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**PROJECT OVERVIEW REPORT  
SIERRA-YOYO-DESAN ROAD AREA GRAVEL  
INVESTIGATION  
NORTHEASTERN, BC**

Submitted to:

New Ventures Branch  
**Ministry of Energy and Mines**  
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Submitted by:

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## TABLE OF CONTENTS

	<b>Page #</b>
1.0 INTRODUCTION AND SCOPE OF SERVICES .....	1
2.0 METHODOLOGY .....	2
2.1 COLLECTION AND REVIEW OF BACKGROUND DATA.....	2
2.2 INVESTIGATION PLANNING .....	3
2.3 FIELD INVESTIGATION.....	3
2.4 LABORATORY TESTING.....	4
2.5 REPORTING .....	5
3.0 BACKGROUND REVIEW.....	5
3.1 BEDROCK GEOLOGY .....	5
3.2 SURFICIAL GEOMORPHOLOGY/GEOLOGY.....	5
3.3 OVERVIEW/ROUTE ASSESSMENTS .....	6
3.3.1 Sierra-Yoyo Access Road Feasibility and Route Location Study, Thurber Consultants (1978).....	6
3.3.2 Sierra-Yoyo Access Road, Soils Survey, Thurber Consultants Ltd. (1979):....	7
3.3.3 Airphoto Mapping of Sand & Gravel Prospects in Kotcho Lake Area of Northeastern BC, J.D. Mollard & Associates (Mollard, 1984b):.....	7
3.3.4 Aggregate Potential Mapping of Sierra-Yoyo-Desan Road Corridor; Blyth et al. (2003).....	8
3.4 ENCANA CORPORATION .....	8
3.5 MOT FILES.....	8
4.0 RESULTS OF GRANULAR RESOURCE STUDY .....	9
5.0 DISCUSSION.....	10
5.1 EXISTING PROSPECTS.....	10
5.2 DELINEATION OF FUTURE PROSPECTS.....	11
5.3 ADDITIONAL WORK.....	12
6.0 LIMITATIONS.....	12
7.0 CLOSURE.....	12
8.0 REFERENCES.....	13

### **LIST OF FIGURES (INCLUDED IN APPENDIX A)**

- Figure 1: General Study Area Location
- Figure 2: Granular Sources and Prospects in the SYD Road Area
- Figure 3: Study Area Geology Units
- Figure 4: Study Area Geological Processes

### **LIST OF TABLES**

- Table 1: Target Areas Investigated
- Table 2: Test Pitting Summary
- Table 3: Soil Testing Details
- Table 4: General Investigation Findings
- Table 5: Aggregate Potentials

### **LIST OF APPENDICES**

- Appendix A: Figures
- Appendix B: Table of Previous Granular Resource Studies and Potential Prospects

### **ATTACHMENTS**

- Annex A: Compact disk containing digital files

## 1.0 INTRODUCTION AND SCOPE OF SERVICES

The British Columbia Ministry of Energy and Mines (MEM) retained AMEC Earth & Environmental Limited (AMEC) to conduct gravel investigations in the Sierra-Yoyo-Desan Road (SYD Road) area in northeastern British Columbia.

The initial scope of services for this assignment were detailed in AMEC's proposal of 9 January, 2003 to the MEM. This report provides a summary of AMEC's background research and the findings of 17 site specific gravel/rock quarry investigations conducted within the SYD Road area. The target areas investigated are summarized below:

<b>Table 1: Target Areas</b>			
<b>Target Area</b>	<b>Location/Access</b>	<b>Target Material</b>	<b>Type of Assessment Conducted</b>
Area 1 (Sahtaneh River)	At confluence of Sahtaneh River and Moss Creek, access was from km 116 of SYD for east portion and km 11.5 of the South Gunnel Road for the west portion	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 1A (Kotcho West)	Kotcho Lake Winter Road, Near Gunnel Creek	Gravel	Site Reconnaissance visit, no test pitting
Area 2 (Metladoo Creek)	Existing Sierra Jim Little Pit and surrounding area, Metladoo Creek area. Access was from km 107 of the SYD Road	Gravel	Level 2 (Development Scale) but with limited soils testing and reporting
Area 3 (Sahdoanah Creek)	Near Sahdoanah Creek. Access was from km 177 of SYD Road	Gravel	Level 2 (Development Scale) but with limited soils testing and reporting
Area 4 (Northwestel Tower Hill)	Near airstrip east of Kotcho Lake. Winter road on a hill where Northwestel towers are located. Access is from km 132 of the SYD Road	Bedrock	Level 1 (Reconnaissance) with limited reporting
Area 4A (Kotcho Lake West)	Near airstrip east of Kotcho Lake, north of Area 4	Bedrock	Access road was deactivated, no assessed
Area 5 (Courvoisier Creek)	North side of Courvoisier Creek. Access is from km 19.5 of Komie Road	Gravel	Level 2 (Development Scale) but with limited soils testing and reporting
Area 5A (Courvoisier Creek Hill)	Hill north of Courvoisier Creek Area to the west of the Komie Road. Access was from km 22 of the Komie Road.	Bedrock	Level 1 (Reconnaissance) with limited reporting
Area 6 (Kotcho West)	Kotcho Lake Winter Road, near Chuatse Creek	Gravel	Site Reconnaissance visit, no test pitting
Area 7/7A (Kyklo Area)	Kyklo Creek area accessed off of SYD Road either along the Kyklo Road at km 102 of the SYD Road or a well lease road at km 100 of the SYD Road	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 8 (Komie North)	Brandt Creek area accessed from km 43 of the Komie Road	Gravel	Level 2 (Development Scale) with an area at Level 1 (Reconnaissance)
Area 9 (Kimea Pit)	Kimea Pit, accessed at km 12 Wildboy Road	Gravel	Level 2 (Development Scale)
Area 10 (Kotcho East)	Site located in an existing cut block at km 121 of the Kotcho Winter Lake Road	Gravel	Level 2 (Development Scale)
Elleh Creek Reserve	The site was located at km 34 to 38 of the Elleh Creek Road	Gravel	Level 1 (Reconnaissance)
Area 10A	Located south of the Kotcho Lake Road on a seismic line accessed at Km 13 of the "Cut Across" Winter Road.	Gravel	Site Reconnaissance visit, no test pitting
Area 11	Km 34.5 of the 61 Road near well B95-L/94-I-05	Gravel	Site Reconnaissance visit, no test pitting

Note: that the Elleh Creek Reserve originally was assessed for Land and Water British Columbia Inc. Figure 1 and 2 (Appendix A) show the locations of the target areas.

Detailed results of the site specific investigations are documented in the following separate reports:

Area 8: Report by AMEC (2003a) submitted to MEM on May 15, 2003 and subsequent addendum letter by AMEC (2003e) submitted to MEM on July 7, 2003.

Area 9: Report by AMEC (2003b) submitted to MEM on May 15, 2003

Area 10: Report by AMEC (2003c) submitted to MEM on May 15, 2003

Elleh Creek Reserve: Report by AMEC (2003d) submitted to MEM and Land and Water British Columbia Inc.) on May 23, 2003.

Areas 1, 2, 3, 4, 5, 5A, 7 and 7A: Field and Laboratory Work-Summary Report by AMEC (2003f) submitted to MEM on July 8, 2003.

These reports should be read in conjunction with this document.

## **2.0 METHODOLOGY**

AMEC's methodology was divided into the following general tasks.

- 1) Collection and review of background data
- 2) Investigation planning
- 3) Field investigation (reconnaissance, test pitting and optional drilling, Level 1 and 2)
- 4) Laboratory testing
- 5) Reporting

These tasks are described in more detail in the sections below.

### **2.1 COLLECTION AND REVIEW OF BACKGROUND DATA**

AMEC conducted a review of the relevant background data prior to the initiation of work. AMEC collected data from the following sources:

- 1) Files and references made available by MEM including:
  - a) Previous gravel investigation reports in the general study area;
  - b) Archaeological impact assessments for the general target areas where available;
  - c) 1:40 000 scale granular resource/terrain mapping conducted in the general study area and any reporting included with the mapping, and
  - d) 1:15 000 scale aerial photography where available.
- 2) Relevant files and references available from the Ministry of Transportation (MoT).
- 3) References for general surficial and bedrock geology available from the Geological Survey of Canada and other government agencies.

4) AMEC project files for the area.

Along with the collection and compilation of data, AMEC conducted interviews with Gerry Hofmann of the MoT and Jim Little, R.P.F., P.Ag. of Mackeno Ventures.

## 2.2 INVESTIGATION PLANNING

Prior to conducting the field investigation, AMEC reviewed available background information and prioritized sites based on the inferred potential to find gravel and/or bedrock. During the process, AMEC had meetings with Sheldon Harrington, B.Sc. of MEM and Jim Little of Mackeno Ventures.

## 2.3 FIELD INVESTIGATION

The field work for the gravel investigation was divided into three phases:

- 1) Site Reconnaissance: Prior to mobilizing equipment to the general project area, Doug Dewar, P.Eng. of AMEC, Jim Little, and Sheldon Harrington conducted a general site reconnaissance to determine the specific logistics for the field work at each site from February 17 to 25 and March 11 to 13, 2003, including:
  - a) Confirmation of site locations and access requirements
  - b) Utility issues. Note that Jim Little of Mackeno Ventures provided all utility clearances
  - c) Assessment of access issues such as snow clearing, tree cutting etc
  - d) Assessment and organization of equipment staging, turn around and parking locations for low-bed trucks
- 2) Level 1 Reconnaissance Investigations: The Level 1 Reconnaissance Investigations consisted of excavating test pits within a given target area at a grid ranging of approximately 250 to 300 m to determine if granular materials were present. In the case of bedrock targets, test pits were excavated into bedrock, if encountered. The actual test pit spacing, numbers and depths are detailed in the individual target area reports separate from this document. The test pitting methodology is summarized below.
- 3) Level 2 Development Scale Investigation: The Level 2 Development Scale Investigations consisted of digging additional test pits in areas where granular materials were encountered to reduce the test pit grid spacing to below approximately 150 m. The actual test pit spacing, numbers and depths are detailed in the reports (AMEC 2003a, b, c, d, e) which are separate from this document. The test pitting methodology is summarized below:
  - 1) For the purpose of this work, granular material was generally defined as soil with less than 15% fines (silt and clay)
  - 2) Test pits were excavated with a tracked excavator provided by Kledo Construction, refer to individual test pit logs for the excavator type. A representative of AMEC (either Shiloh Jorgensen, E.I.T., Bradley Jackman, C.Tech or Bob McFadden), supervised the test pit excavation and logged the test pits using the Modified Unified Soil Classification system.
  - 3) Test pits were excavated to 3 m.

- a) If no granular material was encountered, the test pit was backfilled. No samples were taken.
- b) If granular material was encountered, the test pit was advanced to the full reach of the excavator. At least one bulk soil sample was taken per test pit if granular material was encountered. Note that in some instances when the samples were fine grained sand, samples were not taken.
- 4) A photograph of excavated soil was taken from every test pit.
- 5) The locations of the test pits were marked on a field airphoto and the coordinates were taken with a hand-held GPS where satellite coverage was available.

Table 2 provides a summary of the test pits excavated in each target area:

<b>Table 2: Test Pitting Summary</b>			
<b>Target Area</b>	<b>Number of Test Pits</b>	<b>Test Pits Encountering Granular Material</b>	<b>Test Pits Encountering Bedrock</b>
Area 1 (Sahtaneh River)	46	7	0
Area 1A (Kotcho West)	0	N/A	N/A
Area 2 (Metladoa Creek)	54	18	0
Area 3 (Sahdoanah River)	67	31	0
Area 4 (Northwestel Tower Hill)	8	0	8
Area 5 (Courvoisier Creek)	74	32	0
Area 5A (Courvoisier Creek Hill)	7	0	7
Area 7A 7/7A (Kyklo Area)	8	0	0
Area 6 (Kotcho West)	0	N/A	N/A
Area 8 (Komie North)	63	50	0
Area 9 (Kimea Pit)	75	55	0
Area 10 (Kotcho East)	26	11	0
Area 10A	0	N/A	N/A
Area 11	0	N/A	N/A
Elleh Creek Pit	45	31	0
<b>Totals</b>	<b>473</b>	<b>235</b>	<b>15</b>

## 2.4 LABORATORY TESTING

Samples obtained in the field were returned to AMEC's soils laboratory in Prince George. AMEC conducted wash sieve grain size analysis for each sample collected. AMEC also conducted a limited number of degradation and sand equivalent tests on crushed granular samples. Table 3 details the laboratory tests conducted for each specific target area:

<b>Table 3: Soil Testing Details</b>			
<b>Target Area</b>	<b>Wash Sieve Analysis</b>	<b>Sand Equivalent Tests</b>	<b>Degradation Tests</b>
Area 2 (Metlandoa Creek)	8	0	0
Area 3 (Sahdoanah River)	18	0	0
Area 5 (Courvoisier Creek)	21	0	0
Area 8 (Komie North)	22	5	5
Area 9 (Kimea Pit)	49	2	3
Area 10 (Kotcho East)	11	3	3
Elleh Creek Reserve	42	0	0
<b>Totals</b>	<b>171</b>	<b>10</b>	<b>10</b>

## **2.5 REPORTING**

Following completion of the field work and laboratory testing, draft reports were prepared for MEM for Areas 8, 9 and 10 and for MEM and Land and Water British Columbia Inc. for Elleh Creek Reserve. Following a MEM review of the draft reports, a project meeting was held at AMEC's Prince George Office between Doug Dewar, P.Eng. of AMEC and Sheldon Harrington and Vic Levson, P.Geo., PhD. of MEM on April 29, 2003, to discuss potential revisions for final reporting and the format of reporting for the remaining areas (Area 1, 2, 3, 4, 5, 5A, 7 and 7A).

## **3.0 BACKGROUND REVIEW**

### **3.1 BEDROCK GEOLOGY**

Stott (1982) indicated that bedrock in the general study area was either the Cretaceous Dunegan Formation (carbonaceous sandstone, massive conglomerate, dark shale or siltstone) or Fort St. John Group (marine shale and thin bedded sandstone). Figure 3 provides a scanned image of Stott's (1982) bedrock map.

### **3.2 SURFICIAL GEOMORPHOLOGY/GEOLOGY**

Mathews (1980) indicated that the general study area had been covered by the Laurentide Ice Sheet during the last glaciation. Mollard (1984a) and Bowes (1986) reported that the general upland area east of the Fort Nelson River appeared "to be a poorly drained till plain complete with multiple swamps and muskeg" (p.1).

During the last ice advance many glacial thrust ridges, drumlins and glacial grooves were created. During the retreat of the glacier many features associated with ablation (melting of the ice) such as meltwater channels, kames and eskers were also created. Bowes (1986) noted that during the retreat of the Laurentide Ice Sheet a series of ice marginal meltwater channels formed. A scanned image of Mathews (1980) map showing features associated with glaciation and deglaciation of the study area is shown in Figure 4. Key features in the study area relating

to glaciation/potential glaciofluvial deposits include the meltwater channels in the Sahtaneh River, Hoffard Creek, Chautse Creek and Petitot River/Kimea Creek areas.

Mollard (1984a) produced a detailed terrain map of a 10 000 km<sup>2</sup> area which encompasses AMEC's current study area. Airphotos (1:24 000 scale) were mapped with the results being presented on 1:50 000 scale NTS maps. The mapping concentrated on separating peatland (or muskeg) from areas of mineral soils with specific emphasis on the presence of permafrost. Within the areas delimited as mineral soils, Mollard (1984a) had separated areas into "streaked" till plains, glaciolacustrine plains or isolated areas of glaciofluvial and fluvial sand and gravel. Mollard (1984a) noted that all significant granular areas mapped were north of the Desan Lake area with some possible pockets of granular material south of the Desan Lake area. Mineral soils areas were further delimited into good, intermediate or poor terrain types based on their suitability for road construction.

Thurber (1979) reported that the till encountered in the plains was typically a gravelly, sandy, silty clay of low plasticity (CL) which typically had a stiff consistency and moisture contents ranging from 15 to 25%. It was also reported that in some areas up to 0.6 m of clayey or sandy silt was encountered overlying the till which could have been of glaciolacustrine origin or weathered till.

### **3.3 OVERVIEW/ROUTE ASSESSMENTS**

As part of the work, AMEC has reviewed 4 overview route geotechnical or airphoto terrain assessments, as detailed below in the section below:

#### **3.3.1 Sierra-Yoyo Access Road Feasibility and Route Location Study, Thurber Consultants (1978)**

Thurber (1978) highlighted some potential sources of granular deposits which included:

1. The "great esker" which was reported to be oriented northwest to southeast between Gunnel Creek and Sahtaneh River. Note that Thurber (1978) found clay till in shovel probes of the great esker, but recommended that the entire esker be systematically searched to determine if there was any granular potential.
2. The series of ridges between Moss Creek and the Sahtaneh River.
3. Terraces located along meltwater channels. Thurber (1978) highlighted one terrace in the Hoffard Creek area (but did not show its location). Additionally, it was noted that the deposits were difficult to delimit on airphotos as the terraces typically had relief of less than 2 m high and were over 60 m wide. It was also noted that relatively thin gravel deposits (less than 2 m thick) were typically found at some locations within these terrace features).

Thurber (1978) recommended a detailed granular resource study be conducted prior to preparation of the contract documents for construction.

### **3.3.2 Sierra-Yoyo Access Road, Soils Survey, Thurber Consultants Ltd. (1979):**

Thurber conducted a soil survey of the proposed Sierra-Yoyo Access Road. Along the proposed route, the only significant granular source found was the area currently referred to as the Esso-Sierra Pit. Thurber discussed 5 other prospects, but stated that any gravel deposits would be “of limited extent and poor quality” (p.6).

### **3.3.3 Airphoto Mapping of Sand & Gravel Prospects in Kotcho Lake Area of Northeastern BC, J.D. Mollard & Associates (Mollard, 1984b):**

Mollard (1984b) conducted airphoto mapping to determine prospects for gravel within the SYD Road area for the proposed extension of the road from the Yoyo Airstrip north to the Desan Lake area. The study area was located between the Petitot River and Hoffard Creek areas (north to south) and within 20 km of the road alignment (east to west). Prospects were classified based on their geological features observed during the airphoto mapping and classified as having either an excellent, good, fair, poor, doubtful or very doubtful chance of encountering granular materials. Fifty-seven prospects were mapped by Mollard (1984b). Of the 57 prospects, 15 were rated as having a good to excellent chance of encountering granular deposits. The prospects considered to have an excellent chance included:

1. Terraces on Sahdoanah Creek (note Mollard had identified the study area as “Sahtaneh Creek” but based on Mollard’s (1984b) key plan, it is actually Sahdoanah Creek)
2. Another terrace on Sahdoanah Creek
3. Four Terraces along the Petitot River
4. A three level terrace north of Hosti Lake

These prospects were all located north of the current SYD Road alignment and outside of the general study area north of the Kimea Creek valley. Mollard (1984b) noted that (p.3) “there are literally tens of millions of yards of granular material in the prospects mapped ” as good or excellent, but as noted above, the majority of these prospects appear to be located outside the general proximity of the SYD Road alignment.

Following the airphoto mapping the MoT conducted a helicopter reconnaissance overview of the proposed road corridor and site-specific field checks of Mollard’s (1984b) prospect sites. Based on the results of the site-specific field checks, some areas were tested using resistivity surveys and/or test pitting. Davidson (1984) summarizes the results of the work.

Following the completion of the MoT’s work, Bowes (1986) stated that the best prospect for gravel within the study area was in areas where meltwater had overtopped the ice marginal channels, reworked the local tills and deposited washed deposits downstream. Bowes (1986) noted that typically a 10% chance of finding gravel should be expected for each prospect investigated within the study area. Additionally, Bowes (1986) noted that other possible sources of gravel included small esker-like features and ice thrust ridges that (p.1) “occur sporadically throughout the area”.

### **3.3.4 Aggregate Potential Mapping of Sierra-Yoyo-Desan Road Corridor; Blyth et al. (2003)**

Blyth et al. (2003) presented the results of aggregate potential mapping on fourteen 1:50 000 scale maps. The study area included a corridor approximately 20 km wide running along the 180 km length of the SYD Road alignment with some additional areas mapped outside the original corridor. Fourteen 1:50 000 scale map sheets presented the aggregate potential mapping (digital files of mapping included in Annex A).

The maps incorporated the results from two separate studies:

1. Heather Blyth, P.Geo. and Vic Levson, Ph.D., P.Geo, conducted aggregate resource mapping using 1997, 1:40 000 scale airphotos for the 20 km wide corridor running along the length of the SYD Road. As part of the work, field checking was conducted for approximately 10 to 25 percent of the delimited areas. The field checking used a helicopter for access and shovel probes to review near-surface soil conditions. Areas interpreted to have granular potential were divided into 1) high, 2) moderate and 3) low potential.
2. Paul Savinkoff, G.I.T., conducted a review of the mapping done by Heather Blyth, P.Geo and a review of additional areas outside of the original study area using 1997, 1:20 000 scale color airphotos. Areas interpreted to have granular potential were divided into 1) high, 2) moderate and 3) low potential. These areas were marked with a different symbol than those delimited by Heather Blyth.

Note that a written report was not included with the mapping.

### **3.4 ENCANA CORPORATION**

EnCana Corporation (EnCana) and their representatives provided information for aggregate potential from the following sources:

1. Seismic shot hole records indicating that granular material had been encountered. EnCana has requested that any seismic shotholes encountering granular material be reported, and
2. Reports from equipment operators that had encountered gravel while digging remote sumps .

Areas reported by EnCana are referred to as the Kotcho Lake Winter Road East Prospect and the 61 Road-Elleh Creek Prospect. One portion of the Kotcho Lake Winter Road East Prospect has been investigated by AMEC as part of this work (Area 10: Kotcho East). These areas are detailed in the table included in Appendix B.

### **3.5 MOT FILES**

As part of the work, AMEC reviewed site-specific records of granular resource studies provided in MoT files. Over 35 previous granular investigations were noted in files with an additional 20

non-investigated prospects noted. The locations of these areas are shown in Figure 2 and detailed information is provided in the table included in Appendix B.

#### 4.0 RESULTS OF GRANULAR RESOURCE STUDY

Table 4 provides a summary of the investigation findings. The reader is referred to the separate AMEC (2003a through f) reports for more details.

Table 4: Investigation Findings		
Target Area	Level of Investigation	General Findings
Area 1 (Sahtaneh River)	Reconnaissance	Limited amounts of granular material consisting of fine grained sand were found within the study area. It appears that there may be limited quantities of borrow sand available within Area 1; otherwise, this area was judged to have no granular potential.
Area 2 (Metladoa Creek)	Reconnaissance	<p>The existing pit within Area 2 appeared to be nearly depleted. Selective mining of gravel may yield additional granular material. Based on the laboratory results, the average gradation from Area 2 was gravelly sand with some silt. There was approximately 81 400 m<sup>3</sup> of potential granular material remaining within Area 2. The granular material appeared to be generally suitable for general borrow with select areas being suitable for HFGSA.</p> <p>It appeared that the highest potential for granular material was north of the existing pit in an area where two reconnaissance test pits were excavated. Further work would be required to verify the potential characteristics, quality and quantity within Area 2.</p>
Area 3 (Sahdoanah Creek)	Reconnaissance	It appeared that the majority of soils encountered during AMEC's field work were sands with some gravel seams. The average sample gradation encountered in Area 3 was sand with some gravel and a trace silt. There was estimated to be approximately 29 200 m <sup>3</sup> of sand within Area 3. Area 3 appeared to be suitable for use as a source of winter road sand, general borrow and possibly SGSB in selected and limited areas.
Area 4 (Northwest Tower Hill)	Reconnaissance	Very weak sandstone and mudstone bedrock was encountered below overburden within the study area. The bedrock did not appear to be a suitable source for crushed products or rip-rap. It appeared to only be suitable for borrow material.
Area 5 (Courvoisier Creek)	Reconnaissance	Although the deposits were relatively thin (less than 2 m in total thickness) there appeared to be a considerable amount of sand and gravel west of the Komie Road. Based on AMEC's preliminary volume estimate, there could be approximately 570 000 m <sup>3</sup> of sand and gravel. The material in area appeared to be suitable for use as SGSB with select areas being suitable for use as HFGSA.
Area 5A (Courvoisier Creek Hill)	Reconnaissance	Very weak sandstone and mudstone bedrock was encountered below overburden within the study area. The bedrock did not appear to be a suitable source for crushed products or rip-rap. It appeared to only be suitable for general borrow material.
Area 7A 7/7A (Kyklo Area)	Reconnaissance	There was no granular material found during the field investigation. The area is not considered to be a future prospect.
Area 8 (Komie North)	Development Scale (north of Komie Road) Reconnaissance (adjacent to Komie Road)	There were potentially significant volumes (>300 000 m <sup>3</sup> ) of sand and gravel within Area 8 in the area north of Komie Road which could be selectively be used as SGSB, HFGSA and in smaller quantities WGBCA. Granular quality testing indicated that the gravelly sand had lower than typically specified durability and possible plastic fines.

<b>Target Area</b>	<b>Level of Investigation</b>	<b>General Findings</b>
		In addition to the main area north of Komie Road, a Reconnaissance Level assessment was conducted in an area adjacent to Komie Road. It was judged that there was granular potential within this portion of the target area and it was concluded that a Level 2 Gravel Investigation could be conducted in this area.
Area 9 (Kimea Pit)	Development Scale	There was potentially significant volumes (>3 000 000 m <sup>3</sup> ) of granular material within Area 9. The majority of the soils with the study area appeared to be suitable for use as SGSB with selective areas being suitable for use as HFGSA and WGBCA. Previous granular quality testing conducted by the MoT and granular quality testing conducted by AMEC indicated that the area had lower than typically specified durability and possible plastic fines.
Area 10 (Kotcho East)	Development Scale	There was a potential for up to 450 000 m <sup>3</sup> of gravelly sand within Area 10. The gravelly sand appeared to be suitable for use as SGSB (although it had an average of 7% fines) and HFGSA (with the addition of fines). Granular quality testing indicated that the gravelly sand had lower than typically specified durability and possible plastic fines.
Elleh Creek Reserve	Reconnaissance	There was potentially significant volumes (>1 000 000 m <sup>3</sup> ) of granular material within the Elleh Creek Reserve. It appeared that selective areas were suitable for use as SGSB, HFGSA and WGBCA. No granular quality testing was conducted.

SGSB = Select Granular Subbase, HFGSA= High Fines Granular Surfacing Aggregate, WGBCA= 25 mm Well Graded Base Course Aggregate

## 5.0 DISCUSSION

### 5.1 EXISTING PROSPECTS

Based on AMEC's review of the study area, the aggregate potentials provided in the mapping by Blyth. et al (2003) tended to be optimistic. It is AMEC's opinion that actual aggregate potentials are as follows:

<b>Potential interpreted by Blyth et. Al. (2003)</b>	<b>AMEC</b>
High	Moderate to Low
Moderate	Low
Low	Very low to remote

A similar comment could be made regarding previous mapping conducted by Mollard (1984b). Bowes (1986) reflected this comment when he noted that there was typically a 10% chance of finding gravel for each prospect (delimited by Mollard, 1984b) investigated within the study area.

- **Esker-Like Features:** Polygons within the study area mapped as having aggregate potential based on "esker-like" features terrain were generally found to be silt or clay till during past field investigations (AMEC and MoT). With the exception of Area 3, which was predominantly sand, these raised or "esker like" features did not appear to contain

granular material. As an example, granular material has not been found in any previous investigations of the “great esker” (Thurber 1978) in the study area. Therefore, AMEC would recommend that future investigations should put a lower priority on targeting these features due to the very low probability of encountering granular material.

- **Meltwater Channel Features:** It generally appeared that the larger the meltwater channel feature, then the better the chance of finding significant quantities of granular material (i.e. Kimea Creek and Elleh Creek). While potentially significant quantities of gravel have been found in Kimea Creek and Elleh Creek areas, no similar scale features are evident directly adjacent to the SYD Road corridor. Note that additional features associated with meltwater include Area 2 (Jim Little Pit area) which appeared to be a fan or outwash plain at the mouth of a meltwater channel currently occupied by Metlandoa Creek and Sahtaneh River. The majority of quality granular deposits related to meltwater channels in the general study area particularly in the Hoffard Creek, Gunnel Creek and Sathaneh River area appear to have been depleted. While it is expected that there may be additional granular deposits within these meltwater channels, it is expected that they will be of generally lower volume and quality.
- **Other features:** Other features included buried infilled pre-glacial channels and features disguised by thin layers of till or glaciolacustrine deposits. A specific example is Area 10 and Area 10A where there was approximately 2.0 m of overburden overlying granular deposits. Area 10 and 10A were identified by representatives of EnCana during seismic surveys. There is only a remote likelihood that Area 10 and 10A would have been delimited during an airphoto review of the general study area. It is AMEC’s opinion that similar “hidden” deposits may exist within the general study area and possibly in close proximity to the SYD Road alignment.

## **5.2 DELINEATION OF FUTURE PROSPECTS**

For the delineation of future prospects within the study area, AMEC would recommend that MEM consider:

- Having any potential granular material encountered during seismic surveys in seismic shot holes reported to the MEM.
- Interviewing local equipment operators, construction foreman and resource company representatives to determine if granular material has been observed during any earthworks, including but not limited to pipeline and remote sump construction.

Given the amount of airphoto interpretation conducted within the study area, this would appear to be the next best method to determine if there were additional granular prospects within the study area, particularly where granular deposits may be disguised or masked by surficial soils.

### 5.3 ADDITIONAL WORK

Within the existing areas investigated by AMEC, if additional development level work is to be conducted it is recommended that the following areas be considered:

- Area 2 (Jim Little Pit): Only thin deposits that could be selectively mined appear to be left within and surrounding the existing pit. While volumes of granular material may be considered small (less than 100 000 m<sup>3</sup>) and crushable material may be scarce, the additional processing and handling costs may offset the hauling costs from other areas to the central portion of the SYD Road.
- If there is a requirement for gravel in the km 61 Road area, Area 11 should be investigated with a Level 1 (Reconnaissance) gravel investigation followed by a Level 2 (Development Scale) gravel investigation, if warranted.

### 6.0 LIMITATIONS

This report has been prepared for the exclusive use of the British Columbia Ministry of Energy and Mines for specific application to the areas described within this report. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. AMEC accepts no responsibility for damages, suffered by any third party as a result of decisions made or actions based on this report. It has been prepared in accordance with generally accepted geological engineering practices. No other warranty, expressed or implied, is made.

This report should be read in conjunction with the other AMEC reports (2003a through f) written for the SYD Road Gravel Investigation project.

### 7.0 CLOSURE

Should you have any questions or comments please contact Doug Dewar at the numbers given above

Respectfully submitted,

**AMEC Earth & Environmental Limited**

Reviewed by:

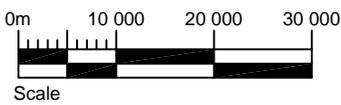
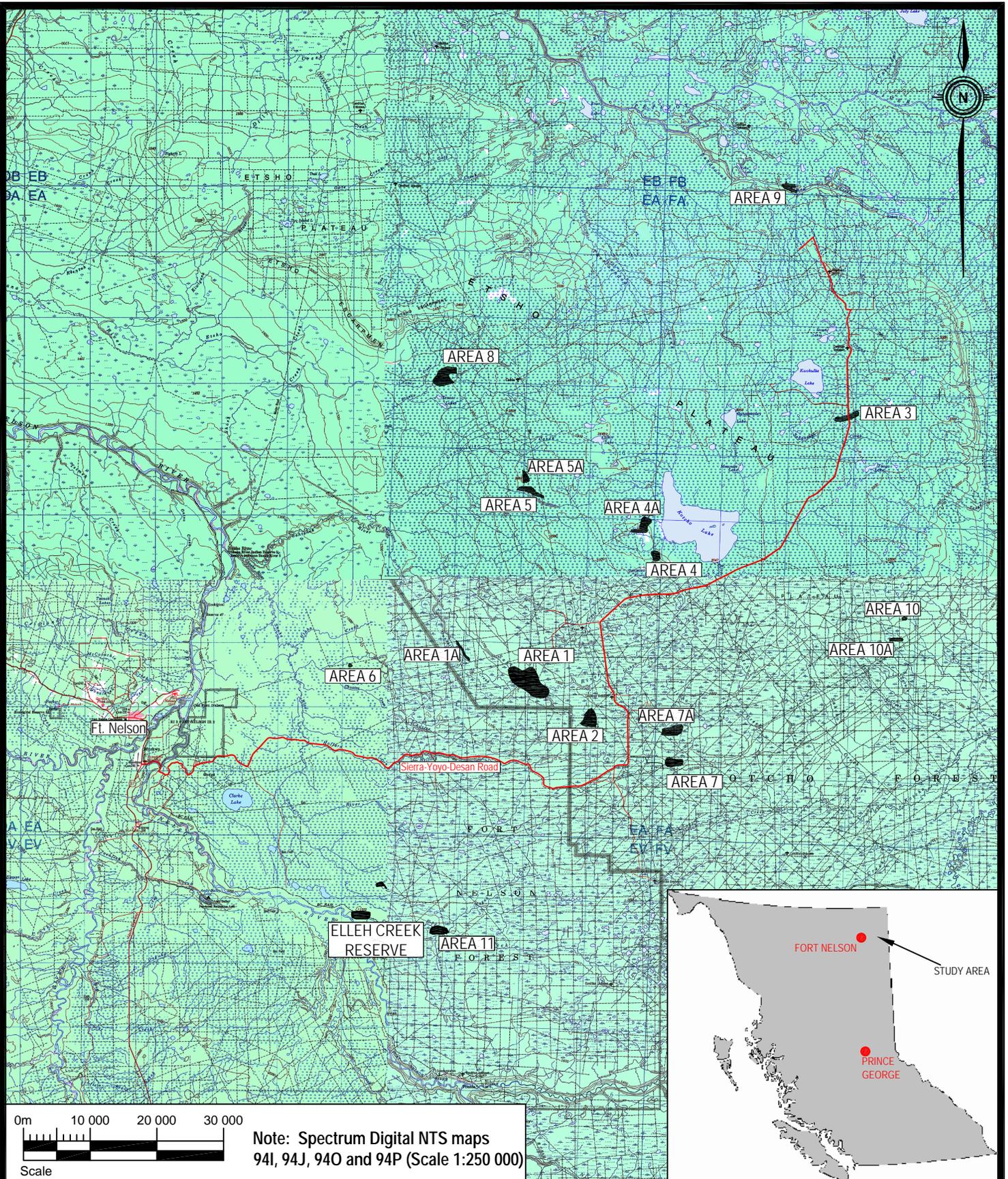
Doug Dewar, M.Sc., P.Eng.  
Geological Engineer

Nick Polysou, P.Eng  
Senior Geotechnical Engineer  
Regional Manager, Central BC.

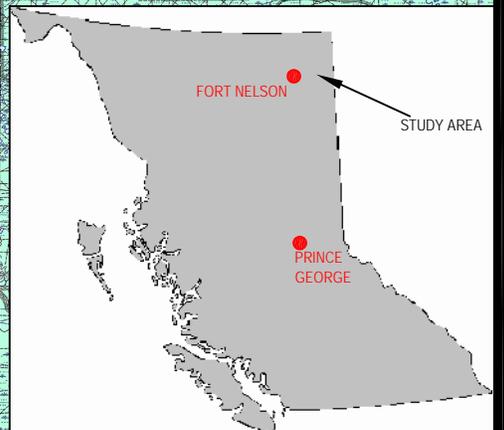
## 8.0 REFERENCES

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- AMEC Earth & Environmental Limited 2003b. Gravel Investigation, Area 9, Sierra-Yoyo-Desan Area Gravel Investigation, Northeastern, BC. Report dated 15 May, 2003 submitted to the New Ventures Branch of the Ministry of Energy and Mines, 25 pp. plus attachments.
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- AMEC Earth & Environmental Limited 2003f. Field and Laboratory Work-Summary Report, Areas 1, 2, 3, 4, 5, 5A, 7 and 7A. Report dated 8 July, 2003 submitted to the New Ventures Branch of the Ministry of Energy and Mines, 23 pp. plus attachments.
- Beeson, C.E. 1985. Kimea Creek Terrace Prospect, Request for Services No. 6393. Internal Ministry of Transportation and Highways Report, file M44-12-4P082, 7 pp. plus attachments.
- Beeson, C.E. 1985a. Magnesium Sulphate Soundness - Kimea Creek Terrace Prospect. Internal Ministry of Transportation and Highways Memo, file M44-12-4P082, 2 pp. plus attachments.
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- Matthews, W.H. 1980. Retreat of the Last Ice Sheets in Northeastern British Columbia and Adjacent Alberta. Geological Survey of Canada, Bulletin 331, 22 pp.
- Mollard, J.D. 1984a. Terrain and Surface Geology Map, Kotcho Area, British Columbia. Letter prepared by J.D. Mollard and Associates Limited for Gulf Canada Resources Inc., 9pp. and accompanying appendices and maps
- Mollard, D.G., 1984b. Letter Report on Airphoto Mapping of Sand and Gravel Prospects in Kotcho Lake Area of Northeastern British Columbia. Letter prepared by J.D. Mollard and Associates Limited for Gulf Canada Resources Inc., 3pp. and accompanying maps.
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- Thurber Consultants Ltd. 25 October 1978. Sierra-Yoyo Access Road Feasibility and Route Location Study. Report to the BC. Ministry of Mines and Petroleum Resources, 14 pp. plus tables and figures.
- Thurber Consultants Ltd. 26 April 1979. Sierra-Yoyo Access Road, Soils Survey. Report to the BC. Ministry of Mines and Petroleum Resources, 7pp. plus test pit logs and figures.
- Thurber Engineering Ltd. 18 December 2001. Sierra-Yoyo-Descan Road Gravel Inventory. Report to BC. Ministry of Energy and Mines, Oil and Gas Initiative Branch, 14 pp.
- Thurber Engineering Ltd. 12 February 2002. Sierra-Yoyo-Descan Road Gravel Inventory. Supplementary Report to BC. Ministry of Energy and Mines, Oil and Gas Initiative Branch, 9 pp.



Note: Spectrum Digital NTS maps  
94I, 94J, 94O and 94P (Scale 1:250 000)




CLIENT:  
**NEW VENTURES BRANCH  
MINISTRY OF ENERGY AND MINES**

TITLE:	<b>GENERAL STUDY AREA LOCATON</b>
PROJECT:	<b>PROJECT OVERVIEW REPORT SIERRA-YOYO-DESAN ROAD AREA GRAVEL INVESTIGATION NORTHEASTERN BC</b>

DATE:	<b>JUNE 2003</b>
JOB #:	<b>KX04335</b>
DRAWN BY:	<b>SANDE</b>
PROJECT MGR:	<b>DDE</b>
CAD FILE:	<b>DRAFTING\KX04335\PSR\FIG1.DWG</b>
FIGURE #:	<b>FIGURE 1</b>

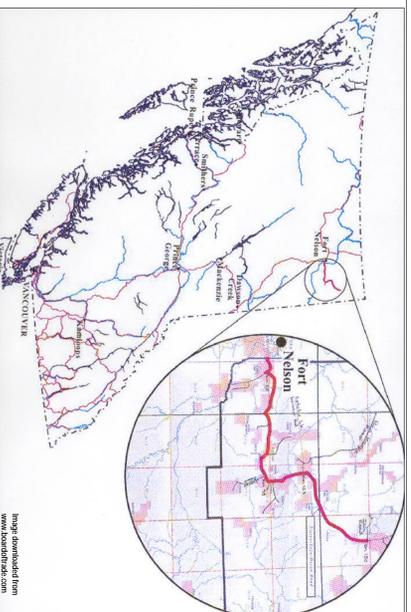


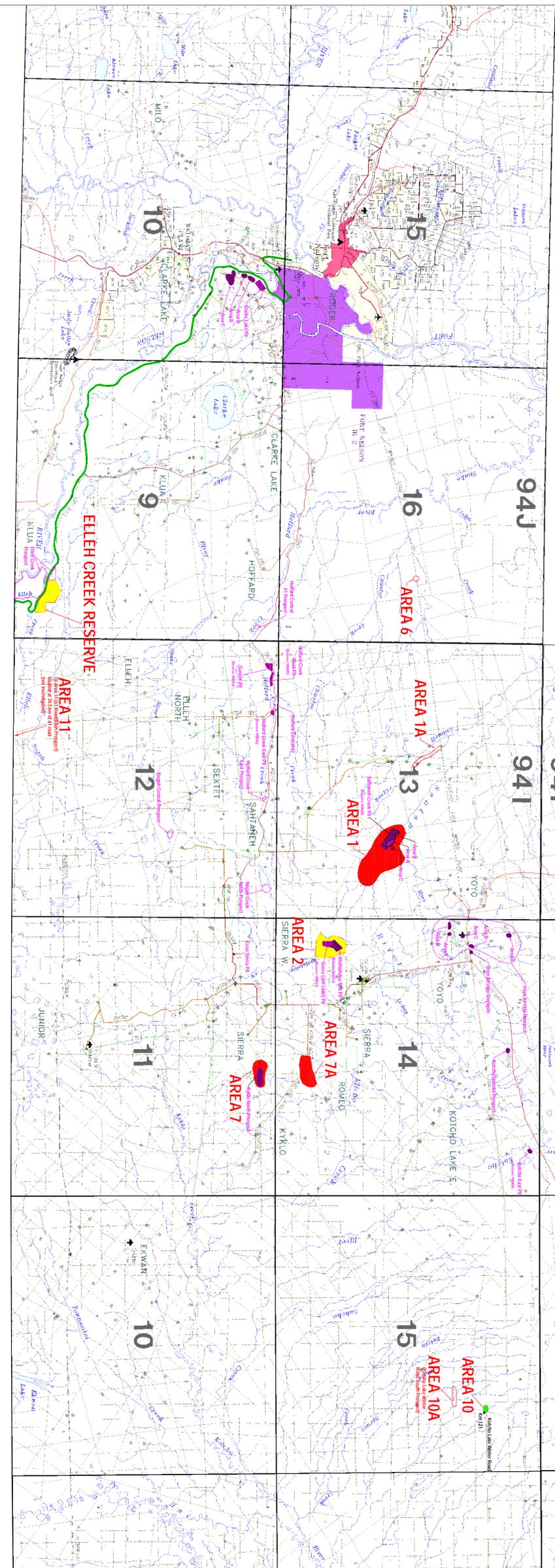
Image downloaded from [www.bornfindrds.com](http://www.bornfindrds.com)

Target Area	Location/Access	Target Material	Type of Assessment
Area 1 (Satehah River)	Access via trail from 116 of ST/OB Creek, access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 2 (Masterson Creek)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Site Reconnaissance work to determine if gravel is present.
Area 3 (Satehah River)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 2 (Development Scale) Reconnaissance work to determine if gravel is present.
Area 4 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 5 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 2 (Development Scale) Reconnaissance work to determine if gravel is present.
Area 6 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 7 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 2 (Development Scale) Reconnaissance work to determine if gravel is present.
Area 8 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 9 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 2 (Development Scale) Reconnaissance work to determine if gravel is present.
Area 10 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 1 (Reconnaissance) with limited reporting
Area 11 (Hornhead Tower Hill)	Access via trail from 116 of ST/OB Creek, located on the west side of the road.	Gravel	Level 2 (Development Scale) Reconnaissance work to determine if gravel is present.

Target Area	Level of Investigation	General Findings
Area 1 (Satehah River)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 2 (Masterson Creek)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 3 (Satehah River)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 4 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 5 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 6 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 7 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 8 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 9 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 10 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.
Area 11 (Hornhead Tower Hill)	Reconnaissance	Gravel was found in the area. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.

**LEGEND:**  
**PREVIOUS WORK:**  
 Unassessed prospect or no information available  
 Not assessed area with greater than 2500m of granular material  
 Assessed pit on less than 2500m of granular material  
**MECS WORK:**  
 Material encountered  
 Significant material encountered in reconnaissance gravel investigation (refer to adjacent table)  
 No granular material encountered  
 Not investigated

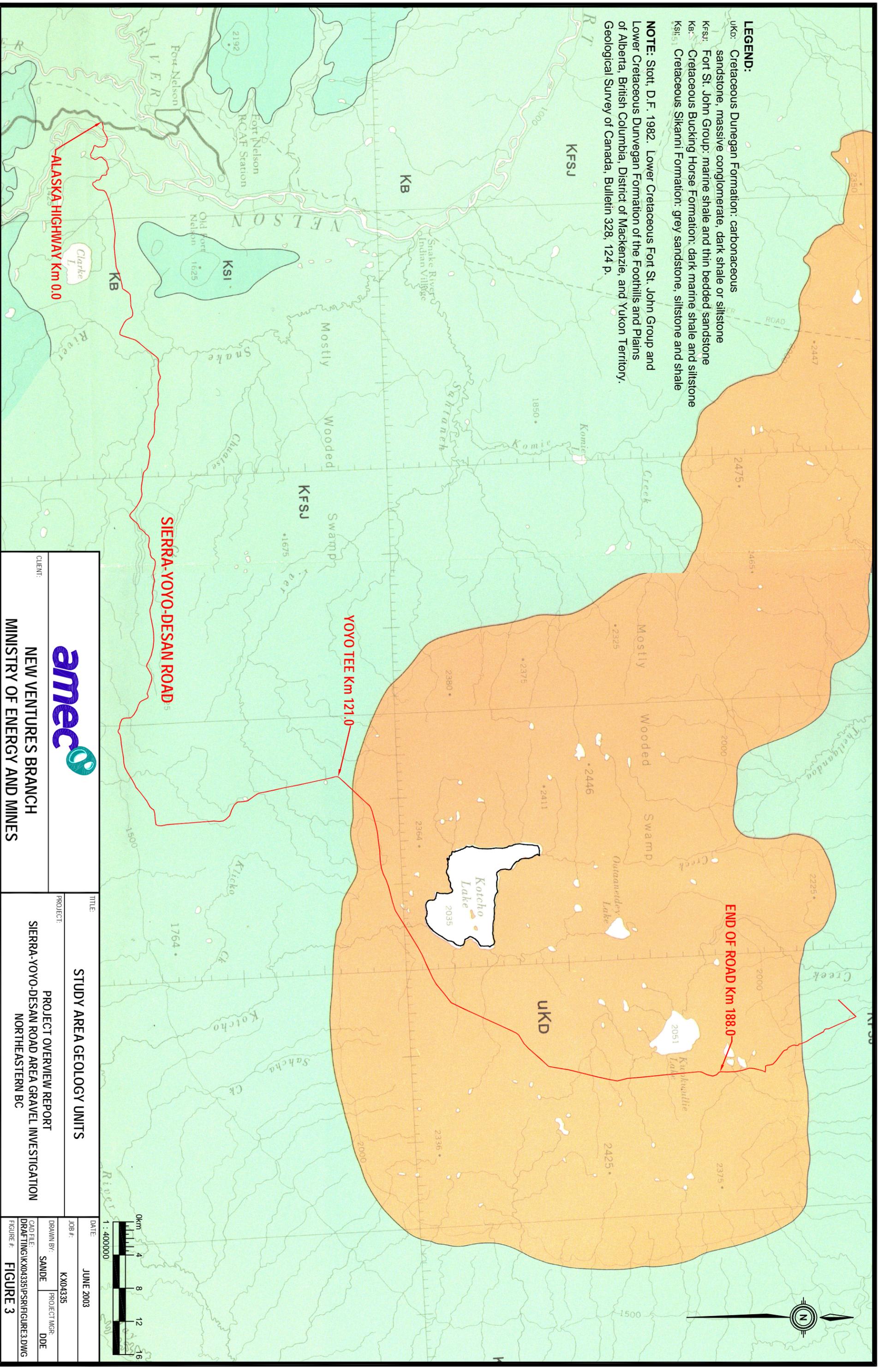
**Investigation Findings:**  
 The investigation findings are summarized in the table below. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade. The gravel is of a medium to coarse grade.



**LEGEND:**

- UKD: Cretaceous Dunegan Formation: carbonaceous sandstone, massive conglomerate, dark shale or siltstone
- KFSJ: Fort St. John Group: marine shale and thin bedded sandstone
- KB: Cretaceous Bucking Horse Formation: dark marine shale and siltstone
- KSI: Cretaceous Sikanni Formation: grey sandstone, siltstone and shale

**NOTE:** Stott, D.F. 1982. Lower Cretaceous Fort St. John Group and Lower Cretaceous Dunvegan Formation of the Foothills and Plains of Alberta, British Columbia, District of Mackenzie, and Yukon Territory. Geological Survey of Canada, Bulletin 328, 124 p.



CLIENT:  
**NEW VENTURES BRANCH**  
**MINISTRY OF ENERGY AND MINES**

TITLE:  
**STUDY AREA GEOLOGY UNITS**

PROJECT:  
**PROJECT OVERVIEW REPORT**  
**SIERRA-YOYO-DESAN ROAD AREA GRAVEL INVESTIGATION**  
 NORTHEASTERN BC

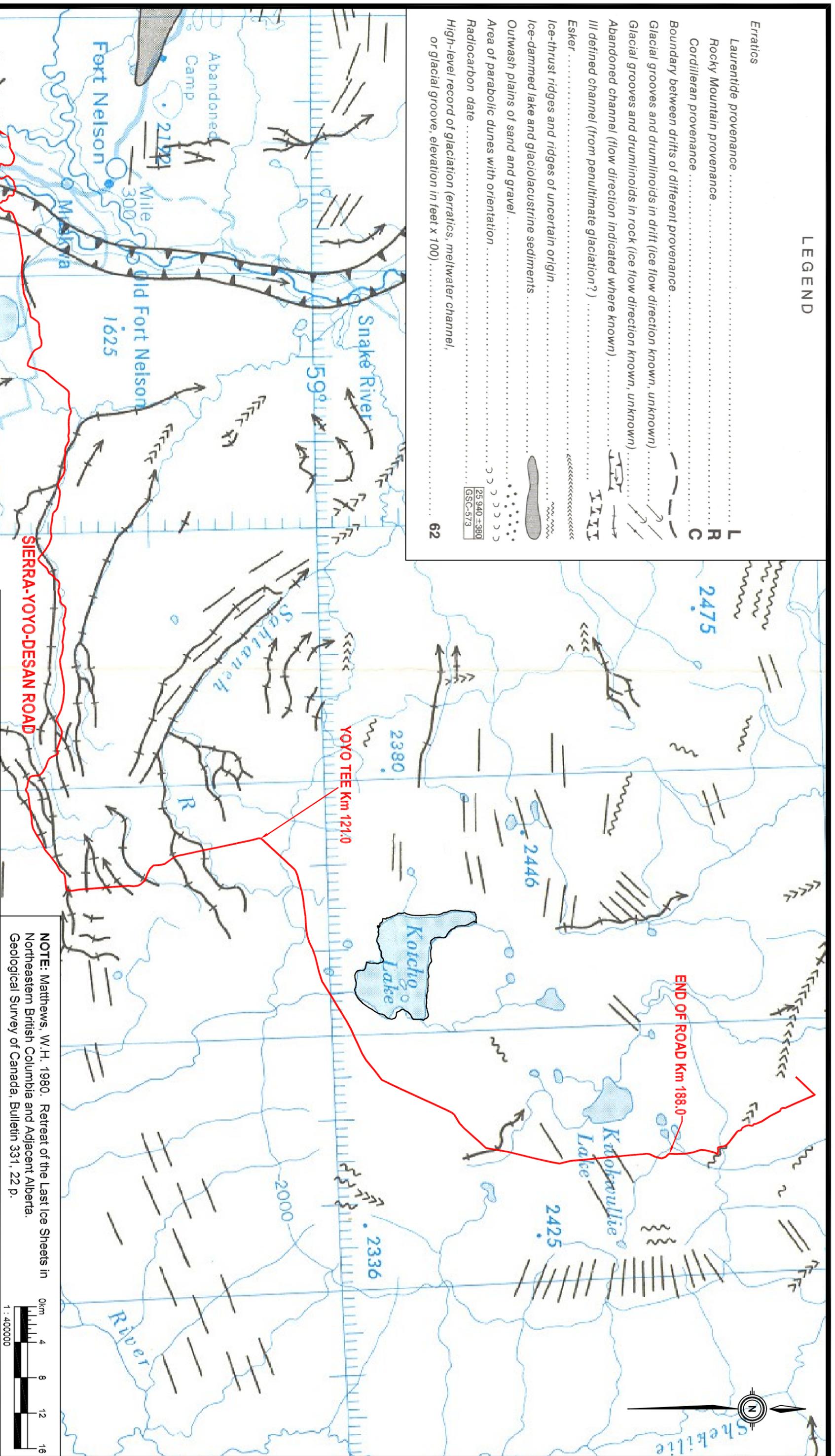
DATE: **JUNE 2003**  
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 FIGURE #: **FIGURE 3**

**LEGEND**

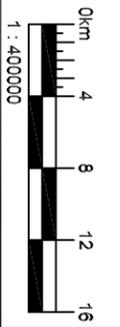
- Erratics
- Laurentide provenance .....
- Rocky Mountain provenance .....
- Cordilleran provenance .....
- Boundary between drifts of different provenance .....
- Glacial grooves and drumlinoids in drift (ice flow direction known, unknown) .....
- Glacial grooves and drumlinoids in rock (ice flow direction known, unknown) .....
- Abandoned channel (flow direction indicated where known) .....
- Ill defined channel (from penultimate glaciation?) .....
- Esker .....
- Ice-thrust ridges and ridges of uncertain origin .....
- Ice-dammed lake and glaciolacustrine sediments .....
- Outwash plains of sand and gravel .....
- Area of parabolic dunes with orientation .....
- Radiocarbon date .....
- High-level record of glaciation (erratics, meltwater channel, or glacial groove, elevation in feet x 100) .....

25 940 ± 380  
GSC-573

62



**NOTE:** Matthews, W.H. 1980. Retreat of the Last Ice Sheets in Northeastern British Columbia and Adjacent Alberta. Geological Survey of Canada, Bulletin 331, 22 p.



<b>NEW VENTURES BRANCH</b> <b>MINISTRY OF ENERGY AND MINES</b>	
<p>CLIENT:</p>	<p>TITLE:</p>
<p>PROJECT:</p>	<p>DATE:</p>
<p>PROJECT OVERVIEW REPORT</p> <p>SIERRA-YOYO-DESAN ROAD AREA GRAVEL INVESTIGATION</p> <p>NORTHEASTERN BC</p>	<p>JUNE 2003</p>
<p>DRAWN BY: SANDE</p> <p>CAD FILE: DRAFTING\KX04335\PSR\FIGURE4.DWG</p> <p>FIGURE #: <b>FIGURE 4</b></p>	<p>JOB #:</p> <p>PROJECT MGR:</p> <p>DDE</p>

**Appendix B: Sierra-Yoyo Desan Road Area – Previous Granular Resource Studies and Potential Prospects**

Name	Map	Location	Status	Details
Area 1: Sahtaneh Creek Pit (Reserve 998008) aka. Sahtaneh Creek Terrace and Sahtaneh River Pit	94 I/13 E001	4 separate areas along Sahtaneh River north of its confluence with Moss Creek.  Access from approximately km 13 of the South Gunnel Highgrade Road	Active area of granular extraction. Thurber (2002) estimated that 306 000 m <sup>3</sup> of granular material remained within the reserve.  Note refer to AMEC (2003f) for the results of AMEC's gravel investigation	<p>In 1984 the MoT had a resistivity study conducted in the Sahtaneh Creek area. The results were used to target areas for the granular resource study conducted by Harrison (1985, MoT internal memo). Harrison reported that the material in the study area (divided into 3 areas: A, B and C) had soils test results of:</p> <p><u>Material Gradation:</u> Oversize: 1% Gravel: 21-32% Sand: 61-73% Fines*: 4-6%  <u>Sand Equivalent:</u> 29-58  <u>Degrade Factor:</u> 20 –36  <u>Magnesium Sulphate:</u> coarse: 5.8% / fine 9.9%  <u>Fracture:</u> count: 44-64%/ mass: 28-57% (typically 52-57)</p> <p>Petrographic analysis conducted on one sample indicated that the crushed material (19.5 mm to 9.5 mm) consisted of 40% sedimentary, 15% metamorphic and 45% igneous rock. The quality was rated as 48% good, 36% fair, 15% poor and 1% deleterious.</p> <p>Within Area A, it was determined that there was 57,000m<sup>3</sup> of potential granular material generally suitable for surfacing aggregate and/or winter sand. No volumes were given for Area B or Area C due to the minimal amounts of granular material encountered in each area.</p> <p>Thony (1989, MoT internal memo) reported the following additional testing results:</p> <p><u>Material Gradation:</u> well graded sandy gravel with 7% fines  <u>Sand Equivalent:</u> 61 (average of two tests)  <u>Degrade Factor:</u> 16 (average of two tests)  <u>Fracture:</u> 80%</p> <p>There was a 1999 Notice of establishment in the file. The area for the reserve essentially expanded the previous area assessed for the Sahtaneh Creek Pit. Note that in previous documents the area is also referred to as the "Sahtaneh River Pit"</p> <p>Testing data from 1988 within the MoT file indicates that soil samples taken from stockpiles had:</p> <p><u>Material Gradation:</u> Oversize: none reported, Gravel: 46-52%, Sand 41-46%, Fines*: 7-8%  <u>Sand Equivalent:</u> 40  <u>Degrade Factor:</u> 19</p> <p>Note that there were no test pit/sample location plans or test pit logs in the file.</p> <p>Additional information in the files includes a letter from McElhanney Consultants to Doug Cobbett (a local trapper) indicating that AEC Oil &amp; Gas Co. Ltd. intends develop a 175 m by 265 m gravel pit within the New Sahtaneh Creek Pit area.</p> <p>Thurber (2002) conducted a reconnaissance level granular resource study (inferred by AMEC due to spacing of test pits). As part of the study, Thurber (2002) estimated that 306 000 m<sup>3</sup> of gravel remained within the reserve.</p>

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details
Area 2: Sierra (Jim Little) Pit (Reserve 988023)	94 I/14 004	6 km west of km 107 along SYD Road, Metlandoa Creek area	Area of previous granular extraction, pit appears to be depleted as reported by Thurber (2002)  Refer to AMEC (2003f) for results of AMEC's gravel investigation	In a MoT internal file report, Lacmuth (1988) detailed materials testing results to determine if material samples from pit would be suitable for high fines surfacing aggregate.  Test results included: <u>Material Gradation:</u> Oversize: None reported Gravel: 55-70% Sand: 24-28% Fines (silt and clay): 8-16% <u>Sand Equivalent:</u> 36-48 <u>Degrade Factors:</u> 17.0 -25.1 <u>Various crusher tests:</u> 65-75% fracture  It was noted that material from the pit may be adequate for surfacing aggregates, but degrade test results did not meet minimum requirements as typically expected for material in the general study area.  A more detailed aggregate investigation was recommended by Polysou (1998).  Thurber (2002) reported that the reserve area appeared to be depleted based on a granular resource study around the existing areas of granular extraction within the reserve boundaries.
Area 2: Jim Little NOI (aka. Metlandoa NOI Pit) (Reserve 988011)	94 I/14 W005	6 km west of km 107 along SYD Road, Metlandoa Creek	Granular resource study conducted and <u>not</u> considered a potential source for granular material by Thurber (2002)  Refer to AMEC (2003f) for results of AMEC's gravel investigation	1999 Request of Notation of Interest (NOI) was included in the MoT files. The proposed area was located north of the existing Sierra (Jim Little) Pit. Note that in some files the NOI is referred to as the "Metlandoa NOI".  Thurber (2002) reported that the reserve area appeared to contain only minor pockets of gravel in poorly drained areas. Therefore, Thurber considered there to be no potential for granular extraction in Reserve 988011.
Area 3: Sahdoanah Creek Pit Reserve 998005	94 P/2 N/E	West of km 174 of SYD Road	Active area of granular extraction. Thurber (2001) estimated that 145 000 m <sup>3</sup> remained within the reserve  Refer to AMEC (2003f) for results of AMEC's gravel investigation	There was no MoT file available for the Sahdoanah Creek Pit, but information in a memo by Davidson (1984, MoT internal memo) indicated that the material encountered in the pit was silt, silty sand, sand and a small amount (2000 m <sup>3</sup> ) of fine gravel. Davidson (1984, MoT internal memo) additionally noted that there was a water table noted at approximately 2 m below the ground surface.  Thurber (2001) noted that an existing pit runs through the northern portion of the reserve along the SYD Road. Thurber (2001) also reported on the results of a granular resource study which indicated that there was approximately 145 000 m <sup>3</sup> of granular material remaining within the reserve. Note that based on the limited materials testing, it appeared that the material was predominantly sand and contained 10 to 15 percent fines.
Area 5: Poco Pit (Reserve 018007) (including the existing Petrocan Pit)	94 P/4 E002	km 29 along Cabin Lake Road at the Courvoisier Creek Crossing	Area of active granular extraction with potential for further granular extraction  Refer to AMEC (2003f) for results of AMEC's gravel investigation	There was a site location plan and test pit plan located in the MoT files. No other geotechnical information was present in the file. The work and filing appeared to be supervised by Mr. Tom Deevy, P.Geo, P.Eng. In a phone interview with Mr. Deevy, he stated that a lense of clean material consisting of sand and gravel suitable for road surfacing material was proved during the investigation.  The study area includes the existing Petrocan Pit. No file information was available on Petrocan Pit within the file.  Additionally, an archaeological inventory and impact assessment was included in the file for the proposed Poco Pit. The study was conducted by I.R. Wilson Consultants Ltd. in October 2001 for the MoT. No archaeological sites or cultural materials were identified in the report.
Area 5: Unnamed Courvoisier Creek Pit	94 P/4	Located along abandoned portion of Cabin Lake Winter Road on north side of Courvoisier Creek	Depleted Pit  Refer to AMEC (2003f) for results of AMEC's gravel investigation	No information available in MoT Files  Based on a site review conducted by AMEC, it appeared that the area was originally a thin (1 to 2 m thick) glaciofluvial deposit that had been mined.

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details
Area 7: Kyklo North Prospect	94 I/11 E001	4.7 km east of km 103 along SYD Road	<p>Area has not been developed, as per discussions with Gerry Hoffman of MoT</p> <p>Refer to AMEC (2003f) for results of AMEC's gravel investigation</p>	<p>Harbicht (1989, MoT internal memo) summarized the findings of a granular resource study conducted on a series of esker-like ridges, kames and terrace like-features in the Kyklo Creek area. The majority of soils encountered were clays (CL), but Harbicht (1989) identified two possible borrow sources:</p> <p>Area A: Approximately 40 000 m<sup>3</sup> of clayey gravel or clayey sand  Area B: Approximately 25 000 m<sup>3</sup> of gravel with some clay (15%)</p> <p>Harbicht (1989) reported the following test results:</p> <p><u>Sand Equivalent:</u> 18-27  <u>Degrade Factor:</u> 1.7-5.3  <u>Average Bulk Density:</u> 2.59-2.62  <u>Absorption:</u> 1.4-2.0%  <u>Magnesium Sulphate:</u> coarse: 5.8% / fine 11.2%</p> <p>Harbicht (1989, MoT internal memo) recommended that the material be considered for use as construction borrow and possible use as high fines surfacing aggregate given the scarcity of granular material in the general area.</p>

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details																																																																																								
Area 9: Kimea Pit (Reserve 908053)	94 P/1 W001	130 km north west of Fort Nelson and 14 km North west of North Helmut Airstrip	Active area of granular extraction. Thurber (2001) estimated that 2 140 000 m <sup>3</sup> remain within the reserve  Refer to AMEC (2003b) for the results of a Level 2 Gravel investigation	<p>Beeson (1985 and 1985a) detailed the results of a granular resource study conducted following a resistivity survey of the general study area. The study area was divided into 3 areas based on material gradations following the excavation of 48 test pits. Area A was located in the northwestern portion of the study area, Area B was located in the southeastern portion of the study area and Area C was located in the in the northeastern portion of the study area. Laboratory test results are summarized below:</p> <table border="1"> <thead> <tr> <th></th> <th>Area A</th> <th>Area B</th> <th>Area C</th> </tr> </thead> <tbody> <tr> <td><u>Volume of Granular Material</u></td> <td>100 000 m<sup>3</sup></td> <td>50 000 m<sup>3</sup></td> <td>485 000 m<sup>3</sup></td> </tr> <tr> <td colspan="4"><u>Material Gradation</u></td> </tr> <tr> <td>Oversize</td> <td>16%</td> <td>26%</td> <td>9%</td> </tr> <tr> <td>Gravel</td> <td>41%</td> <td>34%</td> <td>26%</td> </tr> <tr> <td>Sand</td> <td>40%</td> <td>36%</td> <td>60%</td> </tr> <tr> <td>Fines (Silt and Clay)</td> <td>3%</td> <td>4%</td> <td>5%</td> </tr> <tr> <td colspan="4"><u>Aggregate Quality Test Results</u></td> </tr> <tr> <td>Sand Equivalent</td> <td>41-76</td> <td>26-41</td> <td>20-59</td> </tr> <tr> <td>Degrade Factors</td> <td>27-41</td> <td>30-41</td> <td>30-37</td> </tr> <tr> <td>Magnesium Sulphate (coarse/fine)*</td> <td>3.5/9.7</td> <td>na</td> <td>na</td> </tr> <tr> <td>Bulk Relative Density (coarse/fine)*</td> <td>2.64/2.62</td> <td>2.63/2.62</td> <td>na</td> </tr> <tr> <td>Absorption (coarse/fine)*</td> <td>1.12/1.28</td> <td>1.77/1.94</td> <td>na</td> </tr> <tr> <td>Fracture (count/mass)</td> <td>na</td> <td>76/76</td> <td>na</td> </tr> <tr> <td colspan="4"><u>Petrographic Composition</u></td> </tr> <tr> <td>Sedimentary</td> <td>29%</td> <td>32%</td> <td>na</td> </tr> <tr> <td>Metamorphic</td> <td>26%</td> <td>37%</td> <td>na</td> </tr> <tr> <td>Igneous</td> <td>35%</td> <td>31%</td> <td>na</td> </tr> <tr> <td>Good</td> <td>38%</td> <td>40%</td> <td>na</td> </tr> <tr> <td>Fair</td> <td>62%</td> <td>60%</td> <td>na</td> </tr> <tr> <td>Poor</td> <td>0.2</td> <td>0</td> <td>na</td> </tr> <tr> <td>Deleterious</td> <td>0</td> <td>0</td> <td>na</td> </tr> </tbody> </table> <p>Based on the gradations and laboratory testing, Beeson (1985) stated that with processing (where applicable) the material would be suitable for:</p> <p><u>Area A and B:</u> 50 mm and 25 mm well graded base, select granular subbase  <u>Area C:</u> 25 mm well graded base, select granular subbase, winter sand</p> <p>Following the granular resource study the pit was developed. Subsequent laboratory testing of a stockpile present in the pit indicated the material had:</p> <p><u>Average Material Gradation:</u> Oversize: none reported, Gravel: 52-63% Sand: 31-38% Fines*: 7-10%  <u>Sand Equivalent:</u> 57  <u>Degrade Factor:</u> 39</p> <p>In the letter of June 23, 1999, the MoT requested that the Kimea Pit reserve be expanded to include additional areas, primarily east of the existing pit.</p> <p>Thurber (2001) reported on the results of a granular resource study which indicated that there was approximately 2 140 000 m<sup>3</sup> of granular material remaining within the reserve.</p>		Area A	Area B	Area C	<u>Volume of Granular Material</u>	100 000 m <sup>3</sup>	50 000 m <sup>3</sup>	485 000 m <sup>3</sup>	<u>Material Gradation</u>				Oversize	16%	26%	9%	Gravel	41%	34%	26%	Sand	40%	36%	60%	Fines (Silt and Clay)	3%	4%	5%	<u>Aggregate Quality Test Results</u>				Sand Equivalent	41-76	26-41	20-59	Degrade Factors	27-41	30-41	30-37	Magnesium Sulphate (coarse/fine)*	3.5/9.7	na	na	Bulk Relative Density (coarse/fine)*	2.64/2.62	2.63/2.62	na	Absorption (coarse/fine)*	1.12/1.28	1.77/1.94	na	Fracture (count/mass)	na	76/76	na	<u>Petrographic Composition</u>				Sedimentary	29%	32%	na	Metamorphic	26%	37%	na	Igneous	35%	31%	na	Good	38%	40%	na	Fair	62%	60%	na	Poor	0.2	0	na	Deleterious	0	0	na
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Name	Map	Location	Status	Details
Area 10: Kotcho Lake Winter Road Prospect which is (Kotcho East)	94 I/15	km 121 of the Kotcho Lake Winter Road	Area where gravel was reported in Encana seismic drill holes  Refer to AMEC (2003c) for the results AMEC's Gravel Investigation	Area was in a cutblock along the Kotcho Lake Winter Road. Area was located along seismic line 77122 holes 638 to 653. EnCana reported 2 m of silt and clay overlying 5 m of gravel (to the full depth explored in the borehole).
Area 10A: Kotcho Lake Winter Road South Prospect	94 I/15	Located south of the Kotcho Lake Road on a seismic line accessed at km 13 of the "Cut Across" Winter Road	Area where gravel was reported in Encana seismic drill holes	Area is accessed via a seismic line. Area was located along seismic line 77123 holes 500 to 533 and 566 to 575. EnCana reported 2 m of silt and clay overlying 5 m of gravel (to the full depth explored in the borehole).
Area 11: 61 Road/Elleh Creek Prospect	94 I/05	km 34.5 of the 61 Road near well B95-L/94-I-05	Area of granular potential based on reports from equipment operators	Representatives of Kledo Construction and EnCana reported that while scouting for sites for a remote sump, gravel was encountered in the area around km 34.5 of the 61 Road (located off of km 61 of the SYD Road) in test pits dug by an excavator. It was reported that the gravel below the topsoil was up to 16 feet (4.9 m) deep. A water table was reported at approximately 8 feet (2.4 m) deep in the test pits.
Elleh Creek Reserve	94J/9	km 34 to 38 of the Elleh Road accessed via km 25 of the SYD Road	Area of existing gravel pits adjacent to the BCR railway tracks	Area of active granular extraction from 3 pits adjacent to the BCR railway tracks. As a separate assignment to this study, AMEC conducted a detailed granular resource study of the area. The results of the study are summarized in the main report accompanying this table.
Elleh Creek Prospect	94J/9	km 34 to 38 of the Elleh Road accessed via km 25 of the SYD Road	Area south and west of Elleh Creek Reserve	Prospect was delimited based on a visual review of terrain south and west of existing Elleh Creek Reserve.
Burlington/Poco Pit	94 P/5	km 43.1 of the Komie Highgrade Road	Area of active granular extraction approximately 200 by 300 m with a stock pile present.	No records were available. Representatives from Kledo Construction stated that material in stockpiles was crushed material, maximum size was approximately 75 mm.

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details
Clarke Lake Pit	94J/10 004	15 km South East of Fort Nelson along Clarke Lake Road	Active area of granular extraction. Pit is depleted as reported by Benke (2002, MoT internal memo).	<p>Monkman (1986, MoT internal memo) presented the results of a granular resource study conducted in and around the existing Clarke Lake Pit. As part of the study, 4 test holes up to 9.1 m depth were drilled in the based on the existing pit and 39 test pits up to 5.6 m depth were dug around the perimeter of the existing pit.</p> <p>Results of the drilling indicated that there was a shallow water table below the base of the existing pit (0.2 to 1.2 m below ground surface). Water encountered in only two of the test pits at 3.0 m depth.</p> <p>Soils encountered were approximately 0.9 m of overburden overlying either a fine sand or gravel. Testing results are summarized below:</p> <p><u>SAND (330 000m<sup>3</sup>)</u></p> <p><u>Average Material Gradation:</u> Oversize: None reported, Gravel: 1 %, Sand: 97%, Fines*: 2%  <u>Possible Uses:</u> sand blanket or granular borrow</p> <p><u>GRAVEL ( 130 000m<sup>3</sup>)</u></p> <p><u>Average Material Gradation:</u> Oversize: 8%, Gravel: 55% Sand: 34% Fines: 3%  <u>Average Sand Equivalent:</u> 57  <u>Average Degrade Factor:</u> 39  <u>Average Durability Index:</u> 59  <u>Magnesium Sulphate Test:</u> coarse: 7.5 / fine 10.5  <u>Average Bulk Density:</u> coarse 2.6 / fine 2.6  <u>Absorption:</u> coarse 1.5% / fine 1.6%  <u>Fracture:</u> coarse 42% / fine 63%  <u>Possible uses:</u> select granular subbase, embankment fill, winter sand (with screening), 25 mm well graded base and medium asphalt mix.</p> <p>Monkman (1986, MoT internal memo) in a clarification memo noted that the sand and gravel could be mixed to produce select granular subbase, embankment fill and winter sand. Additionally, Monkman (1986, MoT internal memo) noted that the production of 25 mm medium asphalt mix would require specialized crushing, blending and/or processing.</p> <p>Benke (2002, MoT internal memo), reported on the results of a granular resource study to determine if there were any areas of additional granular resources. Forty-eight test pits were excavated in three areas (Sites A, B and C) located south of the existing Clarke Lake Pit. Soils encountered in the majority of test pits were a clay-rich basal till with the occasional area of clean fine sand with no gravel. Based on the results of the test pitting program, Benke (2002, MoT internal memo) concluded that there was no granular potential in any of the areas tested. These areas are roughly shown on the key plan.</p>
Esso-Sierra Pit	94 I/11 W001	3 km west of the intersection of the SYD Road and the PDR 58 road (Sierra Junior Road)	Gerry Hoffman of MoT indicated that the Pit had most likely been depleted.	<p>The file contained mainly paperwork dealing with the transfer of the gravel pit from Imperial Oil to the MoT. Laboratory test results from 1984 indicated that samples taken from the Esso-Sierra Pit had the following properties:</p> <p><u>Material Gradation:</u> Oversize: None reported, Gravel: 36-42%, Sand: 50-63%, Fines: 2-8%  <u>Sand Equivalent:</u> 34  <u>Degrade Factor:</u> 4  <u>Average Bulk Density:</u> 2.58-2.60  <u>Absorption:</u> 1.4-1.6%</p> <p>Note that test pitting site plans were not included in the file.</p>

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details
Gunnell Pit (Reserve 908054)	94 I/12 W001	km 55 along the SYD Road between the road and Hoffard Creek  Note that Gunnell Creek was not in the general vicinity of the of the pit, which was located adjacent to Hoffard Creek	Depleted area of previous granular extraction as stated by Thurber (2001)	Laboratory test results in MoT internal files from 1984 included within the file for samples taken from the working face of Gunnell Pit are summarized below:  <u>Material Gradation:</u> Oversize: Not reported, Gravel: 28-38%, Sand: 54-67%, Fines: 2-8% <u>Sand Equivalent:</u> 39 <u>Degrade Factors:</u> 15 <u>Average Bulk Density:</u> 2.57-2.59 <u>Absorption:</u> 1.1-1.4%  Note that there were no detailed site plans or reports included within the file. A granular resource study conducted by Thurber (2001) indicated that Gunnell Pit had been depleted.
Geodetic Kame Pit	94 P/7 F/93	General area southwest of Kah Lake and south of Kah Creek	It was determined that there were no suitable granular material within the reserve.	Four areas: the Geodetic Kame, Kah Creek drumlin, Kah Creek Ridge and Kah Creek Knob were assessed in 1984. It appeared that two test pits were excavated in each area. Based on the site plan sketches and limited soil testing results it appears that soils within these areas were either silt and clay or fine grained sand with trace gravel (<5%) and trace to some silt (10%).
Hoffard Central #1 Prospect	94 J/9 001	10 km west of the intersection of the SYD Road and PDR 181, south of the SYD road on the south side of Hoffard Creek	Prospect	No information was present in the file, with the exception of a site location plan.
Hoffard Central #2 Prospect	94 I/12 W002	South side of Hoffard Creek south of the SYD Road 1km west of turn off to PDR 158 Road	Prospect	No information in file other than prospect location.
Hoffard Creek East Prospect	94 I/12	South side of Hoffard Creek (refer to location map)		The prospect was located on the MoT key map, but no file information was available.
Hoffard Creek East Pit (Reserve 998006)	94 I/12 W004	Located southwest of the junction of the SYD Road and PDR 158 on the north side of Hoffard Creek.	Active area of granular extraction. Thurber (2001) estimated that 20 000 m <sup>3</sup> remained within the reserve.	There was a 1999 notice of establishment included in the file with a site plan. No additional information was provided.  Thurber (2001) reported that the reserve area appeared to be nearly depleted based on a granular resource study around the existing areas of granular extraction within the reserve boundaries. Thurber (2001) reported that 20 000 m <sup>3</sup> of granular material remained in the pit. It was noted that there was a potential for more gravel to the east.  Note that there appears to be an additional "Hoffard Creek East Prospect" located 10 km east of the intersection of the SYD Road and PDR 158 (mapsheet 94I/12E 001). The prospect is shown on the MoT key location map, but no information was available in the MoT files.
Hoffard Creek West (Reserve 998009)	94 I/12 W003	Located between Hoffard Creek (to the south) and the SYD Road (to the North) approximately 5 km west of turn off to PDR 158 Road	Active area of granular extraction. Thurber (2001) estimated that 15 000 m <sup>3</sup> remained within the reserve	The file contained a 1999 Notice of Establishment (NOE) for the Section 16 Map Reserve.  Thurber (2001) reported that the reserve area appeared to be nearly depleted, based on a granular resource study around the existing areas of granular extraction within the reserve boundaries. Thurber (2001) reported that the remaining gravel was located in the northwest portion of the reserve.
Kimea West Prospect	94 P/11	Approximately km 20 of the Wildboy access road between Yeka Lake and Kimea Creek	Area reported to have granular material	Based on information provided by others, it appeared that an existing petroleum plant in the area was built on a glaciofluvial deposit along Kimea Creek. The general area around the plant was interpreted by Blyth et. al. (2003), to have a high potential for encountering gravel. Note that it was reported that many additional areas of granular extraction are evident along the north side of Kimea Creek in the vicinity of the Kimea West Prospect.

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details
Kotcho Drumlin	94 I/14 W003	Approximately 1 km south of km 130 of the SYD Road.	It was determined that there were no suitable granular materials within the reserve.	Soils encountered in two test holes drilled in the area in 1984 referred to as the "Kotcho Drumlin" were high plastic silt and clay with a trace sand.
Kotcho East Pit (Reserve 998004)	94 I/14 E001	South of the SYD Road on the east side of the Kotcho River.	Granular resource study conducted and <u>not</u> considered a potential source for granular material by Thurber (2001)	The file contained a 1999 Notice of Establishment (NOE) for a Section 16 Map Reserve for the Kotcho East Pit.  Thurber (2001) reported that the reserve area appeared to not contain granular resources based on the results of a detailed granular resource study.
Nogah Creek North Prospect	94 I/12 E003	Nogah Creek north of the SYD Road	Prospect	No information was presented in the files other than a prospect location map. It should be noted that the site was also referred to as Mollard #37 and #38 from the overview study performed by Mollard (1984b).
Nogah Central Prospect	94 I/12 E002	Nogah Creek south of the SYD Road	Prospect	
North Helmut Airstrip Pit Prospect (a.k.a. Mollard 57 Prospect)	94 P/10 W001	Adjacent to the south end of the North Helmut Airstrip	Area of limited granular potential (less than 7000 m <sup>3</sup> ). There are no records in MoT files to indicate whether the prospect had been mined.	Following a resistivity survey, a granular resource study was conducted in an area south of the North Helmut Airstrip on an esker-like ridge. Eighteen test pits were excavated with a backhoe. Beeson (1985, MoT internal Report) reported that approximately 7 000 m <sup>3</sup> of gravelly sand and sandy gravel with a trace sand. Based on the limited quantities available, Beeson (1985, MoT internal Report) recommended that the potential source area only be considered for local projects. Beeson (1985, MoT internal Report) stated that the material appeared to be suitable for use as: pit run surfacing aggregate and with selective extraction, as select granular subbase and 25 mm well graded base.  Lab testing results are summarized below:  <u>Material Gradation:</u> Oversize: None, Gravel: 52-46% Sand: 42-50% Fines*: 2-7% <u>Sand Equivalent:</u> 31 <u>Degrade Factor:</u> 0.2 to 0.5 (note tha clay lumps were included in testing) <u>Durability Index:</u> 27 <u>Average Bulk Density:</u> 2.50-2.58 <u>Absorption:</u> 1.55 -2.85%
Quintana Prospect	94 P/7 W002	4.5 km northwest of North Helmut Airstrip	It was determined that there were no suitable granular materials onsite.	Beeson (1985, MoT internal report) detailed the results of a granular resource study conducted in the Quintana Prospect. Five test pits were excavated with a backhoe in areas determined to have the potential for granular deposits following a resistivity survey. It was determined that approximately 20 000 m <sup>3</sup> of fine sand with trace silt was available in the prospect. Beeson (1985, MoT internal Report) noted that the sand was not suitable for use as winter sand, but could be used as a sand blanket separator layer.  Laboratory testing results indicated the soil was 1-17% gravel, 76-92% sand and 7% fines and had a sand equivalent of 37.
Reserve 998038 (in the MoT Geodetic Kame Pit File, but located in area other than the original Geodetic Kame Pit)	94 P/7 E001	South of PDR 36 near intersection of PDR 36 and PDR 37.	Active pit. Thurber (2001) estimated that approximately 75 000 m <sup>3</sup> remain within the reserve.	The MoT file contained a notice of establishment for Reserve 988038. There was no other information in MoT files available regarding the reserve.  Thurber (2001) conducted a granular resource study in an area reported to be an esker and ice thrust deposit. Thurber (2001) estimated that there was approximately 75 000 m <sup>3</sup> of sand and gravel containing less than 25% fines remaining within the reserve.

\* Silt and clay material passing the 200 mm sieve.

Name	Map	Location	Status	Details
West Coast Pit (Reserve 812622)	94 P/5	km 43.4 (Site 1) and 44.5 (Site 2) of the Komie Highgrade Road	Two areas of active granular extraction both 100 by 300 m in size. Stockpiles of crushed material in each pit	No records were available for the pit.
Yoyo Airstrip Prospect	94 I/14 W002	9.5 km northwest of confluence of Sahtaneh River and Lichen Ck. Site accessed via the Cabin Winter Road	It was determined that there were no suitable granular materials onsite.	Davidson (1985, MoT internal memo) reported that a resistivity survey was conducted to target areas of potential granular resources within the study area. Four test pits were excavated within the target areas. Soils excavated were a mixture of silt and clay with localized sand deposits.  Note that the site locations shown for the Yoyo Airstrip Prospect are taken directly from the MoT gravel source map and do not match the information presented in the file. Specifically, there were 4 sites in the file (A to D) and 5 sites (A to E) are shown on the map.
Yoyo Junction Stockpile (Reserve 908052)	94 I/14 W001	West of Yoyo-Helmut Road Intersection	Stockpile, material has since been used	The file contained a notice of continuation for use of the stockpile written in 1992.  It appears that the material in the stockpile was hauled to the site from the Sahtaneh Creek Pit in the winter of 1984/1985, based on a letter by Bowes (1986, MoT internal Files).

\* Silt and clay material passing the 200 mm sieve.