CANADIAN ZINC CORPORATION

DEVELOPER'S ASSESSMENT REPORT
ALL SEASON ROAD PROJECT
PRAIRIE CREEK MINE

MAIN REPORT Volume 1 of 3

SUBMITTED IN SUPPORT OF:

Environmental Assessment of
Prairie Creek Mine EA 1415-01

SUBMITTED TO:

Mackenzie Valley Review Board
Yellowknife, NT X1A 2N7

SUBMITTED BY:

Canadian Zinc Corporation
Vancouver, BC V6B 4N9

April 2015

PROJECT FACT SHEET

CORPORATE DATA

Project Name	Prairie Creek Mine
Company Name and Address	Canadian Zinc Corporation Suite 1710, 650 West Georgia Street Vancouver, B.C., V6B 4N9 Telephone: (604) 688-2001 Fax: (604) 688-2043 Canadian Zinc Corporation 9926-101st Avenue PO Box 500 Fort Simpson, NT X0E 0N0 Telephone: (867) 695-3963 Fax: (867) 695-3964
Contacts	Alan Taylor, Chief Operating Officer and VP Exploration David Harpley, VP Environment & Permitting Affairs Wilbert Antoine, Manager of Northern Development

COMMUNITY DATA

First Nation Territory	Nahanni Butte Dene Band, Dehcho
Nearest Community	Nahanni Butte, 95 km south-east
Other Communities	Fort Liard, 165 km south-east Fort Simpson, 185 km east
Land Claims Status	In negotiation**,** Dehcho Process

PROJECT DETAILS

Location	550 km west of Yellowknife, NWT 61°33’ N latitude, 124°48’ W longitude
Undertaking	~185 km all season road to the Liard Highway essentially using the existing, permitted winter road alignment

GONDI AEK'ÉHZE ADLÁ

Gondı Éhgonı́ʔá

Dıı Praırıe Creek Mıne góhts'edı tł'a Góhdlı Ndehé k'eh yunahnee tł'uh nıt'ı ıı gots'ę́ xǫh shíhtah á goʔǫ. Káa azhǫ t'áh Canadıan Zınc Corporatıon (CZN) gots'ęh á agǫ́ht'e. K'ǫ́ǫ 1980 kéhonı́dhe ekúh á ndéh gozhíhe gots'ęh satsǫ́ kázhe gha seegúdlá agǫ́ht'e t'áh t'ahsíı met'áh alaeda thela á agǫ́ht'e. Canadıan Zınc Corporatıon alaa dáǫndıı t'áhsíı zháúhłéh gha, ndéh k'eh alaeda, saamba hołéh ts'ęhk'eh dágǫndíh olíı gok'aagenéhta ghaádé á Ndehé gots'ęh Tu Ehxǫgehndıh-ke (MVLWB) ndéh gots'ęh tu t'áh agot'ı t'áh alagenda kéhnaogeníhthı gha edı̨htł'éh goegedake. Ezhıı gǫǫthąh chu t'ahsíı k'édahnízheh k'é ǫkı getsı̨ gha ndéh t'áh aget'ı̨ gha edı̨htł'éh gǫzha. Xaye goek'élué k'ę́ę́ ehnąątanı̨ łıé gets'ı̨ gha gots'ęh Lıard ek'élu ts'ęh dégodéʔá ezhıı chu łıé gehtsı̨ gha. Canadıan Zınc Coporatıon káa edheh xaye goek'élué t'áh aget'ı̨ gha ndéh gha edı̨htł'éh (LUP MV2003F0028) goı̨ts'ęh ɻ̨lé. Ezhıı edı̨htł'éh egedake k'eh ndéh t'áh agot'ı̨ ts'ı̨hʔǫ́ǫ́ dágǫndíh olıı (EA) gha magoadá. Ezhıı gots'ı̨hʔǫ́ Ndéh t'áh Agot'ı̨ Gok'aagenehta-ke (MVRB) megháádé alaeda gha edı̨htł'éh (EA0809-002) goagenı̨hchú tł'a satsǫ́ kázhe k'é gots'ę́ xaye goek'élué gehtsı̨ gots'ęh zhek'ę́ę́ goalagenda gha á ǫt'e.

Edáıdzęa Zaa k'eh ehts'édı̨ı, 2011 ekúh Ndéh t'áh Agot'ı̨ Gok'aagenehta-ke (MVRB) edı̨htł'éh gedı̨tł'éh gháádé tł'a CZN azhıı ghálaúdá gedı gots'ęh dágǫndíh t'áh athııt'ı̨ gha gedı ghááde tł'a kıı met'áh ndéh tsı̨́dhe íle olı gots'ęh kíí kǫ́tah gots'ęh dene hútł'íé zheghǫh kaegenı̨ʔá gha íle olı gedı̨. Dıı edı̨htł'éh Ndéh gots'eh Tu Exǫedıh gha Gedéhttth'ı-ke (MVLWB) gots'ę́ anajá gots'ęh á, Egochı̨é Zaa, 2013 ekúh satsǫ́ kagele gha edı̨htł'éh goghǫ́chu. Ezhıı gots'ę ek'élu nı̨ʔá gúlıı nátheʔa anaogedleh gha Ndéh gots'ęh Tu Exǫedıh gha Gedéhttth'ı-ke (MVLWB) gots'ęh Parks Canada ndéh gots'ęh tu t'áh aget'ı̨ gha edı̨htł'éh gúlíı gogházenı̨la.

CZN dúh dáǫndıı ek'élu t'áh aút'ı̨ genı̨dhę tł'a sats'ǫ́ kázhe k'é gots'ęh Tetsela T'ahsíı Ehdahníazheh K'é (TTF) gots'ę́ satsǫ́ kazhe nı́zhe kéhonídhı gha k'ǫ́ǫ xaye égonídhı godakaedutı̨́h genı̨dhę, ezhıı tł'a Lıard ek'elu ts'ęh satsǫ́ kázhe k'é gots'ę́ ek'élu nı̨ʔa k'ę́ę́ ehnaatanı̨ á agǫ́ht'e. Xaye thaa ek'élu dákáedénı̨tǫ íle gots'ęh xaye dágǫndíh gha keots'edı̨hshǫ íle t'áh ghǫh á k'ǫ́ǫ́ xaye éonádheh ek'élu dákáedetı̨ tł'a got'áodéʔá á agǫ́ht'e. Dıı satsǫ́ káezha azhǫ godı̨ náendíh gots'ę́ dehzha íle édé met'áh saamba hołéh ts'ęhk'eh t'ą́ą́ agújá olı. Ndéh t'áh agot'ı̨ ts'ı̨hʔǫǫ dagodíh olı (EA) gha gok'aoneta ekúht'áh k'ǫ́ǫ xaye egonádheh ek'élu dákáedatǫ édé xǫ mehchı̨é nekéh zhek'eh at'ı̨ gha

k’áhla ndéh góhtęle olı chu ts’enɻdhę. Dehsee met’áh xaye goek’élué hohłéh gha zhah golé et’ıı chu ghǫh náets’enɻdhe. Xaye goek’élué gha gonezu íle édé met’áh thɻ́ ek’élu dákáedetɻ́h ts’ɻhʔǫ́ǫ́ t’áh thaa gots’ę́ satsǫ́ kaezha exáedezhe gha dúwé olí. CZN dıı t’ahsíı kazháǫndíh k’agenéhtǫ t’áh yundee dágǫɻt’e ghάádé káa dúlé łáánı xaye ek’élu hołéh sǫ́ǫndı genɻdhę. Kaǫndíh k’óó dıı t’ahsíı kazháǫndíh t’áh dúwé goedelé gohthę k’áhla kagǫndíh gots’ęh ndéh thekǫ at’ɻ t’áh k’éʔǫ́ǫ́ dzáágǫ́ht’e gohthę chu k’ála kagǫ́ht’e. Ndéh t’ah agot’ɻ tsʼɻhʔǫǫ dágodíh olıı (EA) t’áh gok’aoneta ekúht’áh chu dáǫndıı t’áh xaye shíhtah ek’élu nezǫh k’éts’endíh gha gots’ęh t’ahsíı nałaadetł’í gots’ęh dáǫndıı t’áh kagodeh gohthę ghǫh sááh ts’edéhttth’ı gha chu goghǫh kaets’enɻʔá.

Dıı kazhágǫndíh ghǫh á CZN kıı hózhítah Tetsela T’ahsíı Ehdahnízheh K’é (TTF) gots’ę́ ek’élu t’áh aget’ɻ gha edɻhtł’éh egedake. Kagǫndíh enɻdé łáánɻ Tetsela T’ahsíı Ehdahnízheh K’é (TTF) gots’ę́ satsǫ́ kaezha ehxáedezhe t’áh dıı t’ahsíı ghǫh kaets’enɻʔa sɻ̨ ch’á k’eots’eʔah.

Saamba hołéh gots’ęhk’eh tł’a, xaye zhǫh ek’élu t’áh ats’et’ı édé met’áh satsǫ́ kazhe ts’ęh saamba hołéh t’áh tthɻ́ agot’ɻ gha. Dıı satsǫ́ kaezha seedleh tł’a saamba t’áh á agot’ɻ, t’áh satsǫ́ kaezha xaye goek’élué dákáedetɻ́h gots’ęh satsǫ́ kázhe k’é mek’ets’endíh énɻdé tthɻ́ saamba gots’ę́ at’ɻ gha. Kíı hóozhɻe tah met’áh ats’et’ɻ gha ek’élu gǫ́lɻ enɻdé kagǫndíh gha íle, kóó dıı mets’ęh saamba hólɻ ehsą́ą́ ek’élu seedleh ts’ę́ íhłéh gha. Hóozhɻe tah met’áh ats’et’ɻ gha ek’élu gǫ́lɻ édé dene k’ǫ́ídéh gha gonezụ olí gots’ęh k’éʔǫ́ǫ́ dúhdę́ę́ gots’ęh Dene zhágǫ́lɻ gohéh t’ahsıı goalagenda gha dúle. Ezhı gots’ęh CZN dúle tłeh gúlıı aǫndíh met’áh hútł’íé tsɻ̨godhıle gots’ęh détíle godlɻ dúh dę́ę́ zháhúhłéh ǫt’e t’áh aget’ɻ. Ezhıı t’áh ghǫh á CZN satsǫ́ kázhe k’é gots’ęh Tetsela T’ahsíı Ehdahnízheh K’é (TTF) gots’ę́ hóozhɻe tah met’áh ats’et’ɻ gha ek’élu gogehtsɻ gha goegedake, ezhıı gǫǫthah chu Tetsela T’ahsíı Ehdahnízheh K’é (TTF) gots’ęh Lıard ek’élu ts’ę́ chu aogeleh gha goegedake, dıı káa enagǫ́t’e édé ałáhndee ehsą́ą́ ek’élu nɻʔa gha.

CZN kíí hóozhɻe tah Lıard ek’élu ts’ę́ ek’élu t’áh athít’ɻ gha edɻhtł’éh nahegháochuh genɻdhę. Satsǫ́ kázhe k’e gots’ęh Tetsela T’ahsíı Ehdahnízheh K’é (TTF) gots’ę́ są́ą́ alaa seedleh gha. Ram Plateau k’eh ek’élu mbáh chu elák’et’ah nanedéh k’é gúlíı nagogets’ɻ gha, ek’élu hołéh met’áh ats’et’ɻ gha gots’ęh satsǫ́ kázhe k’é dúwé elák’et’ah netła nɻdé got’áh ats’et’ɻ gha. Tetsela T’ahsíı Ehdahnízheh K’é (TTF) gots’ęh Lıard ek’élu ts’ę́ są́ą́ gotł’ą́h goghálagenda gha. Saamba t’áh dágǫndíh ghάádé dúlé chu ełegháádé

golats’enda. Dúh thaale yundaa saamba t’áh dágǫndíh olıı gok’aats’enéhtǫ ghάádé tł’a ehgháádé aots’ǰlá olí ezhı á hútł’ıé gots’ę́ káets’enɻʔá.

Ek’élu Hołéh

CZN, Allnorth Consultants Ltd, setsǫ́ kázhe k’é gots’ęh Lıard ek’élu ts’ę́ ek’élu hóozhɻé tah met’áh ats’et’ı dánátheʔá édé nezu olı gots’ęh Ram Plateau elák’et’ah nanedéh k’é hołéh gha dágǫndíh nahegha gok’ánahta góhgedıdí. Allnorth godɻh ek’élu nɻʔá olıı, godı gots’ęh ek’élu gha gohtł’éh adleh gha, deh gáh nezhágóʔá gots’ęh azhıı t’áh godezhí gots’ęh daǫndıı t’áh seegots’ǰłá olıı ezhıı gok’aagonéhtǫ.

2014, Įmbéh gots’ęh Xat’ą́ą́ ekúh Allnorth azhíı keogǰhʔǫ ghάts’ında t’áh gok’aonehtǫ ǫkı enats’ıt’e. Azhıı ek’élu hołéh gok’éh hútł’ıé maeda gha sɻ́ yuzhee daatł’éh.

- Nahʔąą Dehé Kǫ́ę́ gots’ę́ ek’élu 10.0 km ǫt’e héh t’áh azhǫ t’áh tł’a 184.2 km. á agǫ́ht’e.

- Alaa 20.5 km. gots’ę́ ek’élu hołeh k’ę́ę́ honǫ gots’ę́ ndéh ełek’éch’a gǫ́lą gots’ęh ehts’ę́taı gots’ę́h ndéh gúlıı kááhʔa.

- Ek’élu ǫkı honǫ ʔǫ́ǫ́ sǫlái goké kaeká gha gots’ęh dɻ honǫ kanáodehtłah (40 km/hr) t’áh mek’ę́ę́ ats’et’ı gha.

- Deha gáh neegóʔá gonechá honǫ ʔǫ́ǫ́ ehts’ędɻ gots’ęh łúlı honǫ lǰh deha atselea gáh negóʔa, dɻ gots’ę́ gúlıı aǫdíh t’áh nezhágóʔá.

- Łą́hdɻ honǫ ʔǫ́ǫ́ dɻ gots’ęh gohtł’éh adleh gha (dɻ honǫ ʔǫ́ǫ́ łúlı tł’a káa meets’enɻdhę gots’ęh gonąą́h ǫkı honǫ ʔǫ́ǫ́ sǫlái tł’a meets’enɻdhę gohthę) ek’élu tł’aa gha gohtł’éh, ttha gots’ęh tthe kázhe ts’ę́ tthe.

- 491.8 hectare kaodacho ehsą́ą́ ndéh t’áh ats’at’ǰ olı.

Azhíı ghálaeda gha godezhı olí:

1. Nácháá Deh gáh Įmbéh édé elá t’áh negóʔá gots’ęh Xaye édé tę k’eh negóʔá.

2. Sılent Hılls KP 96 gots'ęh 102 gots'ę́ shíh mbáh godagodenaʔáhle gonɻʔá, ndéh delǫ́ íle gohthę.

3. KP 23, 25, 28 gots'ęh 123 deha gáh neegóʔá tthe ts'edehk'éh gha góʔǫ́.

4. KP 34 gots'ęh 39 gots'ęh Sundog Creek mbáh gok'eaídlɻh gombáh gónɻʔá gha seegots'eleh gha.

5. Ek'élu k'ę́ę́ ndehgóhtę ehsáonéht'a gǫ́lɻ olı.

6. KP 23.5, 25.5 gots'ęh 89.8 deha zhánecha gáh nezhágóʔa. Mek'ę́ę́ neegóʔa łié latth'ǫnǫ ʔǫ́ǫ́ ǫkı honǫ goké kaendee zháhúhłéh gha góʔǫ́.

7. KP 140 gots'ęh 174.5 gots'ę́ ǫkı honǫ dechɻ gots'ęh są́ą́ met'áh ek'élu hohłéh gha ttha gots'ę́ ehgháedezhe gha.

Allnorth ek'élu dánáoʔá ts'enɻdhę tł'a káa mek'ę́ę́ aots'eleh gha dúle genɻdhę. Allnorth, Ram Plateau elák'et'ah nanedéh k'e gúlęę, ek'élu ts'ęh sɥlái dechɻ theʔǫ ehsą́ą́ nezɥ olí genɻdhę. Nezɥ ezhıı ghakats'enehta gogháádé dáǫndıı gots'ehtsɻ gha seenɻ́gots'ɻ́ʔáh gha góʔǫ́.

Ndéh K'aonétǫ

Dıı satsǫ́ kazhe k'é gots'ę́ ek'élu hołéh tł'a xaye goek'élué dánátheʔa k'ę́ę́ ehsą́ą́ nɻʔá gha. Ek'élu ndéh góhté kááhʔa gots'ęh tthe tah gozhíh dítǫ́, tu t'áh gozhíh zháodɻ́ʔá, nagoghɥh k'é zhágóla, tthenadekeh gots'ęh tthe tthéhítła gots'ęh zhah tthéhítła olı t'áh shíh tah gónɻʔá á agǫ́ht'e. Ek'élu ehts'ędɻ dechɻ kathaa gots'ę́ NahʔąąDehé Ndéh K'éhodíh (NNPR) k'eh nɻʔá gha.
CZN, Tetra Tech EBA ndéh dáúɬɻ k'eh ek'élu nɻʔá olı goahnda góhgedı ts'ɻhʔǫ́ǫ́ á yunɻ́h ndéh goedehtł'éhíichuu, tthe dáúɬɻ gǫ́lɻ ghaádé ndéh edehtł'éhé, dúh gots'ęh ndéh edehtł'éhíichuu, LLDAR ndéh éegɻ́hdzáh, godheh golagɻnda-ke gok'aagenéhtǫ ts'ęh edɻhtł'éh kazháǫndıh k'agenehtǫ. Ehsáágodande gots'ę́ ek'élu k'ę́ę́ ndéh k'eh gots'ęh tthe tah godelǫ́ íle azhıı ghǫh xáádé kagǫndíh agǫ́ht'e gok'aagenéhtǫ. Godhąh ndéh dáǫndíh tł'a ndéh ehtę gǫ́lɻ, godáodenaʔah k'eh ndéh íle édé tthe tah godelǫ́ íle gots'ęh tthe zhíhágóʔá kazháǫndíh gok'agenéhtǫ. Azhíı gha zhalagɻnda tł'a ndeh daúɬɻ, tthe

dáúłᶆ, gotł’éh dáúłᶆ gots’ęh ndéh góhtę gǫ́lį ghάádé dáǫndıı ek’elu hólį olíí gha zhágᶆndá.
Ek’élu ndéh zhíhe góhtę k’eh godlį nᶆʔá k’óó kíí azhǫ naexᶣ olı ǫt’e íle. Tetra Tech EBA, łą́hdᶆ honǫ ʔǫ́ǫ́ taı dechį gotah gots’ę́ á ndéh dúle naexᶣ ǫt’e gedı gots’ęh ǫkı honǫ ʔǫ́ǫ́ dᶆ dechį tł’a dúle mek’eh nagoxᶣh ǫt’e kóó godagodenaʔah íle édé dzęndáh agǫ́ht’e t’áh kíí kajá íle olí gedı. Tetra Tech EBA 174 km gots’ę́ ek’élu hołéh gha k’ę́ę́ gok’aogenehtǫ ghάádé tł’a 7.2 km gots’ę́ á shíhdą́ą́ ndéh ítła olí agǫ́ht’e gots’ęh ndéh naenedah olıı t’áh hútł’ıé agǫ́ht’e genᶆdhę. Azhıı gots’ęh 54.9 km gotah tł’a kíí see hútł’íé agǫ́ht’e íle gots’ęh gonááh 20.65 km tł’a tu gok’ᶆłᶆh olı kóó see kaodéhtł’í íle. Gonááh t’ahsíı met’áh godezhí godlį ndááh tł’a ndéh dah zhádílᶆh, 29.6 km kaodande tł’a ndéh zhíh nágoedah olı agǫ́ht’e gots’ęh 17.8 km gotsę́ tł’a zhah tthééhítła gohthe agǫ́ht’e. Hútł’íe godlį t’áh ek’élu t’ahsą́ą́já olı zhagóla tł’a ehk’ę́ę́ zháodᶆʔá á agǫ́ht’e t’áh á 76.7 km gots’ę́ kagǫndíh ts’edı gots’ęh 7.4 km gots’ę́ tł’a hútł’íé agǫ́ht’e íle. Godį ek’élu hołéh t’áh meghǫh gonejı ts’ęhk’eh ts’ę́ aots’eleh gha dúwé édé kexǫedíh t’áhsą́ą́ meghǫh gonejı t’ą́ą́ aots’eleh gha. Godį hútł’íé gonejı zhágǫ́lį sᶆ tł’a see kaodéhtł’íé gonejı íle agǫ́ht’e zhágǫ́lį ʔǫ́ǫ́ts’ę́ ek’élu holéh gha gonejı á agǫ́ht’e. Gonejı ts’ęhk’eh ts’ę́ aots’eleh t’áh k’eots’eʔah édé met’áh ndéh k’eh gots’ęh ek’élu tsᶆdhı ch’á k’eots’eʔah gots’ándı gha. Ek’élu k’ę́ę́ KP048.8-50.8, KP053.7-0546, KP055.8-059.9 gots’ęh KP115.7-115.9 ezhıı á see goxǫedıh t’áh ek’élu hołéh gha.

Got’áh Dágǫ́ht’e Olí

Yunᶆh Gok’ę́ę́ T’ahsíı Ka Ats’et’ᶆ. Dıı ek’élu gots’ęh elák’et’ah nanedéh k’e hołéh ts’ęhk’eh tahsíı t’áh dzááguht’e ch’á k’eots’eʔah t’áh tł’a taı gots’ę́ met’áh t’asą́ą́ gǫ́ht’e olı; tahsíı kaats’et’ı gots’ęh golǫ gots’ęh doo ka gots’ę́ ats’et’ᶆ gha gonezᶣ gots’ęh golǫ káa edᶆgoʔǫ́ǫ́ aots’ehʔᶆ gohthᶆ. Ek’élu gulį édé mek’ę́ę́ náts’edzéh gots’ęh ehdzoo ats’ehʔᶆ gha godezhí íle agúhjá édé dene łǫ gots’ę́ at’ᶆ agǫ́hjá olí. Kaǫndíh kóó ełets’áts’edı t’áh t’ahsáágondeh ch’á gots’ęh golǫah hútł’ıé ats’ehʔᶆ gohthę ka kexǫts’ehndıh gha góʔǫ.

T’ahsáágondeh Gohthę. Ndéh k’eh dágǫndíh gots’ęh ek’élu k’ę́ę́ dágǫndíh ghάádé t’ahsíı nahłaadetł’í gha gonejı zhágóla, naane agǫ́ht’e tł’a kíí see kaǫndíh gha gonejıle agǫ́ht’e íle. Naane agǫ́ht’e tł’a dúle t’ahsíı nałaadétł’ı t’áh hútł’íé nígodę́ę́dhé kóó dagodéhtł’íé agondeh tł’a azhıı k’ezheh ghάádé á dáodéhtł’ıé agújá olı gots’ęh dágodéhthaa gha agǫ́ht’e olí kek’ehodejǫ. T’ahsíı tu láǫndíh k’ezheh á met’áh gonejı, t’ahsíı ndéh gotłehé gots’ęh met’áh ahsíı edítła (acıd) kaǫndíh. Kaǫndíh kóó met’áh

t’ahsíı edítła (acıd) tł’a tłeh tehnı 1,400 lıtres kaecho gots’ę́ zǫh t’áh są́ą́ k’ezheh gha. Funeal Creek gots’ęh Sundog Creek ezhıı á see t’ahsıı náhłaadétł’ı olí agǫ́ht’e. Godı tue zhagǫ́lı tł’a kíí see kaodéhtł’íé t’ahsíı naładetł’ı ghǫh gonejı íle, tł’a godhąhzhágoʔá agǫ́ht’e gots’ęh medhąh tł’a ek’élu det’aazı gots’ęh ehttth’ı déʔá godlı agǫ́ht’e t’áh. T’ahsíı nałaadetł’ı gohthę tł’a ek’élu nezǫh hołéh, gonezǫ édé zǫh mehchıe k’ets’enezho, nezǫ ats’et’ı t’áh mehchıe k’etsts’ę́zho, t’ahsíı nahłaadétł’ı olí gha saats’edéhtth’ı gots’ęh ek’éadheh met’áh ahsíı nałaadétł’ı ghálats’enda olı ts’ehła, t’ahsíı kazháǫndıh t’áh meghǫh kahútł’íé gonejı íle aots’eleh.

Nahʔą̨ą Dehé Ndéh K’éhodíh (NNPR). Praırıe Creek satsǫ́ k’azhe k’e gots’ęh xaye goek’élué t’áh ndéh k’eh dágúht’e olı gok’ats’enehtǫ ghá́adé sahcho tł’a kíí húłt’íé zhededíh gha íle sǫ́ǫ́ndı gots’ęh sahcho dene t’ahsǫlá olı ts’ęhk’eh kaodétł’íé agǫ́ht’e íle. 2010 ekúh Golder adı ghá́adé tł’a dúle sahcho ts’ęhk’éh gonejı kexǫedıh gha sááh nígots’ı́le. Dıı sahcho Nah’ą̨ą Dehé Ndéh K’éhodíh k’ę́ę́ nadeʔáh olı ts’enı̨ʔáh tł’a ek’élu łáǫlíı met’áh ats’et’ı gǫ́lı édé á ats’edı. Kaǫndíh kóó kíí séé mehchıe kanéht’é gha íle gots’ęh mehchıe nágotłah k’egohthe gha íle gots’ęh kıı see sah kanáht’e Praırıe Creek k’ę́ę́ nadeʔáh agǫ́ht’e íle t’áh ghǫh á kíí sah exǫedıh gha sááh nígots’ı́łe ǫǫthah meghalats’enda gha íle. Nahʔą̨ą Dehé Ndéh K’éodíh tł’a kíí ek’élu ts’ı̨hʔǫǫ ndéh k’eh dzaagǫ́ht’e gha íle kóó dene gots’ę́ at’ı gha gonezǫ olí.

Gonááh. Kíı gonááh ndéh gots’ęh t’ahsíı gúlíı égodéhdıh gúlı̨le. Alaeda t’áh gots’ęh kǫ́ę́ gotah gots’ęh ek’élu t’áots’edı̨hthe olí, tł’a satsǫ́ kazhe k’é golaeda t’ahsíı ts’enı̨dhę gots’ęh k’éʔǫǫ dene gots’ę́ at’ı t’áh. Nahʔą̨ą Dehé gots’ę́ ek’élu gots’ęh Lıard ek’élu k’ę́ę́ setsǫ́ kázhe k’é gots’ęh mehchıe k’egohthe t’áh húłt’íé mehchıe łǫ k’egohthe agújá olí. Xaye goek’élué gǫ́lı édé chu kagújá olı. Dıı ek’élu tł’a ǫhk’éha mek’ę́ę́ dzáágǫ́ht’e káhʔa kóó mehchıe łǫ zhek’ę́ę́ at’ı ts’ı̨hʔǫ́ǫ́ séégots’ı́lá olí.

Gohéh Seegúdlá

Káa Nahʔą̨ą Dehé Dene Band gots’ęh Łíídlı̨ı̨ Kǫ́ę́ Fırst Natıons got’áhogedehthı gha gohéh seegúdla agǫ́ht’e kóó, CZN k’áhla ndéh k’eh dágǫndíh olí gok’aonete gots’ęhk’eh Dene kádeʔa gots’ęh Ndéh Ts’ę́ K’aodhee gohéh alagıdéh. Ekélu t’áh ats’et’ı á hútł’íé meghǫh káets’enı̨ʔá, dene gúlíı zhet’áh at’ı ts’ı̨hʔǫ́ǫ́ t’ahságondeh gohthę gots’ęh golǫah gots’ęh yunı̨́h gok’ę́ę́ náts’edzéh gha dzáágondeh gohthę. CZN amıı dúle ek’élu k’ę́ę́ at’ı gha nıgǫ́t’ǫ gǫǫthąh dene zhet’áh at’ı olí gots’ęhk’eh gok’agenehta gha.

EXECUTIVE SUMMARY

Introduction

The Prairie Creek Mine site is located in the southern Mackenzie Mountains in the south-west corner of the Northwest Territories. The Mine is 100% owned by Canadian Zinc Corporation (CZN), and consists of significant mine infrastructure and facilities constructed in the early 1980's. After completing numerous preliminary engineering, environmental and economic studies, CZN applied to the Mackenzie Valley Land and Water Board (MVLWB) for a Type A Water Licence and a Type A LUP to support reactivation of the Mine for production. In addition two Type A LUP's for transfer facilities approximately half-way along the winter access road and at the junction of the road with the Liard Highway were also issued. CZN previously held LUP MV2003F0028 for operation of a winter road. As part of the regulatory process, the applications were referred to environmental assessment (EA). In the terms of reference (TOR) for EA0809-002, issued by the Mackenzie Valley Review Board (MVRB), construction and operation of the winter access road in support of mine operations was included in the scope of development.

The MVRB issued their Report of EA on December 8, 2011 and concluded that the proposed development as described, including CZN's commitments, is not likely to have any significant adverse impacts on the environment or to be a cause for significant public concern. The file was returned to the MVLWB for the permitting phase, and mine operations permits were subsequently issued in September 2013. As changes were made to the access road alignment during the EA, CZN applied for and received new access road LUP's and Water Licences from both the MVLWB and Parks Canada.

CZN's current access road operating plans are based on an early winter opening of the road from the Mine to the Tetcela Transfer Facility (TTF), roughly mid-way along the road to the Liard Highway, in order to start the haulage of concentrates to the TTF. This early winter opening is imperative because of the limited and unpredictable time period available during the winter season, which creates a risk of not being able to transport all of the concentrate product to market, hence reducing revenue. Concerns were also raised in the EA process regarding the ground being sufficiently frozen to support the weight of vehicles in early winter. Sufficient snow availability at this time of year for road bed construction is also a variable of concern. If conditions are not favourable, road construction and opening could be delayed, further limiting the available haulage window. CZN has considered these risks, and the data available indicate that road construction should be possible as planned most years. However, the risk of seasonal delay remains, and this risk could increase in the longer term if the effects of warming due to climate change continue. Concern was also expressed during the EA regarding maintaining safe road conditions through the mountains in winter, and the potential for spills and effective spill response.

For these reasons, CZN has now applied for permits to use the road in all seasons to the TTF. This will enable the year-round transport of concentrates to the TTF, and alleviate the concerns described above.

From an economic perspective, winter-only access unduly delays the receipt of any revenue generated by sales of the concentrate. This delay in revenue is a significant financial burden given the incurred operating cost of producing the concentrate and storing it at the Mine until the next winter road is operational. All season access would significantly reduce this problem, however the benefits will be partially offset by the anticipated significant capital cost to upgrade the access road. All season access could also promote other activities, such as increased tourism, and greater involvement of local aboriginal groups may occur. Also, with all season access, CZN could consider alternate, cheaper and more environmentally-friendly fuels to power the operation (such as propane or liquefied natural gas (LNG)) that are already being developed in the region. Therefore, in addition to applying for all season road use from the Mine to the TTF, CZN is now applying for all season road use from the TTF to the Liard Highway also, which when combined includes the entire road.

CZN wishes to obtain new permits to allow all season road use to the Liard Highway. Phase 1 construction would see the western portion of the road upgraded for all season use from the Mine to the TTF. A second airstrip would also be built on the Ram Plateau near the road to support road construction and maintenance, and to act as an alternate to the Mine strip in bad weather. Phase 2 construction would see the eastern portion of the road upgraded from the TTF to the highway. Construction of Phase 1 and Phase 2 could also occur concurrently, subject to financing. Recent financial projections for mine economics indicate that the latter is both likely and necessary.

Road Engineering

CZN requested Allnorth Consultants Ltd. (Allnorth) to complete an investigation to determine a preferred alignment and design for an all season access road connecting the mine site to the Liard Highway, Highway 7, and locating an airstrip proximal to the road and the Ram Plateau. Allnorth's scope included defining the road location, defining potential borrow sites, evaluating major and minor stream crossings, and identifying and resolving significant construction challenges.

Following an initial desk top review, two field investigations were completed by Allnorth in summer/fall, 2014. The key elements of the road design are:

- Total length of 184.2 km, including the existing 10.0 km of the Nahanni Butte Access Road.
- 20.5 km of preliminary road design representing 10 different stratified types and 6 unique sections.
- A 5 m wide running surface with a 40 km/hr design speed.

- 18 major stream crossings with preliminary designs and 90 minor stream crossings represented by 4 conceptual designs
- 74 borrow pits identified (49 of which are required, with 25 as back-up) to supply subgrade borrow, aggregate, and rock from quarrying.
- A total disturbed area for all activities combined 491.8 hectares.

The main construction challenges include:

(1) Liard River crossing, barge in the summer and winter ice bridge in winter
(2) The western slope of the Silent Hills from KP 96 to 102, potential slope and ground stability issues.
(3) The rock blasting required at KP 23, 25, 28, and 123 stream crossings.
(4) The construction of road bed along the edge of the Sundog Creek floodplain from KP 34 to 39.
(5) Permafrost potential at various locations along the route.
(6) Major stream crossings at KP 23.5, 25.3, and 89.8 requiring 40 plus metre span / multi span structures.
(7) Surface aggregate for road construction from KP 140 to 174.5 may be located up to 20 km away.

Allnorth concluded that the proposed route can be constructed within all reasonable expectations. Allnorth also defined a preferred airstrip location on the west side of the Ram Plateau, approximately 5 km from the road alignment. Detailed field investigation will be required to complete a detailed design required for construction.

Geotechnical Findings

An all season road to the Mine will essentially follow the winter road alignment. The road will cross terrain that includes local discontinuous permafrost and karst, with the potential occurrence of thermokarst, sinkholes, debris flows and thaw slumps, as well as rock fall, rock slides, and snow avalanches in mountainous terrain. Approximately 85 km of the road passes through the Nahanni National Park Reserve (NNPR).

Tetra Tech EBA was requested by CZN to evaluate the terrain along the proposed all-season route, including analysis of historical stereo aerial photos, review of geology and surficial geology mapping, review of recent high-resolution orthophotography and contour data derived from LIDAR survey, previous geotechnical and terrain analysis reports for the route and its predecessors, and other terrain and geotechnical reports from the region. Key aspects of the study included the evaluation of likely contributing factors of existing natural and/or anthropogenic slope instabilities in rock and soils as related to the surrounding terrain and/or permafrost, consideration of ground instabilities in karst terrain including sinkholes; and ground-truthing in the form of geotechnical field investigation and laboratory testing for selected portions of the

route. Work objectives included providing baseline information on terrain, geology, soils, and permafrost, as well as providing a basis for the suitable design and construction of an all-season road.

Though most of the route has the potential to cross permafrost, not all of it is thaw-sensitive. Tetra Tech EBA estimated that about 73 km likely has at least some thaw-sensitive permafrost, and another 24 km may also have thaw-sensitive permafrost, but slope aspect or elevation makes it slightly less likely. Based on a qualitative risk assessment, Tetra Tech EBA estimated that about 7.2 km of the terrain along the proposed all-season route represents a high risk to the road route with respect to slope instabilities or other ground movements, and 54.9 km represents a moderate risk, out of a total of 174.1 km evaluated. The Liard River crossing has a high risk with respect to flooding, and 20.65 km of the route has a moderate risk. Other moderate risks include 4.3 km of the route for overland flow, 29.6 km for seismic activity, and 17.8 km for avalanche activity. Since there is considerable overlap in the moderate risk designations, a total of 76.7 km was estimated to represent a moderate risk to the road, and 7.4 km was estimated to represent a high risk to the road. Where road design and construction mitigations are insufficient to adequately reduce the risk, there are management methods to help further reduce the risk and, in high risk zones, there are also specific contingencies to help manage the risk. Many of the same areas of risk introduced by terrain are also potentially more affected by road development than the lower-risk sections of the road, and so it is anticipated that the proposed mitigations will help protect both the terrain and the road. Road sections KP048.8-50.8, KP053.7-054.6, KP055.8-059.9, and KP115.7-115.9 will need particular attention during detailed design.

Impact Assessment

Traditional Harvesting. With the application of the proposed mitigation measures, there are three residual effects identified for the proposed all season access road and airstrip, including: positive residual effects on subsistence harvest and harvesting areas of Moose and Dall's Sheep; and, adverse residual effects to Moose harvest pressure. Access road operations are expected to increase traditional land use in the area since a re-aligned access road will afford easier access to hunting areas and trap lines. However, a cooperative effort is required to control road access because un-authorized use poses risks to safety and to wildlife from hunting pressures.

Accidents and Malfunctions. The risk of a spill varies from low to high according to terrain on certain road sections. A spill at some locations could have a high consequence, however the severity and duration of the impact varies according to the substance being transported. The greatest risks are posed by liquid substances, such as diesel and acid. However, the risk of an acid spill is limited due to the transportation of totes with a maximum 1,400 litre size. The Funeral Creek and Sundog Creek road sections pose the highest risk of spills. Risks to wetlands are low because the road largely avoids them, and the road is generally flat and straight where it is proximal to them. Spill risks can be effectively mitigated by good road design and construction, driving in good conditions and at safe speeds, and having suitable spill response procedures in place, including control points and response materials available at key locations along the road.

NNPR. The environmental assessment for the Prairie Creek Mine and winter road predicted a low but manageable risk to the regional Grizzly Bear population associated with bear-human encounters and mortality (Golder 2010). Golder (2010) suggested this risk to regional grizzly populations could be managed with a Bear Management Plan. Potential residual effects to Grizzly Bear movements through NNPR were predicted from the proposed all season access road. However, since traffic volumes and speed limits will remain low, and there are few resident bears using the Prairie Creek corridor, no further mitigation is considered necessary beyond the Bear Management Plan. No significant, adverse impacts are predicted to the NNPR ecosystem or visitor experience due to the all season road, but a significant positive impact on NNPR tourism is possible.

Other. No significant impacts are predicted for other subjects of note and valued environmental components. Employment prospects and benefits to local communities are expected to be enhanced with the all season road, due to mine requirements and increased tourism. Traffic on the Nahanni Butte access road and Liard Highway in summer will be between 50-100% higher due to mine traffic, although this traffic increase on the highway would also occur with a winter road to the Mine. Although the highway is in poor condition in places, the additional traffic is expected to be a catalyst for highway improvements.

Engagement

In addition to engagement arrangements in connection with existing Impact Benefit Agreements with the Naha Dehe Dene Band and Lidlii Kue First Nation, CZN has and is continuing to engage with local First Nations and government agencies during this EA process. The main issue of concern is access control, given the risk of road use by non-resident hunters, which represents a safety concern and could lead to negative effects on wildlife and traditional harvesting. CZN is pursuing additional options to restrict road access to authorized users.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF APPENDICES

	Appendix
Volumes 2A and 2B	
Proposed Prairie Creek Mine Access Road: Allnorth Engineering Consultants, April 2015	**1A** **1B**
Volume 3	
Geotechnical Evaluation: Tetra Tech EBA, March 2015	**2**
High Water Levels for Prairie Creek Mine Access Road Stream Crossings: EBA Engineering Consultants Ltd., November, 2012	**3**
Stream Crossing Design Water Levels for Prairie Creek Mine Access Road: Tetra Tech EBA, December, 2014	**4**
Regional Streamflow Time Series Trend Analysis: Northwest Hydraulic Consultants, October 2010	**5**
Analytical Certificates: Maxxam Analytics, 2014	**6**
Vegetation and Wildlife & Wildlife Habitat, Developers Assessment Report Sections: Tetra Tech EBA, February 2015	**7**
All Season Road – Review of Stream Crossings in NNPR: Hatfield Consultants, September, 2014	**8**
Stream Crossing Habitat Assessments: Hatfield Consultants, September, 2014	**9**
Habitat Assessment of Sundog Creek Channels for Realignment: Hatfield Consultants, September, 2014	**10**
Liard River Bathymetry And Bank Survey: Hatfield Consultants, January, 2015	**11**
"Fort Liard Feels Cut-Off from NWT due to poor road": Northern News Service, June 2011	**12**
CZN Engagement Records	**13**
CZN Engagement Plan	**14**

LIST OF ACRONYMS

ADK	Acho Dene Koe Band
Ag	Silver
AMSL	above mean sea level
ANFO	Ammonium nitrate-fuel oil
BC	British Columbia
BMP	Best Management Practice
Cadillac	Cadillac Explorations Ltd.
CBH4	Navigation Canada Designation for the Prairie Creek Airstrip
Ca	Calcium
CCME	Canadian Council of Ministers of the Environment
Cond	Electrical Conductivity
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
Cr	Chromium
CRP	Closure and Reclamation Plan
CZN	Canadian Zinc Corporation
Cd	Cadmium
Cu	Copper
DAR	Developer's Assessment Report
DCFN	Dehcho First Nations
dB	decibel (measurement of sound pressure level)
EA	Environmental Assessment
EC	Environment Canada
ENR	Environment and Natural Resources
EOSD	Earth Observation for Sustainable Development
Fe	Iron
FSCP	Fuel Spill Contingency Plan
GDP	Gross Domestic Product
GNWT	Government of the Northwest Territories
GVW	Gross Vehicle Weight
Ha	hectare (area 100 m by 100 m)
Hg	Mercury
Kg	kilogram
Km and KP	Kilometre marker along access road, Km 0 is Prairie Creek Site
km	Kilometre
INAC	Indian and Northern Affairs Canada
IBA	Impact and Benefits Agreement
JMRFN	Jean Marie River First Nation
LKFN	Liidlii Kue First Nation
LTF	Liard Transfer Facility
LUP	Land Use Permit
m	metre
m^2	1 metre by 1 metre (area)
m^3/day	cubic metres per day (flow volume)

List of Acronyms (cont'd)

Mg	magnesium
mg/L	milligrams per litre
MOU	Memorandum of Understanding
MTS	Mine Training Society
MVLWB	Mackenzie Valley Land and Water Board
MVRMA	Mackenzie Valley Resource Management Act
MVEIRB	Mackenzie Valley Environmental Impact Review Board
MVRB	Mackenzie Valley Review Board
NAG	Non Acid Generating
NDDB	Naha Dehe Dene Band
NNPR	Nahanni National Park Reserve
NO_2	Nitrogen Dioxide
NT or NWT	Northwest Territories
O_3	Ozone
PAG	potentially acid generating
Pb	Lead
PDAC	Prospectors and Developers Association of Canada
PDR	Project Description Report
PC	Parks Canada
pH	Measurement of water acidity or alkalinity
PM_{10}	Particulate Matter with a micron diameter of 10 or less
SARA	Species at Risk Act
Sb	Antimony
SEIA	Socio-Economic Impact Assessment
SNP	Surveillance Network Program
SO_2	Sulphur Dioxide
STP	Sewage Treatment Plant
t/d, tpd	Tonnes per day
TDS	Total dissolved solids
TK	Traditional Knowledge
TOC	Total Organic Carbon
TOR	Terms of Reference
TSP	Total Suspended Particulates
TSS	Total Suspended Sediments
TSX	Toronto Stock Exchange
TTF	Tetcela Transfer Facility
ug/L	micrograms/litre
µs/L	microSiemens/cm (measure of conductivity)
WMP	Wildlife Management Plan
WSC	Water Survey of Canada
Zn	Zinc

DEFINITION OF TERMS

TERM	DEFINITION
Acid generating	Solid material containing sulphides which produce a weakly acidic solution after oxidation and leaching
Berm	A mound or bank of earth used as a barrier
Concentrate	The valuable minerals produced by the Mill after separation from most of the non-economic or gangue minerals
Dissolved metals	Metals dissolved in water
Grandfathered	A previously regulated activity that is exempt from a new environmental assessment process
Karst	A type of topography that is formed on limestone rocks by dissolution.
Neutral drainage	Drainage from solid material containing sulphides which is not acidic, but may contain dissolved metals
Polje	A flat floored, steep sided enclosed basin which is fed by groundwater.
Reclamation	To return the land to productive use, as near as possible to its original state
Stratigraphy	A sequence of different rock types, usually from young to old
Total Metals	Metals occurring in water in both the dissolved form and contained in suspended sediment

TABLE A: CONCORDANCE TABLE

Terms of Reference				Location in DAR	
Section	**Title**	**Sub-Section**	**Description**	**Section**	**Additional Reference**
2.3	Public Engagement	1	Engagement Summary	7.2	
		2	Engagement Methods	7.1	
		3	Traditional Knowledge info. collection	7.3	
		4	Engagement Plan		Appendix ?
2.4	Summary Materials	1	English and South Slavey summaries		Exec Sum
		2	Concordance table		Table A
		3	Commitments table		Table B
2.5	Developer	1	Corporate Summary	2.1	
		2	Ensure contractor's commitments	2.2	
		3	Environmental Performance	2.3	
		4	Corporate Policies	2.4	
3.3	Geographic Scope	1	Spatial Study Area boundaries	3.1	
3.4	Temporal Scope	1	Temporal boundaries	3.2	
3.5	Alternatives	1	Temporal boundaries	3.3	
5.1	Existing Environment and Baseline Conditions - Biophysical	1	Terrain, Geology, Soils, and Permafrost	4.1	
		2	Climate	4.2	
		3	Water Quality and Quantity	4.3	
		4	Species at Risk	4.4	
		5	Fish and Aquatic Habitat	4.5	
		6	Wildlife and Wildlife Habitat	4.6	
		7	Vegetation	4.7	
5.2	Existing Environment and Baseline Conditions -	1	Education, Training and Skills	5.1	
		2	Harvesting	5.2	
		3	Cultural and Heritage Resources	5.3	
		4	Tourism	5.4	
		5	Regional and Local Economies	5.5	
		6	Existing Transportation Routes and Related Infrastructure	5.6	
6	Development Description	1	Project Components and Activities	6.3	
		2	Road Design Considerations	6.4	
		3	Construction Phases and Schedule	6.5	
		4	Existing Infrastructure, Facilities	6.6	
		5	Existing Management Plans	6.7	

Table A: Concordance Table (cont'd)

Terms of Reference				Location in DAR	
Section	**Title**	**Sub-Section**	**Description**	**Section**	**Additional Reference**
7.2	Key Lines of Inquiry	1	Traditional Harvesting and Traditionally Harvested Species	8	
		2	Effects of Potential Accidents and Malfunctions	9	
		3	Impacts to NNPR	10	
7.3	Subjects of Note	1	Terrain, Soils, Permafrost and Karst	11.1	
		2	Granular Materials	11.2	
		3	Air Quality	11.3	
		4	Noise	11.4	
		5	Water Quality and Quantity	11.5	
		6	Species at Risk	8 & 10	
		7	Fish and Aquatic Habitat	11.6	
		8	Wildlife and Wildlife Habitat	11.7	
		9	Vegetation	11.8	
		10	Cultural and Heritage Resources	11.9	
		11	Employment and Benefits to the Community	11.10	
		12	Impacts on Existing Transportation Infrastructure	11.11	
8	Efects of the Environment on the Project	1	Efects of the Environment on the Project	12	Appendix ?
9	Potential Accidents and Malfunctions	1	Potential Accidents and Malfunctions	13	Appendix ?
10	Cumulative Effects	1	Cumulative Effects	14	
11	Follow-Up and Monitoring	1	Follow-Up and Monitoring	15	
12	Closure & Reclamation	1	Closure & Reclamation	16	

TABLE B: COMMITMENTS TABLE

Commitment	Ref.
Engagement	
CZN will continue to engage First Nations throughout the EA process.	7.4
Future engagement with aboriginal groups and government agencies will continue as described in the Engagement Plan.	7.4
Culture	
A brochure of photographs of heritage resources will be compiled and provided to contractors as part of the road Construction, Operation and Maintenance Plan.	11.9
Road Construction	
Brush and debris from clearing the right of way will be windrowed adjacent to the right of way, with breaks every 100 m. Trees felled will be bucked.	App.
During road construction, operations and reclamation, there will be regular inspections by supervisory, maintenance and environmental staff, as well as community monitors. Any evidence of impacts, or conditions that might lead to impacts, will be immediately brought to the attention of the transportation manager. Any obvious problems, such as sediment dispersal, will be rectified immediately by construction/maintenance crews.	11.6
A short and long term road maintenance program would be developed at the detailed road design stage.	15
To minimize impacts related to permafrost, the standard approach taken regarding the cut slope angle will be 1:1 with some variability depending on soil type and site conditions.	A1
For wet, ice rich, or permafrost sections, typical overland construction will include no disturbance of the natural ground layer and placing timber horizontally in a corduroy style to help support the road subgrade.	A1
All reasonable options have been considered to keep maximum grades at 8% or less (preferred). However given the steep mountainous terrain and passes from KP 6 to 30, there are a number of sections with a 10% maximum grade and one short section of 12%.	A1
The subgrade will be left to settle over one summer period to mitigate winter construction risks.	A1
Fuel caches will be located on flat, stable terrain, or in a natural depression, away from slopes leading to water bodies, located above the Q100 high water mark, outside the defined riparian area of proximal bodies of water, will not be stored on the surface of frozen lakes or streams, will have secondary containment for stationary fuel containers with a capacity greater than 230 L, and the containment will be 10 percent greater than the capacity of the largest fuel container.	A1
Solid waste will be organized and stored securely so that it does not attract wildlife, will be removed from the site progressively as the operation is under way, and will be incinerated using a proper manner of incineration.	A1
Non-combustible solid waste will be removed from the sites by the end of construction and operation.	A1

Table B: Commitments Table (continued)

Road Construction (continued)	
Sanitary and grey water will either be collected in tanks for subsequent transfer to trucks for off-site disposal at suitable locations, or processed locally (sumps), meeting the required standards for effluent dispersal. Specific locations will have approved plans which meet the regulatory requirements and site specific conditions.	A1
If permafrost is a factor in the general area of a borrow pit, water should not be allowed to pond on it and create a surface thaw condition leading to permafrost degradation.	A1
If permafrost is present and cannot be avoided in the pit development area, mitigation plans must be in place for dealing with any thawing of slope materials, and for the control and filtration of any resulting melt-water.	A1
Road Operation	
Measures for avoiding concentrate dust and potential tracking of concentrate off-site will be adopted (i.e. bags or bulk concentrate hauled inside a trailer box with a tarpaulin cover, truck wheel-wash)	6.3
Any bags temporarily stored at the TTF will be under cover.	6.3
Signs will be posted advising road users that the land is the traditional land of the NDDB, and a request that the road not be used and that no hunting should occur. Signs will also warn of the dangers posed by frequent, heavy mine traffic.	6.3
The security check-point will be moved in summer to a location on the road west of the river crossing.	6.3
Winter road management plans will need to be reviewed for the all season road to consider applicability to summer conditions.	6.7
Implement CZN's Controlled Road Use Plan.	8.10
Suitable speed limits on the Prairie Creek All Season Road.	8.10
Discourage use of engine retarder breaks.	8.10
A winter driving policy requiring tire chains to be used on haul trucks in the mountains (Phase 1 KP 0-29) to increase traction.	8.10
Containers for sulphuric acid will be totes weighing approximately 1.4 tonnes.	9.2
The GNWT (1998) dust suppression guidelines will be implemented at the TTF and along portions of the road located in environments which are more prone to adverse effects from road dust accumulation (e.g. lakes, wetlands), as appropriate, to limit dust generation during the snow free months. Dust management will begin with road surfacing material which is coarse and minimally erodible, where practical. Where dust is problematic, watering will occur as and when required. Vehicles will adhere to speed limits on roads, which will help limit the re-suspension of particulate material.	11.3
Reclamation	
Bridges will be removed from stream crossings, abutments will be removed or pushed-back. Material will be pulled-back to recontour side-hill cuts. Erosion control measures will be installed as necessary. Restoration of disturbed areas will be promoted by stabilization measures and vegetation by natural invasion.	App.
The progress of reclamation in disturbed areas will be monitored.	11.6

Table B: Commitments Table (continued)

Spill Response	
Proper design and construction of the access road, avoiding steep terrain and hairpin turns as much as possible.	11.5
Designated spill control points will occur at key locations along the road, and response materials will be stored at these locations. Trailers stocked with response equipment will also be parked at other locations so that responding crews can hook them up and move them to the spill location.	9.5
A response team with large equipment will be stationed at the Mine. Another response team will reside at Nahanni Butte.	9.5
Maintenance crew will be working on the road somewhere between Km 40 and Km 170 (i.e. from Cat Camp to the Nahanni Butte Access Road) and will have spill response training.	9.5
For operations, an incident management system will be used to respond to spills.	9.5
Drivers will also receive an orientation package describing the road and specific sections/conditions before driving the road for the first time, and they will be required to read it. Drivers will check in and out, and be in communication with control during the journey.	9.5
For the operating period, the spill response team will consist of 6 personnel: 1 Supervisor, 1 Safety Watch, and 4 Responders, one of which will be a mechanic.	9.5
A silt or other form of curtain will be stored approximately mid-point between the Mine and Funeral Creek ready for deployment to reduce flow in part of Prairie Creek adjacent to a spill.	9.5
A Control Point will be established near the mouth of Funeral Creek.	9.5
Control Points will be established on two Funeral Creek tributaries at their confluence with the main stem. Similar Control Points will also be established on Sundog Creek in two locations (one just above the main falls and one just before the creek flows onto the fluvial outwash plain), and downstream of the Polje Creek, Tetcela River and Grainger River crossings. An additional control point will be established at the toe of the Silent Hills on the west side since the road section above is considered to have a high risk of a spill.	9.5
Spill kits will be carried on vehicles with materials appropriate for the loads.	9.5
For operations, comprehensive spill kits will be maintained at the Mine site, Cat Camp, the Tetcela Transfer Facility, Grainger Gap, and the Liard Transfer Facility.	9.5
Equipment at the Control Points will include booms and absorbents in addition to material to create temporary dams, such as board weirs, sand bags and other inert materials that would be stored at the location. Shovels will also be left on site for use in making a dam also. A supply of soda ash will also be kept at Control Points to neutralize an acid spill.	9.5
Two bladders with a capacity of approximately 10,000 L will be acquired. This would provide the means to commence the recovery and temporary storage of spilled liquid quite soon after the spill. One would be stationed with a pump at one of the Control Points on an upstream tributary to Funeral Creek.	9.5
A vacuum truck will be on stand-by at the Mine.	9.5

Table B: Commitments Table (continued)

Water and Water Quality	
Properly maintaining and inspecting vehicles for leaks, and using drip pans for stationary equipment.	11.5
Fish	
The fish habitat against the south bank will be lost, but would be replaced by comparable new habitat to the north. This work would be completed in the late fall when the floodplain is dry apart from isolated deep pools. Any pools would be subject to fish salvage before filling. In order to ensure the excavated channel remains open and utilized long-term, a series of very large (small car-size) boulders would be placed in the channel.	6.4
All crossings will follow DFO's *Operational Statements* for creek crossings, including span structures and culverts.	11.6
In-stream works and crossings will be avoided as much as possible.	11.6
Blast energy will be limited to that required, and fly rock avoided as much as possible.	11.6
Once the road and crossings have been built, disturbed areas will be reclaimed by grading, and providing runoff and sediment controls, as necessary.	11.6
Replace any habitat losses to the satisfaction of DFO.	11.6
Minimize disturbance of stream banks and riparian areas at stream crossings.	11.6
Remove temporary crossing structures to avoid blockage and erosion	11.6
Construct a stable road bed adjacent to creeks and providing for runoff control to minimize the dispersal of sediment during precipitation events.	11.6
Promote re-vegetation of riparian areas to further reduce the potential for sedimentation.	11.6
Avoid disruption of the only known spawning location in the area (bull trout in Funeral Creek) during the spawning period (mid-August).	11.6
Wildlife	
A no hunting policy for all Project employees and contractors while working and/or at the Mine site.	8.10
A wildlife and wildlife habitat mitigation and monitoring plan that includes annual engagement with members of the Naha Dehe Dene Band to monitor measureable parameters of effects.	8.10
Policy giving wildlife the right-of-way, obligating drivers to stop (when safe to do so) for wildlife seen on or immediately adjacent to the road, to allow them to move away.	8.10
Policy that all Project-related transportation activities are to give the right-of-way to any wildlife that such activity may encounter.	8.10
Develop standard aircraft procedures for flying into and departing from the proposed airstrip to accommodate wildlife, if present on or near the airstrip.	8.10
Maintain a minimum flight altitude of 600 m except during take-off and landings.	8.10
Dust suppression strategies (e.g., water or approved dust suppressant products) in accordance with the GNWT dust suppression guidelines.	8.10
Follow the existing draft Contaminant Loading Management Plan and soil sampling along the road bed both before and during haul operations.	8.10

Table B: Commitments Table (continued)

Wildlife (continued)	
An education program of wildlife related policies and mitigation to all Project employees and contractors, including a bear awareness program to ensure employees and contractors are informed of bears and other potentially dangerous wildlife and the level of risk.	8.10
Project employees and contractors to avoid all known or suspected den and nest sites.	8.10
An alert system to warn personnel of Woodland Caribou and other sensitive wildlife in the local area by relaying sighting information to vehicles/aircraft and equipment operators and on-site personnel.	8.10
Wildlife sighting logs to be completed by all Project employees and contractors for wildlife sightings (e.g., Dall's Sheep, caribou, Wood Bison) with respect to species, location along the access road/ airstrip, numbers, and reaction to Project activity. If a problem area is identified, corrective measures will be considered.	8.10
ENR's Woodland Caribou Best Management Practices for Industrial and Commercial Activities (once developed) to be incorporated into the wildlife monitoring program, where feasible, to manage or mitigate habitat impacts and sensory disturbances on Woodland Caribou.	8.10
Snow removal practices along the access road and airstrip to manage high snow banks, so that wildlife can readily move off as vehicles/aircraft approach.	8.10
A structure for reporting human-dangerous wildlife encounters at the TTF and resulting incidents to inform Mine management and ENR staff.	8.10
A protocol for dealing with problem bears, with a designated chain of responsibilities for ensuring worker safety and efficient and speedy resolution of incidents.	8.10
A Waste Management Plan that prohibits littering, purposely feeding wildlife, and storing attractants accessible to wildlife. Incinerate all waste foods and human garbage consistent with current industry good management practices to minimize wildlife attraction to the local area. Adaptive management will be applied to waste management practices. If wildlife are found to be attracted to the site (i.e., problem wildlife) additional management practices, if required, will be adopted.	8.10
Fuel storage facilities that meet industry standards for tank construction, location and spill containment.	8.10
Appropriate materials management systems will minimize the risk of accidental spills or leakage of concentrate, diesel fuel/ hydrocarbons, and other hazardous materials being shipped to the mine site. This includes ensuring hydrocarbon and chemicals that are hauled along the access road or stored at the TTF are in industry standard containers with appropriate spill containment and management measures in place.	8.10
Staff trained on the existing spill management plan and procedures to quickly respond to an accidental spill. The plan will include provision for rapid deployment of cleanup crews and for contaminant and cleanup of spilled material and contaminated surfaces.	8.10
Managing the small portion of the winter road not used for all season access to prevent predator and non-Project related travel of the corridor, if necessary.	8.10
Preservation of natural drainage patterns along the haul road to maintain the natural function and processes of peatland habitats adjacent to the haul road.	8.10

Table B: Commitments Table (continued)

Wildlife (continued)	
A policy to avoid significant changes to water levels while pumping water from a known Beaver pond in the fall and winter periods.	8.10
Maintain sufficient buffer distances between development activities (e.g., re-fuelling and material storage) and waterbodies, where possible.	8.10
Non-mine vehicles, including all-terrain vehicles (ATVs) and snowmobiles will be prohibited on site.	8.10
Pets will be prohibited along the all season access road.	8.10
Adherence to standard industry best practices during construction.	10.13
Prohibit pumping water from ponds occupied by Trumpeter Swans during nesting.	10.13
Discuss issues and considerations regarding wildlife populations and effects during the Technical Advisory Committee meetings proposed by CZN in EA0809-002.	10.13
Report annual updates and results of the Wildlife Mitigation and Management Plan, Controlled Road Use Plan, and inspections and enforcements.	10.13
Reporting and evaluating wildlife sightings along the access road and airstrip, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered.	10.13
Prohibit hunting, trapping, harvesting, and fishing by site employees and contractors.	10.13
The appropriate regulatory agencies (i.e., GNWT ENR and Parks Canada) will be contacted to receive additional direction regarding new issues that arise.	10.13
Surveying for and reporting the presence/absence of Collared Pikas (ranked as May Be At Risk in the NWT) at borrow sources BP 14 and 16 prior to Project-related disturbances, and consider additional mitigation should pikas be present.	11.7
Cease barging activities if Wood Bison are observed crossing the river near the barge location.	11.7
Provide the Dehcho Land Use Planning Committee (and others as requested) the post-construction digital footprint of the all season access road and associated facilities to incorporate into ongoing cumulative effects monitoring across the Dehcho.	11.7
Surveying for and reporting the presence/absence of Collared Pikas (ranked as May Be At Risk in the NWT) at borrow sources BP 14 and 16 prior to Project-related disturbances, and consider additional mitigation should pikas be present.	11.7
Amend the existing draft Wildlife Mitigation and Monitoring Plan, as necessary, to include the monitoring of measureable parameters of effects.	11.7
Vegetation	
Development and implementation of an invasive species management plan to ideally prevent, or if necessary, control the establishment of invasive plant species in off-site vegetation communities adjacent to the roadway.	8.10
Confine all season road development activities to the approved winter road corridor to the greatest extent feasible.	11.8
Train staff in fire prevention protocols and emergency response procedures.	11.8
Construction in accordance with best standard industry practices in relation to soil disturbance, hydrology maintenance and construction in permafrost areas.	11.8

Table B: Commitments Table (continued)

Vegetation (continued)	
Refuelling of trucks and equipment away from any stream, lake, wetland or other water body, per industry standards.	11.8
Terrain	
Map subsidence features on the Ram Plateau between Km 59 and Km 84, within about 200 metres of the road. Annually review these features and document any change in conditions.	10.10
Construction will be managed such that travel across the ground does not occur when it is in its most vulnerable state.	11.1
Embankment fill-only (overlanding) techniques are proposed for thaw-sensitive permafrost areas.	11.1
Summer/fall construction is proposed to take place when the ground is seasonally more likely to be relatively dry. The benefit of summer/fall construction in terrain that is not thaw-sensitive is that the construction team will be able to see more clearly where the cross-drainage installations should be placed, and backfill placement and compaction will be greatly improved.	11.1
Cutslopes in thaw-sensitive terrain should be avoided if at all possible. If cutslopes in thaw-sensitive terrain are unavoidable, it may be possible to protect some cutslopes with a drainage blanket to help mitigate the effects of thaw and meltwater, or design near-vertical cutslopes to allow the organic layer to be draped over the cutslope to shade and protect it.	11.1
If cutslopes in thaw-sensitive terrain are unavoidable, a much greater need for vigilance in monitoring and maintenance is required.	11.1
Careful placement of culverts even where there are no obvious stream channels will help reduce the likelihood of ponding water alongside the road embankment.	11.1
Regular inspections will help identify areas where surface water drainage provisions need to be changed or improved.	11.1
The development, working and restoration of borrow sources will be carefully planned and carried out to reduce or avoid negative effects including permafrost thaw and soil erosion.	11.1
Some general guidelines for borrow sources are: minimize the surface area of the open cut; grade slopes to reduce slumping; grade material storage and working areas to promote drainage and avoid standing water; and, restore the borrow source when construction is completed by grading slopes to match the natural ground and drainage of the surrounding area, and replacing overburden.	11.1
Careful culvert placement and sizing is especially important on slopes that already have significant existing slope instabilities and the potential for new instabilities.	A2
In areas of switchbacks, any road location that receives a culvert on an upslope reach of a stream should also receive a culvert or culverts on the road sections downslope that re-cross the same stream, and water should not be allowed to flow off the ends of switchbacks into inappropriate areas.	A2
If a significant seismic event occurs, it would be prudent for a pilot vehicle to inspect the road before trucks resume travelling on it.	A2

Table B: Commitments Table (continued)

Terrain (continued)	
The avalanche assessment and map prepared previously for the road will be incorporated into an appropriate Road Operations Plan.	A2
Parks is preparing a National Parks Caving Directive which may have information of value in karst terrain, and should be contacted.	A2
Socio-Economics	
In order to ensure that its contractors and subcontractors honour and adhere to all commitments made, CZN will ensure, through written contracts, that all such parties are aware and comply with all the terms and conditions that are associated with such permits that are necessary for operations.	2.2
CZN will endeavour to ensure that all service providers are fully qualified and responsible to undertake the tasks required prior to issuing contracts.	2.2
When hiring contractors, CZN will provide instruction and training, if necessary, to bind all contractors and sub-contractors to corporate policies.	2.4
CZN is required to post available employment positions with local Bands, and suitable and available NDDB members have priority. CZN has also committed to give preference to competitive and able consortia with local and northern content for procurement and business opportunities.	6.3
Monitoring	
Monitoring data will be compatible with the NWT Cumulative Impact Monitoring Program, where possible.	15
Update the existing draft WMMP to include all season monitoring and species potentially affected by all season access road/ airstrip use. Additional considerations include: mortality thresholds for additional species at risk (e.g., Trumpeter Swan, Collared Pika), Moose, and Dall's Sheep; monitoring, evaluating, and reporting harvest pressure, particularly along the Nahanni Range portions of the outfitter zone located outside the NNPR boundary; and, educating and promoting First Nations voluntary reporting of harvests from along the all season access road.	15
If excessive use of the road occurs by non-residents, and hunting pressures or safety concerns result, additional access control measures will need to be considered involving local communities and government agencies.	15
Monitor any borrow pits incorporating tall cut slopes or adjacent to environmentally sensitive areas for any evidence of slope instability during any excavation operations.	A1
Carry out at least monthly visual inspections for areas designated high-risk due to potential slope stability or ground stability issues until seasonal baselines for behavior are established, and then carry out regular visual inspections thereafter, including at least one inspection prior to spring freshet to confirm that culverts are free-draining, then monthly during the thaw season, and at least once during the winter for areas with hazards that exist in winter (e.g. for rock fall that is freeze/thaw-related).	A2
Carry out inspections for high-risk areas within 24 hours of major rainfall events, abnormally high spring thaw events or significant seismic events, and/or prior to mine traffic travelling the road.	A2

App=Application 2.2=DAR Section A1=Appendix 1

1.0 INTRODUCTION

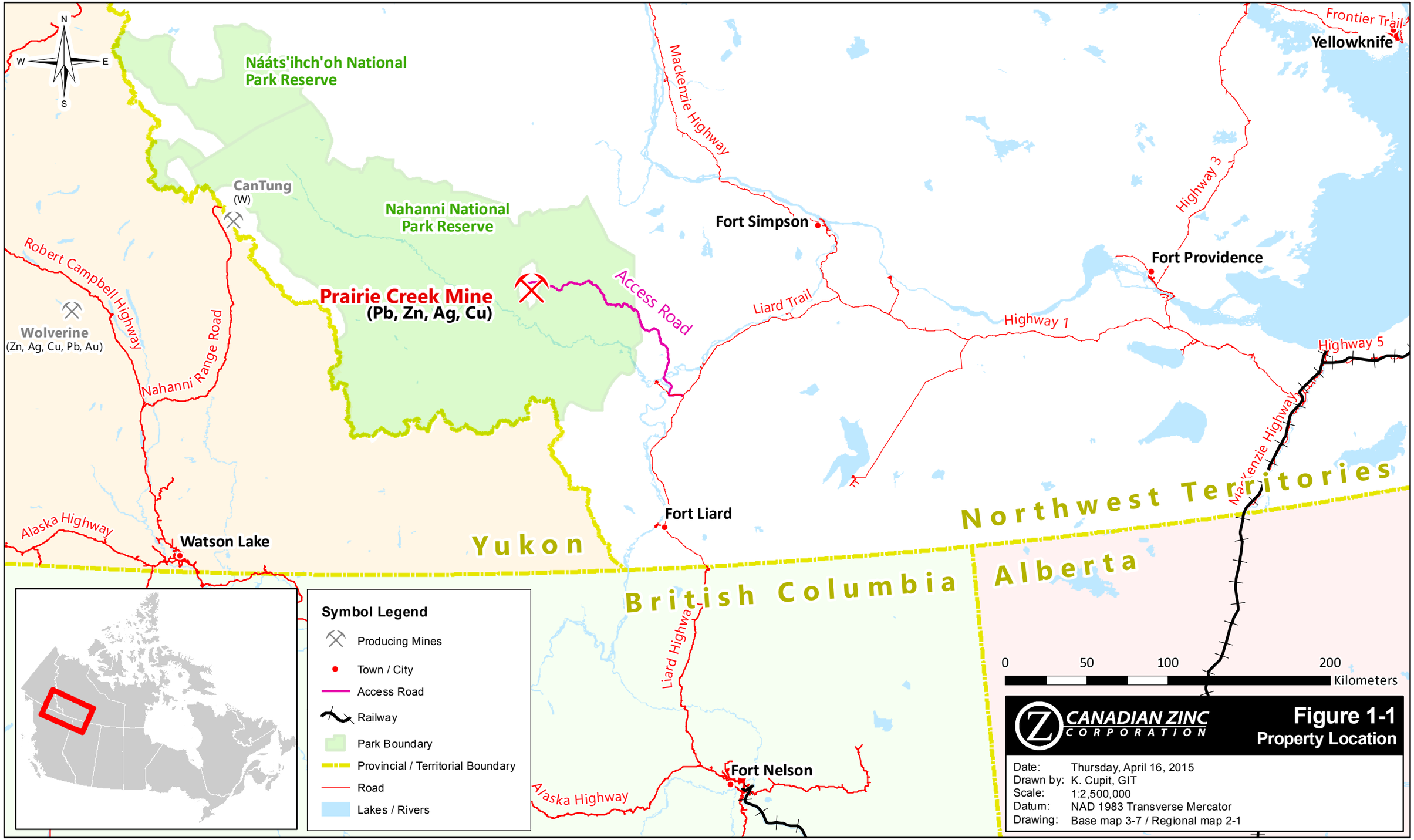
1.1 Background

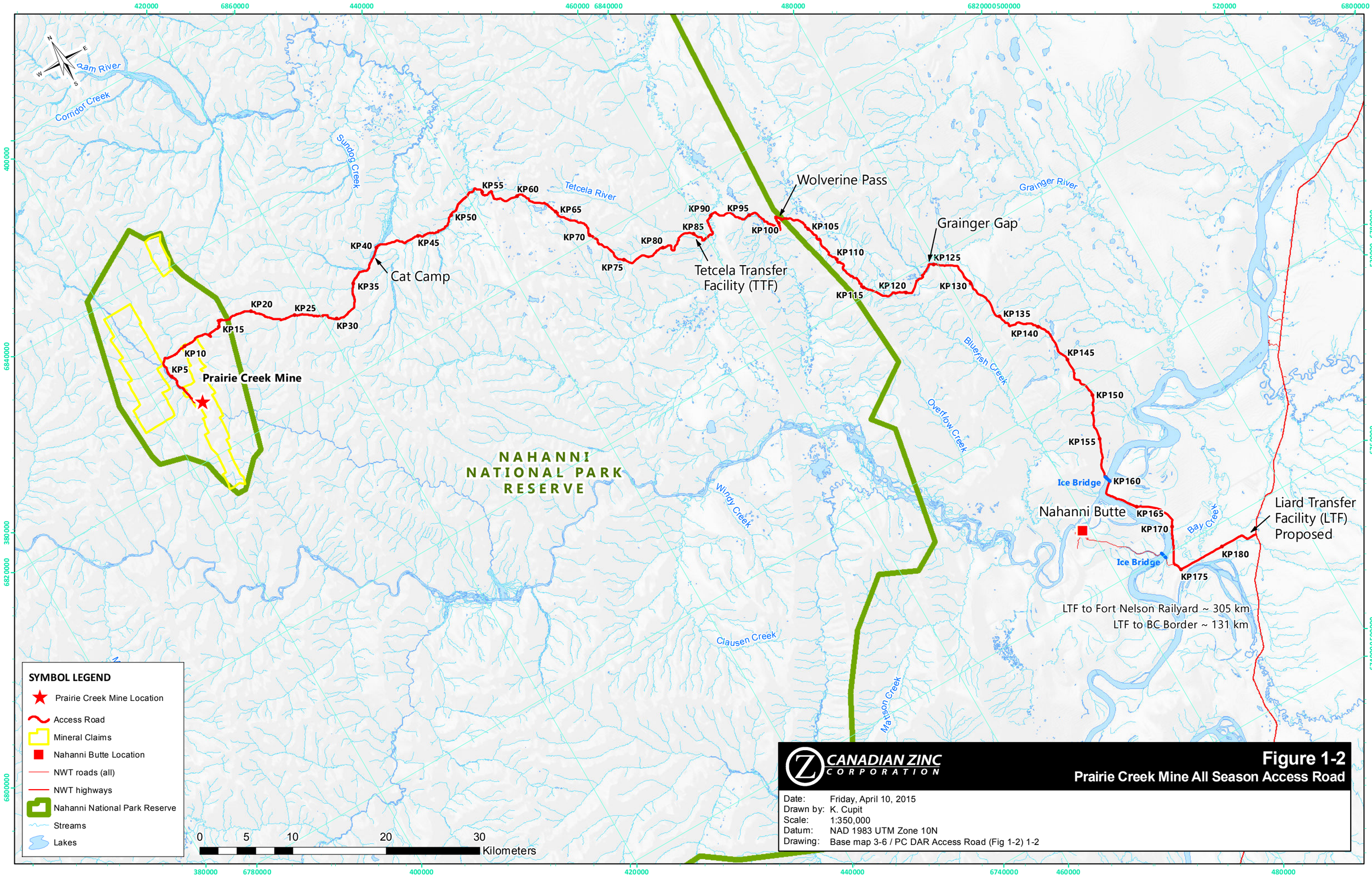
The Prairie Creek Mine site is located in the southern Mackenzie Mountains in the south-west corner of the Northwest Territories (Figure 1-1). The Mine is 100% owned by Canadian Zinc Corporation (CZN), and consists of significant mine infrastructure and facilities constructed in the early 1980's. The Mine received an operating Water Licence in 1982 and Land Use Permits (LUP) in 1980 to allow production of concentrates of lead and zinc and a silver-bearing copper concentrate and use of an access road from the Mine to the Liard Highway. The Mine was three months from production when it was placed into receivership due to market conditions. CZN, formerly named San Andreas Resources Corporation acquired the property in 1991, and has since expanded and developed the mineral resource.

After completing numerous engineering, environmental and economic studies, in 2008 CZN applied to the Mackenzie Valley Land and Water Board (MVLWB) for a Type A Water Licence and a Type A LUP to support reactivation of the Mine for production, and two Type A LUP's for transfer facilities approximately half-way along the access road and at the junction of the road with the Liard Highway. CZN already held LUP MV2003F0028 for operation of a winter road. As part of the regulatory process, the applications were referred to environmental assessment (EA). In the terms of reference (TOR) for EA0809-002, issued by the Mackenzie Valley Review Board (MVRB), construction and operation of the access road in support of mine operations was included in the scope of development.

The MVRB issued their Report of EA (REA) on December 8, 2011. The MVRB concluded that the proposed development, as described in the REA and including CZN's commitments, is not likely to have any significant adverse impacts on the environment or to be a cause for significant public concern. The file was returned to the MVLWB for the permitting phase, and mine operations permits were subsequently issued, including Water Licence MV2008L2-0002 issued on September 24, 2013. As changes were made to the access road alignment during the EA, CZN applied for and received new access road LUP's and Water Licences from both the MVLWB and Parks Canada.

CZN's current access road operating plans are based on an early winter opening of the road from the Mine to the Tetcela Transfer Facility (TTF) at approximately Km 84 (see Figure 1-2), roughly mid-way along the road to the Liard Highway, in order to start the haulage of concentrates to the TTF. This is imperative because of the limited and unpredictable time period available during the winter season. Concerns were raised in the EA process regarding the ground being sufficiently frozen to support the weight of vehicles in early winter. Sufficient snow availability at this time of year for road bed construction was also a concern. If conditions are not favourable, road construction and opening could be delayed.


N
W
E
S
Náàts'ihch'oh National Park Reserve
Nahanni National Park Reserve
CanTung
(W)
Prairie Creek Mine
(Pb, Zn, Ag, Cu)
Wolverine
(Zn, Ag, Cu, Pb, Au)
Robert Campbell Highway
Nahanni Range Road
Alaska Highway
Watson Lake
Access Road
Mackenzie Highway
Fort Simpson
Liard Trail
Highway 1
Fort Liard
Highway 3
Fort Providence
Frontier Trail
Yellowknife
Highway 5
Mackenzie Highway
Yukon
Northwest Territories
British Columbia
Alberta
Liard Highway
Alaska Highway
Fort Nelson
0
50
100
200
Kilometers
Symbol Legend
Producing Mines
Town / City
Access Road
Railway
Park Boundary
Provincial / Territorial Boundary
Road
Lakes / Rivers
CANADIAN ZINC CORPORATION
Figure 1-1
Property Location
Date: Thursday, April 16, 2015
Drawn by: K. Cupit, GIT
Scale: 1:2,500,000
Datum: NAD 1983 Transverse Mercator
Drawing: Base map 3-7 / Regional map 2-1


Ram River
Corridor Creek
Sundog Creek
Tetcela River
Grainger River
Bluefish Creek
Overflow Creek
Windy Creek
Clausen Creek
Mattson Creek
Bay Creek
NAHANNI
NATIONAL PARK
RESERVE
Prairie Creek Mine
Cat Camp
Tetcela Transfer
Facility (TTF)
Wolverine Pass
Grainger Gap
Nahanni Butte
Ice Bridge
Ice Bridge
Liard Transfer
Facility (LTF)
Proposed
KP5
KP10
KP15
KP20
KP25
KP30
KP35
KP40
KP45
KP50
KP55
KP60
KP65
KP70
KP75
KP80
KP85
KP90
KP95
KP100
KP105
KP110
KP115
KP120
KP125
KP130
KP135
KP140
KP145
KP150
KP155
KP160
KP165
KP170
KP175
KP180
LTF to Fort Nelson Railyard ~ 305 km
LTF to BC Border ~ 131 km
SYMBOL LEGEND
Prairie Creek Mine Location
Access Road
Mineral Claims
Nahanni Butte Location
NWT roads (all)
NWT highways
Nahanni National Park Reserve
Streams
Lakes
0 5 10 20 30
Kilometers
CANADIAN ZINC CORPORATION
Figure 1-2
Prairie Creek Mine All Season Access Road
Date: Friday, April 10, 2015
Drawn by: K. Cupit
Scale: 1:350,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-6 / PC DAR Access Road (Fig 1-2) 1-2

CZN has considered these risks, and the data available indicate that road construction should be possible as planned most years. However, the risk of seasonal delay remains, and this risk could increase in the longer term with the effects of climate change. Concern was also expressed during the EA regarding the road conditions through the mountains in winter, and the potential for spills and effective spill response.

For these reasons, CZN applied for permits to use the road in all seasons to the TTF. This will enable the year-round transport of concentrates to the TTF, and alleviate the concerns described above.

From an economic perspective, winter-only access unduly delays the receipt of any revenue generated by the sales of the concentrate. This delay in revenue is a significant financial burden given the incurred operating cost of producing the concentrate and storing it at the Mine until the next winter road is operational. All season access would remove this problem, but is counter-balanced by the anticipated significant cost to upgrade the portion of the access road from the TTF to the Liard Highway. However, all season access could promote other activities, such as increased tourism, and greater involvement of local aboriginal groups may occur. Also, with all season access, CZN could consider alternate, cheaper and more environmentally-friendly fuels to power the operation, such as propane or liquefied natural gas (LNG). Therefore, in addition to applying for all season road use from the Mine to the TTF, CZN also applied for all season road use from the TTF to the Liard Highway, which when combined includes the entire road.

The road bed from the Mine (Km 0) to Km 39 (Cat Camp) is already of all season quality. In addition, Cadillac's road LUP provided for all season use of that section. The majority of the remainder of the road to the TTF location is on solid ground with very little muskeg terrain.

CZN wishes to obtain new permits to allow all season road use to the Liard Highway. Phase 1 construction would see the western portion of the road upgraded for all season use from the Mine to the TTF. A second airstrip would also be built on the Ram Plateau near the road to support road construction and maintenance, and to act as an alternate to the Mine strip in bad weather. Phase 2 construction would see the eastern portion of the road upgraded from the TTF to the highway. Construction of Phase 1 and Phase 2 could also occur concurrently, subject to financing. Recent financial projections for mine economics indicate that the latter is both likely and necessary

1.2 Access Road Regulatory History

Between 1970 and 1980, extensive underground development of the Mine took place. A winter tote road from Camsell Bend into the Mine was established in 1974/75 in order to bring supplies and heavy equipment in. An engineering feasibility study was completed by Kilborn Engineering (B.C.) Ltd. in 1980 for Cadillac, with environmental assessments directed by Ker Priestman, culminating in Preliminary Environmental Evaluation reports, one on the Mine, Mill and Camp, and one on the Winter Access Road, both dated May 1980. The latter study was the basis for a successful application for Land Use Permit N80F249.

A new access road was constructed from the recently built Liard Highway (Northwest Territories Highway 7) into Prairie Creek, beginning in the summer of 1980. The road intersected the Highway 3 km north of Lindberg Landing, approximately 7 km north of the Blackstone River. At that time, the Highway south to Fort Liard was not completed. The access road was used extensively over the period from late January to the end of March in both 1981 and 1982. In excess of 800 loads were hauled into the Mine over these two years.

CZN applied for a LUP to use the existing access road alignment to re-supply the Mine in May, 2003. The MVLWB referred the application to EA, however CZN requested a judicial review of the referral decision, and the Supreme Court of the Northwest Territories ruled that the road was 'grandfathered' according to Section 157.1 of the Mackenzie Valley Resource Management Act, because the undertaking was previously assessed in the 1980's and LUP N80F249 was issued. LUP MV2003F0028 for use of the road was subsequently issued by the MVLWB on April 7, 2007. Subsequent to receiving the road permit, an evaluation of the road determined that washed-out sections of the road required repair, and further permits were needed. A quarry permit and Water Licence were issued in relation to the repairs, as well as an authorization from Fisheries and Oceans Canada following several fisheries studies.

As noted above, in the terms of reference (TOR) for EA0809-002, construction and operation of the access road in support of mine operations was included in the scope of development. However, the MVRB indicated that it would not be assessing structures already in existence in connection with the access road, as explained in the following statement contained in the MVRB ruling:

"The Review Board accepts the argument made by Canadian Zinc and others that conducting an impact assessment of the construction of facilities, including the road, which have been present on the land for over 25 years is not likely to generate any useful information even if it is possible. The Review Board will not be assessing construction impacts of already built structures."

The Board also indicated that it would consider proposed changes to the access road. CZN did indeed propose changes, and these were assessed. Changes were made to the access road alignment during the EA to address concerns from the Naha Dehe Dene Band about wetland/wildlife issues, and from Parks Canada regarding re-routing around the unique Polje-karst features.

As a result, after the EA, CZN applied for and received new access road LUP's and Water Licences from both the MVLWB and Parks Canada. The MVLWB issued LUP MV2012F0007 and Water Licence MV2012L1-0005 on January 10, 2013 and Parks Canada issued LUP Parks2012-L001 and Water Licence Parks2012_W001 on August 26, 2013.

2.0 INFORMATION ON THE DEVELOPER

2.1 Corporate History and Operational Experience

Overview

Canadian Zinc Corporation's head and registered office is located at Suite 1710, 650 West Georgia Street, Vancouver, British Columbia, Canada V6B 4N9. CZN also has a regional office in Fort Simpson at: 9926-101st Avenue, PO Box 500, Fort Simpson NT, X0E 0N0. The corporate registered NWT address is Lawson Lundell LLP, P.O. Box 818, 4908-49th Street, Yellowknife, NT, X1A 2N6.

CZN is listed on the Toronto Stock Exchange, the OTC Bulletin Board in the United States, and on the Frankfurt Exchange in Germany.

The CZN Board of Directors is:

John F. Kearney	Chairman, President and Chief Executive Officer
Alan B. Taylor	Chief Operating Officer and Vice-President, Exploration
John A. MacPherson	Board Member
Brian Atkins	Board Member
Dave Nickerson	Board Member

As required by National Instrument 58-201, CZN's corporate governance practices are outlined in the Management Information Circular posted on the SEDAR website, www.sedar.com, dated May 12, 2009 and on CZN's website: www.canadianzinc.com.

CZN's interest in the 100%-owned Prairie Creek Mine began in 1991. CZN's intention is to bring the Mine into production at the earliest possible date. Beginning in 2012, Canadian Zinc diversified efforts in a second area of mineral interest in central Newfoundland. CZN acquired Paragon Minerals and their portfolio of 10 prospective base and precious metal projects, including the South Tally Pond Project. In addition during 2013, CZN acquired Messina Minerals and the Tulks South and Long Lake projects.

None of the above noted properties have been in commercial production, and therefore CZN has no corporate operational experience.

Corporate History – Prairie Creek Project

Mineralization was first discovered at Prairie Creek in 1928. Cadillac Explorations Ltd. (Cadillac) acquired the property in 1966. Underground development started in 1969. Environmental assessments in 1980-81 were the basis for successful applications for operating Land Use Permits (LUP's) and a Water Licence.

An access road was constructed from the then partially completed Liard Highway (Northwest Territories Highway 7) into Prairie Creek, beginning in the summer of 1980. The road intersected the Liard Highway 3 km north of Lindberg Landing, approximately 7 km north of the Blackstone River. The road was used extensively over the period from late January to the end of

March in both 1981 and 1982. In excess of 800 loads were hauled into the Mine site over these two years. In May 1982, the Mine was placed into receivership and was held on care and maintenance status until 1990.

In 1991, CZN (at that time named San Andreas Resources Corporation (SARC)) negotiated an option to acquire an interest in the property. In 1993, SARC exercised its option to acquire a 100% interest in the mineral properties and a 60% interest in the plant and facilities of the Mine subject to a 2% net smelter royalty. The remaining interest in the plant and facilities along with the royalty were subsequently purchased by CZN in 2004.

In 1999, SARC's name was changed to Canadian Zinc Corporation. Prior to the enactment of the Mackenzie Valley Resource and Management Act (MVRMA) in 1999, Land Use Permits (LUP's) were issued by Indian and Northern Affairs Canada (INAC). A history of permitting is given in Table 2-1. Six of CZN's applications to the MVLWB for exploration activities have been referred to EA, along with the operations applications.

In November 2001, applications for a LUP for development of an underground decline to allow more efficient definition drilling of the mineral resource, and a Water Licence for pilot plant testing of the ore were submitted to the MVLWB. Both applications were referred to a joint EA. LUP MV2001C0023 and Water Licence MV2001L2-0003 were subsequently issued in September, 2003.

CZN applied to use the existing access road alignment in May, 2003. The Supreme Court of the Northwest Territories ruled that the road was 'grandfathered' under the MVRMA according to Section 157.1. LUP MV2003F0028 for use of the road was issued by the MVLWB on April 7, 2007. Subsequent to receiving the road permit, an evaluation of the road determined that washed-out sections of the road required repair, and further permits were needed. A quarry permit and Water Licence were issued in relation to the repairs, as well as an authorization from Fisheries and Oceans Canada (DFO) following several fisheries studies.

A request to amend the Phase 2 surface drilling LUP was made to allow further exploration outlying from the Main Zone. The amendment application was referred to EA in June, 2004 and became EA 0405-002 (Dec. 23, 2005) for the Phase 3 surface drilling project. LUP MV2004C0030 was issued in May, 2006. Additional water quality studies and wildlife surveys were conducted in support of permit requirements.

Detailed baseline studies describing the existing environment in the vicinity of the Prairie Creek Mine and along the existing access road corridor were undertaken in 1980-81 as a component of previous environmental assessments conducted in support of operating permits (Land Use Permits and a Water Licence) issued at that time. Water Survey of Canada (WSC) operated an automated flow monitoring station on Prairie Creek adjacent to the Mine from 1974-1990. Additional studies to update the baseline were undertaken in 1994-1995 in support of further permitting efforts. These studies included field assessments and descriptions of fisheries and aquatic resources, as well as wildlife populations and wildlife habitat.

TABLE 2-1: HISTORY OF PERMITTING ACTIVITY – PRAIRIE CREEK MINE

Permit/Licence Type	Permit/Licence Identifier No.	Permit/Licence Purpose	Date of Application	EA	Date Issued	Expired/ Expires	Issuing Agency	Enabling Legislation
Land Use Permit	N80F249	Winter Road	04-Mar-80	Yes	02-Jul-80	1983	DIAND	TLA&R
Land Use Permit	N80F248	Expl DDH & u/g dev	04-Mar-80	Yes	14-Apr-80	12-Apr-85	DIAND	TLA&R
Water Licence	N3L3-0932	Mining & Milling	30-Jul-80	Yes	01-Jul-82	30-Jun-86	NWTWB	NIWA&R
Quarry Permit	81/42	Gravel quarry	31-Mar-81	No	02-Jul-81	Per N80F248	DIAND	TQR
Land Use Permit	N86C537	Expl DDH	12-Feb-86	No	07-Apr-86	30-Oct-86	DIAND	TLA&R
Land Use Permit	N87C668	Expl DDH	21-Jan-87	No	06-Mar-87	30-Sep-88	DIAND	TLA&R
Land Use Permit	N92C778	Expl DDH	11-Jun-92	No	27-Jul-92	30-Dec-94	DIAND	TLA&R
Land Use Permit	N95C373	Expl DDH	01-Mar-95	No	12-Apr-95	10-Apr-98	DIAND	TLA&R
Land Use Permit	MV2000C0030	Expl DDH (6-7)	28-Jul-00	Yes	14-Jun-01	13-Jun-06	MVLWB	MVRMA
Land Use Permit	MV2001C0022	Expl DDH (50-60)	05-Mar-01	Yes	30-Nov-01	29-Nov-08	MVLWB	MVRMA
Land Use Permit	MV2001C0023	U/G Decline	05-Mar-01	Yes	10-Sep-03	09-Sep-10	MVLWB	MVRMA
Water Licence	MV2001L2-0003	Pilot Plant	05-Mar-01	Yes	10-Sep-03	09-Sep-19	MVLWB	MVRMA
Winter Road	MV2003F0028	Winter Road	25-Sep-03	No	11-Apr-07	10-Apr-14	MVLWB	MVRMA
Land Use Permit	MV2004C0030	Expl DDH (amend)	01-Jun-04	Yes	11-May-06	10-May-13	MVLWB	MVRMA
Water Licence	MV2007L8-0026	Rehab winter road	07-Jun-07	No	20-May-08	19-May-13	MVLWB	MVRMA
Authorization	SC04-006	Rehab winter road	04-Jul-08	No	15-Aug-08	31-Oct-10	DFO	Fish. Act
Quarry Permit	2008QP0011	Rehab winter road	29-Jun-07	No	28-Feb-08	27-Feb-09	INAC	MVRMA
Water Licence	MV2008L2-0002	Mine Operations	2-Jun-08	Yes	24-Sep-13	23-Sep-20	MVLWB	MVRMA
Land Use Permit	MV2008D0014	Mine Operations	2-Jun-08	Yes	17-Jun-13	16-Jun-18	MVLWB	MVRMA
Land Use Permit	MV2008T0012	Liard Transfer Facil.	2-Jun-08	Yes	17-Jun-13	16-Jun-18	MVLWB	MVRMA
Land Use Permit	2009-L02	Winter Road	-	No	18-Jun-09	10-Apr-14	PCA	Parks Act
Water Licence	2009-W02	Winter Road	-	No	18-Jun-09	19-Mar-13	PCA	Parks Act
Land Use Permit	MV2012C0008	2nd Decline	20-Feb-12	No	10-May-12	10-May-17	MVLWB	MVRMA
Water Licence	MV2001L2-0003	Site UG waters	26-Mar-12	No	10-May-12	9-Sep-19	MVLWB	MVRMA
Land Use Permit	MV2012F0007	Road Operations	17-Feb-12	Yes	10-Jan-13	10-Jan-18	MVLWB	MVRMA
Water Licence	MV2012L1-0005	Road Operations	1-May-12	Yes	10-Jan-13	10-Jan-20	MVLWB	MVRMA
Land Use Permit	Parks2012-L001	Road Ops and TTF	19-May-12	Yes	26-Aug-13	26-Aug-18	PCA	Parks Act
Water Licence	Parks2012_W001	Road Ops	19-May-12	Yes	26-Aug-13	26-Aug-18	PCA	Parks Act
Land Use Permit	MV2013C0002	Expl DDH (amend)	15-Jan-13	No	25-Apr-13	24-Apr-18	MVLWB	MVRMA

Abbreviations & Notes:

TLA & R	Territorial Lands Act and Land Use Regulations
NIWA & R	Northern Inland Waters Act and Regulations
TQR	Territorial Quarrying Regulations
NWTWB	Northwest Territories Water Board

valid

CZN has conducted extensive studies to further define baseline conditions. Additional water quality data collection commenced in 2001, with an expanded program since 2004. In 2005, a climate station was re-activated at the Mine site. In addition, a number of fisheries studies have been carried out, along with a stream flood assessment. Further wildlife surveys have been undertaken, and a wildlife sighting log has been maintained at the camp. The flow station on Prairie Creek was re-activated in 2013, operated by WSC.

In 2008, CZN applied to the MVLWB for a Type A Water Licence and a Type A LUP to support reactivation of the Mine for production, and two Type A LUP's for transfer facilities. CZN previously held LUP MV2003F0028 for operation of a winter road. In the TOR for EA0809-002, construction and operation of a winter road in support of mine operations was included in the scope of development. The MVRB issued a positive REA on December 8, 2011. The MVLWB issued mine operations permits, including Water Licence MV2008L2-0002 on September 24, 2013. As changes were made to the access road alignment during the EA, CZN applied for and received new winter road LUP's and Water Licences from both the MVLWB and Parks Canada.

2.2 Honouring Commitments

It is CZN's policy to achieve and maintain a high standard of environmental care in conducting its business as a resource company, and through its developments, contribute to sustaining society's material needs. CZN's approach to environmental management seeks continuous improvement in performance by taking account of evolving scientific knowledge and community expectations.

From time to time, CZN will need to secure the assistance of contractors and subcontractors (service providers) to carry out various tasks requiring specific expertise related to the operation of the Prairie Creek Mine. In order to ensure that its contractors and subcontractors honour and adhere to all commitments made, CZN will ensure, through written contracts, that all such parties are aware and comply with all the terms and conditions that are associated with such permits that are necessary for operations.

CZN has Impact Benefit Agreements (IBA's) with the Naha Dehe Dene Band (NDDB) and the Liidlii Kue First Nation (LKFN), and a Socio-economic Agreement (SEA) with the Government of the Northwest Territories). While the contents of the IBA's are confidential, a copy of the SEA can be found on CZN's and the GNWT's websites. These documents contain certain commitments. Contracts issued by CZN will be consistent with these commitments.

It is standard policy that all service providers must comply with all pertinent laws and regulations.

CZN will endeavour to ensure that all service providers are fully qualified and responsible to undertake the tasks required prior to issuing contracts.

2.2.1 Compliance with Socio-economic Agreement

The Socio-economic Agreement (SEA) between the GNWT and CZN is intended to ensure benefits flow to the 'north' from an operating Prairie Creek Mine, and commitments made

during the EA and permitting are kept. Most of the provisions of the SEA are specific to the operating period. CZN is currently preparing for construction of the Mine, but the development is some ways off at present, in fact CZN recently asked the MVLWB to place the operating Water Licence in abeyance because the Company is not ready to proceed with development yet, and the abeyance would suspend certain submission requirements specified in the Licence. The major impediment to moving forward is the down-turn in the mining industry, and the related difficulty in raising the necessary financing. Therefore, it is premature to judge CZN on many of the commitments contained in the SEA because it is simply too early.

Part of CZN's preparations for construction and operation of the Mine include seeking commercial bids for the various components of construction requirements, and promoting and hosting training programs to develop a local skill base from which to draw on at a later date. Further comments on these items are provided below in relation to SEA compliance.

The SEA contains a listing of hiring priorities, employment commitments, and hiring requirements for contractors. CZN has adopted the noted hiring priorities for some time regarding the staff compliment currently on site. Regarding contractors, CZN has always encouraged drilling and mining contractors to use as many local employees as possible. Regarding future contracts, as noted above, CZN has requested commercial bids for a number of items, and these bids include reference to the employment commitments of the SEA, and make it clear that successful contractors must comply with these, and that northern content is a component of the selection process.

Regarding skills and training, in support of the Company's commitment to build skill capacity for Dehcho residence's to be considered for employment positions at the Mine, CZN partnered with neighbouring First Nation communities, the GNWT, the Federal Government of Canada, the Mine Training Society (MTS) and Aurora College to deliver a 3-year, $4 million "Sliver Lining" training program which was administered locally in Fort Simpson. The training courses offered under the Silver Lining program included Mine Administration, Heavy Equipment Operator, Environmental Monitor, Camp Cook, Road Construction, Diamond Driller, Mineral Exploration Field Assistant, Class 5 Driver Licence, Advanced Medical First Responder, Small Engine Repair, Building Trades Helper, and many others. The program's target outcome was to create employment opportunities for 70 Dehcho residents.

The program operated from March 2011 to March 2014, and had a total of 264 individuals participating in 23 training courses, including 8 courses delivered at the Mine. Based on MTS' Silver Lining completion report, 109 participants have been employed and another 20 have returned to school. All parties were delighted with exceeding the Silver Lining program's proposed targets.

The SEA calls for establishment of a SEA Committee which will oversee compliance with the SEA. The committee has not yet been formed because of the delayed schedule of mine construction noted above.

2.2.2 Compliance with Previous Commitments

CZN's record of compliance with commitments is shown in Table 2-2.The Phase 1 surface exploration drilling LUP included commitments to build roads by stripping and stockpiling surficial material, and to back-blade the material back over the road on completion of drilling. The majority of all drilling undertaken was carried out either on mountain tops or adjacent to arterial access roads. Soils were very thin and stony. Consequently, there was very little material stripped. Some material was back-bladed over drill pads, but access roads were left because of the high probability of future use. The Phase 2 drilling area was superimposed on the Phase 1 area, and the Phase 3 area on Phase 2. Hence, all access roads have been left for future use since exploration in areas outlying from the Mine site is not complete.

CZN fully complied with an extensive list of commitments made for the Decline and Pilot Plant projects. As part of Decline development, CZN undertook to treat all water discharging from the mine, including drainage from the existing 870 level portal and from the new Decline which joins the 880 m level workings. The combined mine water flow is treated at the point where it exists the 870 level portal. Flows are monitored daily and sampled weekly. Waste rock from the Decline was placed on a prepared, clayey soil pad just west of the 870 level portal.

A pilot plant was never operated at the mine, and thus there were no tailings or process water for disposal. The large pond, originally built for tailings storage, was also not used. Hence, many of the commitments made in the EA were not applicable.

There was a similarly long list of commitments for the Phase 3 drilling project, and high level of CZN compliance. The main environmental issues with this project were the potential for sediment production and crossings of Prairie Creek. Creek sampling ultimately showed that sediment levels in the creek are controlled by flow conditions, and that project activities had no impact or significant influence. CZN had intended to produce a seed mix for reclamation. However, subsequent to permitting, a vegetation specialist from the Government of the Northwest Territories (S. Carriere) recommended against the use of a seed mix because of the difficulty of preventing the introduction of non-local species. The Phase 3 drilling LUP has expired, but has been replaced with LUP MV2013C0002 which has similar conditions. Therefore, CZN has not yet contemplated reclamation-related activities.

TABLE 2-2: CZN'S RECORD OF COMPLIANCE WITH COMMITMENTS

Permit/Licence				EA No.	Commitment	Compliance
Type	**No.**	**Purpose**	**Issued**			
Land Use Permit	MV2000C0030	Phase 1 surface drilling (6-7 holes)	14-Jun-01	00/002	Exclusive use of water as drilling medium	Complied
					Build roads by stripping & stockpiling surficial material, back-blade over when drilling complete	Mostly not possible due to thin soil. Roads still in use.
Land Use Permit	MV2001C0022	Phase 2 surface drilling (50-60 holes)	30-Nov-01	01/003	None.	
Land Use Permit	MV2001C0023	Underground Decline and Pilot Plant	10-Sep-03	01/002	Approved geotechnical assessment of tailings facility before receiving process water	Tailings facility never used
					Tailings solids to be retained in Mill thickeners	No Pilot Plant and no tailings produced
					Process water to be tested before discharge, treated if necessary	No Pilot Plant
					Pilot Plant to be operated inside Mill	No Pilot Plant
					Use up to 75 m^3/day from wells	Max use was approx 12 m^3/day
					Inspect tailings dams daily during development	Tailings facility was never used. However, per Water Licence, dams were inspected annually by an engineer, and frequently by site staff. No instabilities requiring response
					Report any dam instabilities to engineers	
					Develop response plans for any dam instabilities	
					Monitor tails pond water level and 870 and Catchment Pond flows weekly	870 flows monitored daily, Catchment Pond weekly. Tails pond not used
					Monitor discharges to environment monthly	Discharges monitored weekly
					Maintain generators to be efficient	Done frequently to minimize consumption
					Daily operations meetings during development	Meetings every morning
					Daily operations report during development	Complied
					Operations monitoring throughout development	Complied
					Test process/tails pond water monthly	No Pilot Plant or tails pond use
					Safety orientation before personnel can work	Mandatory
					Monitor Decline discharge rate daily	870 & Decline flows monitored jointly
					Decline discharge to have settling before release	2 sumps underground, Polishing Pond

TABLE 2-2 (CONT'D)

Permit/Licence					Commitment	Compliance
Type	**No.**	**Purpose**	**Issued**	**EA No.**		
Water Licence	MV2001L2-0003	Underground Decline and Pilot Plant	10-Sep-03	01/002	Decline discharge to be treated if necessary	870 & Decline flows treated jointly
					Test Decline discharge for quality monthly	Tested weekly
					Develop Decline in carbonate rock	Complied
					Weekly waste rock sampling, monthly testing	Complied
					Store water rock near portal or in plant site	Complied
					Allow Decline to flood after program	Complied
					Secure entrance to Decline	Decline driven from 870 1 km from portal
					Use existing roads to access Decline	Complied
					Construct sumps in the Decline, primary at portal	Complied, primary near 870 portal
					Construct polishing pond for 870 portal discharge	Complied
					Line polishing pond, enable cleanout/floating hydrocarbon capture	Complied
					Manage all mine water	Complied
					Employ absorbant pads/booms in sumps/ponds	Complied
					Discharge all site water via Catchment Pond	Complied
					Manage ammonia levels, use gelignite if necessary	Complied
Land Use Permit	MV2004C0030	Phase 3 surface drilling (50 sites)	11-May-06	0405-002	Field survey spring 2006 by qualified biologist	Complied
					Develop re-vegetation seed mix based on survey	Not recommended by GNWT
					Establish test plots for re-vegetating roads	Outstanding
					Restore new roads and drill pads and those used when no longer required	Outstanding
					Prevent hunting by staff	Mandatory
					Address species at risk in survey, including caribou	Complied
					No work if listed species present until appropriate mitigation	Complied
					Create wildlife management plan	Complied
					Create flight impact management plan	Complied

TABLE 2-2 (CONT'D)

Permit/Licence					Commitment	Compliance
Type	**No.**	**Purpose**	**Issued**	**EA No.**		
Land Use Permit	MV2004C0030	Phase 3 surface drilling (50 sites)	11-May-06	0405-002	Revise Health and Safety Plan re bears	Complied
					Use Little Quartz roads to access Zones 8 and 9	Complied
					Relocate Galena Creek road to reduce creek crossings	Complied, although permafrost forced Inspector to order use of old road
					Implement erosion prevention measures	Complied
					Clean equipment prior to crossing Prairie Creek	Complied
					Don't cross Prairie Creek before June 15	Complied
					Maintain water clarity in compliance with CCME	Complied
					Follow PDAC's E3 guidelines	Complied
					Weekly water samples at 3 locations	Complied
					Maintain a wildlife log	Complied

2.3 Environmental Performance

CZN has a very good environmental performance record in terms of the absence of significant negative events, and regulatory compliance (see Table 2-3). CZN's environmental performance is discussed below with reference to regulatory compliance. Permits issued during CZN's tenure are discussed.

As part of the underground Decline Development project, CZN undertook during the EA to treat the mine water discharging from the 870 level portal. This flow pre-dated CZN's operations on site. Thus, CZN planned to treat mine water from the existing workings in addition to water pumped from the new Decline. The Water Licence for this activity lists concentration limits for several parameters, mainly metals, to be met by treated water leaving the Polishing Pond. Since water treatment started in 2006, CZN has found it challenging to consistently meet the limit for zinc with its exploration-scale water treatment process, mainly because of the difficulty in settling out fine particulate matter. Dissolved metals have been successfully removed from the water, however, a small quantity of fine sediment has remained and is sufficient to elevate total metal concentrations. The water treatment process has evolved as more knowledge of conditions has been acquired, and CZN has made several changes, employing additional mixing and reaction tanks and secondary treatment processes. These have helped but have not entirely solved the problem. The situation is not expected to be an issue during operations when a much more sophisticated and automated treatment system will be employed. It should also be noted that

recent studies in Prairie Creek have noted that there has been no significant impact on the creek from historical untreated mine discharges.

TABLE 2-3: CZN'S PERMITS AND RECORD OF COMPLIANCE

Permit/Licence				EA No.	Compliance
Type	**No.**	**Purpose**	**Issued**		
Land Use Permit	MV2000C0030	Phase 1 surface drilling (6-7 holes)	14-Jun-01	00/002	Closed.
Land Use Permit	MV2001C0022	Phase 2 surface drilling (50-60 holes)	30-Nov-01	01/003	Closed.
Land Use Permit	MV2001C0023	Underground Decline and Pilot Plant	10-Sep-03	01/002	In compliance.
Water Licence	MV2001L2-0003				
Land Use Permit	MV2004C0030	Phase 3 surface drilling (50 sites)	11-May-06	0405-002	In compliance. CZN ordered to abandon new Galena road
Land Use Permit	MV2003F0028	Winter Road	11-Apr-07	No EA	In compliance.
Water Licence	MV2007L8-0026	Winter Road	20-Mar-08	No EA	In compliance.
Land Use Permit	MV2012C0008	2nd Decline (not yet used)	10-May-12	No EA	In compliance.
Land Use Permit	MV2013C0002	Phase 4 surface drilling (50 sites, not yet used)	25-Apr-13	No EA	In compliance.

The LUP for the Phase 3 surface exploration drilling required CZN to cut a new road section adjacent to Galena Creek to reduce the number of stream crossings from three to one. CZN undertook to cut a new road, however the area was found to contain significant muskeg and permafrost which proved to be a problem to establish a stable road bed. The Inspector determined that the area was unstable and ordered CZN to stabilize the new cut, install sediment production controls and revert to the old road, which CZN did.

On November 4, 2013 CZN received a Written Warning from Environment Canada regarding contravention of the Canadian Environmental Protection Act (1999), specifically the Storage Tank for Petroleum Products and Allied Petroleum Products Regulations. CZN had removed a storage tank from service without supervision by a professional engineer, as required by the Regulations.

On July 4, 2012 CZN was given a stop work order by the Inspector regarding LUP MV204C0030 and the unauthorized discharge of drill water from a drill sump. CZN developed

an excess water infiltration plan, which was approved by the Inspector on July 6, 2014. The plan was implemented and drilling was re-started.

2.4 Corporate Policies

CZN, being a publicly traded company on the Toronto Stock Exchange, maintains strict adherence to corporate policies relating to, but not limited to, corporate governance, ethical behaviour, and accounting practices. These policies are listed and can be reviewed on CZN's website (**www.canadianzinc.com**).

Throughout the exploration and development of the Prairie Creek Mine, CZN has adopted the Principles for Responsible Exploration as outlined in the Prospectors and Developers Association of Canada e3 (environmental excellence in exploration) Plus Principles and Guidelines located on website **www.pdac.ca/e3plus/**. The main principles would similarly relate to operations and are listed as follows:

1. Adopt responsible governance and management
Objective: To base the operation of exploration on sound management systems, professional excellence, the application of good practices, constructive interaction with stakeholders, and the principles of sustainable development.

2. Apply ethical business practices
Objective: To have management procedures in place that promote honesty, integrity, transparency and accountability.

3. Respect human rights
Objective: To promote the principles of the United Nations Universal Declaration of Human Rights by incorporating them into policies and operational procedures for exploration.

4. Commit to project due diligence and risk assessment
Objective: To conduct an evaluation of risks, opportunities and challenges to exploration, and prepare strategies and operational plans to address them before going into the field.

5. Engage host communities and other affected and interested parties
Objective: To interact with communities, indigenous peoples, organizations, groups and individuals on the basis of respect, inclusion and meaningful participation.

6. Contribute to community development and social well-being
Objective: To have measures in place which support the social and economic advancement and capacity building of communities whose lives are affected by exploration, while respecting the communities' own vision of development.

7. Protect the environment
Objective: To conduct exploration activities in ways that create minimal disturbance to the environment and people.

8. Safeguard the health and safety of workers and the local population

Objective: To be proactive in implementing good practices for health and safety performance in all exploration activities and seek continual improvement.

When hiring employees and contractors, it is standard CZN practice to carry out a mandatory site orientation session with prospective workers. This orientation consists of, amongst other aspects, a thorough review of site procedures and safety protocols. This includes workers reviewing and agreeing to comply with CZN's Code of Business Conduct and Ethics. This Code requires mandatory compliance with many aspects, such as; Honest and Ethical Conduct, Conflicts of Interest, Protection of Company Assets, Equal Opportunity, and Health Safety and Environmental Protection. In addition to this, CZN maintains a standard Whistleblower Policy which permits anonymous reporting of any regulatory concerns.

When hiring contractors, CZN will provide instruction and training, if necessary, to bind all contractors and sub-contractors to corporate policies. Such policies will include social, environmental, human rights, and health and safety policies. Compliance with such policies will be a contractual obligation for services or supplies. A process will also be in place for monitoring and enforcing compliance.

CZN has developed internal management plans relating to Health and Safety, and Fuel Spill Contingency. These plans would need to be reviewed for adequacy to support the proposed operation.

CZN is committed to the responsible and sustainable development of the mineral resource at Prairie Creek. CZN is acutely aware of the ecological value and importance of the area to First Nations, conservationists and the public in general. CZN has every intention of designing and operating the project with the best available technology so that the temporary impact on the environment during operations is minimal, and long-term effects after closure are negligible.

CZN believes that mineral development and conservation of ecological resources need not be mutually exclusive. CZN's vision is a development where the unique ecology is protected, and mineral extraction and the related economic benefits successfully co-exist with traditional aboriginal land uses and the Nahanni National Park Reserve. Although the Park is forever, the Mine will operate for only a relatively short time and will bring substantial benefits to local communities in the form of business opportunities, training and jobs, and will be a catalyst for regional development, tourism and economic activity that can be sustained long after the eventual but inevitable mine closure.

3.0 SCOPE AND ALTERNATIVES

The scope of development and scope of assessment were determined by the Review Board and are described in the TOR. This section describes the geographic and temporal (time) scope used in this assessment, and the alternatives to the development.

3.1 Geographic Scope

The minimum geographic scope for each valued component was defined in the TOR, and is presented in Table 3-1.

TABLE 3-1 MINIMUM GEOGRAPHIC SCOPE

Valued Component	Minimum Geographic Scope
Harvesting	Within 50 km of the project
Terrain, soils, permafrost, and karst topography	Within 30 km of the project
Granular materials	Within 5 km of the project
Air quality	Within 30 km of the project
Noise	Within 50 km of the project
Water quality and quantity	The surface and subsurface watersheds to the point where reasonable foreseeable project effects cease to occur
Species at risk	Defined on a species-specific basis as an area large enough to assess potential impacts at a local population level, taking into consideration the seasonal movements, migratory movements, and lifecycle requirements of each species
Wildlife and wildlife habitat (including birds)	Defined on a species-specific basis as an area large enough to assess potential impacts at a local population level, taking into consideration the seasonal movements, migratory movements, and lifecycle requirements of each species
Fish and aquatic habitat	The surface water watersheds which are intersected by the project
Vegetation	Within 50 m of the project
Traditional land use	Within 50 km of the project
Ecological integrity, visitor experience and cultural resources of Nahanni National Park Reserve	Same as the geographic scope identified for the above subjects of note
Employment and benefits to the community	The Mackenzie Valley, with a focus on communities in the Dehcho region
Transportation infrastructure	Nahanni Butte access road and Liard Highway from Nahanni Butte to Fort Nelson

3.2 Temporal Scope

As noted in the TOR, the temporal scope for assessment includes the effects of the project on valued components during construction, operation, closure and post-closure. For cumulative impact assessment, the temporal scope is the same in terms of potential combination with effects from past, present and reasonably foreseeable future projects.

All valued components are assessed herein based on a two year construction period, a 14 year mine operating period, a two year closure period, and a five year post-closure period. It is assumed that the road will only operate to support construction, operation and closure of the mine. Others may desire road operations after mine closure, but this would need to be determined at a later date and confirmed prior to mine closure. Each component is evaluated taking account of differing intensity of activities and any seasonal sensitivity. Clearly, access road activities are locally intense during road construction. Consideration will be given to seasonal effects in relation to key life cycle periods (e.g. spawning, calving and the rut) as well as traditional times of harvesting.

Valued components are also assessed for the mine decommissioning and reclamation phase, followed by a period of monitoring and site management. For most components, applicable activities will be much less and the corresponding potential for impacts similarly less than for the operating period. During decommissioning, road use will be much less than during operations. After closure, road use will cease but monitoring may require inspections using aircraft.

3.3 Alternatives to the Development

The development consists of the construction and operation of an all season road and airstrip, and expansion of the Tetcela Transfer Facility (TTF). However, the main part of the development is the road since the airstrip and TTF expansion would not be needed without it. The purpose of the all season road is to be able to transport all of the mineral concentrates produced annually at the Mine out to market, and preferably to do that continuously rather than over the winter only, because this delays obtaining the revenue from concentrate sales in a timely manner. Therefore, alternatives to the development are assumed to be other means to achieve this purpose.

The Phase 1 road development would see an all season road built to the TTF, an airstrip built and the TTF expanded. The object of this is to allow concentrates to be hauled to the TTF year round, thus reducing the total transportation required in winter to take the concentrates the rest of the way to the Liard Transfer Facility (LTF) near the highway. The alternatives to this development are considered to be:

- Alternative 1 – Use more trucks in winter to collect the concentrates from the Mine; and,
- Alternative 2 – Fly out those concentrates that could not be transported out over the winter road.

The Phase 2 road development would see an all season road built to the LTF. The alternatives to this development are considered to be the same as for the Phase 1 development. Therefore, we will consider the alternatives as 1.1 and 1.2 for Phase 1, and 2.1 and 2.2 for Phase 2. In order to include the road development proposal in an analysis of alternatives, we will refer to the proposals as alternatives 1.0 and 2.0.

The TOR specifies that an analysis of alternatives should take into account the *Multiple Accounts Analysis* (MAA) described by Robertson and Shaw (2004), and that the alternatives analysis should include technical feasibility, cost-benefit analysis, socio-economic effects, and environmental effects, and the alternatives should be ranked with an explanation of the ranking.

From Robertson and Shaw (2004), MAA is a tool that provides the means by which evaluators can consider the most suitable, or advantageous alternative, from a list of alternatives, by weighing the relative benefits and costs (or losses) of each. The method involves three basic steps:

1. Identify the impacts (benefits and costs) to be included in the evaluation;
2. Quantify the impacts (benefits and costs); and
3. Assess the combined or accumulated impacts for each alternative, and compare these with other alternatives.

For each alternative, the indicators to be ranked will be technical feasibility, cost-benefit, socio-economic effects, and environmental effects. A scaled value will be assigned for each indicator. The authors found that a 9-point scale is readily understandable and typically provides the range and discretion well suited to this type of evaluation. The best alternative for any indicator is always given a scalar value of '9'. If the second best alternative is only half as good as the best alternative, it would be given a value of '4-5' and so on. The cumulative 'score' of an alternative is obtained by averaging the scalar values of the indicators for that alternative. The higher the score, the more favorable the alternative is.

Analysis of Phase 1 Alternatives

The first indicator to be analysed is technical feasibility. Alternative 1.0, all season road construction, is considered to be very feasible from an engineering perspective. Alternative 1.1, extra trucks in winter, is considered to have questionable feasibility. This is a time of the year when there are multiple winter roads in the north, and there is a high demand for trucks. CZN would be reliant on the availability of a contractor fleet, and this poses a risk in terms of acquiring enough trucks to transport all of the concentrates out. Alternative 1.2, flying out concentrates, is considered feasible if suitable aircraft are available, but would be expensive due to the weight. This is considered further in the next indicator. Scaled values assigned for this indicator for alternatives 1.0, 1.1 and 1.2 are 9, 4 and 7, respectively.

The next indicator to be analysed is cost-benefit. For alternative 1.0, all season road construction to the TTF, there would be the significant cost of all season road construction. However, annual road maintenance costs and haulage costs will be less compared to a winter road. This is shown in the following summary:

	Phase 1		Phase 2	
Road	**Winter**	**All Season**	**Winter**	**All Season**
Capital Cost ($M)	2	25	2	50
Annual Maintenance ($M)	2	1.5	2	1
Annual Haul ($M)	18	15	18	12
Annual Saving on Supplies ($M)				-3
Annual Increase in Revenue ($M)				-9
NPV Cost (11 year mine life, 10% discount rate)	**132**	**132**	**132**	**56**

The unofficial cost of full all season road construction was estimated at $50 million. Therefore, the construction cost from the Mine to the TTF (Phase 1) would be approximately $25 million (this section is marginally shorter (86 km) but has more bridges). This compares to an annual full winter road construction cost of $ 2 million. The annual maintenance cost of a full all season road is estimated at $1 million, compared to $2 million for a winter road. Therefore, for Phase 1, the all season road maintenance cost would be $1.5 million ($0.5 million for the all season portion and $1 million for the winter portion). Haulage costs have been estimated at $100/tonne on an all season road, and $150/tonne on a winter road. At full production, the Mine is expected to produce 120,000 tonnes of concentrates annually. Therefore, the total annual haulage cost for a winter road is $18 million, and for an all season road $15 million (Phase 1). The NPV cost for the two scenarios assuming an 11 year mine life and discount rate of 10% is the same at $132 million. However, this comparison does not account for the availability of a contractor truck fleet, and if there is a high demand due to warmer than usual winter conditions, haul costs are likely to be higher. Haul costs on the all season road would be the same because the trucks would either be mine-owned, or contractor-owned on a long-term contract. As a result, the all season alternative (1.0) is scored marginally higher than the winter alternative (1.1).

For the purpose of the analysis, it was assumed that winter conditions and truck availability limits the annual transportation capacity of a winter road to 90,000 tonnes. For alternative 1.2 (flying the excess), 30,000 tonnes would be flown out. However, the cost of flying (approximately $8/tonne/km) is greater than the value of the concentrate. Therefore, it would not make economic sense to fly concentrate. Any concentrate that could not be transported out by road would remain at the Mine until the next transport season.

Scaled values assigned for the cost-benefit indicator for alternatives 1.0, 1.1 and 1.2 are 9, 8 and 3, respectively.

Socio-economic effects is the next indicator to be analysed. There would be little if any difference between alternatives 1.0 and 1.1, since the same truck traffic would occur from the Mine to the TTF, but with a different seasonal distribution. Therefore, there would be the same amount of work for drivers and mechanics, many of whom may be regional or northern residents. However, an all season road would mean full-time, year-round work for truckers rather than seasonal work over the winter. For alternative 1.2, there would be less work for truck drivers, but this would be somewhat compensated by aircraft loading crews at the Mine and at Fort Liard, the likely aircraft destination as this is the closest strip that does not require an ice

bridge for road connection to the Fort Nelson railhead. Scaled values assigned for this indicator for alternatives 1.0, 1.1 and 1.2 are 9, 9 and 7, respectively.

Regarding environmental effects, with hauling in summer, alternative 1.0 has the potential for wildlife effects in that season, as well as spills, although this potential can be mitigated. Alternative 1.1 means winter hauling, which can be a time of greatest disturbance to wildlife. It can also be argued that summer hauling is inherently safer than winter hauling, resulting in a lower risk of spills. Therefore, alternative 1.0 is considered marginally superior to alternative 1.1. Alternative 1.2 is seen as causing marginally less effects than the other alternatives because flights are regarded as superior to trucking. Scaled values assigned for this indicator for alternatives 1.0, 1.1 and 1.2 are 7, 6 and 9, respectively.

A summary of values and cumulative scores for each alternative is as follows:

Indicator	Alternative 1.0	Alternative 1.1	Alternative 1.2
	All Season Road	More Trucks	Fly Out Excess
Technical Feasibility	9	4	7
Cost-Benefit	9	8	3
Socio-economic Effects	9	9	7
Environmental Effects	7	6	9
Cumulative Scores	34	27	26

Analysis of Phase 2 Alternatives

For technical feasibility, the analysis of alternatives is the same, and the scaled values assigned for alternatives 2.0, 2.1 and 2.2 are 9, 4 and 7, respectively.

For cost-benefit, the winter road – all season road comparison described above is used again, however this time, a full all season road will allow year-round hauling, and savings on the cost of supplies and increases in revenue now occur. Supplies will become cheaper because most can be deferred until later in the year instead of having to purchase them in advance to be hauled in one the winter road. Revenues on concentrate sales will increase because concentrates can be transported to market much sooner, instead of being captive at the Mine until the next winter road season. The annual estimated supplies cost saving and revenue increase are shown above. The values are negative as they are a subtraction in the overall NPV cost calculation. The NPV cost of the all season road is $56 million, significantly less than the NPV cost of the winter road at $132 million. Therefore, the cost-benefit of the all season road is much higher. The analysis for alternative 2.2 (fly out excess) is the same as 1.2.

Scaled values assigned for the cost-benefit indicator for alternatives 2.0, 2.1 and 2.2 are 9, 5 and 3, respectively.

For socio-economic effects, there would be a large difference between alternatives 2.0 and 2.1, although the same truck traffic would occur, but with a different seasonal distribution. The difference is because, on the plus side, an all season road would provide an opportunity for significant tourism, with associated spin-off benefits to the region. However, on the minus side,

such a road also increases the potential for hunting pressures from people outside of the region. This can be mitigated by access controls and other initiatives. Alternative 2.2 would be the same in that there would be less work for truck drivers, somewhat compensated for by aircraft loading crews at the Mine and at Fort Liard, but the overall socio-economic potential would be much less than alternative 2.0 due to tourism. Scaled values assigned for this indicator for alternatives 2.0, 2.1 and 2.2 are 9, 5 and 3, respectively.

For environmental effects, the comparison of alternatives 2.0 and 2.1 is similar to Phase 1 with respect to the potential for effects on wildlife, spills and safer summer hauling, but alternative 2.0 would mean a potential for non-resident hunting. Alternative 2.2 is seen as causing less effects. Scaled values assigned for this indicator for alternatives 2.0, 2.1 and 2.2 are 7, 7 and 9, respectively.

A summary of values and cumulative scores for each alternative is as follows:

Indicator	**Alternative 2.0**	**Alternative 2.1**	**Alternative 2.2**
	All Season Road	**More Trucks**	**Fly Out Excess**
Technical Feasibility	9	4	7
Cost-Benefit	9	5	3
Socio-economic Effects	9	5	3
Environmental Effects	7	7	9
Cumulative Scores	34	21	22

4.0 EXISTING ENVIRONMENT AND BASELINE CONDITIONS

For locations along the road by kilometre (Km or KP) marker, please refer to Figure 1-2. For greater detail, refer to the road design drawings in the road design report in Appendix 1 authored by Allnorth Engineering Consultants (Allnorth).

4.1 Terrain, Geology, Soils and Permafrost

4.1.1 Topography, Terrain, Geology and Karst Features

Topography and Terrain

The Mine site is at an elevation of 850 m above mean sea level (AMSL), and is situated in topography characterized by low mountains and narrow valleys with an average relief of 300 m. The Mine site is located within the Alpine Forest-Tundra section of the Boreal Forest, characterized by stunted fir with limited undergrowth and open areas dominated by lichen.

The currently permitted winter access road leaves the Mine site heading north along the Prairie Creek valley for about 7 km before turning east to cross the Mackenzie Mountains. As the road climbs out of the Prairie Creek valley it enters Sub-Alpine Shrub and Alpine Tundra from an elevation of approximately 1000 m AMSL at Km 10. The road continues to climb through the Alpine to a summit of 1530 m at Km 17, then dropping down and leaving the Sub- Alpine again at the 1000 m elevation around Km 25. As the road drops from the 1000 m elevation to the 900 m elevation, it passes through a spruce-lichen Alpine forest zone similar to that found at the Mine site and then into Riparian Alluvial habitat in the Sundog tributary valley bottom.

From Km 40 to Km 55, the road crosses forest developed on glacial depositional deposits, and crosses Polje Creek (otherwise known as Bubbling Springs Creek) which drains the Poljes before ascending the Ram Plateau. As the road crosses the Ram Plateau, it passes through an open forest Black Spruce/Pine Parkland setting between the 830 to 930 m elevations, before dropping down into the Tetcela River valley. The valley consists of a mixed coniferous/deciduous closed forest. The road then passes through a short distance of muskeg open shrub/sedge wetland at the headwaters of Fishtrap Creek, and climbs up and over the Silent Hills, again a closed mixed coniferous/deciduous forest. The road alignment then runs along the eastern slopes of the Silent Hills, an area of black spruce, before passing through mixed coniferous-deciduous-pine parkland prior to entering the Grainger River headwaters at Grainger Gap (Second Gap), staying north of, and never crossing into, the Bluefish Creek basin.

Once through the Grainger Gap, the road alignment turns south along the foothills of the Front Range through mixed deciduous coniferous forest towards Nahanni Butte, avoiding the Grainger Tillplain. The road crosses the Liard River near the community and continues through forest to the Nahanni access road and on to the Liard Highway.

The Tetcela Transfer Facility (TTF) will be located at approximately Km 84 of the access road. The location is on the eastern edge of the Ram Plateau in Black Spruce/Pine open forest

approximately 2 km north-west of the Tetcela River. The area is a broad spur of land approximately 392 m AMSL in elevation.

For more information on the terrain along the access road, the reader is referred to a 2010 report by Golder Associates on behalf of CZN, submitted as Appendix 16 to the DAR for EA0809-002.

Area Geology

The access road is entirely underlain by sedimentary rock sequences generally consisting of various combinations of limestone, dolostone, siltstone, shale and mudstone.

There is a general reduction in geological structural complexity from the area of the Prairie Creek Mine site (steeply folded and faulted rock units) east to the Liard River (flat lying undisturbed sedimentary units). All rocks west of the Grainger Gap (Km 120) have been affected and displaced by the Laramide mountain-building events that affected much of western North America in Late Cretaceous time.

Structural complexity is also expressed in topographic relief which generally decreases from west to east. For ease of reference, based on geology and topographic expression, the access road has been divided into six regional physiographic zones (refer to Figure 4-1), namely:

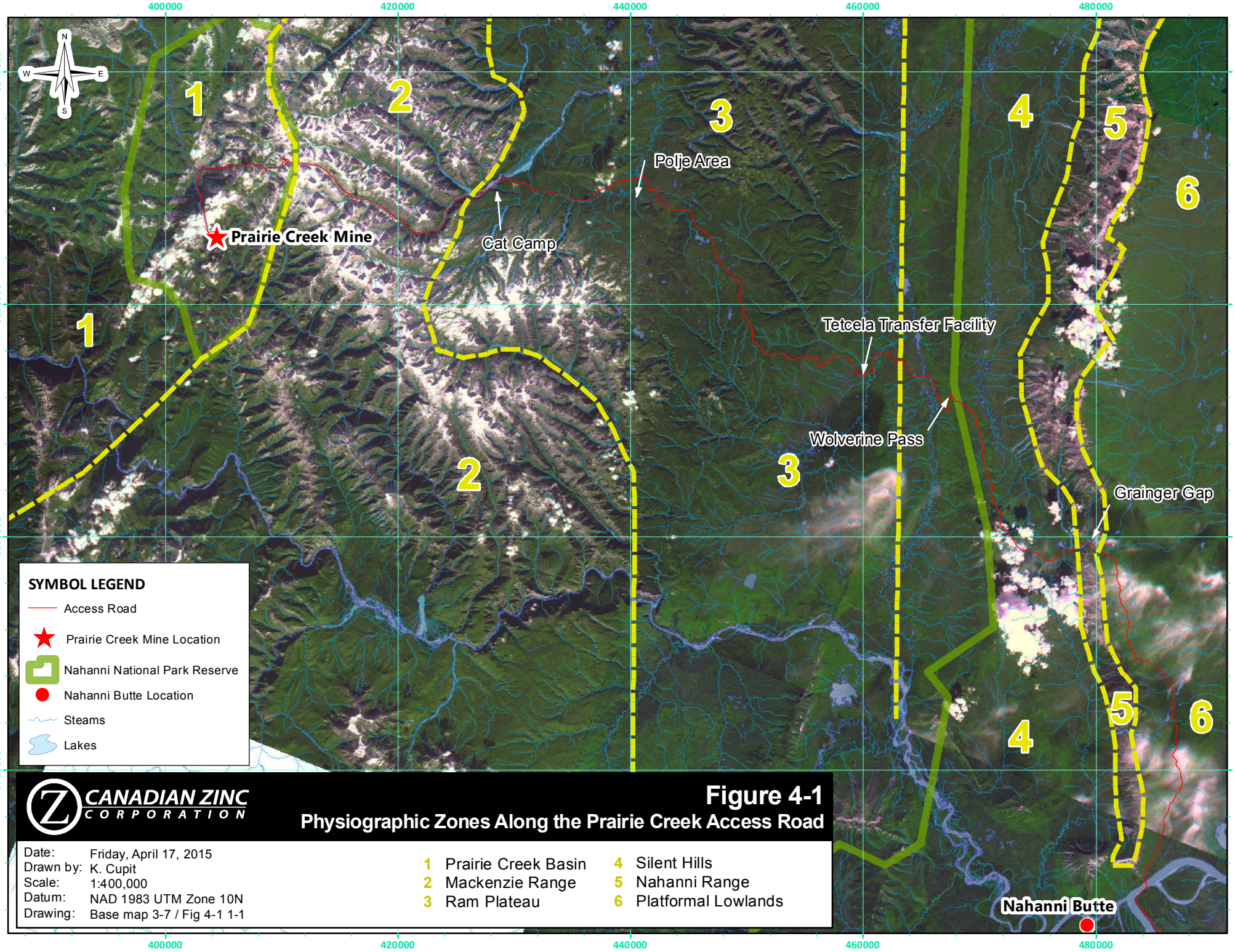
- Prairie Creek Basin (Km 0-Km 14.5)
- Mackenzie Range (Km 14.5-Km 40)
- Ram Plateau (Km 40-Km 90)
- Silent Hills (Km 90-Km 117)
- Nahanni Range (Km 117-Km 121)
- Platformal Lowlands (Km 121 to Liard River)

The region has been mapped on a broad reconnaissance type scale by the Geological Survey of Canada. The Prairie Creek area has been mapped and documented in GSC Memoir 412 (Figure 81) entitled "The Prairie Creek Embayment and Lower Paleozoic Strata of the Southern Mackenzie Mountains" by Morrow and Cook in 1987. The most detailed maps for the remainder of the road are covered by the Geological Survey of Canada "Map 1378A, Geology of Virginia Falls" and "Map 1377A, Geology of Sibbeston Lake", both printed in 1976. These reports along with mapping completed by CZN, have been adapted to show the geology in simplified form in Figure 4-2.

Prairie Creek Basin (Km 0-Km 14.5)

The area adjacent to Prairie Creek (PC) lies within the Mackenzie Mountains and contains up to 1,000 m of topographic relief in the form of abrupt cliffs and mountains.

Between Km 0 and Km 14.5, the road is underlain by rocks of the Prairie Creek Embayment which is a paleo-basin developed during Ordovician times and received active sedimentation during Ordovician-Silurian times. The regional Laramide deformation severely foreshortened the Prairie Creek Embayment units and the entire sedimentary rock sequence underwent compression to form complex folds and steep regional reverse-type faulting.

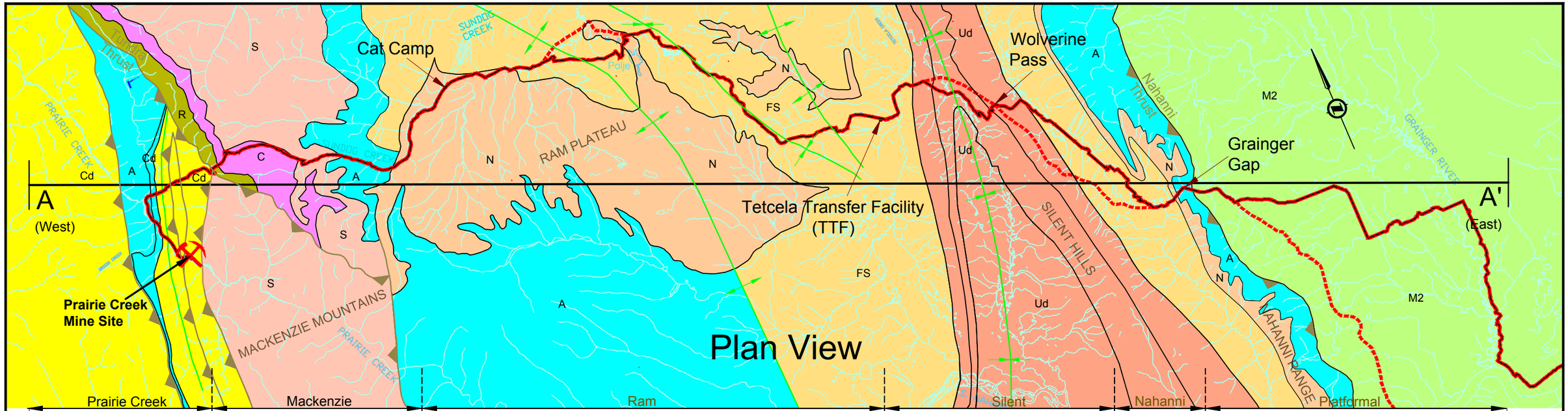


CANADIAN ZINC CORPORATION

Figure 4-1
Physiographic Zones Along the Prairie Creek Access Road

Date: Friday, April 17, 2015
Drawn by: K. Cupit
Scale: 1:400,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-7 / Fig 4-1 1-1

1 Prairie Creek Basin
2 Mackenzie Range
3 Ram Plateau
4 Silent Hills
5 Nahanni Range
6 Platformal Lowlands



Legend

Prairie Creek Formations

- Cd Cadillac
- A Arnica
- W Whittaker
- R Road River

Platform Formations

- M2 Mesozoic Units
- Ud Upper Devonian Unit
- FS Fort Simpson
- A Arnica
- N Nahanni
- S Sombre
- C Camsell
- R Road River

- Major Faults
- Access Road
- Access Road Re-Alignments
- Formation At Depth

Partly Adapted from Geological Society of Canada Maps 1378A and 1377A

Approximate Scale

0 1 2.5 5 10 20

Kilometres

Figure 4-2

Simplified Regional Geology
Along the Prairie Creek Access Road

File: DAR Fig 4-17.dwg
Date: October 2009
Scale: As Shown

CANADIAN ZINC CORPORATION

A basal thrust is evident, as exposed on the north side of Funeral Creek, at approximately Km 14.5, and is referred to by Morrow et al. as the Tundra Thrust. The Thrust is a regional structure that dips moderately to the east and defines the eastern edge of the Prairie Creek Embayment rock sequence. The Thrust displaces the eastern sedimentary sequence over the folded Prairie Creek units (Cadillac Formation).

Mackenzie Range (Km 14.5-Km 40)

The road attains a maximum elevation of 1,522 m at Km 17, referred to as Sundog Pass. From the Pass eastward, all drainage reports to Sundog Creek, a tributary of the Ram River which subsequently drains into the Mackenzie River. In this physiographic section, the road slopes downhill to the east towards Cat Camp. The area is characterized by tight valleys, a number of stream crossings, active talus fields, box canyons and steep slopes.

East of the Tundra Thrust (Km 14.5), thick mountain forming assemblages of sedimentary rocks forming the Cadillac mega-breccia are overlain by the Camsell Formation which is in turn overlain by the thick sequence of the Sombre Formation. The latter consists of dolostones and limestones, and is subsequently overlain by the cherty siltstones referred to as the Arnica Formation up to the eastern edge of the Mackenzie Mountain range at Km 40. These platformal rock units are thought to be related to the rock units found within the Prairie Creek Embayment.

As the road approaches Cat Camp (Km 37), younger Devonian age units of the Headless Formation and the thick, competent limestone units of the Nahanni Formation become exposed and form the prominent bluffs and walls of the large box canyons around Sundog creek. At around Km 40, the terrain opens up into the broad, undulating Ram Plateau.

Ram Plateau (Km 40-Km 90)

The Ram Plateau is a regional feature which, depending upon what is included, is an area up to 30 Km east-west and over 100 Km north-south. It is characterized by moderately rolling terrain with local steep walled canyons and incised drainages.

The Ram Plateau is underlain by the Nahanni Formation which, where eroded, forms prominent bluffs and box canyons. The Nahanni Formation is a limestone unit and is susceptible to erosion and/or dissolution by surface and ground waters. The dissolution of the Nahanni Formation has been intense enough in places to form karstlands. The Nahanni Formation is well exposed in the rugged area of the Ram River just to the north of the access road. The Nahanni Formation arches up in a broad antiform and has been eroded to form spectacular box canyons. Overlying the Nahanni Formation are the black shales of the Horn River and Fort Simpson Formations, which tend to form impermeable caps that protect the underlying limestones from erosion.

Silent Hills (Km 90-Km 117)

Rock exposure in this area is generally poor, however regional mapping has shown the area to be underlain by Mesozoic sedimentary formations which vary from carbon-rich shales to mudstones and siltstones. These units overlie and are younger than the Nahanni assemblage to the west. Formations mapped by the GSC above the Nahanni Formation include the Yohin Formation containing thinly bedded sandstones, the Clausen Formation, consisting of black shales, and the Flett Formation limestones in the core of the syncline at Wolverine Pass.

Nahanni Range (Km 117-Km 121)

At Km 117, the road approaches a mountain pass, referred to locally as the Grainger Gap or Second Gap, which cuts through the front range mountains of the Nahanni Range. The eastern basal slope of the Nahanni Range contains the Nahanni Thrust structure which defines the eastern limit of the Mackenzie Fold Belt. The Nahanni Thrust is a regional fault that dips at a shallow angle to the west and can be followed for many kilometres surficially and at depth through seismic profile. From the east, the Nahanni Range is the first set of mountains and forms the prominent regional buttress of bluffs against the lowlands to the east. The rugged appearance of the Nahanni Range is formed by the competent rock units of the Arnica and Nahanni Formations which have been thrust upwards.

The elevation in Grainger Gap is 520 m and is bounded to the north and south by steep mountain peaks of the Nahanni Range up to 1,400 m in elevation.

Platformal Lowlands (Km 121 to Liard River)

East of the Nahanni Thrust lie the relatively undisturbed horizontal sedimentary layers of the Interior Plains.

Topography is very subdued and poor drainage produces extensive areas of swamp and muskeg; hence, exposure of bedrock in the area is very limited. All drainage in this area reports to the Grainger River which in turn flows into the Liard River. Some historic oil and gas wells show the subsurface being underlain by Mississipian age black shales, mudstones and siltstones of the Besa River Formation.

Extensive Quaternary river alluvium material occurs associated with the Liard and South Nahanni Rivers. In addition, glacial moraine-type deposits, including till deposits, are extensive throughout the area. Surficial geology has been mapped by the GSC in Map 1693A, entitled "Surficial Geology Southern Mackenzie River Valley", dated 1988.

Karst Features

Background

The process of karst formation is caused by carbon dioxide dissolved in rain that percolates through the soil as a weak solution of carbonic acid. The infiltrating water naturally exploits any crack or crevice in the rock. Over long periods of time, carbonate rocks (such as limestone) begin to dissolve. However, surface lowering and wall retreat within fissures and caves occur at a rate of no more than a few millimetres per 100 years in tropical conditions, and rates are even less in temperate (colder) climates.

Openings in competent carbonate bedrock increase in size, and an underground drainage system begins to develop allowing more water to pass and further accelerating the formation of karst. Eventually, this can lead to the development of subsurface caves.

Karst Development on the Ram Plateau

The Ram Plateau is defined as the broad geographic area between the Silent Hills Range (east) and the Mackenzie Mountains (west), over 30 km east-west and greater than 100 km north-south. Topography throughout the Ram Plateau is subdued compared to the adjacent mountain ranges, however, many areas within the plateau contain incised, rugged steep-sided canyons, which are especially well developed in the Ram River area.

The steep-sided canyons generally formed as a result of the exposure of thick beds of the competent Nahanni Formation limestones. The Nahanni Formation is susceptible to dissolution or karstification due to its calcium carbonate composition.

Structurally, the Ram Plateau is underlain by a series of gently alternating folded anticlines and synclines. The Nahanni Formation is overlain by shales of the Horn River/Fort Simpson Formation which, by virtue of their very fine grained nature, are quite impervious to water infiltration.

Dr. Derek Ford, a renowned karst expert from McMaster University in Hamilton, Ontario, has completed numerous studies of the karst landforms and processes within the Ram Plateau and has identified many areas of particular focus within this terrain. The focus of the study is the area generally to the south of the access road where the Nahanni Formation is well exposed and incised. Many karst features were identified and documented and include, but are not limited to the Poljes, sinkholes (dolines), suffosion terraces, caves, labyrinth karst, and tower karst.

The Polje Area

The Polje area is one of the areas of karst development that has been the primary focus of research. The area occurs along the access road near Km 50 where the Nahanni Formation is exposed. At Km 55 to Km 57, the access road crosses the trend of the Poljes which are referred to as the First, Second and Third Poljes. Figure II-2 in the 2010 Golder Report shows the location of the road route in relation to specific terrain and karst features. This figure also shows recent photographs of the various karst features proximal to the road.

A Polje is defined as a flat floored, steep sided enclosed basin which is fed by groundwater. A Polje does not have any apparent surface water source, such as a creek or river, water entering or leaving via subterranean means. Depending on groundwater flow, water levels within a polje can vary considerably and the feature can either be full of water or empty. Ford et al determined that the poljes are connected hydrologically through subterranean conduits or aquifers. Dye tracing experiments confirmed the movement of groundwater from south to north, that is, from the Third to the Second to the First Polje, the water finally emanating to the surface as the Bubbling Spring just north of the First Polje. The spring feeds Polje Creek which flows north to Sundog Creek.

In addition to the Polje area, the former winter access road alignment crosses what Ford terms the Southwest Suffosion Terrace (Km 48 to 54), which is an elevated plateau above the Polje system. A number of suffosional sinkholes are developed in this area due to dissolution of the Nahanni Formation underneath the shale cap. Due to the elevation difference, groundwater drains to the Poljes and to the Bubbling Springs area. The revised winter route avoids the

Southwest Suffosion Terrace and the Polje system completely, crossing Polje Creek more than 1 km downstream from the Bubbling Springs area.

4.1.2 Surficial Materials, Soils, Borrow and Permafrost

General

Terrain, geology, soils and permafrost are diverse over the length of the proposed all-season road, with numerous and varied terrain units encountered along the route. These features are summarized in sections of a Tetra Tech EBA geotechnical report in Appendix 2 on the basis of existing information, supplemented with the ground-truthing work carried out in 2014. The description of features encountered is organized by road section evaluated. Figures are included to show where the 2014 field work was done, as well as related previous field work done by others in road sections where permafrost and/or slope stability is important.

Items relating to permafrost or borrow that are consistent to all road sections are described in separate subsections, after the station-by-station discussions. Test hole logs are presented by road section, along with the related laboratory test results. A summary of site-specific features along the proposed all-season route is also included in the station-by-station summary of mapping and field observations in an appendix.

Borrow – General Observations

Borrow sources identified by Allnorth are highly variable in material type. Site soils consisting of silts and clays are frost-susceptible. If they are frozen with a high soil moisture content, these soil types are also likely to be thaw-sensitive. Coarse-grained soils such as sands and gravels should be frost-stable, as long as they contain less than 10% fines. Similarly, bedrock is likely to be frost-stable and not thaw-sensitive, unless weathered bedrock has ice in it. Ice in bedrock can be present in joints or bedding planes or between fissile laminations.

Permafrost

Nahanni Butte is mapped near the southern boundary of the “extensive discontinuous” permafrost zone and the route appears to be entirely within that zone (Heginbottom et al. 1995). Within this zone, 50 to 90% of the land area may be underlain by permafrost. Locally, the likelihood of permafrost will depend on elevation, but also on local soil and ground cover conditions. The very small scale of Heginbottom et al.’s permafrost map makes it difficult to discern the transitions between the areas where anticipated ground ice content is mapped as low (<10%), and where it is mapped as medium (10-20%), or low to medium. Based on estimated landmark locations, it appears that the terrain on the east side of the Front Range is more likely to have a low to medium ice content, and the terrain between the Front Range and the Tetcela River is more likely to have a medium ice content. However, there is enough local variation that actual ice content will depend on a series of local factors including the grain size of the soils encountered, ground cover, and local slope aspects.

Where present, the average temperature of the permafrost is expected to be very close to 0°C in the lower elevation areas, and probably less than about -2°C at higher elevations along the route. Therefore, in silty or clayey soils, there may be high unfrozen moisture content (Heginbottom et al. 1995). As well, it is anticipated that locally silty/clayey soils may incorporate some ice lenses or laminations, while granular soils should have relatively low ice content. Rivers or streams or lakes and ponds that have unfrozen water year-round likely moderate the local ground temperature (typically within 10 to 50 m of the shoreline), as well as providing a potential source of water for ice lens formation. Depending on the type of groundcover, thickness of organic soils, underlying soil types (fine-grained or coarse-grained), degree of site disturbance, and proximity to waterbodies, the active layer is estimated to range between 0.6 and 3 m thick.

Where streams or ponds are ephemeral or freeze to the bottom every winter, it is anticipated that permafrost could be present regardless of soil or rock type. Where water flows and/or is deep enough to remain unfrozen year-round, a talik or unfrozen zone is likely to be present beneath the stream. The smaller creeks evaluated by Hatfield Consultants Ltd. were considered to have the potential to freeze to the bottom every winter. Even the larger channels were considered to have a high potential of freezing, although these streams might also have some deeper, unfrozen pools, for example, Sundog Creek, Polje Creek, Tetcela River, and Grainger River. Locations where there is a bedrock substrate would be more likely to retain unfrozen pools. Streams in gravel along the route appear to have greatly-reduced water levels even before the onset of winter (email communications, March 5, 2015; D.Harpley, C.Jaeggle, R.Kors-Olthof).

As noted above, forest fires may affect ground temperature regimes and permafrost due to changes to the protective organic layer over the frozen mineral soils, particularly if the fire burns hot and damages the organic layer. The loss of a forested canopy can also reduce shade and allow the ground to become warmer, accelerating thaw. On steeper slope sections, it is also important to consider the potential for fires resulting in dead trees and the subsequent loss of root strength in helping to retain near-surface soils.

Climate warming can also affect ground temperatures and permafrost characteristics, and might be expected to have a greater effect on a usually cool slope than on a slope that is already warmer due to slope aspect, especially if that warm slope already has less permafrost.

4.2 Climate

A climate station was erected at Prairie Creek in 1994, on the floodplain just south of the Mine site. The station was equipped with temperature, relative humidity and wind strength and direction sensors affixed to a cable-stayed mast, together with an independent tipping-bucket rain gauge. All instruments sent readings to a data-logger powered by a battery whose charge was maintained by a solar panel. A period of site inactivity followed station installation, with the result that data was not downloaded and the stored data was lost. CZN refurbished and restarted the station in late May 2005. Data has been collected and downloaded regularly since that time, although a data logging malfunction occurred starting in August 2008. The station has been operational again since September 2009.

In terms of spatial boundaries for the assessment, the western Dehcho Region is considered appropriate given the distribution of weather stations and their relevance to the road corridor and the Liard Highway from the Nahanni Butte access road to the BC border. For practical purposes, this means data from stations at the Mine, Fort Simpson and Fort Liard need to be studied. Regarding temporal boundaries, data from 1980 to the present is considered a reasonable indicator of prevailing conditions. A key consideration is the potential for future warming. We can review the oldest data available for comparison to the present as an indicator, however it is well documented that warming trends may have accelerated relatively recently.

Climate data local to the area has been summarized in Table 4-1 (data from older measurements were converted from imperial to metric). Figure 4-3 shows recorded temperatures at the Mine from 27 May 2005 to 18 November 2013.

Data for the Mine site in 1980 (Cadillac) was estimated from stations in the region. Rainfall for the site was estimated at approximately 300 mm/year, and precipitation 508 mm/year. These are both roughly 50% greater than those recorded at the Fort Simpson airport (1980). However, the average mean daily temperatures for the year were comparable at around -5^{o}C.

The Mine site is slightly more temperate than Fort Simpson, cooler in the summer but warmer in the winter. Fort Simpson and Fort Liard are assumed to be suitable surrogates for Nahanni Butte. Conditions indicated by the two climate stations are quite similar in terms of amounts of rainfall and snow. However, Fort Liard appears to be a few degrees warmer annually.

There are some interesting differences in data reported at Fort Simpson between 1980 and 2000. The more recent data indicates a warmer (1.2^{o}C) average mean daily temperature for the year. However, the difference is more pronounced in mid-winter months where more recent temperatures are several degrees warmer. This pattern was generally repeated in the incomplete data for 2009, although it varies from month to month. 2009 appears to have had similar temperatures to 2000, on average. Annual rainfall was roughly 13% less in 2000 at 224 mm, although total precipitation was 7% greater at 369 mm. Peak precipitation occurs in the summer months of June-September in the form of prolonged rainfall events. The summer of 2009 was unusually wet, especially in September.

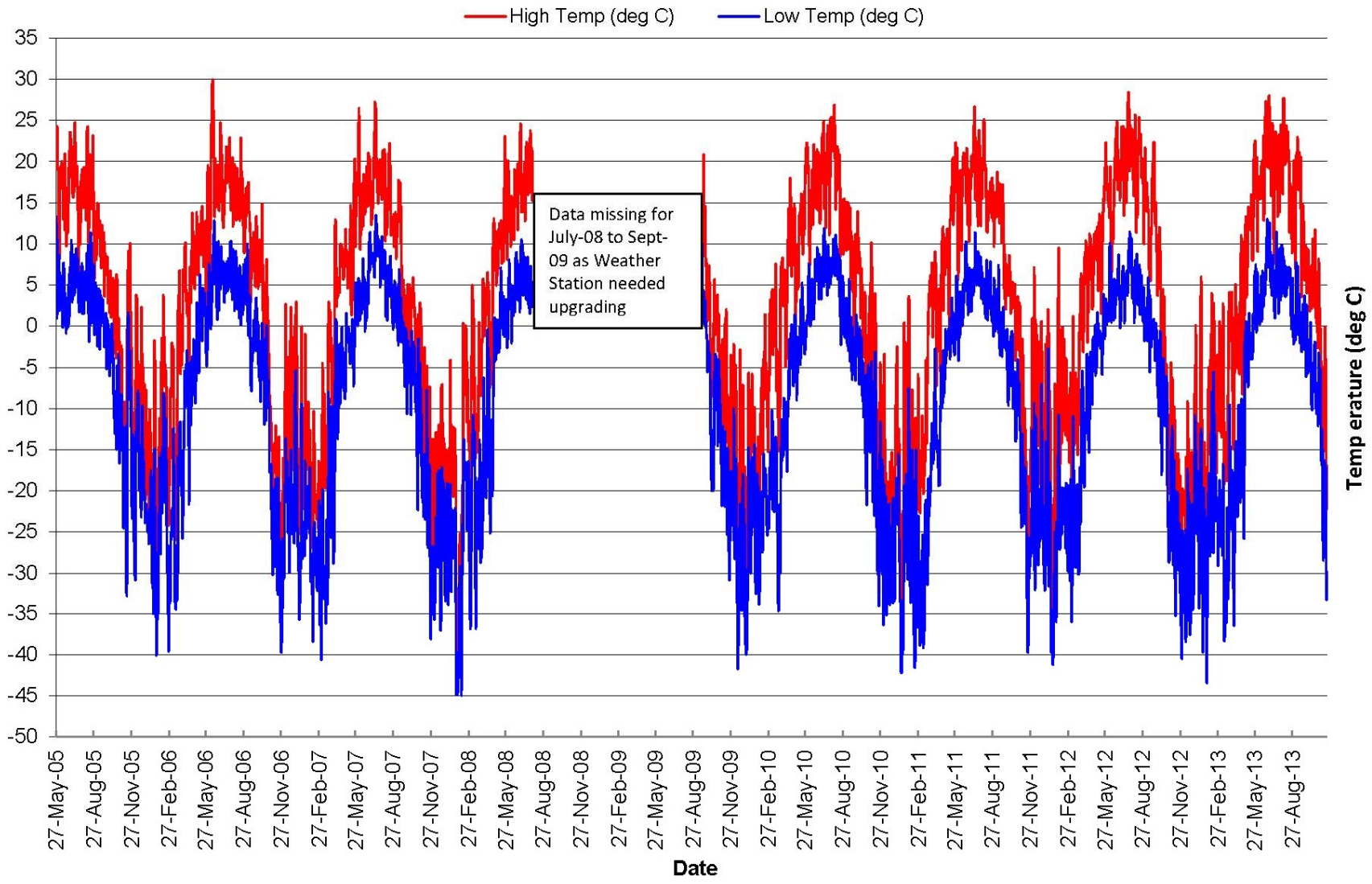
Temperatures at the Mine site from 1980 to 2012 have remained generally consistent, averaging -5^{o}C annually. Rainfall appears to have increased, although this may be distorted by the lack of snow course data, with some snow reporting as rainfall in winter months. Therefore, total precipitation may not have changed. However, it is clear that rainfall totals for the year vary largely in response to the number and intensity of summer rainfall events. The Mine site experienced two flood events in recent times, in June 2006 and August 2007. Both were in response to intense rainfall. The former is indicted by the monthly rainfall of 139 mm. The monthly rainfall for the latter was 80 mm. The events are more accurately represented by daily rainfall totals of 37 mm on 17 June 2006 and 25 mm on 7 August 2007.

TABLE 4-1: CLIMATE DATA

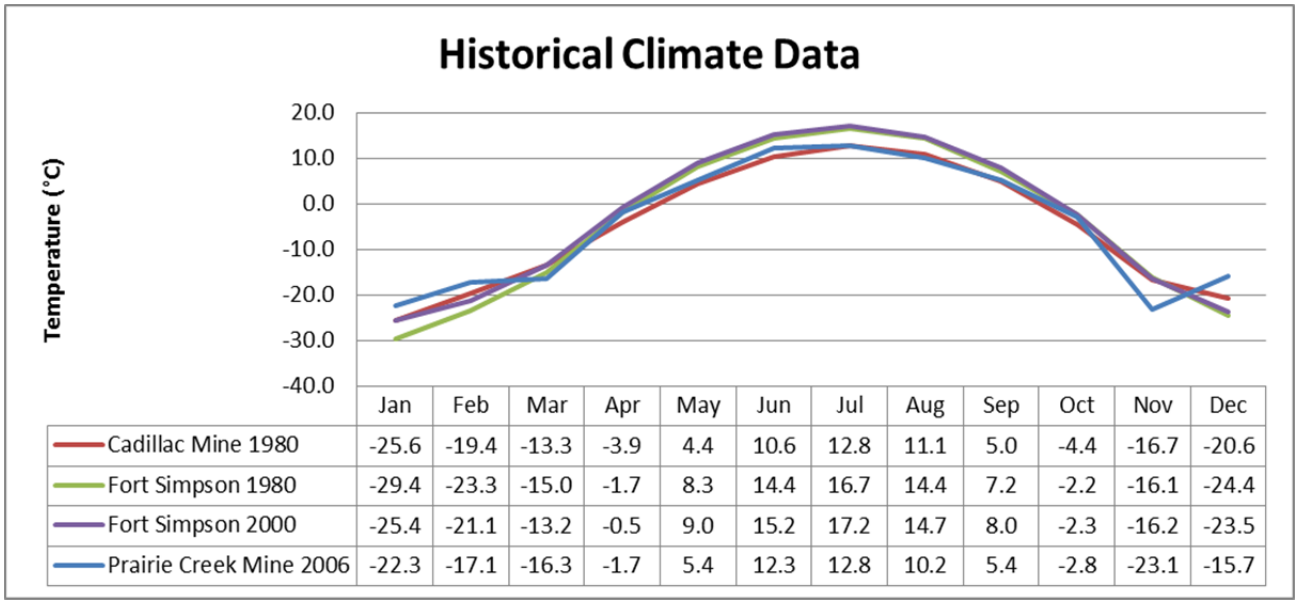
	Station/Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Cadillac 1980	Mean Daily Temp °C	-25.6	-19.4	-13.3	-3.9	4.4	10.6	12.8	11.1	5.0	-4.4	-16.7	-20.6	-5.0
	Rainfall mm	0.0	0.0	0.0	2.5	25.4	58.4	86.4	71.1	48.3	7.6	0.0	0.0	299.7
	Precipitation mm	22.9	22.9	20.3	25.4	40.6	58.4	86.4	71.1	58.4	48.3	30.5	22.9	508.0
	Evaporation mm	-	-	-	-	<25	76.2	101.6	76.2	50.8	<25	-	-	330.2
Prairie Creek 2006	Mean Daily Temp °C	-22.3	-17.1	-16.3	-1.7	5.4	12.3	12.8	10.2	5.4	-2.8	-23.1	-15.7	-4.4
	Rainfall mm	0	0	24	18.8	80.1	139	59.8	56.8	32.4	3.2	0	0	414.3
	Wind Speed (km/h)	2.2	2.4	5.9	6.1	6.3	5.7	6.3	4.9	4.9	3.7	3.1	2.5	4.5
	Most Frequent Wind Dir.	W	W	W	E	W	W	W	W	W	W	W	W	W
Prairie Creek 2012	Mean Daily Temp °C	-22.6	-15.5	-15.5	-2.0	5.3	10.4	13.6	11.6	7.1	-6.3	-21.4	-25.0	-5.0
	Rainfall mm	0.0	15.5	16.3	18.6	37.9	118.8	47.9	84.3	23.5	5.1	0.0	0.0	367.9
	Wind Speed (km/h)	2.0	1.9	3.5	3.5	4.5	3.4	3.3	2.4	2.9	3.5	2.1	2.0	2.9
Fort Simpson 1980	Mean Daily Temp °C	-29.4	-23.3	-15.0	-1.7	8.3	14.4	16.7	14.4	7.2	-2.2	-16.1	-24.4	-4.4
	Rainfall mm	0.0	0.0	0.0	2.5	22.9	40.6	45.7	53.3	25.4	7.6	0.0	0.0	299.7
	Precipitation mm	20.3	17.8	17.8	15.2	30.5	40.6	45.7	53.3	30.5	27.9	25.4	20.3	345.4
Fort Simpson 2000	Mean Daily Temp °C	-25.4	-21.1	-13.2	-0.5	9.0	15.2	17.2	14.7	8.0	-2.3	-16.2	-23.5	-3.2
	Rainfall mm	0.2	0	0.1	3.0	21.5	47.8	59.2	56.7	23.6	11.6	0.2	0	224.0
	Snowfall cm	24.0	21.2	18.8	14.4	6.2	0	0	0.5	5.3	29.4	27.3	23.2	170.3
	Precipitation mm	18.5	17.5	15.9	16.0	28.2	47.8	59.2	57.2	28.6	38.9	22.7	18.6	369.0
	Wind Speed (km/h)	7.8	8.9	9.8	10.6	10.7	9.8	8.9	9	9.1	9.6	8.4	7.4	9.2
	Most Frequent Wind Dir.	NW	NW	NW	E	E	E	NW	NW	E	E	NW	NW	NW
Fort Simpson 2009	Mean Daily Temp °C	-24.9	-22.8	-18.2	-0.5	6.2	15.2	16.4	15.3	10.8		-13.8		
	Rainfall mm	0	0	0	0	21	71.2	40.6	94.9	124.4		0		
	Snowfall cm	40.6	24	35.6	12.2	12	0	0	0	0		33.3		
	Precipitation mm	31.4	17.2	30.8	9	32.6	71.2	40.6	94.9	124.4		19.6		
Fort Liard 1979	Mean Daily Temp °C	-25.7	-28	-12.9	-1.3	8.0*	14.3	18.9	16.2	11.5	4.1	-5.7	-16.8	-1.5
	Rainfall mm	0	0	0	4	53.4	48.8	78.7	50.1	62.2	3	4	0	304.2
	Snowfall cm	8.5	9.5	15	18.5	0	0	0	0	0	0	0	16	67.5
	Precipitation mm	8.5	9.5	15	22.5	53.4	48.8	78.7	50.1	62.2	3	4	16	371.7
Fort Liard 2006	Mean Daily Temp °C	-23.6^	-12.7	-12.5	3.1	10.3	15.2^	18.2^	14.8^	9.6^	2.4^	-20.1^	-15.1^	-0.9
	Rainfall mm	0	0	0	0	37.8	132.4	20.8*	50.2	24.2	38.4	0	0	303.8
	Snowfall cm	32.8	21.2	26.6	19	0	0	0	0	0	19.5	67.1	13	199.2
	Precipitation mm	13.8	13	18.2	17	37.8	132.4	20.8*	50.2	24.2	50.7	34.2	9	421.3

^ Incomplete Data * Estimated

FIGURE 4-3 TEMPERATURES RECORDED AT PRAIRIE CREEK MAY 27, 2005 – NOVEMBER 18, 2013



Monthly temperatures recorded at the Mine and Fort Simpson are shown graphically below. This shows that there isn't a great difference between the locations, or over the time span.

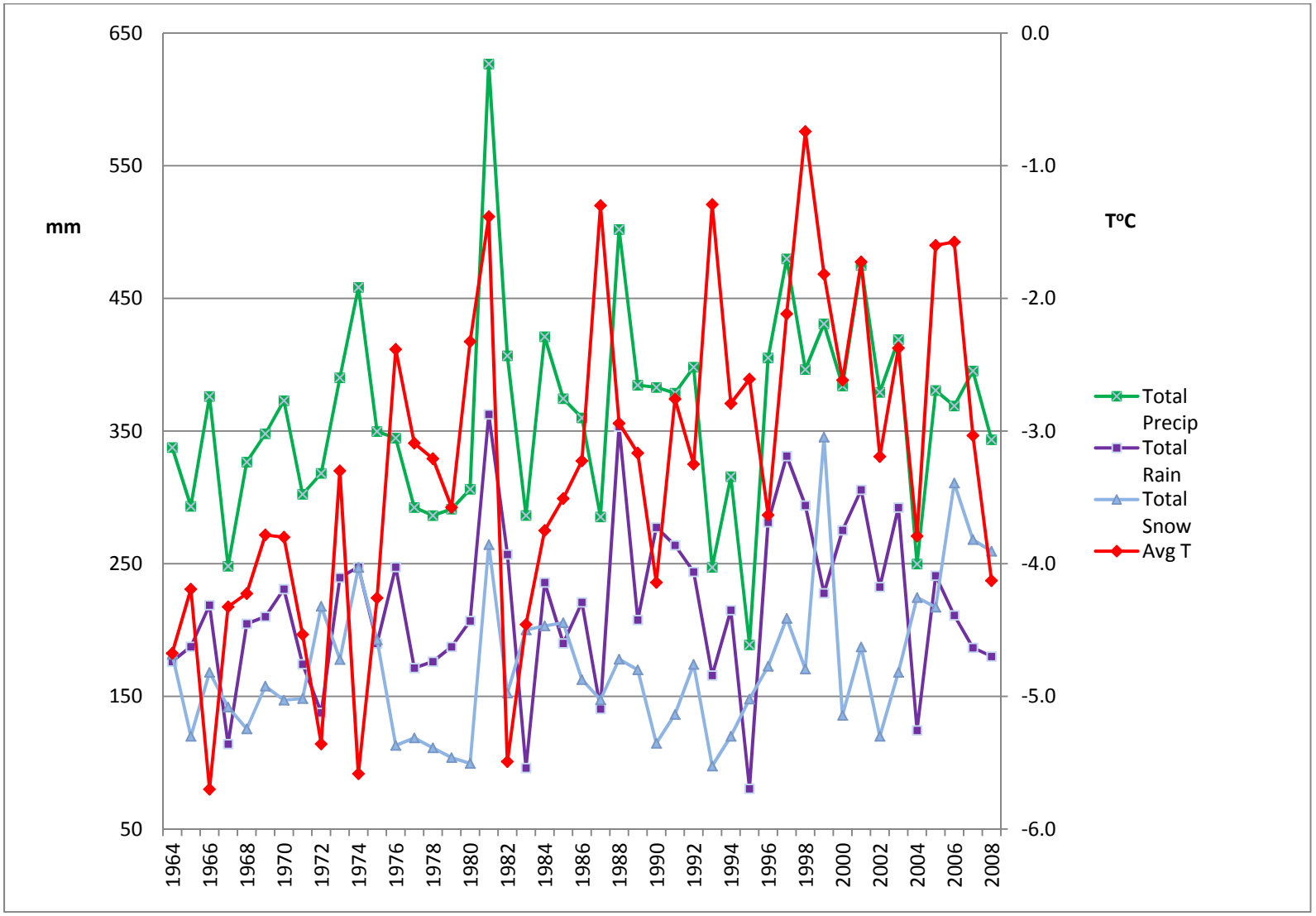


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cadillac Mine 1980	-25.6	-19.4	-13.3	-3.9	4.4	10.6	12.8	11.1	5.0	-4.4	-16.7	-20.6
Fort Simpson 1980	-29.4	-23.3	-15.0	-1.7	8.3	14.4	16.7	14.4	7.2	-2.2	-16.1	-24.4
Fort Simpson 2000	-25.4	-21.1	-13.2	-0.5	9.0	15.2	17.2	14.7	8.0	-2.3	-16.2	-23.5
Prairie Creek Mine 2006	-22.3	-17.1	-16.3	-1.7	5.4	12.3	12.8	10.2	5.4	-2.8	-23.1	-15.7

Apart from the long-term status of discontinuous permafrost, climate conditions and the potential for change is a relevant consideration for the timing of ice formation on the Liard River, and thaw. For an all season road, this will determine the timing of switch over from barge to ice bridge, and vice versa. In this regard, the long-term weather station record at Fort Simpson was studied. Figure 4-4 shows annual average temperature and precipitation data for the period 1964-2008. Despite significant variation from year to year, some trends can be discerned. Average annual temperatures varied around -5^{o}C at the start of the period, but appear to have increased to around -2.5^{o}C by 2000. The increase seems to have stalled since that time, and may perhaps have decreased slightly. A similar pattern is evident in rainfall. Annual amounts varied mostly in the 150-250 mm range from 1964 to 1980. Thereafter, the range expanded to 100-350 mm, although in 2004-2008 the earlier range seems to have re-established itself. Snowfall also seems to have increased slightly, and variations become more extreme. Total precipitation largely mirrors rainfall patterns. One might conclude that, overall, the climate has warmed a few degrees and precipitation variations have become more extreme.

If temperatures are warming, ice bridges in the area should be opening later, and closing sooner. This is not the case at the Liard River crossing near Fort Simpson. Data for the crossing indicate that the 5 year average opening to light traffic was November 25, compared to the 35 year average of November 26 (GNWT Department of Transport). Similarly, the 5 year average closing was April 24, compared to the 30 year average of April 22. Therefore, either there hasn't been significant climate change, or it hasn't affected crossing operations.

FIGURE 4-4 AVERAGE ANNUAL TEMPERATURES AND PRECIPITATION, FORT SIMPSON, 1964-2008



The above data doesn't indicate the presence of seasonal fog. However, it is common knowledge that ground fog is prevalent in low lying areas in the spring and fall coincident with low temperatures after periods of rainfall. The fog develops overnight and usually dissipates during the following day, although sometimes it can persist all day. The Prairie Creek site is more prone to ground fog year round due to the higher elevation and colder temperatures, but the incidence is greater in the spring and fall.

The climate data presented above is considered suitable for the determination of trends in the context of the proposed all season road. This is despite the occurrence of some data gaps and estimates in certain data. Climate conditions, and their variance, are not expected to have a significant bearing on the construction or operation of the road.

Traditional knowledge on climate patterns was obtained from elders in Nahanni Butte on January 20, 2015. Elders advised that in the 1960's when they would go trapping in January-February, temperatures would get as low as -50^{o}C. Now, temperatures are typically only as low as 30^{o}C. A general consensus is that there is less snow now than 20-30 years ago, and that it melts earlier. Evidence of permafrost thaw has been seen. This includes the slumping of banks of the lower South Nahanni River, and slough's that are now dry in summer whereas previously they held water due to frozen ground below.

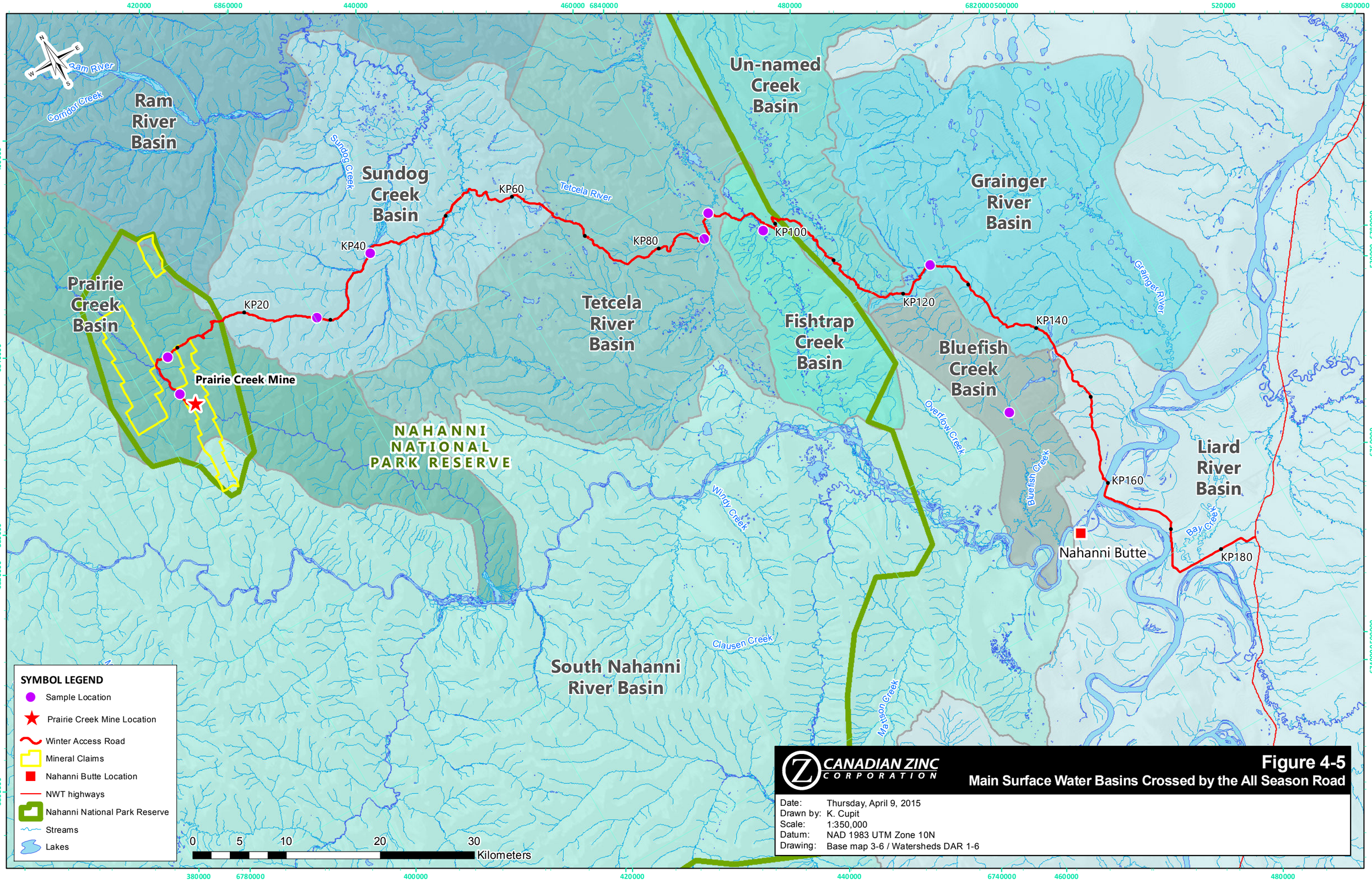
4.3 Water Quality and Quantity

4.3.1 Surface Water Resources

Overview

Figure 4-5 shows the main surface water basins crossed by the access road. From west to east, these are Prairie Creek, Sundog Creek, Tetcela River, Fishtrap Creek, an un-named creek, Grainger River and Liard River. In terms of stream crossings, there is a wide variety of crossing types. From the Mine at Km 0, the road does not cross Prairie Creek, but runs adjacent to the creek and crosses a large tributary called Casket Creek, which is a braided alluvial fan at the crossing. From there, the road runs east adjacent to Funeral Creek, another Prairie tributary, before heading over a high elevation pass (and watershed divide) into the Sundog Creek basin. The road also runs east adjacent to this creek, but crosses two significant tributaries, and the main stem twice in upland terrain. Thereafter, the road runs along the southern edge of a wide alluvial floodplain to Cat Camp at Km 40, crossing one significant tributary at Km 39.

From Cat Camp, the road crosses a number of small streams which are tributaries to Sundog or Polje Creek, itself a tributary of Sundog, until crossing Polje Creek main-stem at Km 55. The road then climbs the Ram Plateau and there no significant stream crossings until a major tributary of the Tetcela River at Km 87, and the river itself at Km 90. The road then crosses swampy terrain and the headwaters of Fishtrap Creek at Km 95 before ascending the Silent Hills to Wolverine Pass. After the pass, the road swings south and runs along the lower slopes of the Silent Hills, crossing a number of small tributaries of an un-named creek consisting of wetlands that flow north. At Km 117, the road turns east again and crosses into the headwaters of the Grainger basin.


Ram River
Corridor Creek
Ram River Basin
Sundog Creek
Sundog Creek Basin
KP60
Tetcela River
KP80
KP40
KP20
Prairie Creek Basin
Prairie Creek Mine
NAHANNI NATIONAL PARK RESERVE
Tetcela River Basin
Un-named Creek Basin
KP100
Fishtrap Creek Basin
Grainger River Basin
Grainger River
KP120
KP140
Bluefish Creek Basin
Overflow Creek
Bluefish Creek
KP160
Liard River Basin
Bay Creek
Nahanni Butte
KP180
Windy Creek
Clausen Creek
Mattson Creek
South Nahanni River Basin
SYMBOL LEGEND
Sample Location
Prairie Creek Mine Location
Winter Access Road
Mineral Claims
Nahanni Butte Location
NWT highways
Nahanni National Park Reserve
Streams
Lakes
0 5 10 20 30
Kilometers
CANADIAN ZINC CORPORATION
Figure 4-5
Main Surface Water Basins Crossed by the All Season Road
Date: Thursday, April 9, 2015
Drawn by: K. Cupit
Scale: 1:350,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-6 / Watersheds DAR 1-6

The road crosses Grainger main-stem at Km 123 and 125, before turning south again to run along the lower slopes of the Front Range to the Liard River crossing north of Nahanni Butte. Along this stretch, the road crosses a number of small tributaries of the Grainger and Liard Rivers. After the Liard River, the road follows the eastern bank of the river to the Nahanni access road, crossing one significant tributary.

Stream and Crossing Characteristics

Stream crossings along the road were classified into major and minor crossings based on size of stream. In addition, any stream suspected or known to host fish, was automatically assumed to be a major crossing. If fish presence was unknown, it was considered a major crossing by default. The major crossings so classified were subsequently visited in order to collect habitat and hydraulic data, including stream and top of bank width, stream depth, gradient and flow velocity, and photos of the site. The habitat data will be discussed in Section 4.5. The hydraulic data was used by Tetra Tech EBA to compute design flood levels to support the design and selection of an appropriate crossing structure.

Some crossings were previously assessed by EBA Engineering Consultants for the permitting of the winter road. These included two crossings of Sundog Creek (2014 road alignment Km 23.5 and 28.8) and one of Polje Creek (Km 53.65). EBA's report for these can be found in Appendix 3. The remainder have been assessed for the all season road, and Tetra Tech EBA's report for these can be found in Appendix 4. The two reports provide data on the major crossings, including basin area and 100-year return period flood information (velocity, channel width, depth and elevation) as well as photos.

Table 4-2 provides data for all streams crossed by the proposed all season road. This includes all streams with a defined channel. It does not include low spots adjacent to the road where a culvert or some other form of water passage structure may be required, or poorly defined channels. For all streams, the type of crossing is identified (e.g. incised bedrock), the stream order, whether fish are thought to be present, whether flow is seasonal (ephemeral) or year-round (perennial), whether the streams banks are stable, and whether the sediment load in water and the bed is high or low. The streams are discussed further below in terms of their basin.

Prairie Basin

As noted, the access road runs north from the Mine adjacent to Prairie Creek, then turns east and runs adjacent to Fast Creek for a short distance, and then Funeral Creek. It does not cross any of the main stems of these creeks. Most streams crossed are small. The largest is Casket Creek at Km 6.1. At the crossing, Casket Creek is an alluvial fan, and there is an existing bridge over the single channel. The floodplain has been active in the recent past, but armouring was installed at the time of bridge installation to 'train' the channel under the bridge. The next largest crossing is a tributary of Funeral Creek at Km 13.4. The road alignment was previously altered to be above the high water mark of Prairie Creek. Road repairs and bank armouring were required to replace the road bed and protect it from erosion. Only Prairie Creek is expected to have flowing water in winter. There may be some flow in the alluvial gravels of Casket Creek, but no surface expression. No icings have been observed in these streams during winter reconnaissance, and there is no evidence of ice-induced higher water levels.

TABLE 4-2: CREEK CROSSING PHYSICAL DATA

2014 Road Km	Stream Name	Type	Order	Fish	Flow	Bank Stability	Sediment Load	
							TSS	Bed
2.9	Prairie Trib.	incised bedrock	3	N	E	S	L	H
3.3	Prairie Trib.	incised bedrock	1	N	E	S	L	L
4.4	Prairie Trib.	small alluvial	3	N	E	S	L	L
6.1	Casket Creek	alluvial fan	4	?	E	U	L	H
6.6	Prairie Trib.	incised bedrock	2	N	E	S	L	L
9.3	Funeral Trib.	incised bedrock	1	N	E	S	L	L
9.8	Funeral Trib.	incised bedrock	2	N	E	S	L	L
10.2	Funeral Trib.	incised bedrock	1	N	E	S	L	L
10.7	Funeral Trib.	incised bedrock	1	N	E	S	L	L
13.3	Funeral Trib.	incised alluvial	3	N	E	U	L	H
13.4	Funeral Trib.	incised alluvial	3	N	E	U	L	H
14.9	Funeral Trib.	incised bedrock	1	N	E	S	L	L
15.2	Funeral Trib.	incised bedrock	2	N	E	S	L	L
15.9	Funeral Trib.	alluvial	2	N	E	S	L	L
20.5	Sundog Trib.	alluvial	3	N	E	S	L	H
23.5	Sundog Trib.	box canyon	4	N	P	U	L	H
25.3	Sundog Trib.	incised bedrock	3	N	E	S	L	L
28.4	Sundog Creek	split flow	4	Y	E	U	L	H
28.8	Sundog Creek	alluvial	4	Y	E	U	L	H
29.2	Sundog Trib.	incised bedrock	2	N	E	S	L	L
29.9	Sundog Trib.	incised bedrock	3	N	E	S	L	L
30.2	Sundog Trib.	incised bedrock	2	N	E	S	L	L
30.9	Sundog Trib.	incised bedrock	2	N	E	S	L	L
31.1	Sundog Trib.	incised bedrock	1	N	E	S	L	L
31.4	Sundog Trib.	incised bedrock	2	N	E	S	L	L
31.7	Sundog Trib.	incised bedrock	2	N	E	S	L	L
32.4	Sundog Trib.	incised bedrock	2	N	E	S	L	L
36.8	Sundog Trib.	incised bedrock	2	N	E	S	L	L
37.9	Sundog Trib.	incised bedrock	2	N	E	S	L	L
39.4	Sundog Trib.	alluvial fan	4	Y	E	U	L	H
43.3	Sundog Trib.	alluvial	2	N	E	S	L	L
45.6	Polje Trib.	bog	1	N	E	S	L	L
46.2	Polje Trib.	small incised	3	Y	E	S	L	L
46.5	Polje Trib.	small channel	2	N	E	S	L	L
48.1	Polje Trib.	small channel	2	N	E	S	L	L

TABLE 4-2: CREEK CROSSING PHYSICAL DATA

2014 Road Km	Stream Name	Type	Order	Fish	Flow	Bank Stability	Sediment Load	
							TSS	Bed
48.7	Polje Trib.	small channel	2	N	E	S	H	L
49.6	Polje Trib.	small incised	3	?	E	S	L	L
50.7	Polje Trib.	small channel	3	N	E	S	L	L
50.8	Polje Trib.	small channel	3	N	E	S	L	L
53.6	Polje Trib.	floodplain channel	1	Y	E	U	H	L
53.65	Polje Creek	incised channel	4	Y	P	U	H	H
56.4	Polje Trib.	small channel	1	N	E	S	H	L
56.5	Polje Trib.	small channel	1	N	E	S	H	L
60.4	Polje Trib.	small channel	2	N	E	S	L	L
61.6	Polje Trib.	small channel	2	N	E	S	L	L
63.6	Polje Trib.	small channel	2	N	E	S	L	L
67.2	Tetcela Trib.	small channel	2	N	E	S	L	L
71.1	Tetcela Trib.	small channel	2	N	E	S	L	L
72.75	Tetcela Trib.	small channel	2	N	E	S	L	L
85.6	Tetcela Trib.	small channel	1	N	E	S	L	L
87.4	Tetcela Trib.	gravel channel	4	Y	P	S	H	H
89.7	Tetcela Main stem	gravel channel	5	Y	P	S	H	H
95.0	Fishtrap Creek	small channel	2	N	P	S	L	L
105.1	Un-named Creek	small channel	3	N	E	S	L	L
105.45	Un-named Creek	small channel	3	N	E	S	L	L
105.55	Un-named Creek	small channel	2	N	E	S	L	L
106.7	Un-named Creek	small channel	2	N	E	S	L	L
107.0	Un-named Creek	small channel	3	N	E	S	L	L
109.2	Un-named Creek	small channel	1	N	E	S	L	L
109.3	Un-named Creek	small channel	2	N	E	S	L	L
109.4	Un-named Creek	small channel	1	N	E	S	L	L
110.6	Un-named Creek	small channel	2	N	E	S	L	L
110.8	Un-named Creek	small channel	1	N	E	S	L	L
111.0	Un-named Creek	small channel	1	N	E	S	L	L
112.0	Un-named Creek	small channel	1	N	E	S	L	L
112.6	Un-named Creek	small channel	1	N	E	S	L	L
112.8	Un-named Creek	small channel	1	N	E	S	L	L
113.2	Un-named Creek	small channel	1	N	E	S	L	L
116.05	Un-named Creek	small channel	2	N	E	S	L	L
116.25	Un-named Creek	small channel	2	N	E	S	L	L

TABLE 4-2: CREEK CROSSING PHYSICAL DATA

2014 Road Km	Stream Name	Type	Order	Fish	Flow	Bank Stability	Sediment Load	
							TSS	Bed
122.4	Grainger Trib.	bouldery channel	2	Y	E	S	L	L
123.4	Grainger River	cobble chanel	3	Y	P	S	L	H
124.8	Grainger River	cobble chanel	3	Y	P	S	L	H
127.1	Grainger Trib.	small incised	2	N	E	S	L	L
131.2	Grainger Trib.	small channel	2	?	E	S	L	L
133.2	Grainger Trib.	small channel	2	?	E	S	L	L
134.9	Grainger Trib.	small channel	2	?	E	S	L	L
136.5	Grainger Trib.	small channel	1	?	E	S	L	L
140.1	Liard Trib.	small channel	1	N	E	S	L	L
140.6	Liard Trib.	small channel	1	N	E	S	L	L
141.0	Liard Trib.	small channel	1	N	E	S	L	L
144.4	Liard Trib.	small channel	1	N	E	S	L	L
146.8	Liard Trib.	small channel	1	N	E	S	L	L
149.9	Liard Trib.	small channel	1	N	E	S	L	L
150.8	Liard Trib.	small channel	1	N	E	S	L	L
152.5	Liard Trib.	small channel	1	N	E	S	L	L
154.9	Liard Trib.	small incised	1	?	E	S	L	L
172.4	Liard Trib.	small channel	1	N	E	S	L	L

Fish: N=No Y=Yes ?=Unknown
Flow: E=Ephemeral P=Perennial
Bank Stability: S=Stable U=Unstable
TSS and Bed: L=Low H=High

Sundog Basin

The access road runs adjacent to Sundog Creek from the pass at Km 17 to Cat Camp at Km 40. It crosses the main stem three times, at Km 20.5 where the stream is relatively small due to proximity to the headwaters, and at Km's 28.4 and 28.8. The road also crosses three significant tributaries at Km's 23.5, 25.3 and 39.4. Flows recede in the Sundog system in the late summer. Stretches of the creek in the floodplain section from Km 29-40 are commonly dry from this time on, with flow in the underlying alluvium. The floodplain widens to a few hundred metres at Cat Camp. There are many old channels and stabilized bars. The all season road alignment will stay to the south edge of the floodplain, on mostly stabilized areas. However, the stream is dynamic when in flood, and channels can change course All crossings are dry in winter, although an icing has been observed at Km 23.5, likely due to groundwater seepage. A high flood level is also evident on the box canyon walls at this location, suggesting an ice-induced effect.

The Polje Creek Basin is part of the Sundog Basin. The road runs parallel to Polje Creek from its headwaters to crossing the main stem at Km 53.65. All tributary crossings are small and will be dry in winter. The main stem channel at the crossing is large (>5 m) and flow under ice is likely in winter. Polje Creek is a series of meanders and ox-box ponds. The lower section of the valley can have water levels above normal top of bank, which has been witnessed.

Tetcela Basin

The road crosses some small Tetcela tributaries, one large tributary at Km 87.4, and the main stem at Km 89.7. The river drains a large area, and so has a relatively wide active floodplain and high bed load of sediment. The banks either side of the floodplain are stable and well vegetated. The river and large tributary likely host water flow under ice in winter.

Fishtrap Creek Basin

The only crossing is of Fishtrap Creek itself. The crossing is near the headwaters in a location where the channel is narrow and dominated by wetland bog and beaver dams upstream and downstream. Water will likely be present under ice in winter. The wetland area supports many ponds which ultimately drain into the creek, which changes to a more conventional channel of flowing water further south approaching the South Nahanni River.

Un-named Creek Basin

Along the eastern slopes of the Silent Hills, there are many small tributaries to an un-named creek which flows north, ultimately becoming a stream and joining the Tetcela River much further north. The creek is also dominated by wetland bog and beaver dams. The road crosses many small tributaries, which will be dry in winter.

Grainger Basin

The road crosses a headwater tributary at Km 122.4 after a short wetland section, and then the main stem at Km's 123.4 and 124.8, west and east of Grainger Gap respectively. The tributary is narrow (~1.5 m), but the main stem is >5 m wide. There are inactive floodplain benches adjacent to the main stem in the Gap area. East of the Gap, the river flows east towards the Liard River,

but there are a number of wetland pockets and small tributaries of Grainger that drain the eastern slopes of the Front Range, and which the road crosses. The main stem hosts water flow in winter, and there is evidence of open water ribbons.

Liard Basin

South of Km 140, the road continues to cross small streams and wetland pockets draining the eastern slopes of the Front Range, but these drain directly into the Liard River. There are no significant tributaries to cross east of the river to the junction with the Nahanni Butte access road.

Seasonal and Annual Flows

Flows in the various larger streams crossed by the access road will mirror the pattern of Prairie Creek, for which there is a good record. The Water Survey of Canada (WSC) operated a hydrometric station on Prairie Creek opposite the Mine and generated average monthly flow data from October 1974 to December 1990. This data is shown in Table 4-3. The table also shows the minimum flow recorded for each month over the 16 year monitoring period.

Higher monthly flows occur over the period May-September, with the peak flow month usually being June coincident with the freshet. The annual low flow month is usually March when flows are approximately 50 times less than in June. However, these data do not account for peak flows observed in the area, which occur associated with intense summer rainfall events. Two such events occurred in July 2006 and August 2007. These events are considered abnormal because they caused erosion of stream banks and CZN's access road to a degree not seen since the Mine and road were built. Freeze-up usually commences in mid-October, and spring thaw in mid-April.

Design 1 in 100 year return period flow estimates for major crossings are provided in Appendices 3 and 4. Appendix 4 also provides equations for the calculation of 1 in 10 year and 1 in 250 year return period flows. These are estimated to be 70% and 115% of 1 in 100 year flows, respectively.

Questions were raised during EA0809-002 regarding the relevance of the 1974-1990 WSC record to present-day flows. Northwest Hydraulics Co. (NHC) performed an analysis of trends using regional flow stations with longer records. Their report is provided in Appendix 5. NHC concluded that there are no obvious trends in either the annual mean or annual peak flows at gauged streams in the Prairie Creek region, and that the 1974-1990 record for Prairie Creek appears to be reasonably representative of average conditions.

TABLE 4-3 MEAN AND MINIMUM MONTHLY FLOWS (M^3/SEC) AT THE PRAIRIE CREEK MINE WSC STATION

Month	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Mean	Min	%
Jan	N/A	0.438	0.781	0.279	0.23	0.375	0.319	0.528	0.773	0.792	**0.145**	0.206	1.23	0.865	0.603	0.269	0.639	0.530	0.145	27.4
Feb	N/A	0.264	0.66	0.269	0.17	0.241	0.162	0.357	0.387	0.55	**0.048**	0.07	0.868	0.703	0.454	0.294	0.595	0.381	0.048	12.6
Mar	N/A	0.122	0.55	0.263	0.167	0.237	0.061	0.31	0.24	0.397	0.064	**0.038**	0.661	0.489	0.292	0.468	0.577	0.309	0.038	12.3
Apr	N/A	0.516	1.1	0.596	0.376	0.325	1.05	0.363	0.536	0.272	0.861	**0.078**	0.526	0.377	0.845	4.34	0.935	0.819	0.078	9.5
May	N/A	16.4	18.4	14.9	**7.84**	10.4	8.64	13.7	9.73	7.86	8.52	13.1	15	8.43	15.1	15.9	13.8	12.358	7.840	63.4
Jun	N/A	19.4	23	-	11.9	24.4	7.26	13.4	19.2	15.8	13.6	12.7	24.4	13.2	37.4	**10.8**	12.1	17.237	10.800	62.7
Jul	N/A	14.9	19.7	14.5	10.6	14.2	9.62	**5.96**	7.51	9.23	13.8	11.5	16.1	8.99	16.8	5.98	9.09	11.780	5.960	50.6
Aug	N/A	12.8	8.52	10.7	6.27	8.89	7.95	**5.12**	8.27	16.9	8.88	7.22	10.3	9.99	8.08	5.19	14.3	9.336	5.120	54.8
Sep	N/A	7.45	5.85	7.47	**3.66**	5.08	6.83	8.06	6.44	6.03	5.48	5.43	6.75	8.3	9.08	4.09	5.08	6.318	3.660	57.9
Oct	2.77	3.1	2.43	2.78	1.57	2.04	5.61	2.75	2.32	**1.54**	2.69	2.84	3.93	2.66	3.73	2.56	1.64	2.762	1.540	55.7
Nov	1.61	1.33	1.04	**0.828**	0.851	1.07	1.3	1.62	1.25	0.859	0.903	2.32	1.32	0.939	1.34	1.72	1.69	1.294	0.828	64.0
Dec	0.79	0.934	0.504	**0.254**	0.629	0.556	1.04	1.3	1.05	0.46	0.535	1.84	1.04	0.770	0.791	0.944	0.812	0.838	0.254	30.3
Mean	**N/A**	**6.52**	**6.91**	**N/A**	**3.71**	**5.67**	**4.17**	**4.47**	**4.82**	**5.09**	**4.65**	**4.81**	**6.87**	**4.66**	**7.87**	**4.41**	**5.15**	**5.319**	**3.710**	**69.8**

4.3.2 Surface Water and Sediment Quality

Surface Water Quality

Water samples were collected in the main drainage basins crossed by the road. Samples were collected at downstream locations where the road crosses or departs from a main watercourse. Sample results are provided in Table 4-4. Laboratory certificates can be found in Appendix 6. Sample locations are shown in Figure 4-5. The main watercourses crossed by the road and having significant flows (Sundog, Polje, Tetcela, Grainger) were sampled twice, once in early summer (June 28) and once in the fall (September 26). Other watercourses were sampled for baseline purposes (Funeral, Fishtrap, Un-named, Bluefish).

All surface waters sampled are alkaline, have high hardness, and pH in the range 8-8.35, reflecting the dominance of carbonates in runoff. Alkalinity, pH, TDS, Ca and Mg tend to be higher in watercourses draining the limestone-rich Ram Plateau. Values are higher in the fall, likely a result of lower flows and less dilution from rainfall.

As might be expected, total and dissolved metals concentrations are low. Dissolved zinc concentrations range from <5-6.4 ppb for the most part, although the Funeral Creek sample had a value of 33.7 ppb. This probably reflects the natural signature related to runoff from the Rico mineralized showing, which is exposed just above the road at approximately Km 10.

Sediment Quality

Sediment samples were collected at the same time as surface waters in the fall. Fishtrap Creek was not sampled because there was no defined stream or sediment at the sampling location. Results are provided in Table 4-5, and certificates in Appendix 6. Soluble pH is consistently alkaline similar to surface water. Total metals are also low, except for calcium and magnesium. The total metal concentration of 319 ppm in Funeral Creek again reflects the Rico showing. Petroleum hydrocarbons were not detected in any of the samples, and all had a very low organic carbon content (<0.2-5.2%).

4.3.3 Groundwater Resources

There are essentially two types of groundwater resources proximal to the all season road alignment, those hosted by alluvium and those hosted by bedrock. Each will be discussed in turn.

Alluvial Groundwater

Groundwater is hosted by alluvium in the major watercourses adjacent to or crossed by the access road. The major watercourses include Prairie Creek, Sundog Creek, the Tetcela River and the Grainger River.

TABLE 4-4: SURFACE WATER QUALITY RESULTS

Sampling Date			Sep 19	Jul 28	Sep 26	Jul 28	Sep 19	Jul 28	Sep 26	Sep 26	Sep 26	Sep 26	Jul 28	Sep 26
		Units	Funeral	Sundog @ Cat Camp	Sundog @ Km 29	Polje Creek		Tetcela		Fishtrap	Un-named Creek	Bluefish	Grainger @ the Gap	
Alkalinity (Total $CaCO^3$)		mg/L	172	104	128	145	193	192	234	205	221	187	154	160
Bicarbonate (HCO^3)		mg/L	210	127	156	177	229	234	280	250	270	224	188	195
Sulphate (SO^4)		mg/L	87.5	13.5	73.5	16.5	30.0	87.3	128	175	30.0	38.7	11.1	16.4
Chloride (Cl)		mg/L	0.75	0.75	0.64	<0.50	1.2	4.2	4.8	3.7	0.91	1.4	<0.50	0.53
Conductivity		uS/cm	465	236	375	319	421	547	656	713	462	415	316	326
pH		pH	8.21	8.14	8.01	8.17	8.38	8.12	8.34	8.29	8.25	8.35	8.23	8.23
TSS		mg/L	<4.0	<4.0	<4.0	<4.0	<4.0	8.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
TDS		mg/L	264	138	276	182	228	374	480	602	350	278	170	210
Hardness ($CaCO^3$)		mg/L	251	130	209	186	223	325	364	321	252	215	182	185
Totals	Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
	Arsenic (As)	ug/L	0.52	0.13	<0.10	0.17	0.12	0.61	0.39	0.47	0.42	0.29	0.31	0.22
	Cadmium (Cd)	ug/L	0.051	0.017	0.013	0.088	0.093	0.046	0.032	<0.010	<0.010	0.012	0.013	0.017
	Copper (Cu)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	1.33	0.68	1.04	2.36	<0.50	<0.50	<0.50
	Iron (Fe)	ug/L	<10	<10	<10	103	49	499	185	111	387	44	54	47
	Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	0.32	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Mercury (Hg)	ug/L	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.01	<0.05
	Selenium (Se)	ug/L	1.49	0.17	0.15	1.13	2.04	0.49	0.50	<0.10	<0.10	0.21	0.17	0.20
	Zinc (Zn)	ug/L	32.8	<5.0	<5.0	6.0	5.8	<5.0	5.1	<5.0	<5.0	<5.0	<5.0	<5.0
	Calcium (Ca)	mg/L	55.1	31.5	42.8	57.3	67.7	96.1	102	75.5	72.1	57.5	52.6	48.5
	Magnesium (Mg)	mg/L	27.6	12.5	24.8	10.5	13.2	20.8	26.6	32.1	17.5	17.3	12.2	15.5
Dissolved	Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
	Arsenic (As)	ug/L	0.50	0.12	0.11	<0.10	0.13	0.35	0.34	0.47	0.40	0.27	<0.10	0.22
	Cadmium (Cd)	ug/L	0.054	0.012	0.028	0.077	0.092	0.025	0.035	0.012	<0.010	0.013	0.016	0.014
	Copper (Cu)	ug/L	0.37	0.27	0.31	0.31	0.37	1.42	0.61	0.57	0.34	0.42	0.54	0.28
	Iron (Fe)	ug/L	5.7	<5.0	<5.0	10.0	14.1	25.3	36.1	95.1	363	37.1	26.5	15.2
	Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Mercury (Hg)	ug/L	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.01	<0.05
	Selenium (Se)	ug/L	1.62	0.19	0.20	1.26	2.05	0.47	0.56	<0.10	<0.10	0.26	0.18	0.24
	Zinc (Zn)	ug/L	33.7	<5.0	<5.0	5.0	6.4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Calcium (Ca)	mg/L	59.1	26.9	41.5	46.8	73.1	78.0	97.7	76.5	68.8	60.5	47.4	46.6
	Magnesium (Mg)	mg/L	28.5	12.1	23.4	9.68	14.6	18.5	24.0	30.0	17.1	16.6	13.1	14.1

TABLE 4-5: SEDIMENT QUALITY RESULTS

Physical Properties	Units	Prairie	Funeral	Sundog @ Km 29	Sundog @ Cat Camp	Polje	Tetcela Trib	Tetcela Main	Bluefish	Grainger
Soluble (2:1) pH	pH	8.77	8.83	8.47	8.54	8.30	8.29	8.35	8.54	8.66
Total Antimony (Sb)	mg/kg	1.19	0.49	<1.0	0.11	0.60	0.79	0.52	0.21	<1.0
Total Arsenic (As)	mg/kg	5.35	6.38	7.3	0.86	5.60	7.06	5.42	5.33	7.7
Total Cadmium (Cd)	mg/kg	1.63	2.15	<0.50	0.247	0.542	0.506	0.409	0.235	<0.50
Total Calcium (Ca)	mg/kg	196000	207000	142000	216000	21500	45300	39100	117000	98900
Total Copper (Cu)	mg/kg	9.10	6.85	<5.0	1.19	9.74	9.98	8.33	6.67	<5.0
Total Iron (Fe)	mg/kg	11000	16000	4050	2460	13100	10100	8920	7020	5310
Total Lead (Pb)	mg/kg	21.8	49.0	8.5	3.84	5.39	6.05	4.63	3.95	4.0
Total Magnesium (Mg)	mg/kg	32900	54100	96100	106000	5140	8710	9020	38800	47900
Total Mercury (Hg)	mg/kg	0.187	<0.050	<0.50	<0.050	<0.050	<0.050	<0.050	<0.050	<0.50
Total Phosphorus (P)	mg/kg	463	276	128	155	484	475	350	177	143
Total Potassium (K)	mg/kg	432	591	<1000	149	413	392	318	333	<1000
Total Selenium (Se)	mg/kg	<0.50	<0.50	<5.0	<0.50	<0.50	0.51	<0.50	<0.50	<5.0
Total Sodium (Na)	mg/kg	113	146	<1000	138	<100	<100	<100	<100	<1000
Total Zinc (Zn)	mg/kg	204	319	42	29.2	69.1	53.2	51.8	22.9	26
EPH (C10-C19)	mg/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100
EPH (C19-C32)	mg/kg	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total Organic Carbon	%	3.3	5.2	2.6	<0.20	0.04	0.68	0.41	0.31	3.0

At the Mine site, groundwater occurs in gravel and sand aquifers, separated by and in some cases confined by clay lenses (see the DAR for EA0809-002). Similar occurrences are expected in the other major watercourse systems. However, the Sundog system appears to be more uniformly coarse alluvium at surface. Sundog Creek water levels recede in late summer and the fall, and the creek disappears into the alluvium in long sections, flow occurring in the groundwater hosted by the alluvium. The Tetcela system is likely to be a mixture of sands, gravels and clays. The Grainger system appears similar to the Sundog system in terms of type of alluvium, although the Grainger River flows year round. This is probably in response to large recharge areas upstream and the funneling effect of Grainger Gap forcing groundwater to surface. Certainly, river flow increases dramatically entering the Gap from the west.

Groundwater in the major alluvial systems generally flows in the direction of the watercourse. Flow gradients will be shallow, but flow may be relatively rapid due to the permeable nature of sands and gravels.

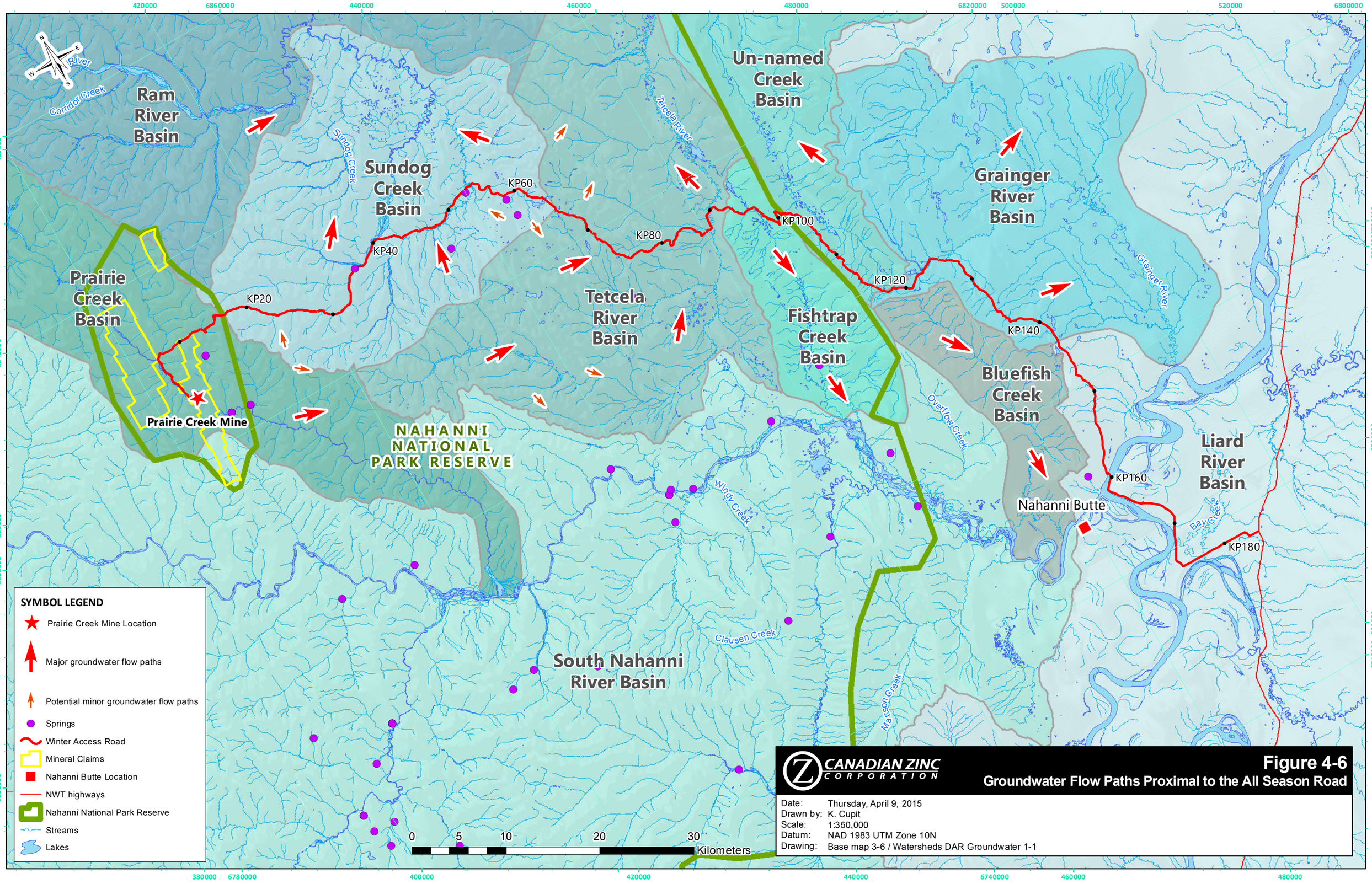
Some groundwater will be hosted in the lesser alluvial systems associated with Polje Creek, Fishtrap Creek and the un-named creek west of the Front Range. These systems are likely dominated by silts and clays, and therefore the groundwater in storage and flows are much less.

Bedrock Groundwater

Bedrock hosts groundwater primarily in fractures and cavities. The more competent formations (i.e. sandstones, dolostones) have a much greater capacity for groundwater storage and transmission than less competent formations (shales). Therefore, the prevalent dolostone formations in the area (e.g. Nahanni Formation) have the potential to be significant groundwater hosts, especially those with karstification cavities. The permeability of such cavities can be high, much higher than sands and gravels, provided they are continuous and inter-connected.

Figure 4-6 shows the expected major flow paths of bedrock-hosted groundwater. Flows will generally be in the same direction as surface water, as for alluvial groundwater, since topographic elevation is usually the main controller of water level elevation, and thus the gradient for flow is towards lower surface elevations. However, discrete fractures or inter-connected cavities have the potential to vary from this general pattern. Potential flows in these are shown in Figure 4-6 as smaller arrows. Karstification on the Ram Plateau means there is potential for bedrock-hosted groundwater flow towards the South Nahanni River. However, it is expected that the majority of this flow, if it exists, will discharge to the upstream tributaries of the Tetcela River. It is considered unlikely that conduits, hydraulic gradients and flow paths for groundwater exist from the Ram Plateau all the way to the South Nahanni River.

Figure 4-6 also shows where springs occur in the area. More springs might be expected to occur in the Ram Plateau area considering the dominance of dolostone. It is considered likely that there is considerable discharge to the beds of watercourses, and that this explains the apparent absence of springs. Some springs are located on the west side of the Ram Plateau in the Polje Creek area, likely where a dolostone host intersects a lower permeability formation below.


Ram River Basin
Sundog Creek Basin
Tetcela River Basin
Un-named Creek Basin
Grainger River Basin
Prairie Creek Basin
Fishtrap Creek Basin
Bluefish Creek Basin
Liard River Basin
South Nahanni River Basin
NAHANNI NATIONAL PARK RESERVE
Prairie Creek Mine
Nahanni Butte
KP20
KP40
KP60
KP80
KP100
KP120
KP140
KP160
KP180
Corridor Creek
Sundog Creek
Tetcela River
Grainger River
Overflow Creek
Windy Creek
Clausen Creek
Matson Creek
Bay Creek
SYMBOL LEGEND
Prairie Creek Mine Location
Major groundwater flow paths
Potential minor groundwater flow paths
Springs
Winter Access Road
Mineral Claims
Nahanni Butte Location
NWT highways
Nahanni National Park Reserve
Streams
Lakes
0 5 10 20 30
Kilometers
CANADIAN ZINC CORPORATION
Figure 4-6
Groundwater Flow Paths Proximal to the All Season Road
Date: Thursday, April 9, 2015
Drawn by: K. Cupit
Scale: 1:350,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-6 / Watersheds DAR Groundwater 1-1

4.4 Species at Risk

The focus of a species at risk assessment by Tetra Tech EBA was the biological status of species at a territorial level, and includes consideration of those species potentially present along the all season access road that are:

- Listed on the *Species at Risk (NWT) Act*;
- Listed on Schedule 1 of the *Species at Risk Act* (SARA) public registry; or
- Ranked by the General Status Ranks of Wild Species in the NWT as May Be At Risk and At Risk.

The all season access road also lies at the distributional limit of other species that have special conservation status, but the occurrence of these species in the region of the road route and NNPR have not been reported or reported only once. The known range of the Canada Warbler (*Wilsonia canadensis*; listed as Threatened under the SARA and At Risk in the NWT) extends as far north as the very southern border of the expanded NNPR, approximately 20 km south of the all season access road junction with the Liard Highway. Since the Prairie Creek all season access road route predominantly follows the permitted winter route (thereby reducing any potential habitat loss) and is slightly outside the northern extent of this species distribution, the Canada Warbler was not evaluated for this effects assessment. Nonetheless, mitigation to alleviate potential adverse effects to the Canada Warbler will be similar to species included in the effects assessment.

Where available, detailed species descriptions presented in the baseline Vegetation and Wildlife Assessment Report for the Prairie Creek Mine (Golder 2010) and the Occupancy Pattern of Caribou in the Prairie Creek Mine Road and Surrounding Area (Golder 2014a) were directly applied.

Tetra Tech EBA's assessment report is contained in Appendix 7. Boreal woodland caribou, northern mountain woodland caribou, wood bison and grizzly bear are local species of particular interest and are discussed below. The following additional species are discussed in Tetra Tech EBA's report:

- Collared Pikas
- Mountain Goat
- Wolverine
- Little Brown Myotis, Northern Myotis, and Western Long-eared Myotis
- Harlequin Duck
- Horned Grebes
- Peregrine Falcon
- Yellow Rail
- Short-eared Owl
- Common Nighthawk

- Olive-sided Flycatcher
- Barn and Bank swallow
- Rusty Blackbird
- Western Toad

4.4.1 Boreal Woodland Caribou (*Rangifer tarandus caribou*)

TABLE 4-6: BOREAL WOODLAND CARIBOU AT A GLANCE

Boreal Woodland Caribou	
NWT Population Summary	
Conservation Status	Listed as Threatened under the NWT (2014) and federal (2003) SARAs
Trend	Declining in the Dehcho
Size	Estimated 2,318 caribou in the Dehcho North and Southwest portions (Species at Risk Committee 2012)
Sensitivities and Threats	Habitat loss and changes resulting from forest fires and human developments that may increase access and hunting success of predators and hunters, and sensory disturbances
Health, Parasites, and Contaminants	A number of parasites known to occur (Johnson et al. 2010). Contaminant levels typical for large mammals and representative of natural background conditions (Deh Cho First Nations ND)
Relationship with the Prairie Creek All Season Road	
Expected Presence	Phase 2 (approximately from KP 125 to the Liard Highway; total of 25 km before joining with the Nahanni Access Road) (Species at Risk Committee 2012)
Seasons of Use	All seasons
Key Habitats	Strongly associated with upland and lowlands with black spruce and lichens (Species at Risk Committee 2012)
Existing Harvest Pressure	Low. Hunted opportunistically for subsistence use, particularly in the winter (Species at Risk Committee 2012)
Traditional Knowledge	
▪ The population west of the Liard River to the mountains considered low abundance but stable (i.e., generally west of the Nahanni Range) (Species at Risk Committee 2012). Whereas the population east of the Liard River to Trout Lake is considered high abundance and stable (i.e., generally east of the Nahanni Range) (Species at Risk Committee 2012). ▪ Animals generally healthy, and disease and parasites not considered a major threat to the population (Species at Risk Committee 2012). ▪ Very sensitive to human noises and disturbances, but are thought to adapt a certain extent to only some disturbance types (Species at Risk Committee 2012).	

Habitat fragmentation and degradation of the boreal forests across Canada have led to declining Boreal Woodland Caribou populations. In the NWT, their overall range has remained relatively intact; however, their populations are protected as a Threatened species under both the territorial and federal SARAs because of their small population size and the expected threat to their habitat (e.g., forest fires and human development).

The Boreal Woodland Caribou population estimated in the Dehcho was reportedly in decline from 2005 to 2010, with the adult female annual survival rate ranging from 62 to 93% (Larter and Allaire 2010). Current population estimates are unknown; however, the Species at Risk Committee (2012) estimated caribou densities in the Dehcho north and southwest were approximately 2 caribou per 100 km^2, and therefore, deriving a population of 2,318 caribou across the 115,888 km^2 area.

The Status of Boreal Caribou in the NWT (Species at Risk Committee 2012) suggests that the all season access road extends through Boreal Caribou range from approximately KP 125 to 173 (east of the Nahanni Range), along the existing Nahanni Butte road, and Liard Highway (Species at Risk Committee 2012). Golder (2010) also reported that Boreal Woodland Caribou may also occupy the Tetcela River and Fishtrap Creek areas (west of the Nahanni Range), which they access via the Grainger Gap. However, uncertainty exists whether the caribou reported occupying the Tetcela River and Fishtrap Creek areas may instead be Northern Mountain Woodland Caribou ecotype. Traditional knowledge may help to clarify this uncertainty, and indicates that Boreal Woodland and Northern Mountain caribou are known to interact particularly west of the Liard River near Nahanni National Park Reserve (Species at Risk Committee 2012). For the purposes of this report, it is assumed that Boreal Woodland Caribou primarily occur east of the Nahanni Range, but may infrequently occur to the west in the Tetcela River and Fishtrap Creek areas.

Group size and daily movements change seasonally. Boreal Caribou live in small groups during much of the year, though group size increases leading up to the rut (rut occurring mid-September to mid-October) and is the highest in March and April (Larter and Allaire 2010). Pregnant females become solitary and disperse from the group to calve; possibly only rejoining another female during post-calving (Larter and Allaire 2010) to minimize predation risk to their calf. Boreal Woodland Caribou are non-migratory, but they do make seasonal movements to exploit best available habitats in response to plant phenology and weather. Movement is most reduced the week or two after calving and in mid-winter (February) (Larter and Allaire 2010), but increases in late summer and fall. Routes of travel include areas with hard ground and adequate cover. These may include high ridges, large river drainages, seismic lines, and snowmobile tracks (Species at Risk Committee 2012).

Individual caribou occupy their home range year round, with the location and size of home ranges being dependent on the distribution and relative availability of high quality habitat, primarily upland and lowland black spruce and lichen dominated habitats (Gunn et al. 2004).

In the Dehcho, collared female Boreal Woodland Caribou occupy home ranges averaging 2,824 km^2 (Larter and Allaire 2010). At individual and population levels, Boreal Woodland Caribou require large expanses of suitable habitat with specific habitat features to support key life requirements (e.g., calving, predator avoidance).

To determine the integrity of existing Boreal Woodland Caribou habitat, the Deh Cho Land Use Planning Committee (ND) completed a minimum patch size analysis, and indicated habitat along the proposed all season road meets the species minimum habitat patch size requirements (>515

ha) and represents core Boreal Woodland Caribou habitat. The density of linear corridors (including the existing Prairie Creek winter road) surrounding the proposed all season road is low, ranging from <0.6 km/km^2 along the Phase 1 section and majority of the Phase 2 section, and a high of 0.6-1.0 km/km^2 in isolated locations along Phase 2, primarily as a result of seismic activity (Deh Cho Land Use Planning Committee ND).

This linear corridor density is below the Dehcho Land Use Planning Committee's (ND) Cautionary Threshold (1.0 km/km^2), which represents the lowest threshold at which development, upon reaching the Cautionary Threshold, should be required to monitor impacts. The majority of lands within the Dehcho also fall below this Cautionary Threshold with a few exceptions including the Cameron Hills and Fort Liard areas (Deh Cho Land Use Planning Committee ND).

Across the larger Dehcho region, the Species at Risk Committee (2012) analyzed the degree of habitat fragmentation using known forest fires (1965-2010) and development activity (e.g., seismic lines, existing roads including the Prairie Creek winter road). Results indicate that 13.8% of Boreal Woodland Caribou range across the Dehcho-South study area remains as unburned habitat patches greater than 500 km^2 in size and beyond 500 m from human disturbances (i.e., the most valuable Boreal Caribou habitat) (Species at Risk Committee 2012). This large undisturbed area (500 km^2), is considered the minimum size required for Boreal Caribou to effectively reduce risk of predation (Species at Risk Committee 2012).

Caribou are particularly sensitive to disturbance during calving, post-calving, and winter periods. On average, female caribou in the Dehcho calve on or around May 15 (but may range from April 30 to June 6) (Larter and Allaire 2010; Species at Risk Committee 2012). During the calving season, females seek secluded habitats that are difficult for predators to access, and include large wetlands and marshes, islands in lakes, high ridges, and burn areas (Species at Risk Committee 2012). In all seasons, Boreal Woodland Caribou are often associated with lichen-rich mature or old growth black and white spruce forests (greater than 100 years old) present within bogs and along lakes and rivers (Gunn et al. 2004; Species at Risk Committee 2012).

In winter, Boreal Woodland Caribou tend to favour uplands of forested rolling hills, bogs, and south facing slopes where the snow is not too deep. Their winter diet consists of up to 80% ground and tree lichens. In summer, they may also occupy forest edges, marshes, burn areas, and meadows on higher ground that provide the fresh green growth of flowering plants and grasses (Species at Risk Committee 2012). In the fall, caribou tend to also occupy higher elevations.

Field observations of caribou (ecotype not classified) occurring throughout the Mackenzie Mountains and east along the proposed all season road have been summarized and reported in Golder 2010 and 2014 (Appendix B). During these studies, few caribou were documented east of the Nahanni Range in the winter and summer (assumed to represent Boreal Woodland Caribou's primary range, as reported by the Species at Risk Committee [2012]); however, caribou tracks and some visual sightings of caribou were also recorded in the Tetcela River and Sundog Creek valleys in the winter (Golder 2010; 2014).

Golder (2014) estimated the area of caribou occupancy during the 2010-2011 and 2014 winters along the all season access road. During the 2010-2011 winter studies, caribou occupancy was estimated to be lowest (less than 20%) from the TTF to the Liard Highway (approximately 100 km to the Liard Highway or 54% of the entire road length) and the highest (80-100%) occupancy from the mine site to KP 18 as well as near the Ram Plateau and Sundog Creek (total 52 km). The remaining sections of the all season access road (Phase 1 sections within the Mackenzie Mountains) were estimated to have moderately-low to moderately-high caribou winter

occupancy (21-79%) (Golder 2014b). In contrast, during the 2014 winter, the area of caribou occupancy was estimated to be low (less than 20%) from approximately KP 8 to the Liard Highway, representing 96% of the entire all season access road (Golder 2014b). These results may indicate annual variation in overwintering caribou along the access road.

During the field surveys, caribou were most commonly observed in the Mackenzie Mountains (e.g., Prairie and Vera creek valleys), and likely represent Northern Mountain Woodland Caribou . Caribou observed in the Tetcela River and Sundog Creek valleys may have been boreal woodland and/or northern mountain woodland caribou.

To date, little is known about the occurrence and frequency of disease and parasites within Boreal Caribou. Johnson et al. (2010) have begun testing boreal caribou occurring in the Dehcho and reported all 104 adult female caribou appeared healthy when examined in the field. Based on the analysis of blood and fecal samples, evidence of ten disease agents were detected, including *Trypanosoma* species, Trichostrongyle-type ova, and *Bovine herpesvirus* 1 at a prevalence of approximately 72, 62, and 38% respectively, of the samples tested. Evidence of these disease agents have also been previously reported in woodland caribou and/or other wild ungulates in Canada and Alaska.

Heavy metals, organochlorines (OC's), and polycyclic aromatic hydrocarbons (PAH's) were measured in key traditional foods across the North. The Deh Cho First Nations (ND) report that caribou kidney and livers collected from the Yukon have the highest levels of naturally occurring cadmium; however, these levels remain safe for human consumption.

Across the Dehcho, some harvests are believed to be unreported, but with this in mind, boreal woodland caribou harvest levels are estimated to range from 100–150 a year (Species at Risk Committee 2012). In the study area, incidental resident harvest for subsistence predominates, with the majority of all harvests occurring in the winter (Species at Risk Committee 2012). A total of 1070 Boreal Caribou harvest sites within living memory (spanning approximately 60 years) from residents of Nahanni Butte and other Dehcho communities were identified and mapped (Gunn et al. 2004).

Based on fixed kernel analysis of these lifetime harvest sites, the larger proportion of Boreal Caribou harvesting occurs around Trout Lake, Kakisa and Tathlina lakes, and Fort Simpson, with a small harvesting area north of Liard River near Nahanni Butte and the southern portion of the proposed all season access road (Gunn et al. 2004).

Currently NWT residents and non-residents are permitted to harvest one caribou annually from the Dehcho and the Nahanni Butte D/OT/02 and South Nahanni D/OT/01 outfitter zones.

4.4.2 Northern Mountain Woodland Caribou (*Rangifer tarandus caribou*)

The Northern Mountain Woodland Caribou range has remained relatively intact due to its innate remoteness. Although, threats of habitat modifications and loss from human developments are increasing. As a result, the Northern Mountain Caribou is listed as Special Concern under SARA and assessed as Secure in the NWT.

The Prairie Creek Mine and the all season access road are located outside of the defined range of Northern Mountain Caribou (ENR 2014c); however, a few caribou have been observed near the Mine and access road route in the spring, summer, and winter (CZN 2010; Golder 2010). ENR (2014) explained that "trace occurrences" of Northern Mountain Caribou are known in the area

east of the Mine site to the Nahanni Range. However, it is not clear which mountain herd(s) occupy this zone.

The Nahanni Complex (consisting of the Lower Nahanni, La Biche, and Coal River herd) and Redstone herds are closest to the Prairie Creek mine and all season access road route (CZN 2010). Based on the Management Plan for Northern Mountain Caribou (Environment Canada 2012b), the Coal River and possibly the La Biche herds overwinter primarily within NNPR, with the Prairie Creek Mine located at the most north easterly edge of their annual ranges; however, the Redstone herd may be the most likely caribou herd occurring near the Prairie Creek Mine

TABLE 4-7: NORTHERN MOUNTAIN WOODLAND CARIBOU AT A GLANCE

Northern Mountain Woodland Caribou	
NWT Population Summary	
Conservation Status	Listed as Special Concern under SARA (2005), but assessed as Secure under the NWT General Status Rank
Trend	The Nahanni Complex and Redstone herds believed to be stable throughout their range (ENR 2014b)
Size	Nahanni complex estimated at 3,000 animals, and Redstone herd estimated at 10,000 (ENR 2014b)
Sensitivities and Threats	Hunting and industrial disturbances. Increased access resulting in increased hunting pressure and predation risk.
Health, Parasites, and Contaminants	Contaminant levels below human and animal health concern (Larter et al. ND). Most of the metals analyzed were found in concentrations similar or lower than Barren-ground Caribou, Reindeer, and/or other mountain ungulates (Larter et al. ND).
Relationship with the Prairie Creek All Season Road	
Expected Presence	Entire Prairie Creek Mine and the all season access road outside the defined species range; however, Northern Mountain woodland caribou may occasionally occur between the Mackenzie Mountains and the Nahanni Range
Seasons of Use	Possibly year round, but infrequent
Key Habitats	Alpine and subalpine plateaus, and open conifer forests found in valley bottoms, lower slopes, and boreal forest zone
Existing Harvest Pressure	Moderate
Traditional Knowledge	
▪ First Nations have reported declining caribou numbers in the mountains (Parks Canada et al. 2009)	

The Nahanni Complex group are estimated to total 3,000 animals (ENR 2014c). Of the three herds, the Coal River herd occupies the largest annual range, covering approximately 30,000 km^2 (with just over half of their range extending into the Yukon) (Weaver 2008; Gullickson and Manseau 2000). In general, the annual range of collared females from the Nahanni Complex extend primarily south of the Prairie Creek Mine and south and west into the Yukon; however, a few individuals may winter near the Prairie Creek Mine site (Weaver 2008). They are known to

spend their calving, summer, and fall periods in the south-east corner of Yukon, and after rut, migrate north and east into the Northwest Territories to spend the winter primarily within the original boundaries of the NNPR and further south into the expanded park zone (Weaver 2008).

The Redstone herd is one of the largest Northern Mountain Caribou herds in the NWT, estimated at 10,000 animals, and covers an annual range of nearly 90,000 km^2 (includes the Dehcho, Sahtu, and Gwich'in regions) (Weaver 2006; ENR 2014c). Recent evidence seems to suggest the Redstone herd is divided into two sub-herds, the Moose Horn River sub-herd ranging the furthest south and likely occurring near the all season access road (Creighton 2006). The Redstone herd occupies range further north and west of the Prairie Creek Mine and all season access road in the Dehcho and Sahtu regions. Their calving and summer periods are spent in the Mackenzie Mountains near the NWT and Yukon border at the headwaters of the South Nahanni watershed, and move down into the boreal forest of the Sahtu regions in the winter. With exceptions, in the fall and winter, some move further south into the Dehcho region and overwinter in the South Nahanni River watershed (north of Virginia Falls) (Weaver 2006).

These caribou herds have an annual range that straddles the Northwest Territories and Yukon, and are migratory; moving in elevation and between summer and winter ranges seasonally. They summer primarily in alpine and subalpine areas, exploiting alpine plateaus for forage and insect avoidance (1,200-1,600 m elevations) (Weaver 2006; Creighton 2006). Calving primarily occurs in the Yukon or near the Yukon/NWT border, where between the last week of May and the first week of June (May 26-June 5), gravid cows disperse to known plateaus and upland sites to calve (Weaver 2008). In particular, the Moose Horn River sub-herd primarily calves near Moose Ponds, in the headwaters of the South Nahanni, Caribou Cry, and Keel rivers (Creighton 2006).

In the winter, the Nahanni Complex herd move to lower elevations in the subalpine (400-900 m elevations) and the Redstone herd (Moose Horn River sub-herd) moves further into river valleys in the boreal forest zone (600-1,700 m elevations) where snow depths are lower and snow is softer (Weaver 2008; Creighton 2006). However, in years with low snowfall, caribou may remain in upper subalpine and alpine areas (1,250 – 1,400 m elevation) (Weaver 2008). On the spring migration to calving ranges, the Moose Horn River sub-herd follow major river valleys, such as the Ravens Throat, Silverberry, and Keel rivers (Creighton 2006), but this varies depending on winter distribution and in some years, may include the Tetcela River valley.

Weaver (2008) identified preferred seasonal habitat based on collared caribou locations. These include:

- Winter (early and late): subalpine and montane open conifer forests found in valley bottoms and lower slopes;
- calving: open and closed conifer habitats near the timberline adjacent to and also within rock outcrops and alpine meadows;
- summer: rock outcrops and snowfields, low shrub, and herb dominated alpine tundra habitats;
- rut: montane plateaus near low shrub and open conifer habitats (often on or near their summer range); and
- migration: major river valleys either following the river courses or along the higher elevation valleys.

Between these elevation and seasonal range migrations, Weaver (2008) found a strong pattern of fidelity to spring migration routes, calving sites, and summer ranges; moderate fidelity to rutting areas; and weaker fidelity to winter ranges and fall migration routes. Calving and the late winter seasons are the most sensitive periods of time when caribou may be occasionally interact with the all season road.

Winter Mine site and access road surveys in January and March 1981 found only one group of 5 caribou to the west of the Mine site (CZN 2010). This is a relatively small number, suggesting the area is not part of the "core" winter range (CZN 2010; Beak 1981). By June 9 and 10, 1981, 19 groups of 74 caribou (including calves) were observed in high elevation habitats (ranging from 1,112 to 1,585 m), and by mid-July, two caribou were observed at 1,370 and 1,555 m; all June and July observations were within 16 km of the Prairie Creek Mine and/or its access road (Beak 1981). Similarly, a few caribou (total of 14 observations of 28 adult females, bulls, and calves, plus a single observation of large group consisting of 25-35 animals) have been reported infrequently in the camp wildlife logs (2001-2008) in June, July, and August (Golder 2010). June 1 was the earliest report of a calf observed within the camp log (Golder 2010). The June observations of females with calves confirm that calving may infrequently occur in the area; however, based on the timing of known calving season (May 26-June 5), the calves observed may have already been a week or two old.

Forty-three caribou were also observed within the first 26 km of the all season access road and documented in ENR's WMIS (ENR 2014a). These observations consisted of eleven separate groups detected in June and July. The group size ranged from 1 to 12 (ENR 2014a).

Caribou occupancy modeling was completed in 2014 to determine the distribution of caribou along the access road route during the non-winter period (Golder 2014b). Using a ground-based caribou sign survey and occupancy model, caribou were predicted to most likely occur in elevated terrain within the Mackenzie Mountains near the Mine site, the lower Sundog Creek drainage, west of the Ram Plateau, and the Silent Hills (Golder 2014b). The remaining sections of the access road displayed a low probability (0.00 – 0.20) of caribou occurrence (Golder 2014b).

A few Northern Mountain Caribou may be expected to occasionally occur near the all season access road year round; however, are uncommon in the winter. Caribou at and near the Prairie Creek Mine site (including near the access road from KP 0-36) may be part of the Nahanni Complex (particularly the Coal River herd), and/or the Redstone herd (i.e., Moose Horn River sub-herd), and/or a local population (Golder 2010). Caribou observed east of the Mackenzie Mountains to the Nahanni Range, along the access road from KP 36-125, are likely from the Redstone herd or are Boreal Woodland caribou.

NWT residents and non-residents are permitted to harvest one caribou annually from the Dehcho and the Nahanni Butte D/OT/02 and South Nahanni D/OT/01 outfitter zones. ENR (2014) report that an average of 159 Northern Mountain Caribou are harvested by non-resident hunters per year throughout the entire Mackenzie Mountains (total of eight outfitter zones). Since 1965, the average annual harvest of mountain caribou by non-resident harvesters has risen from 44 (from 1965 to1968) to 171 (from 1991 to 1997) (Veitch et al. 2000). After Dall's Sheep, Mountain Woodland Caribou are the second-most sought after species in the Mackenzie Mountains by non-resident harvesters (Veitch et al. 2000). The number of Northern Mountain Caribou harvested each year by residents of Nahanni Butte or the Dehcho region are unknown.

Northern Mountain Caribou harvested from the Nahanni Butte D/OT/02 and South Nahanni D/OT/01 outfitter zones were found to have metal and radionuclide contaminant levels below human and animal health concern (Larter et al. ND). Although metal and radionuclide concentrations were found in caribou kidney and/or muscle tissue, the levels were similar or lower than Barren-ground Caribou, Reindeer, and/or other mountain ungulates (e.g., sheep, goats) except for cadmium and mercury (Larter et al. ND). Cadmium levels found in caribou kidney tissue was significantly lower than compared to moose inhabiting the southern Mackenzie Mountains.

4.4.3 Wood Bison (Bison bison athabascae)

TABLE 4-8: WOOD BISON AT A GLANCE

Wood Bison	
NWT Population Summary	
Conservation Status	Listed as Threatened under the SARA (2003) and ranked At Risk in the NWT
Trend	Slowly increasing (ENR 2010)
Size	In 2004, the Nahanni herd estimated at 400 animals (ENR 2010)
Sensitivities and Threats	Disease, collisions with motor vehicles, and drowning
Health, Parasites, and Contaminants	Believed to be free of bovine tuberculosis and bovine brucellosis, and no anthrax outbreak has been recorded (ENR 2010)
Relationship with the Prairie Creek All Season Road	
Expected Presence	Phase 2 from approximately KP 140 to along the Liard Highway
Seasons of Use	All seasons
Key Habitats	Liard River and its tributaries, meadows, and oxbows with sedges and horsetails
Existing Harvest Pressure	Negligible to low
Traditional Knowledge	
▪ Some communities no longer recognize bison as part of their heritage, due to the long ago absence of wood bison in the NWT (ENR 2010). Re-introduced herds allow for cultural and spiritual reconnection (ENR 2010).	

Historically, Wood Bison ranged throughout most of the boreal regions of western Canada, including the Dehcho and specifically the Nahanni Butte areas. Due to overharvesting and a period of severe winters, Wood Bison were thought to be extinct until a residual population of approximately 200 Wood Bison (believed to have not hybridized with Plains Bison) were discovered remaining in Wood Buffalo National Park, NWT in 1957 (Parks Canada 1984). Today, Wood Bison are listed as Threatened under SARA (2003) and ranked as At Risk in the NWT.

Wood Bison present along the all season access road route are part of the Nahanni herd, which were re-introduced near Nahanni Butte over a span of 18 years (1980, 1989, and 1998) as part of a re-introduction program into their former range. During this time, approximately 100 Wood

Bison were re-introduced. By 2004, the Nahanni herd was last estimated at 400 animals, and their population is considered to be slowing increasing (ENR 2010; Larter and Allaire 2007).

Wood Bison undertake seasonal movements to best utilize differing habitats and food resources. However, their annual distribution largely remains within the Liard River valley, and are seldom observed in the Nahanni National Park Reserve (Parks Canada et al. 2009). Their range extends on both sides of the Liard River, from the Blackstone River (approximately 25 km east of Nahanni Butte) south into northern British Columbia (Golder 2010). Project-related activities may encounter Wood Bison year round in the Phase 2 development from approximately KP 140 to the Nahanni Butte access road (total of approximately 35 km) and beyond along the Liard Highway to Fort Liard.

Golder (2010; 2014) summarized bison observations reported during the Prairie Creek Mine and access road surveys. Bison were yet to be introduced to the area by the time of Beak's early 1980 surveys; however, since then, four bison were observed at the airstrip in Nahanni Butte in June 2006, 13 bison were seen in December 2010, and three bison were seen in February 2011. Bison visual observations and tracks have been reported within 2 km of the Liard and South Nahanni rivers and their oxbows (Golder 2010; 2014).

Wood Bison observations from the Dehcho Nahanni Bison Classification Surveys (1999 to present) and incidental observations have also been reported in ENR's WMIS (ENR 2014a). A total of 440 bison (including calves) documented in the WMIS were concentrated along the Liard River, at the community of Nahanni Butte, and the oxbows and tributaries towards the Liard Highway (ENR 2014a) (Phase 1 KP 156 to 184.5).

Wood Bison are grazers, and rely heavily on sedges and horsetail that grow in meadow openings, particularly in the winter. In summer, bison can be found in small willow pastures, wetlands, and uplands where they feed on sedges, grasses, forbs, and willow leaves and twigs. In the fall, they can be found in forests and in winter, bison move to graminoid fens and lakeshores where they feed on sedges.

Larter and Allaire (2007) indicate that the Nahanni herd is known to commonly swim across the Liard River to access important habitat on either side of the river. Although animals may cross the Liard River anywhere within the herds range, crossings are known at Swan Point (approximately 6 km downstream from the proposed access road barge crossing) and Muskeg and Kotaneelee rivers (at least 130 km upstream from the access road barge crossing). While crossing, a few bison are known to drown annually during spring break up and peak discharge from the mountains (Larter and Allaire 2007).

The Government of the Northwest Territories maintains an extensive program to prevent bison from diseased herds interacting with those considered disease-free. The Nahanni herd is thought to be healthy, and free of bovine tuberculosis (*Mycobacterium bovis*), brucellosis (*Brucella abortis*), and Johne's disease (*Mycobacterium avium paratuberculosis*) (Larter and Allaire 2007). Similarly, no anthrax (*Bacillus anthracis*) outbreak has been reported within this herd (EBR 2010).

Wood Bison are known to be attracted to and become habituated to roadways, traffic, and human activities. The all season access road may provide bison with palatable forage along the roadway side slopes, easier travel with long sightlines to see approaching predators, and suitable habitat to avoid biting insects. Bison are known to occupy habitats on and near the Liard Highway, which places them at risk of vehicle-collisions. Bison-vehicle collisions have been reported on the Liard

Highway, particularly where known bison trails converge onto the Highway between Flett Crossing and Muskeg River (highway section between Nahanni Butte and Fort Liard) (Wildlife Collision Prevention Program 2014). Since 2000, a total of 12 bison from the Nahanni herd have been reportedly involved in vehicle collisions, with most collisions occurring from August to October (associated with the rut season) (Larter and Allaire 2007; Wildlife Collision Prevention Program 2014). Of these 12 reported collisions, local residents were most commonly involved than compared to commercial and tourist traffic (Wildlife Collision Prevention Program 2014).

Residents of Nahanni Butte and Fort Liard have each been allowed a single Wood Bison harvest per year since 1998. Since this time, Larter and Allaire (2007) have reported only two bison being harvested. This seems to indicate bison harvest has not been an important component of today's subsistence harvest from these two communities. However, the current NWT Hunting Guide now permits NWT residents to harvest Wood Bison from this herd via a tag quota for one male bison to be hunted from July 1 to June 30.

4.4.4 Grizzly Bear (*Ursus arctos*)

TABLE 4-9: GRIZZLY BEAR AT A GLANCE

Grizzly Bear	
NWT Population Summary	
Conservation Status	Assessed as Special Concern by COSEWIC (2012) and ranked as Sensitive in the NWT
Trend	Stable within the NNPR (Parks Canada et al. 2009)
Size	Estimated 665 Grizzly Bears in NNPR (Parks Canada et al. 2009), and 10 individual Grizzly Bears in the Prairie Creek drainage and adjacent Mackenzie Mountains (Weaver 2006)
Sensitivities and Threats	Human developments and activities, hunting
Health, Parasites, and Contaminants	No baseline conditions known to date
Relationship with the Prairie Creek All Season Road	
Expected Presence	Predominantly in Phase 1 from KP 0-70, with low expected presence the remainder of the road
Seasons of Use	Year round, as denning habitat may exist in the Prairie Creek drainage (Golder 2010)
Key Habitats	High elevation valleys associated with subalpine and alpine habitat types
Existing Harvest Pressure	Low to negligible
Traditional Knowledge	
▪ There used to be more Grizzly Bears at the eastern portion of the South Nahanni Watershed and near Nahanni Butte (Parks Canada et al. 2009).	

The current distributions of Grizzly Bears have significantly contracted from their historical range in southern and western Canada; however, they are reportedly expanding in the NWT,

Nunavut, Saskatchewan, and Manitoba (COSEWIC 2012a). They are considered highly sensitive to human disturbances, and risk higher rates of mortality near roads and human developments. Consequently, Grizzly Bears were assessed by COSEWIC as Special Concern (2012) and ranked as Sensitive in the NWT.

The majority of the Grizzly Bears occupying the NWT occur in the Mackenzie Mountains (ENR 2014b). Within Nahanni National Park, their population is considered stable and, in 2009, estimated at 665 individuals (Parks Canada et al. 2009). Weaver (2006) suggested 500 Grizzly Bears in this population is needed to maintain a viable population. Within the Greater Nahanni Ecosystem, Grizzly Bear occurrence was reportedly higher in mountainous habitats, such as Prairie Creek, than compared to the boreal forested zone (Weaver 2006). Those individual bears detected within the boreal forest zone were usually associated with mountainous terrain (Weaver 2006), possibly indicating that the boreal forest zone may represent the periphery of individual home ranges that are less frequently occupied. Home range sizes are negatively correlated to habitat quality. Weaver (2006) estimated the average male Grizzly Bear range may encompass as much as 2,147 km^2, a home range much larger than estimated Grizzly Bear range sizes in the Yukon (COSEWIC 2012a).

In the Mackenzie Mountains, Grizzly Bears are active from approximately mid-April to late October. Grizzly Bear habitat use outside of the denning season is complex and a function of many factors including plant phenology (as plants make up about 90% of their diet), prey availability and distribution, and human presence (ENR 2014d). Miller et al. (1982) reported Grizzly Bears in the Mackenzie Mountains select for alpine habitats in June and July (likely in response to availability of food sources), subalpine habitats in August, both alpine and subalpine habitats equally in September, and higher elevation habitat types as winter approached. Similarly, Weaver (2006) documented Grizzly Bears in the Greater Nahanni Watershed most commonly occur in high elevation valleys associated with subalpine and alpine habitat types in June. Less commonly, Grizzly Bears occupy spruce-lichen woodland or pine-aspen habitat types at the lower elevation boreal forests (Weaver 2006).

Dens are located predominantly on southeast facing slopes in alpine habitat between 1,400 to 1,800 m in elevation; however, a few dens are reported in subalpine habitat, and even fewer in white spruce forest habitat (Miller et al. 1982). Golder (2010) indicated potential denning areas may occur on the eastern slope of the Mackenzie Mountains. Pregnant females give birth to cubs in February while hibernating.

Grizzly Bear densities were predicted by Weaver (2006) across the Greater Nahanni Ecosystem, including the entirety of Phase 1 of the all season access road. These modeling results indicate that Grizzly Bear densities are predicted to be high to very high (22 to 28 bears per 1,000 km^2) at the Mine to approximately KP 39, moderate to low (17 to 10 bears per 1,000 km^2) from approximately KP 39 to 70, and consistently low for the remainder of their study area through the boreal forest zone (Weaver 2006). The areas of high to moderate densities reported by Weaver (2006) also correlate with the Important Wildlife Area designated for Grizzly Bears in the Greater Nahanni Ecosystem (Wilson and Haas 2012). Of particular importance, the area north and northwest of the original NNPR boundaries (and north of the Prairie Creek Mine and proposed all season road) has the largest expanse of high to very high predicted Grizzly Bear densities, and Weaver (2006) concluded this area is particularly important for a viable grizzly population. Based on Weaver's (2006) predicted bear density map, the all season access road from KP 0 to 39 bisects a potential bear movement corridor from the South Nahanni River to this more northern area.

Grizzly Bears can be expected to occur throughout the length of the all season access road; however, are most common in Phase 1 from KP 0 to 70. Considering known den site elevation preferences, denning may occur near KP 0 to 40. Grizzly Bears are considered infrequent visitors to the remainder of the road, including the entire Phase 2 development. However, a single Grizzly Bear has been documented in the Nahanni Range, near the Grainger Gap (Phase 2 KP 125) (ENR 2014a).

As reported by Golder (2010), Grizzly Bears have been infrequently observed during the wildlife surveys, with observations restricted to five visual observations (including a sow with two cubs) and sign including bear diggings, feeding logs, tracks, and scat. Anecdotal information from the camp observation logs suggest that a number of lone Grizzly Bears move through the Prairie Creek valley each spring and summer (May to August), along with occasional family groups (sow and cubs) (CZN 2010). Observations were mostly in the immediate Mine site area, the airstrip, and the road in between (CZN 2010). Information from Canadian Zinc is that Grizzly Bears numbering up to 5-6 per annum are commonly seen moving up the Prairie Creek valley in the spring, and down the valley in the summer. Groups are usually a single male or a sow with one or two cubs. The same groups have been seen infrequently in the Sundog Creek drainage as far east as Cat Camp.

In the Mackenzie Mountains, non-resident hunting of Grizzly Bears has been prohibited since 1982; however, NWT residents may harvest one adult Grizzly Bear (not accompanied by a cub or in a den) from August 15 to October 31. First Nations subsistence hunts are permitted year round. The reported Grizzly Bear harvests from the Mackenzie Mountains occur primarily in the Gwich'in and Inuvialuit Settlement areas (COSEWIC 2012a). From 2001 to 2010, an average of 42.4 Grizzly Bears are killed in the NWT annually, of which, 69% are hunted (49.6% subsistence hunts), 30% are killed for defense of life or property, and less than 1% are killed because of an accident, vehicle-collision, or research-related (COSEWIC 2012a).

4.5 Fish and Aquatic Habitat

4.5.1 Fish Presence and Habitat

Prairie Creek watershed upstream

Many studies have been conducted in the Prairie Creek system north of the NNPR since 1980, including those reported in Ker Priestman (July, 1980), Beak Consultants (March, April, May, September 1981), Rescan (May-June, September 1994), and Mochnacz (August 2001). The dates and key findings of these studies were summarized in the EA08-09-002 DAR.

By the end of the 2001 fieldwork, it was known that both bull trout (*Salvelinus confluentus*) and mountain whitefish (*Prosopium williamsoni*) spawn in Prairie Creek upstream of the Mine site, most likely in Funeral Creek. Prairie Creek lacks overwintering habitat in its upper reaches, and woody debris and over-hanging vegetation is sparse. In contrast, Funeral Creek has many deep pools. Arctic grayling (*Thymallus arcticus*) are known to inhabit lower Prairie Creek, but were not found upstream of the original NNPR boundary. The presence of steep rapids and rock ledges in combination with strong spring flows may be the cause. Each of these species is a salmonid, the first two are fall spawners and the last spawns in spring. Slimy sculpin (*Cottus cognatus*), a forage species, inhabits the main stem creek and some tributaries above and below

the Mine. In addition, Fisheries and Oceans Canada reported spawning bull trout in Funeral Creek on August 15, 2005. The fish are thought to be resident species, over-wintering in the area.

Remainder of Access Road

Beak Consultants Ltd. conducted aquatic studies along the winter road in 1981. In addition, Dillon Consultants investigated creek crossings of the existing and new alignments in 2006 and 2009, respectively. Golder Associates also conducted a limited study in upper Sundog Creek in 2008. Detailed information was provided during EA0809-002. This section presents a summary of findings.

Sundog Creek

Sundog Creek flows east then north to the Ram River. Arctic grayling and slimy sculpin use Sundog Creek and its tributaries, despite a general lack of nutrients, woody debris and vegetation. Grayling migrate up the creek in spring, presumably to spawn, utilizing higher spring water levels. From Km 29-40, Sundog Creek is a wide floodplain adjacent to the road, tapering to the west. It consists of a series of braided channels that change location seasonally and from year to year. Deep pools occur in scour holes where large boulders occur in the channel, or against rock bluffs on the floodplain edges. These pools host grayling. Flows subside is summer and fall, leaving large reaches without flow, and fish stranded in the pools. Unfortunately, water levels drop further through the fall and winter, and the pools disappear or freeze to the bottom.

From Km 24-29, Sundog Creek is a single channel hosted by a predominantly rock substrate. Some deep pools exist, hosting grayling. Some of these may be deep enough for over-wintering if there is sufficient flow from groundwater seepage. Upstream of Km 24, no fish are present because a large waterfall (>10 m) is a migration barrier.

Polje Creek

Polje Creek is a tributary of Sundog. It drains the western side of the Ram Plateau, including the poljes. The main stem is a wide (5-10 m) and deep (1-3 m) single channel with frequent meanders and ox-bows. Habitat for fish is good, with strong flows of good quality water, frequent woody debris for cover, and overhanging vegetation. Beak found grayling in the system in 1982. However, tributaries are quite small and dominated by organics, providing poor habitat and suggesting fish absence. The main stem likely provides over-wintering habitat.

Mosquito Lake (just east of the Poljes) technically is part of the Polje Creek basin, but there is no defined outlet to the creek via the poljes. The lake reportedly contains fish (Ker Priestman, May 1981), but specific data are not available. If it does, they are a resident, trapped population.

Tetcela River

The Tetcela River drains the central and eastern parts of the Ram Plateau, and flows north to the North Nahanni River. The road crosses the main stem and a large tributary once each. Fish surveys by Beak (1981) and Rescan (1994) recorded the presence of Arctic grayling, whitefish, northern pike, lake chub, burbot, slimy sculpin, and longnose sucker. Adult and juvenile grayling were found. At the main stem crossing, the channel bankfull width is 30 m and wetted width 11

m at moderate-low flow conditions. Bankfull height is 1.9 m and residual pool depth 1.0 m. Woody debris and cover habitat is common.

Fishtrap Creek

The road crosses the creek near its headwaters where fish habitat is poor and wetlands dominate. A fish survey by Beak (1982) collected no fish. Beavers dams are common in the area. The creek flows south to the South Nahanni River, but it is much further downstream before the creek becomes a defined channel and provides good fish habitat.

Un-named Creek

The valley between the Silent Hills and the Front Range hosts an un-named creek that flows to the north. The creek consists of wetlands and beaver ponds with no obvious channel. Small tributaries of this system drain the eastern slopes of the Silent Hills, and are crossed by the access road. These are almost certainly not fish-bearing.

Grainger River

The Grainger River headwaters are located in the area immediately west of Grainger Gap, south of the un-named creek system and north of the Bluefish system. The road crosses a short Grainger wetland area, a tributary to Gap Lake, then the main stem twice before exiting the Gap on the east side. The revised road alignment then runs along the lower slopes of the Front Range, crossing small tributaries of Grainger River. All crossings have the potential to host fish, except for the wetland area. The main stem in Grainger Gap has a normal wetted width of 5 m, and depth of 0.3 m, but there are deep pools and adult grayling are visible in these pools. Dillon caught grayling and sculpin in 2005. Northern pike appear to be using the Grainger River (Beak, 1981), and one pike was seen in Gap Lake during a bathymetry survey in July 2012.

Liard River

The revised road alignment running along the lower slopes of the Front Range also crosses small tributaries of the Liard River. These also have the potential to host fish, but their size, poor habitat and preponderance of wetlands and/or beaver dams downstream makes this unlikely.

4.5.2 Harvesting

Regarding previous harvesting for fish in the area, the TK Assessment Addendum Report (2009) by Crosscurrents Associates provides some insight into traditional practices and harvesting locations. The report is confidential, but was made available to CZN and the Review Board during EA0809-002. Without going into great detail which might raise confidentiality concerns, the following excerpts provide useful information:

- *Yeah, my father and them used to go for beaver out there [Fishtrap Ck.] and I used to go with them long ago... There is jackfish and grayling. There used to be trout fish at the mouth of the river long ago*

- Nahanni trappers are aware of the fish species in the main creeks in the area: *Inconnu and grayling and jackfish [in Tetcela River].... The same, jackfish, graylings and inconnu [in Fishtrap Creek]. I think they used to catch bull trout in there too.*

- *Jackfish in the lake* (near Second Gap)

- During spring hunting expeditions into the area, some fishing has taken place upriver (Grainger), but fishing primarily occurs at the mouth of the creek: *I've been all over in that area [Grainger River]... Jackfish, only jackfish I think….oh, grayling too*

Therefore, traditional harvesting of fish seems to have been focussed on the mouth of Fishtrap Creek, likely Bluefish Creek also, and the main stems of the Tetcela and Grainger Rivers proximal to the road alignment. This is in addition to lakes and stream mouths accessible from the South Nahanni River (including Prairie). These locations may still be used currently, although information from elders suggests locations near the river are preferred for ease of access, which would exclude Tetcela. Grainger at Grainger Gap may still be used since local trappers have a cabin there.

The Beak (1981) study of fish and invertebrates in Prairie Creek and the main streams crossed by the inter road contains data on metals in fish tissue, but these appear to be specific to fish from Prairie Creek. More recent metals data in tissue from fish caught in lower Prairie Creek was reported in EA0809-002. To our knowledge, there are no fish tissue data for fish collected from stream crossed by the road. The Beak study does, however, contain data on fish captured at road crossing locations, and on benthic invertebrates.

4.5.3 Stream Crossing Habitat

In order to characterize the habitat of streams to be crossed by the all season road, a two-step process was adopted. In the first step, an airborne reconnaissance was undertaken to determine those crossings where fish are known to be, or could be, present. The initial classification so derived determined those crossings with habitat (fish-bearing) and without habitat (fish not present). In the second step, stream crossings assumed to host habitat were subject to ground-based assessment, both to confirm the presence of suitable habitat, and after confirmation, to collect habitat data. The results of this process are described below.

The airborne reconnaissance was undertaken in July 2014 by Hatfield Consultants' fisheries biologist John Wilcockson, and CZN's VP Environment Dave Harpley. In addition to those streams known to host fish at crossing locations based on past surveys, other stream crossings were evaluated from the air. The criteria for inclusion as possible habitat was a defined channel (no matter how wide) with a connection to a main stem, no obvious barriers to migration from downstream, and evidence of flowing water, at least seasonally. In the absence of data suggesting otherwise, a crossing was assumed to be fish-bearing. Table 4-10 provides a list of crossings that were classified as fish-bearing or potentially fish-bearing after the reconnaissance. The reconnaissance of Sundog and Polje tributaries was conducted in the presence of Parks Canada representatives David Britton (NNPR Superintendent) and Garry Scrimgeour (fisheries biologist). A memo summarizing the results of the survey was prepared for them after the work for comment. No comments were received. A copy of the memo can be found in Appendix 8. Note that the crossing at Km 43 was previously assumed to be fish-bearing, but further

investigation indicated that downstream sections are inaccessible to fish, which was proven by no fish being recovered during electro-shocking of the reach covering the crossing location.

TABLE 4-10: CROSSINGS CLASSIFIED AS POTENTIALLY FISH-BEARING

Catchment	Km Marker		Stream Type	Survey
	Winter	All Season		
Sundog		28.4	Main stem	Yes
	29.2	28.9	Main stem	Yes
	39.8	39.4	Tributary	Yes
Polje	46.0		Tributary	Dry, grassy
	47.0	46.2	Tributary	Yes
	49.1		Tributary	Multiple slump barriers
	49.4		Tributary	No channel outlet
	50.2	49.6	Tributary	Yes
	54.3	53.5	Tributary	Yes
	54.4	53.6	Main stem	Yes
Tetcela	87.2	87.2	Tributary	Yes
	89.7	89.7	Main stem	Yes
Grainger	122.8	122.4	Tributary	Yes
	123.7	123.4	Main stem	Yes
	125.1	124.8	Main stem	Yes
	131.3	131.2	Tributary	Yes
	133.7	133.2	Tributary	Yes
	135.6	134.9	Tributary	Yes
	136.7	136.5	Tributary	Yes
Liard	144.7		Tributary	Multiple beaver dams
		151.3	Tributary	High water only
	152.4		Tributary	No channel
	154.4	154.9	Tributary	Yes

The crossings listed in Table 4-10 were visited for ground-based habitat assessment in September 2014. Assessments were completed for those crossings in the 'Survey' column with a 'Yes' notation. Where a 'Yes' is not indicated, an assessment was not completed because, on

further investigation, the crossing was not considered to be a potential host for fish, and the reason is provided. The results of the habitat assessments completed can be found in Appendix 9. The crossings assessed were automatically considered to be major crossings for the purpose of crossing design engineering, in addition to some other significant crossings in terms of flow that are not fish-bearing (Km 27.4, a Sundog tributary, for example).

In lower Sundog Creek, the proposed all season road will be aligned to stay on the south side of the floodplain. The creek is braided along this section, and channels are dynamic in terms of locations from year to year. At present, there are three locations between Km 37 and 39 where a creek channel is up against the south bank, and there is no opportunity to move the road upslope in order to avoid the channel. This is explained in a memo by Hatfield consultants which can be found in Appendix 10. The road construction concept is to re-align the creek channel away from the south bank in the three locations noted. The memo provides habitat information for these locations and other background information. The memo was provided to Parks Canada for comment and as a record of work undertaken jointly in July 2014.

4.6 Wildlife and Wildlife Habitat

Additional species with Secure and Sensitive populations in the NWT have known distributions along or near the all season access road. The focus of this assessment is the biological status of species or species groups traditionally harvested and those that are of ecological significance.

White-tailed Deer (*Odocoileus virginianus*), Mule Deer (*O. hemionus*), and Elk (*Cervus elaphus*) have been expanding their range north, but are rarely observed in or around NNPR and Nahanni Butte. These species are not discussed further.

4.6.1 Dall's Sheep (Ovis dalli dalli)

Dall's Sheep populations are ranked as Secure in the NWT. Their populations have been estimated at 14,500 to 26,500 of which 14,000 to 26,000 occur in the Mackenzie Mountains (Veitch 2014). Depending on the quality of habitat, Dall's Sheep densities may range from 20 to 55 sheep per 100 km^2, but are uncommonly over 55 per 100 km^2 (Barichello et al. 1987). Weaver (2006) reported that Dall's Sheep densities within the Greater Nahanni Ecosystem averaged 37 sheep per 100 km^2.

Important Dall's Sheep concentration areas within the Mackenzie Mountains are known to occur along and near the all season access road include the Nahanni Plateau (along Phase 1 KP 0-39), Ram Plateau (Phase 1 KP 61 is the closest point (approximately 4 km) to the Ram Plateau), and the Nahanni Range (Phase 2 KP 124-160). Dall's Sheep commonly spend their entire lives within a single well-defined mountain block or range (Simmons 1982), remaining primarily within the subalpine and alpine zones. Therefore, little dispersal is expected to occur between those potentially occupying the Nahanni Plateau, Ram Plateau, and Nahanni Range. Although infrequent, dispersal to new ranges has been reported, particularly involving young rams, although adult ewes have also been documented dispersing (Simmons 1982).

TABLE 4-11: DALL'S SHEEP AT A GLANCE

Dall's Sheep	
NWT Population Summary	
Conservation Status	Not assessed by COSEWIC, and ranked as Secure in the NWT
Trend	Not Rated within NNPR, but status considered good (Parks Canada et al. 2009). In the NWT, populations likely stable
Size	Estimated at 800-1,200 within the Greater Nahanni Ecosystem (Weaver 2006) and 14,000-26,000 in the Mackenzie Mountains (Veitch 2014)
Sensitivities and Threats	Overharvesting, human disturbances, disease
Health, Parasites, and Contaminants	Generally healthy, but known to host sheep lungworm (*Protostrongylus stilesi*) and the ecthyma virus
Relationship with the Prairie Creek All Season Road	
Presence along the All Season Road	Phase 1 within the Nahanni Plateau from KP 0-39 and Phase 2 along the Nahanni Range from KP 124-160
Seasons of Use near the Access Road	All seasons
Key Habitats	Alpine and subalpine plateaus, ridges, and mineral licks
Existing Harvest Pressure	Moderate
Traditional Knowledge	
▪ No known reports	

Outside the rutting period, adult males are often observed alone or in small groups of other males, whereas, ewe groups (including young rams, yearlings, and lambs) commonly occur in larger groups (ENR 2014f). Movements between annual ranges, as well as to mineral licks, are commonly confined to this specific mountain block. Annual movements between these ranges commonly follow the same route. In general, good winter habitat is also good summer habitat, with the winter range simply a contraction of the summer range (Simmons 1982; Beak 1981).

In the summer, Dall's Sheep commonly occupy high alpine meadows, and slowly begin moving to their winter ranges at lower elevations as snow accumulates. Sheep are particularly sensitive on their winter ranges, when suitable food resources are restricted and winter weather influences snow deposition and hardness. Optimum winter habitat includes low plateaus and ridges with shallow or wind swept snow, near timberline where snow crusting is limited, and in areas where forage is most accessible (Simmons 1982). A winter range is commonly utilized each year; however, shifts in winter range are known to occur (Simmons 1982).

Mineral licks are also an important habitat feature, particularly for ewe groups in the spring and early summer, but are regularly visited throughout the snow-free period (Parks Canada 1984). Parks Canada (1984) report Dall's Sheep visits to mineral licks "begin in early June, peaks in July, and ends by October". A high fidelity to mineral licks has been reported, with ewe groups travelling 5 to 20 km from their summer feeding areas to a mineral lick (Simmons 1982; Parks

Canada 1984). Particularly, the location of mineral licks are believed to strongly influence the summer distribution of ewes, lambs, and juvenile groups (Parks Canada 1984).

At the Prairie Creek Mine, Beak (1981) reported the presence of a mineral lick below Adit #3 and explained the attraction to possibly rock salt used for melting ice. Near the all season access road, known mineral licks occur primarily along the South Nahanni and Liard rivers, including near the confluence with Prairie Creek (at least 25 km from the all season access road) (Wilson and Haas 2012; Parks Canada 1984). Known mineral licks near the confluence of Prairie Creek and the South Nahanni River are known to be visited by both Dall's sheep and Moose, and are subsequently considered important points of interest for Park visitors (Parks Canada 1984). Dall's Sheep travelling to this Prairie Creek/South Nahanni River mineral lick may move along Prairie Creek.

Another mineral lick is known approximately 11 km north of the all season access road nearest to KP 10, and multiple licks are known near the Liard River crossing and the community of Nahanni Butte (Wilson and Haas 2012; ENR 2014a). Dall's Sheep occurring on the Nahanni Range may occupy mineral licks on the north side of the Liard River, including a moderate and high density mineral lick area approximately 10 km west (nearest point) of the Phase 2 access road, and smaller mineral lick areas near KPs 156-157 (Wilson and Haas, ENR 2014a).

Sheep are grazers and require food supplies that are adjacent to suitable terrain to escape predators. Grasses and sedges compose the majority of their diet, with leaves and stems of some shrubs, forbs, mosses, and lichens selected seasonally. Typically, rugged terrain is occupied to escape from predators, and females will seek isolated high cliffs and ridges to lamb. Lambing occurs in late May to early June, with lambing completed by June 9-10 (Beak 1982 in Golder 2010). Beak (1981) indicated Dall's Sheep observations suggest three possible lambing areas: 1) Folded Mountain within a kilometre from Phase 1 KP 7 of the all season access road; and 2 and 3) peaks immediately east and west of the Mine site airstrip (both within a kilometre of Phase 1 KP 2 and 3). Similarly, the Nahanni Range would provide suitable lambing areas.

As indicated by CZN (2010), Dall's Sheep inhabit the Prairie Creek Mine site area and are regularly observed during the spring and summer around the mine, moving to fall range (including rutting) and winter range to the east of Prairie Creek on the Nahanni Plateau. Sheep, primarily ewes, yearlings and lambs, are common on the east side of the valley above the Mine and Mill site in the spring. Rams appear to be more widely dispersed, including the west side of the Prairie Creek valley. This draw to the Mine site by ewe, lamb, and juvenile groups in the summer may be attributable to possible soda ash near Adit #3, as described by Beak (1981), and to human presence which deters predators.

Surveys indicate sheep occur along the access road from the Mine site throughout the Nahanni Plateau, along Funeral Creek and the pass to Sundog Creek, primarily in the winter, spring, and early summer. On the Nahanni Range, March surveys indicated sheep occurred primarily north of the all season access road at elevations greater than 1,000 m, compared to the road elevation at 500 m (Beak 1981). In June 2006, the largest group of Dall's Sheep were immediately adjacent to the Mine site (Golder 2010).

Based on the camp log records, Dall's Sheep (primarily ewes with lambs, yearlings) are commonly at and near the Mine and Mine site airstrip in June and July, with sheep observations declining into August, September, and October (Golder 2010). Golder (2010) suggests the ewes, yearlings, and lambs may undertake a late-summer dispersal away from areas immediately around the Mine site. Overall, rams appear more widely dispersed away from the Mine site; the

nearest known observation location being on the west side of the Prairie Creek valley (Golder 2010).

Threats to Dall's Sheep in the NWT include disease, human disturbance, inability to quickly colonize new areas, and potential over harvest (Barichello et al. 1987; ENR 2014b). Dall's Sheep are moderately resilient to human disturbances if within a continuous population (i.e., the Mackenzie Mountain population); however, they show a low resilience to disturbances if the population is fragmented or isolated from others. Dall's sheep are known to habituate to harmless human activity in routine space and time (Weaver 2006).

Although Dall's Sheep are considered healthy in the NWT, they are known to host sheep lungworm (*Protostrongylus stilesi*), which has been linked to fatal pneumonia outbreaks (ENR 2014f). Similarly, the ecthyma virus, a contagious virus to people and other ungulates including Moose and caribou, have also been reported in the NWT (ENR 2014f).

In the Mackenzie Mountains, non-resident harvesters preferentially seek trophy Dall's Sheep during their hunts from July 15 to October 31. During the 2012 hunting season, a total of 207 rams were harvested by non-resident harvesters; up from the average annual harvest of 197 calculated over the past 22 years (Larter and Allaire 2013). The meat is later distributed to the local communities, including Nahanni Butte. Resident and general hunting licence holders (e.g., First Nations groups) also harvest for subsistence in the Mackenzie Mountains. In the Mackenzie Mountains, resident hunters reportedly harvested 7 rams (Larter and Allaire 2013), and general hunting licence holders are known to harvest approximately 20-30 Dall's Sheep a year.

4.6.2 Moose (Alces alces)

Moose commonly occur throughout the boreal forest, and their populations are listed as Secure in the Northwest Territories. Based on traditional harvesting areas identified during local consultations, an aerial Moose survey was conducted along the Liard River and uplands in 2004 (RWED 2005) (including Nahanni Butte and the Phase 2 portion of the all season access road east of Nahanni Range). Based on these results, the Moose density was estimated at 0.049 Moose/km² and the population was believed to be stable (RWED 2005). Similarly, the density of Moose around Nahanni Butte and the southeast portion of the NNPR ranged from 0.02-0.07 Moose/km^2 (Parks Canada 2009).

Moose habitat is not considered limiting within the geographic scope of the Prairie Creek all season road. Low elevation habitats such as semi-open forests and habitats with an abundance of willow and other deciduous shrubs close to lakes, inside river valleys and riparian areas, and along lakeshores are favoured by Moose, and common east of Nahanni Plateau. Suitable habitat types include tall and low shrub, wetlands (treed, shrub, and herb), coniferous open, broadleaf open, and mixedwoods. NNPR wardens also observed Moose occupying high elevation subalpine shrublands (a narrow band of shrubs in the transition between subalpine forests to alpine tundra) in the late fall and early winter, and with increasing snow deposition, moved to lower elevations later in the winter (Parks Canada 1984).

TABLE 4-12: MOOSE AT A GLANCE

Moose	
NWT Population Summary	
Conservation Status	Secure in the NWT
Trend	Assumed to be Stable (Parks Canada et al. 2009; RWED 2005)
Size	Density estimates range from 0.02-0.07 moose/km^2 around Nahanni Butte and southeast portion of the NNPR (Parks Canada et al. 2009). Also, 0.049 moose/km^2 in the Liard River valley (RWED 2005).
Sensitivities and Threats	Over harvesting, predation, vehicle collisions
Health, Parasites, and Contaminants	Cadmium levels relatively high in Moose kidney and liver tissues taken from the southern Mackenzie Mountains and Liard/Mackenzie river valleys (Larter and Kandola 2010). Ticks are rare. Moose warts (papillomas) and hydatid tapeworm cysts common (RWED 2005).
Relationship with the Prairie Creek All Season Road	
Presence along the All Season Road	The entire Phase 1 and 2 portions
Seasons of Use near the Access Road	All seasons
Key Habitats	Valleys and riparian areas, mineral licks, semi-open forests, early successional habitats, lakeshores
Existing Harvest Pressure	Moderate
Traditional Knowledge	
▪ Moose are an important game animal in the NNPR (Parks Canada et al. 2009) ▪ Local accounts from the Dehcho region indicate the Moose population has been decreasing in some areas and stable in others (ENR 2014b)	

Moose are primarily browsers, and browse on willow, young aspen and balsam poplar, Saskatoon, Canada buffalo-berry, rose, and red-osier dogwood. These preferred browse species commonly occur in abundance in semi-open early successional habitats such as floodplains, oxbows, wetlands, regenerating burns, and previously disturbed areas. Habitats with a high cover of willow and other browse material support Moose throughout the year, especially in the winter, and occur throughout the All season access road route east of Nahanni Plateau (beginning at approximately Phase 1 KP 37) to the Liard Highway.

The use of browse material declines in the spring and summer when forbs, grasses, and aquatic plants are available. Wet and aquatic habitats are common feeding areas during all non-winter months, but tend to peak during late June to early August when plant nutrition and digestibility are highest. In addition, Moose may seek aquatic habitats in the summer to avoid heat stress.

Moose also seek distinct habitats to minimize detection from predators and avoid insect harassment. Dense coniferous forests and tall shrub stands are used to conceal from predators,

and open wind exposed ridgelines and aquatic habitats are used to avoid insects. They may also use lake shorelines and islands to reduce encounters with predators, especially during calving.

Gill (1978) recognized mineral licks as critical Moose habitat that are utilized year round, but especially in the winter. Along the Prairie Creek all season access road, known mineral licks occur primarily near the South Nahanni and Liard rivers (Wilson and Haas 2012). Based on known mineral lick locations and/or density map (Wilson and Haas 2012; ENR 2014a), the Phase 1 and 2 road developments may pass as close as:

- 11 km (approximately) south of a single known mineral lick (nearest to Phase 1 KP 10);
- 10 km (approximately) west of moderate and high density mineral lick areas located north of the Liard River (nearest to Phase 2 KP 151);
- 2 km (approximately) of a high density mineral lick area located near the Nahanni Butte airport (nearest to Phase 2 KP 162-164) and a single mineral lick near Phase 2 KP 156); and
- Within a few 100 m from three mineral licks near Phase 2 KP 157, the junction with the Nahanni Access road, and along the Liard Highway (nearest to Phase 2 KP 178-184.5).

Another area of mineral licks occur near the confluence with Prairie Creek and the South Nahanni River, at least 25 km from the all season access road (Parks Canada 1984). These known mineral licks are known to be visited by Moose (Parks Canada 1984), which may access the mineral lick along the South Nahanni River and the Prairie Creek valleys.

Previous field surveys for the Prairie Creek Mine and its access road observed Moose and Moose sign at the Mine site and along most of the length of the access road, albeit more commonly east of the Nahanni Plateau (Golder 2010; 2014b). Presumed Moose high and moderate winter and summer ranges included the area north of Liard River to the Grainger River, the Tetcela River and Fishtrap Creek valleys, and Silent Hills (Beak 1981). However, Moose were occasionally observed in the Mackenzie Mountains, along Prairie Creek and at the Mine site in the spring and summer. Over a seven year period (2001-2007), a total of three adult Moose were reported in the camp observation logs near the Mine and Mine site airstrip (Golder 2010). Movement corridors likely occur along low valleys in the Mackenzie Mountains, along the existing access road, and along major rivers and their larger tributaries.

Moose are assumed to be the preferred subsistence species in the area. Metal concentration analyses were conducted from Moose occurring in the Liard and Mackenzie River valleys and the southern Mackenzie Mountains due to concern of metal contaminants in country foods. The level of cadmium, mercury, and zinc were higher in Moose from the southern Mackenzie Mountains than compared to the Liard/Mackenzie river valleys (Larter and Kandola 2010). However, only cadmium levels in Moose kidney and liver tissue were above levels reported elsewhere and were considered a public health concern (Larter and Kandola 2010). As a result, a public health advisory is in effect for cadmium levels reported in Moose liver and kidney tissues taken from the southern Mackenzie Mountains and Liard/Mackenzie river valleys (including all portions of the all season road) (Larter and Kandola 2010). Moose have also been found to commonly host Moose warts (papillomas) and hydatid tapeworm cysts, but ticks are rare (RWED 2005).

Traditional harvesting of Moose within the original boundaries of NNPR concentrated along the eastern boundary and into Yohin Lake, and totalled approximately 2 to 12 Moose annually (Parks Canada 1984). No other harvest locations and harvest numbers are known; however,

assumed to frequently occur along the Liard River valley and the Liard Highway. NWT residents and non-residents are permitted to harvest one Moose annually from the Nahanni Butte D/OT/02 and South Nahanni D/OT/01 outfitter zones. Across the Mackenzie Mountains, non-residents harvested a record number (85 Bull Moose) in 2012, the largest known harvest since records began in 1991 (Larter and Allaire 2013). This increased harvest was attributed to outfitter zone (D/OT/01) ownership changes, which prior to 2005, the majority of this outfitter's clientele targeted Dall's sheep, consequently only harvesting 24 Moose a year (Larter and Allaire 2013).

4.6.3 Furbearers

Furbearers are an important economic and cultural resource for many hunters and trappers in the north. Based on available species range maps and previous wildlife field surveys conducted in the Prairie Creek project area, three furbearing species were chosen to represent all furbearers potentially occurring in the area of the all season access road. These include: Grey Wolf (*Canis lupus*), Beaver (*Castor canadensis*), and Marten (*Martes americana*). Wolverines, another important furbearer, also occur along the all season access road.

TABLE 4-13: FURBEARERS AT A GLANCE

Furbearers	
NWT Population Summary	
Conservation Status	Grey Wolf, Beaver, and Marten – All Secure in the NWT
Trend	Population trend unknown in NWT or Dehcho
Size	Population size unknown in NWT or Dehcho
Sensitivities and Threats	Over harvesting, habitat loss, human activities
Health, Parasites, and Contaminants	No baseline conditions known for most species. Cadmium levels elevated in Beaver, but at levels suitable for consumption. Beavers in the Dehcho are considered a healthy food (Deh Cho First Nations ND)
Relationship with the Prairie Creek All Season Road	
Presence along the All Season Road	Entire Phase 1 and 2
Seasons of Use near the Access Road	Year round
Key Habitats	Various, wherever suitable habitat exists
Existing Harvest Pressure	Low
Traditional Knowledge	
▪ No known reports	

The habitat requirements and potential distributions of these selected species along the all season access road are considered representative of other furbearers also occurring in the area (e.g., Red Fox *Vulpes vulpes*, Snowshoe Hare *Lepus americanus*, Muskrat *Ondatra zibethicus*, River Otter *Lontra canadensis*, American Mink *Neovison vison*, Canada Lynx *Canadensis*, and weasel species). Although these additional species were not selected for a focused effects assessment,

the potential for Project-related effects and applicable Project mitigation to reduce adverse effects are addressed by the selected representative species.

Furbearer distribution and population abundance have not been formally surveyed for the Prairie Creek Mine and its access road; however, they are expected to occur throughout the all season access road route wherever suitable habitat exists.

Grey Wolves are hunted and trapped for their fur and are important to the local and regional economies in the north. The Grey Wolf is a habitat generalist, occupying habitats with an abundance of prey. Wolf densities in the Dehcho, particularly areas near Trout and Celebita lakes, are considered to be relatively high (Larter 2004b). Across the boreal forest zone of the NWT, estimates reach as high as one wolf per 101 km^2 (Van Zyll de Jong and Carbyn 2000). An estimated 30 to 75 Grey Wolves were expected to occur in and around NNPR, and were considered widely occurring (Parks Canada 1984). A pack, ranging in size generally from two to sixteen individuals (ENR 2014b), maintains a home territory, which varies in size depending on prey densities. Within this territory, wolves construct dens to raise their pups; the denning period typically beginning by early May. Inside the original boundaries of NNPR, Grey Wolf dens were associated with waterbodies, and an occupied wolf den was once reported near the Prairie Creek-South Nahanni River confluence (Parks Canada 1984). Grey Wolf dens are reused in consecutive years, and wolves at the den site are sensitive to human disturbances.

There have not been any formal Grey Wolf studies conducted for the Prairie Creek Mine and its access road; however, several wolves have been observed incidentally during aerial surveys and in the camp observation logs (Golder 2010). Wolves have been reported at the Prairie Creek Mine and Harrison Creek, near the Mine site airstrip, and along the access road (Golder 2010). During this time, the number of Grey Wolves detected ranged from one to a pack of five (Golder 2010). Grey Wolves are expected to occur throughout the entire Prairie Creek all season access road.

Beavers are a common harvest species in the NWT; they are traditionally harvested for their pelt, hide, and meat. Beavers occur primarily at low elevations, where wetlands, slow moving streams, ponds, and lakes are present. Their distribution and abundance are dependent on habitat quality, and they are sensitive to water level changes, especially in the fall and winter. Based on available habitat along the all season access road, Beaver are assumed to range primarily from Phase 1 KP 64-86 and the entire length of Phase 2. However, their abundance is expected to be higher along the Tetcela River and Fishtrap Creek valleys, and east and west of the Nahanni Range where there are more wetlands, then compared to the mountainous regions.

Low concentrations of cadmium have been documented in the kidney and livers of Beaver collected from the Slave River and Mackenzie deltas (INAC 2004). Cadmium is naturally present across the NWT, and finds its way into the food web from the weathering of rocks and subsequent plant uptake (INAC 2004). Cadmium may also be released into the environment from burning fuels and refuse. Concentrations are low and are not considered harmful to Beavers or to the people eating them.

Marten are expected to occur throughout the forested areas traversed by the all season access road east of the Mackenzie Mountains (Phase 1 KP 64-86 and entire length of Phase 2). They favour mature coniferous forest stands with complex downed and overhead structures; however, all habitats may be occupied if abundant prey and cover exist. Marten were considered common inside the original boundaries of NNPR (Parks Canada 1984). Marten prefer forests with a high canopy cover, and in general, do not travel across open areas that are 200 m wide or greater (Salmo Consulting Inc. et al. 2004). Marten populations are generally cyclic in response to their

dominant prey populations. Like many furbearers, Marten are particularly sensitive to disturbance during their denning period (March or April), when litters are born in dens within rock piles, tree roots, deadfall, or peat banks. Marten are considered to be relatively tolerant to human disturbances and activities, but are vulnerable to overharvest (Salmo Consulting Inc. et al. 2004).

In the NWT, Wolves are classified as both big game and furbearers. All NWT residents are permitted to harvest as many Grey Wolves as they have tags for, and non-residents may hunt within an outfitting zone (ENR 2014b). All residents require a licence to trap.

Non-residents hunting within the Mackenzie Mountains harvest, on average, approximately 15 Grey Wolves a year; however, 24 were harvested in 2012 (the highest recorded harvest since records began in 1991 (Larter and Allaire 2013). Harvesters within these outfitter zones did not harvest Wolverine (Larter and Allaire 2013).

4.6.4 Waterfowl and Trumpeter Swan (*Cygnus buccinators*)

TABLE 4-14: WATERFOWL AT A GLANCE

Waterfowl	
NWT Population Summary	
Conservation Status	All ranked as Secure or Sensitive in the NWT
Trend	Population trend unknown in NWT or Dehcho
Size	Population size unknown in NWT or Dehcho
Sensitivities and Threats	Over harvesting, habitat loss
Health, Parasites, and Contaminants	Contaminant levels depend on the species and migration habits; however, waterfowl in the Dehcho are considered healthy and nutritious (Deh Cho First Nations ND)
Relationship with the Prairie Creek All Season Road	
Presence along the All Season Road	Entire Phase 1 and 2 with higher densities assumed to occur from Phase 1 KP 62-86 and the entire length of Phase 2 (KP 86 to the Liard Highway)
Seasons of Use near the Access Road	Spring, summer, and fall
Key Habitats	Lakes, ponds, wetlands, rivers, streams, and oxbows
Existing Harvest Pressure	Low
Traditional Knowledge	
▪ No known reports	

In the NWT, flocks of various waterfowl species are frequently observed migrating each spring and summer. Many waterfowl species remain in the Dehcho region and likely along the all season access road route for the purposes of breeding. Some species may only use this area for spring and/or fall staging for a short period of time, before continuing on with their migration, and others may migrate through the area without staging.

Waterfowl select habitats that provide secure nest sites, and safe areas for rearing young and molting adults. Specific nesting habitat requirements vary with species, and can range from tree cavities, mats of vegetation in the water or at the water's edge, and the ground in wooded uplands. Waterfowl have a high fidelity to breeding sites, returning to the same nest site each year in the spring. Within the NWT and the Dehcho, waterfowl generally breed throughout the boreal forest at higher densities than mountain valleys. However, waterfowl can be expected to occur and breed wherever their habitat requirements are met. Consequently, they are expected throughout much of the low lying habitats along all season access road including productive shallow waters of lakes, ponds, wetlands, rivers, and streams. Although low densities of waterfowl may be expected along Prairie, Sundog, and Funeral creeks (as well as other mountain streams), the Tetcela River and Fishtrap creek valleys (from Phase 1 KP 62-86 and Phase 2 KP 86-97), the wetlands west of the Nahanni Range (Phase 2 KP 103-123), the wetlands east of the Nahanni Range (Phase 2 KP 142-147), and the oxbows and streams from the Liard River to the Liard Highway (Phase 2 KP 156-158 and 161-184) are expected to support higher densities.

During spring and fall migration, waterfowl may occur in higher densities along the all season access road, where suitable habitat exists. The timing of the spring migration for the all season access road is unknown; however, it is assumed to begin by mid to late April and continue until the last week of May (EBA 2003; Latour 2003). Fall migration is more prolonged (ranging from late August and into October) as migrants gradually travel south and peak migration, as seen in the spring, is more relaxed.

Suitable staging habitat is likely restricted to the low elevation habitats along the Tetcela River valley, east of Nahanni Range, and near the Nahanni Access Road and Liard Highway since ice cover likely remains at the Prairie Creek Mine and Nahanni Plateau during spring migration.

Within the NNPR, Yohin and Rabbitkettle lakes are considered important waterfowl breeding habitats (Parks Canada et al. 2009). Yohin Lake, approximately 20 km southwest from the all season access road, supports a small nesting population of Trumpeter Swans (*Cygnus buccinators*). Rabbitkettle Lake, in the Ragged Range near the western edge of NNPR, supports several species of loons and grebes (Parks Canada et al. 2009).

Trumpeter Swans are considered Not At Risk (1996) in Canada and are ranked as Sensitive in the NWT. There are no known threats to their population in the NWT. Favorable habitat for both nesting and foraging includes freshwater marshes and large boreal ponds and lakes. Requirements for nesting habitat include approximately 100 m for take-off from the water, accessible forage, and low human disturbance (Mitchell and Michael 2010). Trumpeter swans that breed in the Greater Nahanni Ecosystem are part of the Rocky Mountain Population known to overwinter in the northwestern USA (Montana, Wyoming, and Idaho). Like many waterfowl species, swans are territorial on their breeding grounds.

In 2005, Trumpeter Swan surveys were conducted across the NNPR and Dehcho Region. In total 415 Trumpeter Swans were detected, including 37 broods (Beyersbergen 2007). During these surveys, Trumpeter Swans were observed throughout the survey area, with the highest concentrations being in the Tetcela River valley and at Yohin Lake (Beyersbergen 2007). During the June 2006 aerial survey along the all season access road, a "few swans" (not recorded to species, but assumed to be a Trumpeter Swan) were observed on ponds nearest to Phase 1 KP 64 (Mosquito Lake) and 75 (Golder 2010).

Threats to waterfowl include potential overhunting and habitat loss.

4.6.5 Raptors

Raptors can be expected to occur and nest near the entire all season access road route, wherever their habitat requirements are met. Suitable nest sites and food resources are the main factors that naturally limit breeding raptors in an area. Raptors exhibit nest site fidelity, returning to the same nest site each year whether this includes a nest in a tree, on a cliff, on the ground, or a nest previously constructed by another species. It is during the mating and incubation stages that raptors are most susceptible to human disturbances, and may desert a nest as a direct result of human activity.

A single known raptor nest, occupied by a Golden Eagle (*Aquila chrysaetos*) in 2010, was documented approximately 5 km southeast of the Prairie Creek Mine (ENR 2014a). Raptor nests within 1 km of the Prairie Creek Mine and its associated Project footprint are unknown.

TABLE 4-15: RAPTORS AT A GLANCE

Raptors	
NWT Population Summary	
Conservation Status	All ranked as Secure or Sensitive in the NWT
Trend	Population trend unknown in NWT or Dehcho
Size	Population size unknown in NWT or Dehcho
Sensitivities and Threats	Disturbances during the breeding season
Health, Parasites, and Contaminants	No baseline conditions known
Relationship with the Prairie Creek All Season Road	
Presence along the All Season Road	Entire Phase 1 and 2
Seasons of Use near the Access Road	All seasons
Key Habitats	All habitat types
Existing Harvest Pressure	None
Traditional Knowledge	
▪ No known reports	

Data within ENR's WIMS presents six raptor species nest within the region. Within the original boundaries of NNPR, three Bald Eagle (*Haliaeetus leucocephalus*) nests are known near Yohin Lake, and one Peregrine Falcon, four American Kestrel (*Falco sparverius*), one Red-tailed Hawk (*Buteo jamaicensis*), and one Northern Harrier (*Circus cyaneus*) nests have been documented along or near the South Nahanni River (ENR 2014a). A single Golden Eagle nest was also reported at the western portion of the NNPR (Parks Canada 1984). Peregrine Falcon is discussed in Section 4.2.10.

During the Prairie Creek Mine and access road field surveys, a single Gyrfalcon and several Golden Eagles were reported (Golder 2010). The only observation of a Gyrfalcon was in January near Funeral Creek, and five Golden Eagles were observed in March and July west of the Prairie Creek Mine, near the eastern most edge of the Nahanni Plateau, north of the Grainger Gap, and along the Silent Hills (Beak 1981). An eagle, not identified to species, was also observed in June 2006 (Golder 2010).

4.7 Vegetation

The following information was extracted from a report by Tetra Tech EBA contained in Appendix 7. For further details, the reader is directed to the appendix.

4.7.1 Conditions Prior to Site Development

The study area is located primarily within the Taiga Cordillera and Taiga Plains Ecozones of the Northwest Territories and is characterized by several significant topographic features (e.g., Mackenzie Mountains, the Nahanni Ranges and the Liard floodplain) resulting in an array of growing conditions, and consequently, numerous vegetation species assemblages (Ecosystem Classification Group 2007). Wild fires occasionally occur in the region and have influenced forested ecosystems throughout much of the landscape. However, the Prairie Creek watershed had not been influenced by any form of human activity, apart from possible First Nations use such as trapping or hunting parties, prior to mineral exploration (Golder 2010).

Mineral exploration and associated infrastructure, including the existing winter access road has affected a small area of the land base of the Prairie Creek watershed and overall Project area, and apart from local influences, has not affected the physical nature or biological composition of natural plant associations or communities in this watershed or ecosystems adjacent to the existing winter access road.

4.7.2 Vegetation Cover Description

The vegetation units described in Appendix 7, represent vegetation cover types, based on predominant physical conditions and species composition (also referred to as vegetation or habitat “units”). Tetra Tech EBA has used the most currently available EOSD vegetation classification descriptions and data and correlated these descriptions to the extent feasible with the information reported in Golder (2010), which was based on Robertson Environmental Service’s (RES) (1994) summary of the earliest studies conducted by Beak (1981, 1982). Relevant information on wildlife use of these habitat units is also provided, as noted during previous investigations of the project area (primarily from Beak [1981]).

4.7.3 Plant Species at Risk

The Northwest Territories General Status Ranking Program is an evaluation of species status within the NWT. Species ranked as ‘May be at Risk’ or ‘At Risk’ are considered the highest priority for further assessment [Environment and Natural Resources (ENR) 2014a]. As part of the background research conducted to assess the presence of plant species at risk in proximity to

the proposed all season access road, Tetra Tech requested occurrence data for vascular plant, bryophyte and lichen species (currently ranked as a species at risk in the NWT) which have been historically observed within a 50 km radius of the study area; recorded as part of the NWT ENR virtual herbarium database (ENR 2014g).

The results of the database search indicate that 16 vascular plants species, one lichen species and 13 bryophyte species currently ranked as 'may be at risk'; one vascular plant species ranked as 'sensitive' and one vascular plant species ranked as 'undetermined' by the NWT General Status Ranking Program have been historically identified within a 50 km radius of the CZN study area. A summary of the database search results, including the NWT General Status Rank, NatureServe global status rank (if applicable) (NatureServe 2014) and approximate recorded distance from the CZN study area boundary is provided in Table 4-16.

TABLE 4-16: PLANT SPECIES AT RISK HISTORICALLY OBSERVED IN PROXIMITY TO THE STUDY AREA

Common Name	Scientific Name	NWT Status[1]	Global Status[2]	Recorded Distance from CZN Study Area
Vascular Plants				
snow fleabane	*Erigeron nivalis*	May be at Risk		2 occurrences – greater than 42.6 km
Porsild's whitlow-grass	*Draba porsildii*	May be at Risk	G3G4	40.2 km
Beringian hairy potentilla	*Potentilla villosula*	May be at Risk	G4	23.4 km
Raup's willow	*Salix raupii*	May be at Risk	G2	24.9 km
velvetleaf blueberry	*Vaccinium myrtilloides*	Sensitive	G5	5.0 km
Canada violet	*Viola canadensis*	Undetermined	G5	6 occurrences – greater than 24.1 km
Nahanni aster	*Symphyotrichum nahanniense*	May be at Risk	G2	19.8 km
Mackenzie sedge	*Carex mackenziei*	May be at Risk	G4G5	20.0 km
Peck's sedge	*Carex peckii*	May be at Risk	G5	24.1 km
Smooth cliff-brake	*Pellaea glabella*	May be at Risk	G5	2 occurrences – greater than 34.8 km
Alaska parsley-fern	*Cryptogramma sitchensis*	May be at Risk	G4	26.2 km
Mingan moonwort	*Botrychium minganense*	May be at Risk	G4G5	29.6 km
green spleenwort	*Asplenium trichomanes-ramosum*	May be at Risk	G5	48.0 km
Yukon fleabane	*Erigeron yukonensis*	May be at Risk	G2G4	34.8 km
white-flowered hawkweed	*Hieracium albiflorum*	May be at Risk	G4G5	28.4 km

TABLE 4-16: PLANT SPECIES AT RISK HISTORICALLY OBSERVED IN PROXIMITY TO THE STUDY AREA

Common Name	Scientific Name	NWT Status[1]	Global Status[2]	Recorded Distance from CZN Study Area
seaside angelica	*Angelica lucida*	May be at Risk	G5	49.0 km
Loesel's twayblade	*Liparis loeselii*	May be at Risk	G5	2 occurrences – greater than 18.8 km
choke cherry	*Prunus virginiana*	May be at Risk	G5	4 occurrences – greater than 24.0 km
Lichens				
aboreal bottle-collection lichen	*Tholurna dissimilis*	May be at Risk	G4G5	48.1 km
Bryophytes				
bigspore arctic granite moss	*Andreaeobryum macrosporum*	May be at Risk	G2G3	5 occurrences – 18.5 km
twinkle mountain-moss	*Arctoa fulvella*	May be at Risk	G3G5	24.9 km
long-necked candlesnuffer	*Encalypta longicolla*	May be at Risk	G3	3 occurrences – greater than 17.0 km
blunt candlesnuffer	*Encalypta mutica*	May be at Risk	G3	3 occurrences – greater than 17.0 km
trim silk moss	*Entodon concinnus*	May be at Risk	G4G5	18.5 km
torque rock moss	*Grimmia torquata*	May be at Risk	G3G5	38.0 km
Mueller feather-moss	*Isopterygiopsis muelleriana*	May be at Risk	G5	38.0 km
alpine plagiobryum moss	*Plagiobryum demissum*	May be at Risk	G3G5	18.5 km
Zier's plagiobryum moss	*Plagiobryum zierii*	May be at Risk	G4G5	38.0 km
six-ranked haircap moss	*Polytrichum sexangulare*	May be at Risk	G4	2 occurrences – greater than 38.0 km
crisp rhabdoweisia moss	*Rhabdoweisia crispata*	May be at Risk	G5	38.0 km
polar limestone moss	*Seligeria polaris*	May be at Risk	G3G5	18.5 km
Velenovsky's hilpertia moss	*Tortula scotteri*	May be at Risk	G1	49.6 km

[1] NWT General Status Ranking (ENR 2014b)
[2] NatureServe global status ranking (NatureServe 2014)

Results of the ENR virtual herbarium search indicate that no vegetation species at risk occurrences have been historically recorded within five kilometres of the CZN study area (ENR 2014g). It should be noted that these results do not necessarily negate the potential presence of

vegetation species at risk within the study area, but they do provide valuable insight with respect to the types of vegetation species which may require further consideration given their presence in the regional context of the study area. Of the species listed above, two species (Nahanni aster and Raup's willow) are currently considered globally imperiled (G2 global status ranking – NatureServe 2014) and one species (Velenovsky's hilpertia moss) is considered critically imperiled (G1 global status ranking – NatureServe 2014). As such, further commentary with respect to these species has been provided in Sections 4.7.4, 4.7.5 and 4.7.6.

Rare plant surveys related to the Prairie Creek Mine Project and associated winter access road were initiated by EBA on behalf of CZN in July 2009 and further surveys were completed in August 2010 (EBA 2010; 2011).

In July 2009, rare plant surveys were conducted along the Prairie Creek Mine winter road; the proposed waste rock storage facility; and the area around camp and the beaver pond to the south.

A total of 340 plant observations, representing 193 species and 44 families of vascular plants, were documented during the 2009 field survey. No plants listed within the federal SARA were observed in the surveyed areas. However, one plant species, few flower meadow rue (*Thalictrum sparsiflorum*), listed as 'May Be At Risk' (ENR 2014b) was documented along the Prairie Creek winter road and an adjacent wetland.

Two additional plant species ranked as 'May Be At Risk' by the ENR were identified along the existing winter access road [Hornemann willowherb (*Epilobium hornemanni*) and linear-leaved willowherb (*Epilobium leptophyllum*)] have restricted distribution in the NWT with limited known occurrences, but are globally secure (Golder 2010). Six plant species ranked as 'Sensitive' by the ENR [alpine anemone (*Anemone drummondii*), bog birch (*Betula pumila*), lesser black-scaled sedge (*Carex atrosquama*), one-glume spike rush (*Eleocharis uniglumis*), alpine groundsel (*Packera pauciflora*) and yellow mountain heather (*Phyllodoce glanduliflora*)] identified adjacent to the Prairie Creek winter road have small regional distributions in the NWT with a small number of known occurrences, but are globally secure. It was concluded that impacts to these local occurrences (and potential additional occurrences near the access road) can be avoided or reduced by limiting the amount of additional land disturbance for upgrades and operation of the all access road.

In August 2010, the proposed Polje By-Pass re-alignment was surveyed for unique or important vegetation communities and rare plants. The habitat in which the proposed Polje By-Pass re-alignment traverses was burned by a forest fire in 1996. The vegetation community now comprises a jack pine regeneration stand approximately 14 years old. No rare plants or sensitive habitats were documented within the jack pine regeneration along the proposed Polje By-Pass alignment. It was concluded that this proposed re-alignment would not threaten rare plants or sensitive vegetation communities (EBA 2011).

4.7.4 Nahanni Aster (Symphotrichum nahanniense)

Nahanni aster is a perennial wildflower endemic to Canada and found only in the southern Mackenzie Mountains in the Nahanni National Park Reserve (COSEWIC 2014b). This species relies on specific habitat requirements and, as a result, the entire population of Nahanni aster is confined to six known sites, all of which are hot and warm springs with tufa (calcium carbonate deposits). The closest known site to the proposed CZN all season road occurs approximately 20 km from the proposed CZN all season road study area boundary.

Given the very small range, habitat specificity and population size of this species, it is considered susceptible to losses resulting from alterations to geothermal processes or landslide events. Nahanni aster is currently ranked as globally imperiled (G2) by NatureServe, special concern by COSEWIC and 'May Be At Risk' by ENR.

4.7.5 Raup's Willow (*Salix raupii*)

Raup's willow is currently considered globally imperiled (G2) by NatureServe and 'May Be At Risk' by ENR. This species has a very restricted range and is known from two sites in NWT, two sites in the Yukon, two sites in Alberta and three sites in British Columbia (ENR 2014h). The closest known occurrence of this species to the proposed CZN all season road occurs approximately 25 km from the proposed CZN all season road study area boundary.

This species is associated with a variety of habitats, including white spruce woodlands, trembling aspen woodlands, gravel floodplains, and black spruce treed bogs. Potential threats to the known occurrences of this species are not currently well understood; however, potential threats from development (specifically logging) have been identified as a potential concern to known populations of this species in Alberta (NatureServe 2014).

4.7.6 Velenovsky's Hilpertia Moss (*Tortula scotteri*)

Velenovsky's hilpertia moss is currently considered critically imperiled (G1) by NatureServe and 'May Be At Risk' by ENR. This species is known from two localities in NWT and British Columbia (ENR 2014h). The closest known occurrence of this species to the proposed CZN all season road occurs approximately 50 km from the proposed CZN all season road study area boundary.

Preferred habitat for this species includes exposed soil on high elevation slopes (NatureServe 2014).

5.0 HUMAN ENVIRONMENT BASELINE

5.1 Education, Training and Skills

A Socio-Economic Impact Assessment (SEIA) for the Prairie Creek Mine was compiled by Impact Economics in 2008, and was submitted to the Review Board with the DAR for EA0809-002 as Appendix 19. The SEIA provides data on regional education levels, and the availability and average skill levels of the local and Dehcho regional labour pool. This section provides relevant details from the SEIA.

The Study Area communities lag behind the rest of the Territory in terms of educational attainment (see Table 5-1), though the 20-year trend does show the percentage of residents with at least high school education is improving. Data for 2011 comes from Statistics Canada's *Census*. In that year, 49.2 percent of the Dehcho region's population aged 15 years and older had a high school diploma compared to 68.9 percent for the territory as a whole. However, surveys conducted for Nahanni Butte and Wrigley are susceptible to sampling errors due to the small populations.

TABLE 5-1: EDUCATIONAL ATTAINMENT
(population aged 15 years and older)

			Study Area Communities			
	Northwest Territories	**Dehcho Region**	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
	% with High School Diploma or More					
1986	51.6	37.8	36.5	16.7	49.7	25
1989	59.8	37.4	13.9	16.4	55.1	25
1991	59.9	40.7	31.7	46.2	52.5	33.3
1994	63.2	39.7	19.7	11.1	54.3	22.6
1996	63.5	47.3	30.4	16.7	62.8	50
1999	66.1	45.3	28.6	34.8	62	28
2001	64.8	45	33.3	..	61.9	39.1
2004	67.5	46.6	31.3	31.7	63.4	37.6
2006	67	45.3	31.3	-	59.1	-
2011	68.9	49.2	31.3	35.7	60.1	25

Source: Compiled by NWT Bureau of Statistics, Summary of NWT Community Statistics, (http://www.stats.gov.nt.ca/Profile/NWTCommunityStats (2008).pdf) accessed September 24, 2009. These data combine Statistics Canada *Census* data (1986, 1991, 2001, 2006) and NWT Bureau of Statistics data.

Within the *2006 Census* data, Statistics Canada has released detailed information specific to Aboriginal peoples. There is a marked difference in the education levels of Aboriginal and non-Aboriginal residents within the Study Area communities. The Aboriginal population from within these communities also underperforms in comparison to the territory's Aboriginal population. From the previous table, 67 percent of the territory's population 15 years of age and older have at least a high school diploma. This figure combines residents of all ethnicities. Table 5-2 contains

the education figures specific to Aboriginal residents of the territory. Here we see that for the Northwest Territories as a whole, 45 percent of Aboriginal residents have a high school diploma or its equivalent—this compares to 34 percent in the Study Area communities. Again, sampling error can have a statistically significant influence on the results from Nahanni Butte and Wrigley.

TABLE 5-2: ABORIGINAL EDUCATIONAL ATTAINMENT

			Study Area Communities			
	Northwest Territories	**Study Area**	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
Aboriginal Population 15 years of age and older	14,465	1,115	365	80	590	80
Less Than High School	7,920	735	285	70	315	65
At Least High School	6,545	380	80	10	275	15

Source: Statistics Canada, Aboriginal Population Profile, 2006 Canadian Census.

While the economic opportunities in the Dehcho region are limited, statistics reveal that the employment record of those with at least a high school diploma is more than twice that of those without Grade 12 or its equivalent. There is a clear division between Aboriginal and non-Aboriginal people in the Study Area communities when it comes to employment. The average employment rate of Aboriginal labour is less than 50 percent, whereas the non-Aboriginal employment rate exceeds 80 percent.

Since there is only a limited population, coupled with the fact that the region has incurred only limited industrial, non-governmental economic activity in the region, there is not a large population with a high or moderate skill level. However, with time, training and potential employment opportunities, the potential labour pool can be enhanced from its present levels.

Additional evidence of the education levels in the Study Area communities comes from the International Adult Literacy and Skills Survey conducted in Canada (see Figure 5-1). The scores are organised into levels of competency, with 4 being the highest. The levels are defined within the survey and represent levels of competency. Level 3 is considered the minimum skills level suitable for coping with the demands of everyday life and work in a complex, advanced society. It denotes roughly the skill level required for successful secondary school completion and college entry. The results do not show intra-regional scores for the provinces and territories, but do show the difference in scores between Aboriginal and non-Aboriginal adults. The percentage of NWT Aboriginal people who fall below Level 3 was approaching 70 percent in 2003 when the survey was conducted. This compares to less than 30 percent for the non-Aboriginal population.

Similar to other regions in the NWT, the smallest communities in the Study Area are without a high school (see Table 5-3). Students from Nahanni Butte and Wrigley must travel to Fort Simpson, Fort Liard or elsewhere to graduate. For children from Wrigley, this means leaving home after completing Grade 9 which could be at the age of 14 or 15. In the Tlicho region, statistics show that bringing high school to the smaller communities has been a major factor in raising the number of graduates in those communities.

FIGURE 5-1: COMPETENCY LEVELS IN PROSE LITERACY, FOR POPULATION 16 YEARS OF AGE AND OVER, BY NWT ETHNICITY AND CANADA (2003)

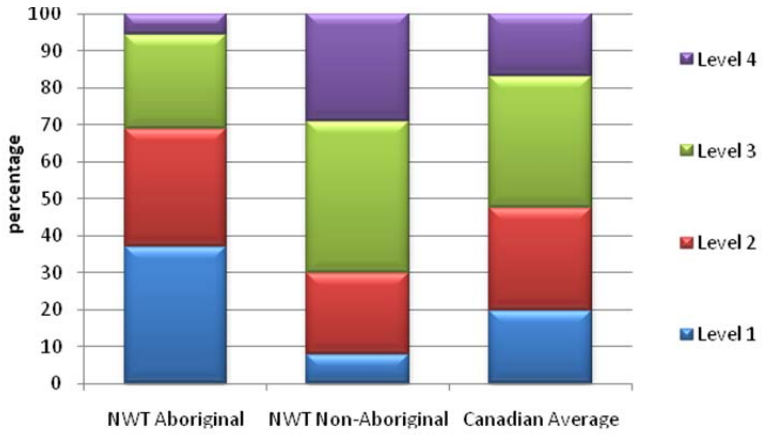


TABLE 5-3: STUDY AREA PRIMARY AND SECONDARY SCHOOLS

Name	Community	Grades
Bompas Elementary School	Fort Simpson	K - 6
Thomas Simpson Secondary School	Fort Simpson	7 - 12
Charles Yohin School	Nahanni Butte	K - 10
Chief Julian Yendo School	Wrigley	K - 9
Echo-Dene School	Fort Liard	K – 12

Source: Department of Education, Culture and Employment, GNWT

Regarding trade certification, data for 2011 are provided in Table 5-4. The number of apprentices/tradesmen in the NWT as a whole is 10% of the population. The smaller communities local to the Prairie Creek Mine have (Nahanni Butte, Jean Marie River, Trout Lake) have a percentage approximately double that, but the numbers are low because of community size. The percentage in the main community, Fort Simpson, is only 8.4.

In support of CZN's commitment to build skill capacity for Dehcho resident's to be considered for employment positions at the Prairie Creek Mine, including the access road, CZN partnered with the neighbouring local First Nation communities, the GNWT, the Federal Government of Canada, the Mine Training Society (MTS), and Aurora College to deliver a 3-year, $4 million "Sliver Lining" training program which was administered locally in Fort Simpson. The training courses offered under the Silver Lining program included, Mine Administration, Heavy Equipment Operator, Environmental Monitor, Camp Cook, Road Construction, Diamond Driller, Mineral Exploration Field Assistant, Class 5 Driver Licence, Advanced Medical First Responder, Small Engine Repair, Building Trades Helper, and many others. The program's target outcome was to create employment opportunities for 70 Dehcho residents.

TABLE 5-4: APPRENTICESHIP AND TRADE CERTIFICATION

	Population 15 & Older	Apprenticeship or trades certificate or diploma	
	Number	Number	%
NWT	31,755	3,190	10.0
Dehcho	2,420	230	9.5
Fort Liard	335	25	7.5
Fort Simpson	1,015	85	8.4
Jean Marie River	45	10	22.2
Nahanni Butte	70	10	14.3
Trout Lake	50	10	20.0
Wrigley	80	-	-

Source: Compiled by NWT Bureau of Statistics

The program operated between March 2011 to March 2014, and had a total of 264 individuals participating in 23 training courses, including 8 courses delivered at the Prairie Creek Mine. Based on MTS' Silver Lining completion report, 109 participants have been employed and another 20 have returned to school. All parties were delighted with exceeding the Silver Lining program's proposed targets.

5.2 Harvesting

The text that follows was prepared by CZN for the EA0809-002 DAR. It was reviewed and edited by the NBDB to ensure correctness and non-confidentiality, with assistance from their consultant, Crosscurrents Associates Ltd. It is repeated here as a record of mostly past traditional harvesting. Some modifications to the text have been made based on TK information provided by Band members during a meeting between CZN and elders/harvesters in Nahanni Butte on January 20, 2015.

> "The lower portion of the Nahæââ Dehé (South Nahanni River) valley is an active travel route, a rich ecological area, a well-utilized harvesting area, and an area of high traditional occupancy. People from Nahæââ Dehé travel the river from late spring, after break-up, through to the fall. Before the coming of motorized boats, travel was generally one-way in the spring time, using moose hide boats, rafts, or spruce bark canoes to bring winter furs, family, and supplies down river to summering areas, trading posts, and settlements toward the mouth and along Náchádeh (Liard River). When motorized boats were introduced to the area, flat-bottomed scows could be used throughout the summer and fall, dependent to some extent on water levels, for both up river and down river travel. Modern aluminium boats with more powerful outboard motors have extended that range.
>
> Dahtaihtth'î (Deadmen Valley), located around the mouth of K'atåo Dehe (Prairie Creek) where it flows into Nahæââ Dehé (Nahanni River), is a high traditional use area for the hunting of moose and sheep and for seasonal fishing. It is also a corridor through which

traditional trails and trap lines run. K'atåo Dehe (Prairie Creek) is the largest creek running into Nahæââ Dehé (Nahanni River) in this area. The part of K'atåo Dehe (Prairie Creek) that NDDB members currently use the most is the portion near the mouth. Deep pools above the first major bend appear to be an important habitat area for grayling and other species and are used for subsistence fish harvesting purposes. Sheep licks near the mouth, in the same vicinity as the grayling pools, also draw local hunters to this area, particularly in the fall. Due to its seasonal importance for hunting, fishing, and trapping purposes, the area has been used over time for both seasonal and year-round camps. For at least one season, a family over-wintered in the area, at the site where a Parks Canada cabin now exists. At least one burial site is located in this valley.

Just east of Dahtaihtth'î, along the Nahæââ Dehé (Nahanni River), is Ala Tthe Zhíhgoîæá (first hole in the mountain, or First Canyon). In the past, before the use of outboard motors, travel along this steep section of the river was primarily downstream in moose hide boats in the spring time, although it is also likely that people would have walked up the valley for hunting purposes at different times of the year given that sheep come down to the lower edges of the valley walls (Dene Nation, 1975). Most hunting is carried out while travelling up the river, keeping an eye on the lower edges of the valley for sheep. Fishing is carried out at the mouth of creeks flowing from the hills.

The landscape along the Prairie Creek Mine access road between Cat Camp and Tthôôtå'ooh (Second Gap, in the Nahanni Range) is quite varied but generally open and accessible, unlike the steep and narrow valleys in K'atåo Dehe (Prairie Creek) and the western section of the road. Although there is documented use of the broad, forested plateau as a traditional trail and harvesting area, the heaviest traditional use of this portion of the road is the wetland valleys running north-south along the Tehts'éhia Dehé (Tetcela River) and Ée Túé (Fishtrap Creek), and along the western side of the Nahanni Range. The plateau area to the west was utilized by Nahæâ Dehé harvesters at least as early as the 1900's, likely longer given that established land use patterns are generally maintained through successive generations. It was specifically used during the winter months as a travel route to the North Nahanni River, Cli Lake, and the pass through the Nahanni Range to Tuhgah (Little Doctor Lake), and as a trap line for beaver, lynx, marten, muskrat, wolf, wolverine, cross-fox, and mink (Dene Nation, 1975). At least one trail followed Shíro Tah Îlî (flowing from the mountains), which is the northwest branch of Tehts'éhia Dehé and located north of the mine haul road.

The settlement at Ée Túé (Fishtrap Creek) was a hub for harvesting activities (Band members indicated that the settlement was very close to the mouth of the creek (January 20, 2015)). Camp sites were likely established and utilized all along the travelled routes (Band members indicated that such camps were only temporary and were used perhaps only for 1 night while on a harvesting expedition, and that the locations were moreoless at random and not in common, frequently used locations (January 20, 2015)). Winter travel was by a combination of snowshoe, dog pack and dog team (Dene Nation, 1975; Dehcho First Nations 1997). The area was used for a range of spring and winter harvesting activities as well as being a key travel corridor. Through Nógha Eteneh GoteodéÆá, this wetland is connected to the narrower wetland valley between Shíha (Silent Hills) and the Nahanni Range, which was also a spring and winter harvesting area

and northerly travel route. The wetland areas were used for spring hunting given the relative abundance of beaver as well as migratory birds. Winter harvesting in the valley area included a wide range of fur species as well as moose, which appear to over-winter in this valley area.

During the latter portion of the 1900's, after the community of Nahanni Butte was fully established, trapping continued between the creek and the southern portions of the plateau. Harvesting continued to take place in the winter and focused on beaver, cross-fox, lynx, marten, mink, wolverine, wolf, woodchuck, squirrel, weasel and ermine (Dene Nation, 1975).

Although fishing was not a primary purpose for people while harvesting in the valley area, except for the lower ends of Ée Túé (Fishtrap Creek), NDDB trappers are aware of the fish species in the main creeks in the area: inconnu, grayling, jackfish, and bull trout.

The Nahanni Range itself was a harvesting area for mountain (Dall's) sheep, likely due to the presence in the area of a sheep lick. Sheep were seen all along the high country and at Tthôôtå'ooh (Second Gap), particularly in summer. In the spring, they calved in the area. The sheep stayed on top of the mountains during the winter where snow is absent. Cabins were established and used on the small lake just west of Tthôôtå'ooh (Second Gap), locally called Second Gap Lake or Gap Lake.

The area between Tthôôtå'ooh (Second Gap) and Náchádeh (Liard River) is the watershed of Endalîâh (Grainger River) which flows from the east side of the Nahanni Range into a relatively flat and marshy area dominated by wetlands and mixed forest cover. One notable geographic feature in this area is Endaa Shíhaa (moose lick hill), which is essentially a low, well-thicketed hill harbouring a mineral lick site. Harvestable spruce is found in certain areas along the banks of the Liard. This area is particularly good habitat for beaver and for boreal woodland caribou, which are known to be in the area at different times of the year, particularly along the lower levels of the Nahanni Range in the spring time. It appears that the caribou move down into the lowlands for the winter, where moose are also found. Endalîâh (Grainger River) is not navigable by boat for much of the year, but there are instances where Nahanni harvesters travelled with dogs from the community along the east slope of the Nahanni Range to Second Gap hunting beaver, and then rafted down the river hunting along the way. Data generated from the Dene Mapping Project (1975) and Dehcho First Nations (1997b) mapping project show extensive traditional use of the lowland area between the Nahanni Range and Liard River, particularly for trapping and big game harvesting purposes, most of which would occur during the winter. Along with boreal woodland caribou, moose, and Dall sheep, the furbearers traditionally harvested in this area include beaver, lynx, marten, muskrat, wolf, wolverine, cross-fox, mink, and weasel (Dene Nation, 1975). The area was also used as a winter travel route northward toward Fort Simpson.

Camps were established in this area for seasonal use during the winter months and at least one cabin was built and occupied for an extended length of time for the purposes of hunting and trapping. During spring hunting expeditions into the area, some fishing has

taken place up-river, but fishing primarily occurs at the mouth. Jackfish and grayling were caught."

To obtain an impression of traditional harvesting activities occurring at the time of EA0809-002, CZN had a discussion with Leon Konisenta, an elder from the Nahanni Dehe Dene Band (NDDB) on January 27, 2010. Mr Konisenta provided the following information:

- Traditional harvesting used to include caribou, particularly in the early 1960's. Some animals were harvested in the Second Gap area. However, no caribou have been harvested for approximately 20 years;

- Harvesting of moose is common. Harvesting occurs near Nahanni Butte, around the Swan Point area and along the Liard Highway. In the fall, members would also travel up the South Nahanni River to the 'flats' to hunt moose. Harvested numbers were plentiful, numbering 25-30 animals in some years. Members did not need to travel too far to find moose, and could use the available access routes. Moose numbers have dwindled, and moose are now more rarely found along the easy access routes. Mr. Konisenta attributes this partly to the introduction of bison to the area. Moose harvesting has also dwindled because "there's too much willow for skidoos";

- Members used to harvest a few Dall's sheep annually from the Nahanni Range in proximity to the village. None are harvested now;

- Trapping used to be very common in the Liard River lowlands, and west of the Nahanni Range to the Wolverine Pass area. Animals trapped included lynx, mink, marten, wolverine, fox, beaver and otter. In 1978, about 600 marten were caught. However, there has been no trapping for 6 years because of a combination of fewer animals, lower pelt prices, and rising costs (fuel for skidoos);

- Trapping was also common in the Yohin Lake, lower Fishtrap Creek and Netla River areas. Trapped animals were mainly marten, beaver and muskrat. Between 30 and 50 animals were trapped in good years. This trapping has also dwindled for the same reasons as above, but still occurs periodically because of the easier access; and,

- Harvesting of berries and medicinal plants was and still is prevalent in the area. Berries include cranberries, blueberries and strawberries. Plants include white moss and Labrador tea. This harvesting used to occur as far away as Yohin Lake and Wolverine Pass. Currently, the harvesting occurs nearer to the village and mountains due to ease of access.

To obtain an updated impression of traditional harvesting activities for this assessment, CZN had a discussion with elders and harvesters from the NDDB on January 20, 2015 in Nahanni Butte. The meeting was attended by Elder Jean Marie Konisenta, Band Council members Peter Marcellais, Tammie Matou and Jayne Konisenta, and Band members Burton Campbell, Lena Marcellais and Raymond Vital. The following information was provided:

- Only Raymond Vital and a few others (Jim, Francis and Tommy Betsaka), have conducted trapping in proximity to the access road in the recent past. The trapping

occurred in the Bluefish Lake and Grainger Gap areas, and the species trapped were marten, beaver, lynx, mink and wolverine. Robert said that he used to go trapping perhaps once a year, but he hasn't used his trap lines since 2005/6;

- Trapping and hunting used to be common from the village to Grainger Gap and through the Gap. They used to hunt moose and caribou. The caribou would only be found east of Grainger Gap. More recently, only moose have been hunted (this may be because hunting is now primarily closer to the village and along the river, and hunters don't venture too far inland (CZN conclusion));

- Raymond Vital said he used to harvest Dall sheep along the Front Range in the 1970's. He remembers harvesting 3 near Granger Gap, and 2 near Bluefish Lake. He says he has never seen mountain goats there; and,

- Raymond Vital fished in Gap Lake about 5 years ago, catching jackfish (pike) and grayling (he has a cabin there). He has also fished in Bluefish Lake and the triangular lake at Km 140, catching grayling, but this was more than 10 years ago.

5.3 Cultural and Heritage Resources

In addition to the historical information provided above, the following is relevant to the possible locations of heritage resources:

> The quantity and density of traditional place names increases significantly as Nahæââ Dehé (Nahanni River) flows into the long section of river referred to as Ndutah (the Splits). This increase in place names is an indication of high use within living and recent generations - due to the abundance of fish, plants, and game animals (such as moose, beaver, and sheep), as well as the presence of tributaries providing links to critical harvesting areas to the north and south. Two traditional, post-contact settlements were located in this area: Chitú (Yohin Lake) and Ée Túé (Fishtrap Creek (elders advised that the settlement was very close to the mouth)). Given its historic use as a travel route and harvesting area, camps have also been set up along this particular section of the river for seasonal and temporary use by the ancestors and current members of the NDDB. There is at least one burial site in this area, as well as a hot-spring which has traditionally been used for medicinal purposes.
>
> The area of Nahæââ Dehé (Nahanni River) between Ndutah (the Splits) and its mouth at Náchádeh (Liard River) is of paramount ecological and cultural importance to NDDB, since it has been the community's primary area of occupation, both historically and currently.

CZN conducted archaeological database searches during previous EA's. The first was conducted on August 18, 2000 through the Canadian Museum of Civilization. The search area encompassed the Mine site area, as well as the entire access road corridor from the Prairie Creek Mine to the Liard River. To accomplish this, the search parameters were defined by geographical coordinates to cover a block extending from 61^{o} 00' to 61^{o}45' N. latitude and from 122^{o}45' to 125^{o}00' W.

longitude. No recorded archaeological sites were identified for the area of interest. The closest identified sites are south of the South Nahanni River near the mouth of the Meilleur River, 35-40 m south of the Mine site.

A second database search was undertaken on December 16, 2004 covering the area of a proposed surface drilling program near the Mine. The search parameters were defined by coordinates 61°27' to 61°40' N latitude and 124°44' to 124°56' W longitude. No recorded archaeological sites were noted within at least 150 m of the area of interest.

CZN held meetings with the NDDB in July and August 2009 as part of a TK addendum. One area of concern was as follows: "Given that the ancestors of the Nahanni people are known to have travelled overland to a greater extent than via waterways, the mountain passes that provide easy access into and between valleys are potential areas for pre-historic and historic artifacts. For this reason, it would be useful to carry out archaeological work". It was agreed that archaeological work should be undertaken in key areas of the Prairie Creek access road, primarily at the Second Gap area in the Nahanni Range, but also at Wolverine Pass in the Silent Hills, and at the crossings of the Tetcela River. CZN engaged Points West Heritage Consulting Ltd. to undertake an Archaeological Impact Assessment (AIA) of the noted key areas. Surveys were undertaken on September 23-24, 2009 led by Gabriella Prager, archaeologist for Points West, and included 2 NDDB elders, Leon Konisenta for both days, and Raymond Vital and Tommy Betsaka on alternate days. The survey party also included representatives from the NDDB. The survey assessed the 3 sections of possible heritage concern that had been identified during the Nahanni Butte Dene Band traditional knowledge study. Visual inspections and shovel tests were conducted. All shovel tests were negative, and no archaeological remains were found in any of the areas examined. Camp remains were found in Second Gap, but those probably date no earlier than cut-lines, that is, the 1980's. Therefore, it was not recorded as an archaeological site. No other cultural evidence was observed.

During EA0809-002, despite the fact that an AIA had been conducted on the most probable locations for heritage resources and none had been found, some government reviewers were of the opinion that additional survey was warranted. Although CZN disagreed, the Company made a commitment to undertake an AIA of the new mine access road alignment from the Liard River to the Grainger Gap. CZN contracted Golder Associates to undertake the assessment. A field investigation was completed on September 20 and 21, 2012 after engagement with and direction from NDDB elders. Band members Peter Marcellais and Leon Konisenta participated in the investigation, which consisted of low level helicopter reconnaissance and pedestrian surveys. No heritage resources were found.

During the meeting with elders and harvesters from the NDDB on January 20, 2015 in Nahanni Butte, elders advised that while harvesting expeditions were indeed made along the north-south valleys historically, harvesters would only camp in a location for one night on an almost random, opportunistic basis. There were no frequently used camp locations. Furthermore, the reason Wolverine Pass and Grainger Gap are prime locations for any heritage resources is the fact that expedition routes converged on these locations for passage between valleys. At the same meeting, elders advised that there were no known burial or culturally important sites proximal to the access road, and that the closest ones were several hundred metres upstream from the proposed Liard River crossing.

While the limestone formations of the Ram Plateau contain innumerable fossils, there are no known rare paleontological resources.

5.4 Tourism

Current tourist activity in the study area is dominated by visitation to the Nahanni National Park Reserve (NNPR). NNPR operations consist of research and traditional activities, the non-commercial component, and tourist activities, the commercial component. The South Nahanni River is used extensively for guiding and canoeing trips during the summer months (see Table 5-5). River tours are supported by a number of outfitting companies from as far away as Ontario. Most tours assemble in Fort Simpson and fly in to Virginia Falls to start their trip just below the falls. The usual trip terminus is Lindberg Landing on the Liard River just north of Blackstone Territorial Park.

Prior to NNPR expansion, some tourism (hiking) and research also occurred in the area of the North Nahanni Karst, proximal to CZN's access road. This area is now within the expanded park.

According to the Socio-Economic Impact Assessment (SEIA) for the Prairie Creek Mine (Impact Economics, March 2010), projections made of economic impacts from expansion of the NNPR were as follows:

- Parks Canada would spend $10 million as a direct result of the park expansion;
- The added spending would increase GDP in the NWT by $7.9 million and create 59 full-time equivalent (FTE) jobs over the ten-year period (this should not be interpreted as creating 59 jobs on an annual basis, but rather an average of 5.9 FTE jobs annually);
- The expanded park would generate an additional $1.5 million in visitor spending on goods and services in the Territory over the initial 10 years—equivalent to an additional $150,000 annually.

The additional $150,000 of visitor spending the park expansion was predicted to generate on an annual basis was estimated to contribute $44,000 to the Territory's yearly GDP.

The 2009 season saw the number of park visitors decline to approximately 750. Impact Economics commented that should tourist levels remain at this level (300 visitors less than the peak), the economic benefits from park expansion would not occur.

It was reported in the Dehcho Drum newspaper (January 21, 2010) that NNPR had 16 employees before the expansion (9 full time and 7 seasonal) and the newly expanded park is currently in the process of hiring 20 new employees (8 full time and 12 seasonal positions). CZN is aware that NNPR operations now include operation of a seasonal office in Nahanni Butte, and the seasonal employment of 3-4 Band members. We understand there are plans to build a permanent office. We believe the intent is to include the village as a formal stopping point for paddlers travelling down-river, although some paddlers used to stop previously, and some would over-night in the village. We also understand that Parks Canada is in negotiations with the NDDB regarding an Impacts Benefits Agreement. Therefore, while hard data is not available, our impression is that

NDDB income and employment associated with the NNPR was not significant prior to park expansion, but that there has been a limited increase since.

TABLE 5-5: NNPR VISITATION STATISTICS

Year	Total Park Visitors	Total Day Visitors	Total Overnight Visitors	# Guide Visitors	# Private Visitors	# Guided Trips	#Private Trips	Total # Trips	Average Group Size	Average Trip Length (days)
1984	888	352	536	-	-	-	-	-		
1985	923	448	475	-	-	-	-	-	5.2	10
1986	724	260	464	-	-	-	-	-	5.0	12
1987	851	310	541	-	-	-	-	-	-	-
1988	936	431	505	301	204	33	61	94	5.6	
1989	1016	487	529	275	254	39	66	105	5.6	11.3
1990	858	279	579	241	338	38	75	113	5.9	11.3
1991	969	295	647	371	276	37	64	101	6.3	13.4
1992	1323	665	658	356	303	36	80	116	5.7	11.1
1993	1391	728	663	341	322	36	85	121	5.5	-
1994	1137	425	712	409	303	43	86	129	5.5	-
1995	1207	405	802	443	359	44	106	150	5.3	10.5
1996	1227	455	772	450	378	42	83	125	6.2	11.0
1997	1062	300	762	429	333	42	75	117	6.5	-
1998	791	185	606	326	280	34	59	93	6.5	-
1999	861	300	561	354	207	34	56	100	6.2	10.6
2000	929	350	579	398	181	38	49	82	6.6	11.7
2001	936	295	641	439	202	45	44	89	7.2	12.3
2002	977	491	486	272	214	29	48	77	6.3	11.4
2003	1018	395	623	383	240	43	43	86	7.2	10.5
2004	887	322	565	270	295	38	67	105	5.3	11.0
2005	1020	306	705	400	305	39	57	96	7.3	13.0
2006	796	215	581	365	216	39	44	83	7.0	11.2
2007	970	236	734	521	213	49	44	93	6.0	14.2
2008	810	269	541	284	257	28	48	77	7.0	12.0
2009	754	297	457	246	154	25	36	61	6.6	13.0
Avg.	**971.6**	**365.4**	**604.8**	**357.9**	**265.2**	**37.8**	**62.5**	**100.6**	**6.2**	**11.7**

5.5 Regional and Local Economies

The Study Area communities can be considered small and relatively isolated. Fort Simpson is the only community within the Dehcho region with a population that exceeds 1,000 (see Table 5-6). Similar to the territory as a whole, the population is dominated by young people below the age of 25. Aboriginal people make up the majority in all Study Area communities. Fort Simpson has the largest number of non-Aboriginal people in relative and absolute terms.

TABLE 5-6: SOUTH-WEST DEHCHO POPULATION AND EMPLOYMENT STATISTICS

		NWT	Nahanni Butte	Fort Simpson	Trout Lake	Fort Liard
POPULATION (2012)	Total	43,349	104	1,251	100	568
	Aboriginal	22,065	101	921	x	543
	Non-Aboriginal	21,284	x	330	x	25
INCOME ASSISTANCE (2012)		2,240	5	58	3	29
TRADITIONAL ACTIVITIES (2008)		39.4	57.6	41.5	74.7	58.7
Hunted & Fished (%)		6.2	14.1	9.0	36.7	29.2
Trapped (%)		8.7	16.3	21.5	48.1	24.7
Produced Arts & Crafts (%)		28.1	77.1	34.4	81.8	66.5
LABOUR FORCE						
Participation Rate	2001	77.1	..	78.1	75.0	69.3
	2004	75.6	69.5	73.3	69.1	66.7
	2006	76.5	58.8	77.3	76.9	61.4
	2009	75.1	53.3	72.9	69.6	67.1
Unemployment Rate	2001	9.5	..	12.9	22.2	19.2
	2004	10.4	24.6	11.0	29.8	19.0
	2006	10.4	20.0	12.1	20.0	27.5
	2009	10.3	18.4	10.5	18.2	14.3
Employment Rate	2001	69.8	..	68.0	58.3	56.0
	2004	67.8	52.4	65.2	48.5	54.0
	2006	68.6	47.1	67.4	53.8	44.6
	2009	67.3	43.5	65.3	57.0	57.5
Selected Employment Rates (2009)	Aboriginal	49.8	41.9	56.2	52.9	53.2
	Non-Aboriginal	83.1	66.7	86.7	88.9	92.2
Labour Force Activity (2009)						
Population 15 & Over		33,730	92	1,008	79	438
Employed		22,702	40	658	45	252
Available Labour Supply		2,616	9	77	10	42
Not in the Labour Force		8,412	43	273	24	144
Employment Profile (2009)	% Full-Time	87.9	67.5	83.9	68.9	87.3
	% Part-Time	11.2	30.0	14.1	28.9	12.7
Employment Profile (2009) % Gov't, Health, Social Serv, Education		43.2	62.5	51.2	73.3	44.8
% Goods Producing		15.5	27.5	13.8	2.2	40.1
% Other Industries		39.2	10.0	32.7	22.2	13.9

Source: NWT Bureau of Statistics

Overall, a weak economy and participation generally below the territorial average means average incomes are similarly low. When coupled with the cost of living and cost of food in comparison to Edmonton and Yellowknife, these low incomes suggest higher rates of poverty among the population and in particular amongst the Aboriginal population.

Employment rates (2009) vary between communities, with Fort Simpson the highest (65%) and Nahanni Butte the lowest (44%). Overall, a steady decline in employment rates is seen since 2001, but participation and unemployment rates have similarly declined. This suggests out-migration and/or an aging population. By far the majority of employment is in government, health, social services and education. Goods producing employment is a distant second. However, the available labour supply is relatively low, except in the large communities of Fort Simpson and Fort Liard, and the proportion of residents not in the labour force is high. Despite this, the proportion of people on income assistance is low.

Most residents are involved in traditional activities, and more than the territorial average. Arts and crafts is the dominant activity, presumably to sustain supplemental income. Approximately 30-85% of residents engage in hunting and trapping, with Nahanni Butte and Trout Lake being on the low and high end of this range, respectively. The statistics on income and cost of living suggest that subsistence hunting and fishing is as much a necessity for some as it is a part of local traditions and culture.

Information from NDDB elders is that trapping is limited and only practiced for a small supplemental income. Most trappers have a wage income as the main source of income. Hunting and fishing is exclusively for local consumption, and nearly all aboriginal households consume traditional food. More details on harvesting activities are provided in Section 5.2 above.

While business services are limited, each First Nation in the Study Area operates a development corporation capable of expanding to take on new roles or brokering joint venture arrangements with larger firms. In Fort Liard, the Acho Dene Koe First Nation (ADK) has developed several joint ventures associated with natural gas production addressing service needs such as drilling, air and ground transportation, and environmental services. They have also pursued construction opportunities, and camp services and catering business through a holding company, Beaver Enterprises. ADK also operates a number of retail businesses selling crafts, other tourist products and fuel.

Fort Simpson offers the largest array of business services in the area. The community is home to several transportation companies servicing industry, tourism and general transportation needs, and a number of accommodation services, including hotels/motels and bed and breakfasts. Other businesses provide expediting services, construction, contracting and general retail services such as grocery outlets, fuel, taxi service, etc.

The Liidlii Kué First Nation's (LKFN) development corporation is Nogha Enterprises. It is classified as a highway, street and bridge construction company by Industry Canada. However, Nogha is involved in a wider array of construction activities, general contracting, and services. Similar to Beaver Enterprises, Nogha has the capacity to expand to meet new demands from industry, either independently or through the formation of a joint venture.

Nahanni Butte and Trout Lake are smaller communities where only limited business and retail services are available. The First Nations in these communities have formed development corporations. However, their ability to expand to meet the business needs of industry is largely untested.

Harvestable spruce is found in certain areas along the banks of the Liard River. Logging has occurred previously in the Lindberg Landing area. A small sawmill operated there previously.

No other mineral exploration has occurred in the study area in the last 30 years, to CZN's knowledge. Exploration for gas in the form of seismic investigation work occurred in the lowland valleys both sides of the Nahanni Range, but pre-dated Cadillac's activities as some seismic lines were used for the access road alignment. No further gas exploration is known to have occurred in the area since that time.

Oil and natural gas reserves are present in the Fort Liard area and in the Cameron Hills. Production fell sharply over the last decade. The only gas field in production was operated by Paramount Resources in the Cameron Hills. Production at the remaining 4 fields near Fort Liard has been suspended or abandoned.

5.6 Existing Transportation Routes and Related Infrastructure

Traffic out-bound from the Mine site on the all season road would join the existing Nahanni Butte access road at Km 174.5, then travel to the Liard Transfer Facility at approximately Km 182, located 2.5km from the junction with Highway #7. The junction is located at Km 131 on Highway #7 (measured from the BC border). The Fort Liard junction is at Km 38. At the Territorial/Provincial boundary, Highway #7 becomes Highway #77. It is a further 173 km to the Fort Nelson rail yard (see Figure 5-2).

The 24 km long Nahanni Butte road is classified as an all-season road, but improvements to accommodate heavy vehicles would be required. It is currently rated for light vehicles only during the summer. During the winter season, an ice bridge is established across the Liard River (at Km 12) and the frozen road bed is better able to handle heavy vehicles. When the ice bridge is not in operation, Nahanni Butte is cut off from direct highway traffic, and boats are required to cross the Liard River.

In 1980-81, Highway #7 was under construction and had connected the Mackenzie Highway #1 to Lindberg Landing. Completion of the Highway to the BC border in order to connect with Fort Nelson via Highway #77 in BC was planned. At the time of Highway #7 construction, there was limited access to suitable road aggregate, and local pits provided mostly silt bearing fill material. This fill has proved to be problematic for the continuing maintenance of the Highway. The Department of Transport for the Government of the Northwest Territories (DOT) has placed weight restrictions on use of the highway from mid-March to early June of each year. However, the GNWT recently announced the allocation of $30 million for Highway #7 improvements over 10 years.

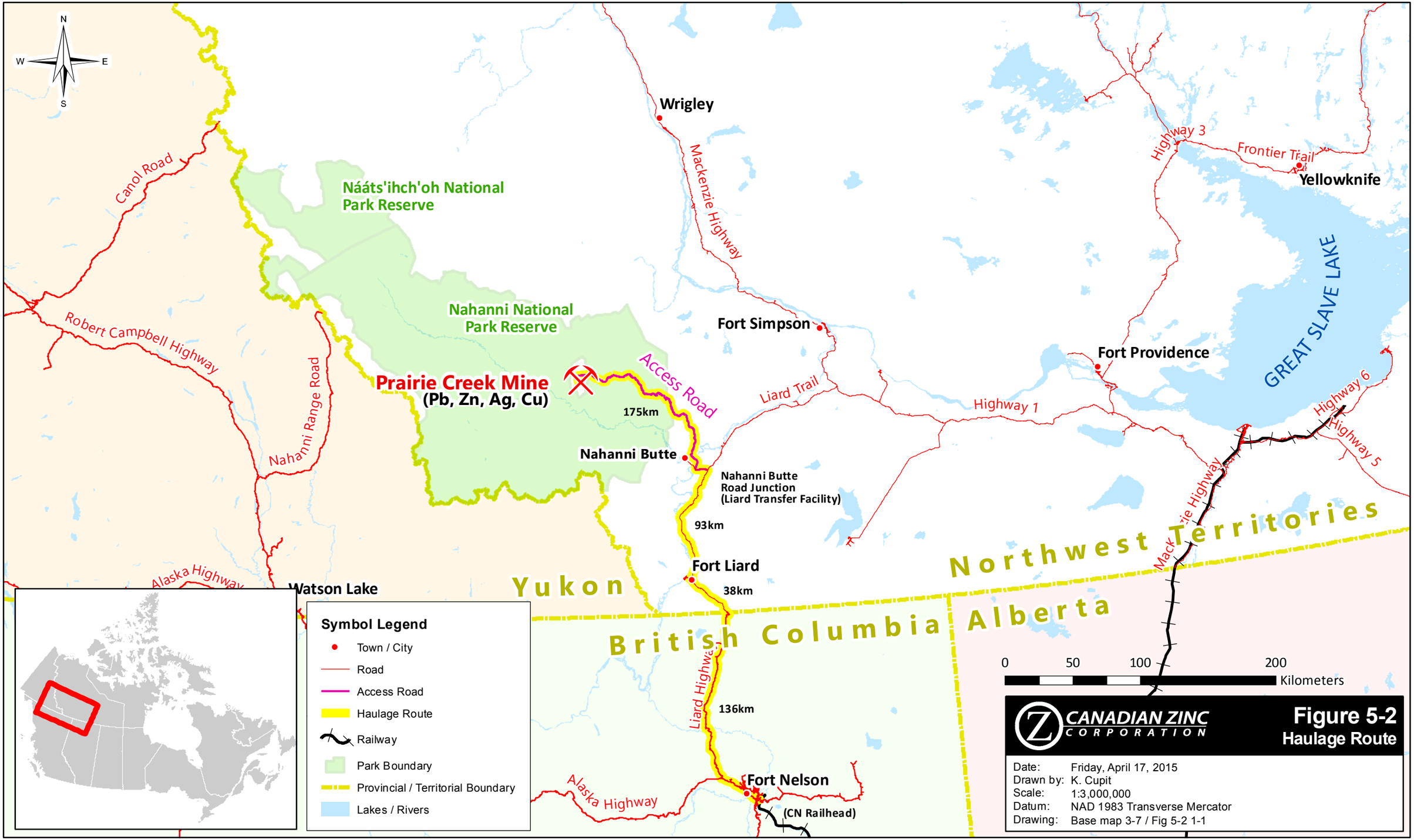

N
W
E
S
Wrigley
Mackenzie Highway
Canol Road
Náàts'ihch'oh National Park Reserve
Nahanni National Park Reserve
Robert Campbell Highway
Nahanni Range Road
Prairie Creek Mine
(Pb, Zn, Ag, Cu)
Access Road
175km
Nahanni Butte
Nahanni Butte Road Junction (Liard Transfer Facility)
93km
Fort Liard
38km
136km
Liard Highway
Fort Nelson
(CN Railhead)
Alaska Highway
Watson Lake
Fort Simpson
Liard Trail
Highway 1
Fort Providence
Highway 3
Frontier Trail
Yellowknife
GREAT SLAVE LAKE
Highway 6
Highway 5
Mackenzie Highway
Yukon
British Columbia
Alberta
Northwest Territories
0
50
100
200
Kilometers
Symbol Legend
Town / City
Road
Access Road
Haulage Route
Railway
Park Boundary
Provincial / Territorial Boundary
Lakes / Rivers
CANADIAN ZINC CORPORATION
Figure 5-2
Haulage Route
Date: Friday, April 17, 2015
Drawn by: K. Cupit
Scale: 1:3,000,000
Datum: NAD 1983 Transverse Mercator
Drawing: Base map 3-7 / Fig 5-2 1-1

Table 5-7 provides somewhat dated but still useful data on monitored highway usage from statistics gathered by the DOT since 1999. The data indicate that usage of the highway north of Fort Liard is quite low with an annual average of less than 50 vehicles/day. Moderate traffic increases (between 2 and 4 times) are noted south of Fort Liard in proximity to the BC border.

Highway #77 in BC is currently an approved 85 tonne gross vehicle weight route. There are some restrictions on the Highway related to over width loads crossing the bridge over the Fort Nelson River at Km 42.

The data in Table 5-7 also indicate past use of the Nahanni Butte access road in winter. This traffic is assumed to be related to village residents, and is an indication of what their use frequency would be in winter during operation of the all season road to and from the Mine. As noted above, outside of the winter season, the village would not have road access, however some residents leave a vehicle on the east bank of the river to be used in conjunction with a boat to travel to and from the village.

Bulk fuel services are currently available in Fort Simpson and Fort Liard. Mine and transport operations could acquire fuel from either of these locations, or potentially more outlying locations such as Hay River and Fort Nelson.

The Liard River between Nahanni Butte and Lindberg Landing is used as the eastern terminus of paddling trips down the South Nahanni River in summer. These are usually guided trips and, based on the data in Table 5-5, number approximately 30-40 per season. Nahanni Butte residents also use this stretch of the river to travel to Blackstone Park where some keep vehicles, and for hunting trips along and from the river. According to the Navigation Protection Act (R.S.C., 1985, c. N-22) which was last amended on April 1, 2014 the Liard River is not classified as navigable since it is not listed in the Schedule to the Act.

TABLE 5-7: HIGHWAY #7 AVERAGE ANNUAL DAILY TRAFFIC

Kilometre	Counter Location	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
35	2.6 km south of Fort Liard	110	110	140	120	na	120	120	120	**	**
253	0.3 km south of Highway 1 & 7	50	50	30	30	na	30	30	30	30	30
Peak Summer Average Daily Traffic (June, July, August)											
35	2.6 km south of Fort Liard		**	**	130	**	130	130	130	**	**
253	0.3 km south of Highway 1 & 7		**	40	40	**	40	40	40	50	50

Values estimated and rounded to nearest 10

TRAFFIC ON HIGHWAY 7 AT FORT LIARD BY COUNTER (PRIOR TO 1999)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998			242	175	207	332	405	326	249			
1997	166	218	211	238					132	89		
1996		195	210				252	197	193	156		142
1995	172	366	339	213	220	209	255	297	220	172	135	134
1994	150	161	197	169	206			231	190	199	162	172
1993	155	165	166	170	180	204	211	193	180	171	162	146

NAHANNI BUTTE WINTER ROAD

	Open	Close	Total	Jan	Feb	Mar
1997	09-Dec-96	17-Apr-97	129	23	40	69
1996	01-Dec-95	25-Mar-96	115	11	10	19
1995	01-Dec-94	26-Mar-95	115	10	17	39
1994	10-Dec-93	26-Mar-94	100		20	10
1993	15-Dec-92	26-Mar-93	102		13	12

6.0 DEVELOPMENT DESCRIPTION

6.1 Project Rationale

CZN's current access road operating plans based on a winter road include early winter opening of the road from the Mine to the Tetcela Transfer Facility (TTF) at Km 84, roughly mid-way along the road to the Liard Highway, in order to start the haulage of concentrates to the TTF. This is imperative because of the volume of material to be moved in a limited and unpredictable time period. Concerns were raised in the EA process by Parks Canada and others regarding the ground being sufficiently frozen to support the weight of vehicles in early winter. Sufficient snow availability at this time of year for road bed construction was also a concern. If conditions are not favourable, road construction and opening could be delayed. CZN has considered these risks, and the data available indicate that road construction should be possible as planned in most years. However, the risk of seasonal delay remains, and this risk could change negatively in the longer term with the effects of climate change. Concern was also expressed during the EA regarding the road conditions through the mountains in winter, and the potential for spills and effective spill response.

The road bed from the Mine (Km 0) to Km 39 (Cat Camp) is already of all season quality. In addition, Cadillac's road LUP provided for all season use of that section. The majority of the remainder of the road to the TTF location is on solid ground with very little muskeg terrain.

For these reasons, CZN applied for permits to use the road in all seasons to the TTF. This will enable the year-round transport of concentrates to the TTF, and alleviate the concerns described above.

From an economic perspective, winter-only access unduly delays the receipt of any revenue generated by sales of the concentrate. This delay in revenue is a significant financial burden given the incurred operating cost of producing the concentrate and storing it at the Mine until the next winter road is operational. All season access would significantly reduce this problem, however the benefits will be partially offset by the anticipated significant capital cost to upgrade the access road. All season access could also promote other activities, such as increased tourism, and greater involvement of local aboriginal groups may occur. Also, with all season access, CZN could consider alternate, cheaper and more environmentally-friendly fuels to power the operation (such as propane or liquefied natural gas (LNG)) that are already being developed in the region. Therefore, in addition to applying for all season road use from the Mine to the TTF, CZN is now applying for all season road use from the TTF to the Liard Highway also, which when combined includes the entire road.

CZN wishes to obtain new permits to allow all season road use to the Liard Highway. Phase 1 construction would see the western portion of the road upgraded for all season use from the Mine to the TTF. A second airstrip would also be built on the Ram Plateau near the road to support road construction and maintenance, and to act as an alternate to the Mine strip in bad weather. Phase 2 construction would see the eastern portion of the road upgraded from the TTF to the highway. Construction of Phase 1 and Phase 2 could also occur concurrently, subject to

financing. Recent financial projections for mine economics indicate that the latter is both likely and necessary.

During EA0809-002, CZN advised that the mechanism for concentrate hauling to market was via the use of bulk bags. The use of bags would allow concentrates to be taken to the TTF for temporary storage, and subsequently re-loaded for hauling to the LTF. There, the bags would be re-handled onto larger trucks for the highway haul to Fort Nelson. Since the EA, some smelters have advised that they are not willing to accept bagged concentrates. Therefore, CZN is likely to use a containerized form of bulk concentrate transport. This approach would not be amenable to re-handling, and would require the whole road to be open before hauling commences. If this is the case, the relatively short winter road operating window would make it more likely that a full all season road (Phases 1 and 2) would be required in order to haul all of the concentrates produced that year to market.

6.2 Alternatives

Alternatives to the development were discussed in Section 3.3. This section considers the alternatives of the main project components within the development.

Access Road

As noted, the all season road would utilize the existing winter road alignment for the most part. This limits the opportunities and necessities regarding alternatives. It would make no sense to develop a new or different corridor, resulting in much greater land clearance and disturbance. A great amount of work went into the selection of the original 1980-81 winter road alignment and construction, and the re-alignments evaluated and approved during EA0809-002. Therefore, alternatives that were considered for the all season road are specific, localized areas proximal to the winter road alignment. These localized areas are discussed in detail in the Allnorth road design report, provided in Appendix 1. A brief summary follows, in west to east order:

- At Km 13.4, the road crosses two non-fish bearing tributaries of Funeral Creek. There is a tight hairpin turn which is difficult for trucks. Options were reviewed to widen the turn. One option consists of a higher elevation alignment combined with cuts and significant fills of the tributary crossing sections. This option would result in several km of new road alignment. Ultimately, the option selected was a slight shift of the existing alignment to the south, combined with slope cutting, and moderate filling of the eastern tributary section. This avoids the need for a significant length of new alignment;

- From approximately Km 24.5 to 28.5, a new alignment is proposed on the south side of Sundog Creek. The existing alignment to the north crosses talus slopes prone to ravelling and avalanche risk, and requires three crossings of the creek. The new alignment avoids the slopes and requires only one crossing of the creek, although a crossing of a major tributary is required;

- The winter road alignment from Km 29 to 39.5 crosses flat ground of the lower Sundog Creek floodplain, either on the south or north bank, and sometimes down the centre. The all season road alignment will remain on the south bank to avoid crossings of the main

channel, although channel re-alignment will be required in two places where the channel abuts rock bluffs;

- Some alignment modifications have been made to the previously approved, but not built Polje Re-alignment from Km 49 to 53.5. The modifications are to straighten the road where possible, and locate it on slightly firmer ground;

- Also on the Polje Re-alignment, from approximately Km 55 to 57, a slightly higher elevation alignment is preferred for better grades, and avoidance of a stream crossing and a tight turn;

- From Km 80.5 to 86.5, a more northerly alignment is preferred to traverse firmer ground;

- From the west side of the Tetcela River to Fishtrap Creek, a more southerly alignment was considered to reduce the Tetcela crossings from two to one and straighten the route. However, this option was rejected due to geotechnical concerns with the steep eastern bank of the river, although a more southerly route was adopted from Km 90.5 to 95 to take advantage of firmer ground and proximity to borrow sources;

- Some alignment modifications have been made to the previously approved, but not built, Wolverine Pass to Grainger Gap Re-alignment from Km 103.5 to 122.5. The revised alignment still avoids the valley bottom and wetlands, but is now proximal to borrow sources;

- A re-alignment is planned from Km 122.5 to 123.5 to avoid a swampy headland area of the Grainger River. However, the re-alignment necessitates a major crossing of the river at Km 123.5;

- Some changes are proposed to the previously approved, but not built Front Range Re-alignment from Km 126.5 to 159.5. The changes involve relatively small shifts of the alignment to take advantage of better ground, better stream crossing locations, and proximity to borrow sources.

Tetcela Transfer Facility

A proposed re-alignment of the road onto firmer ground necessitated a slightly modified location for the Tetcela Transfer Facility (TTF). Instead of being at approximately Km 84, the TTF will now be located at approximately Km 86. At the proposed revised location, the ground is still relatively flat and distant from watercourses, as before. The new location is also closer to borrow sources.

Regarding TTF design, despite footprint enlargement, the overall design will remain the same, except the proposed storage buildings will be longer in order to manage the increased capacity (see revised design in Allnorth's report in Appendix 1).

Airstrip

Several options were considered for a new airstrip location to replace the historical Cat Camp location. Two east-west alignments north of Km 45-49 were rejected because of concerns regarding cross-winds. Two more options north of Km 53-54 in the Polje Creek valley were rejected because of wet ground. Another two options a little further east on the edge of the Ram Plateau were considered to be candidates. The more western one of these two was selected as the preferred option following ground inspection.

6.3 Project Components and Activities

This section discusses project components and activities based on the list provided in Section 6.1 of the TOR. General answers to the list are provided in Table 6.1. The following text expands on these as necessary. Many of the answers are discussed in detail on Allnorth's design report in Appendix 1.

Equipment requirements are listed in Table 6-2. Depending on the construction model adopted for the road, the same equipment would be used for both phases of the road, as well as the TTF and Airstrip. If construction of Phase 1 of the road, the TTF and the airstrip is completed by a 'captive' equipment fleet based at the Mine, the fleet would likely be considerably smaller than that indicated.

6.3.1 Concentrate Containment

As noted above, the mechanism for concentrate hauling to market over the winter road in EA0809-002 was via the use of bulk bags. If Phase 1 of the all season road is built before Phase 2, including the TTF as part of Phase 1, then concentrate hauling to the TTF would occur year-round using bags. The same measures for avoiding concentrate dust and potential tracking of concentrate off-site will be adopted as described in EA0809-002 (i.e. bags clean on the exterior, bags hauled inside a trailer box with a tarpaulin cover, truck wheel-wash). The bags would be temporarily stored under cover at the TTF until the winter period when they would be collected by contractor trucks accessing the TTF from the highway. At that time, mine trucks would continue to haul concentrate, either to the TTF or to the Liard Transfer Facility (LTF) near the highway. If Phase 2 of the road is built subsequently, or at the same time as Phase 1 which is more likely, concentrates would be hauled directly to the LTF without re-handling or storage at the TTF.

Some smelters have advised that they are not willing to accept bagged concentrates. If CZN sends concentrates to such smelters (this is likely but dependent on prices at the time), CZN intends to use a containerized form of bulk concentrate transport, either in addition to or instead of bags. The likely form of the containers is shown in Figure 6-1. The containers are part of a custom-made trailer with a side-door opening mechanism, and top composed of a stretchable tarpaulin. This mode of bulk material transport is in wide use. Figure 6-1 shows a "Convey Ore unloading system". This system has been designed to maximize the payload transported while reducing overall maintenance cost and increasing reliability. A tipper table replaces hydraulic system on trucks used for dumping. The tipper will dump an entire truck load at once by tipping the unit on a 55 degree angle. The payload will be 40-50 tonnes.

TABLE 6-1: PROJECT COMPONENTS AND ACTIVITIES

	Activity	Access Road	TTF	Airstrip
1	Design standards	B.C. Forest Engineering Manual	National Building Code	Transport Canada for VFR approaches
2	land requirements (footprint, location, permanent or temporary, ownership, zoning)	See design report for footprint and locations. All footprints for life of project, except for borrow sources. Land used, not owned		
3	right of way clearing	Approx. 10 m more than winter road (20 m) in places plus stockpiles		
4	road construction methods	See design report	-	-
5	cut and fill estimates and plans for excess material disposal/storage	See design report	-	-
6	water crossing structures and locations	See design report	-	-
7	alterations to stream flow	None, except L Sundog	None	None
8	borrow source locations, quality and quantities, activities and methods (including gravel crushing)	See design report		
9	temporary winter or all season access roads to borrow areas	See design report		
10	camps, staging areas, laydown areas, access roads and other support facilities	See design report		
11	fuel storage and management	See design report		
12	explosives manufacturing, storage, transportation, and use	Temporary storage and limited use of stick-type explosives	None	None
13	toxic or hazardous materials to be used	Only liquid fuels		
14	equipment requirements (by phase)	See DAR text		
15	concentrate containment	See DAR text		None
16	solid, liquid, and gas waste management	See design report		
17	water use	See design report (and water sources from EA0809-002)		
18	wastewater treatment	See design report		
19	mobilization and demobilization (this should include a discussion of related activities and land requirements which are necessary for construction but not a part of the project)	See design report and DAR text		
20	frequency of vehicle and aircraft movement during construction	See DAR text		
21	routine maintenance activities	See design report		
22	expected traffic volumes and weights during all phases	See DAR text	-	-
23	clean-up and restoration of work areas during construction phase	See design report		
24	Reclamation	See design report and DAR text		
25	procurement and implementation approach	See DAR text		
26	training, employment and business opportunities	See DAR text		
27	ongoing operations and maintenance of the all season road (including access control)	See design report and DAR text		
28	Jurisdiction	Parks Canada & MVLWB	Parks Canada	

TABLE 6-2: EQUIPMENT REQUIREMENTS

#	Description of unit	Size classification
6	Dozers	D8T, D7R, D6N
4	Excavators	200 & 300 size
3	Graders	16H, 14H
2	Loaders	966H, 980H, 950, BM4600
6	Articulated Rock Trucks	A35D, 5350
2	Fuel Trucks	5 Ton
4	Service Trucks with enviro fuel tanks	1-2 Ton crewcab flat deck
2	Water trucks for road dust control	Water Tank Truck Tandem Axle
2	Mobile Fuel Storage Trucks	Fuel Truck on Tandem Axle
1	Tow tractor/drag tractor	8960 JD6WD tractor
30	Tractor/trailer units	Flatbed/lowbed
2	Tree mulchers	SK 200 TR mulcher
2	Rock Crushing Plan and Screening Plant	Finlay cone or jaw crusher and screener
2	Snow Plow Tandem trucks & sanders	Dump Trucks on Tandem Axle with snow plow or underbody plow
2	Emergency Transport Vehicles	3/4 Ton 4x4 pickup with Mobile Treatment Centre
2	Surveyor pickups	3/4 Ton pickup
1	Environmental Monitor	3/4 Ton pickup
1	Safety Supervisor	3/4 Ton pickup
2	Mechanics	2 Service Trucks (2-4 Ton)
3	Superintendent / Supervisors	3 Trucks 3/4 Ton pickup
8	Bridge Sub-contractor crew, including supervision	3 Trucks (1 Ton pickups with fuel), 2 Trucks (2-4 Ton)
3	Bridge Sub-contractor excavators	200 & 300 size
1	Bridge Sub-contractor crane / pile driver	
1	80 man camp with water well on site	25-30 trailer units depending on camp population
1	Mechanics Shop	Coverall Temporary Shelter
1	Camp Incinerator	Double chamber burn incinerator
4	Fuel Tanks for Gasoline and Diesel Storage	various sized double wall enviro tank for fuel storage
1	Sewage Lagoon	Fenced lagoon for camp sewage
1	Portable Warming Shelter	Wheeled trailer for field work
2	Generator and Heating Equipment	Gensets with double 1,000 gallon propane fuel tanks on skid

The trailers would be top-loaded at the mine. The tarpaulin tops are stretched over and latched on one-side. The tops are permanently anchored on the other side. The tarpaulin forms a tight seal with the trailer body, and is designed to shed water and prevent ingress. It will also prevent fugitive emissions. The side door will have a tight seal when closed, and is locked in transit.

FIGURE 6-1: BULK CONCENTRATE TRANSPORT AND CONVEY ORE UNLOADING SYSTEM

Bulk concentrate transport would not involve re-handling en route. The trailers would be filled at the Mine in a loading bay and travel directly to an unloading facility at the Fort Nelson rail-head. The truck and empty trailers would then return to the Mine for re-loading. During filling, dust suppression and wheel-wash approaches would be adopted as for bagged transport.

Concentrate hauling using containers would require the whole road to be open before hauling commences, and would not require use of the TTF.

6.3.2 Tetcela Transfer Facility

If constructed to manage bagged concentrates, and if Phase 1 of the road is built before Phase 2, the TTF would be enlarged from the version supporting winter road haul operations from the Mine to the highway. This is to accommodate storage of all of the concentrates between the closure of the last winter road from the TTF to the Highway to the opening of the next winter road. The sheds for winter road operations would be lengthened to create the additional storage, and the TTF would become the main concentrate storage location, as opposed to the Mine. A revised TTF design is shown in the Allnorth report in Appendix 1.

A dry storage shed may also be provided to store incoming materials. These would be brought in during the winter and mostly hauled directly into the Mine, however there might be a need to have some storage at the TTF to allow hauling to the Mine over the course of the following spring and summer.

During the winter period, fuel will be back-hauled into the Mine directly and there will be no need for temporary storage at the TTF. However, a truck fueling station with a 12,000 litre storage tank in a bermed and lined enclosure may be provided so that the mine fleet can fuel up at the TTF instead of at the Mine, thus avoiding the haul of that fuel into the Mine.

Because the TTF facility would be in operation all season, fire-fighting equipment and protocols will be in place.

6.3.3 Vehicle and Aircraft Frequencies

Vehicles

Construction

Table 6-2 indicates that construction activity would involve approximately 35-40 heavy vehicles/equipment, and approximately 10 light trucks. However, frequency of travel will likely be much less on a daily basis. Firstly, the intensity of road construction would be at a maximum if all of the fleet was in operation, and it is more likely that a lower intensity of construction would be adopted. Secondly, most of the vehicles would remain localized at the sites of construction, these being locations where road sub-grade or running surface material is being placed, where borrow is being acquired, and where bridges are being built. Travel between these locations, and the Mine and camps, will likely be mostly by the small support trucks.

Operations

The Mine will produce ~120,000 tonnes of concentrate per annum when the Mine is producing at maximum capacity. Therefore, approximately 330 tonnes will be produced daily. A conservative estimate of truck payload capacity is 40 tonnes. This would translate into approximately 8 trips/day. However, this is increased to 9 trips/day to allow for approximately 10% of the time when travel does not occur due to road maintenance issues (rockfalls, avalanches, wash-outs) or poor conditions (white outs or intense rainfall). For Phase 1 trips to the TTF, the trucks would return empty, unless they carry some supplies that were left in storage at the TTF.

Travel on the Phase 1 road to the TTF and back (~170 km) at a conservative average speed of 30 km/hour would take approximately 5.7 hours, say 6.5-7 hours including unloading, rest and turnaround. Haul trucks would likely operate in two or three shifts. A two shift operation would see 4-5 trucks making the return trip twice a day. A three shift operation would see 3 trucks making the return trip three times a day. The size of the haul fleet would depend on the number of shifts, but would be approximately 20-25% greater than haul needs to allow for break-downs and maintenance needs. Travel from the TTF to the LTF in winter would be the same intensity as indicated in EA0809-002 for winter road operations.

With the Phase 2 road built, concentrates would be hauled out of the Mine daily to travel the 175 km of the all season road and on to the LTF (Km 182) near the Liard Highway (Km 185), and subsequently to Fort Nelson (303 km of highway travel). Hauling will not occur during periods when crossings of the Liard River (Km 160) are not possible. At the Liard River crossing near Fort Simpson, the 10 year average (1998-2008) dates for ferry operation are May 13 to November 4 (157 days), and for ice bridge operation November 28 to April 21 (142 days). However, 60 tonne ice bridge crossings are only possible from January 15, and likely have to end before April 21. We can assume March 31 (75 days). This means 232 days for hauling (157 plus 75). However, this should be reduced by 10% to allow for days when travel does not occur due to road maintenance issues or poor conditions. Therefore, we can assume that 210 days are available for hauling at the normal capacity in an average year. Based on this, moving 120,000 tonnes of concentrate using trucks with 40 tonne loads would require 14.3 trips per day, say 15 given that an additional load could be hauled periodically, as necessary. Supplies would be taken into the mine on the back-hauls. Special deliveries would be in addition to this, such as explosives, but these would be infrequent.

Travel time from the Mine to the LTF and back at a conservative average speed of 30 km/hour would be approximately 12hrs. We can assume 13 hours with breaks and because in winter, tractor assist may be required to ascend the Silent Hills, and in summer there would be the barge crossing of the Liard River, which could be a bottle-neck. Travel from the LTF to Fort Nelson at 60 km/hour would take approximately 5 hours, 10 hours for a return trip.

Reclamation

Equipment requirements for reclamation are likely to be similar to those for construction, with perhaps fewer heavy equipment items because borrow is not being dug, hauled and placed.

Aircraft

The proposed airstrip in the Ram Plateau area is intended to support road construction and maintenance, and act as an alternate landing location if the Mine airstrip is not accessible. Table 6-3 provides an indication of expected flight frequencies. The flights related to the road are mainly for crew changes, but also could be related to providing spare parts. These flights would potentially be necessary because construction operations could be isolated from the Mine due to lack of road access. In any event, it would be more efficient to fly to the Ram strip rather than to the Mine and then drive either crew or parts to the construction location. Some of the indicated flights might be to the airstrip just east of Wolverine Pass. However, these are likely to be few since that strip would only be used in winter, as it was historically.

The number of flights diverted from the Mine, and thus landing at the road strip, was estimated by applying the percentage of flights typically delayed historically to the total number of Mine flights expected.

The flight frequencies indicated in Table 6-3 are those related to CZN's operations. The Ram strip would be available for use by others, either for emergency landings or planned tourism activities. These flights would be additional.

TABLE 6-3: FREQUENCY OF FLIGHTS TO ALL SEASON ROAD AIRSTRIP

Month	Mine Flights	% Flights delayed		Diverted Flights	Winter Road Flights	All Season Road Flights	
		0-24 hr	>24 hr			Construct	Maintain
January	20	15	15	6	8		
February	20	15	15	6	4		
March	20	15	15	6	4		
April	20	15	15	6			
May	20	10	10	4		16	4
June	20	10	10	4	2	16	4
July	20	10	10	4		16	4
August	20	10	10	4		16	4
September	20	10	10	4		16	4
October	20	15	15	6			
November	20	15	15	6			
December	20	15	15	6	8		
Total	**240**			**62**	**26**	**80**	**20**

6.3.4 Traffic Volumes and Weights

Traffic volumes are indicated in Section 6.3.3 above. The concentrate haul will be accomplished using a tractor-trailer combination specific to requirements. It could be a tandem tractor pulling a tri-axle flat deck trailer, a standard hi-boy or step deck 7 axle tractor/trailer, or a tractor towing two shorter, hinged multi-axle trailers. The GVW of these units is ~60-70 tonnes and they would haul ~40-50 tonne loads.

In-bound loads would be much less heavy, and many back-hauls could be empty apart from fuel because the total weight of annual supplies is ~25,000 tonnes.

The Mine will require approximately ~8,000,000 litres of diesel fuel per year. With fuel brought in on concentrate truck back-hauls, this equates to approximately 2,700 L/trip. The trucks will likely have dedicated tanks installed behind the cab or on the trailers for the fuel haul, with a maximum capacity of 10,000 L.

6.3.5 Staging Areas and the Liard Crossing

For Phase 1 of the all season road, no staging is necessary for operations since the haul from the TTF to the LTF is in winter, and the ice bridge will be open. However, staging might occur on the Liard River banks in the fall to barge equipment across, ready for winter road construction.

For Phase 2, staging will be necessary in summer because of the Liard River crossing. Staging areas are indicated in the Allnorth report. The travel of the 364 km round-trip from the Mine to the LTF and back should take 13 hours. Drivers based at the Mine should be able to complete a return trip in one shift. Shift times will creep forward on consecutive days until 7 days is reached when the driver must take a 36 hour break. If problems are encountered with this plan, an

alternative would be to stage trailers on one side of the river, or at the junction with the Nahanni access road, and have one of those locations as a transfer point (exchange of haul and back-haul trailers).

Hauling from Fort Nelson to the LTF and back at 50 km/hour would take approximately 12 hours. Therefore, it is assumed that Fort Nelson based crews would do the hauling with a day and night shift. This will mean slightly more than one truck per hour in either direction travelling on the highway on average.

It is unlikely that the same type of truck will travel on the Mine road and the highway. This is because gearing, tyres and potentially other items are likely to be different.

The location of the Liard River crossing is shown on Figure 1-2. The location is shown in more detail in Allnorth's design report in Appendix 1. Allnorth have produced proposed specific alignments for a seasonal ice bridge and a summer barge crossing. The latter includes ramps. Design details are provided in their report. The alignments are based on a bathymetric survey of the river channel in this area collected by Hatfield Consultants in September 2014. Hatfield's report on the survey is provided in Appendix 11.

6.3.6 Access Control

CZN is aware that the Nahanni Butte community is concerned that the all season road could be used by non-residents for hunting up to the NNPR boundary. For the winter road, a manned security 'check-point' is to be located where the winter road starts at the junction with the Nahanni Butte access road. The check-point will be manned by NDDB members who will record road use, and deter non-mine use. Signs will be posted advising road users that the land is the traditional land of the NDDB, and a request that the road not be used and that no hunting should occur. Signs will also warn of the dangers posed by frequent, heavy mine traffic. However, once built, the winter road will be a public road on territorial land, and access by the general public cannot legally be denied. The check-point would be continued for the all season road during the winter period.

In summer, a barge would operate on the Liard River crossing for mine traffic. The barge would be private, and so not available for public use. However, there is a concern that non-resident hunters could access the interior via the river using their own boats. In view of this, and the potential for circumvention of the check-point at the junction with the Nahanni Butte access road, the check-point will be moved in summer to a location on the road west of the river crossing. The intention is to locate the check-point further up the road where it cannot be by-passed by non-mine vehicles. The exact location will be chosen based on input by NDDB members.

Despite the above, CZN is pursuing other initiatives that would provide an additional deterrence to access. One option is a "no shooting" corridor, up to 1 km either side of the centre-line, established along the territorial portion of the road and enforced by Environment and Natural Resources (ENR) personnel. Such a corridor is currently in operation on the Ingraham Trail north of Yellowknife, and is intended as a safety measure for road users and residences near the road. Advice provided to CZN by GNWT representatives is that the corridor is effective in

limiting hunting. The premise would be that a no shooting corridor on the Prairie Creek road would deter hunting because vehicles would have to travel off-road beyond the 1 km corridor. However, there are some considerations. First, ENR maintain that the corridor would need to apply to all people, aboriginal and non-aboriginal, although a Band on the Ingraham Trail disputed this based on infringement of aboriginal rights. Second, the GNWT would have to agree to, and provide the necessary resources for, enforcement. We believe that NDDB members could be co-opted to assist with the enforcement, given that they will be manning the check-point, and staffing environmental monitoring of the road based on a previously agreed commitment by CZN. We have discussed this initiative with the Bands and government departments, and believe it is feasible. Currently, some NDDB members, the acting Chief and Council of LKFN, and Industry, Tourism and Investment (ITI) are in support. Engagement is continuing.

Another initiative CZN is interested in is having the land designated as private as part of a Dehcho land claims settlement. The road would then be private and could be legally gated. CZN would have a road use agreement with the NDDB or DCFN. This is the model adopted by Fortune Minerals for access to their Nico project in the Tlicho. The difficulty of this initiative is that the schedule of land claims settlement cannot be determined, although we understand progress is being made and there is optimism that a settlement may occur soon.

6.3.7 Procurement, Training, Employment, Business Opportunities

Training was discussed in Section 5.1. Local labour and business will be given preferential treatment when accessing jobs and goods and services contracts, for the Mine and the road. These and related commitments are set out in the IBA's with the NDDB and LFN, and in the SEA with the GNWT. CZN is required to post available employment positions with local Bands, and NDDB members have priority if they are suitable and available. CZN has also committed to give preference to competitive and able consortia with local and northern content for procurement and business opportunities. The priority hierarchy is NDDB first, LKFN second, next the Dehcho, then the NWT.

6.4 Road Design Considerations

The design of the road is described in the Allnorth report in Appendix 1. Since the all season road follows the general alignment of the permitted winter road, much of the information developed by SNC Lavalin and provided during EA0809-002 is also relevant. Some of the specific considerations listed in the TOR are discussed below.

The proposed road will not have runaway lanes. SNC previously determined that road grades are not steep enough to require them. The Allnorth road design has not increased road grades, and in cases has reduced them.

There will be no safety railings. Such railings would be ineffective in stopping trucks from leaving the road surface. Also, they are not considered to be necessary given the low vehicle volumes and slow speeds.

Geotechnical stability, landslide potential and avalanche risks (based on mapping by Alpine Solutions) have been considered by Tetra Tech EBA. Their findings were incorporated into the Allnorth road design, and can also be found in Appendix 2.

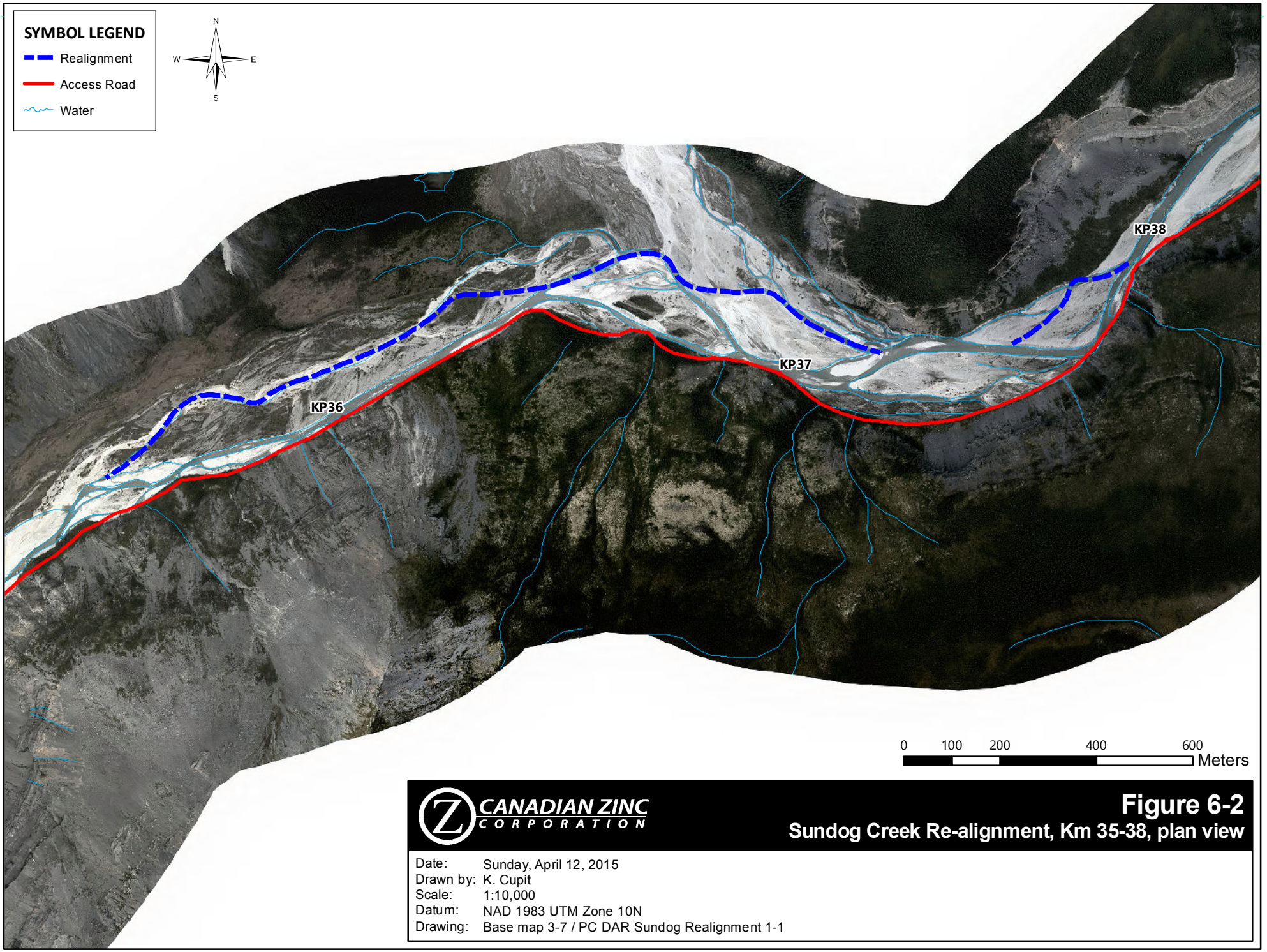
Watercourse crossing structures are described in the Allnorth report. There is a need to re-align Sundog Creek near Cat Camp. This is explained below.

Sundog Creek Re-alignment

From Km 29 to 40, the road traverses the lower Sundog Creek floodplain. The current winter road alignment is located generally in the central part of the floodplain, and would result in multiple creek crossings in summer. For the all season road, CZN plans to maintain the alignment on the south edge of the floodplain, thereby largely avoiding contact with active creek channels. However, between Km 35.1 and 37.9, there are a number of locations where a creek channel is close to, or abuts, the south edge of the floodplain against either steep talus slopes or rock bluffs (see Figure 6-2). A habitat assessment of this area was completed by Hatfield Consultants. Their report is provided in Appendix 10. At Km 35.1, the road will need to have heavy armour for protection from the adjacent channel, but from Km 36 to 36.3, 37 to 37.2 and 37.7 to 37.9, the channel is against the bank and will need to be re-aligned.

Sundog Creek in these locations has a large floodplain and the location of the active channels changes from year to year. It is possible that natural changes to flow over time would remove the current active channel along the cliff face. There are a number of old channels in this area. Our plan is to "train" the creek to flow in one of the old channels away from the south bank. Figure 6-2 shows the proposed new creek alignment after training. The fish habitat against the south bank will be lost, but would be replaced by comparable new habitat to the north.

Training would be accomplished by deepening an old channel by excavation, and placing the excavated material in the existing channel. This work would be completed in the late fall when the floodplain is dry apart from isolated deep pools. Any pools would be subject to fish salvage before filling. In order to ensure the excavated channel remains open and utilized long-term, a series of very large (small car-size) boulders would be placed in the channel. Spring flows will scour around the boulders and create deep pools, re-creating the pools that exist on the south bank. The boulders should also ensure the trained creek stays in the channel. An additional benefit of placing large boulders here is that they would provide refuge habitat (back eddies). Figures 6-3 and 6-4 show oblique photos of these areas and where the new channels would be located relative to the current channels. This approach was discussed with a professional hydrologist, who confirmed that it is feasible.



CANADIAN ZINC CORPORATION

Figure 6-2
Sundog Creek Re-alignment, Km 35-38, plan view

Date: Sunday, April 12, 2015
Drawn by: K. Cupit
Scale: 1:10,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-7 / PC DAR Sundog Realignment 1-1

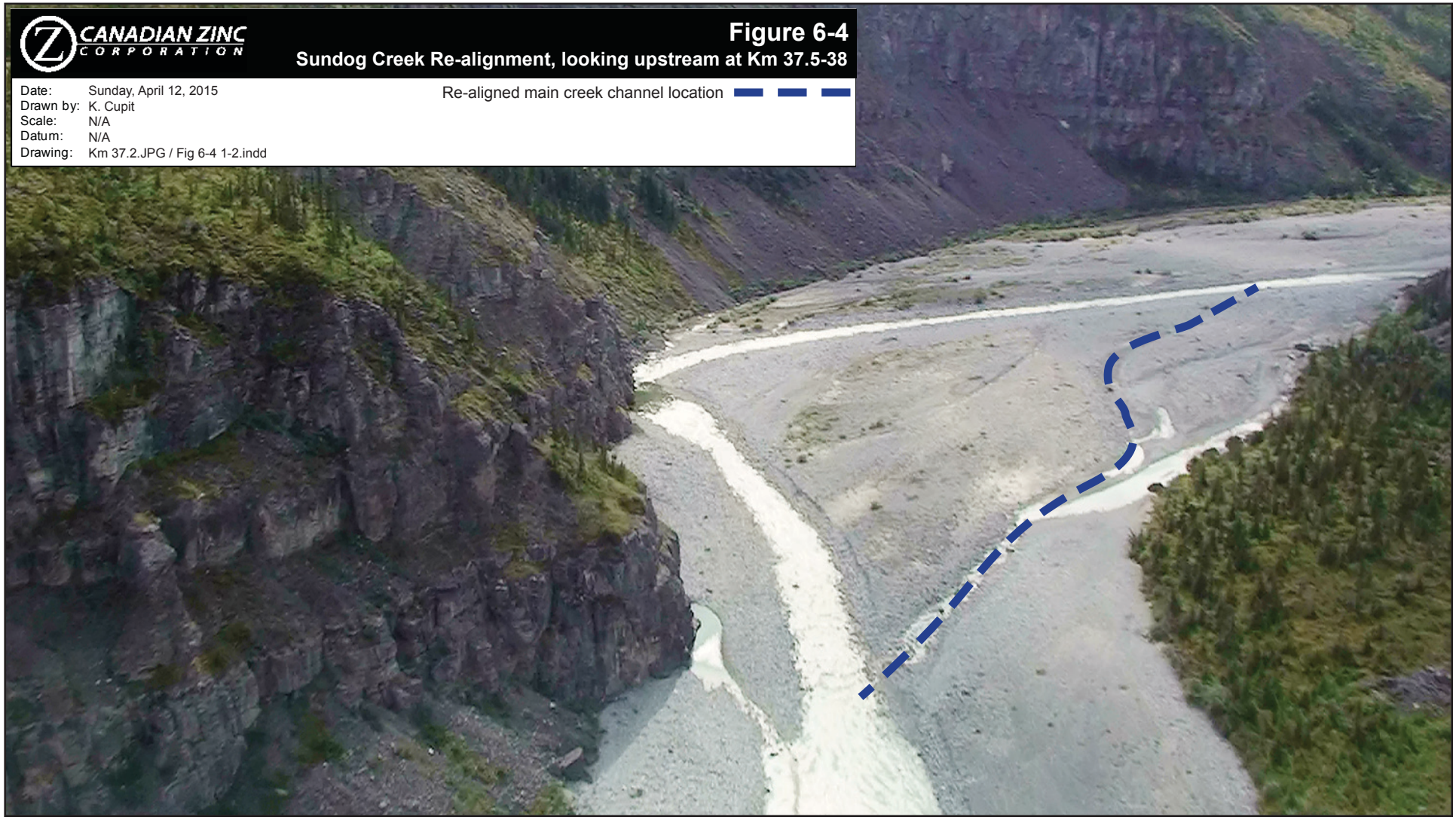

CANADIAN ZINC
CORPORATION
Figure 6-3
Sundog Creek Re-alignment, looking upstream at Km 35.5-36.5
Date: Sunday, April 12, 2015
Drawn by: K. Cupit
Scale: N/A
Datum: N/A
Drawing: Km 36.2.JPG / Fig 6-3 1-2.indd
Re-aligned main creek channel location

CANADIAN ZINC CORPORATION

Figure 6-4

Sundog Creek Re-alignment, looking upstream at Km 37.5-38

Date: Sunday, April 12, 2015
Drawn by: K. Cupit
Scale: N/A
Datum: N/A
Drawing: Km 37.2.JPG / Fig 6-4 1-2.indd



6.5 Construction Phases and Schedule

There are at least two general approaches that could be taken regarding all season road construction. One would be to build the road on an aggressive schedule with a pre-determined completion date. Another would be to work on the road over several years, taking advantage of more favourable weather and ground conditions. Given the overall nature of CZN's mine development plan, and the expected longevity of the Mine (>20 years), the latter approach is most likely to be adopted. Mine construction and the initial years of mine operations would be based on a winter road. Work on the all season road could continue over this period, and after it, given that revenues from concentrate sales will likely be needed to enable funding of the considerable cost of road construction. As such, it is likely that there would not be a pre-determined schedule for road completion, since it would be dependent on financial conditions.

In the Allnorth report in Appendix 1, Table 5 lists optimal road construction seasons by road section, and optional seasons. For most road sections, the optimal construction season is summer or early fall when conditions are generally dry. This period is essentially mid-June to September. Optional seasons are dry fall and winter with low snow cover. This period would be September to December, depending on snowfall. Winter construction is preferred for two road sections, Km 90-96.5 and Km 150-175.3, however, construction in dry summer conditions is optional for these sections. Therefore, the period not preferred for road construction is April to mid-June, the period covering freshet. Note that depending on the snow pack, and prevailing weather conditions at the time, spring conditions could be suitable for road construction, with appropriate precautions in proximity to fish-bearing streams.

Regarding spawning, fish-bearing streams crossed by the road dominantly host grayling, which spawn in the spring. Northern pike also occur in the Tetcela and Grainger Rivers, but these are also spring spawners. This coincides with the period of construction inactivity. The only system with a greater diversity of fish potentially present at road crossings is the Tetcela River. The river hosts lake chub and long nose suckers, but these are also spring spawners. The river also hosts whitefish, which spawn in the fall or winter, and burbot which spawn in winter. Summer, fall and winter construction of river crossings, with necessary precautions regarding in-stream work and standard silt control measures in riparian areas, should be possible without fish spawning impacts.

All season road construction could occur at both ends of the road, potentially at the same time. Construction crews would have access to facilities and supplies (the Mine and a camp east of the Liard River). Construction from the Mine would mean that the construction equipment would be captive at the Mine end. Equipment would also be captive at the eastern end of the road, unless it is removed at the end of winter and returned by barge after spring. Because of the nature of the equipment required, and its cost if it is captive and not in use, it is more likely that construction will start in the east and progress westwards, particularly if the whole road is to be built (Phases 1 and 2).

The winter road would be used to transport culverts, bridge components and any other non-local materials to the approximate locations of need. Only the materials required for the following summer-fall construction season would be brought in each winter.

Allnorth recommends that construction of the Km 90-96.5 and Km 150-175.3 section subgrades occur in winter. However, they also recommend that placed subgrade be left for a full summer season prior to top layer (gravel) placement for all sections east of Km 40 to allow for settling and drainage. This means a general preference for subgrade placement outside of the summer period. In winter, the winter road will be in operation, and will need to be coordinated with the all season road construction. Trucks will be able to drive on frozen subgrade. Detours around active construction areas may need to be maintained so road operations are not inhibited.

Table 6-4 provides a construction schedule for concurrent construction of Phases 1 and 2 of the road. The main assumption is that subgrade is placed first, then after one whole summer season, the top layer is placed later. Bridges are installed after the subgrade, and can be installed before the top layer. Bridge installation could occur in any season with the appropriate precautions. Bridge spans could be launched onto temporary footings, allowing access to both sides of a stream, and then placed on long-term footings later. Spans might be placed on the temporary footings in winter from the winter road. For some locations and circumstances, the contractor may apply to have a limited equipment ford of a crossing outside of the winter period.

TABLE 6-4: SCHEDULE FOR CONCURRENT CONSTRUCTION OF PHASES 1 AND 2

Year	Season	Activity
1	Fall or winter	Subgrade construction from the Nahanni access road to the Liard River
		When the ice bridge is in place, construct NW and SE landing areas adjacent to Liard River
		Open up borrow pits BP 159A, 158 or BP 151.
		Bulk store required borrow material (gravel, coarse rock, rip rap, etc.) at both landing locations
		Construct subgrade from Liard to Grainger Gap
		Store adequate fuel & equipment on NW side of the Liard for summer construction of road approach
	Summer	Complete NW and SE Liard barge ramps
		Top layer construction from the Nahanni access road to the Liard River
2	Winter	Subgrade construction Grainger Gap to Km 86
	Summer	Top layer construction from the Liard to Grainger Gap
		Install Grainger River bridges (3)
		Top layer construction from Grainger Gap to Wolverine Pass
	Fall	Subgrade construction of Silent Hills switchbacks (unless already completed for winter road)
3	Winter	Install Tetcela River bridges (2)
		Subgrade construction Km 86 to Km 40
		Stockpile borrow material from BP 47 A, B
	Summer	Top layer construction from Wolverine Pass to Km 40
		Install Polje Creek bridge
	Fall	Construct lower Sundog Km 40 to the Mine including Sundog bridge installations (4)

If only Phase 1 of the road is to be built, the schedule would start with the Year 3 subgrade construction from Km 86 (the TTF) to Km 40. Subgrade is not deemed necessary from the Mine

to Km 40 due to the existing all season condition of the road base. Work on the lower Sundog channel re-alignment would be completed in the fall when significant stretches of the creek are typically dry, and the only fish present are limited numbers of grayling associated with deep pools. Irrespective of whether the whole road or just Phase 1 is built, some road construction from the Mine end is likely using the existing mine fleet of dozers and trucks. Note that Sundog Creek is potentially fish-bearing only to the large waterfall at Km 25.

6.6 Existing Infrastructure and Facilities

Road Construction

During road construction, the Liard Highway and Nahanni Butte access road will be used by the equipment listed in Table 6-2 to access the road, potentially on an annual basis for 3 years or more, and service vehicles to provide supplies and for crew changes. Traffic on the Liard Highway is currently approximately 1 vehicle/hour in winter, 2 in summer (Table 5-7). Road construction traffic will likely cause this to double on average during the periods of mobilization and demobilization, but during construction, the increase will probably be only 10-20%. Traffic on the Nahanni Butte access road is currently approximately 1 vehicle/hour in winter. Traffic volumes in summer are unknown, but are probably less in the absence of an ice bridge over the Liard River. Road construction traffic will likely also cause this to double on average during the periods of mobilization and demobilization. During construction, the increase may be up to 50%.

Depending on the locations of construction, the existing airstrips at the Mine and Nahanni Butte may be used occasionally for crew changes. These flights are likely to be small planes, up to the size of a Twin Otter, carrying up to 20 people. A fraction of the number of flights indicated in Table 6-3 for road-based strips would then divert to the Mine and Nahanni strips.

Road Operations

In Section 6.3.3 it was noted that, during mine operations, the number of mine vehicles using the Nahanni access road and Highway #7 will likely be approximately just over 1 per hour in either direction, including concentrate haul trucks and special deliveries. This frequency is marginally more than the current volume on the highway in winter, but less in summer. Therefore, highway traffic will roughly double in winter, and be approximately 60% higher in summer. The Mine traffic will similarly cause approximately a doubling of traffic on the 10 km section of the Nahanni Butte access road to the highway. Note that this traffic will be using this infrastructure during winter road operations. The difference is that the same Mine traffic would use the Nahanni access road in winter and summer, as opposed to winter only i.e. a lower frequency for longer. Traffic on the highway will not change between winter road and all season road operations. It is currently the intention to have winter and summer concentrate haulage on the highway from the LTF with winter road operations.

Depending on the locations of road maintenance and inspections, the existing airstrips at the Mine and Nahanni Butte may be used occasionally. These flights are likely to be small planes, up to the size of a Navajo, carrying up to 5 people. A fraction of the number of flights indicated in Table 6-3 for road-based strips would then divert to the Mine and Nahanni strips.

Use of the LTF would be the same as for the winter road because the traffic will be the same.

Capacity of Existing Facilities

In terms of the public roads, they are generally under-utilized and have the capacity to support much higher usage. However, the condition of the roads is in question. Highway #7 is known to have road bed issues, leading to closures periodically in the spring, and also weight restrictions. Local communities have been vocal regarding the poor condition of the highway. A copy of an article is provided in Appendix 12 which provides some relevant background. The article indicates that the community of Fort Liard do not use the highway significantly to travel north, preferring to travel south to BC. It is clear that the NWT Department of Transportation (DOT) is aware of the road issues. An engineering study was completed to assess repair requirements, and as the article indicates, some repair work was completed. CZN has also spoken to DOT regarding the state of the road and a need for improvements to support mine operations. The GNWT recently announced that $30 million will be set-aside for highway improvements over 10 years.

The increased use of existing airstrips will be very small considering their current use, and no changes are necessary.

6.7 Existing Management Plans

Monitoring and management plans for the permitted winter road are specified in LUP's from Parks Canada and the MVLWB. For the most part, these formalize the draft plans that were submitted during EA0809-002. Therefore, a draft of most of the plans already exists. In some cases, a revised draft has been submitted for review since permits were issued. None of the plans have been deemed complete as yet because either a draft has not been provided for review, or the review process has not been completed. The specific plans are listed below with appropriate comments.

Spill Risk Analysis Plan: A draft of this plan has not been provided although a spill risk analysis was completed during the EA. The plan will need to be reviewed for the all season road to consider applicability to summer conditions.

Spill Contingency Plan: A draft of this plan was provided during the EA, but a revised draft has not been provided since permitting. The plan will need to be reviewed for the all season road to consider applicability to summer conditions.

Quarry Management (Aggregate Site) Plan: Quarry management plans are required by the MVLWB, and Aggregate Site Plans by Parks Canada. No plans have been provided to date. We assume such plans will be required for each borrow location.

Sediment and Erosion Control Plan: A draft of this plan was provided during the EA, but a revised draft has not been provided since permitting. The plan will need to be reviewed for the all season road to consider applicability to summer conditions.

Road Operation Plan: A draft of this plan was not provided during the EA, but the information that will largely make up the plan was. The plan will need to be reviewed for the all season road to consider the lower intensity of traffic and commensurate road management requirements.

Construction, Operation and Maintenance Plan: A draft of this plan has not been provided. The plan will need to be reviewed for the all season road to consider the different construction, operation and maintenance requirements.

Interim Closure and Reclamation Plan: A draft of this plan has been provided for Water Licences, but not for LUP's. The plan will need to be reviewed for the all season road to consider the different closure and reclamation requirements.

Waste Management Plan: A draft of this plan was provided during the EA, but a revised draft has not been provided since permitting. The plan may need some revision for the all season road but should be largely applicable.

Wildlife Mitigation and Monitoring Plan: A draft of this plan was provided during the EA, but a revised draft has not been provided since permitting. The plan will need to be reviewed for the all season road to consider the modified traffic frequency and applicability to summer conditions.

7.0 PUBLIC ENGAGEMENT

7.1 Engagement Methods

CZN has a long history of communications with the affected parties. Since the inception of the MVRMA in 1999, CZN has had many formal and informal meetings related to its numerous Land Use Permit and Water Licence applications. The majority of these applications to the MVLWB were subsequently forwarded to Environmental Assessment. Additional meetings were held, both within the affected communities and region. CZN has had a regional office in Fort Simpson for many years, led by Wilbert Antoine as CZN's Manager of Northern Development. Mr. Antoine has assumed the main community interaction function on behalf of CZN and has a great amount of experience in mining.

CZN worked with the NDDB to set up community liaison. When CZN negotiated a memorandum of understanding (MOU) with the NBDB in 2008, and later an IBA in January 2011, one component of it was an agreement that CZN would nominate a community liaison representative (Mr. Antoine) and the NDDB would hire a liaison representative. George Betsaka initially filled this role for the NDDB, until it was assumed by Jim Betsaka. CZN had a designated contact person in their head office (Vancouver). CZN has a toll free number, and Dehcho residents can call the head office directly. Many of the local communities' immediate concerns have been addressed this way. The main method of daily communication is via telephone and meetings. The NDDB liaison position is currently vacant.

Engagement with government and regulatory agencies is a shared responsibility. CZN's VP Environment and Permitting Affairs, David Harpley, is in regular contact with the MVLWB, MVEIRB, GNWT (ENR and Lands) and Parks Canada (Fort Simpson). CZN's VP Corporate Development, Joseph Lanzon, is in regular contact with the GNWT (ITI) and Parks Canada (Ottawa), as well as the DCFN Grand Chief.

CZN negotiated and signed an IBA with the LKFN in June 2011. Mr. Antoine is also an LKFN member, and regularly updates Band members on CZN's activities and progress.

Some Band members from Nahanni Butte and Fort Simpson have been employed at the Mine seasonally for many years in relation to site care and maintenance and exploration activities. This has provided local employment, but is also a mechanism for carrying information back to the communities regarding company and site activities.

Over the past 20 years, CZN has provided numerous tours of the Mine site for local communities, and various governmental agencies. CZN strongly encourages these tours in order for people to experience the site first hand and for them to fully understand what is there. CZN has found many prior misconceptions about the project are cleared up upon such visits. In addition, many government officials and the MVLWB and MVRB have toured the Mine.

CZN views itself as a valued member of the community and maintains a visible presence by sponsoring events and attending regional functions. CZN has sponsored the annual Canadian Zinc Open in Fort Simpson since 2003. The golf tournament is usually held over a weekend in early August. The community regard this as one of the highlights of the year, and the event is

attended by CZN executives. An annual Winterfest is held in Nahanni Butte, usually in late January. CZN provides food and prizes, and activities are held involving all ages. The first Winterfest was held on January 26, 2010. The event is often an opportunity for CZN to also meet with the community to discuss progress made on the project, and future activities and issues.

7.2 Engagement Summary

7.2.1 Pre-Application Engagement

Over the past 20 years, CZN has expanded dialogue with local groups, including the Dehcho First Nations (DCFN), Acho Dene Koe Band (ADK, Fort Liard), Sambaa K'e First Nation (SKFN, Trout Lake), Jean Marie River First Nation (JMRFN, Jean Marie River), Village of Fort Simpson, Parks Canada (Parks-CZN-DCFN Technical Advisory Committee), local businesses, and various territorial and federal government agencies. Considerable engagement occurred before and during the application, EA and permitting processes for mine operating permits (see engagement log in Appendix 26 of the EA0809-002 DAR).

Before CZN submitted applications for all season road permits, CZN explained the intention to submit applications during meetings held with the community of Nahanni Butte (including the acting Chief and some Band councillors), the Chief and Council of LKFN, the Grand Chief of the DCFN, the Chiefs of ADK, JMRFN and SKFN, and the President of the Fort Simpson Metis Nation. Engagement records for these meetings are provided in Appendix 13.

7.2.2 Post-Application Engagement

EA scoping meetings were held in Nahanni Butte on June 9, Fort Liard on June 10, and Fort Simpson on June 11, all 2014.

On November 28, 2014 CZN participated in a community meeting with the NDDB in Nahanni Butte, and a meeting with the Chief and Council of LKFN in Fort Simpson. CZN provided an update on activities, and progress made with the EA process and studies for the all season road. Specifically, CZN discussed options to control access in regards to use of the road by non-resident hunters, an issue of significant concern for the NDDB. On January 20, 2015 at the time of Winterfest, CZN participated in another community meeting with the NDDB in Nahanni Butte, which was essentially a repeat of the November meeting. The access control issue was discussed again, as well as enhanced tourism potential related to the road. Engagement records for these meeting are provided in Appendix 13. CZN also had a dinner meeting with the Chief of the NDDB and their legal and environmental advisors on January 22, 2015 during which the subject matter of the recent community meeting was discussed, and options for controlling access were considered in detail.

Over the same period noted above, Messrs. Antoine and Lanzon have kept the Grand Chief and other Band chiefs informed of recent developments through informal face-to-face and telephone conversations.

The Parks Canada – CZN – DCFN Technical Advisory Committee has met three times since submission of the all season road permit applications, on June 5, August 17 and November 28, all 2014. The EA of the all season road was discussed, amongst other matters.

7.3 Traditional Knowledge Information Collection

For EA0809-002, CZN participated in a traditional knowledge (TK) program undertaken for the NBDB by Crosscurrents Associates Ltd (Crosscurrents). Crosscurrents had already documented relevant TK information. During two meetings in Nahanni Butte, CZN provided details of the mine project, and the NDDB provided comments and concerns. This information was subsequently summarized by Crosscurrents in a TK Addendum Report dated August 2009 which is on file with the MVRB. The addendum report has non-confidential and confidential portions. CZN received a full copy after signing a confidentiality agreement with the NDDB.

On January 20, 2105 after Winterfest in Nahanni Butte, CZN met with elders and harvesters to acquire data and answers to fulfill the commitments of the TOR. Some of the questions related to historical climate conditions, stream flows, harvesting locations and results, and camp site and grave locations. The TK information received is summarized in the relevant section of this assessment report. Table 7-1 indicates the TK items, and how and where they were used in the report.

TABLE 7-1: USE OF TRADITIONAL KNOWLEDGE

Traditional Knowledge Item	DAR Section	
	Used In	How Used
Climate change.	4.2	Baseline climate section.
Species at risk abundance, types and habits	4.4	Baseline species at risk section.
Fish abundance, types and locations.	4.5	Baseline fish section.
Wildlife abundance, types and locations.	4.6	Baseline wildlife section.
Overview of what animals were harvested, where and when, how harvesting patterns have changed from previously to now.	5.2	Traditional harvesting baseline.
Where traditional activities were undertaken and the location of camps.	5.3	Baseline cultural and heritage resources section.
The number of aboriginals deriving income from traditional activities, and what proportion that is of total income.	5.5	Baseline economics section.
Collection of TK.	7.3	TK Information Collection Section.
Additional information on harvesting that has and is occurring in the area.	8.1	Harvesting effects assessment
Appropriate approach for finding and protecting heritage resources.	11.9	Cultural and heritage resource effects assessment.

7.4 Future Engagement

Future engagement with aboriginal groups and government agencies will continue as described in the Engagement Plan submitted with CZN's applications for all season road permits. A copy of the plan is provided in Appendix 14.

CZN has and is continuing to engage with local First Nations and government agencies during this EA process. The main issue of local concern is access control, given the risk of road use by non-resident hunters, which represents a safety concern and could lead to negative effects on

wildlife and traditional harvesting. We have discussed in this document initiatives to control access, including signs advising that the road is used by heavy vehicles and is the territory of the Naha Dehe Dene Band, operation of a security check-point west of the river, and the fact that, in summer, the barge crossing the Liard River would be private. The concern is that this may not be sufficient to deter some non-resident hunters, and that they might use their own craft to cross the river. Therefore, CZN is pursuing additional options to restrict road access to authorized users. One option is the adoption of a "no-shooting" corridor along the territorial portion of the road from the Liard Highway to the NNPR boundary. However, this requires multi-party collaboration and agreement. CZN is proposing to hold round-table discussions with local groups and government representatives on this issue, and others, in the near future, and will report on the progress made as the EA continues through the analysis phase.

8.0 EFFECTS ASSESSMENT – TRADITIONAL HARVESTING

Sections 8.1-8.10 below were extracted from the Tetra Tech EBA report in Appendix 7.

8.1 Current Knowledge on Harvested Wildlife and Harvesting Areas

The following is an excerpt from the DAR (CZN 2010) outlining the information from the Traditional Knowledge Assessment Report Addendum and Mr. Konisenta regarding harvested wildlife and important harvesting areas:

Mr. Konisenta information:

- Caribou: Traditional harvesting used to include caribou, particularly in the early 1960's. Some animals were harvested in the Second Gap area. However, no caribou have been harvested for approximately 20 years;
- Moose: Harvesting of moose used to be common. Harvesting occurred near Nahanni Butte, around the Swan Point area (along the Liard River, approximately 6 km downstream from the proposed Liard River crossing) and along the Liard Highway. In the fall, members would also travel up the South Nahanni River to the 'flats' to hunt moose. Harvested numbers were plentiful, numbering 25-30 animals in some years. Members did not need to travel too far to find moose, and could use the available access routes. Moose numbers have dwindled, and Moose are now rarely found along the easy access routes. Mr. Konisenta attributes this partly to the introduction of bison to the area;
- Dall's Sheep: Members used to harvest a few Dall's sheep annually from the Nahanni Range in proximity to the village. None are harvested now; and
- Furbearers: Trapping used to be very common in the Liard River lowlands, and west of the Nahanni Range to the Wolverine Pass area. Animals trapped included Lynx, Mink, Marten, Wolverine, Fox, Beaver, and River Otter. In 1978, about 600 Marten were caught. However, there has been no trapping for six years because of a combination of fewer animals, lower pelt prices, and rising costs (fuel for skidoos). Trapping was also common in the Yohin Lake, lower Fishtrap Creek and Netla River areas. Trapped animals were mainly Marten, Beaver, and Muskrat. Between 30 and 50 animals were trapped in good years. This trapping has also dwindled, but still occurs periodically because of the easier access.

Traditional Knowledge Assessment Report Addendum:

- Lower portion of the South Nahanni River valley: is a rich ecological area, well utilized for harvesting, and an area of high traditional occupancy. River travel allowed access from late spring, after break-up, through to the fall.
- Deadman Valley: located at the confluence with Prairie Creek and the South Nahanni River (at least 25 km from the all season access road). High traditional use area for hunting Moose and Dall's Sheep. The sheep licks (mineral licks), near the confluence, are hunted, particularly in the fall. From here, people also travelled up Prairie Creek to set trap lines.

- First Canyon: located approximately 14 km downstream from the Prairie Creek-South Nahanni River confluence. Most hunting is carried out while travelling up the river, keeping an eye on the lower edges of the valley for sheep.

- Lower South Nahanni River and surrounding wetlands (referred to as the Splits): High quantity of traditional place names indicating high use within living and recent generations. There is an abundance of harvested species (e.g., Moose, Beaver, and Dall's Sheep) here, as well as tributaries providing access to additional critical harvesting areas to the north and south, including Yohin Lake and Fishtrap Creek.

- Tetcela River, Fishtrap Creek, and Bluefish Creek valleys: Although documented use of traditional harvesting and traditional trails throughout the region, and likely along the entire all season access road (as overland travel was common), these wetland valleys received the heaviest traditional use. A settlement was once located at Fishtrap Creek, and harvesting occurred throughout the area including winter trapping for Beaver, Cross-fox, Lynx, Marten, Mink, Wolverine, Grey Wolf, Woodchuck, Squirrel, Weasel, and Ermine, and spring harvesting of migratory birds as well as Beaver. Moose were also harvested, as they were known to overwinter in this valley area. The plateau areas were specifically used during the winter months as key travel corridors to the north towards the North Nahanni River, Cli Lake, and the pass through the Nahanni Range to Little Doctor Lake, and as a trap line for Beaver, Lynx, Marten, Muskrat, Grey Wolf, Wolverine, Cross-fox (i.e., Red Fox), and Mink.

- Nahanni Range: prime harvesting area for Dall's Sheep, likely due to the presence in the area of a sheep lick. Sheep are seen all along the high country and at Second Gap, particularly in the summer. In the spring, they calve in the area. The sheep stay on top of the mountains during the winter where snow is absent.

- Grainger River watershed from Nahanni Range Second Gap to the Liard River (lower portion of the all season access road): the area is relatively flat and dominated by wetlands and mixed forest cover. A known mineral lick occurs here (Moose lick hill). This area is particularly good habitat for beaver and for woodland caribou, which are known to be in the area at different times of the year, particularly along the lower levels of the Nahanni Range in the spring time. It appears that the caribou move down into the lowlands for the winter, where moose are also found. This area is known for extensive traditional use of the lowland area between the Nahanni Range and Liard River, particularly for trapping and big game harvesting purposes, most of which would occur during the winter. Along with Woodland Caribou, Moose, and Dall's Sheep, the furbearers traditionally harvested in this area include Beaver, Lynx, Marten, Muskrat, Grey Wolf, Wolverine, Cross-fox, Mink, and Weasel. Spring hunting expeditions also occurred into the area.

At present, little harvesting, including hunting and trapping activities, occur proximal to the all season access road due to restricted access. Harvesting areas near the all season access road are assumed to be principally associated with the Liard and South Nahanni rivers, as well as the Liard Highway that provide access to immediately adjacent lands.

Based on fixed kernel analysis of these lifetime harvest sites, Boreal Caribou are harvested primarily near the communities including a small harvesting area north of the Liard River near Nahanni Butte and the southern portion of the proposed all season access road (Gunn et al. 2004).

In 1984, Parks Canada reported hunting across the southern Mackenzie Mountains have been minimal to non-existent, and concluded that the hunting pressure inside the NNPR boundaries was very low and did not pose any adverse effects to wildlife populations. Harvesting inside the original boundaries of the NNPR were reportedly "minimal to non-existent", with hunters accessing the park along the South Nahanni River (Parks Canada 1984). Inside the NNPR boundary, year round hunting and trapping activities were concentrated along the eastern most boundary closest to Nahanni Butte and into Yohin Lake, seldom occurring beyond the entrance to the First Canyon (approximately 14 km downstream from the Prairie Creek-South Nahanni River confluence) (Parks Canada 1984). However, Parks Canada wardens reported occasional summer hunting and trapping excursions further into NNPR as far as Virginia Falls, and Dall's Sheep were occasionally harvested from the Prairie Creek mineral licks (at the confluence with the South Nahanni River) (Parks Canada 1984).

There are historical trap lines near the all season access road at Grainger Gap. A NDDB member (R. Vital) has a cabin on the west side of the Gap. The next nearest trap line is to the south of the Liard Highway in the Arrowhead Hills (pers. comm. Steve Gooderham November 24, 2014). Local area trapping and subsistence harvest data are unknown.

8.2 Effects to Harvesting and Harvesting Areas

The alignment of the Prairie Creek all season road will generally follow the winter access road alignment, which was modified to address concerns from the Naha Dehe Dene Band about wildlife issues and from Parks Canada regarding re-routing around the unique polje karst features. The permitted winter road (and likewise this proposed all season access road), was re-routed from the original 1980's winter access road to avoid environmentally and culturally sensitive areas identified through consultations.

Current harvesting is restricted in the area of the proposed all season access road, with the winter access road allowing for winter access only. During the EA for the new winter road, the Naha Dehe Dene Band considered the potential impacts on their harvesting activities in the areas in and around the seasonal access road. They are of the opinion that the winter road has the potential to improve their harvesting activities because of the improved access. This is the greatest impediment to their harvesting at present. Although traditionally important, little harvesting, including hunting and trapping activities, is assumed to occur at present any distance beyond the Liard and South Nahanni rivers. Harvested species and general harvest levels are assumed based on information provided by Mr. Konisenta and the Traditional Knowledge Assessment Report Addendum.

Boreal Caribou subsistence hunts and furbearer trapping occur primarily in the winter. The existing winter access road provides access to suitable furbearer and Boreal Caribou range; therefore, the all season access road is considered to provide little additional benefit to winter harvest and trapping activities in terms of facilitation of traditional harvesting. With the development of the proposed all season access road, year round access will allow harvesting of other species that have previously been limited (e.g., Northern Mountain Caribou, Moose, Dall's Sheep). However, this must be counter-balanced by the concern that improved access will encourage hunting by non-residents, considered in the next section.

With the addition of the proposed all season access road, harvesters could access the surrounding area on a year round basis, providing an economic and cultural value to the members of the Naha Dehe Dene Band until closure of the access road (Table 8-1). The Naha Dehe Dene Band were

also directly involved in the re-alignment of the road to avoid areas they consider sensitive to wildlife. Therefore, mitigation has effectively been applied to limit impacts to specific sensitive and existing harvesting areas. No further mitigation is recommended.

TABLE 8-1: PROJECT EFFECTS ON PREDICTED HARVESTING AND HARVESTING AREAS

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Positive	Low	Moderate	Moderate	Moderate	Moderate	High
Northern Mountain Caribou	Both	Positive	High	Moderate	Moderate	Moderate	Moderate	Moderate
Moose	Both	Positive	High	Moderate	Moderate	Moderate	Moderate	High
Dall's Sheep	Both	Positive	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Wolverine	Both	Positive	Low	Moderate	Moderate	Moderate	Moderate	High
Grey Wolf	Both	Positive	Low	Moderate	Moderate	Moderate	Moderate	High
Beaver	Both	Positive	Low	Moderate	Moderate	Moderate	Moderate	High
Marten	Both	Positive	Low	Moderate	Moderate	Moderate	Moderate	High
Overall Significance								
Moderate								

Confidence in this assessment is moderate since local harvesting areas, harvesting and trapping levels, and propensity to harvest "less preferred" species (e.g., Dall's Sheep) are assumed and the winter road will provide better winter hunting and trapping access. The measurable parameter for effects to harvesting and harvesting areas is qualitative based on the belief of members of the Naha Dehe Dene Band that the road supports local harvesting and access to harvesting areas.

Based on the predicted overall positive effects predicted, the all season access road is not predicted to impede the harvest or change sensitive and existing harvesting areas. Positive residual effects are anticipated.

8.3 Effects on Wildlife from Harvesting Pressure

Current levels of harvesting (includes both trapping and hunting) along the all season access road is very low, as access restricts use. Areas adjacent to the Liard and South Nahanni rivers that are accessible by boat in the summer and snowmobile in the winter are likely utilized. Although the South Nahanni River allows access into the NNPR, the reported harvest levels inside the park are low. The permitted winter road currently permits winter access from the Nahanni Access Road to the Prairie Creek Mine.

Within the original boundaries of the NNPR, non-resident hunters are not permitted to hunt; only those holding a NWT General Hunting Licence (primarily Aboriginal subsistence harvesters) are allowed (Larter and Allaire 2013). The expanded park boundary now encompasses 80% of Phase 1 and 42% of Phase 2 of all season access road, as well as portions of two outfitting zones (the Nahanni Butte D/OT/02 and South Nahanni D/OT/01) that are in operation for non-resident hunters.

The Nahanni Butte D/OT/02 and South Nahanni D/OT/01 outfitting zones cover much of the Mackenzie Mountains found within the Dehcho, and the proposed all season access road is located within both. Portions of the all season access road including the majority of Phase 1 and Phase 2 KP 86-142 (extending 40 km outside of the NNPR boundary) are within an outfitting zone. Although now mostly part of the NNPR, non-resident hunters continue to be allowed to hunt within these outfitting zones until their current outfitting permits with Parks Canada terminate in 2019. With the termination of the outfitting zones in 2019, no wildlife harvesting by non-resident hunters will be allowed across the entire NNPR. Outside the NNPR boundary, non-resident hunter harvests will continue to be permitted along a 40 km section of the all season access road (Phase 2 KP 102-142) that lies inside outfitting zone D/OT/02.

Hunter harvest reports from all Mackenzie Mountain outfitting zones (total of six other outfitting zones besides the Nahanni Butte and South Nahanni) have been reported from 1991 to 2012. During this time, an average of 366 outfitter non-resident hunting licenses have been sold for the Mackenzie Mountains per year (Larter and Allaire 2013). These non-residents have reported harvesting six species: Dall's Sheep, Northern Mountain Caribou, Moose, Mountain Goat, Grey Wolf, and Black Bear. Of these species, Dall's Sheep and Northern Mountain Caribou were most commonly harvested (averaging 197 and 159, respectively per year), followed by Moose (averaging 56 per year), Grey Wolf (averaging 15 per year), and Mountain Goat (averaging 9 per year, primarily from the Nahanni Butte and South Nahanni zones), and Black Bear (averaging less than 1 per year) (Larter and Allaire 2013).

With outfitting permits with Parks Canada terminating in 2019, non-resident harvests along approximately 100 km of the all season access road and at the proposed airstrip will be completely eliminated. Non-resident harvests will be constrained within a 40 km section of the all season road, where the D/OT/02 outfitting zone extends outside the NNPR boundary. Mountain Goat, Dall's Sheep and Moose would be likely targets by non-resident guided hunters, and to a much lesser extent Grey Wolf and Wolverine. NDDB elders (R. Vital, J.M. Konisenta) say Mountain Goats have not been seen north of the village and Dall's sheep are scarce also. Of the target species by non-residents, currently Moose are the only important subsistence harvest species.

Non-residents are permitted to harvest Dall's Sheep from 15 July to 31 October and Moose from 1 September to 31 October. These harvest periods coincide with those of the subsistence harvests.

In combination with subsistence harvests, non-resident hunter harvesting within this 40 km section of all season access road places moderate to high levels of harvesting pressure on Moose and Dall's Sheep. Moose are considered the primary subsistence harvest species, and non-resident hunter harvests of Moose are increasing. Dall's Sheep and Mountain Goat are less favoured subsistence species (assumption based on the reported 20-30 Dall's Sheep harvested annually from the entire Mackenzie Mountains and no reported Mountain Goat harvests). Dall's Sheep and Mountain Goats along this section of access road (Nahanni Range) may be particularly sensitive to overharvest due to their isolation from larger populations; however, subsistence harvest of Dall's Sheep and Mountain Goats are considered negligible.

CZN is in the process of engaging with the Naha Dehe Dene Band and government regarding control of the use of the access road. CZN commits to use means available to control road use with the assistance of the Naha Dehe Dene Band and to monitor un-authorized use of the road as primary mitigation. A Controlled Road Use Plan was approved for use of the winter access road; however, this will need to be upgraded for Mine operations and all season access to incorporate

safety and security, communications, road use monitoring, and wildlife response and reporting. CZN believes this is important for safety reasons, and to minimize the potential for harvesting pressures on wildlife.

CZN's intent is to work with the Naha Dehe Dene Band to discourage use of the full access road by non-residents. When the road is open, the un-authorized road use will pose safety risks. CZN will be able to impose rules for its employees and contractors (e.g., no hunting or straying off the access road alignment) but does not have jurisdiction to impose rules on others. Parks Canada regulations for NNPR stipulate that "existing roads in NNPR are restricted access only and are not open to the public for motorized use", with exceptions for Aboriginal people pursuing their traditional harvesting rights (Parks Canada 2013), resulting in the exclusion of non-Project related and non-Aboriginal travel along approximately 51% of the all season access road.

Direct engagement with the proprietors of the Nahanni Butte D/OT/02 outfitting zone regarding access to the Nahanni Range portion of their outfitting zone (outside the NNPR boundary) and hunting agreements along and near the access road may be required. This includes total harvests from this portion of their outfitting zone.

The key issue is control of access by non-resident hunters. CZN previously committed to the operation of a security check-point where the winter road leaves the Nahanni Access Road. CZN will commit to the operation of the check-point year–round for the all season road. CZN will also engage with the NDDB regarding the most efficient location of the check-point outside of the winter period. The concern is that hunters could access the road via the Liard River, thus avoiding the check-point if it is located at the Nahanni Access Road. It may be more effective to locate the check-point on the north-west side of the Liard River and some distance from the river. The check-point would deter access, but access could not be legally denied.

CZN would operate a barge on the river for truck traffic, and this barge would be private, so would not be available to non-residents. However, this would not prevent non-residents from using their own boats. As a benefit to NDDB members, CZN could consider barge use by NDDB members, and even consider barge transits to the village from the crossing location which would facilitate road use by residents and/or access to the Liard Highway.

Besides the elimination of non-resident guided hunts inside NNPR boundaries, Parks Canada regulations restricting public use of roads (except Aboriginal people pursing traditional harvesting) inside the park, and CZN's security check-point and barge control near the beginning of the road, there are two other possibilities that may deter use of the road by non-residents:

- a no shooting corridor similar to that operating on the Ingraham Trail which prevents shooting within 1 km off the road alignment. The corridor is primarily for safety, but should be equally effective in deterring non-resident hunters who would have to travel more than 1 km off-road to hunt. CZN is exploring the adoption of a corridor with the GNWT, and has had initial engagement with the NDDB and LKFN on the matter. The NDDB have not yet taken a position, while the LKFN are supportive.

- Dehcho land claims discussions are on-going. A conclusion of these discussions could enable the area of the road to be designated private, which would allow the road to be gated and un-authorized access could be legally denied. This is the situation for the access road to Fortune Mineral's Nico Mine in the Tlicho Region. This would be the best outcome for the Prairie Creek road in terms of controlling non-resident hunting, but the timetable of land claims discussions is uncertain.

CZN is continuing to investigate the above two possibilities because they would provide additional mitigation. Therefore, the predicted effect on harvesting pressure with operation of the proposed all season access road is dependent on the magnitude of mitigation applied. As a base, we can assume that: 1) non-resident harvests will cease in the NNPR by 2019; 2) resident harvests outside the expanded boundaries of NNPR will increase; 3) non-resident harvests outside the NNPR will occur without either of the two additional mitigation possibilities noted above; and 4) subsistence harvest levels of Moose will increase and somewhat increase for Dall's Sheep from current levels, but the overall harvest in the region will decrease after 2019. The predicted effects of this base case are summarized in Table 8.2. If the two additional mitigation possibilities are also adopted, the predicted effects on Dall's sheep for Phase 2 and on Moose reduces to low, and the overall significance is low.

TABLE 8-2: PROJECT EFFECTS ON PREDICTED HARVESTING PRESSURE

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Adverse	Low	Moderate	High	Low	Moderate	High
Northern Mountain Caribou	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Moose	Both	Adverse	Moderate	Moderate	High	High	Moderate	Moderate
Dall's Sheep	Phase 1	Positive	Moderate	Moderate	High	Moderate	High	Moderate
Dall's Sheep	Phase 2	Adverse	Moderate	Moderate	High	Moderate	Moderate	Moderate
Wolverine	Both	Adverse	Low	Moderate	High	Low	Moderate	High
Grey Wolf	Both	Adverse	Low	Moderate	High	Low	Moderate	High
Beaver	Both	Adverse	Low	Moderate	High	Low	Moderate	High
Marten	Both	Adverse	Low	Moderate	High	Low	Moderate	High
Overall Significance								
Low								

Confidence in this assessment is moderate since the existing and future subsistence harvest levels of Moose and Dall's Sheep by members of the Naha Dehe Dene Band are unknown. In addition, the effects assessment assumes non-resident harvests will cease in the NNPR in 2019, thereby, eliminating all existing non-resident harvests throughout much of the all season road.

The measurable parameters for harvesting pressure are the total number of hunters and trappers reported accessing the all season road (at the control gate as part of the Access Control Plan or otherwise) a year, and the belief of the Naha Dehe Dene Band members whether the all season access road supports unacceptable hunting pressure on harvest species.

Based on the predicted adverse effects from harvest pressure and the current distribution of harvesting, without additional mitigation (e.g., 1 km no-shooting corridor, private road through the Dehcho Land Claim process), the all season access road is likely to result in a low level of residual effects to Moose and Dall's Sheep. These road-related changes in harvest pressures could affect subsistence and economic wildlife resources. With the application of either additional mitigation steps discussed, no residual effects are predicted.

8.4 Effects of Direct Habitat Loss on Harvested Wildlife

The approved winter road will be used during the Mine start-up phase and early operations, at least 2 years prior to the construction of an all season road. With the alignment of the all season access road essentially the same as the winter road alignment, only an additional 9 km (approximately 18 ha) of road will be been cleared to allow for the all season road, as well as 45.34 ha for the borrow sources and their access roads, and 7.62 ha for the proposed airstrip (total 70.96 ha). A total of 9 km of new alignments from the winter road route are required to bypass boggy or wet areas that are conducive for winter road operations, but need to be avoided, to the extent possible, by the proposed all season road alignment, and to avoid most of the steep talus in upper Sundog Creek.

Effects associated with clearing the road route and winter operations of the access road (including temporary camps and bulk fuel areas) have been permitted for the life of the Prairie Creek Mine. Therefore, the remaining Project-related effects are assessed for clearing 70.96 ha of total harvested wildlife habitat for the construction of the all season access road and airstrip (Table 8-3).

TABLE 8-3: PROJECT EFFECTS ON PREDICTED HARVEST SPECIES HABITAT LOSS

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Adverse	Low	Low	High	Low	Moderate	Moderate
Northern Mountain Caribou	Both	Adverse	Low	Low	Moderate	Low	Moderate	Moderate
Moose	Both	Adverse	Low	Low	Moderate	Low	Moderate	High
Dall's Sheep	Both	Adverse	Low	Low	Moderate	Low	Moderate	High
Wolverine	Both	Adverse	Low	Low	Moderate	Low	Moderate	High
Grey Wolf	Both	Adverse	Low	Low	Moderate	Low	Moderate	High
Marten	Both	Adverse	Low	Low	Moderate	Low	Moderate	High
Beaver	Both	Adverse	Low	Low	Moderate	Low	Moderate	Moderate
Overall Significance								
Low								

The alignment of the Prairie Creek winter access road was modified from the early 1980's alignment to address concerns from the Naha Dehe Dene Band about wetland/wildlife issues, and from Parks Canada regarding re-routing around the unique polje karst features. In addition, the approved winter road was re-aligned to upland habitat on the east side the Nahanni Range to avoid bisecting Woodland Caribou and Moose habitat.

The additional footprint for the all season access road and airstrip consist of direct loss of habitat potentially occupied occasionally by the assessed species. This direct loss of habitat will occur during construction and is reversible after closure.

Although a few Northern Mountain Caribou have been observed near the all season access road, primarily in the summer, the proposed access road and airstrip lie outside their defined annual range and are not considered important habitat for the local herds. Of the additional footprints

proposed within Northern Mountain Caribou habitat (e.g., Nahanni Plateau), beyond the approved winter road, an additional 4 km of road (realigned to avoid steep talus scree) and six preferred borrow sources are proposed; totalling approximately 10 ha.

Similar to Northern Mountain Caribou, direct habitat loss within Dall's Sheep range is limited to the Phase 1 development phase KP 0-32, where 4 km of the access road is realigned to avoid steep talus scree and four borrow sources are proposed. In addition, a 1 km road section and two preferred borrows through the Nahanni Range (Phase 2 KP 122.5-123.5) are proposed; however, the Nahanni Range portions of the Project traverse through lower habitat at least 500 m in elevation below the Dall's Sheep habitat. Dall's Sheep habitat in the Ram Plateau is not part of the proposed all season access road route or airstrip (nearest approximately 4 km distance).

The airstrip, a 4 km road realignment (Phase 2 KP 90.5-94.5), and the majority of the preferred borrow sources proposed are located within the boreal forest zone east of the Mackenzie Mountains to the west of the Nahanni Range. This habitat is potentially suitable for Moose, Wolverine, Grey Wolf, and Marten.

No additional clearing is required within Boreal Caribou habitat east of the Nahanni Range, except for four preferred borrow sources and a 1.5 km borrow source road (total 15.41 ha) located in upland habitat at the edge of Boreal Caribou range.

The proposed all season access road and airstrip also avoid wetlands and ponds, as much as possible, thus inherently minimizing direct effects to Beaver habitat. However, water resources may be required during the construction and operation phases of the all season access road (e.g., dust suppression), but the water sources approved for winter road construction are lakes, and the volumes approved for extraction are less than 10% of lake volume. The same sources would be used for the all season road. Beavers are sensitive to water level changes, especially in the fall and winter when they are storing and using cached food, and overwintering in lodges. Significant changes to water levels in Beaver-occupied ponds may cause abandonment.

In the design of the approved winter road, the NBDB were directly involved in plans to re-align the road to avoid areas they consider sensitive to wildlife, such as wetlands. Similarly, borrow source locations for construction of the all season road were deliberately selected inside or immediately neighbouring the road right-of-way, as much as possible. Temporary camps and transfer facilities will be located inside borrow disturbance areas, whenever possible. Therefore, mitigation has effectively been applied in the design stages to limit impacts, including direct and indirect habitat loss, disturbance to wildlife, and mortality. No further mitigation is recommended due to the re-vegetation potential upon closure.Confidence in this assessment is high since the amount of habitat directly lost is relatively low compared to the winter road, and the proportion of habitat types (or land cover class) disturbed by the Project will not exceed 20% of their total area within 100 m of the road corridor. The measurable parameter for direct habitat loss is total footprint of the all season access road and its facilities that deviate from the approved winter road and associated facilities.

Project related effects to wildlife habitat loss is reversible following decommissioning and reclamation of disturbances. No residual effects are anticipated from the direct habitat loss.

8.5 Effects from Project-Related Wildlife Disturbances

Indirect consequences of Project-related disturbances can occur as a result of road, airstrip, and borrow source construction, operation/extraction, and closure. These indirect consequences may

be in the form of avoidance of the disturbance area and surrounding habitat (i.e., functional habitat loss due to the road itself, traffic, dust), as well as altered movements (e.g., habituation and attraction), and energetics when interacting with the road, borrow source, and/or airstrip.

Avoidance

Scientific evidence suggests avoidance behaviour of land use developments is dependent on the frequency and type of human activity, visual and noise disturbances, and season. Site infrastructure (e.g., storage sheds, forklift, small crew at the TTF, electrical power generator) required for the operation of the proposed Phase 1 all season access road and the TTF remains similar to that already permitted for use of the Prairie Creek Mine winter road, except for the season of use. With the arrival of concentrate trucks, forklifts will be used to load and unload concentrate bags inside the storage sheds. Similarly, noise levels will remain the same as winter operations; estimated at approximately 99 decibels (dBA), which is similar to a highway transport truck (Golder 2010). At 0.5 km from the road, this noise level (99 dBA) is expected to reduce to 35 dBA (Golder 2010) (the level between normal speech and a whisper). Noise disturbances from the operation of the all season road differ from the winter road in temporal extent, not noise level.

With the proposed all season road, there will be a reduction in daily traffic volumes during winter operations and general site activity compared to the winter road. The Prairie Creek winter road daily traffic volume (from late November to early April) will be approximately 37 vehicles, round trip, per day.

To compare, during winter operations, the proposed all season access road Phase 1 development will include approximately six trucks making two round trips per day (total 12 vehicles, round trip, per day) (as well as year round). Therefore, the Phase 1 all season road development will significantly reduce the number of daily vehicle-wildlife interactions over the winter as a direct result of minimizing the number of trips. This is particularly important considering the winter period is a time when many wildlife species are most sensitive to disturbances.

With the development of Phase 2, 16 trucks will make a single return trip daily (total of 16 vehicles, round trip, per day or approximately 1 concentrate truck every 0.75 hours), winter and summer. This traffic volume is still considerably less than the existing Prairie Creek Mine daily winter road volumes; however, traffic volumes proposed are extended throughout the year.

Studies have indicated traffic volumes at 15 vehicles per hour (equivalent to 90 trucks, round trip, per day) affected Boreal Caribou behaviour in Newfoundland and Alaska (Anderson et. al 2002). Although there has been no studies regarding Boreal Caribou responses to low traffic roads in the NWT, the proposed traffic volumes for the Phase 1 and 2 developments (including both scenarios) are below traffic volumes that have been known to induce adverse behavioral responses in Boreal Caribou elsewhere. In contrast, studies indicate Grizzly Bears cross low traffic volume roads and do not avoid high quality habitats nearby (COSEWIC 2012a; Chruszcz et al. 2003). However, because Grizzly Bears are more likely to cross low volume roads, mortality as a result of vehicle collisions may be greater (Chruszcz et al. 2003). This is mitigated to some degree by maintaining slow traffic speeds.

Northern Mountain Caribou were found to avoid habitat within 2 km of high use roads (defined as paved or winter plowed roads) and within 1 km of low use roads (defined as dirt or gravel roads) in northern British Columbia; however, the associated traffic volumes weren't considered (Polfus et al. 2011).

The use of the Prairie Creek Mine access road by non-mine related traffic (e.g., snowmobiles, all-terrain vehicles) will be controlled to the extent possible using a check-point. As such, the potential for disturbance associated with this use can be minimized. As well, speed limits will be enforced for safety and to minimize dust. Dust accumulation along gravel roads may reduce habitat quality. The majority of the large dust particles released from the construction, operation, and closure phases of the all season road are anticipated to settle out about 10 m from its source. However, dust deposition may extend up to 100 m away from the all season access road, potentially along the alpine tundra portions of Phase 1, depending on site conditions (e.g., wind) and particle size characteristics.

The construction phase of the all season access road and airstrip is expected to generate the greatest degree of disruption, at least temporarily; however this disruption will be localized to the sites of construction and will decline into the operations phase. Overall, the daily level of visual and noise disturbances from the proposed all season access road is likely reduced from levels predicted during winter road use.

Altered Movements

Wildlife may change their movement patterns and behaviour in association with the all season access road, its associated facilities, and the airstrip, as well as its traffic, embankment characteristics, and/or plowed snow banks. Any changes in their movements are related to their sensitivity to disturbances and human-activities, as well as the level of disturbance. However, wildlife sensitivity to human-related disturbances and activities vary depending on a number of factors including the species, individual, season, and past experiences. Some species may be wary of the all season access road (and its activities or snow banks) and hurriedly cross or deflect from crossing at that particular location. Other species may utilize the roadway as a travel corridor and habituate to human activities. For example, Boreal Woodland caribou cross low traffic roads (and other linear features, such as the existing winter road and cutlines) year round; however, cows are less likely to cross with young calves. Therefore, the all season access road itself may alter the movements of Boreal Caribou cows with calves until the route is suitably re-vegetated.

Other species, such as Red Fox, Moose, Black Bear, and Grey Wolf are likely to travel along the access road corridor. Marten are also relatively tolerant to human disturbances and activities; but tend not to cross open areas (natural or man-made) that are 200 m wide or more (Salmo Consulting Inc. et al. 2004) (wider than the proposed access road and its facilities, and airstrip).

Moose are also considered relatively tolerant to human disturbances (Salmo Consulting Inc. et al. 2004), although they may still be affected by the visual and noise disturbances from vehicle traffic and unacceptably high snow banks. Available evidence suggests moose may avoid linear features and other land use developments by 100 to 500 m depending on the season, sex, surrounding habitat, especially if hunted (Salmo Consulting Inc. et al. 2004). Moose encountering vehicles travelling on the all season road or air traffic may show minor displacement behaviour and temporarily avoid the immediate area.

In contrast, Dall's Sheep are commonly observed at and near the Prairie Creek Mine and its associated activity sites in the summer. Dall's Sheep near Phase 1 of the all season access road may be habituated to Project-related disturbances.

Traffic on the all season access road may also encounter harvest species at or travelling to mineral licks known to occur within 11 kilometres of the Mine site, Phase 1 KP 10, Phase 2 KP 151, 156, 157, the Nahanni Access Road, and along the Liard Highway. Moose (and their

predators) are main users of the mineral licks along Phase 2, Nahanni Access Road, and Liard Highway. Dall's Sheep (and their predators) on the Nahanni Range may use the known mineral licks nearest to Phase 2 KP 151-157, as well as near the Mine site and Phase 1 KP 10. Dall's Sheep, particularly ewe groups (with lambs and yearlings) commonly utilize mineral licks from June to early October; during this time, they are known to habituate to human activities (e.g., consistently observed at the Prairie Creek Mine site).

Several harvest species may also become attracted to the all season access road and its facilities. Attraction to foods and other materials stored at the facilities could occur if proper handling and storage procedures are not followed. Of the selected harvest species, Wolverine, Grey Wolf, and Marten have the potential to become attracted to the access road and its facilities to gain access to food, shelter, and security (e.g., from predators, insects).

Project-related disturbances leading to avoidance and altered movements during construction, operation, and closure may have energetic consequences and, if severe in magnitude and frequency (species dependent) (Anderson et al. 2002), may lead to individual health declines and possibly population declines. Anderson et al. (2002) summarized the results of studies completed on caribou near moderate and low traffic roads. Barren-ground Caribou responded to moderate traffic volumes (defined as 15 vehicles per hour) in northern Alaska by moving faster and for a farther distance than their responses to low traffic volumes (defined as less than 1 vehicle per hour; similar to the proposed all season access road traffic volume) (Anderson et al. 2002).

Based on the available information, a small number of individual harvest animals may be expected to be present in the vicinity of the all season access road and associated infrastructure year round, and may potentially directly encounter or be disturbed by localized road and airstrip-related noise or activities. Considering the existing indirect habitat potentially lost as a result of the existing Prairie Creek Mine winter road and its activities, the proposed all season access road is not believed to noticeably amplify these adverse effects.

To mitigate project-related wildlife disturbances, measures in effect for the winter road will be maintained throughout construction, operation, and closure of the all season road, including:

- Strict use of CZN's Controlled Road Use Plan and Waste Management Plan to minimize traffic and other disturbances, maintain low speed limits, as well as to limit wildlife attractants;
- Reporting and evaluating wildlife sightings along the access road, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered;
- Snow removal practices along the access road and airstrip to manage high snow banks, so that wildlife can readily move off as vehicles approach and aircraft flyover; and
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so, particularly when in convoy) for all wildlife seen on or immediately adjacent to the road, giving wildlife the opportunity to move off.

All general mitigation measures proposed are summarized in Section 8.10.

The predicted effect of Project-related disturbances on harvestable wildlife, after mitigation is applied, is summarized in Table 8-4.

TABLE 8-4: PROJECT EFFECTS ON PREDICTED PROJECT-RELATED DISTURBANCES

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Adverse	Low	Moderate	High	High	Moderate	High
Northern Mountain Caribou	Both	Adverse	Low	Moderate	Moderate	High	Moderate	High
Moose	Both	Adverse	Low	Moderate	Moderate	High	Moderate	High
Dall's Sheep	Both	Adverse	Low	Moderate	Moderate	High	Moderate	High
Wolverine	Both	Adverse	Low	Moderate	Moderate	High	Moderate	High
Grey Wolf	Both	Adverse	Low	Moderate	Moderate	High	Moderate	High
Marten	Both	Adverse	Low	Moderate	Moderate	High	Moderate	High
Beaver	Both	Adverse	Low	Moderate	Moderate	High	Moderate	Moderate
Overall Significance								
Low								

Confidence in this assessment is moderate since traffic volumes along the all season access road are considered low (and below sensitive species known thresholds), but the sensitivity of harvested species to development-related activities differs with a number of factors (e.g., species, season, individual, project activity). The measurable parameter for Project-related disturbances is the number of direct human encounters with dangerous wildlife, number of reports of possible wildlife attraction and habituation to the Project, and overall Project and non-Project related traffic.

Based on the predicted overall low adverse effects predicted and the current distribution of harvesting, indirect habitat loss as a result of the all season access road and airstrip are not anticipated to adversely affect current harvesting areas and effort. With adherence to mitigation, there are no residual effects anticipated that will adversely alter current harvesting.

8.6 Risks to Harvested Wildlife from Non-Harvest Mortality

The assessment of non-traditional mortality includes vehicle collisions, increased human interactions, and defense of life/property kills. It does not include mortality as a direct result of traditional subsistence harvest and non-resident hunter harvests.

Although the risk of collisions are low, all assessed wildlife species have the potential to encounter vehicle and air traffic as well as equipment operating at the TTF during Phase 1, year round throughout the entire length of the Project. The risk to each species differs depending on their inherent behaviours, abundance along the access road and airstrip, and seasonal use of the surrounding area. During winter operations, bears will be hibernating and Northern Mountain Caribou will have primarily migrated out of the area; therefore, they are not likely to interact with the Project during this time.

Throughout the year, some species may be more reluctant to remain on the roadway and airstrip for any length of time, rather opting to quickly cross (e.g., Boreal Caribou cow with calf) and other species may selectively occupy the roadway/airstrip for travel and securing food. For

example, Black Bears may be attracted to the low traffic access road, particularly in the spring when plant emergence may be earlier than in the forest, thereby increasing their risk of vehicle collisions. Similarly, bears and Wolves may use the access road to travel, putting themselves at greater risk of mortality.

Wildlife can also be reluctant to move off the roadway/airstrip or become trapped in the winter if snow banks are built up too high, although year round, the all season access road and airstrip will have low traffic volumes. Traffic during construction, operation, and closure phases pose a low risk to wildlife. Across the NWT, vehicle collisions do not pose a major threat to Boreal Caribou (Species at Risk Committee 2012). Only "very small numbers" of accidental mortality from vehicle collisions have been reported across NWT to date (Species at Risk Committee 2012). The risk of wildlife-vehicle collisions is low due to suitably slow speed limits and low traffic volumes on the road.

Wood Bison are commonly a problem along the NWT highways, often causing significant damage to vehicles and risk to human and bison themselves. Wood Bison may be encountered along the southern portion of Phase 2 of the all season access road near the Liard River, along the Nahanni Access Road, and along the Liard Highway.

Potential attraction and habituation of bears, Grey Wolf, and Wolverine to food waste, human garbage, and sewage sludge is of particular concern since this can lead to an increase of human-wildlife encounters, risk to people, and associated wildlife relocation or mortality. As outlined in the CZN (2010) DAR, individuals that are attracted to the Project and become habituated can become highly problematic for industrial camps; the mortality risk for these individuals is higher. Across the north, existing mines and camps have successfully managed wildlife attractants with monitoring and modifications as required.

Mortality of furbearers may occur during clearing activities that occur in the winter denning and natal seasons. Accidental mortality at the den sites (hibernation and natal dens) is associated with clearing activities (construction phase only); however, an encounter with dens (hibernation and natal dens) while constructing the 9 km of all season road, borrow sources, and airstrip is considered rare. Since the all season access road and borrow sources are proposed to follow or closely follow the winter road route, few animals are believed to be denning in the area.

Once the roadway is cleared, the construction of the roadbed and operation of the access road may also affect Beavers. The construction of the roadbed has the potential to alter surface water drainage, thereby altering downstream Beaver habitat. In addition, pumping from local water sources may be required periodically during the construction and operation phases for compaction and dust suppression. Beavers are sensitive to water level changes, especially in the fall and winter. Significant changes to water levels in Beaver-occupied ponds may lead to higher risk of predation if Beavers are forced to abandon the pond or direct mortality if significant water volumes are removed in the winter.

To mitigate to risk of mortality, measures that were previously proposed for the winter access road (and TTF) will be followed (CZN 2010; Golder 2010), including, but not limited to:

- Food and food wastes and other putrescible matter will be incinerated on a daily basis and always stored in a manner inaccessible to furbearers to reduce the risk of attraction and habituation to the access road, its facilities, and the airstrip;
- Strict use of CZN's Controlled Road Use Plan and Waste Management Plan to minimize non-Project related traffic and other disturbances, as well as to limit wildlife attractants;

- Reporting and evaluating wildlife sightings along the access road, airstrip, and at the TTF (especially Black Bear, Grey Wolf, and Wolverine), and if an attractant is identified, corrective management options for waste management will be considered;
- Snow removal practices along the access road and airstrip to manage high snow banks, so that wildlife can readily move off as vehicles/air traffic approach;
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so, particularly when in convoy) for all wildlife seen on or immediately adjacent to the road, to give them time to move away.
- Develop standard aircraft procedures for flying into and departing from the proposed airstrip to accommodate wildlife, if present on or near the airstrip;
- Maintain a minimum flight altitude of 600 m during all times, except during take-off and landings;
- Bear awareness (and other dangerous species) program to ensure employees and contractors are aware and informed of the risk level on Project entry for the first time and on a regular basis;
- Similar to the Prairie Creek Mine site, a structure for reporting human-dangerous wildlife encounters at the TTF and resulting incidents to inform Mine management and ENR staff;
- A protocol for dealing with problem wildlife, with a designated chain of responsibilities for ensuring worker safety and efficient and speedy resolution of incidents;
- Annual reporting of bear observations, movements, incidents, and how incidents were resolved;
- No significant changes in water levels permitted and/or adhering to the DFO Water Withdrawal Protocol if pumping water from a known Beaver pond in the fall and winter periods; and,
- Design and construct the all season access road with suitable culvert placement and sizes to maintain natural drainage patterns.

The predicted effect of Project-related mortality on harvestable wildlife, after mitigation is applied, is summarized in Table 8-5.

TABLE 8-5: PROJECT EFFECTS ON PREDICTED NON-HARVEST MORTALITY

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Adverse	Low	Low	Moderate	Low	Low	High
Northern Mountain Caribou	Both	Adverse	Low	Low	Moderate	Low	Low	High
Moose	Both	Adverse	Low	Low	Moderate	Low	Low	High
Dall's Sheep	Both	Adverse	Low	Low	Moderate	High	Low	High
Wolverine	Both	Adverse	Low	Low	Moderate	Low	Low	High
Grey Wolf	Both	Adverse	Low	Low	Moderate	Low	Low	High
Marten	Both	Adverse	Low	Low	Moderate	Low	Low	High
Beaver	Both	Adverse	Low	Low	Moderate	Low	Low	High
Overall Significance								
Low								

Confidence in this assessment is high since Project-related traffic volumes are low and below sensitive species known thresholds throughout the life of the all season road, the access control plan is expected to minimize non-Project related traffic, and applicable policies and plans will manage wildlife attractants and travel across the road. The measurable parameter for Project-related mortality is the total number of wildlife-vehicle collisions and defense of life and property kills a year.

Based on the predicted overall low mortality effects predicted and the current distribution of harvesting, mortality from non-harvesting related access road effects is not anticipated to adversely affect current harvesting areas and harvest species abundance. With adherence to mitigation, there are no residual effects anticipated that will adversely alter current harvesting.

8.7 Effects on Contaminant Levels in Harvested Wildlife

For the effects assessment of the construction, operations, and closure of the Prairie Creek Mine winter access road, CZN (2010) identified mineral concentrates and diesel fuel as the primary sources of potential wildlife effects in the event of a release. Special deliveries will also be required for consumables such as explosives and mill reagents. In the event of a release to the environment, a few resident animals may be affected if they ingest plants, soils, or water potentially affected with these products. While being transported along the access road from the Mine, concentrates will be bagged securely and handled carefully to minimize the risk of rupture or spillage. Given the high value of the concentrate, great care will be taken in transport, handling, and storage procedures as necessary.

In the previous EA, CZN advised that their intention is to ensure the bags of concentrate are clean on the outside after filling and during storage and transport. Transport trucks will similarly be clean by not entering the storage shed directly, and driving through a wheel-wash before leaving site. Truck boxes will have sides and a tail-gate, and the tops will be covered by tarpaulin for secondary containment of any dust. As part of the draft Contaminant Loading Management Plan, CZN also committed to sampling the soils of the road bed in a number of locations, both before and during haul operations. The intent is to confirm that no significant concentrate dust is

being emitted. Since these measures would be continued for all season road operations, we believe they represent a suitably high level of mitigation to avoid effects due to contaminant levels. CZN expects to use a bulk concentrate transport method, consisting of trailer boxes with tarpaulin covers. This approach is expected to be no worse than bags in terms of potential concentrate releases.

In the proposed Phase 1 development, the TTF will become the main concentrate storage location. The existing concentrate storage shed at the Mine may be moved to the TTF, and additional storage sheds are proposed to add to the existing infrastructure at the TTF (or existing sheds will be removed and replaced with a larger structure). Concentrates will be stored at the TTF inside these dry storage sheds until the following winter road operation window or until Phase 2 (all season access road from the TTF to the Nahanni Access Road) is constructed the following year.

During the winter operation period, fuel will be back-hauled into the Mine directly and there will be no need for temporary storage at the TTF. Diesel fuel, other hydrocarbons, mill process chemicals, and other potential mine-related and other supplies will be delivered to the Mine in industry standard tanks, containers or consumer packages. However, a truck fueling station with a 10,000 litre storage tank in a bermed and lined enclosure may be provided so that the Mine fleet can fuel up at the TTF instead of at the Mine, thus avoiding the haul of that additional fuel into the Mine.

With the construction and operation of the proposed Phase 2 development, the concentrates stored at the TTF from the previous year and those processed at the Mine in subsequent years will be transported year round along the entire all season road, with back hauls transporting fuel and other Mine-related supplies.

Wildlife that are most at risk of adverse effects from potential contaminant inputs to the environment due to the construction and operation of the all season access road are those with smaller home ranges, year round presence (particularly overwintering), and have a large proportion of their territory within 100 m (largest predicted dust deposition zone) of the all season road. Since the risk of accidental rollover is greatest during winter driving conditions, species overwintering in the immediate area of the access road are of most concern. Based on this criteria, two of the selected harvestable species, Beaver and Marten, are most at risk as they have relatively small winter ranges and a few individuals likely occur year round near the all season access road. Larger mammals that have larger home ranges and are present on an infrequent or seasonal basis (e.g., caribou, Moose, Dall's Sheep) are less likely to be exposed to potential road-related materials.

Potential effects on vegetation and soil chemistry, and subsequently on wildlife that forage on them, may occur during construction, operation, and closure of the access road and TTF. If a spill occurs, the effects would be localized and of short duration until the spilled material is recovered. Effects on waterbodies and the wildlife they support are a primary concern in the event of accidental spills and leakage of materials, as well from dust deposition during snow-free periods.

The majority of the large dust particles dispersed from the construction, operation, and closure phases of the all season road are anticipated to settle out about 10 m from source. However, dust deposition may extend up to 100 m away from the all season access road potentially along the alpine tundra portions of Phase 1, depending in part, on site conditions (e.g., wind) and particle size characteristics. Naturally occurring heavy metals, such as cadmium are found across the

NWT and have found their way into the food chain to ultimately affect the consumption of wild foods.

A current public health advisory is in effect for cadmium levels found in Moose (kidney and liver tissue only) that occur in the southern Mackenzie Mountains and the Liard/Mackenzie river valleys. Similarly, caribou kidney and livers collected from the Southern Mackenzie Mountains also have high levels of naturally occurring cadmium; however, these levels remain safe for human consumption. Dall's Sheep metal levels are also high, but at levels suitable for consumption. Low but reportable concentrations of cadmium are also found in the kidney and livers of Beaver collected from the Slave River and Mackenzie deltas (INAC 2004).

Cadmium is naturally present across the NWT, and finds its way into the food web from the weathering of rocks and subsequent plant uptake (INAC 2004). Cadmium may be released further into the environment from dust deposition from the all season access road in the spring, summer, and fall. Existing concentrations of cadmium and other heavy metals are still considered low and are not considered harmful to wildlife or to the people eating them (with the exception of the Moose kidney and liver tissue public health advisory).

The GNWT (1998) dust suppression guidelines will be implemented at the TTF and along portions of the road and airstrip, as appropriate, to reduce dust generation during the snow free months. This will generally involve watering dust-prone areas as and when required, as well as adhering to speed limits on roads, which helps limit the re-suspension of particulate material.

Similarly, the Phase 1 road development within the Mackenzie Mountains include portions of steep terrain, as does the Phase 2 road development over the Silent Hills. Accidental rollover, particularly during winter months, poses the greatest risk for accidental release. An all season road will mean much less traffic in winter.

Appropriate materials management systems, spill contingency procedures (including truck driver training in spill response), dust management procedures, and transport safety procedures will be in place to minimize the risk of dust deposition, accidental spills or leakage, including rollovers, and subsequent cleanup of spills, should they occur. The existing spill management plan will be reviewed and improved, as necessary, prior to road and airstrip operation.

To mitigate to risk of possible contamination of harvest resources, measures that were previously proposed at the Prairie Creek Mine and winter access road (and its facilities) will be followed (CZN 2010; Golder 2010), including, but not limited to:

- Implement appropriate materials management systems to minimize the risk of accidental spills or leakage of concentrate, diesel fuel, other hydrocarbons, and other hazardous materials being shipped to the Mine site;
- Diligent management of dust along the access road, airstrip, and transfer facilities following the dust management plan;
- Follow the existing draft Contaminant Loading Management Plan and soil sampling along the road bed both before and during haul operations;
- Implement a winter driving policy requiring tire chains to be used on haul trucks in the mountains (KP 0-29) to increase traction; and
- Finalize and train staff on the existing spill management plan and procedures to quickly respond to an accidental spill. This plan will include provision for rapid deployment of

cleanup crews and for contaminant and clean-up of spilled material and contaminated surfaces.

The predicted effect of Project-related effect on contaminant levels in harvestable wildlife, after mitigation is applied, is summarized in Table 8-6.

TABLE 8-6: PROJECT EFFECTS ON PREDICTED HARVEST SPECIES CONTAMINANT LEVELS

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Adverse	Low	Low	High	Low	High	High
Northern Mountain Caribou	Both	Adverse	Low	Low	High	Low	High	High
Moose	Both	Adverse	Low	Low	High	Low	High	High
Dall's Sheep	Both	Adverse	Low	Low	High	Low	High	High
Wolverine	Both	Adverse	Low	Low	High	Low	High	High
Grey Wolf	Both	Adverse	Low	Low	High	Low	High	High
Marten	Both	Adverse	Low	Low	High	Low	High	High
Beaver	Both	Adverse	Low	Low	High	Low	High	High
Overall Significance								
Low								

Confidence in this assessment is moderate since the risk of Project-related effects on contaminant levels in wildlife are predicted to be low with adherence to mitigation; however, existing contaminant levels in many harvest species remains unknown. No residual effects resulting from Project-related wildlife contamination are anticipated. Since no residual effects are anticipated, and the natural levels of heavy metals are known to occur in harvestable species at varying concentrations across the north, no measurable parameter for Project-related effects to the consumption quality of harvest species is proposed.

Based on the predicted overall low risk of contaminant related effects, the proposed all season access road is not anticipated to contribute to the consumption quality of harvest species.

8.8 Effects to Predator-Prey Relationships of Harvested Wildlife

Although not the only predator in the region, Grey Wolves are considered the primary predator of adult ungulates in the Dehcho. A number of other predators (e.g., Grizzly Bear, Golden Eagle), prey on ungulate calves and Beavers. Densities of predators in the Dehcho are generally unknown. Grey Wolf densities are considered relatively high near Trout Lake; however, they are unknown near the all season access road. Aerial surveys conducted for the Prairie Creek Mine and access road infrequently detected Grizzly Bear, Wolverine, and Golden Eagle in the area.

Predation can be a significant factor in determining prey abundance and distribution. To minimize the risk of encountering a predator, prey species have evolved several strategies such as remaining solitary or in small groups, occupying habitats where alternate prey densities are low, and birthing in isolation near protective cover. Human developments, such as roads, may challenge

prey strategies and alter predator behavior. Some predators (e.g., bears, wolves) use roads for travel, a strategy that increases prey encounter rates (Anderson et al. 2002) and, therefore, predation risk to harvested species. For example, the Species At Risk Committee (2012) identified that Boreal Caribou are at greater risk of predation and harvesting if they occur within 400 m or of a road or seismic line. With the approved winter road development, the proposed all season road and airstrip will not significantly alter predator travel.

Predation can also be a major source of ungulate calf mortality, which can have a direct effect on the populations (Anderson et al. 2002). Possible Dall's Sheep lambing areas exist within approximately 1 km from Phase 1 KP 2, 3, and 7. These sections of the all season access road currently exist as all season quality from past construction and access road approvals. Therefore, the proposed all season access road is not anticipated to alter existing predation that may possibly occur on Dall's Sheep lambs. Similarly, the access road has been re-aligned specifically to avoid sensitive wildlife areas (identified by the Naha Dehe Dene Band members) and wetlands. The proposed airstrip and all season access road includes approximately 10 km of new vegetation clearing west of the Nahanni Range, outside designated Boreal Caribou range.

Predator-prey dynamics may be altered after a forest fire or human disturbance (e.g., the all season access road). In particular, Moose favour these early regenerating habitats and respond with increasing populations, thereby, correspondingly increasing their predators' populations. Large blocks of forests at the proposed airstrip location and along the all season access road are in various stages of regeneration after fires in the 1940s, 1970s and 1990s. In the north, Boreal Caribou prefer forests at least 100 years old and, in comparison, Moose are thought to benefit from young forests less than 30 years of age. Therefore, based on the fire history of the local area, regenerating habitats are aging beyond Moose preferences (youngest known burn area is approximately 25 years old). As the regenerating habitats age, this level of predator-prey dynamic should eventually be restored to pre-existing disturbance levels.

Similarly, human disturbances may attract predators seeking food and shelter, thereby increasing encounter rates with prey near areas of human activity. Predators, such as Red Fox, Wolverine, Grey Wolf, and bears have been known to source food from litter, people purposely feeding, and unsecure containments.

Mitigation for possible adverse effects to the predator-prey relationships have been incorporated into the design of the airstrip and all season road by locating the proposed infrastructure on or near existing disturbances, and re-aligning the all season road around important wetlands and wildlife areas. Additional mitigation includes:

- Managing the small portion of the winter road not used for the all season access to prevent predator and non-Project related travel of the corridor, if necessary; and,
- Implementing a waste management plan that prohibits littering, purposely feeding wildlife, and storing attractants accessible to wildlife.

The predicted effect of clearing an additional approximately 10 km of airstrip and access road on the predator-prey dynamics, after mitigation is applied, is summarized in Table 8-7.

TABLE 8-7: PROJECT EFFECTS ON PREDICTED HARVEST SPECIES PREDATOR-PREY RELATIONSHIPS

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Boreal Caribou	Phase 2	Adverse	Low	Moderate	High	High	Moderate	High
Northern Mountain Caribou	Both	Adverse	Low	Moderate	High	High	Moderate	Moderate
Moose	Both	Adverse	Low	Moderate	High	High	Moderate	Moderate
Dall's Sheep	Both	Adverse	Low	Moderate	High	High	Moderate	Moderate
Wolverine	Both	Adverse	Low	Moderate	High	High	Moderate	Moderate
Grey Wolf	Both	Adverse	Low	Moderate	High	High	Moderate	Moderate
Marten	Both	Adverse	Low	Moderate	High	High	Moderate	Moderate
Beaver	Both	Adverse	Low	Moderate	High	High	Moderate	Low
Overall Significance								
Low								

Confidence in this assessment is high since the amount of clearing for the realignment of the all season road (three road sections, each less than 4 km in length) is negligible compared to the approved winter road and outside sensitive Boreal Caribou defined range. It is not plausible to measure effects to predator-prey dynamics as a direct result of the all season access road and airstrip considering its direct association with the existing winter road corridor.

With adherence to mitigation, no residual effects resulting from Project-related effects to predator-prey dynamics is anticipated.

8.9 Effects to Traditionally Harvested Plants

Given the differences in structural diversity and community composition associated with the vegetation community types present within the study area, it is anticipated that berry and medicinal plant vegetation community types will vary substantially with respect to the availability and abundance of materials utilized by the local human community. Such uses are assumed to include the harvest of plants for traditional medicinal use and the harvest of berries for human consumption.

Based on the review of applicable literature (Cambell and Luckert 2012) it is understood that berry harvesting represents an important food source for local Aboriginal communities and offers a substantial economic offset. Based on 1997 values, a per capita replacement cost of $201.14 was calculated for blueberries harvested by the Nahanni Butte community. It can be assumed that such replacement costs have increased when considering inflation and the likelihood of an increasing human population.

Given that the full range of traditional uses of local vegetation species for medicinal and consumption purposes, and preferred areas for harvesting such species cannot be appropriately quantified as part of this assessment, Tetra Tech's approach for assessing potential project related impacts to traditionally important plant species was conducted by examining potential effects to the landscape supporting such species, rather than a detailed account of potential

effects to a specific plant or group of plants. This approach allows for a quantifiable determination of habitat loss relative to the CZN study area. This approach assumes that all vegetation communities within the study area are of equal importance with regards to traditionally important plant species; however, as previously discussed, vegetation community types within the CZN study area likely vary in their relative importance with respect to the harvest of traditionally important plants given differences in species diversity and site productivity.

Negative, direct project related effects to habitat potentially capable of supporting traditionally important plants will occur as a result of project development which will require the removal of surface vegetation; however, these effects will be partially mitigated by limiting the amount of new disturbance required for construction by constructing the majority of the all season road within the confines of the approved winter road route. The approved winter road will be fully cleared of woody vegetation prior to construction of the all season road, with the exception of 9 km of additional clearing located outside of the approved winter road route.

The extent of direct effects will be confined to the constructed road right of way (maximum 20 m wide) and the footprint of borrow areas and the airstrip, which will be limited in frequency to once during project construction. For Phase 1 of the all season road, surface area encompassed by the road surface will be 85.6 ha, while Phase 2 will encompass 89.4 ha. The footprint area for both phases of the project, including the road footprint, borrow areas, borrow access roads, camps and the airstrip is 236.5 ha. Based on the calculated areas for EOSD land cover classes present within the 100 m wide study area, the proportion of land cover classes disturbed by each phase of the project will not exceed 20 % of the respective land cover class area.

It is expected that project related effects to traditionally important plants will be reversible following decommissioning and reclamation of proposed disturbances. Based on the rating criteria used for this assessment, the significance of direct project related effects to vegetation communities capable of supporting traditionally important plants is anticipated to be low. Following reclamation, no residual effects to traditionally important plant species are anticipated.

Negative, indirect effects to habitats potentially capable of supporting traditionally important plants would be anticipated to occur primarily during the operations phase of the project. During this time period, vehicle operation along the roadway has the potential to generate road dust which, based on the review of applicable literature (summarized in Section 7.3.5), has the potential to alter physical and chemical properties present in off-site vegetation communities, and therefore, potentially altering the health and vegetation composition of such sites. Similarly, the potential for spills of deleterious substances associated with vehicle use of the roadway during operation (and construction) may affect vegetation communities in a similar manner, as well as resulting consequences to the suitability of traditionally important plants for human consumption. The extent, magnitude and duration of such effects are considered moderate given the potential for off-site effects to traditionally important plants during the operational phase of the project. Frequency of effects would be considered moderate as potential effects will occur at regular intervals throughout the operational phase of the project; however, a low volume of traffic is anticipated during operation of the roadway. Any such indirect effects are considered reversible assuming adherence to appropriate mitigation standards.

A third potential indirect consequence of road construction may include the introduction of invasive plant species. Such species have the potential to alter the community composition of off-site vegetation communities and out-compete desirable native vegetation species. The extent, magnitude and duration of such effects are considered moderate given the potential for off-site

effects to traditionally important plants during the operational phase of the project. Frequency of effects would be considered moderate as potential effects may occur at regular intervals throughout the operational phase of the project. Any such indirect effects are considered reversible assuming adherence to appropriate mitigation standards.

A positive consequence of road construction would be the improved access to areas of plant harvesting proximal to the road.

The following mitigation measures are recommended to reduce or eliminate potential indirect project related effects to traditionally important plants:

- Dust suppression strategies (e.g., water or approved dust suppressant products) in accordance with the GNWT dust suppression guidelines;
- Preparation of an Emergency Response Plan for spill containment and management along the access road;
- Fuel storage facilities that meet industry standards for tank construction, location and spill containment;
- Hydrocarbon and chemicals that are hauled along the access road or stored at the TTF are in industry standard containers with appropriate spill containment and management measures in place; and
- Development and implementation of an invasive species management plan to ideally prevent, or if necessary, control the establishment of invasive species in off-site vegetation communities adjacent to the roadway.

With adherence to the mitigation measures described above, the significance of indirect project related effects to traditionally important plants is anticipated to be low. No residual effects to traditionally important plant species are anticipated as a result of the project.

8.10 Traditional Harvesting Mitigation and Best Management Practices

The general mitigation and best management practices considered for the proposed all season access road include previous commitments for the approved winter access road (CZN 2010; Golder 2010), together with specific measures for the proposed all season access road. Proposed mitigation and best management practices include the development and/or implementation of the following:

- A no hunting policy for all Project employees and contractors while working and/or at the Mine site;
- CZN's Controlled Road Use Plan;
- Suitable speed limits on the Prairie Creek All Season Road;
- Discourage use of engine retarder breaks;
- A winter driving policy requiring tire chains to be used on haul trucks in the mountains (Phase 1 KP 0-29) to increase traction;

- A wildlife and wildlife habitat mitigation and monitoring plan that includes annual engagement with members of the Naha Dehe Dene Band to monitor measureable parameters of effects;
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so, particularly when in convoy) for all wildlife seen on or immediately adjacent to the road, to allow them to move away;
- Policy that all Project-related transportation activities are to give the right-of-way to any wildlife that such activity may encounter;
- Develop standard aircraft procedures for flying into and departing from the proposed airstrip to accommodate wildlife, if present on or near the airstrip;
- Maintain a minimum flight altitude of 600 m during all times, except during take-off and landings;
- Dust suppression strategies (e.g., water or approved dust suppressant products) in accordance with the GNWT dust suppression guidelines;
- Follow the existing draft Contaminant Loading Management Plan and soil sampling along the road bed both before and during haul operations;
- An education program of wildlife related policies and mitigation to all Project employees and contractors, including a bear awareness program to ensure employees and contractors are informed of bears and other potentially dangerous wildlife and the level of risk;
- Policy for all Project employees and contractors to avoid all known or suspected den and nest sites;
- An alert system to warn personnel of Woodland Caribou and other sensitive wildlife in the local area by relaying sighting information to vehicles/aircraft and equipment operators and on-site personnel;
- Wildlife record logs to be completed by all Project employees and contractors for all wildlife sightings (e.g., Dall's Sheep, caribou, Wood Bison, and carnivores) with respect to species, location along the access road and airstrip, numbers observed, and reaction to Project activity. If a problem area is identified, corrective measures will be considered.
- ENR's Woodland Caribou Best Management Practices for Industrial and Commercial Activities (once developed) to be incorporated into the wildlife monitoring program, where feasible, to manage or mitigate habitat impacts and sensory disturbances on Woodland Caribou;
- Snow removal practices along the access road and airstrip to manage high snow banks, so that wildlife can readily move off as vehicles/aircraft approach;
- A structure for reporting human-dangerous wildlife encounters at the TTF and resulting incidents to inform Mine management and ENR staff;
- A protocol for dealing with problem bears, with a designated chain of responsibilities for ensuring worker safety and efficient and speedy resolution of incidents;

- A Waste Management Plan that prohibits littering, purposely feeding wildlife, and storing attractants accessible to wildlife. Incinerate all waste foods and human garbage consistent with current industry good management practices to minimize wildlife attraction to the local area. Adaptive management will be applied to waste management practices. If wildlife are found to be attracted to the site (i.e., problem wildlife) additional management practices, if required, will be adopted;
- An Emergency Response Plan for spill containment and management along the access road;
- Fuel storage facilities that meet industry standards for tank construction, location and spill containment;
- Appropriate materials management systems to minimize the risk of accidental spills or leakage of concentrate, diesel fuel, other hydrocarbons, and other hazardous materials being shipped to the mine site. This includes ensuring hydrocarbon and chemicals that are hauled along the access road or stored at the TTF are in industry standard containers with appropriate spill containment and management measures in place;
- Staff training on the existing spill management plan and procedures to quickly respond to an accidental spill. This plan to include provision for rapid deployment of cleanup crews and for contaminant and cleanup of spilled material and contaminated surfaces;
- Managing the small portion of the winter road not used for all season access to prevent predator and non-Project related travel of the corridor, if necessary;
- Preservation of natural drainage patterns along the haul road to maintain the natural function and processes of peatland habitats adjacent to the haul road;
- A policy to avoid significant changes to water levels while pumping water from a known Beaver pond in the fall and winter periods;
- Maintain sufficient buffer distances between development activities (e.g., re-fuelling and material storage) and waterbodies, where possible;
- Non-mine vehicles, including all-terrain vehicles (ATVs) and snowmobiles will be prohibited on site;
- Pets will be prohibited along the all season access road; and
- Development and implementation of an invasive species management plan to ideally prevent, or if necessary, control the establishment of invasive plant species in off-site vegetation communities adjacent to the roadway.

8.11 Fishing

As noted in Section 5.2, the only fishing known to have occurred in proximity to the road alignment in the last decade was by Raymond Vital, who fished in Gap Lake about 5 years ago, catching pike and grayling. He also fished in Bluefish Lake and the triangular lake at Km 140, catching grayling, but this was more than 10 years ago. Others in the Nahanni Butte community may have fished in local lakes. No fishing is known to have taken place west of Gap Lake for

some time, and it is considered unlikely to have occurred given the distance and access limitations.

In a recent discussion with NDDB elders (January 20, 2015), Raymond Vital stated that he is in favour of the all season road because it will afford much easier access to his cabin at Gap Lake, his trap-lines nearby, and fishing locations. The road will also access further inland, and will encourage traditional harvesters to access the NNPR and potentially fish in the Tetcela River and other streams further west. Therefore, the road will represent a positive impact on the traditional harvesting of fish.

The improved access created by the road also provides the potential for access by non-residents. Hunting is likely to be activity prompting the access, but some fishing is possible. The Grainger River hosts primarily grayling, but numbers are generally low and the fish are relatively small (<15 cm). Similar fish are likely present in Gap Lake, but are isolated from the river by beaver dams. A northern pike approximately 40 cm long was seen in Gap Lake, and would be of greater interest to sport fishers.

The extent and magnitude of positive effects to traditional fishing as a result of the road are considered to be low to moderate, to persist for the duration of road operation, and reversible after road closure. The extent and magnitude of negative effects from non-resident fishing as a result of the road are considered to be low because hunting is likely to be the chosen activity, and the existing fish resource is not substantial or particularly interesting. Effects will persist for the duration of road operation, and are reversible after road closure. Improved control of access of non-residents would further reduce potential effects. Confidence in this assessment is moderate since the expected future interests of traditional and non-resident fishers may not be entirely accurate.

8.12 Managing Hunting and Fishing

The TOR asks for information on mechanisms of resource management agencies and other parties to manage hunting and fishing by resident hunters and fishers, non-resident hunters and fishers, and aboriginal harvesters. The responsibility for resource management on territorial land rests with the GNWT agency Environment and Natural Resources (ENR). ENR is responsible for wildlife management and enforcement of policies. With respect to the access road, ENR have an interest in boreal caribou and wood bison protection, particularly in the lowlands east of the Front Range. Aboriginal groups share this interest, although some consider the bison a nuisance. ENR also have an interest in the protection of other wildlife that are subject to hunting in respect of the access road on territorial land, including moose, however this interest is tempered by the fact that these other wildlife species are not threatened on a population level. Similarly, ENR have policies regarding fishing, but there are no threatened species present along the road, except for Bull trout on territorial land surrounded by the NNPR. Mine employees and contractors will not be permitted to fish, and it is unlikely non-residents will travel the distance required on the access road to fish for Bull trout, particularly as the trout present are rarely >15 cm in length.

With the development of the access road, resident hunters and fishers, and aboriginal harvesters, are more likely to venture inland to hunt and fish. It is reasonable to expect that residents, non-aboriginals and aboriginals, will respect the wishes of the NDDB, who will be staffing the

security check-point on the road, with respect to hunting and fishing pressures. More specifically, we expect that most people will comply with the wishes of the NDDB and CZN in terms of the " no hunting or fishing by un-authorized personnel" signs that will be posted on the road, despite the fact that access cannot currently legally be denied. Aboriginal groups and CZN are concerned that there could be some non-resident hunters that will not be dissuaded by the signs and check-point, and ENR currently has limited ability to prevent hunting by such people. This is why CZN is seeking the additional assurance and deterrent that would be afforded by a "no shooting" corridor being adopted on the access road. This would provide ENR with a procedural mechanism to effectively enforce no hunting in proximity to the road. West of Wolverine Pass to Km 17, the road crosses the NNPR and non-aboriginal hunting is effectively controlled by Parks Canada policies.

8.13 Cumulative Effects

With the application of the proposed mitigation measures, there are two residual effects identified for the proposed all season access road and airstrip relevant to traditional harvesting:

- Positive residual effects on subsistence harvest and harvesting areas of Moose and Dall's Sheep; and,
- Adverse residual effects to Moose harvest pressure.

The potential cumulative effects of the Prairie Creek Mine and associated Project infrastructure, including the entire winter access road, were most recently discussed in the CZN DAR (2010) for the Mine and winter road. In their Report of EA (REA), the MVEIRB concluded that the proposed development is not likely to have any significant adverse impacts on the environment or to be a cause for significant public concern.

Golder had been retained by CZN to undertake the cumulative effects assessment (CEA) for that Project, which was provided as Appendix 17 to the DAR (Golder, 2010). This previous CEA for wildlife was performed in the context of residual effects from the Project, and how the potential residual effects could be additive to residual effects from other resource development projects in the immediate vicinity or broader geographic region (i.e., southern Mackenzie Mountains). Three mining projects were identified for consideration in the CEA: the Howard's Pass district (Selwyn Project), the existing Cantung Mine and, the Mactung development proposal in the MacMillan Pass area. Given the spatial separation between the Prairie Creek Mine and winter access road, and the three mine projects in the Mackenzie Mountains to the north, the potential for the identified residual effects from the Prairie Creek Mine and winter access road to result in a cumulative effect on the species discussed was determined to be unlikely (CZN DAR 2010).

Over the foreseeable future, there are a few anthropogenic activities that may interact to cumulatively affect wildlife, these include:

- Exclusion of non-resident harvesting in the Nahanni Butte and South Nahanni outfitting zones inside the expanded NNPR boundary; and
- Protection from anthropogenic development through the Draft Interim Dehcho Land Use Plan conservation zones and other parks in the region.

Moose and Dall's Sheep adverse effects potentially persist as a result of the proposed all season access road and airstrip after mitigation is applied. In contrast, positive affects remain for members of the Naha Dehe Dene Band by providing additional access to Moose and Dall's Sheep harvesting areas. Residual wildlife effects from the proposed all season access road has the potential to interact adversely primarily with the Prairie Creek Mine and its airstrip. These could affect Dall's Sheep.

The proposed all season access road effects assessment includes associated effects during winter operations, and therefore, essentially negates the predicted winter operation effects.

Moose: The environmental assessment for the Prairie Creek Mine and winter road predicted a low likelihood of vehicle collisions with moose along the Prairie Creek winter access road, but was not expected to be a cumulative effect for regional moose populations in the NWT (Golder 2010). The proposed all season access road reduces traffic volumes from the approved winter road levels and, therefore, essentially negates this potential cumulative effect. However, the cumulative harvest pressure anticipated because of the proposed all season access road may act cumulatively with Moose-vehicle mortality assumed to occur along Highway 7. Strict access control measures are required to monitor and manage non-Project related travel and hunting pressure along the all season access road.

Dall's Sheep: The environmental assessment for the Prairie Creek Mine and winter road predicted it was unlikely that cumulative effects on Dall's sheep habitat or populations would occur with full operation of the Prairie Creek Mine and its winter access road with other mines across the region (Golder 2010). However, potential residual effects in harvest pressure as a result of the proposed all season access road may act cumulatively with the predicted residual effects to Dall's Sheep lambing activity in the spring (May to June) near the airstrip and Folded Mountain. However, this is counter-balanced by the end of outfitter hunting for sheep in the NNPR by 2019. Strict access control measures and flight management (during lambing season) into the Prairie Creek Mine are required to monitor and manage non-Project related travel, hunting pressure, and disturbances to lambing areas near the Mine site and Phase 1 of the all season access road.

Fishing by non-residents, which would be cumulative on the limited existing traditional fishing, has the potential to limit the positive impact on traditional fishing afforded by improved road access. Non-resident fishing has the potential to reduce the abundance of fish, making traditional fishing less successful. However, existing fish stocks are judged to be already limited, and not likely to be of significant recreational interest to non-residents. Therefore, the overall cumulative effect is assessed to be low, with a moderate accuracy, and reversible on closure of the road.

9.0 EFFECTS ASSESSMENT – ACCIDENTS AND MALFUNCTIONS

9.1 Road and Transfer Facility Design

This sub-section describes how road design considerations and the transfer facility design will help minimize the risk of accidents and malfunctions.

CZN previously evaluated the winter access road with a view to making modifications that promote greater safety and reduce the risk of accidents and, therefore, spills. The focus of evaluations was the elimination of tight hairpin turns and reduction in road grades to less than 8% as much as possible. The Polje Re-alignment was adopted to avoid the poljes, but also eliminated two hairpin turns and associated steep grades. Road modifications up to Wolverine Pass were also implemented to eliminate or open tight hairpins and reduce grades. In addition, road sections were re-aligned to take them out of wetland areas from Wolverine Pass to Grainger Gap, and from the Gap to the Liard River crossing. This reduces the potential for impacts to wetlands from road activities.

Since the proposed all season road will essentially follow the revised winter alignment, the design improvement for the winter road will transfer to the all season road. Allnorth have reviewed the winter route, and have proposed some alterations for all season use, partly to avoid wet areas, but also to improve grades and bends in places. Two specific areas of change will make the road safer. From Km 23.5 to 28.3, the road will now stay on the south side of Sundog Creek and avoid significant talus slopes on the north side which posed maintenance issues, and also avalanche risks. The switchbacks on the west side of the Silent Hills have been further revised to improve grades.

In addition to physical changes to the road, operational procedures will be adopted to minimize the risk of spills along the access road. Appropriate speed limits will be set for all sections of the road. Before the road is opened for traffic, an operations supervisor will drive the road and note appropriate speeds and locations where additional warning is required. Following this, signs will be made and posted along the road.

The TTF was previously to be located at Km 84 on the winter road. This location was chosen to be the furthest east the road could be travelled before encountering lowland terrain which would take longer to freeze each winter. The location is in a relatively flat area distant from watercourses. Review of an all season road alignment has prompted re-alignment of the road in this area further north onto firmer ground. This will necessitate moving the TTF location. A location at Km 86 has been chosen that still meets the objectives of the winter road location.

9.2 Materials to be Hauled

Table 9-1 provides a summary of materials of environmental significance that will be hauled outbound from, and inbound to, the Prairie Creek Mine during the operating period. Details are given regarding the form of the material, package size, package type, number of packages per load, and number of loads per year. Bulk liquid hauls are considered to pose the greatest risk

because of the potential for rapid migration in the event of a spill. Diesel fuel and mineral oil are the main bulk liquids being hauled. The largest quantity of material to be moved is concentrates.

TABLE 9-1: MATERIALS OF ENVIRONMENTAL SIGNIFICANCE TO BE HAULED

Material	Form	Package	Contents	Tonnes per load	Units per load (max)	No. loads	Total loads
Outbound							3,082
Mineral concentrates	Solid	Bag/bulk (kg)	3,000	39	13	3,077	
Hazardous waste	Various	Drum (litres)	205	10	49	5	
Inbound							1,133
Fuel and Oil							
Diesel	Liquid	Tanker (litres)	10,000		1	800	
Mineral Oil (Explosives)	Liquid	Tanker (litres)	10,000		1	3.5	
Petroleum fluids	Liquid	drum (litres)	205	20	98	4	807
Mill Supplies and Reagents							
Jaw Crusher Liners	Solid	Pallets (Kg)	250	15	60	0.6	
Cone Crusher Liners	Solid	Pallets (Kg)	250	15	60	1.2	
Ball Mill Liners	Solid	Pallets (Kg)	250	15	60	0.9	
Grinding Balls	Solid	drum (litres)	250	15	60	6.9	
Ferro Silicon	Solid	bag (kg)	1000	20	20	7.2	
Glycol	Liquid	drum (litres)	205	20	98	1.0	
Flocculant	Solid	bag (kg)	200	10	50	0.1	
DF067	Liquid	drum (litres)	205	20	98	0.4	
SIBX	Solid	bag (kg)	1000	20	20	1.6	
MIBC	Liquid	drum (litres)	205	20	98	0.0	
Soda ash	Solid	bag (kg)	1000	20	20	21.1	
P82	Solid	bag (kg)	1000	20	20	1.9	
AQ4	Solid	bag (kg)	1000	20	20	7.3	
Copper sulphate	Solid	bag (kg)	1000	20	20	19.0	
3894	Liquid	drum (litres)	205	20	98	0.2	
RTR3	Solid	bag (kg)	1000	20	20	0.2	
SIL N	Solid	bag (kg)	1000	20	20	5.0	
Sodium sulphide	Solid	bag (kg)	1000	20	20	8.7	
Backfill Cement	Solid	bag (kg)	1000	30	30	170.7	254
Water Treatment Reagents							
Sulphuric acid	Liquid	Tote (litres)	1,400	20	14	21.6	
Sodium sulphide	Solid	bag (kg)	1000	20	20	2	
Ferric sulphate (Ferix 3)	Solid	bag (kg)	1000	20	20	3	
Lime	Solid	bag (kg)	1000	20	20	12	39
Mine Supplies							
Mine operating supplies	Solid	Pallets (Kg)	500	15	30	33.3	33
Explosives Components							
Sensitizer	Solid	boxes (Kg)	152	10	66	6	
Sodium nitrate	Solid	bag (kg)	25	15	600	6	
Ammonium nitrate	Solid	bag (kg)	1000	30	30	10.5	23

The main change from EA0809-002 is the form of container for sulphuric acid. Previously, 20,000 L tanker deliveries were envisaged. Now, delivery in totes weighing approximately 1.4

tonnes is planned. This represents a significant reduction in the risk of spills because of the much smaller container size, and the fact that totes are quite durable and not easily ruptured.

9.3 Screening of Material Release Modes

Potential sources of contamination to surface water and groundwater exist with the construction, operation and decommissioning of the access road. These are as follows:

- Spills and leaks from road construction, maintenance and decommissioning;
- Spills and leaks from vehicles using the access road; and,
- Dispersal of concentrates and other materials from haul trucks.

Potential sources of contamination to surface water and groundwater exist with the operation of the TTF. These are as follows:

- Spills and leaks from fuel tanks;
- Spills and leaks from vehicles using the TTF; and,
- Dispersal of concentrates.

9.3.1 Concentrates

From Table 9-1, the material requiring the greatest number of haul loads will be concentrates. The continuous loss of a small quantity of concentrate during the haul along the access road would potentially contaminate the road bed and adjacent land with metals, and this could lead to contaminated soil and runoff. With this process, there is a potential for metal uptake in vegetation and elevated metals levels in waterways and aquatic life. Metals are naturally present in all environmental media, some in the form of essential minerals, but the loss of concentrate could elevate metals concentrations to the point that they could cause impacts.

CZN recognized the risks posed by concentrate loss early on, and chose to address this risk by placing all concentrates in sealed bags, with an emphasis on a bagging process that ensures bag exteriors are clean. Haul trucks collecting the bags will pass through a wheel wash before leaving the concentrate storage shed as an added precaution to avoid the tracking of contaminated material along the haul route. The bags will be hauled inside a trailer box with a tarpaulin cover. The bags would be temporarily stored under cover at the TTF during Phase 1 until the winter period when they would be collected by contractor trucks accessing the TTF from the highway. At that time, mine trucks would haul concentrate to the Liard Transfer Facility (LTF) near the highway. If Phase 2 of the road is built subsequently, or at the same time as Phase 1, the bagged concentrates would be hauled directly to the LTF without re-handling or storage at the TTF. Any spills of concentrate will be immediately cleaned-up. The concentrates are dark in colour and have a sugary texture. The material should be readily visible.

As noted above, CZN expects to use dedicated trucks transporting concentrate in bulk, either as well as or instead of bags. The concentrate would not be rehandled at the TTF but will travel the length of the all season road in one transit. The same precautions will be used to avoid dust (clean exteriors, wheel wash).

CZN previously developed a draft Contaminant Loading and Management Plan for the winter road. The Plan includes a monitoring proposal for soils along the road bed, starting with a pre-concentrate haul baseline and regular monitoring during operations. If dust is being lost during concentrate haulage, it would be expected to be shown in this monitoring before any significant releases to local soil and water, surface water and groundwater. We believe the same monitoring proposal is suitable for all season road operations.

9.3.2 Leaks

Leaks are considered to be on-going small losses of fuel or oil mainly from vehicles using the access road and TTF. Such leaks can be minimized by properly maintaining and inspecting vehicles, ensuring all seals are effective. For equipment that stands periodically, such as construction equipment, the use of drip pans will minimize impacts from small leaks. CZN and contractors will be responsible for operating construction equipment and haul trucks. CZN will ensure these are properly maintained. Contractor construction equipment and haul trucks will be inspected for leaks before they are allowed to operate, and corrective measures taken if necessary. The risks posed by small leaks are not considered to be significant. The quantity of the contaminant is quite small, and there is little potential for a significant distance of transport to a water body. Areas of staining can also be collected and disposed of appropriately.

Small fuel tanks will be used at construction camps and the TTF to feed generator sets. All tanks will be above ground and double-walled or within lined containments. The containments will collect any leaks, but will also have a volume of at least 110% of the tank to retain the fuel in the event of tank failure.

9.3.3 Spills

Trucks will be carrying concentrates, fuel, reagents and chemicals, including acid. In winter, the winter environment will limit the risks posed by spills to some degree. This is because spills are usually not able to travel far, are easily contained and can be readily cleaned-up with minimal risk to surface water and groundwater. Risks to surface water exist, but surface water contamination should be visible and can be cleaned up with downstream interception and collection. There is a risk to groundwater from a large spill if the spill is not completely absorbed by snow or surficial soil, and the underlying bedrock is permeable. The dolomitic rocks of the Nahanni Formation that form the Ram Plateau are potentially permeable, as are granular locations, such as flood-plains.

9.3.4 Screened Releases

In terms of the potential for impacts, spills of liquid substances are considered to pose the greatest risks, specifically diesel fuel, fuel oil and sulphuric acid. Other than these substances, most of the materials being hauled on the road will be relatively inert. The exceptions are concentrates, sodium sulphide and ammonium nitrate, all of which are soluble to some degree and could cause a significant impact if spilled into, or subsequently dissolve into, water. However, the number of loads of the latter two materials will be quite low, two and eleven respectively. As a result, spills of these substances are considered in the risk analysis below.

9.4 Risk and Consequence by Road Section

A matrix for the risk of spills, and their consequence, for different sections of the access road is given in Table 9-2. The matrix is based on the Failure Modes and Effects Analysis approach (http://technology.infomine.com/enviromine/issues/cls_fmea.html) developed by Robertson and Shaw. In the matrix, 'risk' can be considered inter-changeably with 'likelihood'. The assessed magnitude of spill risk and consequence by road section is shown in Figure 9-1.

Proximity to water is indicated as well as the ground composition. Grade refers to elevation change along the road, and alignment to the sinuosity of the road. Containment refers to the opportunity to collect spilled material in a reasonable timeframe (a few hours) without entry to the nearest water body. A risk level is then assigned to the road section based on a combination of these factors. Next, a consequence level is assigned based on the nature of the local environment and a spill actually occurring. Individual road sections are discussed below.

Prairie/Fast Creek Section

The road from the Mine to Km 7.4 parallels Prairie Creek and Fast Creek. There are sections that are immediately adjacent to the creek. Spills in these locations would be problematic because it may not be possible to prevent part of a spill entering the creek. The consequence if a spill did occur would be potentially high for these sections, depending on the material spilled. However, the risk of a spill is low because the road grade is flat and the alignment is generally quite straight. Prairie Creek over this reach is considered to be migration habitat for Bull trout. No spawning habitat is known to occur. Fish may over-winter in deep pools. Therefore, any spills entering the creek pose a possible but limited risk to fish. Rapid response would be necessary.

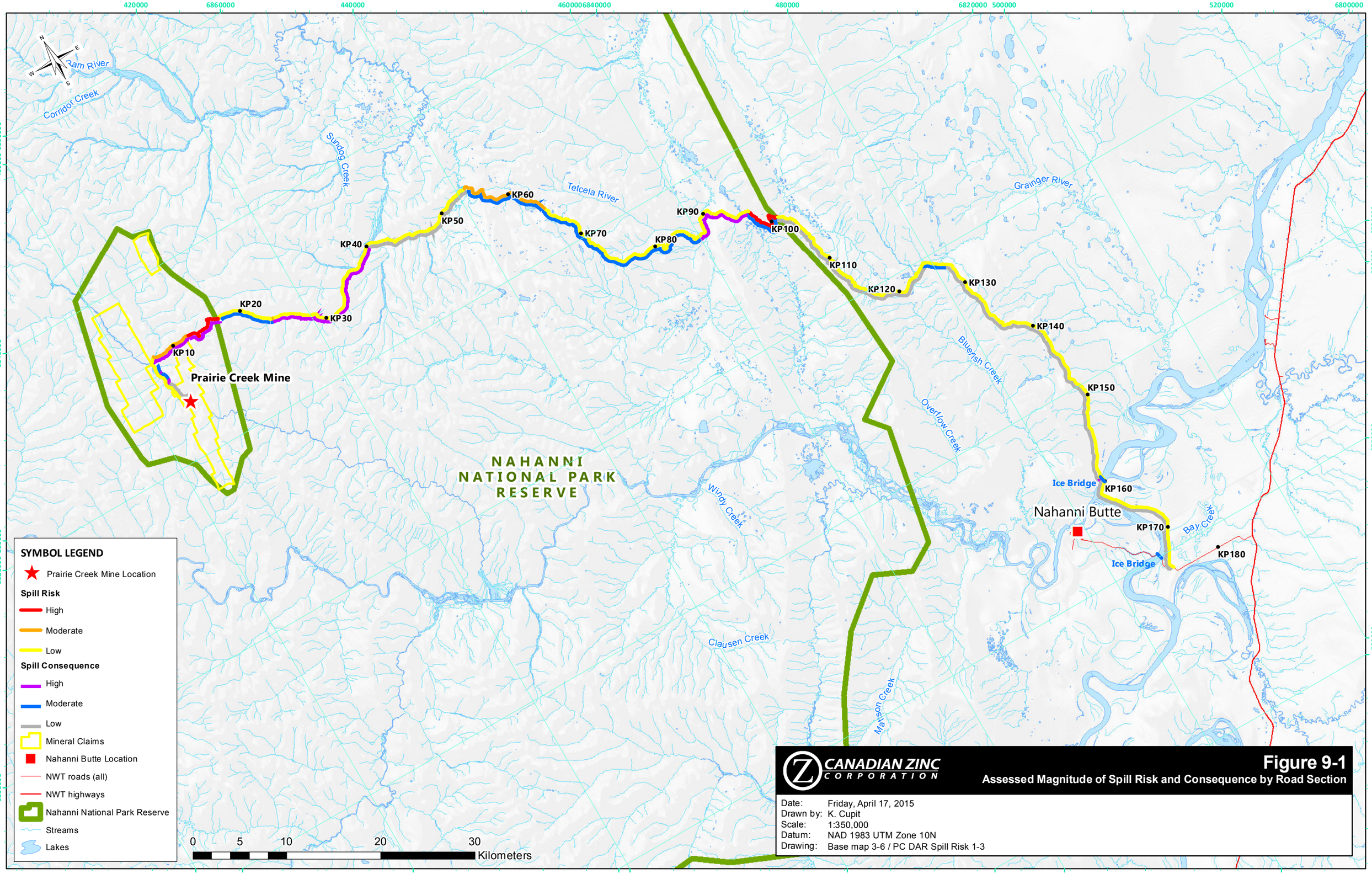
Funeral Creek Section

Between Km 7.4 and Km 17.2, the road parallels Funeral Creek. Conditions are similar to the Prairie Creek section except the grade is steeper. The consequence is also higher because of the presence of a spawning Bull trout population, which may be resident in winter. The road is not proximal to the creek from approximately Km 12.3 onwards where the grade steepens. Also, the creek is impassable to migrating fish where the main stem splits into three forks (upstream of Km 12.7.

The section considered to pose the highest risk of a spill is from Km 13 to Km 17. A spill over this section would be considered a 'worst-case' scenario from a response perspective because of the road grade and grade separation between road and creek below. The section starts with a switch-back crossing of a Funeral Creek tributary. For operations, this switch-back will be 'opened-out' to make turning easier, and the crossing will be a broad structure. The section has a steep grade and crosses a steep side slope. In the event of a spill, it would be difficult to access the area below the road and the speed of spill response may also be affected.

TABLE 9-2: ASSESSMENT OF SPILL RISK AND CONSEQUENCE

Km from Mine		Proximity to Water	Ground Type	Grade	Alignment	Containment	Risk	Consequence
From	To							
Prairie/Fast Creek								
0	3.5	30-80	Silty sand	Flat	Broad curves	Readily contained	Low	Low
3.5	4.2	1	Sandy gravel	Flat	Broad curves	No containment	Low	High
4.2	5.3	10-50	Sandy gravel	Flat	Broad curves	Can be contained	Low	Moderate
5.3	5.5	1	Sandy gravel	Flat	Straight	No containment	Low	High
5.5	6.2	20-100	Silty sand	Flat	Straight	Can be contained	Low	Moderate
6.2	7.4	10-50	Sandy gravel	Flat	Straight	No containment	Low	High
Funeral Creek								
7.4	12.0	1-50	Silty sand	Gentle	Broad curves	No containment	Moderate	High
12.0	17.2	1-30	Sandy gravel	Steep	Straight	No containment	High	High
Sundog Creek								
17.2	23.3	1-30	Sandy gravel	Gentle	Straight	Can be contained	Low	Moderate
23.3	23.5	1-50	Sandy gravel	Steep	Straight	No containment	Moderate	Moderate
23.5	28.1	20-100	Sandy gravel	Gentle	Straight	No containment	Low	High
28.1	40.2	1-5	Gravel	Flat	Straight	No containment	Low	High
Sundog Creek tributaries								
40.2	53.6	1-1000	Silt/organic	Flat	Straight	Readily contained	Low	Low
53.6	64.5	300-1000	Silt/organic	Gentle	Straight	Readily contained	Moderate	Moderate
Tetcela & Fishtrap								
64.5	86.8	100-1000	Silt/organic	Gentle	Straight	Readily contained	Low	Moderate
86.8	95.8	1-1000	Silt/organic	Flat	Straight	Can be contained	Low	High
95.8	102.0	300-2000	Silt/organic	Steep	Curves	Containment toe of slope	High	Moderate
Wolverine Pass to Grainger Gap								
102.0	124.5	1000-2000	Silt/organic	Flat	Straight	Readily contained	Low	Low
Grainger Gap to Liard								
124.5	127.0	1-200	Silty sand	Flat	Straight	Can be contained	Low	Moderate
127.0	159.8	200-2000	Silty sand	Flat	Straight	Readily contained	Low	Low
Liard Crossing								
159.8	160.4	0	Ice/Water	Flat	Straight	No containment	Low	High
Old Logging Road								
160.4	174.5	200-1000	Silt	Flat	Straight	Can be contained	Low	Low



CANADIAN ZINC CORPORATION

Figure 9-1

Assessed Magnitude of Spill Risk and Consequence by Road Section

Date: Friday, April 17, 2015
Drawn by: K. Cupit
Scale: 1:350,000
Datum: NAD 1983 UTM Zone 10N
Drawing: Base map 3-6 / PC DAR Spill Risk 1-3

Sundog Creek Section

The first section of Sundog Creek to Km 23.2 poses a low risk because road conditions are good. An incised tributary of Sundog Creek exists at Km 23.3-23.5. There are no fish because of a high waterfall (~10 m) at Km 25. Nevertheless, any spilled material in the crossing area could enter the bed gravels and would pose a risk to possible fish presence downstream during the spring migration (grayling). Should a spill occur in this area, a response can be made between Km 23.5 and the falls at Km 25.

From Km 23.5 to 28.1, the road crosses an upland bench and is some distance from the creek. The risk of a spill is reduced. Grayling likely migrate up the creek in the spring, but either retreat or are stranded as flows recede through the summer. Some have been noted in deep pools, although these pools may not survive the winter. The road bed is good and generally broad between Km 28.1 and Km 40.2. Spill risk is low. However, any spill would require an immediate and complete response because of the road location on the creek floodplain. Spilled liquid could seep into the alluvial gravels.

Sundog Tributaries Section

From Km 40.2 to Km 64.5, spill risk is low because of good road conditions. Consequence is also low because the road is not proximal to water apart from generally small tributary creeks to Sundog Creek, and Polje Creek. Spills, if they occurred, could be readily responded to with complete clean-up. From Km 53.6 to Km 64.5, risk is slightly greater because of an increase in road grade and the fact that the road crosses karst terrain. Polje Creek is quite narrow at the crossing location and the road would be good at the approaches. To the east, the road grade increases to climb onto the karst plateau. Soil cover overlying limestone will readily limit the migration of any spills until such time as a spill response occurs.

Tetcela River and Fishtrap Creek Section

From Km 64.5 to Km 86.8 (including the TTF), road conditions are good and the road is not proximal to water bodies. Travelling east to Km 95.8, the Tetcela and Fishtrap valleys are crossed, including wetlands. The consequence of a spill would be high, but the risk of a spill is low because the valleys are broad and road conditions are good. Also, apart from the water crossings, the boggy ground should facilitate containment and response should a spill occur. Note that the portion of the road crossing these valleys would only open as part of Phase 2.

Km 95.8 to Km 102 is a difficult piece of road climbing the Silent Hills because of the switchbacks and grade. Improvements will be made in the form of switchback modifications and grade reduction. The consequence of a spill is moderate because this section is at least a few hundred metres from Fishtrap Creek. Spill response in the wooded area would be difficult but feasible before spilled materials could migrate significantly. However, any spilled material reaching the toe of the slope could be intercepted. Also, the fish habitat of Fishtrap Creek in this area is poor, and no fish were found in surveys. Therefore, impacts would be limited even if spilled material evaded capture.

Wolverine Pass to Grainger Gap Section

From Km 102 to Km 124.5, the road has been re-aligned to avoid valley bottom wetlands, apart from a short section near Grainger Gap. The new route will be mostly flat and straight, posing a low risk of spills.

Grainger Gap to Liard River Section

The headwaters of the Grainger River in the Grainger Gap area include some deeper channel sections with upwelling groundwater. The road bed is flat and straight and spill risks are low. The revised road route along the toe of the Front Range towards Nahanni Butte will also have a low risk of spills due to good road conditions.

Liard Crossing and Old Logging Road

The consequence of a spill at the Liard crossing would be potentially high, but the risk of a spill should be low. The old logging road to the Nahanni access road is set back from the river and is flat and generally straight.

9.5 Spill Severity and Duration by Road Section

From the previous sub-section, any road section assessed as having a moderate or high consequence as a result of a spill was brought forward for this spill severity and duration analysis (see Table 9-3). In this sub-section, spills of specific substances are considered.

From Section 9.3, the substance considered in this analysis are concentrates, diesel fuel/fuel oil, sulphuric acid (although individual container quantities will be small), and sodium sulphide and ammonium nitrate considered together.

For each road section and substance, severity was assigned as being low, moderate or high. Definitions are as follows:

- Low – Spill not likely to result in fish or animal mortality, no significant ecosystem damage
- Moderate – Spill may ultimately result in limited fish or animal mortality, some short-term ecosystem damage
- High – Spill could result in fish or animal mortality, ecosystem damage

In addition, the duration of the severity was also considered on a scale of short, moderate and long. Definitions are as follows:

- Short – 0-24 hours
- Moderate – 1-7 days
- Long – >7 days

Discussion by road section is given below.

TABLE 9-3: ASSESSMENT OF SPILL SEVERITY AND DURATION

Km from Mine		Proximity to Water	Containment	Risk	Substance	Severity	Duration
From	To						
Prairie/Fast Creek							
3.5	7.4	1-100	Some areas no containment	Low	Diesel/oil	High	Moderate
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	High	Short
Funeral Creek							
7.4	17.2	1-50	No containment	Mod-High	Diesel/oil	High	Moderate
					Sulphuric	Moderate	Short
					Concentrate	Low	Long
					AN/Sulphide	High	Short
Sundog Creek							
17.2	40.2	1-100	Some areas no containment	Mod-High	Diesel/oil	Moderate	Moderate
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	Moderate	Short
Sundog Creek tributaries							
53.6	64.5	300-1000	Readily contained	Moderate	Diesel/oil	Moderate	Long
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	Moderate	Short
Tetcela & Fishtrap							
64.5	86.8	100-1000	Readily contained	Low	Diesel/oil	Moderate	Long
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	Low	Short
86.8	95.8	1-1000	Can be contained	Low	Diesel/oil	High	Moderate
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	High	Short
95.8	102.0	300-2000	Containment toe of slope	High	Diesel/oil	Moderate	Moderate
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	Low	Short
Grainger Gap to Liard							
124.5	127.0	0-100	Can be contained	Low	Diesel/oil	High	Moderate
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	High	Short
Liard Crossing							
159.8	160.4	0	No containment	Low	Diesel/oil	High	Moderate
					Sulphuric	Low	Short
					Concentrate	Low	Long
					AN/Sulphide	Moderate	Short

Prairie/Fast Creek Section

The severity of a diesel/oil or ammonium nitrate (AN)/sulphide spill is adjudged to be high as it could result in the mortality of migrating or over-wintering fish. The duration of the severity for AN/sulphide is classified as short due to the diluting effect of flowing alkaline water, and an expectation of spill response. The duration for diesel/oil is considered to be moderate as hydrocarbon residues are likely to persist longer. However, it should be noted that the risk of a spill occurring is considered to be low. The severity of an acid spill was judged to be low because of the probable small quantity in relation to creek flow.

Funeral Creek Section

The same substance severities and durations were assigned for this road section, and for the same reasons. The difference for this section is that the risk of a spill occurring is considered to be moderate to high, with the high risk specific to the Km 12-17.2 section. The severity of an acid spill was judged to be moderate because of the reduced creek flow.

Sundog Creek Section

The severity of a diesel/oil or ammonium nitrate (AN)/sulphide spill is adjudged to be moderate because of the possible presence of fish. Note that the risk of a spill occurring is considered to be moderate for Km 23.3-23.5, and low for the remainder of this section.

Sundog Tributaries Section

The severity of a diesel/oil or ammonium nitrate (AN)/sulphide spill is adjudged to be moderate because, unless a spill occurs right at the Polje Creek crossing, the affected area should be some distance from a fish-bearing stream, and spill response should prevent any discharge to such a stream. However, there may be some ecosystem damage for a limited duration, except for diesel/oil which could persist longer.

Tetcela River and Fishtrap Creek Section

The three road sub-sections comprising this road section were retained for analysis because they have different characteristics. From Km 64.5 to Km 86.9, the road crosses karst plateau and is not proximal to water bodies. The severity of a diesel/oil spill is adjudged to be moderate because of the absence of a fish bearing stream, and the likelihood of spill dissipation and response before residues might reach such a stream. However, the risk of a spill is low. The severity of an acid spill is considered to be low because of the small quantity and alkaline rock. Duration will be short.

Residue from a diesel/oil spill could persist if the liquid were able to percolate into underlying rock fractures. There is some risk of hydrocarbon migration in groundwater within karst formations if this occurs. However, this migration will be very slow (groundwater flows typically are), and the hydrocarbons will degrade and attenuate along the flow path, likely rendering concentrations insignificant long before they reach a surface water body. The risk of

significant effects on the karst itself is considered to be low given the substantial diluting effect of natural waters.

From Km 86.8 to Km 95.8, the Tetcela and Fishtrap valleys are crossed, including wetlands. The severity of a diesel/oil or ammonium nitrate (AN)/sulphide spill is adjudged to be high if it occurs between Km 87 and Km 90 in close proximity to the fish-bearing Tetcela River. In other areas, spill response should prevent high severity. However, there may be some ecosystem damage for a limited duration, except for diesel/oil which could persist longer. Note, the risk of a spill is considered to be low in this generally flat terrain.

Km 95.8 to Km 102 is the Silent Hills switchbacks, and any spilled material reaching the toe of the slope could be intercepted. Hence, the severity of a diesel/oil spill is adjudged to be moderate because it should not result in fish mortality. There may be limited ecosystem impact.

Grainger Gap to Liard River Section

The severity of a diesel/oil, sulphuric acid or ammonium nitrate (AN)/sulphide spill is adjudged to be high if it occurs in close proximity to the fish-bearing Grainger River. In other areas, spill response should prevent high severity. However, there may be some ecosystem damage for a limited duration, except for diesel/oil which could persist longer. Note, the risk of a spill is considered to be low in this generally flat terrain.

Liard Ice Bridge

The severity of a diesel/oil spill is adjudged to be high if it occurs because it could penetrate through the ice and the substance is persistent. The severity of a sulphuric acid or ammonium nitrate (AN)/sulphide spill is considered to be moderate because of the substantial size and dilution of the river, and because the latter substances should not dissolve significantly prior to response.

9.5 Spill Mitigation and Response Plans

9.5.1 Spill Response Time

For the estimation of response time, it is necessary to consider where resources will be. In the first instance, a response is likely to be mounted by the driver of the truck that caused the spill using a kit on-board, or failing that, a response would be mounted by drivers of trucks in the same convoy or arriving on the scene a short time afterwards. While the response these truck drivers would mount may be effective, they may be limited in their ability to respond if the spill is too large for the spill equipment readily available. Therefore, we can assume that small spills would have a response time of within an hour, but larger spills would have a longer response time.

For larger spills, there will be designated spill control points at key locations along the road, and response materials will be stored at these locations. There will also be trailers stocked with response equipment parked at other locations so that responding crews can hook them up and move them to the spill location. However, for any response to a large spill, a spill response team

will need to mobilize to the spill location. A response team with large equipment will be stationed at the Mine. Another response team will reside at Nahanni Butte. Therefore, we can assume that a spill response team will never be more than 90 km from the site of a large spill. We can further assume that responders would travel at approximately 40 km/hour, and therefore they would take approximately 2h15m to arrive at the spill site. In addition, it is likely that a maintenance crew will be working on the road somewhere between Km 40 and Km 170 (i.e. from Cat Camp to the Nahanni Butte Access Road). This crew will also have spill response training and could respond to a spill faster than the other crews, thus lowering the response time.

9.5.2 Response Preparedness

Response System

For the operating period, an incident management system will be used to respond to spills. CZN plans to adopt the Incident Command System (ICS) that is widely used by governments and industry. This lets trained regulators, contractors and other external resources quickly integrate with and augment the spill management team. Selected ICS documentation will be incorporated into the Spill Contingency Plan.

A spill classification system will also be used that is in wide use in industry, as follows:

Level 1 A **minor** event that is confined to the Company property and can be handled by CZN/available contractor personnel using the response resources, manpower and equipment, at hand. Employee safety is not significantly affected and public safety and property is not endangered. The Incident Commander is the Shift Supervisor.

Level 2 A **moderate** event where an incident has occurred or spread beyond Company property, or employee safety is endangered or external resources such as fire, police or ambulance or contractors/external resources are required, but public safety is not endangered. The Incident Commander is the Mine Manager or his delegate.

Level 3 A **major** event where public safety or property is endangered or major off-site environmental impacts have occurred or could occur, and external resources are required. The Incident Commander is the Mine Manager or a Vice President.

Driver Preparation

All drivers will be expected to know the following:

- Existence and content of the appropriate sections of the SCP;
- Properties and hazards associated with the cargo(s) being carried and also the vehicle fuel;
- Composition and use of the on-board spill response kit and requirement to wear personal protective equipment (PPE); and,
- Required notification procedures to be employed in the event of an incident and details to be communicated.

Drivers will also receive an orientation package describing the road and specific sections/conditions before driving the road for the first time, and they will be required to read it. Drivers will check in and out, and be in communication with control during the journey. The intent is to have communications coverage for the entire road. This is for safety and operations reasons.

Spill Response Team

For the operating period, the spill response team will consist of 6 personnel: 1 Supervisor, 1 Safety Watch, and 4 Responders, one of which will be a mechanic. The responders will work on the buddy system in teams of two. Any required increase in the number of responders will also be in teams of 2. The Supervisor is responsible for all communications off the spill site, and directs and documents operations in a chronological log.

The Safety Watch will be an experienced employee with intimate knowledge of the operations and safe operating procedures. The Safety Watch's primary responsibility will be to police safety and coach the responders. The Safety Watch may also help unload or deploy equipment in the early stages of a response or assist from time to time if required, but safety policing is the priority.

As mechanical equipment such as pumps and skimmers could be involved, the inclusion of a mechanic with his tools is appropriate. The team would be supported by other units delivering additional equipment, as necessary.

Spill Control Points

When a spill occurs, there is a potential for spilled material to enter a water body and flow either above or below any ice cover. Flow can also occur in a dry watercourse. Contaminants can be carried away from the spill site. A number of areas exist where a spill could enter a watercourse. Sensitive areas were identified along Prairie and Funeral Creeks, especially the upper section of Funeral Creek, Sundog Creek, and the Polje, Tetcela and Grainger stream crossings. "Control Points" will be established at pre-determined locations from which spill containment and recovery operations can be mounted to limit the migration of a spilled substance from an upstream location.

Establishment of Control Points along Prairie and Funeral Creeks would be challenging because the road parallels the creeks and the creeks may have significant flows of water. However, a silt or other form of curtain will be stored approximately mid-point between the Mine and Funeral Creek ready for deployment to reduce flow in part of Prairie Creek adjacent to a spill. The curtain is not intended to contain a spill, but rather would assist spill response by providing a more quiescent environment. The Funeral Creek stream width is quite narrow. Absorbents will be available for placement along the bank between the stream and the road, and/or across the stream itself temporarily, as necessary. A Control Point will be established near the mouth of Funeral Creek since a spill upstream could move rapidly down the creek.

The upper section of Funeral Creek consists of two tributaries adjacent to the road which are not fish-bearing. However, the creek downstream is sensitive because of the possible presence of over-wintering fish, and the fact that it is a spawning stream. This section of the road is considered the most challenging in terms of mounting a response in the event of a spill because of the steep terrain and grade separation between the road and creek. Consequently, Control Points will be established on these tributaries at their confluence with the main stem. The intent is to prevent migration downstream of the Control Point of any substance spilled in the upstream catchment. Similar Control Points will also be established on Sundog Creek in two locations (one just above the main falls and one just before the creek flows onto the fluvial outwash plain), and downstream of the Polje Creek, Tetcela River and Grainger River crossings. An additional control point will be established at the toe of the Silent Hills on the west side since the road section above is considered to have a high risk of a spill.

Spill Equipment

Spill kits will be carried on vehicles with materials appropriate for the loads (i.e. type of sorbent). Trucks transporting fuel will carry sorbent specific to hydrocarbons. Trucks carrying acid will be dedicated trucks with specially trained drivers, and spill kits specific to acid.

For the operating period, comprehensive spill kits will be maintained at the Mine site, Cat Camp, the Tetcela Transfer Facility , Grainger Gap, and the Liard Transfer Facility. In addition, custom built and stocked road trailers dedicated to spill response will be on hand, containing equipment, materials and tools. This will include absorbents and soda ash. The trailers would be stationed at Cat Camp, the TTF and Grainger Gap to be approximately evenly spaced along the road. One or more of the trailers could be readily hooked up and towed to a spill site. There is no need to locate the trailers in high risk locations because responders will still need to travel to the spill location, collecting the nearest trailer on the way. The trailers would be used for preventative maintenance, training and spill response activities.

Non-dedicated equipment such as backhoes, dozers, crane trucks, dump trucks, vacuum trucks etc. would be called to spill sites on a priority basis in the event of need. The Mine and the transfer stations will have heavy equipment present during the operating period. This would be made available immediately in the event of need.

Equipment at the Control Points will include booms and absorbents in addition to material to create temporary dams, such as board weirs, sand bags and other inert materials that would be stored at the location. Shovels will also be left on site for use in making a dam also. A supply of soda ash will also be kept at Control Points to neutralize an acid spill.

Given the number of fuel/oil deliveries, the quantity that could be spilled if an accident occurs, and the potential duration of severity, CZN considers it appropriate to be prepared for a significant hydrocarbon spill at the key high risk locations. Temporary dams would likely only be effective for a short period before they were inundated, or liquid would start to seep. It would take time for a vacuum truck and equipment to arrive at a spill location, and this could hamper response to a large spill. Therefore, we propose to acquire two bladders with a capacity of approximately 10,000 L. This would provide the means to commence the recovery and temporary storage of spilled liquid quite soon after the spill. One would be stationed with a pump at one of the Control Points on an upstream tributary to Funeral Creek. This bladder would also

be available to the Control Point on the other tributary because they would be in close proximity. A bladder at this location is considered important because the location is some distance from the road, and it would not be accessible to a vacuum truck. The other bladder would be stored with a pump on the trailer stationed at Cat Camp. From this location, the trailer could be taken upstream (west) on Sundog Creek, or east to respond to any spills near the tributaries of Sundog Creek. These locations would address the road sections considered to have a high risk of spills, and potentially high severity. We believe a bladder would be suitable for these areas because natural stream flows should be small or non-existent, and any spill should flow in a confined channel and be amenable for recovery.

The Silent Hills is also a high risk location, but any spill there is likely to have multiple, smaller flow paths because of the absence of a watercourse. A bladder is not proposed here because it is not likely to be useful, and control strategies such as temporary dams are likely to be sufficiently effective.

Response to Specific Spills

Concentrates

Either externally clean 3,000 kg bags of concentrates will leave the Mine strapped inside truck boxes with tarpaulin covers, or bulk concentrate will be in containerized trailers with tarpaulin covers. In the event of a truck roll-over along the road, some of the bags could fall from the vehicle and there is a risk of these breaking open. Concentrate in the containers would also likely spill. Spill exercises addressing these potential occurrences will be undertaken. A back hoe may be required to pick up the material. Contaminated soil would also be recovered. If bags were to roll down a steep grade after an accident and split apart in an area where no heavy machinery access is possible, then shovels and manpower will be required to recover the material. A crane truck or helicopter may also be required in the recovery.

Bulk Fuel

Diesel fuel will be brought into the Mine via 10,000 litre tanks during operations. Each haul truck will have one such tank anchored to the vehicle. Control Point locations have been designed to stop the wider migration of spills of diesel fuel. Response equipment and material would be appropriate for the possible quantity of a spill. A worst case discharge would be the total cargo on a vehicle. Spill kits will be stocked with the necessary response material for the spill of a full tank. A vacuum truck will be on stand-by at the Mine with a capacity of at least 12,000 litres. In addition, we have proposed the use of bladders to facilitate the rapid commencement of spilled liquid recovery.

Acid

Sulphuric acid will be brought into the Mine in durable totes. Approximately 22 such loads are expected. A small risk of a spill would exist. Response equipment and material would be appropriate for the quantity and nature of a spill, and dedicated spill response kits would be appropriately stocked. A vacuum truck will be on stand-by at the Mine. Bags of soda ash to neutralize any spilled acid will also be stored in the trailers and at Control Points in animal-proof

containers (salt is an attractant to ungulates), and exchanged seasonally (to avoid caking in wet conditions).

9.6 Environmental Triggers of Accidents and Malfunctions

The MVEIRB TOR Section 7.2.2, Item 7, requires consideration of how the environment may contribute to potential accidents, malfunctions, and spills. Tetra Tech EBA has considered the ways in which flooding, overland flow, landslides and ground movement, seismic activity, and avalanche activity can affect the integrity and/or operation of the road, which in turn can have an effect on potential accidents, malfunctions and spills. These potential environmental contributors and the risk matrix and specific road design and construction mitigations to be used to manage these events are discussed in Tetra Tech EBA's report in Appendix 2.

Based on the qualitative risk assessment, Tetra Tech EBA estimated that about 7.2 km of the terrain along the proposed all-season route represents a high risk to the road route with respect to slope instabilities or other ground movements (by thawing, sliding, flowing, falling, settling or collapsing), and 54.9 km represents a moderate risk, out of a total of 174.1 km evaluated. The Liard River crossing represents a high risk with respect to flooding, and 20.65 km of the route represents a moderate risk. Other moderate risks included 4.3 km of the route for overland flow, 29.6 km for seismic activity, and 17.8 km for avalanche activity. Since there is considerable overlap in the moderate risk designations, a total of 76.7 km was estimated to represent a moderate risk to the road, and 7.4 km was estimated to represent a high risk to the road.

9.7 Cumulative Effects

Contamination

In terms of pre-existing contamination along the road corridor, the Cat and Grainger Camps are old road construction camps along the access road that pre-date the tenure of CZN and its predecessor. As such, the camps are abandoned or orphaned sites. Cat is at approximately Km 39, and Grainger is at Km 137 on the old winter road alignment. At each site, large fuel tanks and a considerable number of steel culverts are present. Accommodation trailers are also present at Cat. The fuel tanks previously stored diesel, but the fuel was disposed of by incineration by a contractor to Indian and Northern Affairs Canada (INAC). This action was taken because the tanks were leaking.

INAC subsequently contracted EBA Engineering Consultants Ltd. to investigate the sites for contamination. EBA produced reports for each site in January, 2007. The Cat site was found to have approximately 155 m^3 of contaminated soil, in addition to some lead-based paint on the trailers and asbestos tiles. The Grainger site was found to have 20 m^3 of contaminated soil. The contaminants do not appear to be mobile or an imminent threat to water quality. The limited extent of apparent contamination means a low risk of significant effects on vegetation and wildlife.

INAC approached CZN with the intent of resolving responsibility for the sites. CZN has voluntarily assumed responsibility. CZN's intent is to remediate the sites when the access road is

opened. CZN does not consider the sites to represent a potential cumulative effect because the sites will be remediated during the early part of Mine operations.

No other contamination is known to exist along the road corridor, nor is any likely in the absence of industrial activities. No development activities are anticipated along the corridor, except for the winter and all season roads, and the TTF. The winter road will precede the all season road, but any identified contamination associated with the former will be cleaned-up immediately, and there is unlikely to be a significant residual impact prior to all season road development. No industrial developments in the future are expected in proximity to the road that could cumulatively lead to water or soil contamination, with the possible exception of developments upstream in the Liard River watershed leading to potentially cumulative contamination of the Liard River if a spill occurred at the all season road river crossing.

Terrain

Effects to terrain, soils, permafrost and karst from construction and operation of the all-season road may be cumulative to those from winter road construction and operation. However, for the most part, if the all-season road is approved, the winter road alignment will also be the all-season road alignment, and therefore there will be no cumulative aspect. As noted above, there will be approximately 9.4 km of winter road alignment that would not become the all-season road alignment. The KP024.3 to KP028.3 reroute will leave a winter road section on the north side of Sundog Creek. This section mostly crosses talus that naturally ravels, and thus is self-reclaiming for the most part, as has occurred since 1981. The KP090.6 to KP095 realignment avoids wetland terrain, and will leave a winter road section crossing sparsely vegetated wetland. This section appears to be naturally reclaiming by gradual encroachment of vegetation from both sides of the ROW, and would do so again after renewed winter use. The KP122 to KP123 realignment also avoids wetland terrain, whereas the winter route will naturally revegetate when no longer in use. In addition to these realignments, there is the original winter road footprint marked by absent or different vegetation which has long wetland sections that will not be used for the new winter road. In general, these appear to be naturally reclaiming by gradual encroachment of vegetation from the sides of the ROW. Therefore, in summary, no significant cumulative impacts to terrain, soils, permafrost and karst are anticipated from the all season road.

10.0 EFFECTS ASSESSMENT – NNPR

Sections 10.1-10.8, 10.9.1 and 10.13 were extracted from Tetra Tech EBA's report in Appendix 7. Introductory discussion for the sections can be found in that report.

10.1 Ecosystem and Habitat Loss

As part of proposed project activities, habitat loss within the NNPR will occur as a direct result of vegetation clearing to accommodate the proposed all season road access route and other associated infrastructure (e.g., borrows and camp locations). It is anticipated that such effects will be mitigated by constructing the proposed all season access road within the ROW of the approved winter access road, which will limit the amount of additional clearing required for construction of the project.

Effects to the relative abundance of habitat types within the NNPR as a result of project development were quantified by comparing the mapped vegetation community types (Earth Observation for Sustainable Development (EOSD) Cover Units) present within the study area to the proposed project disturbance footprint. Table 10-1 presents the anticipated habitat loss within the NNPR as a result of proposed project construction. For comparative purposes, Table 10-1 also presents the area of each respective EOSD cover type within the project study area, which for the purpose of this assessment encompasses a 50 m buffer surrounding proposed project related disturbances.

The proposed disturbance area encompassed by the road surface (Phase I and Phase II combined) and other proposed disturbances within the NNPR will be 117.5 ha. Based on the calculated areas for EOSD land cover classes present within the 100 m wide study area, the proportion of land cover classes disturbed by the project will not exceed 20% of the respective land cover class area.

Given the low proportion of habitat loss relative to available habitat within the study area and the mitigation of project related effects by reducing clearing requirements by constructing within the approved winter road route, the extent, magnitude, duration and frequency of potential project related effects are considered low, and reversible following decommissioning and reclamation of project related disturbances. The overall significance of effects with respect to habitat loss within the NNPR is considered low and no residual effects are anticipated as a result of project construction.

10.2 Effects on Wildlife Habitat Fragmentation and Movement

The NNPR encompasses the majority of the South Nahanni River watershed, a large naturally diverse area that allows for natural ecological processes. The current level of habitat fragmentation inside the NNPR is very low and limited to the 1980's Prairie Creek Mine winter road that has naturally re-vegetated, the approved winter access road, and the visitor trails, campgrounds, and park stations, as well as natural forest fires.

TABLE 10-1: SUMMARY OF TERRESTRIAL ECOSYSTEMS POTENTIALLY DISTURBED BY PROJECT CONSTRUCTION WITHIN THE NNPR

EOSD Land Cover Class	Phase I Road Area (ha) *	Phase II Road Area (ha) *	Airstrip Area (ha)*	Borrow Site Area (ha)*	Borrow Site Access Road Area (ha)*	Tectela Transfer Facility (ha)*	Cleared Area Outside of Winter Road Route (Phase I) (ha)*	Cleared Area Outside of Winter Road Route (Phase II) (ha)*
Broadleaf-dense	3.43	5.82	0.00	1.63	0.00	0.00	0.00	0.45
Broadleaf-open	0.11	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Bryoids	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coniferous-dense	6.38	1.96	0.00	1.01	0.06	0.35	0.00	1.19
Coniferous-open	17.30	1.43	0.00	2.93	0.36	0.00	2.01	0.92
Coniferous-sparse	2.77	0.10	0.00	0.90	0.07	0.00	0.09	0.13
Exposed land	11.38	0.00	7.62	3.39	0.00	0.00	0.52	0.00
Herb	0.05	0.00	0.00	0.00	0.00	0.00	0.00	
Mixedwood-dense	5.14	5.15	0.00	2.81	0.00	1.65	0.00	2.05
Mixedwood-open	0.51	0.01	0.00	0.00	0.00	0.00	0.00	0.02
Rock/rubble	5.77	0.00	0.00	1.93	0.00	0.00	0.00	0.00
Shadow	1.58	0.00	0.00	0.78	0.00	0.00	0.00	0.00
Shrub-low	11.42	0.00	0.00	2.57	0.31	0.00	1.34	0.00
Shrub-tall	1.68	0.05	0.00	0.10	0.00	0.00	0.00	0.00
Water	0.29	0.00	0.00	0.09	0.00	0.00	0.00	0.00
Wetland-shrub	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Wetland-treed	0.00	1.79	0.00	0.04	0.00	0.00	0.00	0.00
Total	**68.49**	**16.36**	**7.62**	**18.18**	**0.80**	**2.00**	**3.96**	**4.78**

*- Values rounded for reporting purposes

The approved winter access road will be constructed at least 2 years prior to the proposed all season road. Once the winter access is constructed, an additional 8 km of right-of-way is proposed to be cleared inside the NNPR (an additional 1 km outside the park boundary), plus an airstrip (7.62 ha) and preferred borrow sources (18.98 ha, including a borrow source access road). The preferred borrow sources are proposed directly within the road right-of-way, as much as possible, and require limited access. Of the preferred borrow sources proposed within the NNPR, only one (1) requires an access road. This borrow pit access road (400 m in length) is proposed as a temporary winter access route near Phase 1 KP 47.

Habitat fragmentation may occur as a direct result of realigning 8 km of the all season access road, developing a single borrow source located off the existing road right-of-way, and the airstrip. Little habitat fragmentation will occur as a result of the proposed borrow sources since all but one borrow is directly connected to the approved winter road. Therefore, the all season access road, one borrow and its access road, and airstrip modestly increases habitat fragmentation beyond the existing winter access.

As fragmentation increases, the integrity of the habitat is reduced leading to changes in species diversity and localized movements; however, some species are considered more sensitive to habitat fragmentation than others. For instance, Salmo Consulting Inc. et al. (2004) report Moose populations appear to be more sensitive to overharvesting and other sources of mortality than compared to habitat loss and fragmentation. In contrast, Boreal Caribou (ranges outside the NNPR) are considered one of the most sensitive to linear disturbances.

As a measure of habitat integrity, linear corridor densities were estimated across the Dehcho in the Dehcho Cumulative Effects Assessment. Mapped linear corridor densities (e.g., seismic line and roads) along the all season access road within NNPR was <0.6 km/km^2 (Phase 1 and portions of Phase 2), with isolated patches consisting of older cutlines near the southern terminus of the access road outside the NNPR boundary at a density of 0.6-1.0 km/km^2.The mapped linear corridor density in the NNPR is the lowest density mapped, and is well below the Dehcho Land Use Planning Committee's (ND) cautionary threshold (1.0 km/km^2), which represents the lowest threshold at which development, upon reaching it, should be required to monitor impacts. The proposed all season access road, borrow sources, and airstrip will not significantly increase habitat fragmentation beyond the existing winter access road.

Habitat fragmentation outside the boundaries of NNPR is equally low, with several proposed NWT Protected Areas Strategy areas of interest and Draft Interim Dehcho Land Use conservation zones that permit regional wildlife movements.

Forest fires inside NNPR also lead to habitat fragmentation, and influence habitat availability and effectiveness for species. Within the area of the all season access road and airstrip, several large scale forest fires have occurred since the 1940's that have encompassed areas east of Nahanni Range, the Tetcela River and Fishtrap Creek valleys, and along the polje by-pass re-alignment. Accidental Project-related ignition of forest fires has the potential to occur along the length of the all season access road and at the airstrip. However, the access road clearing can also act as a fire break, as was the case on the Ram Plateau near Mosquito Lake.

For boreal forest birds (e.g., Olive-sided Flycatcher and Common Nighthawk) the effects of habitat fragmentation are generally unknown; however, habitat models suggest that the effects of habitat loss are far greater than increasing fragmentation (AXYS 2001). Along the all season access road and airstrip, available habitat for Olive-sided Flycatcher and Common Nighthawk (as well as other boreal forest birds) is not limiting, and movements across the proposed developments are not likely to be adversely altered.

Wildlife may change their local movement patterns and behaviour once disturbed by the all season access road, its facilities, and airstrip, as well as its traffic, embankment characteristics, and/or plowed snow banks. Any changes to their movements are directly related to their sensitivity to disturbance levels and human-activities. Wildlife sensitivity to human-related disturbances and activities vary depending on a number of factors including the species, individual, season, and past experiences. Some species may be wary of the all season access road (and its activities or snow banks) and hurriedly cross or deflect from crossing at that particular location. Northern Mountain Caribou, Moose, Dall's Sheep, and Grizzly Bear may alter their movements in response to the proposed road, airstrip, and their traffic; however, Grizzly Bear may be the most sensitive to the proposed all season access road and may show a higher degree of reluctance to cross. Although, the degree of reluctance varies, and CZN has observed grizzlies walking along the existing all season road several times in the Prairie Creek and Sundog Creek valleys. In the mountainous section (approximately Phase 1 KP 0-33) within Grizzly Bear,

Northern Mountain Caribou, and Dall's Sheep range the road currently exists as all season quality.

The sensitivity of Grizzly Bears to roads is dependent on the existing degree of fragmentation, traffic volumes, season, gender, and surrounding habitat quality. Salmo Consulting Inc. et al. (2004) suggested traffic volume was the most important predictor of Grizzly Bear movements across roads. Therefore, it is important to maintain low traffic volumes (such as 16 concentrate trucks, per day (equivalent to 1 concentrate truck approximately every 0.75 hours), which is proposed along the all season access road) throughout the life of the Project.

Weaver (2006) indicated a large area in the Mackenzie Mountains, approximately 25 km north of the all season road, as having the largest expanse of high to very high predicted Grizzly Bear densities. Based on Weaver's (2006) predicted bear density map, the all season access road from KP 0 to 39 crosses perpendicular with potential bear movements while travelling to this predicted high use area. Low traffic volumes proposed are not expected to inhibit Grizzly Bear population recovery, since studies indicate Grizzly Bears (both sexes) cross low traffic volume roads (COSEWIC 2012a; Chruszcz et al. 2003; Salmo Consulting Inc. et al. 2004).

Harlequin Ducks are also sensitive to human-related disturbances. Within the forested zone, the approved winter road, and therefore, the all season access road travels parallel with and crosses 4 km of the Sundog Creek tributary, which is possible Harlequin Duck habitat (Phase 1 KP 37-41). Although traffic along the all season access road will parallel possible Harlequin Duck habitat, it will not substantially alter Harlequin Duck movements.

In contrast, Dall's Sheep are commonly observed at and near the Prairie Creek Mine and its associated activity sites in the summer. Dall's Sheep near Phase 1 of the all season access road may be habituated to Project-related disturbances. In addition, the all season access road is located at least 500 m below possible Mountain Goat habitat along the Nahanni Range and outside the defined range of Northern Mountain Caribou, and is not anticipated to significantly affect goats and caribou.

The all season access road (estimated at 20 m wide right-of-way) and the airstrip are not considered a full barrier to wildlife movement. They are permeable, year round, to all species assessed since the proposed developments remain narrow and Project-related traffic volumes are low. With only the proposed Phase 1 development, a total of approximately six trucks, averaging 30 km/hr, will make two return trips daily from the Mine to the TTF. With the development of Phase 2, 16 Project-related trucks averaging 30 km/hr, will make a single return trip daily from the Mine to the Liard Transfer Facility (LTF).

Northern Mountain Caribou, Moose, Dall's Sheep, and Mountain Goats travel several kilometres to reach mineral licks. During this time, they may encounter the proposed all season access road, as mineral licks are known within 11 km of the Mine site, Phase 1 KP 10, Phase 2 KP 151-157, the Nahanni Access Road, and along the Liard Highway. No mineral licks are known near the proposed airstrip. Dall's Sheep, particularly ewe groups (with lambs and yearlings) commonly utilize mineral licks from June to early October; however, they are also known to habituate to human activities since they are consistently observed at the Prairie Creek Mine site. Since the traffic volumes are low, the all season access road is not considered a barrier to movements.

Forest clearing (resulting in a small level of habitat fragmentation) will occur during winter construction of Phases 1 and 2 and the airstrip, and is reversible after closure. Besides designing the all season access road and borrow source locations to follow the already permitted winter road corridor and right-of-way, no further mitigation associated with habitat fragmentation is

recommended. Potential effects to wildlife movements will occur principally during construction and operation.

The use of the Prairie Creek Mine access road by non-mine related traffic (e.g., snowmobiles, all-terrain vehicles) will be controlled to the extent possible using a check-point. As such, the potential for disturbance associated with this additional use can be minimized or avoided. As well, suitable speed limits will be enforced to minimize disturbances.

To mitigate project-related wildlife disturbances, measures recommended to minimize effects from the winter road will be continued from construction to closure of the proposed all season road and airstrip, as well as additional measures specific for all-weather use. These include:

- Strict use of CZN's Controlled Road Use Plan to minimize traffic and other disturbances and maintain low speed limits;
- Reporting and evaluating wildlife sightings along the access road, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered;
- Snow removal practices along the access road and airstrip to manage high snow banks, so that wildlife can readily move off the roadway as vehicles approach;
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road to allow them to move away.
- Discuss main issues and considerations regarding wildlife populations and effects during the Technical Advisory Committee meetings proposed by CZN in EA0809-002; and
- Report annual updates and results of the Wildlife Mitigation and Monitoring Plan, Controlled Road usage, and inspections and enforcements.

All general mitigation measures proposed are summarized in Section 10.13.

With adherence to the mitigation, the predicted effects to habitat fragmentation and barriers to movements are summarized in Table 10-2.

Confidence in this assessment is moderate since the amount of habitat fragmentation within the area of the proposed clearing is low (considering the majority of clearing has been approved for the winter road) and select species are expected to infrequently encounter the access road and airstrip (e.g., naturally low species densities, large home ranges, seasonal distribution). However, species' sensitivity to disturbances vary depending on a number of biotic and abiotic factors including season, gender, and harvesting pressure. The measurable parameter for Project-related disturbances is the number of Project-related encounters with wildlife and overall Project and non-Project related vehicle traffic recorded at the check-point annually.

Overall, the predicted adverse effects are moderate, but reversible after the Mine's life. With adherence to mitigation, there are low residual effects of low significance anticipated that will adversely alter local wildlife movements in NNPR.

TABLE 10-2: PROJECT EFFECTS ON PREDICTED HABITAT FRAGMENTATION AND MOVEMENT

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Northern Mountain Caribou	Both	Adverse	Moderate	Moderate	Moderate	Low	Moderate	High
Moose	Both	Adverse	Low	Moderate	High	Moderate	Moderate	Moderate
Dall's Sheep	Both	Adverse	Low	Moderate	Moderate	Moderate	Moderate	Moderate
Mountain Goat	Both	Adverse	Low	Moderate	Moderate	Low	Moderate	High
Grizzly Bear	Phase 1	Adverse	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Trumpeter Swan	Both	Adverse	Low	Moderate	Moderate	Moderate	Moderate	Moderate
Harlequin Duck	Phase 1	Adverse	Low	Moderate	Moderate	Moderate	Moderate	Moderate
Common Nighthawk	Both	Positive	Low	Moderate	High	Moderate	Moderate	High
Olive-sided Flycatcher	Both	Positive	Low	Moderate	High	Moderate	Moderate	High
Overall Significance								
Low								

10.3 Effects on Wildlife Species Distribution and Abundance

Species avoidance and abundance effects from Project-related disturbances can occur as a direct result of road and airstrip construction, operation, and closure activities, as well as indirectly by providing hunting access. These consequences may range from minor to strong avoidance. In areas without hunting, avoidance to roads is either non-existent or very temporal in nature (Jalkotzy et al. 1997).

The use of the Prairie Creek Mine access road by non-mine related traffic will be controlled to the extent possible using a check-point and a private Liard River barge crossing. With these controls, potential effects can be minimized. However, subsistence harvesting activities along the road may directly change wildlife abundance along the access road, and if significant, may cause wildlife to avoid the road. These potential effects may also occur during the period of winter road operation before the all season road.

A few Northern Mountain Caribou may occasionally occur near the proposed all season access road and airstrip on an annual basis; however, these proposed developments are located outside their defined range. Northern Mountain caribou may occur on the Nahanni Plateau, the lower Sundog Creek drainage, west of the Ram Plateau, and the Silent Hills primarily during the non-winter period. Disturbance related effects on Northern Mountain Caribou are considered low since the all season access road is not part of their core range (including their calving and primary winter range), and consequently, they may occur infrequently in the area. If present, Northern Mountain Caribou are likely to avoid the proposed access road and airstrip. Traditional knowledge and the Species at Risk Committee 2012 indicate that roads may affect Boreal Caribou as far as 1 km away (Species at Risk Committee 2012). Northern Mountain Caribou are assumed to be as sensitive to roads as Boreal Caribou. However, their exposures to Project-

related disturbances are expected to be limited and sporadic, and traffic levels are low, infrequent, and predictable, particularly during operation, thereby minimizing potential disturbances.

The proposed all season access road and airstrip are located primarily in low elevation habitats, approximately 500 m below possible Mountain Goat habitat on the Nahanni Range. Further, on the Ram Plateau, possible Mountain Goat habitat is located at least 4 km from the proposed access road route and airstrip, and therefore, goats are not likely to be disturbed. Roads are thought to affect Mountain Goats within a 400 m zone of influence and aircrafts within 1 km (AXYS 2001). Subsistence harvests of Mountain Goats are negligible and are not expected to alter Mountain Goat distribution and abundance. In addition, non-resident harvests are expected to be terminated inside NNPR by 2019. Mountain Goats are generally reluctant to move from their mountain blocks and, therefore, their distribution and abundance across the landscape is expected to change little over time as a result of the access road, airstrip, and negligible hunting pressure.

In Kluane National Park, Moose are relatively tolerant of roads, aircraft, and related disturbances, and the predicted zone of influence to which Moose were adversely affected by roads and aircraft was approximately 100 and 200 m, respectively (AXYS 2001). Other available evidence suggests moose may avoid linear features and other land use developments by 100 to 500 m depending on the season, sex, surrounding habitat, and hunting pressure (Salmo Consulting Inc. et al. 2004). Linear features, such as the approved winter road, may disturb Moose that have home ranges along its length.

Since subsistence Moose harvesting is permitted inside NNPR (non-resident harvests to terminate by 2019), Moose may avoid the proposed all season access road and airstrip by 500 m or more, depending on the level of hunting pressure (less avoidance distance if negligible to low hunting pressure). This has the potential to directly affect Moose abundance in a localized area. Mr. Konisenta indicated to CZN (2010) that Moose harvesting was common along easily accessible corridors; however, Moose numbers have dwindled, and are now rarely found along these same easy access routes. Mr. Konisenta attributes this partly to the introduction of bison to the area; however, hunting pressure is also a likely root cause.

By managing hunting pressure, Moose avoidance and abundance affects along the proposed all season access road may be minimized. For example, a Boreal Caribou study modelled potential habitat use (including buffer distances from roads and cutlines) and compared this with known lifetime harvest kill sites and aerial survey sightings across the Dehcho. This study indicated that Boreal Caribou distribution has remained stable at the regional level within living memory (approximately 60 years) even with hunting (Gunn et al. 2004).

Dall's Sheep sensitivity to roads and aircraft in Kluane National Park was determined to be low, with the predicted zone of influence reaching as far as 200 and 500 m, respectively (AXYS 2001). Like Mountain Goats, Dall's Sheep are generally reluctant to move from their mountain block, and therefore, their distribution across the landscape changes little over time as a result of land use developments. A few Dall's Sheep have traditionally been harvested annually from the Nahanni Range in proximity to Nahanni Butte (outside NNPR). Although none are apparently harvested now, the proposed all season access road allows access for Dall's Sheep subsistence harvesting inside the NNPR in the Mackenzie mountains which has the potential to reduce the resident population. However, boat access to Dall's Sheep inside the NNPR via the South Nahanni River exists, with low hunting pressure to date.

In Kluane National Park, Grizzly Bears were found to be the least tolerant of road-related disturbances (AXYS 2001). It was suggested Grizzly Bears are adversely affected 3 km from roads in the fall and 500 m in the spring and summer (AXYS 2001). Even on a seasonally closed road (such as a winter only road) the zone of influence was approximately 600 m, and when the road re-opened, the zone of influence increased to 1,200 m (AXYS 2001). Therefore, the proposed all season access road has the potential to affect Grizzly Bear distribution, particularly for those bears with home ranges within the Mackenzie Mountains, as the boreal forest zone generally represents the periphery of individual home ranges that are less frequently occupied. CZN's recorded anecdotal sightings suggest the numbers of grizzlies in the immediate area is low (as expected for species with large home ranges), and those present are currently not perturbed by the road. This may change with the all season traffic, but note that the road from KP 0-33 is of all season quality already and is likely to be utilized in non-winter seasons for maintenance related to the winter road permits, thus any impacts to grizzly distribution may have occurred prior to the all season road. As such, Grizzly Bear distribution is not likely to be significantly affected by the all season road.

Trumpeter Swans are also highly sensitive to human activities and developments while at their breeding ponds (ESRD 2013). Intense or sustained levels of disturbances near active breeding ponds during the breeding season may result in nest loss, clutch failure, increased predation to young, and abandonment of the entire pond (ESRD 2013). Even low level repeated disturbances over time may result in reduced use or abandonment (ESRD 2013). As a result of their sensitivity, ESRD recommends all permanent or long-term developments (including roads) avoid habitat occupied by Trumpeter Swans by 500 m (ESRD ND). Breeding Trumpeter Swans have been observed primarily in the wetlands and ponds in the Tetcela River valley and at Yohin Lake, as well as near Phase 1 KP 64 (Mosquito Lake) and 75. Known or suspected Trumpeter Swan ponds and wetlands along the proposed all season access road are outside the recommended 500 m buffer, except at Phase 1 KP 64 (Mosquito Lake) and 75. Additional wetlands occupied by Trumpeter Swans may also occur within this 500 m buffer, particularly at Phase 1 KP 65.5 and Phase 2 KP 86 and 98. Although the proposed all season access road has been re-aligned to avoid wetlands and ponds, as much as possible, potential adverse effects to a few territorial Trumpeter Swans is of moderate magnitude and moderate likelihood of effect. However, their willingness to relocate will depend on the timing of disturbances. Upon spring arrival, Trumpeter Swans may select available territorial ponds further from the access road due to the low but regular traffic volumes, thereby, avoiding road-related disturbances during the sensitive nesting and rearing periods.

Harlequin Ducks and their habitat may be sensitive to traffic related disturbances and susceptible to dust-related changes to water pH and invertebrate abundance and diversity. Considerable disturbances at the nest site may lead to site abandonment. However, potential nesting habitat is limited near the proposed all season access road and the probability of occupation is low.

The proposed all season access road is not likely to affect Common Nighthawk and Olive-sided Flycatcher distribution and abundance. Both species may occupy the proposed roadway while feeding, and prefer forest clearings and habitat edges found along the access road and airstrip. Common Nighthawks have been known to nest and forage in and near human developments, and may eventually show some degree of tolerance.

Predation can also be a significant factor in determining prey abundance and distribution. Prey species have evolved several strategies such as remaining solitary or in small groups, occupying habitats where alternate prey densities are low, and birthing in isolation near protective cover to minimize the risk of encountering a predator. The integrity of prey species habitat plays a critical

role in their strategies to avoid predation risk. Roads and other human developments decrease the integrity of habitats and increase predation risk to ungulates since predators may use roads to travel faster and access new habitats. However, in the subalpine and alpine zones where Northern Mountain Caribou and Dall's Sheep occur, access roads provide less advantage to predator travel. Similarly, in the boreal forest zone, the approved winter access road currently supports predator travel.

CZN's intent is to work with the Naha Dehe Dene Band to discourage use of the full access road by non-residents. CZN will be able to impose rules for its employees and contractors, but does not have jurisdiction to impose rules on others. Although, Parks Canada regulations for NNPR stipulate that "existing roads in NNPR are restricted access only and are not open to the public for motorized use", with exception for Aboriginal people pursuing their traditional harvesting rights (Parks Canada 2013), thereby resulting in the exclusion of non-Project related and non-Aboriginal travel along approximately 51% of the all season access road. CZN also proposes to operate a private barge on the Liard River, which will not be available for non-resident use.

These potential effects can be mitigated by implementing the following:

- Strict use of CZN's Controlled Road Use Plan to minimize traffic and other disturbances and maintain low speed limits;
- Follow dust suppression strategies (e.g., water or approved dust suppressant products) in accordance with the GNWT dust suppression guidelines;
- Prohibit pumping water from ponds occupied by Trumpeter Swans during the nesting period;
- Educate staff and contractors on CZN's wildlife policies;
- Reporting and evaluating wildlife sightings along the access road and airstrip, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered;
- Report annual updates and results of the Wildlife Mitigation and Monitoring Plan, Controlled Road usage, and inspections and enforcements; and
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road, to allow them to move away.

The predicted effects on wildlife distribution and abundance in NNPR are summarized in Table 10-3.

Measureable parameters are the number of key species (e.g., Grizzly Bear, Dall's Sheep, Moose, Trumpeter Swan) recorded along the all season access road and airstrip (similar to the camp logs) to assess the percent occupancy of species. Parks Canada (2009) uses a similar approach to monitoring Grizzly Bears observed by park visitors. This approach does not provide a measure of relative abundance, but it does provide a relative index of distribution and the number of human-wildlife encounters. In addition, the annual traffic volume reported at the check-point provides a relative measure of disturbance levels.

TABLE 10-3: PROJECT EFFECTS ON PREDICTED SPECIES DISTRIBUTION AND ABUNDANCE

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Northern Mountain Caribou	Both	Adverse	Low	Moderate	Moderate	Low	Moderate	Moderate
Moose	Both	Adverse	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Dall's Sheep	Both	Adverse	Low	Moderate	Moderate	Moderate	Moderate	Moderate
Mountain Goat	Both	Adverse	Low	Moderate	Moderate	Low	Moderate	High
Grizzly Bear	Phase 1	Adverse	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Trumpeter Swan	Both	Adverse	Moderate	Moderate	High	Moderate	Moderate	Moderate
Harlequin Duck	Phase 1	Adverse	Moderate	Low	Moderate	Low	Moderate	High
Common Nighthawk	Both	Positive	Low	Low	Moderate	Moderate	Moderate	Moderate
Olive-sided Flycatcher	Both	Positive	Low	Low	Moderate	Moderate	Moderate	Moderate
Overall Significance								
Moderate								

Confidence in this assessment is moderate since the level of non-Project related traffic is unknown but assumed to be restricted to a few local subsistence harvesters. Overall, low residual effects are anticipated.

10.4 Effects on Vegetation Species Distribution and Abundance

As significant effects to the relative abundance of terrestrial ecosystems within the NNPR are not anticipated as a result of the project, it can be reasonably assumed that the distribution and abundance of characteristic or 'common' vegetation species associated with these habitats are not likely to be significantly affected by project activities. However, populations of rare plants, which can be characterized by limited spatial distribution, limited size and/or limited densities, can be particularly vulnerable to disturbance.

Based on the results of an NWT ENR virtual herbarium database search, 16 vascular plants species, one lichen species and 13 bryophyte species currently ranked as 'may be at risk'; one vascular plant species ranked as 'sensitive' and one vascular plant species ranked as 'undetermined' by the NWT General Status Ranking Program have been historically identified within a 50 km radius of the CZN study area, the closest occurrence being located 5 km from the CZN study area.

Of the species identified as part of the ENR database search, two species (Nahanni aster and Raup's willow) are currently considered globally imperiled (G2 global status ranking – NatureServe 2014) and one species (Velenovsky's hilpertia moss) is considered critically imperiled (G1 global status ranking – NatureServe 2014), the closest occurrence of these species being located approximately 20 km from the CZN study area.

Rare plant surveys related to the Prairie Creek Mine Project and associated winter access road were initiated by EBA on behalf of CZN in July 2009, and further surveys were completed in August 2010 (EBA 2010; 2011).

In July 2009, rare plant surveys were conducted along the Prairie Creek Mine winter road; the proposed waste rock storage facility; and the area around camp and the beaver pond to the south.

A total of 340 plant observations, representing 193 species and 44 families of vascular plants, were documented during the 2009 field survey. No plant species listed within the federal SARA were observed in the surveyed areas. However, one plant species, few flower meadow rue (*Thalictrum sparsiflorum*), listed as 'May Be At Risk' (ENR 2014b), was documented along the Prairie Creek winter road and an adjacent wetland. As the species appears locally abundant within the study area, conversion of the winter road to an all season access is unlikely to threaten the viability of this species locally, considering confirmed observations were identified outside of the proposed development footprint.

Two additional plant species ranked as 'May Be At Risk' by the ENR were identified along the existing winter access road (Hornemann willowherb *Epilobium hornemanni* and linear-leaved willowherb *Epilobium leptophyllum*), have restricted distribution in the NWT with limited known occurrences, but are globally secure (Golder 2010). Six plant species ranked as 'Sensitive' by the ENR—alpine anemone (*Anemone drummondii*), bog birch (*Betula pumila*), lesser black-scaled sedge (*Carex atrosquama*), one-glume spike rush (*Eleocharis uniglumis*) alpine groundsel (*Packera pauciflora*) and yellow mountain heather (*Phyllodoce glanduliflora*) — identified adjacent to the Prairie Creek winter road have small regional distributions in the NWT with a small number of known occurrences, but are globally secure. It was concluded that impacts to these local occurrences (and potential additional occurrences near the access road) can be avoided or reduced by limiting the amount of additional land disturbance for upgrades and operation of the all season access road.

In August 2010, the proposed Polje By-Pass re-alignment was surveyed for unique or important vegetation communities and rare plants. The habitat in which the proposed Polje By-Pass re-alignment traverses was burned by a forest fire in 1996. The vegetation community now comprises a jack pine regeneration stand approximately 14 years old. No rare plants or sensitive habitats were documented within the jack pine regeneration along the proposed Polje By-Pass alignment. It was concluded that this proposed re-alignment would not threaten rare plants or sensitive vegetation communities (EBA 2011).

Based on the findings of the ENR database search and results of the rare plant surveys conducted, the extent, magnitude, duration and frequency of potential project related effects to rare plant species resulting from conversion of the approved winter access road to an all season road are characterized as low and reversible. The overall significance of effects to rare plants within the NNPR is considered low. No residual effects to rare plants are anticipated assuming appropriate application of mitigation strategies related to indirect project effects resulting from dust generation, spills and the introduction of invasive species.

10.5 Effects from Invasive Wildlife Species

Invasive wildlife species are non-native species introduced into areas beyond their natural range by humans and are capable of causing harm to the environment and outcompeting native species. To date, there are no known invasive wildlife species present in the NWT.

However, alien wildlife species, are native species that have been introduced beyond their natural ranges due to their natural dispersal from surrounding provinces or territories. Example alien wildlife species to the NWT include the House Sparrow (*Passer domesticus*) and European Starling (*Sturnus vulgaris*).

Alien wildlife species, such as the House Sparrow and European Starling, expand their distributions into new ranges and out-compete desirable native wildlife. Preferred House Sparrow habitat includes human settlements in which it remains year round. House Sparrows are reported in the communities of Fort Simpson and Fort Liard; however, there are no known reports in Nahanni Butte and the NNPR (Sullivan et al. 2009). House Sparrows are known to outcompete native bird species from suitable nest sites. Similarly, the European Starling, preferring to remain year round, occurs in and near human settlements with a component of open, grassy areas. They are relatively aggressive birds and outcompete for nesting cavities. One European Starling was observed near Rabbitkettle Lake inside the NNPR, and there have also been a few observations near the communities of Fort Liard and Fort Simpson (Sullivan et al. 2009).

Construction of the approved winter access road may already increase the range extension of invasive wildlife species such as the House Sparrow and European Starling into areas not currently occupied (or assumed to not be occupied). The winter access road will be cleared at least 2 years prior to the construction of the all season access road; therefore, the all season access road will not pose any additional adverse effects to native species from the expanded distribution of alien wildlife.

Potential effects from invasive wildlife species as a result of the all season access road and its associated infrastructure and activities will remain similar to baseline winter road conditions. Mitigation measures are not considered necessary, beyond the general mitigation and best management practices (refer to Section 6.10).

Confidence in this assessment is high since the all season access road route will be cleared and alien wildlife (e.g., European Starling) has already been recorded inside the NNPR. Overall, predicted effects from alien wildlife species expansion into the NNPR on boreal forest birds is negligible to low. No residual effects are anticipated.

10.6 Effects from Invasive Vegetation Species

Invasive plants have the ability to aggressively establish and quickly spread in new environments. These adaptations coupled with their ability to out compete native species can affect plant species richness, diversity, and the composition and function of affected natural ecosystems (Haber 1997). The successful introduction and colonization of an area by invasive plant species relies, in part, on the presence of suitable habitat, access to a source of invasive plant material, and a means of dispersal.

The disturbances associated with development projects can unintentionally create growing conditions that facilitate the successful establishment of invasive plants. Exposed soil resulting from the removal of plant cover is particularly susceptible to colonization. Dirty equipment transported to site from other areas can act as a dispersal mechanism for invasive plant propagules that may have become lodged in tires and mud.

The most effective management of invasive plants is preventing their establishment into an area (Carlson and Shephard 2007; Schrader and Hennon 2005; USDA 2006; Polster 2005; Clark

2003). Removal once established is more costly and can be particularly challenging logistically in more remote northern areas.

In August 2010 EBA completed an invasive plant survey and reclamation assessment along the existing Prairie Creek Mine access road, and a rare plant survey along the proposed and now approved road re-alignments (EBA 2011). Surveys were conducted from August 9 to 13, 2010. The study area for these surveys included that section of the access road occurring within the boundaries of the expanded Nahanni National Park Reserve.

No invasive alien plant species were documented along the portions of the access road surveyed; consequently, they are not believed to be an issue at this time.

The Prairie Creek Mine site and existing winter access road have been in place since 1982, and Mine-related heavy equipment is already on site. In the future, any new equipment would be brought in along the access road on trucks or tractor trailer units. Similarly, Mine supplies and fuel will be brought in along the access road. Invasive plants are usually brought into a site (or along an access road) through dirty vehicles or heavy equipment operating during the non-winter period, when seeds of invasive plants can more readily be mixed with mud or dirt on vehicles or equipment, and then fall off along a road way or at a work site.

The risk of invasive species introduction during the construction and operation of Phase 1 (which occurs within the NNPR) of the all season access road will be minimal, as all equipment and vehicle traffic associated with this phase of the project will be brought into the site during the winter months. Operations during the summer construction season would be within a closed system, which is the time period that is most conducive to the spread and establishment of invasive species. The risk of invasive species introduction will increase upon completion of Phase 2 of the project which would allow for the transport of vehicles and equipment during the summer months, and thereby increase the potential for transport of invasive species into the study area. It is recommended that an invasive species management plan be developed prior to project construction to determine appropriate best management practices with respect to the prevention of invasive species establishment and invasive species control. The invasive species management plan should be developed in consultation with applicable stakeholders to ensure proposed mitigation efforts comply with existing regulations which may potentially limit the application of specific invasive species control measures (e.g. use of herbicides in National Parks).

The use of seed mixes for re-vegetation of disturbance areas may also introduce invasive species. Given this risk, CZN's approach (as defined in EA0809-002) for re-vegetation of disturbed areas will rely primarily on encroachment of native species from surrounding vegetation communities.

Given the low anticipated traffic volumes anticipated for the all season road and the application of additional mitigation strategies (which should include an invasive species management plan) the extent, magnitude, duration and frequency of potential effects from invasive species introduction are considered low and reversible.

Overall, the significance of effects from invasive plants is expected to be low. No residual effects are anticipated assuming the appropriate application of mitigation strategies

10.7 Effects on the Ability of Wildlife Species to Recover

Effects at individual and wildlife population levels are known to incur with increasing human developments and activities. Habitat loss and fragmentation, changes to movements and behaviour, and mortality are key examples of development-related effects that, if significant, have the potential to adversely affect the condition of species.

Minimizing habitat loss and fragmentation and avoiding sensitive wildlife areas and unique landscapes identified by the Naha Dehe Dene Band and Parks Canada were fundamental in the routing design of the winter road, and thus the all season access road. Similarly, limiting Project-related disturbances and traffic-wildlife encounters are inherent in the Project operations design. Wildlife-Project encounters, which have the potential to alter wildlife movements and increase mortality, are anticipated to occur most intensely during the construction and operation phases. At Project closure (approximately six years after Mine closure), Project-related wildlife encounters will be significantly reduced and habitats will be recovering, permitting the recovery of species populations.

Species, such as Grizzly Bear and Northern Mountain Caribou that have large annual ranges, low reproductive rates, and/or have specialized needs are often considered to have low ecological resilience and are less likely to recover from unacceptable effects (Salmo Consulting Inc. et al. 2004). A certain level of available habitat is required to maintain viable populations in a given land base. Grizzly Bears are believed to require at least 1,000 ha of available habitat (minimum patch size) (Salmo Consulting Inc. et al. 2004).

Grizzly Bears are known to have relatively low resilience (COSEWIC 2012). In NNPR, an expansive area that is predicted to support high to very high Grizzly Bear densities occurs approximately 25 km north of the all season access road (Weaver 2006). This area was suggested to be particularly important to support a viable grizzly population. Parks Canada estimated that 665 Grizzly Bears are currently present in the NNPR, and suggest 500 bears are required to maintain a viable population (Parks Canada et al. 2009; Weaver 2006).

Northern Mountain caribou have relatively low reproductive rates, are forage specialists, and have relatively high calf mortality. The proposed all season access road and airstrip are located outside the defined range of the caribou herds occupying NNPR. ENR (2014) explained that “trace occurrences” of Northern Mountain caribou are known in the area east of the Mine site to the Nahanni Range. Consequently, the all season access road is not located within a core caribou area. The proposed Project will not affect the ability of Northern Mountain caribou herds to recover as only a small portion of the herd is expected to be infrequently exposed to the proposed Project.

Species such as Moose respond quickly during habitat recovery, as twin births are common after forest fires or human disturbances (e.g., clear-cuts). Forest renewal after habitat disturbance and natural fire cycles will promote Moose recovery.

Other species, such as small mammals, have the highest ecological resilience as they mature early, have high reproductive rates, and are habitat and/or food generalists (Salmo Consulting Inc. et al. 2004).

The proposed all season access road will include a 4 km re-alignment within the boreal forest zone and an additional 4 km re-alignment in the Nahanni Plateau subalpine tundra (plus an additional 1 km outside park boundaries). Although the proposed all season access road may directly affect 4

km of boreal forest bird habitat within the NNPR, only a fraction of the regional populations will be exposed to the Project-related habitat loss and activities, and adverse Project-related encounters as a result of traffic are considered inconsequential at the population level. Therefore, the Project is not anticipated to change the ability of boreal forest bird species present within NNPR to recover.

Trumpeter Swans have a relatively low resilience since they will not re-nest if a clutch is lost, have specific breeding and staging habitat requirements, and delayed maturity (ESRD 2013). The proposed all season access road mainly avoids wetlands and ponds, particularly those in the Tetcela River valley where breeding Trumpeter Swans concentrate. However, the access road alignment runs adjacent to the shoreline of Mosquito Lake, where "a few swans" (assumed to be Trumpeter Swans) were observed during the June 2006 aerial survey. Any Trumpeter Swan potentially breeding at this lake, and any other large pond within approximately 500 m of the all season access road, may be adversely disturbed by Project activity. Since Trumpeter Swans are territorial during the nesting season, it is likely that a single pair will occupy a breeding lake (ESRD 2013); therefore, minimizing the number of individuals affected for a given wetland disturbance. Although the proposed all season access road may affect a few Trumpeter Swans, it is not expected to adversely alter their ability to recover since the proposed road routes at least 500 m away from most core breeding ponds.

Potential Harlequin Duck nesting habitat is extremely limited near the proposed all season access road. Although Harlequin Ducks and their habitat are particularly sensitive to human-related disturbances, the likelihood of their occurrence near Project-related activities is low.

At a landscape level, species that occur in isolation from other larger populations are less resilient, have less ability to recover, and are less likely to persist over time. The long term maintenance and viability of a population is a balance between individuals removed from a population (e.g., dispersal, mortality) and those introduced (e.g., immigration and birth) (AXYS 2001).

Although infrequent, Dall's Sheep dispersal to new ranges has been reported, particularly involving young rams, although adult ewes have also been documented dispersing (Simmons 1982). Dall's Sheep occupying the Nahanni Range and Ram Plateau are spatially isolated from larger populations on the Nahanni Plateau and Mackenzie Mountains; however, infrequent dispersal is anticipated.

Similarly, The Ragged Range near the Yukon border was identified as core Mountain Goat range; however, smaller discontinuous, occupied areas exist along the South Nahanni River (Wilson and Haas 2012). Although Mountain Goats were not observed during the Prairie Creek Mine and access road aerial surveys, defined Mountain Goat range near the all season access road occurs along the Nahanni Range as well as further north onto the Ram Plateau and south onto the Headless Range. Mountain Goats, primarily juvenile males have been reported dispersing up to 93 km. Mountain Goats possibly occurring on the Nahanni Range and Ram Plateau are not completely isolated from the other populations along the South Nahanni River, and dispersal likely occurs.

Possible dispersal corridors for Dall's Sheep and Mountain Goats are unknown; however, preferred routes of travel may include the South Nahanni River and creeks with suitable canyons and steep topography. Nonetheless, the all season access road mainly travels parallel to potential dispersal corridors, and is not expected to impede dispersing individuals. In addition, low traffic

volumes will be maintained which should minimize wildlife-vehicle encounters during operations.

Mitigation to possible changes in species ability to recover have been incorporated into the design of the all season road and its operations by routing it in direct association with the winter road, re-aligning around important wetlands and wildlife areas (where possible), and maintaining low traffic volumes. The following additional mitigation is proposed:

- Strict use of CZN's Controlled Road Use Plan to minimize traffic and other disturbances and maintain low speed limits;
- Prohibit pumping water from ponds occupied by Trumpeter Swans during the nesting period;
- Educate staff and contractors on CZN's wildlife policies; and
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so, particularly when in convoy) for all wildlife seen on or immediately adjacent to the road, to allow them to move away.
- Discuss main issues and considerations regarding wildlife populations and effects during the Technical Advisory Committee meetings proposed by CZN in EA0809-002; and
- Report annual updates and results of the Wildlife Mitigation and Monitoring Plan, Controlled Road usage, and inspections and enforcements.

The predicted effect from the proposed all season access road on wildlife species' ability to recover, after mitigation is applied, is summarized in Table 10-4.

TABLE 10-4: PROJECT EFFECTS ON PREDICTED ABILITY OF WILDLIFE SPECIES TO RECOVER

Species	Road Phase(s)	Direction	Magnitude	Geographical Extent	Duration	Frequency	Reversibility	Certainty
Northern Mountain Caribou	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Moose	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Dall's Sheep	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Mountain Goat	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Grizzly Bear	Phase 1	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Trumpeter Swan	Both	Adverse	Moderate	Moderate	High	Low	Moderate	Moderate
Harlequin Duck	Phase 1	Adverse	Moderate	Low	High	Low	Moderate	High
Common Nighthawk	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Olive-sided Flycatcher	Both	Adverse	Low	Moderate	High	Low	Moderate	Moderate
Overall Significance								
Low								

Confidence in this assessment is high since the proposed all season access road is not located in core habitat, traffic volumes are low, and access control will be implemented. A measurable parameter is the number of key species (e.g., Grizzly Bear, Dall's Sheep, Moose, Trumpeter Swan) recorded along the all season access road to assess the percent occupancy of species. This approach does not provide a measure of relative abundance, but it does provide a relative index of distribution and the number of human-wildlife encounters. In addition, the annual traffic volume reported at the check-point provides a relative measure of avoidance.

With adherence to mitigation, there are no residual effects restricting the recovery of species.

10.8 Effects on the Ability of Habitat to Recover

It is understood that the all season access road will be reclaimed within six years of the closure of the Prairie Creek Mine site. As part of the reclamation objectives for the project, it is anticipated that re-vegetation of the roadway, borrow sources and other disturbances associated with the development of the all season access road will occur primarily through encroachment of native species from surrounding vegetation communities.

A reclamation assessment of the original winter road was conducted by EBA (EBA 2011) to assess the progress of natural reclamation (re-vegetation) of the roadway. Based on the findings of the assessment, it was determined that natural re-vegetation of the roadway was occurring and species composition on the roadway was reflective of species present in adjacent undisturbed habitats. Given the similarity of habitats between the original winter access road and the proposed all season access road, it can be reasonably assumed that reclamation of disturbances along the proposed all season access would progress along a similar trajectory as the original winter road, assuming efforts are made to re-establish and/or maintain conditions on disturbed sites that are conducive to the re-establishment of native vegetation species.

As part of the DAR prepared for the approved winter road access, CZN has committed to constructing road infrastructure in accordance with standard industry best practice, including guidelines described in the *Northern Land Use Guidelines: Access Roads and Trails* (INAC 2008). It is anticipated that adherence to such practices will assist natural re-vegetation and re-establishment of disturbed habitats within the project area. All best management practices, including the salvage of topsoil, erosion control measures, and the maintenance of the existing hydrological regimes (using appropriately placed culverts or other methods) should be determined prior to construction.

Assuming adherence to standard industry best practices during construction, the extent, duration and frequency of potential project related effects to the ability of disturbed habitats to recover are considered low and reversible.

Overall, the significance of effects is expected to be low. No residual effects are anticipated assuming the appropriate application of mitigation strategies.

10.9 Ecosystem Functioning

10.9.1 Wildlife and Vegetation

Tetra Tech's scope of work for this assignment was the assessment of potential project related effects to wildlife and vegetation resources, including potential effects to these resources within the confines of the NNPR.

The preceding sections detail the assessment of potential project related effects to specific facets of ecosystems within the NNPR as they relate to wildlife and vegetation, including potential ecosystem effects pertaining to habitat loss, habitat fragmentation, species distribution and abundance, invasive species and the ability of habitats/species to recover from potential project related effects. The significance of effects for all for these ecosystem considerations was determined to be low to moderate, while residual effects were not anticipated or could be managed with appropriate mitigation strategies.

Given the low significance of project related effects to individual wildlife/vegetation considerations examined as part of the NNPR effects assessment and the high probability of successful management of residual effects associated with proposed project development, the significance of effects to the overall function of ecosystems as they pertain to wildlife and vegetation within the NNPR is considered low, assuming adherence to applicable mitigation strategies.

10.9.2 Water Quality

This section details the assessment of potential project related effects to ecosystems within the NNPR as they relate to water quality, and the ability to recover from potential project related effects.

Potential effects on water quality are related to ground disturbances and sediment in runoff associated with road construction and reclamation, sediment in runoff from freshet and intense rainfall events, and leaks and spills from road construction, operation and reclamation.

Sediment can be created during construction and reclamation activities associated with sheet flow over disturbed surfaces, and erosion and channelling leading sediment discharge to watercourses. Activities close to watercourses have a greater potential for effects. Sediment discharge during road operations may be associated with the freshet and intense rainfall events, and surfaces may be erodible if they have not been stabilized, if there is insufficient drainage control, if flows are greater than those assumed for the design of structures, and if there is slope instability from degradation, permafrost thaw, or seismicity.

Issues related to sediment discharge can be effectively mitigated with appropriate construction and design approaches, employment of best practices for all activities, appropriate road maintenance and sediment control measures. Suitable techniques can and should be detailed in the following plans: Sediment and Erosion Control Plan; Construction, Operation and Maintenance Plan; and, Interim Closure and Reclamation Plan. Assuming such plans are developed and adhered to, the effects of sediment discharge on water quality should be low.

Despite all efforts to control sediment release, there will likely be instances of unforeseen discharge. However, such instances are typically of short duration, and impacts are limited. These events typically occur associated with high runoff or flow events. During these times,

there is usually a high sediment load in water courses already, and the sediment discharge from a disturbed area represents a small fraction of the sediment load.

Therefore, the significance of effects from sediment discharge on water quality for ecosystem considerations was determined to be low, and residual effects are not anticipated or can be managed with appropriate response activities.

Effects from leaks and spills were considered in Section 9. Effects on water quality in the NNPR were determined to be low to moderate. Appropriate mitigation was discussed in the form of road design and operation considerations to promote safety, controlled vehicle speeds, and spill response planning. Residual effects are possible from a significant hydrocarbon spill, but the overall risk is considered to be low, and not likely to be significant on an ecosystem scale.

10.9.3 Fish

Section 4.5 provided details of fish presence in streams crossed by the access road. The Sundog system hosts grayling primarily. The Tetcela system hosts a wider variety of fish. Given that the risk of effects on water quality from sediment release and leaks and spills is generally low, effects on fish should also be low. Further, road construction will occur mainly outside of the spring period when grayling and other fish spawn, and if any construction work occurs in spring, it will not be proximal to fish-bearing watercourses. Therefore, the potential for effects on the important life stage of the fish present fish will be limited. Appropriate crossing structures have been designed for fish-bearing streams. Section 6 advised that a portion of a Sundog channel will need to be re-aligned away from the south bank of the floodplain to allow for road construction. Similar habitat will be created towards the centre of the floodplain, 'anchored' by large boulders which will also create pool habitat. Therefore, habitat area and value will be maintained.

There is considered to be a low significance of project related effects to fish in terms of function of ecosystems within the NNPR.

10.10 Karst Formations

Golder Associates (2010) completed a terrain assessment of the winter route as part of EA0809-002. Their report is Appendix 16 to that DAR. Regarding karst, Golder concluded the following: "The risks to the proposed access route from the potential for renewed subsidence associated with the karst features appear to be small. Nonetheless, it is recommended that the zone of intense karst terrain that exists in the vicinity of Km 56 be avoided by re-routing the access route to the north of the karst valley". The Polje Re-alignment was adopted and provided for the said re-routing, taking the road north and avoiding the poljes. This was also a request by Parks Canada. Since the all season road will generally follow the winter alignment, including the Polje Re-alignment, similar conclusions can be drawn with respect to karst formations.

In their report, Golder did make a recommendation regarding karst: "Map subsidence features on the Ram Plateau between Km 59 and Km 84, within about 200 metres of the road. Annually review these features and document any change in conditions". This was proposed as a monitoring approach to provide early warning of any subsidence developing. This recommendation would be adopted for the all season road also.

10.11 Wilderness Quality and Visitor Experience

The majority of visitors to the NNPR visit locations along the South Nahanni River, including Virginia Falls, Deadman Valley, Krauss Hotsprings, Cirque of the Unclimbables and Rabbitkettle Lake. Most of these visits are relating to raft/canoe trips downstream from Virginia Falls, or rock climbing/hiking trips. All visitors access the park via small planes, usually on floats but also by wheeled landings. Once at their landing locations, visitors will not encounter commercial traffic, other than other small plane flights coming and going during their trips, or larger plane over-flights at high altitude. There visitors have no contact with the Mine, and most are likely unaware of its presence. During all season road operations, these visitors will be distant from the road, and similarly will likely be unaware of road activities. There will be some aircraft traffic associated with the road, but this will be north and east of the South Nahanni River, will probably not be noticed by visitors on the river, and will be a small increment compared to regular park traffic in summer. Therefore, the all season road is not expected to have any negative effects on visitors to the South Nahanni River.

To our knowledge, there are very few visitors to the NNPR in proximity to the road alignment. There have been a few in some years, but most years there are none. We believe the people that have visited sought out the area for wilderness quality and hiking. Most likely the area receives few visitors because of the absence of fixed wing landing locations, and perhaps also because of less advertising compared to the other park attractions. During all season road activities, Phase 1 and 2, these visitors will notice the road, and their visitor experience will be impacted. However, this situation is counter-balanced by the improved access the road will represent, and the likelihood that considerably more visitors will use the road to access the park, and if an airstrip is built on the Ram Plateau, visitor numbers are likely to increase further.

Following the 2009 expansion, the NNPR now covers an area of 30,000 km^2. There are vast areas of the area where no activity at all occurs. Therefore, the area is not lacking in wilderness opportunities. Consequently, all season road activities are considered to be of low negative significance in terms of visitor experience, but potentially of high positive significance in terms of increasing the number of visitors.

10.12 Long-Term Changes

A low significance of project related effects to wildlife/vegetation was concluded in the assessment above. A low risk of effects to water quality, fish and karst formations was also determined, and no significant negative effects on visitors. Long-term use of the road does introduce a risk of accumulation of contaminants over time, and of the possible introduction of invasive species. The mitigation strategies for these risks should ensure they do not become significant.

As noted above, the development of an all season road and airstrip will afford better access to the area, and realistically could enable a significant increase in visitors, and raise the overall NNPR visitation above the recently stagnant 900-1,000 range per year. This positive outcome could be the most significant long-term change to the park.

10.13 Nahanni National Park Reserve Mitigation and Best Management Practices

During EA0809-002, the original winter access route was optimized to reduce environmental and logistical risks. With direct consultation with the Naha Dehe Dene Band and Parks Canada, four re-alignments were included in the revised and approved winter road route to avoid unique karst terrain and areas considered sensitive to wildlife. Therefore, mitigation has effectively been applied to limit impacts, including direct and indirect habitat loss, disturbance to wildlife, and mortality within NNPR at the design stage.

The Nahanni National Park Management Plan (Parks Canada 2010) seeks opportunities to maintain the quality of the land, water, air, and wildlife, while expanding visitor experience and encouraging the discovery of NNPR by visitors and respecting traditions and cultural values. This park plan recognizes the Prairie Creek Mine and its access road within the NNPR expansion area, and provides mitigation to minimize potential effects to wildlife from the road (e.g., access control) as well as park-related activities involving potential visitor disturbances, trail development, and aircraft disturbances.

Besides the general mitigation and best management practices outlined in Sections 5.0-7.0, mitigation specifically outlined to avoid and/or minimize effects to the Nahanni National Park Reserve from Project-related construction, operation, and closure is provided:

- Adherence to standard industry best practices during construction;
- Strict use of CZN's Controlled Road Use Plan to minimize traffic and other disturbances and maintain low speed limits;
- Prohibit pumping water from ponds occupied by Trumpeter Swans during the nesting period;
- Snow removal practices along the access road to manage high snow banks, so that wildlife can readily move off the roadway as vehicles approach;
- Educate staff and contractors on CZN's wildlife policies;
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so, particularly when in convoy) for all wildlife seen on or immediately adjacent to the road, to allow them to move away;
- Discuss main issues and considerations regarding wildlife populations and effects during the Technical Advisory Committee meetings proposed by CZN in EA0809-002;
- Report annual updates and results of the Wildlife Management Plan, Controlled Road usage, and inspections and enforcements;
- Reporting and evaluating wildlife sightings along the access road and airstrip, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered;
- Hunting, trapping, harvesting, and fishing by site employees and contractors will be prohibited;

- Managing the small portion of the winter road not used for the all season access to prevent predator and non-Project related travel of the corridor, if necessary;
- Pets will be prohibited along the access road; and
- The appropriate regulatory agencies (i.e., GNWT ENR and Parks Canada) will be contacted to receive additional direction regarding new issues that arise.

10.14 Cumulative Effects

With the application of the proposed mitigation measures, there is one residual effect identified for the proposed all season access road and airstrip in terms of the NNPR ecosystem:

- Adverse residual effects to Grizzly Bear movements in NNPR.

Over the larger geographic region, there are a small number of human developments and activities that may interact to cumulatively affect wildlife in NNPR:

- Highway 7 (a gravel road considered to be a low traffic highway by the Department of Transportation (DOT)) and the Nahanni Butte access. The average annual daily traffic volumes on Highway 7 collected from 2002 – 2011 ranged from 30-50 vehicles, with peak summer (June, July, August) daily traffic volumes reaching 40-70 vehicles (DOT 2012); and
- Active and inactive mines, their access roads, and airstrips including:
  - The Selwyn Project includes a 22 km approved access road (the Howard's Pass Access Road) at the headwaters of Flat River that is located inside the expanded NNPR boundary. This access road has been granted a 30 year licence of occupation. This mine and access road is located within the annual ranges of the Nahanni Complex and Finlayson caribou herds. The Prairie Creek Mine and access road are located at the extreme limit of the Nahanni Complex herds' winter range.
  - The Cantung mine includes a low traffic gravel road constructed in the early 1960's (referred to as the Nahanni Range Road). This road is located in the upper reaches of the Coal and La Biche river watersheds, immediately outside the expanded NNPR border. This road is managed by controlled gated access, with an apparent high level of success (Anderson et al. 2002). The Coal River Northern Mountain Caribou herd (part of the Nahanni Complex) occupies this area in the spring, summer, and fall, and crosses this road on their annual migrations (Weaver 2008). The Prairie Creek Mine and access road are located outside their defined annual range; however, a few caribou may occur near the all season access road in the winter.
  - The existing DAR (CZN 2010) considered the Mactung Mine, 339 km to the northwest, too far from the Prairie Creek Mine and its access road and was not likely to act cumulatively with the Prairie Creek Mine and activities. Species with large home ranges, such as Grizzly Bears and Northern Mountain caribou, were assessed. Management measures, including a Bear Management Plan for the Prairie Creek Mine and its access road, can go a long way to reduce the risk of cumulative impacts to regional grizzly populations. Similarly, the Mactung mining project predicts that there will be no effects on the overall health and migration of the Redstone caribou population. The Redstone herd may also occur in the area of the Prairie Creek mine;

however, it is thought to be subdivided into two subherds, with only the Moose Horn River subherd potentially occupying the area of the Prairie Creek Mine, but does not encompass the Mactung project area.

- Prairie Creek Mine is at KP 0 of the proposed all season access road. Three residual effects were identified for the Prairie Mine and winter access road, these included (Golder 2010):
  1) Potential for air traffic effects to Dall's sheep lambing activity in the spring (May-June) on the slopes above the airstrip and on Folded Mountain;
  2) Potential for mortality of Dall's Sheep, Woodland Caribou (no distinction between Northern Mountain and Boreal woodland caribou), Moose, and Wood Bison from operation of the access road (November to mid-April) when populations are present in proximity to the access road alignment; and,
  3) Potential for movements of Woodland Caribou and Grizzly Bear to be affected by sensory disturbance related to mine site activity and human presence.

Overall in the wildlife cumulative effects assessment for the Prairie Creek Mine and the winter access road, Golder (2010) predicted the Selwyn, Cantung, and Mactung projects (proposed and active) were too far from the Prairie Creek Mine and its access road to likely interact adversely. The Prairie Creek Mine site is 186 km air distance from the existing Cantung mine site, 242 km from the Selwyn Project, and 339 km from the propose Mactung Mine development area (Golder 2010).

There has been low industrial interest in the local area, which has been driven by land withdrawals over the past decade as the Dehcho Land Claim Process has been on-going (Senes 2011). Reportedly very few industrial interests were within or close to the Sambaa K'e candidate protected area given its remote location, climate, and small population base which limit economic growth potential (Senes 2011). Similar limits to industrial interest are anticipated in the region of the NNPR.

Besides human developments, there are other conservation programs occurring over the larger geographic region that have the potential to moderate adverse effects from human developments. Connecting to the NNPR, large corridors surrounding major rivers (e.g., the Mackenzie, Root rivers to the north) are defined as conservation zones in the Draft Interim Dehcho Land Use Plan, as well as large areas further away encompassing Sibbeston Lake to the North Nahanni River and Arrowhead Hills (NWT PAS 2014). Trout Lake (Sambaa K'e), approximately 100 km southeast of NNPR, is a proposed National Wildlife Area (NWT Protected Areas Strategy candidate protected area). Inherent in the values of conservation zones and national parks/wildlife areas, any new industrial developments will be prohibited. Therefore, little additional land use developments are anticipated in the immediate future surrounding NNPR to adversely interact with residual effects potentially occurring as a result from the proposed all season access road.

Grizzly Bear adverse effects potentially persist as a result of the proposed all season access road and airstrip after mitigation is applied. Residual wildlife effects from the proposed all season access road has the potential to interact adversely primarily with the Prairie Creek Mine and its airstrip. These could affect Grizzly Bear.

The proposed all season access road effects assessment includes associated effects during winter operations, and therefore, essentially negates the predicted winter operation effects.

Grizzly Bear: The environmental assessment for the Prairie Creek Mine and winter road predicted a low but manageable risk to the regional Grizzly Bear population associated with bear-human encounters and mortality (Golder 2010). Golder (2010) suggested this risk to regional grizzly populations could be managed with a Bear Management Plan for the Prairie Creek Mine. Potential residual effects to Grizzly Bear movements through NNPR were predicted from the proposed all season access road. However, since traffic volumes and speed limits will remain low, and there are few resident bears using the Prairie Creek corridor, no further mitigation is considered necessary beyond the Bear Management Plan.

Water and sediment impacts on fish from road construction and operation in the Prairie Creek and Funeral Creek watersheds have the potential to be cumulative on potential impacts on fish from Mine operation, including treated water discharge which could affect migration patterns. However, no residual impacts on water quality or fish are predicted from the road development, and therefore there is no cumulative aspect.

11.0 EFFECTS ASSESSMENT – SUBJECTS OF NOTE

11.1 Terrain, Soils, Permafrost and Karst Topography

Sub-sections 11.1.1, 11.1.2, 11.1.4 and 11.1.5 were extracted from the Tetra Tech EBA report in Appendix 2.

11.1.1 Potential Effects Due to Road Construction Activities

The proposed road development is described in detail in earlier sections of this report. In general, construction activities will include:

- Development of winter access roads;
- Road construction in winter, summer or fall;
- Set up and operation of camps;
- Drilling for geotechnical investigation along the alignment and in the borrow sources and quarries;
- Stripping and stockpiling of organic material from borrow sources and quarries;
- Removal of material from borrow sources and quarries; preparation of material if/as needed for use; stockpiling;
- Hauling and placing of borrow material for the all-season road;
- Installation of bridges and culverts;
- Grading and compaction of constructed embankment; and
- Placement of surfacing gravel.

All of these activities require travel across the ground (as described above in terms of the terrain, geology, soils and permafrost) along the route and to borrow sources, or working in an area of open cut in a borrow source. The ground is in its most vulnerable state in the spring, summer and fall when the air/surface temperature is increasing, and the active layer is thawing or thawed. Travel over ground with tracked or wheeled equipment when the ground is in this vulnerable state can potentially cause deformation of or damage to the soil and vegetative surface (particularly in areas of soft, fine-grained soils and peat), compaction of organic peatlands, pumping of water to the surface or collection of surface water in deformations to form areas of standing water.

In areas of ice-rich permafrost, the change in ground surface characteristics could result in an increase in ground surface temperature and a corresponding increase in the depth of the active layer and subsequent thaw slumps, thawing of ice-rich soil, slope and soil instability, erosion and subsidence in the permafrost. Subsidence or the presence of new low-lying areas or surface channels can also change the surface water drainage, even beyond the area of vehicle travel. With thermal and physical erosion comes the likelihood of sedimentation.

Constructing roadway cutslopes in thaw-sensitive permafrost would require the removal of the organic layer, and cutting into the ground, both of which potentially expose permafrost, which in areas of ice-rich permafrost could cause subsidence and water ponding along the cutslope and embankment toe, excessive erosion and sedimentation, thaw that progresses from the cutslope and then under the road, causing excessive settlement or complete loss of the road embankment, or even a retrogressive thaw slump or flow that results in the ongoing failure of the slope continuing above the original cutslope. The same issue applies to the extraction of construction materials from borrow sites. If such borrow sites are located adjacent to the road, these issues are likely to also affect the road. Where borrow areas are not located in permafrost, there may still be the potential for erosion and sedimentation occurring, or sloughing and collapse of over-steepened borrow pit slopes.

The all season road has the potential to disturb existing slope instabilities or to create new instabilities, both large and small. Although such features can reactivate on their own, disturbance can increase the likelihood of reactivation. For example, if the road reroutes surface water drainage into a marginally-stable area, slope instabilities could result. Or, if the road cuts into the supporting toe of an old landslide, that cut could result in the slide reactivating, even if it is not a slope in permafrost soils. Cuts in rock slopes or talus or scree can also result in loss of toe support. As well, if large fills are placed in marginally-stable areas, the additional weight of the fill may reactivate old instabilities, whether it is an outright slope failure, or merely an increased rate of slope creep.

Road construction can also result in general soil disturbance and an increase in erosion and sedimentation compared to natural levels.

11.1.2 Potential Effects Due to the Physical Presence and Operation of the Road

The ground (terrain, geology, permafrost and karst) can also be affected by the physical presence of the all season road including embankment, bridges and culverts after it is built. There are significant issues and challenges in constructing and operating a road in discontinuous permafrost terrain.

The perception that the existing winter road is in relatively good condition may suggest that much of the ground is not too sensitive to permafrost thaw. However, a properly constructed and operated winter road, even in highly thaw-sensitive permafrost terrain, should lead to little or no disturbance of the ground surface and no permafrost degradation. There are numerous examples of successful winter roads throughout northern Canada, many on winter road routes that have been operated for decades. In contrast, places where disturbance from winter road operation has been observed can all be linked to terrain disturbance during either winter road construction when there is still insufficient snow cover, or operation of the road too late into spring, after thawing has already started. The relatively good condition of the existing winter road is probably more indicative of the two winters of use it experienced, along with reasonable winter road construction and operating practices, followed by 33 years of vegetation regrowth.

As noted above, permafrost and ice-rich soils are highly sensitive to changes in ground temperature, and this is particularly true of the warm permafrost found along the route. Even slight changes can cause an increase in the thickness of the active layer, instability, thaw settlement and subsidence due to loss of permafrost. Introducing a new material on the ground surface could change this balance. For example, in warm permafrost, the edges of the embankment tend to allow the permafrost beneath to thaw, typically causing ponding along the

embankment toe, while in the middle of the embankment, the permafrost may be preserved or even grow. Snow drifting tends to increase this effect. Although the road grade is plowed, the sides of the embankment tend to build up drifted or plowed snow, which insulates the ground and reduces the amount of heat escaping from the ground in winter. This means that the permafrost on the edges of the fill does not cool as much in winter as it would without an embankment, while in the middle of the road, it might even be colder than normal because it is plowed all winter. The snow drifting/plowing effect can potentially reach well past the toe of the embankment.

The road fill can also form a barrier to the movement of unchannelized surface water, resulting in another source of surface water that can accumulate or pond along the toe of the embankment, which in turn can contribute to additional thermal erosion (thawing), and also potentially to slope stability issues. Similarly, the embankment can also create preferential paths for surface water drainage that do not match with the natural surface water drainage pattern, where water runs along the toe of the road fill for some distance instead of across it. In this case, the water can also contribute to physical erosion. Locations where the water is finally directly downslope can also be affected, by erosion and even slope instabilities. Even subsurface water flow in the active layer can be affected if the depth of thaw is greater at the edges of the embankment than at the middle, as this creates another way in which cross-road drainage can be blocked. Culverts can also contribute to heave in the winter and thaw settlement in the summer in soils that are frost-susceptible and thaw-sensitive, and can result in thermal erosion in ice-rich terrain.

As mentioned previously in the discussion on climate change, the challenges of constructing and operating roads in warm discontinuous permafrost terrain are very evident on Highway 3 (Yellowknife to Behchoko) and Highway 7 (Liard Highway), both of which have been plagued by continuous settlement issues and instabilities, even after a significant reconstruction in the case of Highway 3. While it is noted there are some differences in the operational, service life and construction characteristics of the territorial highways as compared to the proposed Prairie Creek all-season road, there are some useful comparisons. The similarities in permafrost characteristics and terrain characteristics indicates that particular care needs to be taken in the design and construction of the all-season road, in order to mitigate the anticipated effects of road presence and operations.

11.1.3 Road Bed, Traffic and the TTF

In addition to the commentary above, regarding the weight of the road bed, this issue arose during EA0809-002 during the first information request (IR) round. IR9 from Parks Canada asked the following:

“Provide details for areas of the access road that are constructed where karst is at, or near, ground surface, as well as sinkhole locations. Specifically, describe the geotechnical stability of the road in light of the characteristics of the karst, traffic loadings, and traffic activities.”

The response provided by Golder Associates was as follows:

“With respect to portions of the access route that traverse through land that contains karst features, this section extends approximately from km 48 to km 85, with intense karst terrain in the vicinity of km 56. Collapse features in the vicinity of the former access route through the

poljes are shown on Figure II-2 of the Terrain Assessment Report (approximate scale 1:20,000). The extent of the Ram Plateau is shown on Figure II-4 (August 2010) at an approximate scale of 1:50,000. The locations of some individual features are shown at this scale. Generally sinkhole features are not evident in the vicinity of the access route east of approximately km 75.

With respect to the geotechnical stability of the karst features, reliance was placed on three lines of inquiry: 'Do any of the closed depressions and karst features appear to have formed recently?', 'Do any of the existing features appear to have been recently active?' and, 'Within the valley that contains the poljes is there any evidence of land movement along the former access route?' Answers to these questions are included in Section 10 of the Terrain Assessment Report and are discussed below:

- No new closed depressions or specific karst features appear to have formed recently.
- One significant subsidence feature that appears to be recently active is evident, though it is located approximately 5 km south of approximate km 63 on the former access route. This feature is approximately 500 to 600 m across and is evident on the 1994 air photos. A review of this feature in September 2009 also showed evidence of relatively recent subsidence movement. Other than this feature, no other features in the vicinity of the access route appeared to be currently active.
- A foot traverse along the former access route through the polje valley revealed one example of dislocation of the road grade since it was abandoned 28 years ago. This feature is located at approximately km 54+500 at the elevation of the plateau and consists of vertical displacement of approximately 1 to 3 m over a length of approximately a hundred metres. It is believed that this feature is a large rotational slide near the crest of the valley slope and is not related to subsidence due to solution cavity collapse. This feature is also shown on Figure II-2 in the Terrain Assessment Report. The polje re-alignment avoids this area. Elsewhere along the access road within the Ram Plateau, no evidence of subsidence activity that disrupts the road is apparent.
- It was concluded from this evidence that the land in the general vicinity of the access route is stable from the perspective of active subsidence formation. Notwithstanding this evidence, it was recommended that the former route through the polje valley not be used and that a new route downstream of these features be developed. The potential hazards associated with renewed subsidence were one of several reasons for this recommended re-routing."

Regarding traffic and the difference between the winter road and the all season road, the volume and speed of traffic will be the same over the course of a year. The difference will be that the traffic on the all season road will be of a much lower intensity and steady year-round, as opposed to an intense winter period with the winter road.

As note previously, the location of the TTF has been modified to locate it on firmer ground and soils of a lower moisture content, and this also reduces the potential for location over permafrost. Nevertheless, a thick granular layer will be placed as a bed for the facility, which would insulate any permafrost.

11.1.4 Mitigation Measures

Numerous mitigation strategies are provided in documents from the Transportation Association of Canada (TAC 2005 and 2010) and from AANDC (INAC 2009, 2010a) to avoid or reduce adverse environmental effects due to road construction and borrow acquisition in the North. AANDC also has guidelines for camp and support facilities (INAC 2010b). Numerous resources are also available in the form of guidebooks, reports and other publications from the British Columbia Ministry of Forest, Lands and Natural Resource Operations (BCMF 2014a, 2014b), which include such topics as forest road engineering, best management practices for hillslope restoration, and karst management. The Karst Management Handbook may be particularly useful in parts of the route that traverse on or close to karst terrain (BCMF 2003). Parks is also preparing a National Parks Caving Directive which may have further information of value in karst terrain. Staff from NNPR should be contacted directly for information, since the directive is currently in draft form.

Construction will be managed such that travel across the ground does not occur when it is in its most vulnerable state. Currently, winter construction is proposed to take place when the ground is frozen, and construction access will be by winter road. Most of the existing winter road alignment in the vicinity of the proposed all-season route appears to have performed very well. Portions of the road that could have performed better provide good information on the types of terrain that require extra caution for the construction of the all-season road, for example, in the thermokarst terrain in the Fishtrap Creek drainage between about KP094.2 and KP095.7. Embankment fill-only (overlanding) techniques are proposed for these thaw-sensitive permafrost areas, meaning that no cut will take place and that the entire road grade will be composed of fill soils (TAC 2010).

Summer/fall construction is proposed to take place when the ground is seasonally more likely to be relatively dry. The benefit of summer/fall construction in terrain that is not thaw-sensitive is that the construction team will be able to see more clearly where the cross-drainage installations should be placed, and backfill placement and compaction will be greatly improved.

Summer/fall construction of the subgrade is not recommended for thaw-sensitive permafrost terrain, however. If construction of a working pad in thaw-sensitive permafrost terrain does not take place in winter, the only other opportunity to access that terrain would be very early in the thaw season. That is, the initial fill placement for a working pad along the route potentially could be done after the snow has gone, but before the subgrade starts to thaw. It should be noted, however, that the success of this method depends greatly on the contractor's ability to control his schedule, and leaving the construction of thaw-sensitive sections until winter is anticipated to be more reliable for protecting thaw-sensitive permafrost, and is therefore preferred. Fill material would be forward-hauled and placed so that no machinery comes into direct contact with the organic layer to be protected.

Because the road embankment can itself affect permafrost, the first strategy is to avoid thaw-sensitive terrain, where possible. If thaw-sensitive terrain cannot be avoided, embankments can be designed and constructed with thickness and width based on terrain type. In warm permafrost, a thicker embankment may not stop thaw of the permafrost, but it provides an additional buffer

to reduce flexing of the underlying subgrade, and the additional width will help to keep early thaw at the embankment toes further away from the highest loaded area.

In areas where snow drifting proves to be an issue along the road, strategies to reduce snow drifting can be examined, designed and installed. It should be recognized that permafrost thaw is unlikely to be prevented, but it may be possible to mitigate the effects of thaw and settlement (TAC 2010).

Cutslopes in thaw-sensitive terrain should be avoided if at all possible. If cutslopes in thaw-sensitive terrain are unavoidable, mitigative solutions are limited and are accompanied by a much greater need for vigilance in monitoring and maintenance to avoid the types of situations described in Section 7.1.1 above. Depending on the site characteristics, it may be possible to protect some cutslopes with a drainage blanket to help mitigate the effects of thaw and meltwater (TAC 2010), or design near-vertical cutslopes to allow the organic layer to be draped over the cutslope to shade and protect it (INAC 2010a). However, these possibilities are not considered to be universal solutions.

Careful placement of culverts even where there are no obvious stream channels will help reduce the likelihood of ponding water alongside the road embankment. Permeable embankments may also be an option in some locations, particularly in areas of ice-rich permafrost, and these can be supplemented with an overlying culvert to pass spring flows (TAC, 2010). It is anticipated that regular inspections of drainage measures after installation will help to identify areas that might unexpectedly pond water, and corrective actions can be taken. The same applies to flowing surface water, and regular inspections will help identify areas where surface water drainage provisions need to be changed or improved.

The development, working and restoration of borrow sources will be carefully planned and carried out to reduce or avoid negative effects including permafrost thaw and soil erosion, in accordance with regional and national guidelines (INAC 2009, TAC 2010). Some general guidelines for borrow sources are as follows:

- Minimize the surface area of the open cut;
- Grade slopes to reduce slumping;
- Grade material storage and working areas to promote drainage and avoid standing water;
- Restore the borrow source when construction is completed by grading slopes to match the natural ground and drainage of the surrounding area, and replacing overburden.

A Sediment and Erosion Control Plan (SECP) can be prepared for the project. The proximity of watercourses, as well as fish habitat, wildlife habitat, and riparian areas downslope and within the road alignment reinforce the need for good erosion and sedimentation control during the course of construction and through the service life of the project. As well, disturbance of permafrost terrain, and subsequent permafrost thaw, are typical consequences of site development, so the SECP needs to mitigate the potential results of that disturbance.

The SECP would be based on the regulatory and Best Practices guidelines applicable to the project. It includes the following elements:

- A review of the applicable regulatory guidelines;

- An evaluation of existing site conditions and a summary of proposed conditions upon the completion of construction;
- Requirements for environmental monitoring including personnel, frequency of inspections, reporting and corrective actions;
- Best Management Practices for construction, including erosion control measures and sedimentation control measures; and
- Best Management Practices specific to permafrost and the mitigation of thermal erosion.

In general terms, all work needs to be conducted and completed in such a manner as to prevent the release of silt, sediment or sediment-laden water, construction wastes or other deleterious substances into streams, ponds or lakes.

11.1.5 Residual Effects

The road alignment, design and construction practices proposed are intended to help reduce the footprints required for the various construction requirements and operations, including borrow sources. As well, the currently proposed alignment is intended to take advantage of the most competent and least sensitive ground available along the general route, which should help to further reduce the impact.

It is anticipated that, with careful surface water management, most if not all of the residual effects will be restricted to the footprint of the road and borrow areas. Even the on-road effects can be reduced by good decommissioning practices that will allow the relatively rapid regrowth of vegetation, including scarifying the road surface to loosen the soil and allow moisture to infiltrate and rooting to occur more easily. The existing winter road also shows that where moisture and nutrients are available, excellent opportunities for regeneration are present and vigorous regrowth of trees is seen.

11.2 Granular Materials

The Allnorth report in Appendix 1 provides extensive information on the granular materials proposed for borrow. Borrow pit development considerations in Allnorth's report include slope stability, but these are addressed in more detail in the Tetra Tech EBA geotechnical report in Appendix 2.

Regarding ownership and operation of borrow pits, the pits will be developed and regulated according to Land Use Permits. LUP's provide for land use, not ownership. The borrow pits would be operated by CZN, or by contractors on behalf of CZN. Contractors would be subject to the same LUP conditions, and pit development plans, as CZN.

11.3 Air Quality

11.3.1 Emissions

Construction, operation and decommissioning of the access road, TTF and airstrip will produce emissions resulting from heavy equipment, transport trucks, smaller trucks on the road, airplanes,

small gensets, and potentially a small incinerator. All sources will have carbon emissions in the form of carbon monoxide (CO) and carbon dioxide (CO_2). Trucks and planes will have the potential to generate dust.

During road construction and decommissioning, haul and small trucks, airplanes, heavy equipment, gensets at camps and potentially a small incinerator will have carbon emissions at the locations of construction and camps. Trucks and planes can generate dust.

During road operations, haul trucks, airplanes, and a genset at the TTF will have carbon emissions. Trucks and planes can generate dust.

During EA0809-002, an air quality assessment was completed by Golder Associates Ltd. (see Appendix 20 of that DAR). The objectives of the assessment was to evaluate potential impacts of Prairie Creek Mine construction, operation and reclamation emissions on local air quality, and propose appropriate monitoring, mitigation and management strategies to minimize any impacts. The evaluation of potential impacts included an assessment of pre-development conditions associated with air quality, preparation of an air emission inventory for the construction, operation and closure phases of the Project, determination of predicted air concentrations resulting from emissions of the Project, and comparison of predicted concentrations with air quality standards. Air concentrations considered included total suspended particulates (TSP), particulate matter with a diameter less than 10 μm (PM_{10}), particulate matter with a diameter less than 2.5 μm ($PM_{2.5}$), and carbon monoxide (CO). Air concentrations resulting from Mine site emissions were determined using the CALPUFF dispersion model. Concentrations resulting from off-site (i.e., winter road and transfer facilities) emissions were determined using the SCREEN3 dispersion model.

Green-house gas (GHG) emissions from the Project associated with use of fuel in vehicles, equipment and power generators was also estimated. Total annual direct GHG emissions during operations of the Project were estimated at 32,600 tonnes of Carbon Dioxide (CO_2) equivalent per year. The major source of GHG emissions from the Project is the use of diesel power generators, accounting for approximately 86% of the total GHG emissions. The second major contributor to the total GHG emissions is the use of diesel vehicles and equipment. The waste incinerator is expected to contribute approximately 0.25% of the total GHG emissions from the Project.

Maximum predicted concentrations of TSP, PM_{10}, and $PM_{2.5}$ resulting from on-site emissions are expected to exceed the respective air quality standards for receptors located within the surface lease that encompasses the Prairie Creek Mine, at the surface lease boundary, and in an area extending 200 m from the surface lease boundary (called the buffer zone). Maximum predicted concentrations of TSP, PM_{10}, and $PM_{2.5}$ are expected to be lower than the respective air quality standards for receptors located beyond the outer part of the buffer zone (i.e., from 200 m from the surface lease boundary and beyond).

Maximum predicted concentrations of CO resulting from on-site emissions are expected to be lower than the respective air quality standards for all receptors assessed within and beyond the surface lease. Maximum concentrations of TSP, PM_{10}, $PM_{2.5}$, and CO resulting from off-site (access road and transfer facilities) emissions are expected to be lower than the respective air quality standards.

The emission rates that were predicted are summarized as follows:

	TSP	PM10	PM2.5	CO
Construction	373.39	138.34	40.29	84.49
Operation	225.19	87.49	40.37	203.67
Closure	99.74	26.56	8.38	1.48

The data show that particulate concentrations are expected to be highest during construction, presumably associated with heavy equipment and trucks, whereas CO concentrations are highest during operations, presumably associated with power generation.

Particulate concentrations for all season road construction will likely be similar to those predicted for mine construction. This indicates that air quality impacts may occur on a localized basis, and that therefore mitigation is required. Particulate concentrations for all season road and airstrip operation are likely to be less than during construction because dust generated by single vehicle/aircraft will be much less and will settle quickly. However, dust could accumulate and so mitigation is also required. Particulate concentrations for all season road decommissioning are likely to be less than during construction.

CO and CO_2 emissions associated with the all season road, TTF and airstrip are expected to be much lower than the Mine, and of no significance from a regional or global perspective. Generators that may be used will be small by comparison to the Mine, probably only one or two units, and operated sporadically. Gas emissions from trucks and heavy equipment during road construction will be similar to those for the winter road. All season road construction may occur over several years, but winter road construction would occur every year. Gas emissions from trucks during road operations will be the same as those for the winter road because the annual volume of traffic will be the same.

11.3.2 Potential Impacts

Potential effects from dust are discussed in more detail in Section 11.9. The following was excerpted from that discussion: The primary dust-related effects resulting from the year round use of the all season road are anticipated to occur within about 10 m of the main development footprint, as this is where the majority of the large dust particles are expected to settle out. However, dust-related effects may occur at greater distances from the roadway depending, in part, on site conditions and particle size characteristics.

Plant species expected to be affected by dust settling along the all season road are generally common and will be “washed” during annual snow melt and rainfall events.

The potential for effects of emissions on wildlife is expected to be limited since most forms of wildlife in the area range widely and are not restricted in their occurrence to locations in immediate proximity to the access road.

Workers involved in road construction and operations at the TTF may be susceptible to respiratory irritation due to dust. Workers should be equipped with dust masks or half-face respirators.

Effects on waterbodies from dust are expected to be minimal. The road is proximal to or crosses many streams, but the limited amount of dust will be carried in the flowing water and settle as sediment, adding only a small increment to the bed load. There are a few significant lakes within 10 km of the road, including Mosquito Lake and Bluefish Lake. The former is a closed system to fish, draining into the poljes. Bluefish Lake is approximately 2 km west of the road, and up-wind most of the time. Contributions of particulates to lakes, and in lake bed sediments, are expected to be minor. The proposed airstrip is not proximal to a lake.

11.3.3 Mitigation

The GNWT (1998) dust suppression guidelines will be implemented at the TTF and along portions of the road located in environments which are more prone to adverse effects from road dust accumulation (e.g. lakes, wetlands), as appropriate, to limit dust generation during the snow free months. Dust management will begin with road surfacing material which is coarse and minimally erodible, where practical. Where dust is problematic, watering will occur as and when required. Vehicles will adhere to speed limits on roads, which will help limit the re-suspension of particulate material.

With the application of these mitigation measures, the significance of dust generation from the construction and operation of the all season road and associated traffic is expected to be low. No residual effects resulting from project related dust generation are anticipated.

11.4 Noise

11.4.1 Wildlife

The generation of noise from road, TTF and airstrip construction and operations is primarily a concern with respect to wildlife. Potential effects were discussed in detail in Section 8. The following was excerpted from that discussion: “Scientific evidence suggests avoidance behaviour of land use developments is dependent on the frequency and type of human activity, visual and noise disturbances, and season. Site infrastructure (e.g., storage sheds, forklift, small crew at the TTF, electrical power generator) required for the operation of the proposed Phase 1 all season access road and the TTF remains similar to that already permitted for use of the Prairie Creek Mine winter road, except for the season of use. With the arrival of concentrate trucks, forklifts will be used to load and unload concentrate bags inside the storage sheds. Similarly, noise levels will remain the same as winter operations; estimated at approximately 99 decibels (dBA), which is similar to a highway transport truck (Golder 2010). At 0.5 km from the road, this noise level (99 dBA) is expected to reduce to 35 dBA (Golder 2010) (the level between normal speech and a whisper). Noise disturbances from the operation of the all season road differ from the winter road in temporal extent, not noise level.”

The construction phase of the all season access road and airstrip, including borrow pits and gravel crushing, is expected to generate the greatest degree of disruption, at least temporarily; however this disruption will be localized to the sites of construction and will decline into the operations phase. Overall, the daily level of visual and noise disturbances from the proposed all season access road is likely reduced from levels predicted during winter road use.

EBA predicted overall low adverse effects on wildlife in terms of magnitude and significance from Project-related disturbances.

11.4.2 Fish

Information on effects from highway traffic noise was obtained from http://www.fhwa.dot.gov/environment/noise/noise_effect_on_wildlife/effects/wild04.cfm:

Sound pressure level (SPL) is responded to in a logarithmic manner and sound levels are measured on a logarithmic decibel scale (dB), which corresponds fairly well to the human hearing response. A value of 120 dB corresponds to about 20 N/m2 – a level at which pain will be experienced. Fish are capable of reception of sound in the water. The sensitivity of fish varies. Many fish have a threshold of 50-70 dB. Several species have been reported to be adversely affected by sound levels >180 dB for two hours or less.

A few studies have found a response by fish to noise. Naïve goldfish have altered their pattern of locomotion avoiding sounds at 30 cm distance (˜2 kHz) and an intensity of 2 dynes/cm2 (0.2 Pa). Changes in pressure (2-18 Pa at a frequency of 70-200 Hz) have caused startle response in herring (*Clupea herengus* L.).(13) Banner and Hyatt(8) reported greater growth rate and fry survival of two minnow species (*Cyprinodon variegates* and *Fundulus similes*) held in quieter tanks. However, the level of noise required to have this effect on growth was greater than that normally encountered with traffic. Juvenile Atlantic salmon have shown an avoidance of low frequency sound (10 Hz), but failed to show a response at a higher frequency of 150 Hz.

Simulated sonic booms have caused startle reactions in guppies. Trout and salmon eggs and fry exposed to sonic booms showed no increase in mortality and there was no apparent difference in the development of fry. The importance of road noise in affecting the behavior of fish populations, particularly the relationship between road traffic levels and any response is not known.

Since the noise of a truck at 0.5 km from the road us 99 dBA, vehicles have the potential to cause effects on fish in the proximity. The above information suggests that fish would be startled, and likely would seek refuge or swim away. It is not known if fish become habituated to regular noise. There is known spawning habitat in Funeral Creek for Bull trout, and it is likely that there is spawning habitat for Arctic grayling and other fish in Sundog Creek, Polje Creek, the Tetcela River and Grainger River. The above information indicates no effects on eggs or fry from noise louder than trucks. For this reason, the risk of long-terms effects on fish from noise is considered to be low.

11.4.3 Humans

As noted in Section 5, harvesters from Nahanni Butte currently do not venture far from the village along the Front Range to hunt. The lack of access deters them going further. The harvesters CZN spoke to are in favour of the road because it will provide access to areas currently difficult or costly to go to. That being the case, it is unlikely harvesters would then complain about traffic noise if they are able to use the road for better access.

The same would apply to increased tourism enabled by road access. Those using the road for tourism and recreation might prefer that heavy trucks are not on the road, but provided they understand that the main reason the road is there is because of those trucks, they will likely accept the trucks, and the associated noise, as necessary. Effects on 'wilderness' tourists were discussed in Section 10.

During EA0809-002, CZN proposed a re-alignment of the winter road to move the terminus to the Nahanni Access Road. The Nahanni Butte community were in favour of this because they felt it better positioned them to gain employment related to the road, and because it would enable them to better control who is using the road. The road was located specifically to avoid it being too close to the village, but close enough to gain the benefits noted. Therefore, it is unlikely the village would have issues with noise associated with the road, if they were able to hear it.

11.5 Water Quality and Quantity

11.5.1 Drainage and Hydrology

The all season road design is described in the Allnorth report in Appendix 1. Elements included in the report are as follows:

- design flood flow and level computations for all major crossings (EBA);
- preliminary designs of crossing structures for major crossings;
- classification of minor stream crossings according to a specific, generic culvert design;
- provision for culverts to ensure drainage patterns and flows are maintained; and,
- specification of slope angles and armouring to avoid instability and erosion.

Road embankments will be up to 1-1.5 m high and may act as snow fences in winter. Meltwater in spring will be channeled under the road bed via culverts and result in no significant changes in drainage patterns.

The hydrology of lower Sundog Creek near Cat Camp (Km 35-38) will be modified to accommodate the road bed on the south side of the floodplain. A creek channel will be trained away from the south bank. No overall changes in flow will occur since the channels change from year to year naturally.

The only location along the route noted for the occurrence of a natural icing is at Km 23, in a major tributary of Sundog Creek. This section of the creek is a box canyon, and the road will cross via an elevated span, well above the icing level.

With the road and structures built according to appropriate detailed designs, and best practices used during road construction and operations, including a comprehensive Sediment and Erosion Control Plan, no significant changes to flows or water levels, drainage patterns, or erosion and sediment deposition is expected.

11.5.2 Water Quality

Potential effects on surface water and groundwater quality from contaminant release, leaks and spills were assessed in Section 9. After screening, it was determined that spills represent a potentially significant source of effects. A risk assessment concluded that the risk of a significant spill is low in most areas, however upper Funeral Creek and the Silent Hills switchbacks were the exceptions. Funeral Creek is considered an area of high consequence because of a spawning Bull trout population. The Silent Hills area is considered to be of moderate consequence because of the opportunity to contain a spill should it occur, and the poor fish habitat in the adjacent lowlands. Specific mitigations have been proposed for these and other areas in the form of control points, repositories of response equipment near the locations, and plans for rapid deployment of response equipment and personnel.

No significant effects on moderate to long-term water quality in surface water or groundwater are expected associated with the road. The quality of local water sources is not expected to change, and therefore will remain suitable for drinking by humans and wildlife, although we don't believe the former use it for drinking.

Grey and brown water associated with construction camps and the TTF will be managed by either temporary storage and subsequent removal for treatment in a plant at the Mine or elsewhere, or disposal in a soak-away sump located so that contaminants dissipate before reaching a waterbody. Only biodegradable, phosphate-free detergents would be used in camps, and there will be no chemical additives, or salt on roads.

With no effects on water quality and no significant sediment discharge, there should be no effects on the aquatic environment.

11.5.3 Terrain and Permafrost

The road alignment and crossing locations have been confirmed or chosen to avoid ground conditions that might cause issues, as much as possible (see Allnorth's report). Many of the crossings and road bed alignments are on gravelly substrates not prone to instability (Prairie, Funeral, Sundog, Grainger). Where unstable ground or permafrost was suspected (see Tetra Tech EBA's report), the road alignment was either adjusted or mitigation built into the design. Borrow pits were also sited with consideration of ground stability and permafrost, and it was noted that prior investigation of such sites will be necessary to confirm material type and extent, and ground conditions for appropriate pit design and development.

11.5.4 Water Withdrawal

Water withdrawal for potable use will be minimal. Withdrawal may be necessary for dust suppression. CZN proposes to use the same sources confirmed for winter road construction, and will limit withdrawal to 10% of the water volume.

11.5.5 Mitigation and Residual Effects

Mitigation has been built into the road alignment and crossings locations, and to the road bed and proposed slopes for stability. Mitigation for concentrate dust and spills has been discussed previously. Additional mitigation is as follows:

- Proper design and construction of the access road, avoiding steep terrain and hairpin turns;
- Controlled use of the road with posted speed limits;
- Requiring each truck to carry a spill response kit and drivers to read CZN's spill contingency plan;
- In-vehicle communications and vehicle tracking;
- Properly maintaining and inspecting vehicles for leaks, and using drip pans for stationary equipment;
- Locating fuel tanks in lined containments with a volume of at least 110% of the tank; and
- Placing all concentrates in sealed bags with clean exteriors, or in containers with tarpaulin covers, and a wheel wash for haul trucks leaving the Mine.

Residual effects may occur if there is a significant hydrocarbon spill that enters groundwater. However, the risk of this occurring is considered to be low.

11.6 Fish and Aquatic Habitat

11.6.1 Road Construction

As explained in Section 6.6, road construction is proposed over a period of up to 3 years, and the expectation is that sub-grade material will be placed primarily in winter between Km 40 and 174. When the sub-grade is placed, culverts would also likely be installed at that time. While major crossings will have span structures, smaller crossings that may host fish may be crossed by installing partially buried culverts. The intent is to allow water passage and recreate a natural substrate in the bottom of the culvert. Preparatory work for span crossings, including abutment preparation, could also be completed at the time of sub-grade placement. The spans themselves could be placed either at that time, or subsequently in any season given that there should be no disturbance of the stream. If access is required to both sides of major crossings, a span can be placed on temporary abutments to allow this, and then the span can be moved onto the permanent location later. For particularly wide or deep crossings, application may be made to have once-over-and-back open water crossings. For example, the Km 23.5 crossing is a box canyon and there are no fish due to a waterfall downstream. Fords at this location via ramps attached to the existing winter road alignment have been authorized previously. In-stream works and crossings will be avoided as much as possible. However, as noted, ford crossings may be requested, and suitable mitigation would be included with the request.

All crossings will follow DFO's *Operational Statements* for creek crossings, including span structures and culverts.

A limited amount of work is planned for the Prairie Creek and Funeral Creek sections. The road may be widened. The bridge over Casket Creek may be enlarged. Additional culverts will be placed along Funeral Creek, and revised crossing of an upstream tributary will be installed. Casket may host Bull trout, which spawn in the fall, although spawning habitat has not been noted. The Funeral tributary is upstream of migration barriers. The winter and summer seasons will be ideal for the proposed work.

From Km 17 to 175, primarily spring spawning fish are present (e.g. Arctic grayling). Grayling are common in all major streams (Sundog, Polje, Tetcela, Grainger), although the Tetcela River hosts a wider variety of fish. Summer, fall and winter appear to be suitable seasons for road construction, including crossings. Smaller streams may host grayling, but the habitat is poor in comparison, and most are inaccessible due to beaver dams (especially Grainger) or natural slope slumps (e.g. Polje tributaries). No important habitat will be lost due to the road, other than in lower Sundog, discussed below. Abutments for spans will be set-back from major streams, and effects on riparian areas will be minimized by this and limiting disruption during construction. However, a limited amount of riparian area loss is unavoidable. Dredging of stream will not be required, with the possible exception of the Liard River. A barge crossing is proposed with ramps at river banks, so material is likely to be placed rather than dredged.

The re-alignment of a channel of lower Sundog Creek was described in Section 6.4. Preparatory work will be completed outside of the spring period when flows are low and significant reaches of the creek are typically dry. The work will consist of deepening old channels to train the channel away from the south bank, and inserting large boulders so that pool habitat is created and the new channel becomes anchored in that location. The new channel design will equal or exceed the amount and value of habitat that will be lost. The preparation work will not affect the currently active channel at the time, but will be completed so that spring flows will break through to the new channel, as occurs naturally in many locations.

Blasting will need to be completed at the three Sundog crossings, although only one is fish-bearing (Km 28.3). Blasting will also be required at the Grainger crossing at Km 123.3. This work may occur in any season except spring. Blast energy will be limited to that required, and fly rock avoided as much as possible.

Water withdrawal will be required for dust suppression and potentially for potable water during construction. The defined water sources for the winter road will be used, and withdrawal limited to 10% of the calculated volume to avoid impacts.

Once the road and crossings have been built, disturbed areas will be reclaimed by grading, and providing runoff and sediment controls, as necessary.

11.6.2 Distribution, Abundance, Health, Harvesting

Construction of the all season road will have no effect on the current distribution and abundance of fish. Fish will still be able to access waterways as before without added obstruction. No blockages will be created restricting access. There is a small risk of road construction leading to slope instability and slumping, which temporarily may restrict access, but these would be of

small scale and quickly removed. Abundance in the lower Sundog Creek reach may increase as a result of the planned new pool habitat.

In Section 11.5, it was noted that the potential for effects on water quality is low. There should be no impacts on fish in this regard. No significant contamination is expected in watercourses. Any concentrate dust issues will be detected by monitoring and corrected prior to any significant water quality degradation. Any spills will be completely remediated. Overall, no negative effects on fish health are expected.

Harvesting of fish was discussed in Section 8.5. The potential for increased harvesting by non-residents in the Grainger system, and therefore effects on abundance, was considered to be low. No effects are expected in any other watershed crossed by the road.

11.6.3 Mitigation

The following mitigation will be implemented:

- Replace any habitat losses to the satisfaction of DFO (this is a requirement of the *Fisheries Act*;
- Make use of DFO's *Operational Statements* for creek crossings, including span structures and culverts:
- Minimize disturbance of stream banks and riparian areas at stream crossings;
- Remove temporary crossing structures to avoid blockage and erosion;
- Construct a stable road bed adjacent to creeks and providing for runoff control to minimize the dispersal of sediment during precipitation events;
- Promote re-vegetation of riparian areas to further reduce the potential for sedimentation;
- Avoid disruption of the only known spawning location in the area (bull trout in Funeral Creek) during the spawning period (mid-August);
- Continue the policy of no fishing by employees and contractors or any other unnecessary disturbance of the aquatic environment;
- Ship all concentrates in bags or bulk free of external concentrate dust;
- Follow a detailed spill contingency plan;
- Follow a detailed Sediment and erosion control plan; and,
- Modify the existing Controlled Road Use Plan for access road operations to promote safety and minimize the risk of accidents.

During road construction, operations and reclamation, there will be regular inspections by supervisory, maintenance and environmental staff, as well as community monitors. Any evidence of impacts, or conditions that might lead to impacts, will be immediately brought to the attention of the transportation manager. It might be expected that there will be some locations where erosion or instability risks exist, and these locations will be subject to regular inspection, especially after snowmelt or precipitation events. Such areas might be subject to routine monitoring of turbidity and/or suspended sediment levels if visual observations are not considered adequate. However, natural variations will pose a conundrum. Any obvious problems, such as sediment dispersal, will be rectified immediately by construction/maintenance crews. The progress of reclamation in disturbed areas will also be

monitored. The criteria for assessing the success of mitigation are no significant changes to pre-construction hydrology, other than the channel re-alignment discussed, and no obvious changes to the clarity of water downstream of crossings compared to upstream.

11.7 Wildlife and Wildlife Habitat

The following sub-sections were extracted from the Tetra Tech EBA report in Appendix 7. Introductory discussion is provided in that report.

11.7.1 Effects from Direct and Indirect Habitat Loss and Alteration

The proposed upgrades from the approved winter road to the all season access road and alternate airstrip require an additional footprint of approximately 70.96 ha (includes an additional 18 ha for the access road realignments, 45.34 ha for borrow sources and their access roads, and 7.62 ha for the airstrip). This is considered a relatively small area in the context of the existing winter road and the common habitats that occur in the region (Golder 2010). The additional clearing for the proposed all season road will include 4 km in Phase 1 and 5 km in Phase 2.

The proposed all season road has been re-aligned to avoid sensitive karst terrain, lowlands, wetlands, and ponds, as much as possible, which have the potential to support several species at risk. Consequently, direct impacts to Little Brown Myotis, Northern Myotis, Western Long-eared Myotis, Horned Grebe, Yellow Rail, Rusty Blackbird, and Western Toad habitat have already been considered and avoided to the extent possible. Bats may overwinter, in hibernaculas in the karst terrain. Hibernacula are critical habitats, and are reused annually.

Bats are most sensitive to disturbance while overwintering. Traffic along the all season access road will continue through the winter, during bat overwintering periods; however, their disturbance from noise, vibration, and visual disturbances during this time will be negligible. COSEWIC (2013) indicates that noise from road disturbances deter foraging bats; however, the severity and disturbance distances are unknown. In both Manitoba and Newfoundland, a 200 m buffer between developments and known hibernacula have been recommended (COSEWIC 2013). Although no bat hibernacula are known near the all season access road, potential habitat such as the karst terrain, are a minimum of 350 m from the already permitted winter road route and airstrip. Not all karst terrain (including caves) provide suitable overwintering bat habitat, nor are all suitable overwintering habitat occupied by overwintering bats.

Indirect impacts to birds and bats from road dust and noise are relatively unknown. However, effects attributed to road dust are typically less than 10 – 20 m from the road, but may extend into habitats 100 m downwind depending on the adjacent landscape and habitat types (e.g., open wetland or pond). Similarly, airborne dust from the access road has the potential to alter Western Toad habitat. Introduced fine sediment into roadside ditches and nearby ponds has the potential to increase water turbidity and possibly degrade the habitat by inhibiting aquatic plant growth and macro-invertebrates, and altering water pH (Forman and Alexander 1998). Habitat alteration effects are considered low in magnitude and local in extent.

The sensitivity of boreal forest birds to noise, human presence and activities is relatively unknown, but some songbird species are thought to be negatively affected by noise. Human-induced noise may mask communication calls; consequently, some species may avoid nearby

habitats. Some species remain in these habitats in lower densities, and may have lower nest success or productivity as a result (AMEC 2005).

Collared Pika habitat is naturally fragmented, with selective preference for boulder fields edged by alpine meadows. Suitable Collared Pika habitat exists in small isolated patches within the first 36 kilometres from the Mine site of Phase 1 of the all season access road. Much of this entire 36 km length of the all season access road exists as all-season quality from former construction and directly follows the new winter road route, which was already approved in EA0809-002. To upgrade the proposed all season road, a new 4 km length section is proposed. This road section and seven preferred borrow sources have the potential to affect Collared Pika habitat, particularly since Collared Pikas were observed and/or heard in talus between Phase 1 KP 15 to 22.

Since a relatively small length of access road will be constructed and Collared Pikas do not occupy all suitable talus habitat within their known range and remain within 10 m of the talus (except during dispersal in July), few Collared Pikas are expected to directly interact with the all season access road and possibly two borrow sources. The new section of access road is to avoid a stretch of boulder fields, but Collared Pikas habitat may occur at the proposed borrow sources (BP 14 and 16).

Although pikas do not hibernate, they remain under the protective and insulating cover of snow during winter. During the snow-free period (e.g., late spring, summer, and fall), a small number of collared pikas may be exposed to and disturbed by localized noise or traffic along the road. Similarly, collared pikas may be expected to forage along the road edge. Pika attempts to cross the road would be uncommon as pikas primarily remain within 10 m of protective cover (the road width itself is less than 10 m wide); however in July, juveniles dispersing from their natal territory may be infrequently exposed to vehicle traffic. The Phase 1 portion of the all season access road has the potential to directly and indirectly affect a few collared pikas that might occur near the road throughout construction, operation, closure, and reclamation phases.

The main way that the all season access road and associated infrastructure and activities may directly and indirectly effect Collared Pika habitat is through direct habitat loss at two borrow sources (BP 14 and 16), widening of the existing road, and changes in the late spring, summer, and fall daily movements including habitat avoidance and disturbance during operations. Direct and indirect habitat loss effects are considered moderate in magnitude and low in geographical extent and duration, as not all Collared Pika habitat remains occupied. The number and frequency of such exposures would be expected to be moderate and periodic. Overall significance is moderate. Confidence in this assessment is moderate due to the existing access road present within Collared Pika range, previous records of Collared Pikas near the road, and the inherent behaviour of pikas to remain within 10 m of the talus for protective cover.

Wood Bison may be sensitive to disturbance, particularly during the calving and post calving season (approximately April to August), and may be wary of human activities particularly the harvested herds. Nevertheless, Wood Bison are known to become habituated to traffic and human activities, and are known to enter Nahanni Butte. While in communities and other development areas, Wood Bison come into conflict with people and may damage property and become a safety hazard to people.

Wood Bison encountering the proposed all season access road may show minor displacement behaviour and move away from the immediate area. The construction phase, in particular, is expected to generate some degree of disruption, at least temporarily. The duration of exposures during construction are expected to be low, perhaps lasting a few minutes to a few months, and

are reversible upon cessation of the activity or by moving away from the activity. Visual and noise disturbances from the access road and associated facilities are considered to be low in magnitude, local in extent, and reversible upon cessation of the activity or by moving away from the activity. The number and frequency of such exposures would be expected to be moderate and periodic. Confidence in this assessment is high since Wood Bison are considered very tolerant of traffic and land use working zones.

No direct loss of preferred Peregrine Falcon and Short-eared Owl nesting habitat is expected as a result of the 8 km of the proposed clearing activities. Peregrine Falcons are known to tolerate a moderate level of human-disturbances; however, breeding individuals not habituated to human activity may be affected by disturbances near the nest site. The nearest potential cliff nesting habitat to the proposed all season access road is in the karst terrain in Phase 1. Short-eared Owls may infrequently occur in the all season access road to feed during the construction, operation, and closure phases, and may conceivably be disturbed by localized vehicle traffic or aircraft noise and activity. Short-eared Owls are sensitive to disturbance during nesting, and may abandon nests as a result. However, they are irruptive breeders to the area and not anticipated to occur every year.

Golder (2010) considered mitigation for clearing the restricted access road and transfer facility footprint unnecessary. Similarly, reducing traffic volumes to the extent possible reduces the potential for Project-related indirect habitat loss effects. To mitigate project-related wildlife disturbances, measures in effect for the winter road will be maintained throughout construction, operation, and closure. Of those mitigation measures, those most noteworthy and specific to reducing Project-related disturbances to wildlife include:

- Strict use of CZN's Controlled Road Use Plan and Waste Management Plan to minimize traffic and other disturbances, maintain low speed limits, as well as to limit wildlife attractants;
- Surveying for and reporting the presence/absence of Collared Pikas (ranked as May Be At Risk in the NWT) at borrow sources BP 14 and 16 prior to Project-related disturbances, and consider additional mitigation should pikas be present;
- Reporting and evaluating wildlife sightings along the access road, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered;
- Snow removal practices along the access road to manage high snow banks, so that wildlife can readily move off the roadway as vehicles approach; and
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road to allow them to move away.

All general mitigation measures proposed are summarized in Section 11.7.7.

Overall, direct habitat effects as a result of the all season access road and its associated infrastructure are expected to be negligible to low in magnitude, local in geographic extent, reversible upon closure, and of low significance. Construction of the all season road, in particular, is expected to generate the greatest degree of disruption, at least temporarily, and infrequent disruption is expected during operations and closure. The disturbance from or avoidance of the all season road and associated activities may disturb wildlife since species

sensitivities to roads and traffic are not well documented, and not clearly known. However, daily traffic volumes are predicted to be low and below sensitive species known thresholds. The duration of exposures, including during construction, are expected to be low, perhaps lasting a few minutes to a few months, and are reversible upon cessation of the activity and at road closure. The number and frequency of such exposures would be expected to be low and infrequent.

Confidence in this assessment is high since the access road is proposed along the existing winter road, as much as possible, avoids sensitive habitats for several species at risk, and operations will remain similar to baseline winter road conditions. With adherence to mitigation, no adverse residual effects are anticipated.

11.7.2 Effects on Wildlife Movement, Distribution, and Abundance

Indirect consequences of Project-related disturbances can occur as a result of road/airstrip construction, operation, and closure. The proposed Project limits the intensity of any potential disturbance by minimizing habitat loss and fragmentation, manages low traffic volumes and speeds, and reduces the proximity to important habitats. For example, 5 km of the 9 km of additional clearing for the proposed all season access road avoids wetland habitat, which directly avoids disturbances to Horned Grebe, Yellow Rail, Barn and Bank swallows, Rusty Blackbird, and Western Toad, should they be present. The proposed all season access road and airstrip will not affect wildlife movement, distribution, and abundance at these locations since there is no direct habitat loss and species have relatively small home ranges.

Consequences of Project-related disturbances can occur as a result of road construction, operation, and closure, and can vary in frequency, magnitude, and severity depending on several factors including the species involved, individual animal, season, and gender.

Some species maintain the same territories year after year (e.g., Peregrine Falcon); however, their tendency to move their territory as a direct result of habitat modification and disturbances for most species are unknown. Conservative action to reduce the Project footprint and Project-wildlife encounters helps to counter these unknowns.

Road and airstrip construction can lead to the creation of habitat edges through otherwise continuous forest. It is these edges, that result from the approved winter road, that provide a conduit for Brown-headed Cowbirds (*Molothrus ater*), a brood parasite that lays its eggs in another species' nest to the detriment of the other species reproductive potential, to penetrate (at least 200 m from the edge) into forests. Similarly, bird predators (e.g., Short-eared Owls, Common Ravens) concentrate their scavenging and hunting activities at habitat edges. While hunting along the access road, Short-eared Owls may infrequently encounter traffic; however, Short-eared Owl populations fluctuate annually in size and distribution and are not expected to occupy much of the access road route.

Wood Bison may become indifferent to the traffic and human activities associated with the all season access road and the transfer facilities. Wood Bison form small herds throughout the year and occupy open habitats, such as roadways to detect approaching predators. The Prairie Creek Mine access road and transfer facilities likely support Wood Bison security habitat. Consequently, Wood Bison may select and gather near the proposed Project infrastructure.

General mitigation measures that are proposed include:

- CZN's Controlled Road Use Plan;

- Speed limits on the Prairie Creek All Season Road;
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road, to allow them to move away;
- An education program of wildlife related policies and mitigation to all Project employees and contractors, including a bear awareness program to ensure employees and contractors are informed of bears and other potentially dangerous wildlife and the level of risk;
- An alert system to warn personnel of Woodland Caribou and other sensitive wildlife in the local area by relaying sighting information to vehicles and equipment operators and on-site personnel;
- Wildlife record logs to be completed by all Project employees and contractors for all wildlife sightings (e.g., Dall's Sheep, caribou, Wood Bison, and carnivores) with respect to species, location along the access road, numbers observed, and reaction to road activity. If a problem area is identified, corrective measures will be considered.

With adherence to mitigation, effects to wildlife movement, distribution, and abundance as a result of the all season access road and its associated activities is considered negligible to low in magnitude, reversible upon cessation of the activity or by moving away from the activity, and a low likelihood of occurrence. No residual effects are anticipated. Confidence in this assessment is high since direct loss of available habitat as a result of the proposed all season access road is low (9 km), many species occur infrequently or in small territories away from road activities, and traffic levels and speeds will be low.

11.7.3 Effects on Predator-Prey Relationships

This section focuses on effects on predator-prey relationships for wildlife species not already addressed in the key lines of inquiry effects assessments.

Wolves are the primary predator of adult Wood Bison; Grey Wolf and Black Bears target calves and juveniles. Although Wood Bison are preyed upon, Moose are considered wolves' preferred prey species considering they are a smaller and more manageable size than bison. By supporting higher predator densities, an increasing Wood Bison population may indirectly influence predation rates on Moose. Mr. Konisenta suggests that Moose numbers have declined partly due to the introduction of bison to the area.

Similarly, predator-prey dynamics may be altered after a forest fire or human disturbance (e.g., the all season access road). In particular, Wood Bison favour these early regenerating grass and forb habitats and respond with increasing populations, thereby, correspondingly increasing their predators' populations.

Predators may incidentally take Collared Pikas, the assessed birds (e.g., Horned Grebe), and Western Toads. Predators, such as Red Fox, Wolverine, Wolves, and bears have been known to source food from litter, people purposely feeding, and unsecured containments. As predators are attracted to human disturbances, their encounter rates with prey occupying nearby habitats also increase.

The general mitigation measures proposed in Section 11.7.7 will lessen any potential predator-prey effects, although no specific measures are recommended. Effects predator-prey

relationships for the species assessed in this section are considered negligible to low in magnitude, moderate in geographical extent, expanding beyond the operational life of the access road, but occurring infrequently. Confidence in this assessment is high since the all season access road route will be already cleared (except for 9 km). No residual effects are predicted as a result of the all season access road affecting predator-prey relationships.

11.7.4 Effects from Invasive Species

Invasive wildlife species are non-native species introduced into areas beyond their natural range by humans and are capable of causing harm to the environment and outcompeting native species. To date, there are no known invasive wildlife species present in the NWT.

However, alien wildlife species, are native species that have been introduced beyond their natural ranges due to their natural dispersal from surrounding provinces or territories. Example alien wildlife species to the NWT include the House Sparrow and European Starling.

Alien wildlife species, such as the House Sparrow and European Starling, expand their distributions into new ranges and out-compete desirable native wildlife. The preferred habitat of the House Sparrow includes human settlements, in which it remains year round. House Sparrows are reported in the communities of Fort Simpson and Fort Liard; however, there are no known reports within Nahanni Butte and the NNPR (Sullivan et al. 2009). House Sparrows are known to outcompete native bird species from suitable nest sites. Similarly, the European Starling occurs in and near human settlements that have a component of open, grassy areas, preferring to remain year round. They are aggressive birds and out-compete native species for nesting cavities. One European Starling was observed near Rabbitkettle Lake inside the NNPR, as well as a few observations near the communities of Fort Liard and Fort Simpson (Sullivan et al. 2009).

A potential effect of constructing the approved winter access road may be to increase the range of invasive wildlife species such as the House Sparrow and European Starling into areas not currently occupied (or assumed to not be occupied). The winter access road will be cleared prior to the construction of the all season access road (except for 9 km); therefore, the all season access road will not pose any significant additional adverse effects to native species from the expanded distribution of alien wildlife.

Potential effects from invasive wildlife species as a result of the all season access road and its associated infrastructure and activities will remain similar to baseline conditions since the winter road route will be cleared prior to construction of the all season road. Mitigation measures are not considered necessary, beyond the general mitigation and best management practices.

Beyond designing the all season access road to follow the already permitted winter road corridor, no further mitigation associated with habitat fragmentation and associated invasive species advancement is recommended.

The predicted effects to invasive wildlife is considered low in magnitude, moderate in geographical extent, expending beyond the operational life of the access road, but occurring infrequently. Confidence in this assessment is high since the winter road will already be cleared and alien wildlife (e.g., European Starling) has already been recorded in the region. No residual effects are predicted as a result of the all season access road affecting invasive wildlife species.

11.7.5 Effects on the Ability of Wildlife to Recover

Habitat loss and fragmentation, changes to movements and behaviour, and mortality are key examples of development-related effects that, if significant, have the potential to adversely affect the condition of the species. A species' ability to recover from significant decline depends on a variety of factors including the species:

- Inherent biological traits, such as home range size, reproductive potential, habitat specialist or generalist;
- Balance between population growth (e.g., immigration and birth) and decline (e.g., emigration and mortality); and
- Occurrence in isolation of core populations.

For instance, Wood Bison have a relatively high resilience to many forms of disturbance; however, they are threatened by disease and overharvesting.

Several of these assessed species occur in the area of the proposed all season access road at the northern extent of their range. Although available habitat exists and human-made threats to these species in the NWT are limited, their populations are ranked from Secure (e.g., Bank Swallow) to May Be At Risk (e.g., Yellow Rail). Recovery of these species populations are largely dependent upon threats faced across their annual range, outside the NWT. Therefore, their population recovery is critically dependent upon conditions outside the all season access road zone of influence.

Minimizing habitat loss and fragmentation and avoiding sensitive wildlife areas and unique landscapes identified by the Naha Dehe Dene Band and Parks Canada were fundamental in the routing design of the all season access road. Similarly, limiting Project-related disturbances and traffic-wildlife encounters are inherent in the Project operations design.

No Project-related effects are expected to significantly cause the assessed species populations to decline, and the Project is not anticipated to affect the ability of these species to recover.

Further descriptions on the ability of wildlife in the NNPR to recover are discussed in Section 10.7.

11.7.6 Risks of Wildlife to Direct and Indirect Mortality

Species discussed in this section are not traditionally harvested in the area of the all season access road.

The predominant risk to wildlife mortality is direct animal-vehicle/aircraft collisions, although the risk is low considering the low traffic speeds (average 30 km/hr) and/or traffic volume. However, species that occupy or are attracted to the Project, and those that occur in highest abundance along the road and airstrip are at greater risk of Project-related mortality. Species, such as Collared Pika, Horned Grebe, Yellow Rail, and Rusty Blackbird that maintain small territories, occur in low densities, or do not venture far from their protective cover have a low risk of Project-related mortality.

Pika abundance within suitable talus patches vary considerably both temporally and spatially (COSEWIC 2011). In 2012, Collared Pikas were reported near the all season access road, and may be present at proposed borrow sources BP 14 and 16. Construction-related disturbances at these proposed borrow sources and other talus fields along the all season access road may result in direct mortality. Potential mortality as a result of construction activities is considered moderate in magnitude, low in duration and geographical extent, and a moderate likelihood of occurrence without mitigation.

Traffic along the access road poses the greatest risk of mortality to Wood Bison, Short-eared Owl, and Western Toad. Since traffic volumes and TTF activities can be a disturbance, are predictable, but have no negative stimulus associated with them, Wood Bison may become indifferent to the traffic resulting in an increased risk of mortality. The Wildlife Collision Prevention Program (2014) reports the highest risk of bison-vehicle collisions in the NWT occurs from August to November and from sunset to sunrise. Mortality of Wood Bison a result of the Prairie Creek Mine access road traffic is considered moderate in magnitude and duration, low in geographical extent, moderate in frequency, and a low likelihood of occurrence since traffic volumes and speed limits will be low.

Larter and Allaire (2007) indicated that the Nahanni Wood Bison herd is known to commonly swim across the Liard River to access important habitat on either side of the river, particularly at Swan Point (approximately 6 km downstream from the proposed all season access road barge crossing) and Muskeg and Kotaneelee rivers (at least 130 km upstream from the all season access road barge crossing). A few bison are known to drown annually during spring break up and peak discharge from the mountains (Larter and Allaire 2007). Known Liard River crossing locations are well up and down-stream from the all season access road barge crossing. Effects to bison mortality and/or avoidance/disturbance from wave action and/or human disturbances is not anticipated. In addition, the barge crossing location is situated on the Liard River approximately 1 km up-stream from a 90 degree bend, which would act to dissipate wave action from barge crossings during summer months.

Short-eared Owls may hunt along the all season road, particularly since low traffic levels are proposed. This increases their encounter rate with vehicles and therefore, risk of collision. However, since Short-eared Owls irregularly occur in an area (a single known observation was recorded near Nahanni Butte), their risk of mortality as a result of the proposed Project is considered negligible.

Similarly, bats may forage along the all season access road during the summer. The risk of bat mortality as a result of vehicle collisions from low traffic volumes and low speeds is low.

Western Toads are particularly susceptible to mortality from high traffic roads due to migration to breeding ponds and dispersal post-breeding. Western Toads are not known to strongly avoid roads or traffic, consequently increasing their risk to road mortality, particularly in the spring and fall near breeding ponds. Bouchard et al. (2009) reported a 6% mortality rate for Northern Leopard Frogs while crossing roads with very low traffic volumes (11 mean vehicles per hour) and a 28% mortality rate at higher traffic volumes (58 mean vehicles per hour). Traffic volumes along the proposed access road are anticipated to be low, below the thresholds identified for Northern Leopard Frogs.

Additional ways the all season access road and associated infrastructure and activities may affect wildlife are through increased predation risk, direct nest loss, and drowning from wave action caused by the proposed barge across the Liard River. Predators, such as Red Foxes, eagles, gulls,

and Common Ravens may be attracted to litter along the road or by deliberate feeding by employees. Once in the area, these predators will prey upon resident species. This attraction of predators may lead to the indirect death of several species, including Collared Pikas, Wood Bison, Horned Grebe, and Short-eared Owl.

Barn and Bank swallows have the potential to be directly affected by nest loss. Besides using natural nesting substrates (e.g., soil banks along rivers and streams), these species favour nesting in buildings, bridges, and sand and gravel pits, and are at risk of accidental nest mortality. Both species are known to occur in the area, principally along the South Nahanni and Liard rivers; however, their risk to road-related mortality is relatively low.

Maintaining low traffic volumes, low speeds (average 30 km/hr), and having re-aligned the access road route away from sensitive wildlife areas, will minimize Project-related mortality effects. Additional mitigation proposed includes:

- Strict use of CZN's Controlled Road Use Plan and Waste Management Plan to minimize traffic and other disturbances, maintain low speed limits, as well as to limit wildlife attractants;
- Surveying for and reporting the presence/absence of Collared Pikas (ranked as May Be At Risk in the NWT) at borrow sources BP 14 and 16 prior to Project-related disturbances, and consider additional mitigation should pikas be present;
- Cease barging activities if Wood Bison are observed crossing the river near the barge location;
- Educate employees and contractors to avoid disturbance to nests;
- Reporting and evaluating wildlife sightings along the access road, and if a problem area is identified, corrective management options for traffic and Project-related activities will be considered; and
- Policy giving wildlife the right-of-way, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road, to allow them to move away.

With adherence to mitigation, direct and indirect mortality effects as a result of the all season access road and its associated infrastructure are expected to be negligible in magnitude, local in geographic extent, infrequent, reversible upon closure, and of low significance.

Confidence in this assessment is high since the access road is proposed as a low traffic-low speed road, avoids sensitive habitats for several species at risk, and species abundances are likely low in the immediate vicinity of the road. Project-related activities that potentially lead to mortality will be reversible following closure of the proposed road, and as such, no residual effects are anticipated as a result of project related activities.

11.7.7 Other Mitigation and Best Management Practices

Mitigation to limit effects to wildlife has effectively been applied at the design stage by engaging with the Naha Dehe Dene Band and Parks Canada to avoid sensitive wildlife and unique karst terrain areas, reducing traffic volumes from the approved winter road levels, and maintaining low speed limits.

Additional general mitigation and best management practices considered for the proposed all season access road incorporate previous commitments for the approved winter access road (CZN 2010; Golder 2010, 2012). Mitigation measures to further avoid or reduce effects on wildlife along the proposed access road include:

- Provide the Dehcho Land Use Planning Committee (and others as requested) the post-construction digital footprint of the all season access road and associated facilities to incorporate into ongoing cumulative effects monitoring across the Dehcho.
- Surveying for and reporting the presence/absence of Collared Pikas (ranked as May Be At Risk in the NWT) at borrow sources BP 14 and 16 prior to Project-related disturbances, and consider additional mitigation should pikas be present;
- Implement a no hunting policy for all Project employees and contractors while working on or off-site for CZN;
- Strict use of CZN's Controlled Road Use Plan;
- Implement and enforce speed limits on the Prairie Creek All Season Road;
- Discourage use of engine retarder breaks;
- Develop a winter driving policy requiring tire chains to be used on haul trucks on the KP 0-29 and KP 96-102 sections to increase traction;
- Amend the existing draft Wildlife Mitigation and Monitoring Plan, as necessary, to include the monitoring of measureable parameters of effects;
- Implement a policy and train employees and contractors to give wildlife the right-of-way, which obligates drivers to stop (when safe to do so) for all wildlife seen on or immediately adjacent to the road, to allow them to move away;
- Develop standard aircraft procedures for flying into and departing from the proposed airstrip to accommodate wildlife, if present on or near the airstrip;
- Maintain a minimum flight altitude of 600 m during all times, except during take-off and landings;
- Follow dust suppression strategies (e.g., water or approved dust suppressant products) in accordance with the GNWT dust suppression guidelines;
- Follow the existing draft Contaminant Loading Management Plan and soil sampling along the road bed both before and during haul operations;
- Provide an education program for wildlife related policies and mitigation to all Project employees and contractors, including a bear awareness program to ensure employees and

contractors are informed of bears and other potentially dangerous wildlife, avoiding all known or suspected den and nest sites, and no littering or feeding wildlife;

- Employ an alert system to warn personnel of wildlife in the local area by relaying sighting information to vehicles and equipment operators and on-site personnel;
- Train all Project employees and contractors to record wildlife sightings (e.g., Dall's Sheep, caribou, Wood Bison, and carnivores) in the wildlife record logs with respect to species, location along the access road, numbers observed, and reaction to road activity. If a problem area is identified, corrective measures will be considered.
- Incorporate ENR's Woodland Caribou Best Management Practices for Industrial and Commercial Activities (once developed) to be incorporated into the wildlife monitoring program, where feasible, to manage or mitigate habitat impacts and sensory disturbances on Woodland Caribou;
- Strict snow removal practices along the access road and airstrip to manage high snow banks, so that wildlife can readily move off as vehicles/aircraft approach;
- Provide a structure for reporting human-dangerous wildlife encounters at the TTF and resulting incidents to inform Mine management and ENR staff;
- Managing the small portion of the winter road not used for the all season access to prevent predator and non-Project related travel of the corridor, if necessary;
- Implement a protocol for dealing with problem bears, with a designated chain of responsibilities for ensuring worker safety and efficient and speedy resolution of incidents;
- Preserve natural drainage patterns along the haul road to maintain the natural function and processes of peatland habitats adjacent to the haul road;
- Develop and implement a Waste Management Plan that prohibits littering, purposely feeding wildlife, and storing attractants accessible to wildlife. Incinerate all waste foods and human garbage consistent with current industry good management practices to minimize wildlife attraction to the local area. Adaptive management will be applied to waste management practices. If wildlife are found to be attracted to the site (i.e., problem wildlife) additional management practices, if required, will be adapted;
- Employ appropriate materials management systems to minimize the risk of accidental spills or leakage of concentrate, diesel fuel, other hydrocarbons, and other hazardous materials being shipped to the Mine site;
- Train staff on the existing Spill Management Plan and procedures to quickly respond to an accidental spill. This plan to include provision for rapid deployment of cleanup crews and for contaminant and cleanup of spilled material and contaminated surfaces;
- Strict adherence to policies to avoid significant changes to water levels while pumping water from a known Beaver pond in the fall and winter periods;
- Maintain sufficient buffer distances between development activities (e.g., re-fuelling and material storage) and waterbodies, where possible;

- Non-mine vehicles, including all-terrain vehicles (ATVs) and snowmobiles will be prohibited on site;
- Pets will be prohibited along the all season access road; and
- The appropriate regulatory agencies (*i.e.,* GNWT ENR and Parks Canada) will be contacted to receive additional direction regarding new issues that arise.

11.8 Vegetation

11.8.1 Effects of Land Clearing on Terrestrial Ecosystems

Effects to terrestrial ecosystems resulting from construction of the future all season road will be reduced as most of the proposed all season alignment will already have been cleared for the current approved winter access road (20 m right-of-way). The only exception is about 9 km of the proposed all season road that varies from the winter road alignment. CZN is currently authorized to construct their new winter access road in accordance with existing LUP's and Water Licences from both the MVLWB and Parks Canada. The MVLWB issued LUP MV2012F0007and Water Licence MV2012L1-0005 on January 10, 2013 and Parks Canada issued LUP Parks2012-L001 and Water Licence Parks2012_W001 on August 26, 2013.

Under these authorizations, approximately 63 km of new alignment will be cleared for the upgrading of the existing winter access road. This will consist of a re alignment to avoid karst features and bisecting the poljes west of Mosquito Lake, a realignment between Fishtrap Creek and Grainger Gap, and a realignment of the road east of Grainger Gap, wherein the new alignment will be located closer to the eastern foot of the Nahanni Range (providing for an ice bridge crossing of the Liard River just east of the community of Nahanni Butte).

The proposed realignment of the access road will result in a shorter road (174.5 km compared to a previous 181.1 km) and a revised footprint. The resulting footprint is summarized by vegetation units in Table 11-1 and is based on a total length of 174.5 km and an assumed average road footprint width of 10 m. The 63 km of old access road footprint that will not be used has naturally re-vegetated since it was initially constructed in 1981. The overall significance of impacts to vegetation from the access road is expected to be low.

The extent of direct effects will be primarily confined to the constructed road footprint (~10 m wide) and the footprint of borrow areas and the airstrip, which will be limited in frequency to once during project construction.

For Phase 1 of the all season road, the surface area encompassed by the road surface will be 85.6 ha, while Phase 2 will encompass 89.4 ha. The footprint area for both phases of the project, including the road footprint, borrow areas, borrow access roads, camps and the airstrip is 237.9 ha. Based on the calculated areas for EOSD land cover classes present within the 100 m wide study area, the proportion of land cover classes disturbed by each phase of the project will not exceed 20 % of the respective land cover class area. It is expected that project related effects to terrestrial ecosystems within the CZN study area will be reversible following decommissioning and reclamation of disturbances, and as such, no significant residual effects are anticipated as a result of project related activities.

TABLE 11-1: SUMMARY OF TERRESTRIAL ECOSYSTEMS POTENTIALLY AFFECTED BY PROJECT CONSTRUCTION

EOSD Land Cover Class	Phase I Road Area (ha) *	Phase II Road Area (ha) *	Airstrip Area (ha)*	Borrow Site Area (ha)*	Borrow Site Access Road Area (ha)*	Tectela Transfer Facility (ha)*	Cleared Area Outside of Winter Road Route (Phase I) (ha)*	Cleared Area Outside of Winter Road Route (Phase II) (ha)*
Broadleaf-dense	3.4	32.0	0.0	4.2	1.1	0.0	0.0	0.4
Broadleaf-open	1.0	9.6	0.0	2.5	1.0	0.0	0.0	0.0
Bryoids	0.7	0.1	0.0	0.5	0.0	0.0	0.0	0.0
Coniferous-dense	6.4	9.6	0.0	1.1	0.1	0.4	0.0	1.9
Coniferous-open	20.7	5.6	0.0	3.6	0.6	0.0	2.0	1.0
Coniferous-sparse	2.8	0.5	0.0	0.9	0.1	0.0	0.1	0.1
Exposed land	21.8	0.0	7.6	3.7	0.0	0.0	0.5	0.0
Herb	0.0	0.3	0.0	0.0	0.0	0.0	0.0	
Mixedwood-dense	5.1	16.2	0.0	6.1	0.0	1.7	0.0	2.6
Mixedwood-open	0.5	1.0	0.0	0.3	0.0	0.0	0.0	0.0
Rock/rubble	6.4	0.0	0.0	3.5	0.0	0.0	0.0	0.0
Shadow	1.7	0.0	0.0	0.8	0.0	0.0	0.0	0.0
Shrub-low	12.1	5.2	0.0	12.6	1.4	0.0	1.3	0.1
Shrub-tall	1.7	6.7	0.0	0.7	0.5	0.0	0.0	0.0
Water	1.2	0.6	0.0	0.3	0.0	0.0	0.0	0.0
Wetland-shrub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wetland-treed	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0
Total	**85.6**	**89.4**	**7.6**	40**.7**	**4.7**	**2.0**	**4.0**	**6.2**

*- Values rounded for reporting purposes

11.8.2 Effects to Merchantable Timber Resources

The Deh Cho Land Use Planning Committee commissioned a study of logging potential of commercially viable forests in the Deh Cho territory (PACTeam Canada 2003), which encompasses the all season road study area. The study was conducted using various metrics to assess logging potential, including the assessment of forest cover mapping to identify suitable stands for logging and the economic viability of conducting logging operations (e.g. access constraints). Based on the results of the study, the majority of the land encompassing Phase 1 of the all season access road study area is currently considered to have low to no potential for commercially viable forestry operations, while the area encompassing Phase 2 of the all season access road is considered to have high to very high potential for commercially viable forestry operations. A portion of this area, from Nahanni Butte to Nahanni National Park Reserve, was identified as being one of the most productive sites in the territory relative to the production of white spruce saw timber.

As a large proportion of Phase 1 and Phase 2 of the proposed all season access road will be constructed using the approved winter road route, the clearing of potential merchantable timber resources will be conducted prior to the all season access road construction, and as such, potential effects to merchantable timber resources in the study area will be minimized. Given the existing clearing requirements for construction of both Phase 1 and Phase 2 of the all season road, it is anticipated that a low volume of merchantable and/or waste timber will ultimately be available for use by the local community.

As clearing for the majority of Phase 1 and Phase 2 of the proposed all season access road will be confined to the proposed project ROW, which will generally follow the approved winter road route, the extent, magnitude, duration and frequency of potential project related effects are considered low and reversible following reclamation. The overall significance of effects to merchantable timber resources are considered low and no residual effects are anticipated as a result of project construction.

11.8.3 Effects from Fire

Based on a study conducted by Bothwell et al. (2004), forest fuels in the regional context of the study area are predominantly described as low-density coniferous forests and non-fuel (wetlands, shrub lands and rock) forest cover types. Results of the Bothwell et al. (2004) study suggest that the fire behaviour in the region (e.g., Nahanni National Park Reserve) is influenced by fuel continuity, associated with mountainous terrain, and may explain a lower proportion of large (>200 ha) fires, relative to other areas examined as part of the study. The mean fire return interval calculated for the region was 28 years, while a fire cycle of 1,142 years was determined for fires greater than 200 hectares.

It can be reasonably assumed that the risk of human caused fire in direct proximity to the proposed all season access road will increase given the potential for fire risks associated with vehicle malfunction and other human induced fire risks (e.g., smoking). These risks would be considered most pertinent during periods of low precipitation and associated decreases in fine fuel moisture content; typically associated with the summer months. Although fire is a natural disturbance within the boreal forest ecosystem, the alteration of natural forest fire cycles has the potential to disrupt long-range ecosystem management objectives (particularly associated with the Nahanni National Park Reserve), along with the potential dangers to local residents and interests of stakeholders in the region (including CZN).

Along with the potential risks posed by development of the all season access road, several positive benefits related to fire management practices in the region can be anticipated as a result of project development. These would likely include increased access to more remote areas of the region should fire control activities be warranted and the potential use of the road as a fire break in certain circumstances.

It is anticipated that potential fire risks associated with construction and operation of the all season access road can generally be avoided through the application of mitigation measures related to fire prevention and emergency response. It is recommended that all staff be trained in appropriate fire prevention techniques, and appropriate emergency response procedures.

Assuming application of appropriate mitigation measures, and the low anticipated volume of traffic utilizing the proposed all season access, the extent, magnitude, duration and frequency of potential fire related effects are characterized as low and reversible. The overall significance of effects is considered low and no residual effects are anticipated.

11.8.4 Effects of Access Road-Related Emissions on Vegetation

The air quality assessment presented in the DAR for the CZN Prairie Creek Mine (CZN 2010) indicated that construction and operation of the winter access road would result in the release of exhaust emissions from equipment, transport trucks, other trucks, and electrical power generation emissions (at the transfer facilities and Cat Camp). Emissions from equipment and trucks are primarily particulates (as carbon soot) and exhaust gases (SO_2, NO_x and SO_2) from burning diesel fuel. These emissions will be of low intensity compared to Mine-site emissions. With snow melt in the spring, the limited amount of particulates will settle onto ground cover vegetation and be absorbed into the organic substrate (CZN DAR 2010; Golder 2010).

During the snow free months, when the all season road will continue to operate at a low intensity, the emissions from trucks, other vehicles and stationary emission sources at the transfer facilities will be of a similar low intensity. As a result, these limited emissions are not expected to have a measurable effect on vegetation adjacent to the all season access road, Cat Camp or the transfer facilities. Overall, the significance of access road related air emissions on vegetation is expected to be low. No residual effects to vegetation are anticipated from road related air emissions.

11.8.5 Effects of Dust Generation on Vegetation

Road construction and use of the access road during the summer months, will generate dust. The potential effects of dust deposition on plant species varies with the deposition frequency, load and duration, as well as the physical and chemical properties of the dust and the plant species involved.

A variety of factors can influence dust deposition patterns, such as particle size, wind direction and velocity, terrain, vegetation density and structure (e.g., tall vs. short), vehicle size, speed, and traffic volumes. Several studies of the effects of road dust on vegetation have highlighted the variability in particle transport, with effects being detected 100 m away (Auerbach et al. 1997), 200 m away (Santelmann and Gorham 1988; Angold 1997), and up to 400 m away (Lamprecht and Graber 1996). Walker and Everett (1987) discovered that up to 75% of the total dust load can generally be deposited within the first 10 m of the road, irrespective of site conditions.

Studies carried out by the United States Environmental Protection Agency (US EPA 1995) also highlight the influence of particle size on dust deposition patterns. Larger particles (e.g., those with an aerodynamic diameter >100 µm) tended to settle within 10 m of the source, while particles with moderate sizes (e.g., with diameters between 30 – 100 µm) settled out within 100 m. Particulates with aerodynamic diameters <15 µm were transported over much greater distances because they were less influenced by gravitational settling

Dust particles that settle directly onto plants can have both a physical and physiological effect. Dust can block stomata, smother leaf surfaces, and increase leaf surface temperature, all of which can reduce the overall photosynthetic efficiency in the plant (Thompson et al. 1984; Pyatt and Haywood 1989; Farmer 1993).

The surrounding environment can also be modified by an increase in dust deposition. Studies have reported changes in substrate properties such as soil pH, soil nutrient regime, earlier snowmelt due to changes in surface albedo, and depth of permafrost thaw (Walker and Everett 1991; Auerbach et al. 1997; Gunn 1998). Longer-term studies have shown that these substrate changes can influence subsequent changes in plant community composition, most notably, a

decline in Sphagnum and lichen species abundance and vigour and an increase in graminoids nearer the dust source (Myers-Smith et al. 2006; Auerbach et al. 1997).

Plant groups such as lichens and Sphagnum moss species tend to have a higher sensitivity to disturbance and are often used as indicators of environmental conditions (Myers-Smith et al. 2006; Markert 1993; Tyler 1989; Spatt and Miller 1981). Documented declines in lichen abundance in studies of road dust deposition have been attributed primarily to the sensitivity of lichens to the physical and chemical properties of the dust, as well as being out-competed by other species that are responding more favourably to the changes in local growing conditions (Myers-Smith et al. 2006; Auerbach et al. 1997). Declines in Sphagnum abundance were largely attributed to changes in soil pH, from acidic to more neutral conditions (Myers-Smith et al. 2006; Auerbach et al. 1997).

The primary dust-related effects resulting from the year round use of the all season road are anticipated to occur within about 10 m of the main development footprint, as this is where the majority of the large dust particles are expected to settle out. However, dust-related effects may occur at greater distances from the roadway depending, in part, on site conditions and particle size characteristics.

Plant species expected to be affected by dust settling along the all season road are generally common and will be "washed" during annual snow melt and summer rainfall events. The GNWT (1998) dust suppression guidelines will be implemented at the TTF and along portions of the road located in environments which are more prone to adverse effects from road dust accumulation (e.g., wetlands), as appropriate, to limit dust generation during the snow free months. Dust management will generally involve watering dust-prone areas as and when required, as well as adhering to speed limits on roads, which helps limit the re-suspension of particulate material.

With the diligent application of these mitigation measures, the significance of dust generation from the construction and operation of the all season road and associated traffic on adjacent vegetation is expected to be low. No residual effects resulting from project related dust generation are anticipated.

11.8.6 Effects on Harvested Plants

There is no direct information with which to assess the potential for impacts related to cultural uses of plant species in the Prairie Creek Mine site area or along the access road. However, CZN was informed by an elder of the Nahanni Butte Dene Band that plants are primarily harvested in proximity to the settlement of Nahanni Butte (David Harpley, pers. comm. in CZN DAR 2010; Golder 2010).

As previously discussed, effects to habitats capable of supporting traditionally important plants within the CZN study area may potentially occur as a direct result of habitat clearing during construction and indirectly from the generation of road dust, potential spills of deleterious substances and introduction of invasive species. All criteria used for assessing potential effects to traditionally important plants were generally rated as low and not significant, considering the use of an existing disturbance (winter access road) for construction of the majority of the all season road and the low anticipated volume of traffic associated with use of the all season road. Assuming the appropriate application of mitigation measures during the life of the project, no residual effects to traditionally important plant species are anticipated from the project.

11.8.7 Effects on Rare Plants

As previously reported, results of the ENR virtual herbarium search indicate that no vegetation species at risk occurrences have been historically recorded within five kilometres of the CZN study area. Of the species identified during the search, two species (Nahanni aster and Raup's willow) are currently considered globally imperiled (G2 global status ranking – NatureServe 2014) and one species (Velenovsky's hilpertia moss) is considered critically imperiled (G1 global status ranking – NatureServe 2014). The nearest known occurrences of these species to the CZN study area are 20 km, 25 km, and 50 km respectively. Potential project-related effects to these species are considered unlikely given the spatial isolation of known populations from the proposed project.

Rare plant surveys related to the Prairie Creek Mine Project and associated winter access road were initiated by EBA on behalf of CZN in July 2009 and further surveys were completed in August 2010 (EBA 2010; 2011).

In July 2009, rare plant surveys were conducted along the Prairie Creek Mine winter road; the proposed waste rock storage facility; and the area around camp and the beaver pond to the south.

A total of 340 plant observations, representing 193 species and 44 families of vascular plants, were documented during the 2009 field survey. No plant species listed within the federal SARA were observed in the surveyed areas. However, one plant species, few flower meadow rue (*Thalictrum sparsiflorum*), listed as 'May Be At Risk' (ENR 2014b), was documented along the Prairie Creek winter road and an adjacent wetland. As the species appears locally abundant within the study area, conversion of the winter road to an all season access is unlikely to threaten the viability of this species locally, considering confirmed observations were identified outside of the proposed development footprint.

Two additional plant species ranked as 'May Be At Risk' by the ENR were identified along the existing winter access road (Hornemann willowherb *Epilobium hornemanni* and linear-leaved willowherb *Epilobium leptophyllum*), have restricted distribution in the NWT with limited known occurrences, but are globally secure (Golder 2010). Six plant species ranked as 'Sensitive' by the ENR—alpine anemone (*Anemone drummondii*), bog birch (*Betula pumila*), lesser black-scaled sedge (*Carex atrosquama*), one-glume spike rush (*Eleocharis uniglumis*) alpine groundsel (*Packera pauciflora*) and yellow mountain heather (*Phyllodoce glanduliflora*) - identified adjacent to the Prairie Creek winter road have small regional distributions in the NWT with a small number of known occurrences, but are globally secure. It was concluded that impacts to these local occurrences (and potential additional occurrences near the access road) can be avoided or reduced by limiting the amount of additional land disturbance for upgrades and operation of the all season access road.

In August 2010, the proposed Polje By-Pass re-alignment was surveyed for unique or important vegetation communities and rare plants. The habitat in which the proposed Polje By-Pass re-alignment traverses was burned by a forest fire in 1996. The vegetation community now comprises a jack pine regeneration stand approximately 14 years old. No rare plants or sensitive habitats were documented within the jack pine regeneration along the proposed Polje By-Pass alignment. It was concluded that this proposed re-alignment would not threaten rare plants or sensitive vegetation communities (EBA 2011).

Based on the results of the rare plant surveys conducted, the extent, magnitude, duration and frequency of potential project related effects to rare plant species resulting from conversion of

the existing winter access road to an all season road are characterized as low and reversible. The overall significance of effects is considered low. No residual effects to rare plants are anticipated assuming appropriate application of mitigation strategies related to dust generation, spill prevention and the introduction of invasive species.

11.8.8 Introduction of Invasive Plants

Trends in invasive alien plant species presence and establishment in the north are being monitored with increasing interest by scientists and regulatory agencies alike. Invasive alien plant species are those that have been introduced into areas beyond their natural range by humans and are capable of causing significant harm to the environment, economy, or society (GNWT and NWT Biodiversity Team 2010). Though the incidence of invasive plant species in the north is still much lower compared to areas further south, the prospect of climate change and increased development could lead to more frequent, unintentional introductions.

Recent studies in northern climates have shown that invasive plants are becoming more prevalent; however, it is unclear whether this is due in part or in combination to a true increase in plant species, the conduct of more surveys specifically targeting invasive species, or increased development in remote areas (Shrader and Hennon 2005; Carlson and Shephard 2007).

Invasive plants have the ability to aggressively establish and quickly spread in new environments. These adaptations coupled with their ability to out compete native species can affect plant species richness, diversity, and the composition and function of affected natural ecosystems (Haber 1997). The successful introduction and colonization of an area by invasive plant species relies, in part, on the presence of suitable habitat, access to a source of invasive plant material, and a means of dispersal.

The disturbances associated with development projects can unintentionally create growing conditions that facilitate the successful establishment of invasive plants. Exposed soil resulting from the removal of plant cover is particularly susceptible to colonization. Dirty equipment transported to site from other areas can act as a dispersal mechanism for invasive plant propagules that may have become lodged in tires and mud.

The most effective management of invasive plants is preventing their establishment into an area (Carlson and Shephard 2007; Schrader and Hennon 2005; USDA 2006; Polster 2005; Clark 2003). Removal once established is more costly and can be particularly challenging logistically in more remote northern areas.

In August 2010 EBA completed an invasive plant survey and reclamation assessment along the existing Prairie Creek Mine access road, and a rare plant survey along the proposed and now approved road re-alignments (EBA 2011). Surveys were conducted from August 9 to 13, 2010. The study area for these surveys included that section of the access road occurring within the boundaries of the expanded Nahanni National Park Reserve.

No invasive alien plant species were documented along the portions of the access road surveyed; consequently, they are not believed to be an issue at this time.

The Prairie Creek Mine site and existing winter access road have been in place since 1982, and Mine-related heavy equipment is already on site. In the future, any new equipment would be brought in along the access road on trucks or tractor trailer units. Similarly, Mine supplies and fuel will be brought in along the access road. Invasive plants are usually brought into a site (or along an access road) through dirty vehicles or heavy equipment operating during the non-winter

period, when seeds of invasive plants can more readily be mixed with mud or dirt on vehicles or equipment, and then fall off along a road way or at a work site.

The risk of invasive species introduction during the construction and operation of Phase 1 of the all season access road will be minimal, as all equipment and vehicle traffic associated with this phase of the project will be brought into the site during the winter months. Operations during the summer construction season will be within a closed system, which is the time period that is most conducive to the spread and establishment of invasive species. The risk of invasive species introduction will increase upon completion of Phase 2 of the project which would allow for the transport of vehicles and equipment during the summer months, and thereby increase the potential for transport of invasive species into the study area. It is recommended that an invasive species management plan be developed prior to project construction to determine appropriate best management practices with respect to the prevention of invasive species establishment and invasive species control. The invasive species management plan should be developed in consultation with applicable stakeholders to ensure proposed mitigation efforts comply with existing regulations which may potentially limit the application of specific invasive species control measures (e.g. use of herbicides in National Parks).

The use of seed mixes for re-vegetation of disturbance areas may also introduce invasive species. Given this risk, CZN's approach (as defined in EA0809-002) for re-vegetation of disturbed areas will rely primarily on encroachment of native species from surrounding vegetation communities.

Given the low anticipated traffic volumes anticipated for the all season road and the application of additional mitigation strategies (which should include an invasive species management plan) the extent, magnitude, duration and frequency of potential effects from invasive species introduction are considered low and reversible.

Overall, the significance of effects from invasive plants is expected to be low. No residual effects are anticipated assuming the appropriate application of mitigation strategies.

11.8.9 Effects to Soil, Hydrological and Permafrost Regimes

The study area is characterized by a variety of vegetation cover types ranging from alpine tundra areas with little to no soil development, to lowland areas dominated by wetland communities and organic soils (Beak 1981). Based on the review of the winter access road DAR (CZN 2010), the study area also contains areas with 'ice-rich ground' or discontinuous permafrost. Road construction in these environments presents challenges, both from the perspective of maintaining a viable, safe road surface and from the perspective of maintaining biological integrity in potentially sensitive environments.

Challenges associated with road engineering in permafrost areas are well documented, and generally result from removal of insulating vegetation (active thaw layer) overlying permafrost soils and disruption of the thermal equilibrium (Ferrians et al. 1970). Once vegetation is removed, the active thaw layer increases and collects greater quantities of moisture leading to greater heaving of the ground during the winter and a greater incidence of sediment flow, landslides and subsidence during the summer. All of these resulting consequences can have detrimental effects to the stability of road surfaces.

Thawing of permafrost can potentially result in direct and indirect negative effects to terrestrial and aquatic vegetation communities (ENR 2014i). Thawing of permafrost resulting in slumping and landslides can physically alter the landscape, and can potentially alter drainage patterns, moisture regimes, and nutrient regimes resulting in changes to community composition.

Sediment releases caused by thawing permafrost can also alter suspended sediment levels in waterbodies, altering chemical and nutrient concentrations which may also result in changes to aquatic vegetation community composition.

Road construction can negatively affect physical and chemical properties of soil including changes to structure, porosity, permeability, organic matter content and chemical conditions; resulting from soil disturbance, compaction and mixing of soil layers (Johnston and Johnston 2004).

Road construction in wetland areas also has the potential to alter hydrology and cause changes to such communities. Jeglum (1975) and Hillman (1987) reported increases in tree growth and the development of a drier treed bog on one side of a road following construction in an open peatland. Similar studies conducted by Lieffers and Rothwell (1987) and Lieffers (1988) found that water drawdown on peatland soils increased growth of shrubs and hardwoods. Prevost et al. (1999) observed that changes in water levels, nutrient levels, and pH generally results in changes to species composition and species growth rates.

The use of existing disturbance areas (winter access road) for construction of a proportion of the all season access road will reduce potential project related effects to soil resources in the study area and avoid wetland areas to the greatest extent feasible. As part of the DAR prepared for the approved winter road access, CZN has committed to constructing road infrastructure in accordance with standard industry best practice, including guidelines described in the *Northern Land Use Guidelines: Access Roads and Trails* (INAC 2008). All best management practices, including the salvage of topsoil, erosion control measures, and the maintenance of the existing hydrological regimes (using appropriately placed culverts or other methods) should be determined prior to construction.

Assuming adherence to standard industry best practices during construction, the extent, duration and frequency of potential project related effects to soils, hydrology and permafrost regimes are considered low and reversible.

Overall, the significance of effects are expected to be low. No residual effects are anticipated assuming the appropriate application of mitigation strategies.

11.8.10 Mitigation and Best Management Practices

General Best Management Practices

Currently authorized changes in the alignment of the winter access road are related to the avoidance of karst features west of Mosquito Lake, avoidance of wetlands between Fishtrap Creek and Grainger Pass, and extensive areas of muskeg between Granger Pass and the Liard Highway. The latter two realignments are favoured by residents of Nahanni Butte. Other realignment changes are to avoid bisecting karst features (poljes) and sharp bends (CZN DAR 2010; Golder 2010).

General best management practices (BMP's) related to mitigating further potential effects on vegetation (including ecosystems and rare plants) along the current winter road corridor and future access road include:

- Confine all season road development activities to the approved winter road corridor to the greatest extent feasible;

- Preparation of an Emergency Response Plan for spill containment and management along the access road;
- Fuel storage facilities that meet industry standards for tank construction, location and spill containment;
- Staff training with respect to fire prevention protocols and emergency response procedures;
- Construction in accordance with best standard industry practices in relation to soil disturbance, hydrology maintenance and construction in permafrost areas;
- Hydrocarbon and chemicals that are hauled along the access road or stored at the TTF meet industry standard containers with appropriate spill containment and management measures in place;
- Refuelling of trucks and equipment away from any stream, lake, wetland or other water body, per industry standards;
- Diligent application of the GNWT (1998) dust suppression guidelines at the TTF and along portions of the road as appropriate; and
- Development and implementation of an invasive species management plan to ideally prevent, or if necessary, control the establishment of invasive species in off-site vegetation communities adjacent to the roadway.

Re-vegetation During Reclamation

It is anticipated that re-vegetation of borrow sources and other disturbances associated with the development of the all season access road will occur primarily through encroachment of native species from surrounding vegetation communities.

Vegetation Control

During operation of the all season access road, it is anticipated that vegetation control may be required to control shrub and tree growth within the road ROW to maintain safe driving conditions. Additional vegetation control may be required in the event that invasive species are identified within proximity to the proposed development.

Control of tree and shrub growth within the proposed ROW should be conducted using mechanical methods (such as a brush mower). The use of herbicides and/or other chemical means of vegetation control are not recommended.

If required, control of invasive species should be conducted in accordance with an invasive species management plan that should be developed prior to project construction. The plan should detail appropriate best management practices with respect to invasive species control. The invasive species management plan should be developed in consultation with applicable stakeholders to ensure proposed mitigation efforts comply with existing regulations which may potentially limit the application of specific invasive species control measures (e.g., use of herbicides in National Parks).

11.9 Cultural and Heritage Resources

11.9.1 Traditional Life

Traditional harvesting was discussed in Section 8. The all season road is not expected to have any significant negative effects on traditional lifestyles, values and culture for the following reasons:

- the road does not enter the village of Nahanni Butte, and will be isolated from the village by the South Nahanni and Liard Rivers;
- the NDDB chose to have the road relocated to its proposed alignment so that they may better participate in activities associated with it, and better control access into the interior on it;
- the road will facilitate traditional activities by enabling better access into the interior, and will not interfere with current activities;
- the road is not proximal to any known culturally important or spiritual sites;
- the community's main interest is jobs and income, coupled with environmental protection;
- CZN's policy for the winter road and all season road is that employees and contractors are not permitted to travel into Nahanni Butte, except for CZN management on official business, and residents of the village; and
- CZN will have a strict policy of not permitting vehicles on Company business to transport liquor or drugs destined for Nahanni Butte.

11.9.2 Cultural/Spiritual Life

In all of the engagements CZN has had with the NDDB, previously associated with EA0809-002, and recently, no one has mentioned any issues regarding impacts on cultural or spiritual sites and activities. In a recent meeting with elders and harvesters (January 20, 2015), the location of the proposed Liard River crossing was questioned regarding proximity to grave sites. On further examination of maps, it was determined that the grave sites are several hundred metres upstream, and not proximal to the crossing location. Again, it is pertinent to note that during previous engagement regarding the alignment of the permitted winter road, the NDDB's preference was to locate it near the village. The all season road alignment will be on essentially the same alignment.

11.9.3 Archaeological Sites

Section 5.3 provided details on CZN's engagement of traditional knowledge (TK) holders in the area, and also explained that sites of potential heritage resources were identified by the NBDB in proximity to CZN's access road, and that CZN subsequently hired an archaeological consultant

to investigate the identified areas. A follow-up AIA was also undertaken of the new winter road alignment along the Front Range to the Liard River. No heritage resources were found.

CZN has looked for heritage resources in the most likely locations of occurrence, based on traditional advice. None have been found. The all season road development will have sections that differ from the currently permitted winter road alignment, just as the permitted winter road alignment has sections that differ from the historical winter road. All season road development will include the development of borrow pits. These will be in areas of low probability of the occurrence of heritage resources, based on TK. Any further field investigations for heritage resources would be literally looking for 'needles in a haystack', and are time consuming and expensive. During the meeting with elders and harvesters on January 20, 2015 CZN asked about locations of camps when traditional harvesters previously went on hunting expeditions in the lowland valleys crossed by the road. NDDB elders advised that there were no preferred camp locations, rather the hunters would select a camp location for an overnight stay almost at random, and would likely not return there. Therefore, they could not advise where to look for camp locations. As such, the camps could be anywhere. Following these comments, CZN asked elders what would make sense regarding the protection of heritage resources. CZN suggested that perhaps what would make sense is to compile a short brochure of photographs of what heritage resources look like. This brochure could then be provided to contractors as part of the road Construction, Operation and Maintenance Plan. The advice would be that if anything is discovered that resembles the items in the brochure, work is to avoid disturbing the items until the relevant authorities have been notified and decisions made. This approach is a common condition in LUP's, except for the brochure aspect. The addition of the brochure is viewed as a practical solution regarding the location of heritage resources, if any exist, since they will be difficult to find, particularly as few people know what they actually look like.

11.10 Employment and Benefits to the Community

As noted elsewhere, CZN has IBA's with the NDDB and LKFN, and a SEA with the GNWT. These were concluded for the Mine and winter road development proposals. Nearly all of the items listed in the TOR have been addressed previously in EA0809-002, and the agreements listed above. With regards to employment, the NDDB IBA provides for first right of refusal for NDDB residents for available positions, assuming qualified candidates apply. Given the low number of residents over the age of 15 (70), and that few have trade qualifications (15), it is not expected that a high number will gain employment with CZN. Consequently, other elements were included in the NDDB IBA, such as the intention to sole source specific contracts, like the road security contract, plus some annual, confidential financial benefits. The LKFN IBA is more geared towards employment, since the number of qualified tradesmen is much higher (85), and therefore the number actually gaining employment at the Mine is also expected to be higher. The SEA with the GNWT essentially cements the intention to hire northern workers first, and to preferentially obtain contracts with northern companies, provided they are competitive. The SEA also has provisions for human resource development, and supporting territorial health and wellness programs. The IBA's are confidential, but the SEA is a public document, and the Board are referred to it for specific details. The IBA's and SEA are pertinent to, and will be retained for, the all season road.

The text below provides answers to the items posed in the TOR. However, CZN considers the agreements referred to above more relevant to this subject matter.

1. *Direct and indirect employment opportunities generated by the development and the potential for uptake of these opportunities locally by Aboriginal peoples and within the North.* There is a strong possibility of the successful road construction company being a northern company, with Aboriginal and northern staff. Aboriginals are likely to be directly involved in security and environmental monitoring of the road, and indirectly involved in providing support services, such as catering.

2. *Current or proposed socio-economic initiatives or agreements (please list and provide the non-confidential details).* Given above. Refer to the SEA on the Public Registry for details.

3. *The effectiveness of past or present socio-economic benefit initiatives including levels of success in improving recruitment, retention, and advancement of workers from potentially affected communities.* CZN has not had commercial operations as yet, so there is no precedent. Refer to Section 7 for the history of CZN's prior engagement with local communities. CZN has had local Aboriginal staff at the Mine for many years. CZN has also participated in training programs, and hosted several (see Section 5.1), with some trainees subsequently being hired by CZN, and some who were already employees.

4. *Employment and income for every phase and year of construction and operation, with particular reference to wage and salary employment by length of employment, form of employment (full time, part time, seasonal), and skills category.* This is impossible to estimate, and is not considered to be particularly relevant. Annual employment and income will depend on the intensity of construction. The construction could be full time or seasonal, depending on project requirements. The chosen construction contractor will be required to maximize the number of local Aboriginal workers, and next northern workers, in keeping with the IBA's and SEA. How many workers he hires and what he pays them will be his decision. We would hope that many local workers will be competent machine and truck operators, so that they are more likely to be available for employment. Training programs are being geared in that direction. During operations, we would hope that local Aboriginals can be the full-time truck drivers, ferry operators, and logistical assistants.

5. *Location of camps (new or existing, temporary or permanent) and size of crews (number of individuals) working at each camp.* As noted in Section 6, during construction, camps will be located approximately every 20 km along the road. Not all camps will be in operation at any one time, rather active camp locations will change as the work progresses. Smaller camps may be retained at Cat Camp, the TTF and Grainger Gap for maintenance work during operations. Crew sizes during construction will depend on the intensity of the work, and will be determined by the successful contractor, appointed after competitive bid. Total crew size is likely to be in the order of 50 people.

6. *Employee drug and alcohol policy.* CZN has an existing drug and alcohol policy. No drugs or alcohol are permitted on site at any time. CZN assumes the right to test job

applicants for drugs and alcohol during the hiring process. The terms of employment give CZN the right to search individuals and/or accommodations on CZN property for drugs and alcohol at any time. Discovery of such substances are subject to immediate confiscation, and removal of the offending employee from site immediately, followed by termination. The policy will be reviewed and updated for operations.

7. *Security personnel at the sites.* As noted above, a security check-point will be operated on the all season road at a location to be chosen west of the Liard River crossing. The check-point will be staffed by NDDB members.

8. *Anticipated access of crews to surrounding communities.* As noted above, road crews will not be permitted to enter Nahanni Butte, unless they are residents.

9. *Potential negative effects of the project such as crime and substance abuse.* As noted above, CZN will implement measures to avoid the all season road and activities from being a facilitator of the transportation of drugs or alcohol. Employees and contractors will not be permitted to facilitate the transport of these substances. The all season road will provide wage income for local Aboriginals and others. The added income might mean that certain individuals are more prone to drug and alcohol abuse. However, this will be no different from winter road operations, except for the different seasons. Drug and alcohol abuse by employees and contracts while not at work is beyond the control of CZN. However, it is an issue that will require consideration for mine operations in terms of awareness and support programs.

10. *Changes to policing demands.* Nahanni Butte currently does not have a police detachment in the village. Visits are made by police from Fort Simpson as necessary. With an expectation of no significant effects of the project on crime and substance abuse, this should not change. No changes in policing demands are expected in other communities, such as Fort Simpson. Highway transport trucks will pass through Fort Liard all season. However, this will occur with operation of the winter road, so there will be no change with all season road operation.

11. *Measures, plans and commitments for maximizing local and Aboriginal employment and businesses.* These have already been incorporated into the IBA's and SEA.

12. *Effects on tourism activities (including potential opportunities for increased tourism) in the region from all season access.* The all season road is not expected to have any negative effects on tourism. On the contrary, CZN believes the road and airstrip could facilitate significantly increased tourism, especially in the area of the NNPR crossed by the road. Road access would make tourism into the region more affordable. It would also enable support services to be provided. There would be greater opportunities for hiking, and potentially overnight accommodation. The tourist traffic would also provide opportunities for guiding and the purchase of native crafts.

13. *Potential for increased exploration in the area.* This only applies to the area from the Nahanni access Road to the NNPR boundary, since exploration within the park would not be allowed. The potential for mineral exploration is considered to be slim given the low

mineral potential of that particular. Oil and gas exploration is possible, but the area was explored previously and the potential appears to be limited, given the lack of follow-up.

14. *Speculative migration into the area.* It is considered unlikely this will be a significant issue, since the only reason for migration would be work, and migration into the area for this reason would not be necessary because the Mine shift rotation will include pick-up locations in Yellowknife, Hay River, Fort Liard and Fort Nelson.

15. *Changes to the cost of living in the area.* The all season road is unlikely to cause changes so significant that could lead to changes in the cost of living. Without in-migration, the demand on housing would not change. Road operations would mean increased traffic from the south to Fort Liard and Nahanni Butte, and this has the potential to lower the cost of transportation to bring supplies to these locations. Therefore, it is possible that there might be some reduction in the cost of living in those communities. However, transportation links to Fort Liard are already well established, so there may be no change there.

16. *How local and Aboriginal participation in contractor and sub-contractor business opportunities will be maximized.* This has already been detailed in IBA- related programs and socio-economic commitments made as part of EA0809-002.

17. *Effects on capacity of local businesses to service other sectors during the construction phase.* Local businesses are assumed to be presently well established, but under-utilized. The relatively short-term period of the road and airstrip construction phase may temporarily correct the under-utilization, and also cause the successful contractors to rent equipment and acquire extra personnel on a temporary basis to fulfil road contracts. Also, it is likely that not all local businesses will be successful in gaining road contracts. Those that aren't may have an opportunity to provide additional services to fill the possible void of those that are. Therefore, the capacity of local businesses to service other sectors during the construction phase is unlikely to be significantly impacted.

18. *The timing and duration of education and skills development programs that would be required for road-related employment.* See Section 5.1. Training programs have already commenced related to Mine operations, and will continue with the goal of achieving the socio-economic objectives already set. These programs include heavy equipment operation and truck drivers, so are equally relevant to the all season road.

19. *Proposed education and training programs required for road-related construction and operation employment.* See 18 above. Training required for use of the proposed road includes Heavy Equipment Operator, Environmental Monitor, Camp Cook, Road Construction, Class 5 Driver Licence, and Advanced Medical First Responder. Training programs for all of these have already been held. CZN is presently in discussions with the Mine Training Society (MTS) and Aurora College regarding additional programs, which the Company may sponsor or help deliver, such as hosting them at the Mine as in the past. All of the training programs listed deliver skills that could be applied to other projects or sectors. Section 5.1 listed the number of people in local communities with trades qualifications that might be available for positions at the Mine or associated with

the road. The number of available workers from the smaller local communities is limited (10 each), but a greater number are available from Fort Liard, Fort Simpson and the rest of the Dehcho. Because of the general absence of economic activity in the region to date, there are few locals with significant experience in road-related trades at a supervisor or managerial level. It would take some time for local personnel to develop these skills.

11.11 Impacts on existing Transportation Infrastructure

In Section 6.5, it was noted that Mine traffic will cause approximately a doubling of traffic on the 10 km section of the Nahanni Butte access road to the highway. This is less than currently planned in winter for winter road operations. There would be impacts in summer because the road is currently only rated for light vehicles. Improvements to accommodate heavy vehicles would be required. The increased truck traffic is unlikely to cause dust or safety concerns considering the generally slow speeds of travel.

The number of mine vehicles using Highway #7 will likely be approximately just over 1 per hour in either direction. Therefore, highway traffic will roughly double in winter, and be approximately 60% higher in summer. The state of the highway has been well documented. It is currently considered to be an impediment to tourism. The additional traffic will exacerbate the current poor road condition. However, we believe the planned mine operations and road use will be a catalyst for road improvements and greater use. In Section 6, we noted that the GNWT recently set aside $30 million over 10 years for road improvements. The increased road traffic will be a concern with respect to dust, safety, the possibility for collisions and spills. Road improvements should mitigate these concerns. An improved road surface should limit dust and be safer. The possibility of collisions and spills is always a concern. Mitigating circumstances are that the truck drivers will be professionals, and they will be trained for responding to the potential spill of their cargo, and carry an appropriate response kit.

Since the highway and Nahanni Access road are currently under-utilized, and tourist traffic is small, the additional roadway use by mine vehicles is not expected to pose a significant issue. However, we assume the DOT will consider the additional traffic, and may choose to post signage warning of the frequent heavy truck traffic.

In Section 6, we noted that the Liard River between Nahanni Butte and Lindberg Landing is used as the eastern terminus of paddling trips down the South Nahanni River in summer, numbering approximately 30-40 per season, and that Nahanni Butte residents also use this stretch of the river to travel to Blackstone Park. Summer use of the all season road would include a barge crossing. The frequency of crossings will likely be approximately one per hour, and will take 5-10 minutes each. Therefore, the barge crossings are unlikely to have any significant effects on the existing use of the river.

12.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The following commentary was extracted from Tetra Tech EBA's report in Appendix 2.

> The impacts of potential climate change need to be considered in the final design of the all-season road. Climate change considerations are also a normal part of Tetra Tech EBA's geotechnical assessments in permafrost regions.
>
> Two key factors play a role with respect to climate change and its probable effects on permafrost along the proposed all-season road:
>
> - Climate change has been ongoing for many years and is expected to continue during and beyond the service life of the road; and
> - Already-warm permafrost will continue to get warmer, and is likely to either continue slowly thawing or start slowly thawing.
>
> A procedure for screening the vulnerability of a development to climate change is outlined by the Canadian Standards Association (CSA, 2010).
>
> The sensitivity of an area to climate change is governed by the characteristics of the permafrost in that area. The all-season road route is in an area of extensive, discontinuous permafrost, with average anticipated ground temperatures just below 0°C at lower elevations and likely warmer than -2°C at higher elevations along the route. The subsurface soils are of highly variable origin along this 184.5 km route, but permafrost with possible ice-rich lenses or layers has been encountered at various locations along the route. Tetra Tech EBA therefore characterizes the site sensitivity to be "high" along route sections with fine-grained soils. This entails most of the route, except for the initial 39 km from the Mine to Cat Camp, and about 2 km in Grainger Gap where granular soils are more prevalent. Along the remainder of the route, some short sections within granular soils likely have "moderate" to "low" sensitivities to climate change, particularly where ground temperatures are likely to be moderated by nearby large water bodies, and where permafrost is less likely to be present. Tetra Tech EBA estimated that about 73 km likely has least some thaw-sensitive permafrost, and another 24 km may also have thaw-sensitive permafrost, but slope aspect or elevation makes it slightly less likely.
>
> Under a "moderate" green-house gas scenario, the mean annual air temperature is estimated to increase about 0.8 °C over the next 30 years. For the proposed 20-year service life for the road, the mean annual air temperature would rise by a total of about 0.5 °C. Under a "high" green-house gas scenario, the mean annual air temperature is estimated to increase about 1.1 °C over the next 30 years. For the 20-year proposed service life for the road, the mean annual air temperature would rise by a total of about 0.7°C (CSA, 2010).
>
> Road embankment and structure design and construction need to account for the likely change in ground temperature over the service life of the project. In cases where direct correlations between air temperature and ground temperature are not available, ground temperature is assumed to change in step with air temperature. Therefore, the ground temperature in 20 years could be at 0°C or potentially warmer than 0°C where permafrost is currently very close to 0°C, and may be warmer than -1.5°C where the permafrost is currently estimated to be warmer than -2°C.

For the “moderate” green-house gas scenario, the increase in air and ground temperatures may be enough to encourage the start of thawing where the permafrost along the route is already near-thawing. Where permafrost is already slowly thawing, further thawing is expected. Such thawing is less important in areas with near-surface bedrock, coarse-grained soils with relatively low soil moisture contents, or even finer-grained soils with relatively low moisture contents, because thawing probably will not result in much noticeable change in the ground conditions in those areas. Areas that have higher soil moisture contents in the form of ice can be affected in two general ways. On the one hand, thawing will probably be slower, because extra energy is required to turn ice to water. On the other hand, areas that do thaw may experience slope instabilities, similar to the retrogressive thaw slump/flow at KP054, or settlement and ponding of water.

Other areas may not actually thaw during the life of the road, but could be prone to higher rates of soil creep, potentially pushing road sections out of alignment or, more seriously, pushing bridge abutments out of alignment and causing distress to the structure. This is a phenomenon which has also been considered in ground that is colder than the project site, for example, on the Inuvik to Tuktoyaktuk Highway.

Based on the review of available information and the 2014 ground-truthing, it is anticipated that the permafrost in some sections of the route may contain layers or lenses of soil that have excess ground ice. The practical implication is that thawing with resulting settlement and ponding could occur in the subgrade along the toes of the road embankment, the numbers or areas of thaw-related slope failures could increase, thaw settlement beneath culverts could cause water flow to be blocked with potential accompanying slope stability issues, and settlements or potentially even failures of road grades could occur. Settlement and ponding are common along the toes of road embankments in warm permafrost, for example, along the reconstructed section of Yellowknife Highway 3 between Behchoko and Yellowknife, where there are also several road sections with relatively severe differential settlements. The nearby Liard Highway 7 has had significant issues and requires significant maintenance efforts, and is constructed in very similar terrain in terms of ground and permafrost conditions as much of the proposed route. Although it is recognized that the territorial highways have different operating and service life requirements as compared to a resource road, and they have not necessarily all experienced the same construction methods and conditions, they do offer some useful comparisons. Accordingly, potential issues with thaw-sensitive permafrost along the proposed Prairie Creek all-season road would be expected to become more frequent as the permafrost becomes warmer, and more likely to start gradually thawing.

Therefore, the consequences of permafrost thaw can be potentially significant, and they are characterized as potentially “major” for structures supported by shallow or deep foundations within fine-grained permafrost with excess ice, but likely “minor” for structures supported on frost-stable granular soils or bedrock beneath the surficial sediments. Such structures would include bridges and culverts along the route in locations where permafrost is present. For road embankments, the consequences of permafrost thaw could be “major” where thaw settlement under culverts goes unnoticed for a long period of time potentially blocking natural water flow, and “minor” for road surfaces that can be readily re-levelled with more fill. These consequences can be mitigated by a reasonable inspection and maintenance schedule.

Considering the site-specific permafrost sensitivity and the associated consequences together results in a risk level "C" (low risk) as defined in CSA (2010) for structures such as bridge and major culverts supported by foundations on or in frost-stable soils or bedrock. With respect to permafrost, this level of risk warrants a qualitative analysis and the use of expert judgement to develop design parameters for a project with routine design parameters.

For structures supported by foundations on or in thaw-sensitive soils, the site-specific permafrost sensitivity and associated consequences together results in a risk level "A" (high risk) as defined in CSA (2010). This level of risk warrants a quantitative analysis to evaluate the ground thermal regime expected to develop beneath the proposed structure over its lifetime. The initial step to proceed with this level of analysis would be to improve the site characterization by conducting a site investigation with boreholes deep enough to determine depths and thicknesses of permafrost. This type of analysis is also useful in optimizing embankment designs in road sections traversing permafrost. It is anticipated that major structures will require a site investigation to determine geotechnical design parameters in any case, irrespective of the anticipated absence or presence of permafrost.

Mitigations and site-specific contingencies are discussed in Tetra Tech EBA's report. Tetra Tech EBA also considered short-term climatic and extreme weather events in a risk analysis. Regarding changes in permafrost and how it will affect the amount the granular material, a reduction in permafrost would only render defined granular sources more viable in terms of suitability for use. That said, Allnorth has defined numerous potential borrow sources, and categorized them into 'intended for use' and 'back-up'. Therefore, no shortage of borrow sources is expected.

The potential for subsidence to affect the road relates primarily to karstification and the Ram Plateau. Tetra Tech EBA covered this item in their report (Appendix 2), and it was considered in Section 10.10 above.

Risks from fires are discussed in Section 13 below.

13.0 POTENTIAL ACCIDENTS AND MALFUNCTIONS

The TOR requests that, for each project phase, accidents and risks to consider in this section include:

- explosions;
- transportation, storage, manufacture and use of explosives; and
- fires.

Regarding explosions not related to explosives, the main risk relates to ignitable and inflammable substances, specifically hydrocarbons. Hydrocarbon fuel will be transported and stored during road construction, operations and reclamation. If there is an explosion due to ignition, the result could be personal injury and/or a spill. The procedures that would need to be followed would be no different than those discussed in Section 9 for a spill. The risks of a spill, and consequences, are also explained in Section 9.

Explosives will be used in limited quantities during road construction, and during mine operations. Explosives are transported in components, and the detonators and explosive media are transported and stored separately, and only combined immediately prior to use. In addition, explosives are transported by dedicated vehicles with specifically trained drivers. Further, the requirements for storage and use are strict, and regulations are strictly enforced. Therefore, the risk of an un-intended explosion is low. The consequences of an explosion would depend on the location, and the magnitude of the explosion. There is potential for loss of life. The environmental consequences are likely to be low because the explosive residues will be dispersed and will be subject to a spill response. Significant quantities of residue are unlikely to enter water. It is prudent to plan for an un-intended explosion, but again, the procedures that would need to be followed would be no different than those discussed in Section 9 for a spill.

Fires started by lightning strikes are quite common in summer. There is evidence of several fires proximal to the road in the recent past, including one that burned up to the road on the Ram Plateau. Fires do not pose a high risk to the road itself, but could alter the nature of the ground which the road crosses. This is discussed in the sections on terrain, soils and permafrost. Fires would pose a higher risk to the Tetcela Transfer Facility due to the presence of infrastructure, including sheds for concentrate storage and potentially a refuelling station. However, the structures would be set-back from the edge of a gravel apron, and therefore should be protected if a fire is nearby. The risk to the sheds would depend on the construction material i.e. metal verses fabric. However, even the loss of the fabric would not be a high consequence, only the replacement cost.

Fires are potentially damaging to vegetation, although fires are part of the natural environment, and some vegetation assemblages are reliant on regeneration following a fire. However, the general approach is to avoid fires and to attempt to extinguish or control them before they grow too large. For prevention, workers and drivers involved in road construction, operations and decommissioning, and TTF operations, require advice regarding safe disposal of cigarette butts and avoiding camp fires. This can be incorporated into the Construction, Operations and Maintenance Plan, the Road Operations Plan and the Closure and Reclamation Plan. Response to fires in proximity to the road and TTF will be coordinated with Parks Canada or ENR, depending

on the fire location. Spill response teams and equipment could be involved in fire suppression proximal to the road.

14.0 CUMULATIVE EFFECTS ASSESSMENT

14.1 Key Lines of Inquiry

Traditional Harvesting

With the application of the proposed mitigation measures, there are two residual effects identified for the proposed all season access road and airstrip relevant to traditional harvesting:

- Positive residual effects on subsistence harvest and harvesting areas of Moose and Dall's Sheep; and,
- Adverse residual effects to Moose harvest pressure.

The environmental assessment for the Prairie Creek Mine and winter road predicted a low likelihood of vehicle collisions with moose along the Prairie Creek winter access road, but was not expected to be a cumulative effect for regional moose populations in the NWT (Golder 2010). The proposed all season access road reduces traffic volumes from the approved winter road levels and, therefore, essentially negates this potential cumulative effect. However, the cumulative harvest pressure anticipated because of the proposed all season access road may act cumulatively with Moose-vehicle mortality assumed to occur along Highway 7. Strict access control measures are required to monitor and manage non-Project related travel and hunting pressure along the all season access road.

Potential residual effects in harvest pressure as a result of the proposed all season access road may act cumulatively with the predicted residual effects to Dall's Sheep lambing activity in the spring (May to June) near the airstrip and Folded Mountain. However, this is counter-balanced by the end of outfitter hunting for sheep in the NNPR by 2019. Strict access control measures and flight management (during lambing season) into the Prairie Creek Mine are required to monitor and manage non-Project related travel, hunting pressure, and disturbances to lambing areas near the Mine site and Phase 1 of the all season access road.

Fishing by non-residents, which would be cumulative on the limited existing traditional fishing, has the potential to limit the positive impact on traditional fishing afforded by improved road access. However, existing fish stocks are judged to be already limited, and not likely to be of significant recreational interest to non-residents, and the overall cumulative effect is assessed to be low.

Accidents and Malfunctions

The existing soil contamination at the Cat Camp and Grainger Camp sites is not considered to represent a potential for cumulative effects with the access road because the sites will be remediated during the early part of Mine operations.

No other contamination is known to exist along the road corridor, nor is any likely in the absence of other industrial activities. Developments upstream in the Liard River watershed could lead to potentially cumulative contamination of the Liard River if a spill occurred at the all season road river crossing.

No significant cumulative impacts to terrain, soils, permafrost and karst are anticipated by Tetra Tech EBA from the all-season road.

NNPR

With the application of the proposed mitigation measures, there is one residual effect identified for the proposed all season access road and airstrip in terms of the NNPR ecosystem:

- Adverse residual effects to Grizzly Bear movements in NNPR.

The environmental assessment for the Prairie Creek Mine and winter road predicted a low but manageable risk to the regional Grizzly Bear population associated with bear-human encounters and mortality (Golder 2010). Golder (2010) suggested this risk to regional grizzly populations could be managed with a Bear Management Plan for the Prairie Creek Mine. Potential residual effects to Grizzly Bear movements through NNPR were predicted from the proposed all season access road. However, since traffic volumes and speed limits will remain low, and there are few resident bears using the Prairie Creek corridor, no further mitigation is considered necessary beyond the Bear Management Plan.

14.2 Subjects of Note

Terrain, Soils, Permafrost and Karst

As noted above, no significant cumulative impacts to terrain, soils, permafrost and karst are anticipated by Tetra Tech EBA from the all-season road.

Air Quality

In the EA0809-002 DAR, maximum predicted concentrations of TSP, PM_{10}, $PM_{2.5}$ and lead resulting from on-site emissions are expected to be lower than the respective air quality standards for receptors located beyond the outer part of the buffer zone (i.e., from 200 m from the surface lease boundary and beyond). Maximum predicted concentrations of NO_2, SO_2 and CO resulting from on-site emissions, and maximum concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO resulting from off-site (access road and transfer facilities) emissions, are expected to be lower than the respective air quality standards for all receptors everywhere. Therefore, it was concluded that impacts from emissions are localized to the Mine site, and there is no cumulative aspect to the impacts. No change to this analysis is anticipated for the all season road compared to the winter road. Gas emissions are generally not considered to be significant from a global perspective.

Noise

Residual effects from noise from road construction and operation are not expected. Residents of Nahanni Butte and a few homesteads along the Liard Highway may periodically notice a higher degree of distant noise from time to time, over and above current normal traffic. However, these residents are not considered to be sensitive to the additional noise, certainly truck and aircraft traffic is common in Nahanni Butte already.

Water Quality and Quantity

Although there is a risk of localized water contamination from spills associated with the access road, the potential for cumulative effects is limited to waterways at either end of the road where other developments may have an influence. At the Mine end of the road, the Mine will discharge treated water into Prairie Creek during operations. Constituents in this discharge that will be elevated relative to background concentrations will be primarily metals, but also sulphate, TDS, nitrogen species and phosphate. Of the materials to be transported on the access road, mineral concentrates will be by far the biggest quantity. A concentrate spill causing a release into either Funeral Creek or Prairie Creek could lead to cumulative metals concentrations in Prairie Creek downstream of the Mine. However, the mineral concentrates are not particularly leachable, and any spill would be rapidly cleaned-up. Therefore, the cumulative metals contribution would be small and of limited duration. Explosives will also be transported on the road, but the volumes and number of loads will be small, and so the risk of an explosives spill will be low, and the risk of a cumulative contribution of nitrogen species to Prairie Creek will be very low.

At the Liard River end of the road, a spill at the river crossing has the potential to lead to the cumulative addition of contaminants already in the river from other activities upstream. The upper Liard River is lacking in industrial development, but crossings and river bank activities have the potential to lead to spills of hydrocarbons into the river. Due to the sheer volume of water in the river, any spill up river is likely to have completely dispersed before the all season road crossing location. Therefore, the potential for cumulative effects is considered to be minimal.

There are no developments presently or expected in the foreseeable future that could lead to cumulative effects to water in the area between the Prairie Creek and Liard River watersheds.

Species at Risk, Wildlife, Wildlife Habitat, Vegetation

EBA determined that with the application of the proposed mitigation measures, there are three residual effects identified for the proposed all season access road and airstrip, including:

- Positive residual effects on subsistence harvest and harvesting areas of Moose and Dall's Sheep;
- Adverse residual effects to Moose harvest pressure; and
- Adverse residual effects to Grizzly Bear movements in NNPR.

Cumulative effects associated with these were discussed in Section 14.1 above.

Fish and Aquatic Habitat

The potential for cumulative effects was discussed above in Section 14.1 under the sub-heading 'Traditional Harvesting'.

Cultural and Heritage Resources

There are no other developments foreseeable that could lead to cumulative effects to cultural or heritage resources.

Employment/Benefits to the Community

The communities of the Dehcho already stand to benefit from operation of the Prairie Creek Mine and the winter access road. Regarding the latter, NDDB members would be involved in manning a security check-point and environmental monitoring, and likely will be involved in ice bridge and road construction, as well as operation of the transfer facilities and possibly truck driving. With an all season road, NDDB members would be involved in many of the same activities. While an ice bridge would be built annually, a winter road would not. However, NDDB members and other Dehcho residents will likely be involved in all season road construction, and much more involved in daily road operations, including driving trucks. This is because, for winter road operations, the mine truck fleet will be quite small, and most of the concentrate haul would be completed by contractors, whereas with an all season road, the haul would be completed by a larger mine fleet without a reliance on contractors.

In terms of present activities in Nahanni Butte, some residents are involved in village and park operations, the latter being seasonal. Operation of the all season road should provide employment for a greater number of residents. In addition, CZN expects that the improved access will be a catalyst for increased tourism, meaning a higher demand for accommodation and meals, traditional crafts and clothing, and hunting/guiding activities. Therefore, collectively, the all season road is expected to provide more employment and benefits to NDDB members and the Dehcho than a winter road.

Nahanni Butte Access Road and the Liard Highway

As noted in Section 11.12, all season road traffic will cause approximately a doubling of traffic on the 10 km section of the Nahanni Butte access road to the highway, while the number of mine vehicles using Highway #7 will likely be approximately just over 1 per hour in either direction, roughly double current winter traffic, and approximately an 60% traffic increase in summer (note that his traffic increase would occur for winter road operations as hauling on the Liard Highway from the Liard Transfer Facility would continue through the summer). Additional tourist traffic would add to this.

Both roads are considered to be under-utilized from a capacity perspective, and well placed to accommodate the additional traffic. This will inevitably mean changes to road maintenance requirements. One of the reasons for the highway being under-utilized is the poor condition of some sections of the road. We believe the increased traffic on the highway will prompt greater attention to this problem and result in better highway conditions for all traffic. The GNWT has already signalled this by allocating funds for a long-term improvement program. In terms of road safety, there will undoubtedly be an adjustment period when road users in the region come to terms with the increased traffic.

15.0 FOLLOW-UP AND MONITORING

15.1 Monitoring

Most of the monitoring and management requirements for the all season road would be the same as for the winter road. This section considers requirements over and above those detailed in the management plans described in Section 6.7. Monitoring data will be compatible with the NWT Cumulative Impact Monitoring Program, where possible.

Allnorth Consultants believe that a short and long term road maintenance program is an essential component for an all season road, and would be developed at the detailed road design stage. The short term road maintenance program would cover the period from the start of right of way clearing, extending five years past the final construction completion date. In addition to standard regular grading of the surface, route maintenance and inspection of all ditches, cross drainages, culverts, and bridge structures to ensure they are operating at full capacity is required. Particular attention must be taken toward the clean-up and restoration of ditches and cross drainages given the construction approach taken to manage and reduce the impact of permafrost. At certain times of year, the process of removing settled material, cleaning ditches, and cross drainages may be an ongoing program extending over the entire road length. It is expected that annual clean-out of inlets of large culverts may be required in late summer to ensure full capacity.

An important consideration during and after construction is the performance of structures and the potential for erosion and sediment dispersal. An appropriate monitoring and adaptive response program will need to be detailed in the Sediment and Erosion Control Plan.

After a period of five years, it is expected that the road prism and site characteristics would stabilize and a reduced approach to manage road ditches, culverts, and cross drainages would be sufficient. This would be a natural progression of the road maintenance program and will be evaluated on an ongoing basis.

Within the mountainous sections from KP 0 to KP 40, which will be subject to rock fall and avalanche influence, an on-going route maintenance and inspection of potential hazards should be conducted. In specific locations where rock fall is common, it is expected that at least annual cleanout will be required to ensure the effectiveness of structures.

As noted by Tetra Tech EBA, Golder (2012) prepared a Draft Wildlife Mitigation and Monitoring Plan (WMMP) for the Prairie Creek Mine and winter access road operation that outlines approaches to reduce potential human-wildlife conflicts and to measure the effectiveness of the mitigation measures implemented. This plan was developed to be dynamic to allow further evaluation through engagement with appropriate stakeholders and development based on the principles of adaptive management.

The draft WMMP considers:

- On-site education consisting of detailed site orientation session for all site personnel and visitors regarding general wildlife education and site-specific wildlife policies and rules, including bear awareness and response programs, wildlife-human conflict management, waste management, and prevention and treatment of problem wildlife;
- Regular surveillance by a wildlife monitor to ensure appropriate policies are being followed (e.g., waste management plan);

- Management of toxic substances, waste, and employee safety on the Mine site;
- Management of sensory disturbances at the mine, airstrip, and access road;
- Dall's Sheep and caribou monitoring program to ensure Project-related effects are minimized;
- Traffic management including but not limited to checking and deterring wildlife from the airstrip prior to take-off and landing, vehicle speed limits, yielding the right-of-way to wildlife, appropriate signage to warn drivers of wildlife "caution zones" (including moveable signs), reporting system of wildlife on the road, and wildlife sweeps prior to avalanche control and management;
- Access road control including signage at the south-eastern terminus of the access road to deter non-mine related use (including ATVs and snowmobiles), manning a check-point and screening station, and reporting of public use of the access road and evidence of land use (e.g., hunting, firewood harvesting);
- Wildlife monitoring by qualified wildlife monitors to conduct ground surveillance at Mine start up and production periods at the Mine and along the access road, responding to and reporting on wildlife incidents and bear encounters, and reporting wildlife-Project interactions (including the wildlife observation logs);
- Ground-based caribou monitoring (caribou numbers, frequency and location of occurrence, and response to aircrafts), during year-round Mine operations and winter access road use by qualified wildlife monitor surveillance at the Mine and airstrip and through reported observation logs by winter road users and pilots at the airstrip;
- Aerial and ground-based reconnaissance surveys to determine Dall's Sheep sensitive lambing areas within 5 km of the Mine site, airstrip, and airstrip approach and their distribution, movements, and behaviour during the parturition period in relation to the Mine and airstrip;
- Incident management and regulatory contacts;
- Data analysis and reporting; and
- Adaptive management triggers, responses, and reporting including a zero mortality threshold and reporting directives for caribou, Wood Bison, Grizzly Bear, Wolverine, Peregrine Falcon, Short-eared Owl, Horned Grebe, Rusty Blackbird, Olive-sided Flycatcher, and Common Nighthawk directly affected by Project-related activities.

Tetra Tech EBA recommends that the existing draft WMMP should be updated to include all season monitoring and species potentially affected by all season access road and airstrip use. Additional considerations for the draft WMMP includes:

- Including mortality thresholds for additional species at risk (e.g., Trumpeter Swan, Collared Pika), Moose, and Dall's Sheep;
- Monitoring, evaluating, and reporting harvest pressure, particularly along the Nahanni Range portions of the outfitter zone that is located outside the NNPR boundary;

- Educating and promoting First Nations voluntary reporting of harvests from along the all season access road; and
- Incorporating additional mitigation measures outlined in this document to minimize non-winter period potential effects (e.g., water pumping from Beaver and Trumpeter Swan ponds).

Significant monitoring of operations and the environment will occur during and after the Mine's life. CZN expects individuals from local communities to be involved in this, preferably as employees. CZN undertakes to share the monitoring results. Discussion of future monitoring requirements and reporting has been initiated with the NDDB and Parks Canada. CZN will actively support appropriate collaborative monitoring initiatives with First Nations, Parks Canada and other regulatory agencies.

15.2 Adaptive Management

The adaptive management responses to adverse conditions determined by monitoring will depend on the nature and magnitude of the conditions noted. For ground stability and erosion control, responses will need to be rapid followed by additional monitoring to confirm that the adaptations were successful. For vehicle-wildlife trouble spots, adaptations may take the form of changes to mandated maximum vehicle speeds by section, or possibly changing the required response procedures for drivers considering the proximity of certain species to the road. These changes would likely be discussed in a multi-party forum before adoption. If excessive use of the road occurs by non-residents, and hunting pressures or safety concerns result, additional access control measures will need to be considered involving local communities and government agencies.

15.3 Engagement and Reporting

During EA0809-002, CZN proposed the formation of a Technical Advisory Committee (TAC) and a Socio-Economic Advisory Committee (SAC). Committee members would include local communities, regulatory agencies and CZN. Results of inspections and monitoring will be reported to relevant regulatory agencies and circulated to members of the proposed committees. The committees would meet three times annually to discuss the results and any need for adaptive responses. Requirements for the all season road would be incorporated into this process.

A summary of CZN's proposed monitoring and management systems for socio-economics was presented in the DAR for EA0809-002 (Table 11-1). These systems will not need to change to include the all season road, but would incorporate considerations for the road.

16.0 CLOSURE AND RECLAMATION

During EA0809-002, preliminary discussions were held with local communities regarding the use of the mine site after mine closure. No firm positions were made at the time, but there was some discussion regarding maintaining some site facilities, including the accommodations, administration building, power facilities, water supply and sewage treatment, and the airstrip. The idea was that the site could be used as a rehabilitation centre, an interpretive centre or a cultural/education centre. Nevertheless, plans and security estimates were made for complete site closure. No further discussions have been held concerning post-mine uses of the mine site and access road.

The construction of an all season road into the Prairie Creek Mine would represent a major infrastructure development that would benefit the Mine and provide road access into the NNPR in summer. The NWT Chamber of Commerce is of the opinion that such major infrastructure elements should be maintained long-term for future uses given their significant cost to put in place. We also believe that there is a compelling argument to maintain the road for NNPR visitors after mine closure, and the road could be used to access the mine site also. However, CZN understands that there is a present requirement to consider the full closure of the road and reclamation of the disturbed area.

Chapter 6 of the BC Forest Road Engineering Guidebook covers road deactivation. The objectives of deactivation are listed as the avoidance of landslides, uncontrolled soil erosion and sediment transport. This will be achieved if the following occurs:

- the road prism and cleared width is stabilized;
- surface drainage patterns are restored or maintained, and subsurface drainage is consistent with natural drainage patterns; and,
- silt and sediment transport is minimized.

Following the initial construction of the all season road, a more detailed, site-specific deactivation plan might be developed. At this time, prior to construction, general road deactivation concepts can be discussed that should achieve the objectives listed above.

The essential approach to road closure would not include removal of the sub-grade and gravel surface, but would include grading and slope flattening where appropriate, and scarifying of the surface to promote invasion of natural vegetation. Crossing structures and culverts would be removed, and disturbed areas near watercourses would be temporarily stabilized until vegetation has established, or permanently stabilized if this will take a long term or may not occur at all.

Grades in excess of 6% may need runoff management structures on a site-specific basis. A cross-ditch is a simple way of passing channeled runoff from the upslope side of the road bed to the downslope side. For larger ditches, it may be necessary to dissipate flows at the ditch outlet to avoid erosion. This can be done by placing boulders in the outlet area. Another runoff passage structure is a waterbar, which may or may not be combined with a cross-ditch.

Soon after initial construction, and throughout the operating period prior to deactivation, it is assumed that the road development will be stable in terms of slope stability, runoff management and sediment control. Measures to achieve this may include those noted above. To stabilize cut

and fill slopes, it may be necessary to place large woody debris or boulders on the slopes, with silt fence used as necessary until vegetation has been established. The latter may take some time as a seed mix will not be used because of the danger of introducing an exotic species, because of the thin or absent soil cover in upland areas, and because of the short northern growing season. However, it is assumed that road deactivation and closure begins with a well-constructed, and inherently stable, road development.

Road sections with significant cuts are likely to be deactivated by pulling back cut material from downslope, and/or importing fill from storage locations created during initial road construction. Runoff may need to be passed across the filled sections using structures. This might involve a cross-ditch. To avoid erosion of the ditch, it might be filled with coarse rock to act as a french drain.

As for cut slopes prior to deactivation, pullback areas may require the placement of large woody debris or boulders on the slopes, with silt fence used as necessary, until vegetation has been established. Some cut areas may have internal drainage ditches to carry upslope runoff or seepage during road operations. If flows are likely to continue after pullback, water conveyance can be continued by filling the ditch with rock prior to pullback to create a trench drain. For localized areas of excessive seepage, more rock can be placed to create a blanket drain.

The exact locations of areas of pullback will need to be determined at the time of construction. General locations where pullback is expected are as follows:

- along Funeral Creek where the road is quite close to the creek, and there are soil banks and cut soil slopes;
- along the new alignment west of Polje Creek where the road will cross several side-slopes; and,
- the western side of the Silent Hills.

Areas with side-slopes where pullback is not expected are as follows:

- along Prairie Creek where upslope areas are composed of rock which is naturally ravelling; and,
- along upper Sundog Creek where the slopes are often rock or coarse talus, which is also naturally ravelling.

All other areas are considered to be sufficiently flat that pullback is not expected to be necessary.

For the restoration of natural drainage, some general approaches can be described which will likely be used. Culverts will be removed, and if upslope flow will continue at the removal location, a passage structure will need to be built, which might be an armoured swale or re-creation of an original creek bed, or a cross-ditch or cross-drain. Culverts will preferably be removed in winter or during dry summer periods. However, methods for removing culverts while flow is occurring are available. Other drainage structures could include one or more of those discussed above.

Where stream crossings have resulted in damage to the banks, these will need to be repaired with stabilization as necessary, preferably using woody debris or boulders. If significant compaction of soils has occurred, some scarification may be needed to promote revegetation via invasion.

For bridge crossings, abutments will need to be removed or pushed back a suitable distance from the creek. Scarification of the newly exposed areas may then be needed. The specific approaches for restoration of natural drainage and stream banks will need to be determined during the operating period, particularly as final deactivation nears.

The timing of initiating reclamation activities is dictated by access constraints and season. Work would be conducted from the Mine in an eastwards direction so that when work has been completed, heavy equipment is at the eastern terminus.

During the summer before the last winter road season, roadway and transfer facility soil surveys will be completed to determine metals content. Any areas requiring remediation will be identified and addressed.

Once most of the materials needed to be transported out of the Mine have been moved, bridges and abutments can be removed. Work on pull-backs, bed scarification, post-closure drainage features and the final landform would be the last activity, and would only commence once all traffic from the Mine has been completed. The road reclamation crews would thus work their way out to the Liard Highway. Road removal and reclamation activities would be supported with temporary trailers providing dining and rest quarters for crews working shifts.

Road monitoring will occur following reclamation. The preferred timing will be late freshet to observe conditions at the height of runoff. Low over-flights, specifically over key areas where problems might occur, are proposed to allow for inspection. If problems are suspected, follow-up inspections will be made by helicopter. The follow-up will include set-downs and the use of small tools (e.g. shovels) and readily transportable materials (e.g. silt fence), as necessary. In areas where silt fence was left after reclamation, if the fence appears not to be needed, it will be removed.

Key areas for inspection include the locations where pullback has occurred, and the switch-backs in the Silent Hills. Other sections of the road are expected to be more stable.

Depending on the results of the first spring monitoring, and whether any silt fence is still in place, the monitoring may need to be repeated the following spring, and again if necessary until all surfaces have stabilized and vegetation has grown. Judging by the natural revegetation of the existing winter access road alignment, the all season road and transfer facility sites will readily revegetate.