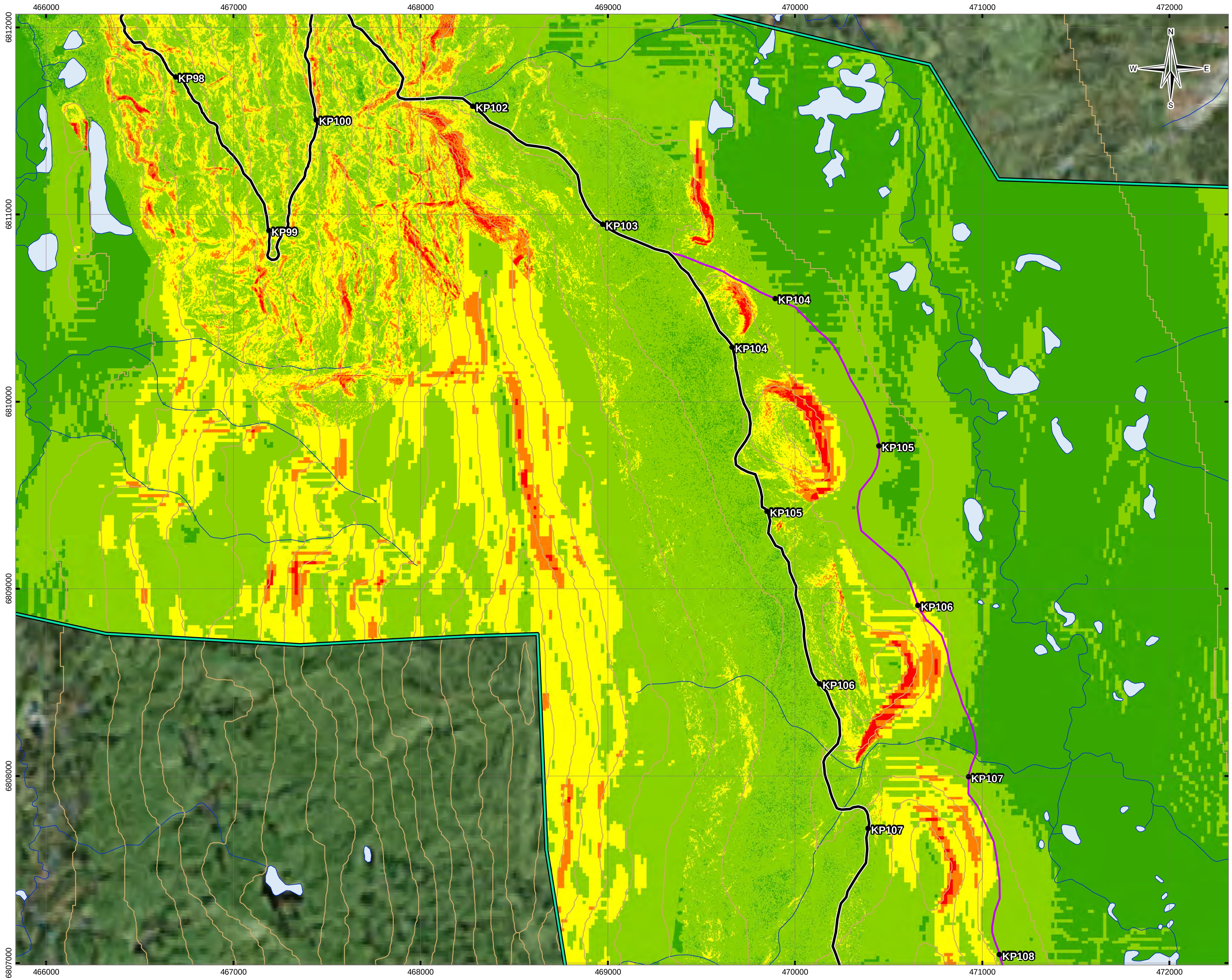
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A15



LEGEND

1 km Buffer (+ additional areas)
Prairie Creek Access Road (Feb 24, 2015)
Alternative Alignment (July 30, 2015)
Contour (40 m)
Watercourse
Waterbody

Slope Gradient

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- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
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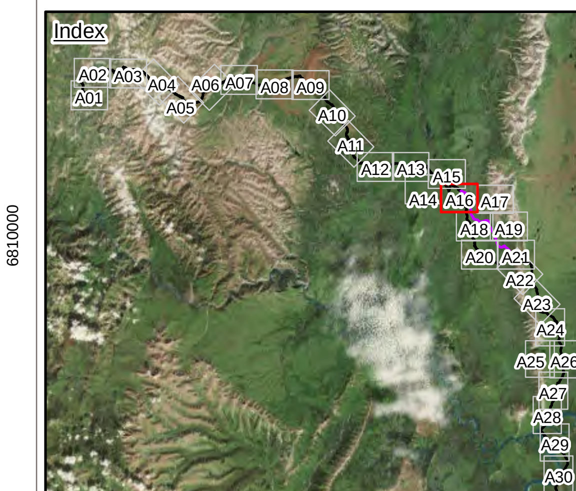


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

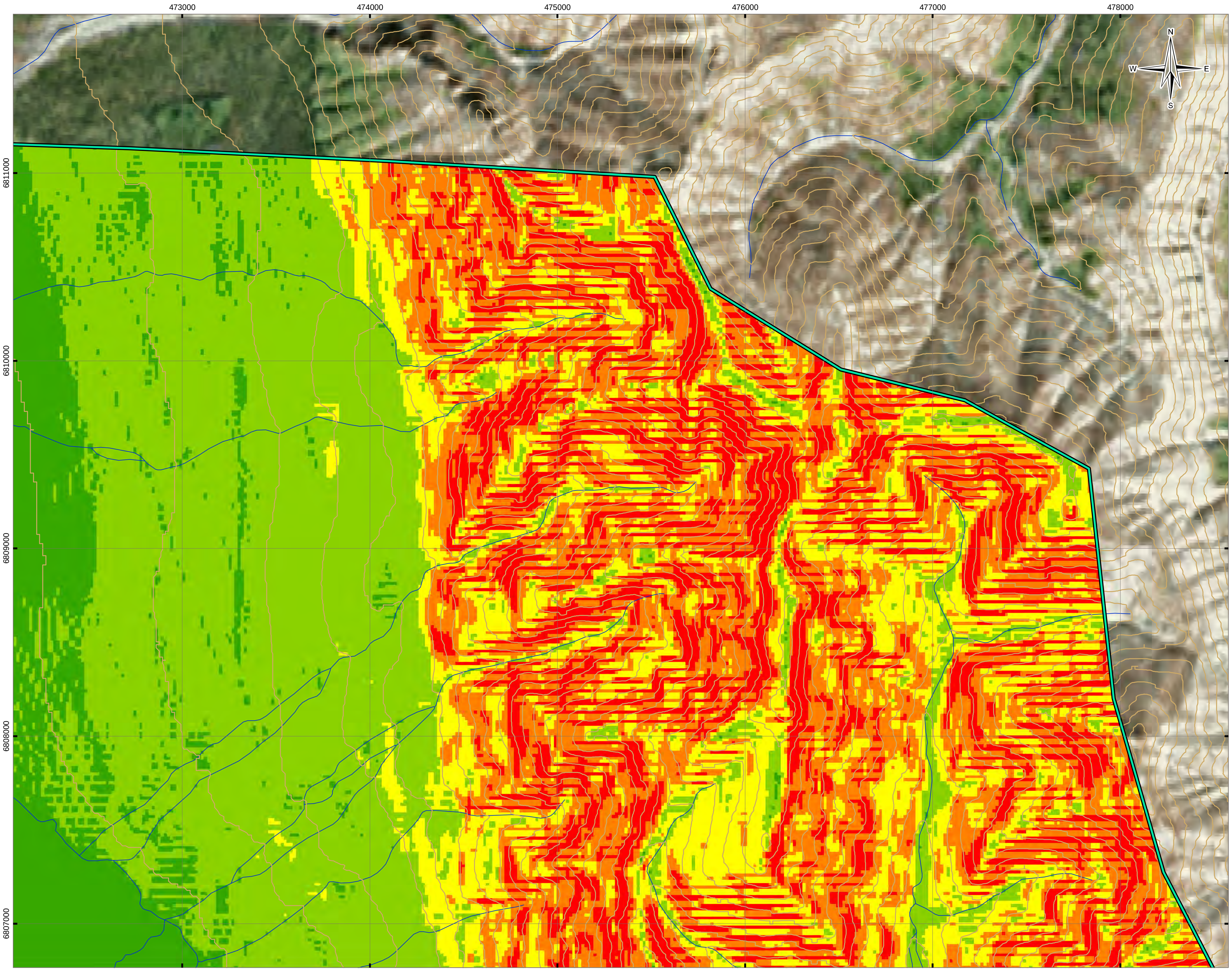
FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A16

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan



LEGEND

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- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

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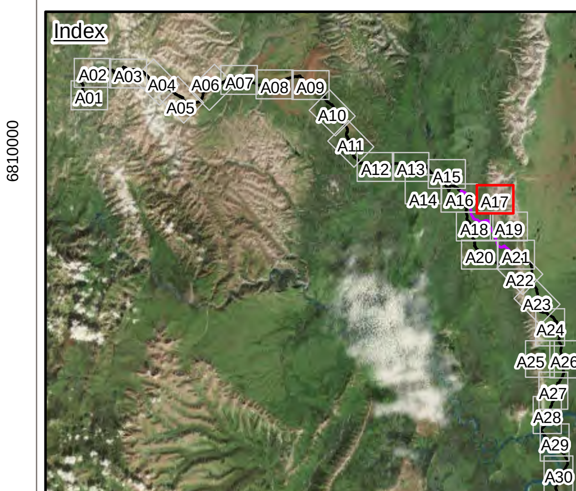
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

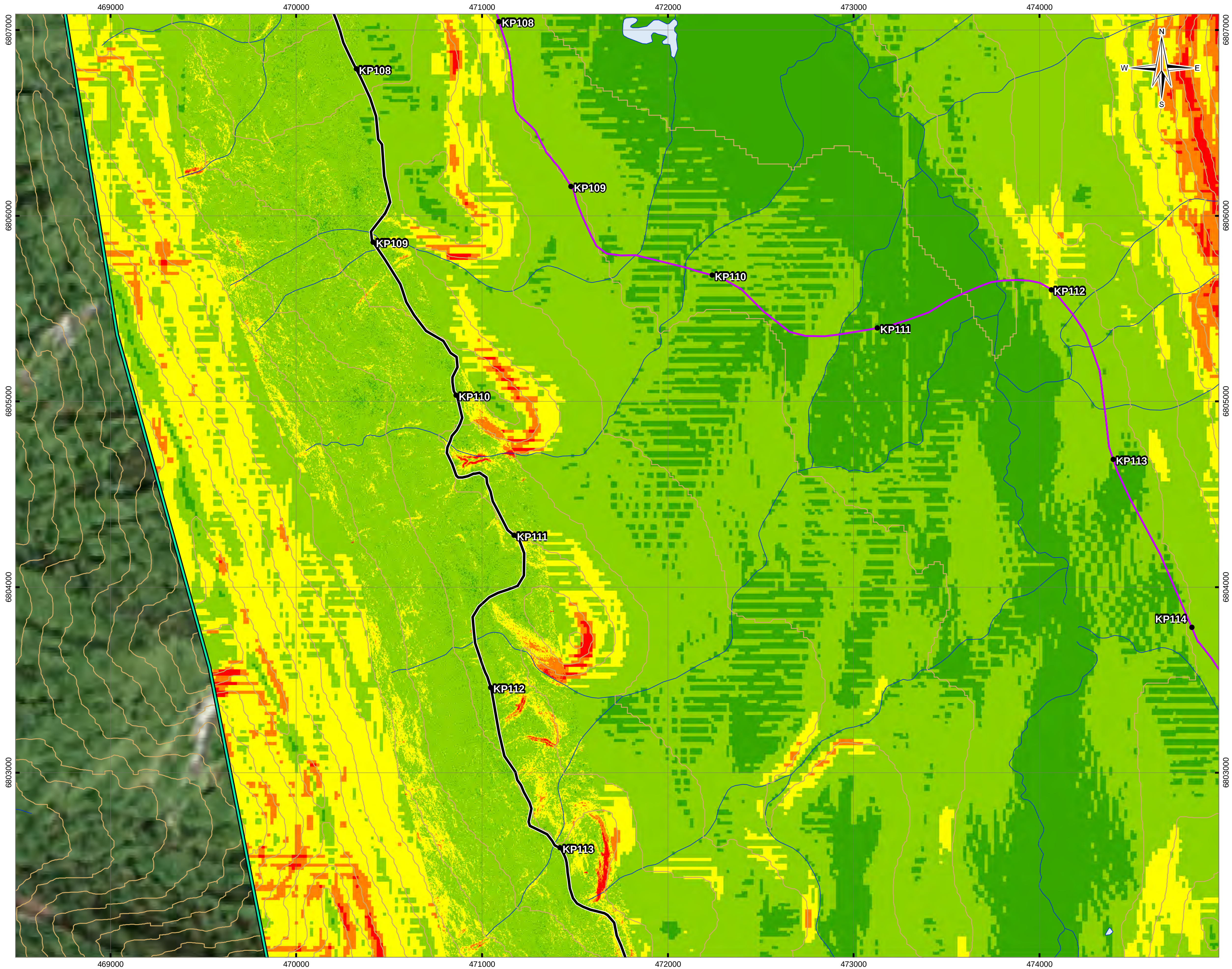
Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SlopeMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	1
OFFICE	**DATE**			
Tt EBA-VANC	August 26, 2015			

Figure A17

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zonderevan



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LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
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- Watercourse
- Waterbody

Slope Gradient

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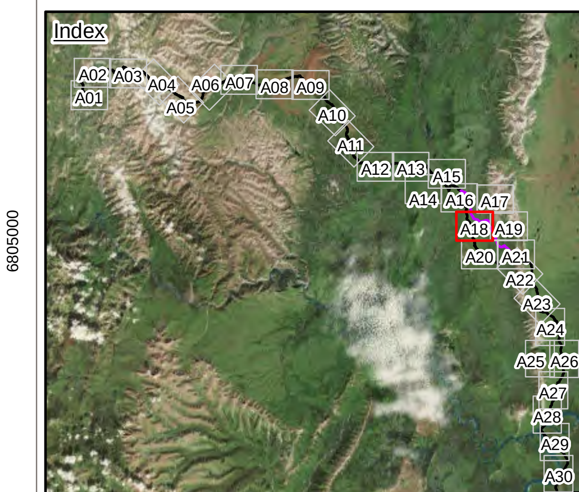


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

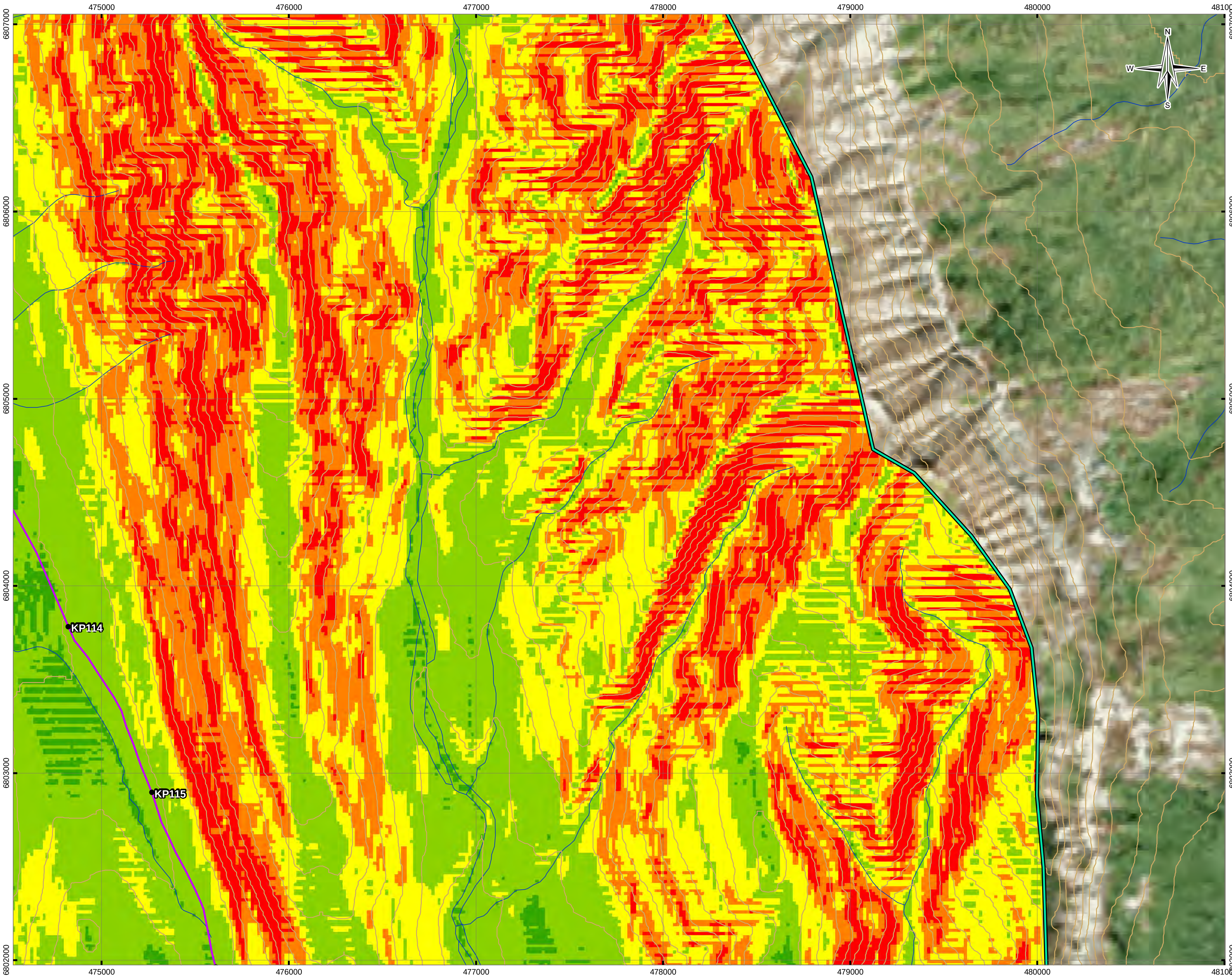
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A18



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
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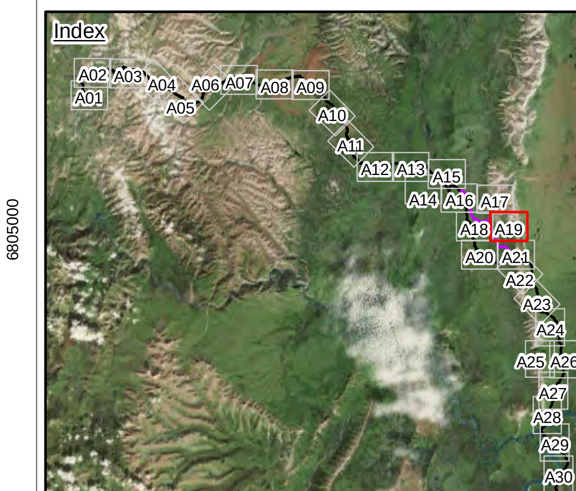

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A19

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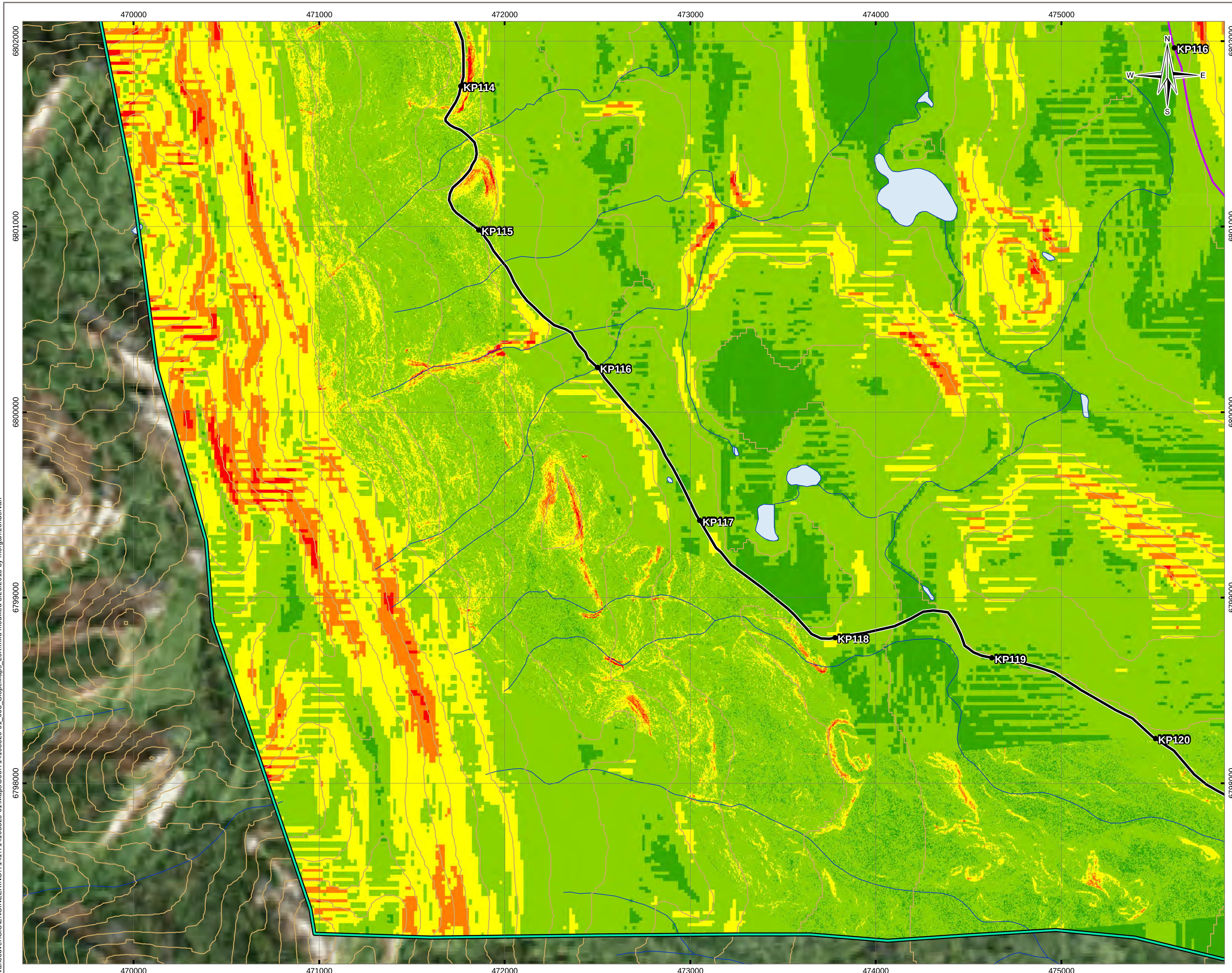

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
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- Watercourse
- Waterbody

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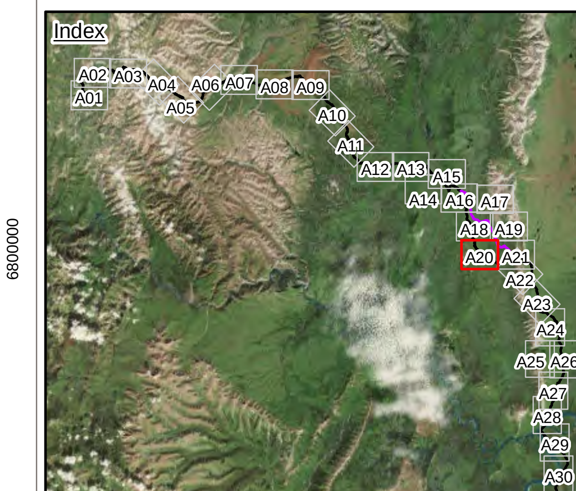


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

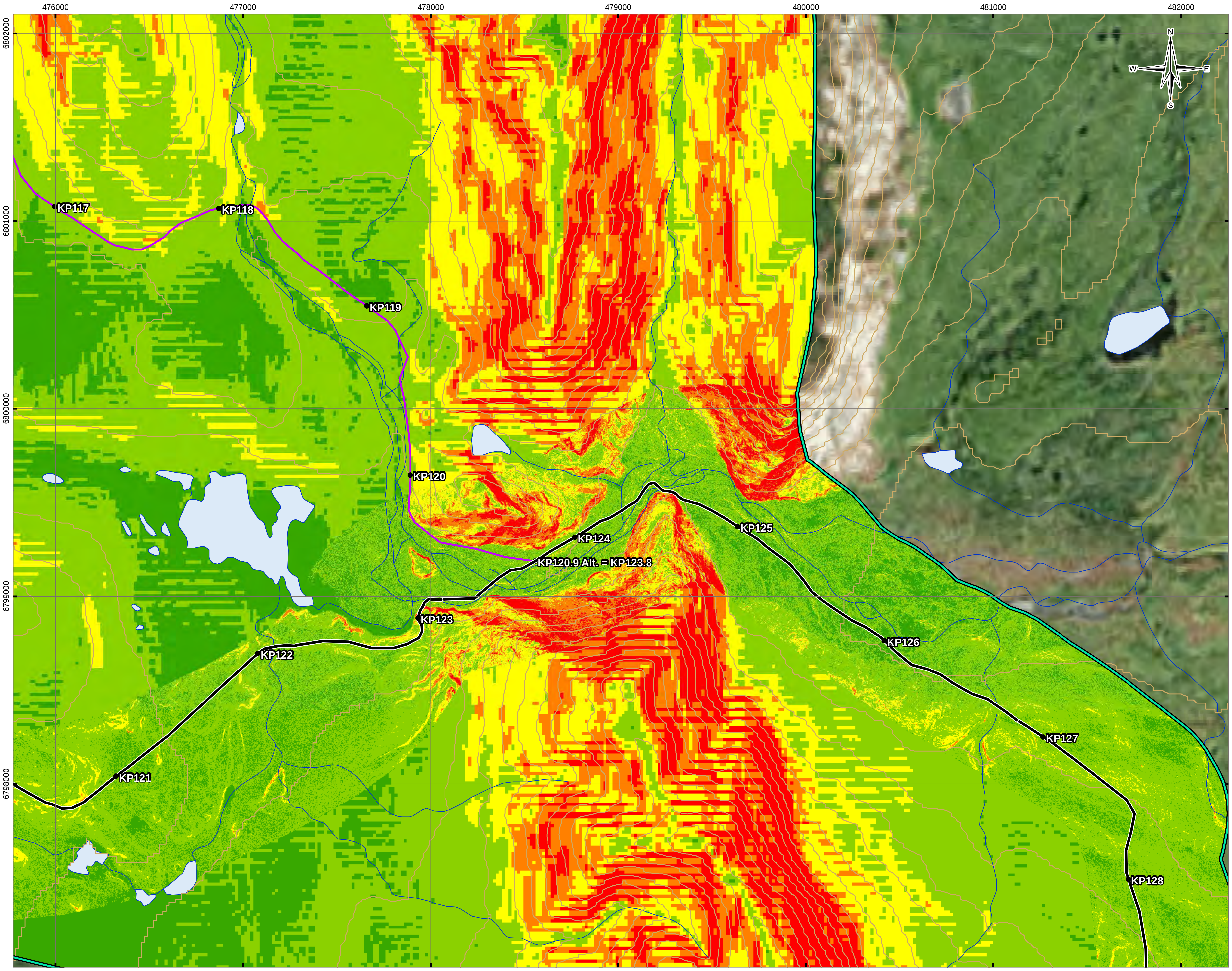
FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A20

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan



LEGEND

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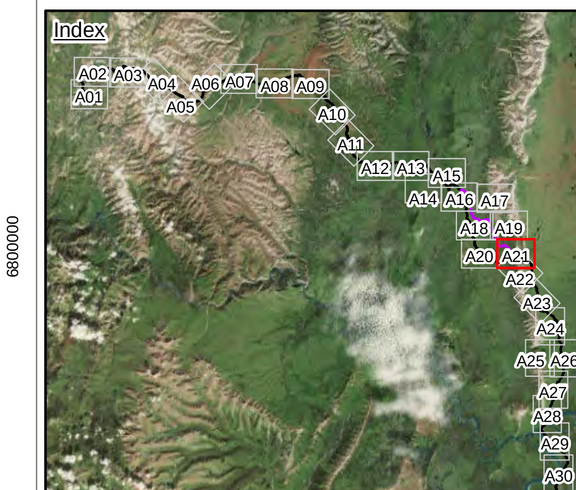

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A21

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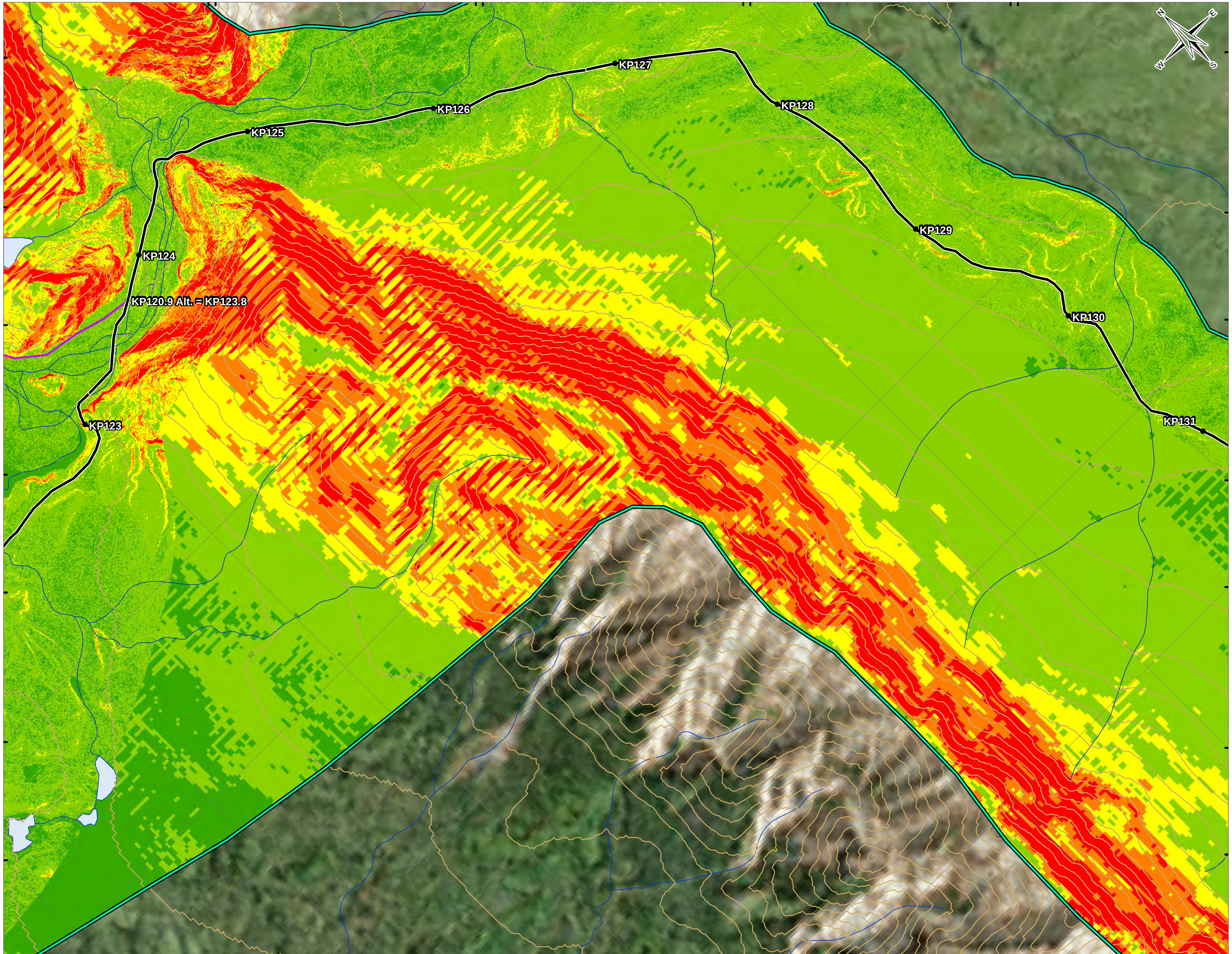

LEGEND

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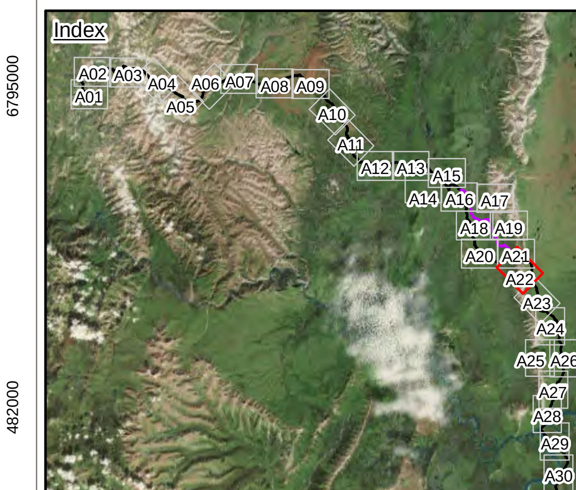

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SlopeMaps_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1
OFFICE	DATE			
Tt EBA-VANC	August 26, 2015			

Figure A22

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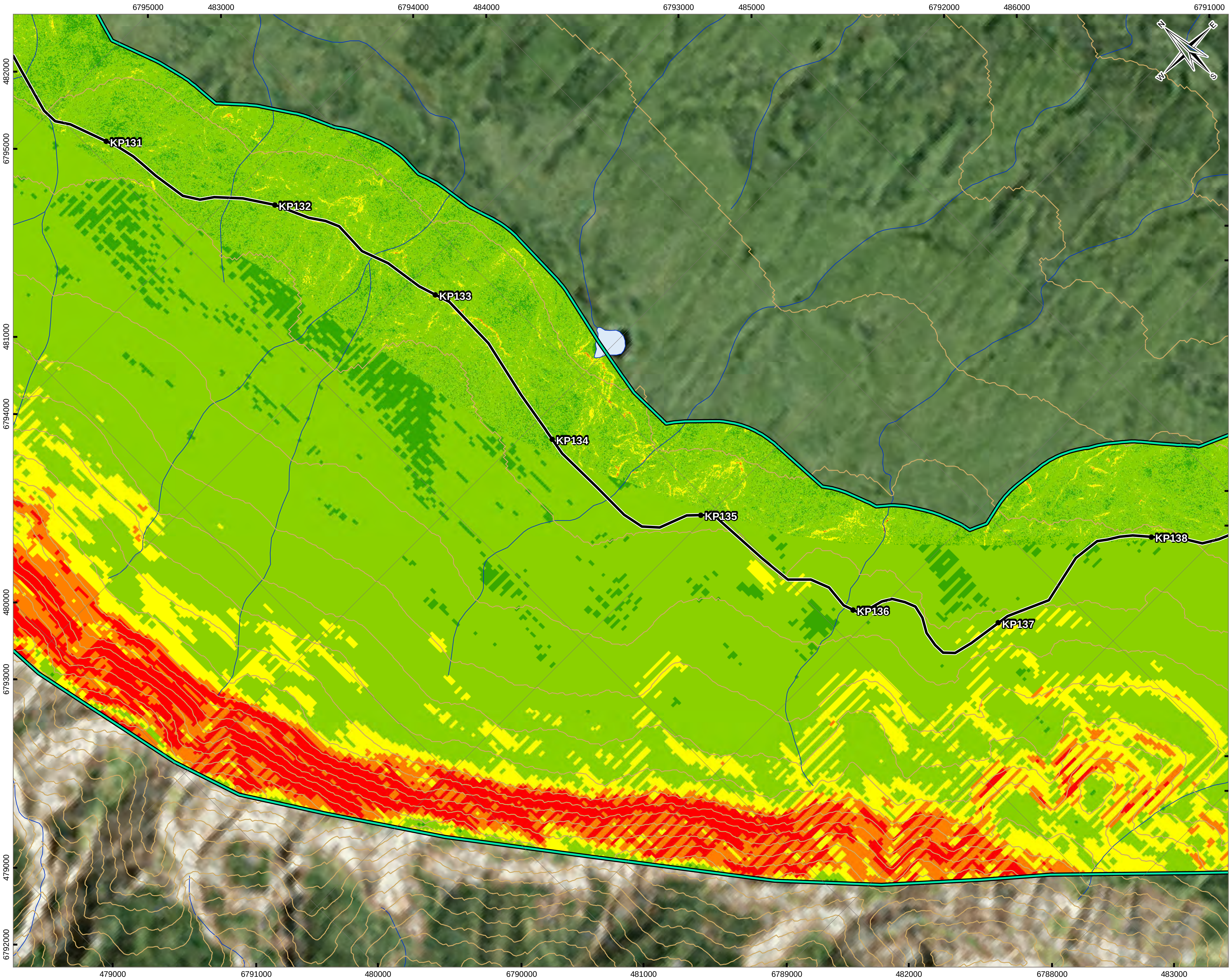

LEGEND

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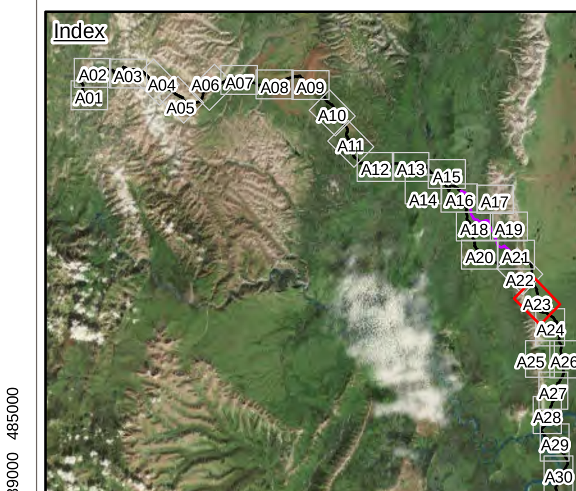

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
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Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A23

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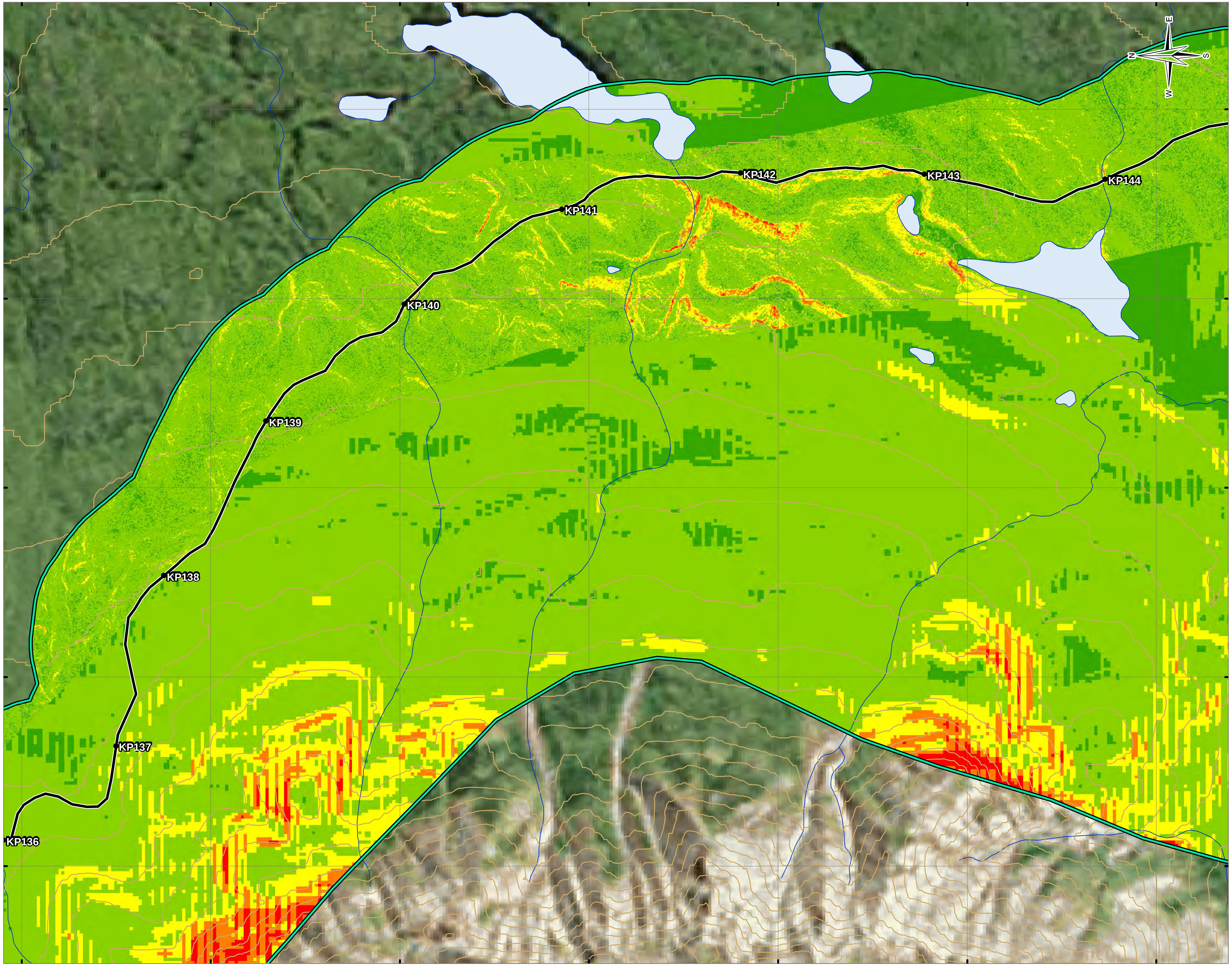

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LEGEND

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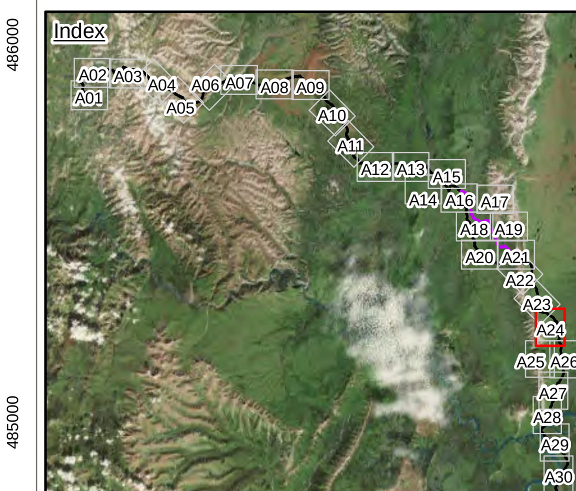


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

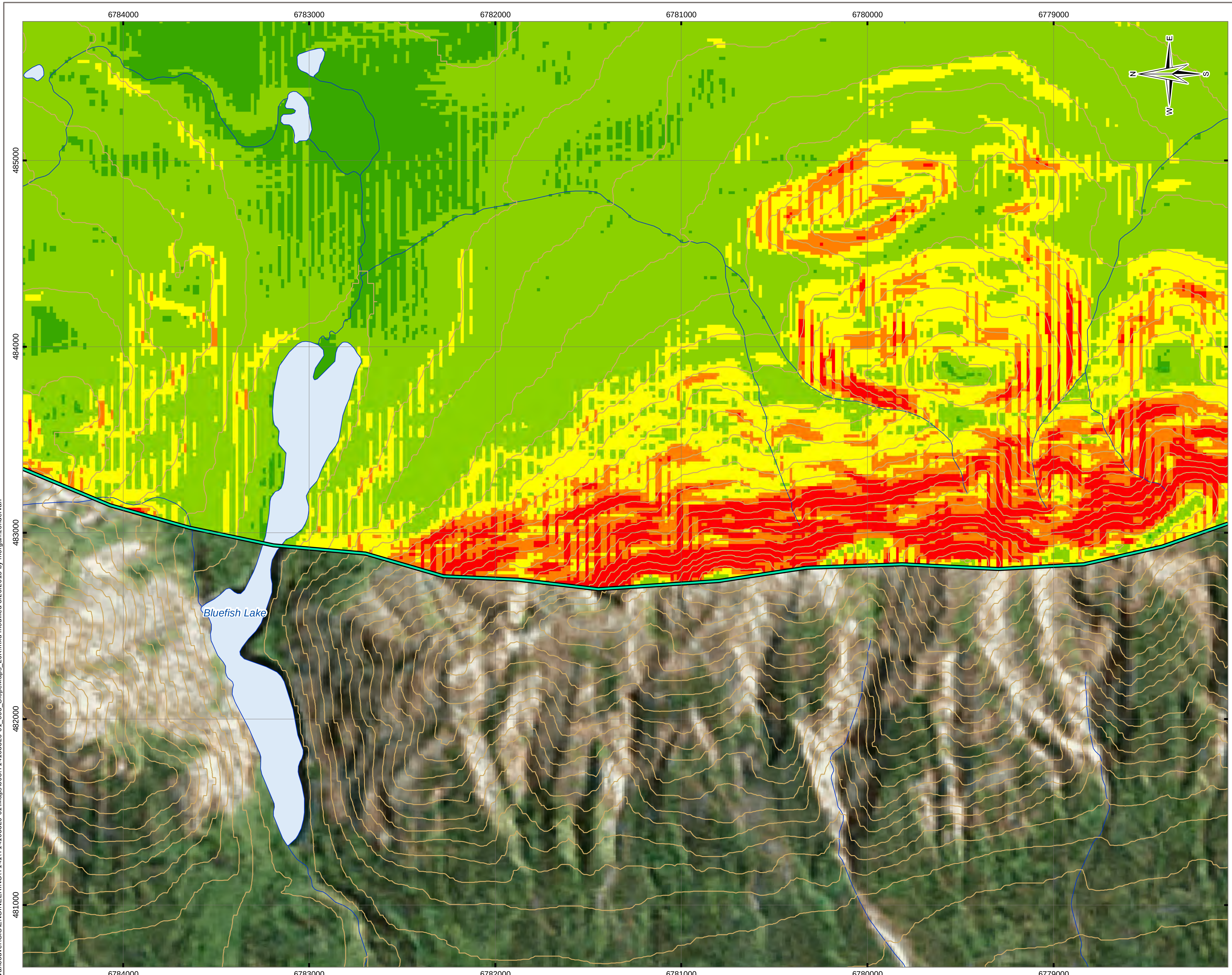
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A24

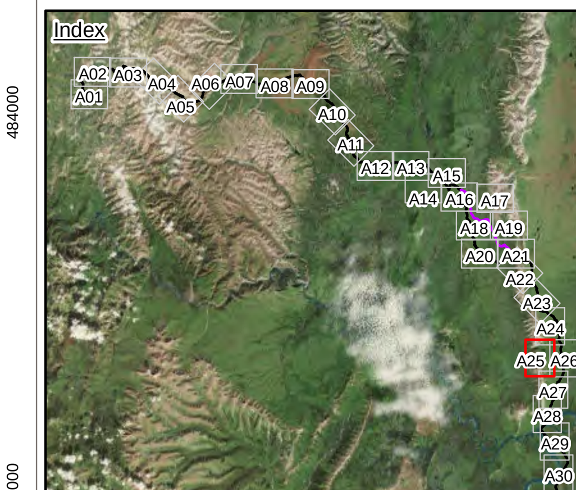


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

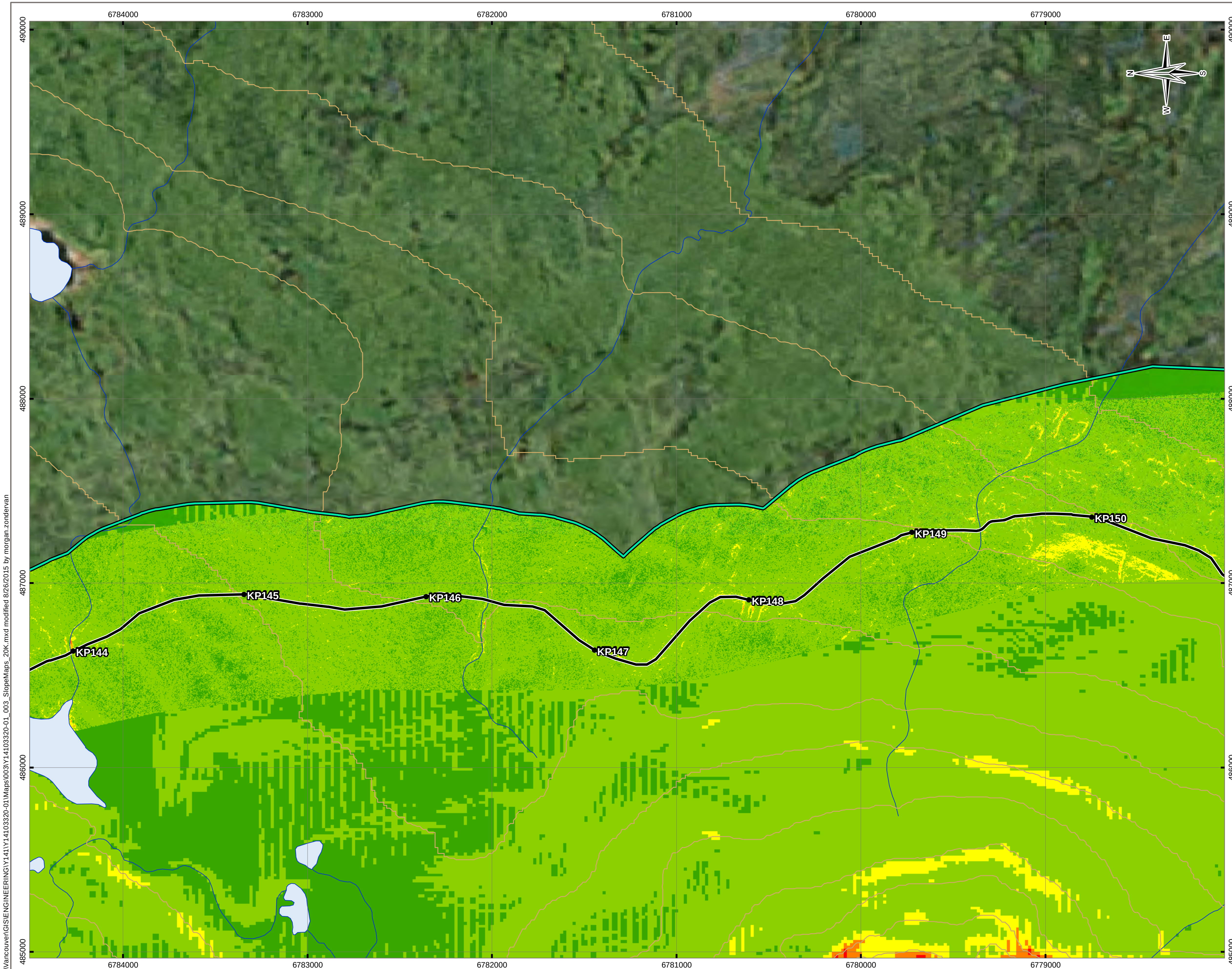
FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A25

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan

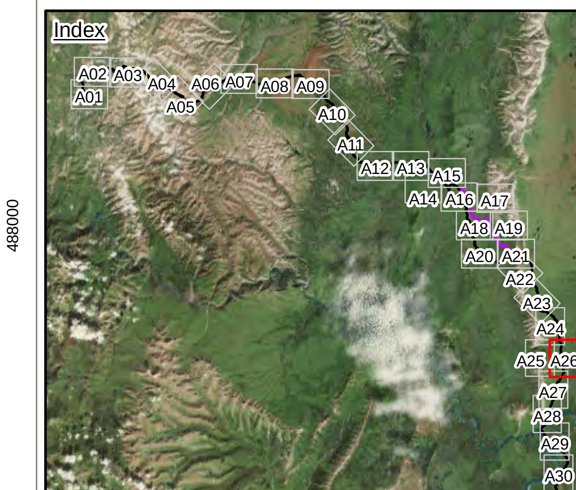


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

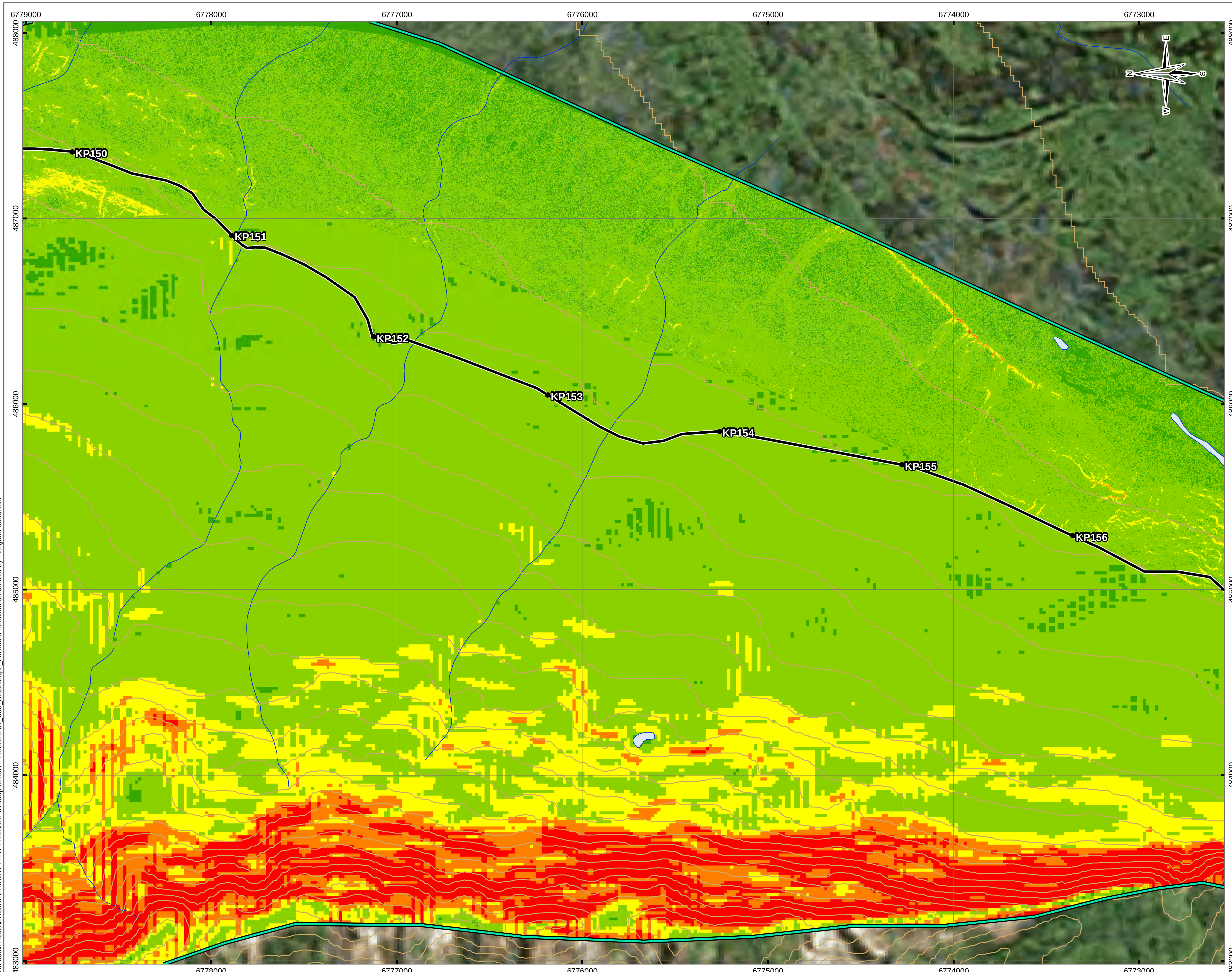
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A26



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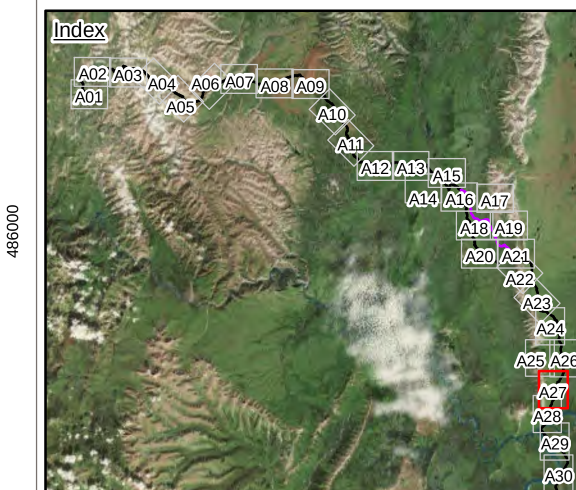
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

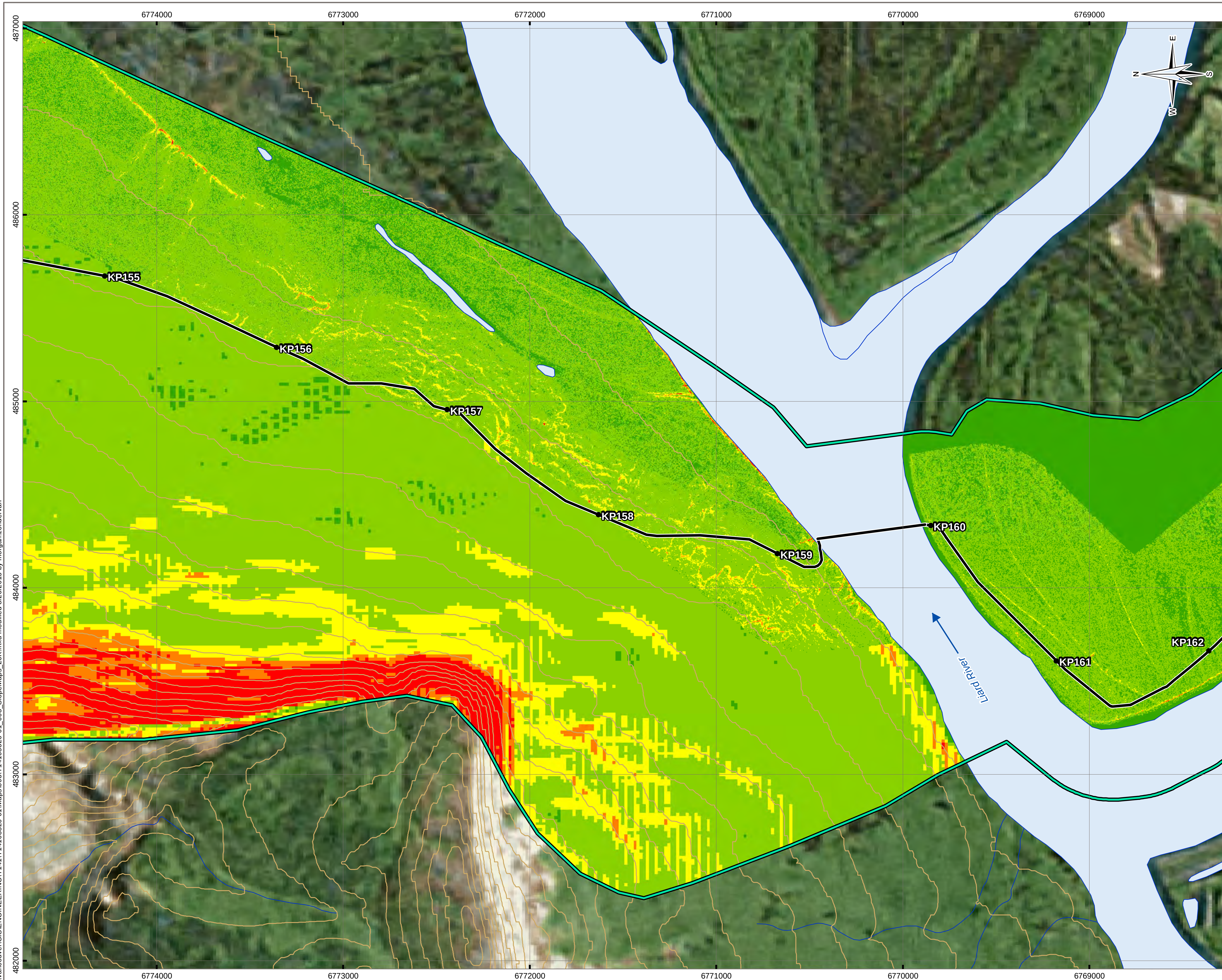
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A27



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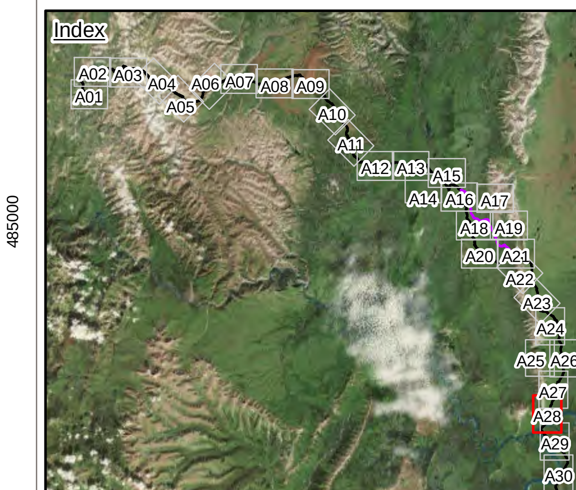
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

Figure A28

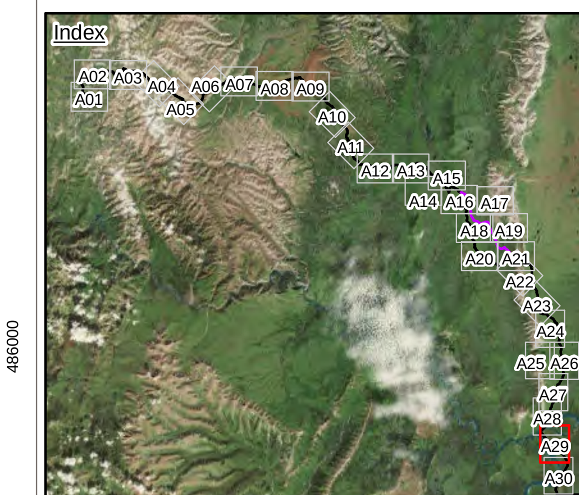
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SlopeMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1

OFFICE	DATE
Tt EBA-VANC	August 26, 2015

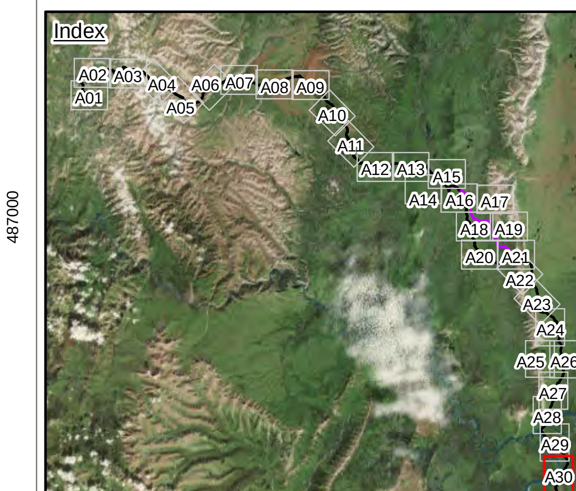
Figure A29

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Slope Gradient

- < 5% (flat)
- 5.01% - 27% (gentle)
- 27.01% - 50% (moderate)
- 50.01% - 70% (moderately steep)
- > 70% (steep)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional slope data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Gradient

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

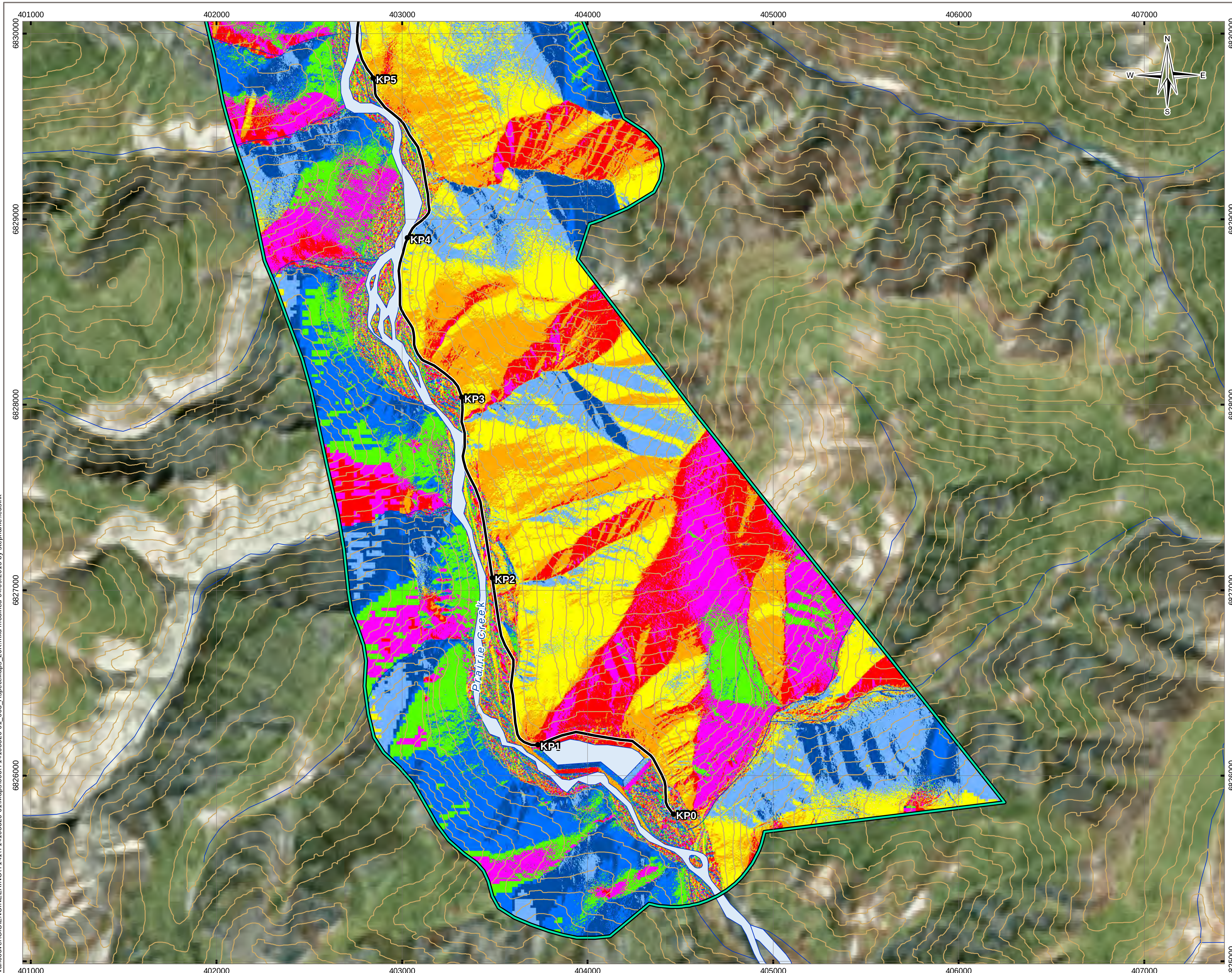
TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SlopeMaps_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	1
OFFICE	DATE			
Tt EBA-VANC	August 26, 2015			

Figure A30

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SlopeMaps_20K.mxd modified 8/26/2015 by morgan.zondervan

APPENDIX B
SLOPE ASPECT MAPS

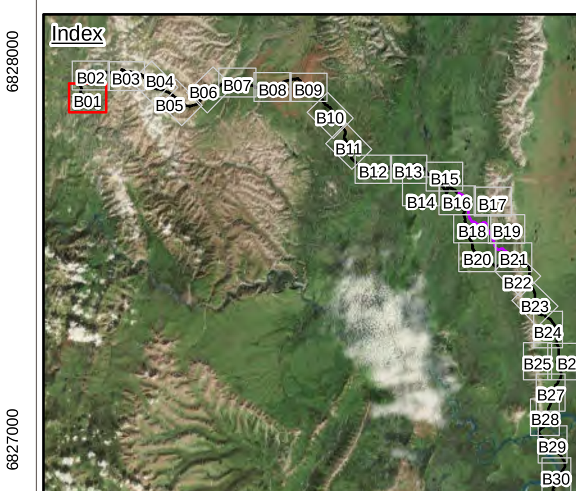


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B01

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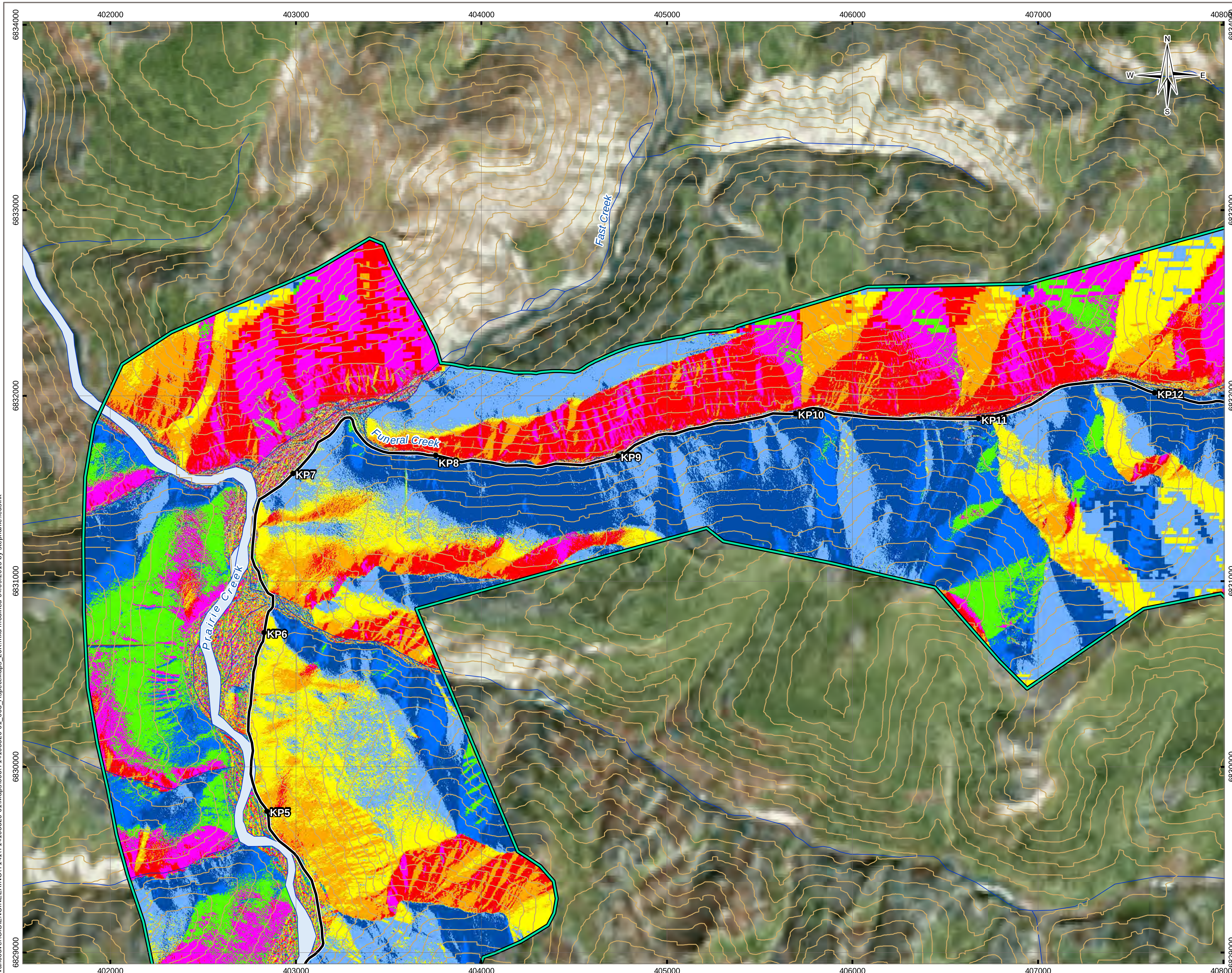
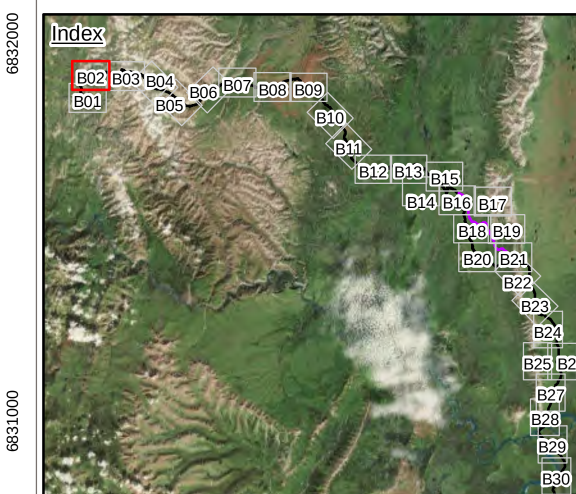


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_AspectMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

Figure B02

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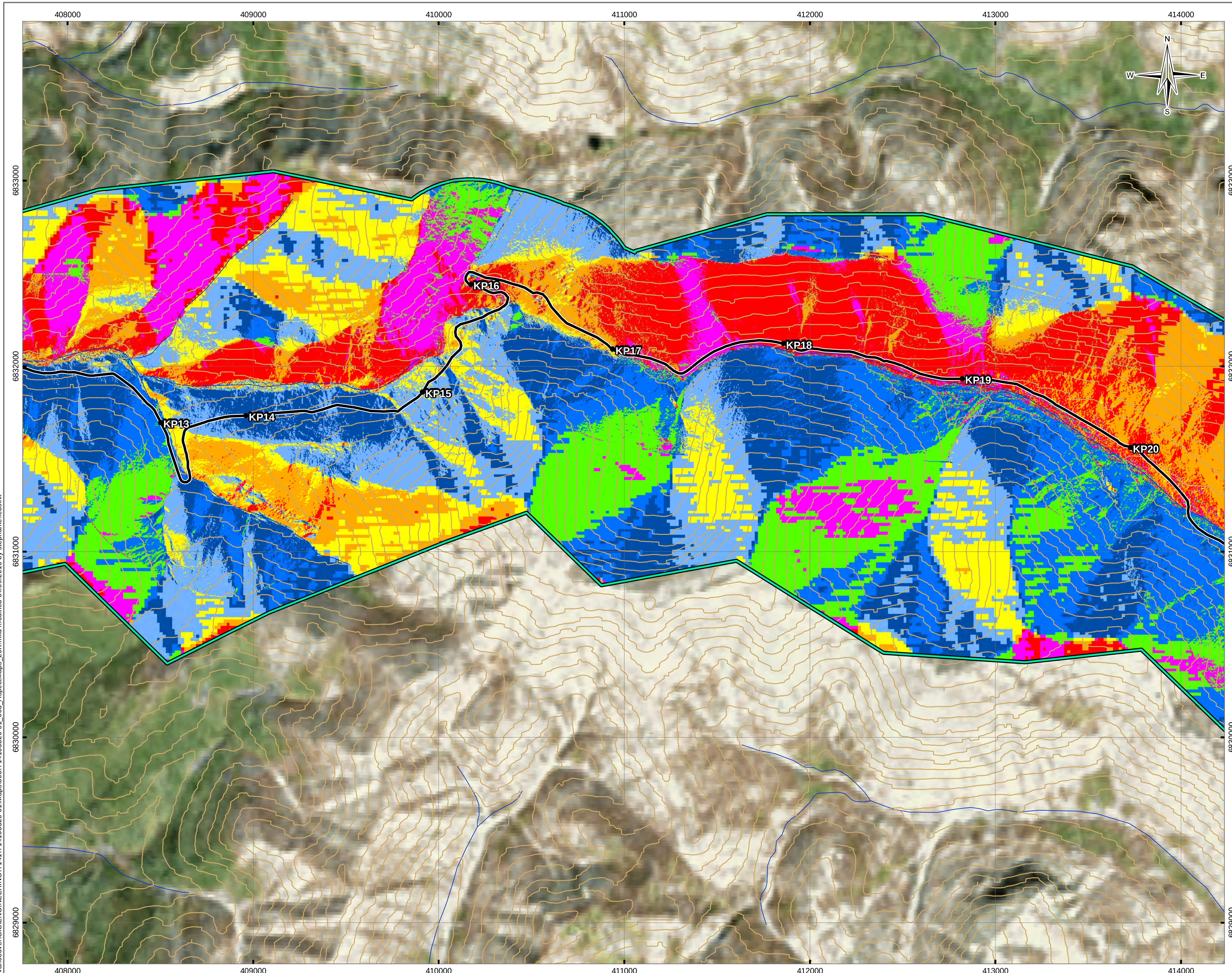

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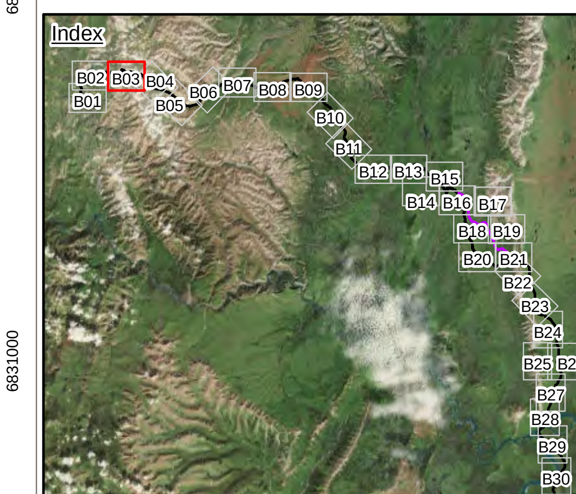
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

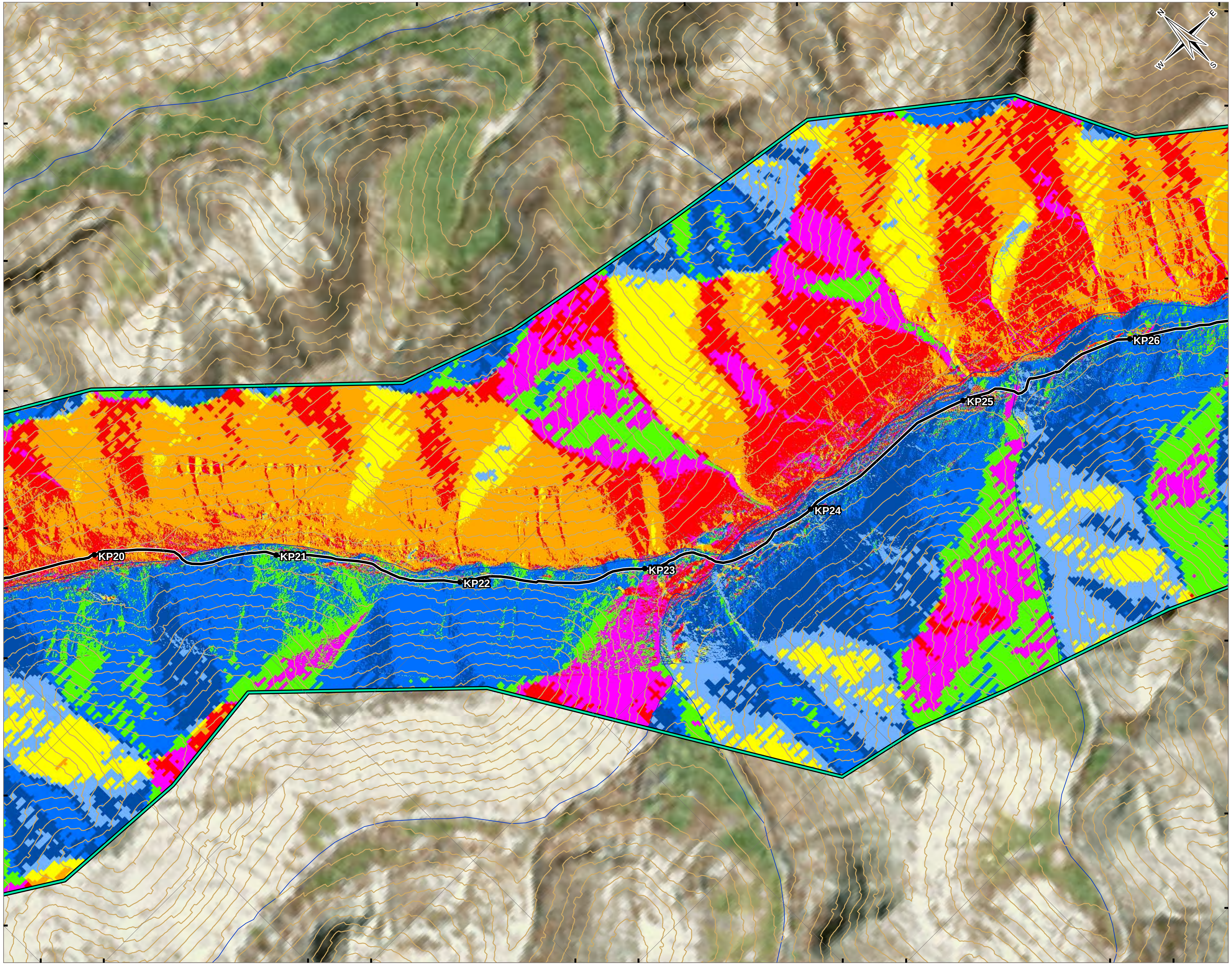
PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_AspectMaps_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure B03



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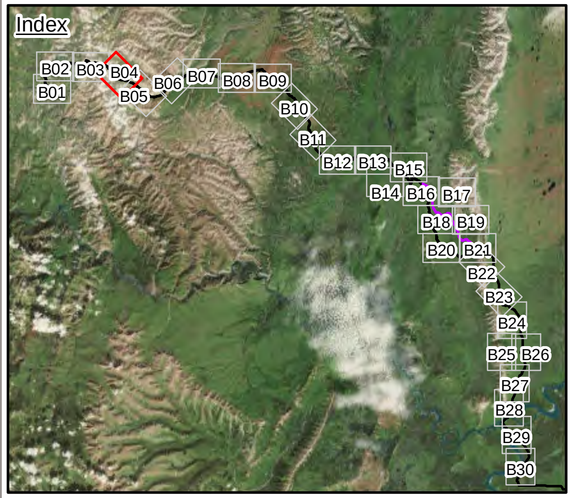
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

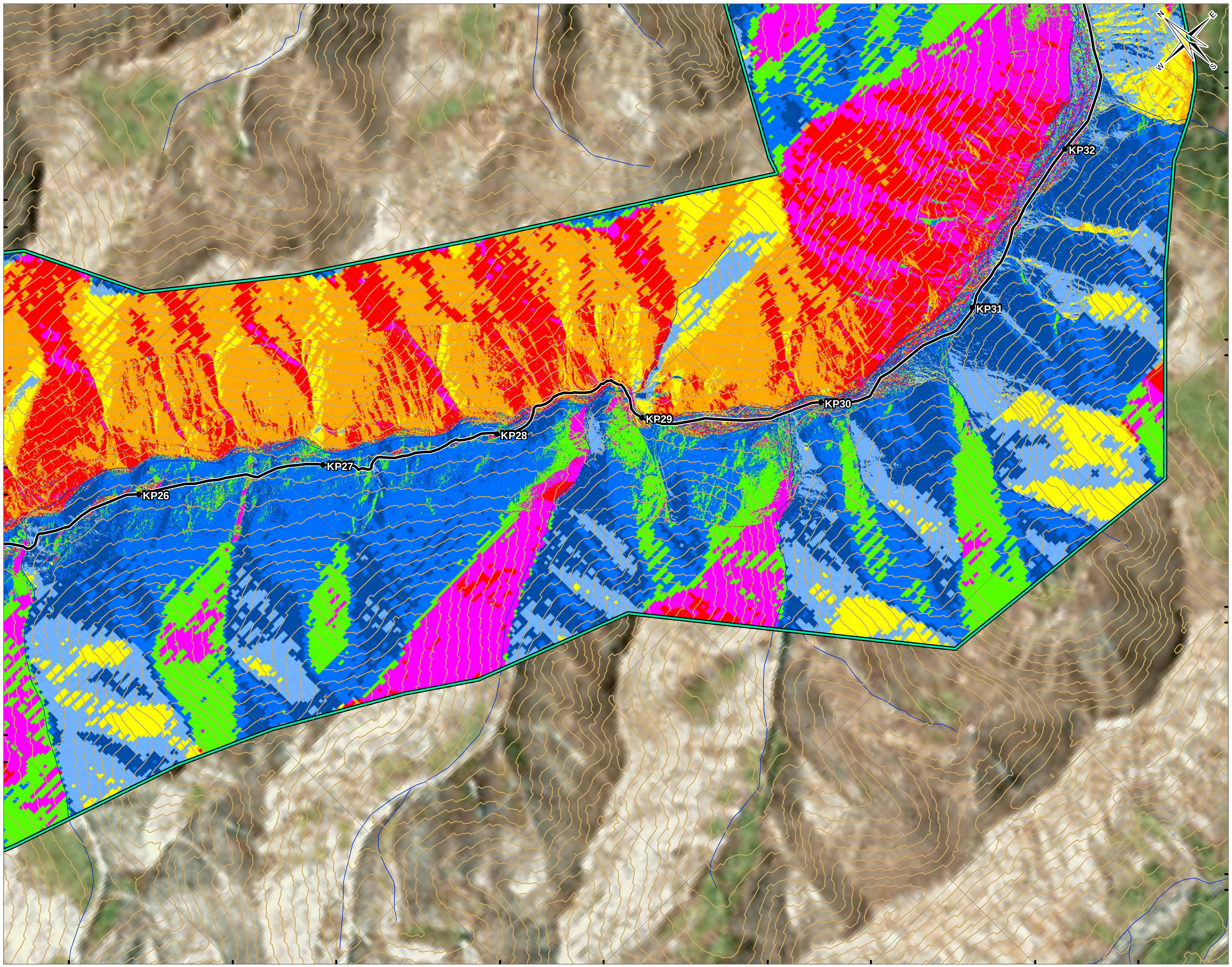
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B04



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
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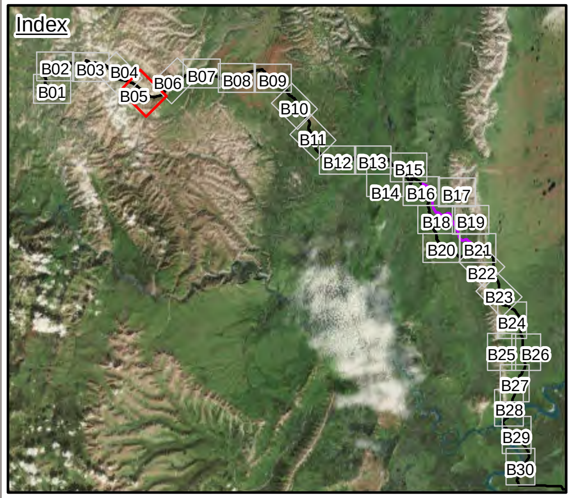
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B05

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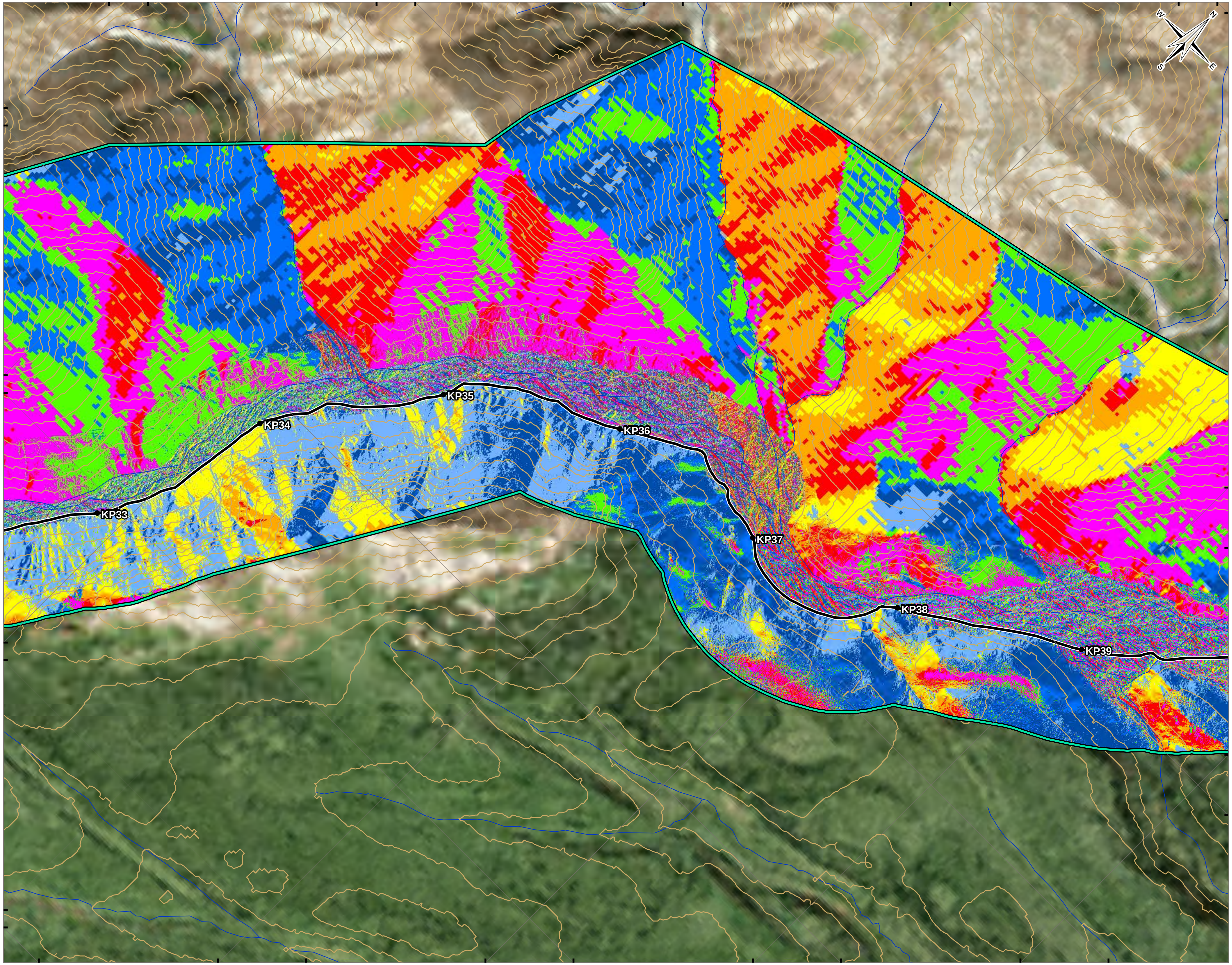

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

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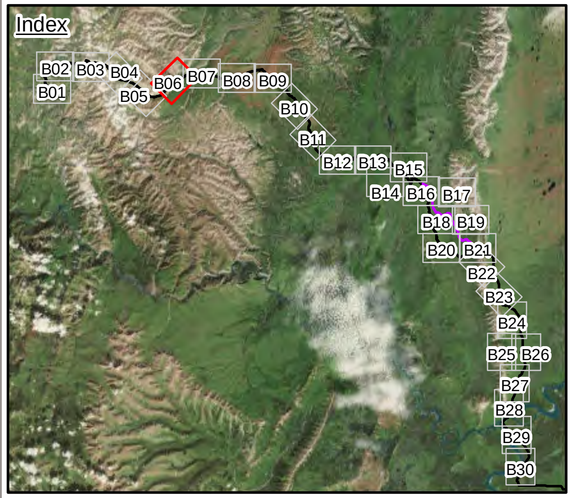
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)

Index



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B06

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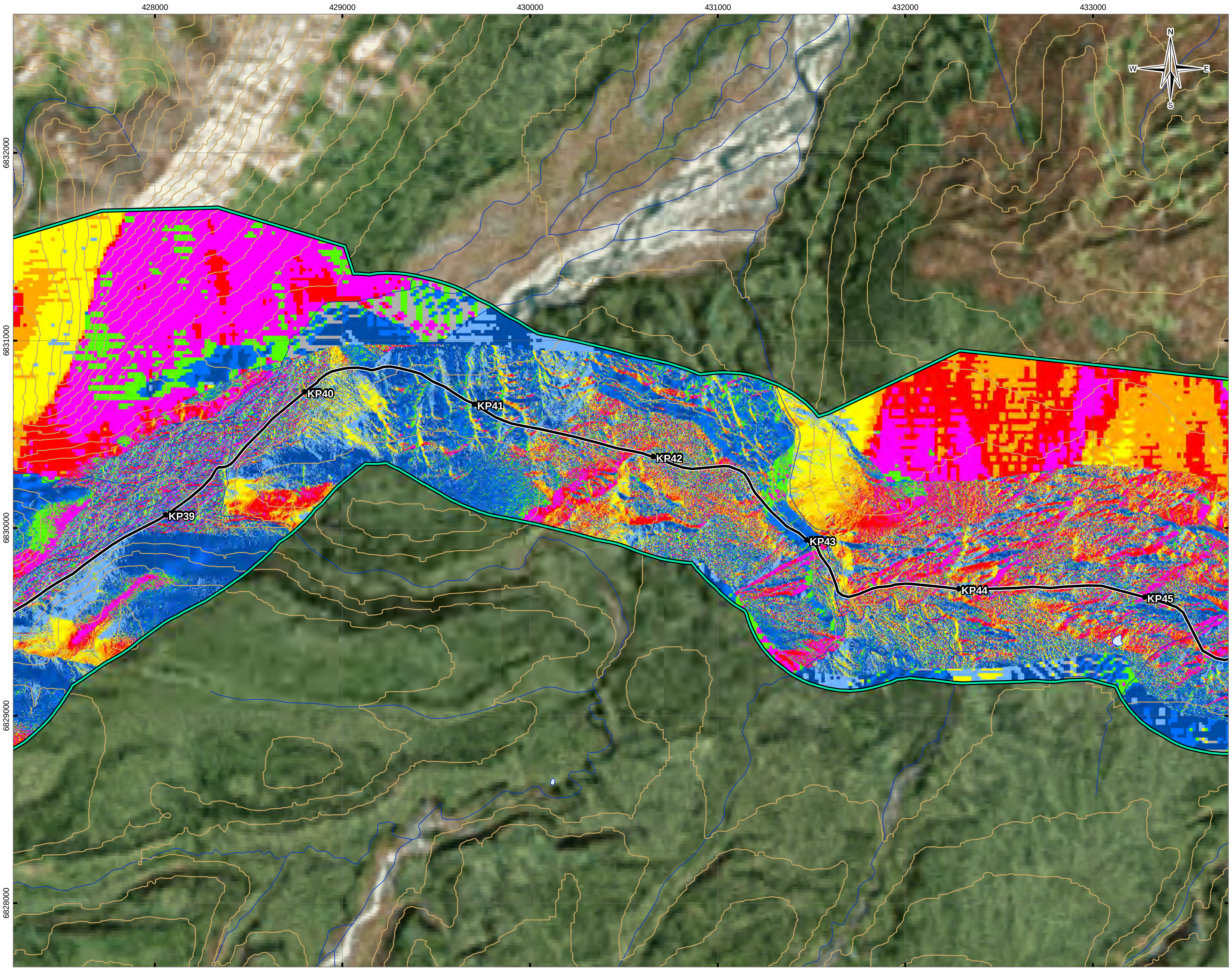
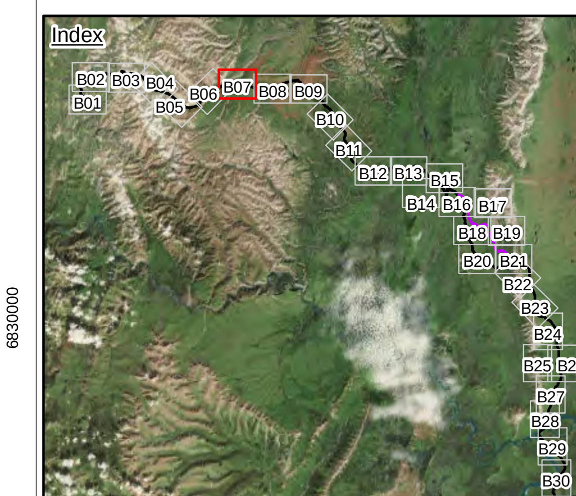


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

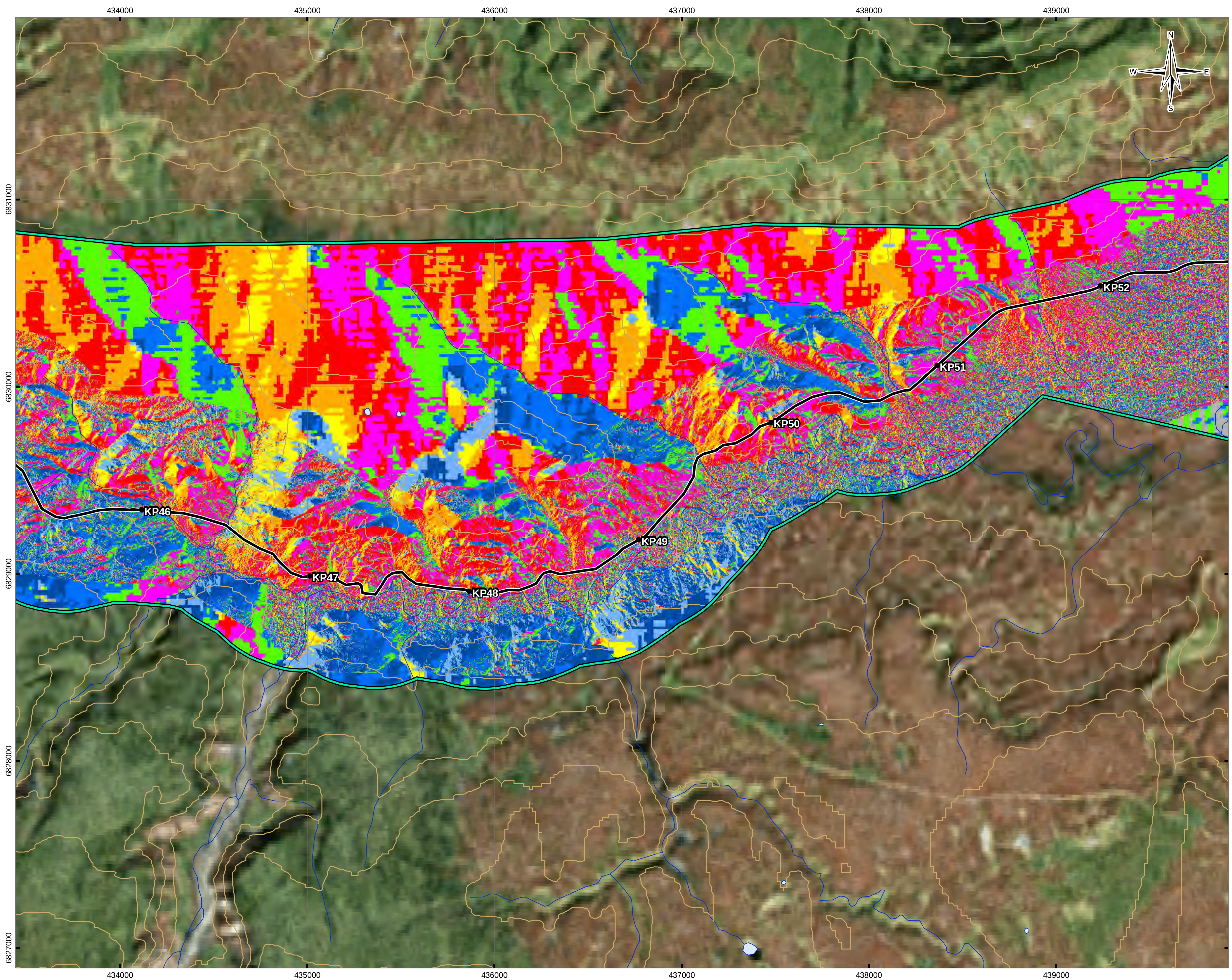
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B07

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



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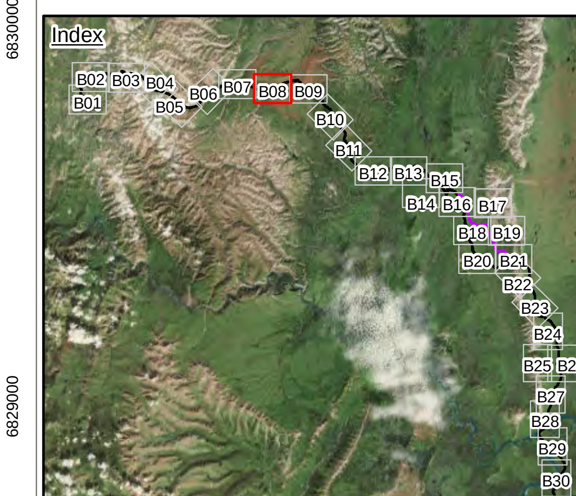
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

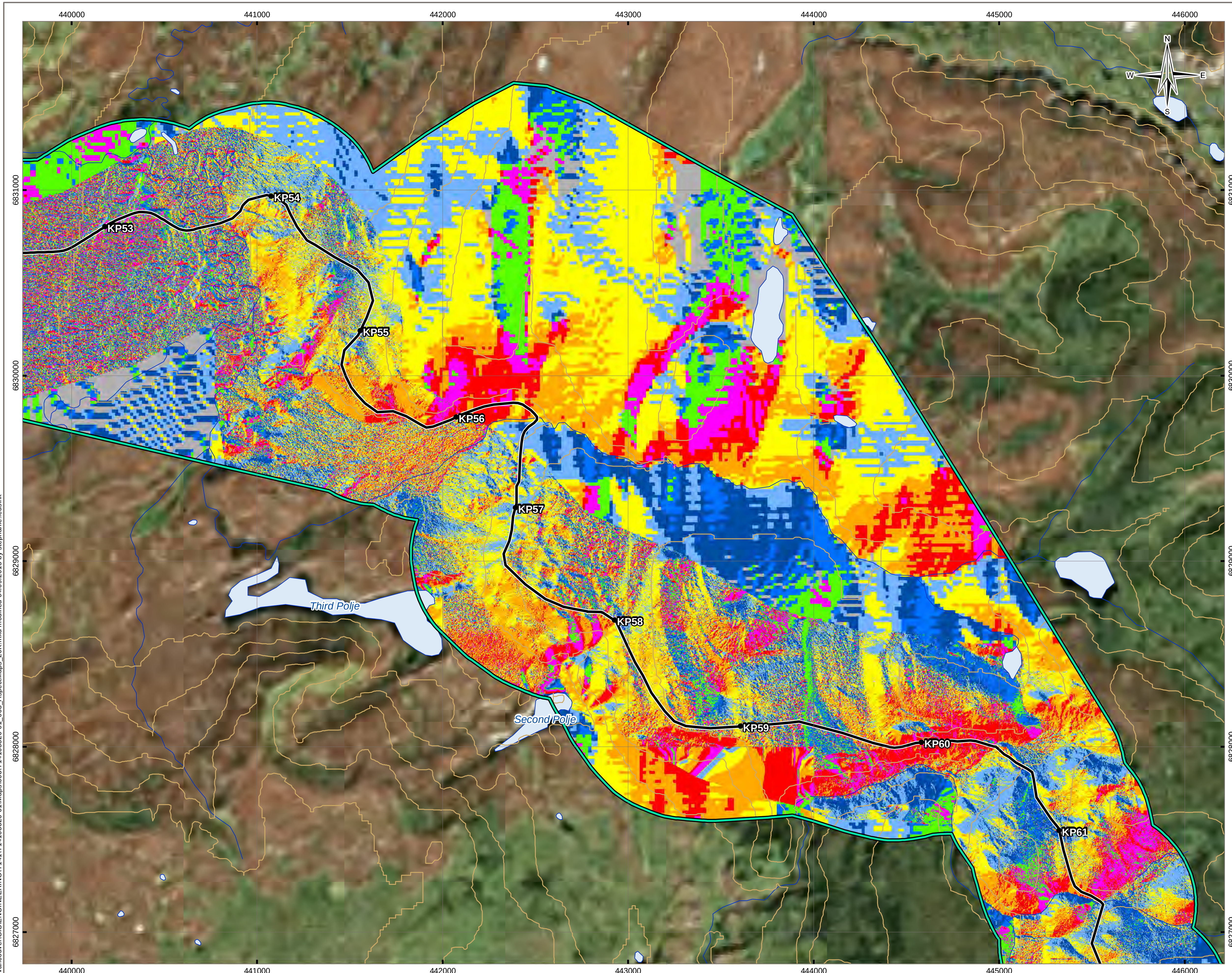
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B08

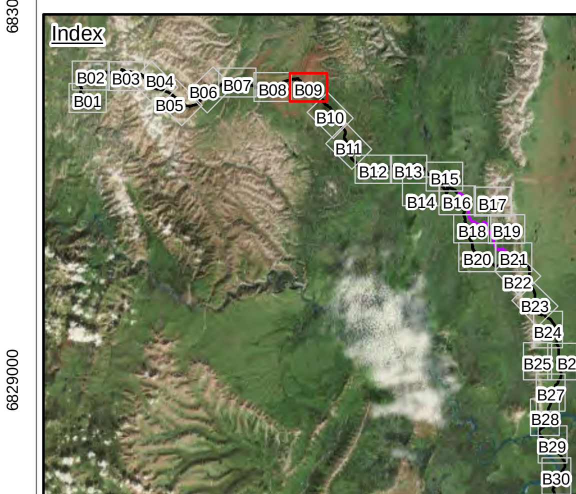


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

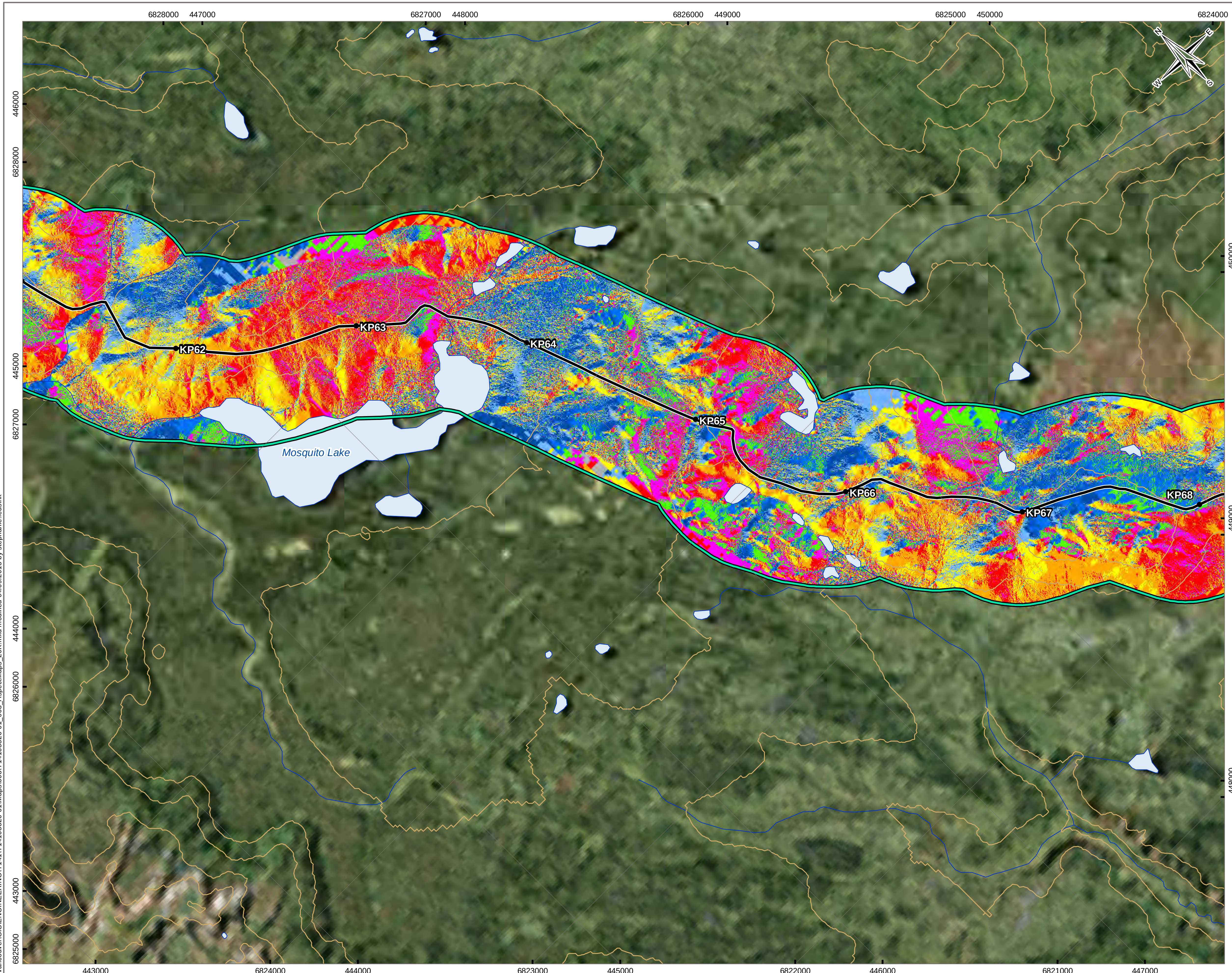
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B09

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



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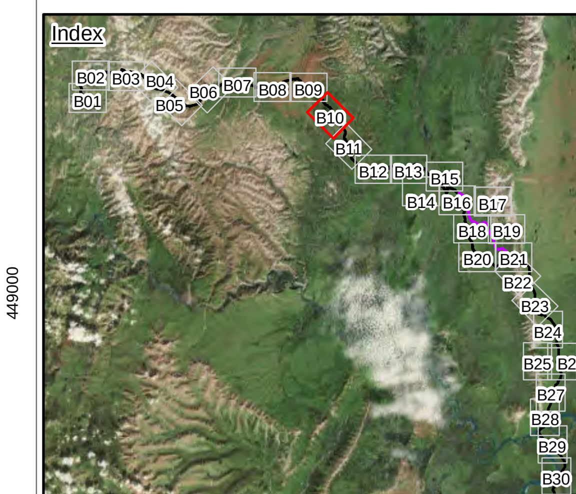
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

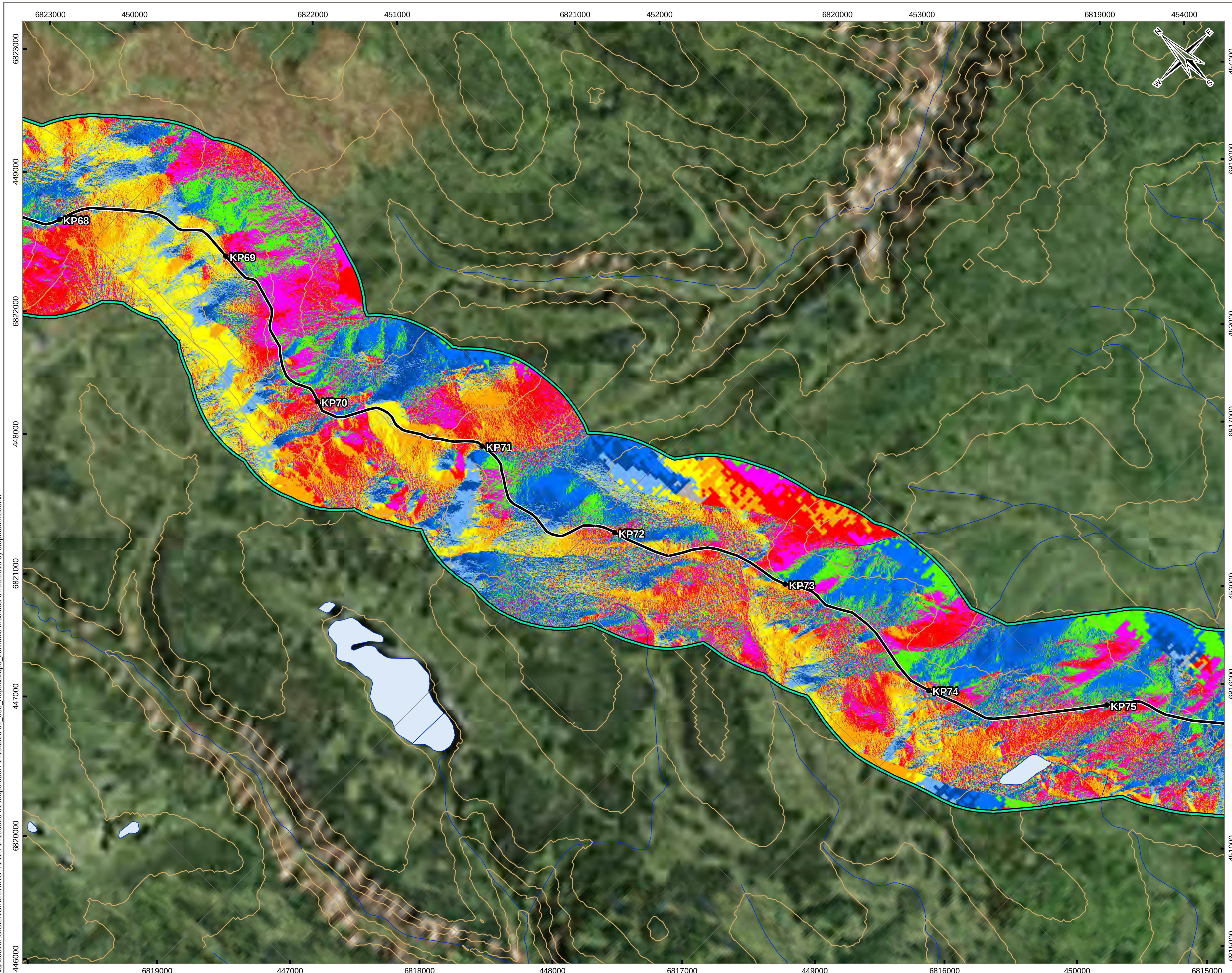
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B10

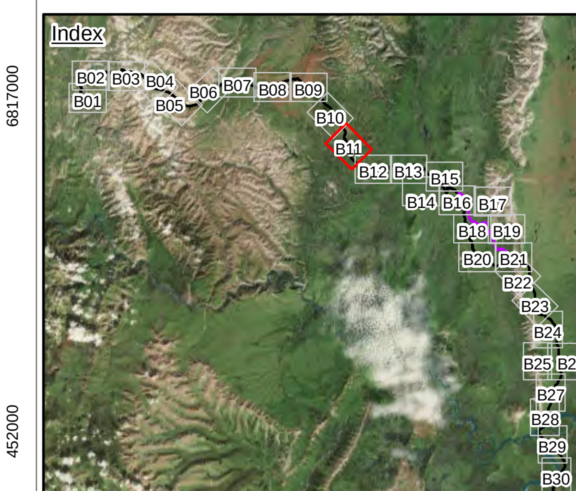


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B11

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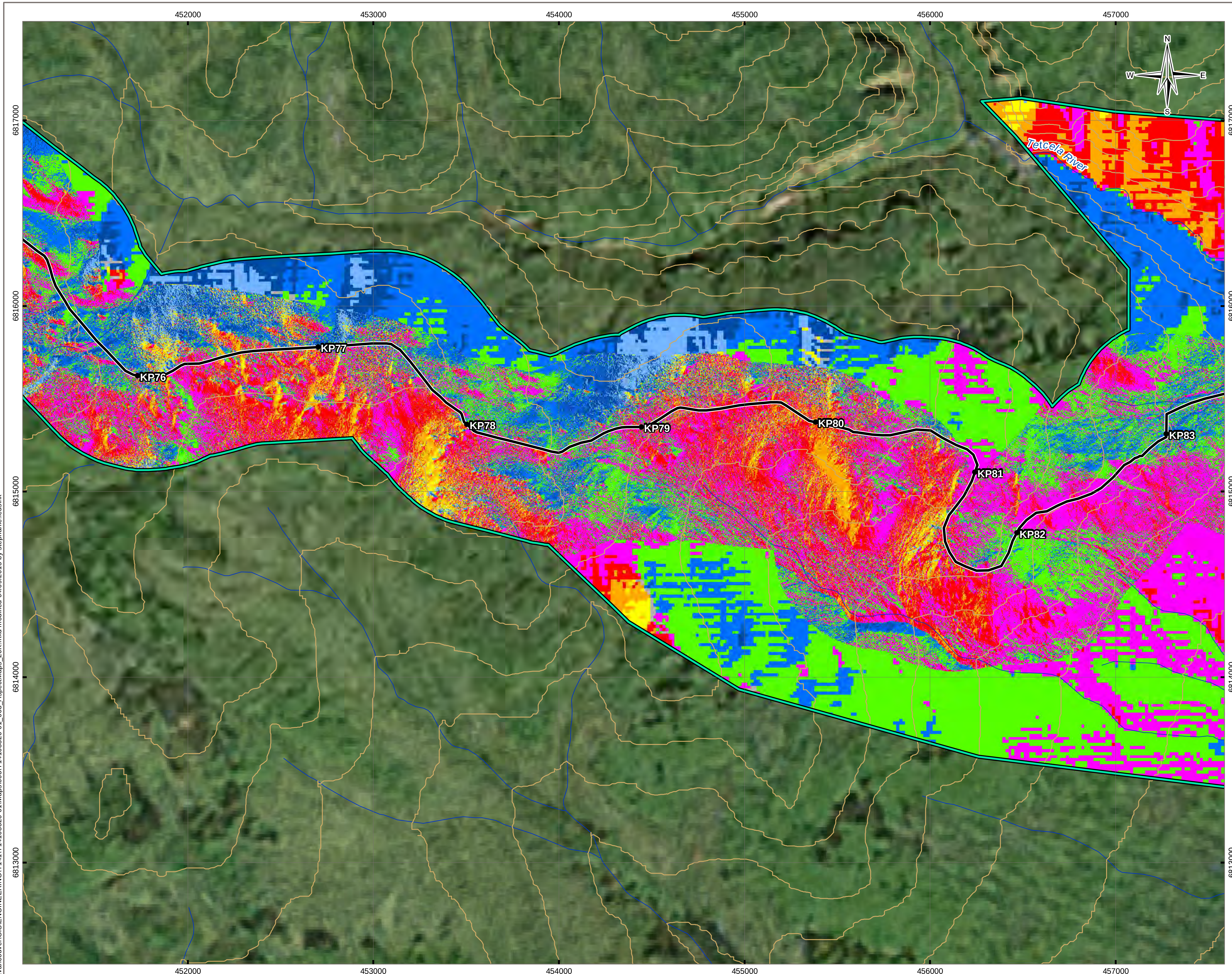


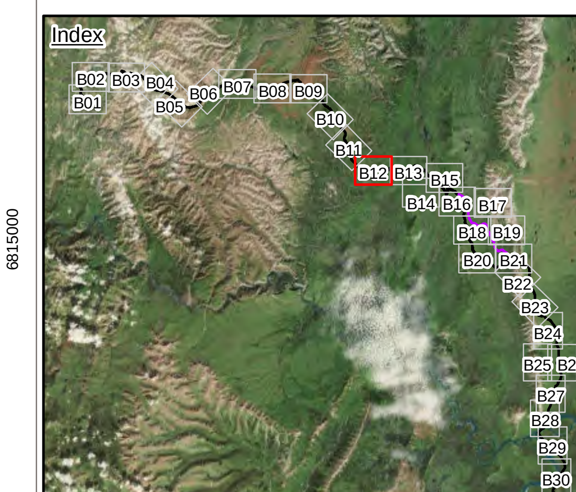
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
- Northeast (22.5-67.5)
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)

Index



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B12

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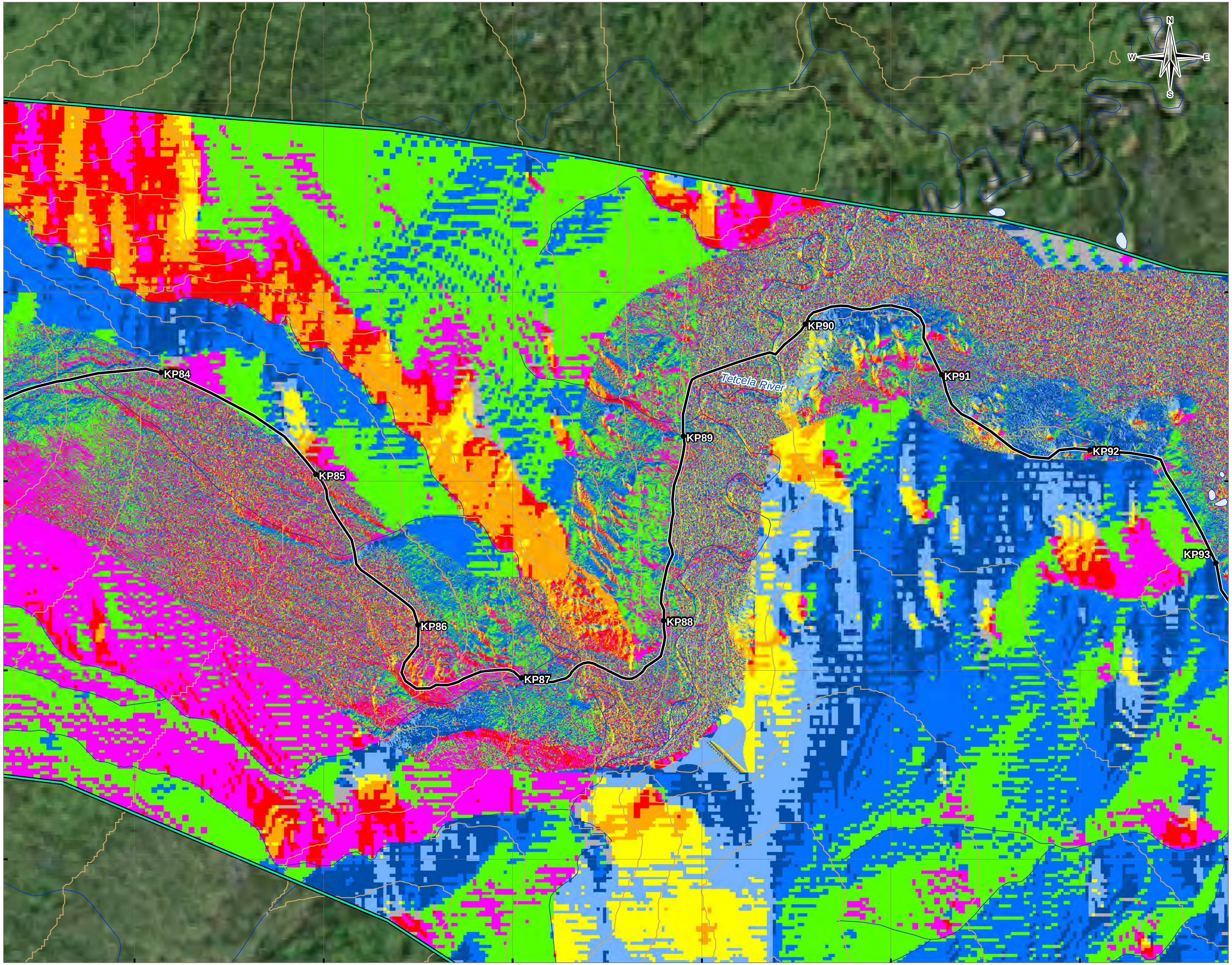

LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
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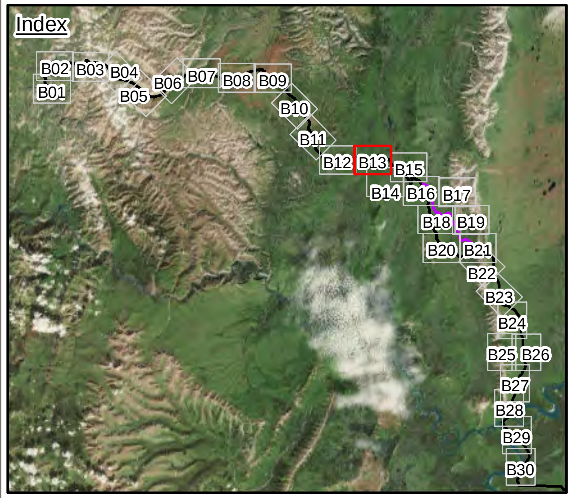
- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

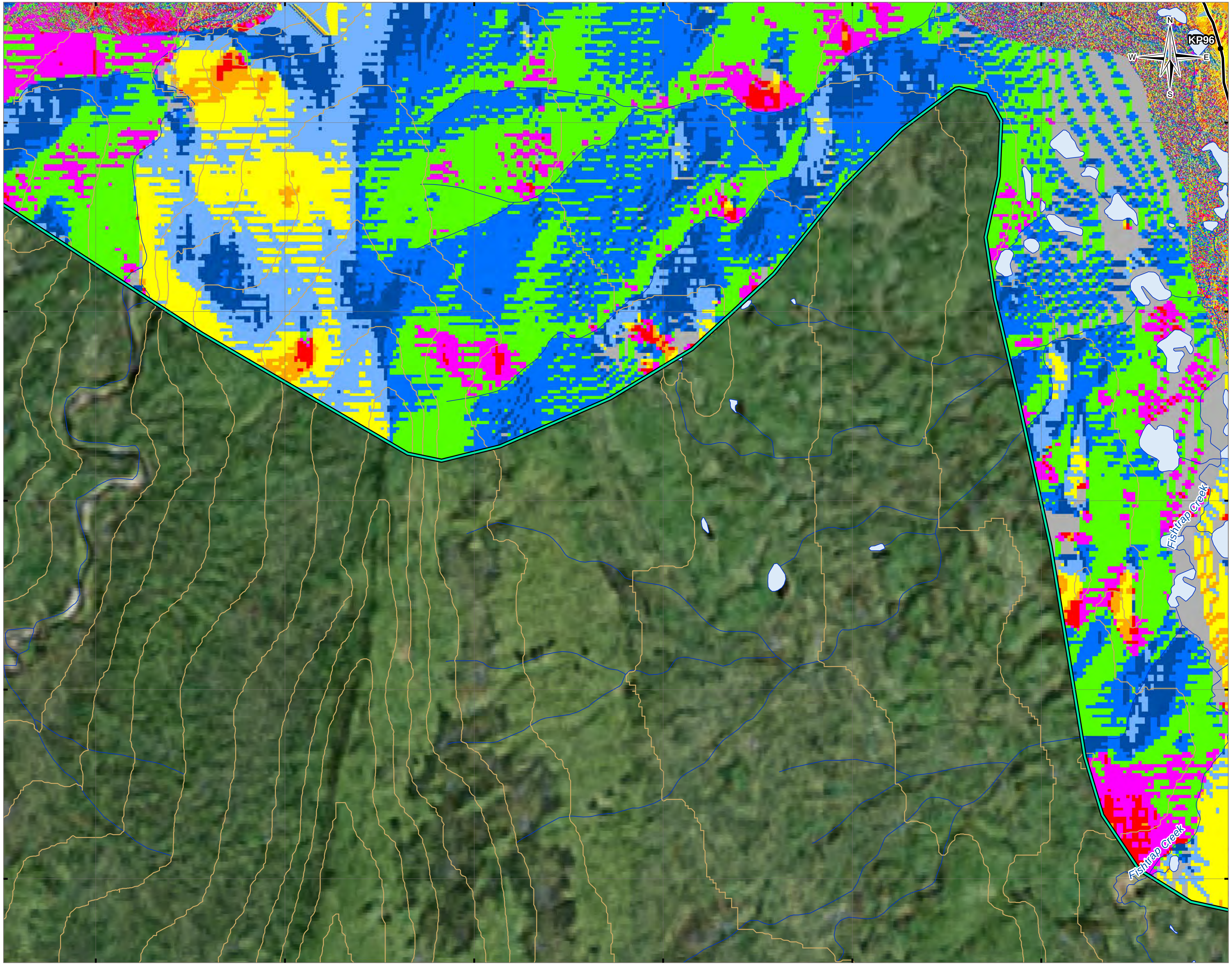
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B13

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.feusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
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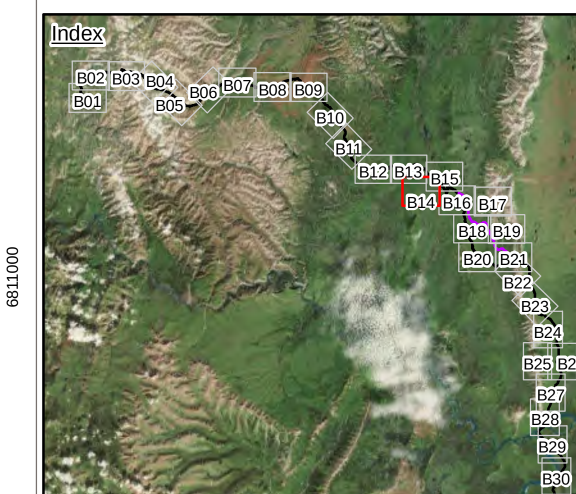
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B14

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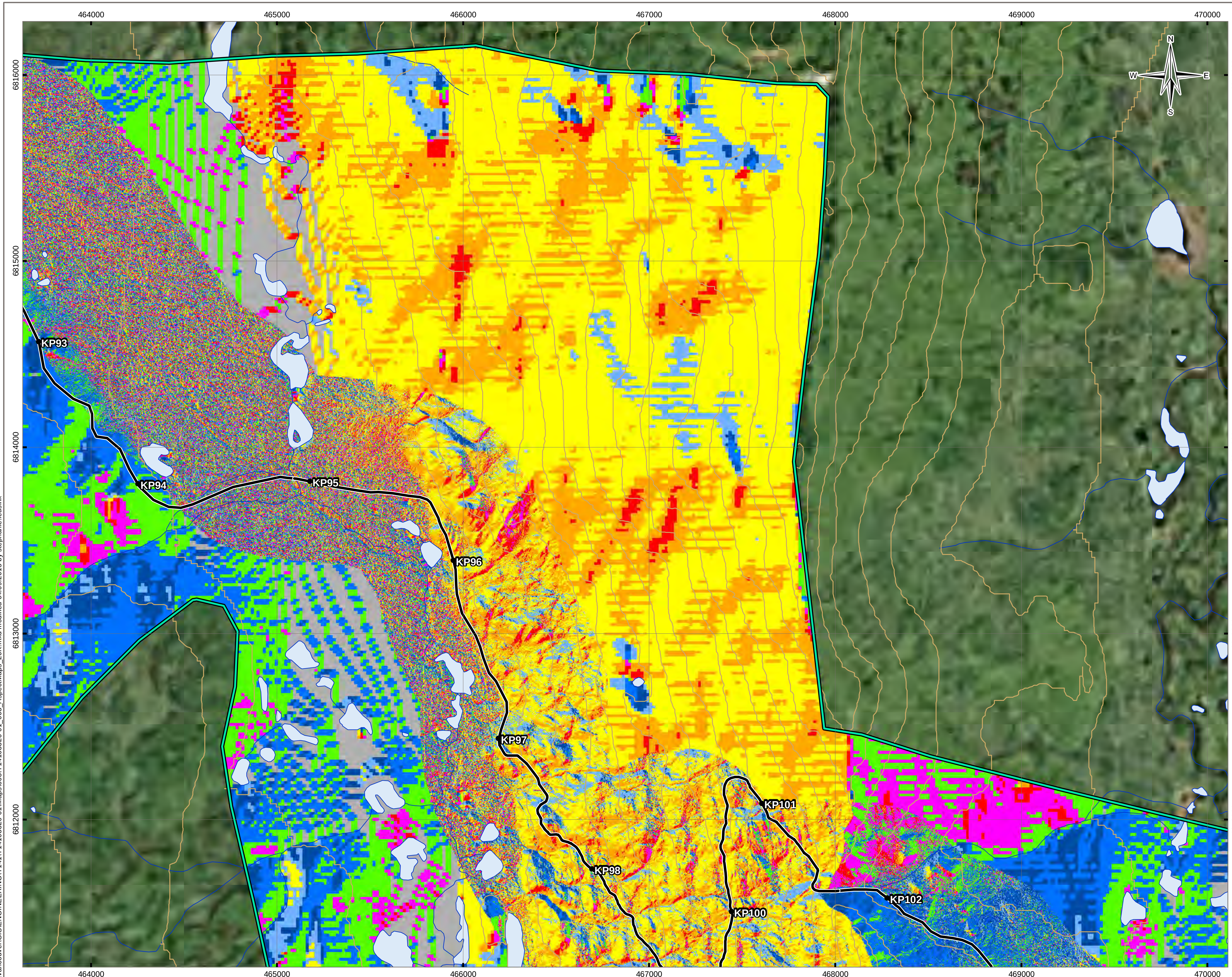

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LEGEND

- 1 km Buffer (+ additional areas)
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- South (157.5-202.5)
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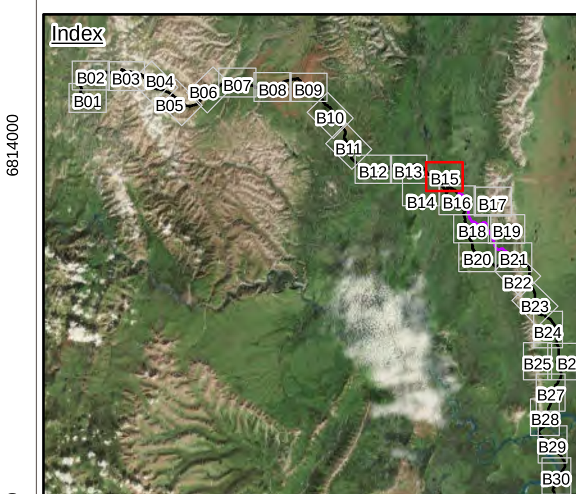
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
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Imagery from ESRI Basemap Service
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STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

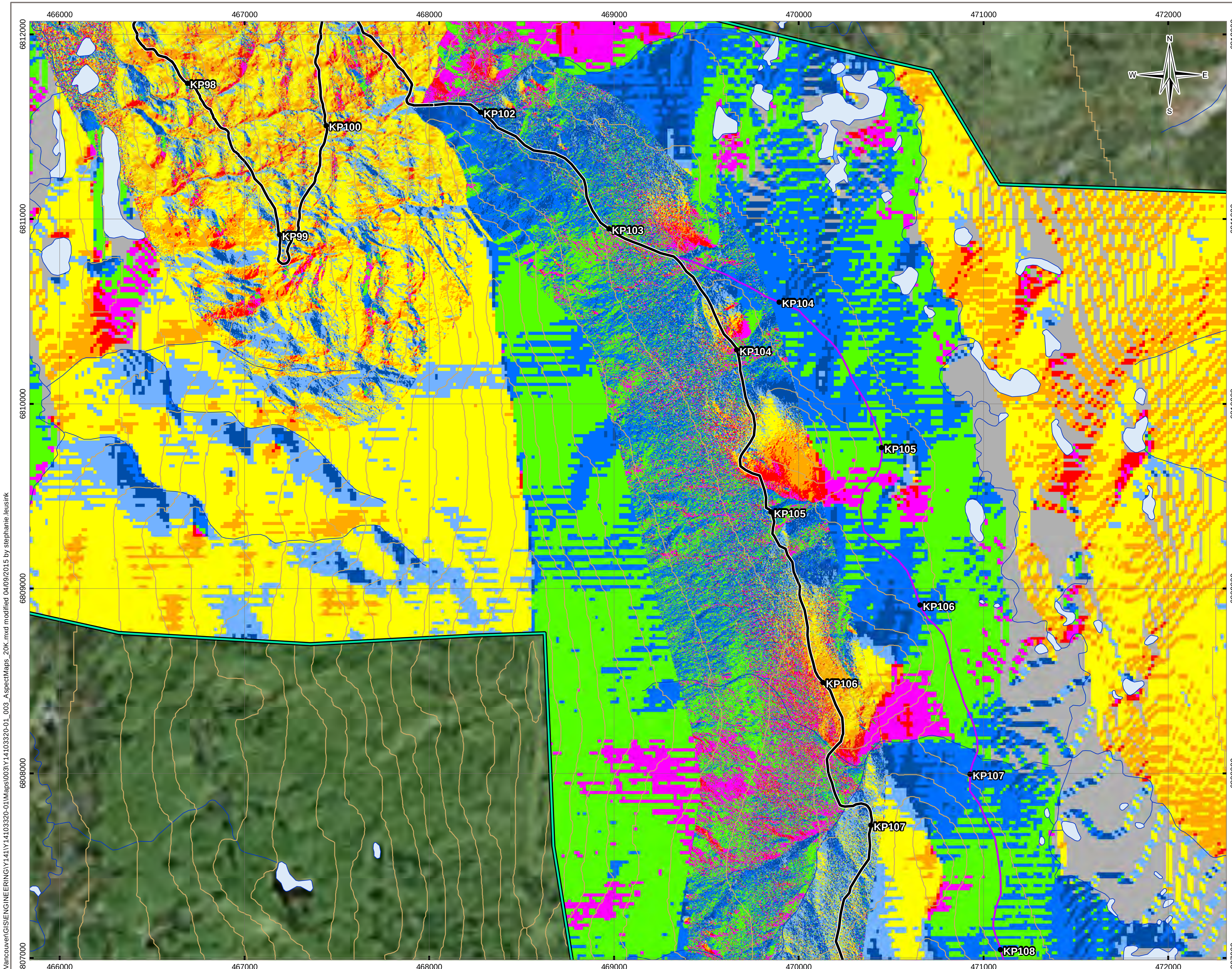
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B15



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

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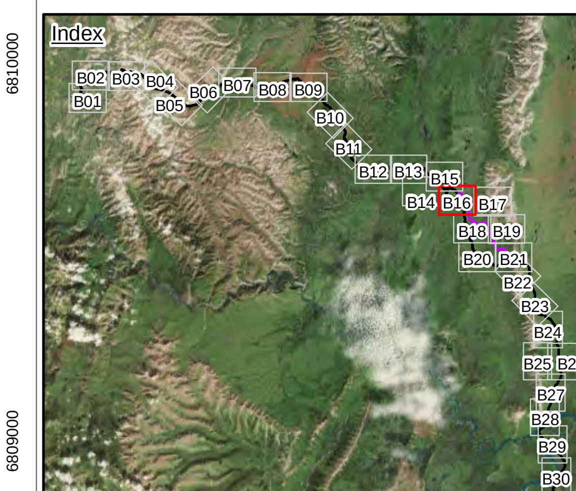
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

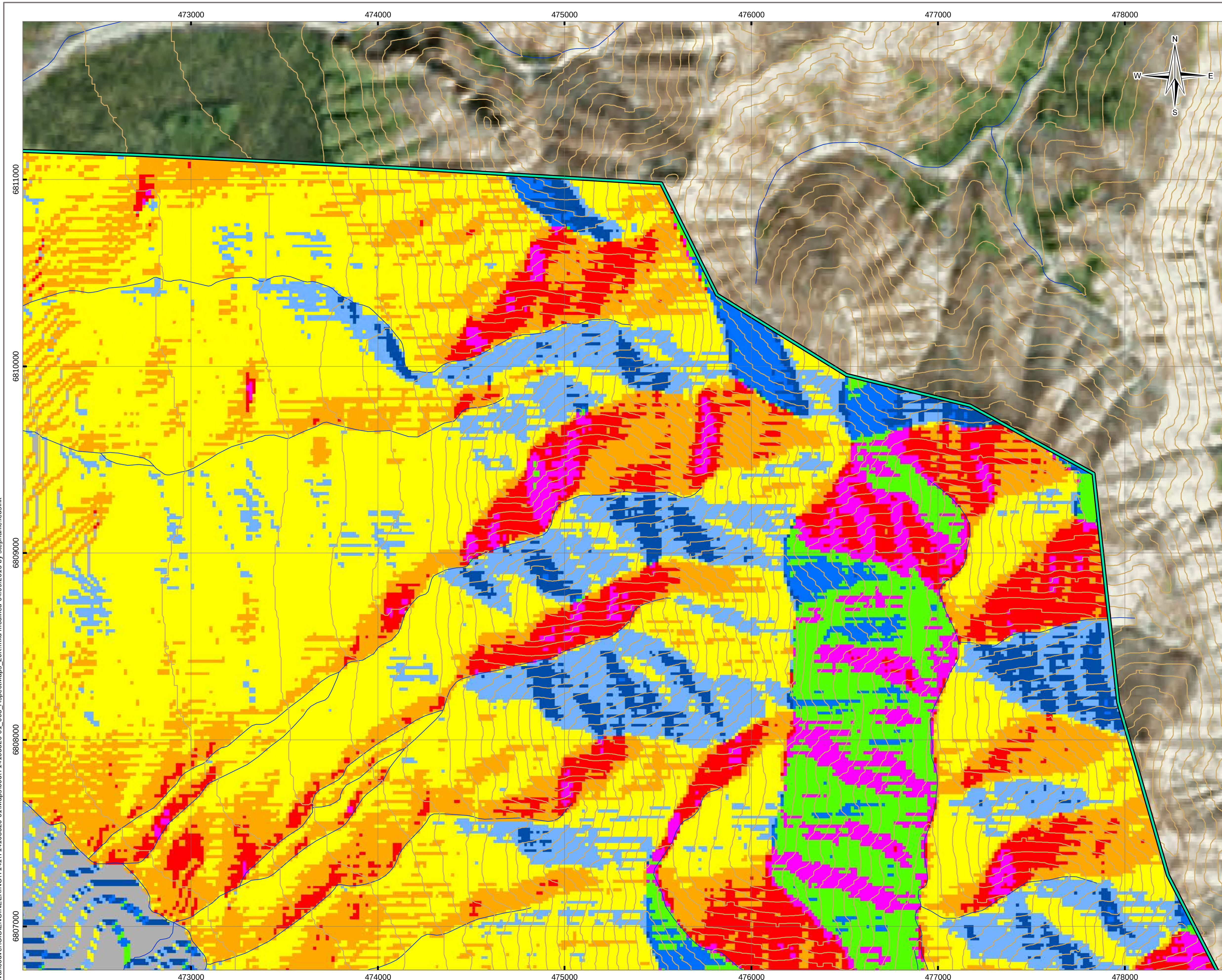
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B16



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
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- Contour (40 m)
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- Waterbody

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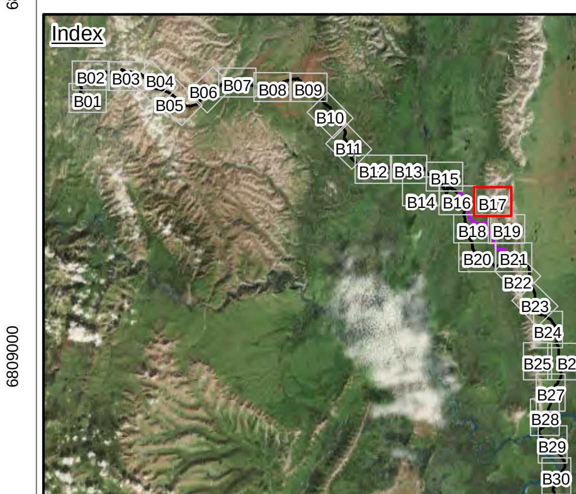
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

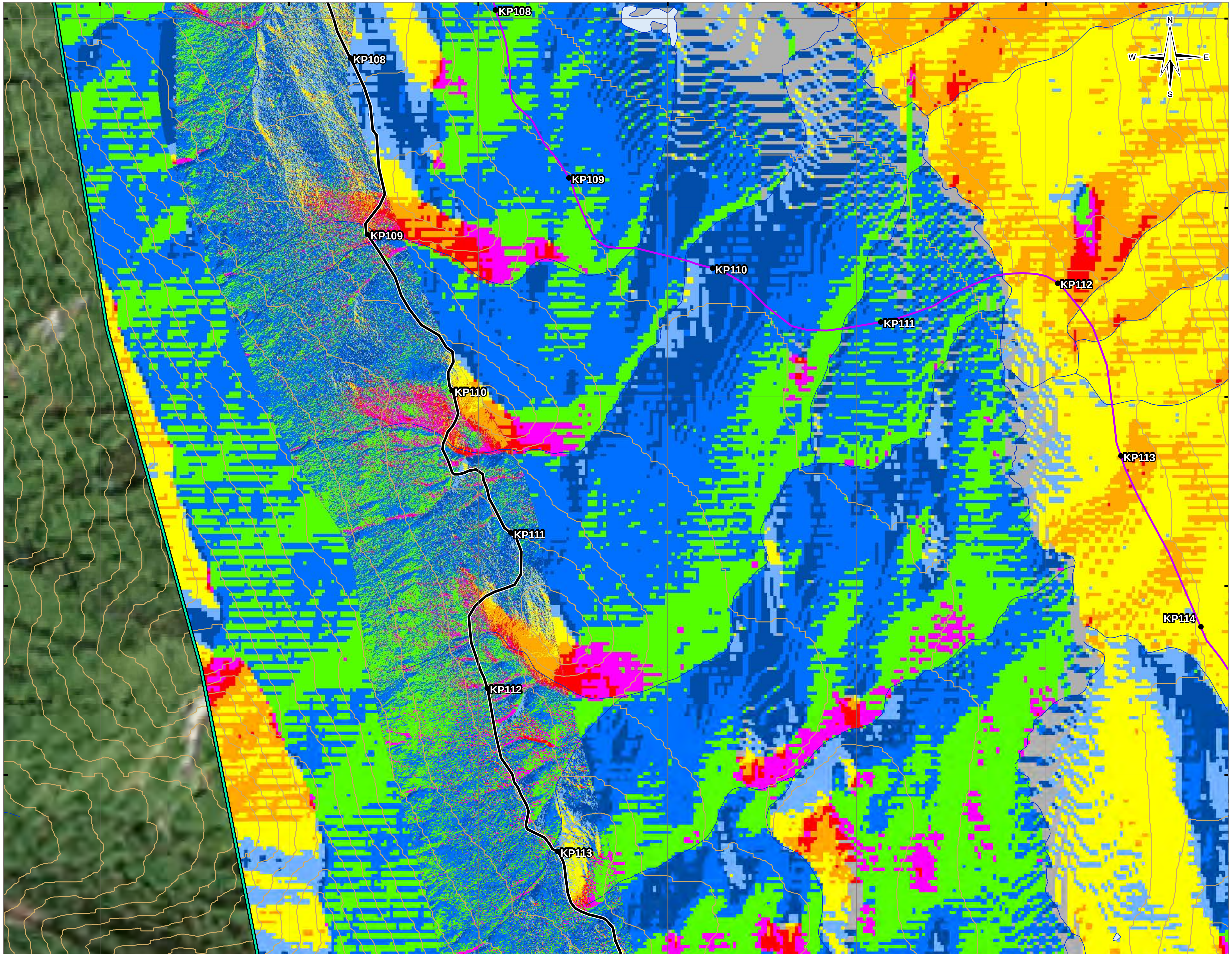
PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_AspectMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

Figure B17



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

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- Northeast (22.5-67.5)
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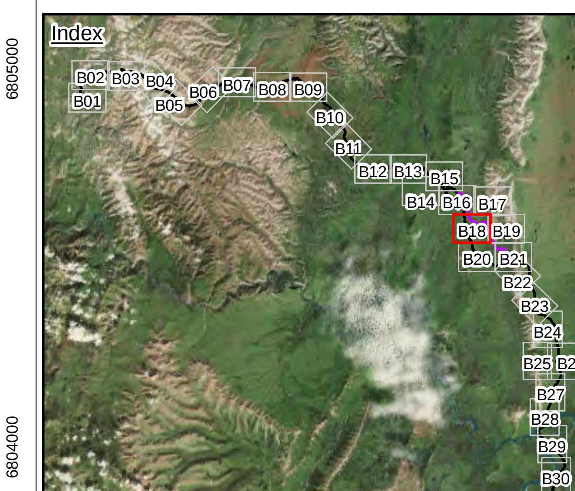
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B18

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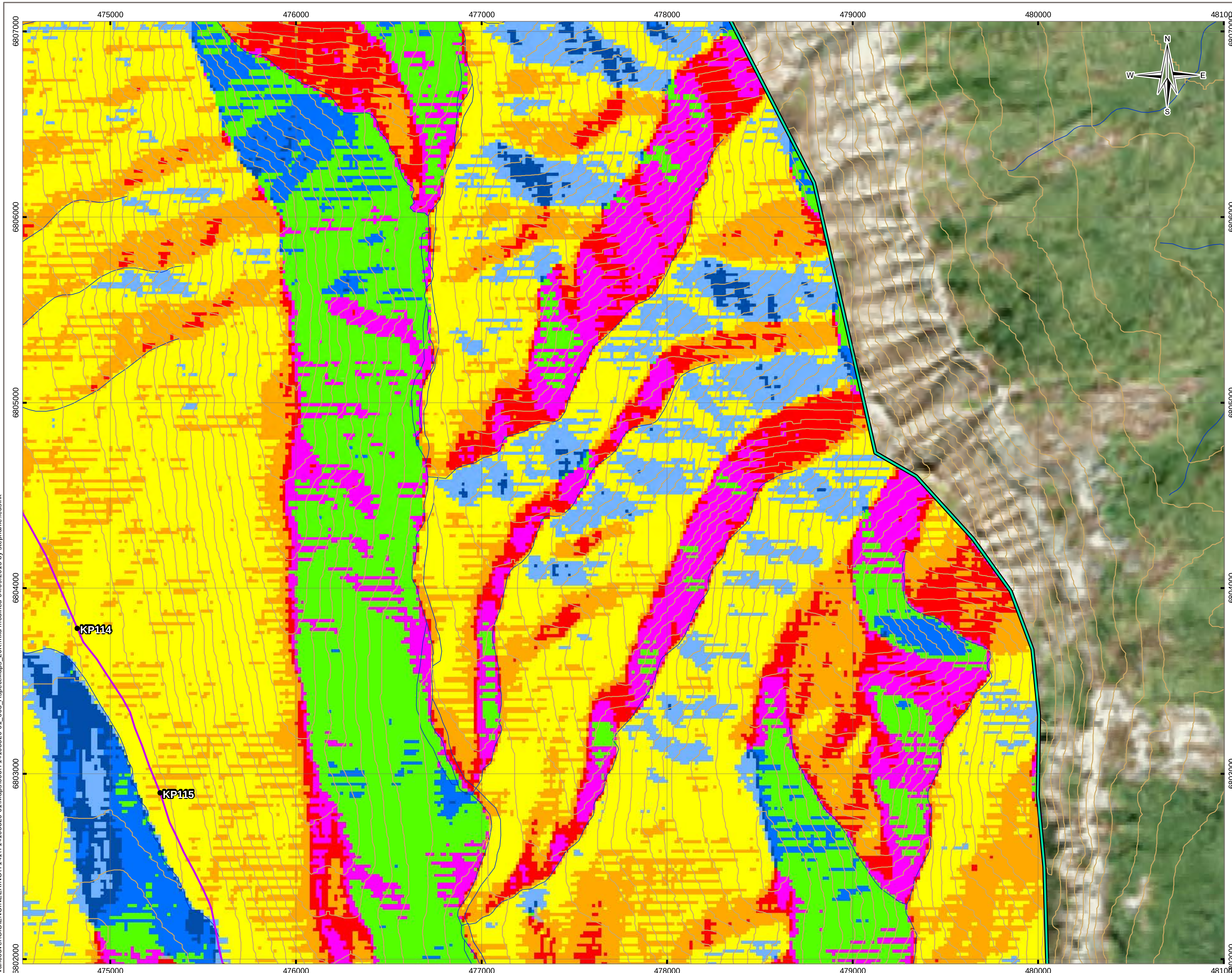

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LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

Aspect

- Flat (-1)
- North (0-22.5)
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- East (67.5-112.5)
- Southeast (112.5-157.5)
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)

Index

NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

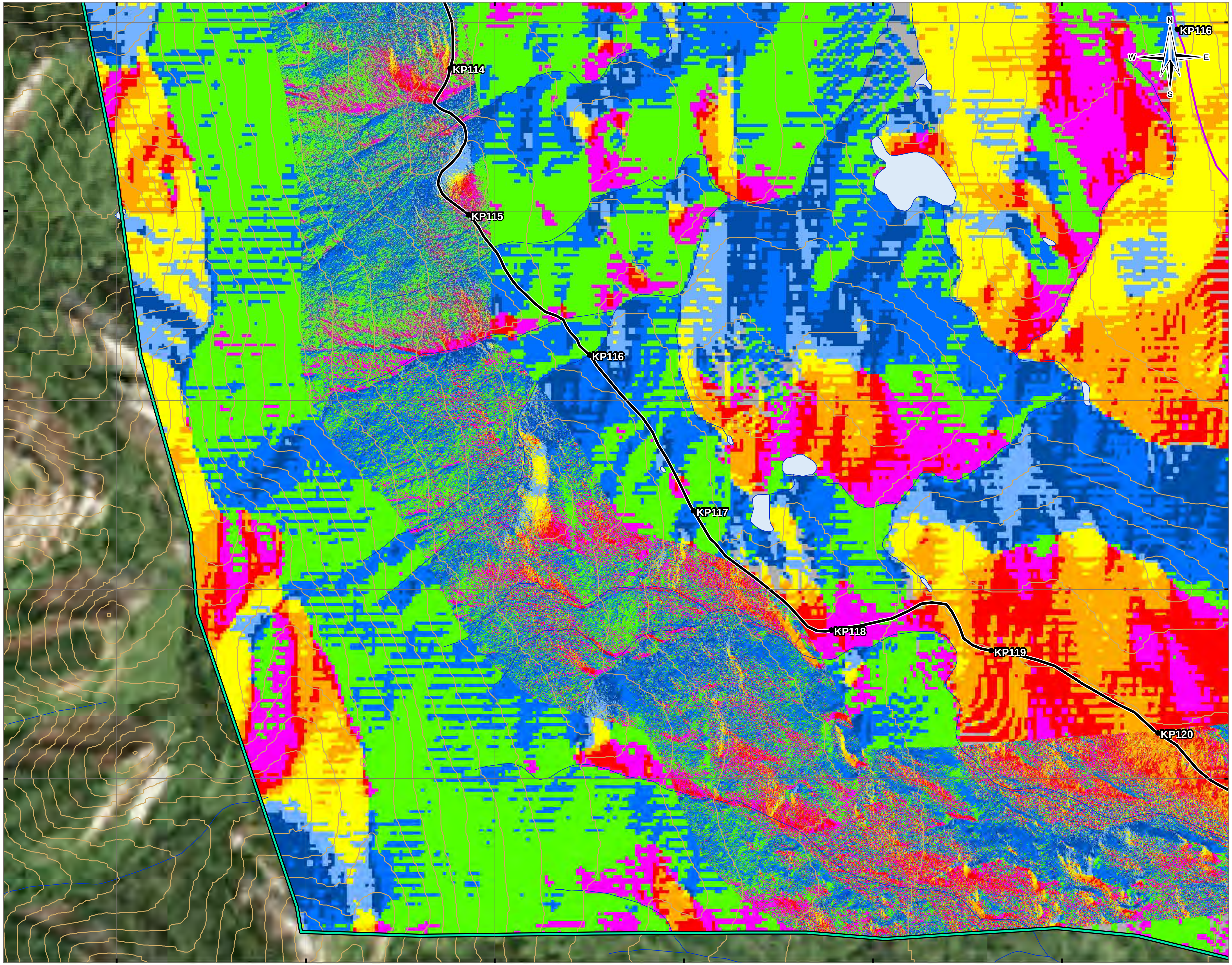
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B19



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
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- Watercourse
- Waterbody

Aspect

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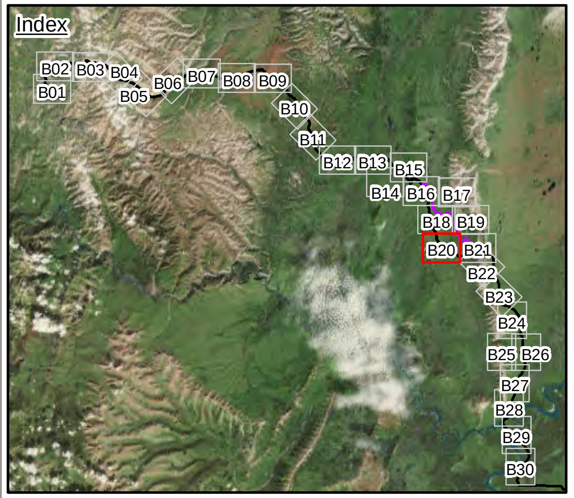
- South (157.5-202.5)
- Southwest (202.5-247.5)
- West (247.5-292.5)
- Northwest (292.5-337.5)
- North (337.5-360)



NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

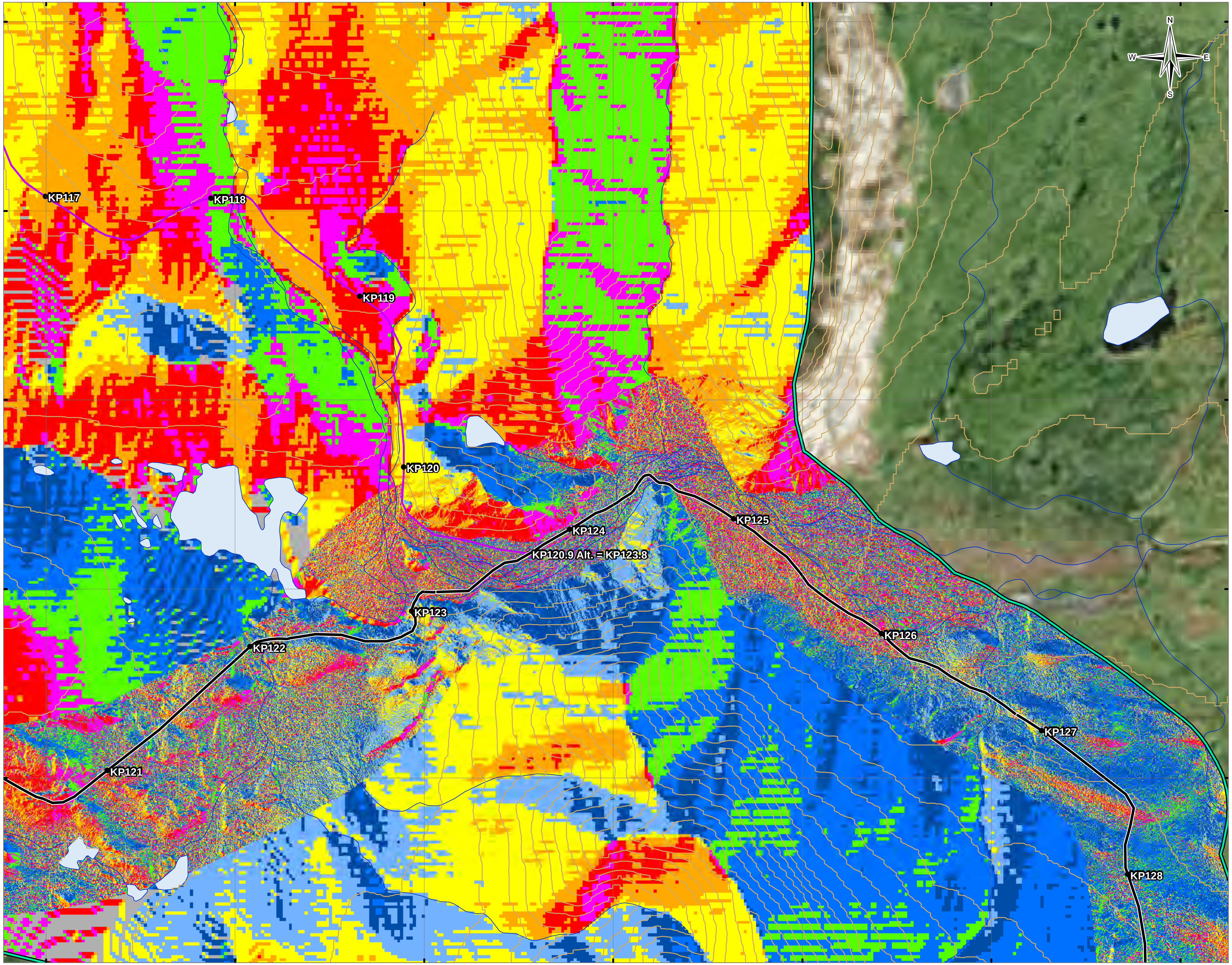
Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_AspectMaps_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	RKO	SM/RKO	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

Figure B20

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink

LEGEND

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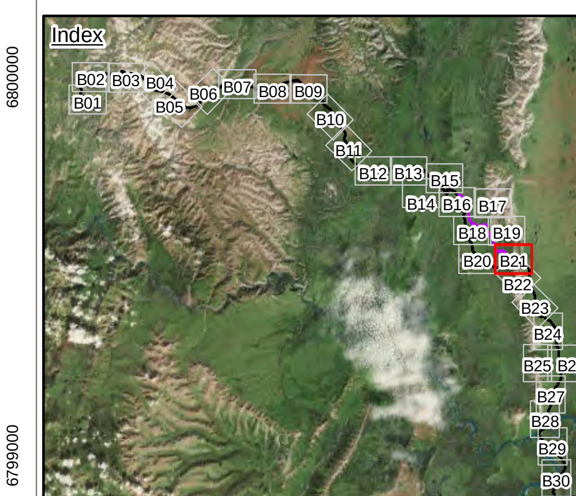


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

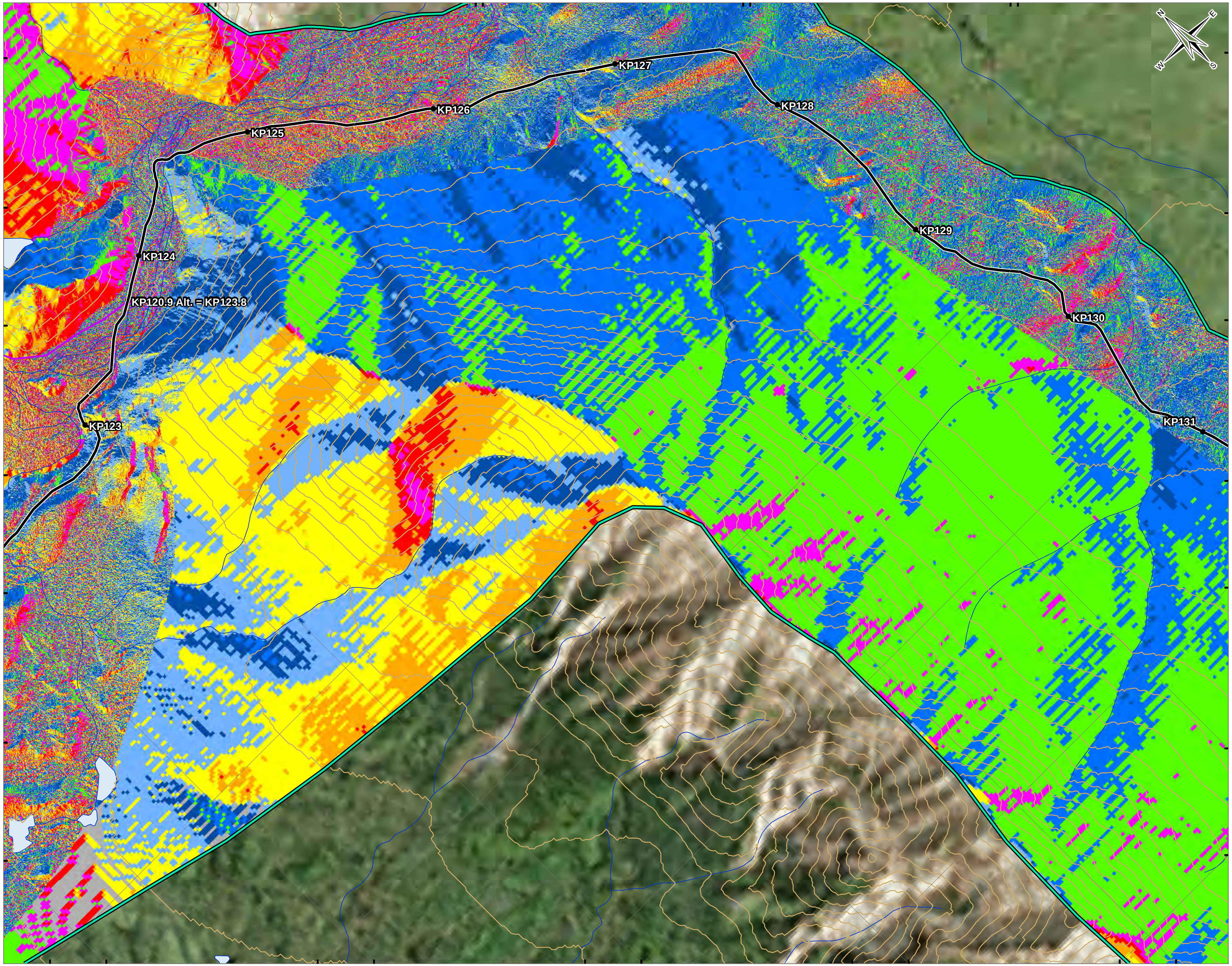
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B21



LEGEND

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- Prairie Creek Access Road (Feb 24, 2015)
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- West (247.5-292.5)
- Northwest (292.5-337.5)
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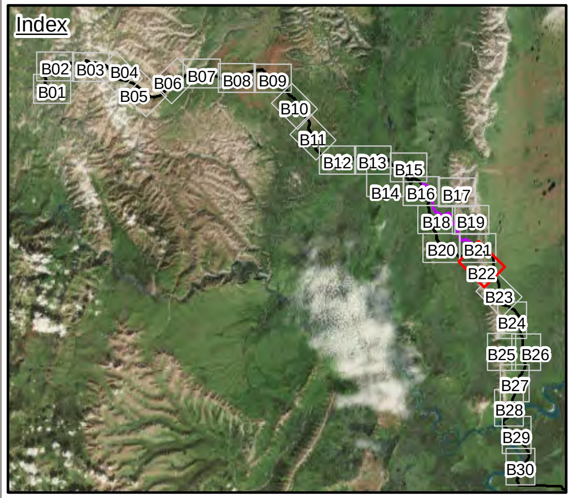

NOTES

Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
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STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

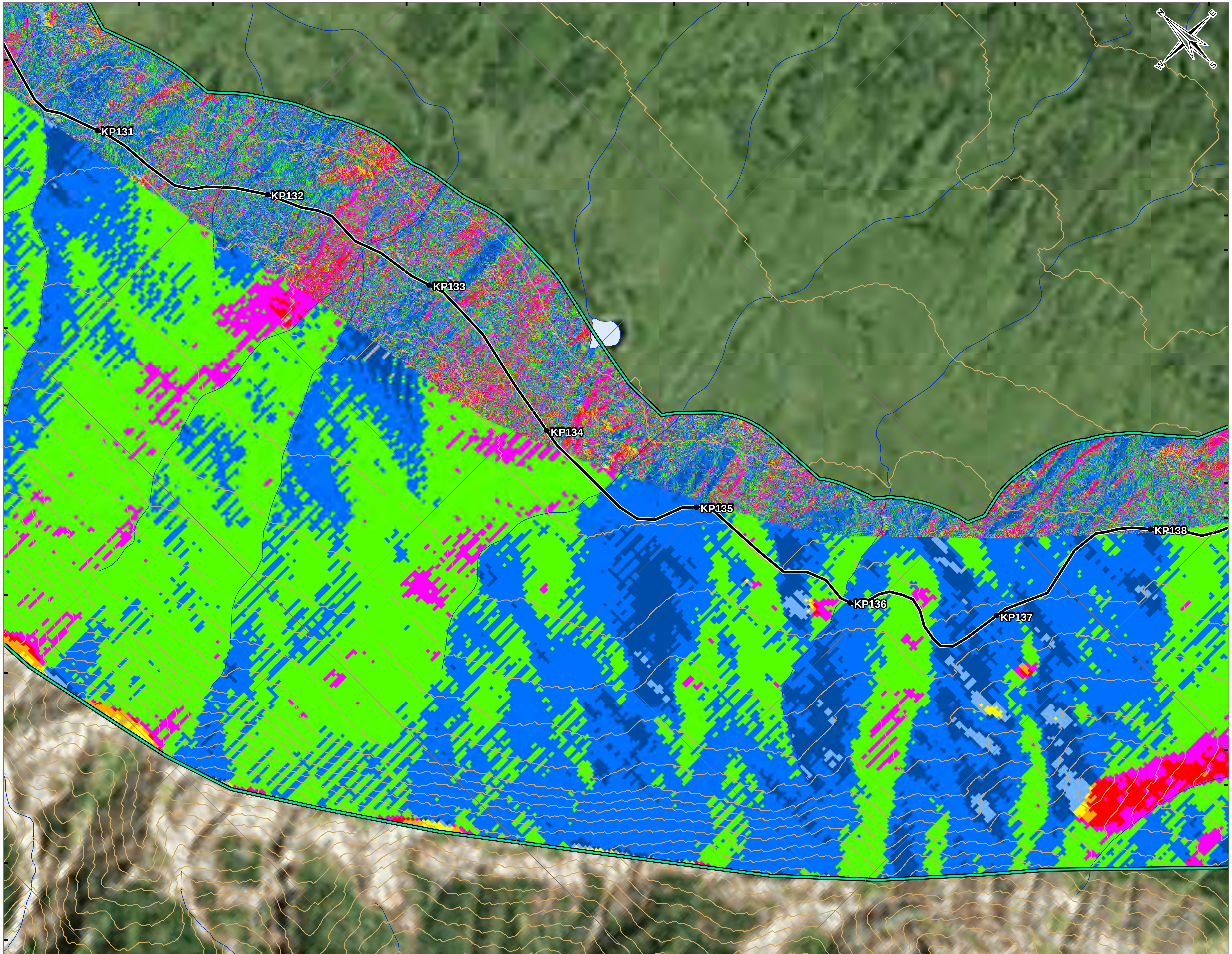
TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B22

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

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- Northwest (292.5-337.5)
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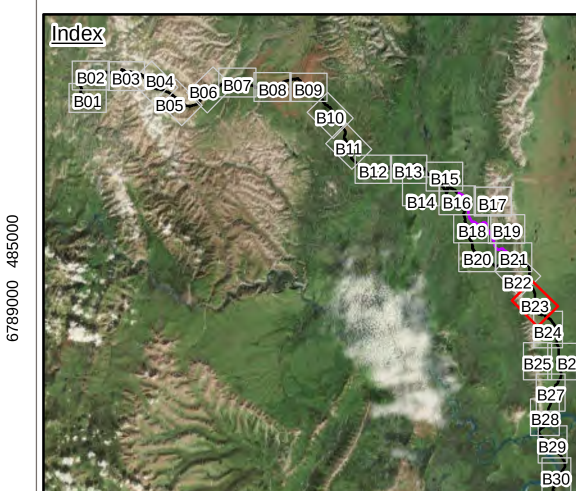


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

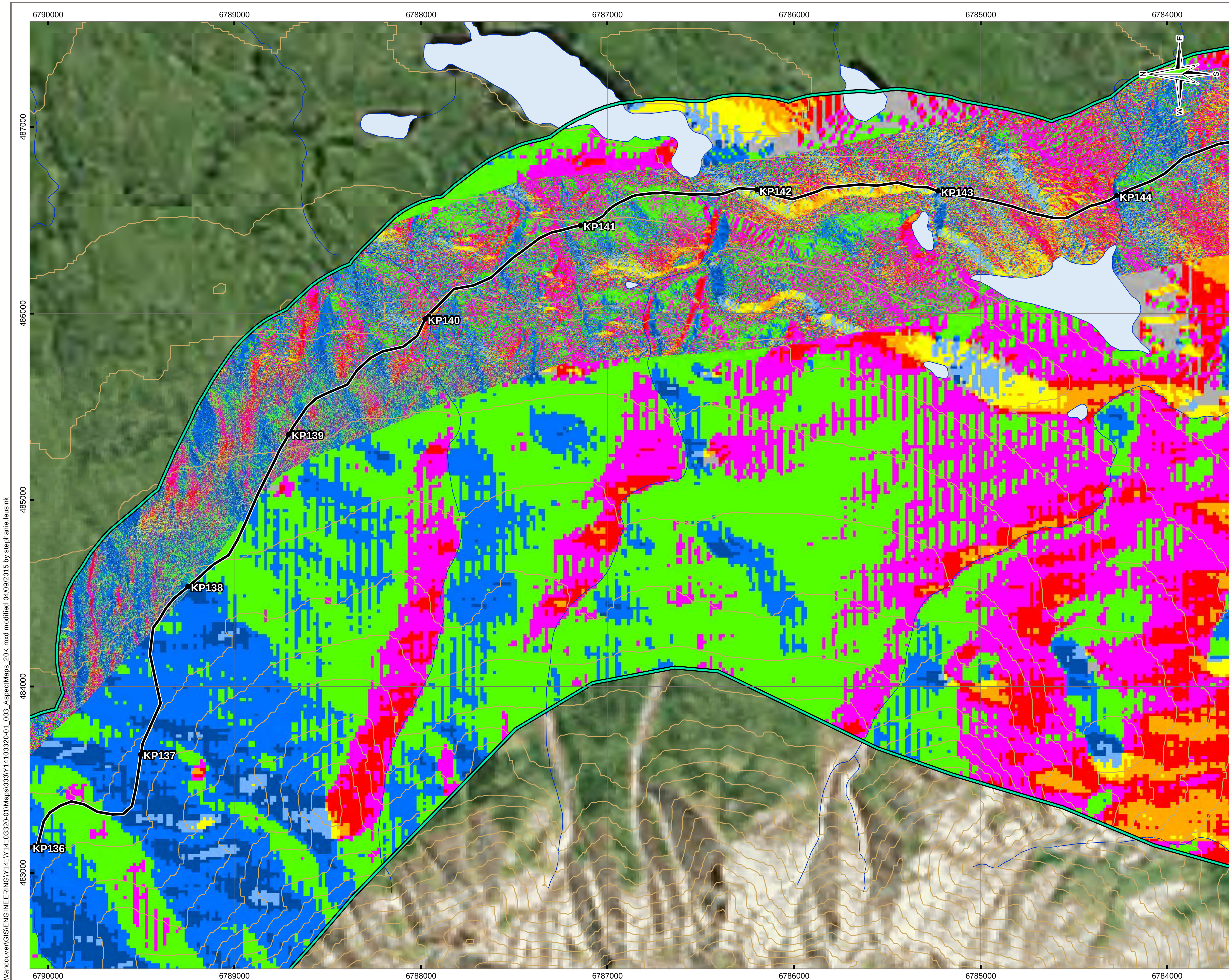
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B23

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

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- West (247.5-292.5)
- Northwest (292.5-337.5)
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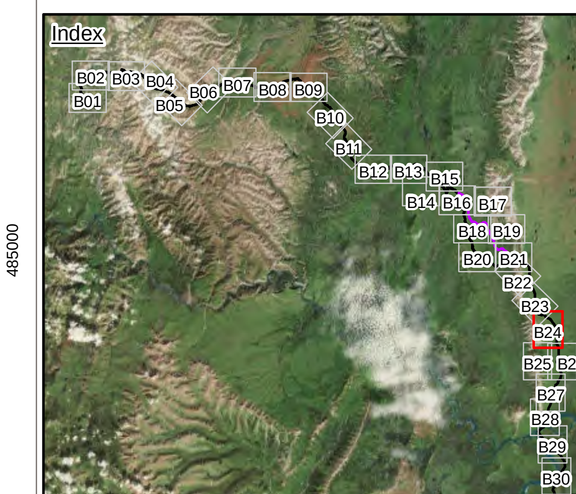


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

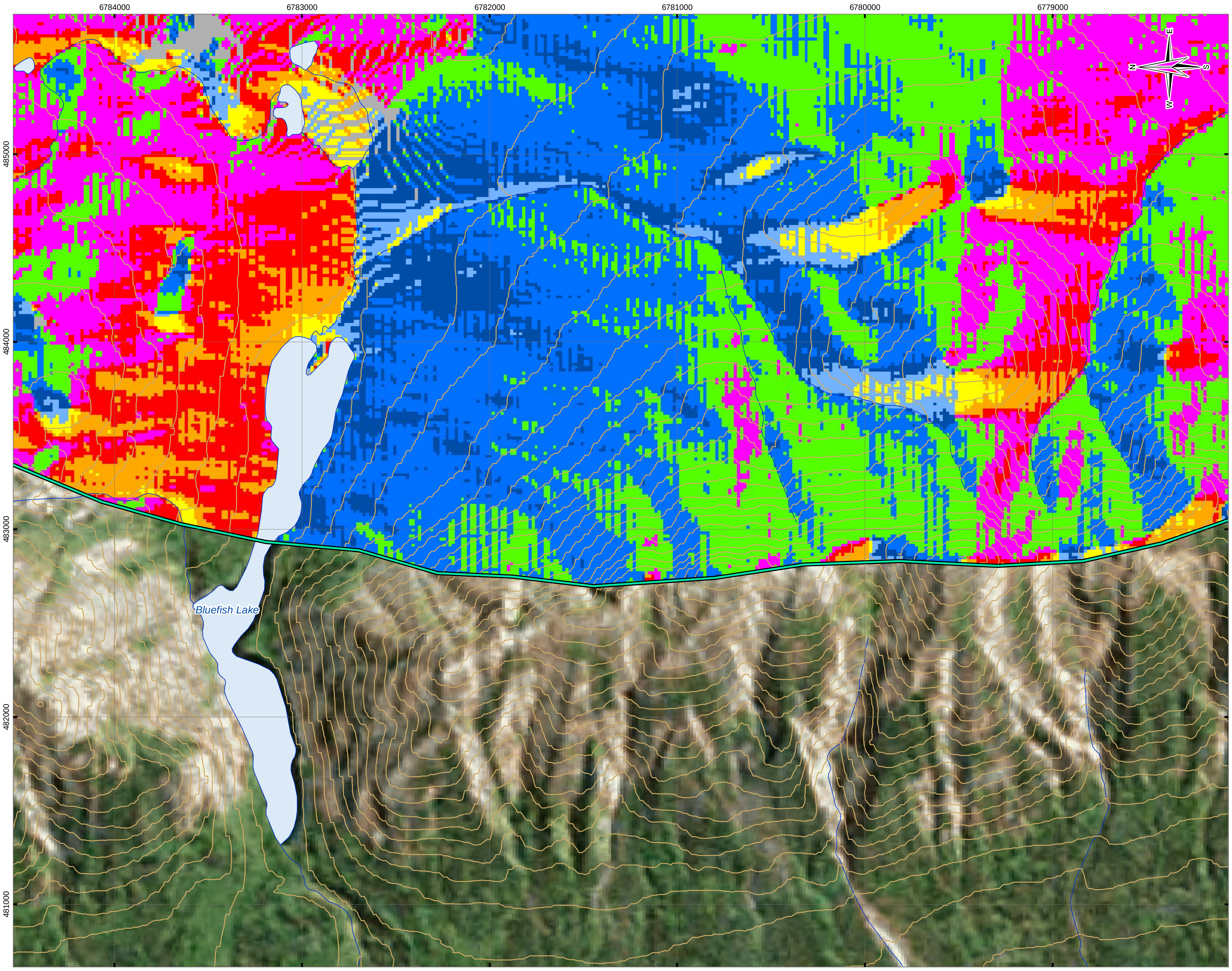
TETRA TECH EBA

FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B24



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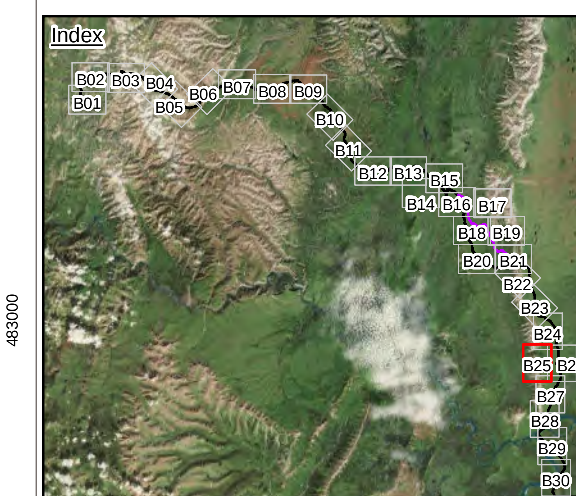

NOTES
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LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

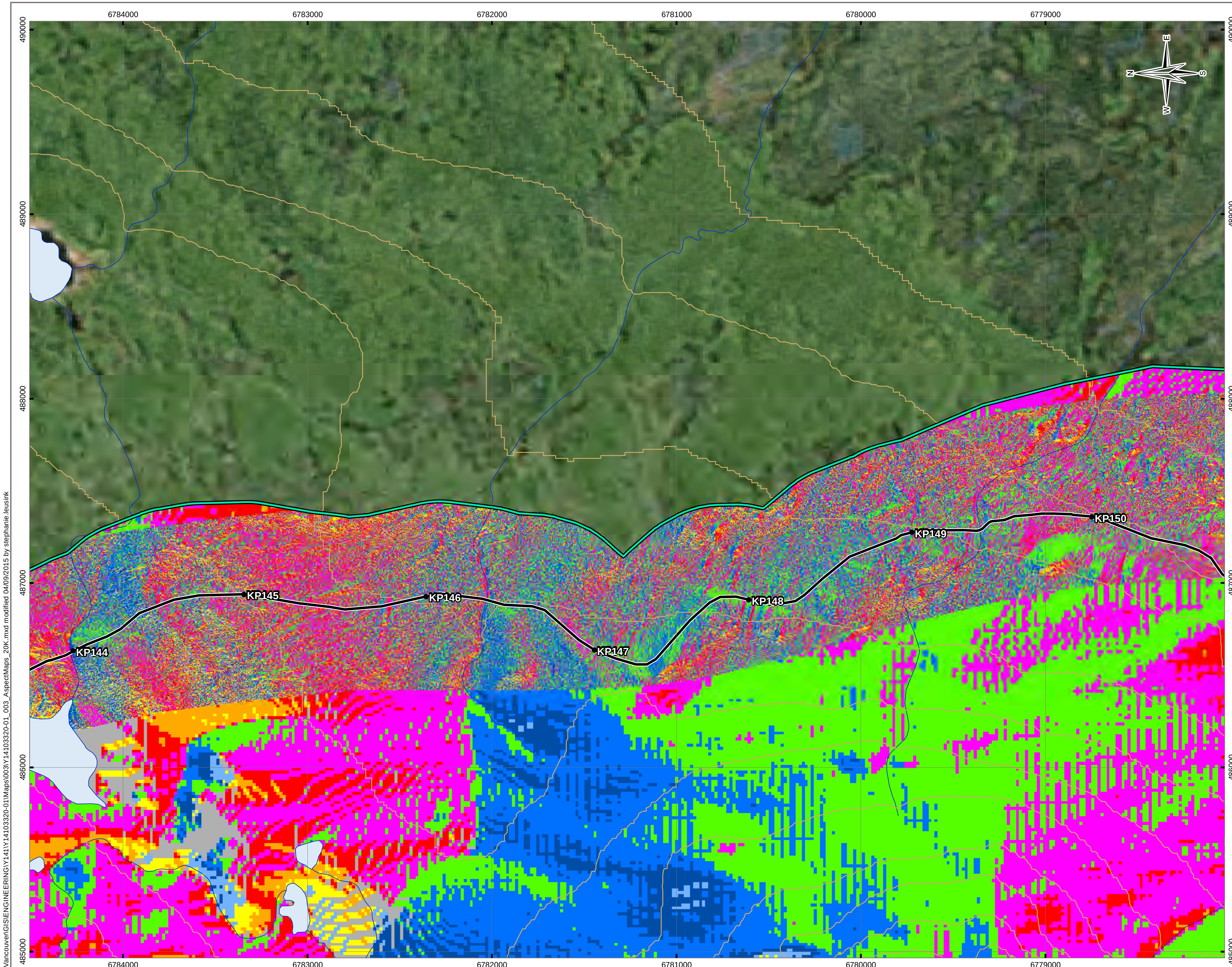
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B25

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

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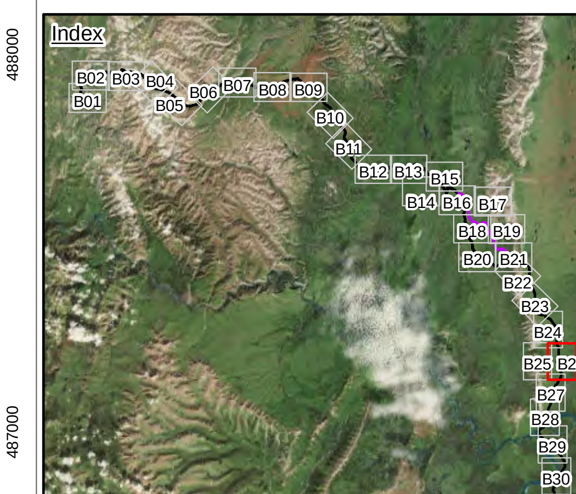


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

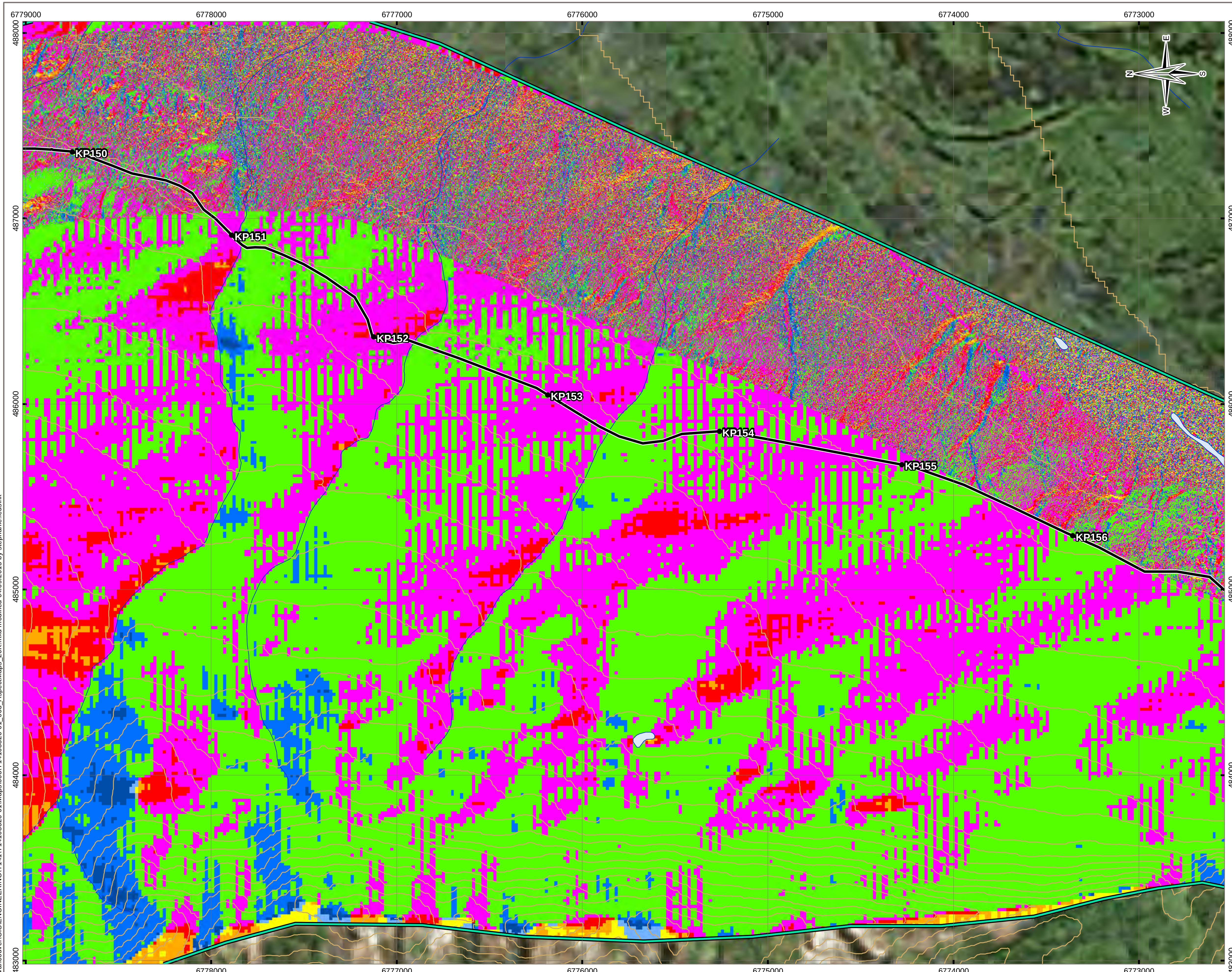
PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_AspectMaps_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure B26



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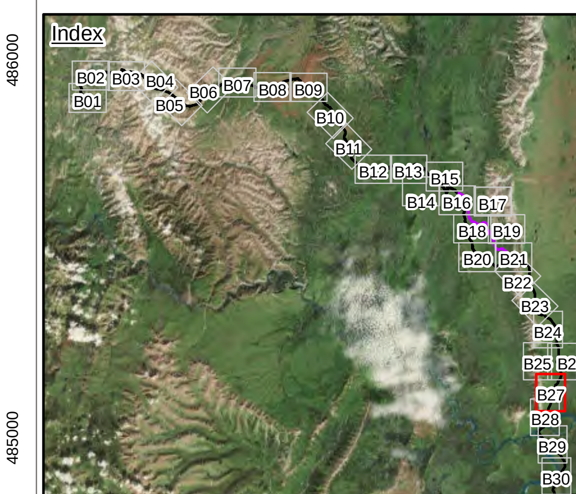

NOTES
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STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

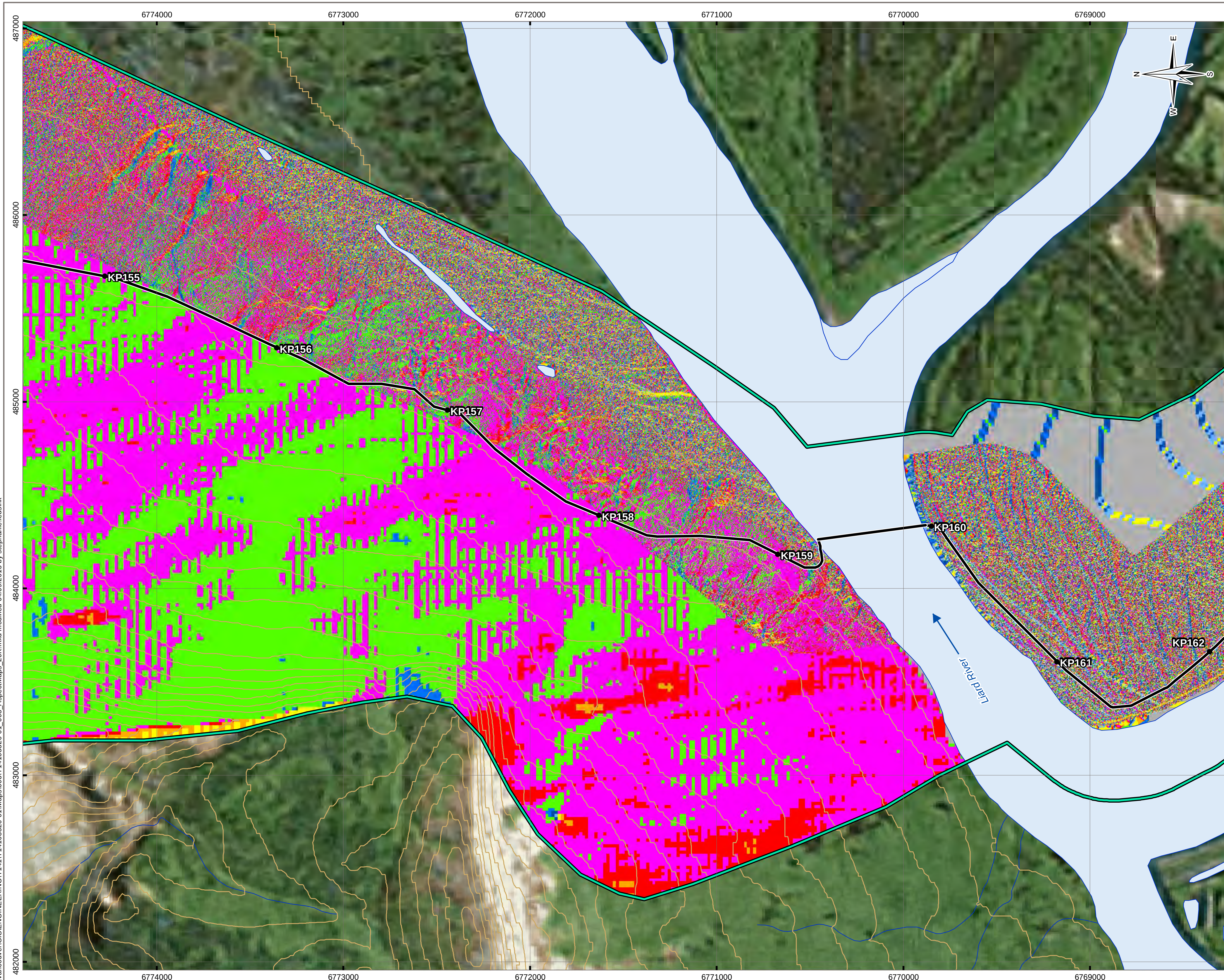
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B27

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_AspectMaps_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

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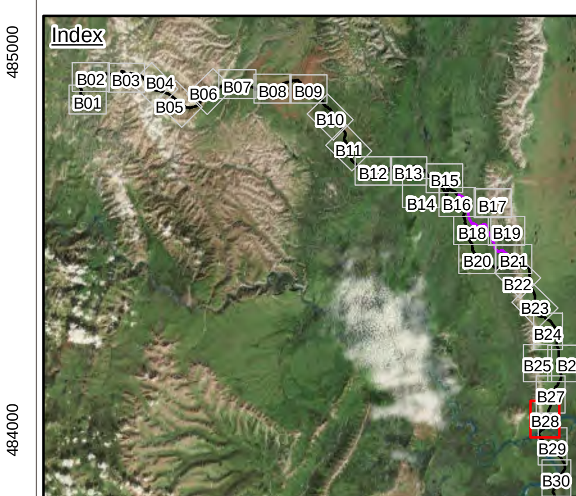

NOTES
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LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

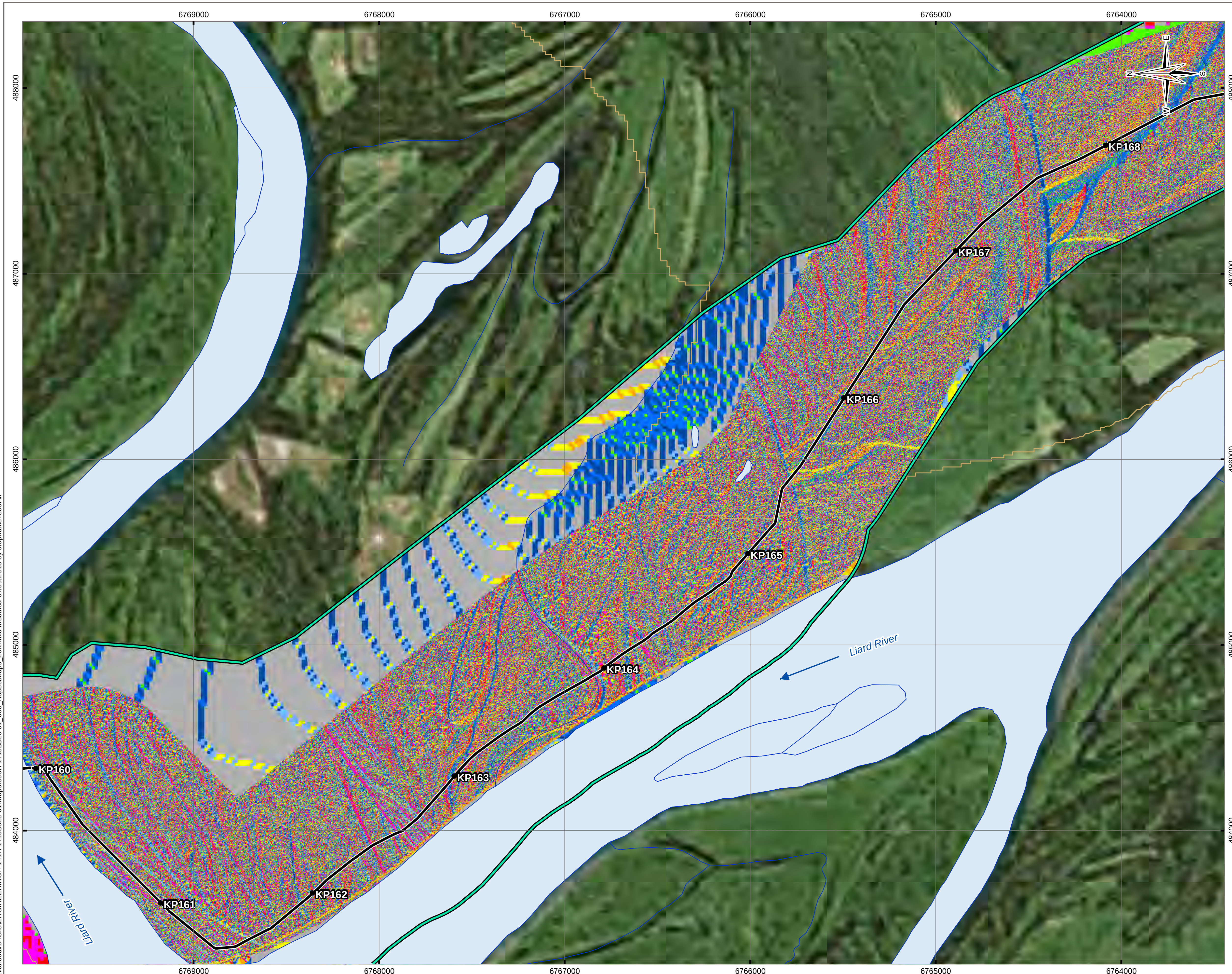
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B28



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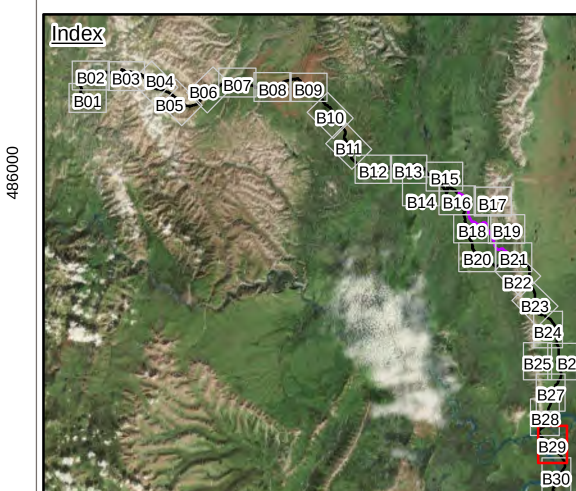


NOTES
Base data source: CanVec.
LiDAR provided by McElhanney (2012).
Imagery from ESRI Basemap Service
Contours and additional aspect data derived from GeoBase 1:50K DEMs

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

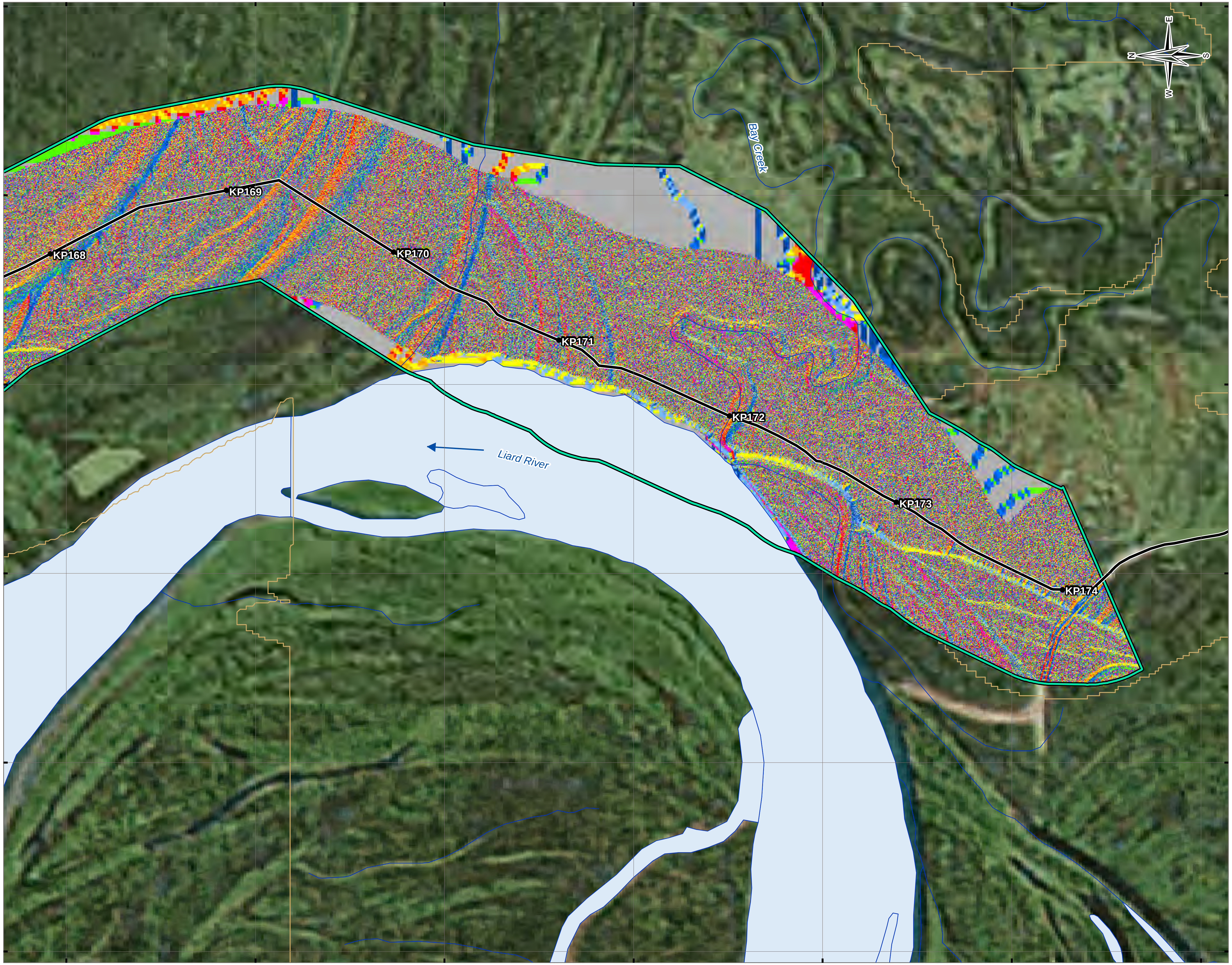
400 200 0 400

Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_AspectMaps_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure B29



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LEGEND

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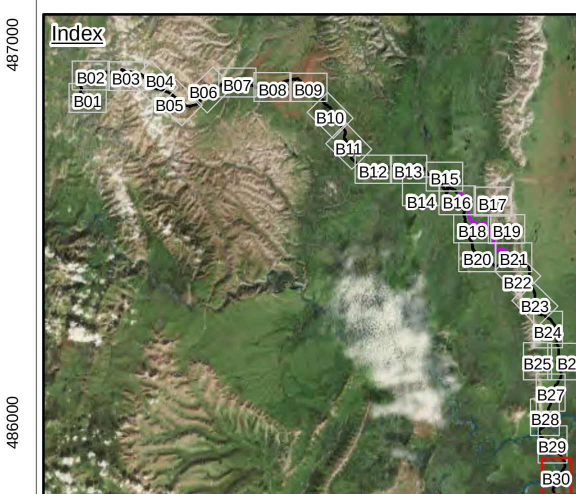

NOTES
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Imagery from ESRI Basemap Service
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STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Slope Aspect

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

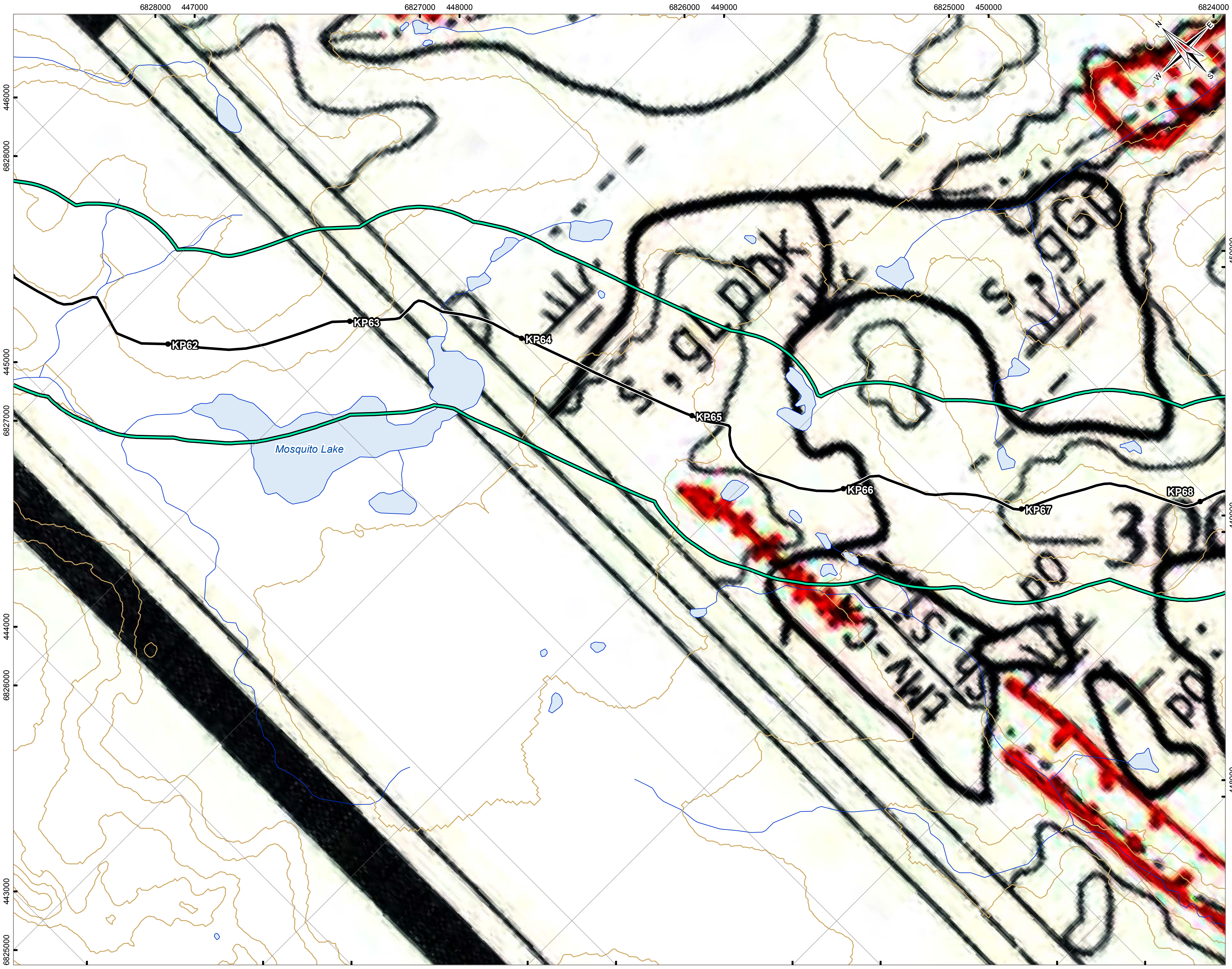
FILE NO.
Y14103320-01_003_AspectMaps_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	RKO	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure B30

APPENDIX C
SURFICIAL GEOLOGY AND GEOMORPHOLOGY MAPS



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LEGEND

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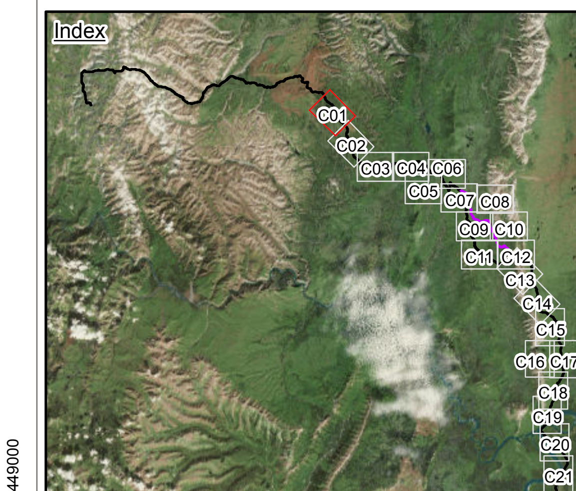
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

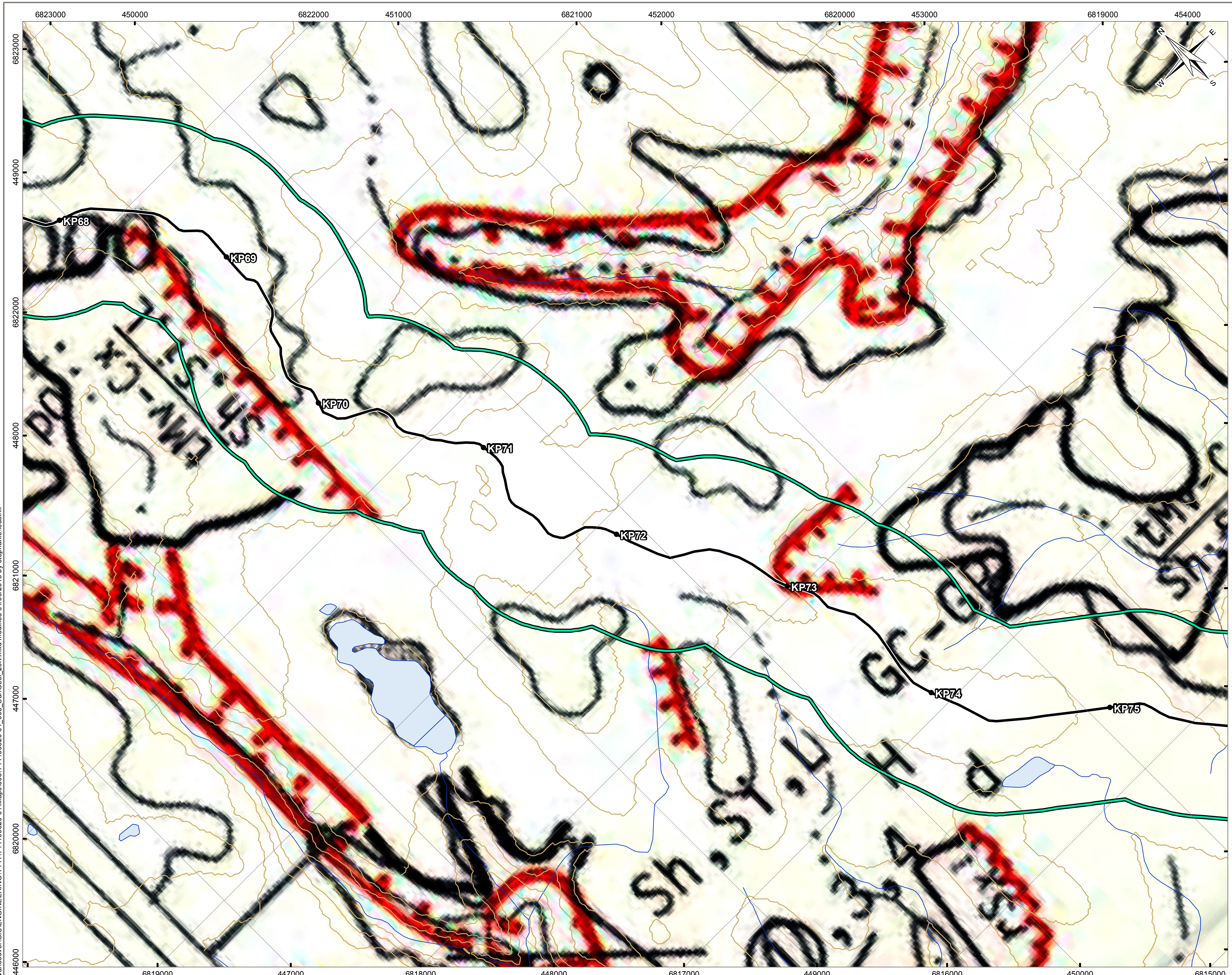
PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SurfGeol_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	-	SM/RKO	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

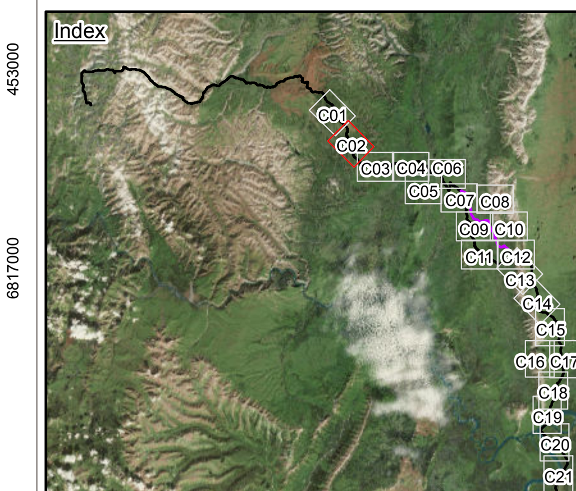
Figure C01



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

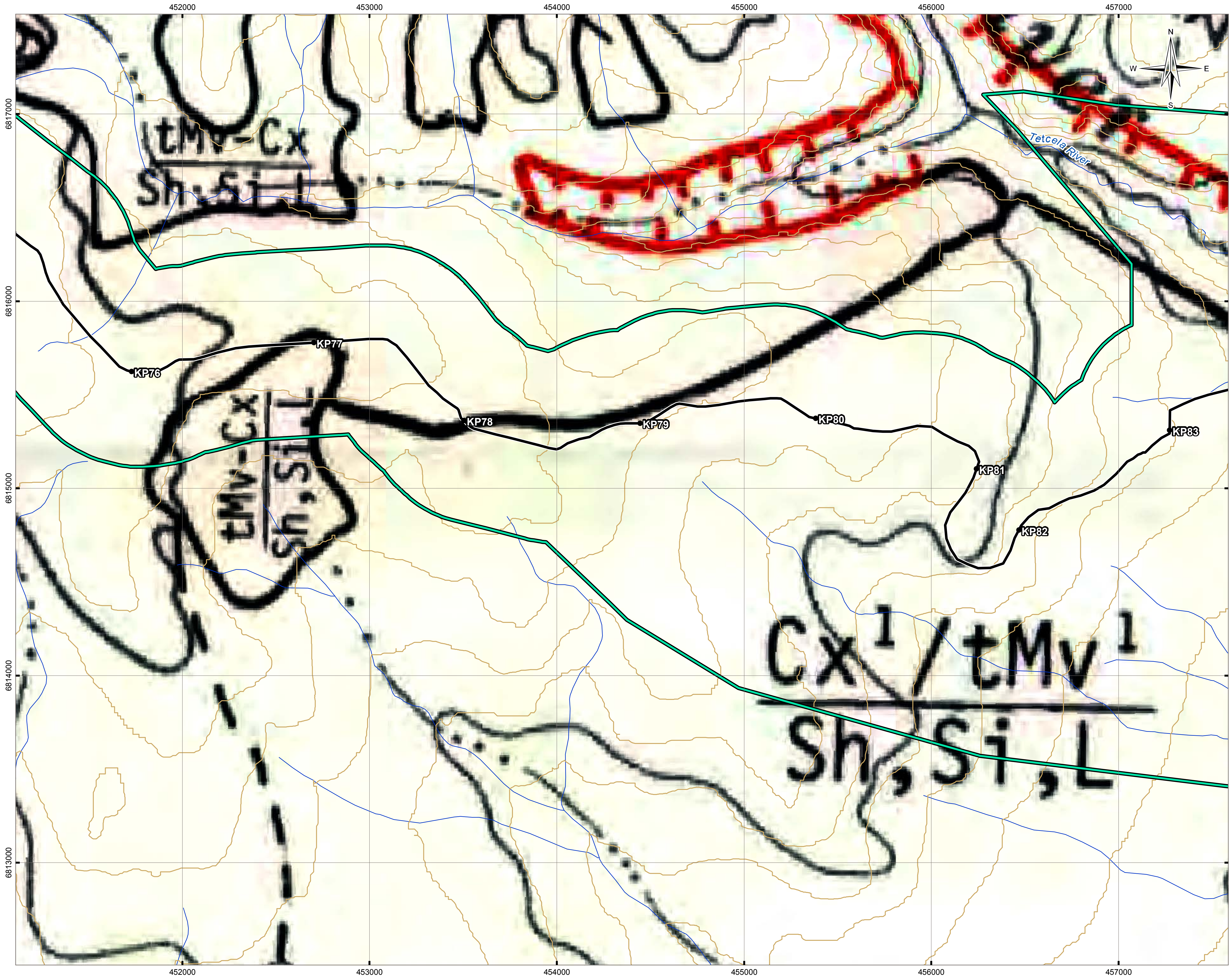
Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SurfGeol_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure C02

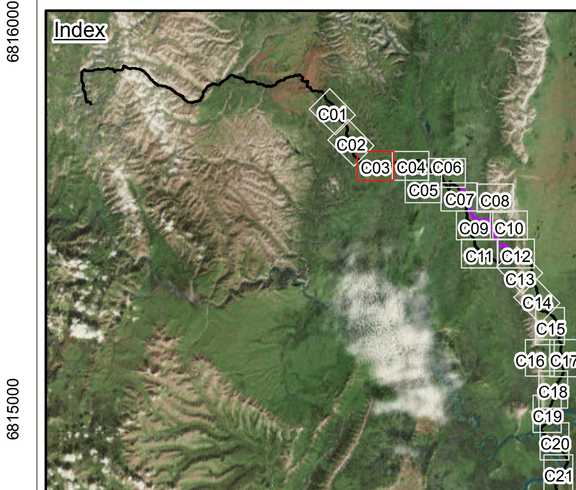
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

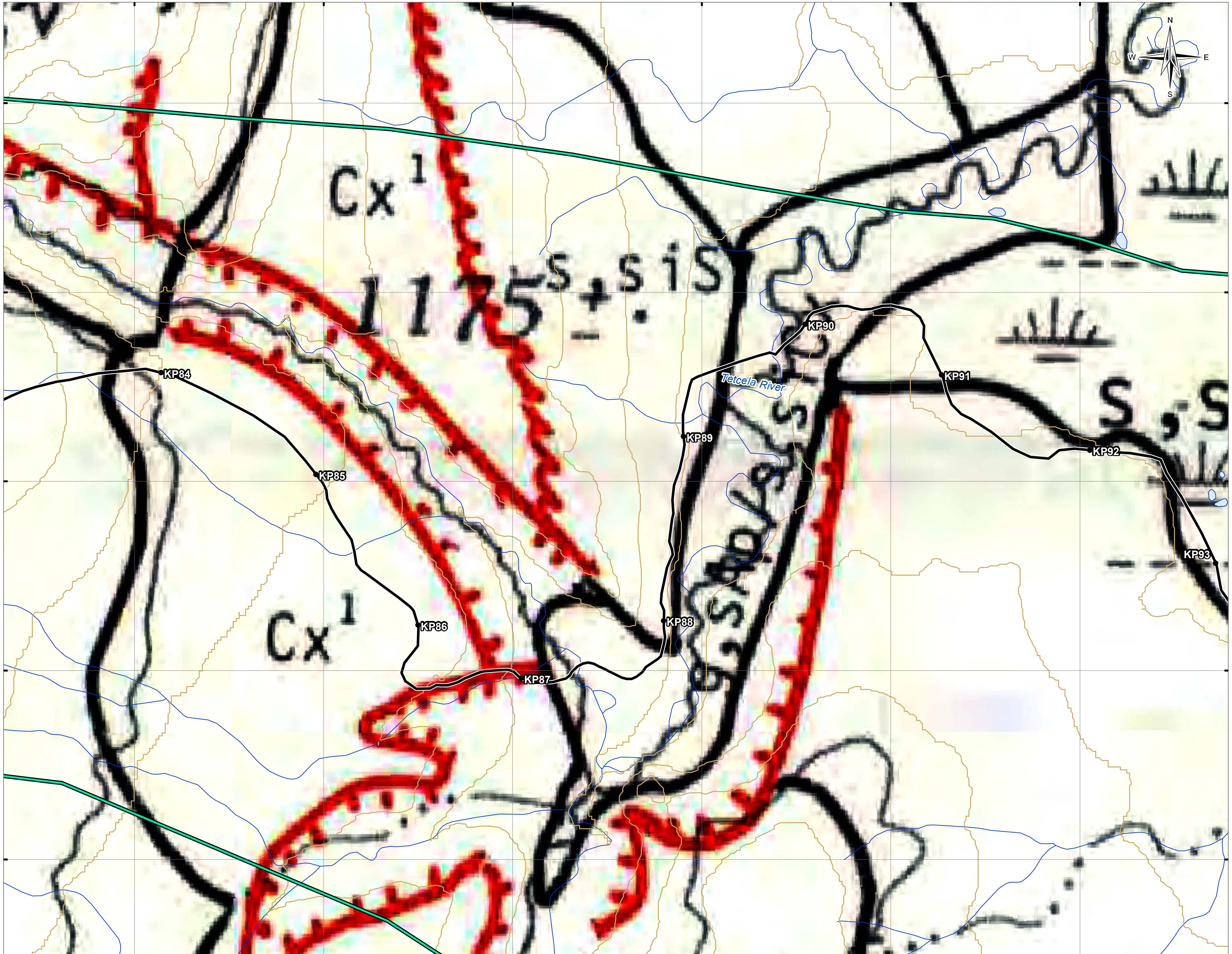
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

TETRA TECH EBA

Figure C03

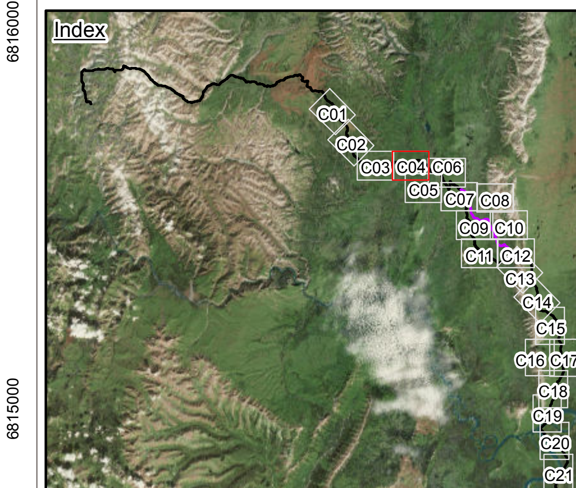
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

TETRA TECH EBA

Figure C04

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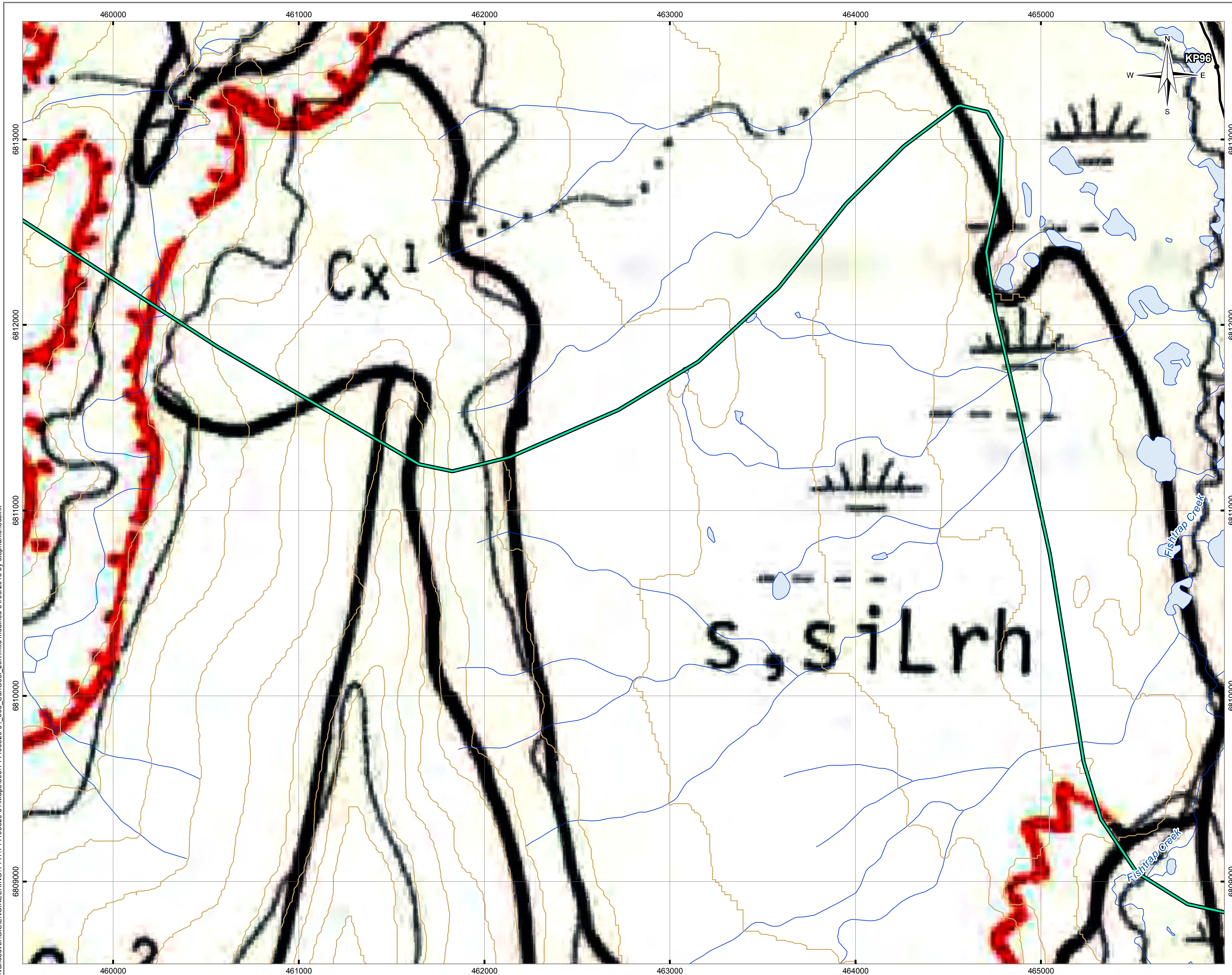
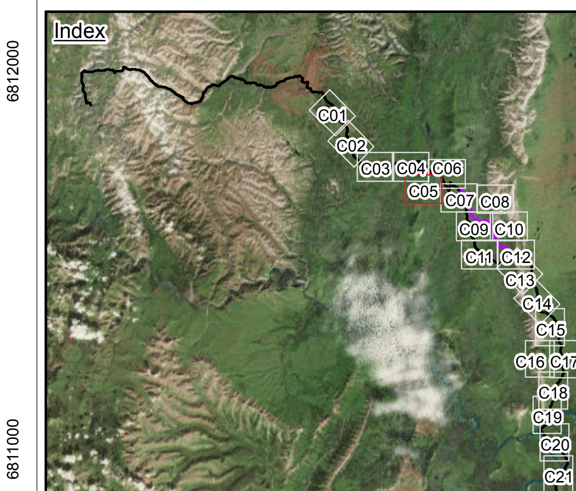


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

TETRA TECH EBA

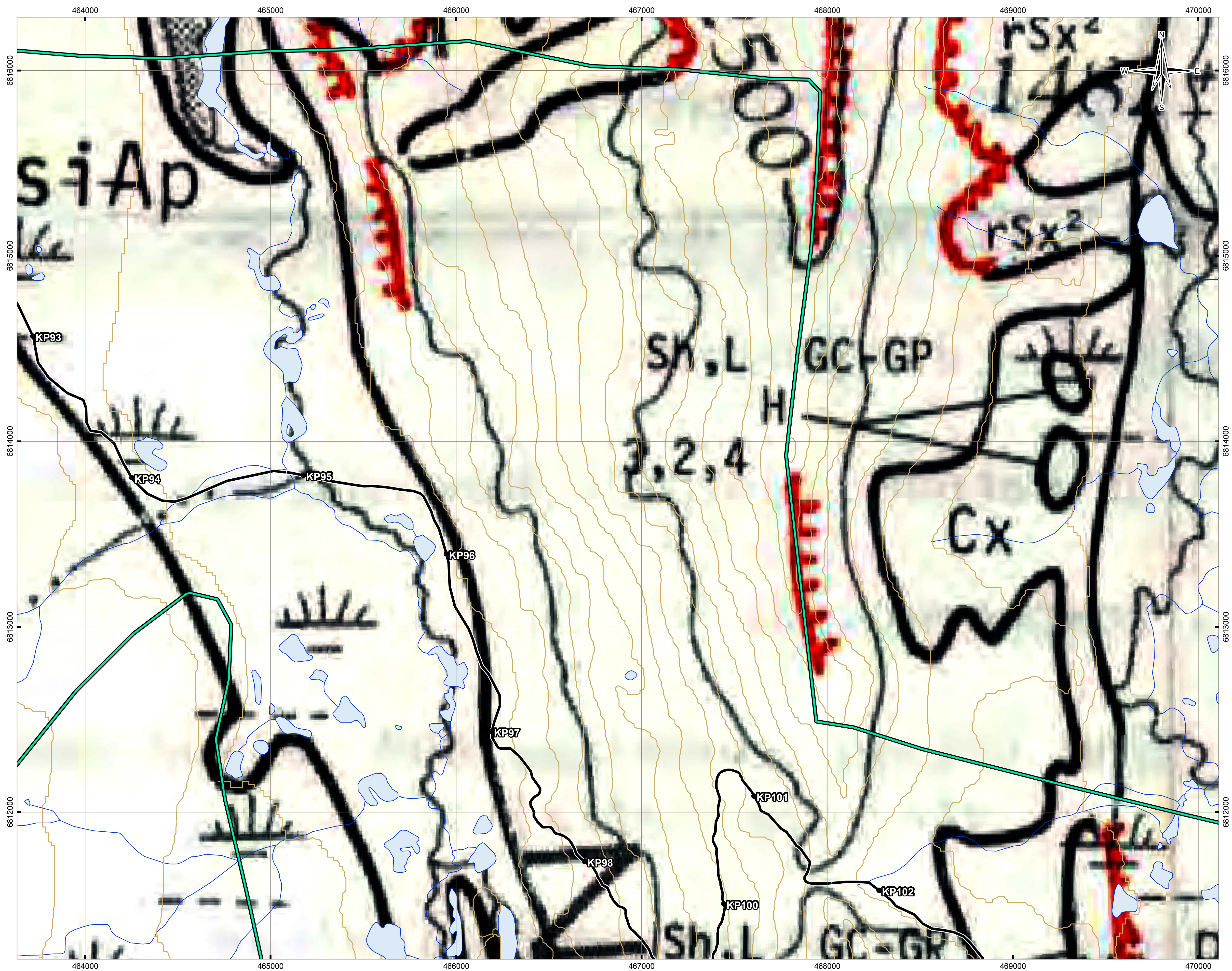
FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C05

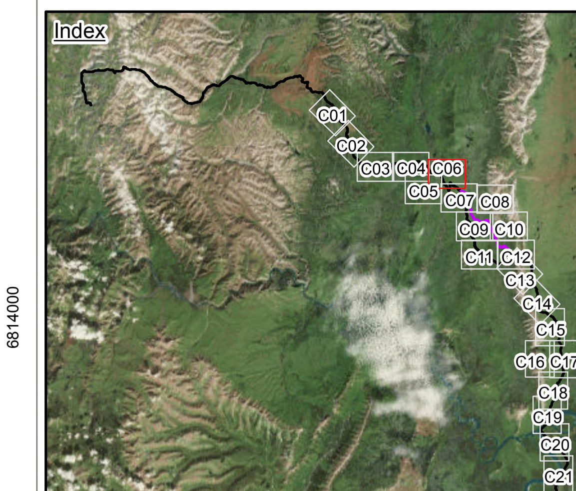
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SurfGeol_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure C06

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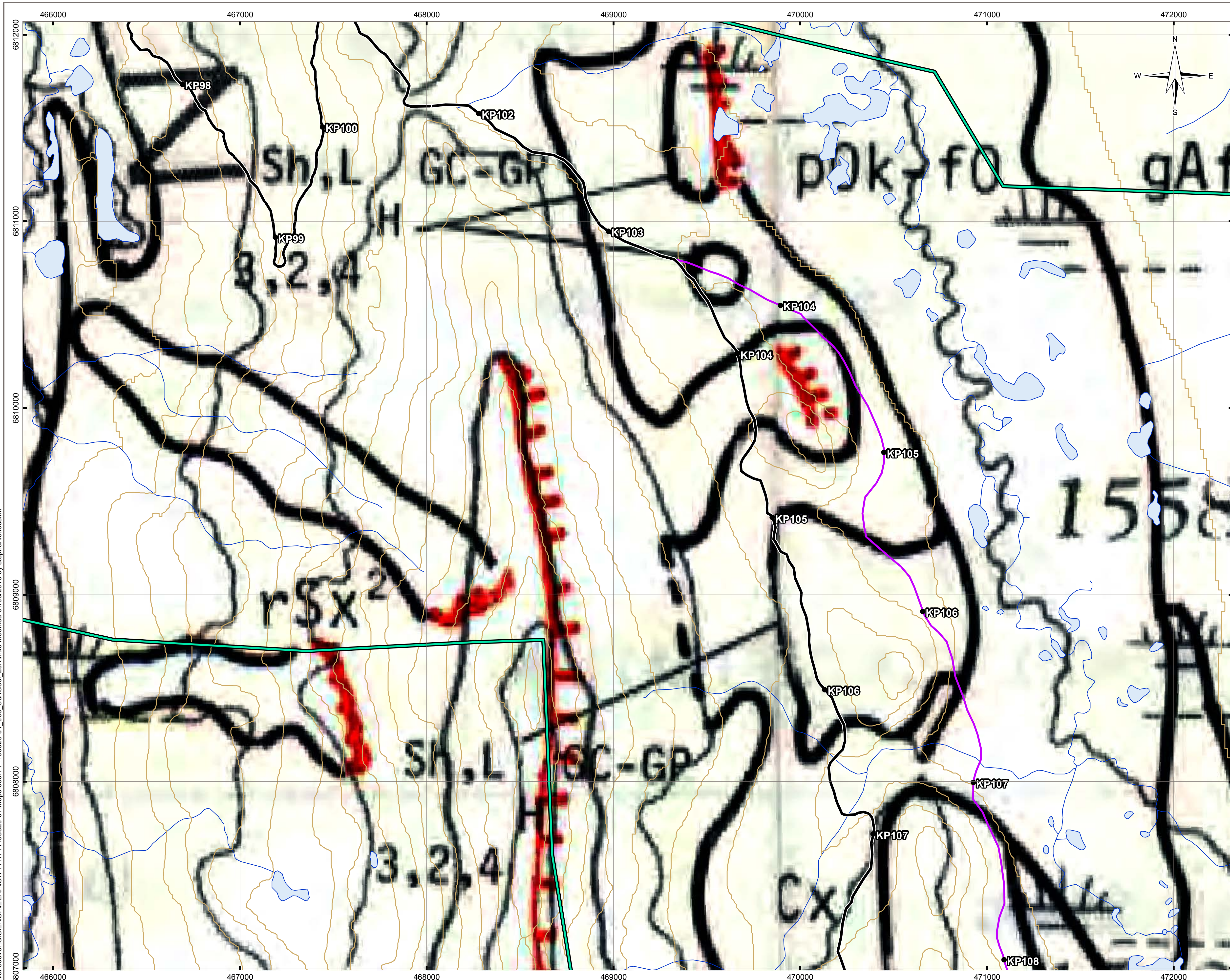
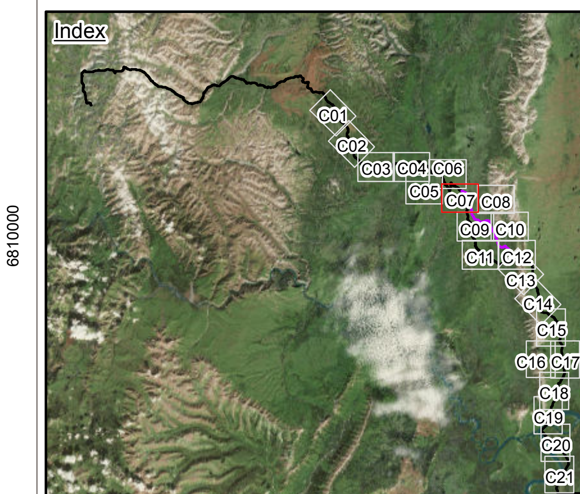


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

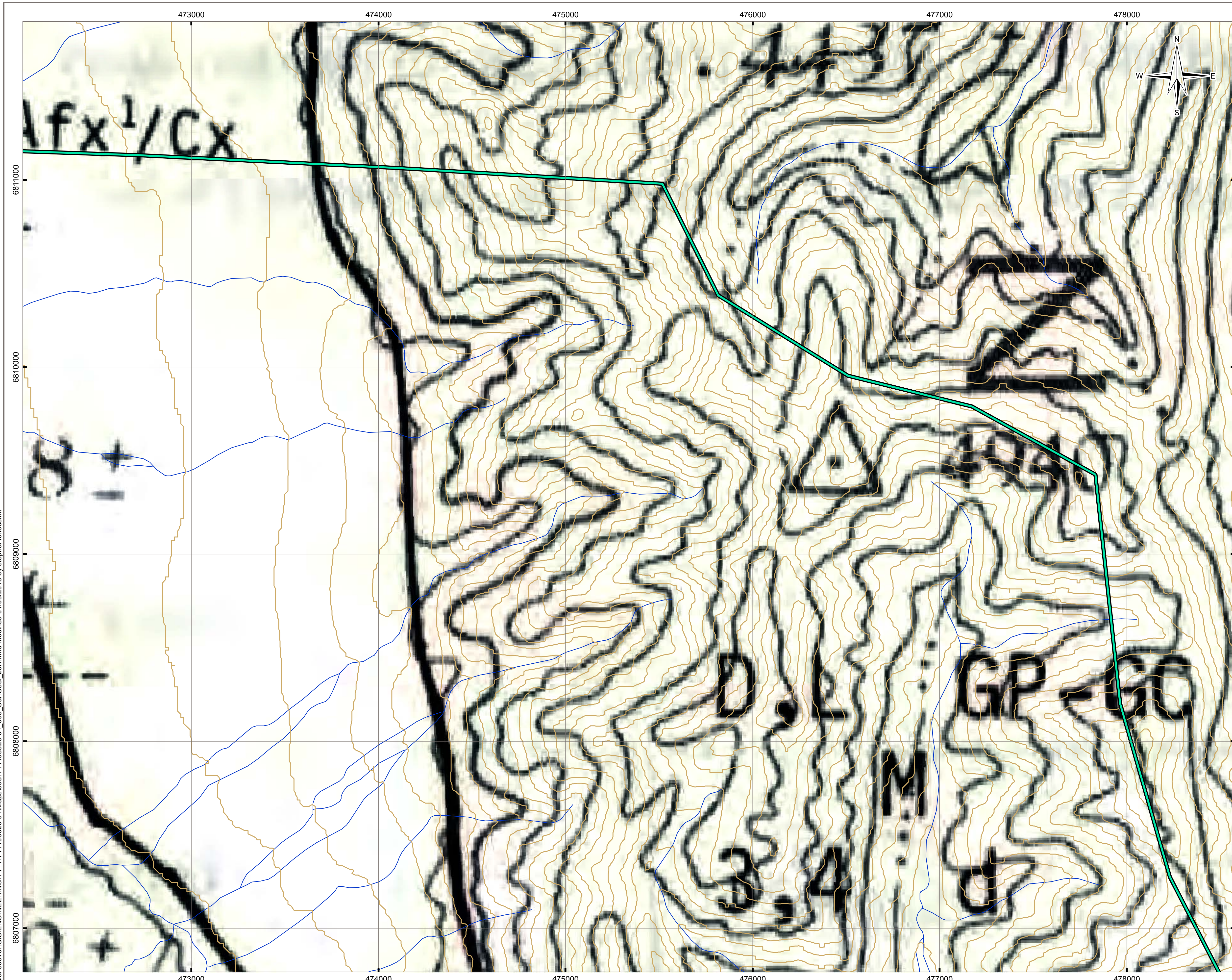
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

TETRA TECH EBA

Figure C07

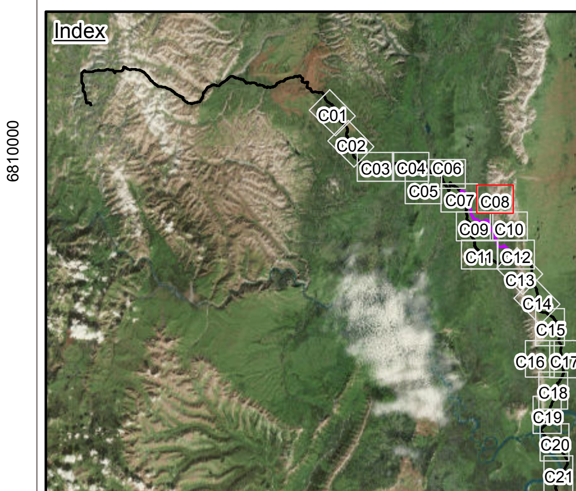
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

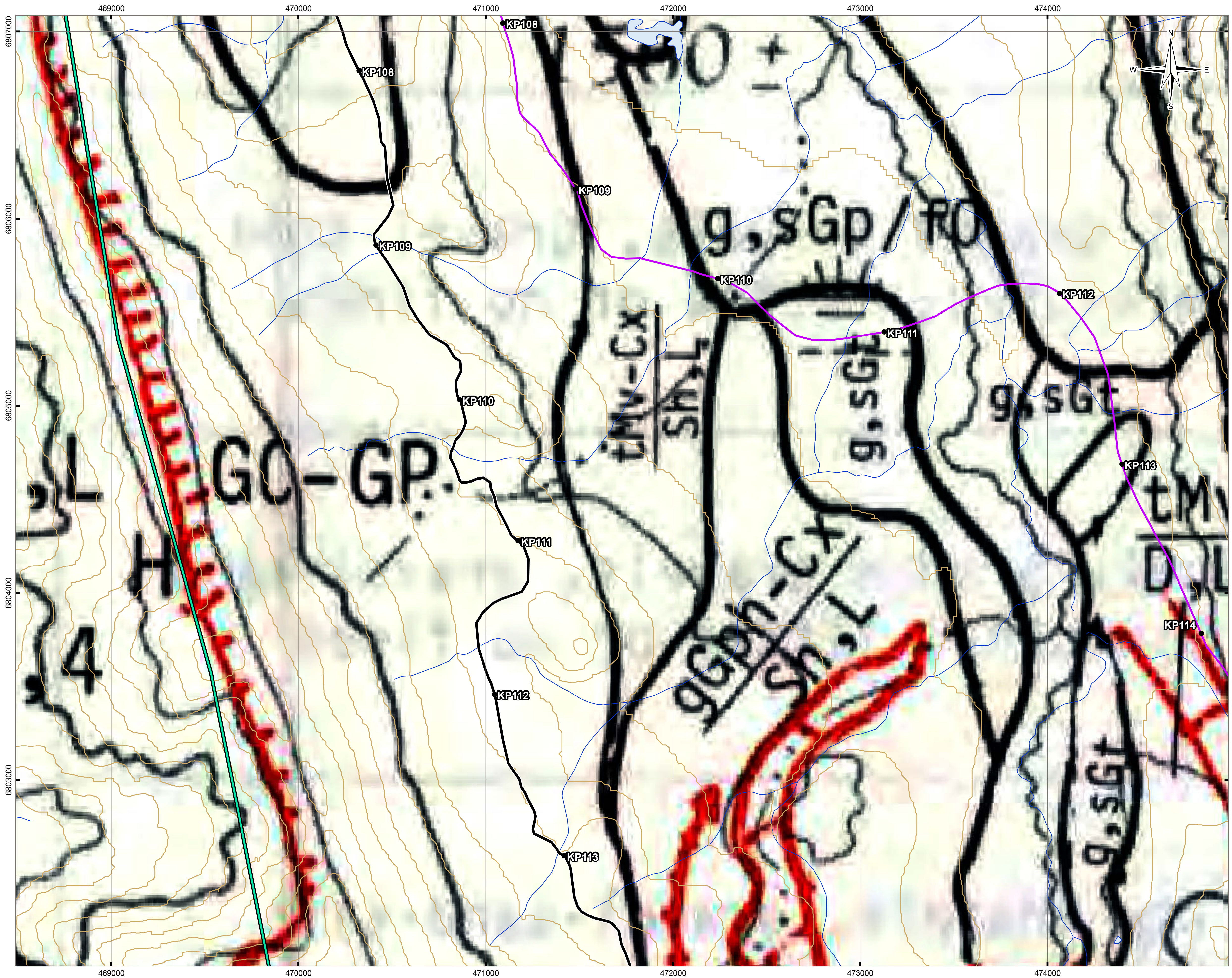
FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C08

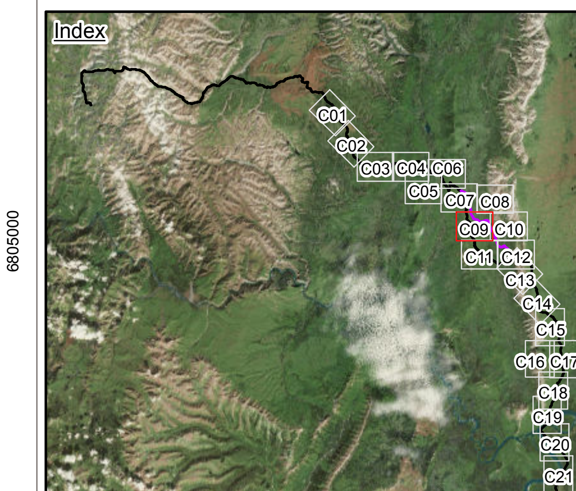
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

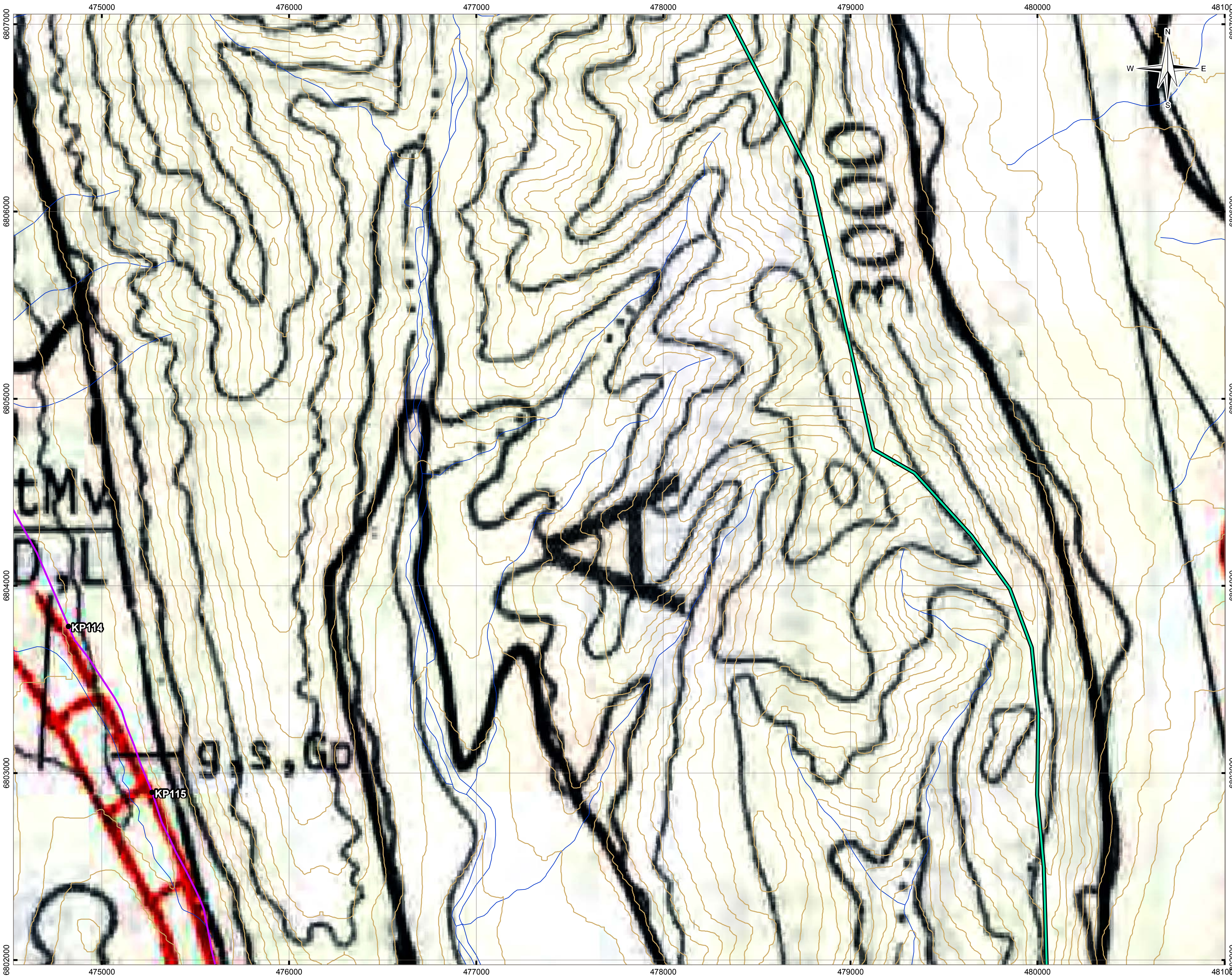
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

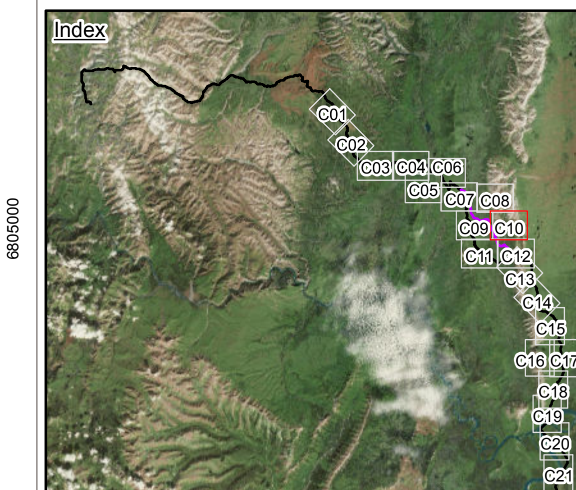
Figure C09



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

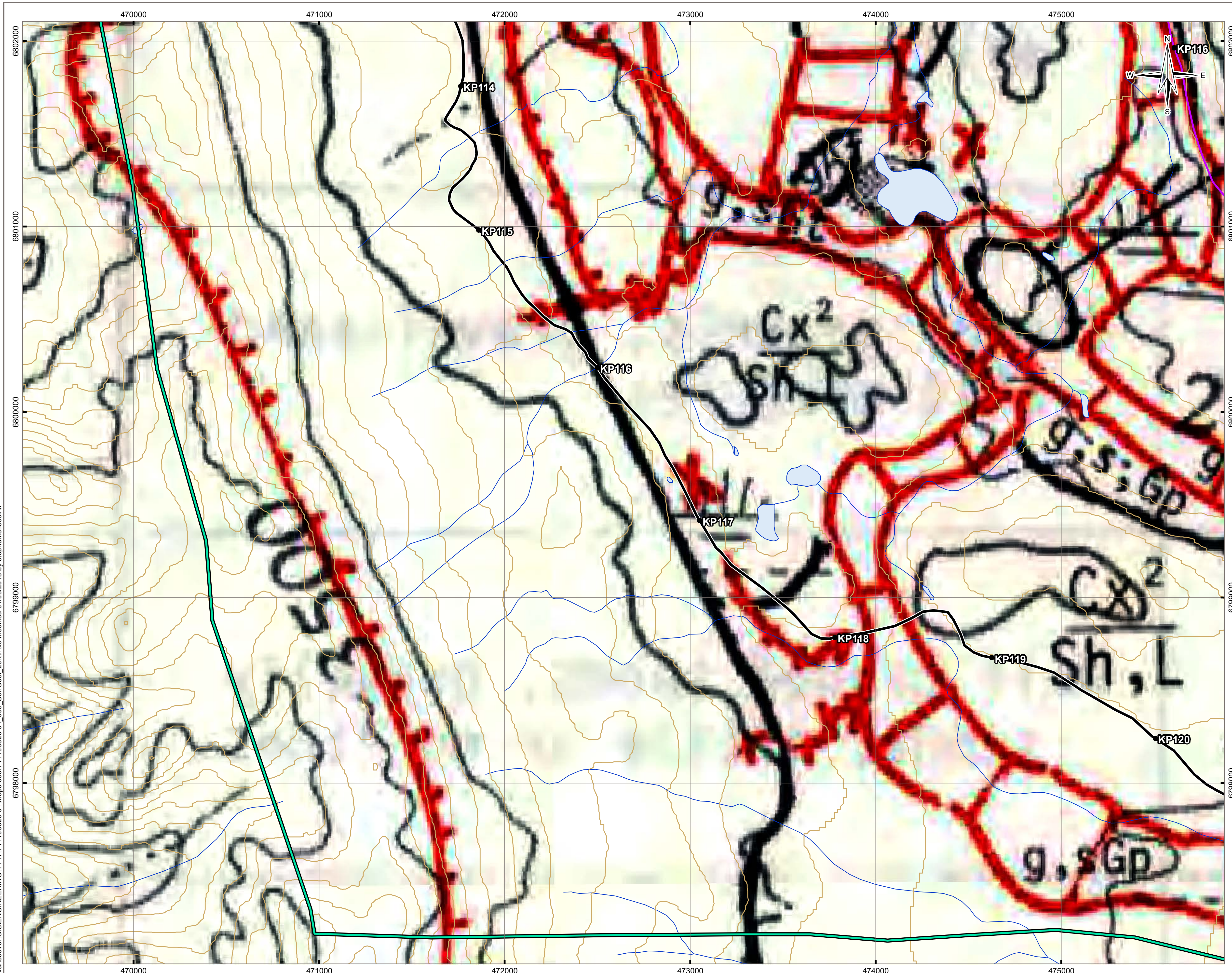
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SurfGeol_20K.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure C10

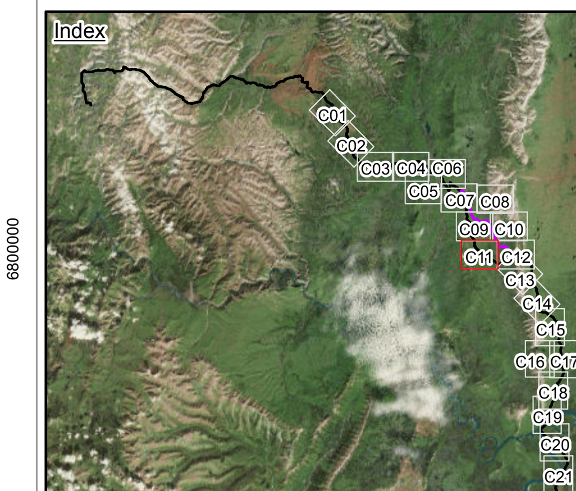
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C11

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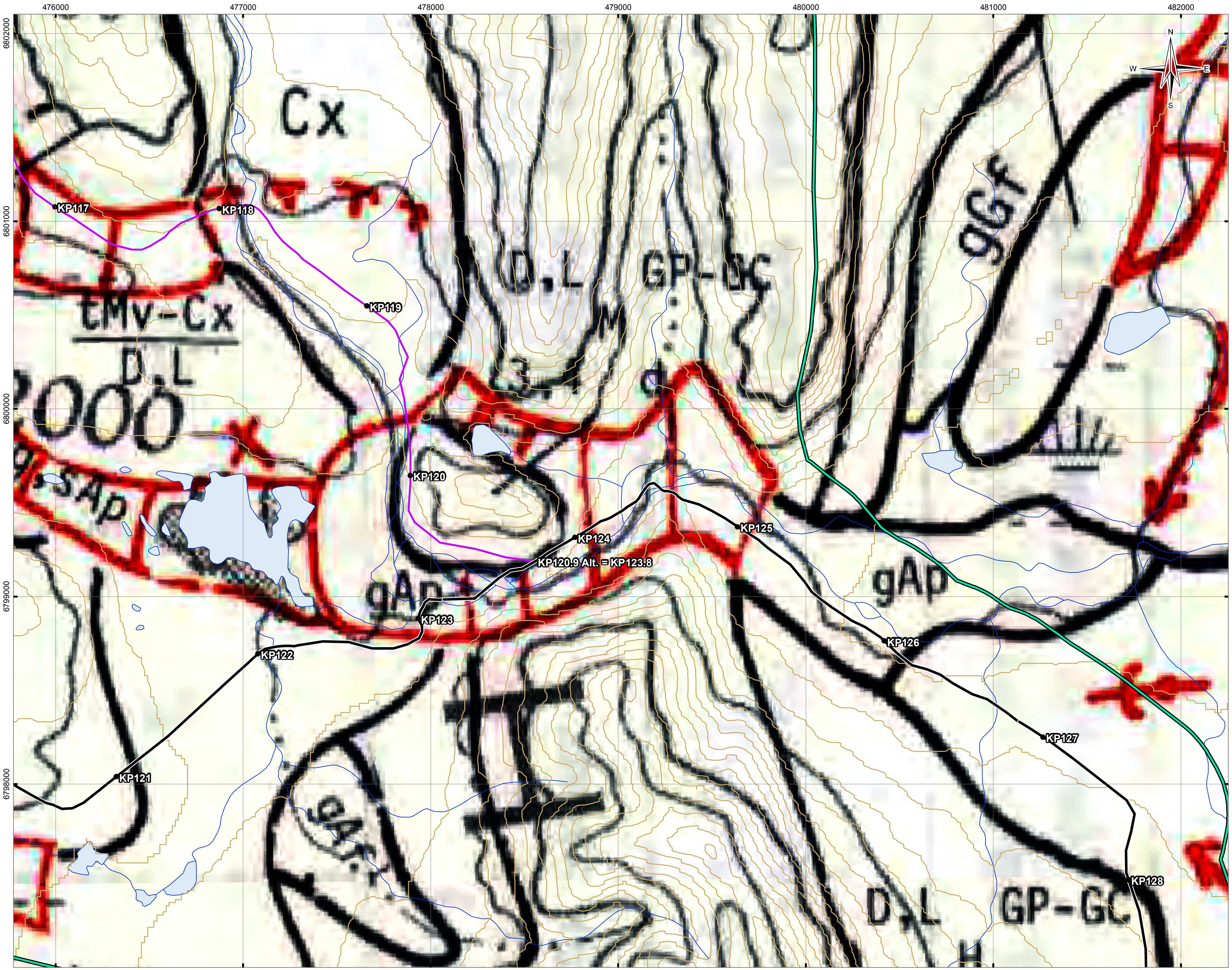

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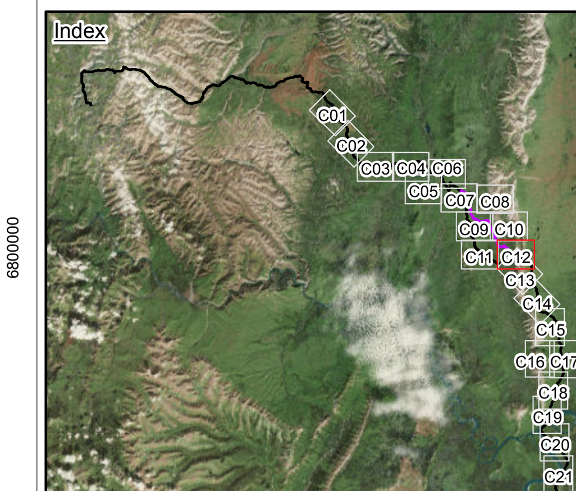
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

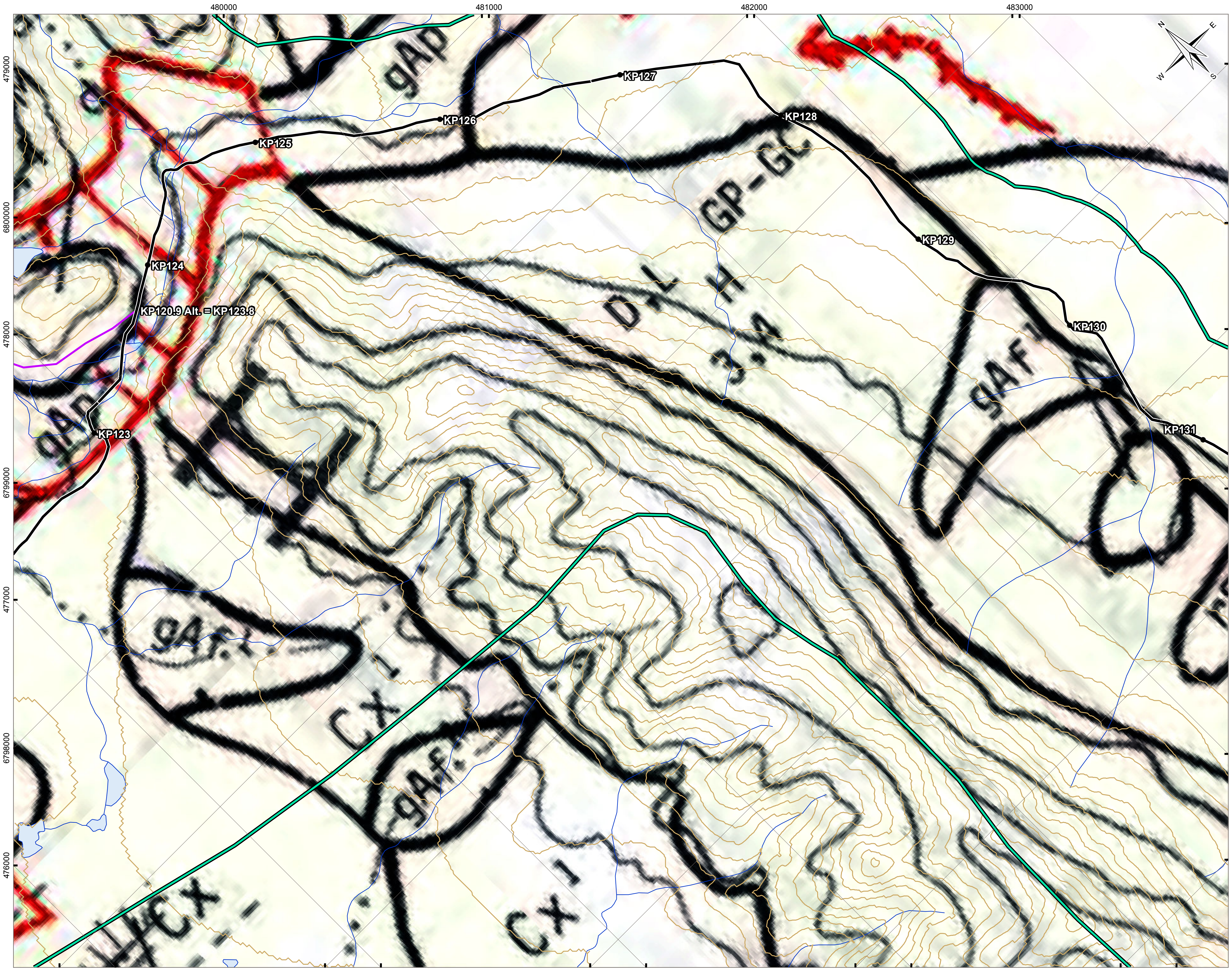
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

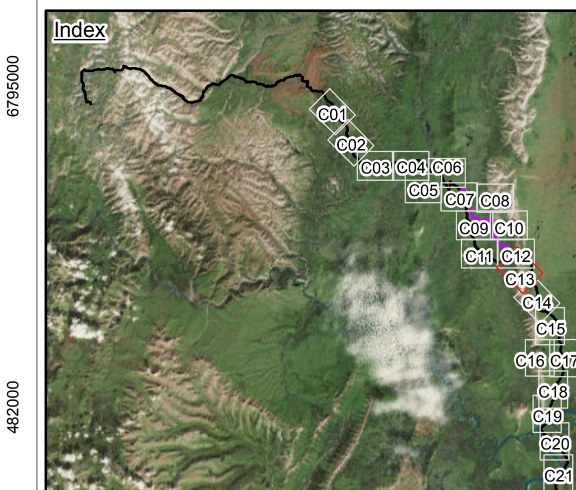
Figure C12



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

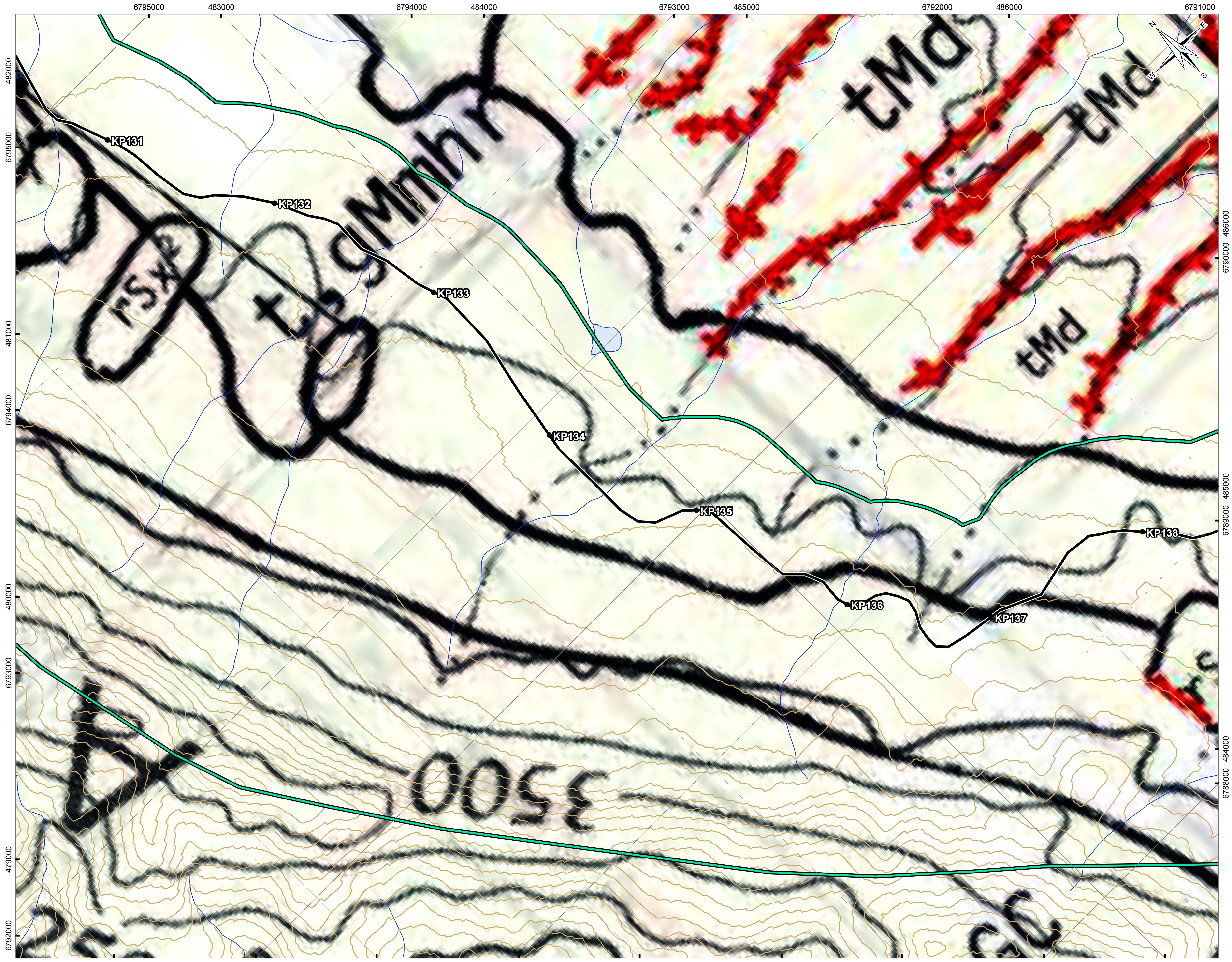
Scale: 1:20,000
400 200 0 400
Metres

FILE NO.				
Y14103320-01_003_SurfGeol_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	-	SM/RKO	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

TETRA TECH EBA

Figure C13

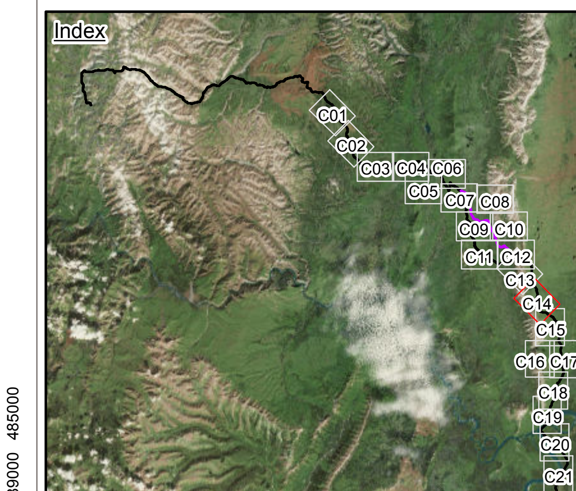
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

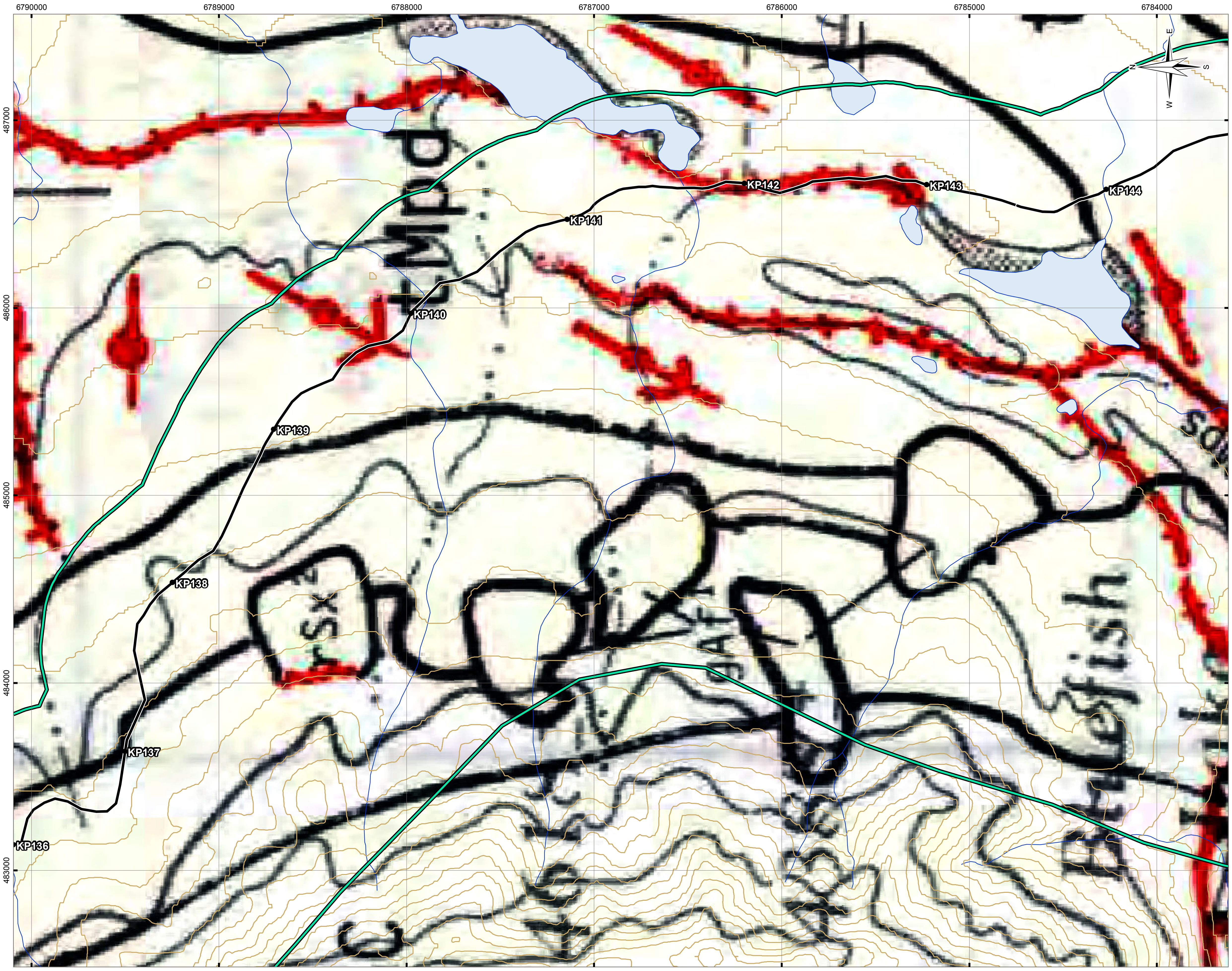
FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C14

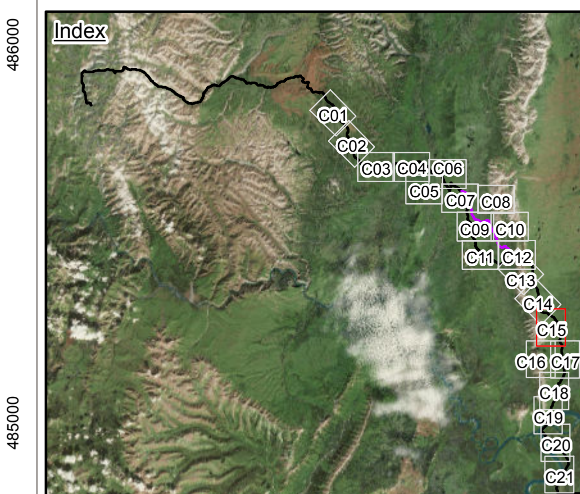
Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_SurfGeol_20K.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

TETRA TECH EBA

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C15

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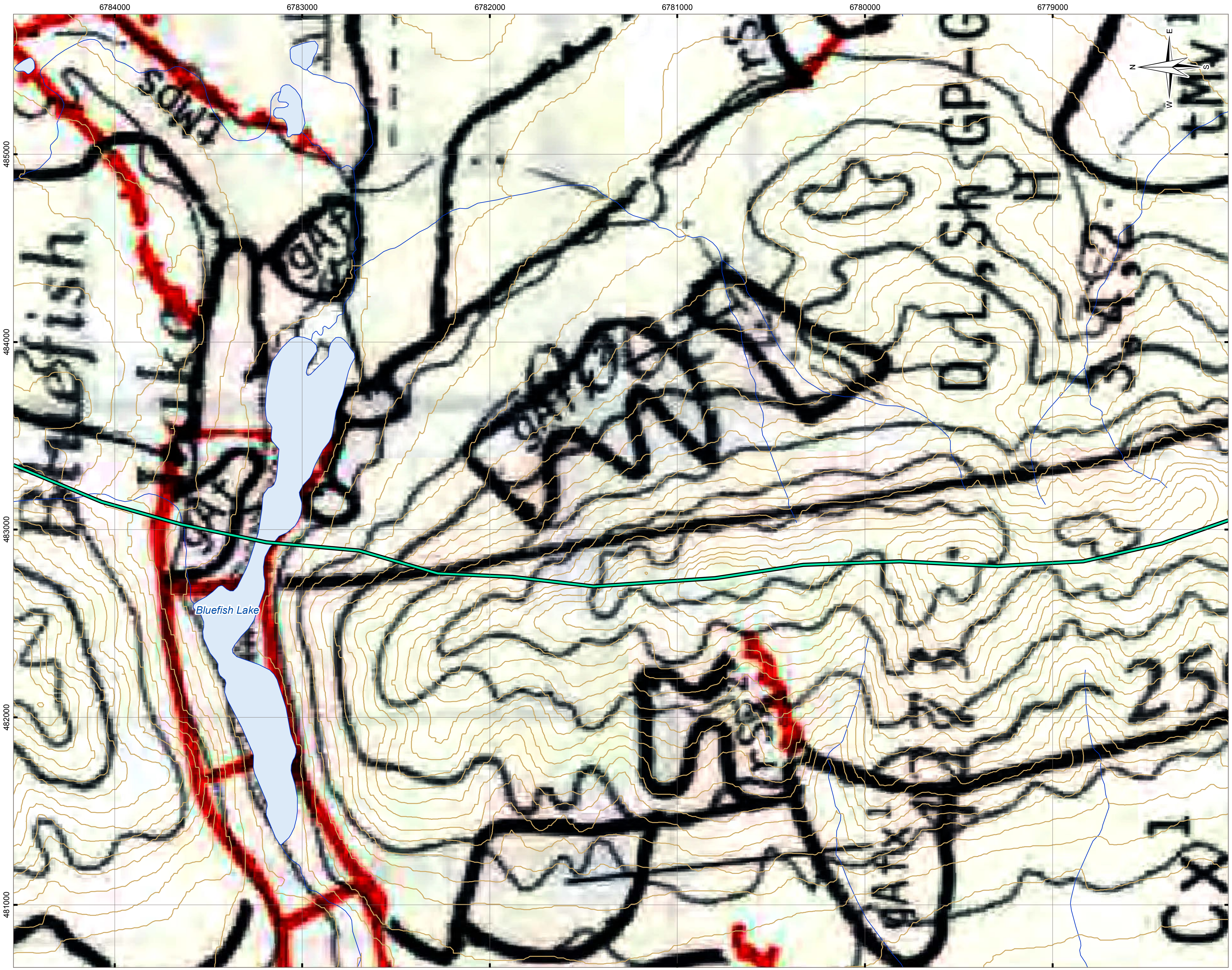
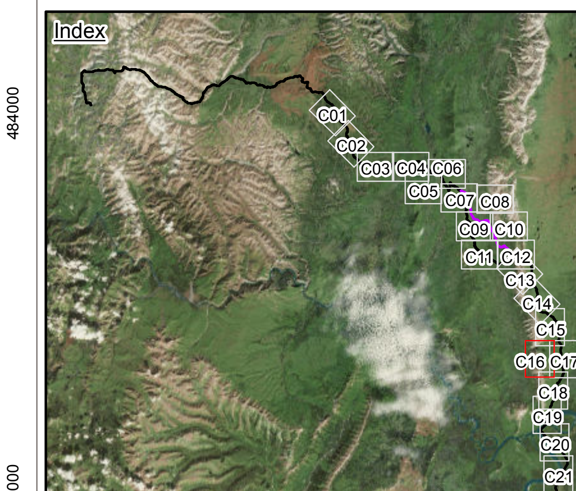


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION: UTM Zone 10	DATUM: NAD83	CLIENT: CANADIAN ZINC CORPORATION
Scale: 1:20,000 (400 200 0 400 Metres)		TETRA TECH EBA
FILE NO.: Y14103320-01_003_SurfGeol_20K.mxd		
PROJECT NO.: Y14103320-01.003	DWN: MEZ; CKD: -; APVD: SM/RKO; REV: 0	Figure C16
OFFICE: Tt EBA-VANC	DATE: September 4, 2015	

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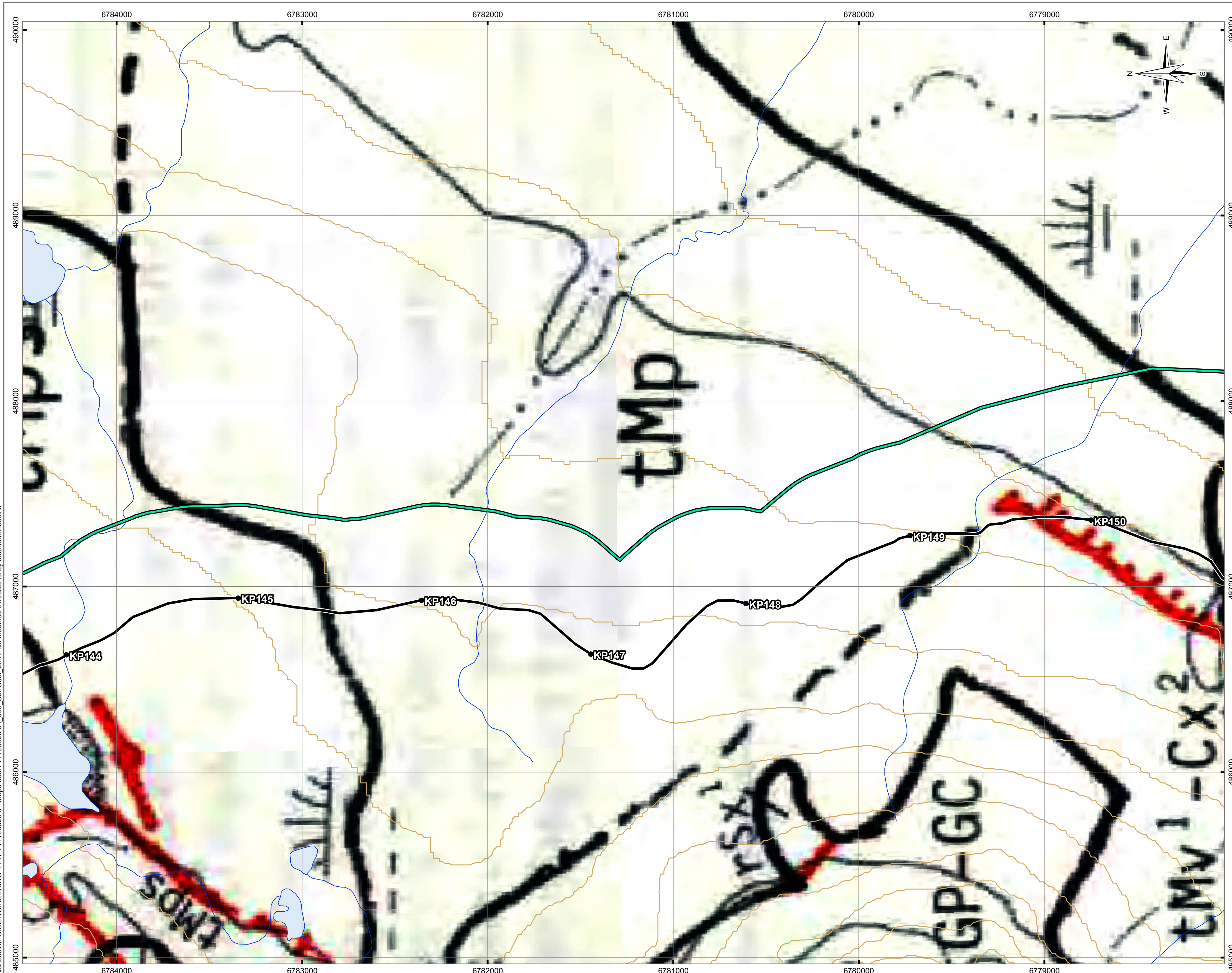

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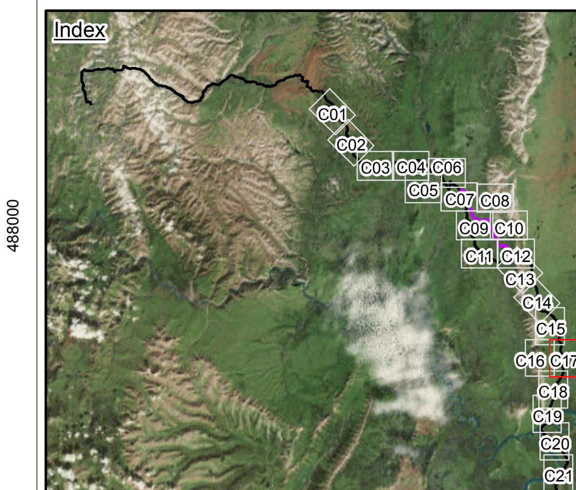
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

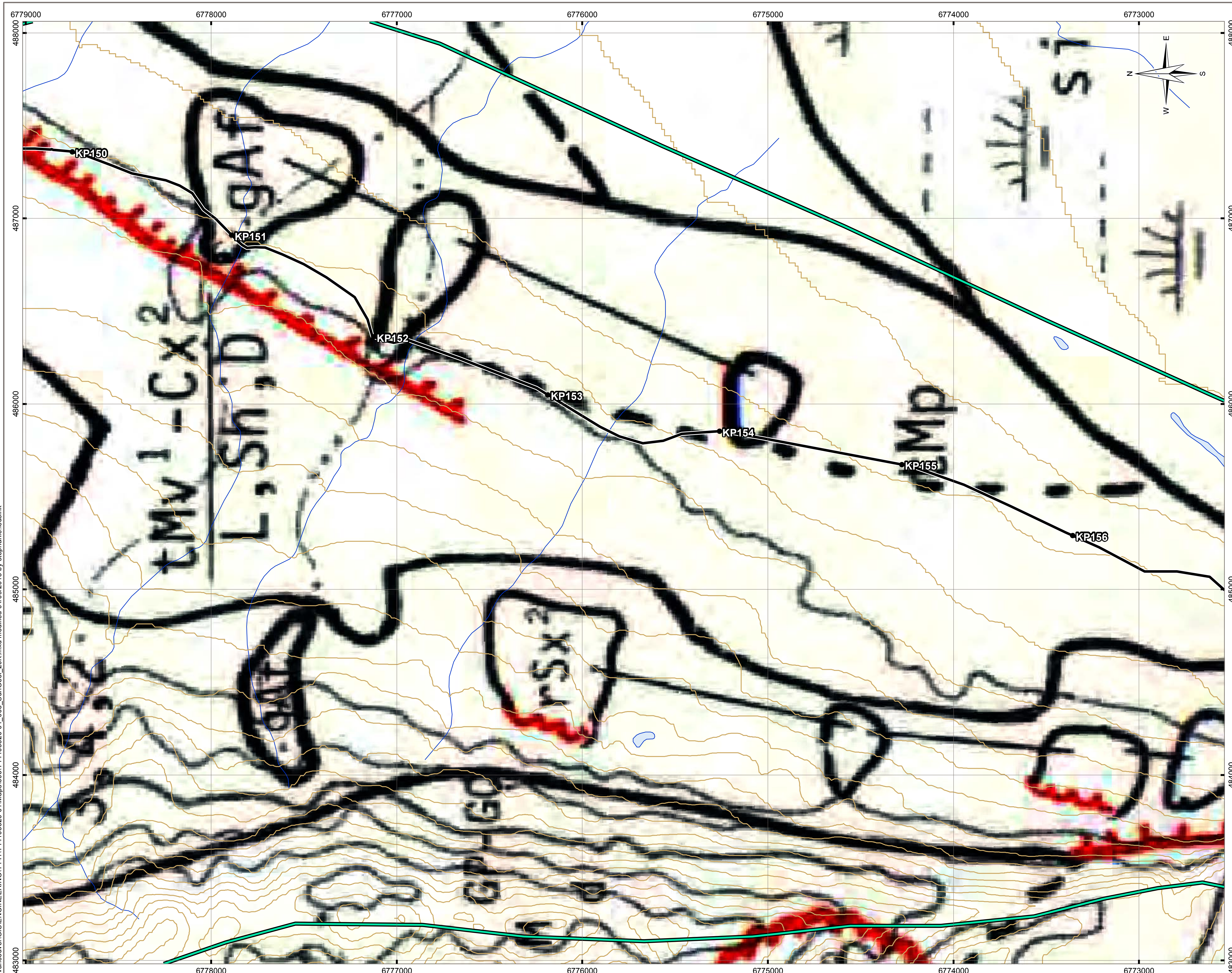
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

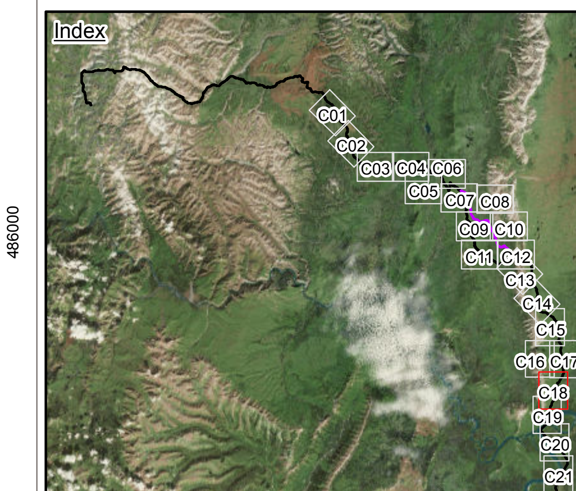
Figure C17



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

400 200 0 400

Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C18

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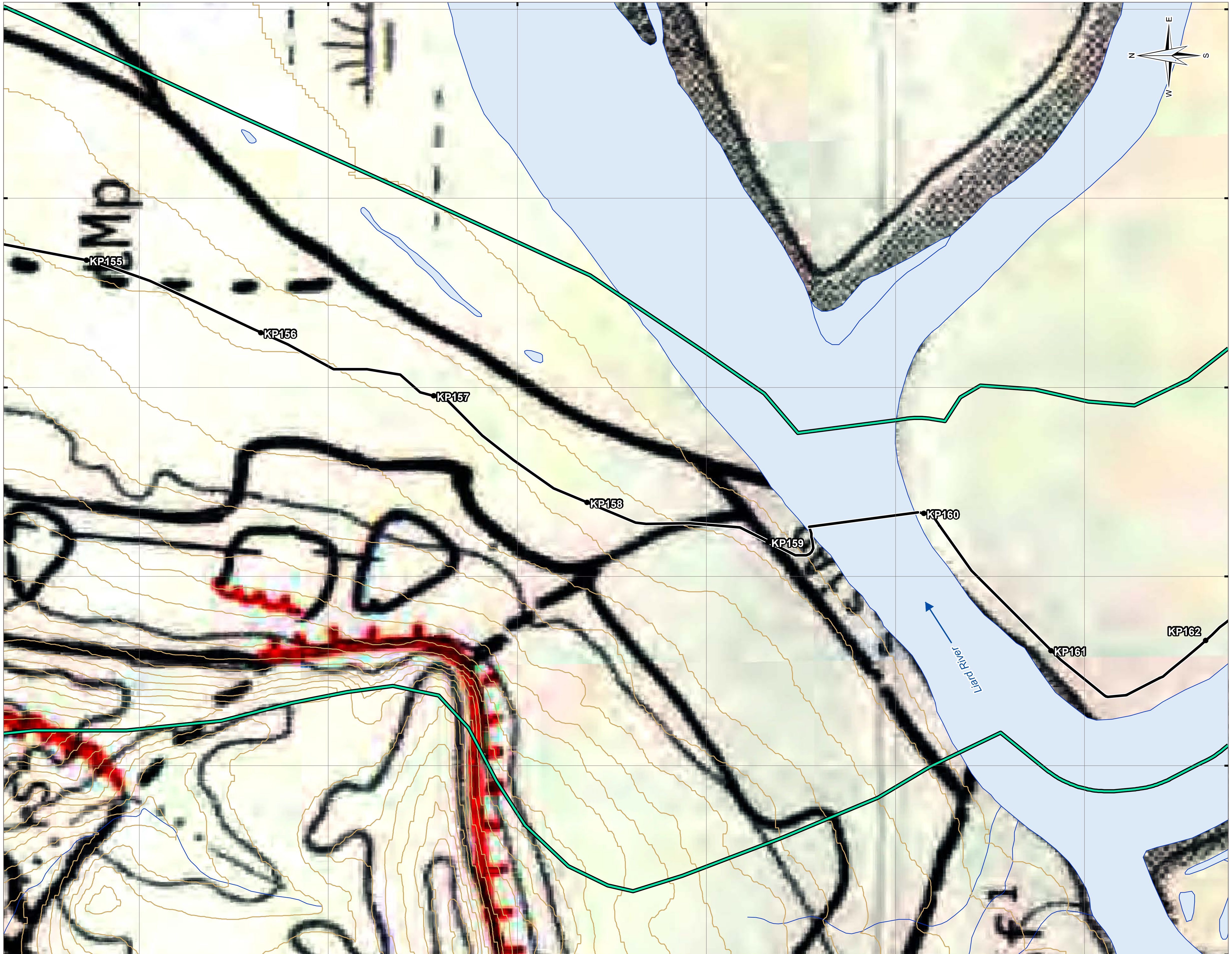
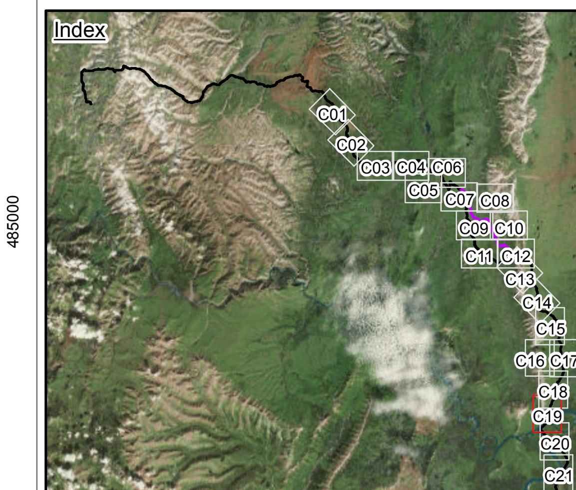


LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

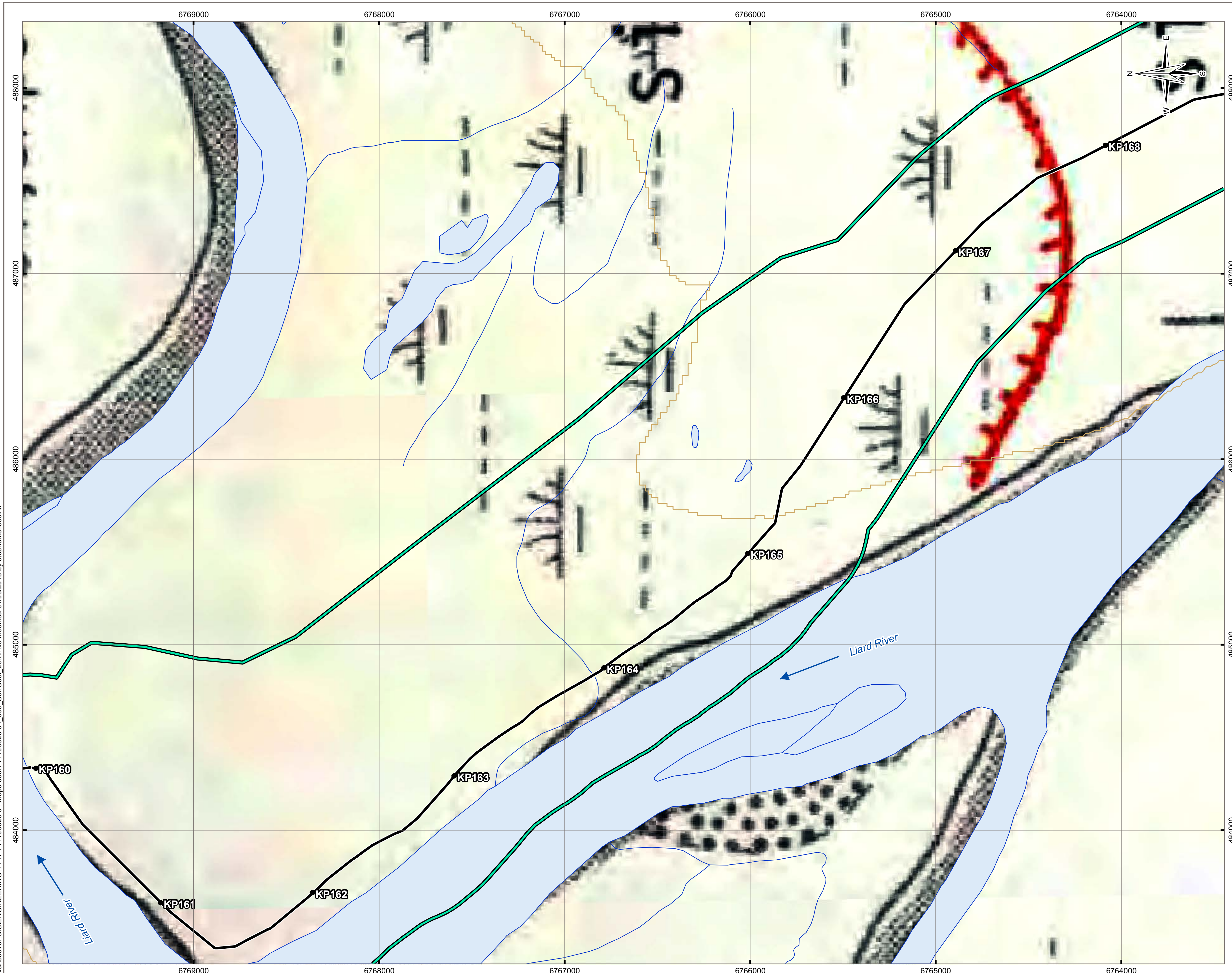
TETRA TECH EBA

FILE NO.
Y14103320-01_003_SurfGeol_20K.mxd

PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	-	SM/RKO	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure C19



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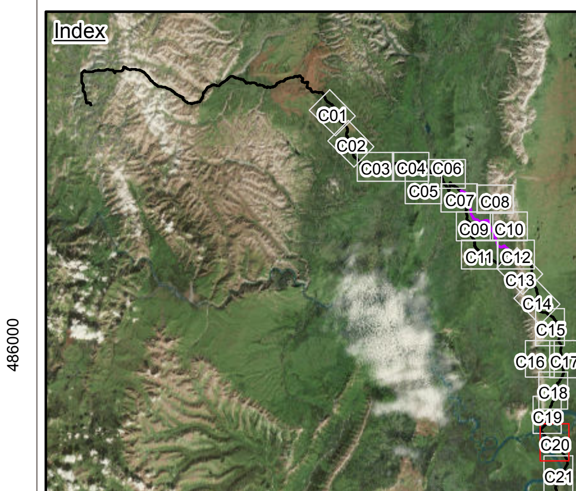
LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

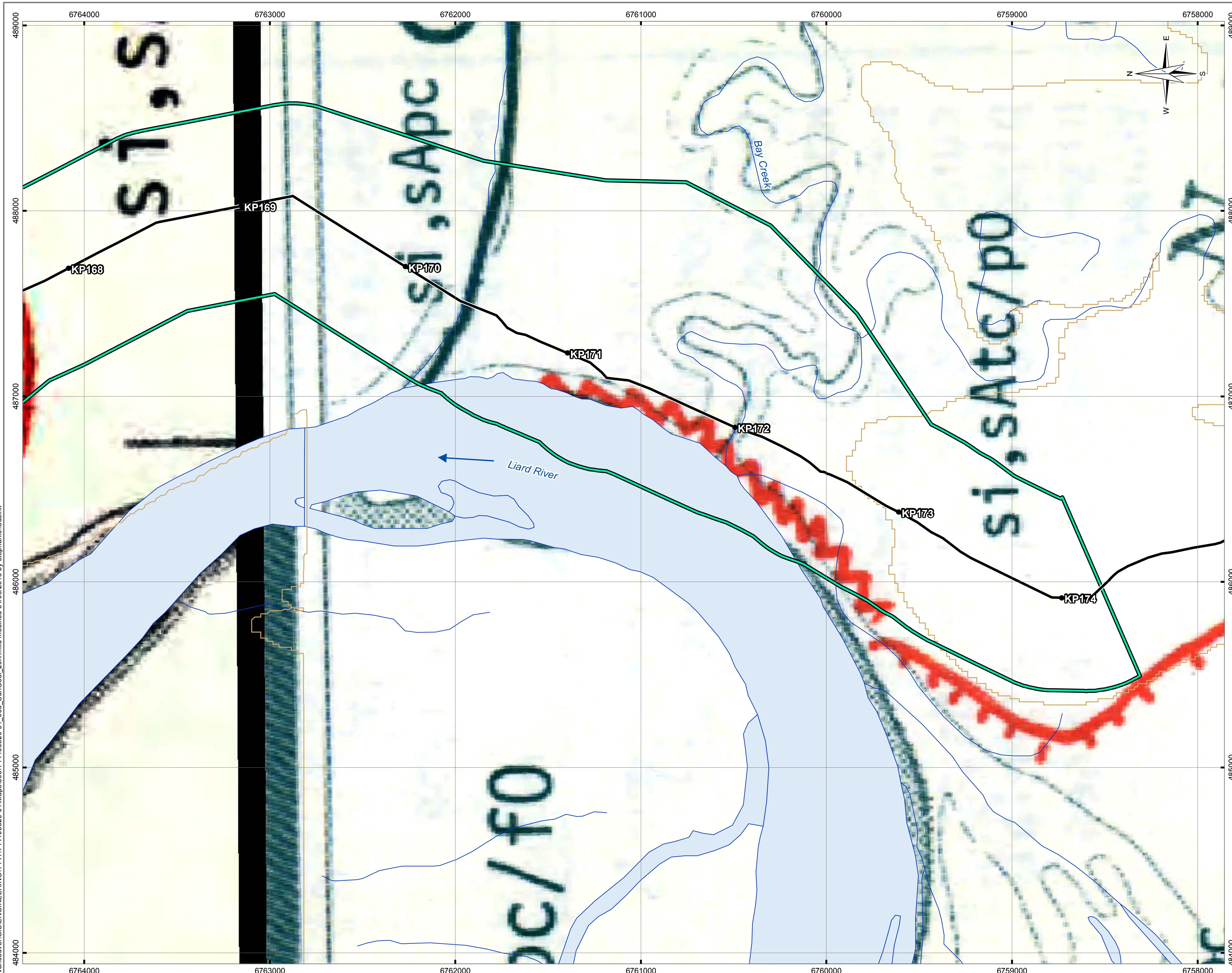
400 200 0 400

Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_SurfGeol_20K.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	-	SM/RKO	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

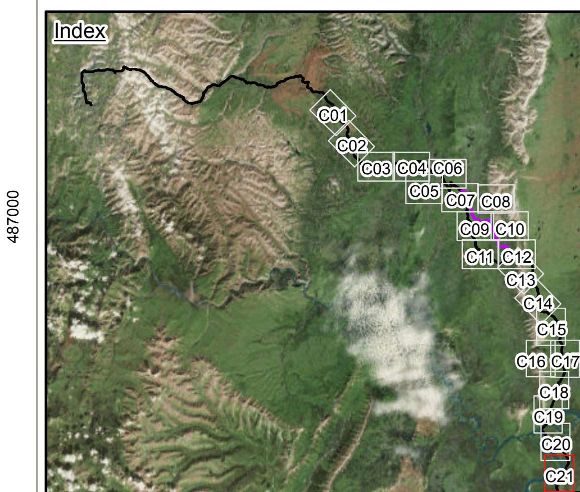
Figure C20



LEGEND

- 1 km Buffer (+ additional areas)
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)
- Contour (40 m)
- Watercourse
- Waterbody

For detailed surficial geology legend see Figure C22



NOTES
Base data source: CanVec.
Surficial geology based on Hawes, 1980 and 1981

STATUS
ISSUED FOR USE

PRAIRIE CREEK ALL-SEASON ROAD

Surficial Geology and Geomorphology

PROJECTION: UTM Zone 10	DATUM: NAD83	CLIENT: CANADIAN ZINC CORPORATION
Scale: 1:20,000 (400 200 0 400 Metres)		TETRA TECH EBA
FILE NO.: Y14103320-01_003_SurfGeol_20K.mxd		
PROJECT NO.: Y14103320-01.003	DWN: MEZ; CKD: -; APVD: SM/RKO; REV: 0	Figure C21
OFFICE: Tt EBA-VANC	DATE: September 4, 2015	

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DESCRIPTION OF MAP UNITS FOR UNCONSOLIDATED MATERIALS

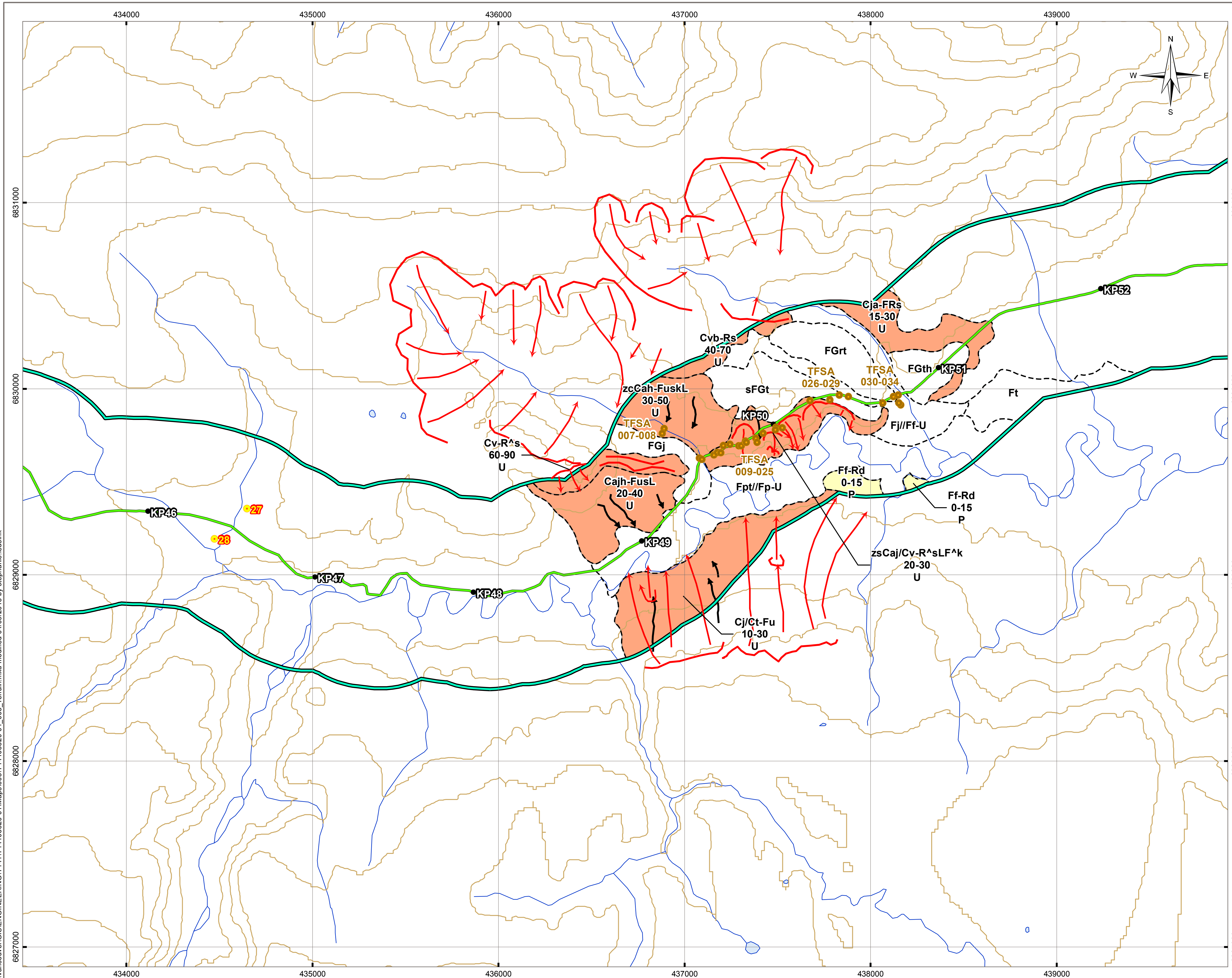
MAP UNIT (NOTE 1)	NAME	SURFICIAL DEPOSIT: MATERIAL	SURFICIAL DEPOSIT: ESTIMATED THICKNESS	LANDFORM: TOPOGRAPHY	LANDFORM: DRAINAGE PATTERN	GROUND ICE (NOTE 2)	UNIFIED SOIL CLASSIFICATION (NOTE 5)	SOILS (NOTES 3 and 3): PREDOMINANT SOIL*	ZONE 6S	6N	5	4	3	2	DOMINANT VEGETATION (NOTE 4): STABLE	AFTER FIRE	COMMENTS
g,sLpbx g,sLpbxv g,sLpbv	Glaciolacustrine beaches	Mainly gravel with minor sand; locally include silt(si); dominant material indicated first	g,sLpbx 1.5-2 m g,sLpbxv 0.5-1.5 m g,sLpbv 0.5-1.5 m	g,sLpbx and g,sLpbxv, parallel to subparallel beach ridges arranged in belts; up to 6° slopes; g,sLpbv, beach material without distinct ridges forming belts up to 6+ km wide	Drainage mainly subsurface	None observed	SP-GP	Eluviated Eutric Brunisol (W) Orthic Eutric Brunisol (W)	5	-	-	-	-	-	P, P-wB-tA	P, tA, wB	Good construction sites and aggregate source where material is coarse; beaches at 800-900 foot (240-275 m) elevations offer the best potential
								Gleyed Eutric Brunisol (I)	2	-	-	-	-	-	P-wB-Wi, bS-wB-Wi, tA-bS-Wi	P, tA, Wi, wB	
								Rego Gleysol (P)	3	-	-	-	-	-	bS-Fm-Er	Wi	
g,s,siGp g,s,siGpv g,s,siGt gGpc	Glaciofluvial plain Glaciofluvial terrace	Gravel, sand and silt; textures vary with the dominant material indicated first	g,s,siGp 1-30+ m g,s,siGpv 0.5-1.5 m g,s,siGt 1-30+ m	Flat to gently sloping	Drainage mainly subsurface	Frozen groundwater in gravel, sand, and silt in zone 2. Not observed elsewhere. Where overlying bog is more than 1.5 m thick permafrost may be present below	GP-GW to SP-SW	Eluviated Eutric Brunisol (W) Orthic Eutric Brunisol (W)	5	5	-	-	-	-	p-wB-tA, P in zones 6S and 6N	P, tA	Good construction sites and aggregate source where material is coarse
								Gleyed Eutric Brunisol (I)	2	2	-	-	-	-	bS-wB-Wi, P-wB-Wi, tA-bS-Wi in zones 6S and 6N	P, tA, Wi, wB	
								Rego Gleysol (P)	3	-	-	-	-	-	bS-Fm-Er in zones 6S and 6N	Wi	
								Gleysolic Turbic Cryosol (P)	-	3	-	-	-	-			
g,sGh g,sGr	Hummocky glaciofluvial deposits Ridged glaciofluvial deposits; includes eskers and esker complexes	Mainly gravel with sand	1-10 m 1-30 m	Hummocks with local relief up to 10 m Long, sinuous esker ridges, up to 30 m high	Drainage mainly subsurface	No segregated ice in well drained sites, but segregated ice may be present in association with silt layers beneath depressions in zones 2, 3, and 6N	GP-GW to SP-SW	Eluviated Eutric Brunisol (W) Orthic Eutric Brunisol (W)	-	-	-	5	-	-	tA-bS-wB, P, wS-tA-wB	P, tA, wB	Good construction sites and aggregate
								Gleyed Eutric Brunisol (I)	-	-	-	2	-	-	bS-tA-wB	tA, wB	
								Gleysolic Turbic Cryosol (P)	-	-	-	3	-	-	bS-Fm-Er, bS-lichen-Er	Wi	
tMp tMpc tMv	Moraine plain	Moderately to strongly calcareous glacial till, typically clay, silt, and minor sand with 5% pebbles and boulders; prefixes g, s, si, or c, indicate lenses of gravel, sand, silt, or clay within the till. If till is thin (tMv), the nature of the underlying bedrock is shown by a fractionated symbol (Note 6 gives bedrock lithology); dominant lithology indicated first	tMp 1.5-50 m tMpc 1.5-50 m tMv <1.5 m	Flat to uniformly sloping; tMp[1], tMv[1]: slope 2°- 5° tMp[2], tMv[2]: slope 5°-15°; map symbol may be suffixed by one or more r, m, s, d, or h (see below) indicating the mapped area in part consists of one or more of these landform units	Downslope seepage in subparallel runs Downslope seepage in shallow channels Downslope seepage in subparallel runs	Locally 5-40% segregated ice as thin (1 mm-2 cm) horizontal layers or in a reticulated network in zones 2, 3, and 6N; presence controlled by exposure, elevation, drainage, and/or organic cover	CL	Brunisolic Grey Luvisol (W)	4	-	3	-	-	-	wS-tA-wB, tA-P-wB in zones 4, 5, 6S, and 6N; wS-wB, bS-wB in zones 2 and 3	tA, P, wB	Failure common along scarps; poor source of aggregate; up to 10% unmapped pO and/or fO; because of drainage by numerous subparallel runs, roads, or berms normal to slope direction, numerous culverts required to avoid impoundment of surface water; slopes susceptible to soil creep and channelling
								Orthic Grey Luvisol (W)		3		3	-	-		wB, tA	
								Brunisolic Turbic Cryosol (W)	-		-	-	4	5			
								Gleyed Grey Luvisol (I)	2	-	3	2	-	-	wS-tA-wB, wS-tA-Wi in zones 4, 5, 6S, and 6N; bS-Wi-Al, bS-wB in zones 2 and 3	tA, wB, Wi, Al	
								Gleyed Brunisolic Grey Luvisol (I)		-		-	-	-			
								Brunisolic Turbic Cryosol (I)	-	2	-	-	1	1			
								Rego Gleysol (P)	4	-	-	-	-	-	bS-Fm-Er in zone 6S; bS-Fm-lichen-Er in zones 4, 5, and 6N; bS-lichen-Er in zones 2 and 3	Wi, Al	
								Gleysolic Turbic Cryosol (P)		5	4	5	5	4			
tMd tMsd tMds tMs	Drumlins Flutings and drumlins Flutings	Moderately to strongly calcareous glacial till; prefixes g, s indicate lenses of gravel or sand within the till	2-30 m	Area consisting largely of parallel drumlins and/or flutings	Trellis pattern or deranged drainage in drumlin areas to parallel seepage or streams in fluted areas	Segregated ice may be present in some drumlins and flutings in zones 2, 3, and 6N, although none has been observed; intervening depressions in the same zones likely contain segregated ice; presence controlled by exposure, elevation, drainage, and/or organic cover	CL	Brunisolic Grey Luvisol (W)	4	-	4	-	-	-	P-tA, tA-P-wB, wS-tA-wB in zones 4, 5, and 6S; wS-wB, bS-wB-Wi in zones 2 and 3	tA, P, wB	Poor source of aggregate except where gravel is present; some drumlins and most flutings are bedrock cored; crests of drumlins and flutings typically well drained; intervening depressions poorly drained
								Orthic Grey Luvisol (W)		-		3	-	-		Wi, wB, tA	
								Brunisolic Turbic Cryosol (W)	-	-	-	-	4	4			
								Gleyed Grey Luvisol (I)	2	-	2	2	-	-	wS-tA-wB, wS-tA-wB in zones 4, 5, and 6S; bS-Wi-Al, bS-wB in zones 2 and 3	tA, wB, Wi, Al	
								Gleyed Brunic Grey Luvisol (I)		-		-	-	-			
								Brunisolic Turbic Cryosol (I)	-	-	-	-	2	2			
								Rego Gleysol (P)	4	-	-	-	-	-	bS-Fm-Er in zone 6S; bS-Fm-lichen-Er in zones 4 and 5; bS-lichen-Er in zones 2 and 3	Wi, Al	
								Gleysolic Turbic Cryosol (P)		-	4	5	4	4			
t,g,sMr	Crevasse fillings or ridge moraine	Moderately to strongly calcareous glacial till, gravel, and sand; textures vary with the dominant material indicated first	1-10 m	Individual, parallel to subparallel, straight to sinuous ridges within a moraine plain; 0.5-5 m relief; slopes 5°-30°	Integrated, weakly developed drainage controlled by ridge pattern	None observed, probably no ice present	CL	Brunisolic Grey Luvisol (W)	6	-	6	-	-	-	P-tA, tA-P-wB, wS-tA-wB in zones 4, 5, and 6S; wS-wB in zones 2 and 3	P, tA, wB	Crests of prominent ridges offer restricted but good construction sites
								Orthic Grey Luvisol (W)		-		6	-	-		wB, tA	
								Brunisolic Turbic Cryosol (W)	-	-	-	-	6	6			
							CL to GP-SP	Rego Gleysol (P)	4	-	-	-	-	-	bS-Fm-Er in zone 6S; bS-Fm-lichen-Er in zones 4 and 5; bS-lichen-Er in zones 2 and 3	Wi, Al	
								Gleysolic Turbic Cryosol (P)		-	4	4	4	4			
t,g,sMh	Hummocky moraine	Moderately to strongly calcareous glacial till, gravel, and sand; textures vary with the dominant material indicated first	1-20 m	Individual to coalescent hummocks; slopes to 20°	Deranged	Crests of prominent hummocks well drained and ice free; lower slopes and depressions commonly have 5-40% segregated ice as thin (1 mm-2 cm) horizontal layers or in a recticulated network in zones 2, 3, and 6N; presence controlled by exposure, elevation, drainage, and/or organic cover	CL	Brunisolic Grey Luvisol (W)	6	-	6	-	-	-	P-tA, tA-P-wB, wS-tA-wB in zones 4, 5, and 6S; wS-wB, bS-wB in zones 2 and 3	tA, P, wB	Crests of prominent hummocks offer restricted but good construction sites
								Orthic Grey Luvisol (W)		-		6	-	-			
								Brunisolic Turbic Cryosol (W)	-	-	-	-	6	6			
							CL to GP-SP	Rego Gleysol (P)	4	-	-	-	-	-	bS-Fm-Er in zone 6S; bS-Fm-lichen-Er in zones 4 and 5; bS-lichen-Er in zones 2 and 3	Wi, Al	
								Gleysolic Turbic Cryosol (P)		-	4	4	4	4			
tMm	Subdued hummocky and rolling moraine	Moderately to strongly calcareous glacial till	5-30 m	Subdued hummocks and rolling terrain; slopes 5°-30°	Deranged	Well drained sites ice free; lower slopes and depressions commonly have 5-40% segregated ice as thin (1 mm-2 cm) horizontal layers or in a reticulate network in zones 2, 3, and 6N; presence controlled by exposure, elevation, drainage, and/or organic cover	CL	Brunisolic Grey Luvisol (W)	6	-	6	-	-	-	P-tA, tA-P-wB, wS-tA-wB in zones 4, 5, and 6S; wS-wB, bS-wB in zones 2 and 3	tA, P, wB	Summits of broad hummocks typically well drained and offer restricted but good construction sites
								Orthic Grey Luvisol (W)		-		6	-	-			
								Brunisolic Turbic Cryosol (W)	-	-	-	-	6	6			
								Rego Gleysol (P)	4	-	-	-	-	-	bS-Fm-Er in zone 6S; bS-Fm-lichen-Er in zones 4 and 5; bS-lichen-Er in zones 2 and 3	Wi, Al	
								Gleysolic Turbic Cryosol (P)		-	4	4	4	4			
t,g,s,S, t,g,s,Sx, s,siS, s,siSx, rS, rSx	Debris avalanche; earthflow, mudflow, flowslide, & slump deposits	Material derived mainly from glaciolacustrine silts and clays, till. Material derived mainly from shale bedrock	Variable	Debris avalanches commonly occur as thin narrow tongues; earthflows and mudflows as bulbous masses; and slump deposits as blocks		Fine grained material may contain segregated ice in zones 2, 3, 6N, and northern part of 6S; presence controlled by exposure, elevation, drainage, and/or organic cover	Variable	Cumulic Regosol (W)	-	-	4	-	4	4	bS-wB-Wi-fireweed or unvegetated in zones 2, 3, and 5	Firewood, Wi	Shale bedrock commonly fails as debris avalanches in mountainous regions; large-scale failures are common along major river scarps in fine textured glacial deposits and in shale bedrock
								Gleyed Cumulic Regosol (I)	-	-	2	-	1	1			
								Rego Gleysol (P)	-	-	4	-	5	5			
								Gleysolic Turbic Cryosol (P)	-	-	-	-			Wi, bS-Wi in zones 2, 3, and 5	Wi	

DESCRIPTION OF MAP UNITS FOR BEDROCK AND MOUNTAIN TERRAIN

MAP SYMBOL	NAME	TOPOGRAPHY	PRINCIPAL BEDROCK UNITS**		SURFICIAL DEPOSITS	UNIFIED CODE	MICRORELIEF	SOILS AND VEGETATION***	ENGINEERING COMMENTS
L* D L,D D,L L,Sh M	Mountains developed in carbonate rocks -limestone and dolomite with minor shale	Mountains up to 1500 m with sharp ridge crests and steep slopes. Ram Plateau area forms a level surface, dissected by deep canyons	L D L,D D,L L,Sh	includes Headless, Landry, and Nahanni formations in Mackenzie Mountains and Flett Formation, in Silent Hills and Liard Range includes Arnica, Manetoe, and Sombre formations in Mackenzie Mountains includes Whittaker and Sunblood formations in Mackenzie Mountains includes Delorme Formation in Mackenzie Mountains and Camsell Formation in Camsell Range includes Funeral Formation	Bare rock with discontinuous patches of limestone and dolomite rubble, bedrock colluvium with a matrix of fines and sand and/or reworked till on crests and steep slopes; variable thicknesses of bedrock rubble and colluvium and/or reworked till at base of slopes; discontinuous veneer of till on plateau areas	GP-GC	Well developed stone polygons, stripes, and nets on flat to sloping ground. Numerous small solifluction lobes in McConnell Range of Franklin Mountains	Steep slopes: no soil development; lichen on bare surfaces. Base of slopes: Orthic Eutric Brunisol or Brunisolic Turbic Cryosol; above timberline Brunisolic Turbic Cryosol; lichen, ericaceous plants above timberline; white spruce, trembling aspen below timberline. Ram Plateau: Orthic Eutric Brunisol, Brunisolic Turbic Cryosol, or Orthic Regosol; lichen, ericaceous plants, some white spruce	Steep slopes and high relief present serious difficulties to engineering activities such as road, pipeline, and related construction; limestone and dolomite are highly resistant and could be used for construction material; coarse deposits of rubble make suitable construction sites and sources of aggregate

Figure C22

APPENDIX D
TERRAIN STABILITY MAPPING FOR HIGH-RISK AREAS



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LEGEND

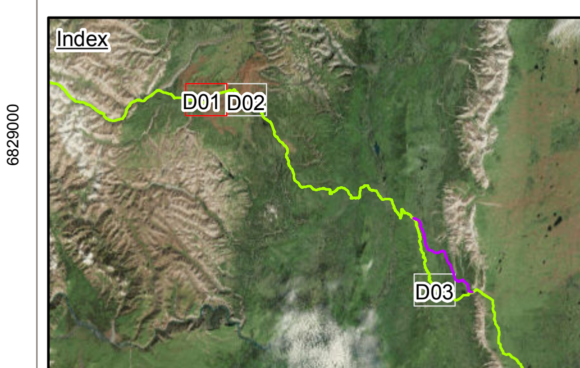
- 1 km Buffer
- Field Site
- TFSA
- Terrain Boundary

Slope Stability Class

- P Potentially Unstable Terrain
- U Unstable Terrain
- Prairie Creek Access Road (Feb 24, 2015)

Geology

- Bedrock outcrop
- Possible Sinkhole or Kettle
- Thermokarst terrain
- Landslide Failure Scar Large (1982)
- Landslide Failure Scar Large (1994)
- Landslide Failure Scar Large (Post-1994)
- Landslide Head Scarp Large (1982)
- Landslide Head Scarp Large (1994)
- Landslide Head Scarp Large (Post-1994)
- Escarpment
- Gully
- Meltwater channel (major)
- Meltwater channel (minor)
- Contour (40 m)
- Watercourse
- Waterbody



NOTES
Base data source: CanVec; GeoBase.

STATUS
ISSUED FOR USE - INTERIM DOCUMENT

PRAIRIE CREEK ALL-SEASON ROAD

Terrain Mapping
KP46 to KP52

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000

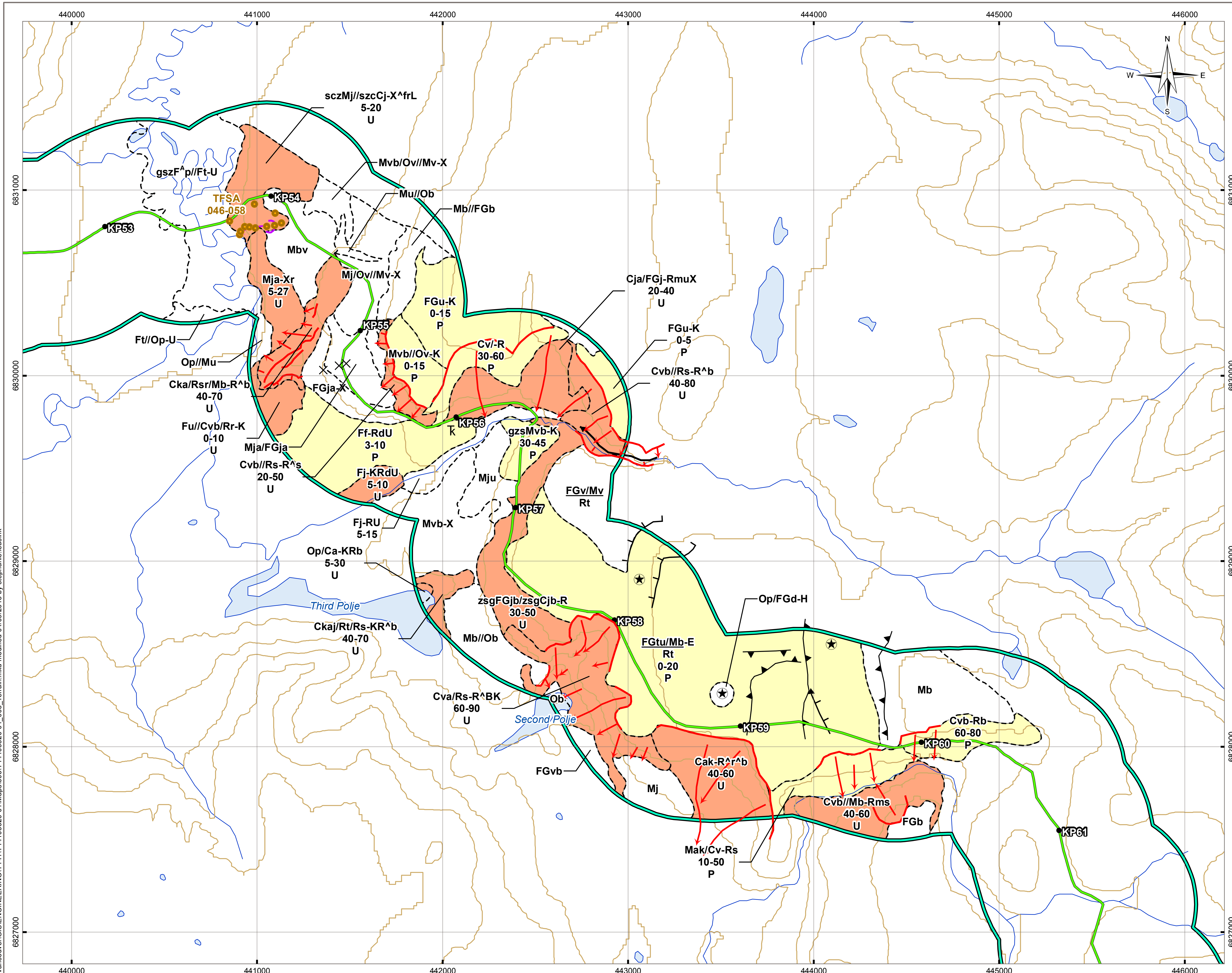
400 200 0 400

Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_Terrain.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
Y14103320-01.003	MEZ	SL	SMC	0
OFFICE	**DATE**			
Tt EBA-VANC	September 4, 2015			

Figure D01



LEGEND

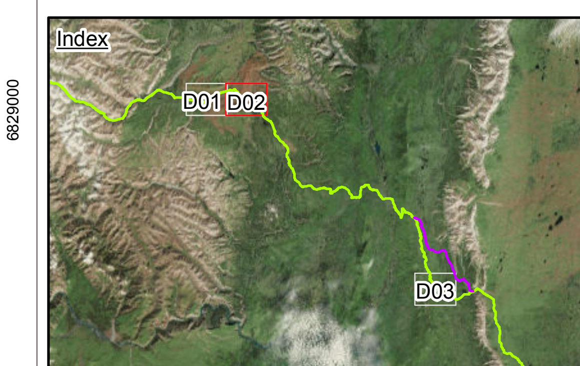
- 1 km Buffer
- Field Site
- TFSA
- Terrain Boundary

Slope Stability Class

- P Potentially Unstable Terrain
- U Unstable Terrain
- Prairie Creek Access Road (Feb 24, 2015)

Geology

- Bedrock outcrop
- Possible Sinkhole or Kettle
- Thermokarst terrain
- Landslide Failure Scar Large (1982)
- Landslide Failure Scar Large (1994)
- Landslide Failure Scar Large (Post-1994)
- Landslide Head Scarp Large (1982)
- Landslide Head Scarp Large (1994)
- Landslide Head Scarp Large (Post-1994)
- Escarpment
- Gully
- Meltwater channel (major)
- Meltwater channel (minor)
- Contour (40 m)
- Watercourse
- Waterbody



NOTES
Base data source: CanVec; GeoBase.

STATUS
ISSUED FOR USE - INTERIM DOCUMENT

PRAIRIE CREEK ALL-SEASON ROAD

Terrain Mapping KP53 to KP61

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

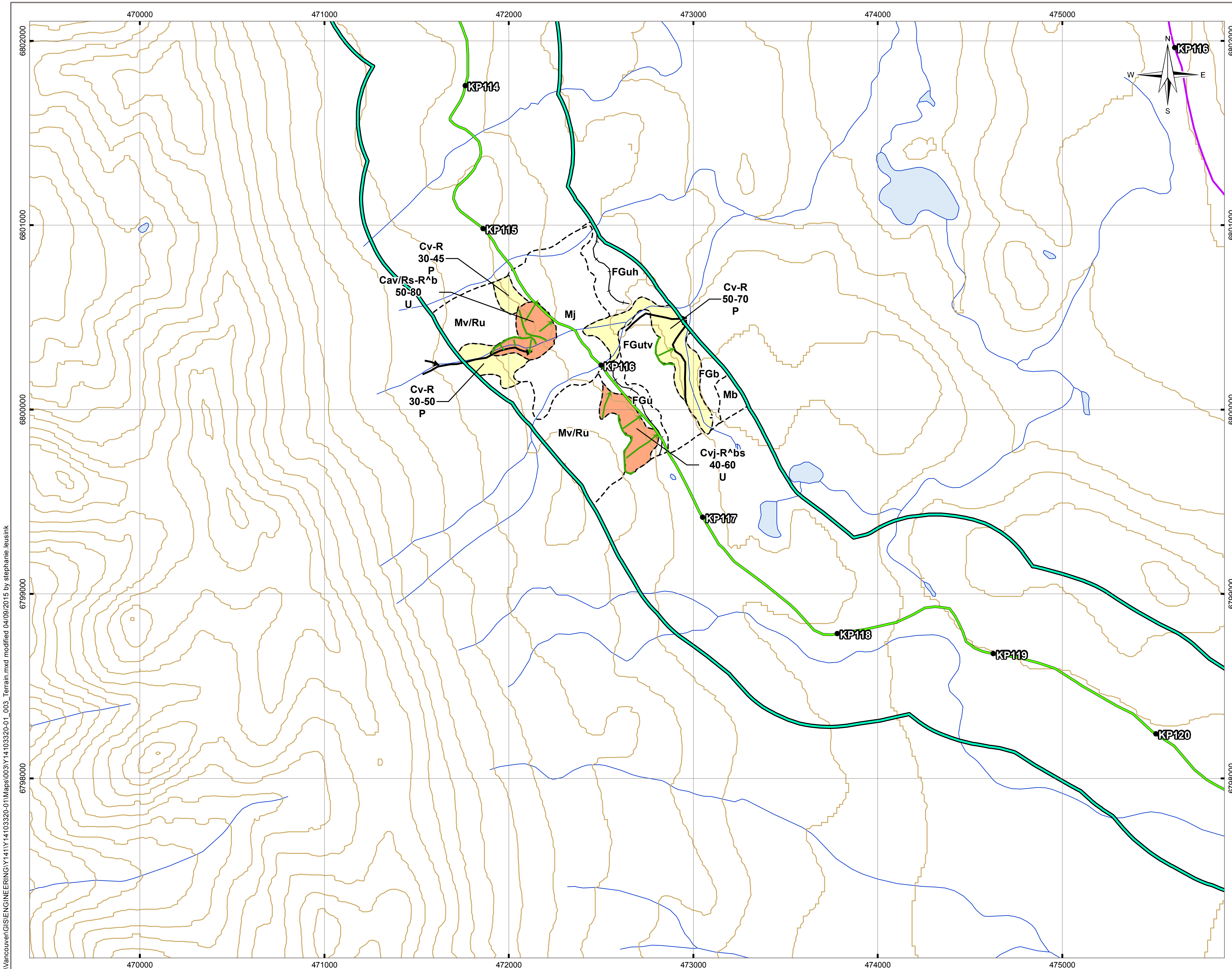
Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.				
Y14103320-01_003_Terrain.mxd				
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	SL	SMC	0
OFFICE	DATE			
Tt EBA-VANC	September 4, 2015			

Figure D02

Q:\Vancouver\GIS\ENGINEERING\Y141\Y14103320-01\Maps\003\Y14103320-01_003_Terrain.mxd modified 04/09/2015 by stephanie.leusink



LEGEND

- 1 km Buffer
- Field Site
- TFSA
- Terrain Boundary

Slope Stability Class

- P Potentially Unstable Terrain
- U Unstable Terrain
- Prairie Creek Access Road (Feb 24, 2015)
- Alternative Alignment (July 30, 2015)

Geology

- Bedrock outcrop
- Possible Sinkhole or Kettle
- Thermokarst terrain
- Landslide Failure Scar Large (1982)
- Landslide Failure Scar Large (1994)
- Landslide Failure Scar Large (Post-1994)
- Landslide Head Scarp Large (1982)
- Landslide Head Scarp Large (1994)
- Landslide Head Scarp Large (Post-1994)
- Escarpment
- Gully
- Meltwater channel (major)
- Meltwater channel (minor)
- Contour (40 m)
- Watercourse
- Waterbody

NOTES
Base data source: CanVec; GeoBase.

STATUS
ISSUED FOR USE - INTERIM DOCUMENT

PRAIRIE CREEK ALL-SEASON ROAD

Terrain Mapping
KP114 to KP120

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
Y14103320-01_003_Terrain.mxd

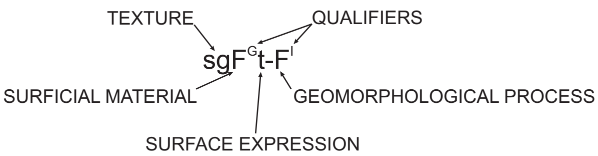
PROJECT NO.	DWN	CKD	APVD	REV
Y14103320-01.003	MEZ	SL	SMC	0

OFFICE	DATE
Tt EBA-VANC	September 4, 2015

Figure D03

TERRAIN STABILITY LEGEND

TERRAIN SYMBOL



Stratigraphic Units: When one or more surficial materials overlie a different material or bedrock. Materials are placed in order of occurrence and separated by a solid line.

e.g.	zEv / gFt	veneer of eolian silt overlying terraced fluvial gravels
	Mh / $gF^{g}p$	hummocky morainal materials overlying glaciofluvial gravels
	/sEv / gFt	a moderately extensive, but discontiuous, eolian veneer on a river terrace

Subclasses: Subdivisions of the general categories of the Geomorphological Processes classification.

e.g.	$F^{A}p$-Mp	a meandering river with backchannels containing flowing orstanding water year-round
	Rs/Cv-VR"bd	gullied bedrock cliffs where rockfall (b) and debris flows (d) start (")
	xrCk-Rb	talus slope receiving rockfall

DELIMITERS

Map Symbol	Definition
.	Components on either side of the symbol are of approximately equal proportion
/	the component in front of the symbol is more extensive than the one that follows
//	the component in front of the symbol is considerably more extensive than the component that follows.

TEXTURE

Symbol	Name	Description
s	sand	particles between 0.0625 and 2.0 mm in size
z	silt	particles between 2 µm and 0.0625 mm in size
c	clay	particles less than 0.002 mm in size
g	gravel	mix of boulders, cobbles and pebbles greater than 2 mm in size

SURFICIAL MATERIALS

Symbol	Name	Description
C	colluvial	Products of mass wastage
F	fluvial	River deposits
F^{G}	glaciofluvial	Fluvial materials deposited by meltwater streams
M	morainal	Material deposited directly by glaciers
O	organic	Accumulation/decay of vegetative matter
R	bedrock	Outcrops/rocks covered by less than 10 cm of surficial material

QUALIFIERS

Symbol	Name	Description
A	active	Used to qualify surficial material and geomorphological processes with regard to their current state of activity

SURFACE EXPRESSION

Symbol	Name	Description
a	moderate slope	Unidirectional surface; 27 to 49%
b	blanket	A mantle of unconsolidated materials; > 1m thick
d	depression	A steep-sided hollow
f	fan	Fan-shaped landform; up to 26%
h	hummocky	Hillocks and hollows, irregular plan; generally > 26%
j	gentle slope	Unidirectional surface; 6 to 26%
k	moderately steep	Unidirectional surface; 50 to 70%
p	plain	Unidirectional surface; 0 to 5%
r	ridged	Elongate hillocks; parallel in plan; generally > 26%
s	steep	Steep slopes; > 70%
t	terraced	Step-like topography
u	undulating	Hillocks and hollows; irregular in plan; generally < 26%
v	veneer	Discontinuous cover of unconsolidated material; < 1m thick

GEOMORPHOLOGICAL PROCESSES

Symbol	Name	Description
E	channeled	Channel formation by glacial meltwater
F	slow mass movement	Slow down-slope movement of masses of cohesive or non-cohesive material and/or bedrock
H	kettled	Depressions due to the melting of buried glacier ice
K	karst	Processes associated with the solution of carbonates
L	surface seepage	Abundant surface or seasonal seepage of moisture
R	rapid mass movement	Rapid downslope movement of dry, moist or saturated debris
U	inundation	Seasonally under water due to high watertable

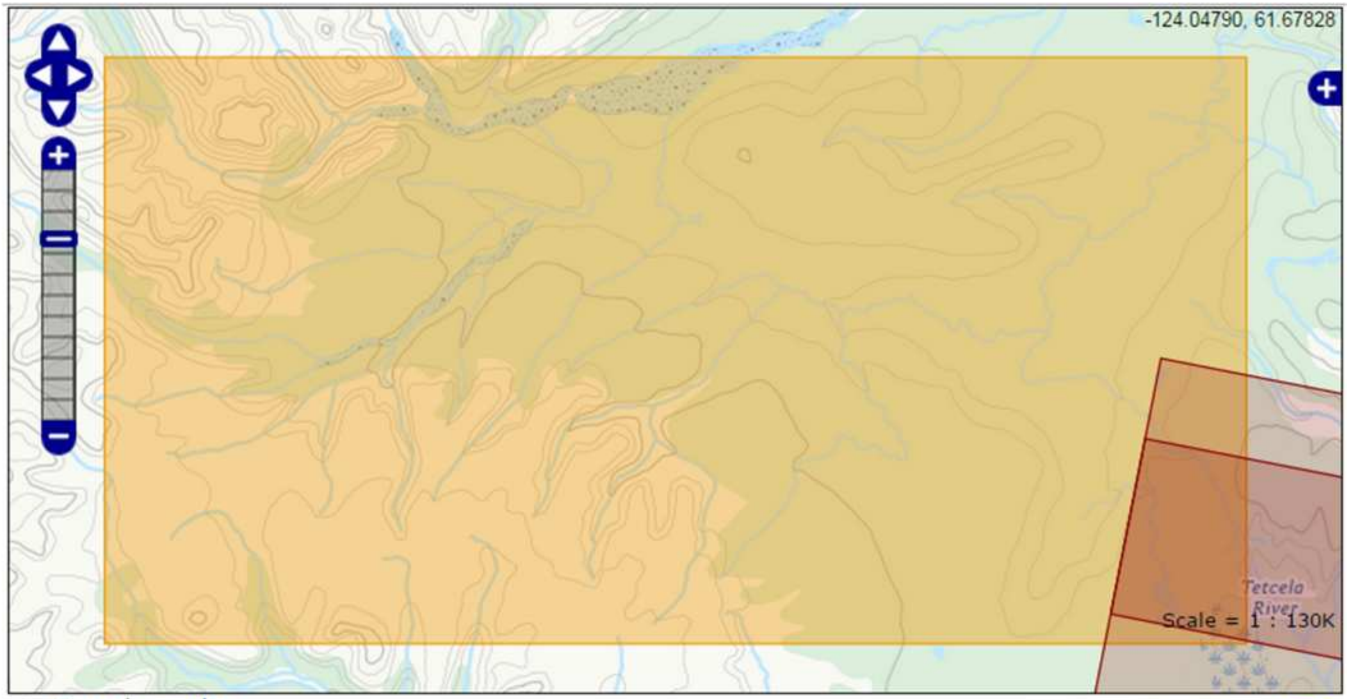
SUBCLASSES FOR PERMAFROST PROCESSES

Symbol	Name
f	thaw flow slides

SUBCLASSES FOR MASS MOVEMENT PROCESSES

Symbol	Name
"	Initiation Zone
k	tension cracks
b	rockfall
d	debris flow
m	slump in bedrock
u	slump in surficial material
s	debris slide
r	rockslide

TETRA TECH EBA



Search results

61 results from a total of 61 returns

Aerial Photo

☑	1994-06-16	A28094	196	Black&White	25000	See Meta		☐
☑	1994-06-16	A28094	197	Black&White	25000	See Meta		☐

Search results

Aerial Photo

☑	1994-06-16	A28094	217	Black&White	25000	See Meta		☐
☑	1994-06-16	A28094	218	Black&White	25000	See Meta		☐
☑	1994-06-16	A28094	219	Black&White	25000	See Meta		☐
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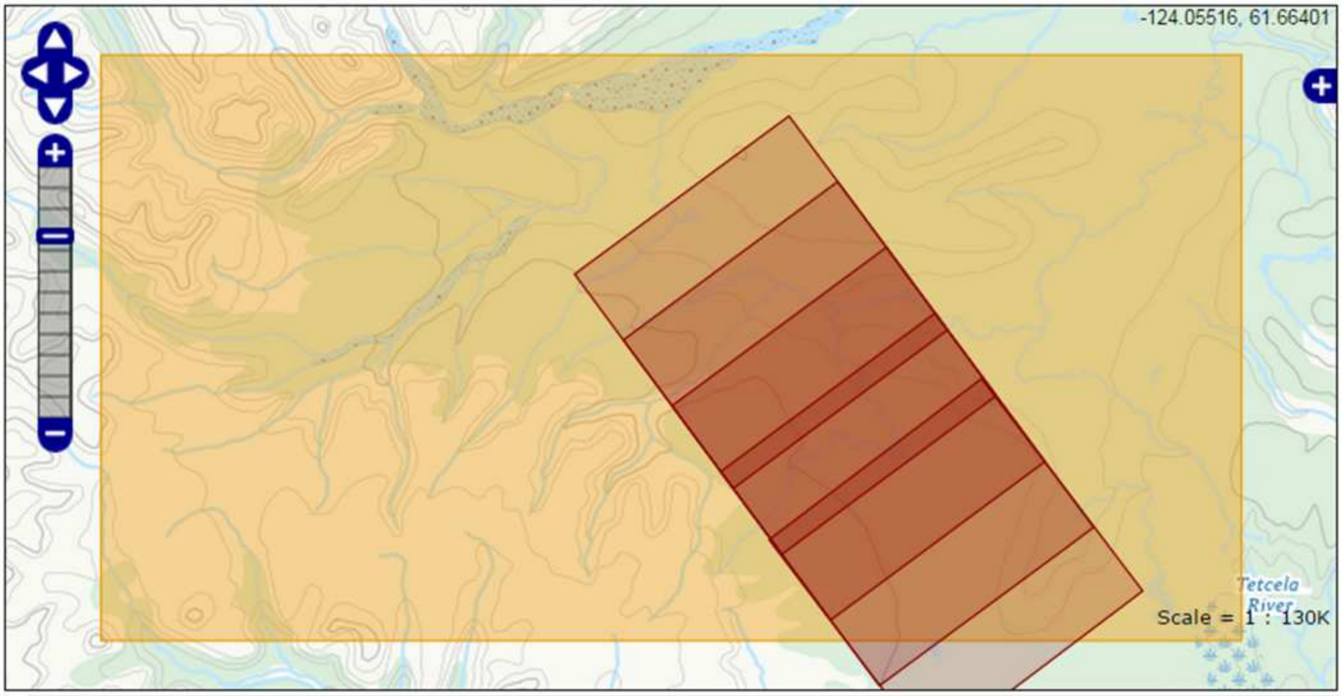

Aerial Photo

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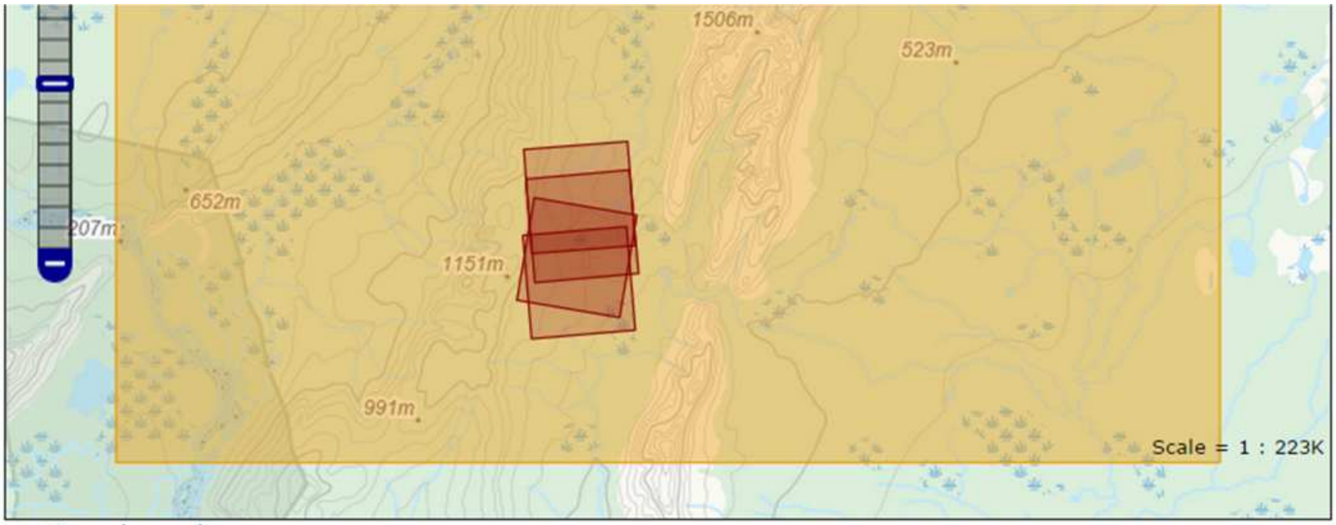

Search results

126 results from a total of 126 returns

Aerial Photo

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APPENDIX E

TERRAIN AND ROUTE DESCRIPTION FOR ALTERNATIVE ALIGNMENT KP103.4 TO KP124

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
103.9	106.4	pOk-fO Sh, L mudstone, siltstone	Rutter and Boydell (1981): alternating bedrock and complex colluvial sediments; bogs and fens northeast of route Rutter (1993): till plain northeast of route; till plain presumably underlies the wetlands Northeast of selected alternative alignment at Site 50 is a wetland area, presumably overlying till. Organic plain (light green on photos), organic veneer (darker green) and fluvial plain (not shown) are all present, obscuring the till below. Drainage is very poor for the organic units and poor for the fluvial ones. The northern alternative alignment option crosses into this wetland unit where it branches off from the selected alternative alignment. The drainage issues of this unit are one reason why the northern alternative option was not selected.	 Site 50A: Bogs and fens are common in the area NE of old winter road. Looking N from 600 m ENE of KP104.  Site 50B: Looking WNW from NE side of former airstrip in wet area on old winter road (from 1.25 km E of KP103)

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
106	107.1	pOk-fO Cx Sh,L Fort Simpson Formation: shale, siltstone calcareous siltstone; silty mudstone in bedrock ridge/knolls	Rutter and Boydell (1981): bedrock to KP106.4, bogs and fens to KP107.1; some of the bogs display thermokarst features Rutter (1993): till plain; till plain presumably underlies the wetlands Site 52 is about 700 m due east of KP106.4 on the selected alternative alignment, near the east-west section of the northern alternative alignment option. Deposits and drainage are the same as above. These are shown in the upper photo. This area is mostly avoided by the selected alternative alignment (except for the area from KP106.5 to KP107.1). Site 58 is 400 m NNW of KP107 on the selected alternative alignment. It shows sandy colluvium at the base of a steep bedrock ridge to the west of the site. The selected alternative alignment avoids these unstable areas by remaining on low ground to the east. This knoll is a proposed borrow area, with the south end of the knoll proposed for the current alignment to the west (left of photo), and the north end at about KP106.4 proposed for the selected alternative alignment east (right of photo). South end of knoll is at about KP106.9.	 At Site 52, looking E across stream that crosses northern alternative option. A relatively straight trail is visible in the middle distance, about 150 m east of stream.  Looking west towards south end of bedrock cliffs and sandy colluvial aprons west of about KP106.8 (Site 58).

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
107.1	109	Sh,L Fort Simpson Formation: shale, siltstone calcareous siltstone; silty mudstone in bedrock ridge/knolls	Rutter and Boydell (1981): bedrock Site 59 shows a sandy colluvial blanket exposed in a small slide west of about KP108.2 on the selected alternative alignment. Similar materials and a larger slide (about 170 m long and 40 m wide) are also seen on the Bing imagery west of about KP107.7. Steep bedrock cliffs above the colluvial material in both areas form parts of a sub-linear bedrock ridge along the east toe of the Silent Hills. Bedrock not visible in upper photo, but noted as Site 72 on Figure 1. Upper slope proposed as borrow. West side of ridge seen in lower photo.	 Fresh failure in sandy colluvium, looking west from approximate alternative alignment at KP108.2.  Looking SSE from 600 m due W of KP107. Gentler W side of bluff; slope failures E side (Photo credit: Allnorth).

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
107.1	109	Sh,L gAfx[1]/Cx to E Fort Simpson Formation: shale, siltstone	Rutter and Boydell (1981): gravelly alluvial fan and colluvial complex Site 54: Coalescing alluvial fans are present 1860 m east of KP108 on northern alternative alignment option (lower photo). These active fans are a second reason the northern alternative alignment option was not chosen.	 Looking N to NE towards alluvial fan complex from valley bottom at about 1870 m due E of KP108.5.

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
109	110	tMv-Cx Sh, L Fort Simpson Formation: shale, siltstone calcareous siltstone; silty mudstone in bedrock ridge/knolls	Site 71: A bedrock ridge and colluvial apron are present about 600 m due E of KP109 on original route and 580 m SW of KP109 on alternative alignment. This location is proposed as BP109 for alternative alignment, potentially providing mineral soil for embankment fill (likely from colluvium), and quarried bedrock crushed for use in road surfacing.	 Looking NNW at proposed borrow area BP109 for alternative alignment. Borrow access road runs from about KP108.8 to the NE, along the E side of the knoll.

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
109	110	g,sGp/fOg tMv-Cx Sh, L Fort Simpson Formation: shale, siltstone	Rutter and Boydell (1981): till veneer and colluvial complex over bedrock, glaciofluvial/organic material to east The next portion of the selected alternative alignment crosses till veneer and complex colluvium (KP109 to KP110). It also crosses several creeks between KP109 and KP113. At KP110 (Site 57), it is difficult to tell from the air if the area is underlain by till or glaciofluvial material (upper photo), but it is moderately well to imperfectly drained.	 Wet area in till or glaciofluvial deposits

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
110	112.6	g,sGp/fO g,sGt gAfx[1]/Cx Fort Simpson Formation: shale, siltstone	Rutter and Boydell (1981): Gravel and sand glaciofluvial sediments are present from KP110 to KP111.7; the western half of this area forms a glaciofluvial terrace, while the eastern half is flat and contains wetlands (fens). Between KP111.7 and KP112.6, the route crosses a large gravel alluvial fan/colluvial complex. At a location 700 m north of KP111, the alluvial fan/colluvial complex is visible in the distance and the overlap or coalescence of the fans is evident. The wet glaciofluvial deposits are visible in the foreground, as are some poorly drained fluvial sediments (light green). Tetra Tech EBA's fieldwork in 2015 suggests that there may be till at the slope break just below the exposed bedrock, but the Hawes (1980) map suggests that this area is covered with colluvium. At a location 480m east-southeast of KP112 (Site 70), a debris flow with levees was identified on one fan. It contains subangular to angular sandy coarse gravel consisting of limestone and/or dolostone. Mitigation for possible debris flows/floods would be required along the road in this area.	 Coalescing alluvial fans, looking NE from a point 700 m due N of KP111. Glaciofluvial sediments are visible in the foreground.

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
112.6	114.5	g,sGp/fO g,sGt tMv D, L Fort Simpson Formation: shale, siltstone	Rutter and Boydell (1981): till veneer and colluvial complex over bedrock; small area of glaciofluvial terrace surround KP113 Site 55 is located 700 m W of KP113 near an alternative alignment option in an area mapped as g,sGp/fO. Some organic veneer and fluvial deposits flanking a creek are present (upper photo). This route option was rejected in favour of alignment on higher, drier ground to the east. Looking SE from a point WSW of KP114 (near Site 56), glaciofluvial sediment is present in the foreground and thin till over bedrock in the background, with exposed bedrock of Nahanni Range above (lower photo).	 Thin organic deposits in foreground and fluvial deposits in background, looking E from N of Site 55. Winter road at bottom of photo is about 700 m W of KP113.6.  Looking SE across glaciofluvial/till deposits from about 450 m W of KP114 (474380 m E, 6803750 m N).

114.5	118	tMv-Cx D, L g,s,Gp Fort Simpson Formation: shale, siltstone	Rutter and Boydell (1981): From KP114.5 to KP117, the selected alternative alignment follows the edge of the Nahanni Range, where another till unit is encountered. From about KP114 to KP116, the selected alternative alignment runs along the eastern edge of a large meltwater channel that appears to contain glaciofluvial sediments. It is thus likely that either thin till or glaciofluvial sand and gravel will be encountered in this area. From KP117 to KP118, glaciofluvial sediment is present. At KP115.3, a steep bedrock slope was identified to the east on the west side of the Nahanni Range (Site 64). At KP116 of the selected alternative alignment, an alternative alignment option heads east across a bedrock ridge before rejoining the selected alternative alignment within a colluvial complex area. High relief is the reason for the rejection of this option. The presence of aspen appears to indicate bedrock close to surface in this area. Although representative photos were taken near Site 65, photos from the 2014 fieldwork show this better (photo taken from a location further west). The alternative alignment option west of KP116 (see photo) crosses from bedrock in the west to a gravelly, flat to hummocky glaciofluvial area with some colluvium, a glaciofluvial plain and then the thin till unit in the east, traversing three large meltwater channels on the way. All of these contain glaciofluvial material, but the central one also exhibits fens. This alignment option was rejected due to poor drainage in its central portion and colluvium in its western part.	 Deciduous trees are aspen

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
118	119.7	Cx Fort Simpson Formation: shale, siltstone	Rutter and Boydell (1981): From KP118 to the end of the route at alternative alignment KP119.7, the route continues to run within the large meltwater channel, but the location of the channel is questionable here and the deposits are mapped as complex colluvial sediments. These flank the headwater portion of Grainger River, which flows south-southeastward within the valley at this location (upper photo) (Site 61). It is difficult to tell from the air the composition of these deposits, but they do appear to have been fluvially eroded at some point in the past (lower photo). Air photo interpretation should be helpful in this area.	 Looking SW at undulating colluvial complex within meltwater channel  Plan view from Bing imagery (Allnorth website)

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
119.7	124 (current route)	gAp g,s,Gpr/Cx D, L Fort Simpson Formation: shale, siltstone to 123.1 Nahanni Formation: limestone, dolomite to 123.6 Landry Formation: limestone to 123.9 Arnica Formation: dolomite to 124	Rutter and Boydell (1981): The large meltwater channel curves eastward through Grainger Gap, forming two channels west of the Gap, one north of a till veneer/colluvial complex area and one south of it. These converge at KP119.7 on the selected alternative alignment. The southern channel contains fluvial gravel deposited by an unnamed tributary of Grainger River, which drains an area to the west, including Gap Lake, and by Grainger River itself, from KP119.7 to where it joins the current alignment. The meltwater channel and the selected alternative alignment skirt around a knob of Nahanni Formation bedrock in this area. An alternative alignment option starting at about KP119.2 skirts around the bedrock knob on its north side, passing north of a small pond and connecting with the original route at KP124.3. In this area, it crosses from colluvium to bedrock to fluvial floodplain sediments of the Grainger River. Steep bedrock cliffs and rockfall talus slopes are the reasons to reject this alignment option. Near KP122 on the current route (Site 67), undulating glaciofluvial sediments consisting of sand and gravel were noted. Clasts are subround to subangular and comprise several different lithologies (upper photo). Well-drained fluvial terrace deposits of the Grainger River were identified on the ground at KP123.5 on the current route (Site 60). The terraces comprise sand and subangular to well-rounded coarse gravel (lower photo). The selected alternative alignment also passes this way, skirting along the north edge of these terraces. The bedrock ridge south of the fluvial terrace is covered with colluvial blanket, veneer and cones on its surface (lower photo).	 Glaciofluvial deposit near KP122  Looking southeast across fluvial terrace toward colluvial material on bedrock slope on south side of Grainger Gap, near west end.

Table E-1: Summary of Mapping and Field Observations – Alternative Alignment KP103.4 to KP124

Start of Interval (km)	End of Interval (km)	Terrain Unit	Route Description	Photos
124.5	124.5	gAp Arnica Formation: dolomite	This location is near the terminal portion of the northern alternative alignment option that was not selected (Site 69). A river-cut exposure on the southern slope of a small knob to the north of the site exposes glaciofluvial material: subangular to well-rounded coarse gravel and coarse sand (photo). This knob is part of a well- to moderately well-drained glaciofluvial terrace whose surface is well above the Grainger River fluvial deposits. They contain clasts of many different lithologies, distinguishing them from the fluvial deposits below, which are dominated by limestone.	Glaciofluvial deposit near KP124.5 (Site 69). Larger clasts are present but are not shown in photograph.

APPENDIX F
TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOTECHNICAL REPORT

This report incorporates and is subject to these "General Conditions".

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.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

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.