



Kiggavik Project Environmental Impact Statement

Tier 3 Technical Appendix 2F

Conceptual Design for Andrew Lake Pit Dewatering Structure



March 16, 2011

REPORT ON

Conceptual Design for Andrew Lake Pit Dewatering Structure, Kiggavik Project

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REPORT



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1.0 INTRODUCTION

1.1 Purpose and Scope

AREVA Resources Canada Inc. (AREVA) is preparing an initial feasibility study for the Kiggavik Project in Nunavut. The proposed Kiggavik Project includes mining development at the Kiggavik and Sissons sites. Figure 1 presents a general site location plan showing the Kiggavik and Sissons sites, which are located approximately 80 to 90 km west of the community of Baker Lake.

At the Sissons site, AREVA proposes to develop the Andrew Lake open pit. Figure 2 presents a site plan for the Sissons site showing the Andrew Lake pit limit. The south west portion of this pit extends into Andrew Lake and a structure is required to allow this end of the lake to be dewatered for the proposed pit development. AREVA requested that Golder Associates Ltd. (Golder) undertake an investigation to characterize the Andrew Lake lakebed sediments, review existing geotechnical conditions and prepare a conceptual design for the dewatering structure required to support development of the Andrew Lake Pit.

This report presents a summary of the review of existing geotechnical information for the site, the results of the lakebed sediment investigation including laboratory testing carried out in 2010, and the conceptual design of the Andrew Lake Pit dewatering structure.

The reader is referred to the Study Limitations which precede the text and forms an integral part of this report.



2.0 GEOTECHNICAL CHARACTERIZATION

Geotechnical characterization of the foundation conditions to support the conceptual design for the Andrew Lake Pit dewatering structure has been based on a review of available geotechnical information for the Sissons and Kiggavik site areas, as well as sampling and laboratory testing of lakebed sediments collected from Andrew Lake by Golder in 2010.

The data review included results from geotechnical investigations carried out in 1988, 2009 and 2010, and a report prepared by EBA Engineering Ltd. (EBA) presenting the results of a geophysical survey carried out along the north end of the Andrew Lake in 2009.

2.1 Geotechnical Investigations

A brief summary of the results of the geotechnical investigations are presented in the follow sections.

2.1.1 1988 Investigations

In 1988, geotechnical investigations were conducted at the Kiggavik site for the purpose of evaluating the subsurface conditions for waste dump foundations, overburden stripping within the open pit area and haul road design. A total of 12 shallow boreholes were drilled using a flight auger coring rig. These boreholes were logged, samples were collected and laboratory testing was carried out on 16 samples. Appendix A includes a summary of the borehole logs and laboratory test results from this investigation.

2.1.2 2009 and 2010 Investigations

In 2009, geotechnical investigations included 5 shallow test pits which were hand excavated and sampled at the Sissons site for the purpose of evaluating the suitability of the subsurface soils for use in underground paste backfill. Five deep boreholes were drilled and logged near the Andrew Lake Pit, four in 2009 and one in 2010. Figure 2 presents the locations of these shallow test pits and the boreholes. Table 2-1 presents a summary of the test pit and borehole locations. Samples collected from the test pits were sent for laboratory testing. Appendix A includes a summary of the borehole logs and laboratory testing results for the test pit samples.



Table 2-1: Summary of 2009 and 2010 Borehole and Test Pit Locations

Test Hole ID	Type	Northing (m)	Easting (m)	Depth (m)	Samples	
					From (m)	To (m)
AND09-02	Borehole	7,134,809	553,319	299	-	-
AND09-03	Borehole	7,134,574	553,312	307	-	-
END09-02	Borehole	7,135,934	554,542	487	-	-
END09-11	Borehole	7,135,895	554,602	439	-	-
AND-10-03	Borehole	7,134,733	552,678	337	-	-
END-OB-09-1	Test Pit	7,136,044	554,601	0.3	0.20	0.30
END-OB-09-2	Test Pit	7,136,018	554,754	0.3	0.20	0.30
END-OB-09-3	Test Pit	7,135,994	554,680	0.3	0.20	0.30
END-OB-09-4	Test Pit	7,135,838	554,607	0.3	0.20	0.30
END-OB-09-5A	Test Pit	7,135,932	554,636	0.3	0.05	0.25
END-OB-09-5B	Test Pit	7,135,932	554,636	0.3	0.25	0.30

2.1.3 2009 Ground Penetrating Radar Investigation

In 2009, ground penetrating radar (GPR) surveys were conducted by EBA to collect stratigraphic data at the north end of Andrew Lake on the Sissons site. The results are presented in EBA 2009 and Figure 2 presents the GPR survey lines along which data was collected in the area of the proposed dewatering structure. Two survey tracks were conducted parallel to and a series of 4 survey tracks were conducted perpendicular to the north shore of Andrew Lake.

It was noted by EBA field staff at the time of the investigation (April 2009) that ice on Andrew Lake in the area of the surveys was frozen down to the lakebed surface and that no distinct ice-water interface was observed in the radar data. The reflection amplitudes and material velocities calculated from diffraction events suggest frozen materials within the area covered by the investigation, which is consistent with that expected in areas where the lake ice freezes to the lakebed.

Summary records of GPR surveys are provided in Appendix A.

2.1.4 2010 Lakebed Sediments Investigation

In 2010, Golder undertook a lakebed sediment investigation for the purpose of characterizing the soft lakebed sediments and water depth in the area of the proposed Andrew Lake Pit dewatering structure. Working from a boat in the lake on August 17, 2010, water depths and sediment thicknesses were measured and where possible, lakebed sediment samples were collected at a total of 24 locations. Samples were returned to the Golder Burnaby laboratory and testing was undertaken on 7 of the samples collected. Figure 2 presents the test locations on the site plan.

A summary of the water depth, sediment thickness and samples collected are presented in Table 2-2. In the area of the proposed dewatering structure at the time of the survey, the lake depth ranged from 0.2 m to 0.75 m with an average depth of 0.6 m. The sediment thickness ranged from 0.05 m to 0.5 m with an average thickness of 0.3 m.



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Table 2-2: Summary of 2010 Lakebed Soundings and Sediment Sample Locations

Sounding ID	Location	Northing (m)	Easting (m)	Water Depth on August 17, 2010 (m)	Sediments Thickness ² (m)
SD01	Andrew Lake	7134728	552855	0.54	0.31
SD02	Andrew Lake	7134594	552889	0.71	0.32
SD03	Andrew Lake	7134492	552952	0.71	0.27
SD04	Andrew Lake	7134431	553008	0.68	0.54
SD05	Andrew Lake	7134381	553050	0.63	0.20
SD06 ¹	Andrew Lake	7134329	553096	0.43	0.04
SD07	Andrew Lake	7134344	553184	0.38	0.32
SD08 ¹	Andrew Lake	7134328	553199	0.21	0.17
SD09 ¹	Andrew Lake	7134338	553144	0.41	0.50
SD10 ¹	Andrew Lake	7134357	553094	0.47	0.32
SD11	Andrew Lake	7134386	553084	0.61	0.34
SD12	Andrew Lake	7134759	552864	0.42	0.04
SD13	Andrew Lake	7134716	552881	0.63	0.05
SD14	Andrew Lake	7134678	552863	0.52	0.43
SD15	Andrew Lake	7134641	552856	0.71	0.25
SD16	Andrew Lake	7134624	552875	0.58	0.38
SD17	Andrew Lake	7134613	552890	0.64	0.14
SD18	Andrew Lake	7134547	552886	0.69	0.35
SD19	Andrew Lake	7134531	552910	0.75	0.22
SD20	Andrew Lake	7134520	552934	0.62	0.35
SD21	Andrew Lake	7134459	552942	0.63	0.22
SD22	Andrew Lake	7134447	552971	0.62	0.37
SD23	Andrew Lake	7134414	553008	0.62	0.31
SD24	Andrew Lake	7134390	553017	0.62	0.16

Notes: 1) Unable to collect sediment sample.

2) Field crew recorded the sediment thickness as the maximum distance that the sampling tool could be advance while working from the boat.

2.1.5 2010 Lakebed Sediments Laboratory Testing

Laboratory testing was carried out on selected samples obtained during the lakebed sampling program. A total of 7 sieves, 5 hydrometers, 2 Atterberg Limit determinations, 7 moisture contents, and 5 organic matter contents were conducted. A summary of the laboratory test results are presented in Table 2-3.

Laboratory testing results are included in Appendix B.



Table 2-3: Summary of 2010 Laboratory Testing Results

Sounding ID	Grain Size Distribution (by weight)			Plastic Limit	Water Content (%)	Organic Matter (%)
	Gravel	Sand	Fines (Silt and Clay)			
SD01	0.0	91.5	8.5	N/T	19.9	0.6
SD02	0.2	90.5	9.3	N/T	20.7	0.6
SD03	2.2	91.5	6.3	N/T	23.6	N/T
SD04	0.8	89.0	10.2	Non Plastic	26.3	2.3
SD05	0.7	91.9	7.4	N/T	24.1	1.1
SD11	0.9	90.1	9.0	Non Plastic	29.6	1.9
SD12	0.2	78	21.8	N/T	44.8	N/T

N/T = not tested

2.2 Subsurface Conditions

The following provides a summary of the subsurface soil and bedrock conditions inferred for the Andrew Lake Pit dewatering structure based on the results of the previous and current site investigations.

2.2.1 Soil Conditions

Based on the results of the 2010 lakebed sampling program, the lakebed sediments encountered consisted of soft, SAND to silty SAND with trace gravel, non-plastic and with low organic matter content. Based on the review of the available geotechnical data within the project area, the soils encountered typically ranged from very loose to loose SAND, some gravel, trace clay to very loose to loose SILT and SAND, trace clay containing boulders and cobbles.

Review of the 1988, 2009 and 2010 drilling records indicates that the soil thickness ranges from 5 m to 15 m within the project area. The soil depth inferred from the GPR surveys indicates a soil thickness that ranges of 5 m to 12 m within the area covered by the survey. Results from the 2009 GPR surveys inferred that frozen ground extends under the north end of Andrew Lake in the area of the GPR investigations.

2.2.2 Bedrock Conditions

Foundation bedrock conditions have been inferred based on five boreholes located at the Sissons site which includes AND09-02, AND09-03, END09-02, and END09-03 drilled in 2009 and AND-10-03 drilled in 2010. The boreholes were drilled with an inclination of between 60 and 85 degrees.

The near surface bedrock encountered in within Andrew Lake Pit and the End Grid area was classified as fresh to moderately weathered, weak to strong, fine to coarse grained, red to grey, metasediment. The near surface bedrock encountered southwest of Andrew Lake Pit was classified as fresh to slightly weathered, very strong to extremely strong, fine to medium crystalline, pink-grey, well banded granitic gneiss. The records of borehole logs are provided in Appendix A.



2.2.3 Lakebed Bathymetry

Bathymetry of the Andrew Lake has been updated based on the water depth soundings collected during the August 2010 investigation. Figure 2 includes the updated Andrew Lake lakebed bathymetry data based on water level estimates prepared by Golder Saskatoon Geoscience group.



3.0 DESIGN BASIS

3.1 Introduction

The general design basis for construction of the Andrew Lake dewatering structure through shallow water which is expected to be less than 1 m in depth includes:

- Maintaining a suitable setback between the open pit limit and the dewatering structure;
- Meeting or exceeding the required safety factors for stability and hydrotechnical design criteria according to the consequence classification as set out in Canadian Dam Association (CDA), 2007; and
- Manageable seepage into the open pit.

Figure 3 presents two alignment options which have been considered for the Andrew Lake Pit dewatering structure. A design basis for the structure has been prepared and summarized in the following sections. Using the design basis, a conceptual design of the dewatering structure, which is applicable for either of the alignment options, has been prepared. A preliminary quantity summary and cost estimate has been prepared for the two alignment options.

3.2 Dam Consequence Classification

The Canadian Dam Association (CDA) Dam Safety Guidelines (CDA, 2007) ranks water retaining dams according to the consequences of a hypothetical dam failure. Potential life loss, economic losses, environmental losses and cultural losses are considered in the classification. Table 3-1 presents the Dam Classification categories according to CDA (2007).

Table 3-1: Dam Classification (CDA 2007, Table 2-1)

Dam Class	Population at Risk	Incremental Losses		
		Loss of Life	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or Fewer	Significant loss or deterioration of <i>important</i> fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities



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Dam Class	Population at Risk	Incremental Losses		
		Loss of Life	Environmental and Cultural Values	Infrastructure and Economics
Very High	Permanent	100 or Fewer	Significant loss or deterioration of <i>critical</i> fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of <i>critical</i> fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting important infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

See CDA, 2007 for additional notes regarding this table.

The proposed Andrew Lake Pit dewatering structure is considered to be classified as a Significant consequence of failure structure based on the following assessment:

- **Population at Risk:** Temporary Only (site personnel);
- **Loss of Life:** Unspecified;
- **Environmental and Cultural Values:** Loss of marginal habitat only / Restoration or compensation in kind highly possible; and
- **Infrastructure and Economics:** Low economic losses; area contains limited infrastructure or services.

3.3 Design Earthquake and Seismic Hazard

Based on the 2007 CDA guidelines dams shall be designed based on an Earthquake Design Ground Motion (EDGM). Selection of the EDGM is based on the consequence of failure of the dam. For a Significant consequence of failure structure, the suggested design earthquake has an annual exceedance probability (AEP) of 1 in 1,000 years.

A query of the Earthquake Canada website using the Andrew Lake site coordinates of 7,134,500 m Northing and 553,000 m Easting, resulted in the peak ground accelerations for several return periods as summarized in Table 3-2. Details of the Seismic Hazard Calculation are included in Appendix C.



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Table 3-2: 2005 National Building Code Seismic Hazard Calculation for Sissons Site

Nominal Return Period (years)	Probability of Exceedance per Annum	Peak Ground Acceleration (g)
1 in 475	0.0021	0.021
1 in 1000	0.001	0.035
1 in 2475	0.000404	0.059

3.4 Design Criteria

The key design criteria for the conceptual design of the Andrew Lake Pit dewatering structure are summarized in Table 3-3.

Table 3-3: Dewatering Structure Key Design Criteria

Description	Assessment	Reference / Comments
Dam Classification	Significant consequence of failure structure.	Using CDA 2007 Dam Classification Table 2-1
Freeboard	2.0 m above normal lake elevation.	See Section 3.5
Roadway Width	20 m (minimum)	■ For haul truck double lane traffic the minimum width is three times the width of the widest haulage vehicle. (NWT and Nunavut, 1995). ■ Assumes construction using CAT 785D - 150 Ton - 6.63 m width.
Safety Berm	2.3 m (minimum) height	■ A shoulder barrier of at least three-quarters the height of the largest tire on any vehicle using the road is required. (NWT and Nunavut, 1995). ■ Assumes construction using CAT 785D - 150 Ton, with Caterpillar 33.00R51 - 3.0 m diameter tires.
Design Earthquake	For Significant consequence of failure structure the suggested design earthquake has an annual exceedance probability (AEP) of 1/1,000 years.	CDA, 2007, Section 6.3 and 6.5
Slope Stability	FoS = 1.5 on static conditions FoS = 1.0 on pseudostatic conditions	CDA, 2007, Section 6.6
Seepage and Drainage Control	Seepage exit gradients should be within acceptable limits for the embankment and foundation materials. Manageable seepage reporting to open pit.	



3.5 Freeboard

Freeboard is the minimal vertical distance between the normal still water surface elevation in the reservoir (lake) and the top of the containment structure. This safety margin is maintained at all time in order to restrict overtopping of the containing structure by large waves, including due consideration of wind and wave setup, and wave run up. (CDA 2007).

Based on the Significant classification, the crest level should be set so that the structure is protected against the most critical of the following cases:

- No overtopping by 95% of the waves caused by the most critical wind with a frequency of 1/1000 year when the reservoir (lake) is at its maximum normal elevation; and
- No overtopping by 95% of the waves caused by the most critical wind when the reservoir is at its maximum extreme level during the passage of the Inflow Design Flood.

Additional considerations for the freeboard are:

- Freeboard should be sufficient to prevent heave of the crest due to frost action (CDA 2007, page 71);
- Final freeboard, including camber, should be sufficient to accommodate expected settlement of the crest and cracks caused by frost action (CDA 2007, page 71); and
- The dam (dyke) should be designed to retain the reservoir safely despite any cracking that may be induced by arching, settlement, or hydraulic fracturing (CDA 2007, page 71).

For this conceptual design a freeboard of 2 m has been provided to meet the above criteria. The freeboard requirements should be reviewed as part of the detailed design stage.

3.6 Slope Stability

The CDA (2007) guidelines adopted as design criteria present the minimum factors of safety against slope stability failure (see Table 3-3) for static and pseudostatic loading using the EDGM. Slope stability analysis was not undertaken for the current conceptual design. Based on experience for dams with similar shallow height rockfill and till construction methods, suitable slope stability factors of safety are expected based on the conceptual design. Slope stability analyses should be undertaken as part of the detailed design stage.



4.0 CONCEPTUAL DESIGN

4.1 Alignment Options

Figure 3 presents the two alignment options which have been considered for the Andrew Lake Pit dewatering structure.

Alignment Option 1 takes advantage of topographic highs located near the northeast end of Andrew Lake. Option 1 is closer to the pit and therefore a lake area of 133,000 m² is required to be dewatered. Alignment Option 1 requires an approximate length of 650 m to be constructed through the lake and 400 m will be constructed over land, for a total length around 1050 m. The Alignment Option 1 will not interfere with the natural outlet to Andrew Lake and thus, a diversion ditch will not be required.

Alignment Option 2 takes advantage of a naturally narrow section of Andrew Lake, farther west of Alignment Option 1. Option 2 is further away from the pit than Option 1 and requires 235,000 m² of the lake to be dewatered. Option 2 requires approximately 350 m of the structure to be built through the lake and an additional 200 m will be constructed over land, for a total length of 550 m. There are no naturally topographic high spots southeast of Andrew Lake near the Alignment Option 2, and therefore careful consideration will need to be given to the location and design of the south abutment. The natural inlet to Andrew Lake is currently situated to the east side (downstream) of Option 2 and will need to be redirected to the west side (upstream) side of Option 2 to prevent inflow into the pit and preserve the natural flow paths between the lakes. The natural outlet is currently situated on the east (downstream) side of Option 2. A diversion ditch will need to be constructed to preserve the natural flow paths between the lakes. Included on Figure 3 are two diversion channel alignment options, labelled A and B, and one of these channels would be required to be constructed along with dewatering structure alignment Option 2.

Table 4-1 presents a comparison of the alignment options.

Table 4-1: Comparison of Alignment Options

Item	Alignment Option 1	Alignment Option 2
Total Structure Length (m)	1050	550
Lake Length (m)	650	350
Abutment Length (m)	400	200
Diversion Channel Length (m)	n/a	655 Option A channel 615 Option B channel
Lake Area Lost (m ²)	133,000	235,000

4.2 Design Concept

The conceptual design of the Andrew Lake Pit dewatering structure consists of rockfill platform placed through Andrew Lake along the selected alignment. A trench would then be excavated through the rockfill and a granular filter material would be placed underwater on the downstream face of the excavation based on material compatibility between the rockfill and till zones. Till would be placed as trench backfill under water in the excavation to act as a low hydraulic conductivity core of the structure. Selected crushed rockfill would be placed as a thermal cap over the till to promote consolidation of the till core and to reduce the thermal variation in the till zone.



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Figure 4 presents a typical cross section and construction sequence for the dewatering structure. The following provides a brief description of key stages of the dewatering structure construction.

Rockfill Embankment and Trench Excavation

- Sediment control silt curtains are deployed into lake around the rockfill embankment area.
- A rockfill embankment would be advanced along the alignment with an initial crest elevation of 167 m at a width of about 50 m. The crest width of the embankment is greater than the minimum 34 m for two way truck traffic (including safety berms) so that the embankment provides both a working platform and a running surface for the large mine haul trucks during construction.
- A large excavator would be used for the trench excavation removing rockfill and lakebed soils from the embankment crest to an approximate depth of 1 m below lakebed and exposing competent foundation soils for the till zone along the alignment. The excavation would have a minimum base width of 5 m. The downstream slope of the excavation includes a bench to allow stable placement of a filter zone.

Filter Zone

- A granular filter material would be placed on the downstream face of the excavation to prevent movement of the finer till core materials into the rockfill, or into zones of open boulders present in the lakebed materials.

Till Core

- Following filter placement, the excavation would be backfilled with a select till material to form a till core zone. The till core material would be advanced along the structure's centerline, parallel with the Filter material.
- The minimum width of continuous till core material at the base of the excavation would be 5 m to minimize seepage through the structure.
- Till core material would be placed to 2 m above water level to provide sufficient freeboard.
- Rockfill would be placed to an elevation of 170 m over the till core zone to help consolidate the till material and to reduce the thermal variation in the till zone.

Schedule

Depending on the alignment option selected, construction of the dewatering structure is estimated to take between 4 and 8 weeks to complete. Construction would be scheduled to be undertaken during the open water season in the summer months of July and August. The construction should to begin in July, following melting of the ice cover from Andrew Lake to allow for the deployment of the sediment curtains. By July, the active layer is expected to begin to develop and the lakebed sediments begin to thaw which will allow for excavation to the design depth.



The dewatering structure construction should be completed before September so that the till and granular materials can be placed before freezing conditions begin at site. This also gives the till core zone time to consolidate under the load of the thermal cap before the winter freeze up.

Following the completion of the dewatering structure construction, it is anticipated that dewatering of the Andrew Lake downstream of the structure will be completed before the winter freeze up. This will allow for maximum frost penetration into the exposed lakebed on the downstream side during the following winter.

4.3 Construction Materials

Mine haul trucks will be used to deliver the following construction materials:

Rockfill

Rockfill used in the dewatering structure construction may be produced by mining operations or quarried specifically for construction of the dewatering structure and should be Non Potentially Acid Generating (NPAG). Potentially Acid Generating (PAG) materials should be avoided during construction due to the limited depth of water the structure will be built in.

Granular Filter

The granular filter material must prevent loss of till core material into the rockfill or boulder/cobble zones within the lakebed till. The filter will be designed based on criteria in Fell et al. (2005), and the U.S. Army Corps (2004), and will meet filtration criteria against the till core specification. Depending on the crushing and screening plant available on site, processing of run-of-mine rock through the crushing plant may be carried out to reduce material handling requirements. The granular filter shall be constructed of NPAG rock.

Till Core

It is anticipated that a well graded till with a maximum particle size of 150 mm and a fines content between 20% and 40% will have a sufficiently low hydraulic conductivity to minimize the seepage through the dewatering structure. The till core material will be comprised of select natural till material excavated during construction.



5.0 QUANTITY AND COST ESTIMATE

To allow for an alignment selection to be carried out, preliminary quantities and conceptual cost estimates have been prepared for the two alignments options presented on Figure 3 and using the typical cross section shown on Figure 4. To estimate the cost of construction, assumptions were made for the cost of excavation, material handling and material placement based on past experiences with other similar projects. The material quantities and conceptual costs are considered to be accurate for a concept screening level with an accuracy range of about -50% to +100%. The cost estimate is for the earthworks only and does not include sediment control, water management, environmental management, fish out or habitat compensation. A summary of the quantity and cost estimation for each dewatering structure option is presented in Table 5-1.

Table 5-1: Summary of Quantity and Cost Estimation for Dewatering Structure Alignment Options

		Alignment Option 1		Alignment Option 2			
				Diversion Channel A		Diversion Channel B	
Item	Unit Cost, Load Haul +Place Material (\$/m ³)	Quantity (m ³)	Cost (\$)	Quantity (m ³)	Cost (\$)	Quantity (m ³)	Cost (\$)
Initial Rockfill with safety berms	3	91,300	273,900	53,760	161,280	53,760	161,280
Trench Excavation (Rockfill)	5	22,100	110,500	9,480	47,400	9,480	47,400
Trench Excavation (Lakebed Soils) (2x effort of rockfill excavation)	10	4,100	41,000	3,480	34,800	3,480	34,800
Production and placement of filter zone	30	3,700	111,000	1,680	50,400	1,680	50,400
Till	3	39,600	118,800	17,520	52,560	17,520	52,560
Surcharge Rockfill (Thermal Cap)	3	28,400	85,200	12,600	37,800	12,600	37,800
Diversion Channel (see Golder 2010a)		n/a			258,000		243,000
Total		189,200 m ³	\$ 740,400	98,520 m ³	\$ 642,240	98,520 m ³	\$ 627,240



5.1 Selected Alignment

Based on the preliminary quantities and conceptual cost estimates presented in Table 5-1, Golder recommends that the alignment Option 1 for the Andrew Lake Pit dewatering structure be selected and advanced through to the next phase of design.

Alignment Option 1 is approximately twice the length of Option 2 and would require nearly twice the material to construct. Alignment Option 2 requires the construction of a diversion channel and when this is factored in the estimated cost of construction for Option 2 is close to the estimate for Alignment Option 1.

Alignment Option 2 requires nearly twice the lake area to be dewatered to support the development of the Andrew Lake Pit over Option 1. The cost of this additional area of lake to be dewatered in terms of lost fish habitat compensation has not been included in the estimate comparison. However, preliminary discussions on construction requirements for fish habitat compensation would be expected to increase the cost estimate for Option 2 over that of Option 1.



6.0 CONCLUSIONS AND RECOMMENDATIONS

A conceptual design for the Andrew Lake Pit dewatering structure has been prepared following the design basis presented and based on a review of the geotechnical characterization data for the foundation conditions in the project area. Two alignment options were considered. Based on a preliminary cost estimate and minimum area of lake dewatering required, alignment Option 1 has been recommended to be selected for detailed design study.

To advance alignment Option 1 to a detailed design study, the following additional work is required:

- The dewatering structure's alignment and geometry should be optimized based on the ultimate size, shape, and location of Andrew Lake Pit;
- A geotechnical investigation should be conducted along the optimized alignment to sample and obtain the foundation material properties;
- A geotechnical investigation should be conducted to confirm the material properties and quantity of till material available for this construction; and
- Ground temperature conditions with depth and time should be determined in the abutment areas of proposed dewatering structure through the installation of thermistor strings in boreholes.



7.0 CLOSURE

We trust that this report is sufficient for your needs at this time. Should you have any questions, or require additional information, please do not hesitate to contact us.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Justin Bieber, EIT
Geotechnical Engineer

JB/JCC/aw/rs

ORIGINAL SIGNED AND SEALED

John Cunning, P.Eng. (BC, NWT, NU)
Associate, Senior Geotechnical Engineer

\\bur1-s-filesrv2\final\2010\1345\10-1345-0026 areva kiggavik\rep 0314_11 conceptual design andrew lake - final\rep 0316_11 conceptual design for andrew lake dewatering structure-final.docx



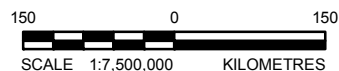
REFERENCES

- EBA Engineering Consultants Ltd., 2010. Areva Resources Road and Mine Infrastructure, Andrew Lake Dyke Survey, submitted to Areva Resources Canada Inc., EBA File: V33101016.400.009, dated January 2010.
- Golder Associates Ltd., 1988. Mining Geotechnical Aspects of the Proposed Kiggavik Uranium Operations Volume I and II, submitted to Urangesellschaft Canada Ltd., Report 882-1421/881-1814G, dated August 1989.
- Golder Associates Ltd., 2009. Assessment of Potential Sources for Paste Backfill Material, submitted to Areva Resources Canada Inc., Report 09-1426-0001, dated November 2, 2010.
- NWT and Nunavat, 1995, Mine Health and Safety Regulations, R-125-95.



LEGEND

- Community
- ✕ Proposed Kiggavik - Sissons Location



REFERENCE

Communities obtained from Geogratis. Other base data obtained from ESRI.
Projection: UTM Zone 14 Datum: NAD 83

PROJECT



AREVA RESOURCES CANADA INC.
KIGGAVIK PROJECT

TITLE

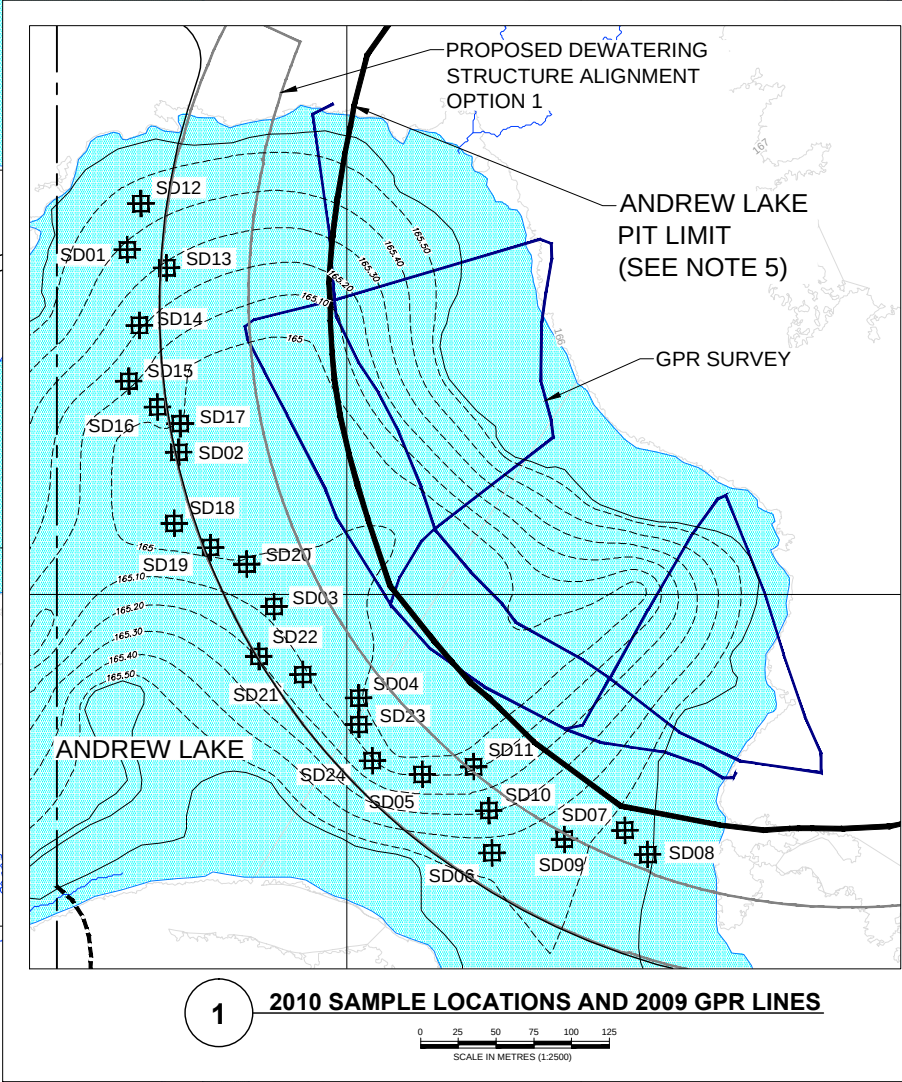
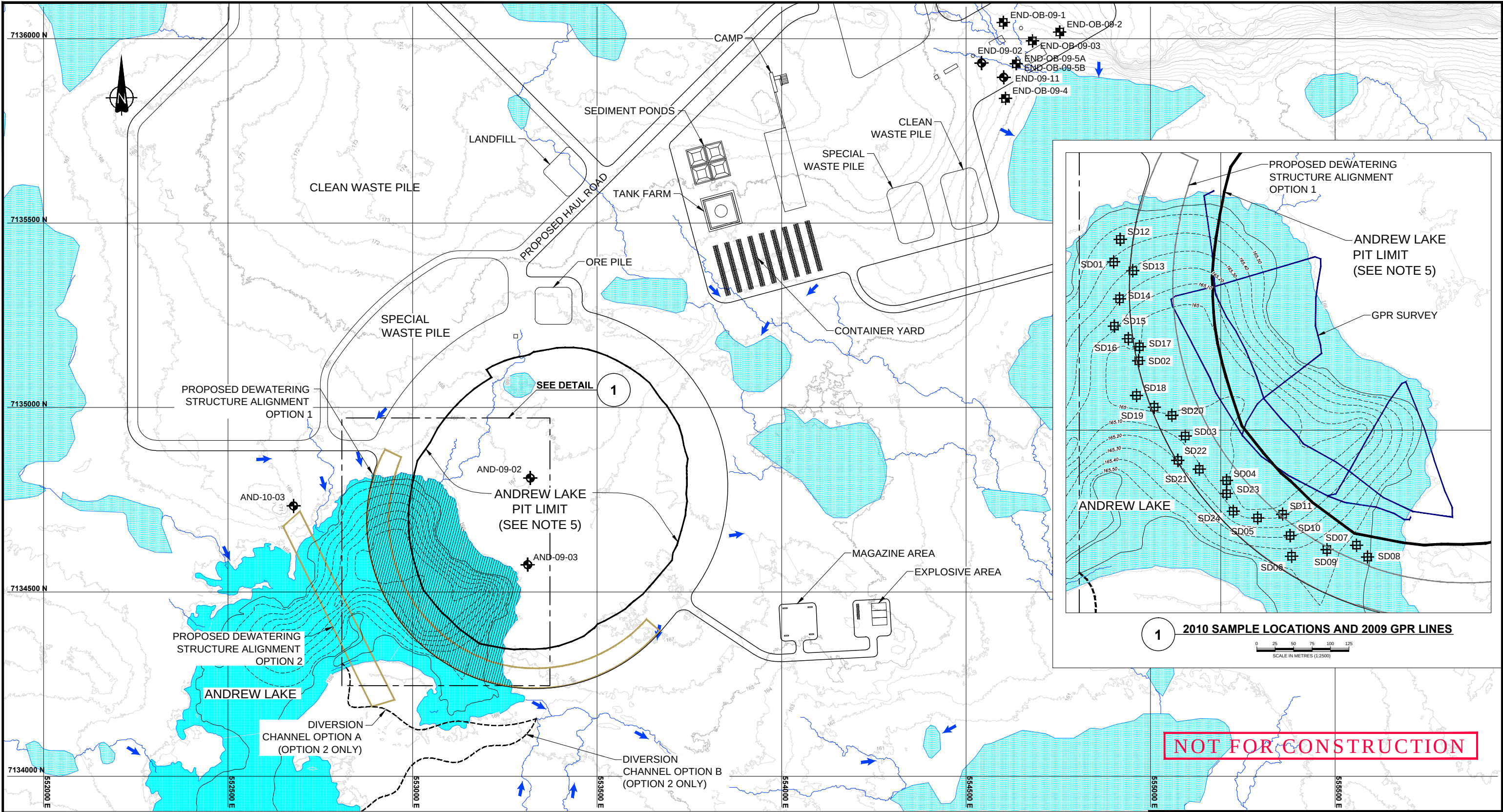
GENERAL SITE LOCATION



PROJECT No. 10-1345-0026			PHASE No. 4	
DESIGN	JB	11JAN11	SCALE AS SHOWN	REV. 0
GIS	CDB	11JAN11		
CHECK				
REVIEW				

FIGURE 1

Drawing File: N:\Bur-Graphics\Projects\2010\1345-0026\Drafting\4\Figures\FIGURE 2.dwg Friday, March 11, 2011 3:23:40 PM By: MHeal



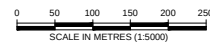
NOT FOR CONSTRUCTION

LEGEND

	MINOR CONTOUR		FLOW DIRECTION
	MAJOR CONTOUR		SD12
	BATHYMETRY CONTOUR		AND-10-03
	PROPOSED INFRASTRUCTURE		END-OB-09-2
	PROPOSED PIT OUTLINE		TEST PIT LOCATION
	CREEK		
	WATER BODY		
	PROPOSED DEWATERING AREA FOR ALIGNMENT OPTION 1		

NOTES

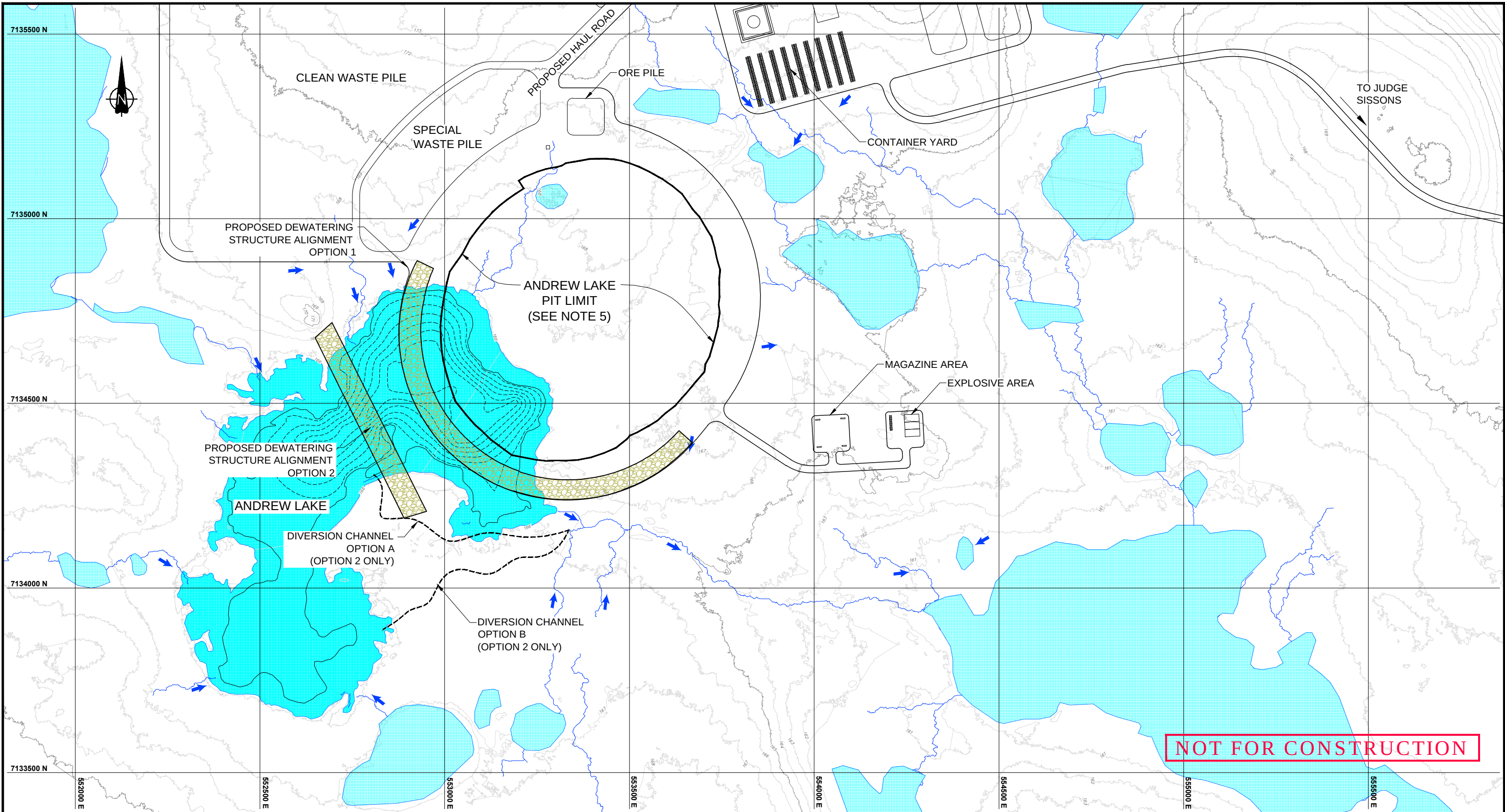
- 1) ALL UNITS IN METRES UNLESS OTHERWISE STATED.
- 2) TOPOGRAPHIC CONTOURS GENERATED FROM LIDAR SURVEY (SUMMER 2008 & 2009).
- 3) CONTOURS SHOWN AT 1m INTERVAL.
- 4) ELEVATIONS ARE REFERENCED TO GEODETIC DATUM; NAD83 UTM, ZONE 14.
- 5) ANDREW LAKE PIT DESIGN PROVIDED BY AREVA (09OCT11).
- 6) ANDREW LAKE BATHYMETRY CONTOURS BASED ON WATER LEVEL ESTIMATES BY GOLDER SASKATOON GEOSCIENCE GROUP. SHOWN AT 0.1m INTERVAL.



PROJECT		AREVA RESOURCES CANADA INC. KIGGAVIK PROJECT						
TITLE								
SISSONS SITE PLAN AND SITE INVESTIGATION LOCATIONS								
 Golder Associates Greater Vancouver Office, BC		PROJECT No.		10-1345-0026	PHASE	4	TASK	
		DESIGN		JV	03NOV10	FILE No.		FIGURE 2.dwg
		CADD		MSH	11MAR11	SCALE	AS SHOWN	REV.
		CHECK				FIGURE 2		
		REVIEW						



Drawing File: N:\Bur-Graphics\Projects\2010\1345-0026\Drafting\4\Figures\FIGURE 3.dwg Friday, March 11, 2011 3:25:10 PM By: MHeal

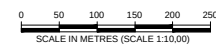


LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR
- BATHYMETRY CONTOUR
- PROPOSED INFRASTRUCTURE
- PROPOSED PIT OUTLINE
- WATER BODY
- DEWATERING STRUCTURE
- CREEK
- FLOW DIRECTION

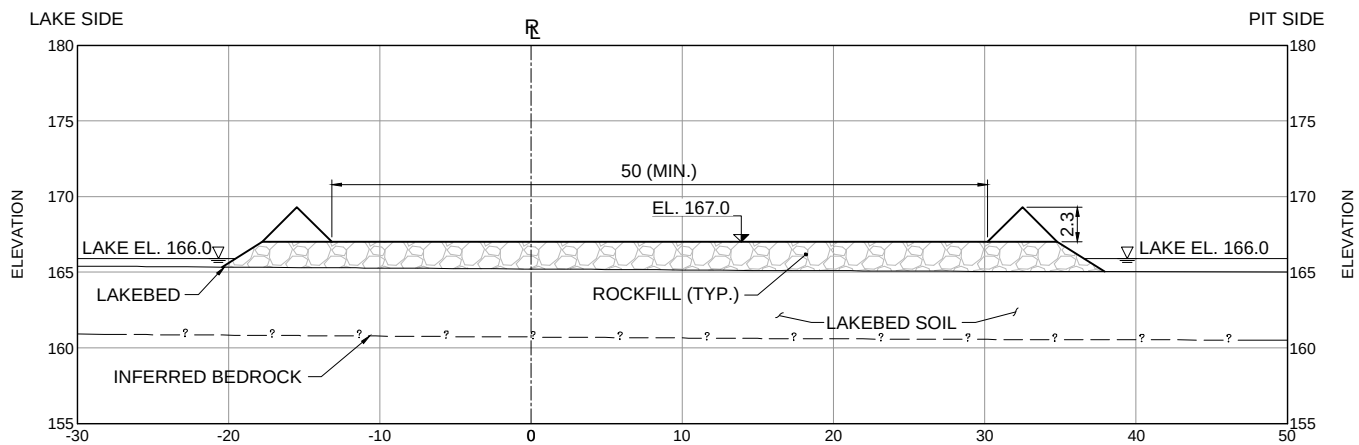
NOTES

- 1) ALL UNITS ARE IN METRES UNLESS OTHERWISE STATED.
- 2) TOPOGRAPHIC CONTOURS GENERATED FROM LIDAR SURVEY (SUMMER 2008 & 2009)
- 3) CONTOURS SHOWN AT 1m INTERVAL.
- 4) ELEVATIONS ARE REFERENCED TO GEODETIC DATUM; NAD83 UTM, ZONE 14.
- 5) ANDREW LAKE PIT DESIGN PROVIDED BY AREVA (09OCT11).
- 6) ANDREW LAKE BATHYMETRY CONTOURS BASED ON WATER LEVEL ESTIMATES BY GOLDER SASKATOON GEOSCIENCE GROUP. SHOWN AT 0.1m INTERVAL.

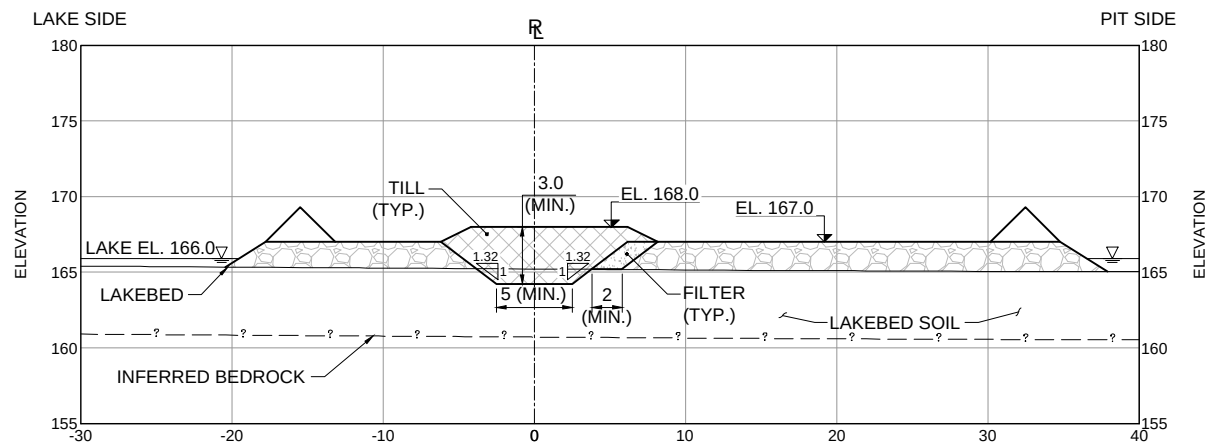


PROJECT		AREVA RESOURCES CANADA INC. KIGGAVIK PROJECT	
TITLE		ANDREW LAKE PIT DEWATERING STRUCTURE ALIGNMENT OPTIONS 1 AND 2	
PROJECT No.	10-1345-0026	PHASE	4
DESIGN	JV	03NOV10	FILE No.
CADD	MSH	11MAR11	SCALE
CHECK			AS SHOWN
REVIEW			REV.
Golder Associates Greater Vancouver Office, BC		FIGURE 3	

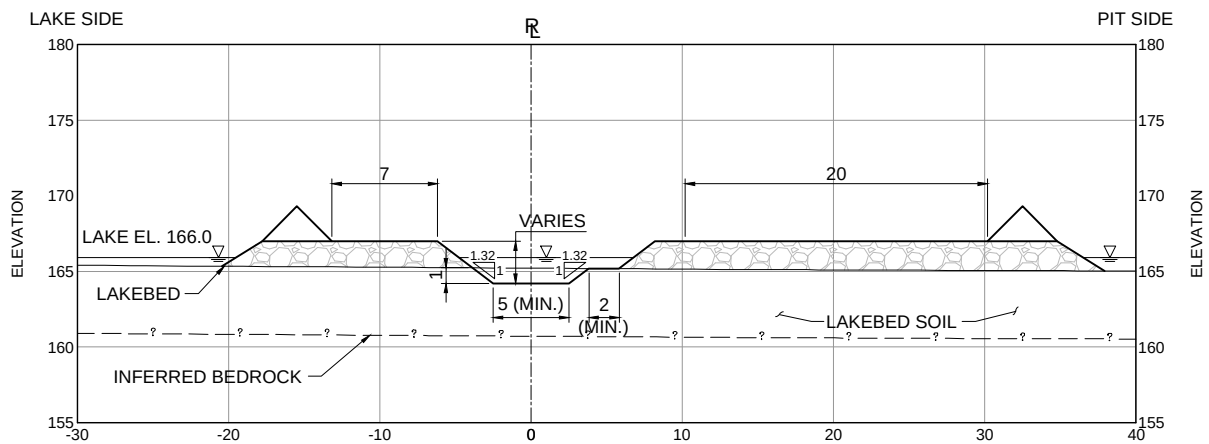
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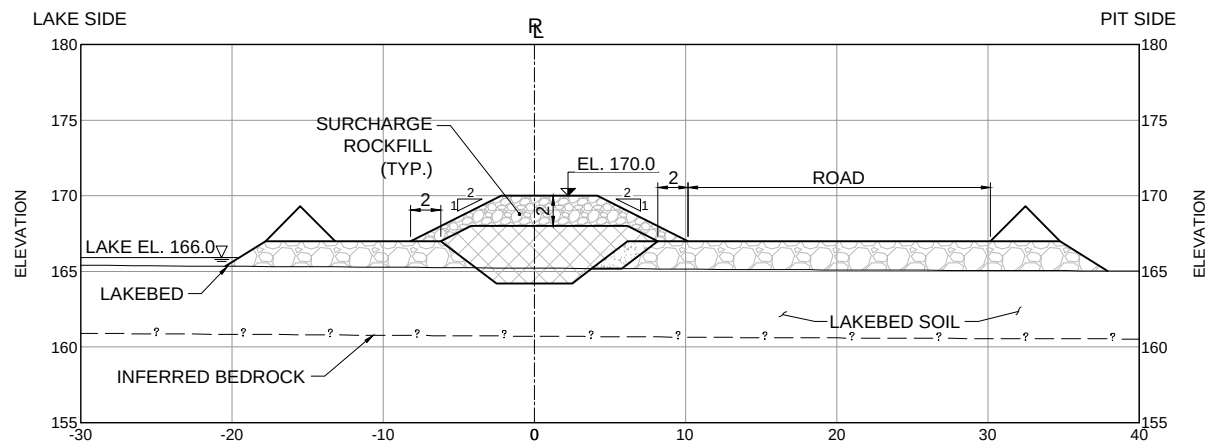
1 INITIAL ROCKFILL PLACEMENT



3 TILL PLACEMENT



2 TRENCH EXCAVATION



4 SURCHARGE ROCKFILL PLACEMENT

LEGEND

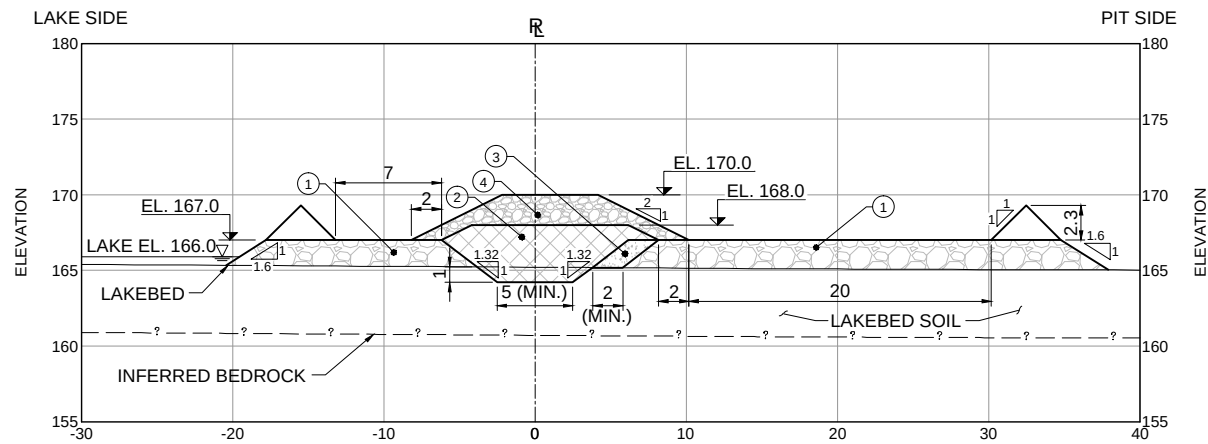
- DESIGN
- ASSUMED LAKEBED
- INFERRED BEDROCK

MATERIAL LEGEND

- 1 ROCKFILL
- 2 TILL
- 3 GRANULAR MATERIAL (FILTER)
- 4 SURCHARGE ROCKFILL

NOTES

- 1) ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED



TYPICAL CROSS-SECTION

NOT FOR CONSTRUCTION

0 2.5 5 7.5 10 12.5
SCALE IN METRES (SCALE 1:500)

PROJECT		AREVA RESOURCES CANADA INC.	
AREVA		KIGGAVIK PROJECT	
TITLE		CONCEPTUAL DESIGN CONSTRUCTION SEQUENCE AND TYPICAL CROSS-SECTION	
PROJECT No.		10-1345-0026	PHASE 4 TASK
DESIGN	JV	03NOV10	FILE No. FIGURE 4.dwg
CADD	MSH	11MAR11	SCALE AS SHOWN REV.
CHECK			
REVIEW			



FIGURE 4



APPENDIX A

Previous Investigation Results

RECORD OF BOREHOLE BH88-MZ1

SHEET 1 OF 1

LOCATION MAIN ZONE 7,148,875.8N X 565,371.7E

BORING DATE 13 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT				
0		Ground Surface	178.10								Frost Depth Indicator
		TOPSOIL - dark brown organic Sandy Silt, wet	178.00								
			0.10								
		SAND- fine to medium subround- ed sand, trace silt, medium brown, loose, moist		1	AS -						
		PERMAFROST @ 0.70m 0.70 to 0.80m - Nbe		2	AS -						
			175.30								
1	MOBILE B-40 MOBILE AUGERS	SAND TILL - fine to coarse Sand, some fine Gravel, subrounded, some Silt, trace Clay, non-plastic (SM)	0.80	3	AS - CPREL					M, H	08 AUG 1988 0.87m 31 AUG 1988 1.01m b = 1920kg/cm d = 1552kg/cm
		PERMAFROST 0.80 to 1.25m - Vs, 1-3mm thick, clear, hard 1.45 to 1.70m - Vs to Vr, 2-3mm thick, hard, light brown from 1.45 to 1.70m SANDY GRAVEL TILL - fine to coarse subrounded Gravel, fine to coarse Sand, some Silt, trace Clay, non-plastic (GM)		4	AS - CPREL					M, H	b = 1840kg/cm d = 1084kg/cm
2		1.70 to 2.30m Cobbles and Boulders		5	AS - CPREL					M, H	
			173.80								
		End of Borehole Auger refusal in boulders and cobbles	2.30								2.30m
3											
4											
5											

0
16-10 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-MZ2

SHEET 1 OF 1

LOCATION MAIN ZONE 7,148,729.3N X 666,152.8E

BORING DATE 13/07/88

DATUM GEODETIC

SAMPLER HAMMER, 83.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 83.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								Cu, kPa	nat.V.- + O.- ● rem.V.- ⊕ U.- ○			Wp	W
0	MOBILE B-40 MOBILE AUGERS	Ground Surface		178.40									
		TOPSOIL - dark brown organic Silt		178.30									
				0.10									
		SANDY SILT TILL - some fine to coarse subrounded Sand, fine and coarse Gravel, some Clay, non-plastic (ML)			1	AS	-						
1		No PERMAFROST			2	AS	-			O	M, H		
				177.00									
		End of Borehole Auger refusal in boulders or cobbles		1.40									
2													
3													
4													
5													

0
16 6 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

BH88-CZ1

SHEET 1 OF 1

LOCATION CENTRE ZONE 7.148.959.7N X 585.843.8

BORING DATE 12 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 83.5kg. DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg. DROP, 760mm



16-10 6 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1 : 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1WD1

SHEET 1 OF 1

LOCATION WASTE DUMP 7,148,381.2N X 665,538.7E

BORING DATE 12 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT						
0	MOBILE B-40 MOBILE AUGERS	Ground Surface		174.10										
		TOPSOIL - black organic Silt, damp		174.00										
		SILTY SAND TILL - fine to coarse subrounded Sand, some fine subrounded Gravel, some Clay, non-plastic (SM)		0.10	1	AS	-							
1		PERMAFROST @ 0.50m 0.60m to 1.25m - Nbn (Est'd)			2	AS	-							M, H
		End of Borehole Auger refusal in boulders or cobbles		172.85										
2				1.25										
3														
4														
5														

0
16-15 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1WD2

SHEET 1 OF 1

LOCATION WASTE DUMP 7,146,358.3N X 565,891.8E

BORING DATE 12 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat.V.- + Q.- ● rem.V.- ⊗ U.- ○	WATER CONTENT, PERCENT Wp W Wi		
0	MOBILE B-40 MOBILE AUGERS	Ground Surface	173.70								
		TOPSOIL - black organics, Silt	173.60								
		sand and gravel, medium to coarse subrounded sand and gravel, trace silt, medium brown	0.10	1	AS	-					
1		0.95 to 1.25m SAND AND GRAVEL		2	AS	-					
		PERMAFROST @ 1.00m 1.00 to 1.70m - Nbe	172.40								
		GRAVELLY SAND TILL - fine to coarse subrounded Sand, fine and coarse subrounded Gravel, trace Silt, trace Clay, non-plastic (SP)	1.30	3	AS	-					
		@ 1.50m cobbles encountered	172.00								
2		End of Borehole Auger refusal in boulders and cobbles	1.70								
3											
4											
5											

0
16-10 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-2WD1

SHEET 1 OF 1

LOCATION WASTE DUMP 7,147,588.1N X 565,791.0E

BORING DATE 12 JULY 1988

DATUM GEODETTIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT			
0	MOBILE B-40 MOBILE AUGERS	Ground Surface		198.20							
		TOPSOIL - black organics, Silt		198.10							
		gravelly till, fine to coarse subrounded sand and gravel, silty damp with abundant cobbles throughout		0.10							
1		PERMAFROST @ 1.00m (Est'd)		195.00							
		End of Borehole Auger refusal in boulders and cobbles		1.20							
2											
3											
4											
5											

0
15 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1 : 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1MHR1

SHEET 1 OF 1

LOCATION MINE HAUL ROAD 7,147,471.7N X 566,346.2E

BORING DATE 12 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ⊗ U.- ○	WATER CONTENT, PERCENT Wp W Wi			
0	MOBILE B-40 MOBILE AUGERS	Ground Surface	203.20								
		TOPSOIL - black, organic Silt, moist	203.10								
		SILTY SAND TILL - fine to coarse subrounded Sand, some fine and coarse subrounded Gravel, some Clay, low plastic, medium reddish brown, moist (SM-SC)	0.10	1	AS	-					
		PERMAFROST not observed ⊙ 0.92m abundant cobbles		2	AS	-					
1		⊙ 0.52 to 0.97m till, mottled medium reddish brown to dark brown ⊙ 0.92 to 1.52m occasional cobbles		3	AS	-				M, H	
		End of Borehole Auger refusal on boulders or cobbles	201.68								
2			1.62								
3											
4											
5											

0
15 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1MHR2

SHEET 1 OF 1

LOCATION MINE HAUL ROAD 7,147,863.9N X 586,206.8E

BORING DATE 12 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 83.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 83.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								Cu, kPa	nat.V.- + Q.- ● rem.V.- ⊗ U.- ○			Wp	W
0	MOBILE B-40 MOBILE AUGERS	Ground Surface		208.30									
		SILTY SAND - fine Sand, trace Clay, light brown, wet		0.00									
				207.85									
		SANDY TILL - fine to coarse subrounded sand, fine to coarse subrounded gravel		0.45	1	AS	-						
1		PERMAFROST @ 0.70m 0.70 to 1.45m - Nbe (Est'd)			2	AS	-			O			
		End of Borehole Auger refusal in boulders or cobbles		206.85									
				1.45									
2													
3													
4													
5													

0
15 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1MHR3

SHEET 1 OF 1

LOCATION MINE HAUL ROAD 7,147,879.5N X 585,178.0E

BORING DATE 11 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa	nat.V.- + Q.- ● rem.V.- ⊗ U.- ○		
0	MOBILE B-40 MOBILE AUGERS	Ground Surface		209.70							
		TOPSOIL - dark grey, black organics, wet		209.60							
		GRAVELLY SAND TILL - fine to coarse subangular Sand, fine and coarse subangular Gravel, some Silt, trace Clay, low plastic, moist (SM-SC)		0.10	1	AS	-				
		①0.60 to 1.35m Increasing Sand content									
1		PERMAFROST @ 1.00m 1.00 to 1.35m - Nbn 1.48 to 1.95m - permafrost melted by augers			2	AS	-				
		① 1.48m abundant cobbles			3	AS	CHREL				
					4	AS	-				
2		End of Borehole Auger refusal in cobbles or boulders		207.75 1.95							
3											
4											
5											

M, H bf = 1324kg/cum
d = 1074kg/cum

0
16 6 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1MHR5

SHEET 1 OF 1

LOCATION MINE HAUL ROAD M 7,148,415.2N X 664,828.4E

BORING DATE 11 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa	nat.V.- + O.- ● rem.V.- ⊕ U.- ○	WATER CONTENT, PERCENT Wp W Wi		
0	MOBILE B-40 MOBILE AUGERS	Ground Surface	222.00								
		TOPSOIL - dark brown organic Silt	221.90								
		SAND TILL - fine to coarse subrounded Sand, some fine and coarse Gravel, subrounded, some Silt, some Clay, medium reddish brown, moist (SM-SC)	0.10	1	AS	-					
		PERMAFROST @ 0.60m 0.60 to 0.90m - Nbn 0.90 to 1.35m - Nbe (Est'd) 1.35 to 2.60m - Nbn and Nbe									
1		abundant cobbles @ 1.35m		2	AS	-		O		M, H	
		1.35 to 2.60m GRAVELLY SAND TILL, fine to medium subrounded sand, fine, trace coarse subrounded gravel, some Silt									
2				3	AS	-					
			219.40								
3		End of Borehole Auger refusal in boulders or cobbles	2.60								
4											
5											

0
15-16 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1 : 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1MHR6

SHEET 1 OF 1

LOCATION MINE HAUL ROAD 7,148,877.6N X 564,480.7E

BORING DATE 11 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, CM/SEC				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH				WATER CONTENT, PERCENT					
								Cu, kPa		nat.V.- + Q.- ● rem.V.- ⊕ U.- ○		Wp W Wp					
0	MOBILE B-40 MOBILE AUGERS	Ground Surface		239.40													
		TOPSOIL - reddish brown organic till		239.30													
		SILTY SAND TILL - fine to coarse subrounded Sand, some fine and coarse subrounded Gravel, trace Clay, moist, lower moisture content 0.48 to 1.26m		0.10	1	AS	-										
		PERMAFROST @ 0.70m 0.70 to 2.80m - Nbn			2	AS	-										
1			1.25 to 2.80m increased gravel content														
		GRAVELLY SAND TILL - fine to coarse Sand, fine and coarse Gravel, some Silt, some Clay, low plastic (SM-SC)															
2					3	AS	-							M, H			
3		End of Borehole Auger refusal in boulders or cobbles		238.80 2.80													
4																	
5																	

0
15 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 25

Golder Associates

LOGGED R.W.M.

CHECKED

RECORD OF BOREHOLE BH88-1MHR4

SHEET 1 OF 1



LOCATION MINE HAUL ROAD 7,148,212.5N X 564,965.1E

BORING DATE 11 JULY 1988

DATUM GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT	HYDRAULIC CONDUCTIVITY, k, CM/SEC		
0	MOBILE B-40 MOBILE AUGERS	Ground Surface	214.70								
		TOPSOIL - dark grey to black organic silt	214.80								
		SILTY SAND TILL - fine to coarse subrounded sand, trace fine to coarse subrounded gravel, medium reddish brown, damp to 0.70m	0.10								
1		PERMAFROST @ 0.70m (Est'd) 0.70 to 1.52m - Nbn		1 AS -							
2		End of Borehole Auger refusal in boulders or cobbles	213.18 1.62								
3											
4											
5											

DEPTH SCALE

1: 25

0
15 6 PERCENT AXIAL STRAIN AT FAILURE
10

Golder Associates

LOGGED R.W.M.

CHECKED

TABLE 6 **SUMMARY OF LABORATORY TEST RESULTS**
MINE AND DUMP OVERBURDEN

Borehole No.	Sample No.	Depth (m)	Grain Size Distribution - %				Plasticity			Unified Class'n	W%	*Other Tests
			Gravel	Sand	Silt	Clay	W	Wp	Ip			
<u>MAIN ZONE</u>												
<u>BH88-MZ1</u>	AS3 (CRREL)	0.70-1.25	13	73	1	13	Non-Plastic			SM	23.7	$\gamma_{bf}1920$ γ_d1552
<u>BH88-MZ1</u>	AS3 (CRREL)	1.49-1.60	40	30	24	6	Non-Plastic			GM	54.2	$\gamma_{bf}1640$ γ_d1064
<u>BH88-MZ1</u>	AS5	1.67-2.30	21	48	22	9	Non-Plastic			SM	9.0	Nil
<u>BH88-MZ2</u>	AS2	0.51-1.25	17	32	40	11	Non-Plastic			ML	10.5	Nil
<u>CENTRE ZONE</u>												
<u>BH88-CZ1</u>	AS2	0.42-0.92	16	43	30	11	Non-Plastic			SM	6.4	Nil
<u>BH88-CZ1</u>	AS3 (CRREL)	0.92-1.14	30	39	21	10	Non-Plastic			SM	22.8	$\gamma_{bf}2109$ γ_d1717
<u>BH88-CZ1</u>	AS4	1.13-1.85	15	44	30	11	Non-Plastic			SM	6.6	Nil
<u>WASTE DUMPS</u>												
<u>BH88-1WD1</u>	AS2	0.53-1.29	17	45	25	13	Non-Plastic			SM	7.7	Nil
<u>BH88-1WD2</u>	AS3	1.25-1.50	35	56	5	4	Non-Plastic			SP	4.4	Nil

* Other Tests - γ_{bf} = Bulk Frozen Density (kg/cu.m). γ_d = Dry Density (kg/cu.m)
Gs = Specific Gravity Soil Solids

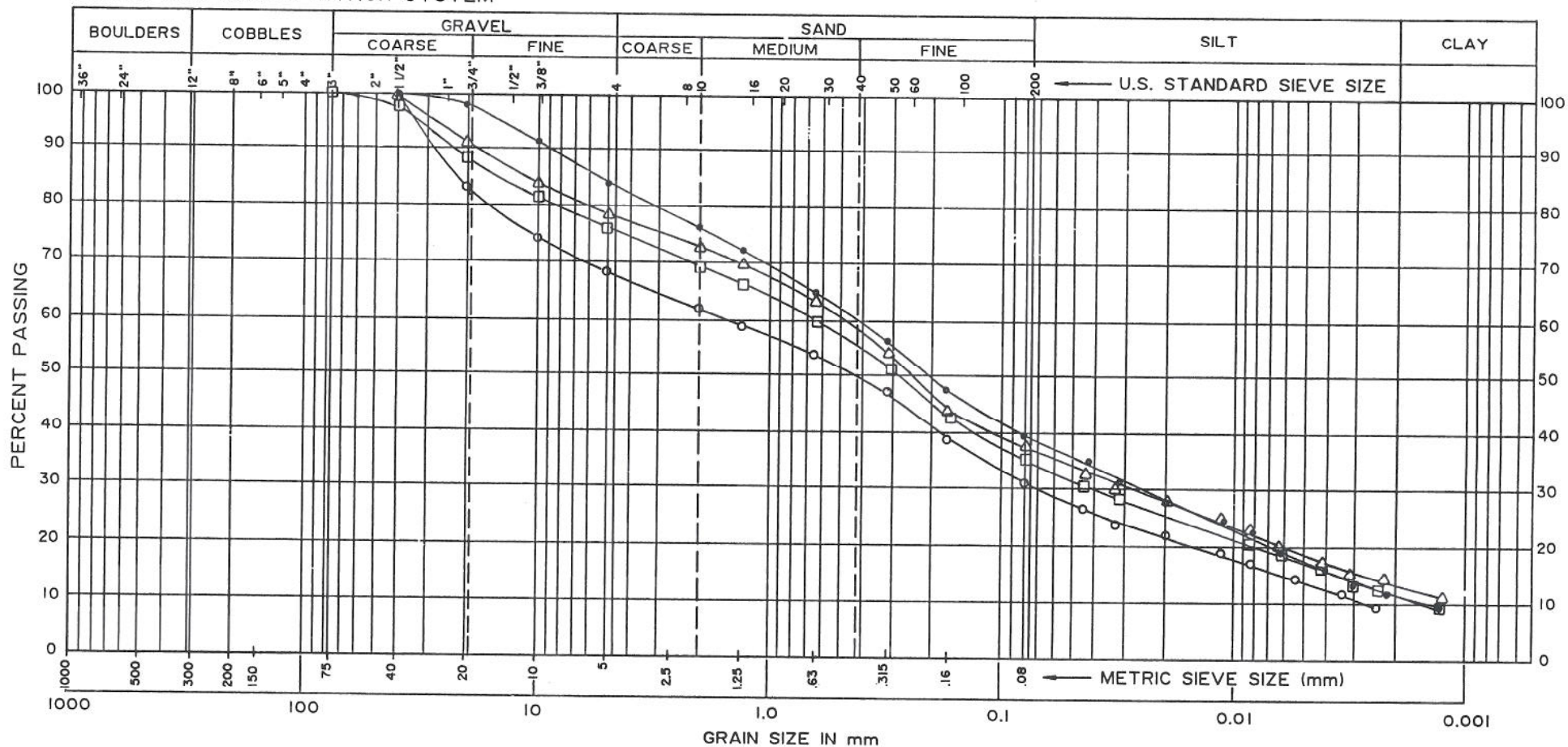
**TABLE 7 SUMMARY OF LABORATORY TEST RESULTS
- MINE HAUL ROAD**

Borehole No.	Sample No.	Depth (m)	Grain Size Distribution - %				Plasticity			Unified Class'n	W%	*Other Tests	
			Gravel	Sand	Silt	Clay	Wl	Wp	Ipa				
BH88-1MHR1	AS3	0.92-1.50	17	45	26	12	Not Tested			SM-SC	9.5	Nil	
			SILTY SAND TILL, some clay, some Gravel										
BH88-1MHR2	AS2	0.90-1.45	Not Tested									13.1	Nil
BH88-1MHR3	AS1	0.00-0.60	Not Tested									9.2	Nil
BH88-1MHR3	AS3 (CRREL)	1.35-1.46	32	38	22	8	Not Tested			SM-SC	23.2	γ_{bf} 1324 γ_d 1074	
			GRAVELLY SAND TILL, some Silt, trace Clay										
BH88-1MHR3	AS4	1.45-1.95	Not Tested									8.4	Nil
BH88-1MHR5	AS2	0.92-1.35	22	41	24	13	Not Tested			SM-SC	10.5	Nil	
			SAND TILL, some Silt, some Gravel, some Clay										
BH88-1MHR6	AS3	1.25-2.80	25	41	22	12	Not Tested			SM-SC	9.1	Nil	
			GRAVELLY SAND TILL, some Silt, some Clay										

* Other Tests - γ_{bf} = Bulk Frozen Density (kg/cu.m), γ_d = Dry Density (kg/cu.m.),

Gs = Specific Gravity Soil Solids

UNIFIED SOIL CLASSIFICATION SYSTEM



REMARKS: SILTY SAND TILL

Hole No.:
Sample No.:
Depth (m):
Dwn.:
Revw'd.:
Date:

SYMBOL	BH No.	Sa. No.	DEPTH (m)	I _p	UNIFIED CLASS.
•	BH88-IMHR1	AS3	0.92-1.50	NOT TESTED ↓	SM-SC
○	BH88-IMHR3	CRREL	1.35-1.46		SM-SC
△	BH88-IMHR5	AS2	0.92-1.35		SM-SC
□	BH88-IMHR6	AS3	1.25-2.80		SM-SC

Unified Soil Classification:

URANGESELLSCHAFT CANADA LIMITED
KIGGAVIK PROJECT

GRAIN SIZE DISTRIBUTION
MINE HAUL ROAD

Golder Associates

Project No. 881-1814D

Figure 2

DRILLING DATE: July 15-21, 2009
 DRILLING CONTRACTOR: BOART LONGYEAR
 LOGGED: MC/JW/MG/EAM
 CHECKED: EAM

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: ANDREW LAKE N 7134809.000 E 553319.000
G.S. ELEVATION: 167.07m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -65
AZIMUTH: 330

RECORD OF DRILLHOLE: AND09-02

DRILLING DATE: July 15-21, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: MC/JW/MG/EAM
CHECKED: EAM

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mAH)	RUN NUMBER	CORE RECOVERY		FRACTURE INDEX PER 0.25m	DISCONTINUITY DATA										BROKEN CORE LOST CORE	ROCK STRENGTH INDEX (R6-R0)	WEATHERING INDEX (W0-W6)	HYDRAULIC CONDUCTIVITY K, m/sec	INSTALLATION DETAILS/ ABANDONMENT DETAILS	ELEVATION (masl Vertical)		
					TOTAL CORE % 0 50 100	R.Q.D. % 0 50 100		Dip Direction 0 90 180 270	DIP w.r.t. CORE AXIS 0 90 180 270	(Jcon) JOINT CONDITION 0 6 12 20 25	(Jr) JOINT ROUGHNESS 0.5 1 1.5 2 3 4	(Ja) JOINT ALTERATION 0 7.5 12.5 15 20	(Jn) NUMBER OF FRACTURE SETS 0 5 10 15 20												
140	LEACHED SCHIST (134.42-154.06m) Slightly to completely weathered and leached, strong foliation, beige with some reddish brown, slightly pitted, fine grained, weak to extremely weak (continued)		27.44 154.06	58											139.96	139.70			No Installation	40					
59																					35				
60																					30				
61																					25				
62																					20				
145				63																	15				
64																					10				
65																					5				
66																					0				
67																					-5				
150	GNEISS (154.06-169.05m) Slightly weathered, strong foliation, some quartz veins (< 20mm) throughout, non porous, red and green, medium to strong			68																	-10				
69																					-15				
70																					-20				
71																					-25				
72																					-30				
155				73																	-35				
74																					-40				
75																					-45				
76																					-50				
77																					-55				
160	METASEDIMENT (169.05-230.34m) Highly chlorite altered, thinly foliated, green, some quartz veining, hematite alteration more pervasive after 169.75m		13.86 169.05	78																	-60				
79																					-65				
80																					-70				
81																					-75				
82																					-80				
165				83																	-85				
84																					-90				
85																					-95				
86																					-100				
87																					-105				
170	- from 176.00-177.57m; becoming reddish greenish white, highly bleached to white			88																	-110				
89																					-115				
90																					-120				
91																					-125				
92																					-130				
175				93																	-135				
94																					-140				
95																					-145				
96																					-150				
97																					-155				
180				98																	-160				
99																					-165				
100																					-170				
101																					-175				
102																					-180				
185				103																	-185				
104																					-190				
105																					-195				
106																					-200				
107																					-205				
190				108																	-210				
109																					-215				
110																					-220				
111																					-225				
112																					-230				
195				113																	-235				
114																					-240				
115																					-245				
116																					-250				
117																					-255				
200				118																	-260				
119																					-265				
205				- at 204.00m; disseminated metallic hematite, Increase in silica content make the rock more brittle/rubblized			120																	-270	
121																									-275
122																									-280
123																				-285					
124																				-290					
210				125																	-295				
126																					-300				
127																					-305				
128																					-310				
129																					-315				
215				130																	-320				
131																					-325				
132																					-330				
133																					-335				
134																					-340				
220				135																	-345				
136																					-350				
137																					-355				
138																					-360				
139																					-365				
225	- at 216.00m; dark purplish red, intensive quartz veining			140																	-370				
141																					-375				
142																					-380				
143																					-385				
144																					-390				
230				145																	-395				
146																					-400				
147																					-405				
148																					-410				
149																					-415				
235	- at 223.80-224.60m; potential fault zone or clay seam, characterized by rubble			150																	-420				
151																					-425				
152																					-430				
153																					-435				
154																					-440				
240				155																	-445				
156																					-450				
157																					-455				
158																					-460				
159																					-465				
245				160																	-470				
161																					-475				
162																					-480				
163																					-485				
164																					-490				
250				165																	-495				
166																					-500				
167																					-505				
168																					-510				
169																					-515				
255	- at 241.00m; green and red banded, frequent veining both concordant and discordant to foliation, mica content is variable, alteration is likely chloritic and K-feldspar			170																	-520				
171																					-525				
172																					-530				
173																					-535				
174																					-540				
260				175																	-545				
176																					-550				
177																					-555				
178																									

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

DEPTH SCALE
1 : 400



SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: ANDREW LAKE N 7134809.000 E 553319.000
G.S. ELEVATION: 167.07m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -65
AZIMUTH: 330

RECORD OF DRILLHOLE: AND09-02

DRILLING DATE: July 15-21, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: MC/JW/MG/EAM
CHECKED: EAM

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mAH)	RUN NUMBER	CORE RECOVERY		FRACTURE INDEX PER 0.25m	DISCONTINUITY DATA															BROKEN CORE LOST CORE	ROCK STRENGTH INDEX (R6-R0)	WEATHERING INDEX (W0-W6)	HYDRAULIC CONDUCTIVITY K, m/sec	INSTALLATION DETAILS/ ABANDONMENT DETAILS	ELEVATION (masl Vertical)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
					TOTAL CORE %	R.Q.D. %		Dip Direction	DIP w.r.t. CORE AXIS	(Jcon) JOINT CONDITION	(Jr) JOINT ROUGHNESS	(Ja) JOINT ALTERATION	(Jn) NUMBER OF FRACTURE SETS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
280	SYENITIC GNEISS (264.00-330.00m) Fresh, strong foliation, black pink and grey, fine to medium crystalline, faint (sometimes moderate) porosity, very strong, occasional sulphides in rock and on discontinuity surfaces <i>(continued)</i> - at 309.50m; K-feldspar alteration becomes pervasive - at 320.00m; K-feldspar alteration becomes intermittent END OF HOLE = 330m		-132.01	330.00	119																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				</

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: ANDREW LAKE N 7134574.000 E 533312.000
G.S. ELEVATION: 166.21m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -70
AZIMUTH: 284

RECORD OF DRILLHOLE: AND09-03

DRILLING DATE: July 22-28, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: EAM/JW/MC/MG/GY
CHECKED: EAM

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mAH)	RUN NUMBER	CORE RECOVERY		FRACTURE INDEX PER 0.25m	DISCONTINUITY DATA										BROKEN CORE LOST CORE	ROCK STRENGTH INDEX (R6-R0)	WEATHERING INDEX (W0-W6)	HYDRAULIC CONDUCTIVITY K, m/sec	INSTALLATION DETAILS/ ABANDONMENT DETAILS	ELEVATION (masl Vertical)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
					TOTAL CORE %	R.Q.D. %		Dip		DIP w.r.t. CORE AXIS	(Jcon) JOINT CONDITION	(Jr) JOINT ROUGHNESS	(Ja) JOINT ALTERATION	(Jn) NUMBER OF FRACTURE SETS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
					0-100	0-100		Direction	Dip	0-90	0-25	0-75	0-20	0-5	1-2	3-4	5-6					7-8		9-10	11-12	13-14	15-16	17-18	19-20																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
0	DRILL BLOCK=2.28mAGS		166.21																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

DEPTH SCALE
1 : 400



[illegible]

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: ANDREW LAKE N 7134574.000 E 533312.000
G.S. ELEVATION: 166.21m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -70
AZIMUTH: 284

RECORD OF DRILLHOLE: AND09-03

DRILLING DATE: July 22-28, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: EAM/JW/MC/MG/GY
CHECKED: EAM

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mAH)	RUN NUMBER	CORE RECOVERY		FRACTURE INDEX PER 0.25m	DISCONTINUITY DATA												BROKEN CORE LOST CORE	ROCK STRENGTH INDEX (R6-R0)	WEATHERING INDEX (W0-W6)	HYDRAULIC CONDUCTIVITY K, m/sec	INSTALLATION DETAILS/ ABANDONMENT DETAILS	ELEVATION (masl Vertical)
					TOTAL CORE %	R.Q.D. %		Dip Direction	DIP w.r.t. CORE AXIS	(Jcon) JOINT CONDITION	(Jr) JOINT ROUGHNESS	(Ja) JOINT ALTERATION	(Jn) NUMBER OF FRACTURE SETS												
280	SYENITIC GNEISS (208.03-296.50m) Fresh, strong foliation, orange black and white, non to faintly porous, medium crystalline, medium strong (<i>continued</i>)			115																					
285	- at 285.00m; increased pitting of core			116																					
290	- from 288.50-289.40m; alteration of rock causing grey/green discolouration and pitting, increased fractures			117																					
295				118																					
300	ALTERED SYENITIC GNEISS (296.50-303.58m) Altered, faintly porous, banded K-feldspar alteration, quartz veining continues, microfractures are abundant - at 299.00m; rock appears bleached, slightly weathered and highly porous - at 299.50m; weathering and pitting increases - from 300.00-309.26m; possible FAULT ZONE		-112.41 296.50	119																					
305	SYENITIC GNEISS (303.58-308.26m) Fresh, with abundant shears at variable angles		-119.06 303.58	120																					
310	BLEACHED SYENITIC GNEISS (308.26-313.95m) Bleached, no longer degradable, slightly weathered, medium strong, pitted and altered, trace amount of microfractures		-123.46 308.26	121																					
315	SYENITIC GNEISS (313.95-321.15m) Red, black, highly microfractured and quartz veining, staining and alteration along joint surfaces		-128.81 313.95	122																					
320	BLEACHED SYENITIC GNEISS (321.15-327.00m) Bleached white-black-pink, microfractures and quartz veining, moderately porous, medium strong with small weak sections		-135.57 321.15	123																					
325			-141.07 327.00	124																					
330	END OF HOLE = 327m			125																					
335				126																					
340				127																					
345				128																					
350				129																					
355				130																					
360				131																					
365				132																					
370				133																					
375				134																					
380				135																					
385				136																					
390				137																					
395																									
400																									
405																									
410																									
415																									
420																									

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

[illegible]

DRILLING DATE: June 8-14, 2009
 DRILLING CONTRACTOR: BOART LONGYEAR
 LOGGED: EMS/GY/AE/TF/JW
 CHECKED: EAM

DEPTH SCALE
1 : 400

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: END GRID LAKE N 7135933.830 E 554542.320
G.S. ELEVATION: 167.72m (Estimated based on LIDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -80
AZIMUTH: 150

RECORD OF DRILLHOLE: END09-02

[illegible]

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: END GRID LAKE N 7135933.830 E 554542.320
G.S. ELEVATION: 167.72m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -80
AZIMUTH: 150

RECORD OF DRILLHOLE: END09-02

DRILLING DATE: June 8-14, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: EMS/GY/AE/TF/JW
CHECKED: EAM

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (mAH)	RUN NUMBER	CORE RECOVERY		FRACTURE INDEX PER 0.25m	DISCONTINUITY DATA																		BROKEN CORE LOST CORE	ROCK STRENGTH INDEX (RG-R0)	WEATHERING INDEX (W0-W6)	HYDRAULIC CONDUCTIVITY K, msec	INSTALLATION DETAILS/ ABANDONMENT DETAILS	ELEVATION (masl Vertical)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
					TOTAL CORE %	R.Q.D. %		Dip Direction	DIP w.r.t. CORE AXIS	(Jcon) JOINT CONDITION	(Jr) JOINT ROUGHNESS	(Ja) JOINT ALTERATION	(Jn) NUMBER OF FRACTURE SETS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
420	METASEDIMENT (393.00-495.00m) Green grey, some veining and microfractures, slight foliation (continued)	MS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ CAL-SASK.GDT 2/11/09 SIB

DRILLING DATE: August 19-22, 2009
 DRILLING CONTRACTOR: BOART LONGYEAR
 LOGGED: MC/JW/EAM/EB
 CHECKED: EAM

DEPTH SCALE
1 : 400

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: END GRID LAKE N 7135895.000 E 554602.000
G.S. ELEVATION: 166.71m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -85
AZIMUTH: 10

RECORD OF DRILLHOLE: END09-11

DRILLING DATE: August 19-22, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: MC/JW/EAM/EB
CHECKED: EAM

[illegible]

DEPTH SCALE
1 : 400



PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: END GRID LAKE N 7135895.000 E 554602.000
G.S. ELEVATION: 166.71m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -85
AZIMUTH: 10

RECORD OF DRILLHOLE: END09-11

DRILLING DATE: August 19-22, 2009
DRILLING CONTRACTOR: BOART LONGYEAR
LOGGED: MC/JW/EAM/EB
CHECKED: EAM

DEPTH SCALE METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m/AH)	RUN NUMBER	CORE RECOVERY		FRACTURE INDEX PER 0.25m	DISCONTINUITY DATA																BROKEN CORE LOST CORE	ROCK STRENGTH INDEX (R6-R0)				WEATHERING INDEX (W0-W6)				HYDRAULIC CONDUCTIVITY K, m/sec	INSTALLATION DETAILS/ ABANDONMENT DETAILS	ELEVATION (masl Vertical)
					TOTAL CORE %	R.Q.D. %																													
								Dip Direction	DIP w.r.t. CORE AXIS	(Jcon) JOINT CONDITION	(Jr) JOINT ROUGHNESS				(Ja) JOINT ALTERATION				(Jn) NUMBER OF FRACTURE SETS																
											0 6 12 20 25	0.5 1 1.5 2 3 4	0.75 1 2 3 4 5 6 8 10 12 15 20	0.5 1 2 3 4 6 9 12 15 20																					
280	METASEDIMENT (270.00-301.30m) Foliated at 60 degrees to core axis, green, fine grained, moderately porous (continued)	MS MS																																	

SASK-ROCK-KIGGAVIK 09-1362-0613-DRILLHOLES.GPJ GAL-SASK.GDT 2/11/09 SIB

DEPTH SCALE
1 : 400



PROJECT: 09-1362-0613 AREVA KIGGAVIK
LOCATION: END GRID LAKE N 7135895.000 E 554602.000
G.S. ELEVATION: 166.71m (Estimated based on LiDAR Data)
DATUM: NAD 83, Zone 14
INCLINATION: -85
AZIMUTH: 10

RECORD OF DRILLHOLE: END09-11

[illegible]

Geotechnical Log

Page 1 of 1

PROJECT : Kiggavik	NORTHING : 7134733.2	EASTING : 552677.5
SITE : Andrew Lake	ELEVATION : 167.3m	DIP : -60
DRILLING CONTRACTOR: Boart Longyear	LOGGED BY: Bibek Shrestha	AZIMUTH : N125
DRILLING TYPE: Diamond	CHECKED BY:	

HOLE ID:	AND-10-03
Hole Diameter: NQ	Core Diameter: NQ
Drilling Date:	31/07/2010 - 08/08/2010
Logging Date:	02/08/2010 - 03/08/2010

RUN	Depth (m)	Graphic Log	LITHOLOGY	TCR (%)	RQD (%)	FF/Run	IRS	WI	Description
1	0		Overburden (not retrieved with the available drilling techniques)						
2	3								
3	6								
4	9.00								
4	9.90								
4	12		Pink-grey, fine to medium crystalline, strong to extremely strong, fairly fresh to slightly weathered, well banded granitic gneiss	100	90	4.8	R5/R6	W2	
5	15			100	98	3.0	R6	W1	Pyrite coating and carbonate infill in joints
6	18			100	100	1.3	R5	W1	~4cm Qz VN at 17.40m @30TCA
7	21			100	91	8.7	R4/R5	W2	Possible structural feature (RZ) characterized by crushed rock with silt/clay as a infilling material from 19.13-19.46m
8	24			100	92	3.0	R5	W2	BC: 19.13-19.23m
9	27			98	95	2.7	R5	W1	LC: 19.23-19.46m
10	30.00			97	97	1.7	R5	W1/W2	~2cm Qz VN at 25.90m @17TCA
11	33			100	93	3.7	R5	W1/W2	In General, Qz VN is common throughout
12	36			100	89	3.7	R5	W1/W2	
13	39.00			99	99	3.0	R5	W1	~2-3cm Qz VN at 36.82m @15TCA
14	42			100	86	6.0	R4/R5	W1/W2	Prominent Qz VN at 38.62-38.91m @14TCA
15	45			100	100	2.7	R5	W1	BC: 10cm between 40.60-40.80m and 5cm between 41.00-41.20m
16	48.00			100	100	1.7	R5/R6	W1	
17	51			97	92	3.7	R4/R5	W2	BC: 50.63-50-73m
18	54								
19	57								
20	60								

BC	LC	Discontinuity Data			
		Jcon	Jn	Jr	Ja
		26	6	3	1
		27	6	2	2
		26	4	2	1
		26	12	3	2
		26	9	3	2
		25	6	2	1
		25	6	2	1
		26	12	3	1
		25	6	3	2
		26	9	2	2
		25	12	2	2
		25	6	2	2
		27	3	2	1
		25	4	2	2

Overburden
 Granitic gneiss
 Quartzite
 Intrusive
 Metasediment
 JN = Joint
 FLT = Fault
 SH = Shear
 VN = Vein
 FR = Fracture
 PL = Planar
 CU = Curved
 UN = Undulating (wavy)
 ST = Stepped
 IR = Irregular
 SL = Slickensided, PO = Polished
 SM = Smooth, RO = Rough
 VRO = Very Rough
 Lost Core (LC)
 Broken Core (BC)

Jcon = Joint Condition
 Jn = Joint Set Number
 Jr = Joint Roughness Number
 Ja = Joint Alteration Number
 (All are average value per run)

Geotechnical Log

Page 1 of 1

PROJECT : Kiggavik	NORTHING : 7134733.2	EASTING : 552677.5
SITE : Andrew Lake	ELEVATION : 167.3m	DIP : -60
DRILLING CONTRACTOR: Boart Longyear	LOGGED BY: Bibek Shrestha	AZIMUTH : N125
DRILLING TYPE: Diamond	CHECKED BY:	

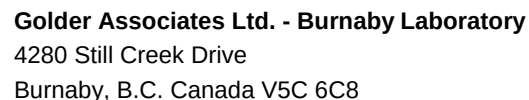
HOLE ID:	AND-10-03
Hole Diameter: NQ	Core Diameter: NQ
Drilling Date:	31/07/2010 - 08/08/2010
Logging Date:	02/08/2010 - 03/08/2010

RUN	Depth (m)	Graphic Log	LITHOLOGY	TCR (%)	RQD (%)	FF/Run	IRS	WI	Description
1	0		Overburden (not retrieved with the available drilling techniques)						
2	3								
3	6								
4	9.00								
4	9.90								
4	12		Pink-grey, fine to medium crystalline, strong to extremely strong, fairly fresh to slightly weathered, well banded granitic gneiss	100	90	4.8	R5/R6	W2	
5	15			100	98	3.0	R6	W1	Pyrite coating and carbonate infill in joints
6	18			100	100	1.3	R5	W1	~4cm Qz VN at 17.40m @30TCA
7	21			100	91	8.7	R4/R5	W2	Possible structural feature (RZ) characterized by crushed rock with silt/clay as a infilling material from 19.13-19.46m
8	24			100	92	3.0	R5	W2	BC: 19.13-19.23m
9	27			98	95	2.7	R5	W1	LC: 19.23-19.46m
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11	33			100	93	3.7	R5	W1/W2	In General, Qz VN is common throughout
12	36			100	89	3.7	R5	W1/W2	
13	39.00			99	99	3.0	R5	W1	~2-3cm Qz VN at 36.82m @15TCA
14	42			100	86	6.0	R4/R5	W1/W2	Prominent Qz VN at 38.62-38.91m @14TCA
15	45			100	100	2.7	R5	W1	BC: 10cm between 40.60-40.80m and 5cm between 41.00-41.20m
16	48.00			100	100	1.7	R5/R6	W1	
17	51			97	92	3.7	R4/R5	W2	BC: 50.63-50-73m
18	54								
19	57								
20	60								

BC	LC	Discontinuity Data			
		Jcon	Jn	Jr	Ja
		26	6	3	1
		27	6	2	2
		26	4	2	1
		26	12	3	2
		26	9	3	2
		25	6	2	1
		25	6	2	1
		26	12	3	1
		25	6	3	2
		26	9	2	2
		25	12	2	2
		25	6	2	2
		27	3	2	1
		25	4	2	2

Overburden
 Granitic gneiss
 Quartzite
 Intrusive
 Metasediment
 JN = Joint
 FLT = Fault
 SH = Shear
 VN = Vein
 FR = Fracture
 PL = Planar
 CU = Curved
 UN = Undulating (wavy)
 ST = Stepped
 IR = Irregular
 SL = Slickensided, PO = Polished
 SM = Smooth, RO = Rough
 VRO = Very Rough
 Lost Core (LC)
 Broken Core (BC)

Jcon = Joint Condition
 Jn = Joint Set Number
 Jr = Joint Roughness Number
 Ja = Joint Alteration Number
 (All are average value per run)



Reference
ASTM C136-06 & C117-04

Borehole:	END-0B-09
------------------	------------------

Sample No.: 1

Depth (m): 0.30

Lab ID No: 140

Other:

Material Specification: NONE

Method:	SPLIT, WASHED
---------	---------------

Date Tested: 8/7/2009

Size of opening, inches

U.S. Standard Sieve Size, opening in meshes / inch

USCS GRAIN SIZE SCALE

24 12 6 3 1 1/2 3/4 3/8 #4 #10 #20 #40 #60 #200

100

90

80

70

60

50

40

30

20

10

0

Percent Finer By Mass

1000 100 10 1 0.1 0.01 0.001 0.0001

Grain Size (mm)

Grain Size (mm)	Percent Finer By Mass (%)
1000	100
4.75	100
2.0	98
0.85	94
0.425	85
0.25	67
0.15	32
0.075	15
0.075	9

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

August 11, 2009

DATE _____

PARTICLE SIZE ANALYSIS OF SOILS

Reference

ASTM D 422-63 (2007)

Project No.: 09-1426-0001/4000

Borehole: **END-0B-09**
Client: Areva

Sample No.: 2

Project: Kiggavik

Depth (m): 0.20-0.30

Location: Nunavut

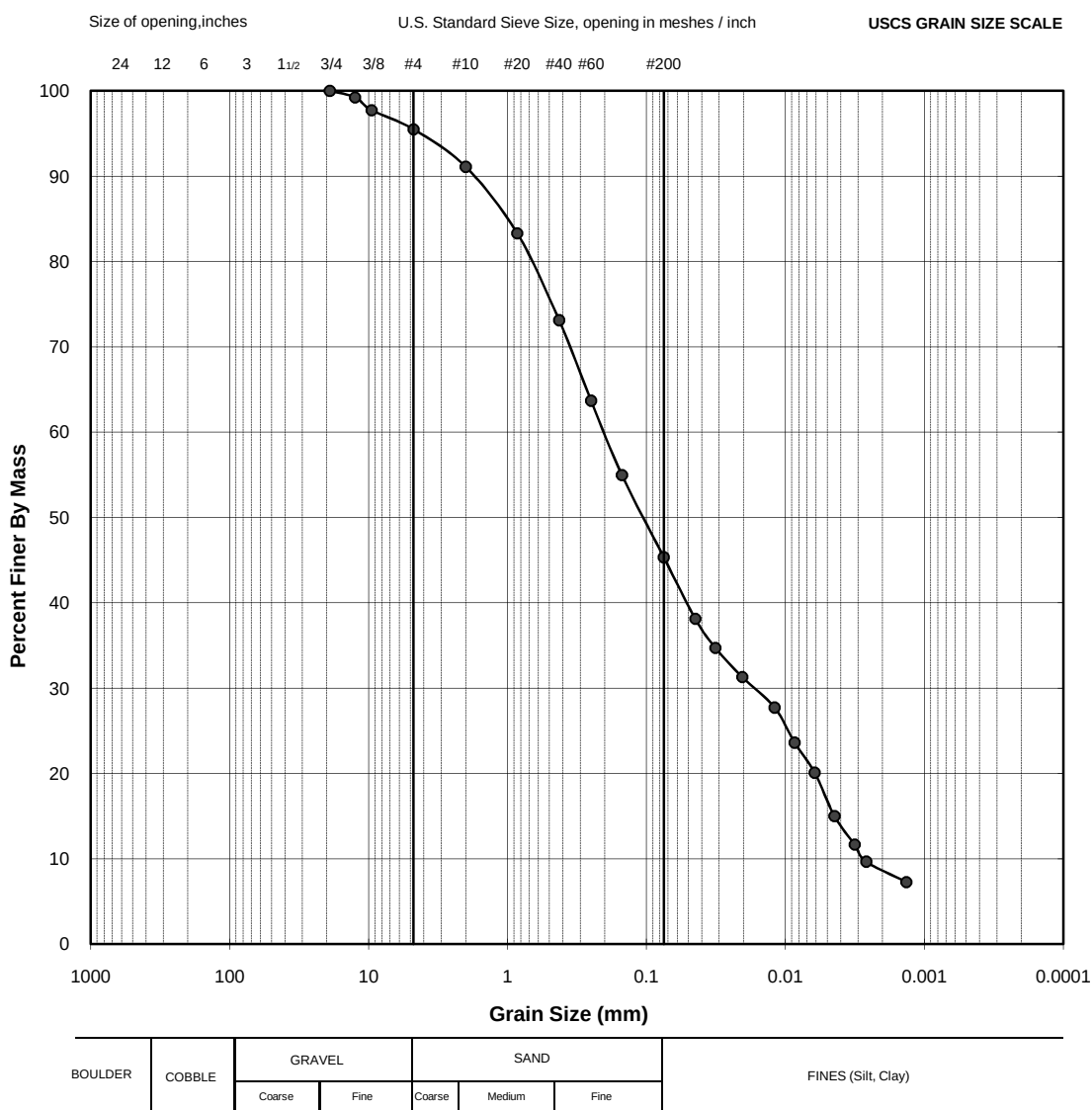
Lab ID No: 140

Specific Gravity (assumed): 2.76

Other
Remarks:
Dispersion Method: Stirring

Dispersion Period (min): 0.00

Sieve Size		% Passing
(USS)	(mm)	
3.5"	87.50	100.0
3"	75.00	100.0
2"	50.00	100.0
1.5"	37.50	100.0
1"	25.00	100.0
3/4"	19.00	100.0
1/2"	12.50	99.2
3/8"	9.50	97.7
#4	4.75	95.5
#10	2.00	91.1
#20	0.850	83.3
#40	0.425	73.1
#60	0.250	63.7
#100	0.150	55.0
#200	0.075	45.3
-	0.0445	38.1
-	0.0319	34.7
-	0.0204	31.3
-	0.0119	27.7
-	0.0086	23.6
-	0.0062	20.1
-	0.0044	15.0
-	0.0032	11.7
-	0.0026	9.7
-	0.0013	7.3



* The test data given herein pertain to the sample provided only. This report constitutes a testing service only.
 Interpretation of the data can be provided upon request.

EB

Aug 9, 2009

LP

August 11, 2009

TESTED BY

DATE

CHECKED BY

DATE

PARTICLE SIZE ANALYSIS OF SOILS

Reference

ASTM D 422-63 (2007)

Project No.: 09-1426-0001/4000

Client: Areva

Project: Kiggavik

Location: Nunavut

Borehole: **END-0B-09**
Sample No.: 3

Depth (m): 0.20-0.30

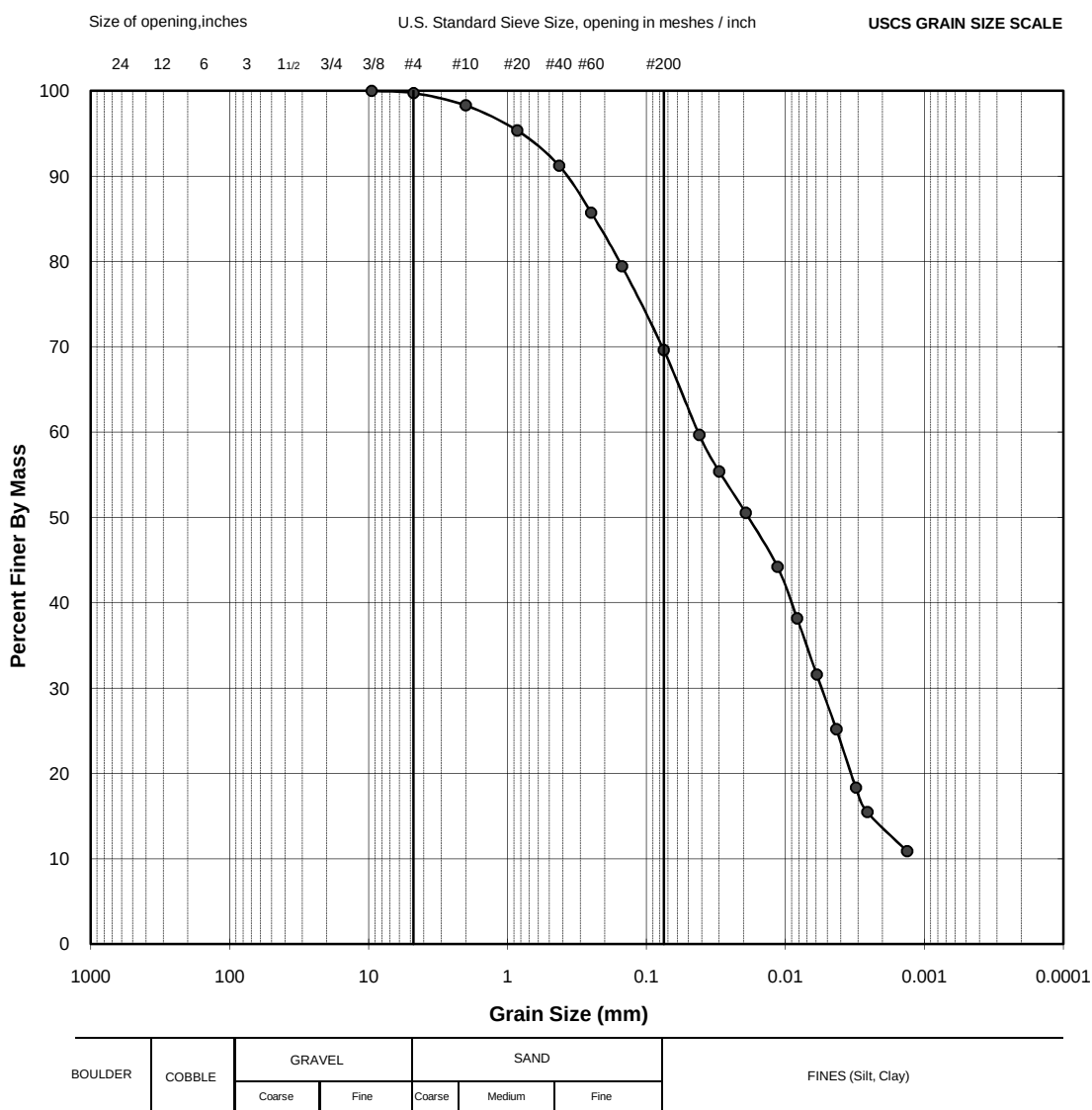
Lab ID No: 140

Specific Gravity (assumed): 2.76

Other
Remarks:
Dispersion Method: Stirring

Dispersion Period (min): 0.00

Sieve Size (USC)	(mm)	% Passing
3.5"	87.50	100.0
3"	75.00	100.0
2"	50.00	100.0
1.5"	37.50	100.0
1"	25.00	100.0
3/4"	19.00	100.0
1/2"	12.50	100.0
3/8"	9.50	100.0
#4	4.75	99.7
#10	2.00	98.3
#20	0.850	95.3
#40	0.425	91.2
#60	0.250	85.7
#100	0.150	79.4
#200	0.075	69.6
-	0.0416	59.7
-	0.0299	55.4
-	0.0193	50.5
-	0.0114	44.2
-	0.0082	38.2
-	0.0059	31.6
-	0.0043	25.2
-	0.0031	18.3
-	0.0026	15.5
-	0.0013	10.9



* The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.

EB

Aug 9, 2009

LP

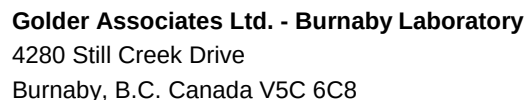
August 11, 2009

TESTED BY

DATE

CHECKED BY

DATE



Reference
ASTM C136-06 & C117-04

Borehole:	END-0B-09
-----------	-----------

Sample No.: 4

Depth (m):	0.20-0.30
------------	-----------

Lab ID No: 140

Other:

Material Specification: NONE

Method: SPLIT, WASHED

Date Tested: 8/7/2009

Size of opening, inches: 24 12 6 3 1 1/2 3/4 3/8 #4 #10 #20 #40 #60 #200

U.S. Standard Sieve Size, opening in meshes / inch

USCS GRAIN SIZE SCALE

Percent Finer By Mass

Grain Size (mm)

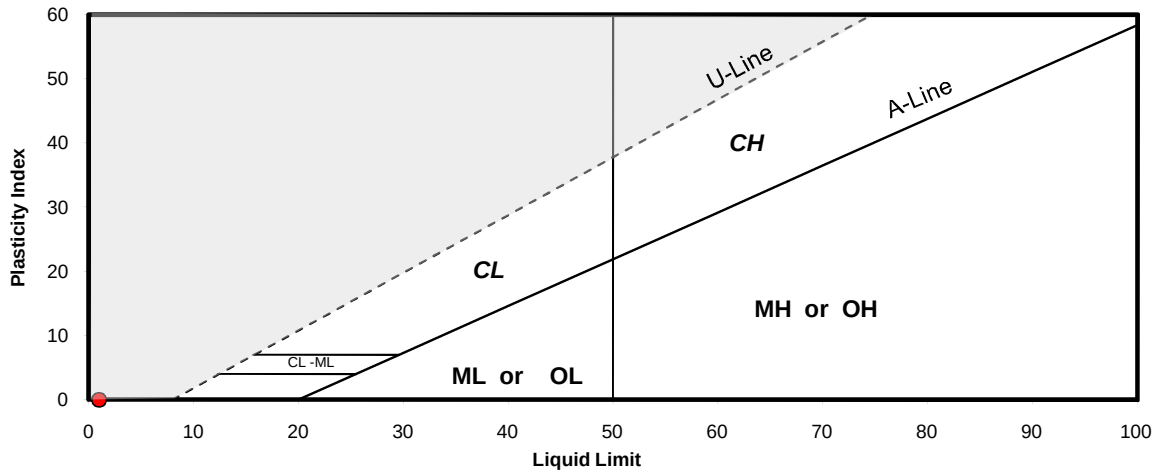
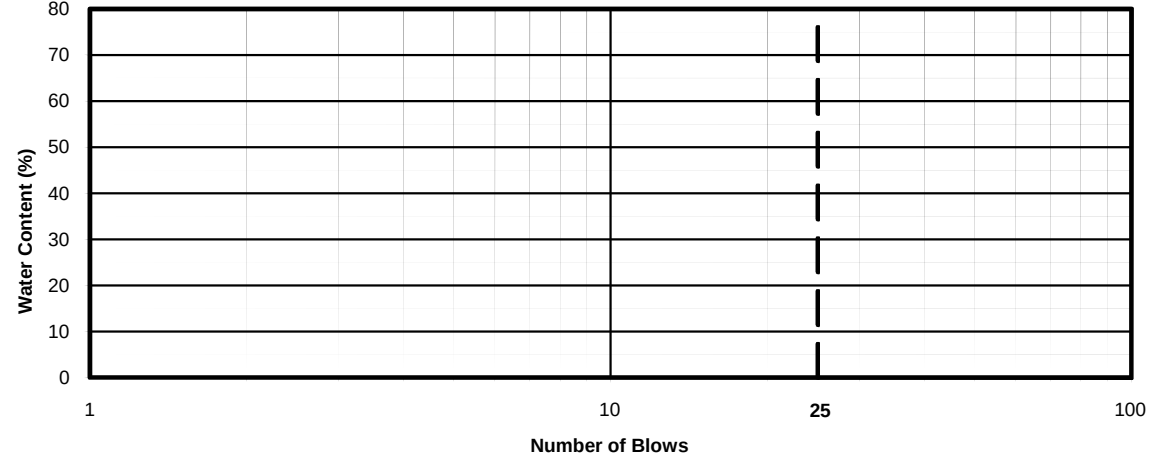
Grain Size (mm)	Percent Finer By Mass (%)
600	100
425	95
300	83
250	80
200	75
150	73
100	65
75	57
60	48
42.5	37
30	26
25	17
20	7

BOULDER		COBBLE		GRAVEL		SAND			FINES (Silt, Clay)	
				Coarse	Fine	Coarse	Medium	Fine		

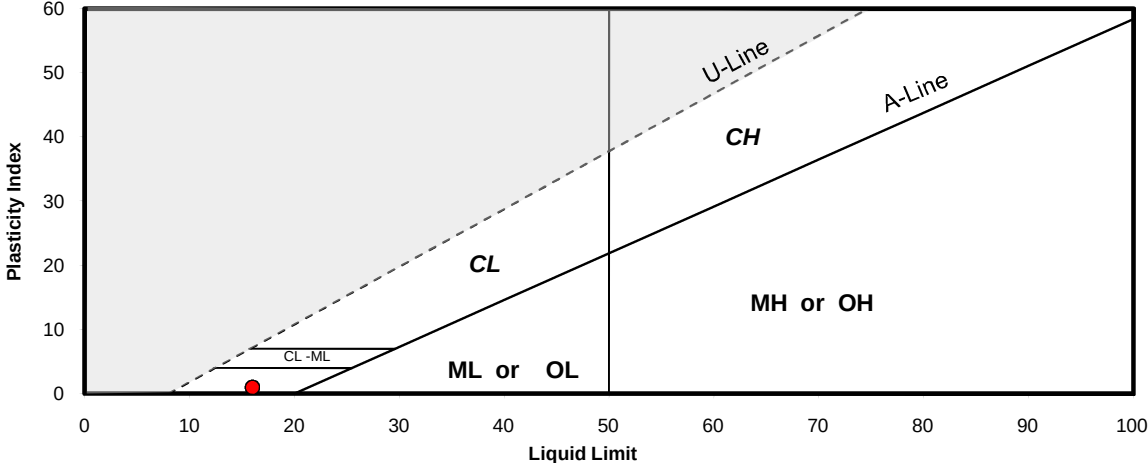
** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.*

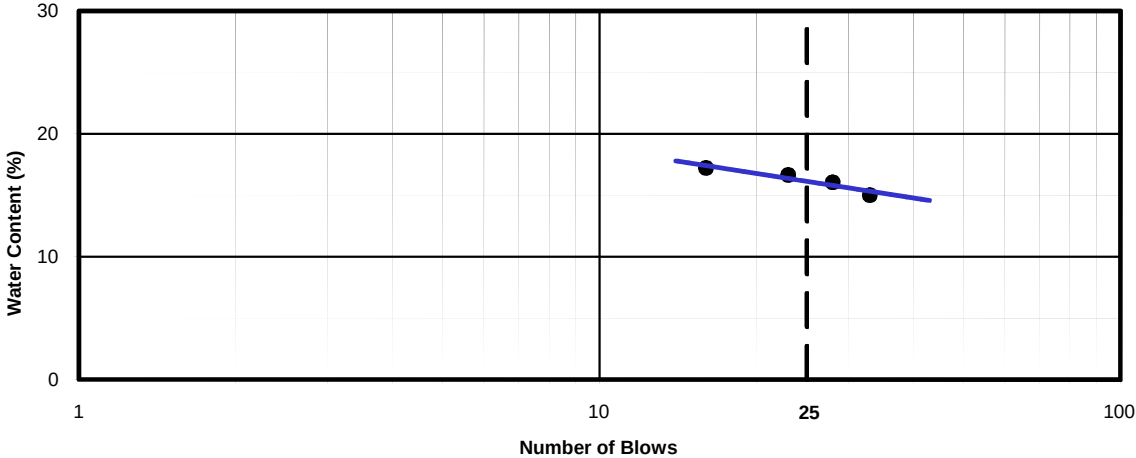
August 11, 2009

DATE _____

Liquid Limit, Plastic Limit and Plasticity Index of Soils				Reference ASTM D 4318-05																	
Project No.: 09-1426-0001/4000		Borehole:		END-0B-09																	
Client: Areva		Sample No.:		2																	
Project: Kiggavik		Depth (m):		0.20-0.30																	
Location: Nunavut		Lab ID No.:		140																	
Method: A-Multi Point		Preparation Method:		Air-Dried																	
Sample Description:		Classification Definition																			
																					
																					
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Test Summary</th> <th style="text-align: center;">Remarks</th> </tr> </thead> <tbody> <tr> <td style="width: 40%;">Percent passing #40 Sieve (%)</td> <td style="width: 20%; text-align: center;">N/A</td> <td rowspan="6" style="width: 40%; vertical-align: top;">Non-Plastic sample</td> </tr> <tr> <td>Liquid Limit</td> <td style="text-align: center;">N/A</td> </tr> <tr> <td>Plastic Limit</td> <td style="text-align: center;">Non Plastic</td> </tr> <tr> <td>Plasticity Index</td> <td style="text-align: center;">N/A</td> </tr> <tr> <td>Natural water content (%)</td> <td style="text-align: center;">11</td> </tr> <tr> <td>Liquidity Index</td> <td style="text-align: center;">N/A</td> </tr> </tbody> </table>						Test Summary		Remarks	Percent passing #40 Sieve (%)	N/A	Non-Plastic sample	Liquid Limit	N/A	Plastic Limit	Non Plastic	Plasticity Index	N/A	Natural water content (%)	11	Liquidity Index	N/A
Test Summary		Remarks																			
Percent passing #40 Sieve (%)	N/A	Non-Plastic sample																			
Liquid Limit	N/A																				
Plastic Limit	Non Plastic																				
Plasticity Index	N/A																				
Natural water content (%)	11																				
Liquidity Index	N/A																				
<i>* The test data given herein pertain to the sample provided only. This report constitutes a testing service only.</i>																					
EB		August 9, 2009		LP																	
TESTED BY		DATE		CHECKED BY																	
DATE		DATE		DATE																	

Liquid Limit, Plastic Limit and Plasticity Index of Soils				Reference ASTM D 4318-05
Project No.: 09-1426-0001/4000 Client: Areva Project: Kiggavik Location: Nunavut	Borehole: Sample No.: 3 Depth (m): 0.20-0.30 Lab ID No.: 140			
Method: A-Multi Point Sample Description: ML	Preparation Method: Air-Dried Classification Definition <i>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity</i>			





Test Summary	Remarks
Percent passing #40 Sieve (%)	
Liquid Limit 16	
Plastic Limit 15	
Plasticity Index 1	
Natural water content (%) 15	
Liquidity Index 0.0	

* The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

EB	August 9, 2009	LP	August 11, 2009
TESTED BY	DATE	CHECKED BY	DATE

GENERAL TESTING RESULTS

Project #: 09-1426-0001/4000
 Short Title: Kiggavik
 Client: Areva
 Location: Nunavut
 Lab ID: 140

Borehole	END-0B-09	END-0B-09	END-0B-09	END-0B-09		
Sample Number	1	2	3	4		
Depth (m)	0.30	0.20-0.30	0.20-0.30	0.20-0.30		
Mass of Dry Soil (g)	346.7	468.5	373.0	1842.2		
Water Content W (%)	22.5	10.5	15.0	3.1		

Borehole						
Sample Number						
Depth (m)						
Mass of Dry Soil (g)						
Water Content W (%)						

Borehole						
Sample Number						
Depth (m)						
Mass of Dry Soil (g)						
Water Content W (%)						

Borehole						
Sample Number						
Depth (m)						
Mass of Dry Soil (g)						
Water Content W (%)						

Borehole						
Sample Number						
Depth (m)						
Mass of Dry Soil (g)						
Water Content W (%)						

EB/TD

August 7, 2009

LP

August 11, 2009

TESTED BY

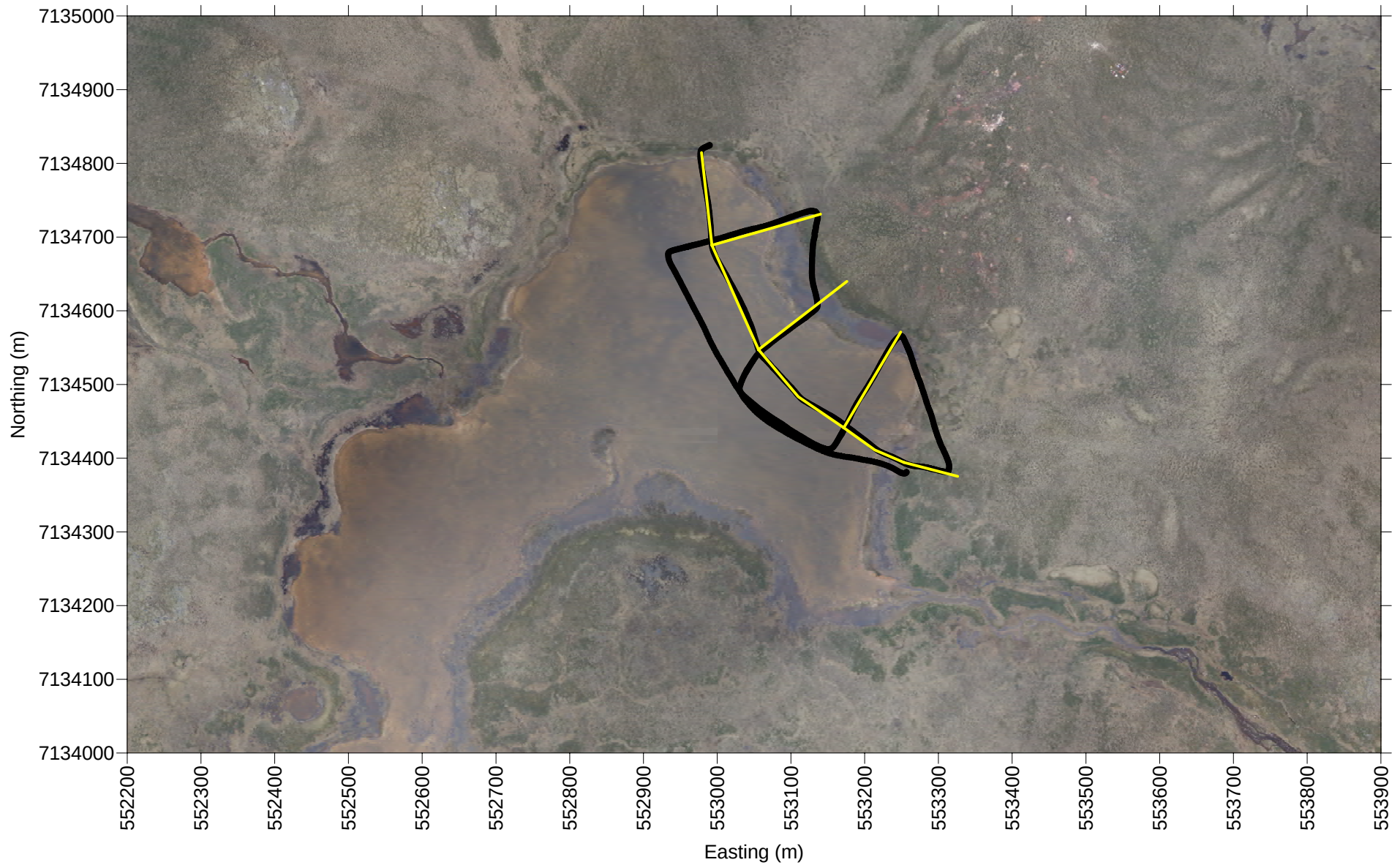
DATE TESTED

CHECKED BY

DATE CHECKED



Summary Records of EBA GPR Surveys



Scale (1:7500)
NAD83
UTM Zone 14

LEGEND



Collected GPR Tracks



Proposed GPR Tracks

CLIENT



EBA Engineering
Consultants Ltd.

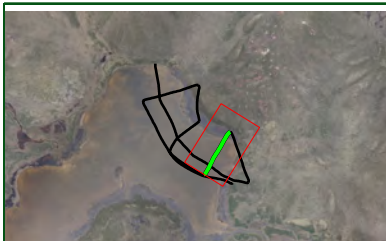
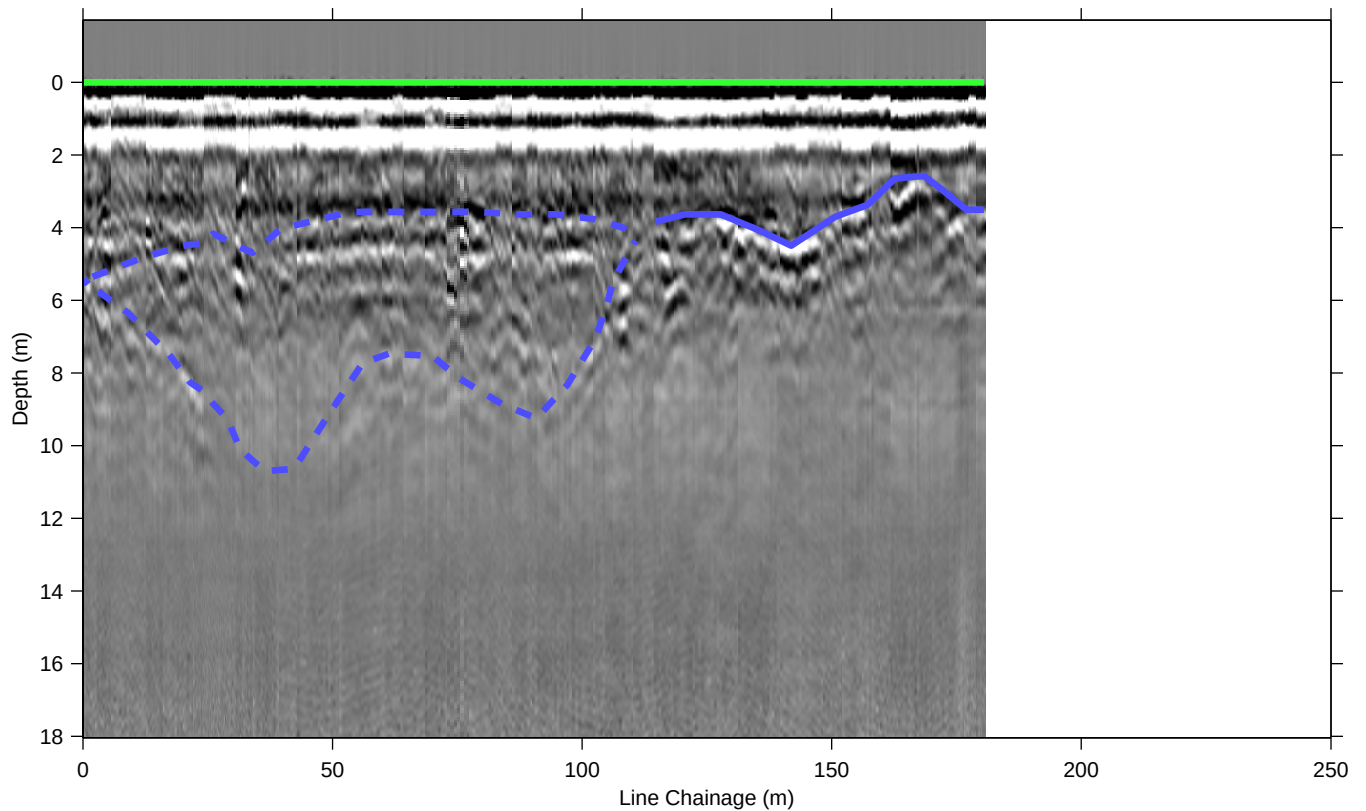
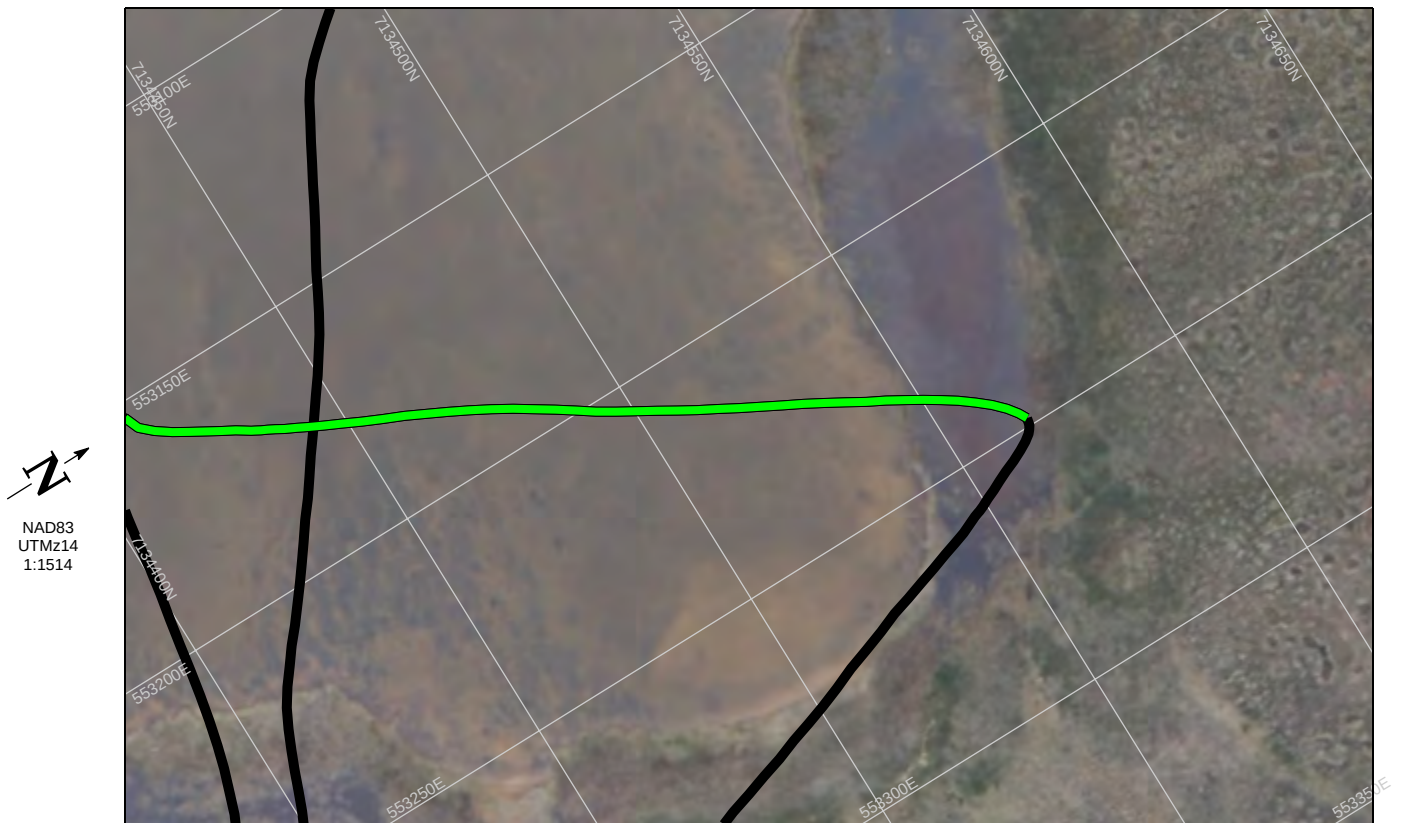


Areva Sissons Project 2008-2009 Subsurface GPR Survey

GPR Survey Coverage
Andrew Lake Proposed Dyke Location

PROJECT NO.	DWN	CKD	REV
V33101016	RJM	NSP	0
OFFICE	DATE		
CGY-EBA	Nov 27, 2009		

Figure D1



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Areva Sissons Project 2008–2009 Subsurface GPR Survey

Proposed Andrew Lake Dyke Location GPR Profiles

Project No.
V33101016

DWN
RJM

CHKD
NSP

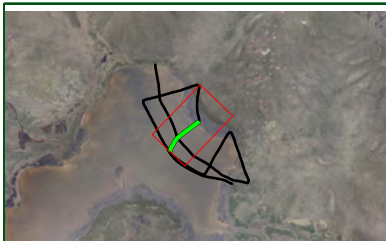
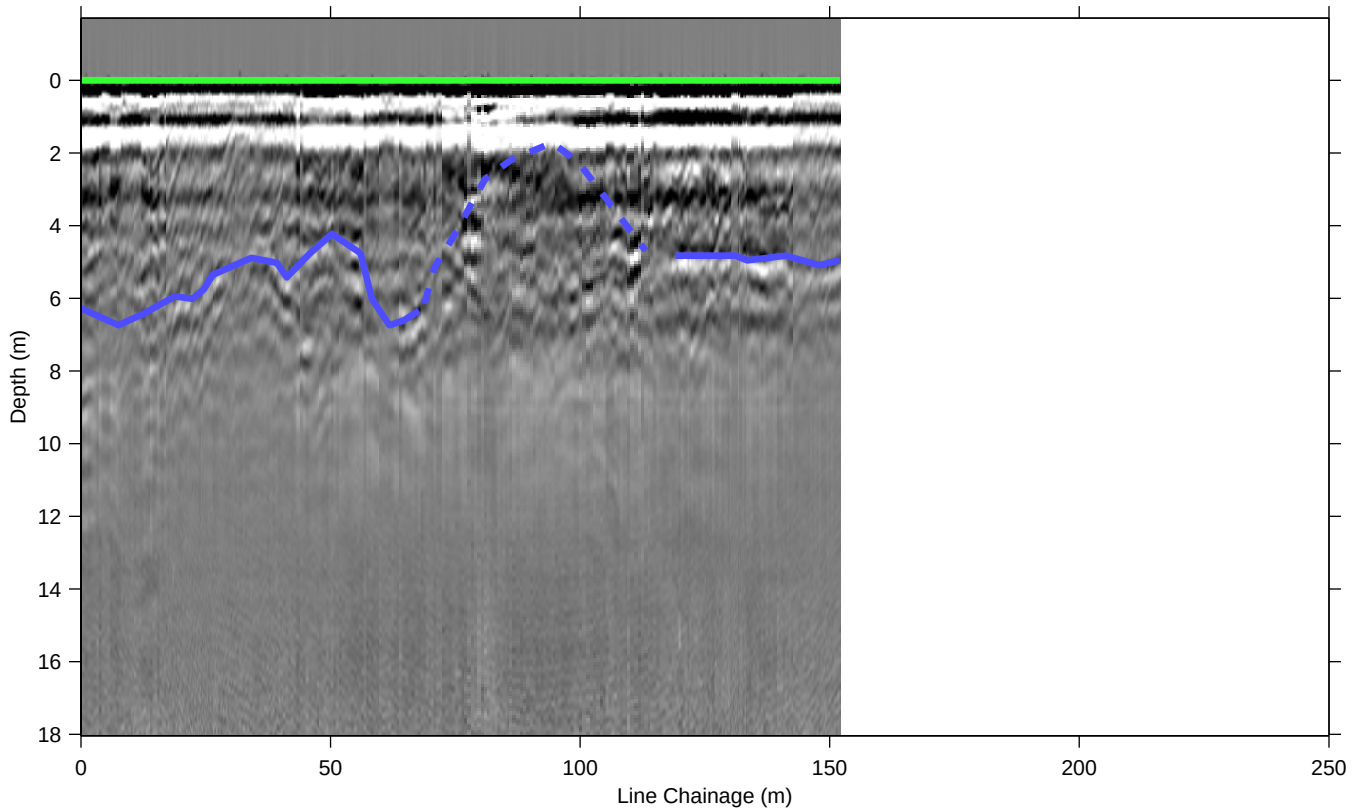
REV
0

OFFICE
Calgary

DATE
Nov. 30, 2009

Figure D3


 NAD83
 UTMz14
 1:1514



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Consultants Ltd.



Areva Sissons Project 2008–2009 Subsurface GPR Survey

Proposed Andrew Lake Dyke Location GPR Profiles

Project No.
V33101016

DWN
RJM

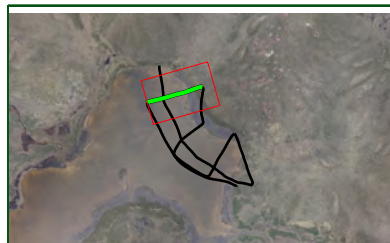
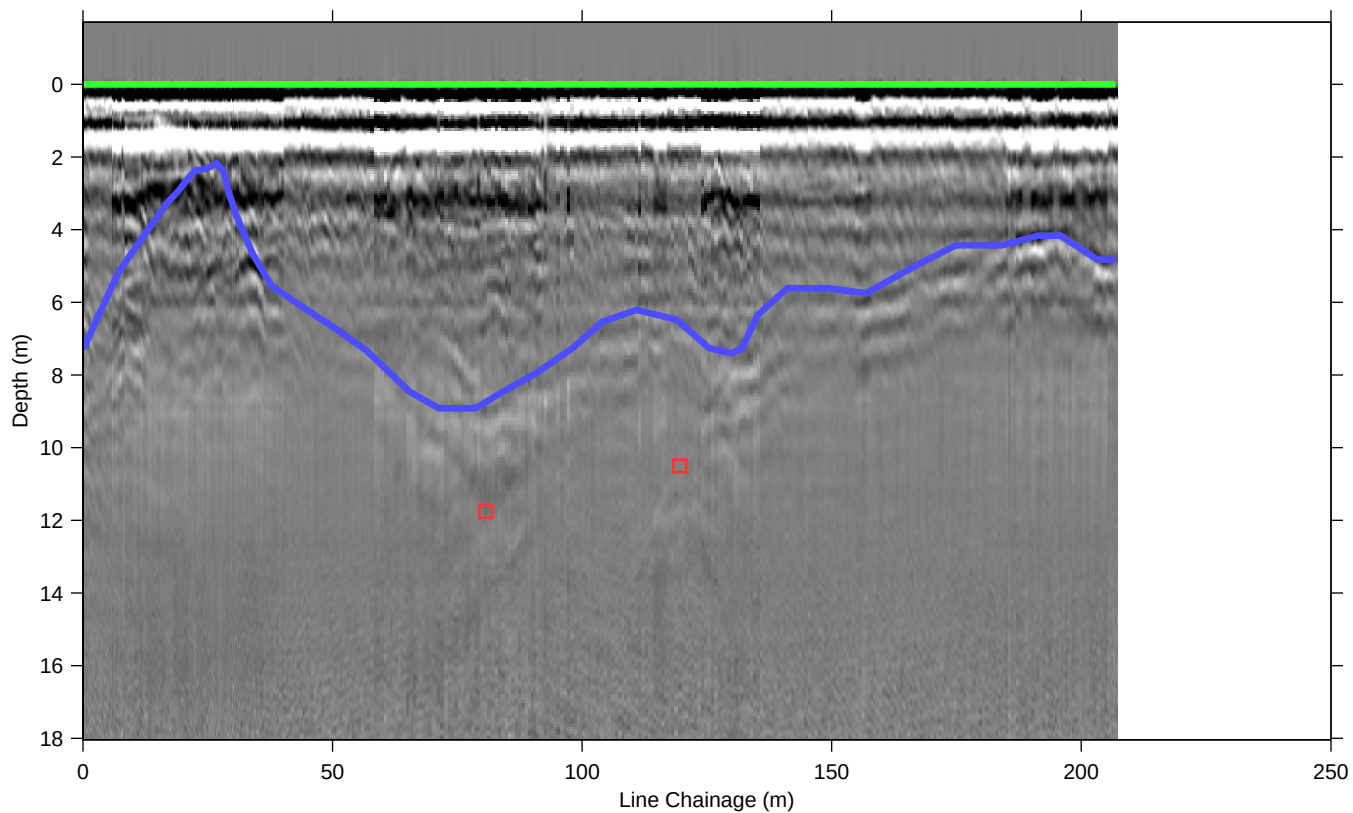
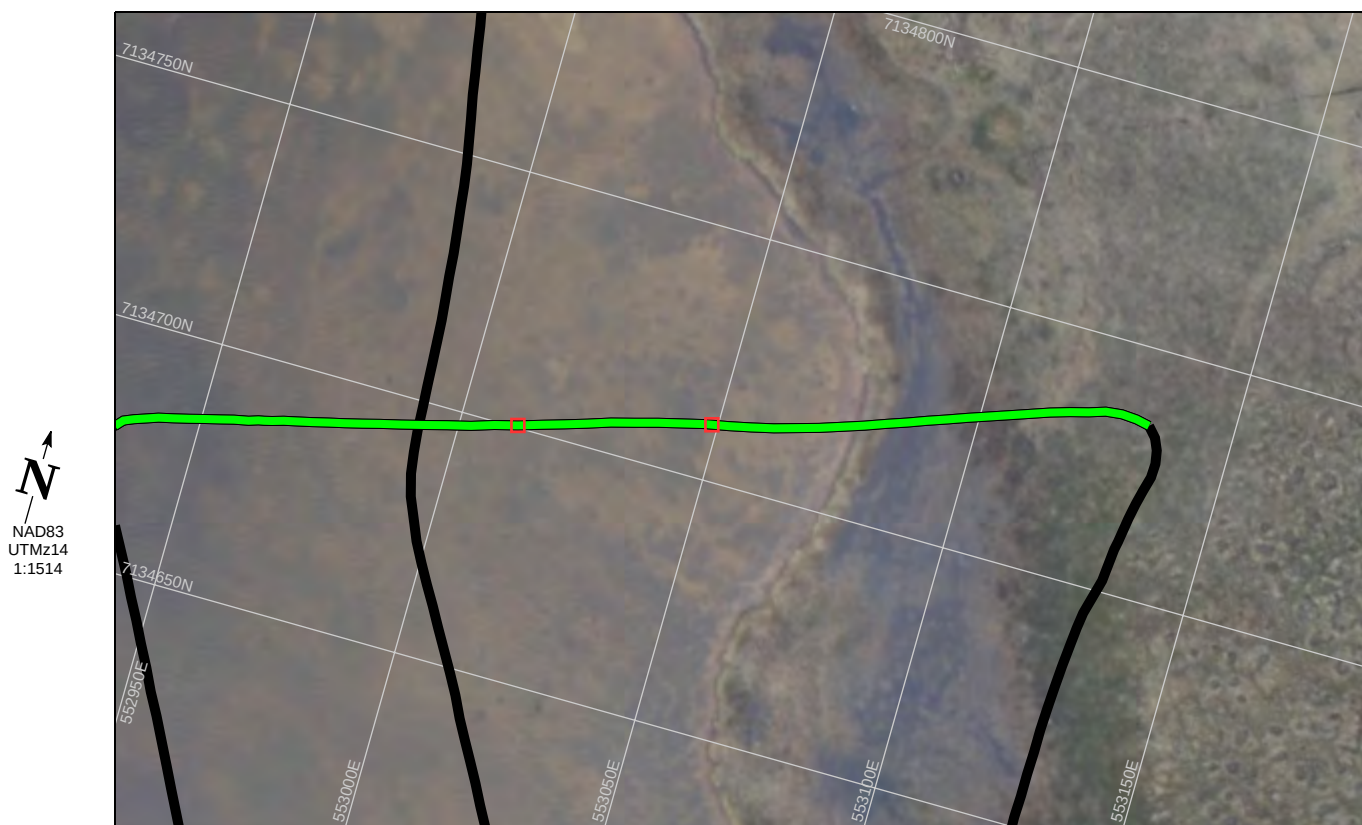
CHKD
NSP

REV
0

OFFICE
Calgary

DATE
Nov. 30, 2009

Figure D4



CLIENT



EBA Engineering
Consultants Ltd.



Areva Sissons Project 2008–2009 Subsurface GPR Survey

Proposed Andrew Lake Dyke Location GPR Profiles

Project No.
V33101016

OFFICE
Calgary

DWN
RJM

CHKD
NSP

REV
0

DATE
Nov. 30, 2009

Figure D5



APPENDIX B

2010 Investigation Results

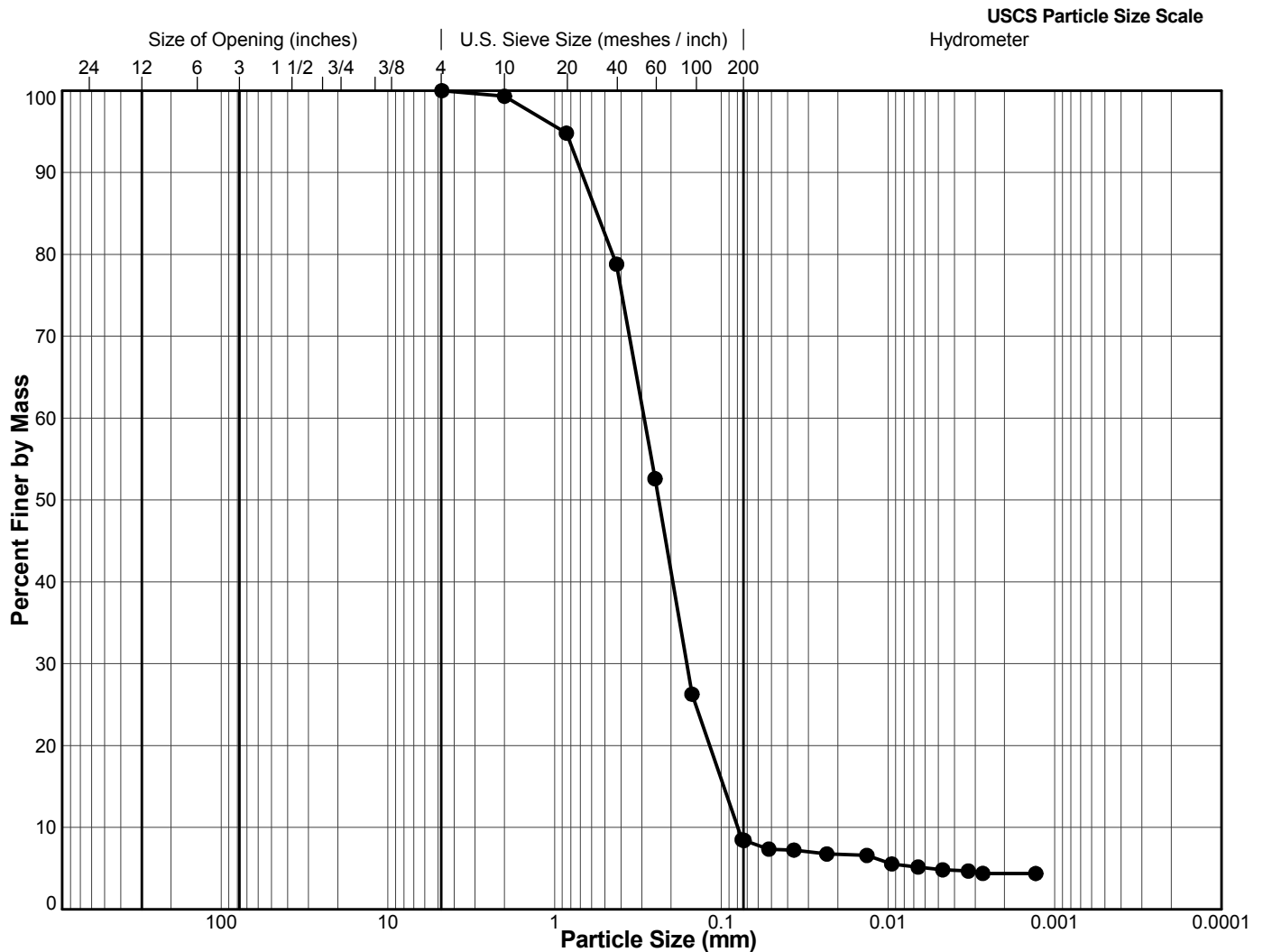
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 01
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 4.75	Hardness: N/A
Method: Split, Washed	Dispersion Method: Air-Jet Cup
Hydrometer ID: BURNABY - 87024	Dispersion Period (min): 5



BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

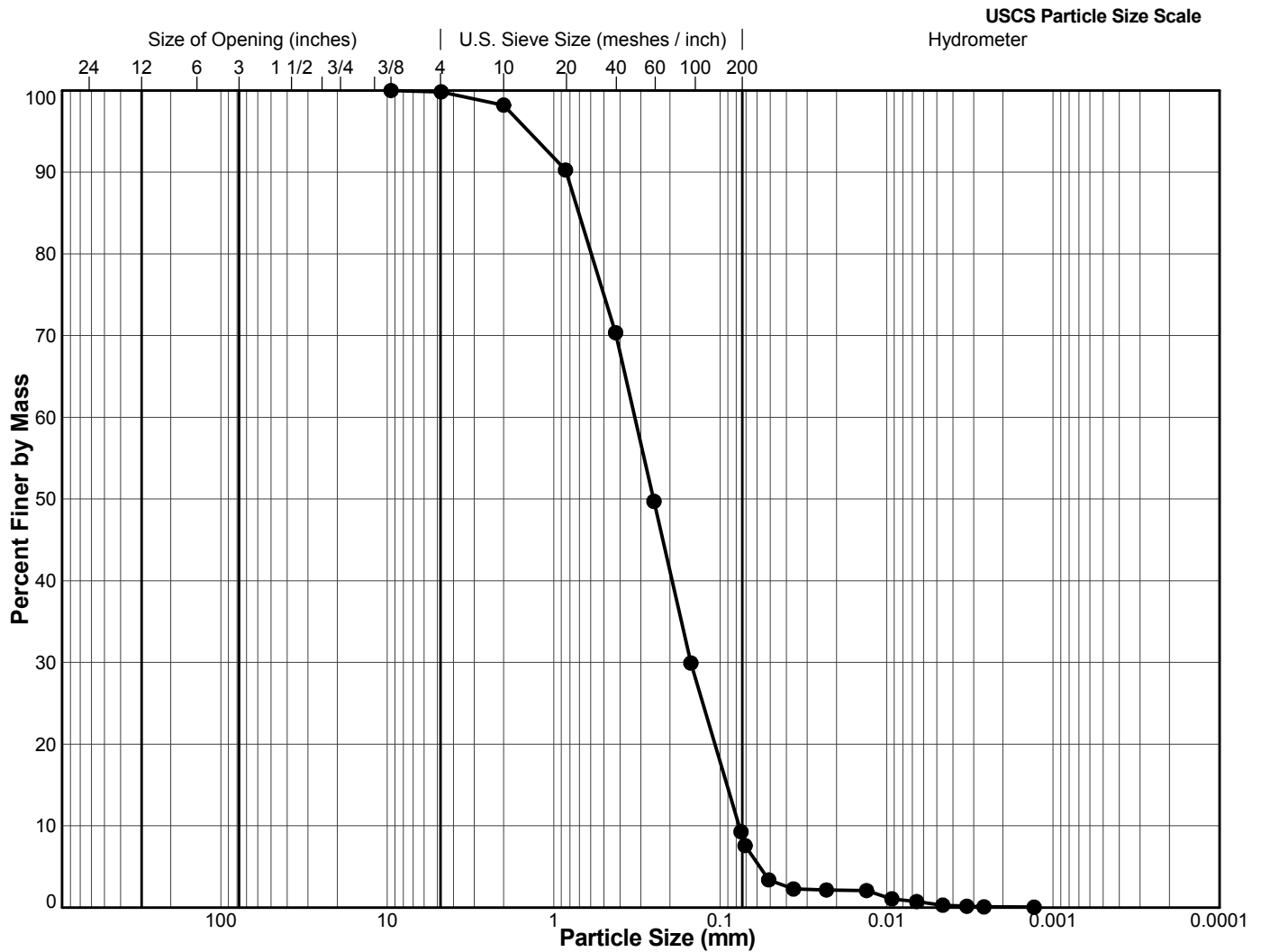
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 02
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 9.5	Hardness: N/A
Method: Split, Washed	Dispersion Method: Air-Jet Cup
Hydrometer ID: BURNABY - 541360	Dispersion Period (min): 5



Boulder	Cobble	Gravel		Sand			Fines (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

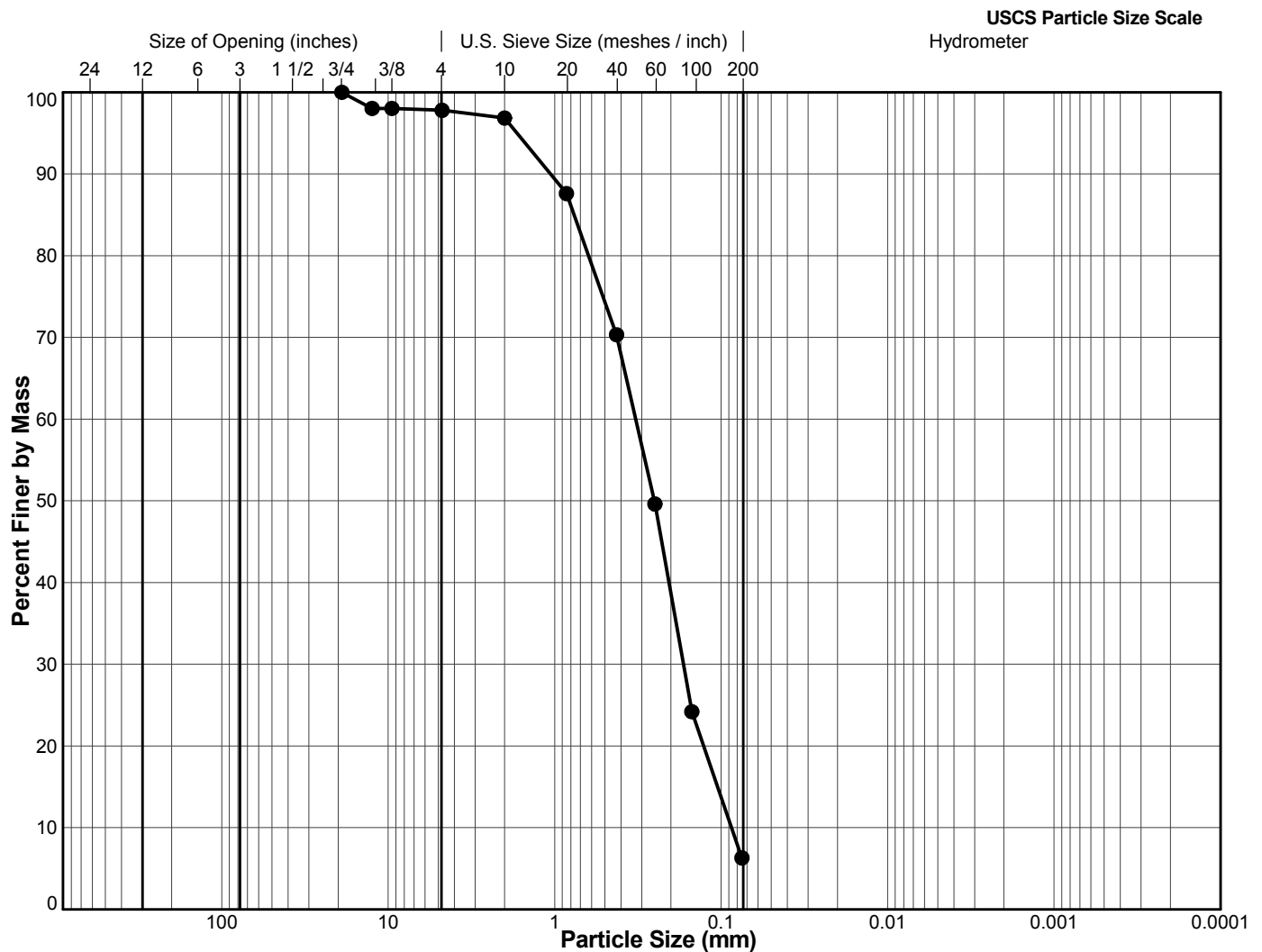
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 03
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 19	Hardness: N/A
Method: Combined, Washed	



BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

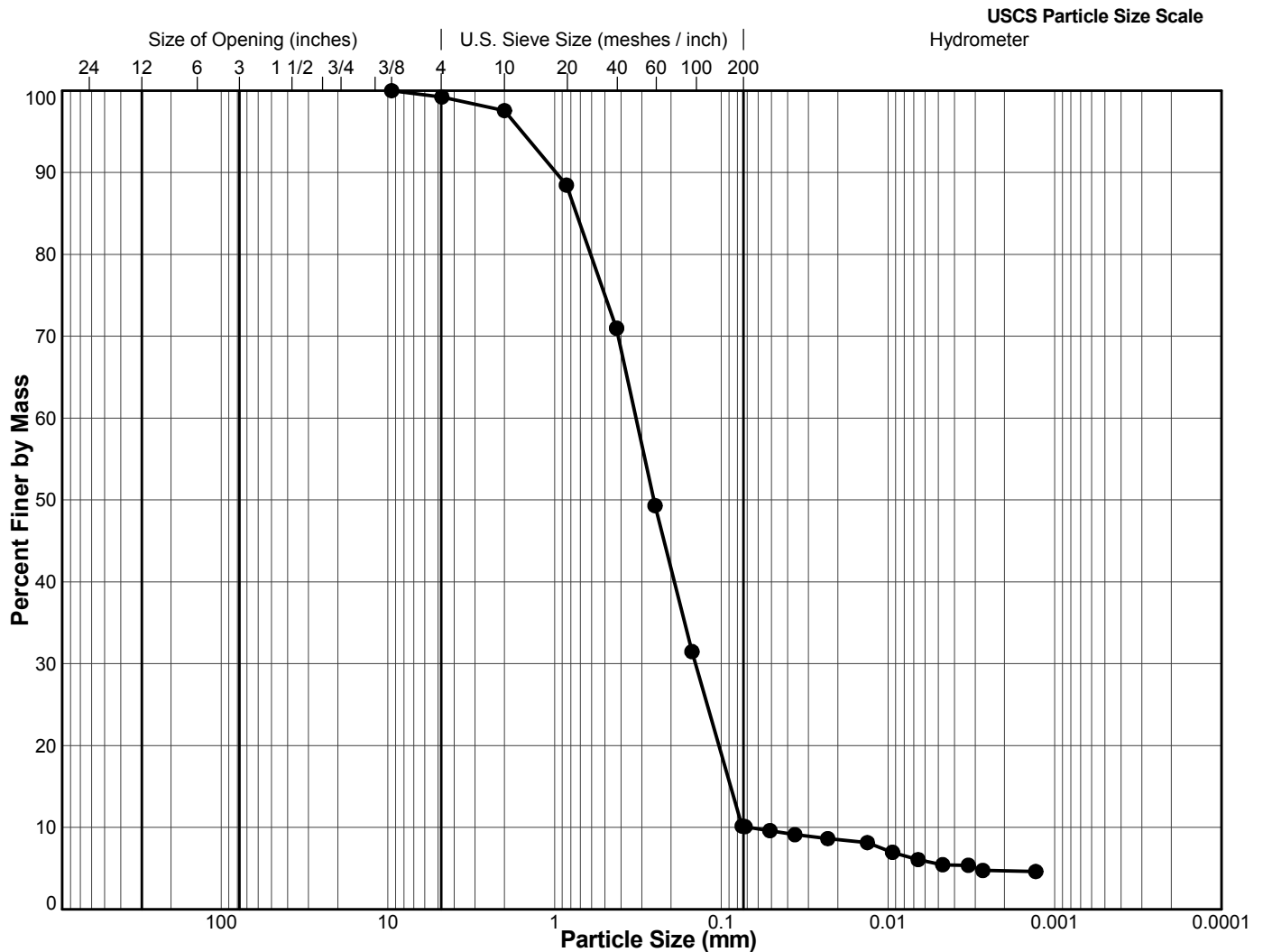
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 04
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 9.5	Hardness: N/A
Method: Split, Washed	Dispersion Method: Air-Jet Cup
Hydrometer ID: BURNABY - 87024	Dispersion Period (min): 5



BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

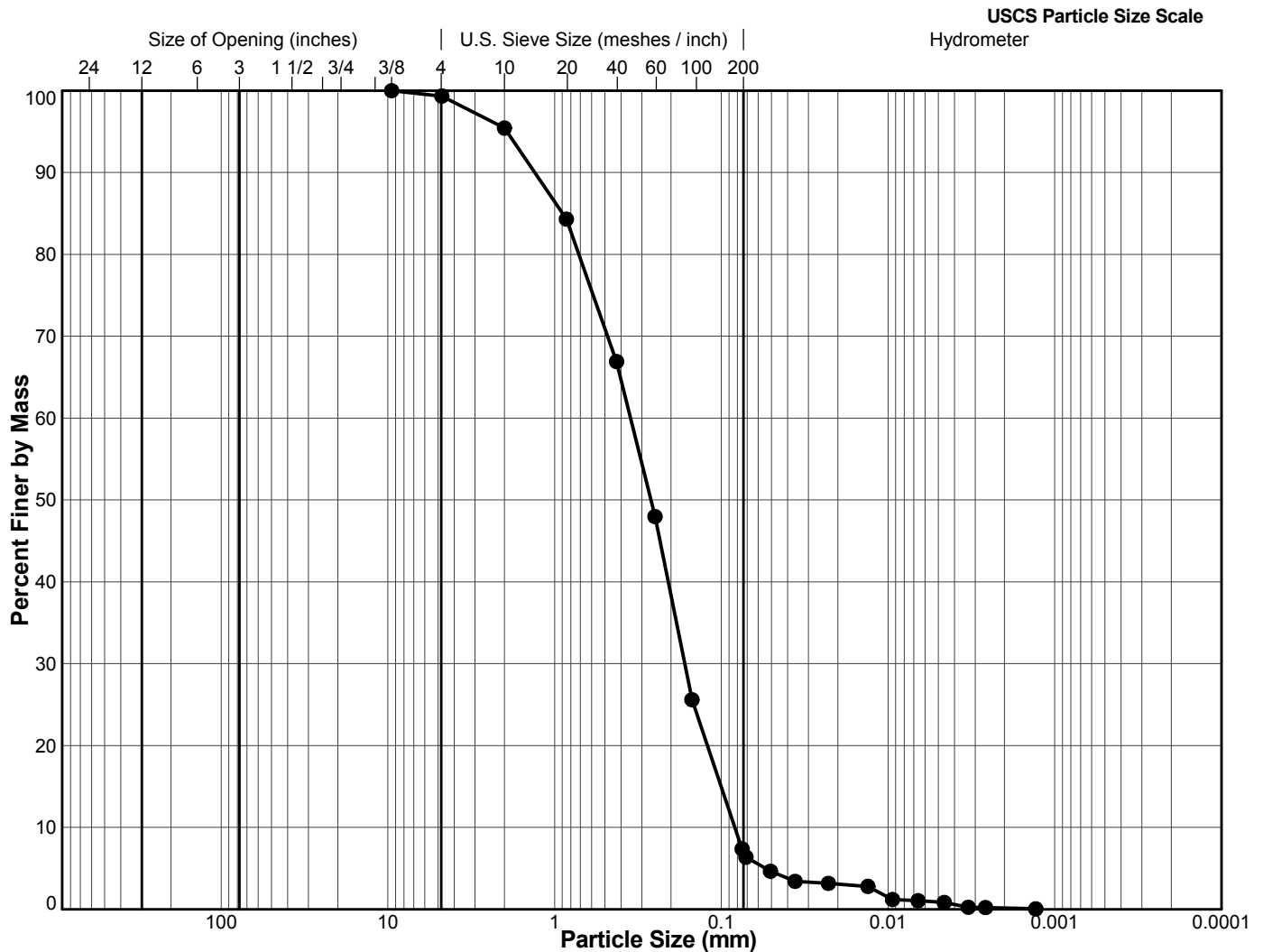
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 05
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 9.5	Hardness: N/A
Method: Split, Washed	Dispersion Method: Air-Jet Cup
Hydrometer ID: BURNABY - 541360	Dispersion Period (min): 5



BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

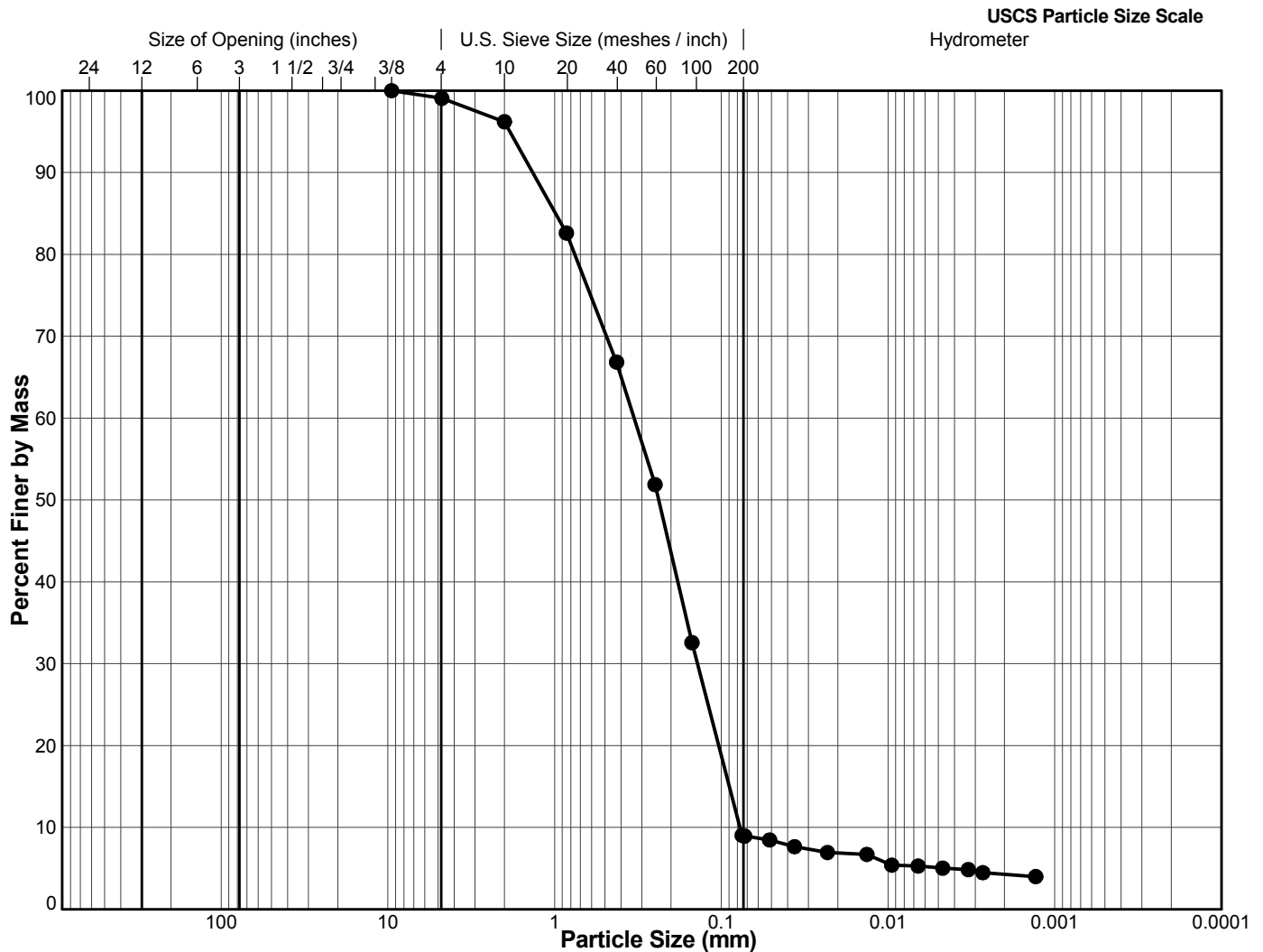
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 11
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 9.5	Hardness: N/A
Method: Split, Washed	Dispersion Method: Air-Jet Cup
Hydrometer ID: BURNABY - 87024	Dispersion Period (min): 5



BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

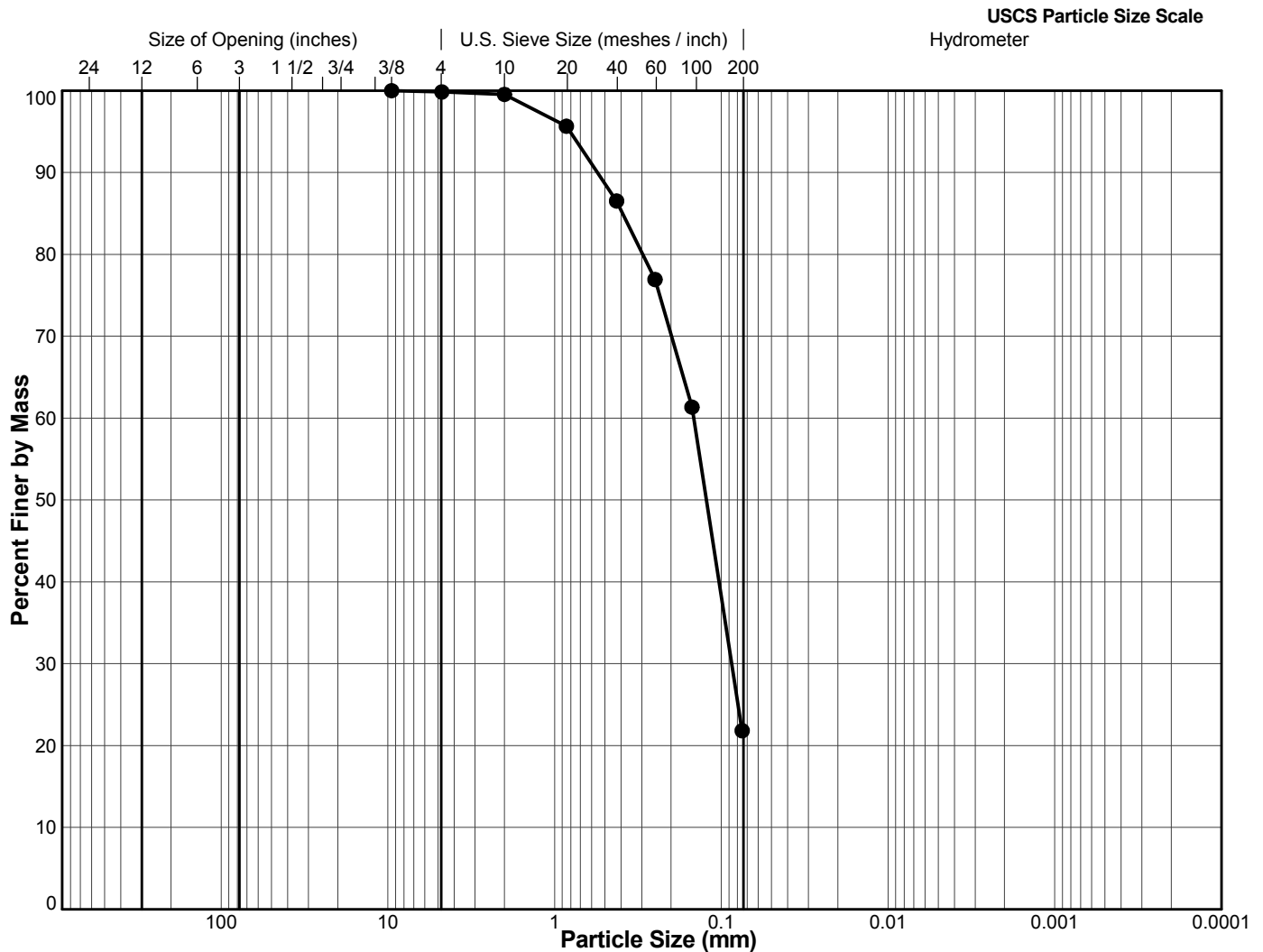
PARTICLE SIZE ANALYSIS OF SOILS

Reference(s)
ASTM D 422-63 (2007)

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 12
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Other Remarks: N/A

Specific Gravity (assumed): 2.65	Shape: N/A
Max. Particle Size Passing (mm): 9.5	Hardness: N/A
Method: Combined, Washed	



BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	

EB/KG	10/20/2010	LP	10/20/2010
Tech	Date	Checked	Date

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

Reference(s)
ASTM D 4318-05

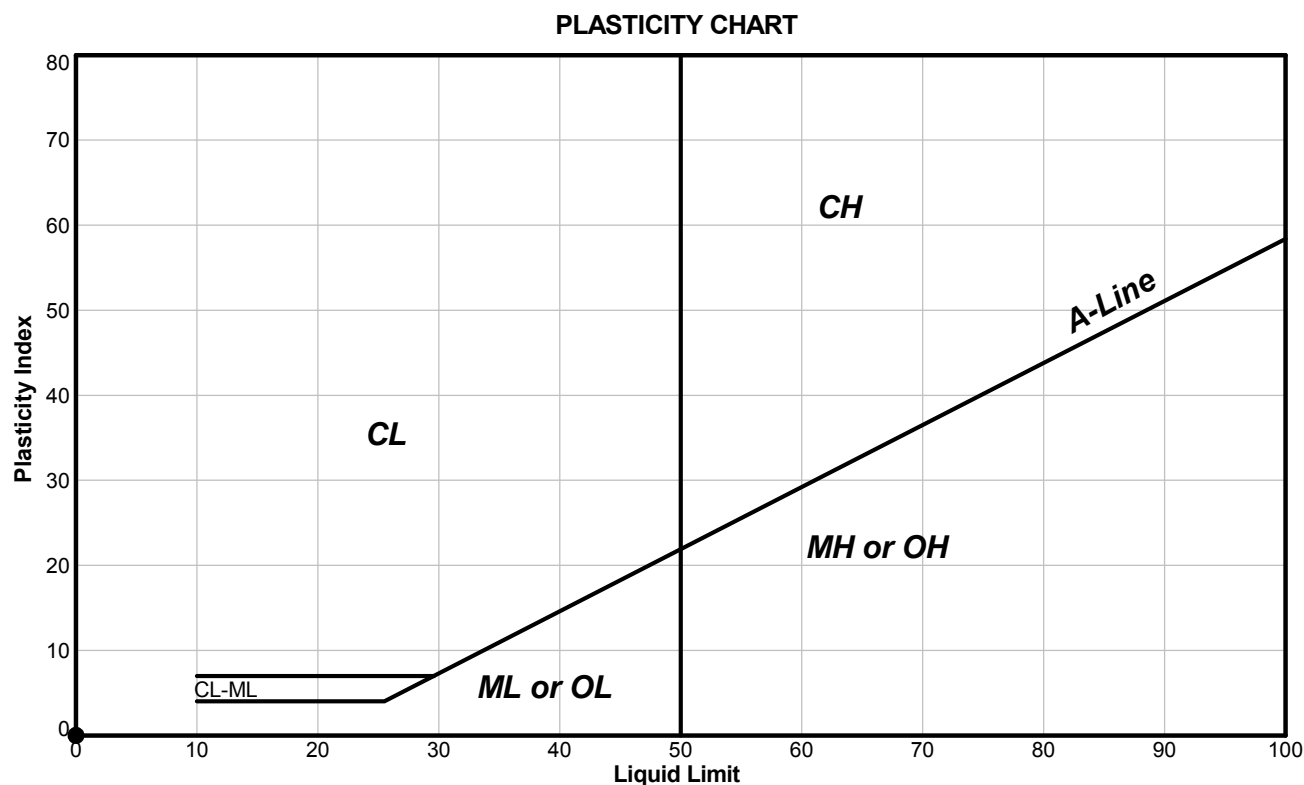
Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 04
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Classification and Definition: Non-Plastic Soil (NP).

Other Remarks: N/A

Test Method: A-Multi Point

Preparation Method: Nonplastic Soil (NP)



Sym.	Sample Location	Sample Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	SD	04	0.00	0.00	71	NP	NP	NP	26.3	NP

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

EB	10/18/2010	LP	10/18/2010
Tech	Date	Checked	Date

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

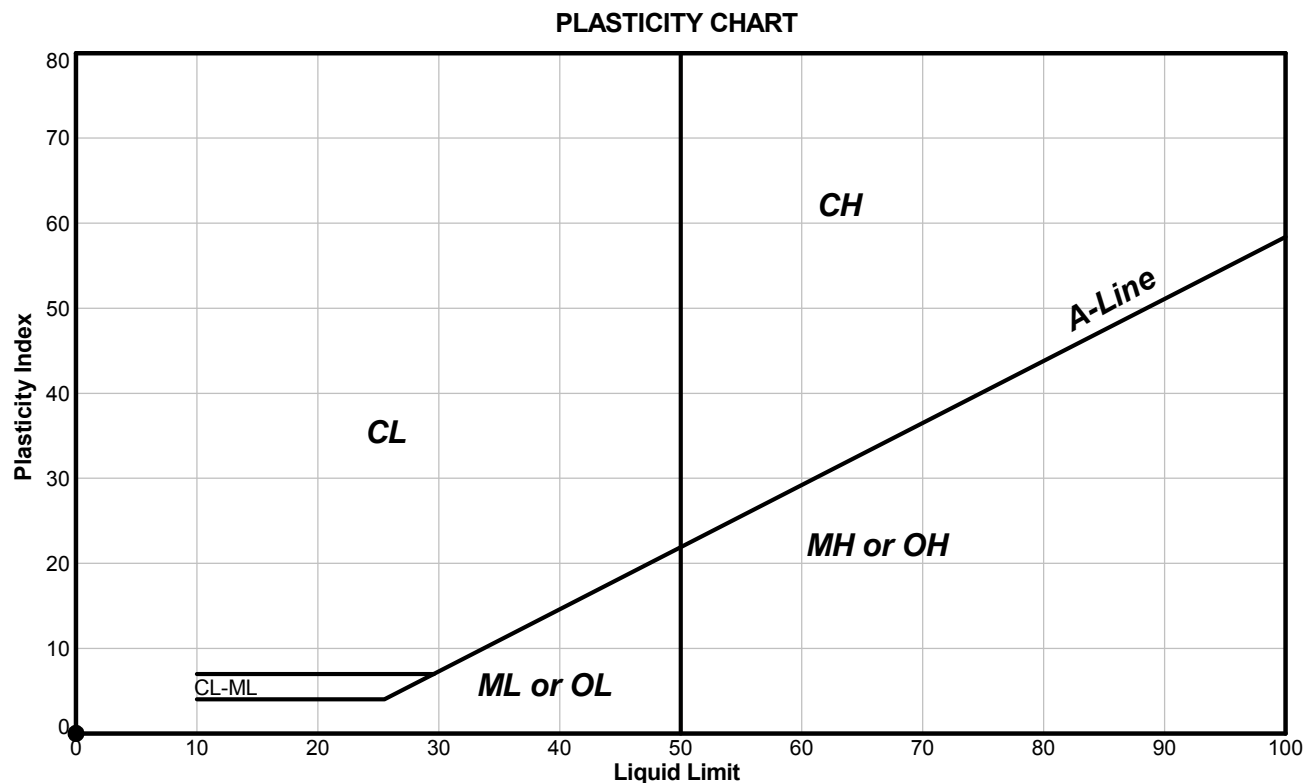
Reference(s)
ASTM D 4318-05

Client: Areva	Sample Location: SD
Project: Kiggavik	Sample No.: 11
Location: Nunavut	Depth Interval (m): N/A
Project No.: 10-1345-0026	Lab Schedule No.: 217

Classification and Definition: Non-Plastic Soil (NP).

Other Remarks: N/A

Test Method: A-Multi Point

Preparation Method: Nonplastic Soil (NP)


Sym.	Sample Location	Sample Number	Depth (m)	Bottom (m)	Percent Passing #40 Sieve (%)	Liquid Limit	Plastic Limit	Plasticity Index	Natural Water Content (%)	Liquidity Index
●	SD	11	0.00	0.00	67	NP	NP	NP	29.6	NP

Note: The test data given herein pertain to the sample provided only. This report constitutes a testing service only.

EB	10/18/2010	LP	10/18/2010
Tech	Date	Checked	Date

WATER CONTENT DETERMINATION

Reference(s)
ASTM D 4959

Client: Areva

Project No.: 10-1345-0026

Project: Kiggavik

Lab Schedule No.: 217

Location: Nunavut

Sample Location	Sample No.	Sample Interval		Water Content (%)
		Depth (m)	Bottom (m)	
SD	01	0.00	0.00	19.9
SD	02	0.00	0.00	20.7
SD	03	0.00	0.00	23.6
SD	04	0.00	0.00	26.3
SD	05	0.00	0.00	24.1
SD	11	0.00	0.00	29.6
SD	12	0.00	0.00	44.8

LP

10/22/2010

Checked

Date

Golder Associates Ltd.

500 - 4200 Still Creek Drive Burnaby, British Columbia, V5C 6C6 Canada
Tel: +1 (604) 296 4200 Fax: +1 (604) 298 5253 www.golder.com

Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils				Reference ASTM D 2974-07																																											
Project No.:	10-1345-0026	Borehole	N/A																																												
Client:	Areva	Sample No.:	SD 01																																												
Project:	Kiggavik	Depth (m):	N/A																																												
Location:	Nunavut	Lab Sch No:	217																																												
Method:	C	Other Remarks:																																													
Oven Temperature	50 degrees Centigrade																																														
Furnace Temperature	440 degrees Centigrade																																														
Moisture Determination	As-received mass																																														
<table border="1"> <tbody> <tr> <td>Moisture Content %</td> <td colspan="5">19.9</td> </tr> <tr> <td>% Passing #4</td> <td colspan="5">100.0</td> </tr> <tr> <td>Trial #</td> <td>1</td> <td colspan="4">2</td> </tr> <tr> <td>Ash Content %</td> <td>99.4</td> <td colspan="4">99.4</td> </tr> <tr> <td>Organic Matter %</td> <td>0.6</td> <td colspan="4">0.6</td> </tr> <tr> <td>UCS Description</td> <td colspan="5">Slightly Organic</td> </tr> <tr> <td>Average Organic Matter %</td> <td colspan="5">0.6</td> </tr> </tbody> </table>						Moisture Content %	19.9					% Passing #4	100.0					Trial #	1	2				Ash Content %	99.4	99.4				Organic Matter %	0.6	0.6				UCS Description	Slightly Organic					Average Organic Matter %	0.6				
Moisture Content %	19.9																																														
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Trial #	1	2																																													
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UCS Description	Slightly Organic																																														
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<i>* The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.</i>																																															
EB	October 18, 2010	LP	October 22, 2010																																												
TESTED BY	DATE	CHECKED BY	DATE																																												

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils				Reference ASTM D 2974-07																												
Project No.:	10-1345-0026	Borehole	N/A																													
Client:	Areva	Sample No.:	SD 02																													
Project:	Kiggavik	Depth (m):	N/A																													
Location:	Nunavut	Lab Sch No:	217																													
Method:	C	Other Remarks:																														
Oven Temperature	50 degrees Centigrade																															
Furnace Temperature	440 degrees Centigrade																															
Moisture Determination	As-received mass																															
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Moisture Content %	20.7																															
% Passing #4	99.8																															
Trial #	1	2																														
Ash Content %	99.5	99.4																														
Organic Matter %	0.5	0.6																														
UCS Description	Slightly Organic																															
Average Organic Matter %	0.6																															
<i>* The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.</i>																																
EB	October 18, 2010	LP	October 22, 2010																													
TESTED BY	DATE	CHECKED BY	DATE																													

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils				Reference ASTM D 2974-07																						
Project No.:	10-1345-0026	Borehole	N/A																							
Client:	Areva	Sample No.:	SD 04																							
Project:	Kiggavik	Depth (m):	N/A																							
Location:	Nunavut	Lab Sch No:	217																							
Method:	C	Other Remarks:																								
Oven Temperature	50 degrees Centigrade																									
Furnace Temperature	440 degrees Centigrade																									
Moisture Determination	As-received mass																									
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Moisture Content %	26.3																									
% Passing #4	99.2																									
Trial #	1	2																								
Ash Content %	97.7	97.7																								
Organic Matter %	2.3	2.3																								
UCS Description	Slightly Organic																									
Average Organic Matter %	2.3																									
EB	October 19, 2010	LP	October 22, 2010																							
TESTED BY	DATE	CHECKED BY	DATE																							

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils				Reference ASTM D 2974-07																												
Project No.:	10-1345-0026	Borehole	N/A																													
Client:	Areva	Sample No.:	SD 05																													
Project:	Kiggavik	Depth (m):	N/A																													
Location:	Nunavut	Lab Sch No:	217																													
Method:	C	Other Remarks:																														
Oven Temperature	50 degrees Centigrade																															
Furnace Temperature	440 degrees Centigrade																															
Moisture Determination	As-received mass																															
<table border="1"> <tbody> <tr> <td>Moisture Content %</td> <td colspan="3">24.1</td> </tr> <tr> <td>% Passing #4</td> <td colspan="3">99.3</td> </tr> <tr> <td>Trial #</td> <td>1</td> <td colspan="2">2</td> </tr> <tr> <td>Ash Content %</td> <td>98.9</td> <td colspan="2">98.9</td> </tr> <tr> <td>Organic Matter %</td> <td>1.1</td> <td colspan="2">1.1</td> </tr> <tr> <td>UCS Description</td> <td colspan="3">Slightly Organic</td> </tr> <tr> <td>Average Organic Matter %</td> <td colspan="3">1.1</td> </tr> </tbody> </table>					Moisture Content %	24.1			% Passing #4	99.3			Trial #	1	2		Ash Content %	98.9	98.9		Organic Matter %	1.1	1.1		UCS Description	Slightly Organic			Average Organic Matter %	1.1		
Moisture Content %	24.1																															
% Passing #4	99.3																															
Trial #	1	2																														
Ash Content %	98.9	98.9																														
Organic Matter %	1.1	1.1																														
UCS Description	Slightly Organic																															
Average Organic Matter %	1.1																															
<i>* The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.</i>																																
EB	October 19, 2010	LP	October 22, 2010																													
TESTED BY	DATE	CHECKED BY	DATE																													

Moisture, Ash, and Organic Matter of Peat and Other Organic Soils				Reference ASTM D 2974-07																						
Project No.:	10-1345-0026	Borehole	N/A																							
Client:	Areva	Sample No.:	SD 11																							
Project:	Kiggavik	Depth (m):	N/A																							
Location:	Nunavut	Lab Sch No:	217																							
Method:	C	Other Remarks:																								
Oven Temperature	50 degrees Centigrade																									
Furnace Temperature	440 degrees Centigrade																									
Moisture Determination	As-received mass																									
<table border="1" style="margin: auto; border-collapse: collapse; width: 80%;"> <tbody> <tr> <td style="text-align: center;">Moisture Content %</td> <td colspan="2" style="text-align: center;">29.6</td> </tr> <tr> <td style="text-align: center;">% Passing #4</td> <td colspan="2" style="text-align: center;">99.1</td> </tr> <tr> <td style="text-align: center;">Trial #</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="text-align: center;">Ash Content %</td> <td style="text-align: center;">98.1</td> <td style="text-align: center;">98.1</td> </tr> <tr> <td style="text-align: center;">Organic Matter %</td> <td style="text-align: center;">1.9</td> <td style="text-align: center;">1.9</td> </tr> <tr> <td style="text-align: center;">UCS Description</td> <td colspan="2" style="text-align: center;">Slightly Organic</td> </tr> <tr style="background-color: #d3d3d3;"> <td style="text-align: center;">Average Organic Matter %</td> <td colspan="2" style="text-align: center;">1.9</td> </tr> </tbody> </table> * The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data can be provided upon request.						Moisture Content %	29.6		% Passing #4	99.1		Trial #	1	2	Ash Content %	98.1	98.1	Organic Matter %	1.9	1.9	UCS Description	Slightly Organic		Average Organic Matter %	1.9	
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EB	October 20, 2010	LP	October 22, 2010																							
TESTED BY	DATE	CHECKED BY	DATE																							



APPENDIX C

Seismic Hazard Calculation

2005 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: Justin Bieber,

February 07, 2011

Site Coordinates: 64.3322 North 97.9033 West

User File Reference:

National Building Code ground motions:

2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.116	0.056	0.023	0.006	0.059

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2005 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. *These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.*

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.015	0.044	0.069
Sa(0.5)	0.008	0.024	0.036
Sa(1.0)	0.003	0.009	0.014
Sa(2.0)	0.001	0.002	0.004
PGA	0.007	0.021	0.035

References

National Building Code of Canada 2005 NRCC no. 47666; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3

Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2005, Structural Commentaries NRCC no. 48192

Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx

Fourth generation seismic hazard maps of Canada: Grid values to be used with the 2005 National Building Code of Canada (in preparation)

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

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