Prairie Creek Mine All-Season Road:
Woodland Caribou & Remote Camera Baseline



PRESENTED TO
Canadian Zinc Corporation

AUGUST 27, 2021
ISSUED FOR USE
FILE: ENW.EENW03326-02

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Conformity Table: Parks Canada Comments*

Table 14 Item	Requirement	Review Comment Reference	Section of Plan
-	*WMMP, Table T3; CZN Response to Review Comment Reference PCA-75 - Remotely triggered cameras – collection of baseline data:* CZN has deployed remotely triggered cameras for several purposes including collection of baseline data and monitoring of various wildlife species. Table T3, under 'Baseline Surveys' for wolverine, states that the "Remote camera survey (deployed June 2019) provide data on seasonal and temporal use and distribution along and within 4 km of the proposed road (including mine site) and wolverine-vehicle collision risk". CZN has also previously indicated that the remote camera survey may be used to provide baseline data for grizzly bears. To date, pre-construction baseline data on wildlife species has not been compiled, analyzed and reported on. In recent discussion with CZN/Tetra Tech, it was clarified that cameras are currently deployed for data collection, but data retrieval will not occur until June 2020. Parks Canada awaits baseline reporting on wildlife species as committed to by CZN (ex. Caribou activity, predator activity and other species as described in WMMP Table T3). Please indicate how the remote camera data will be analysed to assess whether the current design of the remote camera survey is appropriate for collecting baseline data on and/or monitoring project effects on wolverine and grizzly bear.	#35	Refer to this Caribou and Remote Camera Baseline Report Also refer to the WMMP
39.	In our previous comments Parks Canada identified several issues with the Caribou Gap Analysis, including methodology and differing interpretations of the significance of the results. These concerns remain; however, they are more relevant to a Phase 2 WMMP and may be raised again during review of a Phase 2 WMMP. These include review comments PC-54, 57, 67, 68, and 71.	#54, 57, 67, 68, and 71	Refer to Sections 3.2.3.1 and 3.2.3.2 in this baseline report.
-	*CZN to remove results from caribou collar studies conducted on herds whose ranges are not known to overlap significantly with the proposed ASR.*	#56	The paragraph summarizing Weaver's results (2006, 2008) is removed from the Caribou and Remote Camera report as it is also presented in the DAR.
13.	*CZN to update Section 2.2 to include explanation of five caribou seasons.*	#58	Reference to Weaver (2008) added to description of seasons in Section 2.2
14.	*Caribou Data Gap Analysis, Tables 2 & 3:* It is noted in the table captions that the surveys were conducted in winter. However, survey timing over the course of a season can have a large influence on detectability thus affecting the comparability of results from surveys conducted at different times of the year. As the results shown in these tables were from surveys conducted at different times of the year (i.e., between December and March), the survey dates should be included in the tables. Please include the dates of the surveys in Tables 2 & 3.	#59	Survey dates included in Tables 2 and 3
15.	*CZN to update the WMMP and Caribou Data Gap Analysis to remove references to caribou density.*	#60	Removed reference to density throughout

Conformity Table: Parks Canada Comments*

Table 14 Item	Requirement	Review Comment Reference	Section of Plan
16.	*CZN to revise Section 2.2.2 to include season in the list of factors that influence caribou habitat use.*	#61	Sentence updated to read "Elevation, land cover types, and distance to anthropogenic disturbances are factors that can influence caribou habitat use in different seasons" (Section 3.2).
17.	*Caribou Data Gap Analysis, Section 2.2.2:* Section 2.2.2 states "Those found nearest to the proposed ASR were generally targeted." It is unclear what is meant by generally targeted and why it was necessary or appropriate for these individuals to be targeted. Please clarify what is meant by "generally targeted" (i.e., how many individuals were targeted, how were they selected) and why it was necessary to limit the analysis to these individuals.	#62	Refer to Section 3.2 sentence updated to read "Since an objective of the collaring program was to better understand caribou range use in the area of the Prairie Creek Mine and proposed ASR, caribou found nearest to the mine and ASR were targeted for collars."
18.	*Caribou Data Gap Analysis, Section 2.2.2.1:* Section 2.2.2.1 states "Elevation trends in caribou habitat use were determined using the satellite collar data. The mean elevation within a 200 m-radius buffer was calculated for each caribou location point, as well as the mean value for each collared individual within each season and over all years." The caribou collar data includes altitude. As such, it is unclear why elevation was calculated based on the collar location data. Please explain why the caribou collar altitude data was not used to examine trends in elevation.	#63	Analyses in Section 3.2.1 updated using collar altitude data.
19.	*CZN to revise Section 2.2.2.1 and Charts 2 and 3 to remove reference to the mean ASR elevation*	#64	Mean ASR elevation replaced with Figure A showing the elevation of the All-Season Road.
20.	*CZN to revise Chart 2 with the seasons in order, present a measure of variability, number of observations, and remove mean elevation.*	#65	Figure C updated to a boxplot with seasons in order and mean elevation removed.
21.	*CZN to revise Chart 3 to depict the range of elevation used by the individual caribou and number of observations used to calculate the mean.*	#66	Figure D updated to a boxplot with number of observations used to calculate the mean added.
24.	*CZN to revise the Caribou Data Gap Analysis to specify the number of animals with functional collars in the various analyses.*	#69	Figures in Section 3.2 specifies number of animals or location points. Overall summary still provided in Table 4.
25.	CZN to revise Chart 9 legend or figure caption to indicate the number of collars that were functioning each year.	#70	Number of collars functioning each year updated in Figures J and K.
27.	*CZN to include predator presence along the ASR in Table 5.*	#72	Included in Table 5 of this baseline report.

** Conformity Table per Table 14 of Parks Canada "Comments on Management Plans and other Submissions under Water License PC2014L8-0006 and Land Use Permit PC2014F0013" dated December 14, 2020.*

EXECUTIVE SUMMARY

Canadian Zinc Corporation (CZN) submitted a Developers Assessment Report (DAR) to the Mackenzie Valley Review Board (MVRB) in 2015 for the proposed Prairie Creek Mine all-season road (ASR; the Project; EA1415-01; CZN 2015). Parks Canada and Environment and Natural Resources (ENR) recommended that additional woodland caribou baseline surveys be conducted and that a caribou data gap analysis be completed using newly acquired data provided by Parks Canada. In response, an aerial caribou survey was conducted in March 2019, a remote camera survey was conducted from July 2019 to September 2020, and additional data from Parks Canada was analyzed. The caribou data gap analysis was presented in a report dated November 8, 2019 and was later reviewed by Parks Canada and ENR.

The intent of this current report is to amalgamate the information presented in the data gap analysis (with updates recommended by regulators) and to present additional results from a remote camera survey in a unified report on woodland caribou, their predators (grizzly bears, grey wolf, wolverine), and other ungulates (moose, Dall's sheep) in relation to the Project.

CZN acquired the following data from Parks Canada: 1) Northern Mountain caribou remote collar data, and 2) Boreal and Northern Mountain caribou observation data collected during the 2010, 2011, and 2014 aerial occupancy surveys completed by Golder.

Results of the caribou aerial surveys, remote collar, and camera surveys suggest that a small number of Northern Mountain caribou occur in proximity of the Mine site and along portions of the proposed ASR. Northern Mountain caribou occurring in the area are believed to be part of the Redstone herd which extends across a large annual range from the Yukon border, and into the Sahtu, and Deh Cho regions. Despite poor survey conditions during the aerial survey in March 2019, results suggest that Boreal caribou also occur at low relative abundance which corroborates ENR's aerial surveys in the ASR area.

The majority of the collared Northern Mountain caribou spent 85% of the time that they were collared 10 km or more away from the proposed ASR. When proximal to the ASR, caribou occurred within the first 65 km (approx.) of the proposed ASR. Although only a few of the collared caribou were present near the proposed ASR in all seasons, the area of those few collared individuals overlapped with the proposed ASR mostly from KP 0 – 16 and in lower Sundog Creek from KP 40 – 50, which is consistent with the Northern Mountain caribou occupancy predictions presented in the DAR.

Only 11% of all collared caribou location points were within 10 km of the ASR in all seasons and years, with the highest proportions of these occurring during the rut/fall migration (17%), post-calving (11%), and calving (11%) periods. These represent the longest amounts of time spent by the collared caribou near the proposed road.

The multi-species remote camera survey involved 46 cameras deployed from June 2019 to September 2020. Cameras were installed along the ASR from KP 1 to 56. Of the 46 cameras deployed, 21 were on the ASR alignment and 25 were spaced 1 km apart along three transects lying perpendicular to the road. Of the 46 cameras installed, data from one camera was unavailable for analysis. The cameras were active for an average of 370 days each (min. = 23 days; max. = 465 days). Dall's sheep was the most-commonly detected species, followed by grey wolf, grizzly bear, ground squirrel, and moose. Northern Mountain caribou were detected at 31% of the cameras (14 of the 45 for a total of 62 independent caribou detections). Camera detections of caribou were primarily in post-calving and fall/rut seasons; limited detections occurred in spring and none occurred during the winter or calving seasons. The woodland caribou detection rate was highest in post-calving. Detections of Dall's sheep and gray wolf were highest in spring, summer, and fall. Grizzly bears were detected in all months when not typically hibernating. Moose were detected in most months, with the highest detections in winter. Wolverine were detected only during the winter and spring months. All focal species except for gray wolf exhibited a diurnal activity pattern. For the six diurnal species, activity peaked around midday with the exception of moose which had a distinct activity peak in the evening.

Woodland caribou occupancy was estimated from the remote camera data to be 35.6% of survey locations after correcting for detection probability. The remote cameras provide no estimate on the actual number of individuals of any species that may be present in an area. The results are best viewed as a measure of frequency of use.

Results from aerial surveys, the collar data, and from the remote cameras, suggest that caribou occur in relatively low abundance along the ASR.

The possible effects to caribou and corresponding mitigation measures presented in the DAR were re-evaluated based on this additional baseline information. Mitigation measures and monitoring programs for both Boreal and Northern Mountain caribou serve to reduce the potential for adverse effects. Based on the indications that a small number of caribou occur proximal to the ASR, the suggested mitigations identified in the DAR to avoid and/or minimize Project-related effects remain appropriate. One additional mitigation was added: blasting from KP 5 – 10 and KP 40 – 50 will be scheduled to occur outside a May 1 to July 15 window (which protects caribou calving and early post-calving times) or if critical for development, will occur only if a pre-blasting survey indicates no caribou are present within 2 km.

CZN has developed monitoring programs for both Mountain and Boreal caribou for the PWR that will be applicable to Phases 2 and 3. We suggest that the Northern Mountain caribou remote camera program focuses solely on monitoring of the ASR. Cameras located along the proposed ASR provide the best opportunity to detect caribou, their predators and other ungulates that can lead to refinement of mitigation.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
ASR	All-season Road
CZN	Canadian Zinc Corp.
ENR	Environment and Natural Resources
GPS	Global Positioning System
PWR	Pioneer Winter Road
WMMP	Wildlife Management and Monitoring Plan

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Canadian Zinc Corporation and their agents. Tetra Tech Canada Inc. (Tetra Tech) 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 document is subject to the Limitations on the Use of this Document attached in Appendix E or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Canadian Zinc Corporation (CZN) submitted a Developers Assessment Report (DAR) to the Mackenzie Valley Review Board (MVRB) in 2015 for the proposed Prairie Creek Mine all-season road (ASR; the Project; EA1415-01; CZN 2015). Parks Canada and Environment and Natural Resources (ENR) recommended that additional woodland caribou baseline surveys be conducted, including a data gap analyses that incorporates additional caribou data available from Parks Canada.

The caribou data gap analysis was presented in a report dated November 8, 2019 and was later reviewed by Parks Canada and ENR. This current report amalgamates the information presented in the data gap analyses[1] with updates recommended by regulators and presents additional results from the remote camera program in a unified report on caribou, their predators (grizzly bears, grey wolf, wolverine), and other ungulates (moose, Dall's sheep) in relation to the Project.

Any new understanding of baseline conditions for caribou and their predators and allies will be integrated into monitoring programs implemented during ASR construction and/or operations.

Two woodland caribou ecotypes are present in the region: the Northern Mountain ecotype present in the western mountainous portion of the region and the Boreal ecotype present in the eastern portion of the region. The aerial surveys covered portions of the region where both ecotypes are known to occur. The remote camera survey program occurred in the portion of the region where only the Northern Mountain ecotype occurs. This report also provides an analysis of collared caribou data provided by Parks Canada Agency; the data is from a Northern Mountain ecotype population. In this report, the term "caribou" is used to refer to caribou of both or either ecotype, in instances where a specific distinction between the two is immaterial. The terms Northern Mountain caribou and Boreal caribou are used where it is important to differentiate between the two ecotypes.

2.0 METHODS

Caribou baseline data and information were compiled from:

1. Aerial caribou surveys
2. Analysis of caribou observation data from the 2011, 2012, and 2014 aerial caribou surveys (collected by Golder for CZN)
3. Analysis of remote collar data (collected by Parks Canada)
4. A multi-species remote camera survey

2.1 Aerial Caribou Surveys (2019)

The 2019 aerial caribou survey was designed with Parks Canada and ENR. The objectives of the aerial survey were to determine caribou (both Boreal and Northern Mountain) relative abundance and distribution in association with distance from the proposed ASR, determine potentially high risk areas for vehicle collisions based on caribou observations, and to develop survey methods that could also be applied to future caribou monitoring.

[1] The data gap analyses (November 2019) provided a summary of existing knowledge of caribou based on the DAR and CZN's 2010, 2011, and 2014 aerial caribou occupancy surveys (Section 2.1 of the November 2019 report). Refer to the DAR for this information.

The aerial survey was conducted across a 4,326 km^2 regional area that was centered on the proposed ASR alignment. The survey boundary ranged between 10 – 20 km on either side of the proposed ASR but excluded the 15 km area between the Liard River and Highway 3 to avoid the community of Nahanni Butte and potential harvesters.

Sample Units and Transect Delineation

Prior to the execution of field work, the survey area was equally divided into 43 – 100 km^2 hexagonal sampling units, the same sampling units used during the Golder 2010, 2011, and 2014 aerial occupancy surveys (see Section 2.2). Sampling units were then stratified into three areas: 1) mountain (KP 0 – 40, predicted to have high caribou occupancy probability), 2) transition (KP 41 – 100, moderate occupancy probability), and 3) boreal (KP 101 – Liard River, low occupancy probability).

Flight transects were predetermined within each of the 43 sample units plus the remaining 26 km^2 (north of the Liard River) area outside of the hexagon units. In the boreal and transition strata, parallel transects were spaced 3 km apart to best fit within the 100 km^2 sampling units. In the mountain strata, the flight transects followed elevation contours and targeted valleys and montane woodlands which are the primary caribou winter habitats. When surveying contours, transects from the lowest elevation were surveyed first followed by higher elevations, to the extent possible.

Once in the field, the spacing of the flight transects were narrowed to every 1.5 km to compensate for unseasonably warm air temperatures and melting snow cover. All sample units were surveyed with the revised 1.5 km transect spacing which doubled the initial survey effort.

Aerial Survey

The 2019 aerial survey was completed by a Tetra Tech biologist and two skilled Nahanni Butte and Fort Simpson community members. Surveys were conducted with a Cessna 206 from March 22 to 27 and a Cessna 185 from March 28 to 31.

The pre-identified transects were followed with allowances for the aircraft to meander off-transect for the surveyors to verify an observation. Methods required that caribou, caribou tracks, and feeding craters were to be verified by circling (to the extent possible, particularly in mountainous terrain), and fresh caribou tracks were to be followed to find the caribou. Each observation was recorded with a Global Positioning System (GPS).

When a caribou was observed, the aircraft deviated off transect (as required) to mark a waypoint at the animal's location and allow for the characterization of the openness of the habitat, which would later be analyzed as part of a sightability correction factor. After investigating a track and recording a caribou visual, the aircraft returned to the pre-determined transect.

The risk of double counting caribou was minimized by remaining inside the selected sample units while following fresh tracks, maintaining appropriate transect spacing, following the pre-determined transects, and flying with a GPS-enabled field tablet that showed the sample units and the flight tracks. The survey of each hexagon unit was completed before stopping to refuel, to the extent possible; stopping the survey was also avoided if a caribou was observed on earlier transects.

2.2 Caribou Observation Data (2011, 2012, and 2014)

Golder (2010, 2011, 2014a) conducted baseline aerial caribou surveys for CZN in the winters of 2010, 2011, and 2014. Results from these aerial surveys were presented in the DAR; however, Parks Canada later provided Tetra Tech with the raw data collected from these winter surveys. Attempts to estimate caribou relative abundance from these winter aerial surveys were made even though these surveys were designed to record caribou presence/absence for caribou occupancy modeling, not to measure caribou abundance. Relative abundance values are provided but should not be relied upon.

2.3 Caribou Remote Collar Data (2015 – 2018)

Parks Canada collared 18 Northern Mountain caribou over approximately 3.5 years (2015 – 2018) and provided the collar data to Tetra Tech for inclusion in the baseline assessment. Parks Canada's survey objective was to better understand caribou range use in the area of the Mine site and ASR.

The analysis was conducted on all caribou with functioning collars to assess habitat use patterns and distribution in relation to the ASR. Where available, analyses looked at year-round population trends as well as trends by season, year, and/or individual. Seasons were based on the six seasons defined by Weaver (2008) for woodland caribou in the greater Nahanni ecosystem. These same seasons were also used by Creighton (2006) to describe seasonal range use by the Redstone herd (which is the herd believed to be present in the vicinity of the Mine site and along the proposed ASR) and to predict seasonal caribou habitat in the Mackenzie mountains (which encompass the Mine site and proposed ASR). A more recent understanding of the Redstone caribou seasons of use is provided in the Species Status Report for Northern Mountain Caribou, authored by the Species at Risk Committee (2020).

The caribou seasons used in the analysis were based on those described by Weaver (2008) and include:

- Winter (January 1 to April 15)
- Spring Migration (April 15 to May 20)
- Calving (May 21 to June 5)
- Post-calving (June 6 to September 24)
- Rut (September 25 to October 15)
- Fall Migration (October 16 to December 31)

Rut and fall migration were subsequently grouped in to one class for the habitat analyses.

2.4 Multi-Species Remote Camera Survey

Parks Canada recommended that CZN use remote cameras to collect Northern Mountain caribou baseline data. Although caribou densities cannot be measured from remote camera data, camera studies do increase the opportunity to detect caribou and other species and are useful to determine species distribution and spatial-temporal indices.

Golder (2019) designed the remote camera study for CZN which is provided in Appendix A. The monitoring objectives of the remote camera study were to: 1) identify locations, times, and seasons when caribou interact with the ASR, (2) measure changes to caribou seasonal movements from calving/summer to wintering areas and changes to predator-prey interactions, and human use, associated with the Project, and (3) to inform adaptive management and operational mitigation of the Project to minimize potential impacts to caribou and other wildlife species. Although designed to target caribou, the remote camera study is also appropriate to monitor the distribution of predators (bears, wolves, wolverine) and other ungulates (Dall's sheep, moose) along the ASR and to monitor wildlife interactions in the vicinity of the ASR.

As with any monitoring program, the efficacy of remote cameras to meet these objectives depends on the number of caribou detections recorded. To increase the likelihood of caribou detections, camera locations along the Project alignment were pre-selected within high or moderate predicted habitat or known occupancy from previous baseline surveys (Golder 2014a, 2014b; Parks Canada 2019) and adjusted in the field, as necessary, based on existing trails located by the deployment crew. While camera monitoring is an effective approach to meet the monitoring objectives defined above, the camera design was not meant to inform or measure wildlife population status or change (body condition or relative abundance).

Fifty (50) remote cameras were available and proposed for deployment in areas specific to meet the objectives:

1. Road Interface Camera Monitoring: Twenty-five (25) camera locations were pre-selected along the ASR alignment, including on the existing 1980s road, between KP 0-70 in areas of higher predicted caribou occupancy to identify the locations, times, and seasons when caribou might interact with the ASR. One additional camera was proposed at the Nahanni National Park Reserve boundary (KP 100) at the request of Parks Canada.

2. Caribou Movement Monitoring: Twenty-four (24) cameras were placed in three perpendicular transects, centered on the ASR alignment with the intent to capture caribou movements between high elevation calving/summer habitat and low elevation wintering habitat. These three transects extend up to 4 km on either side of the ASR and bisect the Prairie Creek valley (KP 7), the high elevation mountain pass (KP 25), and the lower Sundog Creek drainage (KP 44). Within each transect, cameras were proposed within nine 1 km x 1 km cells with placement focused on game trails, trail networks, and highly suitable habitat to maximize caribou detection, and as recommended by the Dene assistant. As outlined by Golder (2019), the cell size and transect approach was selected to provide variation in distance from the road and generally conformed to similar previous monitoring designs.

One Reconyx Hyperfire2 remote camera with passive infrared and a night time infrared illuminator was deployed at each location. Cameras were spaced at least 500 m apart and pre-programmed to collect both motion-triggered and time lapse images. The cameras were programmed to collect five rapid-fire images per motion trigger and no quiet periods. Camera settings are provided in Appendix B.

While deploying the cameras, the surveyors recorded additional site details relating to the camera (e.g., SD card number and size), site (e.g., GPS location, elevation, surrounding habitat type, site photos), and wildlife sign.

Images were reviewed for detections of wildlife using the WildTrax platform (www.wildtrax.ca). Images were tagged to species, vehicle type, number of individuals in the image, total number of individuals in a group inferred from sequential images, and age class and sex. Fifteen percent of the remote camera images were reviewed for accuracy by a separate image classifier.

Wildlife detections were divided into events (independent detections) based on a two-minute time interval. Images captured within two minutes were considered to be part of the same detection event to minimize double-counting of the same individual in multiple photos. A thirty-minute interval was also tested and resulted in roughly 10% fewer events. The two-minute interval was ultimately selected because of the desire for greater temporal granularity though recognizing that there is likely to be some higher counts of the same individual animals that may spend extended time around the same camera.

Independent detections of vehicle traffic were classified using a 30-second time interval which was considered to be more appropriate for the nature of vehicle movements and ultimately providing more accurate counts.

Camera effort was estimated using the time-lapse images programmed to be captured at noon on each day. A camera was considered active on each day if the noon time-lapse image was present and not out-of-view.

An index of relative abundance was calculated as the number of events (independent detections) in a given time period divided by the effort (in days) in that time period and multiplied by 100 days. Relative abundance was calculated for the following time-periods:

- The entire survey period;
- Each calendar month of deployment, to identify monthly patterns; and
- Each week of deployment, used as repeated survey periods for the occupancy estimation.

Daily patterns of animal and vehicle activity were analyzed using the analysis package ‘activity’ (version 1.3.1; Rowcliffe 2021) in the statistical software R (version 4.1.0; R Core Group, 2021) The analysis package uses a circular kernel probability density function (PDF) to estimate activity from time-specific detection data (Rowcliffe et al. 2014).

Presence-absence data from repeated visits to a location can be analyzed using an occupancy model. An occupancy model simultaneously accounts for both imperfect detection of a species and the probability of occupancy. Remote camera data can be used in an occupancy modelling framework by segmenting the detection data into regular time intervals that represent repeated visits. For this study, woodland caribou occupancy was estimated using the approach of Mackenzie et al. (2003 and 2018) using the ‘occu’ function in the R package ‘unmarked’ (version 1.1.1; Fiske and Chandler 2011). The number of active camera days within each one-week survey period (“visit”) was used as an observation covariate to account for differences in sampling effort among camera locations. The following site-level covariates were selected to account for site-level variability in location, habitat type, and to address the objective of determining if caribou distribution is influenced by the presence of the existing 1980s road:

- Elevation
- UTM Easting
- UTM Northing
- Proportion forested habitat within 100 m of the camera location
- Proportion shrub/grass habitat within 100 m of the camera location
- Proportion barren habitat within 100 m of the camera location
- Distance to ASR

Habitat variables were calculated using 30 m resolution Land Cover of Canada data, which is part of the North American Land Change Monitoring System (NALCMS) (CCRS 2015).

Covariates were assessed for multicollinearity using the function ‘vif’ in the R package “car” (Fox and Weisberg 2019). Elevation was found to be highly correlated with easting and was discarded from further consideration.

Models with subsets of the candidate covariates were generated and compared using Akaike's Information Criterion corrected for small samples (AIC_c). Of the 64 sub models incorporating various combinations of the covariates (sub models are listed in Appendix C), the sub model with the lowest AIC_c was selected as the top model and considered the most appropriate to model woodland caribou occupancy. Model fit was assessed using a chi-square goodness-of-fit test comparing the sample data to a simulated dataset created using parametric bootstrapping (1,000 simulations) following the method described in Fiske and Chandler (2019). Covariate effects in the top model were visualized by predicting occupancy for a range of values for the covariate of interest while holding the remaining covariates at their mean value.

3.0 CARIBOU AERIAL SURVEY

3.1 Aerial Caribou Survey, 2019

A crew of three observers and a pilot surveyed all sampling units from March 22 – 31, 2019. Inclement weather extended the survey period but culminated in a total of 21 survey hours. Occasionally, deviations away from the planned transects occurred in the field due to localized low cloud and/or high winds. In particular, low cloud persisting over several days resulted in low survey coverage in one mountain sample unit (approximately 9 km west of the Mine site).

The mountains received snowfall approximately one week prior to the survey, but it was unlikely a snow obliterating event. The weather station at the Prairie Creek Mine recorded five days (March 11 – 15) of precipitation totaling 23 mm but no snow was recorded at the Fort Simpson weather station (note: precipitation was also not recorded at the Nahanni Butte weather station).

During the survey, air temperatures were unseasonably warm, and the snow cover slowly diminished throughout the survey period (Table 1; photos 1 to 9).

Table 1: Summary of Aerial Survey Conditions

Date	Sample Unit[1]	Total Survey Hours	Mean Daily Temperature (ºC) (min. to max.)		Snow Cover Description (approx.)
			Mine Site	Nahanni Butte	
March 22	B, T	5.25	-2.57 (-11.15 to 11.89)	Data not available	~80% at survey start and end. Only ~20% in the few open wetlands and ~90% in closed forests
March 23	-	-	-1.34 (-8.58 to 11.27)	0.6 (-1.3 to 2.5)	-
March 24	B, T	6.0	-0.97 (-6.54 to 3.61)	4.7 (-5.8 to 15.2)	~80% at survey start and ~60% at survey end
March 25	-	-	1.24 (-4.84 to 8.50)	6.4 (-1.4 to 14.2)	-
March 26	B	0.5[2]	-1.31 (-7.90 to 7.77)	Data not available	
March 27	M	4.5	-1.00 (-8.61 to 3.07)	3.6 (-5.9 to 13.2)	~60% at survey start and ~75% at end. Approx. 100% coverage in forests, 60% on east and west facing slopes, and 10% on south facing slopes
March 28	B, T, M	2.0	-4.30 (-12.27 to 7.23)	Data not available	~60% at survey start and end

Table 1: Summary of Aerial Survey Conditions

Date	Sample Unit[1]	Total Survey Hours	Mean Daily Temperature (ºC) (min. to max.)		Snow Cover Description (approx.)
			Mine Site	Nahanni Butte	
March 29	-	-	-1.08 (-8.58 to 5.30)	5.5 (-2.9 to 13.9)	-
March 30	-	-	-0.91 (-10.15 to 8.82)	0.8 (-4.5 to 6.1)	-
March 31	B, M	2.75	-1.29 (-8.58 to 2.11)	3.8 (-6.9 to 13.6)	~35% at survey start and end
Total		**21.0**			

1. Mountain (M) KP 0-40, Transition (T) KP 40 – 101, and Boreal (B) KP 101 – Liard River.
2. Transect that was surveyed on March 26 was repeated in its entirety on March 28. No wildlife observations from the March 26 survey.

- Day not surveyed

The average snow depth was 22 cm and 0 cm based on measurements from an undisturbed area off the Nahanni Butte airstrip on March 22 and 30, respectively. During the survey, the overall snow cover on March 22 was estimated to be 80%, with forested areas mostly snow covered (90%); open wetlands were 20% snow covered (Table 1). By March 31, the overall snow cover was approximately 35% (Table 1).

Flight altitude varied between approximately 100 to 300 m above ground level and at groundspeeds of approximately 145 to 230 km/hr depending on the terrain and wind conditions.

Although the survey conditions were generally poor overall due to unseasonably warm temperatures, the narrow 1.5 km transect spacing likely improved the encounter rate of animals (32.6% survey coverage). Although not ideal for detecting fresh tracks, the prolonged period since last snowfall likely also increased the detection of tracks that had accumulated on the landscape (Serrouya et al. 2016). However, as the snow continued to melt towards the end of the survey period, the track detection rate and track quality would have also declined.

No caribou were detected during the 2019 aerial survey in any of the mountain, transition, or boreal strata. Caribou tracks and/or feeding craters were detected in six mountain sampling units (plus immediately outside the study area boundary) on average 10.6 km from the proposed ASR (ranging from 4.78 – 17.73 km; Figure 1). Since no caribou were detected, a sightability correction factor could not be measured based on distance the animal was observed from the transect and openness of the habitat. Although abundance could not be corrected, the aerial survey does suggest that caribou relative abundance is low near the proposed ASR alignment.

Serrouya et al. (2016) could also not correct for sightability but suggested that their low survey counts correctly mirrors sampling units with low density. This is because counting errors increase with the size of the counts, as per a Poisson distribution (Serrouya et al. 2016). Although Serrouya et al.'s (2016) survey conditions were also poor, they suggested that they were still able to correctly classify low density sampling units.

Despite the poor snow conditions in March 2019, eight moose observations totaling 11 individuals (includes four individuals off transect), two groups of Dall's sheep totaling 13 individuals, one group of 25 bison, two groups of 11 ptarmigan, an owl, and a falcon (both species unknown) were recorded. Moose were most often detected in open and semi-open forests within approximately 350 m from the survey transect. The bison were in semi-open forests and Dall's sheep in open alpine. Tracks of moose and wolf were also recorded, as well as Dall's sheep trails and general game trails.

3.2 Aerial Caribou Surveys 2010, 2011, and 2014

Golder (2010, 2011) conducted aerial caribou surveys in December 2010 (December 10 – 11 and 17) and February 2011 (February 8 – 9, 18, and 24) within a 9,261 km^2 study area divided into 93 hexagonal sampling units centered on the ASR. Surveys covered 8.4 and 9.5% of the study area in 2010 and 2011, respectively. Caribou were observed in the western portion of the proposed ASR, including the upper drainages of Prairie Creek (north of the Mine and ASR), as well as in the lower Sundog Creek and the Tetcela River drainages (Golder 2010; 2011). Caribou were observed in 20% of the units sampled (Golder 2014).

Golder repeated these surveys in 2014 (February 5 – 6, 20 – 21, and March 13 – 14) and increased the sampling effort. The survey covered 19.5% of the study area. Caribou and caribou tracks were detected in 15% of the units sampled (Golder 2014).

Spatial models were then developed to predict caribou occupancy based on caribou presence and elevation. Since the 2014 survey was repeated in each sample unit multiple times, the 2014 model had greater certainty and smaller standard error and was the model that best represented caribou winter occupancy (Golder 2014a). The 2014 model predicted a high probability (>80%) of caribou wintering proximal to KP 0-8 and a low probability (0-20%) for the rest of the proposed ASR to the Liard Highway (Golder 2014a).

Caribou observed during all surveys and survey years were mostly in Northern Mountain caribou range, with the exception of one group observation (2014 survey; unknown number of individuals) in the upper Grainger River area (northwest of Grainger Gap) in Boreal caribou range.

The number of groups observed in 2010 and 2011 were very similar (8 and 9, respectively; Table 2), while the number observed in 2014 was much lower, with only two groups detected. The number of total individuals was highest in 2011 and only slightly lower in 2010 (Table 2). The number of individuals within groups was not recorded during the 2014 surveys; however, based on the low number of groups detected that winter, it can be assumed that there was a low number of individuals. The overall mean group size was larger in 2011 than in 2010, as was the number of individuals in the largest group. Among all survey years, the data implies caribou were most abundant in 2011, although this was still a relatively low abundance.

Table 2: Caribou Observations during Aerial Surveys in 2010, 2011, and 2014[1]

Parameter	2010	2011	2014
Total Number of Groups	8	9	2
Total Number of Caribou Observed	62	89	N/A
Mean Group Size	7.75	9.89	N/A
Largest Group Size	15	26	N/A
Smallest Group Size	1	1	N/A

Timing of Surveys: 2010 surveys conducted December 10-11 and 17, 2011 on February 8-9, 18, and 24, and 2014 on February 5-6, 20-21, and March 13-14.
N/A = not available

To calculate caribou relative abundance in 2010, 2011, and 2014, the total area surveyed for each year was determined by buffering the recorded flight line by 250 m (the perceived visual detection distance on either side of the aircraft). Relative abundance estimates were calculated for caribou groups and individuals by dividing the number of each by the total area surveyed that year (Table 3). Since the number of individuals within groups was not recorded in 2014, the relative abundance of individuals could not be calculated for that year.

Table 3: Caribou Relative Abundance in 2010, 2011, and 2014 as Determined from Regional[1] Aerial Surveys[2]

Survey year	Surveyed Area (km^2)	Group Abundance (groups/km^2)	Individual Abundance (individuals/km^2)
2010	778	0.010	0.081
2011	877	0.010	0.102
2014	1,804	0.001	N/A

1. Regional area covering 9,261 km^2 roughly centered on the ASR.
2. Timing of Surveys: 2010 surveys conducted December 10-11 and 17, 2011 on February 8-9, 18, and 24, and 2014 on February 5-6, 20-21, and March 13-14.

Caribou relative abundance was low for all survey years. The relative abundance of caribou groups was essentially the same for 2010 and 2011, while the detections of individual caribou was higher in 2011 than 2010. 2014 had the highest number of repeated survey areas; however, that year also had the lowest observed caribou group relative abundance (and by extension, a likely low relative individual abundance as well).

4.0 COLLARED CARIBOU DATA

Elevation, land cover types, and distance to anthropogenic disturbances are factors that can influence caribou habitat use in different seasons (COSEWIC 2014). These influences were evaluated using Parks Canada's satellite collar data to better understand Northern Mountain caribou habitat use patterns across their annual range and near the proposed ASR.

Eighteen female caribou were captured and collared in 2015 (six individuals in February and twelve in December; Table 4). Since an objective of the collaring program was to better understand caribou range use in the area of the Prairie Creek Mine and proposed ASR, caribou found nearest to the mine and ASR were targeted for collars. The collection of collar data continued into 2018 from only seven individuals (Table 4).

Table 4: Time Period of Collar Data Collected

Device ID	Device Name	Start	End	Number of Days	Total Data Points
37681	PC15-07	15-Dec-15	28-Apr-16	135	152
37682	PC15-02	21-Feb-15	4-May-15	72	119
37683	PC15-03	23-Feb-15	26-Oct-17	976	1312
37684	PC15-04	24-Feb-15	26-May-17	822	1310
37685	PC15-06	25-Feb-15	26-Aug-17	913	956
37686	PC15-08	16-Dec-15	28-Feb-17	440	588
37687	PC15-09	16-Dec-15	24-Jun-18	921	1404
37688	PC15-10	17-Dec-15	21-May-18	886	1007
37689	PC15-11	17-Dec-15	2-Sep-16	260	405
37690	PC15-12	17-Dec-15	12-Jun-18	908	1076
37691	PC15-13	17-Dec-15	13-Aug-18	970	1343
37692	PC15-14	16-Dec-15	25-Mar-16	100	158
37693	PC15-15	17-Dec-15	4-Aug-18	961	993
37694	PC15-16	17-Dec-15	6-Jul-18	932	1047
37695	PC15-05	25-Feb-15	15-Dec-17	1024	1577
37696	PC15-17	17-Dec-15	19-Jul-18	945	1405
37697	PC15-01	21-Feb-15	17-Dec-17	1030	1624
37698	PC15-18	17-Dec-15	26-Jun-17	557	391

4.1 Elevation

The proposed ASR traverses easterly over a mountain pass and through the lower Sundog Creek area, remaining in valleys to the extent possible. Elevations of the proposed ASR range from as low as 700 m in the lower Sundog Creek area to a maximum of 1,520 m at the mountain pass (near KP 17; Figure A).

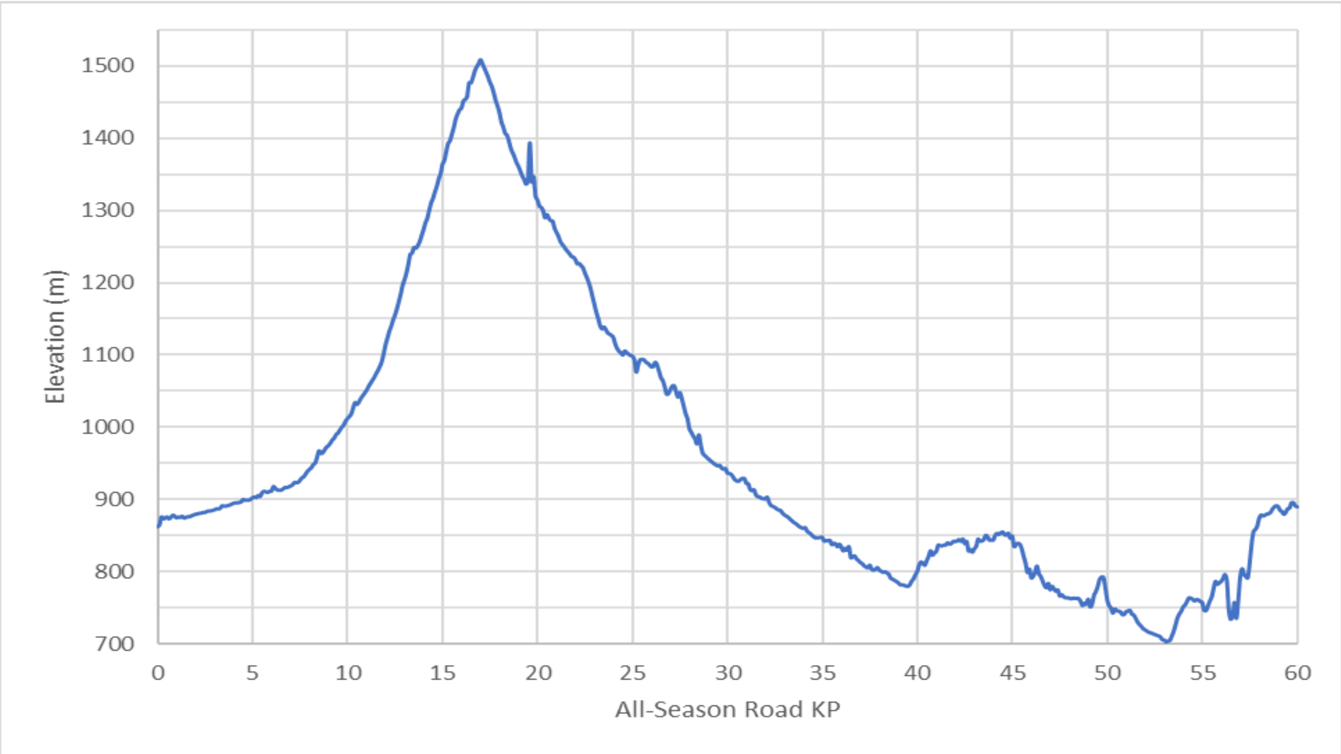

Figure A: Elevation of the All-Season Road from KP 0 and KP 60

Elevation trends in caribou habitat use were determined using the satellite collar data. The mean elevation was calculated from each collar location point, as well as the mean value for each collared individual within each season and over all years. The pattern of elevation use by caribou in all seasons, over all years, is normally distributed (Figure B), with most caribou using elevations between approximately 900 m to 1,650 m throughout the year. These elevations are similar to those along the ASR from KP 5 to 32.

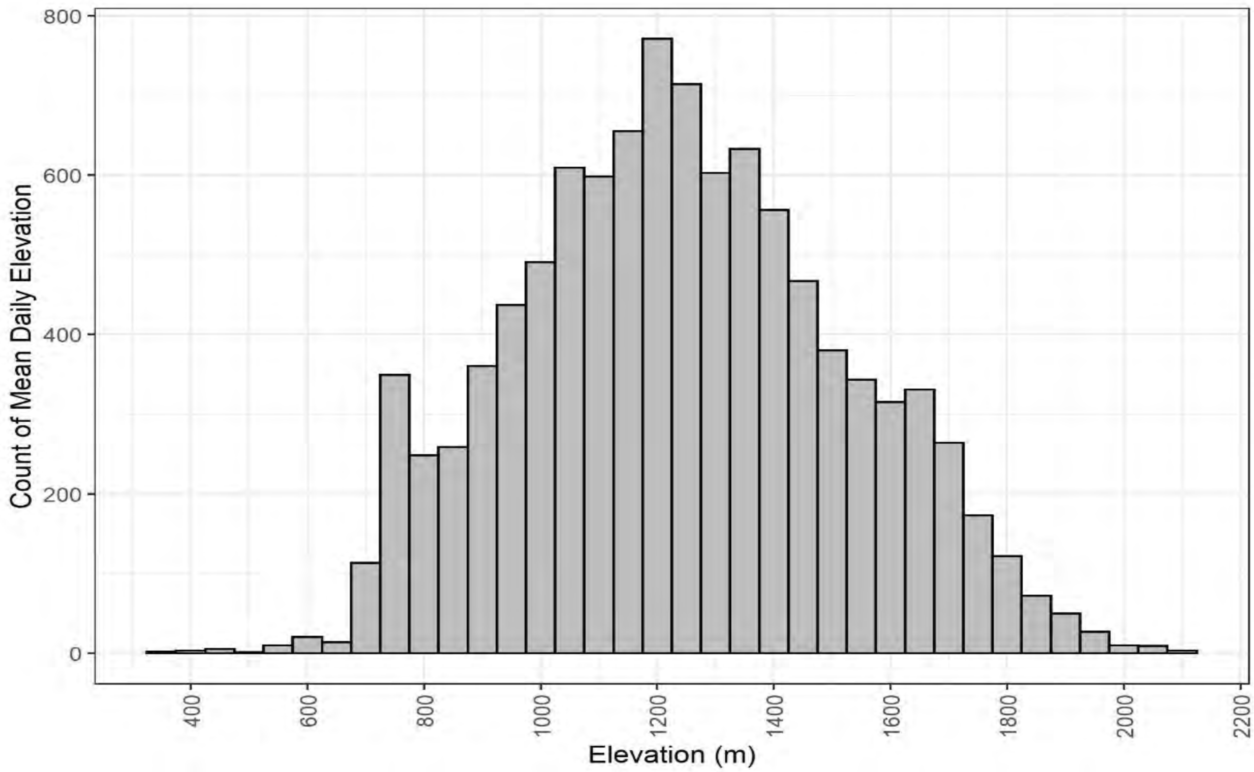

Figure B: Count of Mean Elevation by all Collared Caribou over all Years and Seasons

Elevations used by collared caribou differed among seasons. The highest mean elevations were used during calving (1,865 m) and post-calving seasons (2,103 m; Figure C), which are similar elevations to the ASR at approximately KP 15-20. Caribou used the lowest elevations in winter and spring mitigation (Figure C). Equivalent elevations used by caribou in the winter and spring migration exist along portions of the ASR from the Mine site to KP 30 and near KP 60.

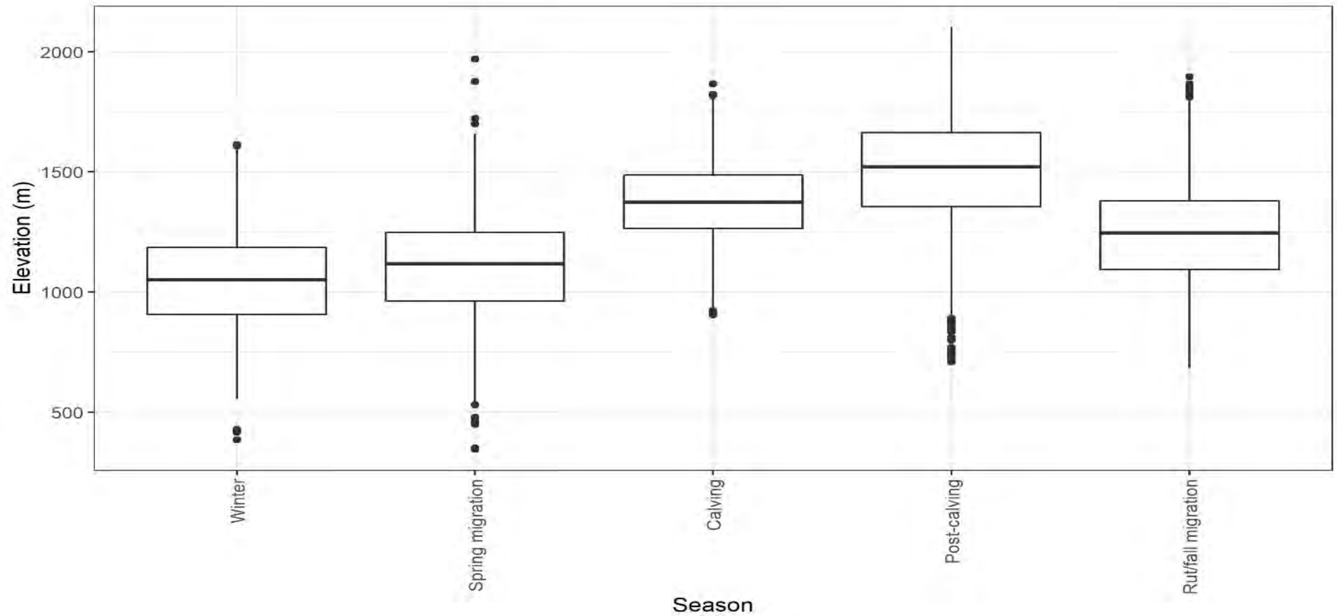

Figure C: Mean Elevation Use for Collared Caribou during Different Seasons

Number of location points: winter (n=5,549), spring migration (n=1,738), calving (n=779), post-calving (n=4,698), and rut/fall mitigation (n=4,117)

Throughout the year, most individuals occupied median elevations between 1,100m – 1,300m m (Figure D). The exception was three individuals who occupied lower elevations, between 752 m and 911 m (expressed as annual means; Figure D).

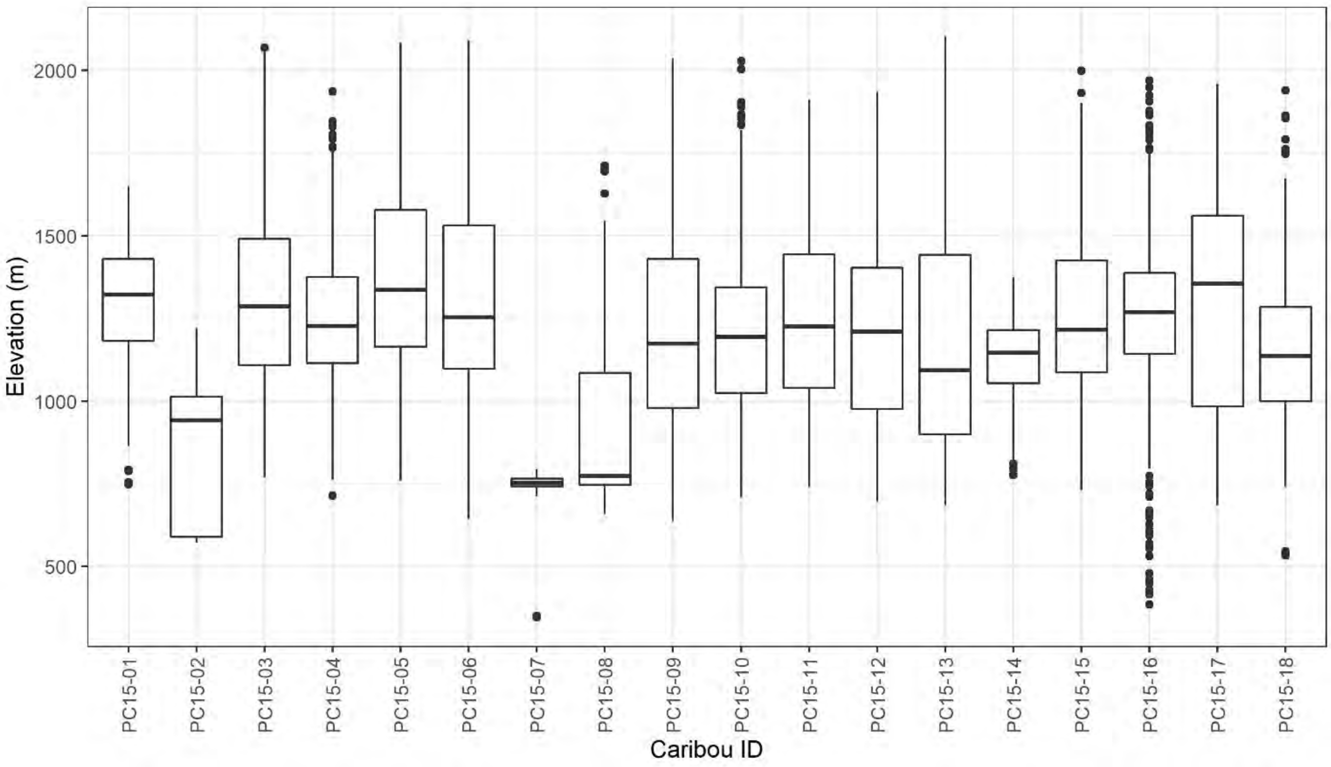

Figure D: Median Elevation Use for each Collared Caribou over All Seasons and Years

Number of location points: Device ID 37681 (n=152); 37682 (n=119); 37683 (n=1,312); 37684 (n=1,310); 37685 (n=956); 37686 (n=588); 37687 (n=1,404); 37688 (n=1,007); 37689 (n=405); 37690 (n=1,076); 37691 (n=1,343); 37692 (n=158); 37693 (n=993); 37694 (n=1,047); 37695 (n=1,577); 37696 (n=1,405); 37697 (n=1,624); and 37698 (n=391)

4.2 Landcover

Landcover trends in habitat use were determined using the satellite collar data and the Natural Resources Canada (2010) landcover dataset. The proportion of each landcover class was determined within a 200 m-radius buffer of each caribou location point. Mean proportion values were calculated for each collared individual and for all caribou within each season and over all years (Figures E – G).

It is important to note that landcover use was not compared to availability and as such, selection cannot be directly inferred. The high or low use of landcover may be indicative only of its relative abundance within caribou annual range.

Over all seasons and years, temperate needle-leaf forest was most used, comprising more than 30% on average of the areas used (Figure E). These forests are characterized as typically having trees taller than 3 metres and having more than 20% vegetation, of which at least 75% is of needle-leaved species (Natural Resources Canada 2010). Grasslands were the second most used habitat, followed by (in decreasing order) shrublands, grasslands with lichen and moss, taiga needle-leafed forests, and barren land (Figure E). Refer to Figure H for landcover classes near the proposed ASR.

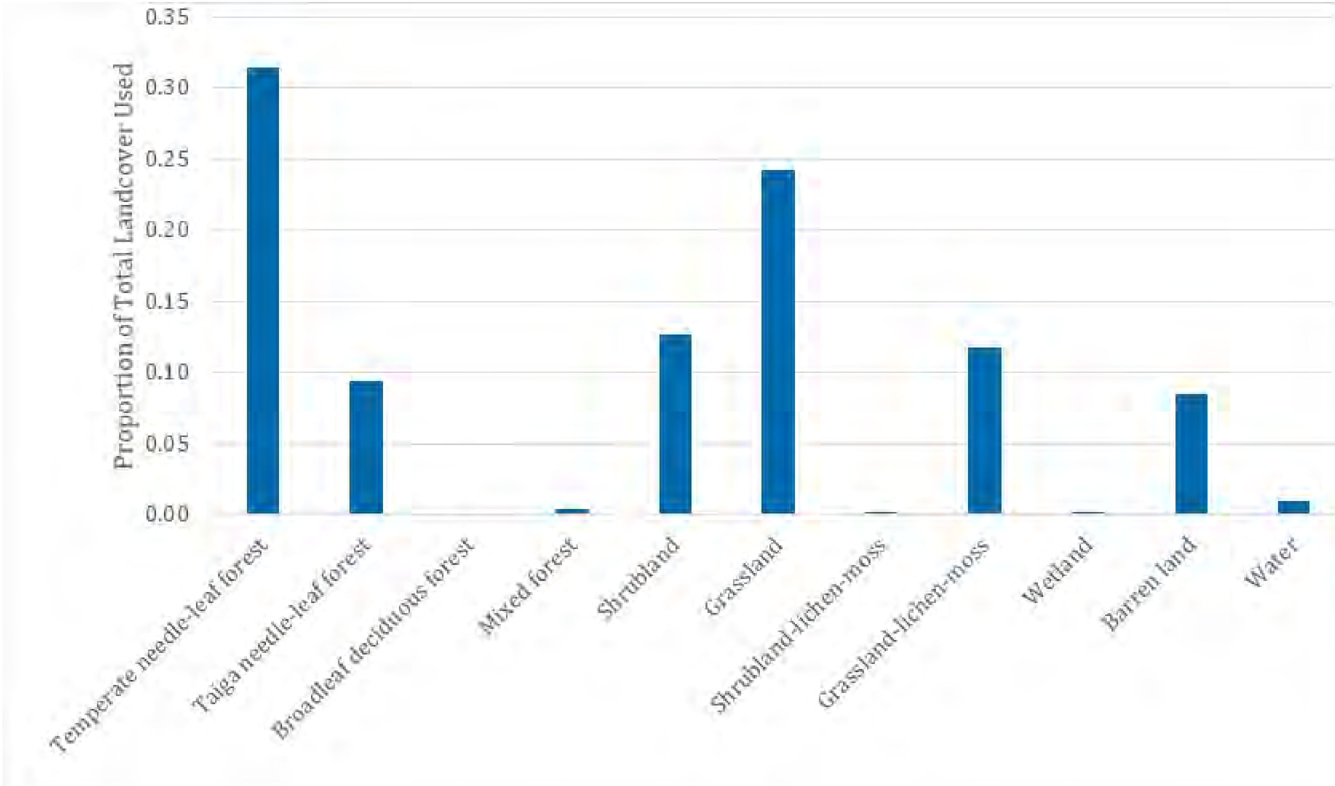

Figure E: Mean Proportion of Landcover Classes Comprising Total Habitat used over all Collared Caribou Locations and All Seasons from 2015 to 2018

Differences in landcover use also existed among seasons (Figure F). Temperate needle-leaf forests were most used during spring, rut, and winter and shrublands and grasslands were most used during calving and post-calving, respectively (Figure F). Grasslands with lichen and moss and barren lands had relatively high use during post-calving compared to other seasons, while temperate needle-leaf forests and grasslands were relatively well-used during calving (Figure F). Wetlands, broadleaf deciduous forests, mixed forests, shrubland-lichen-moss, and water landcover classes had low use.

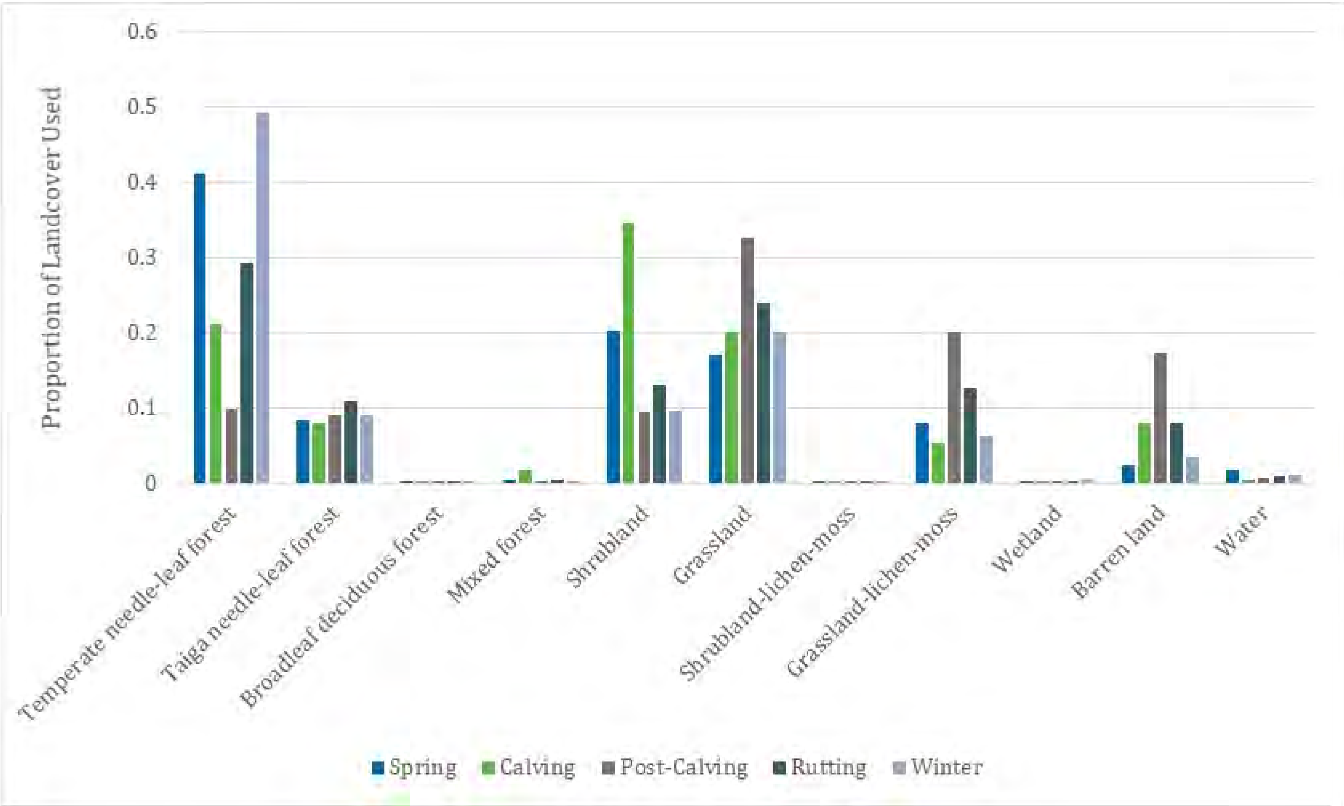

Figure F: Mean Proportion of Landcover Classes used by all Collared Caribou in each of 5 Seasons from 2015-2018

Individual caribou use varied among landcover classes (Figure G). Individuals most-commonly used temperate needle-leaf forest, followed by shrubland. However, some individuals used these two classes almost exclusively, and others used a broader range of classes (Figure G).

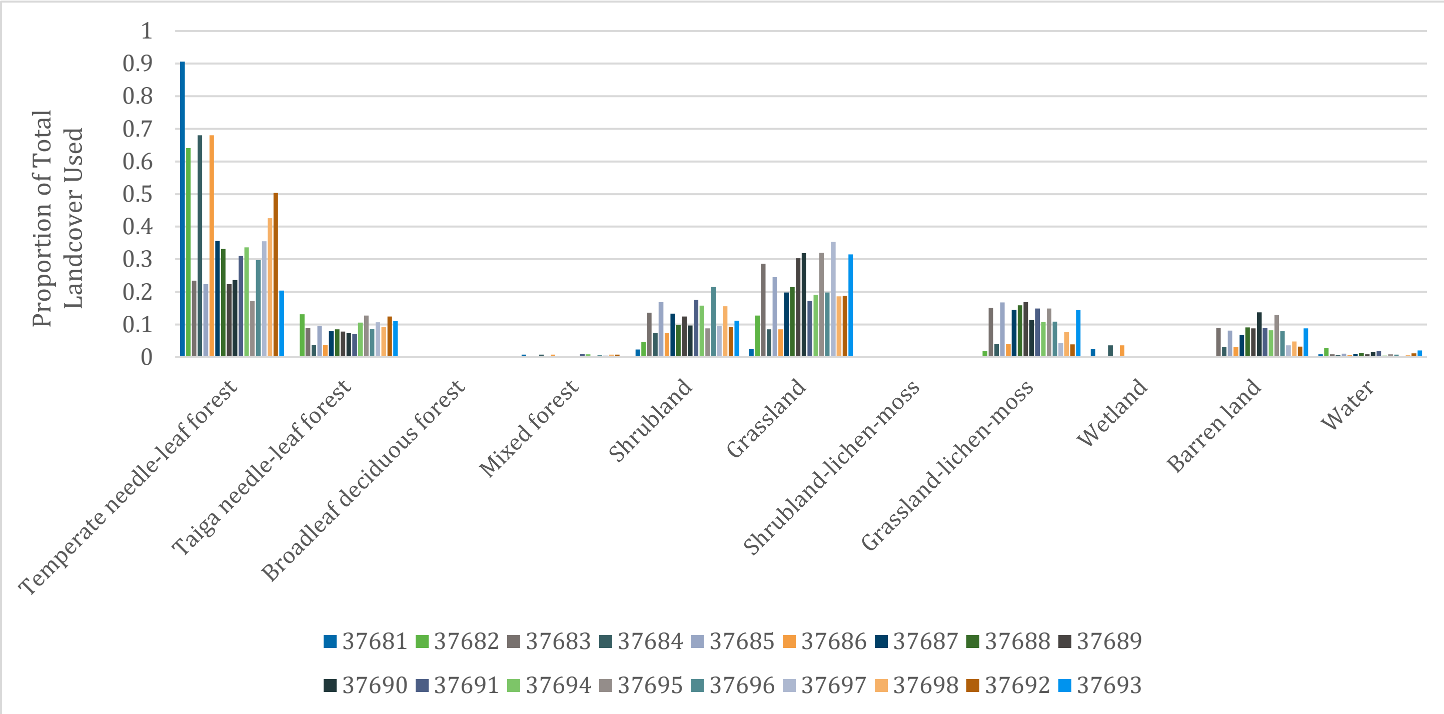

Figure G: Mean Proportion of Landcover Classes Used by Individual Collared Caribou Over All Seasons from 2015-2018

Number of days with collar data: Device ID 37681 (n=135 days); 37682 (n=72 days); 37683 (n=976 days); 37684 (n=822 days); 37685 (n=913 days); 37686 (n=440 days); 37687 (n=921 days); 37688 (n=886 days); 37689 (n=260 days); 37690 (n=908 days); 37691 (n=970 days); 37692 (n=100 days); 37693 (n=961 days); 37694 (n=932 days); 37695 (n=1,024 days); 37696 (n=945 days); 37697 (n=1,030 days) and 37698 (n=557 days). Refer to Table 4 for details

The proportion of each landcover class comprising each distance buffer away from the ASR grouped from KP 0 – 60 was calculated (Figure H). Landcover classes were distributed unevenly, although similarly, with distance from the proposed ASR, with temperate needle-leaf forest dominating across the region, followed by shrubland, mixed forest, barren land, and grassland (Figure H). Because of the similarity among distances, it is unlikely that the mapped landcover classes were driving the patterns observed in caribou distribution with distance to the ASR (refer to Section 3.2.3).

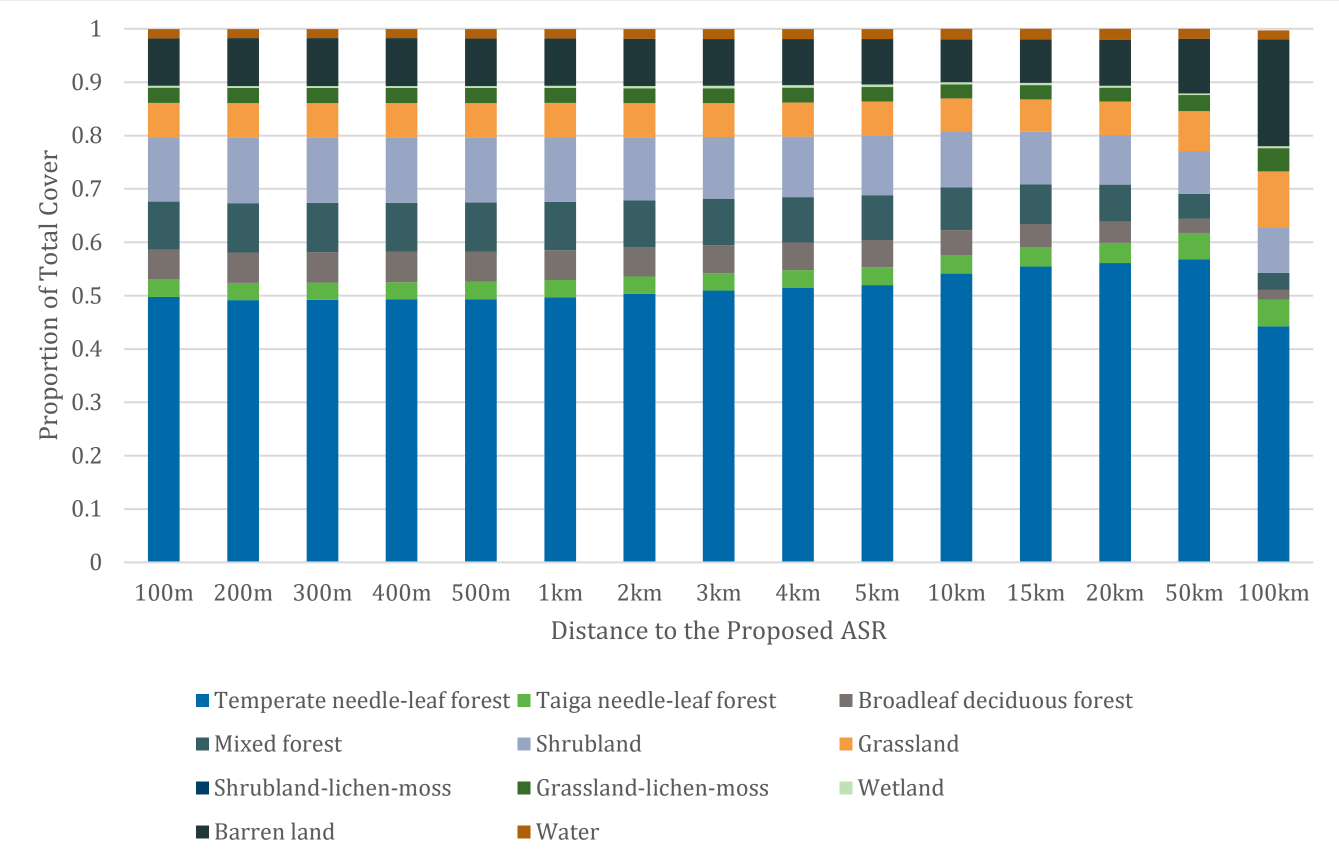

Figure H: Proportion of Landcover Classes Near The Proposed ASR

Creighton (2006) also analyzed data from ten collared Redstone caribou to predict seasonal habitat classifications across a regional area that covered the Mine site and ASR between approximately KP 0 to 100. Overall, Creighton (2006) predicted:

- KP 0 to KP 15 habitat is suitable for caribou in all seasons, except calving
- KP 15 to KP 30 habitat is avoided by caribou except during the post-calving season
- KP 30 to KP 50: habitat is suitable for caribou in all seasons except during fall migration
- KP 50 to KP 100: habitat is suitable for caribou in the winter, spring migration, rut and fall migration, but the habitat is avoided during the calving and post-calving seasons

4.3 Distribution in Relation to the All-Season Road

The Species at Risk Committee's (SARC 2020) Species Status Report for Northern Mountain caribou has mapped the area of the Prairie Creek Mine and ASR as being an area where there is a "trace occurrence" of mountain caribou. This describes an area that is inside the "extent of occurrence" but outside the "area of occupancy". The area mapped as "trace occurrence" recognizes that caribou occur but they are outside the area which they normally occupy (SARC 2020).

The full 2015 – 2018 caribou collaring dataset was made available to Tetra Tech in March 2019 and was analyzed for the caribou collared near the ASR. Caribou distribution in relation to the proposed ASR was analyzed using individual collar locations and estimated range locations. A collared caribou location point may represent the location of multiple individuals. As indicated in Table 2, the mean group size during the 2010, 2011, and 2014 baseline aerial surveys ranged from 8 to 10 individuals (minimum of 1 individual and maximum 26). The group size of caribou reported near the proposed ASR in ENR's WMIS 2014 dataset ranged from 1 to 12.

Using the satellite collar data, individual location points were related to the proposed ASR, both qualitatively by observing the distribution of all location points in relation to the road (Figures 2 – 4, see Figure section) and quantitatively by calculating the proportion of time spent at various distances to the proposed ASR (Figures I – J). Notably, collar fix rate decreases as collar batteries age, which could bias location points used in the analyses.

4.3.1.1 Collar Locations

Overall, the distribution of caribou location points indicates that only a small proportion of relocations during the four years that caribou were collared were near the proposed ASR (Figure 2 including inset figure). The Mine site and proposed ASR exist at the southeastern limit of the collared caribou's annual range (Figure 2). When collared caribou were within approximately 10 km of the proposed ASR, their location points were mostly around KP 0 – 10 and in the lower Sundog Creek area (KPs 30 – 50). More caribou location points were within 10 km of the ASR in 2015, 2016, and 2017 but not in 2018 when a fewer number of collars were transmitting (Figure 2).

Of the point locations near the ASR, the majority were during, in decreasing order, winter, rutting, and post-calving (Figure 3). Most of the collared caribou spent the calving season closer to the NWT and Yukon border where Redstone caribou are known to calve (Figure 3). The exception was a collared female which spent the 2015, 2016, and 2017 calving season approximately 10 km from the proposed ASR in the Prairie Creek area (Figure 3). Another collared female spent the 2016 calving season approximately 10 km from the proposed ASR in the lower Sundog Creek area, but no additional collar data is available for this individual in subsequent calving seasons.

Individual collared caribou varied in their proximity to the proposed ASR over all years and seasons (Figure 4). Ten of the 18 collared caribou were within 10 km of the ASR at least once in the time that they were collared (Figure 4). Only three collared individuals spent any notable time in the vicinity of the proposed ASR. Similarly, at least three collared individual's distribution may have intersected with the proposed ASR at any point in the time collared (from 2015-2018), including one that spent a considerable amount of time near the proposed road in the lower Sundog Creek area (Figure 4); described further below.

To estimate the amount of time spent near the proposed ASR, the ASR footprint was buffered by increasing distances from 100 m to 100 km. Within each of these buffers, the total number of location points falling within the buffer was divided by the total number of location points recorded to estimate the proportion of time spent within that distance from the ASR. This analysis was conducted for all collared caribou in each season, all caribou in each year, and each individual caribou in all seasons and years (Figures I – J, respectively).

In all seasons, the proportion of time collared caribou spent within 1 km of the proposed road was essentially zero (caribou do transit across the proposed ASR but spent little time proximal to it), and only 2% of their time was spent within 5 km (Figure I). Beyond 5 km from the proposed ASR, the proportion of location points (or estimated collared caribou's time spent) increased relatively linearly with distance from the proposed ASR (Figure I). Although only 11% of all collared caribou location points were within 10 km of the ASR in all seasons and years, the highest proportion of location points within 10 km were during the rut/fall migration (17%), post-calving (11%), and calving (11%; Figure I). Although 11% of the calving season collar locations were within 10 km of the proposed ASR, the remaining calving location points (89%) were >100 km away. This was also described above and depicted in Figure 3 relating to the two collared females spending the calving season within 10 km of the ASR which is well outside the known Redstone caribou calving area. Collared caribou spent 79% and 72% of the time >100 km away during the spring and post-calving seasons (Figure I).

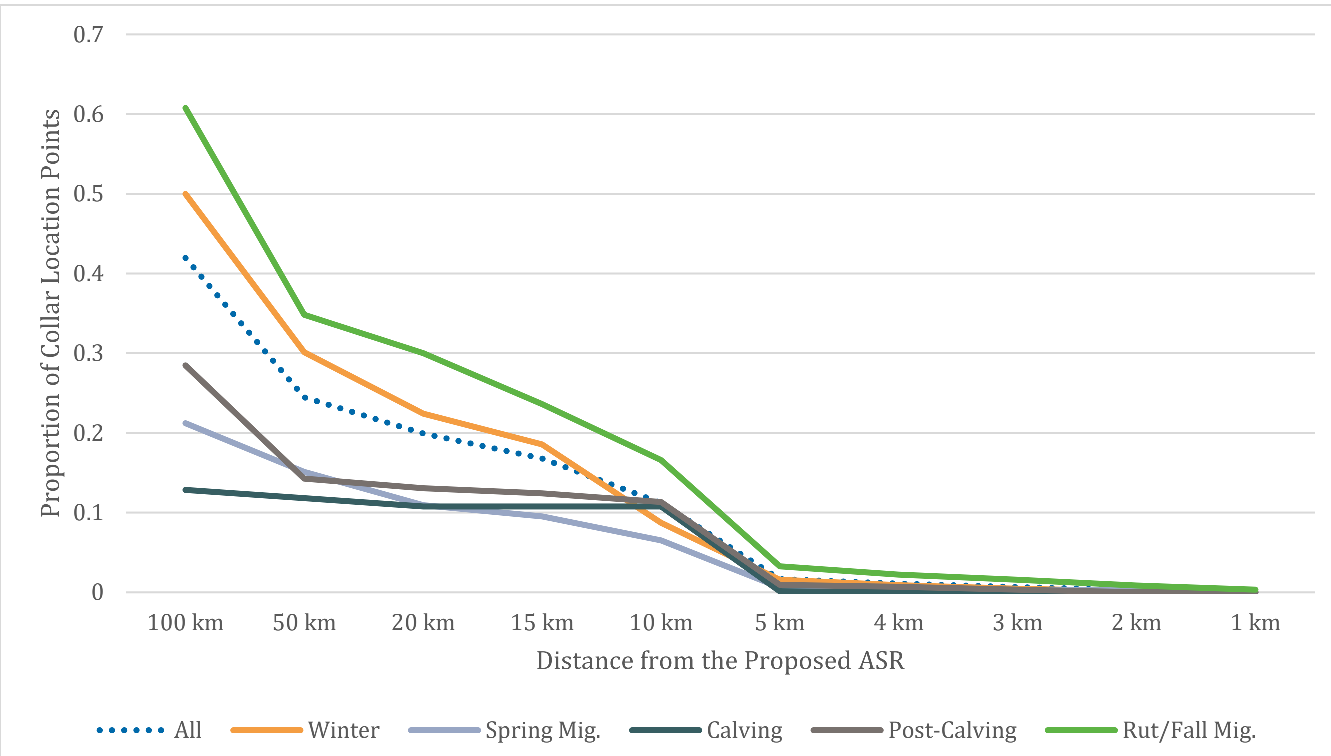

Figure I: Proportion of Collar Location Points within Various Distances to the Proposed ASR during Different Seasons and Over All Years

Number of location points: winter (n=5,549), spring migration (n=1,738), calving (n=779), post-calving (n=4,698), and rut/fall mitigation (n=4,117).

A similar pattern was observed when compared among years (over all seasons). In any given year (2015 – 2018), the collared caribou spent approximately 2% of their time 5 km or closer to the proposed ASR (Figure J). The collar data also indicates that the overall time spent between 5 km and 100 km from the ASR has decreased each year. This may be attributed to a low fidelity to winter and rut areas, as previously identified by Weaver (2008) and may indicate that the collared caribou occurrence in the region of the proposed ASR fluctuates over time. Collared caribou spent 70% of their time within 100 km of the ASR in 2015, 47% in 2016, 27% in 2017, and 14% in 2018 (Figure J).

Figure J: Proportion of Time Spent by Collared Caribou within Various Distances of Proposed ASR During Different Years and Over All Seasons

Number of functioning collars: 2015 (n=18), 2016 (n-17), 2017 (n=14), and 2018 (n=7). Refer to Table 4 for details.

On an individual scale (over all years and seasons), 83% (n=15) of the collared caribou spent 85% of the time that they were collared 10 km or more away from the proposed road (Figure K). Although most collared caribou occurred distant from the proposed ASR, three were the exception and occupied an area in the vicinity of the proposed road most of the time collar data was available for those individuals. One caribou (device ID 37686) spent the greatest amount of time near the proposed ASR in the lower Sundog Creek area, with 18% of the collar locations within 5 km of the ASR, 6% within 2 km, and essentially zero within 500 m (Figure K). Overall, this caribou remained within 20 km of the proposed road for the duration that the data were available (14 months; December 16, 2015 to February 28, 2017), including during the 2016 calving season.

Two other collared caribou (device IDs 37681 and 37697) spent 3% of their time within 5 km and essentially no time any closer than 3 km from the proposed road (Figure K). Beyond 5 km from the proposed road:

- The collared caribou with device ID 37681 spent the majority of the 5-month period that collar data were available between 5 – 10 km from the proposed ASR in the lower Sundog Creek area (Figure K). No collar data is available during calving for this individual.
- The collared caribou with device ID 37697 spent approximately 60% of the time between 5 – 10 km of the proposed ASR (34 months; collar data available from Feb. 21, 2015 – Dec. 17, 2017) and 15% of the time 15 km or more away (Figure K).

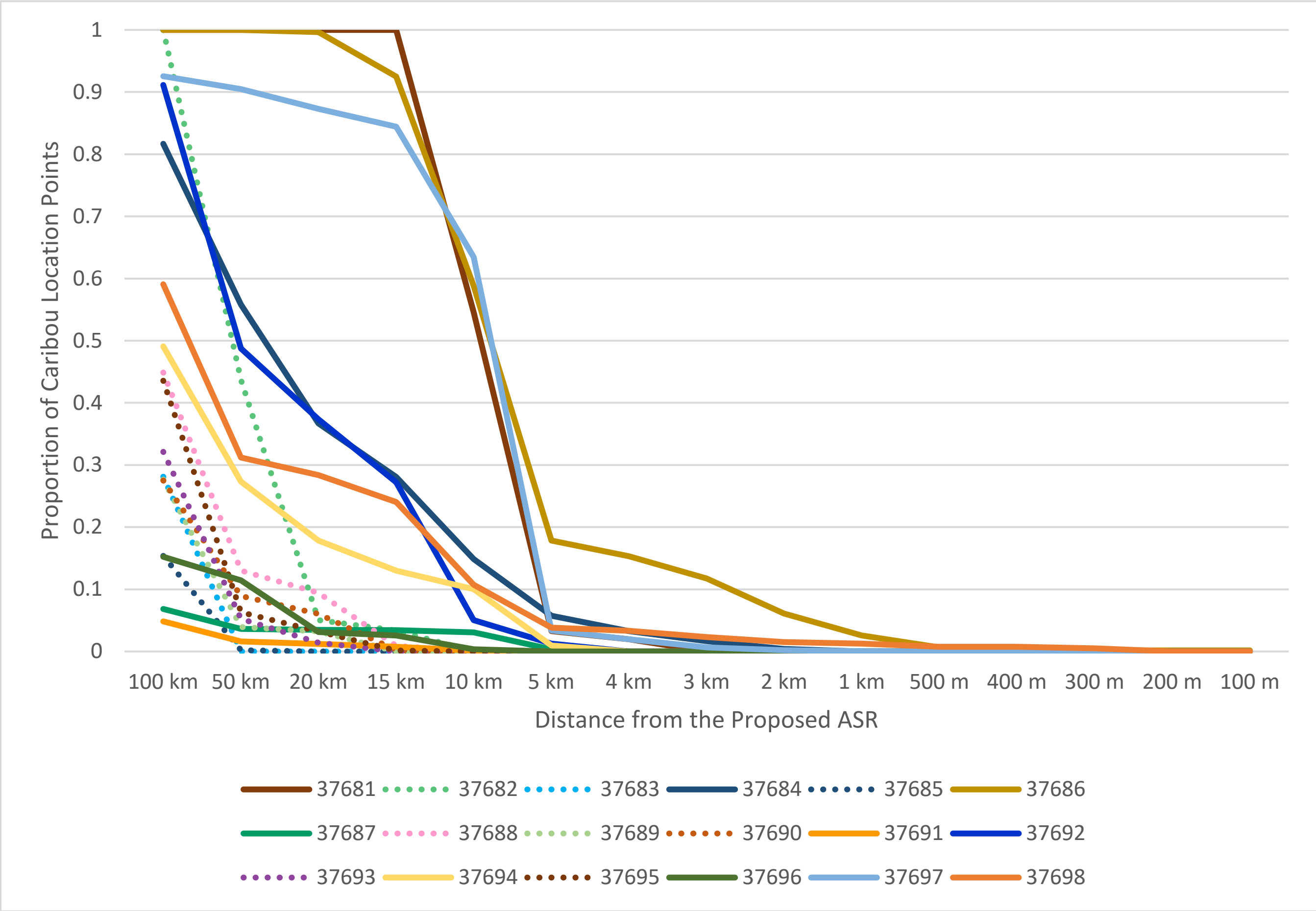

Figure K: Proportion of Time Spent by Individual Collared Caribou within Various Distances of the Proposed ASR Over All Years and Seasons

Number of days with collar data: Device ID 37681 (n=135 days); 37682 (n=72 days); 37683 (n=976 days); 37684 (n=822 days); 37685 (n=913 days); 37686 (n=440 days); 37687 (n=921 days); 37688 (n=886 days); 37689 (n=260 days); 37690 (n=908 days); 37691 (n=970 days); 37692 (n=100 days); 37693 (n=961 days); 37694 (n=932 days); 37695 (n=1,024 days); 37696 (n=945 days); 37697 (n=1,030 days) and 37698 (n=557 days). Refer to Table 4 for details

4.3.1.2 Range Estimation

Caribou range estimations were calculated using the collar location data and Kernel Density Estimation (KDE). Rather than delineating a single area representative of a collared caribou's range, KDE provides clusters where a given proportion of caribou locations occurred. KDE analyses were conducted for all collared caribou and by season to show patterns across time and space. Both 50% (core range) and 95% (overall range) KDE analyses were performed, indicating respectively, where 50% and 95% of all caribou locations, for a given season, occurred. Mapped results of all the KDE analyses are presented in Figures 5 (annual distribution) and 6a – 6e (seasonal distribution, see Figures Section).

Results indicate that the collared caribou range covers an extensive area from the NWT/Yukon border, the western portion of the proposed ASR, and north into the Sahtu Region (Figure 6). The proposed ASR is located at the southeast edge of the collared caribou's overall (95%) and core (50%) annual ranges (Figure 5).

Core range varies by season with a few collared individuals' core range overlapping with the proposed ASR from KP 0-20 and in the lower Sundog Creek from KP 40-50 during spring, post-calving, and rut (Figures 6a-6e). This is a similar distribution to what was predicted in the baseline occupancy models presented during the Environmental Assessment.

The core and overall ranges by season are described as follows:

- Winter (Figure 6a): Collared caribou generally overwintered along the eastern front of the Mackenzie Mountains extending from the proposed ASR in the south and north into the Sahtu Region. This winter range is typical of the Redstone herd which winters across the Deh Cho, Sahtu, and Gwich'in regions. Core winter range did not overlap with the proposed ASR; however, the overall (95%) range overlapped the western 18 km of the proposed road, as well as from KP 36 – 56 (lower Sundog Creek).
- Spring (Figure 6b): In spring, the overall range shifted west as the collared cows travelled from winter range to the calving area near the NWT/Yukon border. Near the proposed ASR, the core range generally contracted from their winter range and extended across the western 20 km of the proposed ASR (approximate). During this period, 79% of all collared caribou location points were more than 100 km away from the ASR (Section 3.2.3.1).
- Calving (Figure 6c): Collared caribou were concentrated near the territorial border during the calving season as shown by the similar size of the core and overall ranges and approximately 90% of all collar locations were more than 100 km away from the ASR (as described in Section 3.2.3.1). Another core range was centred on the Nahanni National Park Reserve boundary northeast of KP 7, approximately 10 km from the proposed ASR. In addition, overall (95%) range was present in the lower Sundog Creek area (approximately KP 30 – 40; a single collared caribou spent the calving season near KP 40). This is also explained by approximately 10% of all collared caribou locations occurring within 10 km of the ASR during the calving season (Section 3.2.3.1)
- Post-calving (Figure 6d): During the post-calving season, the majority of the collared caribou were spread between the territorial border and the Nahanni National Park Reserve border, and very few were present near the proposed ASR (72% of all collar location points were more than 100 km from the ASR). The collared caribou that remained 10 km west of KP 7 during the calving season continued to remain in the area and extended its range across KP 0 – 15. In the lower Sundog Creek area, overall (95%) range also expanded across to approximately KP 25 – 50.
- Rutting (Figure 6e): During the rut season, collared caribou continued to disperse across a large regional area near their winter range. Core range mostly occurred near the Nahanni National Park Reservice border well north of the proposed ASR, as well as overlapping with the proposed ASR from approximately KP 0 – 19 and KP 40 – 43. However, collared caribou also occupied overall (95%) range that fully encompassed the proposed ASR from KP 0 – 61. As described in Section 3.2.3.1, collared caribou spent the greatest amount of time (24%), within 15 km of the proposed road during the rut.

5.0 MULTI-SPECIES REMOTE CAMERA SURVEY

5.1 Camera Locations, Duration, and Effort

A total of 46 remote cameras were deployed from June 17 to 20, 2019 and left to run until September 23 and 24, 2020 (Appendix C). Cameras were deployed along the ASR from KP 1 to 56 and the three transects (Figure 7). Of the 46 cameras deployed, 21 were on the ASR alignment and 25 were spaced 1 km apart along the three transects. All cameras were located on or within 4 km of the proposed ASR alignment. Four cameras planned on the ASR near KP 61, 67, 69, and at the Nahanni National Park Reserve boundary (KP 101) were not deployed in June 2019 to allow the survey crew to quickly depart from the mountains before a large weather system arrived. Images from one transect camera, location B04, were not retrieved in 2020 and the data was unavailable for analysis.

A total of 13 cameras were deployed facing existing wildlife trails, seven were at the edge of a clearing or a burn area, five along a ridgeline or valley, and 20 on the existing 1980s road or trail (Appendix C). Camera location R01 was deployed on the existing road in between the Mine site and the airstrip, and R02 was on the existing road facing towards the airstrip.

Total sampling effort was 16,634 active camera-days. Active camera days were counted as each day a camera was operational with an uncompromised[2] field of view (Figure L). Most cameras (27 of 45) were active for more than 400 days (Figure L). On average, the cameras were active for 370 days (min. = 23 days; max. = 465 days). While deployed, one camera malfunctioned (undetermined reason), another was damaged (due to a black bear), and the field of view of seven cameras became compromised either by snow, after being bumped by wildlife, and for an undetermined reason.

[2] The camera field of view becomes compromised when the camera angle (field of view) changes by more than 50% and to such an extent that large and medium-bodied wildlife would no longer be detected if traveled in front of the unit.

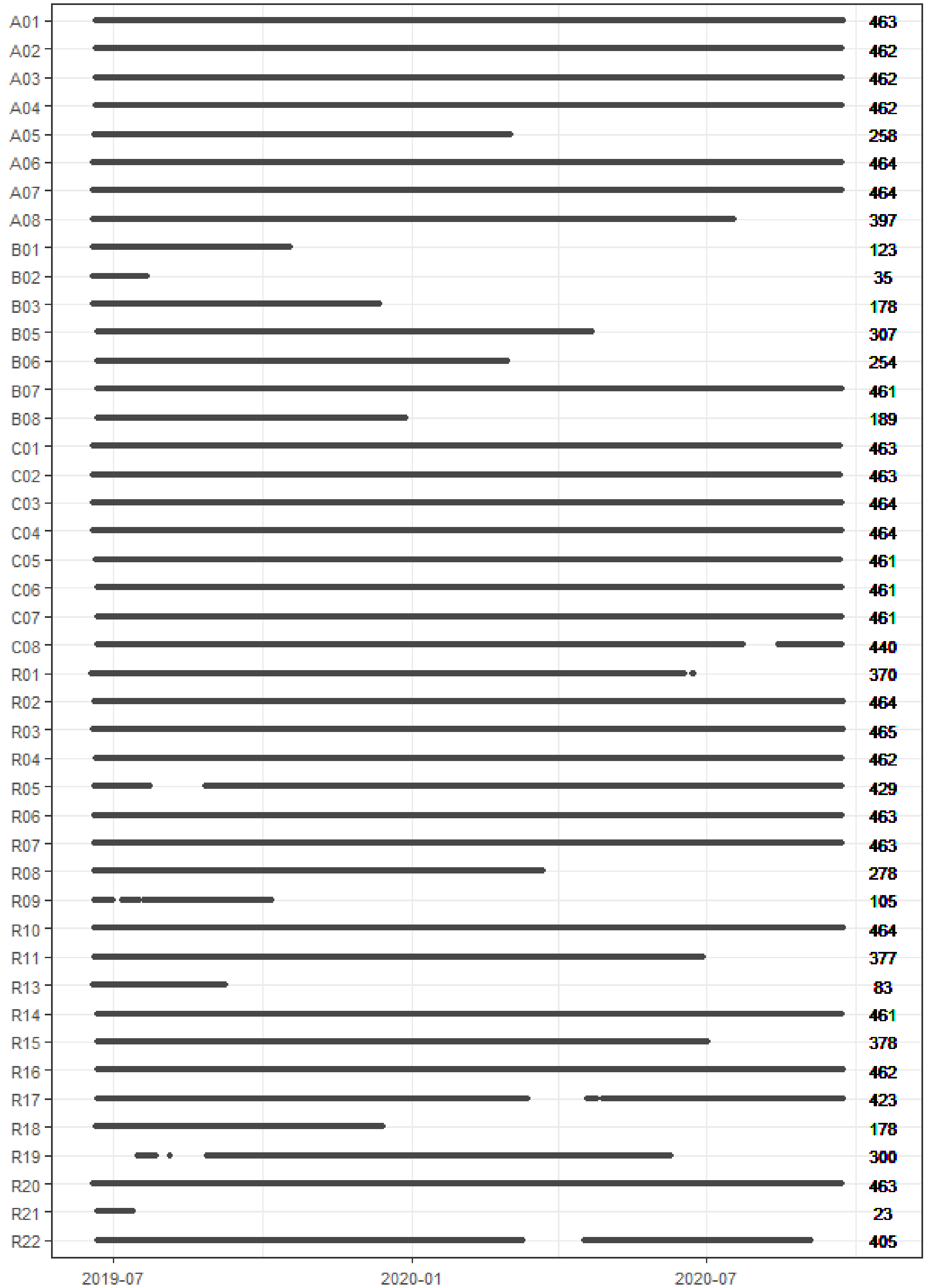

Figure L: Active Camera Duration (Bars) and the Number of Active Camera Days (Numbers at Right) for each Camera Location

5.2 Species Detections

Dall's sheep was the most-commonly detected species (363 detections) and was also detected at the highest number of camera locations (56%; or 25 of the 45 analysed cameras), followed by grey wolf, grizzly bear, ground squirrel, and moose (Figure M). Caribou were detected at 31% of the cameras (14 of the 45) for a total of 62 caribou detections. Wolverines were detected at 24% of the cameras (11 of the 45). It is important to note that the number of individual animals that comprise the detections is not known. It is possible that a small number of individuals are responsible for many or most detections of a species. This may be especially true for cameras located along the road where individuals may be successively detected as they pass each camera.

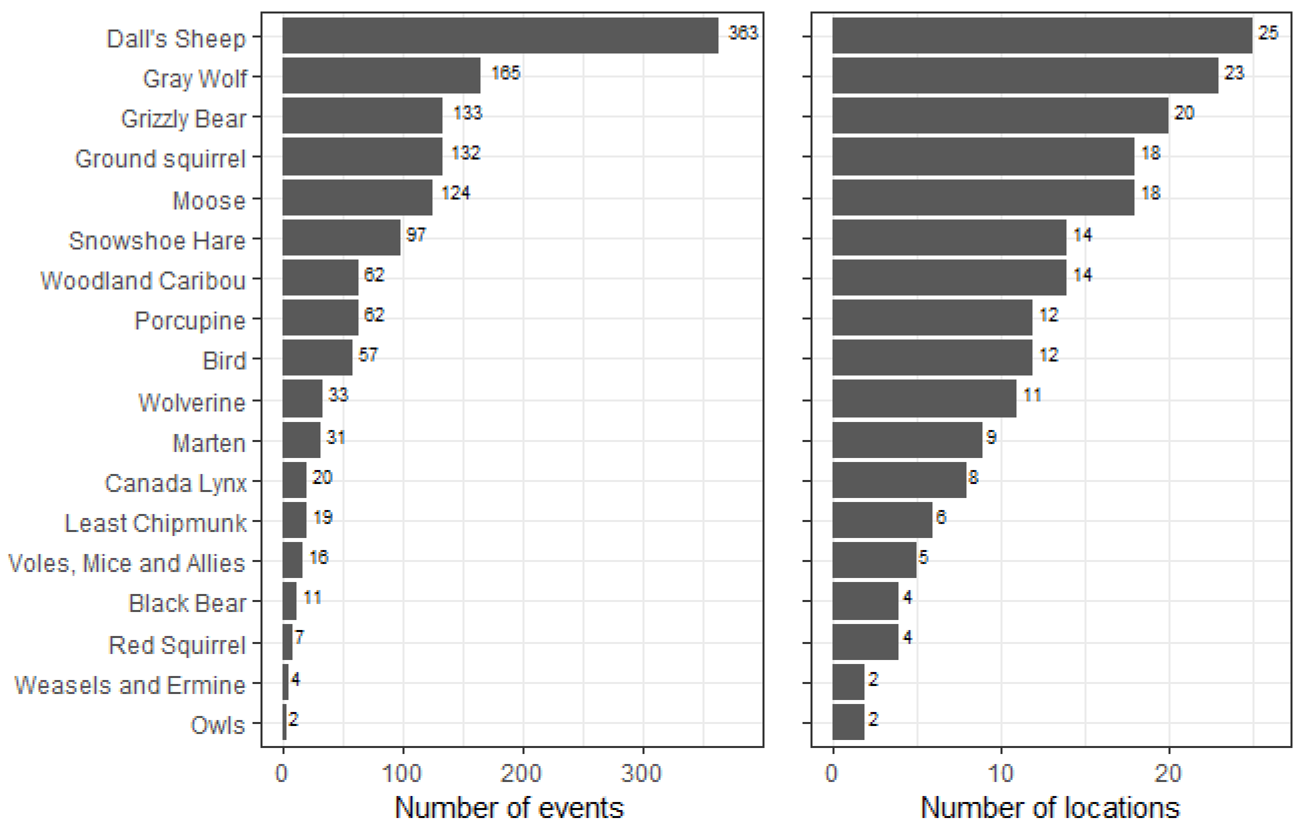

Figure M: Wildlife Detection Events by number of Events and Number of Locations (Cameras)

Group size was estimated for the focal species based on direct observation and or the number of individuals inferred from sequential images in Figure N. A group size of one was the most common in the focal species. Largest group sizes were detected for Dall's sheep and gray wolf with a maximum of 11 and 6 individuals detected per group, respectively. The maximum detected group size of caribou and grizzly were both 3.

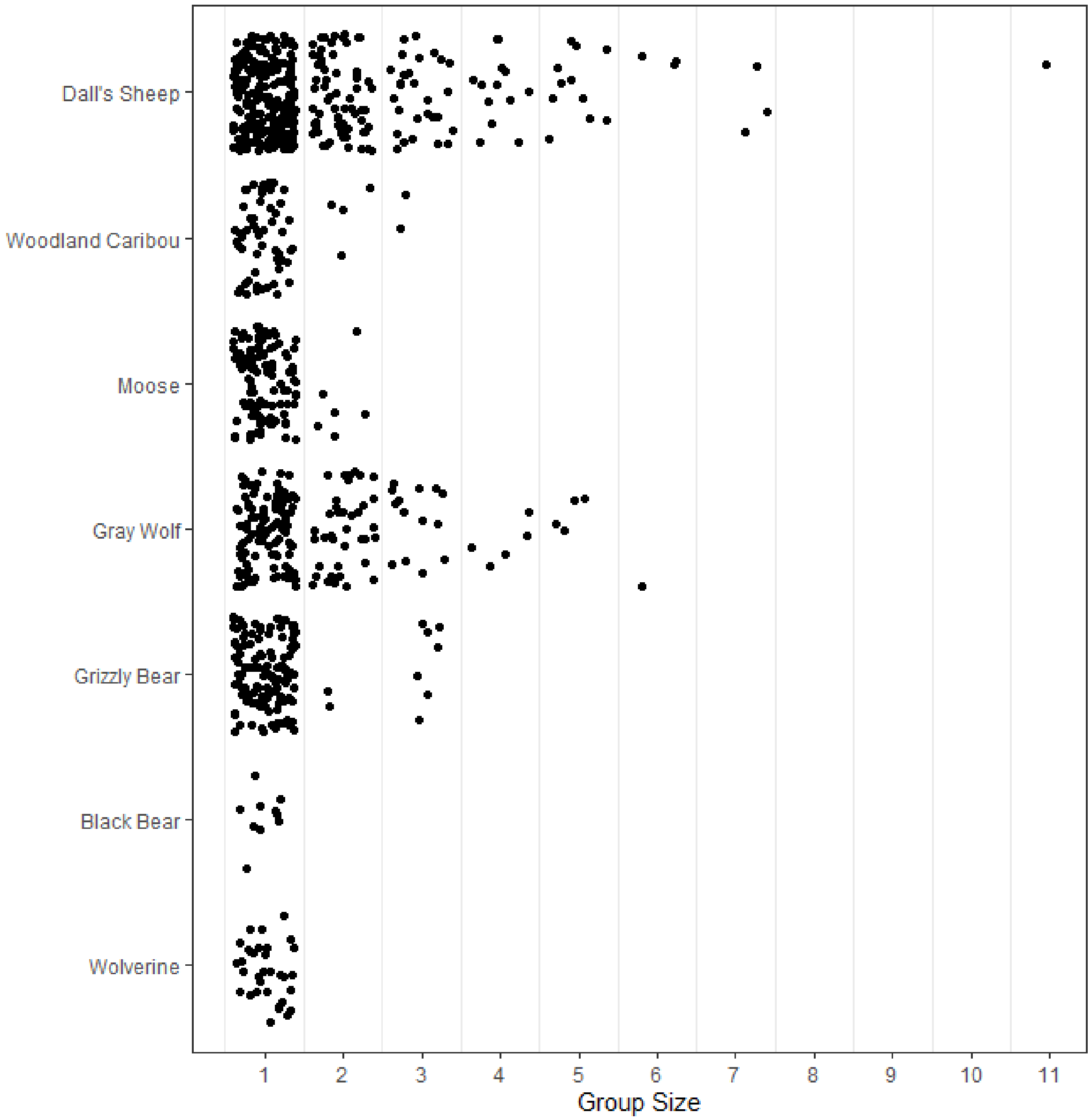

Figure N: Number of Individuals (Group Size) in Detection Events Determined from Either Direct Observation of Individuals in an Image or Inferred from Sequential Images.

5.3 Detections by Camera Location

Focal species (i.e., caribou, Dall's sheep, moose, gray wolf, grizzly and black bears, and wolverine) were unevenly detected across camera locations (Figure 8). Black bear was not detected west of camera R20 (approximately ASR KP 43). Caribou were detected in the western portion, up to approximately ASR KP 25. The remaining five focal species were detected at various camera locations across the remote camera study area.

Camera detections of caribou were primarily in post-calving and fall/rut seasons, limited detections occurred in spring and none occurred in winter or calving seasons (Figure 9). The caribou detection rate (standardized as the number detection events per 100 camera-days) was highest in post-calving.

5.4 Temporal Patterns

Detections of Dall's sheep and gray wolf were highest in spring, summer, and fall (Figure O). Grizzly bears were detected in all months when not typically hibernating. There were few detections of black bears. Moose were detected in most months with highest detections in winter. Wolverine were detected only in the winter and spring months. The highest detection rate of caribou was in June 2020 at 1.07 detections/100 camera-days.

All focal species except for gray wolf exhibited a diurnal activity pattern (Figure P). For the six diurnal species, activity peaked around midday with the exception of moose which had a distinct activity peak in the evening.

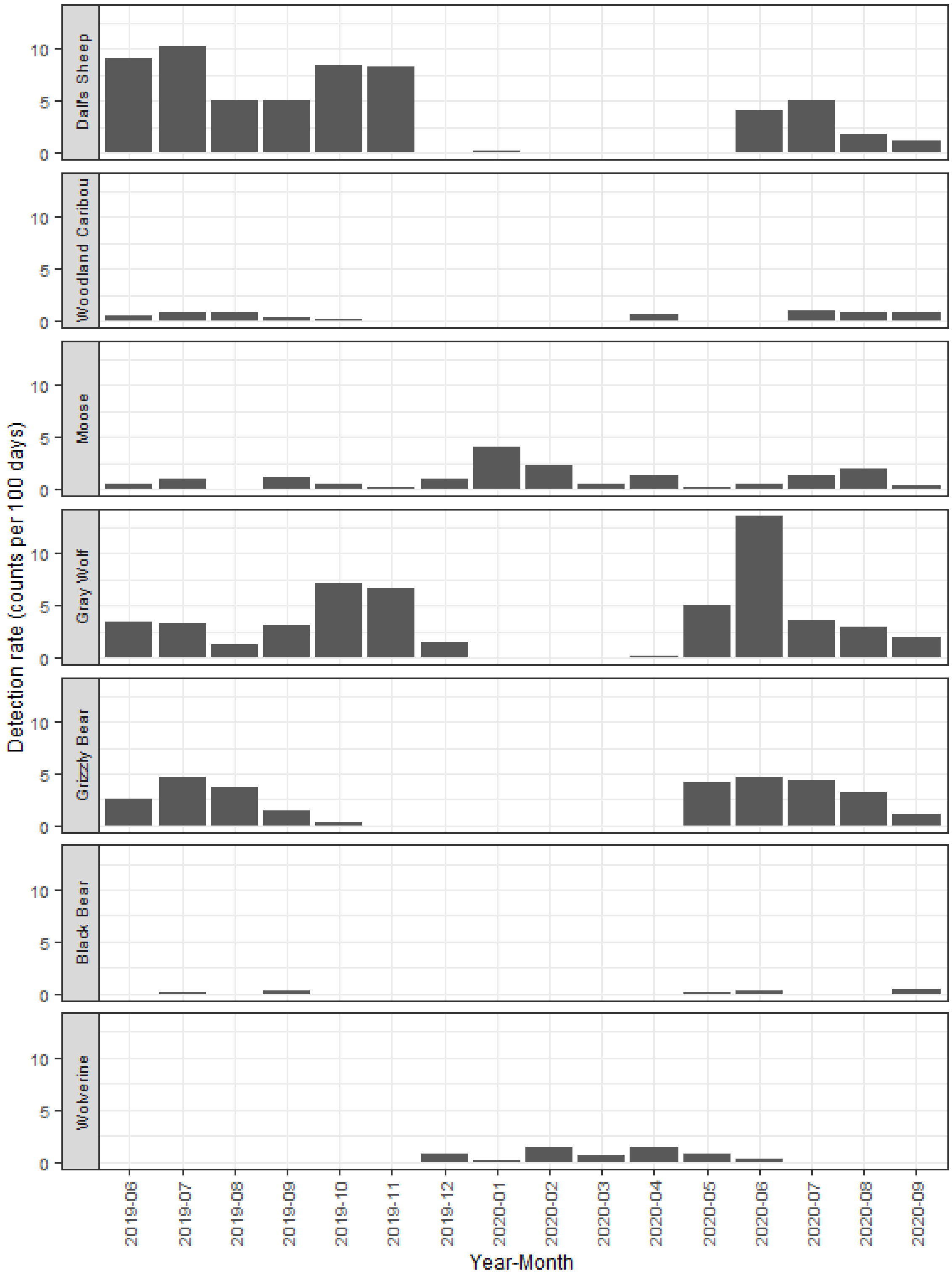

Figure O: Focal Species Detection Rates by Month of Camera Deployment

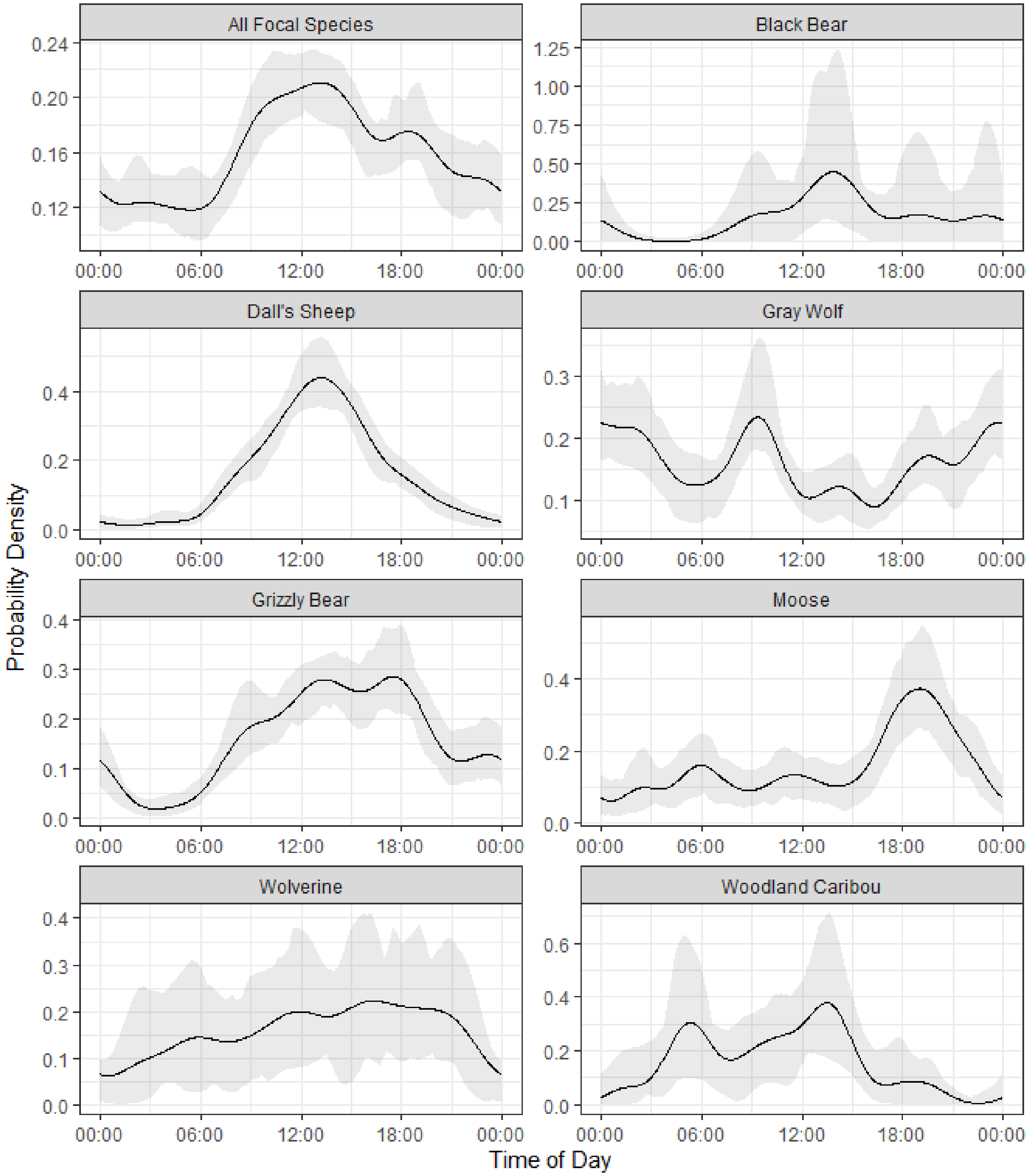

Figure P: Daily Patterns of Focal Species Detection Rates (Shown as Probability Density with 95% Confidence Intervals) for Cameras Located Along the ASR

5.5 Caribou Occupancy

The top model to estimate caribou occupancy included the covariates UTM northing, elevation, distance to ASR and proportion of barren habitat (Figure Q). The model parameter estimates, and test statistics (presented in Appendix C) indicate there is high confidence in the effect of elevation, distance to ASR and proportion of barren habitat ($P < 0.05$) and moderately-high confidence in the effect of UTM northing ($p = 0.073$). The chi-square goodness-of-fit test comparing the sample data to a simulated dataset created using parametric bootstrapping reported a test statistic = 0.321 indicating no difference in data distributions and an adequate model fit.

The detection probability of caribou was 0.060 per 7-day survey period. Occupancy when covariates are set at their mean value was 0.460. This can be interpreted as expecting caribou to occupy 46% of the camera locations in the region after correcting for detection probability and assuming infinite sampling (the population level estimate). The remote cameras, however, were preferentially placed in locations expected to have higher detections of caribou and may not represent the entire landscape. A more realistic statistic is the percent of area occupied (PAO) which represents the true estimated occurrence state across all surveyed locations. The PAO estimate is 0.356 (0.318 – 0.455 [95% CI]) meaning 35.6% of the survey locations are estimated to be occupied by caribou at some point during the year, after correcting for detection probability. For comparison, the simple or naïve calculation for occurrence based solely on the number of camera locations where caribou were detected is 31.8% (14 of 44 camera locations).

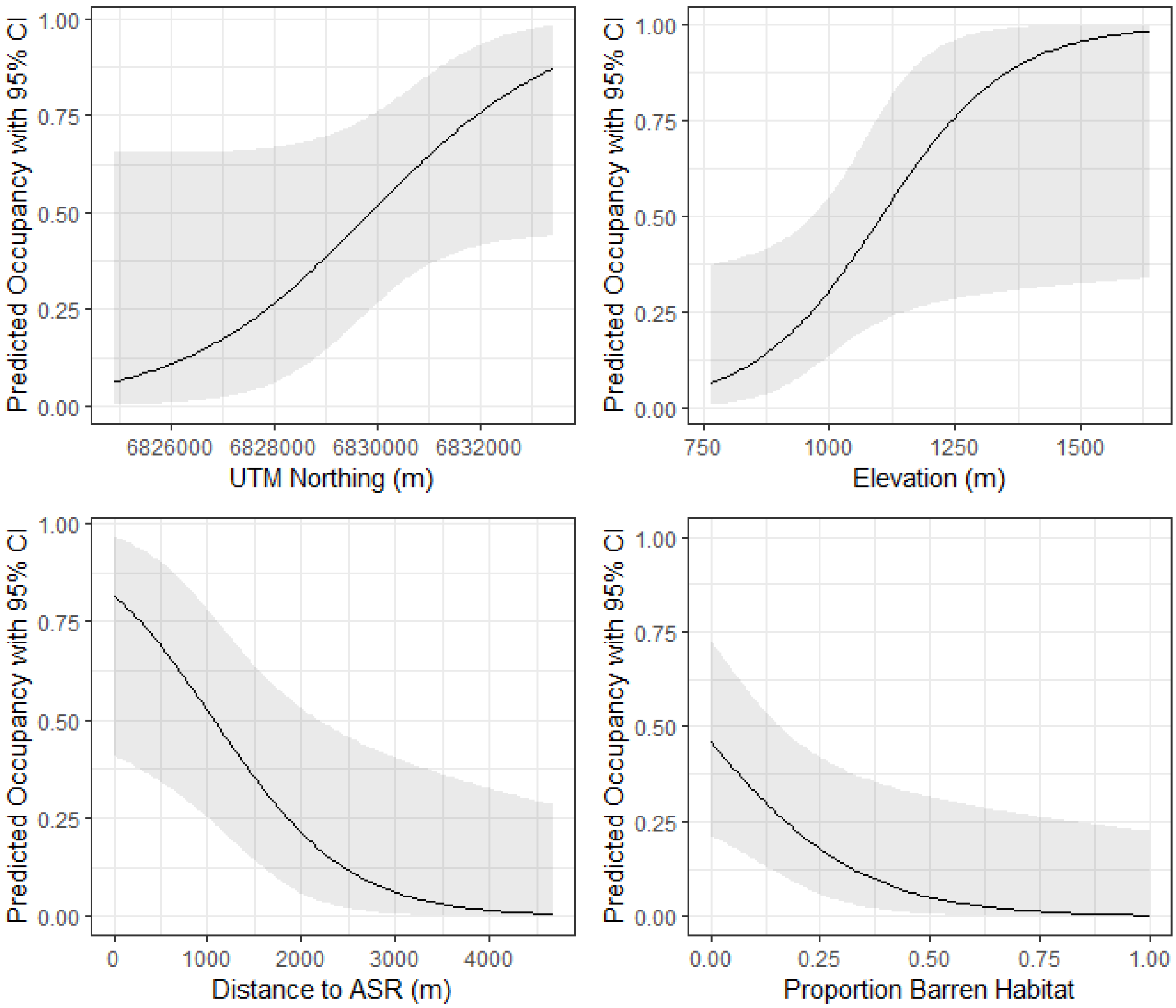

Figure Q: Predicted Caribou Occupancy for each Covariate in the Top Model

5.6 Vehicle Traffic

Vehicle were detected at cameras R01 to R11 (KP0 to KP17) (Figure R). There were 1,272 vehicle detection events of vehicles (passenger vehicles), heavy equipment (airplanes, haul trucks, bulldozers, and front-end loaders), and all terrain vehicles. Ninety percent of vehicle detections were at the two cameras located on the road between the Mine site and airstrip (R01) and on the road facing the airstrip (R02). Detections of passenger vehicles and heavy equipment were primarily restricted to R01 and R02 cameras (R02).

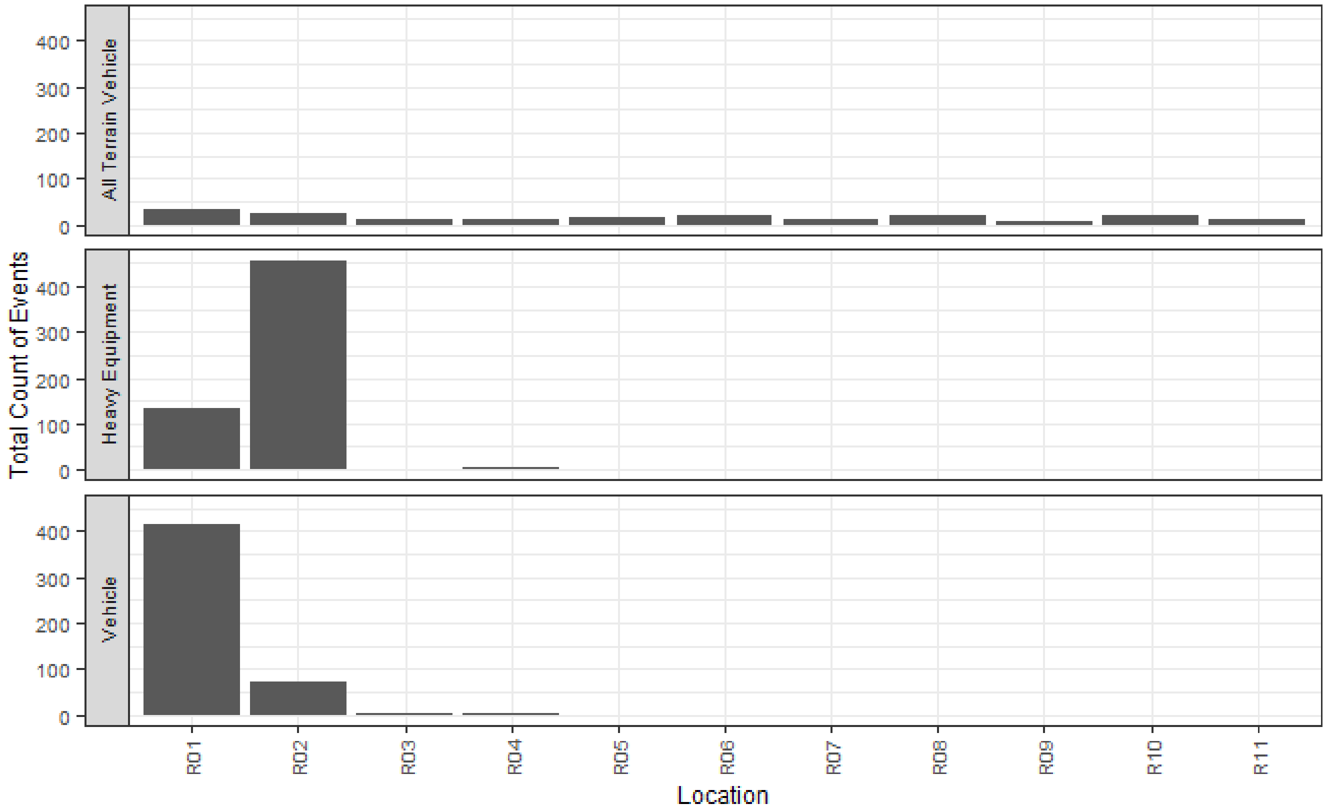

Figure R: Total Count of Vehicle Detection Events for Camera Locations with Vehicle Activity

Vehicle activity was highest from August to November in 2019 (Figure S). On a daily basis, vehicles were active from approximately 6 AM to 9 PM (Figure T). The patterns of vehicle activity during the 2019 – 2020 camera deployment reflect the phase of the mine project at that time and are not necessarily indicative of anticipated vehicle volumes and patterns of activity when the PWR or ASR is operating. The results shown here do, however, indicate how vehicle activity can and likely will be analyzed after future camera deployment.

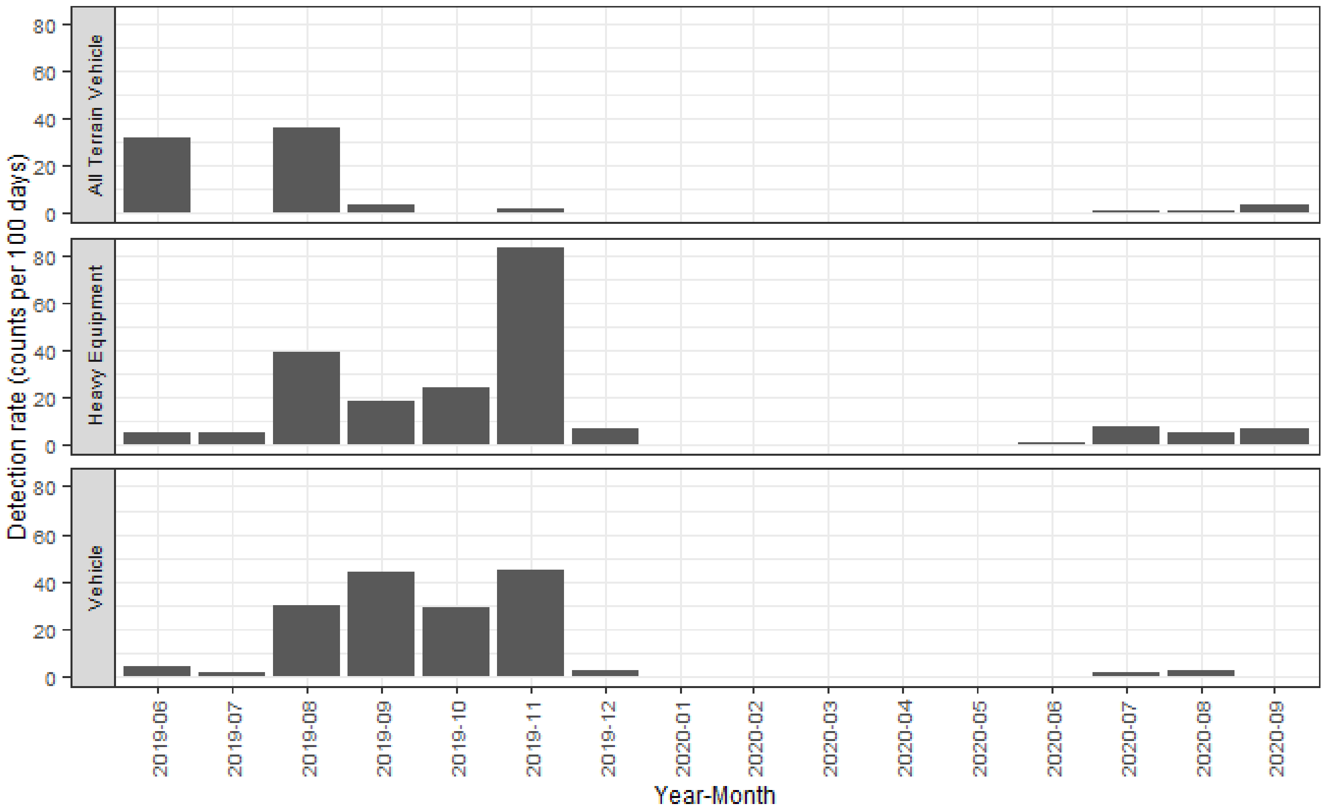

Figure S: Vehicle Detection Rates by Month of Camera Deployment

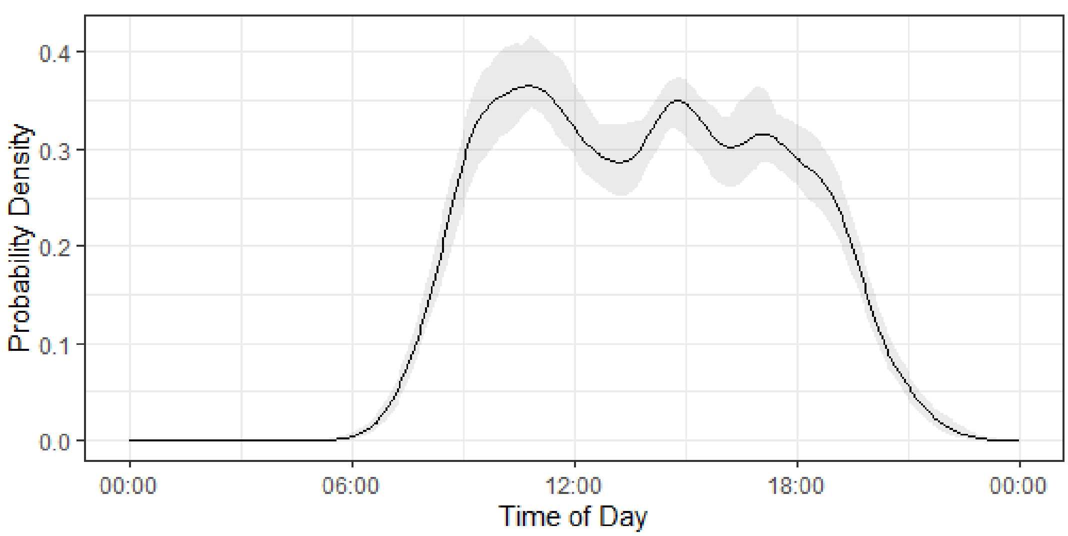

Figure T: Daily Pattern of Vehicle Detections (Shown as Probability Density with 95% Confidence Intervals) for Cameras That Recorded Vehicles

6.0 MITIGATION AND EFFECTS EVALUATION

Results of the caribou aerial surveys, remote collar, and camera surveys suggest that Northern Mountain caribou occur at low relative abundance proximal to the Mine site and along portions of the proposed ASR. Northern Mountain caribou occurring in the area are believed to be part of the Redstone herd which occurs across a large annual range extending from the Yukon border, and into the Sahtu, and Deh Cho regions. Despite poor survey conditions during the aerial survey in 2019, results suggest that Boreal caribou also occur at low relative abundance, which corroborates ENR's aerial surveys in the ASR area (Allaire page 178-179 of the ASR Environmental Assessment Public Hearing Transcripts).

The majority of the collared caribou spent 85% of the entire time that they were collared 10 km or more away from the proposed ASR. When in the area of the ASR, the area of the collared individuals overlapped with the proposed ASR mostly from KP 0 – 16 and in lower Sundog Creek from KP 40 – 50, which is consistent with the Northern Mountain caribou occupancy predictions presented in the DAR.

Although only 11% of all collared caribou location points were within 10 km of the ASR in all seasons and years, the highest proportion of location points within 10 km were during the rut/fall migration (17%), post-calving (11%), and calving (11%) and represents a time when the collared caribou spend the longest amount of time near the proposed road.

Caribou occupancy based on the remote camera data was estimated to be 35.6% of the survey locations after correcting for detection probability. Camera detections occurred primarily in the post-calving and fall/rut seasons, with limited detections in spring and none in the winter or calving seasons. The remote cameras provide no estimate on the actual number of caribou present in an area; the results are best viewed as a measure of frequency of use.

Mitigation proposed and caribou effects predicted in the DAR were re-evaluated based on this additional baseline information. Mitigation proposed in the DAR to avoid and/or reduce potential effects to caribou are provided in Table 5.

Table 5: Mitigation to Avoid and or Minimize Effects on Caribou

Mitigation
Avoid Boreal caribou habitat by moving the portion of the ASR alignment to upland habitat east of the Nahanni Range, as identified by Indigenous groups
Minimize habitat loss and predator access by retaining the Project alignment on the existing 1980s road as much as possible
Reduce the likelihood of caribou mortality by installing windrows, lumber, or other brush clearing material at intersections with other linear features to discourage access and limit sightlines of predators and humans
Reduce the likelihood of caribou mortality, harvest pressure and other road disturbing effects by controlling traffic and restricting road access where CZN has authority, including: ▪ Private barge crossing ▪ Checkpoint station ▪ Signage to discourage non-Project traffic ▪ Reporting caribou seen along the road to other drivers
Minimize disturbances to caribou by following blast management (e.g., pre-blast monitoring, setback distances, and restricted activity periods) practices: ▪ No blasting within 1 km of a caribou ▪ Schedule blasting outside the Boreal caribou calving season (May 1 to July 15), to the extent possible
Minimize likelihood of altering caribou habitat by following dust suppression and spill contingency practices
Minimize disturbances to caribou by following minimum aircraft altitude and best practices near wildlife

Table 5: Mitigation to Avoid and or Minimize Effects on Caribou

Mitigation
Manage road operations to minimize risk of habitat alterations and mortality risk: ▪ Low traffic speed (max 60 km/hr) ▪ Low traffic volume ▪ Wildlife given right-of-way ▪ Snow berm management (bank heights, berm breaks) ▪ Caution zone signage
Monitor for potential caribou effects from the ASR, including harvest monitoring, caribou and their predators along the ASR and in relation to traffic, time, and seasons.

Mitigations and monitoring programs for both Boreal and Mountain caribou reduce the potential for adverse effects. Based on the indications that a small number of caribou occur proximal to the road, mitigations identified in the DAR to avoid and/or minimize Project-related effects remain appropriate. After considering the caribou collar data during the calving period, blasting from KP 5 – 10 and KP 40 – 50 will be scheduled to occur outside a May 1 to July 15 window (which protects caribou calving and early post-calving times), unless critical for the ASR development (not applicable for the Pioneer Winter Road which is planned outside of the calving and post-calving period). In the unlikely event that blasting is required, a pre-blast survey will be performed within visible line of sight up to 2 km from the blast location. Blasts will cease if caribou calves are observed within this search area.

The DAR acknowledged that some Northern Mountain caribou occur near the proposed ASR and assessed potential Project-related effects and outlined CZN's mitigation and monitoring plans for this species. The DAR also evaluated potential effects to Boreal caribou. Adverse effects on Northern Mountain and Boreal caribou, but assessed to have low significance, were associated with direct habitat loss, reduced habitat effectiveness (i.e., potential spills), risk of mortality from improved predator access and harvest pressure, caribou-vehicle collisions, and avoidance of the road. The DAR predicted caribou effects to be adverse overall, low in magnitude, local and moderate in geographical extent, reversible over the life of the proposed ASR, and low in significance.

Adverse change to Boreal caribou abundance was predicted to be of moderate significance in the DAR. However, since Boreal caribou have been observed only once in all the baseline aerial surveys, and the proposed ASR traverses upslope areas (as requested by the Nahanni Butte Dene Band to avoid caribou habitat east of Grainger Gap), the predicted effects on Boreal caribou abundance presented in the DAR are considered conservative.

Upon considering the new baseline information, the Northern Mountain and Boreal caribou conclusions within the DAR remain the same. In particular, the risk of caribou-vehicle collisions is predicted to be low. The camera baseline results indicate that caribou do occur proximal to the western section of the road, though the detection rate was very low (the highest monthly detection rate was 1.07 caribou detections/100 camera-days) and primarily during post-calving and fall/rut seasons. The risk of a caribou-vehicle collision is also dependent upon the traffic volumes when caribou are also proximal to the road, and traffic speeds. Seiler (2003) predicts that wildlife successfully cross higher-speed roads at the traffic volumes proposed for the ASR (estimated at 1.2 – 21.4 average annual daily haul trucks) and none would be killed. To further reduce the risk of an animal-vehicle collision, Seiler (2003) recommends speed reductions on high-speed roads. Unlike the roads used in the Seiler (2003) model, the ASR has slow traffic speeds (30-60 km/hr) which further reduces the risk of a caribou-vehicle collision.

CZN has developed monitoring programs for both Mountain and Boreal caribou for the PWR. These will be built upon for Phases 2 and 3 which include the construction and operation of the ASR. Existing monitoring for PWR includes a remote camera program for Northern Mountain caribou and a winter track program for Boreal Caribou. Additional monitoring programs, such as the animal-vehicle collision program, traffic, and harvest monitoring, are also applicable to caribou.

The overall PWR caribou monitoring program is expected to be applicable to monitoring that will occur during Phases 2 and 3. We suggest that the Northern Mountain caribou remote camera program focuses solely on monitoring of the ASR. The perpendicular camera transects provided information on caribou use in areas away from the road, but only for one of the three transects. Additional remote camera monitoring of areas away from the ASR is unlikely to inform the characterization of effects from the ASR and further mitigation given the relatively low occurrence of Northern Mountain caribou. Cameras located along the proposed ASR provide the best opportunity to detect caribou, their predators, and other ungulates that can lead to refinement of mitigation.

7.0 CLOSURE

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

Respectfully submitted,
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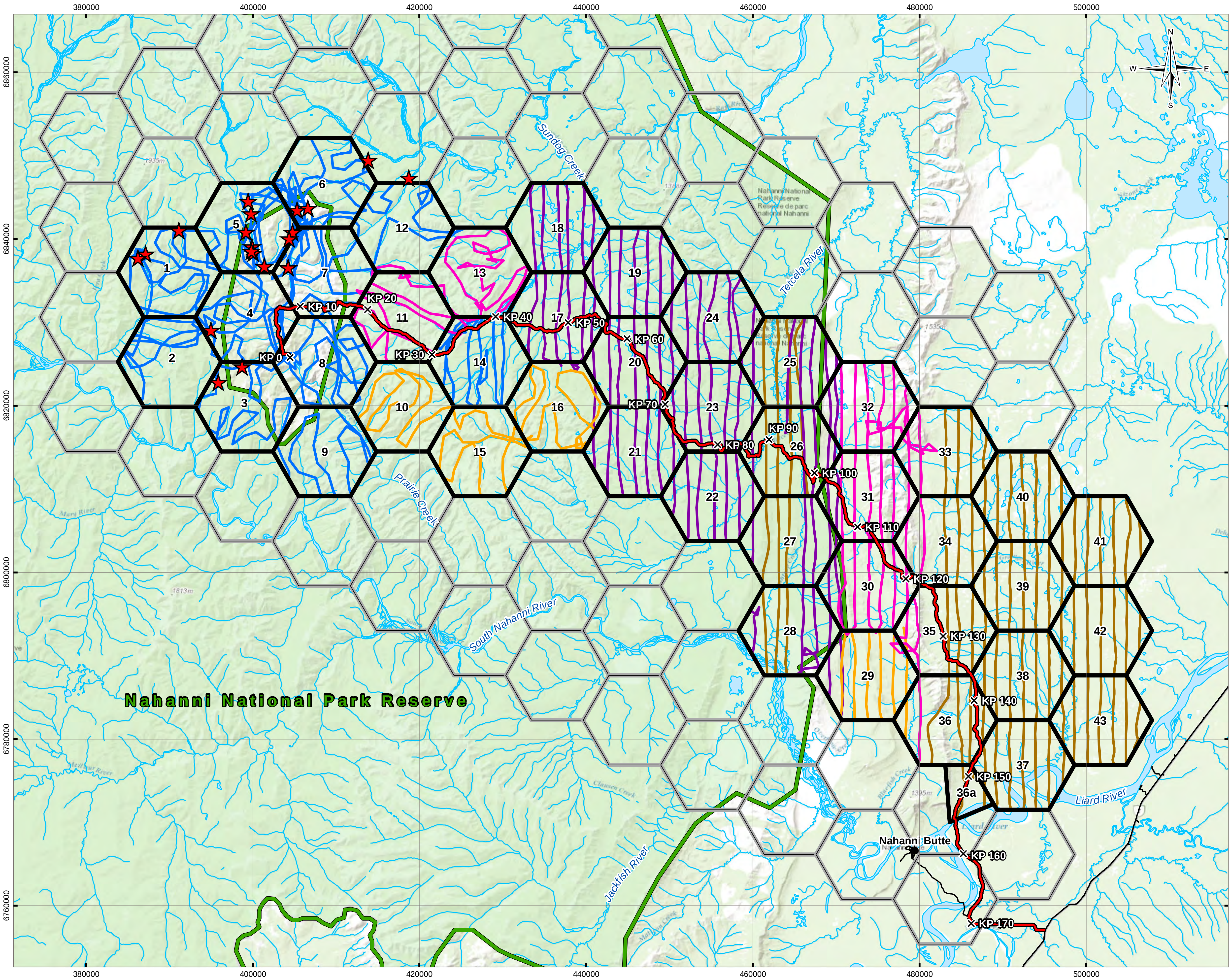
FIGURES



LEGEND

- Caribou Track Observation
- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)
- 2019 Study Area
- Golder Survey Unit (100 km² Hexagon)

Survey Tracks by Date

- March 22, 2019
- March 24, 2019
- March 27, 2019
- March 28, 2019
- March 31, 2019

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

2019 Aerial Caribou Survey

PROJECTION: UTM Zone 10	DATUM: NAD83	CLIENT: CANADIAN ZINC CORPORATION
Scale: 1:450,000 (5 2.5 0 5 Kilometres)		TETRA TECH
FILE NO.: EENW03326-02_Figure01_CaribouSurvey.mxd		
OFFICE: Tt-VANC	DWN: SL; CKD: YL; APVD: KL; REV: 0	Figure 1
DATE: August 18, 2021	PROJECT NO.: ENW.EENW03326-02	

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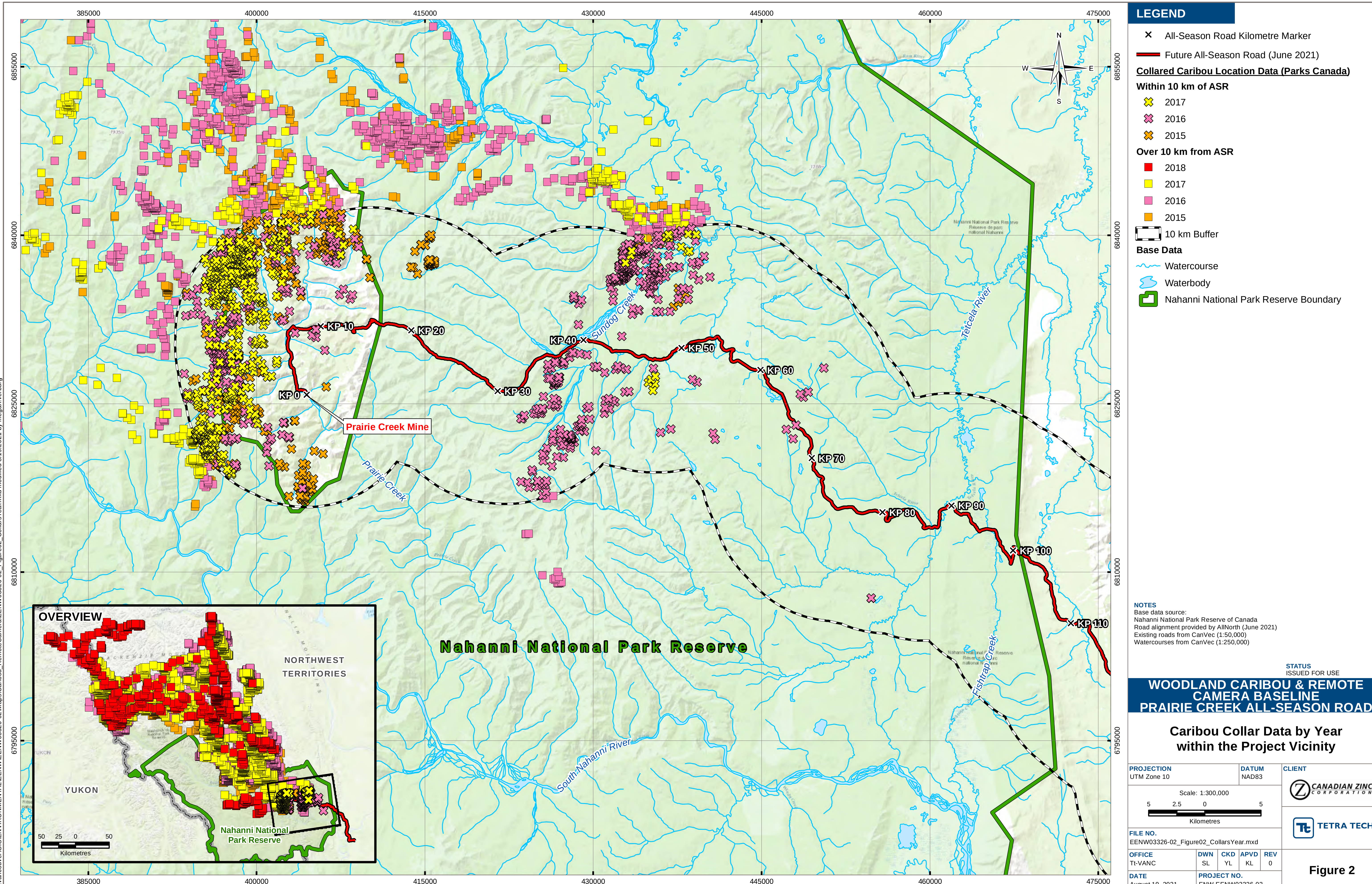
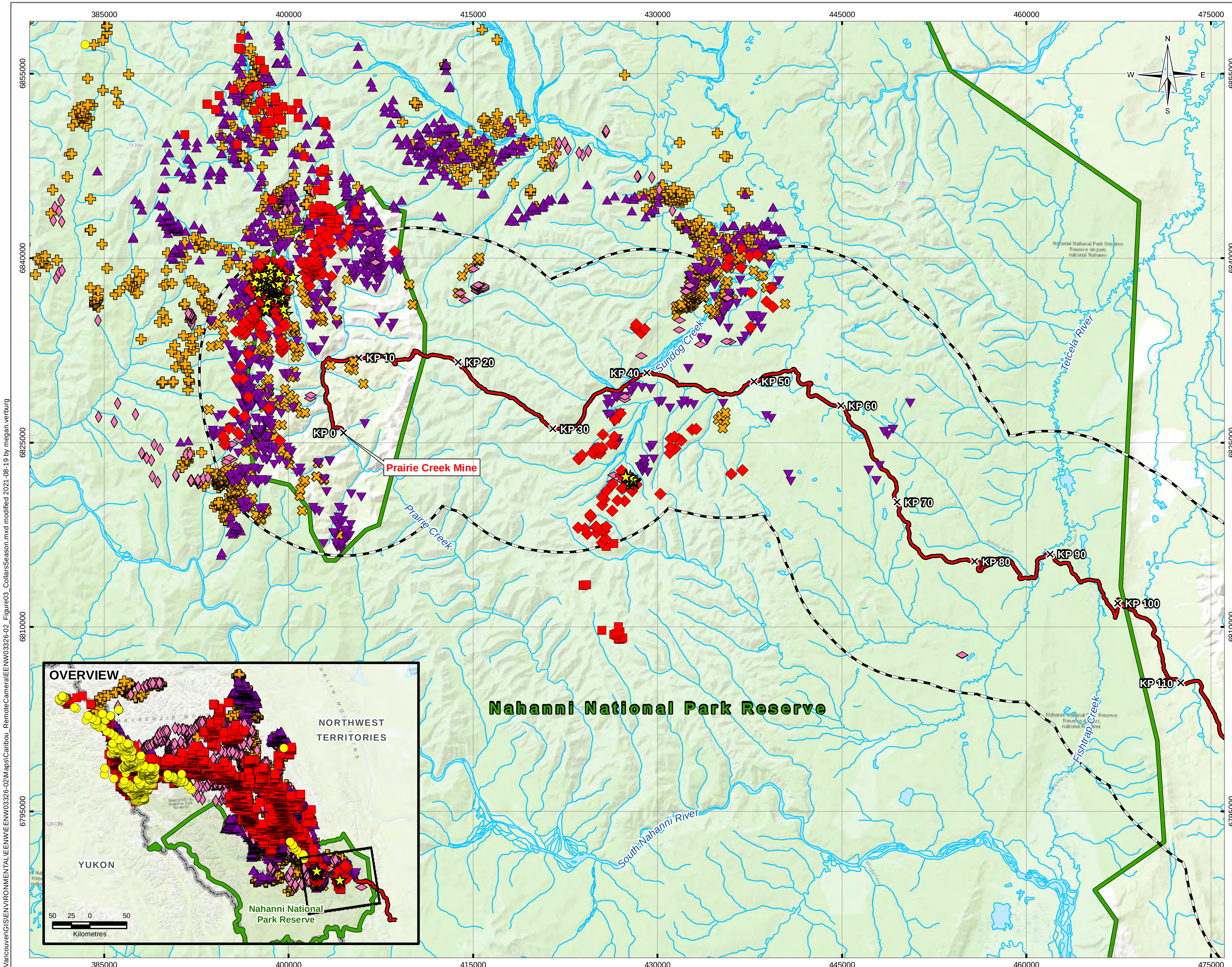


LEGEND
All-Season Road Kilometre Marker
Future All-Season Road (June 2021)
Collared Caribou Location Data (Parks Canada)
Within 10 km of ASR
2017
2016
2015
Over 10 km from ASR
2018
2017
2016
2015
10 km Buffer
Base Data
Watercourse
Waterbody
Nahanni National Park Reserve Boundary
NOTES
Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
STATUS
ISSUED FOR USE
WOODLAND CARIBOU & REMOTE CAMERA BASELINE
PRAIRIE CREEK ALL-SEASON ROAD
Caribou Collar Data by Year within the Project Vicinity
PROJECTION
UTM Zone 10
DATUM
NAD83
CLIENT
CANADIAN ZINC CORPORATION
Scale: 1:300,000
5 2.5 0 5
Kilometres
FILE NO.
EENW03326-02_Figure02_CollarsYear.mxd
TETRA TECH
OFFICE
Tt-VANC
DWN
SL
CKD
YL
APVD
KL
REV
0
DATE
August 19, 2021
PROJECT NO.
ENW.EENW03326-02
Figure 2
Nahanni National Park Reserve
Prairie Creek Mine
KP 0
KP 10
KP 20
KP 30
KP 40
KP 50
KP 60
KP 70
KP 80
KP 90
KP 100
KP 110
Sundog Creek
Prairie Creek
Tetcela River
Fishtrap Creek
South Nahanni River
OVERVIEW
NORTHWEST TERRITORIES
YUKON
Nahanni National Park Reserve
50 25 0 50
Kilometres
385000
400000
415000
430000
445000
460000
475000
6855000
6840000
6825000
6810000
6795000
Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure02_CollarsYear.mxd modified 8/19/2021 by megan.verburg



LEGEND

- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Collared Caribou Location Data (Parks Canada)

Within 10 km of ASR

- Winter (Jan 1 - Apr 15)
- Spring (Apr 16 - May 20)
- Calving (May 21 - Jun 5)
- Post-calving (Jun 6 - Sep 24)
- Fall/rut (Sep 25 - Dec 31)

Over 10 km from ASR

- Winter (Jan 1 - Apr 15)
- Spring (Apr 16 - May 20)
- Calving (May 21 - Jun 5)
- Post-calving (Jun 6 - Sep 24)
- Fall/rut (Sep 25 - Dec 31)
- 10 km Buffer

Base Data

- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES
Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Caribou Collar Data by Season within the Project Vicinity

PROJECTION: UTM Zone 10
DATUM: NAD83
CLIENT: CANADIAN ZINC CORPORATION

Scale: 1:300,000
5 2.5 0 5
Kilometres

TETRA TECH

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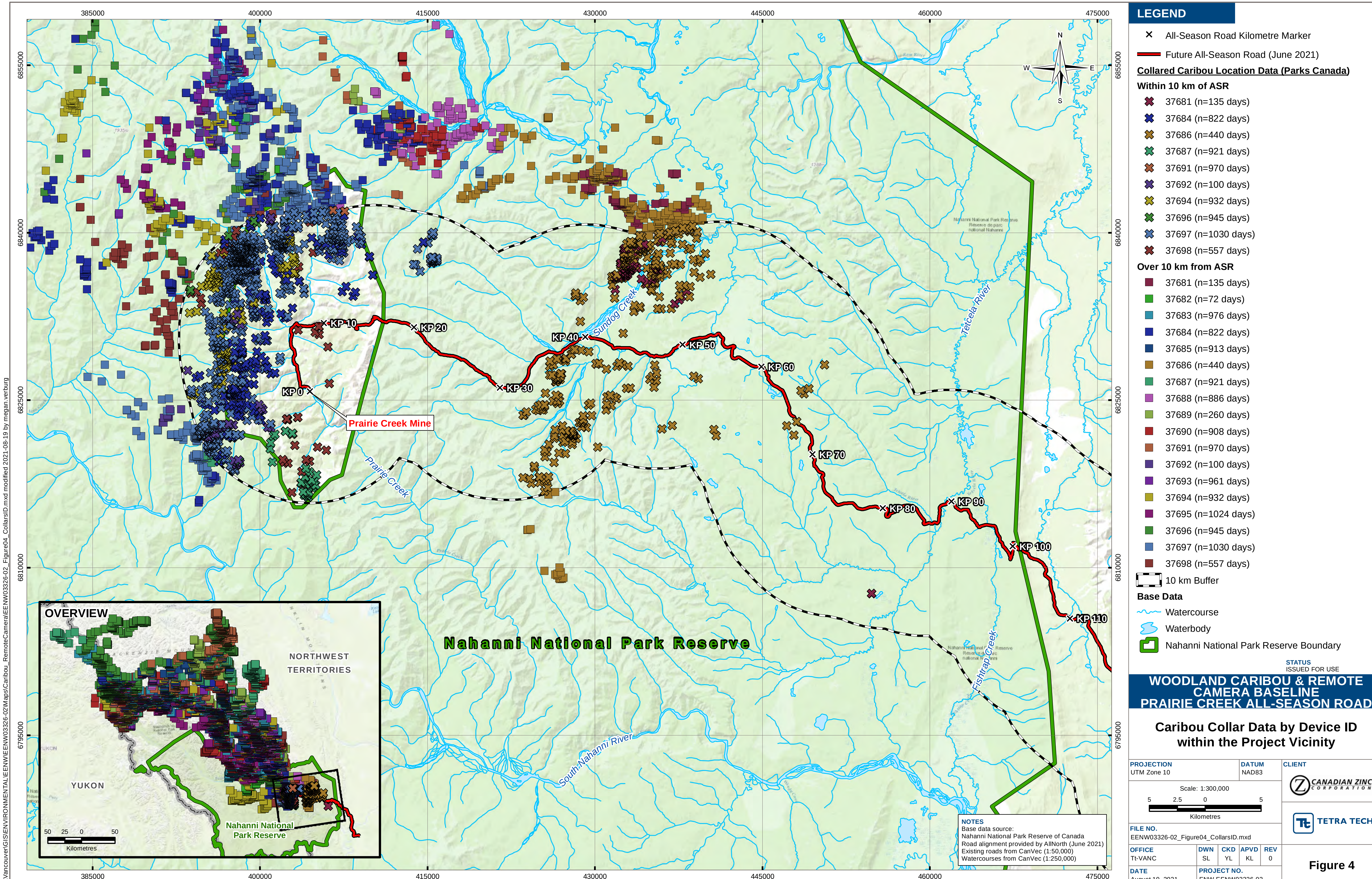
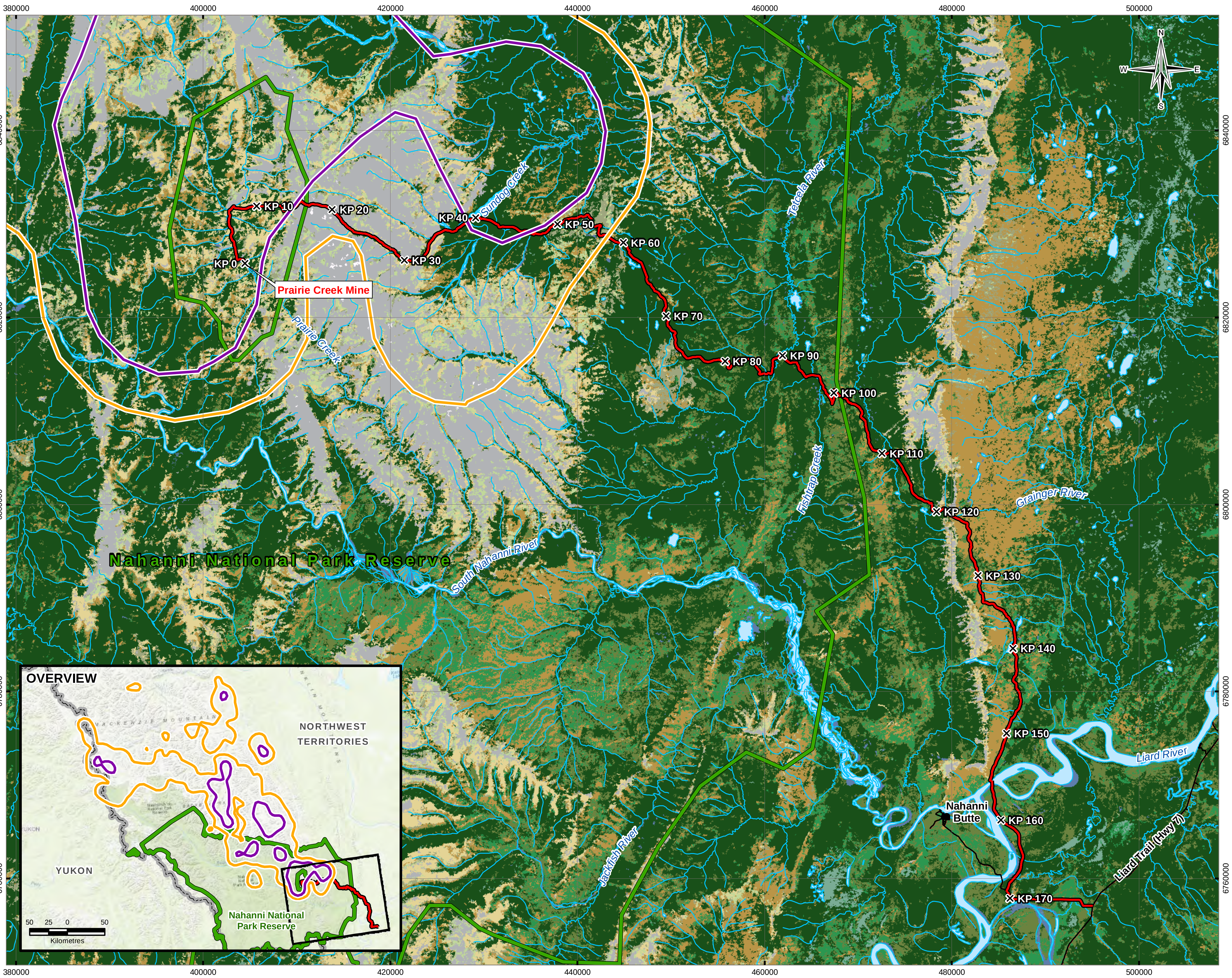
Tt-VANC	SL	YL	KL	0

DATE: August 19, 2021
PROJECT NO.: ENW.EENW03326-02

Figure 3


LEGEND
All-Season Road Kilometre Marker
Future All-Season Road (June 2021)
Collared Caribou Location Data (Parks Canada)
Within 10 km of ASR
37681 (n=135 days)
37684 (n=822 days)
37686 (n=440 days)
37687 (n=921 days)
37691 (n=970 days)
37692 (n=100 days)
37694 (n=932 days)
37696 (n=945 days)
37697 (n=1030 days)
37698 (n=557 days)
Over 10 km from ASR
37681 (n=135 days)
37682 (n=72 days)
37683 (n=976 days)
37684 (n=822 days)
37685 (n=913 days)
37686 (n=440 days)
37687 (n=921 days)
37688 (n=886 days)
37689 (n=260 days)
37690 (n=908 days)
37691 (n=970 days)
37692 (n=100 days)
37693 (n=961 days)
37694 (n=932 days)
37695 (n=1024 days)
37696 (n=945 days)
37697 (n=1030 days)
37698 (n=557 days)
10 km Buffer
Base Data
Watercourse
Waterbody
Nahanni National Park Reserve Boundary
Nahanni National Park Reserve
Prairie Creek Mine
KP 0
KP 10
KP 20
KP 30
KP 40
KP 50
KP 60
KP 70
KP 80
KP 90
KP 100
KP 110
Sundog Creek
Prairie Creek
Tetcela River
Fishtrap Creek
South Nahanni River
OVERVIEW
NORTHWEST TERRITORIES
YUKON
Nahanni National Park Reserve
Kilometres
NOTES
Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
STATUS
ISSUED FOR USE
WOODLAND CARIBOU & REMOTE CAMERA BASELINE
PRAIRIE CREEK ALL-SEASON ROAD
Caribou Collar Data by Device ID within the Project Vicinity
PROJECTION UTM Zone 10
DATUM NAD83
CLIENT
CANADIAN ZINC CORPORATION
Scale: 1:300,000
Kilometres
FILE NO. EENW03326-02_Figure04_CollarsID.mxd
TETRA TECH
OFFICE Tt-VANC
DWN SL
CKD YL
APVD KL
REV 0
DATE August 19, 2021
PROJECT NO. ENW.EENW03326-02
Figure 4
Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure04_CollarsID.mxd modified 2021-08-19 by megan.verburg



Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure05_KDE_All.mxd modified 2021-08-18 by megan.verburg

LEGEND

- ✕ All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Kernel Density Estimation Results

- 50% KDE Home Range
- 95% KDE Home Range

Land Cover Class (30 m)

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Temperate or sub-polar shrubland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Wetland
- Barren land
- Urban and built-up
- Water
- Snow and ice

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
Land Cover from NALCMS (2010)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Kernel Density Estimation (KDE) (All Caribou, All Years, All Seasons) within the Project Vicinity

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:400,000

5 2.5 0 5
Kilometres

FILE NO. EENW03326-02_Figure05_KDE_All.mxd

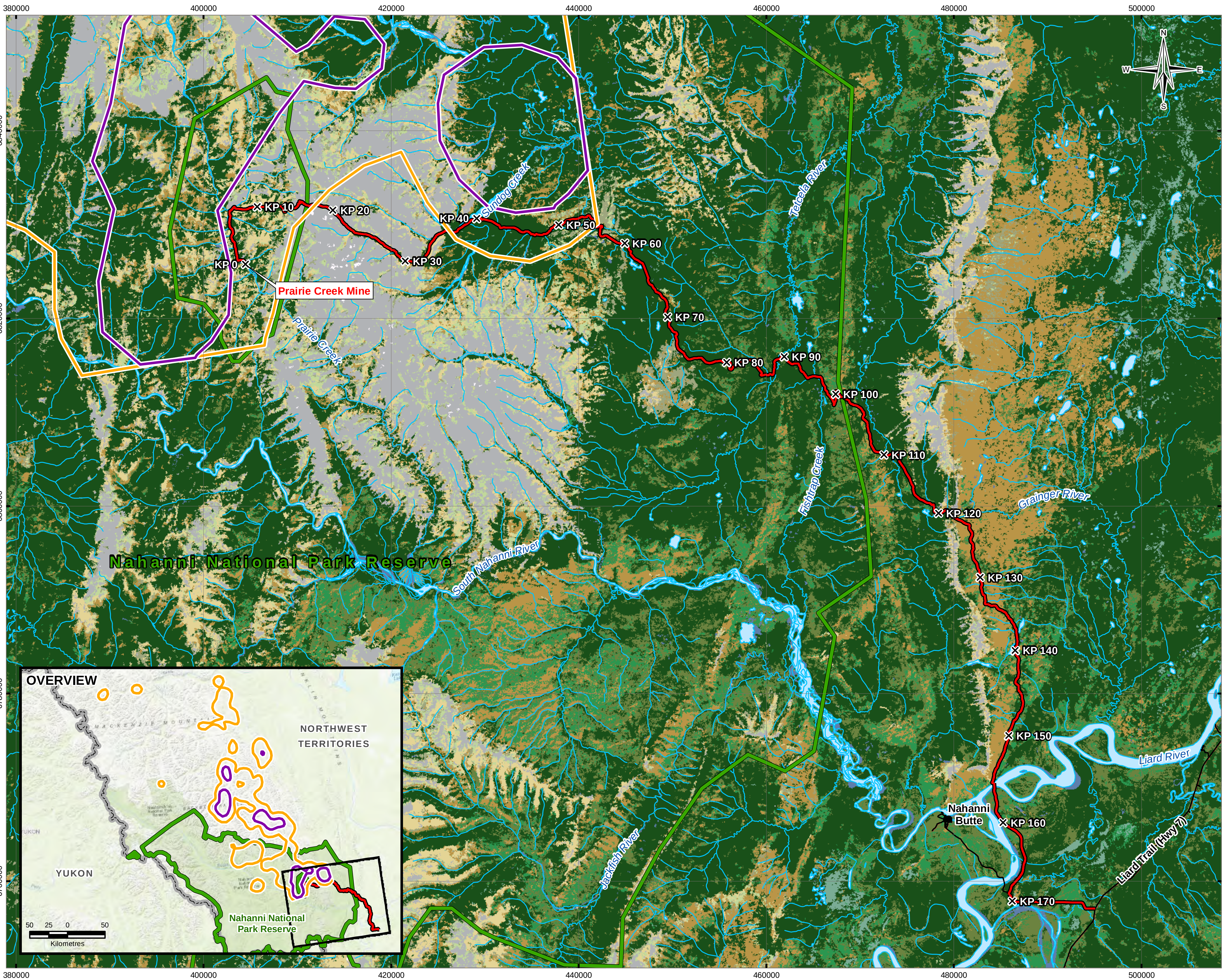
TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	KL	0

DATE August 18, 2021

PROJECT NO. ENW.EENW03326-02

Figure 5



LEGEND

- ✕ All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Kernel Density Estimation Results (Winter)

- 50% KDE Home Range
- 95% KDE Home Range

Land Cover Class (30 m)

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Temperate or sub-polar shrubland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Wetland
- Barren land
- Urban and built-up
- Water
- Snow and ice

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES
Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
Land Cover from NALCMS (2010)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Kernel Density Estimation (KDE) (All Caribou, All Years, Winter) within the Project Vicinity

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:400,000
5 2.5 0 5
Kilometres

TETRA TECH

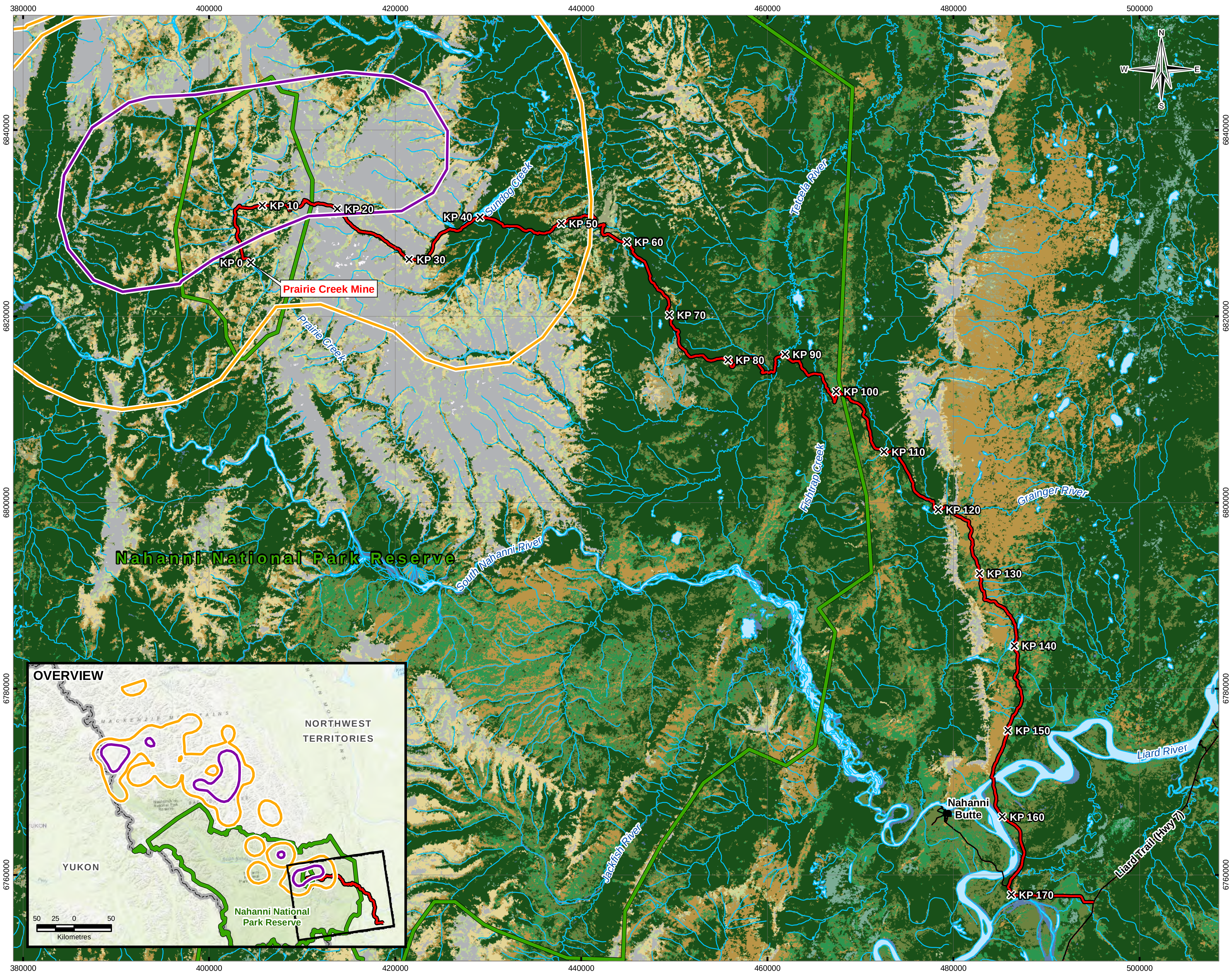
FILE NO.
EENW03326-02_Figure06a_KDE_Winter.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	KL	0

DATE	PROJECT NO.
August 18, 2021	ENW.EENW03326-02

Figure 6a

Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure06a_KDE_Winter.mxd modified 2021-08-18 by megan.verburg



LEGEND

- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Kernel Density Estimation Results (Spring)

- 50% KDE Home Range
- 95% KDE Home Range

Land Cover Class (30 m)

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Temperate or sub-polar shrubland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Wetland
- Barren land
- Urban and built-up
- Water
- Snow and ice

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
Land Cover from NALCMS (2010)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Kernel Density Estimation (KDE) (All Caribou, All Years, Spring) within the Project Vicinity

PROJECTION UTM Zone 10 | **DATUM** NAD83 | **CLIENT** CANADIAN ZINC CORPORATION

Scale: 1:400,000
5 2.5 0 5
Kilometres

TETRA TECH

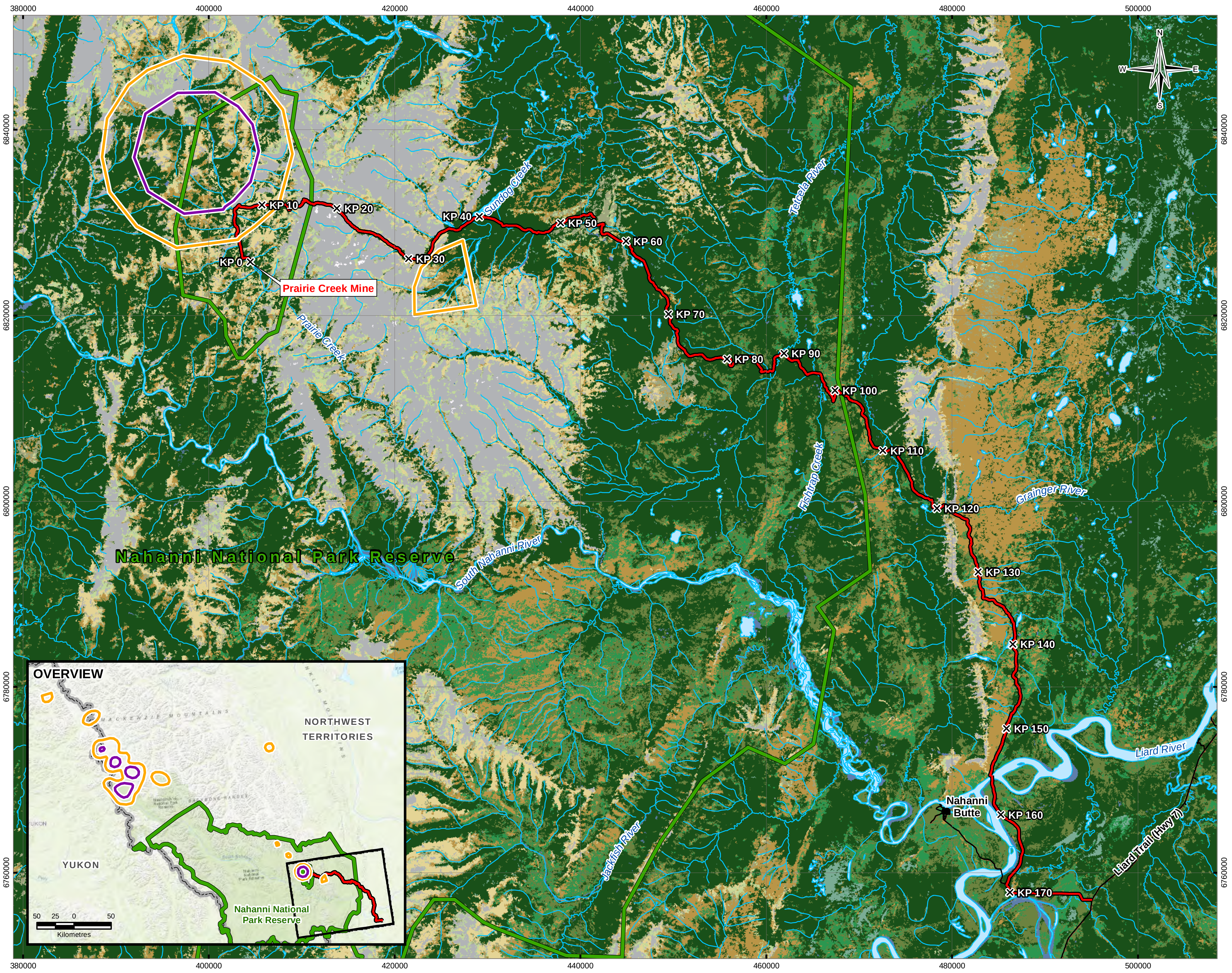
FILE NO. EENW03326-02_Figure06b_KDE_Spring.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	KL	0

DATE August 19, 2021
PROJECT NO. ENW.EENW03326-02

Figure 6b

Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure06b_KDE_Spring.mxd modified 2021-08-19 by megan.verburg



Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure06c_KDE_Calving.mxd modified 2021-08-19 by megan.verburg

LEGEND

- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Kernel Density Estimation Results (Calving)

- 50% KDE Home Range
- 95% KDE Home Range

Land Cover Class (30 m)

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Temperate or sub-polar shrubland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Wetland
- Barren land
- Urban and built-up
- Water
- Snow and ice

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
Land Cover from NALCMS (2010)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Kernel Density Estimation (KDE) (All Caribou, All Years, Calving) within the Project Vicinity

PROJECTION UTM Zone 10
DATUM NAD83
CLIENT CANADIAN ZINC CORPORATION

Scale: 1:400,000
5 2.5 0 5
Kilometres

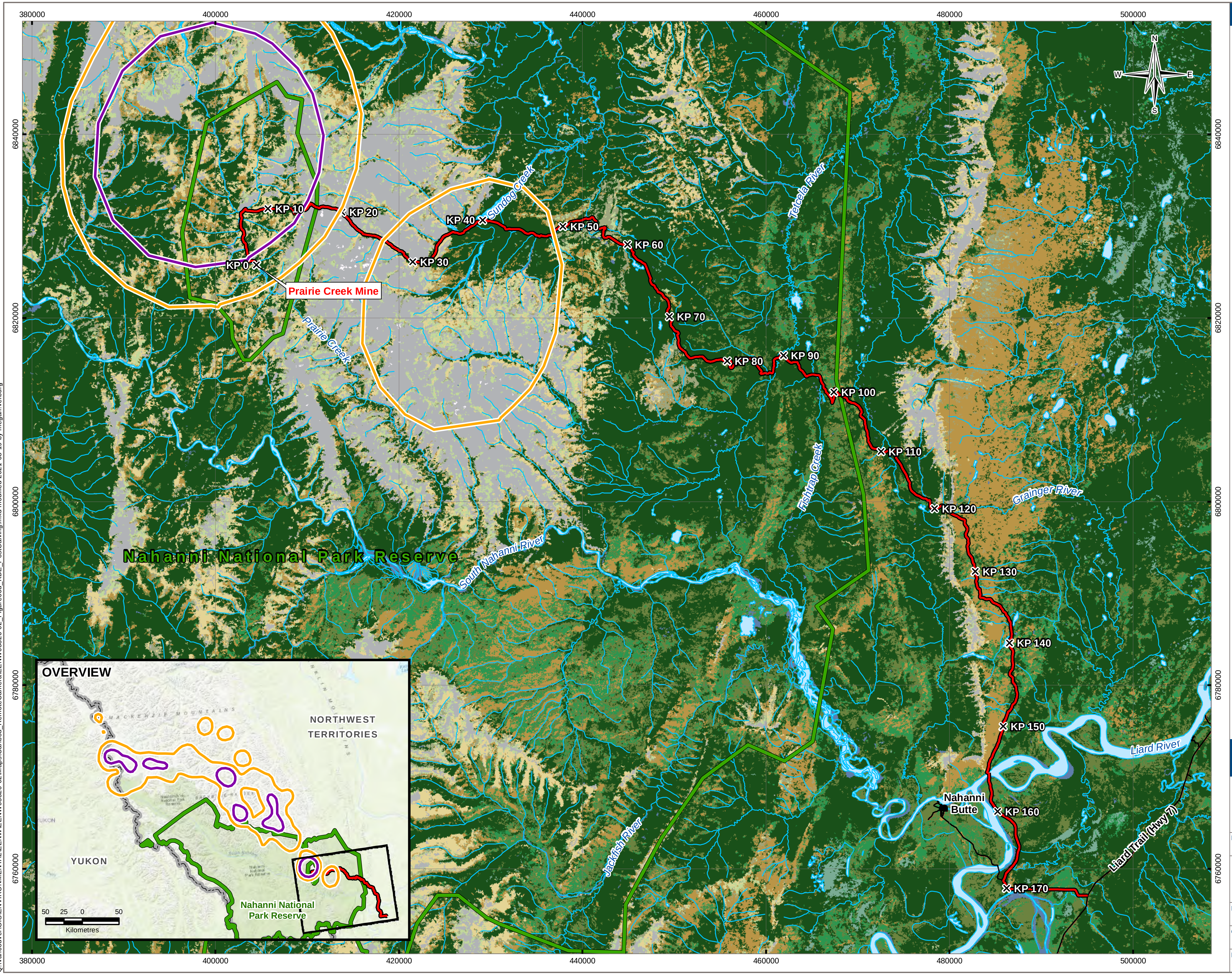
TETRA TECH

FILE NO. EENW03326-02_Figure06c_KDE_Calving.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	KL	0

DATE August 19, 2021
PROJECT NO. ENW.EENW03326-02

Figure 6c



LEGEND

- ✕ All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Kernel Density Estimation Results (Post-calving)

- 50% KDE Home Range
- 95% KDE Home Range

Land Cover Class (30 m)

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Temperate or sub-polar shrubland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Wetland
- Barren land
- Urban and built-up
- Water
- Snow and ice

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
Land Cover from NALCMS (2010)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Kernel Density Estimation (KDE) (All Caribou, All Years, Post-calving) within the Project Vicinity

PROJECTION UTM Zone 10

DATUM NAD83

CLIENT Canadian Zinc Corporation

Scale: 1:400,000
5 2.5 0 5
Kilometres

FILE NO. EENW03326-02_Figure06d_KDE_PostCalving.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	KL	0

DATE August 19, 2021

PROJECT NO. ENW.EENW03326-02

TETRA TECH

Figure 6d

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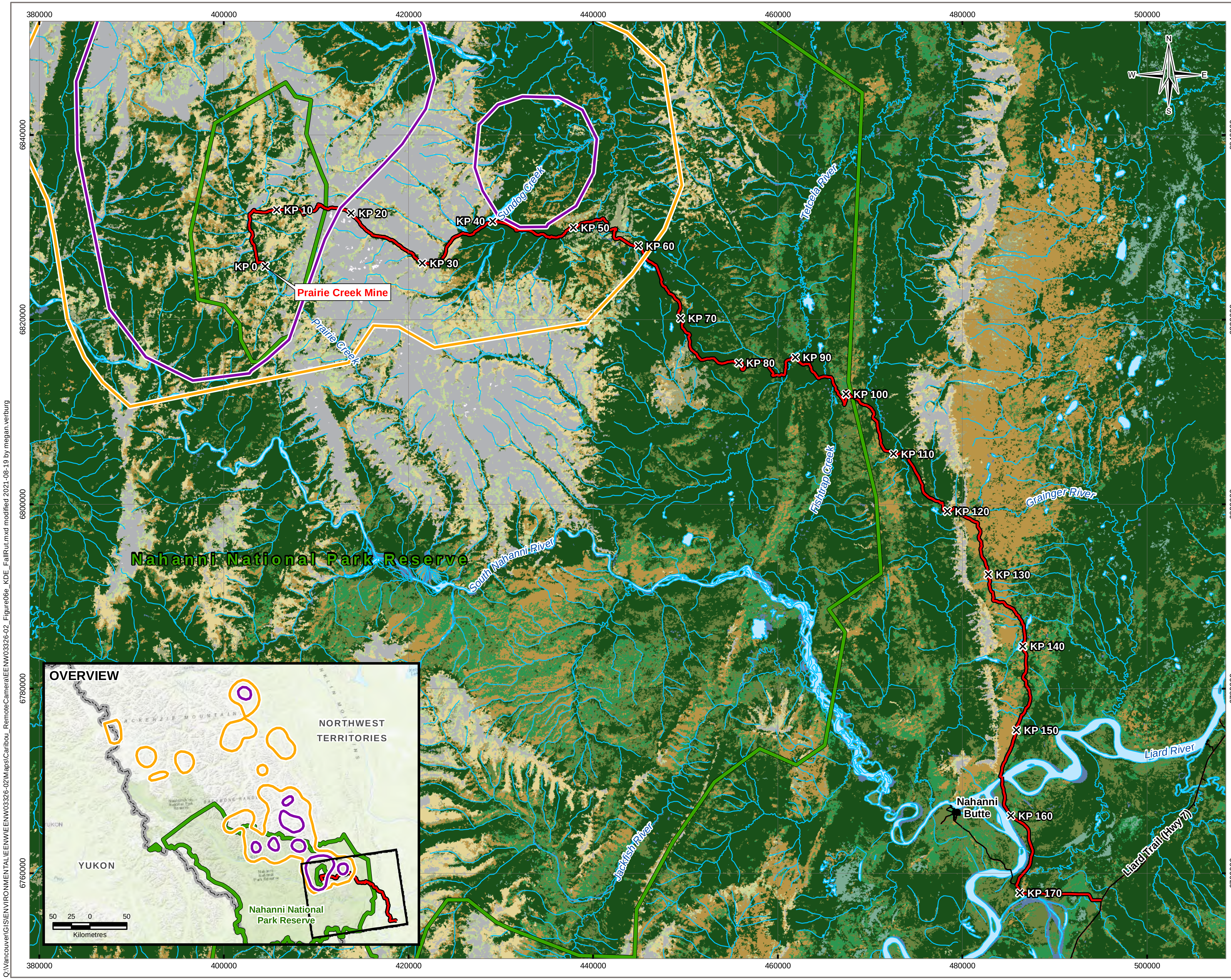


LEGEND

- All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Kernel Density Estimation Results (Fall/Rut)

- 50% KDE Home Range
- 95% KDE Home Range

Land Cover Class (30 m)

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Temperate or sub-polar shrubland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Wetland
- Barren land
- Urban and built-up
- Water
- Snow and ice

Base Data

- Community
- Existing Road
- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Existing roads from CanVec (1:50,000)
Watercourses from CanVec (1:250,000)
Land Cover from NALCMS (2010)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Kernel Density Estimation (KDE) (All Caribou, All Years, Fall/Rut) within the Project Vicinity

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:400,000
5 2.5 0 5
Kilometres

TETRA TECH

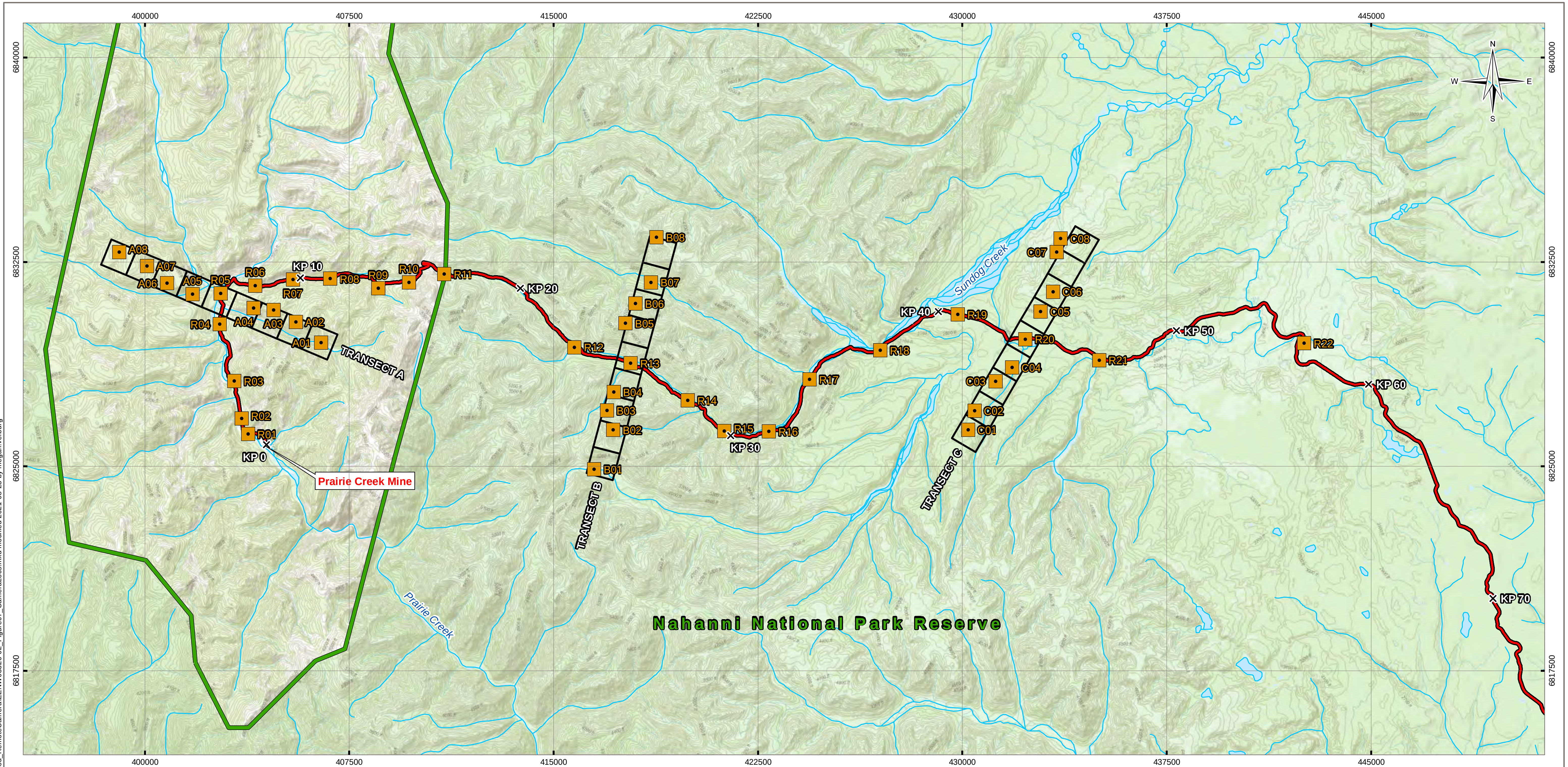
FILE NO. EENW03326-02_Figure06e_KDE_FallRut.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	YL	KL	0

DATE August 19, 2021

PROJECT NO. ENW.EENW03326-02

Figure 6e



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LEGEND

- Camera Location
- Camera Survey Transect
- × All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Base Data

- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES
Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Watercourses from CanVec (1:250,000)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Remote Camera Locations

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:140,000
2 1 0 2
Kilometres

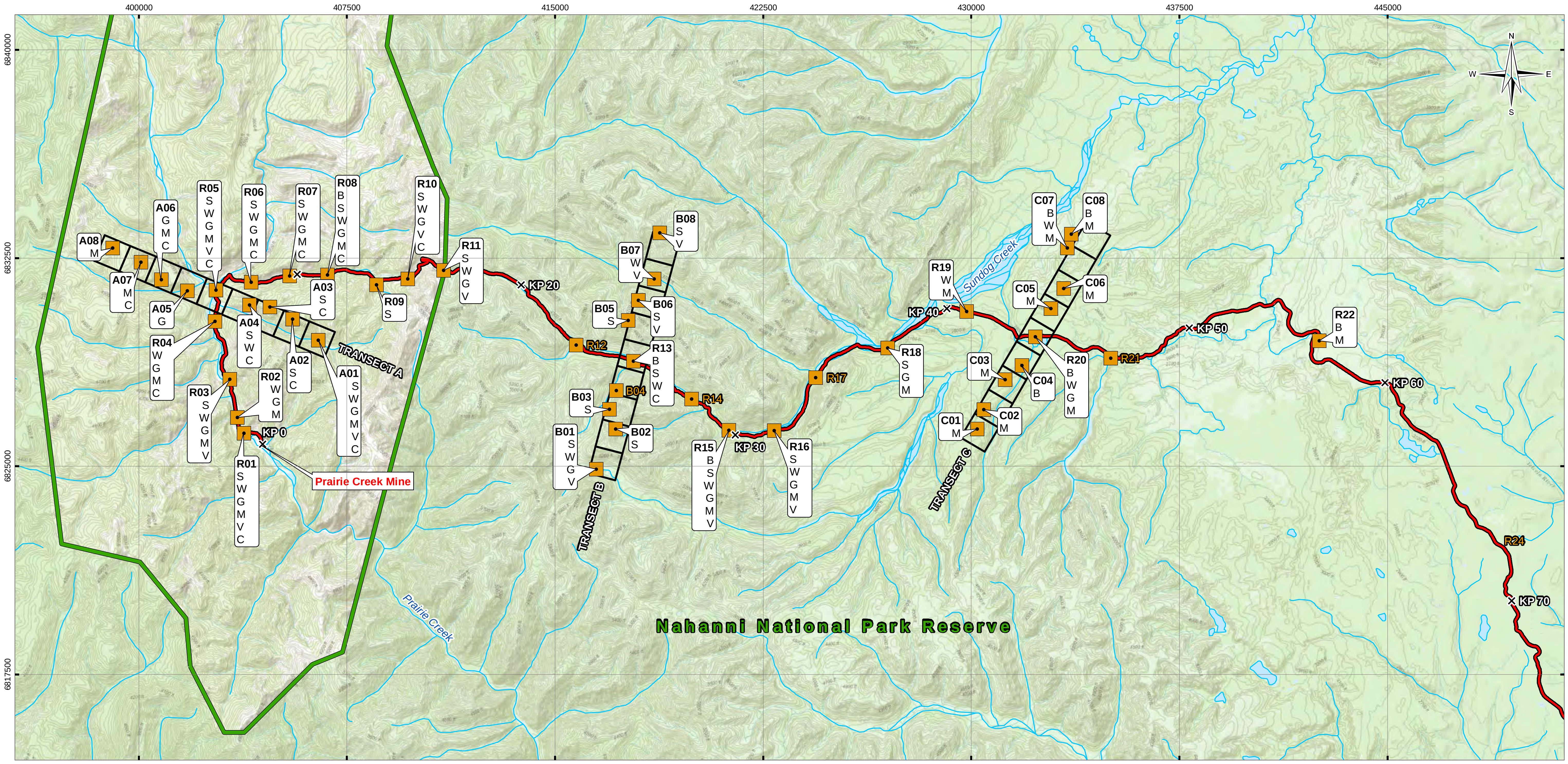
FILE NO.
EENW03326-02_Figure07_CameraLocs.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0

DATE	PROJECT NO.
August 23, 2021	ENW.EENW03326-02

Figure 7



LEGEND

- Camera Location
- Camera Survey Transect
- × All-Season Road Kilometre Marker
- Future All-Season Road (June 2021)

Base Data

- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

Common Name	Map Code
Black Bear	B
Dall's Sheep	S
Gray Wolf	W
Grizzly Bear	G
Moose	M
Wolverine	V
Woodland Caribou	C

NOTES
Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Watercourses from CanVec (1:250,000)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Remote Camera Detections of Focal Species

PROJECTION: UTM Zone 10
DATUM: NAD83
CLIENT: CANADIAN ZINC CORPORATION

Scale: 1:140,000
2 1 0 2
Kilometres

TETRA TECH

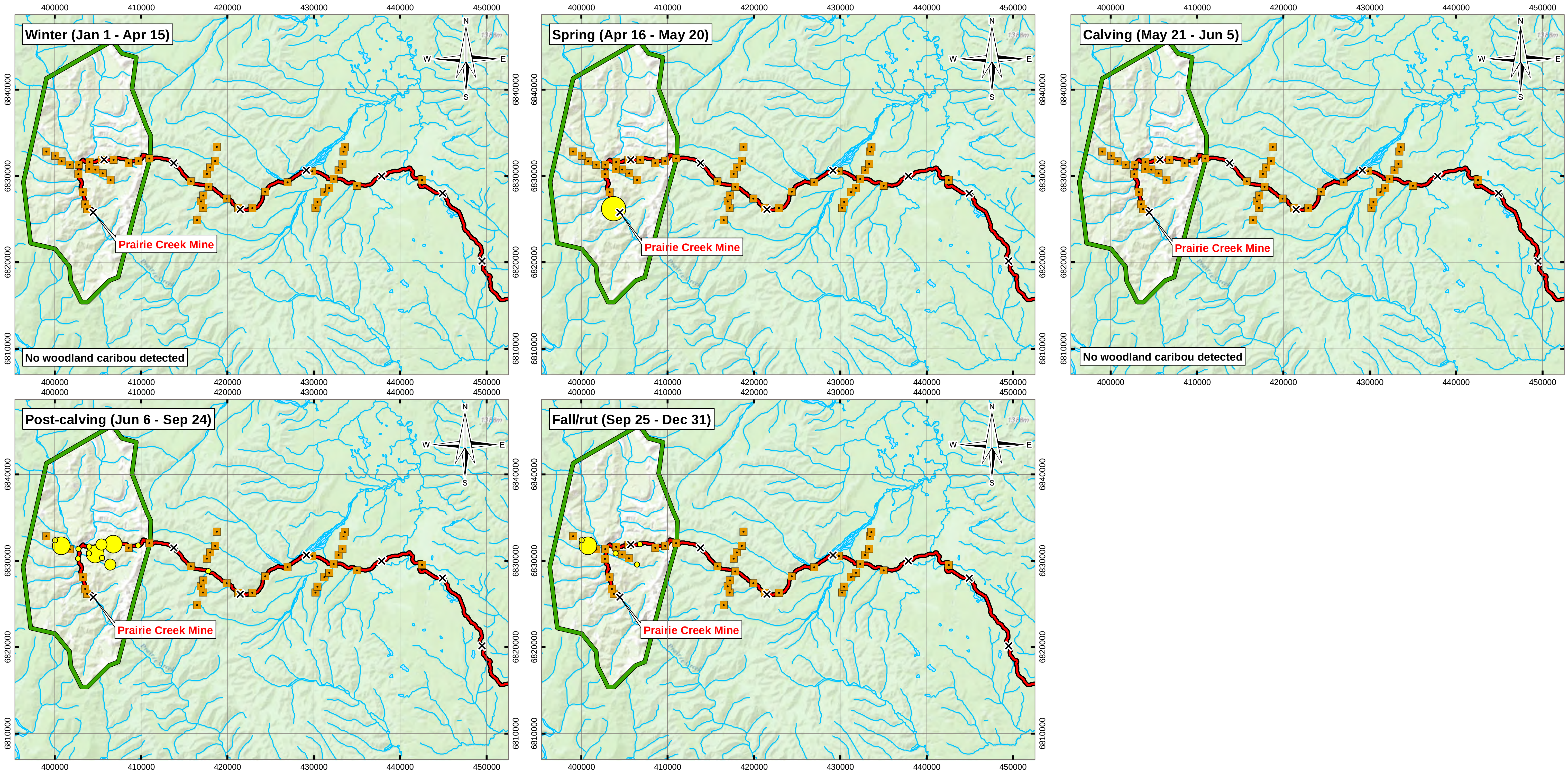
FILE NO.: EENW03326-02_Figure08_CameraDetections.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0

DATE: August 23, 2021
PROJECT NO.: ENW.EENW03326-02

Figure 8

Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure08_CameraDetections.mxd modified 2021-08-23 by megan.verburg



Q:\Vancouver\GIS\ENVIRONMENTAL\EENW\EENW03326-02\Maps\Caribou_RemoteCamera\EENW03326-02_Figure09_DetectionRate.mxd modified 2021-08-23 by megan.verburg

LEGEND

Camera Location

Relative Abundance Index (Detections per 100 Camera-days)

- 0 - 2
- 2 - 4
- 4 - 6
- >6
- No Woodland Caribou Detected

All-Season Road Kilometre Marker

Future All-Season Road (June 2021)

Base Data

- Watercourse
- Waterbody
- Nahanni National Park Reserve Boundary

NOTES

Base data source:
Nahanni National Park Reserve of Canada
Road alignment provided by AllNorth (June 2021)
Watercourses from CanVec (1:250,000)

STATUS
ISSUED FOR USE

WOODLAND CARIBOU & REMOTE CAMERA BASELINE PRAIRIE CREEK ALL-SEASON ROAD

Remote Camera Caribou Detection Rate by Caribou Season

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CANADIAN ZINC CORPORATION

Scale: 1:450,000
5 2.5 0 5
Kilometres

FILE NO.				
EENW03326-02_Figure09_DetectionRate.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MRV	SL	KL	0
DATE	PROJECT NO.			
August 23, 2021	ENW.EENW03326-02			

TETRA TECH

Figure 9

PHOTOGRAPHS

Photo 1: Closeup of the forested cover near KP 147 on March 22, 2019 at 11:00 am

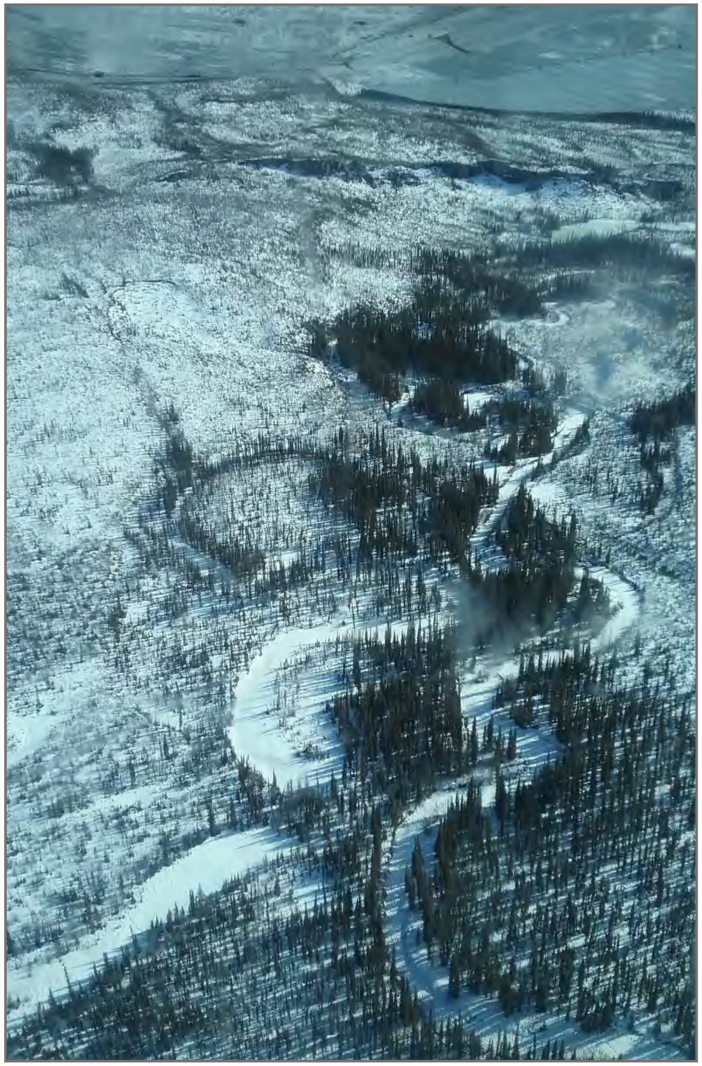


Photo 2: Aerial view of Poljie Creek on March 24, 2019 at 15:50 pm

Photo 3: Aerial view of Fishtrap Creek on March 24, 2019 at 16:48 pm

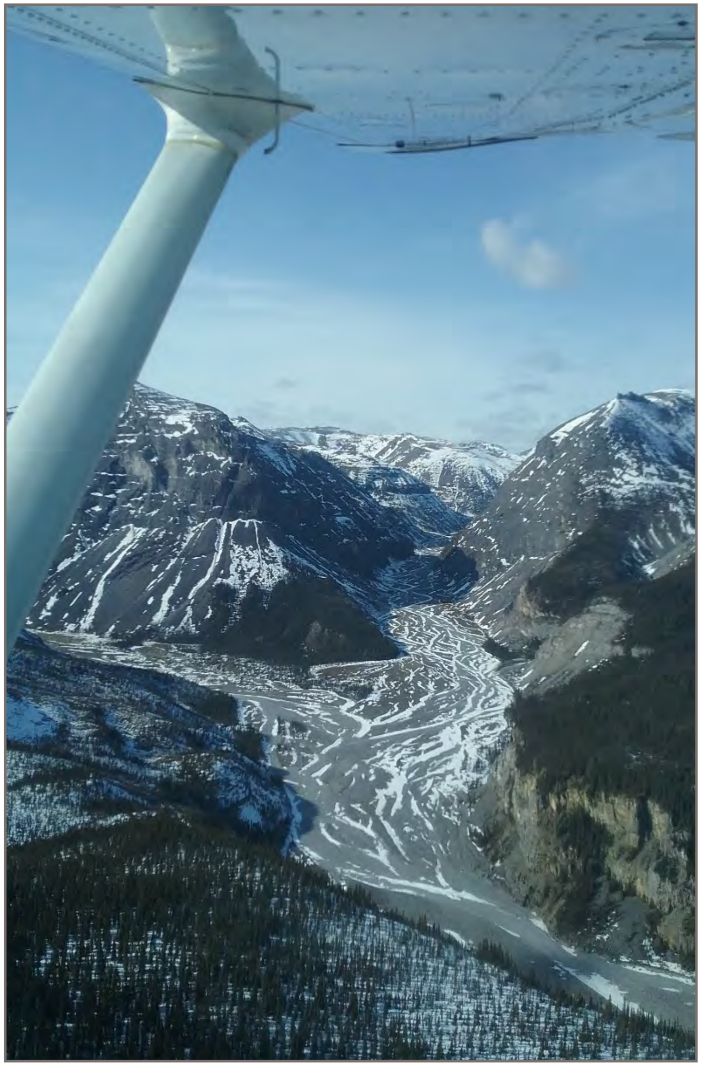


Photo 4: Sundog Creek valley on March 24, 2019 at 16:00 pm

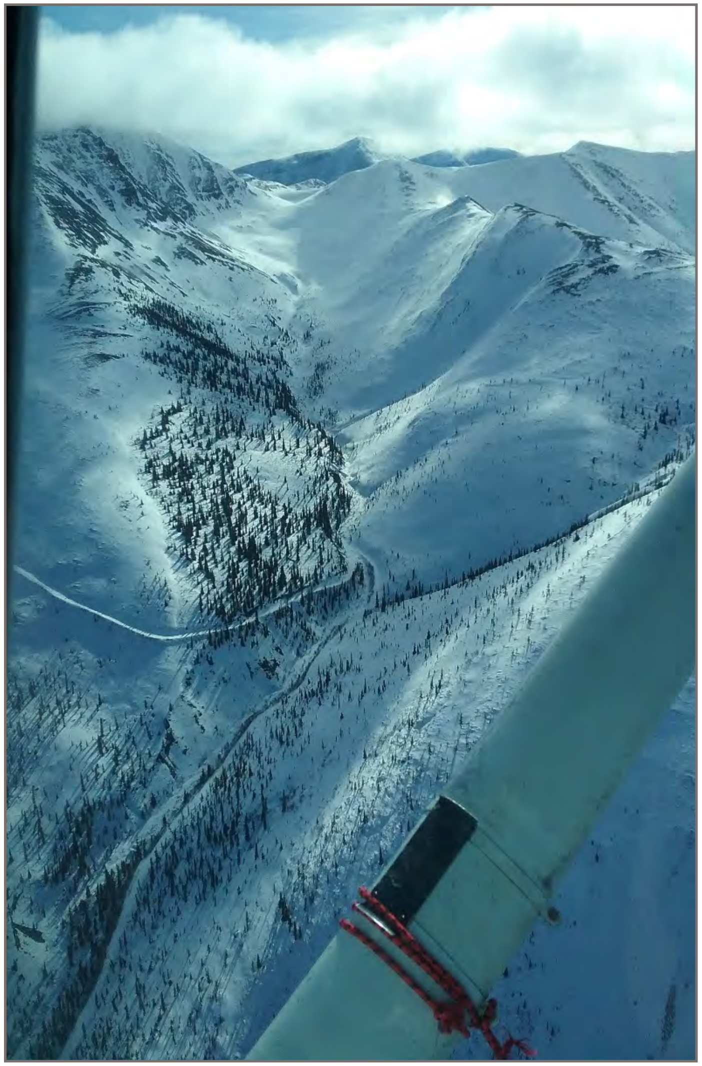


Photo 5: Funeral Creek and existing 1980s winter road near KP 15 on March 27, 2019 at 12:22 pm

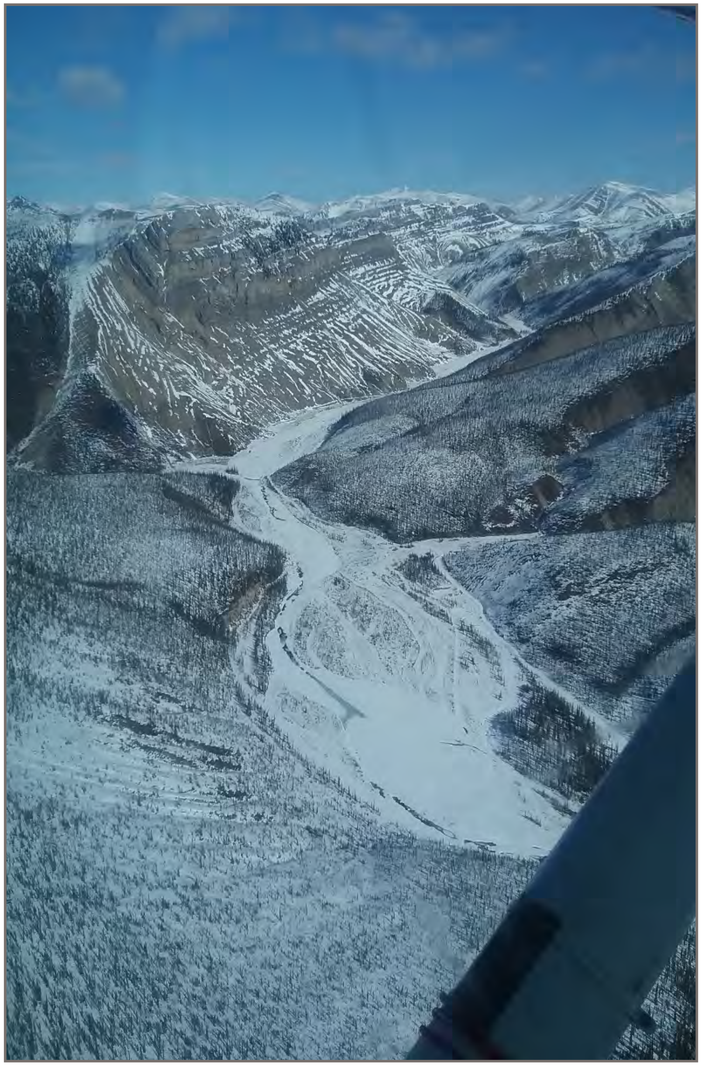


Photo 6: Confluence of Prairie, Funeral, and Casket creeks on March 27, 2019 at 13:35 pm

Photo 7: View in the mountain strata near KP 25 on March 31, 2019 at 12:07 pm

Photo 8: Lower Sundog Creek area (previous burn area) north of KP 40 on March 31, 2019 at 12:20 pm

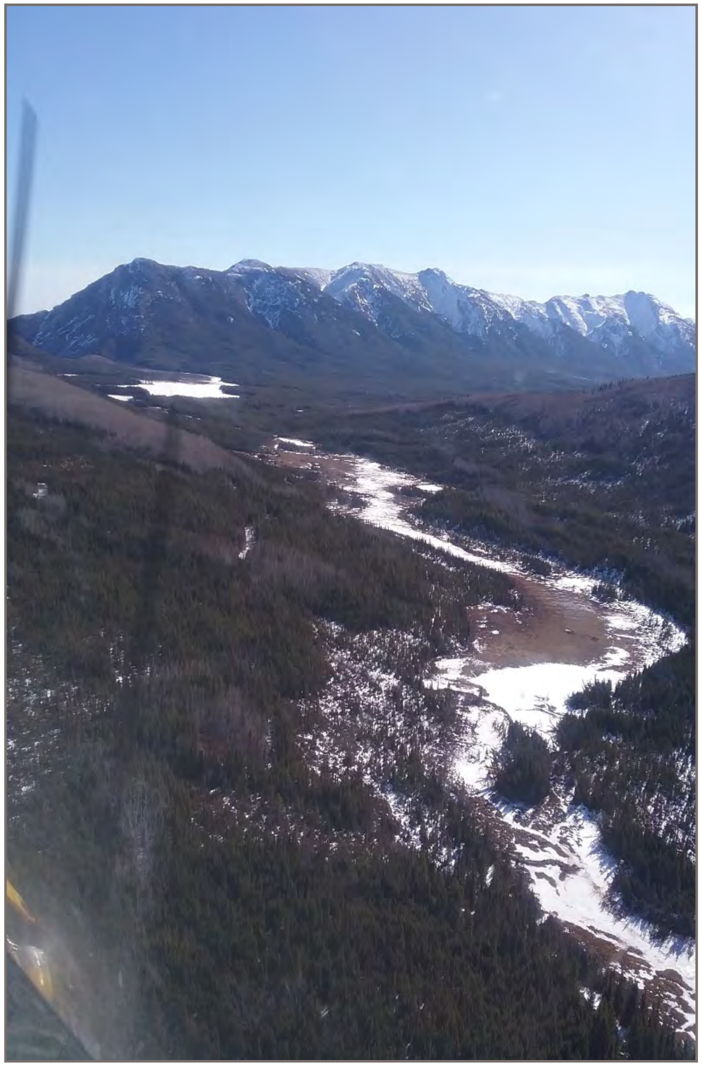


Photo 9: Looking south along the western slopes near Grainger Gap (near KP 120) on March 31, 2019 at 13:15 pm

APPENDIX A

GOLDER (2019) REMOTE CAMERA DESIGN

TECHNICAL MEMORANDUM

DATE July 10, 2019 **Project No.** 19123984

TO Sarah Arnold, Danielle Thompson
Parks Canada, Yellowknife Field Office

CC Dave Harpley, Karla Langlois

FROM Dan Coulton, Paula Bentham

CAMERA STUDY DESIGN FOR PRAIRIE CREEK ALL-WEATHER ROAD

Measure 6-1, Part 2 of the Mackenzie Valley's Report on Environmental Assessment for the Prairie Creek All Season Road Project (Project), requires Canadian Zinc Corporation (CZC) to submit a baseline survey plan for review and approval to Parks Canada within the Nahanni National Park Reserve (NNPR) and to the Government of the Northwest Territories on territorial lands. Golder Associates Ltd. (Golder) was contracted by CZC to provide technical support in preparation of a remote camera monitoring plan for caribou within the NNPR following engagement with Parks Canada.

Monitoring Objectives

Golder and Tetra Tech met with Parks Canada on June 5, 2019 in Yellowknife. At this meeting Parks Canada indicated key concerns for the Project included how the road (and traffic) will affect caribou including vehicle collisions leading to injury or mortality, altering movement patterns, use by predators and improvements to human access disturbances (indirect effects and mortality) relative to existing conditions. It was agreed that the intent of the remote camera monitoring should be to inform mitigation and adaptive management of the Project to minimize impacts to caribou and other wildlife.

The following are the proposed primary objectives of the remote camera study design.

1) Identify areas, times and seasons when caribou may interact with the Project to inform the application of operational mitigation.

2) Measure changes to caribou seasonal movements from calving/summer to wintering areas associated with the Project using before-after-control-impact design.

3) Measure changes in access by predators and from human use from the Project.

In addition to the objectives for monitoring caribou, the remote cameras will capture images of other wildlife including predators (bears, wolves, lynx), other ungulates (moose, Dall's sheep, wood bison), furbearers (fisher, wolverine), some birds (waterfowl). Where these wildlife species may have similar monitoring objectives as caribou, then the monitoring design presented here may capture other wildlife interactions and movements relative to the Project. Changes to the proposed design to address other wildlife specifically would likely result in fewer cameras along the Project alignment, which will be the most informative to mitigation placement and effectiveness for caribou.

Golder Associates Ltd.
2nd floor, 3795 Carey Road, Victoria, British Columbia, V8Z 6T8, Canada T: +1 250 881 7372 F: +1 250 881 7470

Methods

Fifty cameras will be deployed in locations along and around the Project that will provide metrics to meet these objectives. In order to measure change prescribed in the monitoring objectives, the study will follow a Before-After-Control-Impact (BACI) approach. This includes accumulating metric data before the all-season access road is built and after the Project becomes operational to quantify the relative changes to caribou from baseline.

Table 1 provides a list of metrics that will be collected for each monitoring objective. The intent is to provide structure to an adaptive management approach where appropriate management responses and mitigation adjustments can be triggered and implemented. As such, the table also includes mitigation and adaptive management thresholds identified in the Project Wildlife Management and Monitoring Plan (Tetra Tech 2018). The exception is the adaptive management threshold for operational effects to caribou movements and predator use, which are new. The proposed threshold requires a measurable change of moderate magnitude and clear association with the road. Ecological thresholds for caribou movements are unknown. Small changes that are statistically measurable may not equate to a measurable change on ecological scales (see Cohen 1988). For example, a measurable reduction in movements between summer and wintering areas by a few days is unlikely to correspond to a measurable reduction in caribou vital rates. It is also necessary to demonstrate strong association with the road for subsequent adaptive management actions to be effective.

Table 1: Study Objectives and Metrics of Project Camera Monitoring

Objective	Metric	Assumptions	Mitigation	Adaptive Management Threshold
Caribou interaction with the Project	Numbers of caribou interacting (near or on) the road. Provides data on areas and times (time of day, season) of relative risk of caribou-vehicle collisions	Traffic speed and volume contribute to wildlife collisions and mortalities	▪ Monitoring and reporting of wildlife observations along the road. ▪ Awareness communication about wildlife presence and location. ▪ Signage in areas where wildlife are repeatedly observed. ▪ Reduced speed limits.	No Project-related caribou injuries or mortalities.
Changes to caribou distribution, occupancy and seasonal movements	Number of caribou detections between higher elevations (summer) and wintering areas (lower elevations). Provides data patterns of caribou distribution, occupancy and movements across the Project as spatio-temporal gradient.	Physical presence of road or sensory disturbance from traffic will reduce seasonal movements (barrier to movement, fragmentation).	▪ Low traffic volume (20 vehicles per day). ▪ Reduced speed limits. ▪ Monitoring and reporting of wildlife observations along the road. ▪ Awareness communication about wildlife presence and location. ▪ Signage in areas where wildlife are repeatedly observed.	Caribou movement rates across the road are reduced from baseline (before road) during operations with moderate magnitude and show strong association with the road.
Changes to access by predators and human use	Numbers of predators (bears, wolves) and human use of the road. Provides data on areas and times of relative predation or harvest risk	Linear features provide travel corridors for predator movements and increase predation risk to caribou Linear features improve access for humans leading to an increase in sensory disturbance and/or hunting pressure and harvest rates	▪ Restrictions to non-Indigenous access at locations where CZC has authority to do so. ▪ Signs deterring access and harvest along the road. ▪ Road management may be used to deter/reduce use by predators or humans (e.g., reduced winter plowing to reduce suitability for predator travel). ▪ Reduce line-of-sight along linear intersecting features	Predator use rates that are increased from baseline during operations with moderate magnitude. Results from camera monitoring will be used to inform the Technical Advisory Group and support harvest monitoring completed at the check station by the Nahanni Butte Dene Band. The Technical Advisory Committee determines when results warrant adaptive management action.

A key determinate of camera monitoring as an effective approach to meeting these monitoring objectives will be the number of caribou detections recorded. To increase the likelihood of caribou detections, camera locations will be selected within high or moderate predicted habitat or known occupancy from previous baseline surveys completed (Golder 2014a, 2014b, PCA 2019), or where existing trail networks are located by the deployment crew. It is assumed based on input that from Parks Canada that camera monitoring for the Project will yield informative results but that the cameras are not meant to measure population status or change (presence, body condition, relative abundance if enough detections are made). As with any monitoring program, the efficacy of cameras to meet monitoring objectives will also be evaluated as part of adaptive management. Some advantages and limitations of camera monitoring are provided in Table 2.

Table 2: Advantages and Limitations of Camera Monitoring

Advantage	Limitation
▪ motion, thermal or scheduled activation (or both) ▪ long monitoring duration (~90 days) ▪ can provide some abundance and behaviour data ▪ does not require estimate of when caribou will be in the study area ▪ community participation on camera placement	▪ short distance for sensor detection (approximately 30 m) ▪ individual camera captures approximately 14.6 ha (in open and flat terrain), so large numbers of cameras would be required to monitor at broad spatial scales ▪ distant subjects may be obscured ▪ many hours needed to review the photos, but automated techniques are being developed ▪ little value to road management, as results may not be available for months after photos are downloaded

Camera location and distribution

Road interface camera monitoring

To inform the caribou-Project interaction objective, 26 cameras will be placed along the road within NNPR at spaced intervals, where there is a higher likelihood of caribou occurring at baseline. Cameras will be located in suitable habitat (where possible), with consideration of previous baseline survey or incidental observations have been made (Golder 2014a and 2014b, PCA 2017, 2019) and where game trails cross the road alignment to maximize detection of caribou interacting with the road. Trails that insect the road alignment will be identified by a survey of the road pre-deployment. These cameras will also inform on the predator use and human access objective. The following baseline information sources will be used in camera location selection along the road alignment.

- Golder 2014a; aerial caribou occupancy winter surveys conducted 2010/2011 (refer to Figures 2 and 3 below from Golder 2014a) and 2014 (refer to Figure 4 below from Golder 2014b). Observations of caribou and tracks during winter/'spring aerial survey show relatively higher use of Prairie Creek and Sundog Creek areas (see Figure 2 from Golder 2014a). Realized occupancy modelled from these data also predict higher use in the Mackenzie Mountains (see Figure 3 from Golder 2014a). Habitat blocks of 0.9-1.0 predicted occupancy should be focus areas for camera placement.

Figure 2 from Golder (2014a)

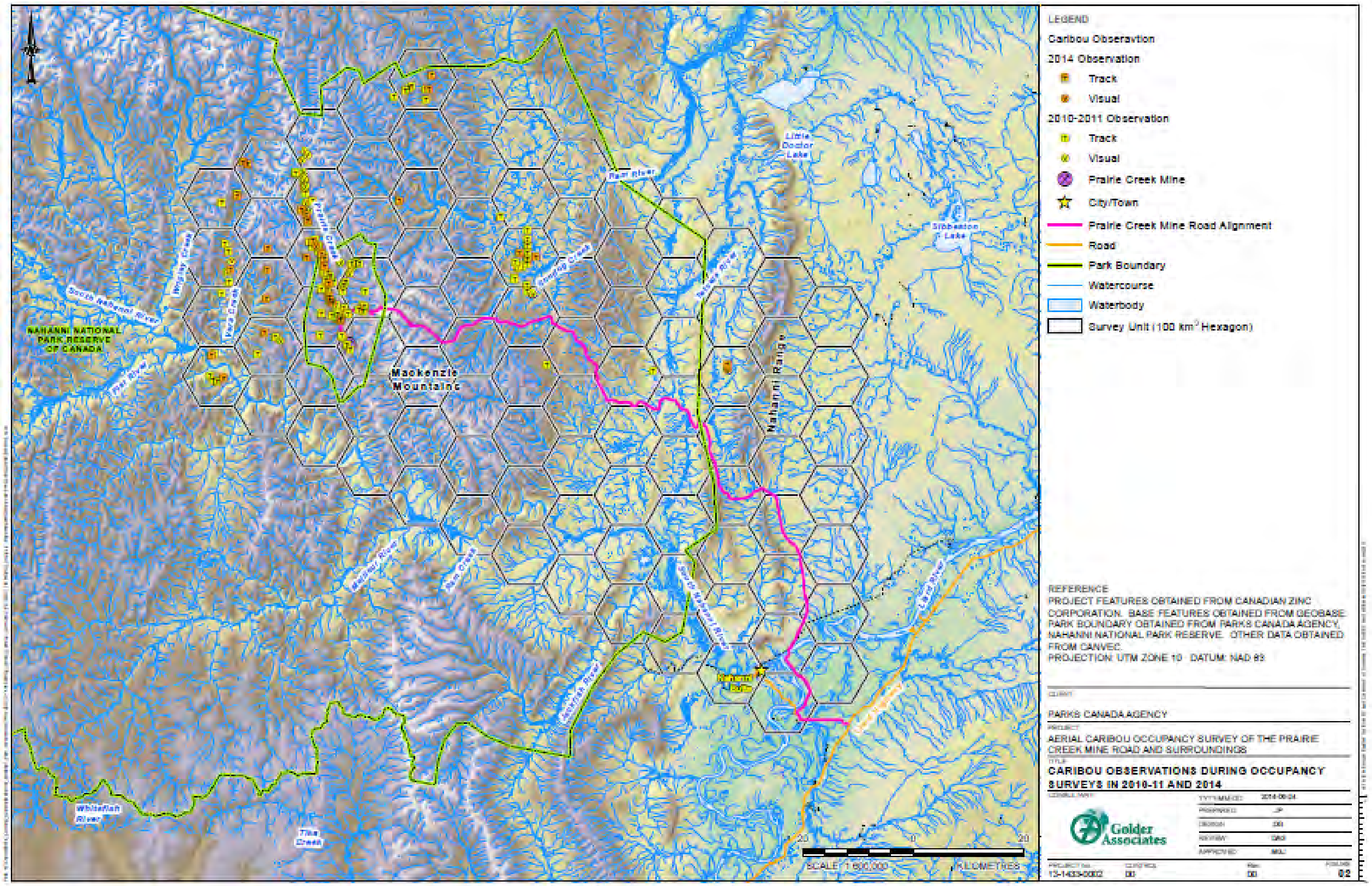
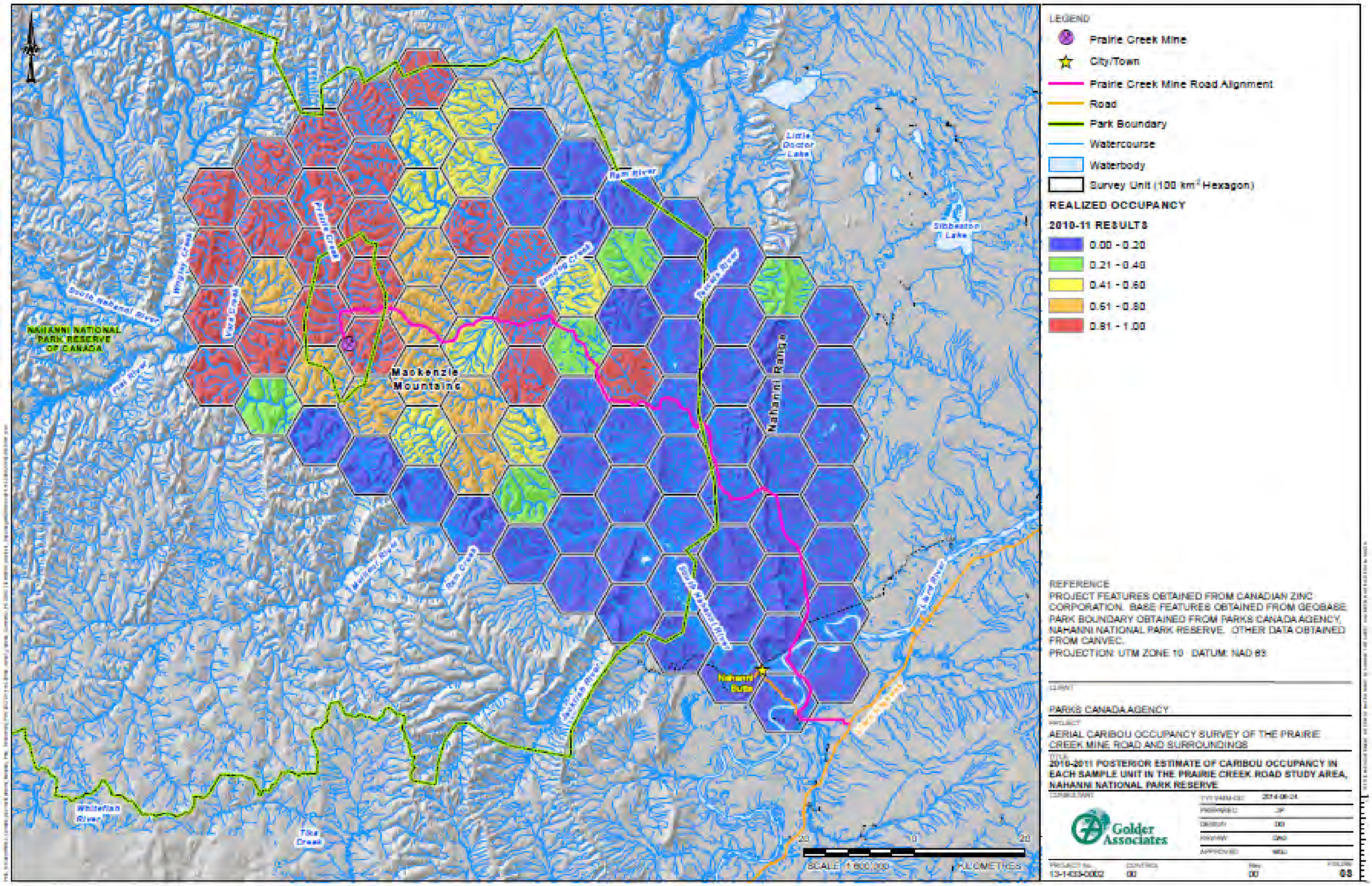


Figure 3 from Golder (2014a)



- Golder 2014b; non-winter ground based track / scat survey completed along the road alignment within 35 blocks of high, moderate and low caribou habitat suitability as defined by Polfus et al. (2013; Figure 2 from Golder 2014b). Blocks of habitat defined as moderate or high had the areas with the highest likelihood of caribou during the non-winter period including the Mackenzie Mountains near the Mine site, the lower Sundog Creek drainage. Incidental observations of caribou and caribou sign also are within this area during non-winter surveys (see Figure 3 from Golder 2014b). These areas have been consistently identified through caribou or caribou sign observations or predictions as key areas to be monitored for caribou use. Based on predictions modeled for non-winter caribou use, six additional sites were predicted to have high occurrence including where the road alignment enters the NNPR (see Figure 3 from Golder 2014b).

Figure 2 from Golder (2014b)

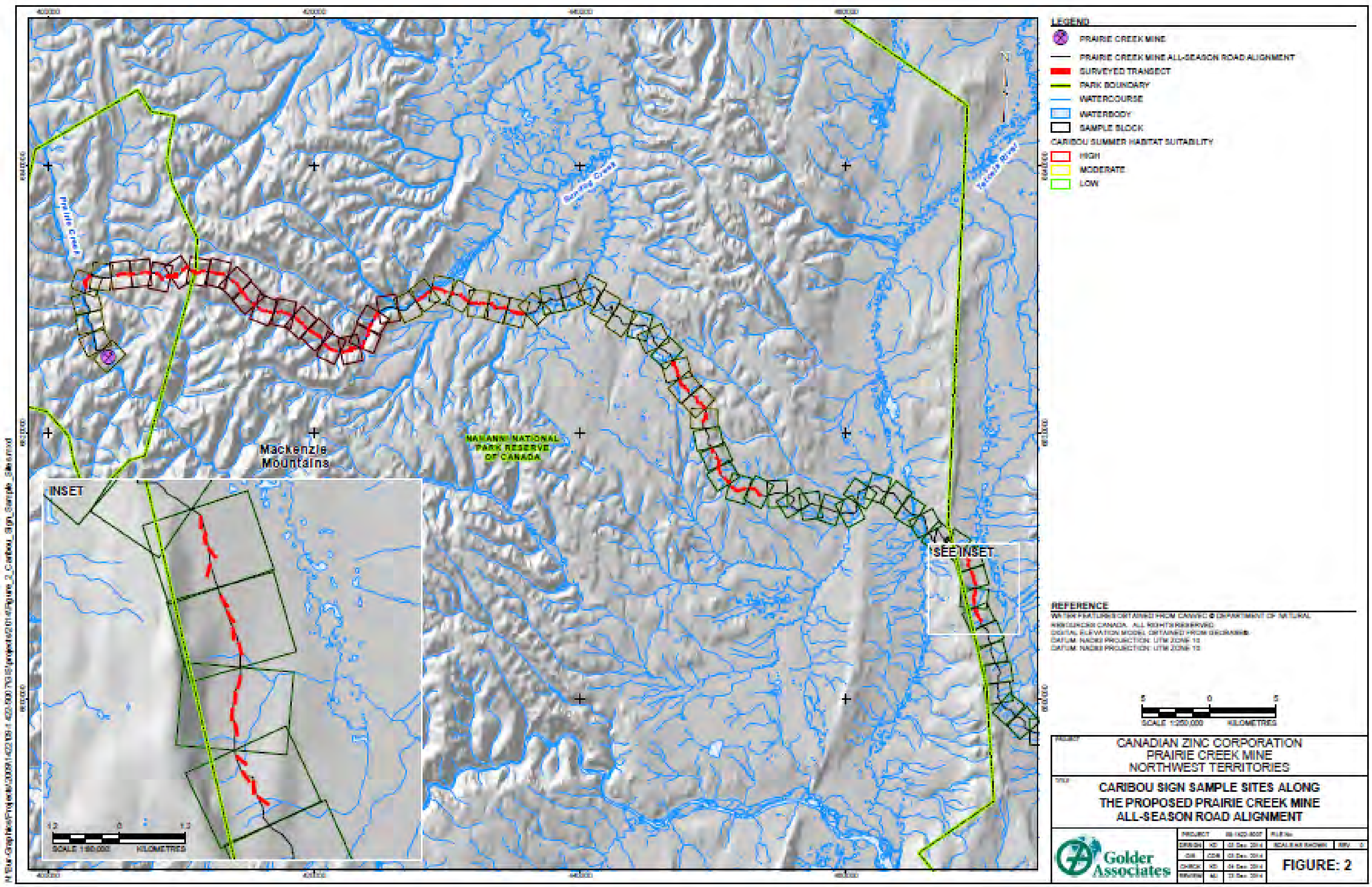
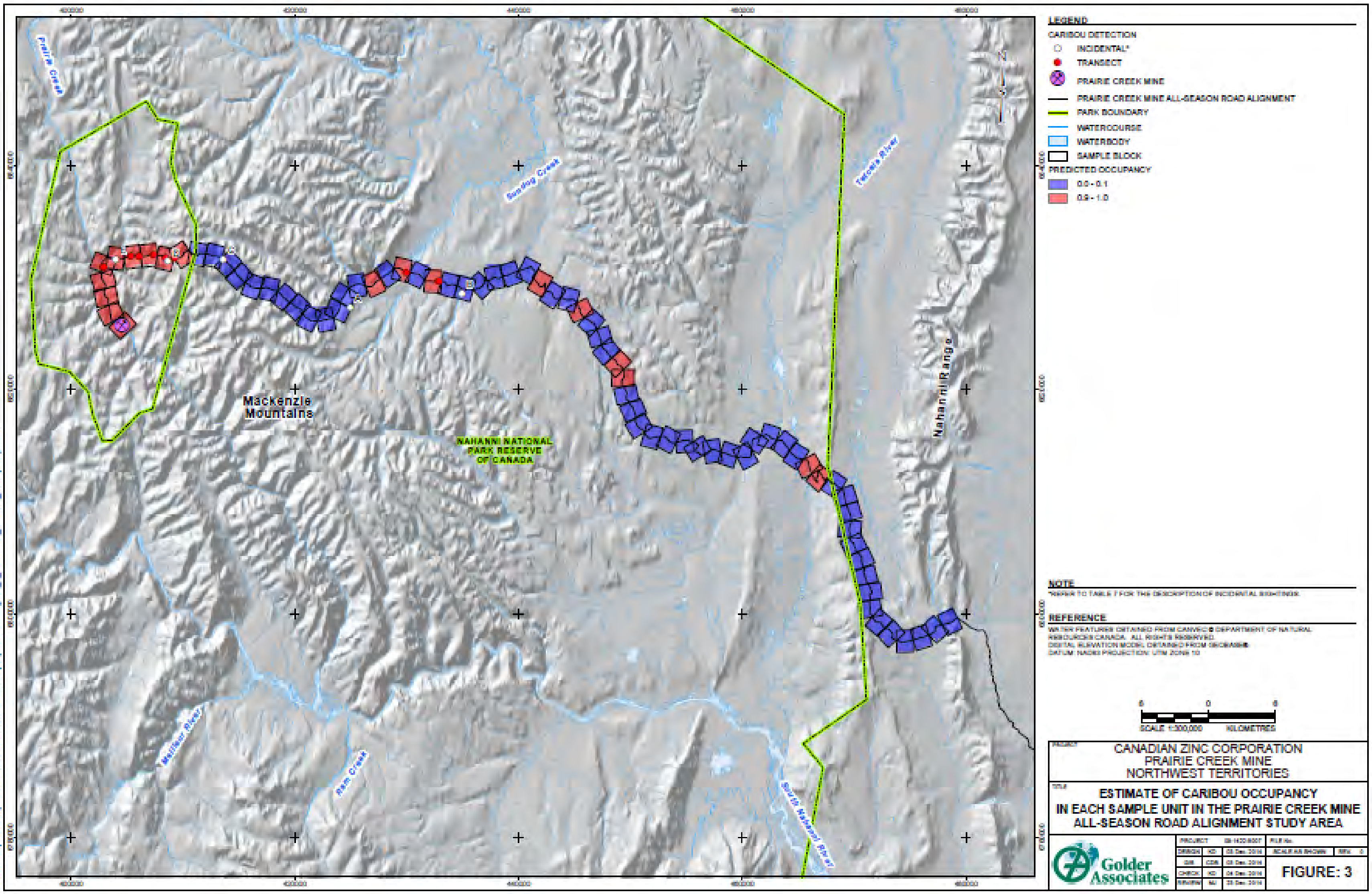
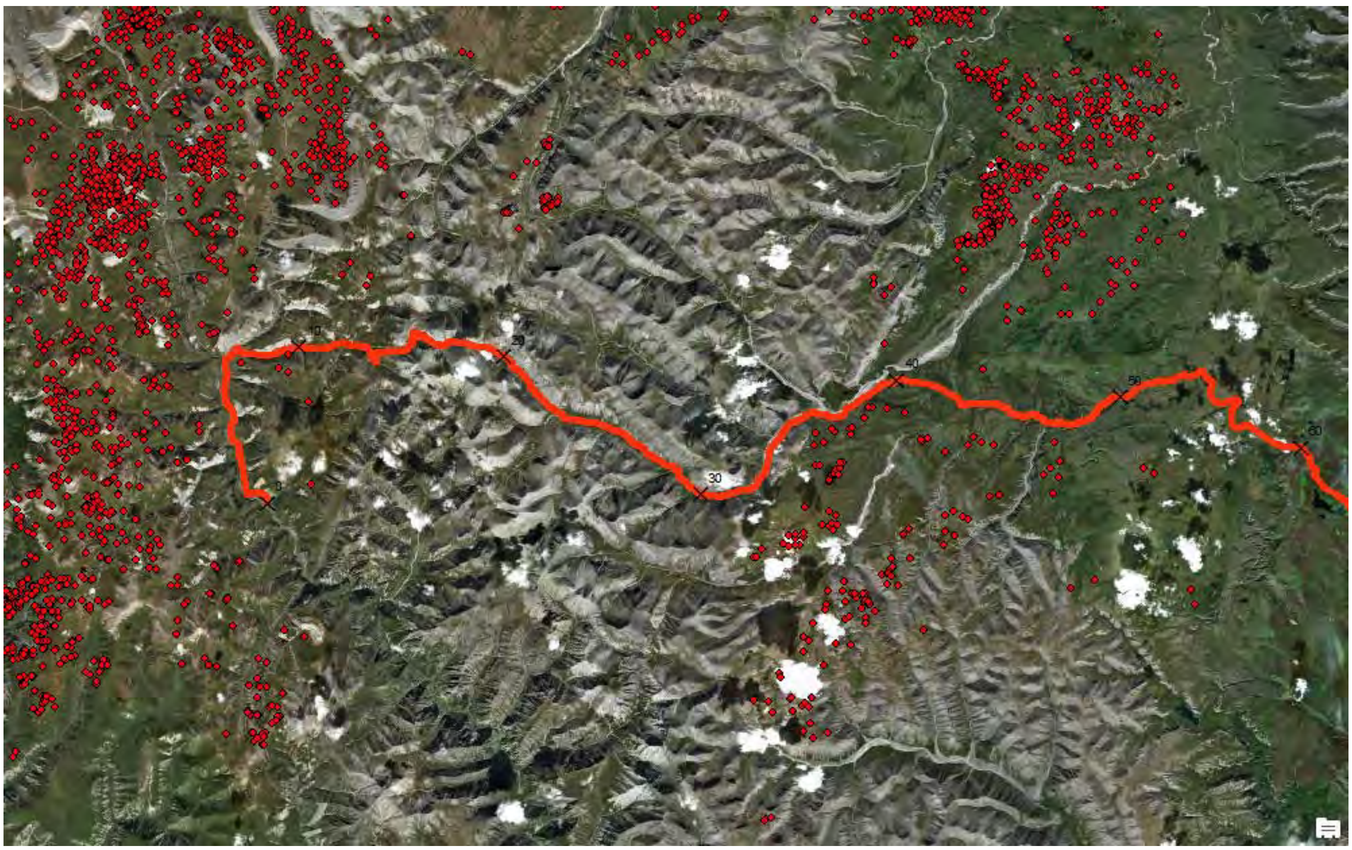


Figure 3 from Golder (2014b)



Cameras will be placed in each of the predicted high use cells and where incidental observations have occurred (n = 22 camera sites). An additional 4 cameras will be located along the road alignment within the Mackenzie Mountains as habitat suitability and occupancy predictions indicate caribou should be present and where Parks Canada cameras have detected caribou (PCA 2019). The locations within each cell will be informed by both habitat suitability but will be field adjusted based on where game trails or networks of game trails are located during pre-deployment surveys. Generally, the locations for cameras are supported by caribou location data provided by Parks Canada (Tetra Tech 2019). The cameras located at the entrance of NNPR will also be informative to changes in public access.

Locations of collared caribou provided by Parks Canada (Tetra Teck 2019)



Caribou Movement Monitoring

Baseline studies and collared caribou movements (PCA 2017; Figures 1 and 2) were considered for camera locations to increase the likelihood of capturing caribou observations on the cameras to inform the objective on caribou movements. Baseline studies of caribou were completed using aerial surveys during winter and spring in 2010, 2011, 2014 (Golder 2014a) and in 2019 (Tetra Tech; no observations). During these surveys observations of caribou and caribou tracks were recorded. In fall of 2014, ground surveys for caribou winter-free scat and tracks were completed along the Project alignment (Golder 2014b). Consideration of these results relative to the Project alignment suggests three areas with the potential to capture caribou movements between higher elevation calving/summer areas and lower elevation caribou winter areas. These include Prairie Creek, the lower Sundog Creek drainage and the Mackenzie Mountains in between as noted for in the previous section. In these areas, 27 cameras (including 3 cameras on roads) will be placed within nine 1km x 1 km cells along a transect centered on the Project alignment (Figures 2 and 3 from Golder 2014a). The transect will be oriented to maximize the potential to capture seasonal movements across elevations (Figure 1). Cameras will be placed at game trails or along trail networks (if possible) or in highly suitable habitats (krummholz/alpine shrub landcover in higher elevations within southern exposure) to maximize detection of caribou. The cell size and transect approach was selected to provide variation in distance from the road and general consistency with the monitoring design used for the Howards Pass Road (Steenweg and Polfus 2013).

The following additional baseline information sources will be used in camera location selection to capture caribou movements.

- Parks Canada (PCA 2017) summarized satellite telemetry data collected on 18 female caribou in the vicinity of the mine site and the Project. Three of these 18 caribou were reported to have crossed the Project alignment. When telemetry is shared, a camera should be deployed within the areas of known crossings. For example, Figure 1 within PCA (2017) provides a kernal density map for collared caribou during the calving season. Based on this figure, placing cameras at the far west end of the Project (adjacent to the mine site; Prairie Creek), and within 1 km moving to the east, will capture known caribou occurrence prior to Project operations. Similarly, Figure 2 (PCA 2017) provides a collared female’s movements on the east side of Sundog Creek crossing the Project alignment. Both of these observations are consistent with the summaries of observations from Golder 2014a and 2014b.

The proposed 50 camera locations are presented in Figure 1. As noted previously the proposed locations considered baseline observations and predictions from previous winter and summer monitoring (Golder 2014a, 2014b, PCA 2017, 2019). Cameras for both road and movement monitoring will be spaced a minimum of 500 m apart to improve sampling independence. It is expected that in-field adjustments to camera locations will occur due to access or habitat availability constraints. The final placement of cameras at sites is suggested to be determined by a community participant to apply local or Traditional Knowledge to the design. At the time of camera deployment, details about microsite camera location will be recorded (e.g., habitat type, orientation, distance from trails, etc.) as well as camera settings.

Cameras will be placed above anticipated snow depth as recommended by Parks Canada at the June 5th meeting, and pointing at the area towards the photo area and facing north. If the ground is sloping up from the camera to the photo area, the camera may need to be higher and angled up. The opposite will be required if the ground is sloping downward. Instructions for activating cameras and testing camera functions are written on the inside panel of the older models. A walk test will be conducted to determine the exposure area. Camera position will be adjusted as required. Cameras should be locked to a tree to prevent theft, particularly those near the road. Ensure there is no “debris” obscuring the view of the camera. Remove any trees, overhanging branches, shrubs or grass as needed. When ready, turn on the camera and select Arm Camera.

Golder Associates Ltd.

Dan Coulton, Ph.D., RPBio
Wildlife Biologist

Paula Bentham, Ph.D., RBiol.
Principal, Senior Ecologist

DWC/PB/al

Attachments: Figure 1: Proposed Locations of Camera Monitoring for Caribou, 2019
Table 3: Location Coordinates (UTM) of Proposed Camera Locations for Caribou Monitoring, 2019

https://golderassociates.sharepoint.com/sites/109817/project files/5 technical work/prairie_creek_asr_camera_design_draft.docx

References

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Golder. 2014b. Modelling caribou occurrence along the proposed Prairie Creek Mine All-season Road. Prepared for Canadian Zinc Corporation by Golder Associates Ltd., Vancouver, BC.

Steeweg, R. and J. Polfus. 2013. Interactions between Nahanni Caribou and Roads: remote camera sampling to monitor potential impacts of increased road activity on caribou and other wildlife in the Nahanni National Park Reserve. Prepared for Parks Canada, Nahanni National Park Reserve. 26 pp.

Parks Canada 2017. Parks Canada Agency's Technical Report to the Mackenzie Valley Environmental Impact Review Board Respecting the Prairie Creek All Season Road Proposed by the Canadian Zinc Corporation.

Parks Canada 2019. Parks Canada Camera Locations with Caribou Detections, 2011 to 2013. Provided by Sarah Arnold, June 12, 2019.

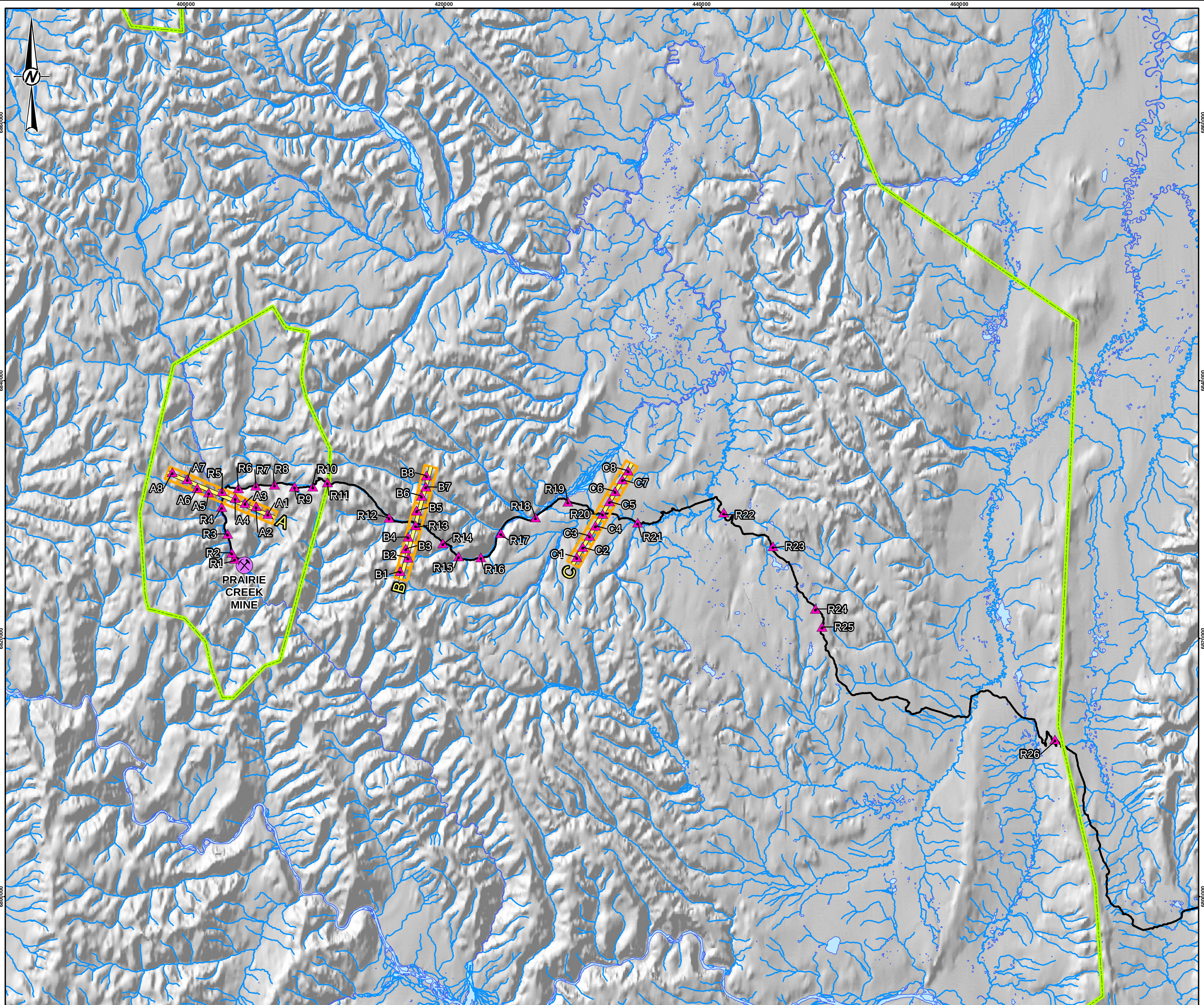
Tetra Tech. 2018. Prairie Creek Mine and Access Road: Wildlife Management and Monitoring Plan, Rev C. Prepared for Canadian Zinc Corporation by Tetra Tech, Yellowknife, NWT.

Tetra Tech. 2019. Map of Collared Caribou Locations in the Nahanni National Park Reserve. Data provided to Tetra Tech by Canada Parks, June 10, 2019.

ATTACHMENTS

Figure 1: Proposed Locations of Camera Monitoring for Caribou, 2019

Table 3: Location Coordinates (UTM) of Proposed Camera Locations for Caribou Monitoring, 2019



LEGEND

- PRAIRIE CREEK MINE
- PROPOSED WILDLIFE CAMERA LOCATION
- CARIBOU DETECTION - INCIDENTAL
- CARIBOU DETECTION - TRANSECT
- TRANSECT
- PRAIRIE CREEK MINE ALL-SEASON ROAD ALIGNMENT
- WATERCOURSE
- PARK BOUNDARY
- TRANSECT CELL
- WATERBODY

CAMERA ID	EASTING	NORTHING	LATITUDE	LONGITUDE
R1	403781	6826191	61.557203	-124.810976
R2	403568	6826653	61.561297	-124.815216
R3	403246	6828124	61.574413	-124.822060
R4	402788	6830205	61.592968	-124.831778
R5	402821	6831413	61.603816	-124.831788
R6	404075	6831659	61.606341	-124.808293
R7	405434	6831861	61.608490	-124.782802
R8	406861	6831919	61.609354	-124.755943
R9	408412	6831773	61.608416	-124.726643
R10	409833	6831763	61.608667	-124.699866
R11	410982	6832104	61.611990	-124.678390
R12	415757	6829371	61.588540	-124.587140
R13	417809	6828765	61.583550	-124.548216
R14	419917	6827392	61.571674	-124.507943
R15	421159	6826360	61.562665	-124.484121
R16	422877	6826278	61.562279	-124.451743
R17	424415	6828178	61.579628	-124.423600
R18	427107	6829379	61.590930	-124.373381
R19	429633	6830613	61.602471	-124.326276
R20	432312	6829673	61.594515	-124.275457
R21	435038	6828978	61.588753	-124.223849
R22	441713	6829764	61.596876	-124.098390
R23	445536	6827159	61.574053	-124.025590
R24	448835	6822312	61.530992	-123.962131
R25	449331	6820916	61.518527	-123.952415
R26	467411	6812176	61.442023	-123.611057
A1	406367	6829673	61.589087	-124.764107
A2	405440	6830253	61.594065	-124.781861
A3	404584	6830514	61.596195	-124.798119
A4	403834	6830880	61.599286	-124.812436
A5	401772	6831315	61.602675	-124.851507
A6	400876	6831675	61.605672	-124.868581
A7	400106	6832363	61.611650	-124.883466
A8	398941	6832886	61.616032	-124.905693
C1	430306	6826320	61.564064	-124.311978
C2	430783	6827099	61.571147	-124.303288
C3	431320	6827961	61.578978	-124.293503
C4	431774	6828761	61.586237	-124.285259
C5	432858	6830629	61.603195	-124.265527
C6	433300	6831428	61.610442	-124.257476
C7	433857	6832325	61.618586	-124.247318
C8	434318	6833026	61.624956	-124.238864
B1	416637	6825219	61.551478	-124.568676
B2	417249	6826253	61.560887	-124.557645
B3	417068	6826968	61.567260	-124.561359
B4	417248	6827878	61.575463	-124.558393
B5	417908	6829932	61.594041	-124.546890
B6	418290	6831058	61.604222	-124.540184
B7	418607	6831769	61.610672	-124.534523
B8	418647	6832634	61.618444	-124.534165

0 6 12

1:300,000 METRES

REFERENCE(S)

1. WATER FEATURES OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
2. DIGITAL ELEVATION MODEL OBTAINED FROM GEOBASE®.

DATUM: NAD83 PROJECTION: UTM ZONE 10

CLIENT

CANADIAN ZINC CORPORATION

PROJECT

PRAIRIE CREEK MINE
NORTHWEST TERRITORIES

TITLE

PROPOSED LOCATIONS OF CAMERA MONITORING FOR CARIBOU, 2019

CONSULTANT

GOLDER

YYYY-MM-DD	2019-07-03
DESIGNED	DC
PREPARED	JP
REVIEWED	DC
APPROVED	DC

PROJECT NO.	CONTROL	REV.	FIGURE
19123984	1000	0	1

Table 3: Location Coordinates (UTM) of Proposed Camera Locations for Caribou Monitoring, 2019

Camera ID	Easting	Northing
R1	403781	6826191
R2	403568	6826653
R3	403246	6828124
R4	402788	6830205
R5	402821	6831413
R6	404075	6831659
R7	405434	6831861
R8	406861	6831919
R9	408412	6831773
R10	409833	6831763
R11	410982	6832104
R12	415757	6829371
R13	417809	6828765
R14	419917	6827392
R15	421159	6826360
R16	422877	6826278
R17	424415	6828178
R18	427107	6829379
R19	429633	6830613
R20	432312	6829673
R21	435038	6828978
R22	441713	6829764
R23	445536	6827159
R24	448835	6822312
R25	449331	6820916
R26	467367	6812176
A1	406367	6829673
A2	405440	6830253
A3	404584	6830514
A4	403834	6830880
A5	401772	6831315
A6	400876	6831675
A7	400106	6832363
A8	398941	6832886
C1	430306	6826320
C2	430783	6827099
C3	431320	6827961
C4	431774	6828761
C5	432858	6830629

Table 3: Location Coordinates (UTM) of Proposed Camera Locations for Caribou Monitoring, 2019

Camera ID	Easting	Northing
C6	433300	6831428
C7	433857	6832325
C8	434318	6833026
B1	416637	6825219
B2	417249	6826253
B3	417068	6826968
B4	417248	6827878
B5	417908	6829932
B6	418290	6831058
B7	418607	6831769
B8	418647	6832634

Coordinates are NAD83, Zone 10

APPENDIX B

REMOTE CAMERA SETTINGS

Remote Camera Settings

Motion Tab	Day/Night Tab
Motion Pictures: On	Take pictures: Both day and night
External trigger pictures: Off	Take videos: NA
Number of Pictures: 5	Flash output: High
Time between pictures: Rapidfire	Minimum shutter speed: 1/60th
Motion video: Off	Maximum ISO: ISO1600 (default)
External trigger video: Off	
Maximum video length: NA	**Display Tab**
Dynamic video: Off	Label: Given camera site number. Example: R1.
Quiet period: No delay	Time format: 24 hour
Sensitivity: High	Temperature units: Celsius
	Show logo: Yes
Time Lapse Tab	
Time lapse pictures: On	**Other Tab**
Number of pictures: 1	Use CodeLoc: No[1]
Time between pictures: NA	CodeLoc: NA[2]
Time lapse video: Off	Resolution: Standard 4:3 (default)
Video length: NA	Loop recording: Off
Time lapse interval: 1 hour	Record audio: Off
Schedule: 12:00 – 13:00	PIR type: Long range (default)
	Delay start: Off

1. CodeLoc not used for 2019-2020; however, during road operations, the cameras should be locked using CodeLoc especially those along the road.
2. Add the CodeLoc number for road operations.

APPENDIX C

REMOTE CAMERA LOCATION DESCRIPTIONS

Camera Location	Total Number of Motion Images[1]	Distance from ASR (m)	Elevation (m)	Micro-Site	Surrounding Habitat
A01	455	2332	1070	Abandoned Mine Trail	Open – dryland/alpine
A02	35010	1565	1344	Wildlife Trail	Open – dryland/alpine
A03	1286	896	1277	Wildlife Trail	Open – dryland/alpine
A04	1916	820	1178	Wildlife Trail	Sparse Forest
A05	67302	1023	953	Wildlife Trail	Open – shrub/ sparse forest
A06	935	2008	1055	Wildlife Trail	Spruce Forest
A07	2718	2874	1278	Wildlife Trail	Open – shrub
A08	28663	4003	1377	Wildlife Trail	Open – shrub
B01	2721	4010	1337	Edge of Clearing	Open – dryland/alpine
B02	34117	2427	1637	Ridgeline	Open – dryland/alpine
B03	867	1888	1300	Edge of Clearing	Open – dryland/alpine
B04	NA	1201	1257	Valley	Open – dryland/alpine
B05	7873	1335	1612	Ridgeline	Open – dryland/alpine
B06	23692	2126	1569	Ridgeline	Open – dryland/alpine
B07	166	3039	1095	Wildlife Trail	Sparse Forest
B08	36475	4676	1524	Ridgeline	Open – dryland/alpine
C01	311	3607	1094	Wildlife Trail	Sparse Forest
C02	141	2878	1052	Wildlife Trail	Sparse Forest
C03	130	1579	958	Wildlife Trail	Sparse Forest
C04	330	1009	866	Edge of Clearing	Sparse Forest
C05	6595	989	910	Edge of Clearing/Burn	Burn Area
C06	5496	1746	1003	Wildlife Trail	Burn Area
C07	435	3207	800	Wildlife Trail	Open Treed Wetland
C08	25775	3718	765	Edge of Clearing/Burn	Burn Area
R01	36212	8	878	Existing 1980s road (between Mine site and airstrip)	Open – shrub
R02	5914	10	877	Existing 1980s road and airstrip	Open – shrub
R03	440	4	888	Existing 1980s road/proposed ASR	Spruce Forest
R04	1090	8	909	Existing 1980s road/proposed ASR	Spruce Forest
R05	5130	1	916	Existing 1980s road/proposed ASR	Open – dryland/alpine
R06	878	4	952	Existing 1980s road/proposed ASR	Open – dryland/alpine
R07	507	9	1002	Existing 1980s road/proposed ASR	Open – dryland/alpine
R08	1400	9	1060	Existing 1980s road/proposed ASR	Open – dryland/alpine
R09	1824	1	1221	Existing 1980s road/proposed ASR and Wildlife Trail	Open – dryland/alpine
R10	1049	5	1347	Existing 1980s road/proposed ASR	Open – dryland/alpine
R11	6405	4	1509	Existing 1980s road/proposed ASR	Open – dryland/alpine
R12	13	48	1170	Edge of Clearing	Open – dryland/alpine

Camera Location	Total Number of Motion Images[1]	Distance from ASR (m)	Elevation (m)	Micro-Site	Surrounding Habitat
R13	133	15	1066	Existing 1980s road/proposed ASR	Open – dryland/alpine
R14	1931	5	1019	Existing 1980s road/proposed ASR	Sparse Forest
R15	2165	4	944	Existing 1980s road/proposed ASR	Sparse Forest
R16	590	2	908	Existing 1980s road/proposed ASR	Sparse Forest
R17	2465	18	861	Existing 1980s road/proposed ASR	Sparse Forest
R18	11706	10	806	Existing 1980s road/proposed ASR	Sparse Forest
R19	1170	19	822	Existing 1980s road/proposed ASR	Spruce Forest
R20	9033	30	848	Existing 1980s road/proposed ASR	Open – dryland/alpine
R21	37706	86	786	-	Sparse Forest
R22	455	215	822	Edge of Clearing	Sparse Forest/Burn Area

1. Camera triggered from the movement of wildlife, vehicles, branches, etc.
NA = B04 images not retrieved from the field

TETRA TECH

APPENDIX D

CARIBOU OCCUPANCY MODEL RESULTS

Caribou Occurrence Model Selection Results

Comparison of models using all combinations of candidate covariates. The model with the lowest AICc was selected as the top model.

Model	p(Int)	psi(Int)	p(effort)	psi(barren_100m)	psi(dist_asr)	psi(elevation)	psi(forest_100m)	psi(northing)	psi(shrub_grass_100m)	df	logLik	AICc	delta	weight
1	-7.54	-0.16	0.69	-5.51	-1.96	1.88	NA	1.34	NA	7.00	-209.41	435.93	0.00	0.23
2	-7.56	0.18	0.69	-5.72	-1.71	2.26	NA	NA	NA	6.00	-211.62	437.50	1.58	0.10
3	-7.51	-0.93	0.68	NA	-1.02	NA	NA	1.20	NA	5.00	-213.33	438.23	2.30	0.07
4	-7.54	-0.56	0.69	-5.37	-2.04	1.99	0.62	1.40	NA	8.00	-209.31	438.74	2.82	0.06
5	-7.54	-0.02	0.69	-5.82	-2.00	1.97	NA	1.37	-0.43	8.00	-209.37	438.85	2.92	0.05
6	-7.53	-0.78	0.68	-1.71	-1.12	NA	NA	1.38	NA	6.00	-212.56	439.39	3.46	0.04
7	-7.53	-1.20	0.68	NA	-1.00	NA	NA	1.16	1.12	6.00	-212.89	440.05	4.13	0.03
8	-7.54	-0.87	0.68	NA	-1.19	0.44	NA	1.17	NA	6.00	-212.91	440.08	4.16	0.03
9	-7.56	-4.63	0.69	NA	-1.92	1.47	4.53	1.46	4.21	8.00	-209.99	440.10	4.17	0.03
10	-7.56	0.07	0.69	-5.69	-1.73	2.30	0.18	NA	NA	7.00	-211.61	440.33	4.40	0.03
11	-7.57	0.24	0.69	-5.87	-1.73	2.31	NA	NA	-0.18	7.00	-211.61	440.33	4.40	0.03
12	-7.50	-1.18	0.68	NA	-1.06	NA	0.41	1.27	NA	6.00	-213.25	440.78	4.85	0.02
13	-7.48	-0.73	0.68	NA	NA	NA	NA	0.68	NA	4.00	-215.94	440.90	4.98	0.02
14	-7.51	-0.64	0.68	NA	-0.59	NA	NA	NA	NA	4.00	-216.07	441.17	5.25	0.02
15	-7.53	-0.59	0.68	NA	NA	NA	NA	NA	NA	3.00	-217.31	441.23	5.30	0.02
16	-7.57	-2.50	0.69	NA	-1.20	NA	1.63	1.38	2.22	7.00	-212.25	441.61	5.68	0.01
17	-7.57	-1.24	0.69	-4.61	-2.05	1.93	1.28	1.41	0.78	9.00	-209.30	441.89	5.96	0.01
18	-7.54	-0.98	0.68	-1.45	-1.11	NA	NA	1.33	0.74	7.00	-212.40	441.90	5.98	0.01
19	-7.52	-1.63	0.68	NA	-1.39	0.72	1.27	1.32	NA	7.00	-212.41	441.93	6.00	0.01
20	-7.58	-0.61	0.69	NA	-0.82	0.57	NA	NA	NA	5.00	-215.23	442.04	6.11	0.01
21	-7.55	-1.14	0.68	NA	-1.16	0.42	NA	1.11	1.11	7.00	-212.49	442.09	6.16	0.01
22	-7.56	-0.93	0.69	NA	NA	NA	NA	NA	1.28	4.00	-216.57	442.16	6.23	0.01
23	-7.53	-0.55	0.68	-1.89	-1.10	NA	-0.33	1.35	NA	7.00	-212.53	442.17	6.24	0.01
24	-7.53	-0.98	0.68	NA	-0.59	NA	NA	NA	1.28	5.00	-215.37	442.31	6.39	0.01
25	-7.50	-1.02	0.68	NA	NA	NA	NA	0.64	1.14	5.00	-215.39	442.35	6.43	0.01
26	-7.45	-0.59	0.67	-1.19	NA	NA	NA	0.75	NA	5.00	-215.42	442.42	6.50	0.01
27	-7.57	-3.80	0.69	NA	-1.43	1.57	3.79	NA	3.93	7.00	-212.69	442.50	6.57	0.01
28	-7.50	-0.48	0.68	-0.86	NA	NA	NA	NA	NA	4.00	-217.03	443.10	7.17	0.01
29	-7.50	-0.52	0.68	-0.91	-0.60	NA	NA	NA	NA	5.00	-215.79	443.16	7.24	0.01
30	-7.57	-0.57	0.69	NA	NA	0.23	NA	NA	NA	4.00	-217.12	443.26	7.34	0.01

Model	p(Int)	psi(Int)	p(effort)	psi(barren_100m)	psi(dist_asr)	psi(elevation)	psi(forest_100m)	psi(northing)	psi(shrub_grass_100m)	df	logLik	AICc	delta	weight
31	-7.61	-0.20	0.70	-2.45	NA	0.79	NA	NA	NA	5.00	-215.87	443.32	7.39	0.01
32	-7.56	0.11	0.69	-5.74	-1.73	2.31	0.14	NA	-0.05	8.00	-211.61	443.33	7.40	0.01
33	-7.50	-0.72	0.68	NA	NA	0.10	NA	0.66	NA	5.00	-215.90	443.39	7.46	0.01
34	-7.56	-0.34	0.69	NA	NA	NA	-0.44	NA	NA	4.00	-217.20	443.42	7.49	0.01
35	-7.59	-0.95	0.69	NA	-0.83	0.55	NA	NA	1.26	6.00	-214.58	443.43	7.51	0.01
36	-7.49	-0.66	0.68	NA	NA	NA	-0.12	0.67	NA	5.00	-215.93	443.44	7.51	0.01
37	-7.48	-0.33	0.68	-2.58	NA	0.69	NA	0.70	NA	6.00	-214.61	443.50	7.57	0.01
38	-7.53	-0.46	0.68	NA	-0.58	NA	-0.32	NA	NA	5.00	-216.02	443.61	7.69	0.00
39	-7.60	-0.91	0.69	NA	NA	0.22	NA	NA	1.29	5.00	-216.39	444.36	8.43	0.00
40	-7.57	-0.95	0.69	NA	-0.91	0.73	0.61	NA	NA	6.00	-215.09	444.46	8.53	0.00
41	-7.48	-0.84	0.68	-0.90	NA	NA	NA	0.70	0.88	6.00	-215.13	444.53	8.60	0.00
42	-7.54	-0.83	0.69	-0.51	NA	NA	NA	NA	1.15	5.00	-216.48	444.54	8.61	0.00
43	-7.48	-0.03	0.68	-1.71	NA	NA	-0.85	0.70	NA	6.00	-215.14	444.55	8.63	0.00
44	-7.54	0.25	0.69	-1.57	NA	NA	-1.11	NA	NA	5.00	-216.51	444.59	8.67	0.00
45	-7.54	-2.39	0.69	-0.16	-1.20	NA	1.52	1.38	2.11	8.00	-212.25	444.61	8.68	0.00
46	-7.54	-1.18	0.69	NA	NA	NA	0.34	NA	1.51	5.00	-216.52	444.62	8.70	0.00
47	-7.48	-1.53	0.68	NA	NA	NA	0.68	0.68	1.58	6.00	-215.22	444.72	8.79	0.00
48	-7.52	-1.42	0.68	NA	-0.61	NA	0.59	NA	1.69	6.00	-215.26	444.78	8.85	0.00
49	-7.52	-0.87	0.68	-0.56	-0.59	NA	NA	NA	1.14	6.00	-215.28	444.82	8.89	0.00
50	-7.52	-1.01	0.68	NA	NA	0.10	NA	0.62	1.13	6.00	-215.36	444.98	9.05	0.00
51	-7.53	0.10	0.68	-1.50	-0.56	NA	-0.94	NA	NA	6.00	-215.44	445.14	9.22	0.00
52	-7.60	0.37	0.69	-2.97	NA	0.75	-0.87	NA	NA	6.00	-215.58	445.44	9.51	0.00
53	-7.59	-0.45	0.69	-2.10	NA	0.71	NA	NA	0.77	6.00	-215.67	445.60	9.67	0.00
54	-7.60	-0.46	0.69	NA	NA	0.19	-0.21	NA	NA	5.00	-217.10	445.78	9.85	0.00
55	-7.50	-0.72	0.68	NA	NA	0.10	0.00	0.66	NA	6.00	-215.90	446.08	10.15	0.00
56	-7.51	0.05	0.68	-2.85	NA	0.64	-0.60	0.67	NA	7.00	-214.49	446.08	10.16	0.00
57	-7.50	-0.49	0.68	-2.28	NA	0.62	NA	0.67	0.49	7.00	-214.54	446.19	10.26	0.00
58	-7.58	-1.79	0.69	NA	NA	0.47	1.20	NA	2.11	6.00	-216.06	446.39	10.46	0.00
59	-7.50	-2.00	0.68	NA	NA	0.37	1.36	0.65	2.03	7.00	-214.95	447.01	11.09	0.00
60	-7.54	-0.44	0.69	-0.89	NA	NA	-0.41	NA	0.77	6.00	-216.47	447.20	11.27	0.00
61	-7.48	-0.51	0.68	-1.22	NA	NA	-0.36	0.70	0.55	7.00	-215.12	447.35	11.42	0.00
62	-7.52	-1.35	0.68	-0.09	-0.61	NA	0.52	NA	1.61	7.00	-215.26	447.62	11.69	0.00
63	-7.60	0.58	0.69	-3.20	NA	0.76	-1.07	NA	-0.23	7.00	-215.58	448.27	12.35	0.00
64	-7.51	0.36	0.68	-3.20	NA	0.66	-0.90	0.67	-0.35	8.00	-214.48	449.07	13.14	0.00

Summary of the Top Model for Caribou Occupancy

Model:

m_top <- occu(formula = ~ effort ~ northing + elevation + barren_100m + dist_asr, data = cari_umf)

Detection Probability:

Parameter	Estimate	SE	z	P(>|z|)
Intercept	-7.54232	2.395294	-3.14881	0.001639
Effort	0.685586	0.343455	1.996146	0.045918

Occupancy:

Parameter	Estimate	SE	z	P(>|z|)
Intercept	-0.1604	0.584746	-0.27431	0.783849
Northing	1.338726	0.747782	1.790262	0.073412
Elevation	1.881687	0.930759	2.021671	0.04321
Barren_100m	-5.51265	2.477102	-2.22544	0.026051
Dist_ASR	-1.96483	0.830567	-2.36565	0.017998

APPENDIX E

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

NATURAL SCIENCES

1.1 USE OF DOCUMENT AND OWNERSHIP

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

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

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL ISSUES

The ability to rely upon and generalize from environmental baseline data is dependent on data collection activities occurring within biologically relevant survey windows.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design or scope, in consideration of the level of the environmental baseline information that was reasonably acquired to facilitate completion of the scope.

1.8 NOTIFICATION OF AUTHORITIES

TETRA TECH professionals are bound by their ethical commitments to act within the bounds of all pertinent regulations. In certain instances, observations by TETRA TECH of regulatory contravention may require that regulatory agencies and other persons be informed. The client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.