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POST-EA INFORMATION PACKAGE INCLUDING AN UPDATED PROJECT DESCRIPTION ALL SEASON ROAD TO PRAIRIE CREEK MINE



APPENDIX 1-11

SUBMITTED IN SUPPORT OF:

Water Licences MV/PC2014L8-0006, and
Land Use Permits MV/PC2014F0013

SUBMITTED TO:

Mackenzie Valley Land and Water Board
Yellowknife, NT X1A 2N7

Parks Canada,
Nahanni National Park Reserve
Fort Simpson, NT X0E 0N0

SUBMITTED BY:

Canadian Zinc Corporation
Vancouver, BC, V6B 4N9

February 2019

APPENDIX 1-11: BORROW PIT SUMARRY

Label	Material Type	Term	Road KP	Application	UTM X/Y	Potential Volume (m ³)	Demand Volume (m ³)	Gross Area (ha)	Net Area (ha)	Comments
BP 2	Calcareous Mudstone Bedrock	long	2.7	Subgrade, Rip rap Surfacing	403340 6827765	80,000	5,000 (rip rap)	1.41	0.2	Existing pit utilized by original road. More volume available if required. Durable crushed surfacing possible but constrained work areas.
BP 4A	Bedrock Limestone / Mudstone	short	4.01	Subgrade	403032 6828909	15,000	Back-up	1.83	0.0	Steep rock cut adjacent to the road which may be removed to widen existing road base and could be utilized nearby. Geotechnical concern due to slope angle.
BP 4B	Colluvium Limestone / Mudstone	short	4.5	Subgrade, Surfacing	403102 6829344	58,000	5,000	2.64	0.5	Volume could easily be doubled if required. Existing pit utilized by original road. Moderately durable as surfacing.
BP 10	Argillite Colluvium	short	10	Rip rap	405709 6831914	5,000	Back-up	0.37	0.0	Possible source of rip-rap material adjacent to the road. Potential permafrost so additional testing required if utilized.
BP 14	Colluvium Limestone	short	14.9	Subgrade, Rip-rap	409766 6831761	27,000	5,000	1.08	0.25	Adjacent to the road. Some riprap in talus.
BP 16	Glacial fluvial Gravel	long	15.8	Subgrade Surfacing	410382 6832295	75,000	10,000	0.78	0.4	Glacial moraine. Large volume available and appears of good quality.
BP 25	Glacial fluvial Gravel	long	25.5	Surfacing	417891 6828651	25,000	10,000	1.0	0.25	Moraine deposit left by glaciers.
BP 33	Large fragmented talus rock	short	33.5	Subgrade, Rip rap	423842 6826838	10,000	Back-up	0.88	0.0	Deposit of fragmented talus rock adjacent to the road. Little or no stripping involved, easy access.

Label	Material Type	Term	Road KP	Application	UTM X/Y	Potential Volume (m³)	Demand Volume (m³)	Gross Area (ha)	Net Area (ha)	Comments
BP 34	Large fragmented talus rock	short	34.5	Subgrade Rip rap armoring	424443 6828239	35,000	10,000	2.15	0.6	Large deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 35	Large fragmented talus rock	short	35.5	Subgrade, Rip rap armoring	424951 6828894	10,000	10,000	0.57	0.57	Deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 37	Large fragmented talus rock	short	37.5	Subgrade, Rip rap armoring	426826 6829170	15,000	10,000	0.65	0.3	Deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 38	Large fragmented talus rock	short	38.3	Subgrade, Rip rap armoring	427451 6829653	30,000	7,500	2.15	0.3	Large deposit of fragmented talus rock parallel to the road. Little or no stripping involved, easy access.
BP 39A	Alluvium Gravel/Cobble	long	38.8	Subgrade, surfacing	428 6830108	34,000	14,000	1.63	0.7	Old floodplain adjacent to the road.
BP 39B	Large fragmented talus rock	long	39.0	Subgrade, Rip rap armoring	428485 6830314	30,000	5,000	1.07	0.25	New proposed borrow, an expansion of the original BP 39.
BP 40	Alluvium Gravel/Cobble	short	40.0	Subgrade, surfacing	428707 6830599	40,000	40,000	2.44	2.44	Old floodplain adjacent to the road. Similar to BP 39 but some stripping and less influence from Sundog Creek.
BP 41	Glaciofluvial Sand - Fine	short	40.5	Subgrade	429606 6830685	7,500	5,000	0.76	0.5	Not field confirmed. Assume similar material as identified at BP 43A. Back-up borrow volume available for localized subgrade requirements.
BP 41B	Glaciofluvial Sand - Fine	short	40.9	Subgrade	429426 6830794	5,000	Back-up	0.31	0.0	Not field confirmed. Assume similar material as identified at BP 43A. Back-up borrow volume available for localized subgrade requirements.

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BP 42	Glaciofluvial Sand - Fine	short	41.2	Subgrade	430293 6830505	16,000	10,000	1.09	0.7	Not field confirmed. Assume similar material as identified at BP 43A. Back-up borrow volume available for localized subgrade requirements
BP 43A	Glaciofluvial Sand – Fine	short	43.1	Road sand, Subgrade	431491 6829886	28,000	Back-up	0.81	0.0	More volume available. Volume to be extracted for long term road sanding operations.
BP 43B	Glaciofluvial Sand – Medium	long	43.7	Road sand, Subgrade	431868 6829691	21,000	21,000	0.64	0.64	More volume available. For long term winter sanding.
BP 47B	Alluvium Gravel/Cobble	short	47.0	Subgrade, Surfacing	434939 6828665	49,000	10,000	2.8	0.6	Alluvial floodplain – assumes 2m depth only.
BP 47C	Colluvium and Bedrock Limestone	long	47.7	Surfacing, Rip rap armoring	435550 6828997	20,000	5,000	0.39	0.25	Assume similar material as BP 47A however adjacent to the road. Requires blasting.
BP 50	Fine Sand	short	50.9	Subgrade	438216 6829974	55,000	Back-up	2.1	0.0	More volume available.
BP 50B	Fine Sand	short	50.2	Subgrade	437641 6829946	10,000	Back-up	0.91	0.0	More volume available but expected to be small borrow area and shallow.
BP 51	Fine Sand	short	51.7	Subgrade	438858 6830441	43,000	14,000	1.23	0.6	More volume available.
BP 53	Fine Sand with minor Gravels	long	53.4	Subgrade	440459 6830858	60,000	16,000	2.64	1.2	Possible limited expansion. Potential long term for winter sanding operations.
BP 54	Carbonate Rock Exposure	short	54.6	Subgrade, Surfacing	441383 6830556	20,000	20,000	1.9	0.8	Two large exposed rock humps. Potential surfacing source for proposed airstrip.
BP 55	Shale-Rock Exposure	short	55.3	Subgrade, Surfacing?	441450 6830055	10,000	Back-up	0.38	0.0	Shale rock knobs comparable to BP 54 however the road passes thru them.

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BP 56	Shale Colluvium /Bedrock	short	55.9	Subgrade, Surfacing?	441918 6829766	50,000	Back-up	0.84	0.0	Exposed shale rock along the upper cut slope of the proposed road. Could be excellent subgrade material and possibly for surfacing. Minor chance of acid generating.
BP 56B	Shale Colluvium /Bedrock	short	56.6	Subgrade, Surfacing?	442390 6829649	30,000	15,000	1.02	0.5	Shale rock knob close proximity to road. Excellent subgrade material or possibly surfacing. Minor chance of acid generating.
BP 59	Gravel – sub-rounded shale & sand	short	59.4	Subgrade, Surfacing	443934 6828136	40,000	Back-up	1.94	0.0	Potential use for airstrip construction. More volume available.
BP 61	Shale Colluvium /Bedrock	short	61.4	Subgrade	445409 6827254	5,900	Back-up	0.37	0.0	More volume available.
BP 64	Glaciofluvial Gravel – Fine	short	64.9	Subgrade, Surfacing	447360 6824430	116,000	Back-up	5.75	0.0	More volume available. Alternate to BP 65 source. The sample taken indicated slightly silty gravel. Required only if BP 65 not an option. 300m access road required.
BP 65	Glaciofluvial Gravel – Fine	long	65.2	Subgrade, Surfacing	447427 6824337	75,000	20,000	1.92	0.5	Small hump.
BP 67	Colluvium – Shale	short	67.5	Subgrade	448634 6822644	6,200	Back-up	0.57	0.0	Main face only.
BP 70	Fine Sand, Some quarry	long	70.9	Subgrade	449549 6819884	30,000	14,000	0.66	0.4	More volume available. Potential rock quarry at north end could be utilized for crush surfacing.
BP 76	Fine Sand	short	76.2	Subgrade	451871 6815634	12,700	Back-up	0.75	0.0	Small hump.
BP 77A	Sandy till	short	77.2	Subgrade	452840 6815788	30,000	14,000	1.61	0.8	Small hump.

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BP 77B	Sandy till	short	77.5	Subgrade	453210 6815603	3,500	Back-up	0.36	0.0	Small hump.
BP 78	Sandy till	short	78.5	Subgrade	453921 6815218	4,500	Back-up	0.36	0.36	Maximum volume available. No expansion possible.
BP 84	Sandy till	short	84.2	Subgrade	458159 6815538	30,000	24,000	2.1	1.8	Possibly could be expanded. Borrow material for expected localized overland sections.
BP86 A	Medium sand	short	86.4	Subgrade, Winter sand	459373 6814018	20,000	Back-up	0.8	0.0	Some limited expansion possible.
BP86 B	Medium sand with gravels	long	86.5	Subgrade, Winter sand	459520 6813948	37,900	16,000	1.12	0.4	Maximum volume available is indicated. No additional volume is available.
BP 87	Alluvial Cobble and Gravels	long	87.5	Subgrade, surfacing	460468 6813925	120,000	55,000	6.44	3.0	Maximum volume available. No expansion possible. Old flood plain - unlikely to have permafrost.
BP 92	Fine sand / silt mixtures	short	91.5	Subgrade	462569 6815294	20,000	10,000	0.76	0.4	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 93A,	Fine sand / silt mixtures	short	92.3	Subgrade	463673 681470	15,000	15,000	0.33	0.33	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 93B	Fine sand / silt mixtures	short	92.3	Subgrade	463704 6814541	15,000	Back-up	0.39	0.0	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 93C	Fine sand / silt mixtures	short	93.6	Subgrade	464015 6814213	20,000	Back-up	0.53	0.0	Not field verified but similar material found in the surrounding

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										area. Borrow volume required for localized overland sections.
BP 94	Fine sand / silt mixtures	short	94.2	Subgrade	464295 6813722	50,000	20,000	2.54	1.0	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 96	Silty sand	short	96.0	Subgrade	465958 6813509	100,000	40,000	3.2	1.2	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 97	Silty sand	short	97.2	Subgrade	466244 6812298	45,000	Back-up	2.34	0.0	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded.
BP 102	Fine sand	short	102.0	Subgrade	467969 6811664	55,000	10,000	1.31	0.3	Borrow volume required for localized overland sections. Could be easily expanded.
BP 102B	Silty sand	short	102.3	Subgrade	468544 6811716	60,000	Back-up	3.03	0.0	Not field verified but similar material found in the surrounding area. Borrow volume required for localized overland sections. Could be easily expanded. Short 175m access road required.
BP 103	Clay based overburden with carbonate based rock	short	103.7	Subgrade, Surfacing, Rip Rap	469432 6810903	30,000	Back-up	2.45	0.0	Large elevated knob with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material, the rock could be blasted/crushed and utilized for road surfacing. Short access road required.

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BP 104	Clay based overburden with carbonate based rock	short	104.1	Subgrade Surfacing	469655 6810510	100,000	60,000	5.54	2.0	Large elevated knob with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material; the rock could be blasted/crushed and utilized for road surfacing. Future test pits will determine the precise shape and size (probably less than 2.5 ha).
BP 107 Alter.	Clay based overburden with carbonate based rock	short	105.5	Subgrade, Surfacing	470605 6808474	100,000	40,000	3.48	2.0	Large elevated knob with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material; the rock could be blasted/crushed and utilized for road surfacing. Requires 400 m access road. Future test pits will determine the precise shape and size.
BP 108 Alter.	Shale rock quarry and Clay based overburden with carbonate based rock	short	108.0	Subgrade, Surfacing	470979 6806457	100,000	Back-up	3.43	0.0	Shifted location. Part of the same geological formation as BP 104, 107 108 Alter. Could serve as borrow for overland subgrade base material (any overburden clay/silt/sand and the rock quarry for crushing/surfacing. Requires 450m access road. Future test pits will determine the precise shape and size

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BP 109 Alter.	Shale rock quarry and Clay based overburden with carbonate based rock	short	108.0	Subgrade, Surfacing	471072 6805816	150,000	65,000	2.89	1.5	Part of the same geological formation as BP 104 and 111. Could serve as borrow for overland subgrade base material (any overburden clay/silt/sand) and the rock quarry for crushing/surfacing. Requires 700 m access road.
BP 110	Sand with mixed coarse fragments/gravel esker type formation. Dry	short	110.5	Subgrade, Surfacing	473294 6805427	50,000	24,000	1.27	0.6	Additional borrow. Dry esker gravel/sand. Need to confirm permafrost.
BP 112 Alter.	Clay based overburden with carbonate based rock	short	112.0	Subgrade	474048 6805656	50,000	Back-up	1.0	0.0	Large elevated knob/ridge with potential clay till type material overlaying a probable carbonate rock type layer underneath. The clay could be utilized for subgrade overland base material.
BP 112.3 Alter.	Alluvial Cobble and Gravels	long	112.3	Subgrade, Surfacing	474353 6805428	100,000	22,000	4.2	1.0	Alluvial gravel fan unlikely to have permafrost. Additional volume could be available. Surfacing material from KP 97 to 115.
BP 119 Alter.	Alluvial Cobble and Gravels	long	119.2	Subgrade, Surfacing	477736 6800337	100,000	7,500	2.91	0.5	Old flood plain, unlikely to have permafrost. Additional volume could be available.
BP 123A	Alluvial Cobble and Gravels	short	123.7	Subgrade Surfacing	478153 6799135	214,000	Back-up	4.63	0.0	Maximum volume available. No expansion possible. Old flood plain, unlikely to have permafrost.
BP 123B	Bedrock Limestone	short	123.7	Surfacing, Rip rap	477960 6799174	90,000	Back-up	2.34	0.0	Exposed rock outcrop knob. Blast rock.

Label	Material Type	Term	Road KP	Application	UTM X/Y	Potential Volume (m³)	Demand Volume (m³)	Gross Area (ha)	Net Area (ha)	Comments
BP 124	Alluvial Cobble and Gravels	short	124.4	Subgrade Surfacing	479,031 6,799,520	40,000	20,000	2.55	1.5	Old flood plain, unlikely to have permafrost. Considered the main surfacing source from KP 125 to 133. Long term if more available volume.
BP 125A BP 125B	Bedrock Limestone	long	125	Surfacing, Rip rap Subgrade	479315 6799489 479483 6799159	160,000	25,000	2.04	0.4	Exposed rock outcrop knob for rock quarry. Would work excellent for overland subgrade borrow from KP 124.8 to 126.8.
BP 126	Colluvium Limestone	short	126.4	Subgrade, Rip rap	480215 6798190	76,000	Back-up	6.23	0.0	Could be rock glacier. Requires additional testing to confirm material and check any potential geotechnical concerns.
BP 129	Alluvial Cobble and Gravels	long	129.0	Subgrade, Surfacing	481684 6797072	75,000	25,000	3.14	0.6	Potential good source of surfacing gravel. Close proximity to the proposed road location.
BP 132	Clay/silt glacial till	short	132.2	Subgrade	482506 6793456	100,000	12,000	7.1	0.5	
BP 136	Clay/silt glacial till	short	136.2	Subgrade	483,136 6789603	100,000	Back-up	14.55	0.0	Back-up borrow volume.
BP 138	Bedrock Limestone	short	138.2	Surfacing, Rip rap	484,101 6788499	100,000	Back-up	3.89	0.0	Exposed rock outcrop knob for rock quarry. A 1.2 km access road is required.
BP 139	Alluvial Cobble and Gravels	long	139.6	Surfacing, Subgrade	484578 6786662	250,000	12,000	18.05	0.7	Large fan with excellent gravel material. A 2.2 km access road is required. Surfacing material from KP 133 to 145. Sample extracted from similar fan formation north west of location.
BP 140	Clay/silt glacial till	short	140.2	Subgrade	486011 6787740	100,000	Back-up	3.43	0.0	Back-up borrow volume.
BP 143	Clay/silt glacial till	short	143.8	Subgrade	486691 6784624	140,000	Back-up	4.18	0.0	Back-up borrow volume.

Label	Material Type	Term	Road KP	Application	UTM X/Y	Potential Volume (m³)	Demand Volume (m³)	Gross Area (ha)	Net Area (ha)	Comments
BP 146	Clay/silt glacial till	short	146.5	Subgrade	486671 6781913	140,000	Back-up	8.62	0.0	Back-up borrow volume.
BP 151 A BP 151B	Alluvial Cobble and Gravels	long	151.5	Surfacing, Rip rap armoring	487108 6777912 487058 6777645	250,000	20,000	18.8	1.0	Must confirm depth and area but expect shallow source (2m deep) spread over a large fan. A potential S3 seasonal stream divides the two defined patches. Surfacing material from KP 145 to 155
BP 154	Clay/silt glacial till	short	154.0	Subgrade	485734 6775155	100,000	20,000	2.23	0.5	Available back-up subgrade borrow if volume not available within R/W.
BP 156	Clay/silt glacial till	short	152.8	Subgrade	484866 6772879	100,000	20,000	2.36	0.5	ADDITIONAL BOROW.
BP 158	Limestone/Carbonate Talus rock deposit	long	158.2	Surfacing, Rip rap armoring	483731 6772187	250,000	20,000	20.5	1.0	Final area must be defined and will be much smaller. Excellent source of mixed talus rumble at the base of limestone/carbonate rock face. A very strategic source to supply from KP 155 to 184. Requires 1.5 km access road.
BP 159A, B	Carbonate Rock	short	159.3	Surfacing, Rip rap armoring	484123 6771167 484080 6770474	120,000	40,000	3.25	1.0	More investigation required but looks like excellent source of large deposit of fragmented carbonate/limestone rock (part of an old landslide broken off mountain face). Geotechnical concerns will regulate and limit the availability.
TOTALS	81 Borrow Identified, 49 Borrow Required, 12 Primary Back-up, 20 Secondary Backup					5,033,200	918,000	233.48	38.34	

Note: Identifies borrow with field samples taken.



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POST-EA INFORMATION PACKAGE INCLUDING AN UPDATED PROJECT DESCRIPTION ALL SEASON ROAD TO PRAIRIE CREEK MINE



APPENDIX 1-12

SUBMITTED IN SUPPORT OF:

Water Licences MV/PC2014L8-0006, and
Land Use Permits MV/PC2014F0013

SUBMITTED TO:

Mackenzie Valley Land and Water Board
Yellowknife, NT X1A 2N7

Parks Canada,
Nahanni National Park Reserve
Fort Simpson, NT X0E 0N0

SUBMITTED BY:

Canadian Zinc Corporation
Vancouver, BC, V6B 4N9

February 2019

1 EVALUATION OF POTENTIAL BORROW PITS

(Alternative Alignment plus additional borrow from KP 130 to 155)

1.1 Km 2.72 – BP2 – Mudstone Bedrock

The potential borrow source at BP 2 consists of crumbling bedrock that has been used in past by Canadian Zinc for miscellaneous roadway improvements. This source is identified as a calcareous mudstone that appears very competent in comparison to the previous siltstone source at 0.55 km. Based on the materials developed here to date, it appears that this rock source readily fragments under the blade of a bulldozer, although this favourable trait may decrease with bedrock depth. In past, the use of a grizzly screening unit at the site removed any oversized materials prior to loading the materials into trucks for movement. The apparent hardness and blocky fracture properties of this material may make it suitable for crushing for surfacing material, and it seems to pack into a very dense state. One limitation for a crushing operation is the proximity to Prairie Creek would constrain the amount of area for the crushing and stockpiling of any large amounts of materials.



Figure 1: BP2 materials pushed from a higher rock face for screening with a grizzly.



Figure 2: Close up of the BP2 mudstone with sparry calcite cementing.



Figure 3: BP2 viewed from the north and showing the limited processing area available.

1.2 Km 4.01 – BP4A – Limestone/Mudstone Face Exposure

While the rock source at 4.01 km is not a preferred material source, there may be a large quantity of this material removed as waste rock in the building of the final road along this section. The material consists of a tall face of limestone/mudstone that may present a rockfall hazard to the present road location. In the event that this rock face has to be excavated back further, large amounts of waste rock will be generated and this material could be used to supply any anticipated borrow needs in the general area. It is anticipated that this material is more suited for subgrade construction than for surfacing material as it fractures quite easily and doesn't appear to be very durable in nature. Again, the close proximity of Prairie Creek will be a constraint to any processing or load out operations proposed here.



Figure 4: The rockfall hazard at 4.01 km may generate a large quantity of waste rock that could be used to supply subgrade borrow needs elsewhere nearby.

1.3 Km 4.49 – BP4B – Limestone/Mudstone Colluvium

Slightly further up the road route from the BP4A location is the site of a developed colluvial limestone/mudstone source that has been designated BP4B. This is basically a large talus slope that abuts to the current roadway, presenting a perfect natural source of shattered rock materials. It appears to result from the same parent rock as in BP4A, but the fragment sizes are much smaller in the colluvial slope. Again, this material seems more appropriate for subgrade construction material than for surfacing material due to its weak plane structure. In terms of ease of development for a talus source in the general area, the BP4B source is very straight forward operation – basically it appears ready to load out as it currently sits. However, if the slopes in the area of BP4A need to be trimmed back due to rockfall issues, then it makes sense to use the BP4A material for borrow instead since it will already be loaded into trucks for removal.



Figure 5: The currently developed face of the colluvium talus slope at BP4B.

1.4 Km 10.02 – BP10 – Argillite Colluvium

Bp10 is a potential source of black argillite colluvium exposed in a slope alongside the roadway at 10.02 km. This material evidently extends for several hundred meters along the road here, but permafrost might be a strong possibility in the slopes as they are located on a northern aspect. Based on the material evident in the surface exposure, any permafrost in this slope may be ice poor, but it may still be a stability factor due to slow creep within the steep slope. The material in the slope does contain some competent looking large fragments that may serve as light to medium sized riprap. Riprap will be needed in this section of the road route, and along adjacent sections as well, to help manage stream flow adjacent to the roadway. This source contains some of the largest and most competent fragments noted on the western end of the road route. Planning for permafrost prior to any development is recommended.



Figure 6: BP10 material showing a wide size gradation. Also note some evidence of creep along the slope – this is assumed to be related to permafrost.



Figure 7: Some of the potential light riprap material noted in the BP10 slope.

1.5 Km 14.88 – BP14 – Limestone Colluvium

Bp14 appears to consist primarily of a limestone talus slope along the road corridor in a high mountain pass at 14.88 km. The gradation of the material is generally toward fragments of less than 0.3m, but some occasional embedded boulders within the matrix could be used for medium to large sized riprap. This talus slope is derived from limestone bedrock, making it an ideal construction material as it poses no risk of acid drainage – it is actually an acid neutralizing material. At this location, the potential borrow pit material is best suited for either subgrade fill or riprap, as the ground is too steep to accommodate a crushing operation for road surfacing material. BP 16 may offer better opportunities for setting up a crushing plant if required. This rock would likely create a superior surfacing material for the new road as it should be quite durable in nature and pack extremely well. The light color of this rock helps reduce solar heat absorption as well, making it a preferred choice if there is a need for filling over permafrost areas to help keep the ground insulated.



Figure 8: The limestone talus slope at 14.88 km (BP14).

1.6 Km 15.8 – BP 16 - Glacialfluvial Gravel

A large esker like deposit of limestone gravel left behind from the glaciers. Appears to be a large quantity and quality should provide enough room to accommodate a crush plant but it may be tight.



Figure 9: Large esker like deposit of glacial-fluvial gravel at 15.8 km.

1.7 Km 25.5 – BP 25 – Glacial-fluvial Gravel

A large esker like deposit of limestone gravel left behind from the glaciers. Appears to be a large quantity and quality. If required, should have adequate room for a crush plant.



Figure 10: Large esker like deposit of glacial-fluvial gravel at 15.8 km.

1.8 Km 33.5, 34.5, 35.5, 37.5, 38.3 – BP 33, 34, 35, 37, 38 – Large Fragmented Talus Rock

All similar large fragmented talus rock deposit found along the lower Sundog Creek parallel to the proposed road location. Will work well for the proposed road construction approach along the lower sections of lower sundog.



Figure 11: Large talus rock deposits along a number of locations of the lower Sundog Creek between Km 33 to 39.



1.9 Km 39.0 – BP39A – Alluvial Floodplain Cobble/Gravel – Carbonates

The original BP 39 (DAR 2015) has been split into two smaller borrow areas, 39A and 39B. BP 39A area was shifted to the outer extent of the original BP 39 area on a fully vegetated old alluvial floodplain along Sundog Creek. This re-defined borrow pit location offers a greater buffer distance from primary Sundog Creek channel and occupies an older portion of historic Sundog floodplain. The borrow material consists of washed carbonate materials (limestone/limy siltstone) that make for a preferable construction material. This light colored, durable, and non-acidic cobble and gravel would be a preferred material for use at many places within the project area because of its properties. It could be processed by crushing and screening into a highly durable, long-term road surfacing material for construction and maintenance purposes. The material is extremely free draining and its light color would not absorb much solar heating so it would assist in insulating fill material over permafrost zones (if required). Because it is situated on the fringe of an old alluvial wash channel, there is a good likelihood that this material is free of permafrost as well. The large flat here is also advantageous for operating a crushing plant and for stockpiling crushed materials until they can be applied to the road. Since the area may be subject to a fluctuating water table (as controlled by seepage from nearby Sundog Creek), any gravel excavation would need to be carried out during periods with a low water table.



Figure 12: View of BP 39A looking east.



Figure 13: Typical gravel and cobble material available at BP39A. This material consists primarily of Paleozoic carbonate rocks as evidenced by the abundance of fossilized coral fragments throughout the aggregates.

1.10 Km 39.2 – BP 39B – Talus Limestone Bedrock

BP39B consists of a large talus rock face. This borrow offers a source of both colluvium and solid rock limestone for road development needs. These raw materials could be used to generate construction materials ranging from crushed surfacing materials and subgrade rock fill, to riprap for armouring. Geologically, this area consists extensively of carbonate based bedrock so all the materials available for borrow here should be acid neutralizing materials.



Figure 14: View of BP 39B on right side of photo, with the original cat camp in the background.

1.11 km 39.5 – BP 40 - Alluvium Gravel/Cobble

Similar deposit as identified at BP 39, an old floodplain of Sundog Creek. Perhaps more attractive than BP 39 because closer proximity (1 km) to the intended destination. Expect it to be a shallow depth as to not compromise the water table. Ample room for crushing plant.



Figure 15: Old flood plain of Sundog Creek utilized as a camp/laydown area (Cat Camp) from the 1980 winter road construction.

1.12 Km 40.5, 41 – BP 41, 41B, 42 - Silty Sand

Not field confirmed but expecting similar material type that was consistently observed in the surrounding area. Should provide adequate base material for subgrade material for expected localized overland sections. Expect shallow pit depths of 2 m.



Figure 16: An aerial view of an elevated “hump” of expected silty sand which should provide adequate base material to support overland sections.

1.13 Km 42.6 – BP43A – Fine Sand – Esker Deposit

At 43.15 km a small esker of fine sand (BP43A) is crossed by the road route. This esker runs in a westerly direction from roadway, and could be developed as a long-term source of sand for winter road sanding and for pipe bedding material during construction. During construction, this sand deposit could also be used for free draining road fill across lowlands.



Figure 17: View of the existing cut for the past winter road across the end of the esker at 42.6 km.



Figure 18: Example of the fine sand in the esker source designated as BP43.

1.14 Km 43.2 – BP43B – Medium Sand Deposit

BP43B is situated at 43.65 km and covers an area containing an existing borrow pit of medium sand from the original winter road construction era. While this particular area has been designated as the borrow site, the sand deposit itself runs from approximately 43.5 km to 45.75 km. As with the BP43A site, this sand has potential for pipe bedding, winter road sanding, and for subgrade fill across lowland areas. The material in BP43B grades a little coarser than the material in BP43A, so it may be a bit more appropriate for lowland fills where the pumping of groundwater into the subgrade may be a concern.



Figure 19: View of the sand material in the original construction borrow at 43.2 km.

1.15 Km 446.5– BP47A, B – Bedrock Limestone/Alluvial Floodplain Deposit - Carbonates

BP47B is situated south of 46.5 km and a potential borrow source consisting of alluvial gravel deposits (carbonate based) with an exposed bedrock limestone face on west boundary. A short 400m access road with a stream crossing is required. The stream within the valley is seasonal and appears to be dry except for during the higher spring runoff periods when it briefly avulses and deposits gravels across the broader floodplain. As such, this deposit is similar to that of BP39, and the depth of excavation could be controlled by a fluctuating water table. There is also a possibility that the low level water flows are carried underground in subterranean channels within the limestone bedrock. This borrow source will be developed and operated in winter periods.



Figure 20: The small stream that would need to be crossed to access BP47A and BP47B.



Figure 21: View of BP47B alluvial deposit area.



Figure 22: Typical BP47B alluvial deposit materials derived from carbonate parent rock.

1.16 Km 47.2 – BP 47C - Colluvium and Bedrock Limestone

Assumed a similar rock formation as identified in BP 47A however is adjacent to the proposed road location so more accessible.



Figure 23: Exposed rock face adjacent to the proposed road at KM 47.2.

1.17 Km 49.8 – BP 50B – Fine Sand

Could be easily expanded and would provide adequate material for localized overland sections.



Figure 24: An example of the fine sand material found near BP 50B.

1.18 Km 50.4 – BP50 – Fine Sand

BP50 is part of a broad area of fine sand found between 50.88 and 51.75 km that could be used for subgrade fill over the wetter lowlands in the area. These lowlands present relatively deep organics and potentially permafrost at depth. This material provides free draining

borrow, but it is also quite fine and it would have to be capped with coarser materials to protect it from potential surface erosion after construction.



Figure 25: The fine sand in BP50 is potential fill for crossing over nearby lowlands.

1.19 Km 50.2– BP51 – Fine Sand

BP51 is part of the same broad sand deposit that BP50 is situated on, but BP51 is located strategically on the west end of a wide lowland with deep organics that the road must cross. This lowland area, possibly with permafrost under it at depth, must be crossed using overland construction techniques to build the subgrade. Overland construction involves “floating” a roadway across areas with deep organics by leaving the organics undisturbed and covering them with a thick layer of imported free-draining material taken from suitable borrow sources. BP51 would provide a suitable borrow source on the western end of the long overland section running from about 51.75 km to 52.95 km. As with BP50, this sand is quite fine and would have to be capped with coarser material to control the potential for surface erosion.



Figure 26: The fine sand in BP51 is a potential overland subgrade borrow source.



Figure 27: Aerial view of the BP51 source area – burned area (grey) indicates the sand.

1.20 Km 52.7 – BP53 – Fine Sand with minor Gravel

BP53 is located at 53.4 km, slightly beyond the eastern end of the wide lowland area that the road must cross between 51.75 km to 52.95 km with overland construction. BP53 is located on the nose of some benched terrain that juts out on its east side toward Poljie Creek and is bordered by an ancient paleo-channel of Poljie Creek on the north. The upper bench level consists primarily of the same fine sand as was noted in BP50 and BP51, while the lower bench has some slightly coarser sand with some minor gravel and shale fragments. All this material is free-draining and suitable for the overland fill required between 51.75 km to 52.95 km. As with the previous borrow sites in this area, this sand is quite fine and would have to

be capped with coarser material to control the potential for surface erosion. Previous subsurface geotechnical drilling at nearby Poljie Creek also indicated some gravel deposition at depth in this general area, so the lower levels of this borrow area have some limited potential for glaciofluvial gravel deposits as well.



Figure 28: Fine sand with minor gravel and shale showings in the lower bench of BP53.

1.21 Km 54.3 – BP54 – Rock Knob - Carbonates

At 54.60 km the road route passes in close proximity to the northern end of a chain of carbonate rock protrusions along the east side of Poljie Creek. The protrusions forming BP54 consist of two low, timbered, rock outcrops on the north end of a chain of carbonate exposures that become visually impressive further south where they form karst cliffs and pinnacles overlooking Poljie Creek. While physically connected to this same chain of karst exposures, the BP54 outcrop knobs are very subdued outlying outcrops, with very little aesthetic value evident. They do however provide a good potential source of carbonate rock that could be developed into a needed source of riprap and ballast for construction within the general area. Depending on the depth of the material that can be developed here, there may be enough volume in these exposures to justify a small rock crushing operation to develop superior surfacing for the road and for the proposed airstrip nearby. This rock would also form an excellent capping material for the sand fill proposed for overland construction in the section from 51.75 km to 52.95 km to the west. It would armour the sand fill from erosion and provide a light colored reflective surface to prevent solar heat absorption into the fill should permafrost be present at depth.



Figure 29: Aerial view (looking east) of the carbonate rock exposures proposed for BP54.



Figure 30: Aerial view (looking southwest) of the timbered carbonate rock knobs (lower center) proposed for BP54. The more exotic karst formations (upper left) that start further south along Poljie Creek, are not part of the proposed BP54 borrow area.

1.22 KM 54.9 – BP 55 – Shale Rock Knobs

Shale rock knobs comparable to BP 54 however the road passes thru them. Could be utilized for excellent subgrade base over overland sections and/or possibly surfacing.



Figure 31: The fragmented shale rock knob the road passes thru at km 55.3.

1.23 KM 55.5 – BP 56 – Exposed Shale Rock Knob

Exposed shale rock knob located along the upper cut-slope of the proposed road. Could provide excellent subgrade material and possibly for surfacing.



Figure 32: A large exposed shale rock sideslope near KM 55.9.

1.24 KM 56.4 – BP 56B – Shale Rock Knob

Exposed shale rock knob located in close proximity to road location. Could provide excellent subgrade material and possibly for surfacing.



Figure 33: An example of the shale rock found at Km 56.5.

1.25 Km 59.1 – BP59 – Sub-rounded Sedimentary Gravels & Sand

BP59 consists of a shale based gravel deposit exposed in a constructed cut at 59.41 km along the old winter road. The material is fairly sandy but is still one of the better looking glaciofluvial gravel materials noted within the general area. It could be used as a lower durability pit-run gravel source, or for fill for the road or the nearby proposed airstrip. This gravelly material appears in exposures along the old winter road right up to about 59.90 km.



Figure 34: Shale based sandy gravel noted along the old winter road at 59.1 km (BP59)



Figure 35: Similar looking material found along winter road at 59.90 km.

1.26 Km 61.10 – BP61 – Siltstone Exposure

BP61 consists of a siltstone outcrop exposed in a cut along the old winter road at 61.10 km. The material is quite fissile and likely of low durability, but is one of the best construction materials found in this section of finer grained moraine deposits with occasional seepage zones. This material can be used to firm up areas of soft ground and to repair some ditch and shoulder erosion that has occurred on a few steep grades along the old winter road west of this location.



Figure 36: Fissile siltstone exposure.

1.27 Km 64.5 – BP64 – Glaciofluvial Gravel - Eskers

BP64 constitutes but a small portion of a very large glaciofluvial kame/kettle deposit that is several kilometers in size and situated south of Mosquito Lake. The material contains sub-rounded sedimentary rock fragments in a matrix of silty sand that would pack well for road surfacing and may even have some natural dust control properties. The potential gravels here are quite deep and additional sampling at depth would be needed if it is necessary to confirm suitable gradation throughout. The BP64 location is situated about 400 m west of the planned road route, and has the best looking gravel from multiple sampling locations taken along the nearby esker chains. This area could be developed for gravel pit purposes with a short section of easily constructed access road across well drained soils. If however, the quantity of materials at BP65 are proven out by deeper test excavations, then it would be simpler to develop those material directly along the roadway.



Figure 37: Overview of major glaciofluvial deposits south of Mosquito Lake (background)



Figure 38: Sub-rounded gravel present in the BP64 sample area

1.28 Km 64.9 – BP65 – Glaciofluvial Gravel

BP65 also falls on the large glaciofluvial kame/kettle deposit previously noted for the BP64 site, but this borrow site falls along the existing roadway and doesn't require additional access road to develop it. BP65 appears to fall along the southern edge of the deposit area, and the depth of deposition will likely be substantially shallower in comparison to the esker deposit at BP64. As evidence of the potential for a shallow deposit here is the rock knob of primarily fissile shale that protrudes up through the area on the west side of the road. The base of this hill may contain more shale than gravel. This shale, in itself, is a potential borrow material for subgrade construction and the rock knob here appears to contain a substantial amount of it. The gravel materials sampled along the road here also appear fairly variable in composition over short distances. That, taken in combination with potentially shallow gravel deposition in this area, indicates a need for additional investigation to a greater depth to confirm materials prior to any large pit development. A low ridge formation (esker?) protruding out into the wetland on the southeast side also may contain gravels, but this formation wasn't sampled during the field reconnaissance. Should further testing in this area indicate a limited gravel volume, the use of BP64 would be the preferred alternative due to the volume available there.



Figure 39: Test pit with well-rounded gravel at BP65. Another test nearby revealed more angular shale gravel content, so the area is somewhat variable for gravel composition.



Figure 40: Exposed face with both blocky and fine fissile shale was noted in a rock knob about 200 m southwest of BP65. This material likely extends back close to the road

1.29 Km 67.1 – BP67 – Shale Colluvium

At 67.52 km the road route runs along the toe of a steep (70%) hillside that is covered in fine shale talus. Shale colluvium is apparent along the entire hillside above the road here up to about 67.8 km, but this location has the cleanest exposed talus material noted in the area. This material would be suitable for overland fills and for firming up areas of soft ground, but wouldn't be a very good surfacing material due to its fractures and sharp fragments. There is

also some potential for ice poor permafrost in this hillside, due to the northern aspect of this talus face, so additional investigation would be prudent before any development is carried out.



Figure 41: Surface talus exposure of fine shale at 67.52 km (BP67).



Figure 42: BP67 talus sidehill (center right) with old road running diagonally across view.

1.30 Km 70.50 – BP70 – Mix Fine Sand / Colluvium Bedrock Quarry

The route crosses a sidehill with an old cut slope showing fine sand material intermixed with minor colluvium shale adjacent to the existing road with exposed colluvium bedrock upslope on the western portion. The sand/colluvium shale mix material (BP70) is free draining and

good for subgrade fills in overland sections. The bedrock could be ripped or blasted and utilized for armouring, subgrade fill, or crushed for surfacing.



Figure 43: Fine sand material at 70.75 km (BP70)



Figure 44: The existing cut slope at BP70. The weathered face appears to be colluvium shale because of the residual fragments left in place, but the slope is in sandy materials.

1.31 Km 75.8 – BP76 – Fine Sand

In an almost mirror image of the BP72 situation, this small hump of sand at 76.23 km (BP76) is strategically located next to a wetland crossing that will need to be built up with fill as well. Again, the existing road footprint can be re-utilised to reduce new ground disturbance at the borrow site.



Figure 45: Another small sand hump at 76.23 km can provide fill for a wetland crossing.

1.32 Km 76.70 – BP77A – Sandy Till

Between 77 km and 78 km a broad lowland area must be crossed by the road, and additional borrow to build overland subgrade fills will be needed. This lowland area only presents a few opportunities for borrowing nearby material, and these areas consist of long low glacial deposition ridges left within the lowland margin area itself. As the existing winter road crosses these low ridges, it is advantageous to borrow the drier materials found in these areas for constructing the subgrade fills across the lowland.



Figure 46: A low ridge of higher sandy till (BP77A) crosses over the road route laterally at 76.7 km. This source of drier material could be used to build some of the overland fills that will be required to cross the wetland.

1.33 Km 77.20 – BP77B – Sandy Till

At 77.70 km, another low relief ridge of dry sandy till (BP77B) lies on the south side of the existing road. This source, in conjunction with BP77A, could be used to supply some fill for the overland subgrade crossing of the lowland to the west of this location.



Figure 47: A small hump of higher sandy till (BP77B) lies on the southern side of the road at 77.20 km. This source of drier material could also be used to construct some of the overland fills that will be required to cross the nearby lowland area.

1.34 Km 78.0 – BP78 – Sandy Till

The nose of a ridge crossed at 78.52 km provides another source of dry sandy till (BP78) for constructing overland fills in this area of low ground.



Figure 48: A small ridge of sandy till (BP78) lies under the road route at 78.0 km. The drier material here could be used to construct adjacent overland fills.

1.35 Km 83.6 – BP 84 – Sandy Till

Long, slender borrow area adjacent to ASR alignment. Expect clay till type material to be utilized for localized overland sections. Permafrost potential along southern boundary.



Figure 49: The road passes through the center of this aspen patch and the borrow area parallels the road.

1.36 Km 85.8 – BP86A – Medium Sand

A soil exposure on an existing cut face along the original winter road reveals a source of medium sized sand at 85.8 km (BP86A). The material appears to be very free draining and suitable for pipe bedding or overland fill material.



Figure 50: Sand material found in an existing cut slope at 86.35 km. This is some of the cleanest sand noted in the area and could be used for pipe bedding and overland fills.



Figure 51: Existing cut slope exposing the BP86A sand material. Large timber growing on the site indicates the area is likely permafrost free.

1.37 Km 86.0 – BP86B – Medium Gravelly Sand

Another nearby soil exposure along an existing winter road cut face at 86.0 km (BP86B) reveals medium sized gravelly sand within the slope. This material could be utilized as road fill for construction over an adjacent lowland area, and for overland construction across other lowland sections to the northwest.



Figure 52: Medium grain sized gravelly sand material found in an existing cut slope at 86.0 km.



Figure 53: Aerial view of the BP86B site (right of center) showing the ridge containing gravelly sand.

1.38 Km 87.1 – BP87 – Alluvial Cobble and Gravels - Carbonates

At about 87.4 km, the Tetcela River is crossed by the route, and the planned road continues eastward across a flat plain which appears to be the site of several relict river channels from past millennia. As such, much of this area is comprised of old river beds and there is substantial subsurface gravel and cobble deposition under this currently forested plain. Hand excavated test holes were almost impossible to carry out to any depth here as the subsurface material consists of large embedded cobbles and gravels in a coarse matrix that is practicably impenetrable to shovels. The composition of the materials deposited here is assumed to be similar in texture to that of the current day active channel nearby – coarse mixtures of gravels and cobbles. This area could provide a critical supply of durable gravel aggregate that could be crushed for making superior surfacing materials. Materials of this nature could be used for road surfacing and grade construction for tens of kilometers in either direction from this site. The presence of innumerable Paleozoic coral fossils within the gravels throughout the Tetcela River system also indicate that the resulting gravels here are derived from carbonate based bedrock and are non-acidic.

Deeper investigation needs to be carried out in the coarse material here to determine the full depth and gradation of the deposited materials, and to ascertain if the water table would present a problem to development of a borrow pit. There is ample area well back of the river near the BP87 site that is suitable for the establishment of a crushing plant and for stockpiling material.



Figure 54: The bed composition of the current day Tetcela River is assumed to be indicative of the materials that should underlie the BP87 site, which is situated well back of the river here, in the timber on the left hand side.

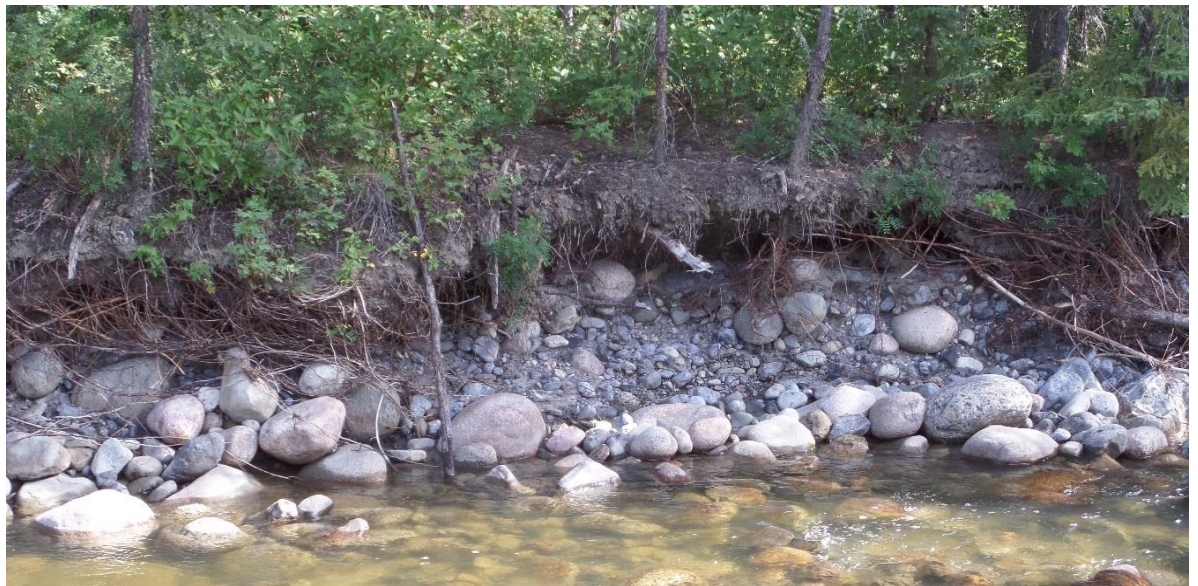


Figure 55: View of some of the material deposited within the existing river bank to the west of the proposed BP87 location. This material is assumed to be typical of the deposition in the borrow area and it would need to be crushed for road surfacing.

1.39 Km 90.5, 91.5, 93.0, 93.6 - BP 92, 93A, 93B, 93C, 94 – Silt Clay

Borrow volume required for localized overland sections. Area and volume could be easily expanded. Initial shovel test pit confirms silt clay material with mix of fine sand.



Figure 56: Aerial view of the landscape from KP 90 to 95. Patches/islands of dry, esker type terrain covered with lodgepole pine/aspen. These humps will provide borrow material to overland the lower, depressed permafrost (likely ice-rich) sections in between.

1.40 Km 95.6 – BP 96 –Sandy Clay / Sedimentary Fragmented Rock

Area and volume could be easily expanded. Field investigation confirmed exposed, loose (sedimentary) rock on the surface and expected to be prevalent throughout the borrow area at depths greater than 1m surface depth. Should provide excellent borrow material for local overland subgrade material.



Figure 57: Aerial view of the landscape near KP 96. Borrow to be extracted from elevated dry humps covered mainly with aspen and lodgepole pine.

1.41 Km 96.8 – BP 97- Clay/Silt

Borrow volume required for localized overland sections. Area and volume could be easily expanded. Initial shovel test pit confirms silt clay material. A short access road to borrow is required.



Figure 58: Aerial view looking west at BP 97 located in middle of photo.

1.42 Km 101.20 – BP 102- Fine Sand

Borrow volume required for localized overland sections. Area and volume could be easily expanded.



Figure 59: Dry sand type material at Wolverine Pass.



1.43 Km 101.50 – BP 102B – Silty Clay

Borrow volume required for localized overland sections. Requires a short 175 m access road. Area and volume could be easily expanded. Not field verified but similar material found in the surrounding area.



Figure 60: Dry elevated “humps” covered with lodgepole pine and aspen should provide adequate silty clay type material for overland sections.

1.44 Km 102.90 – BP 103 - Clay till Overburden/Carbonate Rock

Large elevated knob with potential clay till type material overlying a carbonate rock layer underneath. Short access road is required. The clay could be utilized for subgrade overland base material, the rock could be blasted/crushed and utilized for road surfacing.



Figure 61: BP 103 is the elevated hump with an exposed sedimentary rock/shale face on the south east side.

1.45 Km 103.30 – BP 104 – Clay till Overburden/Carbonate Rock

Large elevated knob with potential clay till type material overlying a sedimentary rock layer underneath. The clay could be utilized for subgrade overland base material, the rock could be ripped and would make excellent subgrade material. Future test pits will determine the precise shape and size (probably less than 2.5 ha).



Figure 62: Similar formation to BP 103 and expect similar soils.



1.46 Km 106.1 – BP 107/BP 107 Alter.– Carbonate Rock

Large elevated knob with potential clay till type material overlying a sedimentary rock layer underneath. The clay could be utilized for subgrade overland base material, the rock could be ripped and would make excellent subgrade material.

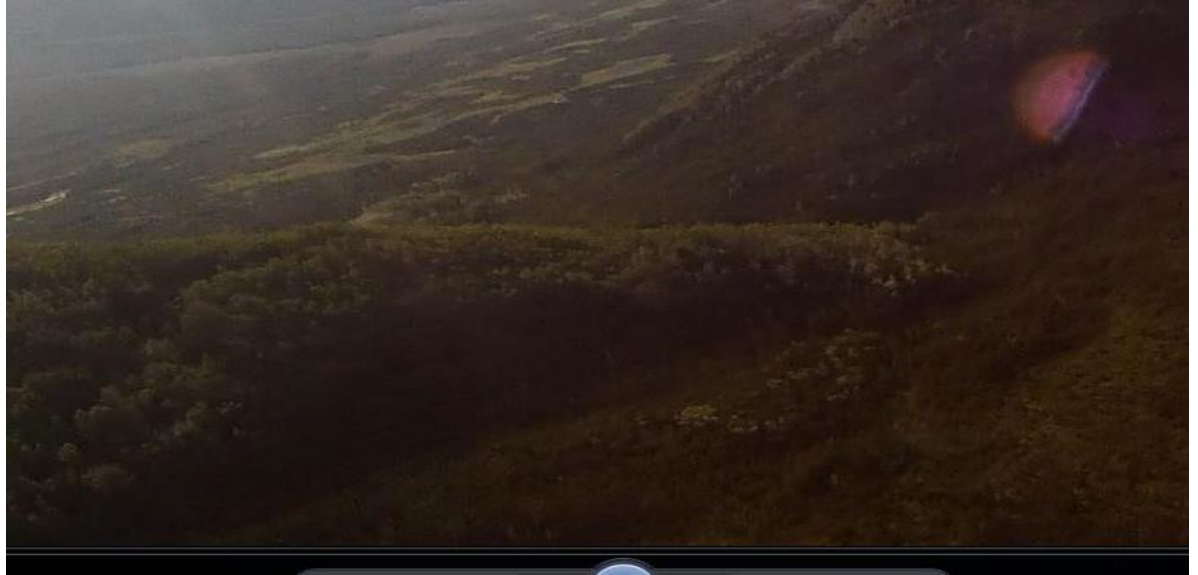


Figure 63: View of BP 107. Similar to BP 103 and 109,

1.47 Km 107.8 – BP 108 Alter. – Clay till Overburden/Carbonate Rock

BP 108 Alter. location has been shifted (vs. 2015 DAR submission) closer to BP 109 as the original location had slope stability concerns. This borrow contains a clay till material suitable for extensive overland volumes required for the ASR. This updated location will share the access road for BP 109.

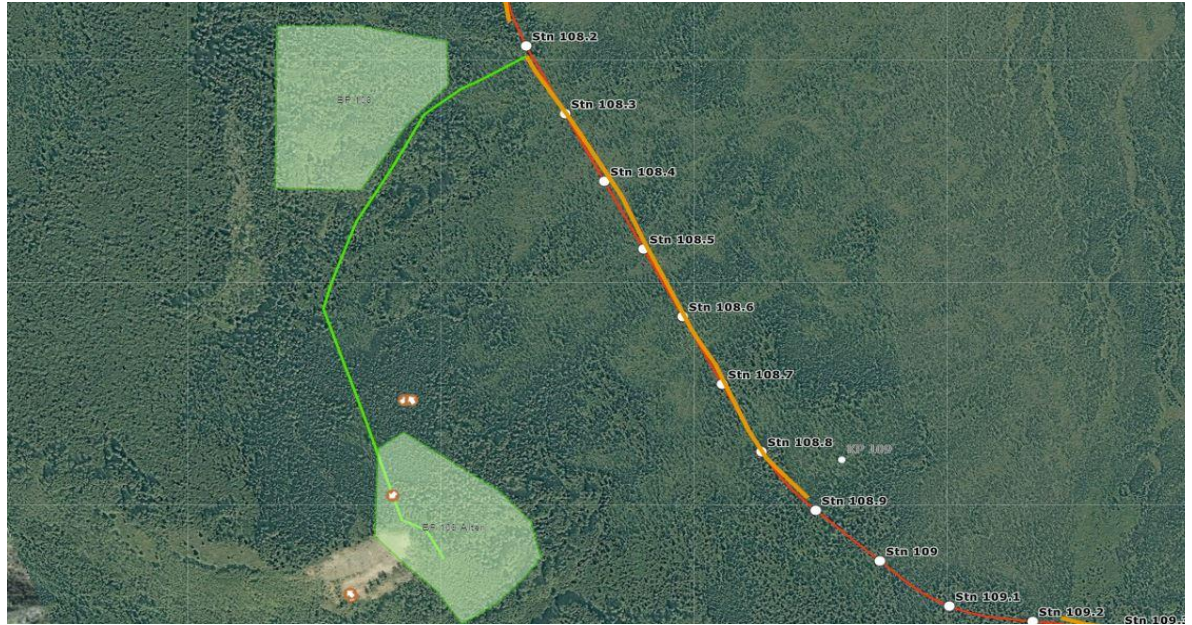


Figure 64: A screen shot view aerial photo of BP 108 (top) relative to BP 109 (bottom).

1.48 Km 108.7- BP 109 Alter. – Clay till Overburden/Carbonate Rock

Large elevated knob with potential clay till type material overlying a sedimentary rock layer underneath. The clay could be utilized for subgrade overland base material, the rock could be ripped and would make excellent subgrade material. Requires 800m access road. Future test pits will determine the precise shape and size.

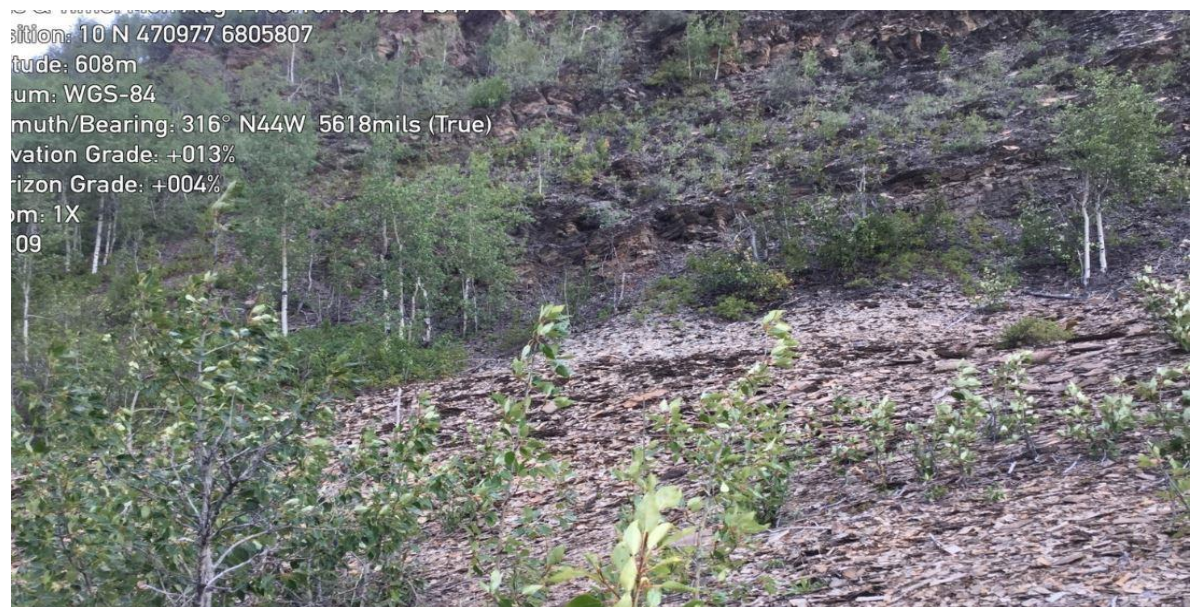


Figure 65. An example of the exposed sedimentary shale rock at BP 109. It is expected this material would be similar representation for BP 103 and 107.

1.49 Km 110.8- BP 110

BP 110 is an additional borrow area not previously identified in the 2015 DAR submission and is response to heavy borrow volume demand required to support overland construction from KP 104 to 111. Silt clay with mixed coarse fragments will provide excellent subgrade material.



Figure 66. A shovel test of material near BP 110 indicates excellent material for overland subgrade material.

1.50 Km 111.6– BP 112 Alter. – Clay/Silt Till

Noticeable, large elevated ridge expected to be clay/silt/ gravel glacial till mix suitable for overland subgrade material. May encounter carbonate bedrock suitable for rock quarry and crushing underlying the till mix.



Figure 67. The noticeable elevated knob/ridge should provide suitable subgrade borrow. The proposed ASR alignment is located at the lower base of the slope.

1.51 Km 112.0 – BP 112.3 Alter. – Alluvial Cobble and Gravels - Carbonates

A large outwash alluvial fan originating from the nearby Franklin Mountains of the Nahanni Range located east of the defined source. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.



Figure 68. Large source of quality limestone gravels and cobbles available along the proposed alternative route near KP 112. Ideal for crusher operation and a stockpile for future maintenance requirements.

1.52 Km 119.1 – BP 119 Alter. – Alluvial Cobble and Gravels - Carbonates

The material deposited at BP 112.3, 118, 119 all originate from the nearby Franklin Mountains of the Nahanni Range in the east. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.



Figure 69: An aerial view of BP 119, downstream from BP 118.

1.53 Km 120.2 – BP123A – Alluvial Cobble and Gravels - Carbonates

Where the route passes through the gap in the Front Range Mountains, known locally as Grainger Gap, there is a substantial potential for developing a crushed natural gravel source that can be used surfacing material over large sections of the road. In this section of the Grainger River (or an unnamed major tributary of it) has changed its channel in recent decades, and has left a large deposition channel abandoned to annual runoff. The current annual runoff avulsion channel flows directly south now, leaving a 500 m section of old channel that had flowed eastward abandoned. Based on all available visual evidence in the field, this relict channel hasn't received any appreciable water flow since the time the original winter road was constructed back in the early 1980's – there isn't any evidence of flows across

that roadway since then. The dry relict channel (BP123A) holds promise for supplying all the material required for a large crushing operation producing surfacing aggregate, as well as other products for road construction. As with much of the other alluvial cobble noted along the route, the Grainger Gap gravels appear to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material.

The large relict channel provides a flat plain with ample room for setting up a crushing plant, and for holding stockpiled materials. This area has potential to be a long-term source of maintenance aggregate as well.



Figure 70: Typical gravel materials found in the abandoned channel at BP123A.



Figure 71: Aerial view of the east end of the relict channel where BP123A is proposed. The ASR splits the borrow area, is located through the semi open forested area.

1.54 Km 120.10 – BP123B – Limestone Bedrock

Directly adjacent to the relict avulsion channel at BP123A, is a limestone bedrock knob that juts up about 10 m in height from the alluvial plain. This rock knob is readily accessible from flat ground on all sides, making it a simple candidate for developing a blasted rock source in this area. While the eroded rock surface is fairly fractured, there is potential for producing larger shot rock and riprap from interior sections of the rock knob via controlled blasting. The limestone rock would be an environmentally friendly material for stream crossing works.



Figure 72: View of the isolated limestone rock knob (BP123B) protruding from the BP123A relict channel plain. This knob has level access on all sides of it making it a very simple location to develop for a source of blasted rock.



Figure 73: Closer view of the limestone bedrock available in BP123B.

1.55 Km 121.1 – BP124 – Alluvial Cobble and Gravels - Carbonates

Similar material type as BP 123, BP 118, BP 119, part of the old floodplain of the Grainger River. Preferred location vs. BP 123A because closer proximity to surfacing requirements between KP 125 to 132.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance.



Figure 74: Another aerial view of the large deposit of gravels and cobbles, this one at KP 124.

1.56 Km 121.40 – BP 125A, 125B - Limestone Bedrock / Limestone Rockslide

An exposed outcrop of limestone bedrock with talus at the base (125B) would make an excellent rock quarry. The northern tip of BP 125A is in close proximity to the proposed road while BP 125B requires a short 400m access road but offers loose talus rock deposit at the base of the face. Both pits would provide excellent base material for overland construction from KP 124.8 to 127.2.



Figure 75: A view of the exposed rock face of BP 125A. The proposed road is located on the right side of photo at the base of the slope on the historic flood plain of Grainger River.



Figure 76: At view of BP 125B with exposed bedrock and talus rock deposit at the base.

1.57 Km 123.4 – BP126 – Limestone Rockslide (Rock Glacier?)

What appears to be a large limestone rockslide above the road at 126.40 km presents an opportunity to access naturally broken rock in a wide range of sizes, varying from large riprap down to fine rubble. The toe of this slide is about 250 m above the road, and it extends another 500 m uphill toward the originating bedrock cliffs. There is an extensive supply of broken rock in this formation, and it doesn't require expensive blasting to produce it – just

sorting of the material and loading it out in trucks. It would require an access trail of about 550 m in length to connect this source to the proposed road route in order to utilise it.

When viewed in the field, this formation has all the appearances of a run-out zone from a large past rockslide, but when viewed on satellite photos the toe of the slide seems to have some appearance of “flowing” material. This raised the question of whether this rubble formation is actually a rockslide deposit or a rock covered glacial remnant, and a subsequent field inspection of the surface debris failed to provide a clear answer to that question. It would be necessary to conduct some subsurface excavation to determine if there is ice present in, or under the rubble. If the formation is the remnant of a glacier, the lower toe of the formation may still provide ample thawed rubble material that has resulted from past ice retreat from subsequent melting.

If the formation is just rockslide debris, there is potential to save the substantial costs of drilling and blasting nearby bedrock to generate riprap sources for the many stream crossings within economic haul range. The finer rubble would also be ideal for subgrade construction across the many lowland areas nearby, especially over areas of permafrost due to its light, solar reflecting color. If, during the construction of the new winter road, there is an opportunity to probe this location, it would provide a definitive answer as to the material core properties of this formation, and indicate its suitability for providing construction materials.



Figure 77: View of the top end of rubble source and the near vertical limestone cliff it originated from.



Figure 78: Limestone colluvium rock gradation available at the middle of the rubble slope.



Figure 79: Finer material evident at the toe of the rubble slope. If the rubble pile is a rock glacier, this portion may be ice free now, as it is at the terminal end of the debris field.

1.58 Km 125.5 – BP 129 – Alluvial Cobble and Gravels

Potential good source of surfacing gravel. Close proximity to the proposed road location.



Figure 80: An example of the gravels at BP 129.

1.59 Km 129.2 – BP 132 – Clay/Silt Till

Clay till borrow material for subgrade overland construction. Expect permafrost around the perimeter.



Figure 81. View of the vegetation cover at BP 132.

1.60 Km 133.2 – BP 136 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction. Some limited potential for alluvial cobble and gravels within the gully and limestone bedrock quarry on the upper portions.



Figure 82 View looking west from the proposed road location. Limited alluvial gravels located in bottom of draw and exposed outcrops of limestone bedrock upper portions. Side slopes (on the lower right) could provide suitable clay/silt/sand till borrow material for subgrade construction.

1.61 Km-134.90 BP 138 – Exposed Limestone / Carbonate Bedrock

BP 138 contains exposed limestone rock outcrops which could be blasted and crushed for surfacing material. Requires a 1.2 km access road.



Figure 83. A view of the exposed limestone rock outcrops.

1.62 Km 136.50 – BP 139 - Alluvial Cobble and Gravels - Carbonates

A large alluvial fan deposit originating from the nearby Nahanni Range in the west. As with much of the other alluvial cobble noted along the route, this source appears to originate from competent carbonate bedrock, making them an environmentally friendly and preferred construction material. Seasonal stream flows during spring thaw. Detailed design would maintain natural drainage channels.

Sufficient volume and area for setting up a crushing plant and for holding stockpiled materials. This area could support aggregate material for long term road maintenance. Requires 2.0 km access road.



Figure 84. An aerial view of the vast alluvial fan deposit at BP 139.

1.63 Km 136.90 – BP 140 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction. Potential permafrost surrounding perimeter.



Figure 85. A raised knob vegetated with mature aspen/cottonwood could provide suitable backup borrow material for subgrade construction.

1.64 Km 140.5 – BP 143 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.



Figure 86. Mature aspen covers the proposed backup borrow material at BP 143.

1.65 Km 143.20 – BP 146 – Clay/Silt Till

Back-up clay/silt/sand till borrow material for subgrade overland construction.



Figure 87. A view of BP 146.

1.66 Km 147.8 – BP 151A, 151B - Alluvial Cobble and Gravels

Must confirm depth and area but expect shallow source (2m deep) spread over a large fan. Some short access road(s) may be required to develop. A significant size (4m wide) seasonal stream divides the two defined patches. Probably requires crushing.



Figure 88: One example of the gravel type material at BP 151.



Figure 89: An aerial view of the large fan at BP 151, KP 151.5.

1.67 Km 153.3, 154.0– BP 154, 156 – Clay/Silt Till

BP 154 and 156 are borrows located on similar geography covered in mature aspen forest consisting of silt/ clay till material for subgrade overland construction. BP 156 is an additional borrow area not previously identified in the 2015 DAR submission and is response to heavy borrow volume demand required to support overland construction from KP 151 to 153.

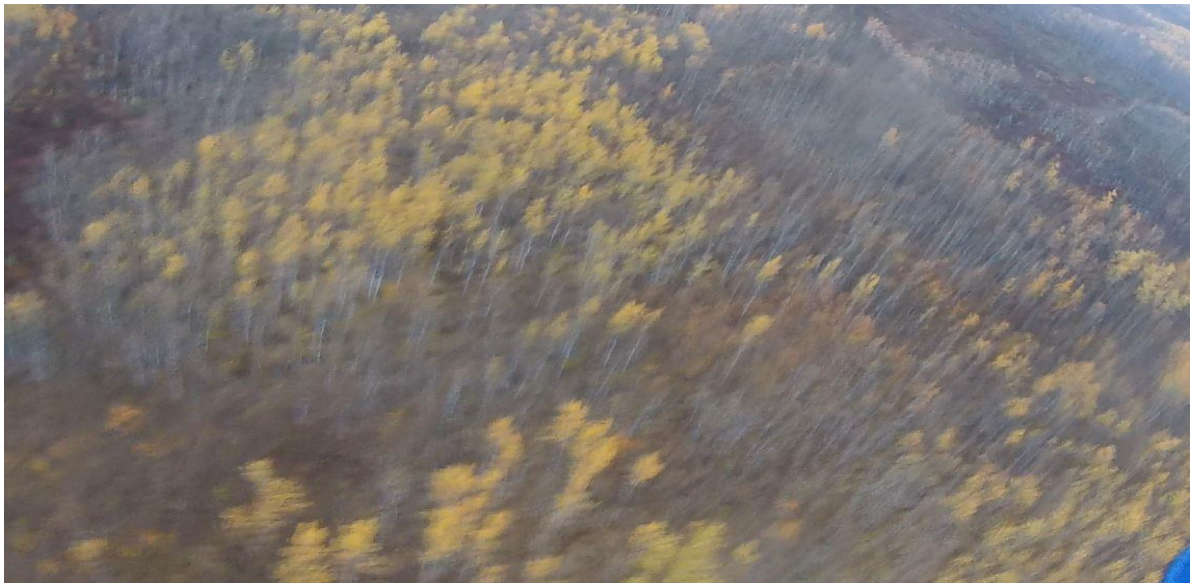


Figure 90: Back-up borrow source option at BP 154.

1.68 Km 154.50 – BP 158 - Limestone/Carbonate Talus Bedrock

Excellent source of mixed talus rubble at the base of limestone/carbonate rock face/bedrock. A very strategic aggregate source to supply surfacing requirements and rip rap from KP 155 to 184. Assumes will be extracted by ripping and blasting quarry. Requires a 1.5 km access road.



Figure 91: An aerial view of large deposit of talus rock at BP 158.

1.69 Km 155.0 – BP 159A – Rock Debris Deposit

Similar type of material as BP 158 but more of a deposit mix of limestone based rocks, gravel, , not likely requiring blasting to extract material.. A detailed investigation to determine the potential and extent of the deposit must be completed. This source would be strategic location to serve aggregate requirements on both the north side and especially the south side of the Liard River where gravel sources are difficult to find.



Figure 92: An example of material deposit at BP 159A.

1.70 Km 155.9 – BP 159A – Rock Debris Flow Fan

On the north side of the proposed Liard River landing/crossing exists a large debris/fan of rubble mix of limestone based rocks, gravel, mixed with clay. A detailed investigation to determine the potential and extent of the deposit must be completed. Likely not a large source of material, but close proximity to ASR works makes it attractive.



Figure 93: An aerial view of the potential aggregate source just above the proposed north landing on the Liard River.



Figure 94: On the surface, the material looks attractive but only additional investigation will determine the true potential of the source.