APPENDIX 4-AB
2012 TMF SITE INVESTIGATION

Klohn Crippen Berger

Seabridge Gold Inc.

KSM Project

2012 TMF Site Investigation

December 2012
M09480A04.730

Klohn Crippen Berger

December 19, 2012

Seabridge Gold Inc.
106 Front Street East, Suite 400
Toronto, Ontario
M5A 1E1

Mr. Brent Murphy
V.P. Environmental Affairs

Dear Mr. Murphy:

KSM Project
2012 TMF Site Investigation

Enclosed please find our KSM 2012 Site Investigation Report presenting results of KCB field investigations conducted in the TMF Area. Specific areas of investigation included till borrow areas for the North Dam, Splitter Dam, Saddle Dam, and Southeast Dam areas, the East Catchment Area, and geotechnical investigation of the Treaty Ore Processing Complex area.

Site investigation work was conducted between June and September 2012 and included geotechnical drilling, sampling and laboratory testing, as well as seismic refraction geophysical surveys.

Please note that the KCB 2012 field investigation program included additional work in the vicinity of the proposed KSM Mine Area. Those results are presented under a separate cover.

Yours truly,
KLOHN CRIPPEN BERGER LTD.

Graham Parkinson, P.Geo., P.Geoph.
Project Manager

GP/PK:tc

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Seabridge Gold Inc.

KSM Project

2012 TMF Site Investigation

EXECUTIVE SUMMARY

Klohn Crippen Berger Ltd. (KCB) conducted field investigations between June 2012 and September 2012 at the site of the proposed KSM (Kerr-Sulphurets-Mitchell) KSM gold-copper mine project in northwestern British Columbia (B.C.) at the request of the project owner Seabridge Gold Inc. (Seabridge). The rugged topography of the project area restricts site access and provides few alternatives for locating facilities. As a result, the proposed Tailings Management Facility (TMF) is located approximately 23 km from the proposed KSM Mine Area facilities. This report describes field investigations and results of analysis for the vicinity of the proposed TMF area.

The 2012 TMF Site Investigation Report expands on previous site investigation work conducted by KCB between 2008 and 2011. The report outlines the methods of investigation and analyses, describes the areas investigated, maps the extent of geologic units, and provides summary tables of the field and laboratory test results. Interpretation of the results is provided separately in the 2012 TMF Design Report.

Detailed information used to prepare maps and data summaries are provided in the report appendices which include: drill hole logs, core photographs, field and lab data sheets, and geophysical survey profiles. The following was accomplished the following in the TMF area;

- Drilled 7 ODEX and/or core holes (total length = 189 m).
- Completed Large Penetration Tests (LPT) and sampling of overburden material in 6 drill holes.
- Installed 7 open-hole piezometers.
- Measured water levels in 71 open-hole piezometers.
- Conducted 13 seismic refraction survey lines (total length = 6,090 m).

The primary purpose of the 2012 TMF Site Investigation was to provide additional information on the character, distribution, and physical and hydrogeologic properties of overburden materials to support the preparation of the TMF Area Design Updates. Specific objectives that were developed following the 2011 Site Investigation Report and that were met during the execution of the 2012 field program are summarized in the table below:

TMF Area	Objectives	Methods
Treaty OPC	OPC foundation conditions, piezo installation	Drill and sample for point load and UCS tests
North Dam	Till borrow availability, piezo installation	Drill and sample, seismic survey, lab tests
Splitter Dam	Till borrow availability, piezo installation	Drill and sample, seismic survey, lab tests
Saddle Dam	Till borrow availability, piezo installation	Drill and sample, seismic survey, lab tests
Southeast Dam and Spillway	Till borrow availability, piezo installation	Drill and sample, seismic survey, terrain analysis, lab tests
East Catchment Area	Intake dam foundation conditions, borrow availability, piezo installation	Seismic survey

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1 INTRODUCTION

This report contains results of field investigations conducted by Klohn Crippen Berger Ltd. (KCB) for Seabridge Gold Inc. (Seabridge) between June and September 2012 in support of the KSM gold-copper mine project in northwestern British Columbia (B.C.). This report describes field investigations and results of analyses for the vicinity of the Tailings Management Facility (TMF).

Specific project sites covered by the 2012 Site Investigation Reports for the TMF Area and the KSM Mine Area are shown below in Table 1.1. Sites within the TMF area are described in detail in Section 3 of this report.

Table 1.1 Specific Project Sites Covered in the 2012 Site Investigation Reports

<table>
<tr><th colspan="2">TMF Area Site Investigation Report</th><th colspan="2">KSM Mine Area Site Investigation Report</th></tr>
<tr><td>Treaty Ore Processing Complex</td><td>Saddle-Splitter Dams</td><td>Mitchell Diversion Tunnel, Glacier Inlets</td><td>Treaty Saddle Portals</td></tr>
<tr><td>North Dam</td><td>Southeast Dam and Spillway</td><td>Mitchell Diversion Tunnel, Outlets</td><td>Treaty Valley Drill Site</td></tr>
<tr><td colspan="2" rowspan="2">East Catchment Area</td><td>Water Storage Dam</td><td rowspan="2">Vicinity of drill holes and outcrop along alignment</td></tr>
<tr><td>Water Treatment Plant</td></tr>
</table>

1.1 Project Description

The proposed KSM Project will mine gold-copper deposits at the Kerr, Sulphurets, Mitchell, and Iron Cap locations using a combination of open-pit and underground block-caving methods. The mine locations lie within the headwaters of Sulphurets Creek. Ore will be crushed at the mine site and conveyed to the site of the proposed processing complex and TMF.

The rugged topography of the region restricts site access and provides few alternatives for locating facilities. As a result, the proposed TMF is located in the Bell-Irving River watershed, 24 km from the proposed KSM Mine Area facilities located in the Unuk River watershed. The proposed KSM Project will include the TMF, water diversion tunnels, a water storage dam, a water treatment plant, waste rock disposal areas, an ore processing complex, an ore transport system, a mineral processing plant, and related road access, accommodation, administration, and maintenance infrastructure.

1.1.1 Project Location

The KSM Project is located in the Boundary Ranges of the Coast Mountains in northwestern BC, a region of heavily glaciated peaks, icefields, and densely forested valleys. During the past several decades glaciers have been receding. The KSM Project is located at latitude 56° 30’ N, longitude 130° 20’ W, approximately 75 km northwest of Stewart, BC (Figure 1.1).

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED _____

SCALE: NTS

CLIENT

SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT

KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE

SITE LOCATION

PROJECT No. M09480A04

FIG. No. 1.1

KCB–R–MPA

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Drawing File: \\int.klohn.com\ProjData\M\VCR\M09480A04 - KSM 2012 PFS\400 Drawings\SI\tmf\FIG 1.1_rB.dwg (afischer)

The KSM Mine Area lies west of the Unuk River, which drains south-westward into Alaskan waters. The Alaska border is approximately 30 km southwest of the mine site. The KSM TMF Area and Mine Area (Drawing D-4001) are separated by a region of glaciers and icefields dotted by high peaks. Streams in the vicinity of the TMF drain to Canadian waters via the Bell-Irving River which ultimately drains to the Nass River.

Site access is currently by helicopter. The nearest existing road access is via Highway 37 to either Bell 2 Resort or the site of the Eskay Mine. Proposed road access to the TMF area is via Treaty Creek from Highway 37, while proposed road access to the KSM Mine Area is via the Coulter Creek to Sulphurets Creek Valley.

1.1.2 Project Area Geology

Geology of the overall KSM Project area is complex. Sedimentary, volcanic, plutonic, and metamorphic rocks are present together with substantial folding, faulting, and hydrothermal alteration. Despite the rugged terrain and geologic complexity, several groups of researchers (e.g. Alldrick and Britton, 1991; Lewis et. al., 1993; Kirkham and Margolis, 1995) and prospectors have mapped much of the area over the past 25 years and a general geological framework has been developed.

The project area lies on the western edge of the Intermountain Tectonic Belt with the Paleozoic to mid-Jurassic age Stikine Terrane on the west, and the mid to upper-Jurassic Bowser Lake sedimentary basin on the east (Henderson et al, 1992). KCB has adopted stratigraphy presented by the MDRU (1996) as the basis for geological mapping and classification. Under this scheme, four main stratigraphic groups are found in the project area:

- The Upper Triassic Stuhini Group comprising sedimentary and volcanic rocks.
- The Lower Jurassic Hazelton Group (divided into the Jack, Betty Creek and Salmon River formations) comprising sedimentary, volcanic, and metamorphic rocks.
- The Middle Jurassic Bowser Lake Group sedimentary rocks.
- The Jurassic Texas Creek Plutonic Suite of igneous intrusive rocks.

Drawing D-4002 is a geologic map of the project area, modified by KCB based on mapping prepared by ERSi/KCB (2011). The ERSi map is based primarily on the geologic map of Massey et al. (2005) which was compiled, in part, from previously published studies (e.g. Britton and Alldrick, 1988; Kirkham and Margolis, 1993; MDRU, 1996).

1.2 Purpose and Scope

The purpose of the field investigation that led to this report is to support design updates of key elements of the TMF and associated water management facilities. The objectives and methods of the site investigation are summarized in Table 1.2 and the areas of investigation are shown in Drawing D-4004.

Table 1.2 Objectives and Methods for the 2012 TMF Site Investigation

Location	Objectives	Methods
Treaty Ore Processing Complex	Geotechnical and foundation parameters for plant design	SPT/LPT, Diamond core drilling (1 hole) , UCS and Point Load testing;
North Dam	Estimate volume of suitable fine-grained till borrow material for dam cores, and locate possible sources for aggregate for plantsite construction	ODEX drilling and LPT till sampling (6 holes); seismic survey (8 lines); geomorphic mapping using available LiDAR images as base maps; field mapping to ground truth interpreted features
Saddle-Splitter Dams		
Southeast Dam		
Southeast Dam and Spillway	Till availability, Bedding and joint orientations for kinematic analysis; constructability assessment	Field mapping of overburden, bedrock and local geohazards
East Catchment Area	Bedding and joint orientations for kinematic analysis; constructability assessment for intake portals and dams	Field mapping of overburden, bedrock and local geohazards, seismic refraction survey (13 lines)

The 2012 Site Investigation report expands on previous site investigation work conducted by KCB between 2008 and 2011 (KCB, 2009; 2010; 2011). Results of all investigations conducted by KCB to date have been used to prepare the 2012 TMF Design Update Report. The organization of this report is shown below:

- **Section 1** of this report describes report content, project location, and limitations on the use of the report.
- **Section 2** presents methods of investigation and describes the scope-of-work of the field investigation, field and laboratory testing, and data analysis.
- **Section 3** presents a summary of geologic and geotechnical results of the field investigation, and field and laboratory testing programs for each of the specific areas investigated.
- **Section 4** summarizes results of hydrogeological tests and observations made in the TMF area.
- **Appendices** at the end of the report present detailed information used to prepare the summaries given in Sections 1 through 4, including drill hole logs, core photographs, data sheets for field and laboratory tests, geophysical survey profiles, and KCB memos describing engineering geologic mapping and terrain analysis studies.

1.3 Limitations and Uses of Report

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Seabridge Gold Inc. for the specific application to the KSM Project. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavored to comply with generally accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

The analyses and conclusions contained in this report are based on data derived from a limited number of test holes obtained from widely spaced subsurface investigations. The methods used indicate subsurface conditions only at the specific locations where samples were obtained or where

in situ tests would infer, only at the time they were obtained, and only to the depths penetrated. The samples and tests cannot be relied on to accurately reflect the nature and extent of strata variations that usually exist between sampling or testing locations.

This report was prepared by Klohn Crippen Berger Ltd. for the account of Seabridge Gold Inc. The material in it reflects Klohn Crippen Berger's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Klohn Crippen Berger Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

2 METHODS OF INVESTIGATION

Site investigation work conducted between June and September 2012 included geotechnical drilling of overburden and bedrock; Drill hole sampling; laboratory testing; groundwater monitoring; and seismic refraction surveying. Work performed at each of the specific project sites is summarized in Table 2.1.

Table 2.1 Summary of the 2012 TMF Site Investigation Program

Area	Core Logging and Sampling	Seismic Survey
Treaty OPC	KC12-64	-
North Dam	-	KC12-SL34
	-	KC12-SL35
Splitter Dam	KC12-OVB44	KC12-SL36
	KC12-OVB45	KC12-SL37
Saddle Dam	KC12-OVB46	KC12-SL38
Southeast Dam and Spillway	KC12-OVB47	KC12-SL39
	KC12-OVB48	KC12-SL40
	KC12-OVB49	KC12-SL41
	-	KC12-SL42
East Catchment Tunnel Outlet	-	KC12-SL43
	-	KC12-SL44
	-	KC12-SL45
	-	KC12-SL46

2.1 Geotechnical Drilling

Seven geotechnical drill holes were completed as part of the 2012 TMF Site Investigation. Drill holes were drilled by Geotech Drilling of Prince George, B.C. using a helicopter-portable exploration drill rig. Helicopter transportation for equipment and personnel was provided by Lakelse Air Ltd. of Terrace, BC.

All holes were drilled using 47.6 mm NQ3/4" ODEX drill configuration equipped with SPT/LPT sampling and testing equipment. Drilling was conducted 24 hours a day, 7 days a week in two 12 hour shifts. A geologist or engineer from KCB was onsite during drilling to monitor activities, pack and log core, and oversee hydrogeological testing. Drill hole locations were initially determined using a hand-held GPS device. As-built drill hole locations and elevations were then surveyed by McElhanney Associates. At the request of Seabridge, drill hole numbering follows sequentially from the 2011 Site Investigation Report and includes drilling in the TMF area. Thus the first 2012 hole numbered in the TMF area is KC12-OVB44. Drawings D-4004, D-4005 and D-4006 show locations of the drill holes.

Geotechnical drilling was performed at the TMF to:

- Determine thickness of overburden soils, and to characterize the underlying bedrock.
- Perform in situ SPT/LPT testing and sampling of overburden soils for identification, classification, and laboratory testing.

- Obtain rock samples for identification, classification, and laboratory testing, and to characterize rock mass quality.
- Install open-hole piezometers (monitoring well) to measure groundwater levels.

Table 2.2 provides a summary of the seven drill holes drilled in the KSM TMF area. Drill hole logs are presented in Appendix I and core photographs are presented in Appendix II, and summary logs are presented in Appendix IV. The results of drilling are discussed in Section 3.

Table 2.2 Summary of 2012 Geotechnical Drilling Program – TMF Area

Drill Hole	Location	Date Started (dd/mm/yy)	Easting (m)	Northing (m)	Elevation (m)	Overburden (m)	Water Level (mbgl)	Hole Depth (m)
KC12-64	Treaty OPC	09/09/12	439500	6280443	1091	2.1	2.68	17.5
KC12-OVB44	Splitter Dam	17/09/12	441552	6276636	1038	20.1	4.34	30.2
KC12-OVB45	Splitter Dam	19/09/12	442397	6276203	934	18.3	5.39	29.0
KC12-OVB46	Saddle Dam	16/09/12	444414	6275650	894	17.8	2.44	28.8
KC12-OVB47	Southeast Dam and Spillway	14/09/12	445202	6275175	845	5.2	3.9	16.1
KC12-OVB48	Southeast Dam and Spillway	10/09/12	446848	6273719	897	7.2	0.46	17.3
KC12-OVB49	Southeast Dam and Spillway	11/09/12	447264	6273954	824	40.8	6.16	50.0
							Total Length of Drilling (m)	**188.9**

2.1.1 ODEX Drilling

ODEX drilling was used to advance holes in overburden soils. The ODEX drill is an air-rotary method that includes drill casing (pipe) with an expansion bit and inner core barrel. While the drill is advancing in overburden, a reamer on the ODEX bit swings out and drills a hole larger than the external diameter of the casing, allowing the casing to be advanced along with the bit. ODEX drilling is particularly effective in unstable overburden ground conditions because the casing prevents collapse of the hole. When the required depth is reached, the drill is reversed and the reamer swings to its minimum diameter, allowing the bit to be lifted up through the casing, which remains in the hole.

LPT sampling at intervals between advances by ODEX was used to gather information as to soil type and density. Cuttings were flushed from the casing with air to minimize the amount of fluid released to the environment during drilling. ODEX drilling was found to be effective to depths of roughly 50 m in the dense basal tills of the TMF area; in some cases the casing could not be advanced below this depth due to high casing friction. Where possible, the casing was recovered at the end of drilling to minimize drilling costs. Drilling continued with a diamond core bit after rock was encountered or when the ODEX casing could no longer be advanced.

It can be difficult to determine the exact depth of bedrock using ODEX drilling alone. The air-percussion hammer pulverizes any rock material and cuttings are returned as sand and rock flour. Gravel, cobbles, and boulders can be difficult to distinguish from weak or weathered bedrock in the

drill cuttings and these materials are too hard to sample by LPT. In some cases, coring was initiated in sufficiently dense overburden materials (e.g. basal tills) to minimize the chance of ODEX drilling beyond the overburden/bedrock contact.

An ODEX drill bit is shown in Figure 2.1. Once bedrock was intersected, triple tube HQ-size (61.1 mm ID, 96 mm OD) core drilling with a diamond-impregnated bit was used.

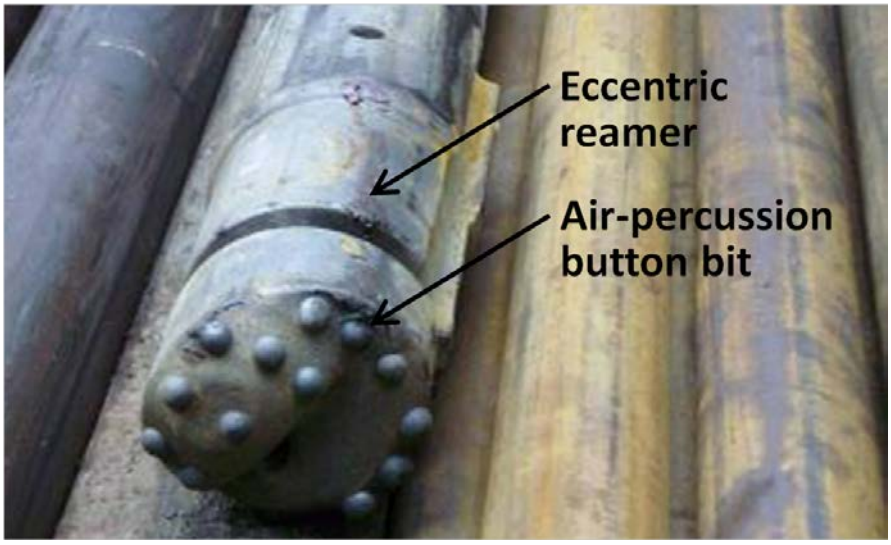

Figure 2.1 ODEX Drill Bit and Reamer for Advancing Casing in Overburden Soils

2.1.2 Core Logging and Sampling

When drilling in overburden soils in the vicinity of the TMF, ODEX casing was used to provide stability for the open hole until bedrock was reached. SPT/LPT sampling was done at 1.5 m intervals while advancing through overburden.

Once in bedrock, core drilling was used to obtain near-continuous bedrock core samples for rock identification (lithology) and classification, and to collect samples for laboratory testing. To reduce potential adverse environmental impact, creek water with no additives was used as drilling fluid whenever possible. When necessary, a biodegradable drilling polymer was added to ease drilling in zones with high rod friction or poor core recovery. Drilling locations were at least 30 m away from the nearest flowing water.

All rock and soil core was logged by a KCB geologist or engineer and photographed at the drill rig. Drill core logs are presented in Appendix I. Core photographs are presented in Appendix II. Core obtained in the TMF area is stored at KSM Camp and was also logged and sampled for exploration potential by a Seabridge geologist. The following geotechnical information was collected from the rock core to be used in assessment of the rock mass:

- Total Core Recovery (TCR), defined as the core recovery percentage measuring the recovered core length vs. the total length drilled.

- Solid Core Recovery (SCR), defined as the drill hole core recovery percentage of solid, cylindrical, pieces of rock core vs. the total length drilled.
- Rock Quality Designation (RQD), defined as the measuring of the degree of jointing or fracture in a rock mass, measured as a percentage of the drill core in lengths of 10 cm or more. The rock mass was classified as shown in Table 2.3.

Table 2.3 Rock Quality Designation (RQD)

RQD	Rock Mass Quality
< 25%	Very Poor
26 – 50%	Poor
51 – 75%	Fair
76 – 90%	Good
91 – 100%	Excellent

- Degree of weathering described in terms of entire rock core mass and in terms of the weathering associated with its discontinuities. Weathering grade varies from I (Fresh) to VI (Residual soil).
- Lithology based, in some cases, on lithology logs provided by Seabridge geologists.
- Rock Strength was described according to ISRM (1978). Rock mass grade was graded from R0 (Extremely weak rock) to R6 (Extremely strong rock).
- Geologic Strength Index (GSI) to characterize jointed rocks based on their structure and surface conditions.
- Discontinuity spacing for joint sets based on true spacing between the discontinuities measured perpendicularly according to ISRM (1978).
- Discontinuity condition.

Natural fractures (non-drilling-induced) and other discontinuities were logged where possible and the following information was recorded:

- joint infilling;
- joint spacing;
- Joint Roughness Coefficient (JRC), ranging from 0 to 20 following ISRM (1978); and,
- joint angle to core axis (alpha, in degrees).

Selected rock core samples were collected for point load tests which were completed in camp. Selected samples were shipped to the KCB Geotechnical Laboratory for unconfined compressive strength (UCS) tests (see Appendix III).

2.1.3 Large Penetration Tests (LPT)

Large Penetration Tests (LPT) to obtain overburden strength and samples were conducted in six drill holes, using a 63.5 kg automatic hammer with approximately 760 mm drop height. A large split-spoon sampler having an outer diameter of 114 mm (4.5 inches) and a length of 457 mm (18 inches) was used to perform the LPT tests. Penetration resistance was measured as number of hammer blows per 152 mm (6 inches) of sampler penetration. The LPT N-value represents the number of hammer blows for the 300 mm (6 inches to 18 inches) penetration interval. The number of LPT tests and locations are summarized in Table 2.4.

Table 2.4 Summary of Large Penetration Tests (LPTs) per Hole

Site ID	Location	No. of LPT Tests	Depth to Bedrock (m)
KC12-OVB44	Splitter Dam	11	20.1
KC12-OVB45	Splitter Dam	10	18.3
KC12-OVB46	Saddle Dam	8	17.8
KC12-OVB47	Southeast Dam and Spillway	3	5.2
KC12-OVB48	Southeast Dam and Spillway	4	7.2
KC12-OVB49	Southeast Dam and Spillway	14	40.8

2.1.4 Piezometer Installation

2012 drill holes were sited to test till borrow areas and piezometer installs were designed to test water level at specific elevations of potential borrow zones.

After completion of the drill holes, six open-hole piezometers were installed within overburden, consisting of either 1.5 inch or 2 inch diameter PVC pipe, with slotted screen (for locations see Drawing D-4007).

The PVC piezometer screens used consisted of factory-slotted PVC pipe supplied in 3.05 m sections. Filter sand was placed around the well screens and a layer of bentonite pellets was placed on top of the sand to seal off the screened interval. The remainder of the hole was allowed to slough around the solid PVC pipe. Bentonite pellets were used to seal the hole at ground level. Water level was measured using an electronic dip tape once the level in the hole had stabilized.

Figure 2.2 Measuring Water Level in an Open-hole Piezometer with Diptape

Open-hole piezometers installed during the 2008, 2009, 2010 and 2011 site investigations were revisited during the 2012 program to measure current water levels. A list of all KCB wells and the date of the last recorded water level is given in Section 5.

2.2 Seismic Refraction Survey

Seismic refraction surveys were completed in the TMF area during 2012 to determine overburden thicknesses and velocities, layering, and bedrock velocities at the proposed tailings and water diversion dams, and to assist in locating potential borrow areas for dam construction materials. Seismic surveys in the TMF area were conducted by Frontier Geosciences Inc. who also conducted seismic surveys at the site in 2009, 2010, and 2011.

Seismic refraction measures the velocities of waves as they pass through the different materials, from which overburden layer thicknesses and depth to bedrock are computed. Material types are interpreted using both published velocity values and from observed correlations between the seismic results and drill holes at the site.

Small dynamite charges initiated by a blasting machine equipped to record the wave initiation time were used to generate p-waves (compression) and s-waves (shear). Geophones (electromechanical transducers) detect the elastic-waves and the waveforms are recorded on a seismograph. The primary purpose of the survey was to determine the approximate depth to bedrock and to locate areas where shallow till borrow materials may be available. Ideally, sources of borrow material would be at or near the ground surface and located away from the valley bottom, where deposits are mostly saturated and dewatering would be required. Figure 2.3 (left) shows the seismograph and laptop computer used to record the seismic waves, and a technician (right) laying out geophones. Survey lines were not cut in riparian zones and shot locations avoided creek locations.

Figure 2.3 Seismic Equipment (Left); Laying Seismic Lines over a Stream (Right)

Thirteen seismic lines were completed within the TMF Area covering a length of 6,090 m. A detailed report by Frontier Geosciences with interpreted seismic cross sections (validated using drill holes on or near the seismic lines) is provided as Appendix V. Seismic lines are summarized in Table 2.5.

Table 2.5 Seismic Lines Locations and Lengths

Line ID	Location	Date of Survey (dd/mm/yy)	Estimated Length (m)
KC12-SL34	North Dam	21/06/12	445
KC12-SL35	North Dam	22/06/12	640
KC12-SL36	Splitter Dam	18/06/12	660
KC12-SL37	Splitter Dam	16/06/12	550
KC12-SL38	Saddle Dam	17/06/12	280
KC12-SL39	Southeast Dam and Spillway	20/06/12	510
KC12-SL40	Southeast Dam and Spillway	20/06/12	475
KC12-SL41	Southeast Dam and Spillway	18/06/12	480
KC12-SL42	Southeast Dam and Spillway	19/06/12	360
KC12-SL43	East Catchment Area	22/06/12	530
KC12-SL44	East Catchment Area	22/06/12	440
KC12-SL45	East Catchment Area	23/06/12	370
KC12-SL46	East Catchment Area	23/06/12	350
		Total Length of Lines (m)	**6,090**

2.3 Geotechnical Laboratory Testing

Soil samples collected from LPT tests were sent to KCB's geotechnical laboratory in Vancouver to determine geotechnical properties of the soils. Rock samples collected during the drilling program were tested in camp (point load tests) and in KCB's laboratory in Vancouver, BC (unconfined compressive strength tests). The test program is summarized in Table 2.6 and the test results are presented in Appendix III.

Table 2.6 Summary of the 2012 Geotechnical Laboratory Testing

Laboratory Test	Procedure	No. of Tests
Atterberg Limits	ASTM D4318-10	38
Moisture Content	ASTM D2216-10	45
Grain Size Distribution (Hydrometer)	ASTM D422-07 (Sieve only) ASTM D422-07 (Complete test)	45 (10)
Visual Description	ASTM D2488-09	45
Point Load Test	ASTM D5731-08	15
Unconfined Compressive Strength Test	ASTM D7012-10	5

3 SITE INVESTIGATION RESULTS

The proposed site of the KSM Tailings Management Facility (TMF) is located approximately 24 km northeast of the mine site and occupies a northwest-southeast trending valley that is continuous across a low drainage divide located at roughly the valley midpoint. The drainage divide is located where the creek draining from the East Catchment Valley joins the TMF valley, and the presence of the drainage divide in the middle of the valley means that surface waters in the northern end of the valley drain northward to Teigen Creek and surface waters in the southern end of the valley drain southward to Treaty Creek (Figure 3.1).

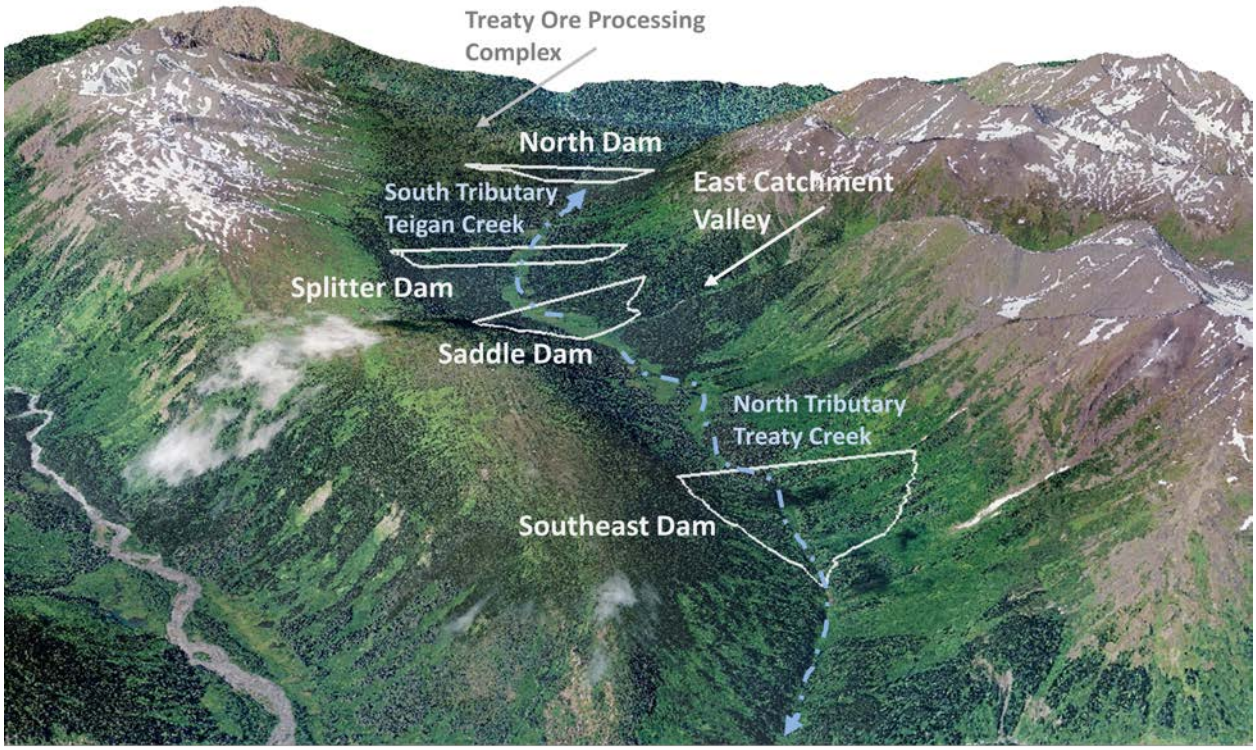

Figure 3.1 Tailings Management Facility Valley (Looking North)

The distribution of alluvial fan sediments deposited where the East Catchment hanging valley enters the TMF valley indicates that flow from the East Catchment Valley has alternated between Teigen and Treaty Creeks. During the spring freshet, sheet-flow has been observed draining toward both Teigen and Treaty Creeks. However, during low-flow periods the East Catchment Valley currently drains northward toward Teigen Creek.

The proposed TMF consists of two primary dams: the North Dam across the South Tributary of Teigen Creek at the north end of the valley; and the Southeast Dam across the North Tributary Treaty Creek at the south end of the valley. Construction of the Splitter Dam and the Saddle Dam at the drainage divide between the North and Southeast Dams is proposed to allow for staging of the TMF into the

North and South Cells. Previous work to characterize the geology of the TMF valley was conducted in 2008, 2009, 2010 and 2011. The 2012 site investigation activities were conducted to refine the understanding of overburden and bedrock conditions at proposed borrow areas in the vicinity of the proposed TMF dam structures and foundation parameters in the area of the Treaty OPC.

The overall shape of the TMF valley is a function of the underlying bedrock structure. Broadly speaking, the valley consists of a syncline whose axis is roughly coincident with the valley bottom (Drawing D-4002). The simple synclinal fold geometry of the valley is complicated by a postulated northeast-southwest striking fault with an apparent left-lateral sense of motion that underlies the East Catchment Valley and intersects the TMF valley near the drainage divide. The TMF valley does not appear to be offset by faulting. Rather, erosional processes appear to have exploited the weaker bedrock present along a pre-existing fault. The offset axis of the syncline may have resulted in erosion and glaciations having carved an irregular course for the valley that mirrors the structure of the underlying bedrock. The results of the structural geology assessment for the TMF valley are discussed in the structural geology report (ERSI/KCB 2011) on the KSM Project Area.

The relationship between the valley morphology and the underlying bedrock is obscured by more recent sediments filling the TMF valley. Drilling and seismic survey results suggest that a glacier-scoured bedrock trough underlies the present valley surface and this bedrock trough is partly filled with dense, basal glacial till overlain by stream alluvium and marsh deposits.

Overlying the till and alluvium along the valley margins are alluvial fans and colluvial deposits that have modified the shape of the valley by deflecting the course of the central stream such that the deepest part of the bedrock trough lies southwest of the present valley bottom in the northern section of the valley, and northeast of the present valley bottom in the southern section. As a result, the thickest overburden soils lie along the valley flanks, rather than along the valley bottom. Sediment thickness along the path of the present drainages has been further reduced as a result of incision by the creeks at the north and south ends of the valley.

Valley slopes at the TMF site are moderate to very steep (slope grade is about 45% at the proposed level of ultimate tailings), with thick conifer forests extending up to the tree line at approximately 1,200 m. Slide-alder-lined avalanche trails and talus cones, particularly on the east side, emerge from high mountain gullies and cut through the forest; some of these avalanche trails reach the valley floor. The valley floor is flat, wide, and marshy at the saddle near the drainage divide and gently sloping and constricting to the north and south, where the central streams are incised into the valley bottom. Slopes in the south end of the TMF valley are typically steeper than in the north end of the valley.

In general terms, five major surficial material types are present in the TMF area:

- ***Glacial basal till*** – a blanket of dense, consolidated, grey, basal till (clay-silt-sand-gravel) covers the bedrock along the valley bottom and underlies the younger alluvial and colluvial sediments filling the valley. The thickness of the till varies from about 10 m to 60 m. The till is thickest along the course of the buried bedrock trough that underlies the present valley surface.

- ***Glacial morainal till*** – the lower slopes of the valley walls are covered a veneer of lateral moraine deposits, up to 10 m thick. Morainal till forms a loose, discontinuous cover over bedrock and is composed of silty sand with some gravel, cobbles, and trace boulders.
- ***Colluvium*** – includes talus, slope wash, and steep-sided debris cones deposited on or at the base of slopes. It is generally derived from erosion of moraine soils and weathered bedrock, and is comprised of angular boulders, cobbles, and gravel with silt and sand.
- ***Alluvial fan and debris flow deposits*** – gently-sloping, wide debris fans deposited on the valley floor by streams descending the steep sides of the valley.
- ***Fluvial and marsh deposits*** – fine and coarse-grained sediments deposited by meandering streams and fringing marshes. These alluvial and marsh deposits are encountered in the flat bottom of the valley floor throughout most of the TMF and are up to about 20 m thick (includes mats of peat and organic-rich silt up to 2 m thick).

The 2012 Site Investigation Program included geotechnical drilling and seismic refraction geophysics. The locations of the drill holes drilled during the 2012 program are summarized in Table 2.2 and the seismic refraction lines are summarized in Table 2.5. The 2012 program locations, and those locations completed in 2010 and 2011 programs, are shown in Drawings D-4004 to D-4006. The drill hole logs are presented in Appendix I and core photographs are presented in Appendix II. Geological logs of RQD, and TCR are presented in Appendix IV. The seismic refraction survey report is presented in Appendix V.

3.1 Treaty Ore Processing Complex Area

The proposed Treaty Ore Processing Complex (OPC) adjacent to the TMF Area is located northwest of the North Dam site on a broad, bedrock plateau that lies between the lower main valley to the east and the high mountain area above treeline to the west. The relatively flat-lying area of the plateau is underlain by interbedded sandstone and siltstone rocks of the Bowser Lake Group which are folded into an anticline, the axis of which is located just west of drill holes KC11-37 and KC11-38. The strike of bedding is northwest-southeast so that beds near and east of the drill holes dip toward the northeast. A pair of prominent, north-trending lineaments is visible in air photos and marks the location of a pair of high-angle faults which cross the site (Drawing D-4002). Differential erosion of sandstone and siltstone units by passing glaciers has sculpted the surface of the plateau into a series of long, bedding-parallel sandstone ridges separated by shallow, linear troughs underlain by siltstone. The ridges are mostly tree-covered with only a thin soil cover. The shallow troughs are filled with loose, saturated sediments covered with marsh plants.

3.1.1 Geotechnical Drilling

KC12-64 (Treaty Ore Processing Complex)

The hole encountered a 0.8 m superficial layer consisting of a poorly graded fine to coarse grained sand, with trace silt and fine gravel. Organics present within the upper zone of the material.

Underlying the superficial layer the hole encountered possible weathered bedrock but due to the use of air rotary drilling to advance the hole from 0 m to 2.1 m, there was no recovery. Logs show that cuttings reveal dark grey with lighter grey sand to gravel sized angular rock fragments, with iron-staining increasing with depth up to 2.1 m which have been interpreted to be possible weathered bedrock.

Bedrock from 2.1 m to 5.5 m (Figure 3.2) is generally a dark grey slightly weathered fine grained siltstone (95%), interbedded with light grey fine to medium grained sandstone (5%). Bedding is recorded at approximately 60° to core axis and bedding/contacts as smooth to irregular/scoured. The intact rock is medium strong, with a strength rating of R3.

Figure 3.2 KC12-64 NQ Rock Core from 2.1 m to 7.96 m

Bedrock from 5.5 m to 17.5 m (Figure 3.3) is generally a light grey fresh to slightly weathered fine to medium-grained sandstone (85%), interbedded with up to 20 mm thick millimeter-scale smooth to irregular/scoured siltstone inclusions (15%). Bedding is recorded at 55° to 70° to core axis and bedding contacts contain mm-scale calcite nodules/stringers. The intact rock is medium strong, with a strength rating of R3.

Figure 3.3 KC12-64 NQ Rock Core from 7.96 m to 13.0 m

The TCR is excellent, averaging 97% throughout the length of the hole. The RQD is good, averaging 86%. Water level in the hole was recorded at 2.68 mbgl.

3.2 North Dam Area

The proposed North Dam is shown in Drawing D-4004. The ultimate dam, with a potential crest elevation of approximately 1,065 m, a crest width of 20 m, and 215 m total height will stretch

between the east wall of the valley and the plateau where the plantsite is proposed to be located (Figure 3.1).

3.2.1 Seismic Refraction Survey

Seismic line KC12-SL34 is located at the toe of the North Dam and ends close to the beginning of line KC11-SL23, separated by a creek. Seismic line KC12-SL35 is located on the dam crest, southeast of line KC12-SL34. The line intersects previous seismic line KC09-SL08 and drill holes KC10-23A, KC10-OVB5, and KC10-OVB4 lie on the same alignment. From the survey:

- The underlying strata can be categorized in to three distinct velocity layers. The surficial layer is reported to have compressional wave velocities ranging between 375 m/s and 550 m/s. The layer is interpreted as loose soils composed of sands and gravels which correlates with the material identified in drill hole logs KC10-23A, KC10-OVB5, and KC10-OVB4. This layer is generally thin, ranging from less than a meter to 3.4 m (northeast end of KC12-SL35).
- The intermediate layer has velocities ranging between 2,060 m/s and 2,465 m/s. The layer is interpreted as clayey-silty gravel and boulders (compact glacial till) which correlates with the material encountered at similar depths in drill hole KC10-OVB4. The depth to the competent bedrock layer varies from less than 1 m to 29 m (station 450NE on KC12-SL35).
- The competent bedrock surficial weathered and unweathered layers have velocities ranging between 3,175 m/s and 5,500 m/s. The lower range velocities are found along KC12-SL35 at the base of the valley, and have been inferred to be weathered or fractured bedrock, whereas the higher ranges of velocities are inferred to be crystalline intact bedrock. The depth to bedrock beneath KC12-SL34 averages 2.9 m.

3.3 Splitter Dam Area

The proposed Splitter Dam is located north of the midpoint of the TMF near the valley drainage divide (Drawing D-4004), approximately 1,000 m from the proposed Saddle Dam. The surficial expression of overburden in the valley floor in the Splitter Dam and Saddle Dam areas is similar, flat and marshy at about El. 900 m with grasses, mosses, bushes, and alder thickets. Several small stream channels meander across the marsh before consolidating into two creeks, one draining northward toward Teigen Creek and the other draining southward toward Treaty Creek. Surface water sheet flow from the East Catchment Valley has been observed reporting to both north and south creeks during periods of heavy rainfall. A significant stream exits the East Catchment Valley at the drainage divide and has created an alluvial fan approximately 750 m wide at the base.

3.3.1 Geotechnical Drilling

KC12-OVB44 (Right Abutment)

This overburden hole was drilled to test an area where seismic indicated potential till borrow. The hole continued for enough into bedrock to identify base of overburden.

KC12-OVB44 encountered a 1.5 m superficial layer consisting of a loose to compact fine to coarse grained sand, with silt and trace gravel and some organics.

Underlying the superficial layer the hole encountered sand, clay and gravel sequences up to 20.1 m. These sequences have been inferred to be dense to very dense glacial till. The clay component of the till is generally described as high plasticity, dark grey, and moisture content wetter than plastic limit. The sand component is generally described as medium to coarse, well graded, subrounded to angular, dark grey, and wet. The gravel is generally described as fine to coarse grained, sandy, well graded, subrounded to subangular, dark grey, and wet. LPT testing is summarized in Table 3.1.

Table 3.1 Summary of LPT Results for KC12-OVB44

Sample No	Depth (m)	Sample Length (m)	Recovery (%)	LPT Blows per 6"	LPT N Value
LPT1	1.9	0.6	100	15,24,24,19	48
LPT2	3.4	0.32	90	20,34,Refusal at 35 cm	101
LPT3	4.9	0.6	100	16,27,30,39	57
LPT4	6.4	0.6	100	23,30,34,43	64
LPT5	7.9	0.65	107	16,24,31,32	55
LPT6	9.5	0.65	107	9,19,23,34	42
LPT7	11.0	0.6	100	14,50,36,38	86
LPT8	14.0	0.6	100	13,29,47,63	76
LPT9	17.1	0.6	100	14,18,36,38	54
LPT10	18.6	0.45	73.8	9,25,34,54	59
LPT11	20.1	0	0	Refusal at 0 cm	101

Bedrock in KC12-OVB44 is generally slightly to moderately weathered fine grained grey to black siltstone. The intact rock is weak, with a strength rating of R2.

The TCR is poor, averaging 31% throughout the length of the hole. The RQD is very poor, averaging 4%. Figure 3.4 shows the highly fractured and broken nature of the bedrock recovered from KC12-OVB44. Water level in the hole was recorded at 4.34 mbgl.

Figure 3.4 KC12-OVB44 NQ Rock Core from 21.96 m to 30.2 m

KC12-OVB45 (Right Abutment)

KC12-OVB45 encountered a 1.6 m superficial layer consisting of a compact to dense fine to coarse grained sand, with silt and gravel, and some organics.

Underlying the superficial layer the hole encountered clay and gravel sequences up to 18.3 m. These sequences have been inferred to be dense to very dense glacial till. The clay component of the till is

generally described as medium to high plasticity, dark grey, and moist. The gravel is generally fine to coarse grained, sandy, well graded, subrounded to subangular, dark grey, and dry to moist. LPT testing in the glacial till is summarized in Table 3.2.

Table 3.2 Summary of LPT Results for KC12-OVB45

Sample No	Depth (m)	Sample Length (m)	Recovery (%)	LPT Blows per 6"	LPT N Value
LPT1	2.0	0.6	100	35,37,35,49	72
LPT2	3.5	0.35	135	32,Refusal at 25.5 cm	101
LPT3	5.0	0.12	100	Refusal at 12.5 cm	101
LPT4	6.5	0.23	153	68,Refusal at 15 cm	101
LPT5	8.0	0.17	113	58,Refusal at 15 cm	101
LPT6	9.6	0.23	115	41,Refusal at 20 cm	101
LPT7	11.1	0	0	Refusal	101
LPT8	12.6	0	0	Refusal	101
LPT9	14.1	0	0	Refusal	101
LPT10	15.7	0.03	120	Refusal at 2.5 cm	101

Bedrock in KC12-OVB45, from 18.3 m to 27.4 m (Figure 3.5), is generally fresh to slightly weathered fine to medium grained grey sandstone. The intact rock is medium strong, with a strength rating of R3.

Figure 3.5 KC12-OVB45 NQ Rock Core from 18.91 m to 24.77 m

The bedrock from 27.4 m to 29.0 m (Figure 3.6) is generally fresh to slightly weathered fine grained dark grey to black siltstone, with 1 mm to 5 mm thick calcite veins at 10° to 30° to core axis at an approximate density of 10 per meter. Some polished and shiny joints present. The intact rock is medium strong, with a strength rating of R3.

Figure 3.6 KC12-OVB45 NQ Rock Core from 24.77 m to 28.95 m

The TCR throughout the hole is excellent, averaging 91% throughout the length of the hole. The RQD is poor, averaging 39%. Figure 3.5 shows the fractured nature of the bedrock recovered from KC12-OVB45. Water level in the hole was recorded at 5.39 mbgl.

3.3.2 Seismic Refraction Survey

Seismic line KC12-SL36 is located to the northwest of the proposed dam location and KC12-SL37 to the southeast of the dam. Both are extensions of previous seismic lines KC11-SL15 and KC11-SL16. Drill holes KC-OVB44 and KC12-OVB45 are located at the start of KC12-SL36 and KC12-SL37 respectively. From the survey:

- The underlying strata can be categorized into three distinct velocity layers. The surficial layer is reported to have compressional wave velocities ranging between 400 m/s and 1,300 m/s and is similar to values in KC11-SL15 and KC11-SL16. The layer is interpreted as sand and gravel and correlates with material found in drill hole KC12-OVB44. This layer is generally thin, ranging in thickness from 0.3 m to 3.7 m.
- The intermediate layer has velocities ranging between 1,800 m/s to 2,400 m/s. The layer is interpreted as gravel colluvium or glacial till which correlates with the dense gravels and hard clays encountered in drill hole KC12-OVB44. The velocity of 1,800 m/s at the beginning of line KC12-SL36 increases slightly to 2100 m/s in the valley bottom. The interpreted velocities for the intermediate layer of line KC12-SL37 are slightly higher, but likely comprised of the same till materials or heavily fractured bedrock, as was encountered in drill hole KC12-OVB45. The thickness of this layer varies between the two lines. On KC12-SL36, the thickness ranges from 1 m at the start to 17 m at station 165NE. On KC12-SL37 the thickness ranges from 2.3 m at station 230NE to 39 m at station 410NE, with an average thickness 14 m.
- The competent bedrock layer has velocities ranging between 3,670 m/s and 5,060 m/s. The lower range velocities are found on KC12-SL37 at station 410NE (largest till cover), with a depth of 46 m. The depth to bedrock on KC12-SL36 ranges from 1.6 m at station 575NE to 19 m at station 165NE, with an average of 9 m.

3.4 Saddle Dam Area

The Saddle Dam area is located near the midpoint of the TMF near the valley drainage divide (Drawing D-4004), approximately 1,000 m south of the proposed Splitter dam. The valley floor in the Saddle Dam and Splitter Dam areas is similar, flat and marshy at about El. 900 m with grasses, mosses, bushes, and alder thickets. Several small stream channels meander across the marsh before consolidating into two creeks, one draining northward toward Teigen Creek and draining southward toward Treaty Creek. Surface water sheet flow from the East Catchment Valley has been observed reporting to both north and south creeks during periods of heavy rainfall. A significant stream exits the East Catchment Valley at the drainage divide and has created an alluvial fan approximately 750 m wide at the base.

3.4.1 Geotechnical Drilling

KC12-OVB46 (Right Abutment)

KC12-OVB46 encountered a 2.1 m superficial layer consisting of a compact to dense fine to coarse grained sand, with silt and gravel, and some organics.

Underlying the superficial layer the hole encountered clay and gravel sequences up to 18.3 m. These sequences have been inferred to be dense to very dense glacial till. The clay component of the till is generally described as medium to high plasticity, dark grey, and moist. The gravel is generally described as fine to coarse grained, sandy, well graded, subrounded to subangular, dark grey, and dry to moist. LPT testing in the glacial till are summarized in Table 3.3

Table 3.3 Summary of LPT Results for KC12-OVB46

Sample No	Depth (m)	Sample Length (m)	Recovery (%)	LPT Blows per 6"	LPT N HP
LPT1	2.1	0	0	Refusal at 0 cm	101
LPT2	3.6	0	0	Refusal at 0 cm	101
LPT3	5.1	0.1	100	Refusal at 10 cm	101
LPT4	6.6	0	0	Refusal at 5 cm	101
LPT5	8.1	0.2	135	63,Refusal at 20 cm	101
LPT6	9.7	0.13	100	Refusal at 13 cm	101
LPT7	12.7	0.1	100	Refusal at 10 cm	101
LPT8	15.7	0.254	0	34,Refusal at 25.4 cm	101

Bedrock in KC12-OVB46, from 18.8 m to 24.19 m (Figure 3.7), is generally fresh to slightly weathered fine to medium grained grey sandstone, interbedded with 5.0 cm to 10 cm thick siltstone beds every 0.5 m to 1.5 m at 45° to the core axis. The intact rock is strong, with a strength rating of R4.

Figure 3.7 KC12-OVB46 NQ Rock Core from 18.8 m to 24.19 m

TCR throughout the hole is good, averaging 79% throughout the length of the hole. The RQD is fair, averaging 54%. Water level in the hole was recorded at 2.44 mbgl.

3.4.2 Seismic Refraction Survey

Seismic line KC12-SL38 is located to the southeast of the proposed dam location and is an extension of KC11-SL-17. Drill hole KC12-OVB46 is located where the two lines meet. From the survey:

- The underlying strata can be categorized into three distinct velocity layers. The superficial layer is reported to have compressional wave velocities ranging between 330 m/s and 990 m/s. This layer is interpreted to be sand and gravel alluvium or gravel colluvium and correlates with the compact sand in KC12-OVB46. The layer is generally thin, averaging 1.5 m in thickness.
- The intermediate layer has velocities ranging between 1,800 m/s and 2,500 m/s. The layer is interpreted as compact sand, gravel and clay till and correlates with the very dense gravels encountered in drill hole KC12-OVB46. The layer thickness ranges from 0.5 m to 18 m (at northeast end), with an average thickness of 5 m.
- The competent bedrock layer has velocities ranging between 4,480 m/s and 4,555 m/s. The depth to bedrock on KC12-SL38 ranges from 1.6 m to 19 m, with an average of 10 m.

3.5 Southeast Dam and Spillway Area

The proposed Southeast Dam and spillway site is located at the North Tributary of Treaty Creek about 2.5 km upstream of its confluence with the main branch of Treaty Creek. The west side of the valley at the Southeast Dam site descends steeply at about 45° from the ridge crest at El. 1,320 m to a prominent slope break at El. 950 m. Below El. 950 m the slope flattens to approximately 20° down to El. 850 m, where it steepens abruptly to form an incised ravine along the creek bed at El. 800 m (Drawing D-4004).

3.5.1 Geotechnical Drilling

KC12-OVB47 (Right Abutment)

KC12-OVB47 encountered a dense to very dense gravel and sand layer up to 5.2 m. The gravel component is generally described as fine grained, well graded, brown, and moist. The sand component is medium to coarse grained. Cobbles and boulders are also present. LPT testing is summarized in Table 3.4.

Table 3.4 Summary of LPT results for KC12-OVB47

Sample No	Depth (m)	Sample Length (m)	Recovery (%)	LPT Blows per 6"	LPT N Value
LPT1	2.0	0.6	83.3	17,26,24,17	50
LPT2	3.5	0	0	Refusal at 0 cm	101
LPT3	5.2	0	0	Refusal at 0 cm	101

Bedrock in KC12-OVB47 from 5.2 m to 6.6 m (Figure 3.8) is generally a fresh medium to coarse grained grey sandstone, with bedding at 70° to core axis.

Figure 3.8 KC12-OVB47 NQ Rock Core from 5.2 m to 10.92 m

From 6.6 m to 13.2 m (Figure 3.8 and Figure 3.9) is fresh medium grained grey sandstone, interbedded with black siltstone at angles approximately 60° to core axis (+/- 20°).

Figure 3.9 KC12-OVB47 NQ Rock Core from 10.92 m to 16.10 m

The intact rock is strong, with a strength rating of R3 to R4. The TCR throughout the hole is excellent, averaging 97% throughout the length of the hole. The RQD is fair, averaging 70%. Water level in the hole was recorded at 3.9 mbgl.

KC12-OVB48 (Right Abutment)

KC12-OVB48 encountered a very dense gravel and silt superficial layer up to 2.7 m. The gravel component is generally described as well graded subangular to angular, grey, and wet, with some cobbles and trace sand.

From 2.7 m to 7.2 m the hole encountered compact sand and gravel sequences. The gravel component is described as fine to coarse grained, subangular to angular, grey, wet, and homogeneous. The sand component is described as generally fine to coarse grained, well graded, subangular to angular, grey, wet, and homogeneous. LPT testing is summarized in Table 3.5.

Table 3.5 Summary of LPT Results for KC12-OVB48

Sample No	Depth (m)	Sample Length (m)	Recovery (%)	LPT Blows per 6"	LPT N HP
LPT1	1.2	0.45	25	28,13,57	70
LPT2	2.7	0.45	84.4	10,14,15	29
LPT3	4.2	0.6	71.7	8,9,12,16	21
LPT4	5.8	0.6	83.3	6,12,13,18	25

Bedrock in KC12-OVB47 from 7.8 m to 8.9 m (Figure 3.10) is generally fresh, fine to medium grained interbedded grey sandstone, with faint iron and other staining along joint surfaces and some partially healed fractures.

Figure 3.10 KC12-OVB48 NQ Rock Core from 7.8 m to 13.1 m

From 8.90 m to 9.80 m (Figure 3.10) is generally fresh fine to medium-grained grey sandstone, interbedded with black siltstone and wavy bedding at 60° to core axis. Pyrite lenses along bedding at approximately 1 per meter, 5 mm to 10 mm.

The intact rock is medium strong, with a strength rating of R3. The TCR throughout the hole is good, averaging 82% throughout the length of the hole. The RQD is fair, averaging 62%. Water level in the hole was recorded at 0.46 mbgl.

KC12-OVB49 (Left Abutment)

KC12-OVB49 encountered gravel, sand, and clay sequences up to 40.8 m. These sequences have been inferred to be dense to very dense glacial till. The clay component of the till is generally described as medium plasticity, grey, and moist. The sand component is described as fine to medium grained, with trace to some clay, gravel in some sections, poorly graded, subangular to subrounded, grey, and wet. The gravel is generally described as fine to coarse grained, clayey with some sand, well graded, angular to subangular, grey to dark brown, and dry to moist. LPT testing in the glacial till is summarized in Table 3.6.

Table 3.6 Summary of LPT Results for KC12-OVB49

Sample No	Depth (m)	Sample Length (m)	Recovery	LPT Blows per 6"	LPT N HP
LPT1	1.8	0.45	44.4	22,21,52	73
LPT2	3.3	0.6	66.7	17,16,13,10	29
LPT3	4.9	0.6	25	9,28,19,22	47
LPT4	6.4	0.34	100	21,28,Refusal	101
LPT5	7.9	0	0	Refusal at 0 cm	101
LPT6	9.4	0	0	Refusal at 0 cm	101
LPT7	10.9	0	0	Refusal	101
LPT8	12.5	0.17	150	53,65,Refusal at 30 cm	101
LPT9	14.0	0.4	123	24,46,Refusal at 41 cm	101

Sample No	Depth (m)	Sample Length (m)	Recovery	LPT Blows per 6"	LPT N HP
LPT10	17.0	0.6	100	29,34,40,34	74
LPT11	20.1	0.56	116	10,20,31,Refusal at 56 cm	101
LPT12	23.1	0.25	80	29,Refusal at 25 cm	101
LPT13	26.1	0.51	133	12,25,18	43
LPT14	28.3	0	0	Refusal at 0 cm	101

Bedrock in KC12-OVB49 (Figure 3.11) is generally described as fresh to slightly weathered fine to medium grained grey to black siltstone, interbedded with bands of fine grained grey sandstone. The intact rock is weak, with a strength rating of R2.

Figure 3.11 KC12-OVB49 NQ Rock Core from 39.3 m to 46.93 m

The TCR throughout the hole is fair, averaging 61% throughout the length of the hole. The RQD is poor, averaging 27%. Water level in the hole was recorded at 6.16 mbgl.

3.5.2 Seismic Refraction Survey

Seismic lines KC12-SL39 through KC12-SL42 are extensions to former lines KC11-SL18 through KC11-SL-21, respectively. Drill hole KC-OVB47 is located on KC12-SL39, KC-OVB48 is located on KC12-SL41, and KC12-OVB49 is located on KC11-SL20. From the survey:

- The underlying strata can be categorized into three distinct velocity layers. The superficial layer is reported to have compressional wave velocities ranging between 330 m/s and 990 m/s. It is interpreted to be sand and gravel alluvium or gravel colluvium. The thickness of the layer averages 1.5 m.
- The intermediate layer has velocities ranging between 1,500 m/s and 2,500 m/s. This is interpreted as compact sand, gravel and clay till which correlates with very dense gravels encountered in drill holes KC12-OVB47 to KC12-OVB49. The exception on a section of KC12-SL42 where the lower range of velocities (1,500 m/s) is interpreted as saturated soils. The layer has a general thickness of 5 m to 10 m with a thickness of up to 27 m at the southwest end of KC12-SL39.
- The competent bedrock has velocities ranging between 4,480 m/s and 4,555 m/s on KC12-SL-39. Lower velocities are found on sections of KC12-SL40 to KC12-SL42 indicating a lower velocity section of bedrock. KC12-SL40 has an interpreted bedrock velocity of 3,515 m/s for about 180 meters from station 0NE to station 180NE, and a velocity of about 4,410 m/s from

station 180NE to 420NE. KC12-SL41 has an interpreted velocity ranging between 4,250 m/s and 4,370 m/s on the southwest end of the line, and a velocity of about 3,350 m/s below the creek and adjacent slopes. KC12-SL42 has an interpreted velocity of 3,220 m/s for the first 35 m at the southwest end of the line, and from that point onwards a velocity ranging between 4,055 m/s and 4,145 m/s.

3.6 East Catchment Area

The East Catchment Valley is a hanging glacial valley that extends eastward from the main TMF valley into the Snowslide Range. The Snowslide Range contains several snowfields and small glaciers, including the East Catchment glacier located about 4 km up-valley from the junction with the main TMF valley, and about 2 km up-valley from the proposed tunnel intake facility. The glacier-carved U-shape profile of the East Catchment Valley has been modified by mass wasting since the retreat of the glacier (particularly along the north side of the valley) so that lower slopes are oversteepened and covered by colluvium and alluvium; upper slopes are predominantly exposed rock. The roughly east-west trending ridges above the East Catchment Valley are about 600 m to 700 m above the valley bottom. The mouth of the East Catchment Valley is about 250 m above the bottom of the main TMF valley, and East Catchment creek has incised this part of the valley. Deposition by the creek has built a large alluvial fan where it intersects the drainage divide between the south tributary of Teigen Creek and the north tributary of Treaty Creek.

3.6.1 Seismic Refraction Survey

KC12-SL43 to KC12-SL46 are located in the area of the East Catchment Valley adjacent to the TMF area where water diversion inlet dam, are proposed. From the survey:

- The underlying strata can be categorized into four distinct velocity layers. The surficial layer has a velocity ranging between 300 m/s and 600 m/s. The layer is interpreted to be comprised of loose materials which are correlated with the dry gravel and sand found in drill hole KC11-36. The layer has generally a thickness ranging between 0.1 m and 7.6 m.
- The intermediate layer has a velocity ranging from 520 m/s to 1,630 m/s.
  - On KC12-SL43, the intermediate layer has a velocity of about 1,450 m/s to 1,630 m/s. This layer is interpreted to be a moderately dense or saturated layer and has a thickness of about 1.5 m to 5.7 m.
  - KC12-SL44 does not have a sufficiently thick secondary layer.
  - On KC12-SL45 the secondary layer has a velocity of 1,145 m/s to 1,450 m/s. This layer is interpreted to be moist to wet gravel and sand, and correlates well with drill hole KC11-36. The layer has a thickness ranging between 4 m and 17.5 m.
  - On KC12-SL46, between stations 0SE and 120SE, the second seismic layer has a velocity of about 1,320 m/s. This is interpreted to be moderately dense and/or partially saturated soils. Between stations 120SE and 210SE, the velocity of the second layer increases to 1,600 m/s, which is interpreted to be fully saturated soils below the creek. On the

southeast hillside the velocity of the second layer reduces to 520 m/s and 850 m/s. This is interpreted to be relatively loose, unsaturated materials.

- The third seismic layer has a velocity ranging from 1,810 m/s to 2,580 m/s.
  - On KC12-SL43 the third seismic layer has a velocity ranging between 2,530 m/s and 2,580 m/s. This layer is interpreted to be very compact till. The average thickness of this layer is about 40 m on the southwest side of the line, and about 15 m on the northeast side.
  - On KC12-SL44 the third layer has a velocity ranging between 2,200 m/s and 2,500 m/s. This layer is interpreted to be compacted till. The layer ranges in thickness from 8 m below the creek in the middle of the line to 25 m at each end of the line.
  - On KC12-SL45 and KC12-SL46 the third layer has a velocity ranging between 1,810 m/s to 2,100 m/s. This layer is interpreted to be dense gravel and sand, which correlates with higher LPT blow counts indicated in the drill hole KC11-36. The layer ranges in thickness between 17.5 m and 43 m.
  - On KC12-SL46 this layer is very thin except for below the creek between stations 120SE and 210SE, where it reaches a maximum thickness of about 10 m.
- The competent bedrock has a velocity ranging between 3,520 m/s and 4,580 m/s.
  - On KC12-SL45 the depth to bedrock is interpreted to be 51 m which correlates with the sandstone layer encountered in KC11-36 at about 53 m.
  - On KC12-SL43 the lowest velocity was found in the middle of the line between about stations 120SE and 300SE.
  - On KC12-46 the lowest velocity was found below the creek.
  - On KC12-SL43 a low velocity zone with a velocity of 2,700 m/s was encountered between stations 190SE to 225SE. This area is interpreted to be a zone of highly weathered, or fractured bedrock, and possible presence of a fault at about station 190SE. In this area, the low contrast in velocities between the overlying till and bedrock causes a depression in the interpreted bedrock surface. The depth of this depression may not be as accurate as the interpreted bedrock depths for the rest of this line.

4 LABORATORY RESULTS

The following tests were carried out on samples taken during the TMF area site investigation program.

Table 4.1 Summary of Laboratory Testing Schedule

Test	# of Tests
Atterberg Limits	38
Moisture Content	45
Particle Size Distribution (inc. 10 hydrometer)	45
Visual Description	45
Point Load	15
Unconfined Compression Strength	5

4.1.1 Atterberg Limits

The Atterberg Limits test is a form of classification for cohesive soils. The plastic limit (PL) and liquid limit (LL) are moisture contents which define the boundaries between plastic, non-plastic, and viscous fluid states. The plasticity index (PI) defines the complete range of plastic state. The test produces indices used for soil identification, classification and correlations to strength.

A total of 38 Atterberg Limits test were performed in accordance with ASTM D4318. The Plastic Limit (W_P) ranges from 11% to 18%. The Liquid Limit (W_L) ranges from 13% to 32%. The Plasticity Index (PI) ranges from non-plastic (NP) to 16. A summary of the results are presented in Table 4.2 below and a graphical plot is presented in Appendix III.

Table 4.2 Summary of Atterberg Limits Results

Site ID	Sample No.	Depth (m)	Site Location	W_L	W_P	PI	Plasticity	Fines Content (%)
KC12-OVB44	LPT 1	1.9	Splitter Dam	28	15	13	Low Plasticity Clay	46.8
KC12-OVB44	LPT 2	3.4	Splitter Dam	28	14	13	Low Plasticity Clay	49.3
KC12-OVB44	LPT 3	4.9	Splitter Dam	28	15	13	Low Plasticity Clay	47.0
KC12-OVB44	LPT 4	6.4	Splitter Dam	27	14	13	Low Plasticity Clay	45.0
KC12-OVB44	LPT 5	7.9	Splitter Dam	28	14	13	Low Plasticity Clay	45.7
KC12-OVB44	LPT 6	9.5	Splitter Dam	27	14	13	Low Plasticity Clay	47.9
KC12-OVB44	LPT 7	11.0	Splitter Dam	26	14	11	Low Plasticity Clay	37.4
KC12-OVB44	LPT 8	14.0	Splitter Dam	23	14	10	Low Plasticity Clay	38.3
KC12-OVB44	LPT 9	17.1	Splitter Dam	23	14	9	Low Plasticity Clay	36.1
KC12-OVB44	LPT 10	18.6	Splitter Dam	23	13	9	Low Plasticity Clay	37.1
KC12-OVB45	LPT 1	2.0	Splitter Dam	29	15	14	Low Plasticity Clay	36.4
KC12-OVB45	LPT 2	3.5	Splitter Dam	27	14	13	Low Plasticity Clay	35.0
KC12-OVB45	LPT 3	5.0	Splitter Dam	28	15	13	Low Plasticity Clay	34.6
KC12-OVB45	LPT 4	6.5	Splitter Dam	29	15	13	Low Plasticity Clay	46.2
KC12-OVB45	LPT 5	8.0	Splitter Dam	28	15	13	Low Plasticity Clay	43.1
KC12-OVB45	LPT 6	9.6	Splitter Dam	25	14	11	Low Plasticity Clay	39.9
KC12-OVB45	CUTTINGS 1	11.1	Splitter Dam	13	13	NP		16.8
KC12-OVB45	CUTTINGS 2	14.1	Splitter Dam	14	13	1	Low Plasticity Silt	36.7
KC12-OVB46	GRAB 1	2.1	Saddle Dam	17	12	5	Low Plasticity Clay	23.9

Site ID	Sample No.	Depth (m)	Site Location	W_L	W_P	PI	Plasticity	Fines Content (%)
KC12-OVB46	GRAB 2	3.6	Saddle Dam	20	12	8	Low Plasticity Clay	27.3
KC12-OVB46	GRAB 3	5.1	Saddle Dam	19	11	7	Low Plasticity Clay	23.3
KC12-OVB46	GRAB 4	6.6	Saddle Dam	19	12	7	Low Plasticity Clay	24.0
KC12-OVB46	LPT 5	8.1	Saddle Dam	23	13	9	Low Plasticity Clay	33.6
KC12-OVB46	GRAB 5	8.1	Saddle Dam	20	12	8	Low Plasticity Clay	25.4
KC12-OVB46	LPT 6	9.7	Saddle Dam	21	13	7	Low Plasticity Clay	28.3
KC12-OVB46	GRAB 6	9.7	Saddle Dam	19	12	7	Low Plasticity Clay	24.4
KC12-OVB46	GRAB 7	11.2	Saddle Dam	18	12	7	Low Plasticity Clay	24.5
KC12-OVB47	LPT 1	2.0	Southeast Dam and Spillway	18	18	NP		8.7
KC12-OVB48	LPT 1	1.2	Southeast Dam and Spillway	23	13	10	Low Plasticity Clay	29.4
KC12-OVB48	LPT 2	2.7	Southeast Dam and Spillway	22	13	9	Low Plasticity Clay	29.9
KC12-OVB48	LPT 3	4.2	Southeast Dam and Spillway	24	14	10	Low Plasticity Clay	30.8
KC12-OVB48	LPT 4	5.8	Southeast Dam and Spillway	23	13	9	Low Plasticity Clay	36.9
KC12-OVB49	LPT 8	12.5	Southeast Dam and Spillway	25	13	12	Low Plasticity Clay	32.3
KC12-OVB49	LPT 9	14.0	Southeast Dam and Spillway	29	15	14	Low Plasticity Clay	35.2
KC12-OVB49	LPT 10	17.0	Southeast Dam and Spillway	32	17	15	Medium Plasticity Clay	38.8
KC12-OVB49	LPT 11	20.1	Southeast Dam and Spillway	31	16	16	Medium Plasticity Clay	63.9
KC12-OVB49	LPT 12	23.1	Southeast Dam and Spillway	14	14	NP		10.2
KC12-OVB49	SA 1	29.0	Southeast Dam and Spillway	26	14	12	Low Plasticity Clay	45.1

4.1.2 Water Content

This test is performed to determine water (moisture) content of soils and is expressed as a percentage. Sater content is the ratio of the mass of water in a given mass of soil to the mass of the dry soil solids. The water content is an important characteristic used for establishing soil properties for use as dam core borrow and compaction behavior relationships. The consistency of a fine-grained soil largely depends on its water content.

A total of 45 Water Content tests were conducted in accordance with ASTM D2216. The water content ranges from 2.7% to 18.2%. A summary of the results are presented in Table 4.3 below and detailed results are presented in Appendix III.

Table 4.3 Summary of Water Content Results

Site ID	Sample No.	Depth (m)	Site Location	Water Content (%)
KC12-OVB44	LPT 1	1.85 - 2.45	Splitter Dam	9.2
KC12-OVB44	LPT 2	3.37 - 3.69	Splitter Dam	9.5
KC12-OVB44	LPT 3	4.89 - 5.49	Splitter Dam	9.2
KC12-OVB44	LPT 4	6.41 - 7.01	Splitter Dam	8.5
KC12-OVB44	LPT 5	7.93 - 8.53	Splitter Dam	10.3
KC12-OVB44	LPT 6	9.46 - 10.06	Splitter Dam	10.3
KC12-OVB44	LPT 7	10.98 - 11.58	Splitter Dam	9.6
KC12-OVB44	LPT 8	14.03 - 14.63	Splitter Dam	9.9
KC12-OVB44	LPT 9	17.08 - 17.68	Splitter Dam	9.2
KC12-OVB44	LPT 10	18.60 - 19.20	Splitter Dam	9.4

Site ID	Sample No.	Depth (m)	Site Location	Water Content (%)
KC12-OVB45	LPT 1	1.95 - 2.55	Splitter Dam	7.5
KC12-OVB45	LPT 2	3.47 - 3.82	Splitter Dam	7.4
KC12-OVB45	LPT 3	4.99	Splitter Dam	7.2
KC12-OVB45	LPT 4	6.51 - 6.66	Splitter Dam	9.3
KC12-OVB45	LPT 5	8.03 - 8.18	Splitter Dam	8.9
KC12-OVB45	LPT 6	9.56 - 9.76	Splitter Dam	7.7
KC12-OVB45	LPT 10	15.65 - 15.68	Splitter Dam	9.7
KC12-OVB45	CUTTING 1	11.08 - 12.61	Splitter Dam	3.0
KC12-OVB45	CUTTING 2	14.13 - 15.65	Splitter Dam	5.6
KC12-OVB46	GRAB 1	2.05 - 3.57	Saddle Dam	5.1
KC12-OVB46	GRAB 2	3.57 - 5.09	Saddle Dam	5.0
KC12-OVB46	GRAB 3	5.09 - 6.61	Saddle Dam	5.0
KC12-OVB46	GRAB 4	6.61 - 8.13	Saddle Dam	4.6
KC12-OVB46	LPT 5	8.13 - 8.40	Saddle Dam	7.5
KC12-OVB46	LPT 6	9.65 - 9.78	Saddle Dam	14.0
KC12-OVB46	GRAB 5	8.13 - 9.65	Saddle Dam	5.6
KC12-OVB46	GRAB 6	9.65 - 11.17	Saddle Dam	5.3
KC12-OVB46	GRAB 7	11.17 - 12.69	Saddle Dam	4.4
KC12-OVB46	LPT 8	15.73 - 15.98	Saddle Dam	9.4
KC12-OVB47	LPT 1	1.98 - 2.58	Southeast Dam and Spillway	7.7
KC12-OVB48	LPT 1	1.20 - 1.65	Southeast Dam and Spillway	9.8
KC12-OVB48	LPT 2	2.72 - 3.17	Southeast Dam and Spillway	8.8
KC12-OVB48	LPT 3	4.24 - 4.86	Southeast Dam and Spillway	8.3
KC12-OVB48	LPT 4	5.76 - 6.36	Southeast Dam and Spillway	10.2
KC12-OVB49	LPT 1	1.82 - 2.22	Southeast Dam and Spillway	2.7
KC12-OVB49	LPT 2	3.34 - 3.94	Southeast Dam and Spillway	5.0
KC12-OVB49	LPT 3	4.86 - 5.46	Southeast Dam and Spillway	3.0
KC12-OVB49	LPT 4	6.38 - 6.72	Southeast Dam and Spillway	8.9
KC12-OVB49	LPT 8	12.46 - 12.76	Southeast Dam and Spillway	8.4
KC12-OVB49	LPT 9	13.98 - 14.38	Southeast Dam and Spillway	9.2
KC12-OVB49	LPT 10	17.02 - 17.62	Southeast Dam and Spillway	10.4
KC12-OVB49	LPT 11	20.06 - 20.60	Southeast Dam and Spillway	16.9
KC12-OVB49	LPT 12	23.10 - 23.35	Southeast Dam and Spillway	11.9
KC12-OVB49	LPT 13	26.14 - 26.65	Southeast Dam and Spillway	18.2
KC12-OVB49	SA 1	28.98 - 29.55	Southeast Dam and Spillway	8.0

4.1.3 Particle Size Distribution (PSD)

This test is a sieving (both dry and wet) method used to determine the particle (grain) size distribution of soil samples as they are passing through certain sieve sizes. The percentage of sand, gravel, and fines can be obtained from the test and used in the classification of soils.

A total of 45 PSD tests were conducted in accordance with ASTM D1140 and D422. The gravel content ranges from 1.4% to 94.7%. The sand content ranges from 4.5% to 70.2%. The fines content ranges from 0.8 % to 63.9%. A summary of the results are presented in Table 4.4 below and a graphical plot is presented in Appendix III.

Table 4.4 Summary of Particle Size Distribution Results

Site ID	Sample Number	Depth (m)	Site Location	Gravel (%)	Sand (%)	Fines (%)	W_L	W_P	PI
KC12-OVB44	LPT 1	1.85	Splitter Dam	23.8	29.4	46.8	28	15	13
KC12-OVB44	LPT 2	3.37	Splitter Dam	16.3	34.4	49.3	28	14	13
KC12-OVB44	LPT 3	4.89	Splitter Dam	19.7	33.3	47.0	28	15	13
KC12-OVB44	LPT 4	6.41	Splitter Dam	22.4	32.6	45.0	27	14	13
KC12-OVB44	LPT 5	7.93	Splitter Dam	23.3	31	45.7	28	14	13
KC12-OVB44	LPT 6	9.46	Splitter Dam	19.9	32.2	47.9	27	14	13
KC12-OVB44	LPT 7	10.98	Splitter Dam	33.1	29.5	37.4	26	14	11
KC12-OVB44	LPT 8	14.03	Splitter Dam	26.6	35	38.3	23	14	10
KC12-OVB44	LPT 9	17.08	Splitter Dam	30.4	33.5	36.1	23	14	9
KC12-OVB44	LPT 10	18.60	Splitter Dam	29.1	33.9	37.1	23	13	9
KC12-OVB45	LPT 1	1.95	Splitter Dam	36.8	26.8	36.4	29	15	14
KC12-OVB45	LPT 2	3.47	Splitter Dam	37.7	27.3	35.0	27	14	13
KC12-OVB45	LPT 3	4.99	Splitter Dam	34.4	31	34.6	28	15	13
KC12-OVB45	LPT 4	6.51	Splitter Dam	22.1	31.7	46.2	29	15	13
KC12-OVB45	LPT 5	8.03	Splitter Dam	27.8	29.1	43.1	28	15	13
KC12-OVB45	LPT 6	9.56	Splitter Dam	30	30.2	39.9	25	14	11
KC12-OVB45	Cuttings 1	11.08	Splitter Dam	33.5	49.6	16.8	13	13	NP
KC12-OVB45	Cuttings 2	14.13	Splitter Dam	19.8	43.5	36.7	14	13	1
KC12-OVB45	LPT 10	15.65	Splitter Dam	37.7	14.2	48.1			
KC12-OVB46	Grab 1	2.05	Saddle Dam	30.3	45.7	23.9	17	12	5
KC12-OVB46	Grab 2	3.57	Saddle Dam	16.2	56.5	27.3	20	12	8
KC12-OVB46	Grab 3	5.09	Saddle Dam	24.2	52.4	23.3	19	11	7
KC12-OVB46	Grab 4	6.61	Saddle Dam	28.9	47.2	24.0	19	12	7
KC12-OVB46	LPT 5	8.13	Saddle Dam	31.1	35.3	33.6	23	13	9
KC12-OVB46	Grab 5	8.14	Saddle Dam	28.2	46.3	25.4	20	12	8
KC12-OVB46	LPT 6	9.65	Saddle Dam	44.5	27.2	28.3	21	13	7
KC12-OVB46	Grab 6	9.66	Saddle Dam	28.5	47.1	24.4	19	12	7
KC12-OVB46	Grab 7	11.17	Saddle Dam	30	45.5	24.5	18	12	7
KC12-OVB46	LPT 8	15.73	Saddle Dam	49.7	47.3	3.0			
KC12-OVB47	LPT 1	1.98	Southeast Dam and Spillway	41.8	49.5	8.7	18	18	NP
KC12-OVB48	LPT 1	1.2	Southeast Dam and Spillway	42.3	28.3	29.4	23	13	10
KC12-OVB48	LPT 2	2.72	Southeast Dam and Spillway	35.7	34.4	29.9	22	13	9
KC12-OVB48	LPT 3	4.24	Southeast Dam and Spillway	41	28.2	30.8	24	14	10
KC12-OVB48	LPT 4	5.76	Southeast Dam and Spillway	26.6	36.5	36.9	23	13	9
KC12-OVB49	LPT 1	1.82	Southeast Dam and Spillway	83.9	15	1.1			
KC12-OVB49	LPT 2	3.34	Southeast Dam and Spillway	76.3	21.7	2.1			
KC12-OVB49	LPT 3	4.86	Southeast Dam and Spillway	94.7	4.5	0.8			
KC12-OVB49	LPT 4	6.38	Southeast Dam and Spillway	73.1	18.8	8.1			
KC12-OVB49	LPT 8	12.46	Southeast Dam and Spillway	36	31.7	32.3	25	13	12
KC12-OVB49	LPT 9	13.98	Southeast Dam and Spillway	29.3	35.5	35.2	29	15	14
KC12-OVB49	LPT 10	17.02	Southeast Dam and Spillway	37.9	23.2	38.8	32	17	15
KC12-OVB49	LPT 11	20.06	Southeast Dam and Spillway	7	29.1	63.9	31	16	16
KC12-OVB49	LPT 12	23.1	Southeast Dam and Spillway	28.9	60.9	10.2	14	14	NP
KC12-OVB49	LPT 13	26.14	Southeast Dam and Spillway	1.4	70.2	28.4			
KC12-OVB49	SA 1	28.98	Southeast Dam and Spillway	20.9	34.1	45.1	26	14	12

4.1.4 Visual Description

The visual description analysis done in the geotechnical laboratory determines the soil type from samples taken and are used to confirm the soil types logged in the field.

A total of 45 Visual Description tests were conducted in accordance with ASTM D2488. The dominant group from the visual description tests is clayey SAND with gravel. There are also occurrences of clayey gravel with sand. A summary of the results are presented in Table 4.5 below and detailed results are presented in Appendix III.

Table 4.5 Summary of Visual Description Results

Site ID	Sample No.	Depth (m)	Site Location	Group Symbol	Group Name
KC12-OVB44	LPT 1	1.85 - 2.45	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 2	3.37 - 3.69	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 3	4.89 - 5.49	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 4	6.41 - 7.01	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 5	7.93 - 8.53	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 6	9.46 - 10.06	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 7	10.98 - 11.58	Splitter Dam	GC	Clayey GRAVEL with sand
KC12-OVB44	LPT 8	14.03 - 14.63	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 9	17.08 - 17.68	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB44	LPT 10	18.60 - 19.20	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB45	LPT 1	1.95 - 2.55	Splitter Dam	GC	Clayey GRAVEL with sand
KC12-OVB45	LPT 2	3.47 - 3.82	Splitter Dam	GC	Clayey GRAVEL with sand
KC12-OVB45	LPT 3	4.99	Splitter Dam	GC	Clayey GRAVEL with sand
KC12-OVB45	LPT 4	6.51 - 6.66	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB45	LPT 5	8.03 - 8.18	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB45	LPT 6	9.56 - 9.76	Splitter Dam	SC	Clayey SAND with gravel
KC12-OVB45	LPT 10	15.65 - 15.68	Splitter Dam	GC	Clayey GRAVEL with sand
KC12-OVB45	CUTTING 1	11.08 - 12.61	Splitter Dam	SM	Silty SAND with gravel
KC12-OVB45	CUTTING 2	14.13 - 15.65	Splitter Dam	SM	Silty SAND with gravel
KC12-OVB46	GRAB 1	2.05 - 3.57	Saddle Dam	SC-SM	Silty, Clayey SAND with gravel
KC12-OVB46	GRAB 2	3.57 - 5.09	Saddle Dam	SC	Clayey SAND with gravel
KC12-OVB46	GRAB 3	5.09 - 6.61	Saddle Dam	SC	Clayey SAND with gravel
KC12-OVB46	GRAB 4	6.61 - 8.13	Saddle Dam	SC-SM	Silty, Clayey SAND with gravel
KC12-OVB46	GRAB 5	8.13 - 9.65	Saddle Dam	SC	Clayey SAND with gravel
KC12-OVB46	GRAB 6	9.65 - 11.17	Saddle Dam	SC-SM	Silty, Clayey SAND with gravel
KC12-OVB46	GRAB 7	11.17 - 12.69	Saddle Dam	SC-SM	Silty, Clayey SAND with gravel
KC12-OVB46	LPT 5	8.13 - 8.40	Saddle Dam	SC	Clayey SAND with gravel
KC12-OVB46	LPT 6	9.65 - 9.78	Saddle Dam	GC	Clayey GRAVEL with sand
KC12-OVB46	LPT 8	15.73 - 15.98	Saddle Dam	GP	Poorly Graded GRAVEL with sand
KC12-OVB47	LPT 1	1.98 - 2.58	Southeast Dam and Spillway	SW-SM	Well-graded SAND with silt and gravel
KC12-OVB48	LPT 1	1.20 - 1.65	Southeast Dam and Spillway	GC	Clayey GRAVEL with sand
KC12-OVB48	LPT 2	2.72 - 3.17	Southeast Dam and Spillway	GC	Clayey GRAVEL with sand
KC12-OVB48	LPT 3	4.24 - 4.86	Southeast Dam and Spillway	GC	Clayey GRAVEL with sand
KC12-OVB48	LPT 4	5.76 - 6.36	Southeast Dam and Spillway	SC	Clayey SAND with gravel
KC12-OVB49	LPT 1	1.82 - 2.22	Southeast Dam and Spillway	GW	Well-graded GRAVEL
KC12-OVB49	LPT 2	3.34 - 3.94	Southeast Dam and Spillway	GW	Well-graded GRAVEL with sand
KC12-OVB49	LPT 3	4.86 - 5.46	Southeast Dam and Spillway	GP	Poorly Graded GRAVEL

Site ID	Sample No.	Depth (m)	Site Location	Group Symbol	Group Name
KC12-OVB49	LPT 4	6.38 - 6.72	Southeast Dam and Spillway	GP	Poorly-graded GRAVEL with sand
KC12-OVB49	LPT 8	12.46 - 12.76	Southeast Dam and Spillway	GC	Clayey GRAVEL with sand
KC12-OVB49	LPT 9	13.98 - 14.38	Southeast Dam and Spillway	SC	Clayey SAND with gravel
KC12-OVB49	LPT 10	17.02 - 17.62	Southeast Dam and Spillway	GC	Clayey GRAVEL with sand
KC12-OVB49	LPT 11	20.06 - 20.60	Southeast Dam and Spillway	CL	Sandy lean CLAY
KC12-OVB49	LPT 12	23.10 - 23.35	Southeast Dam and Spillway	SW-SM	Well-graded SAND with silt and gravel
KC12-OVB49	LPT 13	26.14 - 26.65	Southeast Dam and Spillway	SM	Silty SAND
KC12-OVB49	SA 1	28.98 - 29.55	Southeast Dam and Spillway	SC	Clayey SAND with gravel

4.1.5 Point Load

The point load test is used to determine the Point Load Strength Index ($I_{S(50)}$) which is used for rock strength classification. The index can be used to determine the rock anisotropy and other rock strength properties such as uniaxial tensile and compressive strengths.

A total of 15 Point Load tests were conducted in camp during the 2012 site investigation. 6 tests were invalid due to varying circumstances (e.g. failure not through core axis, small pieces breaking off at platens, etc.). The $I_{S(50)}$ for 9 tests range from 1.72 MPa to 18.6 MPa (axial) and 0.5 MPa to 22.9 MPa (diametric). A summary of the results are presented in Table 4.6 below.

Table 4.6 Summary of Point Load Results

Site ID	Sample No.	Depth (m)	Site Location	Lithology	$I_{S(50)}$ (MPa)	Test Type	Comments
KC12-64	PLT3-d	7.6	Treaty OPC	Sandstone	0.5	Diametric	Fracture at 30 degrees TCA
KC12-64	PLT1-d	8.5	Treaty OPC	Sandstone	9.52	Diametric	Vertical fracture through intact rock
KC12-64	PLT2-a	10.5	Treaty OPC	Sandstone	7.9	Axial	Fracture 10 degrees TCA
KC12-64	PLT4-d	15.5	Treaty OPC	Sandstone	8.62	Diametric	Sandstone. Fracture 20 degrees TCA
KC12-OVB45	PLT2-d	21.2	Splitter Dam	Sandstone	15.02	Diametric	Sandstone. Fracture 35 degrees TCA
KC12-OVB45	PLT1-d	23.0	Splitter Dam	Sandstone	15.16	Diametric	Sandstone. Fracture 30 degrees TCA
KC12-OVB46	PLT2-a	22.7	Saddle Dam	Sandstone/ Siltstone	18.6	Axial	Vertical fracture
KC12-OVB46	PLT1-a	25.6	Saddle Dam	Sandstone/ Siltstone	1.72	Axial	Fracture through intact rock. Vertical fracture.
KC12-OVB47	PLT2-d	11.0	Southeast Dam and Spillway	Sandstone	14.72	Diametric	U-shaped fracture near siltstone/sandstone contact (not right along contact)

4.1.6 Unconfined Compressive Strength

This test determines unconfined compressive strengths of rock. Drill core specimens undergo loading at specified loading rates until failure. The loading data and other test parameters are recorded and the UCS is calculated.

A total of 5 Unconfined Compressive Strength (UCS) tests were conducted in accordance with ASTM D7012-10. The UCS ranges from 51.7 MPa to 179.35 MPa. A summary of the results are presented in Table 4.7 below and detailed results and photographs are presented in Appendix III.

Table 4.7 Summary of Unconfined Compressive Strength Results

Site ID	Sample No.	Depth (m)	Site Location	Compressive Stress (MPa)	Failure Type
KC12-64	UCS1	8.70 - 8.90	Treaty OPC	51.70	Diagonal Fracture, Vertical Fracture
KC12-OVB46	UCS1	25.71 - 26.32	Saddle Dam	81.73	Vertical Fracture
KC12-OVB47	UCS1	15.08 - 15.45	Southeast Dam and Spillway	179.35	Vertical Fracture
KC12-OVB48	UCS1	11.90 - 12.37	Southeast Dam and Spillway	129.55	Completely broken; no distinct fracture type
KC12-OVB49	UCS1	41.19 - 41.45	Southeast Dam and Spillway	93.92	Completely broken; no distinct fracture type

5 SUMMARY OF 2012 HYDROGEOLOGICAL OBSERVATIONS

Hydrogeological data was collected in the form of water level measurements in drill holes during the 2012 site investigation in the TMF Area. Water level measurements were single measurements collected from the newly and previously installed piezometers at the well location and the locations are presented in Drawings D-4007 to D-4009.

The most recent water levels for newly installed wells in 2012 are given in Table 5.1.

Table 5.1 Groundwater Level Measurements for installed in 2012 Wells

Point ID	Site Location	Reading Date	Easting (m)	Northing (m)	Elevation (m)	Water Depth (mbgl)	Groundwater Elevation (m)
KC12-64	Treaty OPC	9/20/2012	439500	6280443	1091	2.7	1088.3
KC12-OVB44	Splitter Dam	9/21/2012	441552	6276636	1038	4.3	1033.7
KC12-OVB45	Splitter Dam	9/21/2012	442397	6276203	934	5.4	928.6
KC12-OVB46	Saddle Dam	9/21/2012	444414	6275650	894	2.4	891.6
KC12-OVB47	Southeast Dam	9/21/2012	445202	6275175	845	3.9	841.1
KC12-OVB48	Southeast Dam	9/21/2012	446848	6273719	897	0.5	896.5
KC12-OVB49	Southeast Dam	9/20/2012	447264	6273954	824	6.2	817.8

Updated water level measurements were also made for all previously installed wells from the 2008 through 2011 site investigations. The most recent water levels for previously installed wells are given in Table 5.2.

Table 5.2 2012 Groundwater Level Measurements for Wells Installed from 2008 to 2011

Point ID	Site Location	Reading Date	Easting (m)	Northing (m)	Elevation (m)	Water Depth (mbgl)	Ground-water Elevation (m)	Comments
KC08-04	Southeast Dam	9/19/2012	446893	6274454	855	18.3	837.1	
KC08-05	Saddle Dam	6/27/2012	444400	6275949	886	3.7	882.5	
KC08-06	North Dam	6/26/2012	440916	6279558	871	22.4	849.0	
KC10-20	Saddle Dam	9/19/2012	443846	6276092	898			Artesian
KC10-21	Saddle Dam	9/19/2012	443290	6276148	889	-0.3	888.9	
KC10-22	Saddle Dam	9/19/2012	443392	6276612	952	15.3	937.1	
KC10-23	North Dam	9/19/2012	440543	6279056	983	-0.5	983.9	
KC10-23A	North Dam	9/19/2012	440544	6279056	983	-0.1	983.3	
KC10-24	North Dam	6/26/2012	441380	6279561	958	20.6	937.1	
KC10-25	North Dam	9/20/2012	440663	6279816	818			Artesian
KC10-25A	North Dam	9/20/2012	440664	6279816	818	1.0	816.7	
KC10-28	Saddle Dam	6/27/2012	443256	6275751	956	12.7	943.0	
KC10-29	Southeast Dam	9/19/2012	446071	6274535	880			Artesian
KC10-30	Southeast Dam	9/20/2012	446378	6274850	842	-3.5	845.9	Artesian
KC10-31	Southeast Dam	9/19/2012	446523	6275018	888			Artesian
KC10-OVB1	North Dam	6/26/2012	441161	6279748	920	-0.5	920.9	
KC10-OVB10	Splitter Dam	9/19/2012	442798	6276881	927	2.4	924.3	
KC10-OVB13	Saddle Dam	9/19/2012	443593	6276348	898	2.3	895.5	

Point ID	Site Location	Reading Date	Easting (m)	Northing (m)	Elevation (m)	Water Depth (mbgl)	Ground-water Elevation (m)	Comments
KC10-OVB14	Saddle Dam	6/27/2012	443521	6276178	895	2.9	891.7	
KC10-OVB14	Saddle Dam	9/20/2012	443521	6276178	895	6.0	888.5	
KC10-OVB15	Saddle Dam	6/27/2012	443232	6276030	901	1.9	899.1	
KC10-OVB15	Saddle Dam	9/19/2012	443232	6276030	901	2.1	898.9	
KC10-OVB17	Saddle Dam	6/27/2012	444036	6275696	962	6.9	955.0	
KC10-OVB29	Southeast Dam	9/20/2012	446460	6274498	825	2.0	823.0	Estimated visually
KC10-OVB3	North Dam	9/20/2012	441237	6279454	915	-3.5	918.6	Artesian
KC10-OVB30	Southeast Dam	9/19/2012	446711	6274796				Well not located beside drill hole. Area overgrown
KC10-OVB31	Southeast Dam	9/19/2012	447066	6274107		27.8		
KC10-OVB32	Southeast Dam	9/19/2012	446089	6274943		13.2		
KC10-OVB4	North Dam	9/19/2012	441072	6279368	874	-4.3	878.7	Artesian
KC10-OVB4A	North Dam	6/26/2012	441072	6279368	874	1.6	872.7	
KC10-OVB5	North Dam	6/26/2012	440804	6279210	899	-0.9	899.8	
KC10-OVB6	North Dam	9/19/2012	441579	6279091	929		928.7	Artesian
KC10-OVB7	North Dam	9/19/2012	441431	6278956	886	0.3	885.7	
KC11-35	East Catchment	9/19/2012	444461	6278080	1241	55.3	1185.7	
KC11-36	East Catchment	9/20/2012	444814	6278280	1224			Artesian
KC11-37	Treaty OPC	9/19/2012	439110	6279770	1076	1.6	1074.5	
KC11-38	Treaty OPC	9/19/2012	438827	6280188	1062	1.2	1060.8	
KC11-CPT1	North Cell	9/19/2012	443595	6276351	900	2.6	897.5	
KC11-CPT2	Saddle Dam	6/27/2012	443524	6276183	896	3.9	892.1	
KC11-CPT2	Saddle Dam	9/20/2012	443524	6276183	896	7.8	888.2	
KC11-CPT3	Saddle Dam	6/27/2012	443238	6276031	910	3.2	906.8	
KC11-CPT3	Saddle Dam	9/19/2012	443238	6276031	910	3.5	906.5	
KC11-CPT4	Saddle Dam	6/27/2012	443835	6276095	898			Piezometer bent, cannot pass probe
KC11-CPT5	Saddle Dam	6/27/2012	443285	6276151	889	-1.0	890.0	
KC11-CPT5	Saddle Dam	9/19/2012	443285	6276151	889	1.3	887.8	
KC11-CPT6	Saddle Dam	6/27/2012	444403	6275945	889	0.4	888.6	
KC11-CPT7	South Cell	9/19/2012	446713	6274794	867	9.6	857.5	
KC11-CPT9	Southeast Dam	9/19/2012	446886	6274456	856	10.4	845.6	
KC11-OVB33	North Dam	6/26/2012	441577	6278315	881			Dry
KC11-OVB34	Splitter Dam	9/19/2012	442072	6277715	893	4.7	888.3	
KC11-OVB35	Splitter Dam	9/19/2012	442473	6277101	892	1.1	890.9	
KC11-OVB36	Saddle Dam	9/19/2012	442986	6276551	906	1.2	904.8	
KC11-OVB37	Saddle Dam	6/27/2012	444797	6276197	887	7.2	879.9	
KC11-OVB38	Southeast Dam	9/19/2012	445648	6275562	911			PVC pipe bent. Monument fallen over. Unable to take level.
KC11-OVB39	Southeast Dam	9/19/2012	445665	6275089	853			Could not access site
KC11-OVB40	Saddle Dam	6/27/2012	444170	6276282	903	16.6	886.4	
KC11-OVB41	Splitter Dam	9/19/2012	442242	6276978	875			Artesian, Plugged
MW-01A	North Dam	9/19/2012	440372	6280549	855			Artesian, Sulphur smell

Point ID	Site Location	Reading Date	Easting (m)	Northing (m)	Elevation (m)	Water Depth (mbgl)	Ground-water Elevation (m)	Comments
MW-01B	North Dam	9/19/2012	440370	6280549	855	3.5	851.2	
MW-02A	Southeast Dam	9/19/2012	447274	6273460	744	5.8	738.1	
MW-02B	Southeast Dam	9/19/2012	447280	6273458	744	9.7	734.6	
MW-03A	Treaty OPC	9/19/2012	439200	6279264	1114	9.4	1104.3	
MW-03B	Treaty OPC	9/19/2012	439206	6279268	1114	9.4	1104.3	

6 CLOSING

This report provides a summary of the 2012 site investigation work and describes ground conditions at major structures. Further interpretation of the data and findings of this report will be included in the design report for those facilities.

KLOHN CRIPPEN BERGER LTD.

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Engineering Geologist

Graham Parkinson, P.Geo., P.Geoph.
Project Manager

REFERENCES

Alldrick, D.J. and Britton, J.M. (1991). Sulphurets Area Geology, parts of NTS 104A/5W, 12W; 104b/8E, 9E; BC Geological Survey, Open file 1991-21, Scale 1:20,000.

ASTM D7012 (2010). "Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures," ASTM International, West Conshohocken, PA, DOI: 10.1520/D7012-10, www.astm.org.

ASTM D4318 (2010). "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils," ASTM International, West Conshohocken, PA, DOI: 10.1520/D4318-10, www.astm.org.

ASTM D2216 (2010). "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass," ASTM International, West Conshohocken, PA, DOI: 10.1520/D2216-10, www.astm.org.

ASTM D2488 (2009). "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)," ASTM International, West Conshohocken, PA, DOI: 10.1520/D2488-09A, www.astm.org.

ASTM D5731 (2008). "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications," ASTM International, West Conshohocken, PA, DOI: 10.1520/D5731-08, www.astm.org.

ASTM D422 (2007). "Standard Test Method for Particle-Size Analysis of Soils," ASTM International, West Conshohocken, PA, DOI: 10.1520/D0422-63R07, www.astm.org.

ASTM D1140 (2006). "Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-µm) Sieve," ASTM International, West Conshohocken, PA, DOI: 10.1520/D1140-00R06, www.astm.org.

Britton, J.M. and Alldrick, D.J. (1988). Sulphurets Map area. In Geological Fieldwork 1987, BC Ministry of Energy, Mines and Petroleum Resources. Paper 1988-1, pp. 199-209.

ERSi (2011). "KSM Project Area Structural Geology Assessment," prepared for Seabridge, Inc. by Earth Resource Surveys, Inc., April.

Frontier Geoscience (2012). "Report on Seismic Refraction Investigation, Tailings Management Facility, Kerr Sulphurets Project, Bell II Area, B.C.," prepared for Klohn Crippen Berger Ltd., July.

Frontier Geoscience (2011). "Report on Seismic Refraction and Resistivity Sounding Investigation, Tailings Management Facility, Kerr Sulphurets Project, Bell II Area, B.C.," prepared for Klohn Crippen Berger Ltd., August.

Frontier Geoscience (2010). "Report on Seismic Refraction, Ice Radar, and Ground Penetrating Radar Investigations, KSM Project, Bell II Area, B.C.," prepared for Klohn Crippen Berger Ltd., August.

Henderson, J.R., Kirkham, R.V., Henderson, M.N., Payne, J.G., Wright, T.O. and Wright, R.L. (1992). Stratigraphy and structure of the Sulphurets area, British Columbia; Current Research, Part A; Geological Survey of Canada, Paper 92-1A, pp. 323-332.

ISRM (1978). Suggested methods for the quantitative descriptions of discontinuities in rock masses. Publication of the International Society of Rock Mechanics.

Kirkham, R V; Margolis, J. (1995). Overview of the Sulphurets Area, Northwestern British Columbia. In Porphyry Deposits of the Northwestern Cordillera of North America. Edited by T.G. Schroeter. Canadian Institute of Mining, Metallurgy and Petroleum, Special Volume 46.

Klohn Crippen Berger Ltd. (2011). "Kerr-Sulphurets-Mitchell Project, 2010 Site Investigation Report," prepared for Seabridge Gold, Inc., February 22.

Klohn Crippen Berger Ltd. (2010). “Kerr-Sulphurets-Mitchell Project, 2009 Site Investigation Report,” prepared for Seabridge Gold, Inc., May 14.

Klohn Crippen Berger Ltd. (2009). “Kerr Sulphurets-Mitchell Project, 2008 Site Investigation Report,” prepared for Seabridge Gold, Inc., April 16.

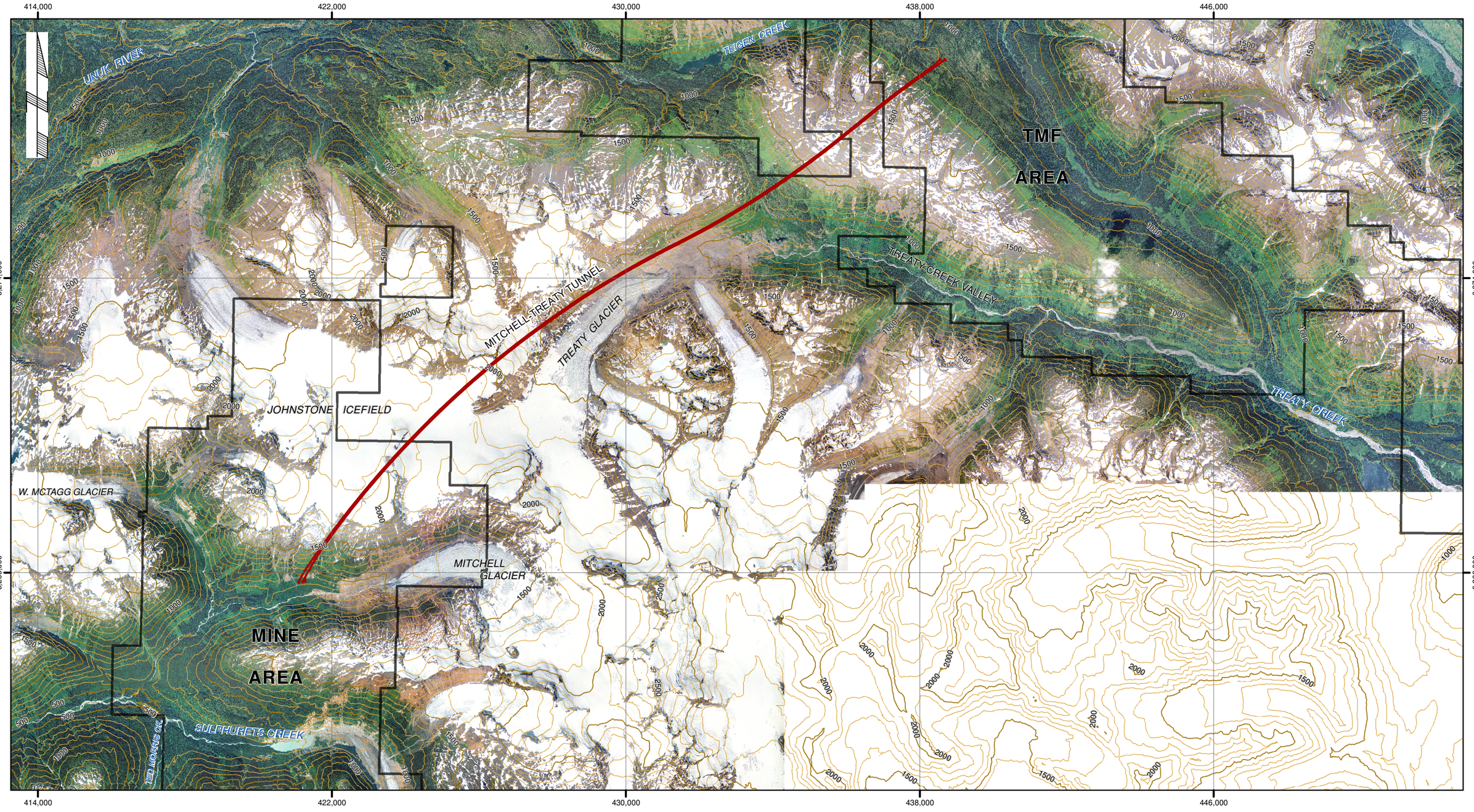
Lewis, P.D., Thompson, J.F.H., Nadaraju, G., Anderson, R.G., Johannson, G.G. (1993). “Lower and Middle Jurassic Stratigraphy in the Treaty Glacier area and Geological Setting of the Treaty Glacier Alteration System, northwestern British Columbia” in, Current Research, Part A, Cordillera and Pacific Margin / Recherches En Cours, Partie A, Cordillere Et Marge Du Pacifique; Geological Survey of Canada, Paper no. 93-01A, 1993; pp. 75-86.

Massey, N.W.D., MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T. (2005): Digital Map of British Columbia: Tile NO9 North Central BC, BC Ministry of Energy and Mines, GeoFile 2005-9.

MDRU (1996). Metallogenesis of the Iskut River Area, Northwestern BC, Final Report. Compiled by P.D. Lewis, A. Toma and R.M. Tosdal. Published by the Mineral Deposit Research Unit, University of British Columbia, June.

DRAWINGS

D-4001	Project Area Aerial Photo Map
D-4002	Project Area Geology Map
D-4003	TMF Geological Map
D-4004	TMF Site Investigation Plan
D-4005	TMF Site Investigation Plan Details
D-4006	TMF 2012 Site Investigation Locations
D-4007	Tailings Management Facility North Dam and East Catchment Piezometer Locations
D-4008	Tailings Management Facility Splitter Dam and Saddle Dam Piezometer Locations
D-4009	Tailings Management Facility Southeast Dam and Spillway Piezometer Location



LEGEND

SEABRIDGE/SEABEE CLAIMS

NOT FOR CONSTRUCTION

SCALE: 0 2,500 m

Notes:
1. *UTM Zone 9N, NAD83*
2. *100m contours from BC TRIM (1995)*
3. *2008 orthophoto*

NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
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A	NOV 2012	DRAFT - ISSUED FOR CLIENT REVIEW	AF	GP	PK	GP

DRAWING NO.

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: PROJECT AREA
AERIAL PHOTO MAP

DATE	PROJECT No.	DWG No.	REV.
DEC 2012	M09480A04	D-4001	B

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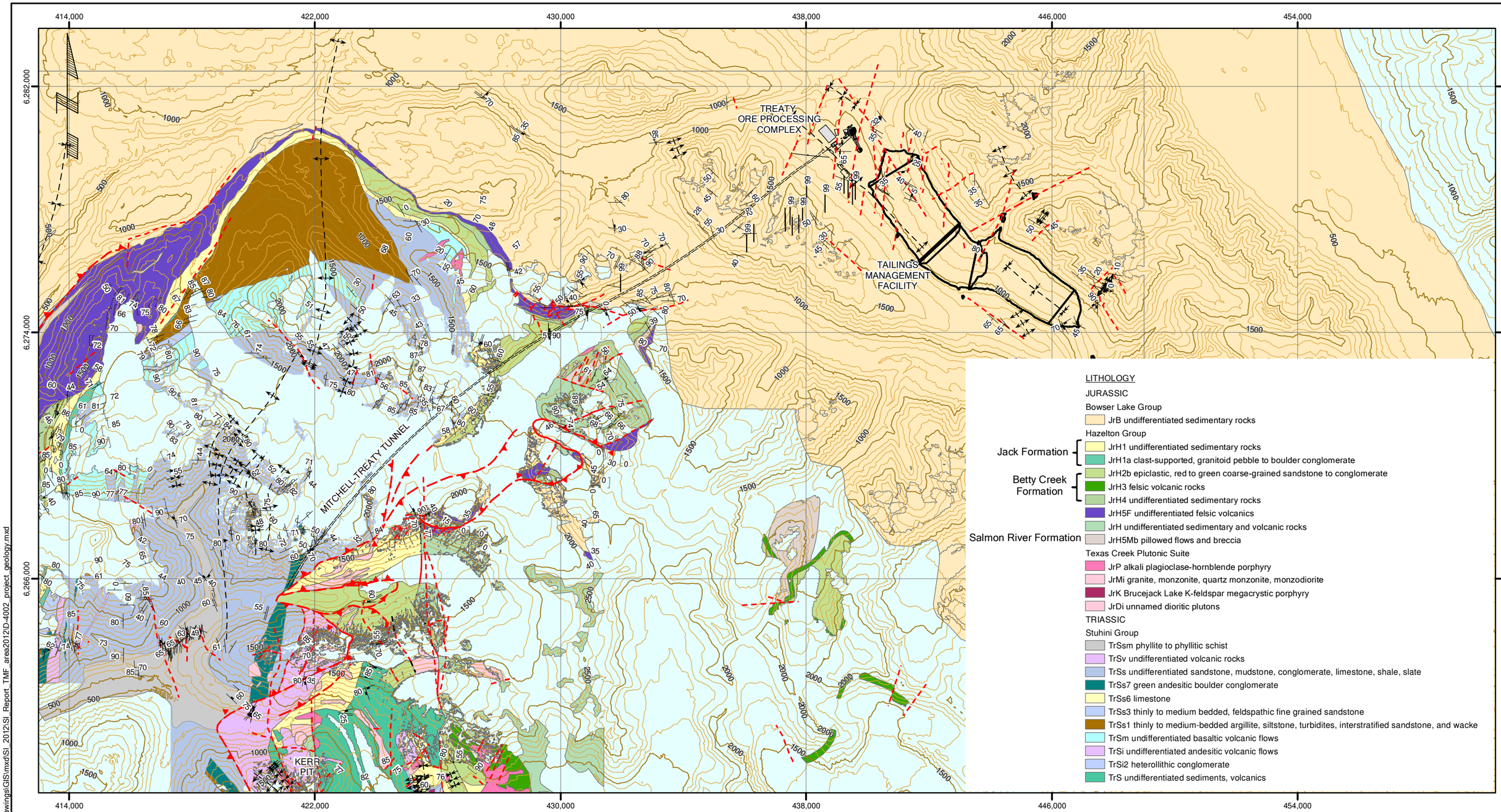

LITHOLOGY

JURASSIC

Bowser Lake Group
- JrB undifferentiated sedimentary rocks

Hazelton Group

Jack Formation
- JrH1 undifferentiated sedimentary rocks
- JrH1a clast-supported, granitoid pebble to boulder conglomerate

Betty Creek Formation
- JrH2b epiclastic, red to green coarse-grained sandstone to conglomerate
- JrH3 felsic volcanic rocks
- JrH4 undifferentiated sedimentary rocks
- JrH5F undifferentiated felsic volcanics
- JrH undifferentiated sedimentary and volcanic rocks

Salmon River Formation
- JrH5Mb pillowed flows and breccia

Texas Creek Plutonic Suite
- JrP alkali plagioclase-hornblende porphyry
- JrMi granite, monzonite, quartz monzonite, monzodiorite
- JrK Brucejack Lake K-feldspar megacrystic porphyry
- JrDi unnamed dioritic plutons

TRIASSIC

Stuhini Group
- TrSsm phyllite to phyllitic schist
- TrSv undifferentiated volcanic rocks
- TrSs undifferentiated sandstone, mudstone, conglomerate, limestone, shale, slate
- TrSs7 green andesitic boulder conglomerate
- TrSs6 limestone
- TrSs3 thinly to medium bedded, feldspathic fine grained sandstone
- TrSs1 thinly to medium-bedded argillite, siltstone, turbidites, interstratified sandstone, and wacke
- TrSm undifferentiated basaltic volcanic flows
- TrSi undifferentiated andesitic volcanic flows
- TrSi2 heterollithic conglomerate
- TrS undifferentiated sediments, volcanics

LEGEND

- ANTICLINE
- SYNCLINE
- DEXTRAL STRIKE SLIP
- FAULT
- OVERTURNED SYNCLINE
- SINISTRAL STRIKE SLIP
- THRUST FAULT
- APPARENT BEDDING
- BEDDING
- FOLIATION
- JOINT
- EUTAXITIC FOLIATION
- MINERAL ORIENTATION LINEATION
- BEDDING WITH FACING DIRECTION CONFIRMED
- BEDDING WITH FACING DIRECTION UNKNOWN
- INVERTED BEDDING
- SLATEY CLEAVAGE / SCHISTOSITY

Notes:
1. *UTM Zone 9N, NAD83*
2. *100m contous from BC TRIM (1995)*
3. *Geology data sources: Klohn Crippen Berger, ERSi (2011)*

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DRAWING NO.

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TAILINGS MANAGEMENT FACILITY
LITHOLOGY AND STRUCTURAL GEOLOGY

DATE	PROJECT No.	DWG No.	REV.
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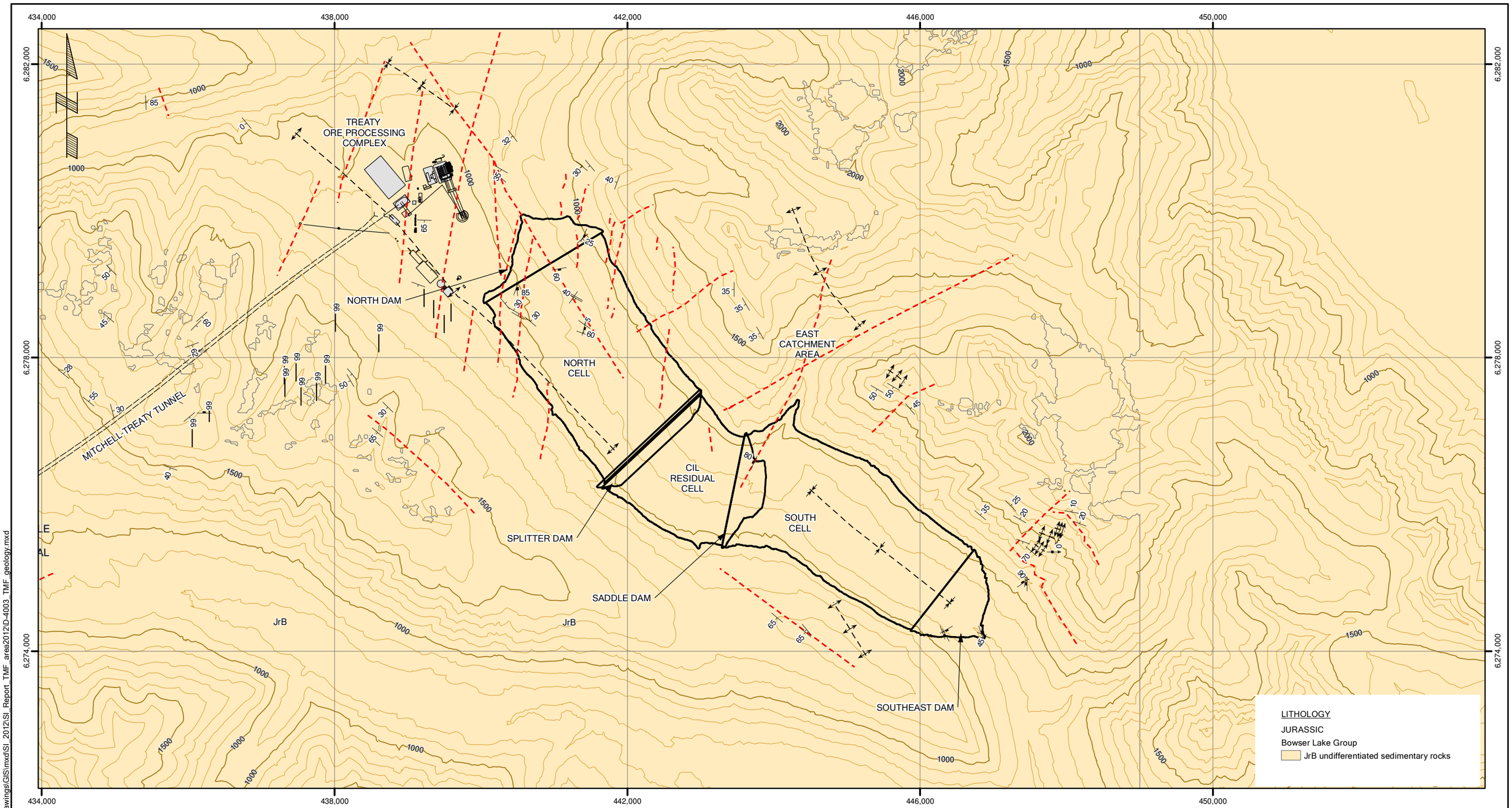

LEGEND

ANTICLINE
SYNCLINE
FAULT
APPARENT BEDDING
BEDDING
FOLIATION
JOINT

NOT FOR CONSTRUCTION

SCALE: 0 1,000 m

Notes:
1. *UTM Zone 9N, NAD83*
2. *100m contours from BC TRIM (1995)*
3. *Geology data sources: Klohn Crippen Berger, ERSi (2011)*

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DRAWING NO.

CLIENT
SEABRIDGE GOLD
Klohn Crippen Berger

PROJECT
KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE
TAILINGS MANAGEMENT FACILITY
GEOLOGICAL MAP

DATE	PROJECT No.	DWG No.	REV.
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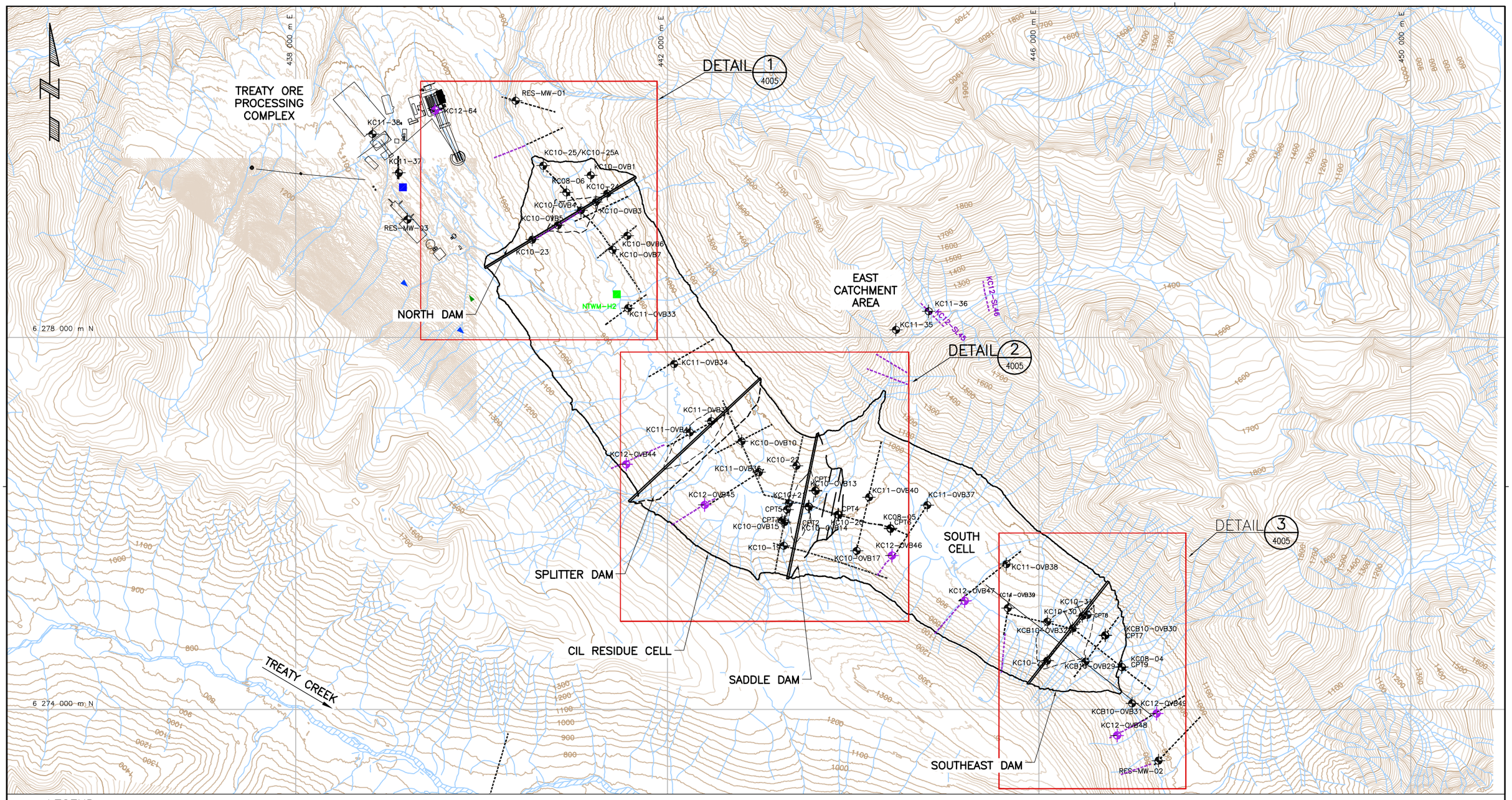

LEGEND

- KC12-0VB44 — DRILLHOLE (KCB 2012)
- KC08-06 — DRILLHOLE (KCB 2008, 2010, 2011)
- RES-MW-03 — MONITORING WELL INSTALLED BY RESCAN
- CPT5 — CONE PENTRATION TEST (2011)
- GEOPHYSICS SURVEY LINE (KCB 2012)
- GEOPHYSICS SURVEY LINE (KCB 2009 2010, 2011)
- NTWM-H2 — STREAMFLOW GAUGING STATIONS
- WEATHER STATION (EL. 1085m)

PLAN

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT, 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA.
2. UTM ZONE 9N. NAD83

DRAWING NO.	REFERENCE DRAWING

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NOT FOR CONSTRUCTION

SCALE: 0 1000 m

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TAILINGS MANAGEMENT FACILITY
SITE INVESTIGATION PLAN

SCALE	PROJECT No.	DWG. No.	REV.
AS SHOWN	M09480A04	D-4004	B

CANCEL PRINTS BEARING PREVIOUS REVISION

KCB-C-MLD

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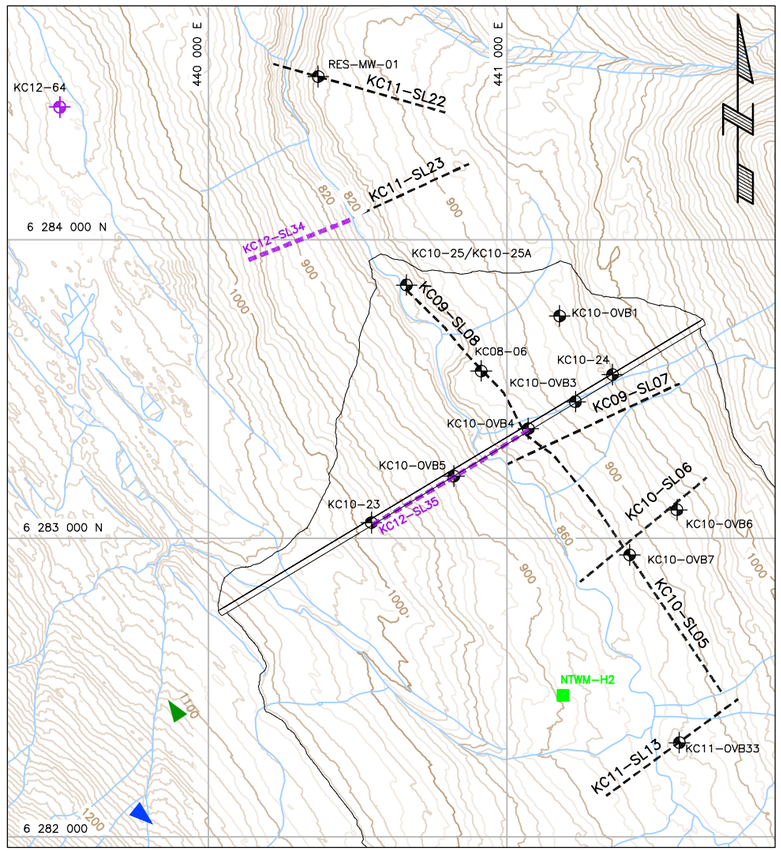
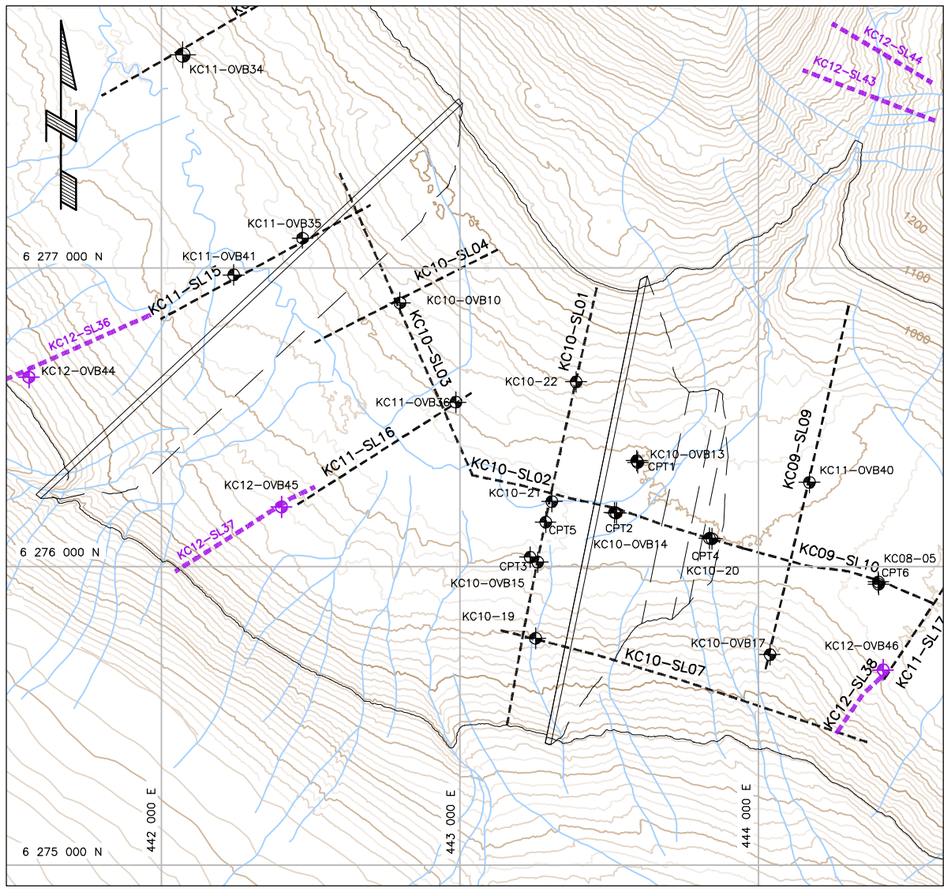
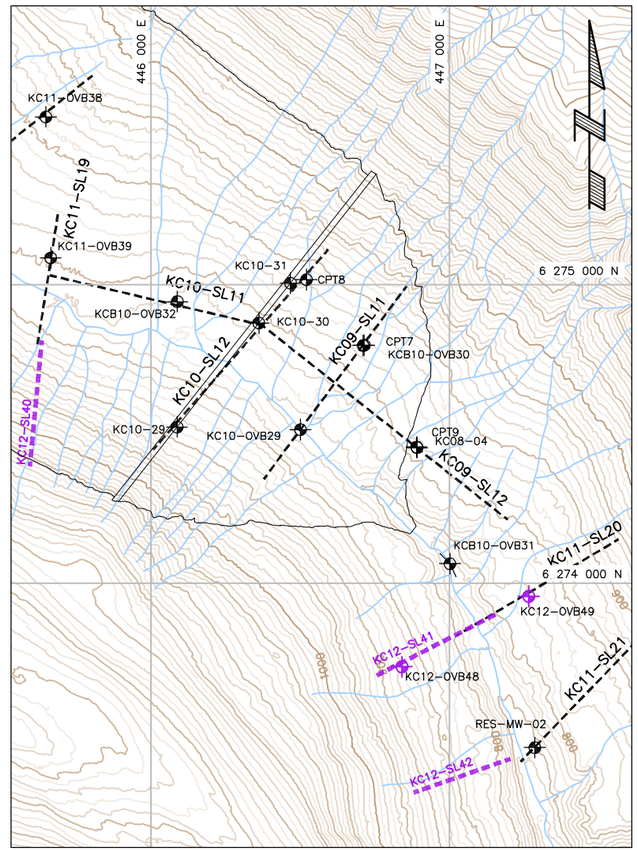


NORTH DAM DETAIL 1 / 4004



SPLITTER DAM AND SADDLE DAM DETAIL 2 / 4004



SOUTHEAST DAM DETAIL 3 / 4004

LEGEND

KC12-64	DRILLHOLE (KCB 2012)
KC08-06	DRILLHOLE (KCB 2008, 2010, 2011)
RES-MW-03	MONITORING WELL INSTALLED BY RESCAN
CPT5	CONE PENTRATION TEST (2011)
KC12-SL35	GEOPHYSICS SURVEY LINES (KCB 2012)
KC10-SL06	GEOPHYSICS SURVEY LINES (KCB 2009 2010, 2011)
NTWM-H2	STREAM FLOW GAUGING STATIONS
	WEATHER STATION (EL. 1085m)

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT, 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA.
2. DATUM: NAD83 UTM ZONE 9.

DRAWING NO.	REFERENCE DRAWING	NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
		B	DEC, 2012	FINAL	AW	MB	HP	GP
		A	NOV, 2012	DRAFT – ISSUED FOR CLIENT REVIEW	AW	MB	HP	GP

NOT FOR CONSTRUCTION

SCALE: 0 400m

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TAILINGS MANAGEMENT FACILITY
SITE INVESTIGATION PLAN DETAILS

SCALE	PROJECT No.	DWG. No.	REV.
AS SHOWN	M09480A04	D-4005	B

CANCEL PRINTS BEARING PREVIOUS REVISION

KCB-C-MLD

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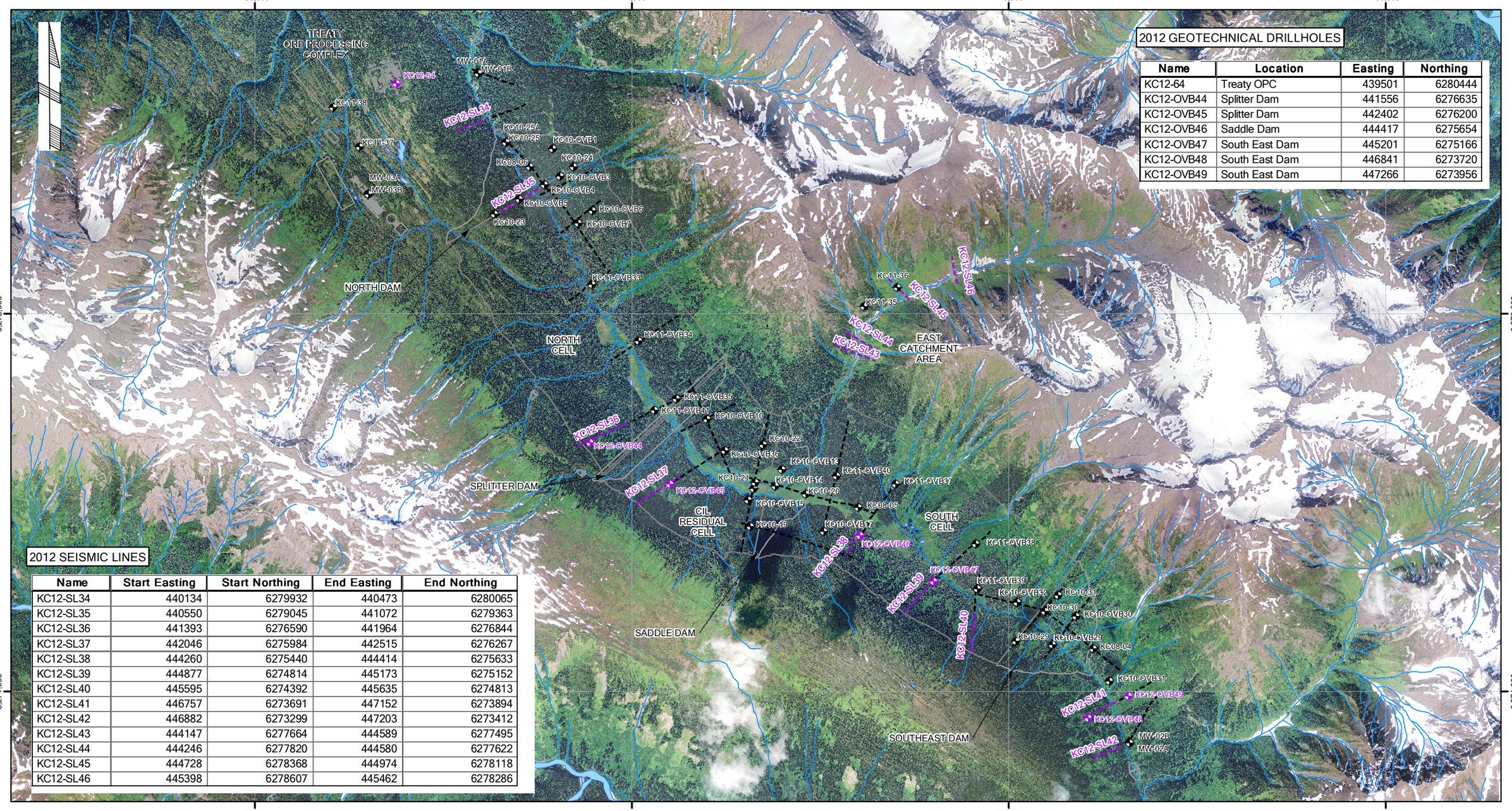

2012 GEOTECHNICAL DRILLHOLES

Name	Location	Easting	Northing
KC12-64	Treaty OPC	439501	6280444
KC12-OVB44	Splitter Dam	441556	6276635
KC12-OVB45	Splitter Dam	442402	6276200
KC12-OVB46	Saddle Dam	444417	6275654
KC12-OVB47	South East Dam	445201	6275166
KC12-OVB48	South East Dam	446841	6273720
KC12-OVB49	South East Dam	447266	6273956

2012 SEISMIC LINES

Name	Start Easting	Start Northing	End Easting	End Northing
KC12-SL34	440134	6279932	440473	6280065
KC12-SL35	440550	6279045	441072	6279363
KC12-SL36	441393	6276590	441964	6276844
KC12-SL37	442046	6275984	442515	6276267
KC12-SL38	444260	6275440	444414	6275633
KC12-SL39	444877	6274814	445173	6275152
KC12-SL40	445595	6274392	445635	6274813
KC12-SL41	446757	6273691	447152	6273894
KC12-SL42	446882	6273299	447203	6273412
KC12-SL43	444147	6277664	444589	6277495
KC12-SL44	444246	6277820	444580	6277622
KC12-SL45	444728	6278368	444974	6278118
KC12-SL46	445398	6278607	445462	6278286

LEGEND

- 2012 DRILLHOLE
- EXISTING DRILLHOLE
- 2009, 2010 AND 2011 SEISMIC LINE
- PROPOSED 2012 SEISMIC LINE

0 1,000 m
SCALE:

NOT FOR CONSTRUCTION

Notes:
1. UTM Zone 9N, NAD83
2. 2008 orthophoto

NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
B	DEC 2012	FINAL	AF	GP	PK	GP
A	NOV 2012	DRAFT - ISSUED FOR CLIENT REVIEW	AF	GP	PK	GP

DRAWING NO.

CLIENT
SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT
KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE
TAILINGS MANAGEMENT FACILITY
2012 SITE INVESTIGATION LOCATIONS

DATE	PROJECT No.	DWG No.	REV.
DEC 2012	M09480A04	D-4006	B

afischer
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Name	Easting (m)	Northing (m)	Elevation (m)	Screened	Reading Date	Water Level (mbgl)
KC08-06	440916	6279558	871	Bedrock	6/26/2012	22.4
KC10-23	440543	6279056	983	Bedrock	9/19/2012	-0.5
KC10-23A	440544	6279056	983	Basal Till/ Bedrock @ 3.7 m	9/19/2012	-0.1
KC10-24	441380	6279561	958	Bedrock	6/26/2012	20.6
KC10-25	440663	6279816	818	Bedrock	9/20/2012	0
KC10-25A	440664	6279816	818	Overburden/ Bedrock	9/20/2012	1
KC10-OVB1	441161	6279748	920		6/26/2012	-0.5
KC10-OVB3	441237	6279454	915	Bedrock	9/19/2012	0
KC10-OVB4 (1)	441072	6279368	874	Bedrock	9/19/2012	0
KC10-OVB4 (2)	441072	6279368	874	Basal Till	6/26/2012	1.5
KC10-OVB5	440804	6279210	899	Bedrock	6/26/2012	-0.9
KC10-OVB6	441579	6279091	929	Bedrock	9/19/2012	0
KC10-OVB7	441431	6278956	886	Bedrock	9/19/2012	0.3
KC11-35	444461	6278080	1241	Bedrock	9/19/2012	55.3
KC11-36	444814	6278280	1224	Bedrock	9/20/2012	0
KC11-37	439110	6279770	1076	Bedrock	9/19/2012	1.6
KC11-38	438827	6280188	1062	Bedrock	9/19/2012	1.2
KC11-OVB33	441577	6278315	881	Basal Till	6/26/2012	0
KC11-OVB34	442072	6277715	893	Bedrock	9/19/2012	4.7
KC12-64	439501	6280444	1091	Bedrock	9/20/2012	2.7
MW-01A	440372	6280556	855	Bedrock	9/19/2012	0
MW-01B	440370	6280549	855	Bedrock	9/19/2012	3.5
MW-03A	439200	6279264	1114	Bedrock	9/19/2012	9.4
MW-03B	439206	6279268	1114	Bedrock	9/19/2012	9.4

LEGEND

- EXISTING DRILLHOLE
- 2012 DRILLHOLE
- PIEZOMETER
- 2009, 2010 AND 2011 SEISMIC LINE
- 2012 SEISMIC LINE

Notes:
1. UTM Zone 9N, NAD83
2. 2008 orthophoto

NOT FOR CONSTRUCTION

SCALE: 0 500 m

NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
B	DEC 2012	FINAL	AF	GP	JM	GP
A	NOV 2012	DRAFT - ISSUED FOR CLIENT REVIEW	AF	GP	JM	GP

DRAWING NO.

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TAILINGS MANAGEMENT FACILITY
NORTH DAM AND EAST CATCHMENT AREA
PIEZOMETER LOCATIONS

DATE	PROJECT No.	DWG No.	REV.
DEC 2012	M09480A04	4007	B

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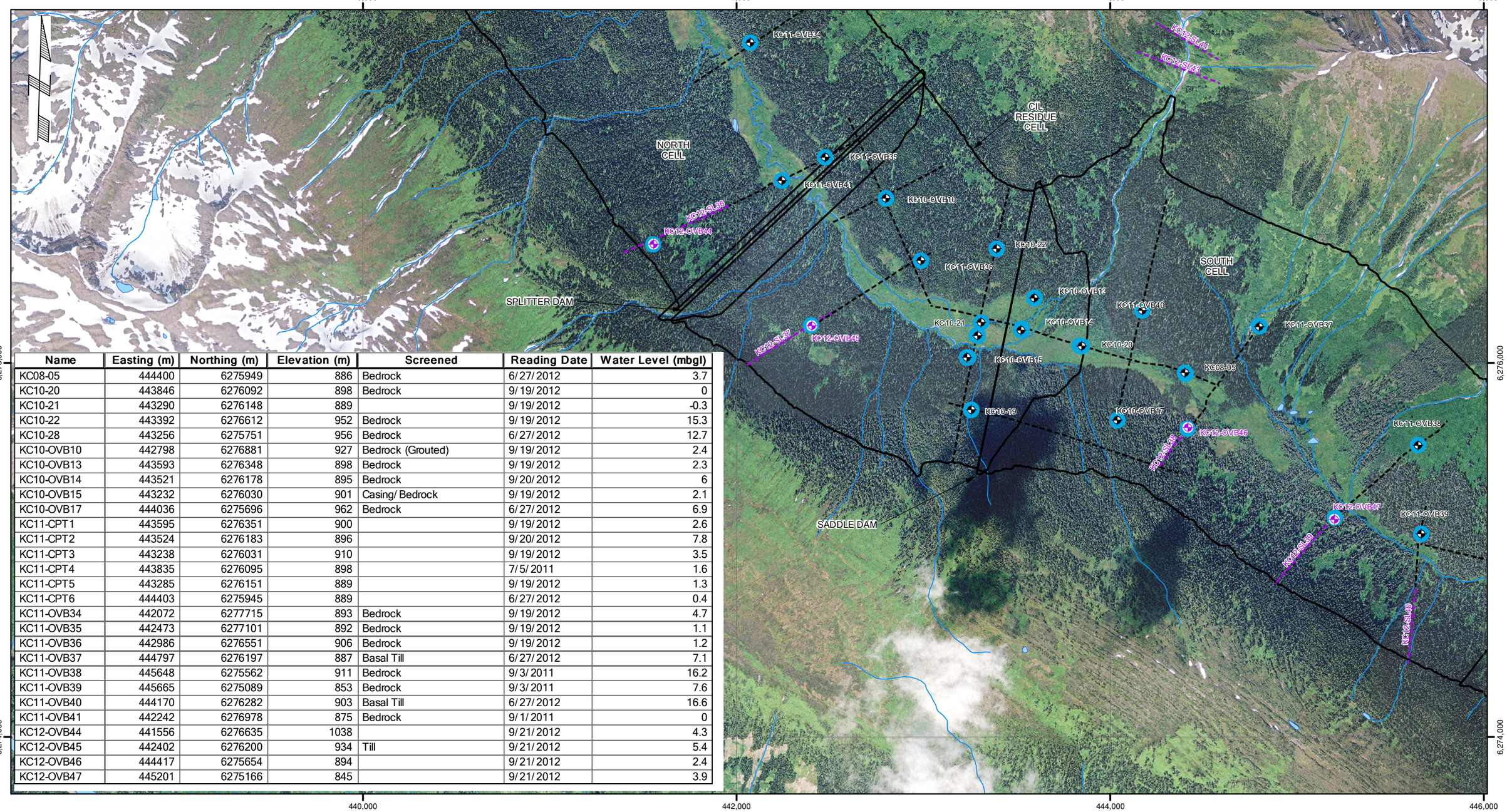

Name	Easting (m)	Northing (m)	Elevation (m)	Screened	Reading Date	Water Level (mbgl)
KC08-05	444400	6275949	886	Bedrock	6/27/2012	3.7
KC10-20	443846	6276092	898	Bedrock	9/19/2012	0
KC10-21	443290	6276148	889		9/19/2012	-0.3
KC10-22	443392	6276612	952	Bedrock	9/19/2012	15.3
KC10-28	443256	6275751	956	Bedrock	6/27/2012	12.7
KC10-OVB10	442798	6276881	927	Bedrock (Grouted)	9/19/2012	2.4
KC10-OVB13	443593	6276348	898	Bedrock	9/19/2012	2.3
KC10-OVB14	443521	6276178	895	Bedrock	9/20/2012	6
KC10-OVB15	443232	6276030	901	Casing/ Bedrock	9/19/2012	2.1
KC10-OVB17	444036	6275696	962	Bedrock	6/27/2012	6.9
KC11-CPT1	443595	6276351	900		9/19/2012	2.6
KC11-CPT2	443524	6276183	896		9/20/2012	7.8
KC11-CPT3	443238	6276031	910		9/19/2012	3.5
KC11-CPT4	443835	6276095	898		7/5/2011	1.6
KC11-CPT5	443285	6276151	889		9/19/2012	1.3
KC11-CPT6	444403	6275945	889		6/27/2012	0.4
KC11-OVB34	442072	6277715	893	Bedrock	9/19/2012	4.7
KC11-OVB35	442473	6277101	892	Bedrock	9/19/2012	1.1
KC11-OVB36	442986	6276551	906	Bedrock	9/19/2012	1.2
KC11-OVB37	444797	6276197	887	Basal Till	6/27/2012	7.1
KC11-OVB38	445648	6275562	911	Bedrock	9/3/2011	16.2
KC11-OVB39	445665	6275089	853	Bedrock	9/3/2011	7.6
KC11-OVB40	444170	6276282	903	Basal Till	6/27/2012	16.6
KC11-OVB41	442242	6276978	875	Bedrock	9/1/2011	0
KC12-OVB44	441556	6276635	1038		9/21/2012	4.3
KC12-OVB45	442402	6276200	934	Till	9/21/2012	5.4
KC12-OVB46	444417	6275654	894		9/21/2012	2.4
KC12-OVB47	445201	6275166	845		9/21/2012	3.9

LEGEND

- EXISTING DRILLHOLE
- 2012 DRILLHOLE
- PIEZOMETER
- 2009, 2010 AND 2011 SEISMIC LINE
- 2012 SEISMIC LINE

Notes:
1. UTM Zone 9N, NAD83
2. 2008 orthophoto

NOT FOR CONSTRUCTION

SCALE: 0 500 m

NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
B	DEC 2012	FINAL	AF	GP	JM	GP
A	NOV 2012	DRAFT - ISSUED FOR CLIENT REVIEW	AF	GP	JM	GP

DRAWING NO.

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TAILINGS MANAGEMENT FACILITY
SPLITTER DAM AND SADDLE DAM
PIEZOMETER LOCATIONS

DATE	PROJECT No.	DWG No.	REV.
DEC 2012	M09480A04	D-4008	B

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Name	Easting (m)	Northing (m)	Elevation (m)	Screened	Reading Date	Water Level (mbgl)
KC08-04	446893	6274454	855	Bedrock	9/ 19/ 2012	18.3
KC08-05	444400	6275949	886	Bedrock	6/ 27/ 2012	3.7
KC10-20	443846	6276092	898	Bedrock	9/ 19/ 2012	0
KC10-29	446071	6274535	880	Bedrock	9/ 19/ 2012	0
KC10-30	446378	6274850	842	Bedrock	9/ 19/ 2012	0
KC10-31	446523	6275018	888	Bedrock	9/ 19/ 2012	0
KC10-OVB17	444036	6275696	962	Bedrock	6/ 27/ 2012	6.9
KC10-OVB29	446460	6274498	825	Bedrock	9/ 20/ 2012	2
KC10-OVB30	446711	6274796	0		9/ 30/ 2008	5.1
KC10-OVB31	447066	6274107	0	Bedrock	9/ 19/ 2012	27.8
KC10-OVB32	446089	6274943	0	Bedrock	9/ 19/ 2012	13.2
KC11-CPT4	443835	6276095	898		7/ 5/ 2011	1.6
KC11-CPT6	444403	6275945	889		6/ 27/ 2012	0.4
KC11-CPT7	446713	6274794	867		9/ 19/ 2012	9.6
KC11-CPT8	446526	6275018	866		9/ 2/ 2011	9.3
KC11-CPT9	446886	6274456	856		9/ 19/ 2012	10.4
KC11-OVB37	444797	6276197	887	Basal Till	6/ 27/ 2012	7.1
KC11-OVB38	445648	6275562	911	Bedrock	9/ 3/ 2011	16.2
KC11-OVB39	445665	6275089	853	Bedrock	9/ 3/ 2011	7.6
KC11-OVB40	444170	6276282	903	Basal Till	6/ 27/ 2012	16.6
KC12-OVB46	444417	6275654	894		9/ 21/ 2012	2.4
KC12-OVB47	445201	6275166	845		9/ 21/ 2012	3.9
KC12-OVB48	446841	6273720	897		9/ 21/ 2012	0.5
KC12-OVB49	447266	6273956	824		9/ 20/ 2012	6.2
MW-02A	447274	6273460	744	Bedrock	9/ 19/ 2012	5.8
MW-02B	447280	6273458	744	Gravel, Fluvial	9/ 19/ 2012	9.7

LEGEND

- EXISTING DRILLHOLE
- 2012 DRILLHOLE
- PIEZOMETER
- 2009, 2010 AND 2011 SEISMIC LINE
- 2012 SEISMIC LINE

Notes:
1. UTM Zone 9N, NAD83
2. 2008 orthophoto

NOT FOR CONSTRUCTION

SCALE: 0 500 m

NO.	DATE	ISSUE / REVISION	DRAWN	CHK'D	DESIGN	APP'D
B	DEC 2012	FINAL	AF	GP	JM	GP
A	NOV 2012	DRAFT - ISSUED FOR CLIENT REVIEW	AF	GP	JM	GP

DRAWING NO.

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TAILINGS MANAGEMENT FACILITY
SOUTHEAST DAM AND SPILLWAY
PIEZOMETER LOCATIONS

DATE	PROJECT No.	DWG No.	REV.
DEC 2012	M09480A04	D-4009	B

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APPENDIX I

Drill Hole Logs

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-64

Klohn Crippen Berger

DATE STARTED: 09-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4 ODEX	COORDINATES (m): E 439500 N 6280443
DATE FINISHED: 10-Sept-2012	LOGGED BY: DP/DH	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	TOTAL DEPTH (m): 17.5	GROUNDWATER (Initial Depth (m)/Date) : -
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 2.68/20-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Jeff/Norm	COLLAR ELEVATION (m): 1091	

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75							2 4								
1				2.13	0.0	0.0	0.0				0.00-0.76 m: SAND (SP), fine to medium with trace coarse, trace silt, trace clay, trace fine gravel, poorly graded, angular, brown, moist, organics present within upper zone of material. (Alluvium)	No recovery from 0 m to 2.13 m due to air rotary advancement. Lithologies based off of drilling conditions and cuttings. Hard drilling/hammering conditions.										
2											0.8 / 1090.2 0.76-2.13 m: Cuttings reveal sand to gravel sized angular rock fragments, dark grey with lighter grey fragments. FeOx staining increases with depth. (Weathered Bedrock?)										
3	1	1		1.83	72.2	50.0	52.8	R3	SW		2.1 / 1088.9 2.13-3.96 m: SILTSTONE (95%), dark grey, fine-grained, slightly weathered, R3, fair quality rock, interbedded with fine to medium-grained, light grey SANDSTONE (5%), bedding approximately 60° TCA, mm - cm scale thickness, bedding/contacts smooth to irregular/scoured, trace hairline calcite veining. Upper 10 cm heavily fractured with FeOx staining, evidence of tumbling in bit. Driller reports extra 0.3 m of drilled material recovered likely cave material.				3	2.95 2.96 3.00	J B J	20 20 60	<1 <1 <1	FeOx FeOx FeOx	6 6 6		
4	2	1		1.54	100.0	90.0	93.3	R3	F-SW		4.0 / 1087.0 3.96-5.50 m: SILTSTONE (95%), dark grey, fine-grained, fresh to slightly weathered, R3, good quality rock, bedding becoming 50 to 60° TCA, mm-scale to 5 mm sized SANDSTONE (5%) inclusions present/rip-up clasts near contacts.				1 1 2	3.40 4.90	J J	20 20	<1 <1	FeOx FeOx, Crush Rx	6 6		

CODES:

DISCONT. TYPE: J: Joint; B: Bedding; S: Shear; Fol: Foliation

DISCONT. INFILL: N: None; FeOx: Iron; Cl: Clay; Ca: Calcite; Qtz: Quartz; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; HW: Highly; SW: Slightly; CW: Completely; MW: Moderately; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 10: Smooth and Wavy; 3: Smooth and Planar; 14: Rough and Wavy; 6: Rough and Planar; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

KCBL_ROCK-SI_W/ DISCONTINUITIES-V3 MASTER ROCK-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-64

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	FRACTURE FREQ. (No. Per 30 cm)	DISCONTINUITY DATA: DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
															5.00	J	25	<1	N	3-6		
															5.35	J	50	<1	Cl	6		
														1	5.45	J	25	<1	N	6		
															5.62	J	20	<1	FeOx	6		
														4	5.70	B	50	<1	FeOx Ca	6		
															5.73	J	80	<1	Ca	3-6		
															5.80	B	60	<1		3		
6																						
	3	1		1.50	100.0	76.7	88.7							1								
															6.50	J	25	<1	FeOx	6		
														1								
															6.80	J	25	<1	FeOx, Ca	18		
7											7.0 1084.0											
											7.00-8.50 m: SANDSTONE (85%), light grey, fine to medium-grained, fresh to slightly weathered, R3, good quality rock, sandier, bedding 55 to 70° TCA, mm-scale SILTSTONE (15%) inclusions, smooth to irregular/scoured, bedding contacts contain mm-scale calcite nodules/stringers, SILTSTONE interbeds up to 20 mm thick.	At 6.70 m: NOTE 1: FRACTURE ZONE: Intersecting joints cause disaggregation of core into coarse-gravel-sized clasts with handling; angular with FeOx staining and trace calcite; mechanically influenced along insipient planes.										
															7.50	J	25	<1	FeOx, Ca	6		
	4	1/2		1.50	100.0	73.3	76.7							1								PLT3-d 3.15 MPa
															8.00	J	15	<1	FeOx, Ca	6		
8											8.5 1082.5											
								R2-R3	F-SW		8.50-10.00 m: SANDSTONE (85%), light grey, fine to medium-grained, fresh, R3, excellent quality rock, calcite/quartz veining, calcite nodules/stringers up to 8 cm, SILTSTONE (15%) interbeds up to 1 cm thick, SANDSTONE/SILTSTONE inclusions, bedding up to 50° TCA, smooth to irregular/scoured, minor rip up clasts present.				8.65	J	40	<1	FeOx	6		PLT1-d 59.96 MPa UCS1 51.70 MPa
														1								
															9.00	J	30	<1	FeOx	6-10		
9															9.05	J	40	<1	FeOx	3		
														3	9.08	J	15	<1		6		
	5	2		1.50	100.0	90.0	93.3								9.30	J	20	<1	FeOx	6		
														1								
															9.50	J	20	<1	FeOx	6		
														1								
10											10.0 1081.0											
								R3	F		10.00-11.50 m: SANDSTONE (95%), light grey, fine to medium-grained, fresh, R3, excellent quality rock, sandier, SILTSTONE (5%) interbeds up to 4 cm, bedding contact s smooth to irregular/scoured, calcite/quartz nodules/stringers mm to cm scale, SILTSTONE inclusions/clasts up to 2 cm thick, bedding approximately 60° TCA.				10.15	J	15	<1	FeOx	6		
														1								
															10.52	J	50	<1	N	6		PLT2-a 71.53 MPa
	6	2		1.50	100.0	96.7	96.7							1								
															10.75	J	30	<1	FeOx	6		

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

KCBL_ROCK-SI_W/ DISCONTINUITIES-V3 MASTER ROCK-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-64

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
11.5 1079.5																						
								R3	F		11.50-17.50 m: SANDSTONE, grey, fine to medium-grained, fresh, R3, excellent quality rock, massive.			1	11.85	J	25	<1	FeOx	8-10		
12	7	2		1.50	100.0	100.0	100.0				At 12.31 m: 3 cm rip up clast.			1	12.34	J	70	<1	N	8-10		
13								R3	F		At 13.10 m: 5 mm thick SILSTONE bed at 60° TCA, 2 mm thick calcite vein at 60° TCA. At 13.30 m: 3 mm calcite vein approximately perpendicular TCA.			1	13.21	J	65		N	2-4		
														1	13.47	J	15	<1	FeOx	2-4		
	8	3		1.50	100.0	92.0	98.0							1								
14														1	14.00	J	20	<1	FeOx	4-6		
														3	14.15	J	15	<1	FeOx	4-6		
															14.20	J	40	1-3	FeOx	6-8		
															14.26	J	30	<1	FeOx	4-6		
								R3	F					1	14.58	V	15	1-3	Ca			
															14.68	V	35	<1	FeOx			
15														1								
														4	15.05	J	45	<1	FeOx	4-6		
															15.10	J	35	<1	FeOx	10-12		
	9	3		1.50	100.0	94.7	100.0								15.13	J	55	<1	FeOx, Ca	8-10		
															15.18	V	10	<1	FeOx, Ca			PLT4-d 54.29 MPa
											15.75-16.10 m: Interbedded with SILTSTONE beds, 70° TCA.			1	15.83	J	60	<1	N	2-4		
16								R3	F													
	10	3		1.50	100.0	96.7	100.0															

KCBL_ROCK-SI_W/ DISCONTINUITIES-V3 MASTER ROCK-TMF.GPJ ROCK-LOG.GDT 11/15/12

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-64

Klohn Crippen Berger

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
														2	17.33	J	20	1-3	FeOx	6-8		
															17.40	J	20	1-3	FeOx, Ca	4-6		
											17.5 1073.5											
18											End of Hole at: 17.5 m 1" Standpipe Piezometer Installation Details: 0 m to 5.6 m: Grout 5.6 m to 6.2 m: Bentonite Seal 6.2 m to 10.5 m: Filter Sand Pack 7 m to 10 m: Slotted PVC (slots cut with hacksaw) 10.5 m to 17.5 m: Bentonite Back Fill											
19																						
20																						
21																						
22																						

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

KCBL_ROCK-SI_W/ DISCONTINUITIES-V3 MASTER ROCK-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB44

Klohn Crippen Berger

DATE STARTED: 17-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4" ODEX	COORDINATES (m): E 441552 N 6276636
DATE FINISHED: 18-Sept-2012	LOGGED BY: JM/DH	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	BEDROCK DEPTH (m): 20.13	GROUNDWATER (Initial Depth (m)/Date) : -
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 4.34/20-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Jeff/Norm	COLLAR ELEVATION (m): 1038	

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
1						SM		0.00-1.50 m: SAND (SM), fine to coarse, and silt, trace gravel, well graded, loose to compact, maximum recovered particle size 10 mm, subrounded to subangular, brown, moist. Some organics present. (Alluvium)					
								1.5 / 1036.5					
						GC		1.50-1.85 m: GRAVEL (GC), fine to coarse, and clay, some sand, well graded, dense, maximum recovered particle size 15 mm, subrounded to angular, brown to grey, moist. (Glacial Till)					
2	LPT1	◢	15 24 24 19	Hard	100	CH		1.9 / 1036.2 1.85-3.37 m: CLAY (CH), gravelly, trace to some sand, high plasticity, hard, brown to grey, moist. (Glacial Till)			46.8	29.4	23.8
3	LPT2	◢	20 34 Refusal at 35 cm	Very Dense	90	GC		3.4 / 1034.6 3.37-7.93 m: GRAVEL (GC), fine to coarse, and clay, some sand, well graded, very dense, maximum recovered particle size 15 mm, subrounded to angular, brown to grey, moist. (Glacial Till)		▽	49.3	34.4	16.3
4			16 27								47	33.3	19.7

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB44

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL
								(continued from previous page)					
6	LPT3	◢	30 39	Very Dense	100			3.37-7.93 m: GRAVEL (GC), fine to coarse, and clay, some sand, well graded, very dense, maximum recovered particle size 15 mm, subrounded to angular, brown to grey, moist. (Glacial Till)					
7	LPT4	◢	23 30 34 43	Very Dense	100						45	32.6	22.4
8	LPT5	◢	16 24 31 32	Very Dense	107	GC	7.9 1030.1	7.93-9.49 m: GRAVEL (GC), and clay, trace sand, gap graded, very dense, maximum recovered particle size 40 mm, subrounded to subangular, dark grey, moist. Fines at plastic limit, with medium plasticity, stiff. (Glacial Till)			45.7	31	23.3
9													
10	LPT6	◢	9 19 23 34	Hard	107	CH	9.5 1028.5	9.49-10.98 m: CLAY (CH), gravelly, some sand, high plasticity, hard, moisture content wetter than plastic limit. Maximum recovered particle size 40 mm. (Glacial Till) At 10.30 m: 600 mm boulder			47.9	32.2	19.9
11			14				11.0 1027.0				37.4	29.5	33.1

TESTING RESULTS: ★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L%; 20 40 60 80

20 60 100 140 180 Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB44

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION (continued from previous page)	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
12	LPT7	◢	50 36 38	Very Dense	100	GC		10.98-14.03 m: GRAVEL (GC), fine to coarse, sandy, clayey, well graded, very dense, maximum recovered particle size 50 mm, subrounded to subangular, dark grey, wet. (Glacial Till)	At 11.7 m: Cuttings mostly rock flour				
13									Missed LPT due to the bit getting stuck in the casing				
14	LPT8	◢	13 29 47 63	Hard	100	CH		14.0 / 1024.0 14.03-17.08 m: CLAY (CH), and gravel, some sand, high plasticity, hard, dark grey, moisture content wetter than plastic limit. Maximum recovered particle size 60 mm. (Glacial Till)	At 14.03 m: Hole producing significant water		38.3	35	26.6
15								At 15.30 m: 200 mm cobble	Missed LPT due to the bit getting stuck in the casing				
16													
17			14					17.1 / 1020.9			36.1	33.5	30.4

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB44

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
								(continued from previous page)					
18	LPT9	◢	18 36 38	Very Dense	100	SC		17.08-20.13 m: SAND (SC), medium to coarse, and gravel, clayey, well graded, very dense, maximum recovered particle size 30 mm, subrounded to angular, dark grey, wet. (Glacial Till)			37.1	33.9	29.1
19	LPT10	◢	9 25 34 54	Very Dense	73.8								
20	LPT11	◢	Refusal at 0 cm		0			20.1 1017.9	At 20.13 m: LPT refusal on rock				
21													
22													
23													

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

>>

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB44

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m) (5 10 15)	RUN LENGTH (m)	TCR (%) (25 50 75)	RQD (%) (25 50 75)	SCR (%) (25 50 75)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm) (2 4)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
											(continued from previous page)											
21				1.83	0.0	0.0	0.0				20.13-21.96m: CORE LOSS. Bedrock drilled with 4 inch ODEX, no cuttings descriptions/recovery.	At 20.13 m: No recovery due to further advancement with down hole hammer										
22	1	1		0.59	21.9	0.0	2.7	R2	SW-MW		22.0 (1016.0) 21.96-30.15 m: SILTSTONE, grey to black, fine-grained, slightly to moderately weathered, R2, very poor quality rock, some quartz grains up to 2 mm diameter.	At 21.96 m: Sections of rubble at top and near base of run			22.00 22.10 22.13 22.15	J J J J	40 45 70 80	1 >3 >3	Ca Crush Rx Crush Rx N	4 12 12 8		
23	2	1		1.52	41.0	0.0	10.9				22.55-24.07 m: Numerous quartz veins up to 10 mm in width.	At 22.55 m: Large sections of rubble			23.50	J	40	>3	Qtz	6		
24	3	1		1.52	32.8	0.0	3.8	R2	SW-MW		24.07-25.59 m: Quartz veins up to 2 mm.	At 24.07 m: Mainly rubble										
25																						

CODES:

DISCONT. TYPE: J: Joint; S: Shear; B: Bedding; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB44

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
26																						
	4	1		1.52	48.1	15.3	24.6	R2	SW-MW			At 25.59 m: Sections of rubble			25.70	J	35 70	<1	N	6		
															26.39	J	70	<1	N	3		
27																						
								R2-R3	SW-MW		27.11-28.63 m: Quartz veins up to 5 mm wide.	At 27.11 m: Mainly rubble			27.10	J	70	<1	N	3		
															27.30	J	60	<1	N	3		
															27.32	J	60	<1	Qtz	10		
															27.40	J	25	3	Qtz	14		
															27.45	J	10	1	FeOx	14		
28	5	1		1.52	30.1	0.0	6.6															
29								R2	SW-MW						28.70	J	35	<1	Qtz	3		
	6	1		1.52	43.7	10.9	16.4															
30																						

CODES:

DISCONT. TYPE: J: Joint; S: Shear; B: Bedding; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB44

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
30.2											End of Hole at: 30.2 m											
											2" Standpipe Installation Details: 0 m to 12.3 m: Grout 12.3 m to 13.2 m: Bentonite Seal 13.2 m to 18 m: Filter Sand Pack 14.3 m to 17.4 m: Slotted Screen 18 m to 18.7 m: Bentonite Seal 18.7 m to 28.7 m: Sand Back Fill 28.7 m to 30.15 m: Cuttings Back Fill											
31																						
32																						
33																						
34																						
35																						

CODES:

DISCONT. TYPE: J: Joint; S: Shear; B: Bedding; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB45

Klohn Crippen Berger

DATE STARTED: 19-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4" ODEX	COORDINATES (m): E 442397 N 6276203
DATE FINISHED: 20-Sept-2012	LOGGED BY: JM/DH	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	BEDROCK DEPTH (m): 18.3	GROUNDWATER (Initial Depth (m)/Date) : 25.7/19-Sept-2012
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 5.39/20-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Jeff/Norm	COLLAR ELEVATION (m): 934	

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
1						SM		0.00-1.60 m: SAND (SM), fine to coarse, and silt, gravelly, well graded, compact to dense, maximum recovered particle size 20 mm, rounded to angular, brown, moist, with some organics present. (Alluvium)					
								1.6 / 932.4					
2	LPT1	◢	35 37 35 49	Very Dense	100	GC		1.60-3.47 m: GRAVEL (GC), fine to coarse, and clay, sandy, gap graded, very dense, maximum recovered particle size 30 mm, subrounded to angular, brown to grey, dry to moist. (Glacial Till)			36.4	26.8	36.8
								3.5 / 930.5					
3	LPT2	◢	32 Refusal at 25.5 cm	Hard	135	CH		3.47-4.99 m: CLAY (CH), and gravel, some sand, high plasticity, hard, brown, moist. (Glacial Till)	Hammer broke after LPT.		35	27.3	37.7
4			Refusal					5.0					

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB45

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL
								(continued from previous page)					
6	LPT3	◢	at 12.5 cm		100	GC	929.0	4.99-6.51 m: GRAVEL (GC), fine to coarse, and clay, sandy, well graded, very dense, maximum recovered particle size 30 mm, subrounded to angular, brown to grey, dry to moist. (Glacial Till)	Hammer fixed prior to succeeding LPT.	▽	34.6	31	34.4
7	LPT4	◢	68 Refusal at 15 cm	Hard	153	CI	6.5 927.5	6.51-8.03 m: CLAY (CI), gravelly, medium plasticity, dark grey, moisture content drier than plastic limit. Maximum recovered particle size 20 mm. (Glacial Till)			46.2	31.7	22.1
8	LPT5	◢	58 Refusal at 15 cm	Very Dense	113	GC	8.0 926.0	8.03-9.56 m: GRAVEL (GC), fine to coarse, and clay, some sand, well graded, very dense, maximum recovered particle size 20 mm, subrounded to subangular, dark grey, moist. Fines are drier than plastic limit. (Glacial Till)			43.1	29.1	27.8
9													
10	LPT6	◢	41 Refusal at 20 cm	Very Dense	115	GC	9.6 924.4	9.56-15.65 m: GRAVEL (GC), fine to coarse, and clay, some sand, well graded, very dense, maximum recovered particle size 30 mm, rounded to subrounded, dark grey, moist. Fines are drier than plastic limit. (Glacial Till)	At 10.50 m: 200 mm diameter boulder drilled.		39.9	30.2	30
11									At 10.90 m: Cuttings turned to dry				

TESTING RESULTS: ★ % FINES ◘ LPT N ■ SPT N; W_P% W% W_L%; 20 40 60 80

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB45

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
								(continued from previous page)					
12	LPT7	◢	Refusal		0			9.56-15.65 m: GRAVEL (GC), fine to coarse, and clay, some sand, well graded, very dense, maximum recovered particle size 30 mm, rounded to subrounded, dark grey, moist. Fines are drier than plastic limit. (Glacial Till)	fine sand/silt, gravel content increased at depth. At 11.08 m: LPT refusal on a large particle.		16.8	49.6	33.5
	Cuttings 1	■											
13	LPT8	◢	Refusal		0								
14	LPT9	◢	Refusal		0				At 14.13 m: Hard drilling through loose sand and gravel; cuttings sample retrieved.		36.7	43.5	19.8
	Cuttings 2	■											
15	LPT10	◢	Refusal at 2.5 cm		120	GW-GM		15.65-18.30 m: GRAVEL (GW-GM), fine, and sand, trace silt, well graded, maximum recovered particle size 10 mm, subrounded to subangular, dark grey, moist. (Glacial Till)			48.1	14.2	37.7
16													
17													

15.7
918.4

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC:

◣ SPT
◢ LPT
■ GRAB
⬟ SHELBY TUBE

20 60 100 140 180
Su - kPa

VANE FIELD LAB
PEAK ◆ ■ ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB45

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	★ % FINES ■ SPT N ◪ LPT N; W_P% W% W_L%
								(continued from previous page)						
18								15.65-18.30 m: GRAVEL (GW-GM), fine, and sand, trace silt, well graded, maximum recovered particle size 10 mm, subrounded to subangular, dark grey, moist. (Glacial Till)						
								18.3 915.7						
19														
20														
21														
22														
23														

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: SPT, LPT, GRAB, SHELBY TUBE

Su - kPa: 20, 60, 100, 140, 180

VANE PEAK ◆ FIELD ◇ REMOLD; ■ LAB □; ▲ UC/2; △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB45

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
19	1	1		1.51	40.1	15.1	32.2	R3	F		18.30-19.81 m: SANDSTONE, grey, fine to medium-grained, fresh, R3, poor quality rock, 1 mm thick calcite veins at approximately 30° TCA.			3	19.32 19.38 19.46	J J J	45 70 80	1-3 1-3 1-3	N Qz, Ca Ca	14 14 14		
														2	19.59 19.65	J J	45 25	1-3 <1	N N	6 3		
										19.8 914.2												
20	2	1		1.52	99.3	7.9	47.4	R3	F		19.81-21.33 m: SANDSTONE, grey, medium-grained, fresh, R3, very poor quality rock, occasional 1 mm thick calcite veins, approximately 6 per m, at 30-60° TCA.	At 19.8 m: NOTE 1: FRACTURE ZONE: Intersecting joints cause disaggregation of core into coarse-gravel-sized clasts with handling.			19.82 19.91	J J	75 75	<1 <1	N N	6 6		
21																						
										21.3 912.7											PLT2-d 94.61 MPa	
								R3	F		21.33-22.98 m: SANDSTONE, grey, fine to medium-grained, fresh, R3, very poor quality rock, calcite veins at 15-50° TCA.			21.63 21.66 21.76	J J J	10 5 40	1-3 <1 1-3	N Ca N	14 10 14		
22	3	1		1.53	100.0	15.8	40.1							3	21.93 22.02 22.04 22.17 22.20	J J J J J	40 20 20 45 20	<1 <1 <1 <1 <1	Ca Ca Ca Ca Ca	6 6 6 6 14		
														5								
														1	22.55 22.56 22.60 22.62	J J J J	60 60 40 60	<1 <1 1-3 <1	N N Ca N	6 6 10 6		
														1								
23								R3	F	23.0 911.0	At 22.90 m: 2-4 mm calcite veins at 20° TCA			2	22.92	J	40	<1	Ca	1		
											22.98-23.77 m: SANDSTONE, grey, fine to medium-grained, fresh, R3, poor quality rock, 10 mm thick	At 23.20 m: See			23.09	J	40	<1	Ca	1		PLT1-d 95.49 MPa

CODES:
DISCONT. TYPE: J: Joint; B: Bedding; S: Shear; Fol: Foliation
DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB45

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
											calcite vein at 50° TCA.	Note 1. Jointed primarily at 40 to 60° TCA.										
											At 23.48 m: 300 mm SILTSTONE bed											
	4	1		1.52	100.0	43.4	98.0								23.73	J	30	<1	N	6		
											23.8 / 910.2			2								
24											23.77-27.43 m: SANDSTONE (70%), grey, fine to medium-grained, fresh, R3, poor quality rock, interbedded with SILTSTONE (30%), 1-30 cm thick beds at 40-60° TCA, wavy, 1-5 mm thick calcite veins, approximately 5 per meter, calcite vein at 24.77 m at 15° TCA				23.99	J	50	1-3	N	3		
															24.08	J	50	<1	Ca	3		
														3	24.15	J	40	1-3	Ca	3		
															24.29	J	15	<1	Ca	1		
								R3	F					1	24.48	J	65	1-3	Ca	6		
															24.72	J	50	<1	N	6		
											At 24.77 m: 3 cm calcite vein at 15° TCA			2	24.78	J	15	>3	Ca	6		
															24.82	J	70	<1	N	3		
25														1								
	5	1/2		1.53	100.0	95.4	92.1								25.23	J	30	<1	Ca	6		
															25.32	J	20	<1	Ca	6		
														3	25.36	J	60	<1	Ca	3		
															25.57	J	70	<1	Ca	3		
														4			60					
															25.72	J	60	<1	Ca	1		
															25.78	J	45	<1	Ca	3		
															25.86	J	65	<1	N	1		
26								R3	F			At 25.91 m: See Note 1.		>>								
														2								
															26.36	J	40	<1	Ca	3		
															26.40	J	50	1-3	Ca	14		
	6	2		1.52	100.0	92.1	58.6							1	26.55	J	70	<1	N	14		
															26.74	J	40	<1	Ca	6		
														>>	26.76	J	30	<1	Ca	6		
27												At 26.83 m: See Note 1.											
														>>								
														>>								
											27.4 / 906.6											
								R3	F		27.43-28.95 m: SILTSTONE, dark grey to black, fine-grained, fresh, R3, very poor quality rock, 1-5 mm thick calcite veins at 10-30° TCA at an approximate density of 10 per meter, some polished and shiny joints present.			>>								
												At 27.67 m: See Note 1. Joints primarily along calcite veins at 10 to 30° TCA, spacing 5 - 10		>>								
28														>>								
	7	2		1.52	100.0	0.0	0.0															

CODES:

DISCONT. TYPE: J: Joint; B: Bedding; S: Shear; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB45

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
29								R3	F		mm, some polished and shiny joints present.											
											29.0 905.1											
											End of Hole at: 29.0 m 2" Standpipe Installation Details: 0 m to 4.5 m: Sand Back Fill(only fill material available) 4.5 m to 5.5 m: Bentonite Seal 5.5 m to 9.5 m: Filter Sand Pack 6.5 m to 9.5 m: Slotted Screen 10 m to 10.5 m: Bentonite Seal 10.5 m to 28.5 m: Cuttings and Sand Back Fill (only available materials)											
30																						
31																						
32																						
33																						

CODES:

DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation

DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB46

Klohn Crippen Berger

DATE STARTED: 16-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4" ODEX	COORDINATES (m): E 444414 N 6275650
DATE FINISHED: 16-Sept-2012	LOGGED BY: JM	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	BEDROCK DEPTH (m): 17.8	GROUNDWATER (Initial Depth (m)/Date) : -
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 2.44/20-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Jeff	COLLAR ELEVATION (m): 894	

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
1						SC		0.00-2.05 m: SAND (SC), fine to coarse, and gravel, trace clay to clayey, well graded, compact, maximum recovered particle size 10 mm, subrounded to angular, brown, moist, weak cementation. (Alluvium)					
2	LPT1	◢	Refusal at 0 cm		0	GC	2.1 892.0	2.05-3.57 m: GRAVEL (GC), fine to coarse, sandy, trace to some clay, well graded, compact to dense, maximum recovered particle size 15 mm, subrounded to angular, brown to grey, dry to moist. (Glacial Till)	Likely some cobbles/boulders through overburden; cuttings appear to be granular At 2.05 m: LPT refusal on large particle	▽	23.9	45.7	30.3
3	Grab1	■											
3	LPT2	◢	Refusal at 0 cm		0	GW	3.6 890.4	3.57-5.09 m: GRAVEL (GW), fine to coarse, sandy, trace to some clay, well graded, very dense, maximum recovered particle size 15 mm, subangular to angular, grey, dry to moist. (Glacial Till)	At 3.57 m: LPT refusal on large particle At 4 m: Hole started making water.		27.3	56.5	16.2
4	Grab2	■											

TESTING RESULTS

★ % FINES ◘ LPT N ■ SPT N

W_P% W% W_L%

× – – – – o – – – – ×

20 40 60 80

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

20 60 100 140 180

Su - kPa

	FIELD	LAB
VANE PEAK	◆	■ ▲ UC/2
REMOLD	◇	□ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB46

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	TESTING RESULTS: ★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L%
								(continued from previous page)						
6	LPT3	◢	Refusal at 10 cm	Very Dense	100	GC	5.1 888.9	5.09-9.65 m: GRAVEL (GC), fine to coarse, sandy, some clay to clayey, well graded, very dense, maximum recovered particle size 15 mm, subrounded to angular, grey, dry to moist. (Glacial Till)	Likely some cobbles/boulders through overburden; cuttings appear to be granular		23.3	52.4	24.2	○ ★ >>
	Grab3	■												
7	LPT4	◢	Refusal at 5 cm		0						24	47.2	28.9	○ ★ >>
	Grab4	■												
8	LPT5	◢	63 Refusal at 20 cm	Very Dense	135						33.6 25.4	35.3 46.3	31.1 28.2	⊙ ★ ★ >>
	Grab5	■												
9														
10	LPT6	◢	Refusal at 13 cm	Very Dense	100	GC	9.7 884.4	9.65-11.17 m: GRAVEL (GC), fine to coarse, and clay, some sand to sandy, well graded, very dense, maximum recovered particle size 15 mm, subrounded to angular, grey, dry to moist. (Glacial Till)			28.3 24.4	27.2 47.1	44.5 28.5	○ ○ ★★ >>
	Grab6	■												
11														

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB46

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION (continued from previous page)	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
12	Grab7	■				GC	11.2 / 882.8	11.17-12.69 m: GRAVEL (GC), fine to coarse, clayey, some sand, well graded, very dense, maximum recovered particle size 20 mm, subrounded to angular, grey, dry to moist. (Glacial Till)	Likely some cobbles/boulders through overburden; cuttings appear to be granular		24.5	45.5	30
13	LPT7	◢	Refusal at 10 cm	Very Dense	100	GC	12.7 / 881.3	12.69-15.73 m: GRAVEL (GC), fine to coarse, sandy, some clay, well graded, very dense, maximum recovered particle size 20 mm, subrounded to angular, grey, dry to moist. (Glacial Till)					
14													
15	Grab8	■							After 15 m: Hole produced a lot of water.				
16	LPT8	◢	34 Refusal at 25.4 cm	Very Dense	0	SW	15.7 / 878.3	15.73-17.80 m: SAND (SW), fine to coarse, and gravel, trace clay, well graded, very dense, maximum recovered particle size 25 mm, rounded to subangular, grey, wet. (Glacial Till)			3	47.3	49.7
17													

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

>>

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CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC:

◣ SPT
◢ LPT
■ GRAB
⬟ SHELBY TUBE

20 60 100 140 180
Su - kPa

	FIELD	LAB
VANE PEAK	◆	■ ▲ UC/2
REMOLD	◇	□ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB46

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	TESTING RESULTS: ★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L%
								(continued from previous page)						
18								15.73-17.80 m: SAND (SW), fine to coarse, and gravel, trace clay, well graded, very dense, maximum recovered particle size 25 mm, rounded to subangular, grey, wet. (Glacial Till)	Likely some cobbles/boulders through overburden; cuttings appear to be granular					
19														
20														
21														
22														
23														

17.8
876.2

20 40 60 80

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: SPT, LPT, GRAB, SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ ▲ UC/2; REMOLD ◇ △ P.PEN/2; FIELD ◆ ◇; LAB ■ □

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB46

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
18				0.97	0.0	0.0	0.0				17.80-18.77 m: Drilled with 4" ODEX; no recovery (only cuttings).											
											18.8 / 875.2											
19	1	1		0.85	47.1	0.0	0.0	R4	F		18.77-28.76 m: SANDSTONE, grey, fine to medium-grained, fresh, R4, fair quality rock, Massive, interbedded with 5.0 to 10 cm thick SILTSTONE beds every 0.5 to 1.5 m at 45° TCA. RQD varies from poor to excellent along depth intervals.	At 18.77 m: NOTE 1: FRACTURE ZONE: Intersecting joints cause disaggregation of core into coarse-gravel-sized clasts with handling. Fractures primarily broken core at 10 to 20° TCA every 5 to 10 cm.										
20	2	1		1.52	100.0	52.6	52.6	R4	F					3	19.69 19.94 20.02 20.10	J J J J	40 30 5 60	<1 <1 <1 <1	N N Ca N	6 6 14 6		
														1	20.20	J	5	<1	N	6		
21																						
	3	1		1.52	85.5	59.2	59.2	R4	F					1	21.13	J	15	<1	N	6		
22																						PLT2-a 136.43 MPa

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB46

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
23																						
	4	1		1.52	100.0	100.0	100.0															
24								R4	F					1	24.30	J	20	<1	N	6		
	5	2		1.52	100.0	72.4	82.2					At 25.42 m: See Note 1. Fractures in Siltstone are at 40 to 80° TCA.										
25								R4	F													PLT1-a 20.34 MPa UCS1 81.73 MPa
	6	2		1.52	100.0	94.1	100.0							2	26.43	J	20	1-3	Ca	14		
26															26.51	J	60	<1	N	3		
														1	26.90	J	20	<1	Ca	3		
27								R4	F						27.33	J	20	1-3	Ca	6		
														2	27.53	J	40	<1	N	3		
														3	27.70	J	30	<1	N	3		
															27.74	J	30	<1	N	6		

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB46

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONTINUITY DATA: DISCONT. DEPTH (m)	DISCONT. TYPE	DISCONTINUITY DATA: ANGLE (From Core Axis)	DISCONTINUITY DATA: APERTURE (<1,1-3,>3mm)	DISCONTINUITY DATA: INFILL TYPE	DISCONTINUITY DATA: SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75							2 4								
28	7	2		1.53	100.7	51.3	78.9				(continued from previous page)	At 28.15 m: See Note 1. Fractures in Sandstone/Siltstone are at 10 to 30° TCA with no infill.		3	27.76	J	20	<1	Ca	3		
															27.96	J	25	<1	N	14		
															28.02	J	15	<1	Ca	3		
															28.13	J	10	<1	N	3		
															28.54	J	20	<1	N	6		
															28.58	J	60	<1	N	6		
											28.8 / 865.2											
29											End of Hole at: 28.8 m											
											2" Standpipe Installation Details: 0 m to 9 m: Cuttings Back Fill 9 m to 10m: Bentonite Seal 10 m to 15m: Filter Sand Pack 11.5 m to 14.5m: Slotted Screen 15 m to 15.5m: Bentonite Seal 15.5 m to 28.76m: Cuttings Back Fill											
30																						
31																						
32																						

CODES:

DISCONT. TYPE: J: Joint; B: Bedding; S: Shear; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB47

Klohn Crippen Berger

DATE STARTED: 14-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4" ODEX	COORDINATES (m): E 445202 N 6275175
DATE FINISHED: 15-Sept-2012	LOGGED BY: DH	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	BEDROCK DEPTH (m): 5.2	GROUNDWATER (Initial Depth (m)/Date) : -
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 3.91/20-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Norm	COLLAR ELEVATION (m): 845	

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
1						GW		0.00-5.20 m: GRAVEL (GW), fine, and sand, well graded, dense to very dense, maximum recovered particle size 20 mm, subrounded to subangular, brown, moist. Sand is medium to coarse; presence of cobbles and boulders. (Glacial Till)					
2	LPT1		17 26 24 17	Dense to Very Dense	83.3						8.7	49.5	41.8
3	LPT2		Refusal at 0 cm		0				At 3.51 m: No change in cuttings; LPT refusal on large particle				
4													

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

>>

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: SPT, LPT, GRAB, SHELBY TUBE

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB47

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	★ % FINES ■ SPT N ◪ LPT N; W_P% W% W_L%
	LPT3		Refusal at 0 cm		0			5.2 839.8 (continued from previous page)	At 5.18 m: LPT refusal on large particle At 5.18 m: Water table intercepted. Lots of water reaching surface while drilling, high permeability material. Hitting hard rock, some ice in cuttings.					20 40 60 80 >>
6														
7														
8														
9														
10														
11														

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: SPT, LPT, GRAB, SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ REMOLD ◇ | FIELD | LAB ■ □ | ▲ UC/2 △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB47

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
	1	1		0.58	100.0	37.9	69.0	R3-R4	F		5.20-6.61 m: SANDSTONE, grey, medium to coarse-grained, fresh, R3-R4, poor quality rock, bedding at 70° TCA.				5.58	J	75	1-3	N	6		
6								R3	F					1	5.89	J	70	<1	N	3		
	2	1		1.50	96.7	89.3	94.0				6.6 / 838.4			2	6.62	J	80	<1	N	6		
											6.61-10.32 m: SILTSTONE (50%) AND SANDSTONE (50%), black (siltstone) to grey (sandstone), fine to medium-grained, fresh, R3, good quality rock, wavy bedding at 70° TCA, discontinuous sandstone lenses.				6.63	J	80	<1	N	6		
7														1	6.94	J	80	<1	N	6		
	3	1		1.52	90.8	50.0	69.7	R3	F			At 7.72 m: Note 1: FRACTURE ZONE: Intersecting joints cause disaggregation of core into coarse-gravel-sized clasts with handling. Likely mechanically influenced.		>>							
8											8.8 / 836.2 8.66-8.80m: CORE LOSS			>>								
														>>								
9								R4	F					3	9.14	J	30	<1	N	6		
															9.22	J	50	<1	N	3		
															9.24	J	30	<1	N	6		
	4	1		1.52	84.9	52.0	71.1							3	9.76	J	3	1-3	Cl	14		
															9.87	J	80	<1	N	6		
10															9.88	J	35	1-3	N	10		
															10.00	J	45	>3	Qz	6		
												At 10.1 m: See		>>								

CODES:

DISCONT. TYPE: J: Joint; S: Shear; B: Bedding; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB47

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
11	5	1/2		1.53	100.0	71.9	96.0	R4	F		10.09-10.32m: CORE LOSS	Note 1		1	10.92	J	80	<1	Qz	3		PLT2-d 92.72 MPa
12	6	2		1.52	100.0	100.0	100.0	R4	F		10.32-13.23 m: SILTSTONE (50%) AND SANDSTONE (50%), black (siltstone) to grey (sandstone), fine to medium-grained, fresh, R4, fair quality rock, bedding at 75° TCA, 5-200 mm thick alternating beds, calcite veins at 30° TCA, 12.8-13.2 m.			10.35 10.50 10.56	J J J	75 60 65	<1 <1 <1	N N N	3 10 3		
13											13.2 / 831.8			2 2 2	11.42 11.48 11.51 11.59	J J J J	40 50 80 20	1-3 <1 1-3 <1	N Qz N N	6 3 3 10		
14	7	2		1.53	100.0	92.2	100.0	R4	F		13.23-14.30 m: SANDSTONE, grey, fine-grained, fresh, R4, excellent quality rock, interbedded with black SILTSTONE at 70° TCA.			2 2 2	12.83 12.85 13.26 13.28 13.49 13.52	J J J J J J	35 30 75 20 35 30	<1 <1 <1 1-3 1-3 <1	N N N Qz N N	6 6 3 6 3 3		
15								R4	F		14.3 / 830.7 14.30-16.10 m: SANDSTONE, grey, medium-grained, fresh, R4, good quality rock, interbedded with black SILTSTONE, up to 30% siltstone at angles approximately 60° TCA +/- 20°. SANDSTONE, medium grey, interbedded with 30% SILTSTONE max 30 cm At 20 to 60° TCA.			2 4 2 1	14.01 14.14 14.18 14.40 14.49 14.55 14.62 14.72	J J J J J J J J	30 60 60 70 50 50 70 30	<1 <1 <1 <1 <1 <1 <1 <1	N N N N N N N N	6 3 3 6 3 3 3 3		UCS1 179.35

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB47

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								MPa
16	8	2		1.20	100.0	83.3	92.5					At 15.8 m: Bit blocked for the remainder of run		1	15.20	J	20	<1	N	3		
															15.23	J	30	<1	Qz	6		
														2	15.61	J	85	1-3	N	6		
											16.1											
											828.9											
17											End of Hole at: 16.1 m											
											2" Standpipe Installation Details: 0 m to 2 m: Cuttings Back Fill 2 m to 3.5 m: Bentonite Seal 3.5 m to 7.5 m: Filter Sand Pack 4 m to 7 m: Slotted Screen 7.5 m to 16.1 m: Bentonite Back Fill											
18																						
19																						
20																						

CODES:

DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation

DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB48

Klohn Crippen Berger

DATE STARTED: 10-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4" ODEX	COORDINATES (m): E 446848 N 6273719
DATE FINISHED: 10-Sept-2012	LOGGED BY: DH/JM	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	BEDROCK DEPTH (m): 7.2	GROUNDWATER (Initial Depth (m)/Date) : -
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 0.46/20-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Norm	COLLAR ELEVATION (m): 897	

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
1	LPT1	◢	28 13 57	Very Dense	25	GC		0.00-2.72 m: GRAVEL (GC), and silt, some cobbles, trace sand, well graded, very dense, maximum recovered particle size 75 mm, subangular to angular, grey, wet. (Alluvium)		▽	29.4	28.3	42.3
2								2.7 894.3					
3	LPT2	◢	10 14 15	Compact	84.4	GW-GC		2.72-4.24 m: GRAVEL (GW-GC), fine to coarse, and sand, some silt, , compact, maximum recovered particle size 30 mm, subangular to angular, grey, wet, homogeneous. (Glacial Till)			29.9	34.4	35.7
4	LPT3	◢	8 9 12 16	Compact	71.7	SC		4.2 892.8 4.24-5.76 m: SAND (SC), fine to coarse, and gravel, silty, well graded, compact, maximum recovered particle size 60 mm, subangular to angular, grey, wet, homogeneous. (Glacial Till)			30.8	28.2	41

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB48

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION (continued from previous page)	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	TESTING RESULTS: ★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L%
6	LPT4	◢	6 12 13 18	Compact	83.3	SC		4.24-5.76 m: SAND (SC), fine to coarse, and gravel, silty, well graded, compact, maximum recovered particle size 60 mm, subangular to angular, grey, wet, homogeneous. (Glacial Till) 5.8 / 891.2 5.76-7.20 m: SAND (SC), and gravel, some clay, some silt, well graded, compact, maximum recovered particle size 30 mm, subrounded to subangular, grey, wet. (Glacial Till)			36.9	36.5	26.6	
7								7.2 / 889.8						
8														
9														
10														
11														

TESTING RESULTS: 20 40 60 80

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT; ◢ LPT; ■ GRAB; ⬟ SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB48

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
				0.60	0.0	0.0	0.0				7.20-8.90 m: SANDSTONE, grey, fine to medium-grained, fresh, R3, fair quality rock, 80% fine grained, 20% medium grained, interbedded, wavy along bedding planes, faint FeOx and other staining along joint surfaces; some partially healed fractures.											
8	1	1		1.10	100.0	53.8	77.4	R3	F			At 7.80 m: NOTE 1: FRACTURE ZONE: Intersecting joints cause disaggregation of core into coarse-gravel-sized clasts with handling (Note 1). FeOx staining visible.		>>								
														2	8.48	J	65	<1	FeOx	5		
															8.62	J	60	<1	Ca	1		
															8.72	J	70	1-3	N	9		
											8.9 / 888.1			>>								
9	2	1		0.90	100.0	43.3	88.9	R3	F		8.90-9.80 m: SILTSTONE (50%) AND SANDSTONE (50%), grey (Sandstone) to black (Siltstone), fine to medium-grained, fresh, R3, poor quality rock, wavy bedding at 60° TCA, pyrite lenses along bedding at approximately 1 per m, 5-1 0mm thick.			3	9.00	J	15	<1	FeOx	3		
															9.02	J	45	1-3	N	5		
															9.22	J	35	<1	FeOx	5		
														3	9.36	J	85	<1	N	11		
															9.40	J	80	<1	N	9		
															9.44	J	75	<1	N	5		
											9.8 / 887.2			1	9.78	J	15	<1	FeOx	5		
10											9.80-14.90 m: SILTSTONE, black, fine-grained, fresh, R3, fair quality rock, massive, 5-10 mm thick discontinuous pyrite lenses at 2-3 per m, random orientations.			1	10.00	J	20	<1	Py	5		
														2	10.40	J	15	<1	Py	7		
	3	1		1.50	100.0	72.0	98.0								10.48	J	5	<1	Py	11		
															10.55	J	10	<1	Py	5		
														1								
11																						
														2	11.15	J	10	<1	FeOx	9		
								R4	F						11.30	J	20	<1	N	9		
														1								
12	4	1		1.50	93.3	97.9	97.9								11.80	J	50	<1	N	7		UCS1 129.55 MPa
														1								

CODES:

DISCONT. TYPE: J: Joint; B: Bedding; S: Shear; Fol: Foliation

DISCONT. INFILL: N: None; FeOx: Iron; Cl: Clay; Ca: Calcite; Qtz: Quartz; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; HW: Highly; SW: Slightly; CW: Completely; MW: Moderately; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 10: Smooth and Wavy; 3: Smooth and Planar; 14: Rough and Wavy; 6: Rough and Planar; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB48

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	FRACTURE FREQ. (No. Per 30 cm)	DISCONTINUITY DATA: DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
13								R4	F						12.23	J	50	<1	N	9		
	5	1/2		1.50	90.0	74.1	100.0								13.56	J	80	<1	N	14		
														2	13.68	J	45	<1	N	6		
															13.80	J	45	<1	N	3		
14														2	13.85	J	75	<1	N	6		
								R3-R4	F						14.40	J	25	<1	N	3		
														2								
										14.9 / 882.1				1	14.86	J	45	<1	N	3		
15	6	2		1.50	75.3	91.2	91.2				14.90-15.50 m: SILTSTONE, black, fine-grained, fresh, R3, fair quality rock, healed and partially healed fractures approximately 1-5 mm, some with calcite infill, primarily at 20-30° TCA. End of run fractured, slickenside fracture surface, likely healed a			1	15.17	J	40	<1	N	10		
															15.30	J	35	<1	N	14		
															15.37	J	3	<1	Qz	1		
										15.5 / 881.5				3	15.45	J	40	<1	N	14		
								R2-R3	F		15.50-17.30 m: SILTSTONE, black, fine-grained, fresh, R3-R4, fair quality rock, massive, 5-10 mm discontinuous irregular pyrite lenses, easily friable along certain lenses.			1								
16															15.88	J	90	1-3	N	18		
															15.99	J	30	<1	Py?	6		
														2								
															16.19	J	40	<1	FeOx	6		
															16.26	J	40	<1	N	3		
															16.33	J	30	<1	Qz	1		
														3	16.38	J	45	<1	N	3		
	7	2		1.50	100.0	61.1	84.4					At 16.7 m: See Note 1.										
															16.81	J	45	<1	FeOx	6		
17														1								

CODES:

DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation

DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB48

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONTINUITY DATA: DISCONT. DEPTH (m)	DISCONTINUITY DATA: DISCONT. TYPE	DISCONTINUITY DATA: ANGLE (From Core Axis)	DISCONTINUITY DATA: APERTURE (<1,1-3,>3mm)	DISCONTINUITY DATA: INFILL TYPE	DISCONTINUITY DATA: SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
										× × × ×	17.3 879.7			1	17.18	J	20	<1	FeOx, Ca	1		
											End of Hole at: 17.3 m 2" Standpipe Installation Details: 0 m to 2.3 m: Grout 2.3 m to 3.5 m: Bentonite Seal 3.7 m to 7 m: Filter Sand Pack 3.7 m to 6.8 m: Slotted Screen 7 m to 17.3 m: Bentonite Back Fill											
18																						
19																						
20																						
21																						
22																						

CODES:

DISCONT. TYPE: J: Joint; S: Shear; B: Bedding; Fol: Foliation

DISCONT. INFILL: N: None; Cl: Clay; Qtz: Quartz; FeOx: Iron; Ca: Calcite; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; SW: Slightly; MW: Moderately; HW: Highly; CW: Completely; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 3: Smooth and Planar; 6: Rough and Planar; 10: Smooth and Wavy; 14: Rough and Wavy; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

Klohn Crippen Berger

DATE STARTED: 11-Sept-2012	LOCATION: Tailings Management Facility	BIT SIZE AND TYPE: 47.6 mm NQ3/4" ODEX	COORDINATES (m): E 447264 N 6273954
DATE FINISHED: 13-Sept-2012	LOGGED BY: DH/JM	RIG MAKE AND MODEL: HP200	COORDINATE SOURCE: HGPS
CLIENT: Seabridge Gold	CHECKED BY: PK	BEDROCK DEPTH (m): 40.84	GROUNDWATER (Initial Depth (m)/Date) : -
PROJECT NAME: KSM 2012 SI	DRILLING CO.: Geotech	AZIMUTH/ANGLE FROM VERT.: VERTICAL	GROUNDWATER (Final Depth (m)/Date) : 6.16/19-Sept-2012
PROJECT NO.: M09480A04	DRILLER: Norm	COLLAR ELEVATION (m): 824	

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
1						GW		0.00-3.34 m: GRAVEL (GW), fine to coarse, some coarse sand, well graded, very dense, maximum recovered particle size 30 mm, angular, light grey to dark brown, moist. (Alluvium)					
2	LPT1	◢	22 21 52	Very Dense	44.4				At 1.82 m: Occasionally cuttings are dust instead of small rock indicating boulders, approximate size 150 mm based on time through one every 1-2 runs (1.53m).		1.1	15	83.9
3								3.3 820.7					
	LPT2	◢	17 16 13 10	Compact	66.7	GW		3.34-4.86 m: GRAVEL (GW), fine to coarse, some coarse sand, well graded, compact, maximum recovered particle size 40 mm, dark grey to brown, moist. (Alluvium)			2.1	21.7	76.3
4								4.9 819.1					
			9 28								0.8	4.5	94.7

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

20 60 100 140 180

Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION (continued from previous page)	DRILLING REMARKS	PIEZOMETER DETAILS	% FINES	% SAND	% GRAVEL
6	LPT3	◢	19 22	Dense	25	GW		4.86-6.38 m: GRAVEL (GW), fine to coarse, well graded, dense, angular to subangular, maximum particle size 40 mm, dark grey to dark brown, wet. (Alluvium)	At 4.86 m: Very few cuttings coming out, loose deposit of gravel, end of LPT broke into less dense layer, approximately 1-2" of penetration per blow, gravel is likely being pushed aside by the bit.	▽			
7	LPT4	◢	21 28 Refusal	Very Dense	100	GW-GM		6.4 / 817.6 6.38-7.90 m: GRAVEL (GW-GM), some coarse sand, trace silt, well graded, very dense, maximum recovered particle size 50 mm, subrounded to subangular, moist. (Alluvium)			8.1	18.8	73.1
8	LPT5	◢	Refusal at 0 cm		0			7.9 / 816.1 7.90-9.42 m: Cuttings reveal possible gravel to boulder sized material. (Alluvium)	At 7.90 m: LPT refusal on large particle At 7.90 m: Mostly rock flour in cuttings, some gravel and boulders, 30-60 cm in size based on distance drilled, with rock flour cuttings suspect boulder field; clay cuttings at 10 m.				
9	LPT6	◢	Refusal at 0 cm		0	GC		9.4 / 814.6 9.42-12.46 m: Cuttings reveal gravel, clay, and mostly rock flour. (Glacial Till)	At 9.42 m: LPT refusal on large particle				
10													
11	LPT7	◢	Refusal		0								

TESTING RESULTS

★ % FINES ■ LPT N ■ SPT N

W_P% W% W_L%

20 40 60 80

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

20 60 100 140 180 Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL
								(continued from previous page)					
12								9.42-12.46 m: Cuttings reveal gravel, clay, and mostly rock flour. (Glacial Till)	At 10.94 m: LPT refusal on large particle; cuttings still clayey, suspect very dense till.				
	LPT8	◢	53 65 Refusal at 30 cm	Very Dense	150	GC		12.5 811.5 12.46-13.98 m: GRAVEL (GC), fine to coarse, clayey, sandy, well graded, very dense, maximum particle size 40 mm, subangular to subrounded, brown, wet. (Glacial Till)			32.3	31.7	36
13													
14	LPT9	◢	24 46 Refusal at 41 cm	Very Dense	123	GC		14.0 810.0 13.98-17.02 m: GRAVEL (GC), fine to coarse, clayey, sandy, well graded, very dense, maximum recovered particle size 40 mm, grey to brown, wet. (Glacial Till)	At 13.98 m: Mostly rock cuttings, some clay/silt/sand.		35.2	35.5	29.3
15													
16													
17			29 34					17.0 807.0			38.8	23.2	37.9

TESTING RESULTS: ★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L%; 20 40 60 80

20 60 100 140 180 Su - kPa

VANE FIELD LAB
PEAK ◆ ■ ▲ UC/2
REMOLD ◇ □ △ P.PEN/2

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT ◢ LPT ■ GRAB ⬟ SHELBY TUBE

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	TESTING RESULTS: ★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L%
								(continued from previous page)						
18	LPT10	◢	40 34	Very Dense	100	GC		17.02-20.06 m: GRAVEL (GC), fine to coarse, and clay to clayey, trace to some sand, well graded, very dense, maximum particle size 60 mm, subangular to subrounded, grey, wet. (Glacial Till)	At 13.98 m: Mostly rock cuttings, some clay/silt/sand.					
19														
20	LPT11	◢	10 20 31 Refusal at 56 cm	Hard	116	CI		20.1 / 803.9 20.06-23.10 m: CLAY (CI), sandy, trace to some gravel, medium plasticity, hard, grey, moist to wet. (Glacial Till)	At 20.06 m: Mainly grey clay and sand cuttings to 22 m, mainly gravel cuttings thereafter.		63.9	29.1	7	
21														
22														
23			29 Refusal					23.1 / 800.9			10.2	60.9	28.9	

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT; ◢ LPT; ■ GRAB; ⬟ SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE PEAK ◆ REMOLD ◇ | FIELD ◆ ◇ | LAB ■ □ | ▲ UC/2 | △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION (continued from previous page)	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL
24	LPT12	◢	at 25 cm	Dense to Very Dense	80	GC		23.10-26.14 m: GRAVEL (GC), sandy, some clay, well graded, dense to very dense, maximum particle size 60 mm, subangular to subrounded, grey, wet. (Glacial Till)	At 23.10 m: Mainly gravel to 25 m, mainly sand/clay cuttings thereafter.				
25													
26	LPT13	◢	12 25 18	Dense	133	SP-SC		26.1 797.9 26.14-28.27 m: SAND (SP-SC), fine to medium, trace to some clay, gravel in some sections, poorly graded, dense, maximum particle size 3 mm, subangular to subrounded, grey, wet. (Glacial Till)	LPT hammer failed; switched to NQ3 coring, driller concerned with ODEX casing getting stuck		28.4	70.2	1.4
27													
28	LPT14	◢	Refusal at 0 cm		0 68.4	GC		28.3 795.7 28.27-29.78 m: GRAVEL (GC), fine to coarse, clayey, some sand, well graded, very dense, maximum recovered particle size 30 mm, angular to subangular, grey to dark brown, moist. (Glacial Till)	At 28.27 m: LPT refusal on large particle				
29	SA1	■							At 28.8 m end of high water infiltration zone, much less water entering casing; cuttings are pebbles, possible gravel layer?		45.1	34.1	20.9

TESTING RESULTS: ★ % FINES ◘ LPT N ■ SPT N; W_P% × – – – – W% ○ – – – – W_L% ×; 20 40 60 80; >>

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: ◣ SPT; ◢ LPT; ■ GRAB; ⬟ SHELBY TUBE

20 60 100 140 180 Su - kPa

VANE FIELD LAB

PEAK ◆ ■ ▲ UC/2

REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	★ % FINES ■ LPT N ■ SPT N; W_P% W% W_L% (20 40 60 80)
30					98.0	CI		(continued from previous page) 29.8 / 794.2 29.78-30.15 m: CLAY (CI), gravelly, medium plasticity, very stiff, dark grey, homogeneous, strong cementation. (Glacial Till) 30.2 / 793.9	At 28.8 m end of high water infiltration zone, much less water entering casing; cuttings are pebbles, possible gravel layer?					
31					23.0	GC		30.15-40.84 m: GRAVEL (GC), fine to coarse, clayey, some sand, well graded, very dense, maximum recovered particle size 30 mm, angular to subangular, grey to dark brown, moist. (Glacial Till)						
32					50.0			At 31.98 m: 300 mm sandstone boulder. 32.28-33.22 m: Only coarse grained gravel recovered, maximum recovered particle size greater than 20 mm. (Glacial Till)						
33									At 33.22 m: Unable to get good recovery with NQ3, cobbles are too big for LPT.					
34					17.6			33.22-34.75 m: Poor recovery, maximum particle size 80 mm, fines washed out. (Glacial Till)						
35								34.75-36.27 m: Poor recovery, maximum recovered particle size 180 mm, possibly highly fractured bedrock but trace fines at end of run. (Glacial Till)						

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: SPT; LPT; GRAB; SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE FIELD LAB: PEAK ◆ ■ ▲ UC/2; REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

OVERBURDEN DRILL LOG OF BOREHOLE NO.: KC12-OVB49

Klohn Crippen Berger

DEPTH (m)	SAMPLE NO.	SAMPLE GRAPHIC	NO. BLOWS PER 15 cm	CONSIST./APP. DENSITY	RECOVERY (%)	USCS	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	TESTING RESULTS: % FINES	% SAND	% GRAVEL	★ % FINES ■ SPT N ◪ LPT N; W_P% W% W_L%
								(continued from previous page)						
36					54.6			30.15-40.84 m: GRAVEL (GC), fine to coarse, clayey, some sand, well graded, very dense, maximum recovered particle size 30 mm, angular to subangular, grey to dark brown, moist. (Glacial Till)	At 33.22 m: Unable to get good recovery with NQ3, cobbles are too big for LPT.					20 40 60 80
37					69.1			36.27-37.50 m: Maximum recovered particle size 330 mm. (Glacial Till)	At 36.27 m: Temporary artesian flow encountered after run from water injected during drilling, flow lasted approximately 2 minutes, high permeability material? (~0.5 L/sec)					
38					16.5			37.50-39.32 m: Maximum recovered particle size 80mm. (Glacial Till)						
39														
40					39.5			39.32-40.84 m: Trace amounts of clay on some rock. (Glacial Till)						
41								40.8 / 783.2						

CODES:

APP. DENSITY OF COARSE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

CONSISTENCY OF FINE-GRAINED SOILS:

DESCRIPTOR	SPT N
Very Soft	<2
Soft	2-4
Firm	4-8
Stiff	8-15
Very Stiff	15-30
Hard	>30

SAMPLE GRAPHIC: SPT, LPT, GRAB, SHELBY TUBE

Su - kPa: 20 60 100 140 180

VANE FIELD LAB: PEAK ◆ ■ ▲ UC/2; REMOLD ◇ □ △ P.PEN/2

KCBL_DRILL LOG (OVB)-SI-V2 MASTER SOIL-TMF.GPJ ROCK-LOG.GDT 11/15/12

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
41								R2	F-SW		40.84-42.37 m: SILTSTONE, black, medium-grained, fresh to slightly weathered, R2, fair quality rock, massive.	Artesian flow at ~0.1 L/sec										UCS1 93.92 MPa
	9	2		1.53	100.0	66.7	73.3					At 41.53 m: NOTE 1: FRACTURE ZONE: Intersecting joints cause disaggregation of core into coarse-gravel-sized clasts with handling; fractures at 90° TCA.		>>	41.48	J	85	1-3	N	3		
42														>>								
											42.4 781.6			>>								
	10	2		1.42	86.7	36.7	46.7	R2-R3	F-SW		42.37-43.89 m: SILTSTONE, grey to black, medium-grained, fresh to slightly weathered, R2-R3, very poor quality rock, 43.0m - 43.89m, largely intact, no fractures, 2 healed joints at 43.15m.			>>								
43														2								
											43.9 780.1			>>								
44								R2	SW-MW		43.89-45.41 m: SILTSTONE, grey to black, medium-grained, slightly to moderately weathered, R2, very poor quality rock, contains a few pieces of fine grained, grey sandstone present, mainly rubble, some faces appear weathered, likely fracture zone.	At 43.84 m: See Note 1. At 43.89-45.41 m: Very slow advance		>>								
	11	2		1.52	40.0	0.0	6.7							>>								
45														>>								
											45.4 778.6			>>								
								R2-R3	SW-MW		45.41-46.93 m: SILTSTONE, grey to black, medium-grained, slightly to moderately weathered, R2-R3, poor quality rock, interbedded with a few thin (<5cm) bands of fine grained, grey sandstone, mainly rubble to 46.2m,	At 45.41 m: Flowing artesian		>>	45.50	J	60	<1	Ca	3		
														>>	45.60	J	60	<1	Cl	10		

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
46	12	2		1.62	80.0	30.0	46.7				two visible discontinuities, intact rock											
								R2	F-SW		46.9 / 775.1 46.93-48.45 m: SILTSTONE, grey to black, medium-grained, fresh to slightly weathered, R2, very poor quality rock, interbedded with thin bands of fine grained, grey sandstone, mostly rubble.	At 46.97 m: See Note 1. At 46.93 m: Flowing artesian										
47	13	3		1.52	30.0	0.0	3.3															
48											48.5 / 775.6											
								R2	F-SW		48.45-49.97 m: SILTSTONE, grey to black, medium-grained, fresh to slightly weathered, R2, poor quality rock, interbedded with thin fine grained, grey sandstone.	At 48.45 m: Flowing artesian		1	48.60	S	50	>3		10		
														5	48.80	S	45	>3	Cl	14		
49	14	3		1.52	60.0	27.3	36.7								49.30	S	60	>3	Cl	10		
50											50.0 / 774.0 End of Hole at: 50.0 m											

2" Standpipe Installation Details:
0 m to 22.6 m: Grout
22.6 m to 24.4 m: Bentonite Seal
24.4 m to 31.3 m: Filter Sand Pack
26.3 m to 29.4 m: Slotted Screen

CODES:
DISCONT. TYPE: J: Joint, S: Shear, B: Bedding, Fol: Foliation
DISCONT. INFILL: N: None, Cl: Clay, Qtz: Quartz, FeOx: Iron, Ca: Calcite, MnOx: Manganese
ROCK MASS WEATHERING: F: Fresh, SW: Slightly, MW: Moderately, HW: Highly, CW: Completely, RS: Residual Soil
SIMPLIFIED JRC: 1: Slickensided, 3: Smooth and Planar, 6: Rough and Planar, 10: Smooth and Wavy, 14: Rough and Wavy, 18: Very Rough and Wavy, or Stepped
ROCK STRENGTH (MPa): R0: Extremely Weak (<1), R1: Very Weak (1-5), R2: Weak (5-25), R3: Medium Strong (25-30), R4: Strong (50-100), R5: Very Strong (100-250), R6: Extremely Strong (>250)

Klohn Crippen Berger

GEOLOGIC DRILL LOG OF BOREHOLE NO.: KC12-OVB49

DEPTH (m)	RUN NUMBER	BOX NUMBER	AVG DRILL RATE (min/m)	RUN LENGTH (m)	TCR (%)	RQD (%)	SCR (%)	ROCK STRENGTH (ISRM)	ROCK MASS WEATHERING	LITHOLOGY GRAPHIC	DESCRIPTION	DRILLING REMARKS	PIEZOMETER DETAILS	DISCONTINUITY DATA: FRACTURE FREQ. (No. Per 30 cm)	DISCONT. DEPTH (m)	DISCONT. TYPE	ANGLE (From Core Axis)	APERTURE (<1,1-3,>3mm)	INFILL TYPE	SIMPLIFIED JRC	PERMEABILITY (m/sec)	LABORATORY STRENGTH TESTS
			5 10 15		25 50 75	25 50 75	25 50 75				(continued from previous page)			2 4								
51											31.3 m to 32.5 m: Bentonite Seal 32.5 m to 49.97 m: Sand/Bedrock Back Fill/Slough											
52																						
53																						
54																						
55																						

CODES:

DISCONT. TYPE: J: Joint; B: Bedding; S: Shear; Fol: Foliation

DISCONT. INFILL: N: None; FeOx: Iron; Cl: Clay; Ca: Calcite; Qtz: Quartz; MnOx: Manganese

ROCK MASS WEATHERING: F: Fresh; HW: Highly; SW: Slightly; CW: Completely; MW: Moderately; RS: Residual Soil

SIMPLIFIED JRC: 1: Slickensided; 10: Smooth and Wavy; 3: Smooth and Planar; 14: Rough and Wavy; 6: Rough and Planar; 18: Very Rough and Wavy, or Stepped

ROCK STRENGTH (MPa): R0: Extremely Weak (<1); R1: Very Weak (1-5); R2: Weak (5-25); R3: Medium Strong (25-30); R4: Strong (50-100); R5: Very Strong (100-250); R6: Extremely Strong (>250)

APPENDIX II

Core Photo Summary

Appendix II
Core Photo Summary

I-1.1 KC12-64

Photo II-1 KC12-64 Box 1 of 3 (2.1 m – 7.96 m)

Photo II-2 KC12-64 Box 2 of 3 (7.96 m – 13.00 m)

Photo II-3 KC12-64 Box 3 of 3 (13.00 m – 17.50 m)

I-1.2 KC12-OVB44

Photo II-4 KC12-OVB44 LPT 1 of 10 (1.85 m – 2.30 m)

Photo II-5 KC12-OVB44 LPT 2 of 10 (3.37 m – 3.69 m)

Photo II-6 KC12-OVB44 LPT 3 of 10 (4.89 m – 5.49 m)

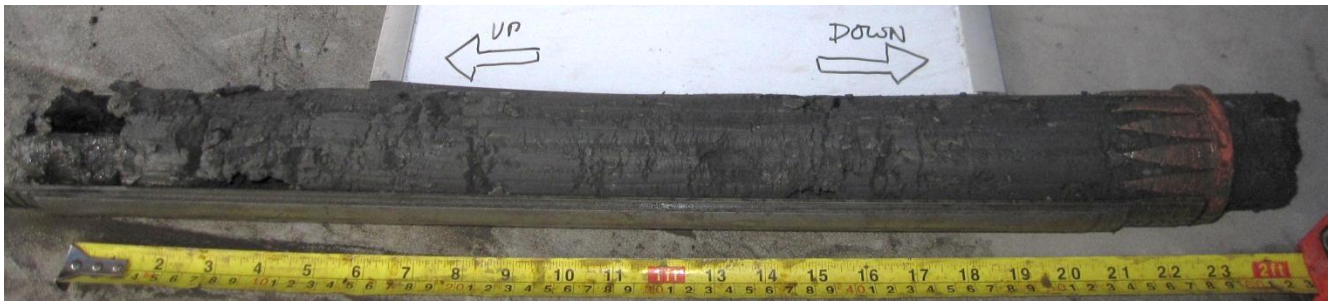


Photo II-7 KC12-OVB44 LPT 4 of 10 (6.41 m – 7.01 m)

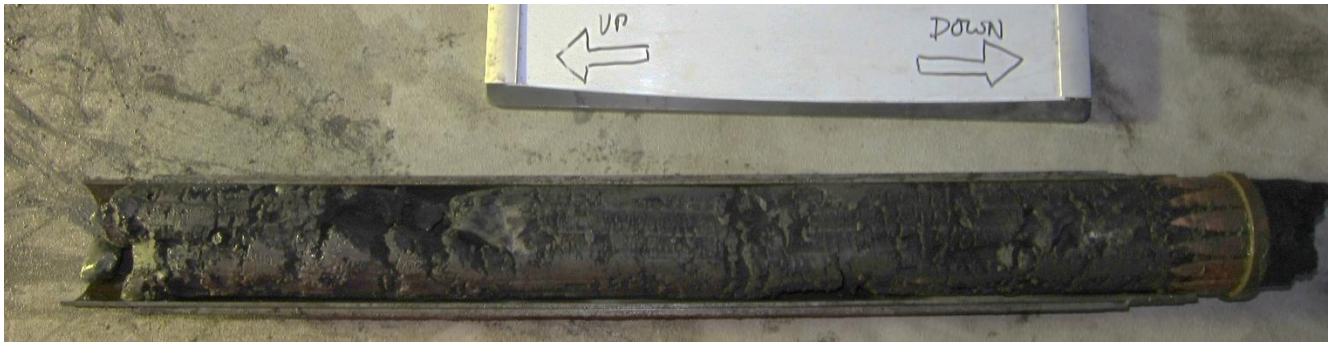


Photo II-8 KC12-OVB44 LPT 5 of 10 (7.93 m – 8.53 m)

Photo II-9 KC12-OVB44 LPT 6 of 10 (9.46 m – 10.06 m)

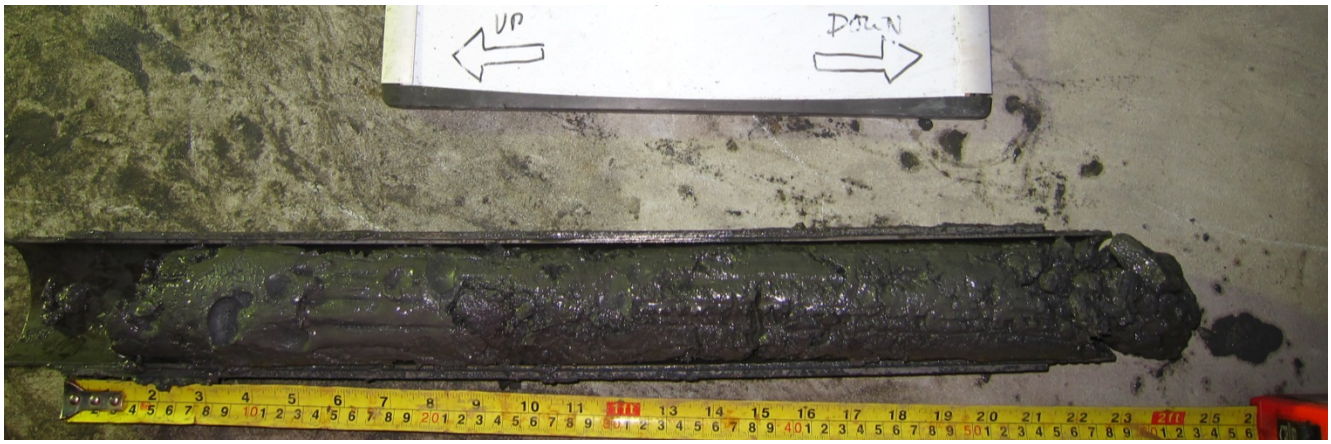


Photo II-10 KC12-OVB44 LPT 7 of 10 (10.98 m – 11.58 m)

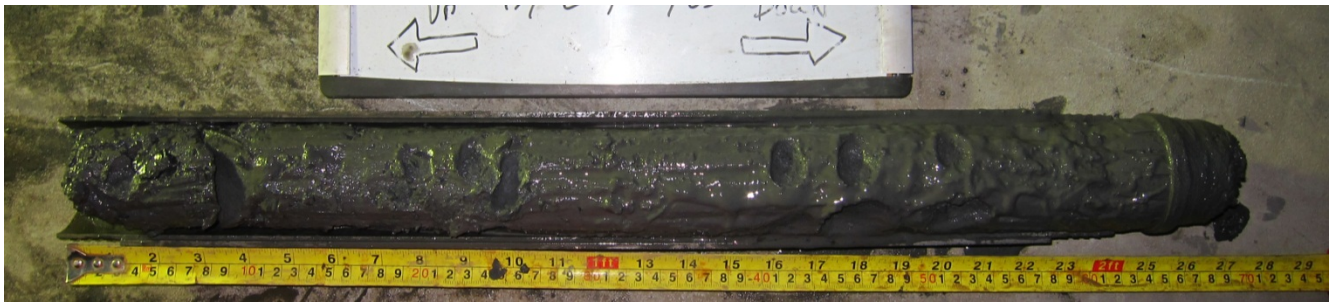


Photo II-11 KC12-OVB44 LPT 8 of 10 (14.03 m – 14.63 m)

Photo II-12 KC12-OVB44 LPT 9 of 10 (17.08 m – 17.68 m)

Photo II-13 KC12-OVB44 LPT 10 of 10 (18.60 m – 19.20 m)

Photo II-14 KC12-OVB44 Box 1 of 1 (21.96 m – 30.15 m)

I-1.3 KC12-OVB45

Photo II-15 KC12-OVB45 LPT 1 of 10 (1.95 m – 2.55 m)

Photo II-16 KC12-OVB45 LPT 2 of 10 (3.47 m – 3.82 m)

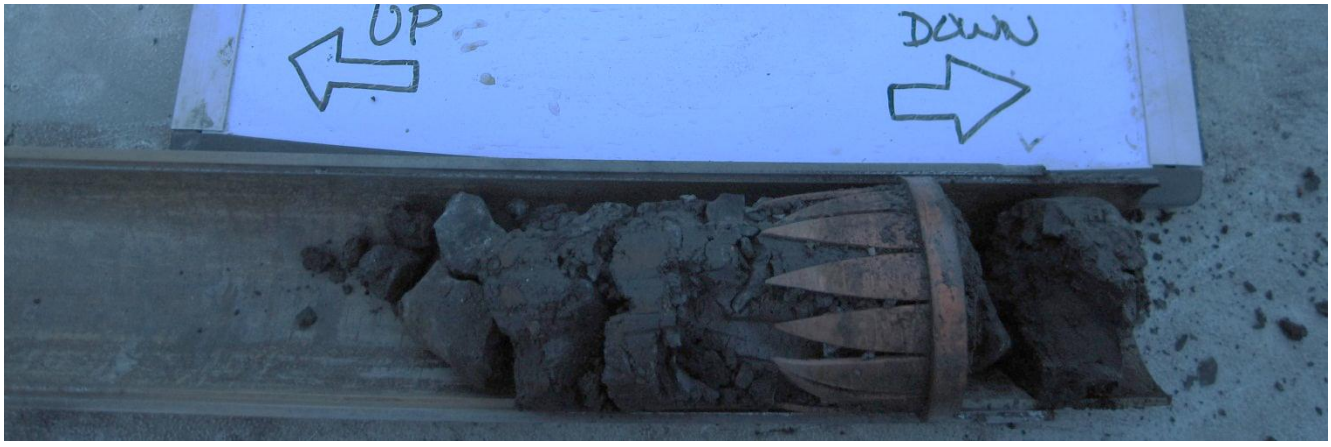


Photo II-17 KC12-OVB45 LPT 3 of 10 (4.99 m – 5.14 m)

Photo II-18 KC12-OVB45 LPT 4 of 10 (6.51 m – 6.66 m)

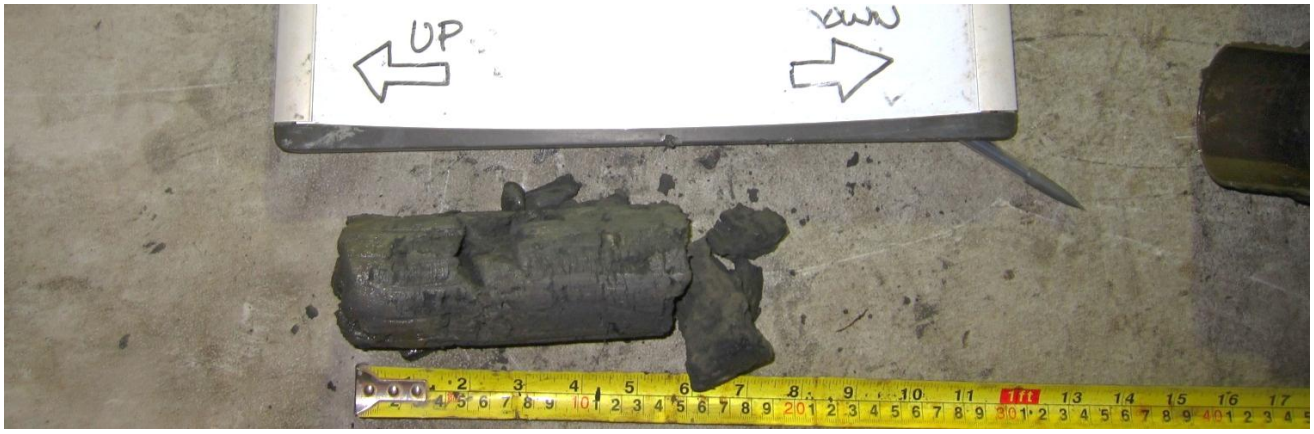


Photo II-19 KC12-OVB45 LPT 5 of 10 (8.03 m – 8.18 m)

Photo II-20 KC12-OVB45 LPT 6 of 10 (9.56 m – 9.76 m)

KC12-OVB45 LPT 7 to 9: No Samples or Photos Taken

Photo II-21 KC12-OVB45 LPT 10 of 10 (15.65 m – 15.68 m)

KC12-OVB45 Cuttings 1 (11.08 m – 12.61 m): No Photo Available

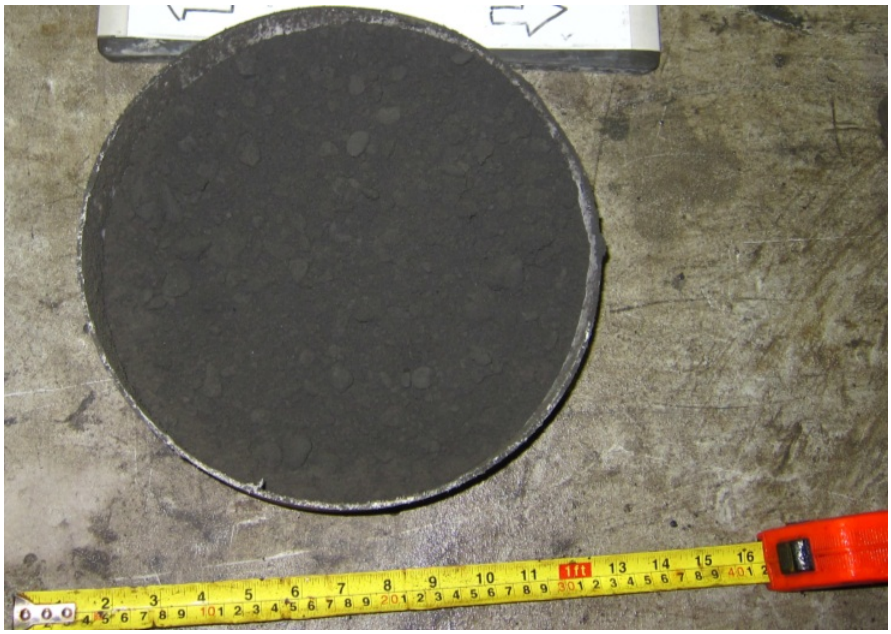


Photo II-22 KC12-OVB45 Cuttings 2 of 2 (14.13 m – 15.65 m)

Photo II-23 KC12-OVB45 Box 1 of 2 (19.2m – 24.92 m)

Photo II-24 KC12-OVB45 Box 2 of 2 (24.92 m – 28.95 m)

I-1.4 KC12-OVB46

KC12-OVB46 Grab 1 to 4: No Photos Taken

KC12-OVB46 LPT 1 and 2: No Photos or Samples Taken

Photo II-25 KC12-OVB46 LPT 3 of 8 (5.09 m – 5.19 m)

KC12-OVB46 LPT 4: No Photos or Samples Taken

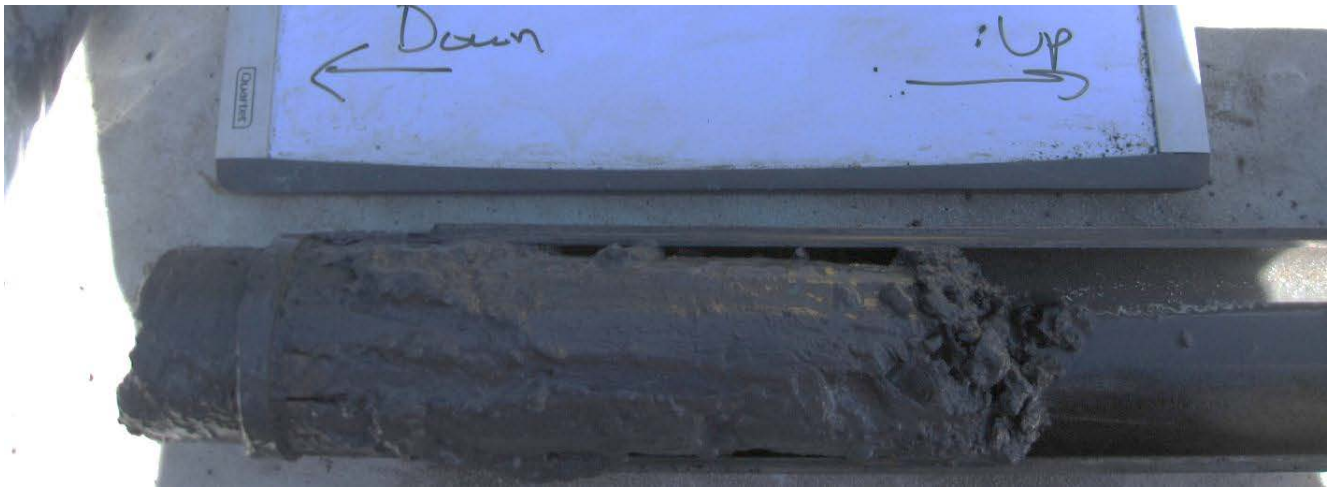


Photo II-26 KC12-OVB46 LPT 5 of 8 (8.13 m – 8.40 m)

KC12-OVB46 Grab 5-7: No Photos Taken

Photo II-27 KC12-OVB46 LPT 6 of 8 (9.65 m – 9.78 m)

KC12-OVB46 LPT 7: No Photos or Samples Taken

Photo II-28 KC12-OVB46 LPT 8 of 8 (15.73 m – 15.98 m)

Photo II-29 KC12-OVB46 Box 1 of 2 (19.17 m – 24.19 m)

Photo II-30 KC12-OVB46 Box 2 of 2 (24.19 m – 28.76 m)

I-1.5 KC12-OVB47

KC12-OVB47 LPT 1: No Photos Taken

Photo II-31 KC12-OVB47 Box 1 of 2 (5.20 m – 10.92 m)

Photo II-32 KC12-OVB47 Box 2 of 2 (10.92 m – 16.10 m)

I-1.6 KC12-OVB48

KC12-OVB48 LPT 1 to 4: No Photos Taken

Photo II-33 KC12-OVB48 Box 1 of 1 (7.80 m – 13.10 m)

I-1.7 KC12-OVB49

Photo II-34 KC12-OVB49 LPT 1 of 13 (1.82 m – 2.22 m)

Photo II-35 KC12-OVB49 LPT 2 of 13 (3.34 m – 3.94 m)

Photo II-36 KC12-OVB49 LPT 3 of 13 (4.86 m – 5.46 m)

Photo II-37 KC12-OVB49 LPT 4 of 13 (6.38 m – 6.72 m)

KC12-OVB49 LPT 5 - 7: No Photos Taken

Photo II-38 KC12-OVB49 LPT 8 of 13 (12.46 m – 12.76 m)

Photo II-39 KC12-OVB49 LPT 9 of 13 (13.98 m – 14.38 m)

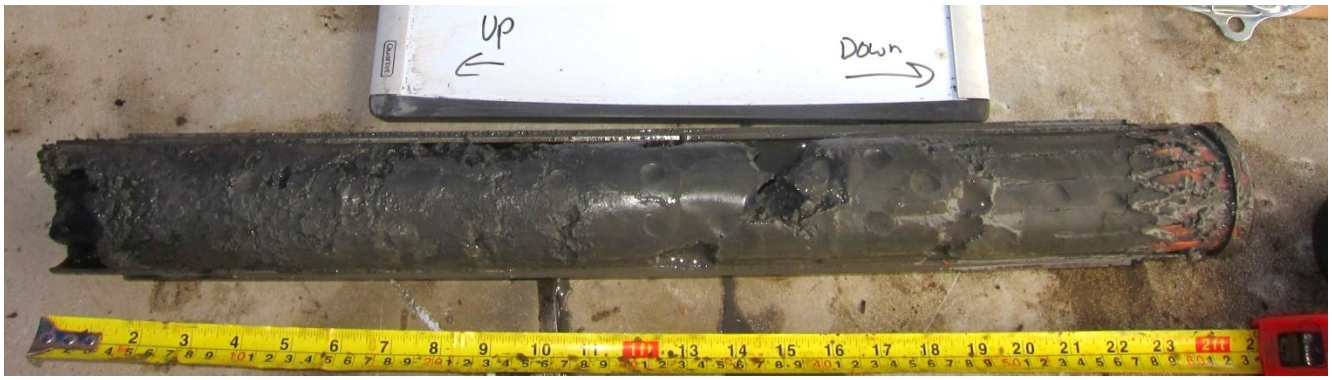


Photo II-40 KC12-OVB49 LPT 10 of 13 (17.02 m – 17.62 m)

Photo II-41 KC12-OVB49 LPT 11 of 13 (20.06 m – 20.60 m)

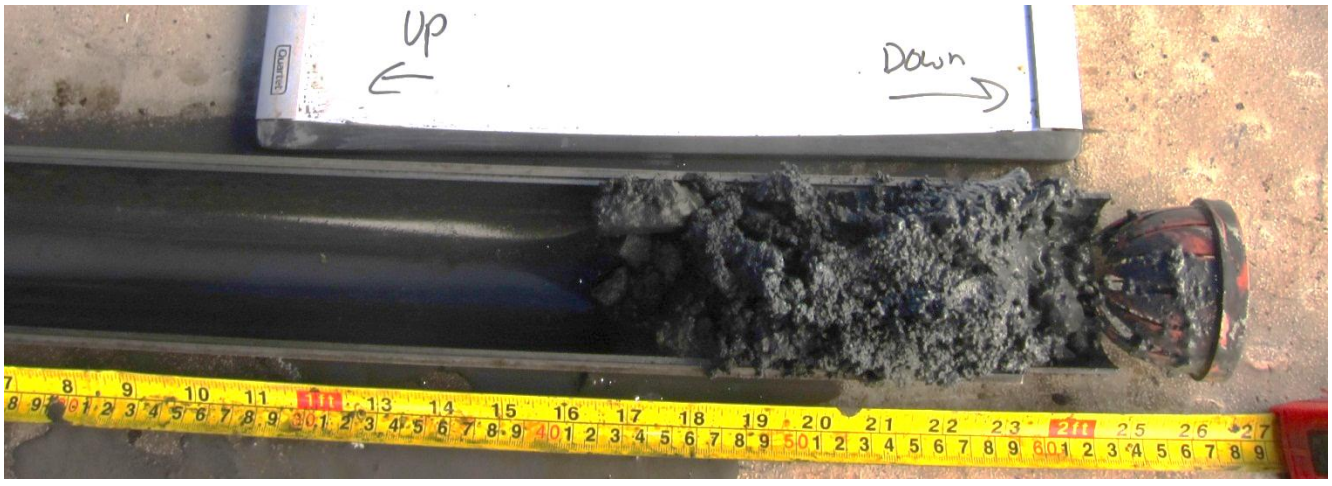


Photo II-42 KC12-OVB49 LPT 12 of 13 (12.46 m – 12.76 m)

Photo II-43 KC12-OVB49 LPT 13 of 13 (26.14 m – 26.65 m)

Photo II-44 KC12-OVB49 Box 1 of 3 (28.24 m – 39.32 m)

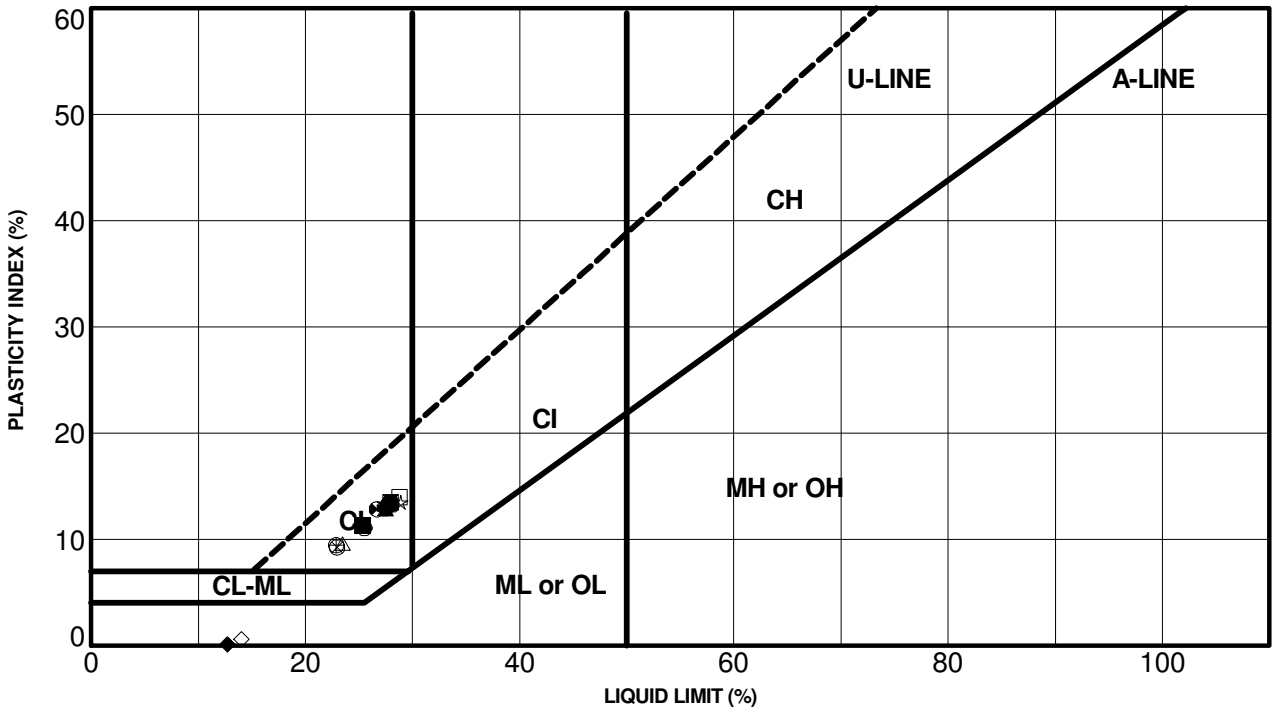
Photo II-45 KC12-OVB49 Box 2 of 3 (39.32 m – 46.93 m)

Photo II-46 KC12-OVB49 Box 3 of 3 (46.93 m – 49.97 m)

APPENDIX III

Laboratory Test Results

PLASTICITY CHART



	HOLE	SAMPLE	DEPTH (m)	W_L	W_P	PI	% FINES	REMARKS/SAMPLE DESCRIPTION
●	KC12OVB44	LPT 1	1.9	28	15	13	46.8	
⧓	KC12OVB44	LPT 2	3.4	28	14	13	49.3	
▲	KC12OVB44	LPT 3	4.9	28	15	13	47.0	
★	KC12OVB44	LPT 4	6.4	27	14	13	45.0	
⊙	KC12OVB44	LPT 5	7.9	28	14	13	45.7	
✿	KC12OVB44	LPT 6	9.5	27	14	13	47.9	
○	KC12OVB44	LPT 7	11.0	26	14	11	37.4	
△	KC12OVB44	LPT 8	14.0	23	14	10	38.3	
⊗	KC12OVB44	LPT 9	17.1	23	14	9	36.1	
⊕	KC12OVB44	LPT 10	18.6	23	13	9	37.1	
□	KC12OVB45	LPT 1	2.0	29	15	14	36.4	
⊠	KC12OVB45	LPT 2	3.5	27	14	13	35.0	
◒	KC12OVB45	LPT 3	5.0	28	15	13	34.6	
☆	KC12OVB45	LPT 4	6.5	29	15	13	46.2	
⊠	KC12OVB45	LPT 5	8.0	28	15	13	43.1	
■	KC12OVB45	LPT 6	9.6	25	14	11	39.9	
◆	KC12OVB45	CUTTINGS 1	11.1	13	13	NP	16.8	
◇	KC12OVB45	CUTTINGS 2	14.1	14	13	1	36.7	

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

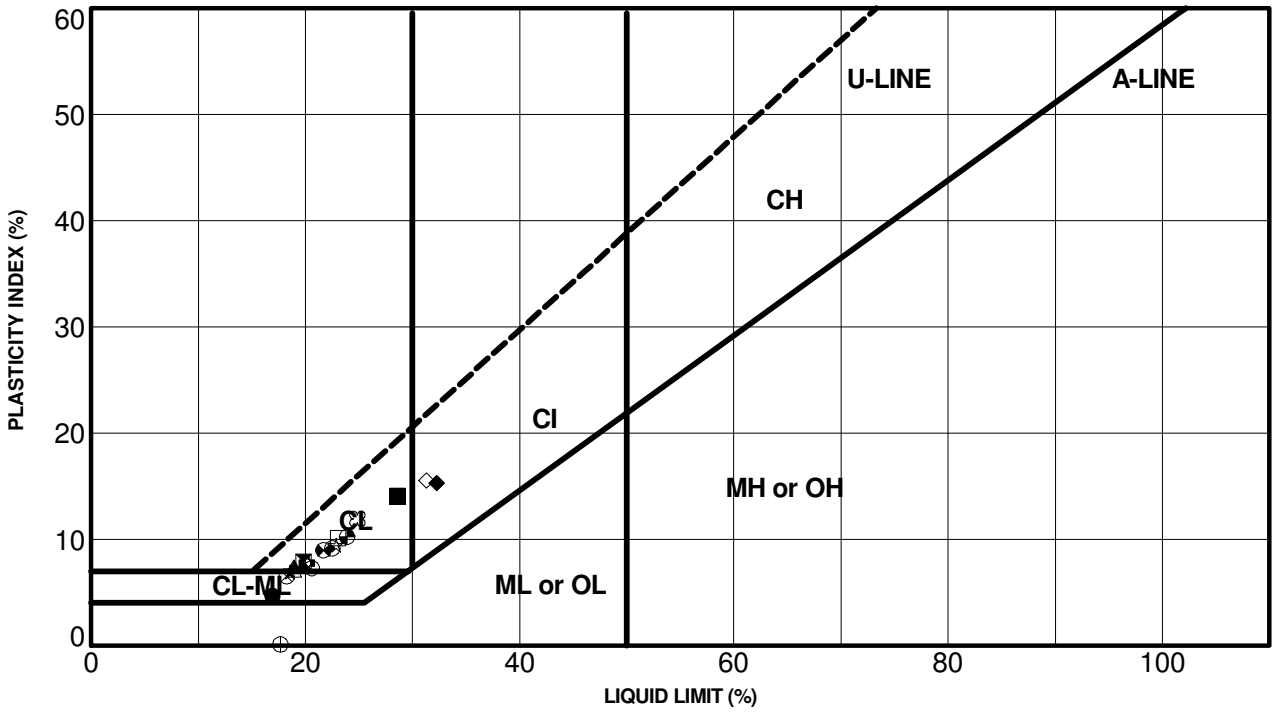
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_ATTERBERG-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

PLASTICITY CHART



	HOLE	SAMPLE	DEPTH (m)	W_L	W_P	PI	% FINES	REMARKS/SAMPLE DESCRIPTION
●	KC12OVB46	GRAB 1	2.1	17	12	5	23.9	
⧓	KC12OVB46	GRAB 2	3.6	20	12	8	27.3	
▲	KC12OVB46	GRAB 3	5.1	19	11	7	23.3	
★	KC12OVB46	GRAB 4	6.6	19	12	7	24.0	
⊙	KC12OVB46	LPT 5	8.1	23	13	9	33.6	
✪	KC12OVB46	GRAB 5	8.1	20	12	8	25.4	
○	KC12OVB46	LPT 6	9.7	21	13	7	28.3	
△	KC12OVB46	GRAB 6	9.7	19	12	7	24.4	
⊗	KC12OVB46	GRAB 7	11.2	18	12	7	24.5	
⊕	KC12OVB47	LPT 1	2.0	18	18	NP	8.7	
□	KC12OVB48	LPT 1	1.2	23	13	10	29.4	
⊠	KC12OVB48	LPT 2	2.7	22	13	9	29.9	
◕	KC12OVB48	LPT 3	4.2	24	14	10	30.8	
☆	KC12OVB48	LPT 4	5.8	23	13	9	36.9	
⊠	KC12OVB49	LPT 8	12.5	25	13	12	32.3	
■	KC12OVB49	LPT 9	14.0	29	15	14	35.2	
◆	KC12OVB49	LPT 10	17.0	32	17	15	38.8	
◇	KC12OVB49	LPT 11	20.1	31	16	16	63.9	

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

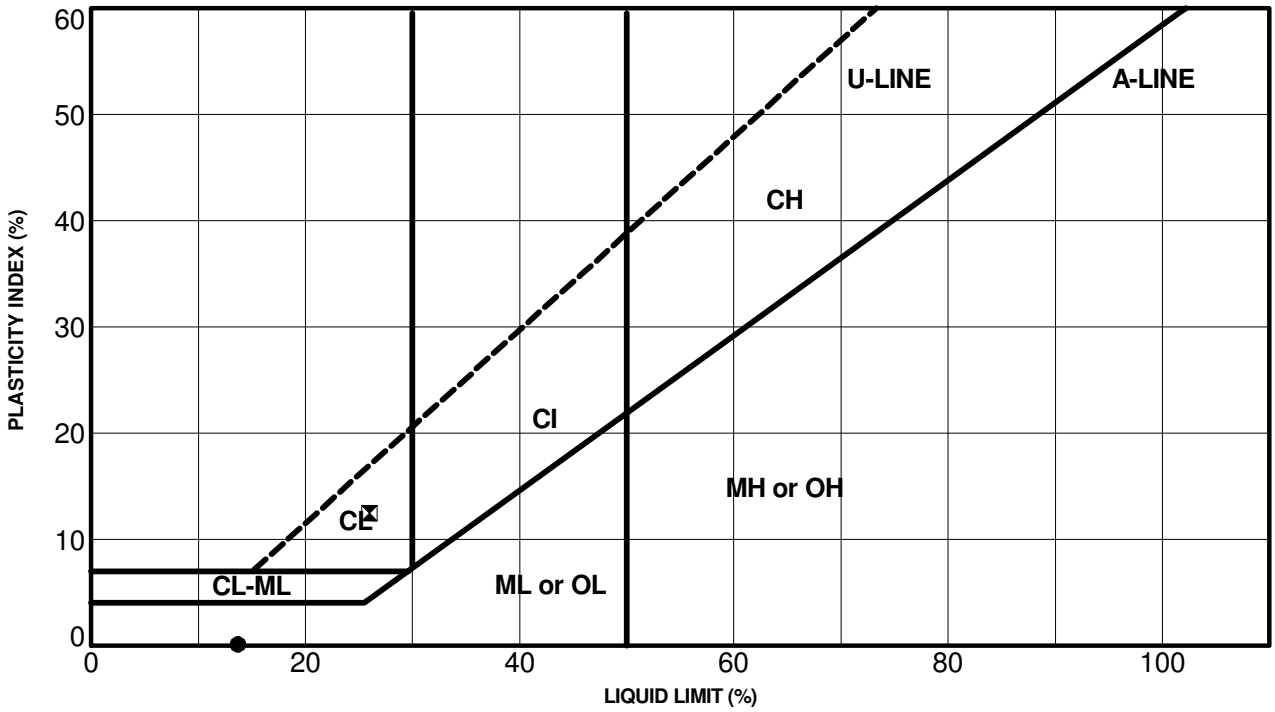
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_ATTERBERG-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

PLASTICITY CHART



	HOLE	SAMPLE	DEPTH (m)	W_L	W_P	PI	% FINES	REMARKS/SAMPLE DESCRIPTION
●	KC12OVB49	LPT 12	23.1	14	14	NP	10.2	
⊠	KC12OVB49	SA 1	29.0	26	14	12	45.1	

Klohn Crippen Berger

PROJECT NO.:	M09480A04
PROJECT:	KSM 2012 Prefeasibility Study
LOCATION:	BC
FIGURE:	
DRAWN BY:	LC **CHECKED BY:** JG

KCB_ATTERBERG-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

WATER CONTENT OF SOIL
(ASTM D2216)

Hole Number	Sample Number	Depth (m)	ID Number	Wet Weight + Tare (g)	Dry Weight + Tare (g)	Tare (g)	Water Weight (g)	Total Dry Weight (g)	Water Content (%)
KC12 - OVB 44	LPT 1	1.85 - 2.45		1305.25	1208.33	154.80	96.92	1053.53	**9.20**
KC12 - OVB 44	LPT 2	3.37 - 3.69		1040.70	963.90	155.04	76.80	808.86	**9.49**
KC12 - OVB 44	LPT 3	4.89 - 5.49		1272.16	1178.78	163.96	93.38	1014.82	**9.20**
KC12 - OVB 44	LPT 4	6.41 - 7.01		1161.16	1083.64	170.38	77.52	913.26	**8.49**
KC12 - OVB 44	LPT 5	7.93 - 8.53		1260.78	1157.62	153.66	103.16	1003.96	**10.28**
KC12 - OVB 44	LPT 6	9.46 - 10.06		1244.57	1138.64	160.32	105.93	978.32	**10.83**
KC12 - OVB 44	LPT 7	10.98 - 11.58		1375.24	1269.46	167.21	105.78	1102.25	**9.60**
KC12 - OVB 44	LPT 8	14.03 - 14.63		1710.46	1571.42	163.73	139.04	1407.69	**9.88**
KC12 - OVB 44	LPT 9	17.08 - 17.68		1249.93	1159.79	181.86	90.14	977.93	**9.22**
KC12 - OVB 44	LPT 10	18.60 - 19.20		1424.72	1316.87	168.70	107.85	1148.17	**9.39**
KC12 - OVB 45	LPT 1	1.95 - 2.55		1715.91	1607.48	152.07	108.43	1455.41	**7.45**
KC12 - OVB 45	LPT 2	3.47 - 3.82		1280.30	1204.59	174.96	75.71	1029.63	**7.35**
KC12 - OVB 45	LPT 3	4.99		1048.23	988.11	155.77	60.12	832.34	**7.22**
KC12 - OVB 45	LPT 4	6.51 - 6.66		776.45	725.00	172.56	51.45	552.44	**9.31**
KC12 - OVB 45	LPT 5	8.03 - 8.18		685.22	643.46	173.07	41.76	470.39	**8.88**
KC12 - OVB 45	LPT 6	9.56 - 9.76		908.95	855.20	157.06	53.75	698.14	**7.70**
KC12 - OVB 45	LPT 10	15.65 - 15.68		181.68	176.07	118.02	5.61	58.05	**9.66**
KC12 - OVB 45	CUTTING 1	11.08 - 12.61		1427.10	1390.41	157.13	36.69	1233.28	**2.97**
KC12 - OVB 45	CUTTING 2	14.13 - 15.65		1088.73	1039.76	166.77	48.97	872.99	**5.61**
KC12 - OVB 46	GRAB 1	2.05 - 3.57		1417.14	1356.67	163.23	60.47	1193.44	**5.07**
KC12 - OVB 46	GRAB 2	3.57 - 5.09		1010.15	970.71	173.81	39.44	796.90	**4.95**
KC12 - OVB 46	GRAB 3	5.09 - 6.61		1283.06	1233.40	174.51	49.66	1058.89	**4.69**
KC12 - OVB 46	GRAB 4	6.61 - 8.13		1576.02	1513.36	164.15	62.66	1349.21	**4.64**
KC12 - OVB 46	LPT 5	8.13 - 8.40		1311.45	1232.85	189.04	78.60	1043.81	**7.53**
KC12 - OVB 46	LPT 6	9.65 - 9.78		899.98	810.21	169.04	89.77	641.17	**14.00**
KC12 - OVB 46	GRAB 5	8.13 - 9.65		1574.50	1500.50	169.80	74.00	1330.70	**5.56**
KC12 - OVB 46	GRAB 6	9.65 - 11.17		1679.19	1603.51	169.22	75.68	1434.29	**5.28**
KC12 - OVB 46	GRAB 7	11.17 - 12.69		1621.10	1559.28	156.18	61.82	1403.10	**4.41**
KC12 - OVB 46	LPT 8	15.73 - 15.98		1076.35	996.35	144.80	80.00	851.55	**9.39**
KC12 - OVB 47	LPT 1	1.98 - 2.58		1525.55	1426.37	141.96	99.18	1284.41	**7.72**
KC12 - OVB 48	LPT 1	1.20 - 1.65		1306.30	1203.42	153.07	102.88	1050.35	**9.79**
KC12 - OVB 48	LPT 2	2.72 - 3.17		1625.94	1506.49	145.95	119.45	1360.54	**8.78**
KC12 - OVB 48	LPT 3	4.24 - 4.86		1703.52	1585.28	149.32	118.24	1435.96	**8.23**

Klohn Crippen Berger

JOB NO:	M09480A04	
PROJECT:	KSM	
LOCATION:	BC	
DATE:	October 22, 2012	
TESTED BY:	LC	CHECKED BY: JG

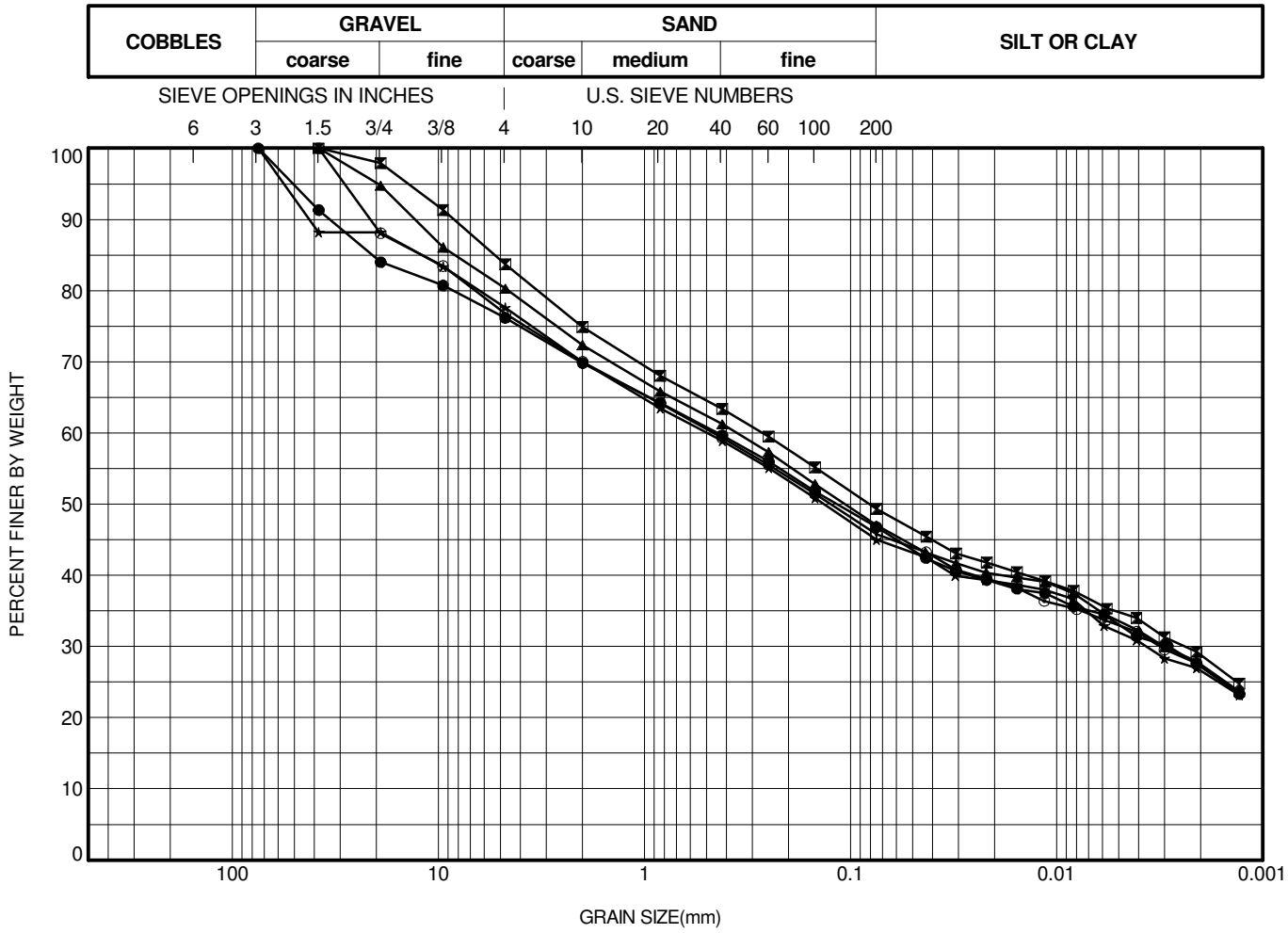
WATER CONTENT OF SOIL

Hole Number	Sample Number	Depth (m)	ID Number	Wet Weight + Tare (g)	Dry Weight + Tare (g)	Tare (g)	Water Weight (g)	Total Dry Weight (g)	Water Content (%)
KC12 - OVB 48	LPT 4	5.76 - 6.36		1443.48	1325.47	165.03	118.01	1160.44	**10.17**
KC12 - OVB 49	LPT 1	1.82 - 2.22		576.11	565.52	175.20	10.59	390.32	**2.71**
KC12 - OVB 49	LPT 2	3.34 - 3.94		1828.40	1750.92	208.06	77.48	1542.86	**5.02**
KC12 - OVB 49	LPT 3	4.86 - 5.46		525.98	514.75	144.56	11.23	370.19	**3.03**
KC12 - OVB 49	LPT 4	6.38 - 6.72		1556.55	1441.70	143.81	114.85	1297.89	**8.85**
KC12 - OVB 49	LPT 8	12.46 - 12.76		1247.52	1165.55	190.36	81.97	975.19	**8.41**
KC12 - OVB 49	LPT 9	13.98 - 14.38		1058.47	982.43	156.14	76.04	826.29	**9.20**
KC12 - OVB 49	LPT 10	17.02 - 17.62		1807.56	1652.18	163.78	155.38	1488.40	**10.44**
KC12 - OVB 49	LPT 11	20.06 - 20.60		1009.00	885.01	151.06	123.99	733.95	**16.89**
KC12 - OVB 49	LPT 12	23.10 - 23.35		973.28	889.00	178.21	84.28	710.79	**11.86**
KC12 - OVB 49	LPT 13	26.14 - 26.65		894.25	783.81	175.77	110.44	608.04	**18.16**
KC12 - OVB 49	SA 1	28.98 - 29.55		1120.34	1049.93	174.21	70.41	875.72	**8.04**

Klohn Crippen Berger

JOB NO:	M09480A04		
PROJECT:	KSM		
LOCATION:	BC		
DATE:	October 22, 2012		
TESTED BY:	LC	CHECKED BY:	JG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB44	1.85	20.989	0.442	0.117				23.8	29.4	46.8
⊠	KC12OVB44	3.37	5.357	0.268	0.081				16.3	34.4	49.3
▲	KC12OVB44	4.89	8.361	0.357	0.107				19.7	33.3	47.0
★	KC12OVB44	6.41	12.034	0.495	0.135				22.4	32.6	45.0
⊙	KC12OVB44	7.93	12.048	0.464	0.125				23.3	31.0	45.7

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB44	LPT 1	1.85		28	15	13	
⊠	KC12OVB44	LPT 2	3.37		28	14	13	
▲	KC12OVB44	LPT 3	4.89		28	15	13	
★	KC12OVB44	LPT 4	6.41		27	14	13	
⊙	KC12OVB44	LPT 5	7.93		28	14	13	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

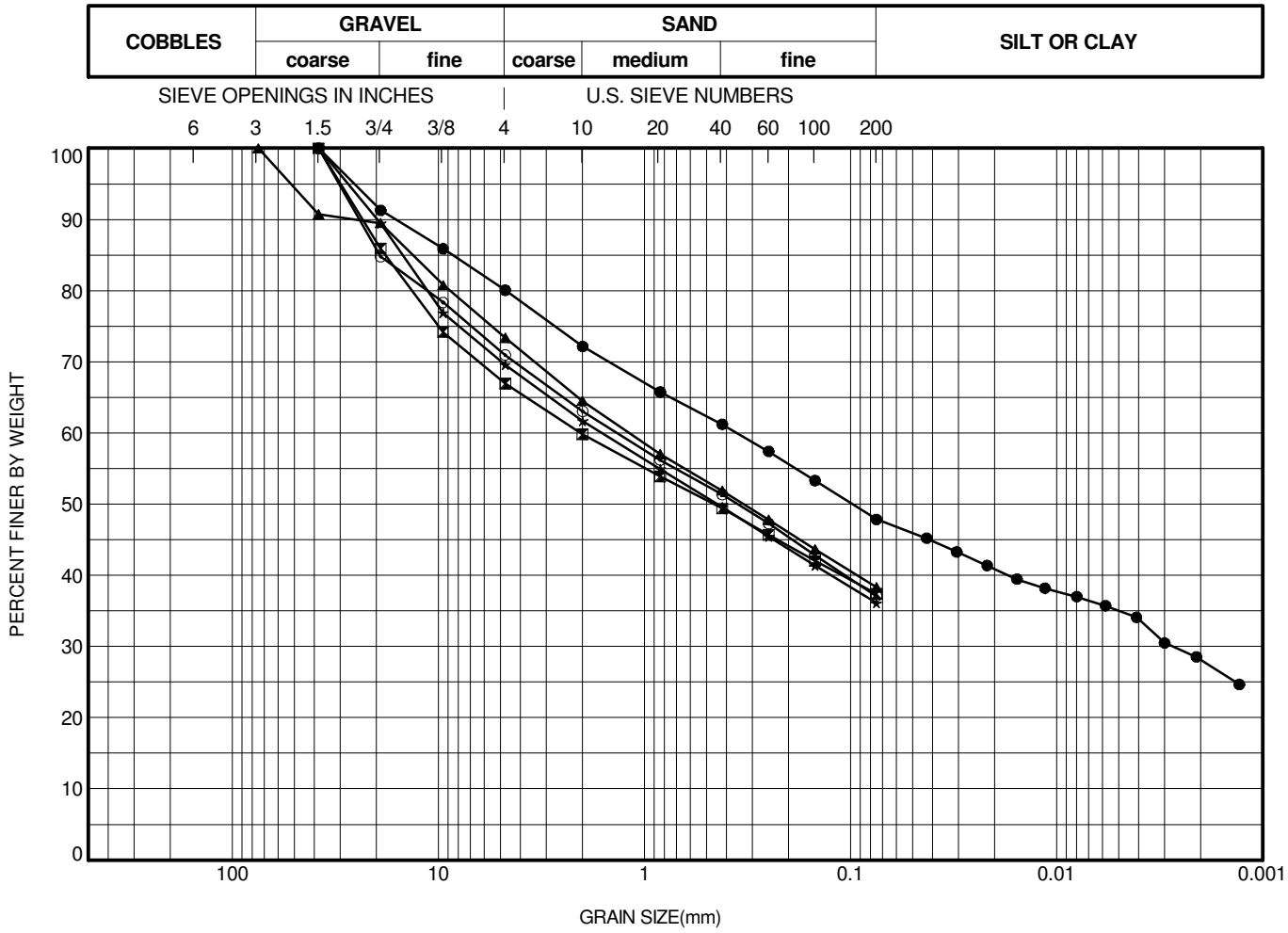
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB44	9.46	8.567	0.356	0.098				19.9	32.2	47.9
⊠	KC12OVB44	10.98	18.073	2.049	0.462				33.1	29.5	37.4
▲	KC12OVB44	14.03	13.336	1.187	0.330				26.6	35.0	38.3
★	KC12OVB44	17.08	14.923	1.615	0.445				30.4	33.5	36.1
⊙	KC12OVB44	18.60	19.294	1.361	0.354				29.1	33.9	37.1

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB44	LPT 6	9.46		27	14	13	
⊠	KC12OVB44	LPT 7	10.98		26	14	11	
▲	KC12OVB44	LPT 8	14.03		23	14	10	
★	KC12OVB44	LPT 9	17.08		23	14	9	
⊙	KC12OVB44	LPT 10	18.60		23	13	9	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

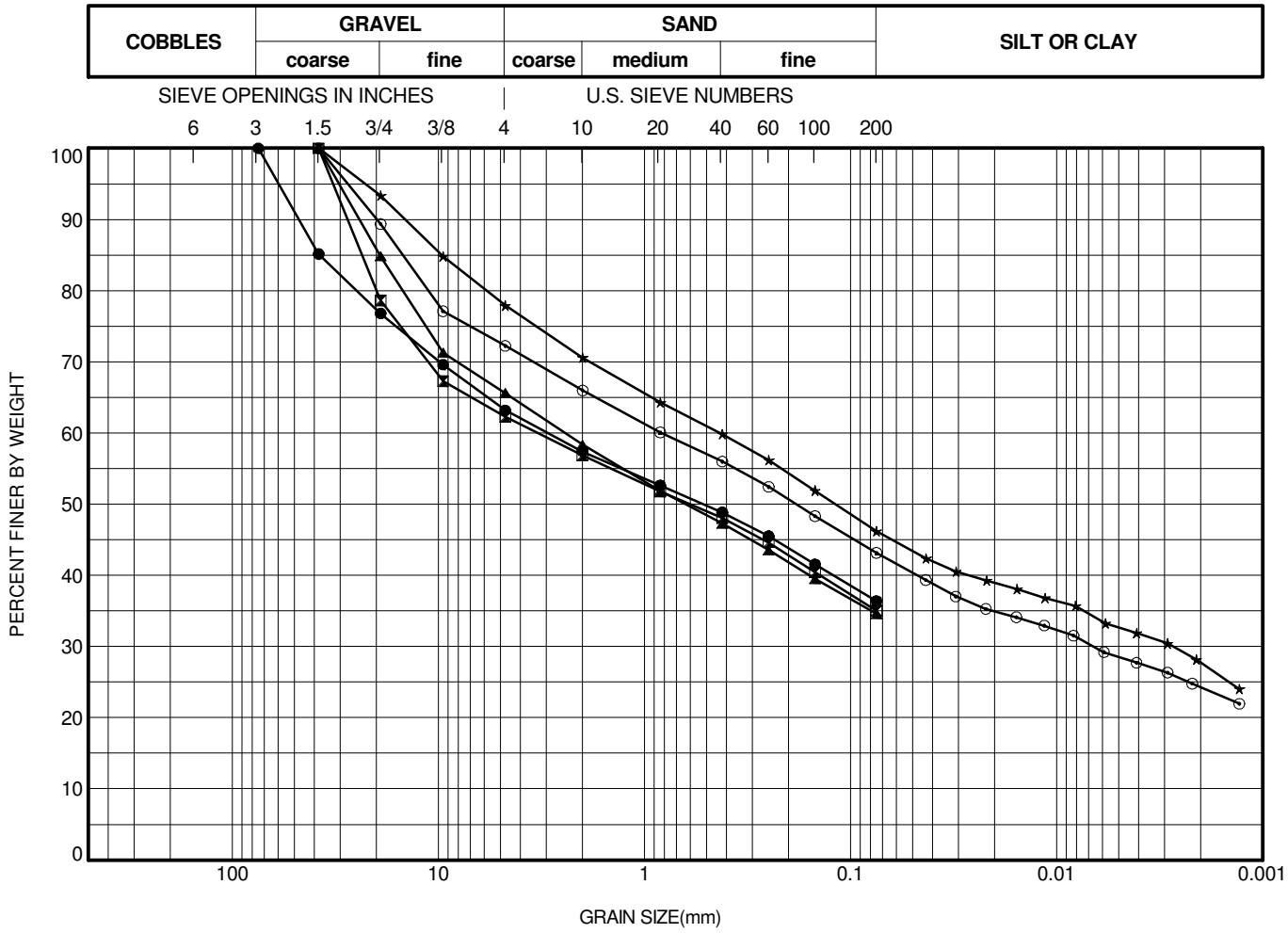
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB45	1.95	37.796	2.954	0.520				36.8	26.8	36.4
⧓	KC12OVB45	3.47	23.482	3.299	0.603				37.7	27.3	35.0
▲	KC12OVB45	4.99	19.260	2.434	0.635				34.4	31.0	34.6
★	KC12OVB45	6.51	9.669	0.430	0.119				22.1	31.7	46.2
⊙	KC12OVB45	8.03	14.916	0.830	0.185				27.8	29.1	43.1

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB45	LPT 1	1.95		29	15	14	
⧓	KC12OVB45	LPT 2	3.47		27	14	13	
▲	KC12OVB45	LPT 3	4.99		28	15	13	
★	KC12OVB45	LPT 4	6.51		29	15	13	
⊙	KC12OVB45	LPT 5	8.03		28	15	13	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

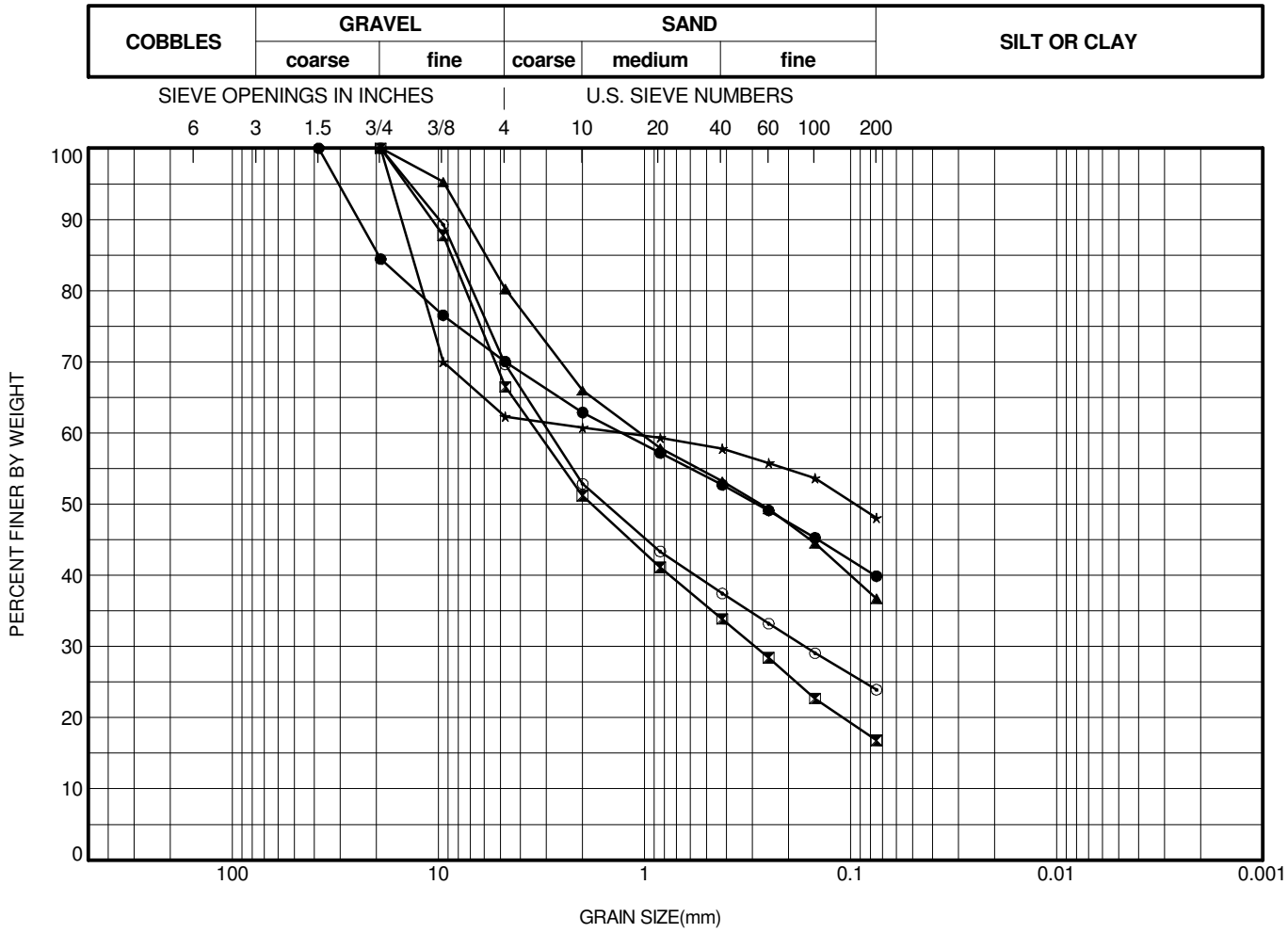
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB45	9.56	19.587	1.290	0.285				30.0	30.2	39.9
⊠	KC12OVB45	11.08	8.698	3.293	1.804				33.5	49.6	16.8
▲	KC12OVB45	14.13	5.921	1.057	0.274				19.8	43.5	36.7
★	KC12OVB45	15.65	13.489	1.268	0.095				37.7	14.2	48.1
⊙	KC12OVB46	2.05	8.184	2.890	1.543				30.3	45.7	23.9

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB45	LPT 6	9.56		25	14	11	
⊠	KC12OVB45	CUTTINGS 1	11.08		13	13	NP	
▲	KC12OVB45	CUTTINGS 2	14.13		14	13	1	
★	KC12OVB45	LPT 10	15.65					
⊙	KC12OVB46	GRAB 1	2.05		17	12	5	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

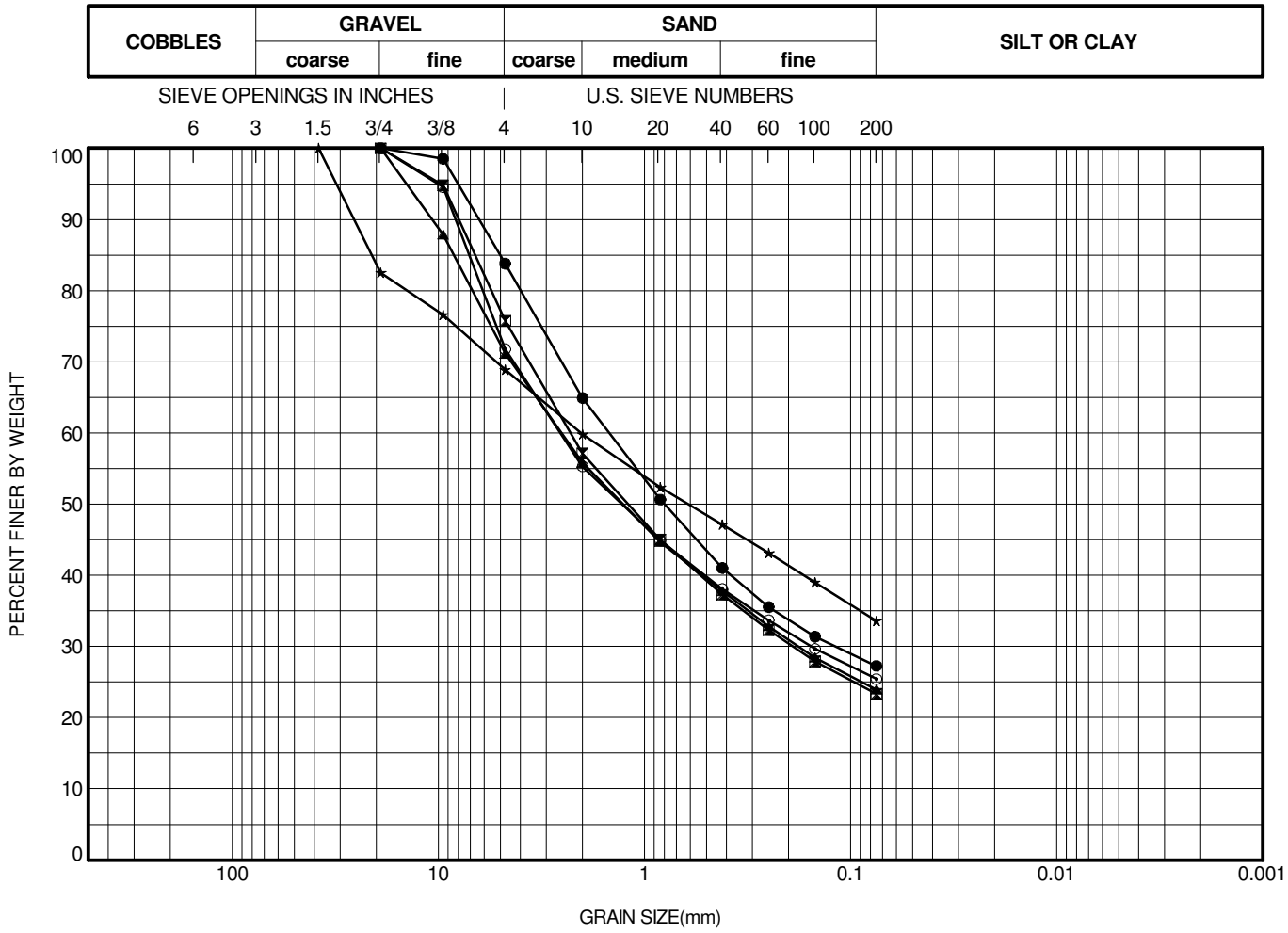
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB46	3.57	5.029	1.485	0.802				16.2	56.5	27.3
⊠	KC12OVB46	5.09	6.655	2.288	1.202				24.2	52.4	23.3
▲	KC12OVB46	6.61	8.447	2.534	1.271				28.9	47.2	24.0
★	KC12OVB46	8.13	21.064	2.034	0.615				31.1	35.3	33.6
⊙	KC12OVB46	8.14	7.118	2.562	1.285				28.2	46.3	25.4

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB46	GRAB 2	3.57		20	12	8	
⊠	KC12OVB46	GRAB 3	5.09		19	11	7	
▲	KC12OVB46	GRAB 4	6.61		19	12	7	
★	KC12OVB46	LPT 5	8.13		23	13	9	
⊙	KC12OVB46	GRAB 5	8.14		20	12	8	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

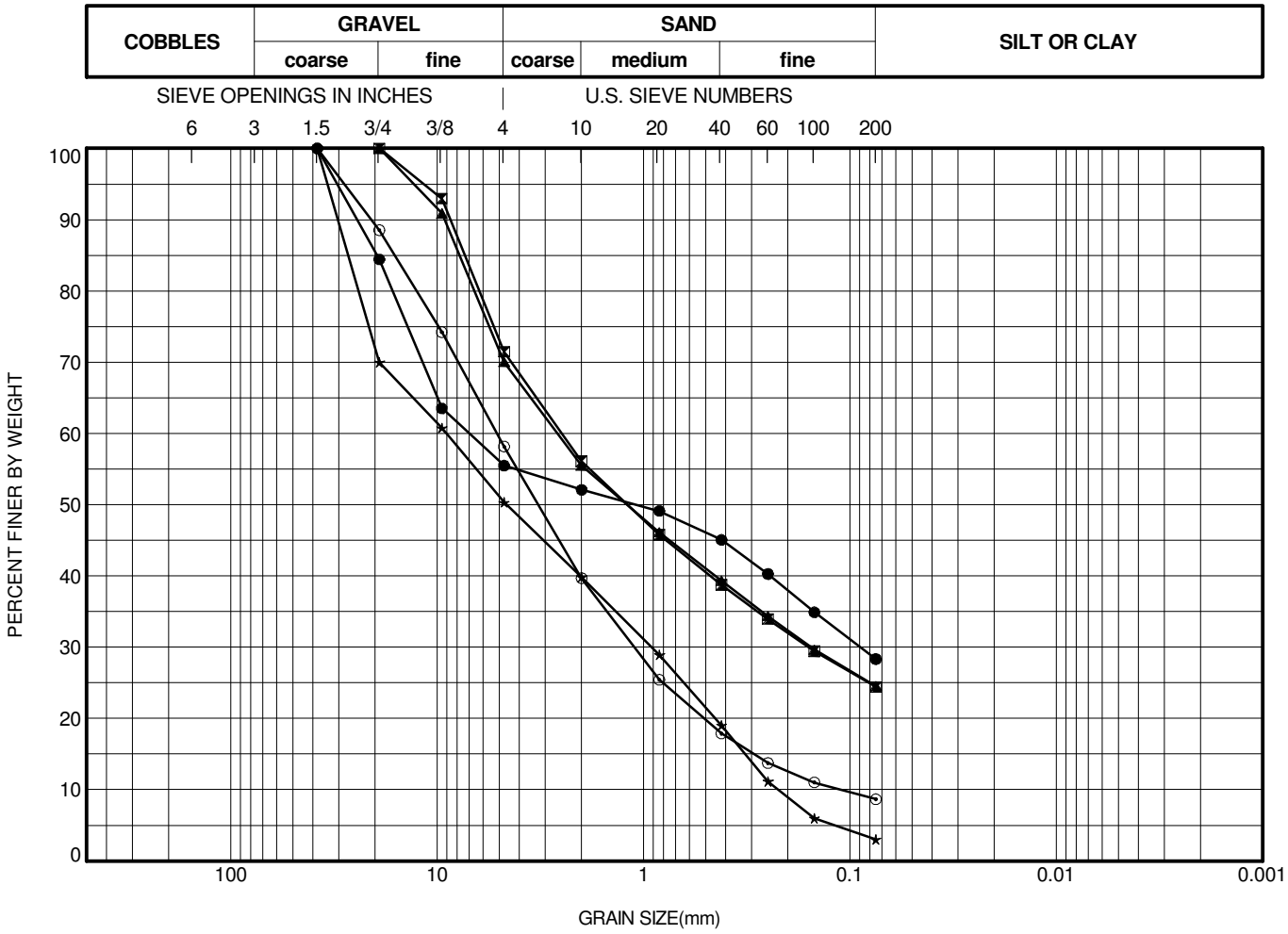
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB46	9.65	19.597	7.023	1.090				44.5	27.2	28.3
⊠	KC12OVB46	9.66	7.359	2.490	1.199				28.5	47.1	24.4
▲	KC12OVB46	11.17	7.826	2.618	1.202				30.0	45.5	24.5
★	KC12OVB46	15.73	27.026	9.053	4.634	0.322	0.223	40.649	49.7	47.3	3.0
⊙	KC12OVB47	1.98	16.088	5.145	3.243	0.293	0.111	46.332	41.8	49.5	8.7

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB46	LPT 6	9.65		21	13	7	
⊠	KC12OVB46	GRAB 6	9.66		19	12	7	
▲	KC12OVB46	GRAB 7	11.17		18	12	7	
★	KC12OVB46	LPT 8	15.73					
⊙	KC12OVB47	LPT 1	1.98		18	18	NP	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

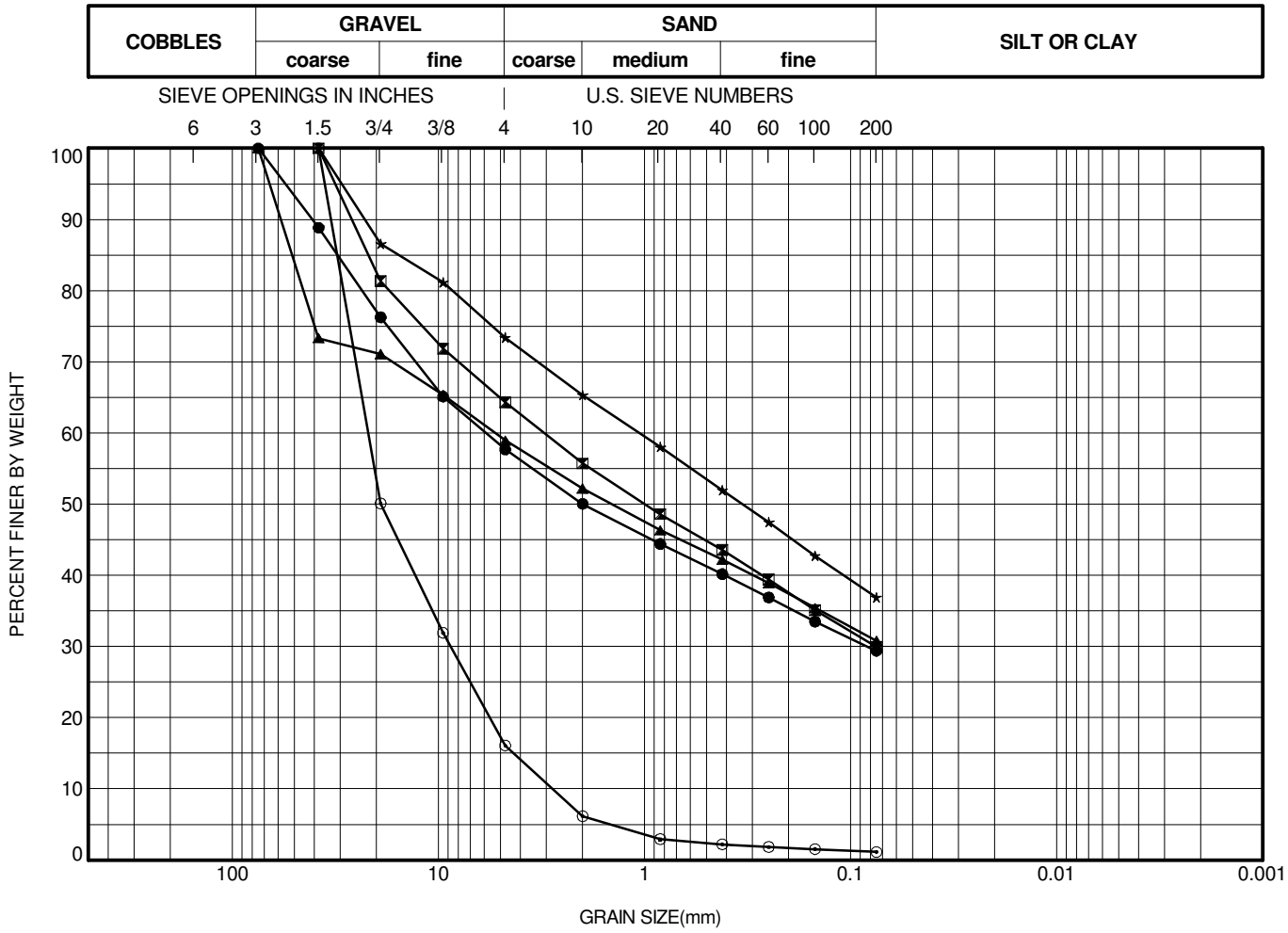
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB48	1.20	30.937	5.905	1.992				42.3	28.3	29.4
⊠	KC12OVB48	2.72	21.909	3.081	0.996				35.7	34.4	29.9
▲	KC12OVB48	4.24	51.327	5.319	1.447				41.0	28.2	30.8
★	KC12OVB48	5.76	15.649	1.064	0.336				26.6	36.5	36.9
⊙	KC12OVB49	1.82	31.015	21.916	19.027	4.324	2.797	7.835	83.9	15.0	1.1

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB48	LPT 1	1.20		23	13	10	
⊠	KC12OVB48	LPT 2	2.72		22	13	9	
▲	KC12OVB48	LPT 3	4.24		24	14	10	
★	KC12OVB48	LPT 4	5.76		23	13	9	
⊙	KC12OVB49	LPT 1	1.82					

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

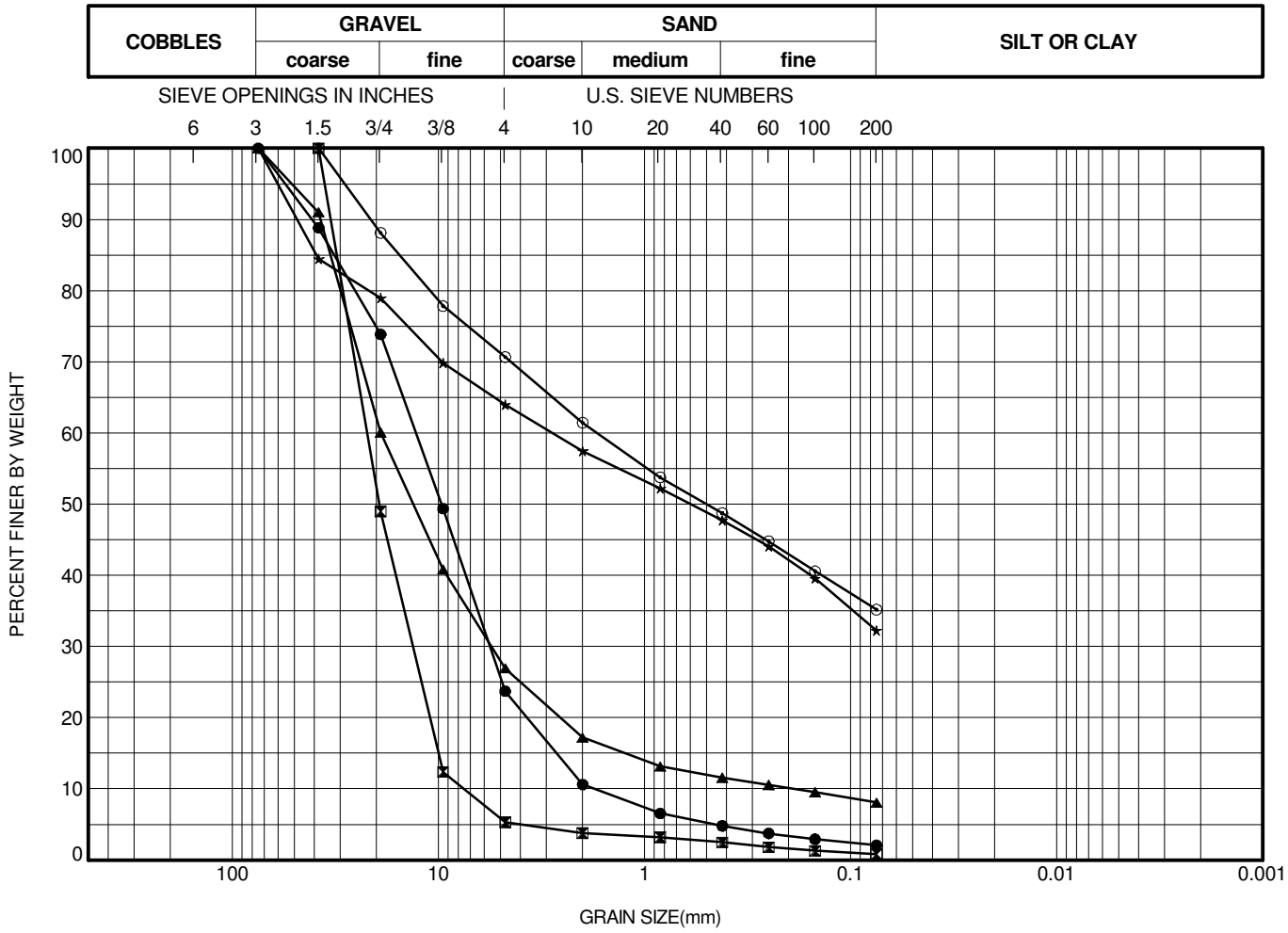
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB49	3.34	32.020	12.883	9.694	2.674	1.760	7.318	76.3	21.7	2.1
⊠	KC12OVB49	4.86	31.154	22.178	19.359	10.009	7.548	2.938	94.7	4.5	0.8
▲	KC12OVB49	6.38	33.395	19.041	13.269	1.250	0.189	100.578	73.1	18.8	8.1
★	KC12OVB49	12.46	39.120	2.798	0.596				36.0	31.7	32.3
⊙	KC12OVB49	13.98	15.472	1.699	0.501				29.3	35.5	35.2

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB49	LPT 2	3.34					
⊠	KC12OVB49	LPT 3	4.86					
▲	KC12OVB49	LPT 4	6.38					
★	KC12OVB49	LPT 8	12.46		25	13	12	
⊙	KC12OVB49	LPT 9	13.98		29	15	14	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

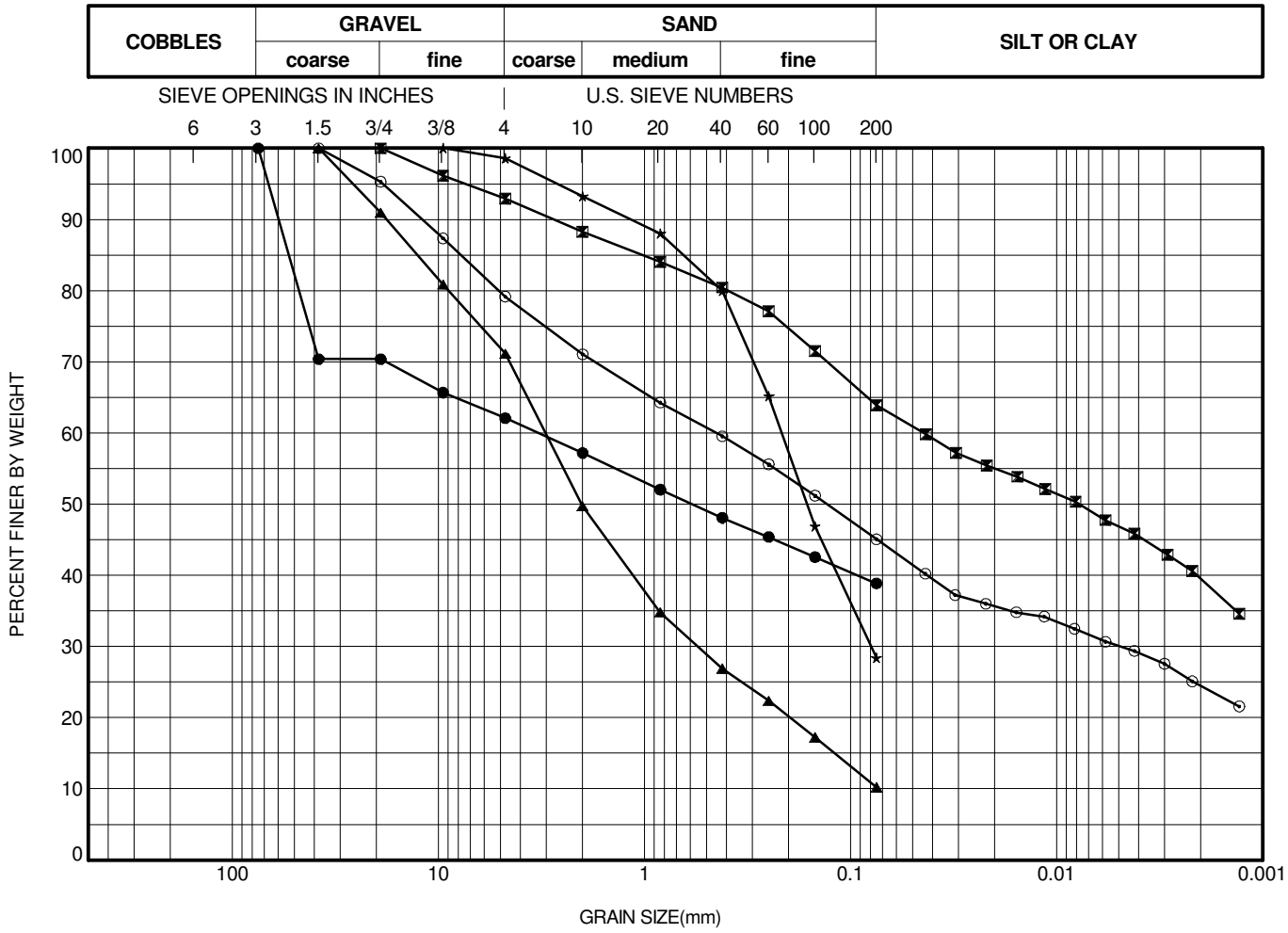
LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	KC12OVB49	17.02	53.300	3.288	0.589				37.9	23.2	38.8
⊠	KC12OVB49	20.06	1.019						7.0	29.1	63.9
▲	KC12OVB49	23.10	12.675	3.030	2.023	0.120		41.241	28.9	60.9	10.2
★	KC12OVB49	26.14	0.647	0.216	0.163				1.4	70.2	28.4
⊙	KC12OVB49	28.98	7.808	0.450	0.130				20.9	34.1	45.1

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	KC12OVB49	LPT 10	17.02		32	17	15	
⊠	KC12OVB49	LPT 11	20.06		31	16	16	
▲	KC12OVB49	LPT 12	23.10		14	14	NP	
★	KC12OVB49	LPT 13	26.14					
⊙	KC12OVB49	SA 1	28.98		26	14	12	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A04

PROJECT: KSM 2012 Prefeasibility Study

LOCATION: BC

FIGURE:

DRAWN BY: LC **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI KSM OCT 2012 T1253.GPJ SIEVE.GDT 11/1/12

VISUAL SOIL DESCRIPTION

(ASTM D2488)

Test Hole	Sample No.	Depth (m)	Group Symbol	Group Name	Soil Classification
KC12 - OVB 44	LPT 1	1.85 - 2.45	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, trace fine gravel, Some silt; Clayey; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), weak reaction to HCl.
KC12 - OVB 44	LPT 2	3.37 - 3.69	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Some gravel: trace coarse gravel, some fine gravel; Silty; Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), weak reaction to HCl.
KC12 - OVB 44	LPT 3	4.89 - 5.49	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Some gravel: trace coarse gravel, some fine gravel; Some silt; Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), weak reaction to HCl.
KC12 - OVB 44	LPT 4	6.41 - 7.01	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Clayey; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 44	LPT 5	7.93 - 8.53	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt, Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), no reaction to HCl.
KC12 - OVB 44	LPT 6	9.46 - 10.06	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Some gravel: trace coarse gravel, some fine gravel; Some silt; Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), no reaction to HCl.
KC12 - OVB 44	LPT 7	10.98 - 11.58	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, some fine gravel; Sandy: trace coarse sand, some medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), no reaction to HCl.
KC12 - OVB 44	LPT 8	14.03 - 14.63	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), weak reaction to HCl.
KC12 - OVB 44	LPT 9	17.08 - 17.68	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY, 4/1), no reaction to HCl.
KC12 - OVB 44	LPT 10	18.60 - 19.20	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, dark greenish grey (5GY 4/1), weak reaction to HCl.
KC12 - OVB 45	LPT 1	1.95 - 2.55	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, some fine gravel; Sandy: trace coarse sand, trace medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 45	LPT 2	3.47 - 3.82	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, some fine gravel; Sandy: trace coarse sand, trace medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), no reaction to HCl.
KC12 - OVB 45	LPT 3	4.99	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, some fine gravel; Sandy: trace coarse sand, some medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 45	LPT 4	6.51 - 6.66	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: trace coarse gravel, some fine gravel; Some silt; Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 45	LPT 5	8.03 - 8.18	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, trace medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), no reaction to HCl.
KC12 - OVB 45	LPT 6	9.56 - 9.76	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 45	LPT 10	15.65 - 15.68	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine; Some sand: trace coarse sand, trace medium sand, trace fine sand; Some silt; Clayey; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 45	CUTTING 1	11.08 - 12.61	**SM**	**SILTY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt (ML); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 45	CUTTING 2	14.13 - 15.65	**SM**	**SILTY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Some fine gravel; Silty; Trace clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are none to low plastic silt (ML); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.

Klohn Crippen Berger

JOB NO.:	M09480A04		Page 1 of 3
PROJECT:	KSM 2012 Prefeasibility Study		
LOCATION:	BC		
DATE:	Nov 1, 2012		
TESTED BY:	LC / BY	CHECKED BY:	JG

VISUAL SOIL DESCRIPTION

(ASTM D2488)

Test Hole	Sample No.	Depth (m)	Group Symbol	Group Name	Soil Classification
KC12 - OVB 46	GRAB 1	2.05 - 3.57	**SC-SM**	**SILTY, CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Trace clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic silt and clay (CL-ML); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 46	GRAB 2	3.57 - 5.09	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Some fine gravel; Some silt; Some clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10Y, 2.5/1), weak reaction to HCl.
KC12 - OVB 46	GRAB 3	5.09 - 6.61	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Some clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, black (N, 2.5/), weak reaction to HCl.
KC12 - OVB 46	GRAB 4	6.61 - 8.13	**SC-SM**	**SILTY, CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Trace clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic silt and clay (CL-ML); Moist, black (N, 2.5/), weak reaction to HCl.
KC12 - OVB 46	GRAB 5	8.13 - 9.65	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Some clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, black (N, 2.5/), weak reaction to HCl.
KC12 - OVB 46	GRAB 6	9.65 - 11.17	**SC-SM**	**SILTY, CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Some clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic silt and clay (CL-ML); Moist, greenish black (10BG, 2.5/1), weak reaction to HCl.
KC12 - OVB 46	GRAB 7	11.17 - 12.69	**SC-SM**	**SILTY, CLAYEY SAND with GRAVEL**	SAND, fine to coarse: some coarse sand, some medium sand, some fine sand; Gravelly: fine gravel; Some silt; Some clay; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic silt and clay (CL-ML); Moist, black (N, 2.5/), weak reaction to HCl.
KC12 - OVB 46	LPT 5	8.13 - 8.40	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Wet, black (N, 2.5/), weak reaction to HCl.
KC12 - OVB 46	LPT 6	9.65 - 9.78	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, fine gravelly; Sandy: trace coarse sand, trace medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, black (N, 2.5/), weak reaction to HCl.
KC12 - OVB 46	LPT 8	15.73 - 15.98	**GP**	**POORLY GRADED GRAVEL with SAND**	GRAVEL, fine to coarse: coarse gravelly, some fine gravel; And sand: some coarse sand, some medium sand, some fine sand; Trace silt; Poorly graded; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt; Wet, greenish black (10BG, 2.5/1), weak reaction to HCl.
KC12 - OVB 47	LPT 1	1.98 - 2.58	**SW-SM**	**WELL-GRADED SAND with SILT and GRAVEL**	SAND, fine to coarse: some fine sand, medium sandy, trace fine sand; And gravel: some coarse gravel, fine gravelly; Trace silt; Well-graded; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt (ML); Moist, dark brown (7.5YR, 3/2), no reaction to HCl.
KC12 - OVB 48	LPT 1	1.20 - 1.65	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: coarse gravelly, some fine gravel; Sandy: trace coarse sand, trace medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 48	LPT 2	2.72 - 3.17	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, some fine gravel; Sandy: trace coarse sand, some medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles re subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 48	LPT 3	4.24 - 4.86	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: coarse gravelly, some fine gravel; Sandy: trace coarse sand, trace medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 48	LPT 4	5.76 - 6.36	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist to wet, greenish black (10GY, 2.5/1), no reaction to HCl.

VISUAL SOIL DESCRIPTION

(ASTM D2488)

Test Hole	Sample No.	Depth (m)	Group Symbol	Group Name	Soil Classification
KC12 - OVB 49	LPT 1	1.82 - 2.22	**GW**	**WELL-GRADED GRAVEL**	GRAVEL, fine to coarse: and coarse gravel, fine gravelly; Some sand: trace coarse sand, trace medium sand, trace fine sand; Trace silt; Well-graded; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt (ML); Moist, dark brown (7.5YR, 3/2), no reaction to HCl.
KC12 - OVB 49	LPT 2	3.34 - 3.94	**GW**	**WELL-GRADED GRAVEL with SAND**	GRAVEL, fine to coarse: coarse gravelly, and fine gravel; Sandy: some coarse sand, trace medium sand, trace fine sand; Trace silt; Well-graded; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt (ML); Moist, dark brown (7.5YR, 3/2), no reaction to HCl.
KC12 - OVB 49	LPT 3	4.86 - 5.46	**GP**	**POORLY GRADED GRAVEL**	GRAVEL, fine to coarse: and coarse gravel, and fine gravel; Trace sand: trace coarse sand, trace medium sand, trace fine sand; Trace silt; Poorly graded; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt (ML); Moist, dark brown (7.5YR, 3/2), no reaction to HCl.
KC12 - OVB 49	LPT 4	6.38 - 6.72	**GP**	**POORLY GRADED GRAVEL with SAND**	GRAVEL, fine to coarse: coarse gravelly, fine gravelly; Some sand: trace coarse sand, trace medium sand, trace fine sand; Trace silt; Trace clay; Poorly graded; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are none to low plastic silt (ML); Moist to wet, dark brown (7.5YR, 3/2), no reaction to HCl.
KC12 - OVB 49	LPT 8	12.46 - 12.76	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: some coarse gravel, some fine gravel; Sandy: trace coarse sand, trace medium sand, some fine sand; Some silt; Some clay; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist to wet, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 49	LPT 9	13.98 - 14.38	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: some coarse gravel, some fine gravel; Some silt; Some clay; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist to wet, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 49	LPT 10	17.02 - 17.62	**GC**	**CLAYEY GRAVEL with SAND**	GRAVEL, fine to coarse: coarse gravelly, some fine gravel; Sandy: trace coarse sand, trace medium sand, trace fine sand; Some silt; Some clay; Maximum particle size is less than 75 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are medium plastic clay (CI); Moist to wet, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 49	LPT 11	20.06 - 20.60	**CL**	**SANDY LEAN CLAY**	CLAY: Trace fine gravel; Sandy: trace coarse sand, trace medium sand, some fine sand; Silty; Maximum particle size is less than 19 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are medium plastic clay (CI); Moist, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 49	LPT 12	23.10 - 23.35	**SW-SM**	**WELL-GRADED SAND with SILT and GRAVEL**	SAND, fine to coarse: coarse sandy, medium sandy, some fine sand; Gravelly: trace coarse gravel, some fine gravel; Some silt; Well-graded; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are nonplastic silt (ML); Wet, greenish black (10GY, 2.5/1), no reaction to HCl.
KC12 - OVB 49	LPT 13	26.14 - 26.65	**SM**	**SILTY SAND**	SAND, fine to coarse: trace coarse sand, some medium sand, and fine sand; Trace fine gravel; Silty; Maximum particle size is less than 9.5 mm; Coarse particles are subrounded and sub-angular. Fines are nonplastic silt (ML); Moist, black (N, 2.5/), no reaction to HCl.
KC12 - OVB 49	SA 1	28.98 - 29.55	**SC**	**CLAYEY SAND with GRAVEL**	SAND, fine to coarse: trace coarse sand, some medium sand, some fine sand; Gravelly: trace coarse gravel, some fine gravel; Silty; Clayey; Maximum particle size is less than 38 mm; Coarse particles are subrounded and sub-angular, trace flat particles, trace elongated particles. Fines are low plastic clay (CL); Moist, stiff to very stiff, greenish black (10GY, 2.5/1), weak reaction to HCl.

Klohn Crippen Berger

JOB NO.:	M09480A03		Page 3 of 3
PROJECT:	KSM 2011		
LOCATION:	Northwestern BC		
DATE:	Sep 20, 2011		
TESTED BY:	LN / BY	CHECKED BY:	JG

Unconfined Compression Test

Hole Number	Sample Number	Depth (m)	Length (L) (mm)	Diameter (D) (mm)	L / D Ratio	Area (mm^2)	Volume (cm^3)	Weight (g)	Bulk Density (g / cm^3)	Max. load at failure (N)	Axial Strain at failure (%)	Compressive Stress (MPa)	Failure Type *	Notes
KC12 - 64	UCS1	8.70 - 8.90	101.41	44.65	2.27	1565.79	158.78	423.40	2.667	80957.6	0.26	**51.70**	1, 2	
KC12 - OVB46	UCS1	25.71 - 26.32	102.30	44.83	2.28	1578.44	161.48	438.60	2.716	128998.4	0.77	**81.73**	2	
KC12 - OVB47	UCS1	15.08 - 15.45	98.51	44.78	2.20	1574.92	155.14	417.92	2.694	282462.1	0.49	**179.35**	2	
KC12 - OVB48	UCS1	11.90 - 12.37	102.65	44.60	2.30	1562.28	160.36	433.63	2.704	202394.1	0.51	**129.55**	5	
KC12 - OVB49	UCS1	41.19 - 41.45	99.75	44.61	2.24	1562.98	155.91	423.11	2.714	146791.3	0.95	**93.92**	5	

***Failure Type:** 1. Diagonal fracture 2. Vertical fracture 3. Shear along foliation or joint 4. conical 5. Completely broken, can't tell fracture type

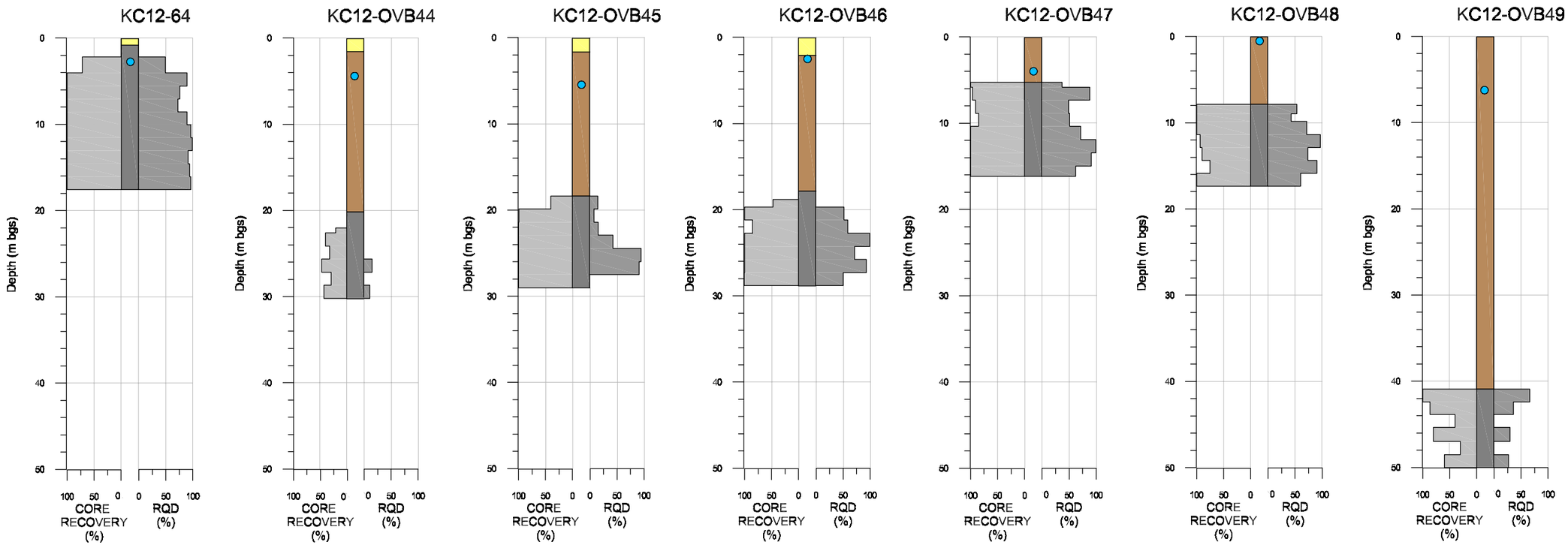
Test Photos

	KC12-64 / UCS1	KC12-OVB46 / UCS1	KC12-OVB47 / UCS1	KC12-OVB48 / UCS1	KC12-OVB49 / UCS1
Before test					
After test					

Klohn Crippen Berger	JOB NO.:	M09480A04	Page 1 of 1
	PROJECT:	KSM	
	LOCATION:	BC	
	DATE:	Oct 24, 2012	
	TESTED BY:	BY	CHECKED BY: JG

APPENDIX IV

Data Plots – Geological Logs



LEGEND

Lithology

- Alluvium
- Till
- Bowser Lake Group

RQD and Core Recovery

- RQD
- Core Recovery

Water Level Measurments

- Water Level

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED DEC, 2012

SCALE NTS

CLIENT: SEABRIDGE GOLD

Klohn Crippen Berger

PROJECT: KSM PROJECT
2012 TMF SITE INVESTIGATION REPORT

TITLE: TMF BOREHOLE SUMMARY LOGS

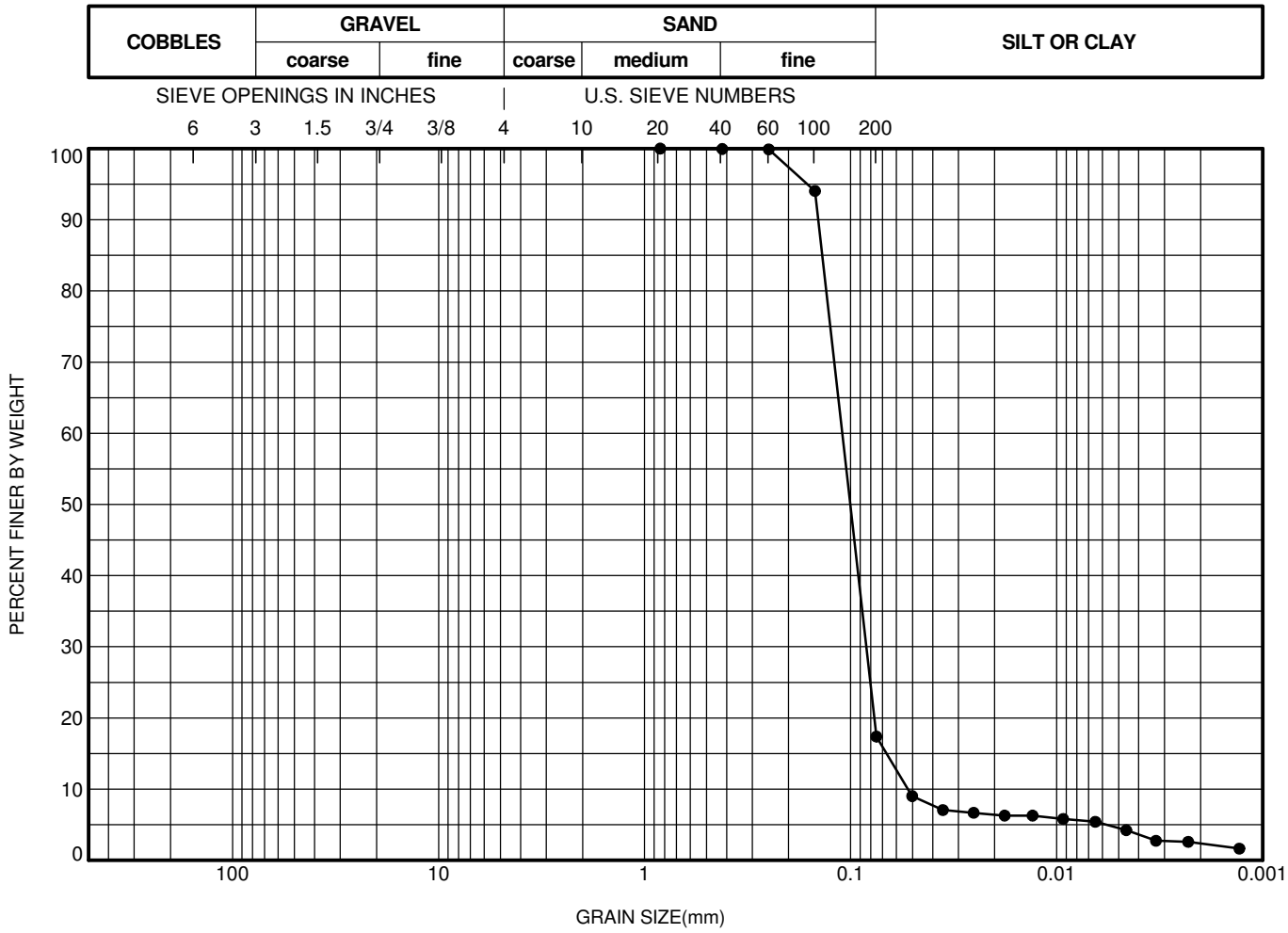
PROJECT No. M09480A04

FIG. No. IV-1

KCB-R-MLD

Time: 08:34:20
Date: 12/18/2012
Scale: 1:2.5849(PS)
Drawing File: Z:\M\VCR\M09480A04 - KSM 2012 PFS\400 Drawings\MINESITE\DRAFTB\FIG_rB TMF Borehole Summary Logs.dwg (dhu)
Xref File(s):
Image File(s): Seabridge_Gold_RGB-1line

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	Tailings	0.10	0.137	0.110	0.100				0.0	82.6	17.4

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Tailings	Coarse Tailings	0.10					Tailing, sand portion w/ 17.4% fines

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A01

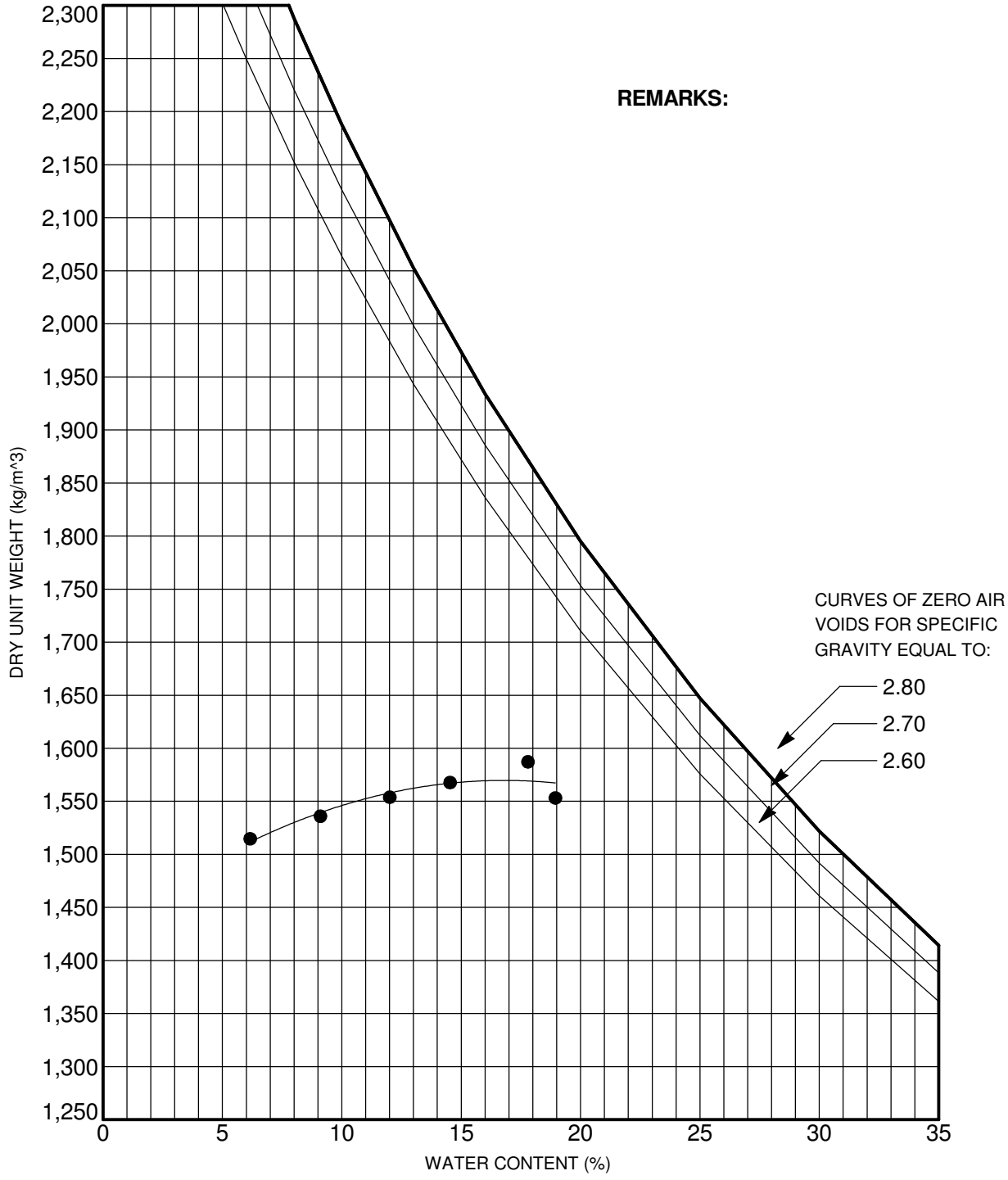
PROJECT: Seabridge Kerr Sulphurets

LOCATION: B.C.

FIGURE:

DRAWN BY: AC **CHECKED BY:** BY

MOISTURE - DENSITY RELATIONSHIP



REMARKS:

	TEST	DEPTH(m)	METHOD	OWC	MDW	MATERIAL DESCRIPTION
●	Tailings	0.1	698A	17.0	1580.0	Tailing, sand portion w/ 17.4% fines

OWC = Optimum Water Content (%) MDW = Maximum dry Unit Weight (kg/m^3)

Klohn Crippen Berger

PROJECT NO.: M09480A01

PROJECT: Seabridge Kerr Sulphurets

LOCATION: B.C.

FIGURE:

DRAWN BY: AC **CHECKED BY:** BY

KCB_COMPACTION_TEST-SI M09480A01_KSM TAILINGS.GPJ 1/15/10

Klohn Crippen Berger

Constant Head Permeability Test

PROJECT NO. :	M09480A01	**PROJECT :**	Seabridge Kerr Sulphurets
LOCATION:	Northwestern, BC	**DATE :**	14-Sep-09
TEST BY:	BY	**CHECKED BY:**	JG

Sample No.: Tailing - Pilot Plant Composite 1, sand w/ 17% fines
Description: Fine sand, some silt, yellowish brown
Method of Preparation: Mixed at 17% water content, hand tamping in 3" mold, 7 layers, dry density 1.58 g/cm^3

Sample Dimensions:

Diameter (D):	7.662 cm	Area (A):	46.108 cm^2
Length (L):	13.790 cm	Volume (V):	635.828 cm^3

Mass of sample:

Mould + sample:	2594.04 g	Sample:	1177.07 g
Mould:	1416.97 g		

Sample initial water content and density:

Bulk density:	1.851 g/cm^3	Water content:	17.00 %
Dry density:	1.582 g/cm^3		

Test Temperature : 1 22 ℃
Coef. of Permeability (k_T): 2.79E-05 cm/sec

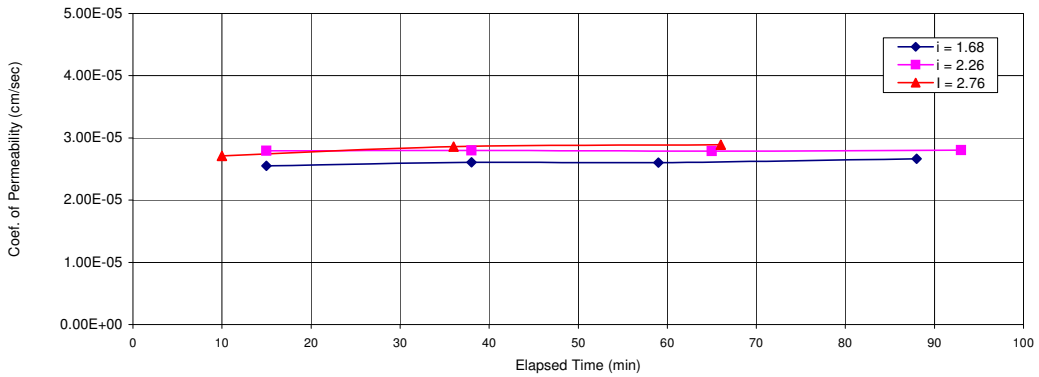
Coef. of Permeability (k_{20}) at 20 ℃: **2.65E-05 cm/sec**

Gradient 1 (**i = 1.68**)								
Determination No.:			1	2	3	4	5	6
Elapsed Time		minutes	15	38	59	88		
Quantity of Discharge	Q	cm^3	2.79	2.43	2.18	4.96		
Specimen Full Length	L	cm	13.79	13.79	13.79	13.79		
Area of Specimen *	A	cm^2	46.11	46.11	46.11	46.11		
Time of Discharge	t	sec	1410	1200	1080	2400		
Constant Head	H	cm	23.2	23.2	23.2	23.2		
Discharge Rate	Q/t	cm^3/sec	0.002	0.002	0.002	0.002		
Turbidity			Clear	Clear	Clear	Clear		
Coef. of Permeability	k=QL/AtH	cm/sec	2.55E-05	2.61E-05	2.60E-05	2.66E-05		

Gradient 2 (**i =2.26**)								
Determination No.:			1	2	3	4		
Elapsed Time		minutes	15	38	65	93		
Quantity of Discharge	Q	cm^3	4.36	3.32	6.09	3.15		
Specimen Full Length	L	cm	13.79	13.79	13.79	13.79		
Area of Specimen *	A	cm^2	46.11	46.11	46.11	46.11		
Time of Discharge	t	sec	1500	1140	2100	1080		
Constant Head	H	cm	31.1	31.1	31.1	31.1		
Discharge Rate	Q/t	cm^3/sec	0.003	0.003	0.003	0.003		
Turbidity			Clear	Clear	Clear	Clear		
Coef. of Permeability	k=QL/AtH	cm/sec	2.80E-05	2.80E-05	2.79E-05	2.80E-05		

Gradient 2 (**i =2.76**)								
Determination No.:			1	2	3	4	5	6
Elapsed Time		minutes	10	36	66			
Quantity of Discharge	Q	cm^3	3.72	6.98	6.17			
Specimen Full Length	L	cm	13.79	13.79	13.79			
Area of Specimen *	A	cm^2	46.11	46.11	46.11			
Time of Discharge	t	sec	1080	1920	1680			
Constant Head	H	cm	38	38	38			
Discharge Rate	Q/t	cm^3/sec	0.003	0.004	0.004			
Turbidity			Clear	Clear	Clear			
Coef. of Permeability	k=QL/AtH	cm/sec	2.71E-05	2.86E-05	2.89E-05			

Turbidity Scale: Dark, Moderately Dark, Slightly Dark, Barely Visible, Clear, Completely Clear



SPECIFIC GRAVITY OF SOIL SOLIDS (ASTM-D854)

Sample No.		Pilot Plant Composite 1					
Flask No.		KL2	KL3	KL4			
Volume of Flask @ 20° C	ml	500	500	500			
Method of Air removal		Boiling	Boiling	Boiling			
De-airing Period	hr	2	2	2			
Test temperature	° C	21.2	21.2	21.2			
Mass of Flask+Water (M_a)	g	675.69	676.10	678.74			
Mass of Flask+Water+Soil (M_b)	g	713.32	713.99	716.18			
Mass of Dish/Flask+Soil		236.26	236.90	238.94			
Mass of Dish/Flask		177.17	177.46	180.10			
Mass of Dry Soil (M_o)	g	59.09	59.44	58.84			
Correction factor (K) @ Test Temperature		0.9998	0.9998	0.9998			
Specific Gravity of Solids @ 20° C		2.753	2.758	2.749			
Average Specific Gravity of Solids @ 20° C		2.751					

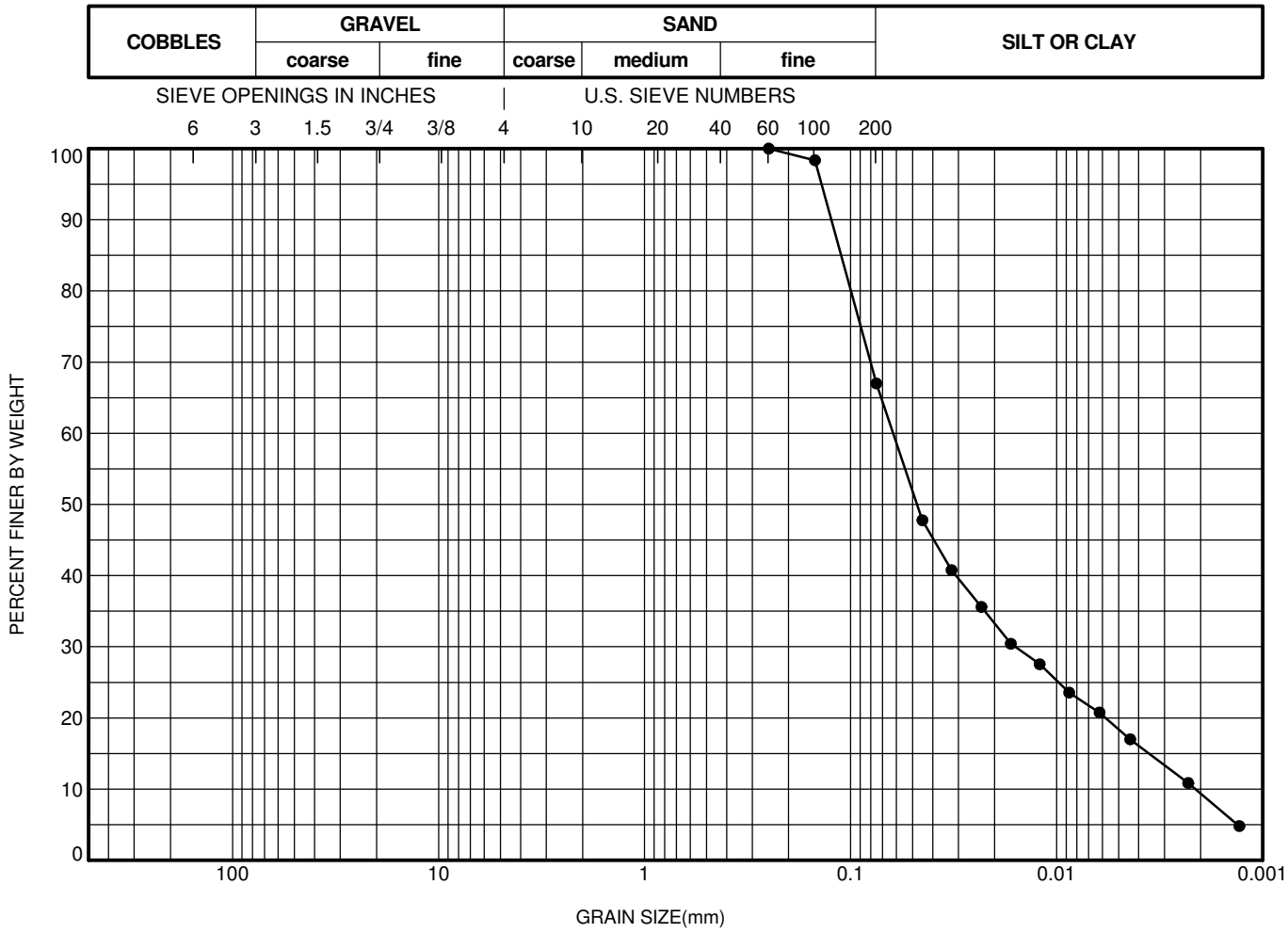
Sample No.							
Flask No.							
Volume of Flask @ 20° C	ml						
Method of Air removal							
De-airing Period	hr						
Test temperature	° C						
Mass of Flask+Water (M_a)	g						
Mass of Flask+Water+Soil (M_b)	g						
Mass of Dish/Flask+Soil							
Mass of Dish/Flask							
Mass of Dry Soil (M_o)	g						
Correction factor (K) @ Test Temperature							
Specific Gravity of Solids @ 20° C							
Average Specific Gravity of Solids @ 20° C							

Specific Gravity of Solids @ 20° C = $(K \times M_o)/(M_o + M_a - M_b)$

Klohn Crippen Berger

JOB NO.:	M09480A01	
PROJECT:	Seabridge Kerr Sulphurets	
LOCATION:	BC	
DATE:	9-Aug-08	
TESTED BY:	BY	CHECKED BY JG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	Tailings	0.00	0.111						0.0	33.0	67.0

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Tailings	Composite 1	0.00					Pilot Plant Composite 1

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

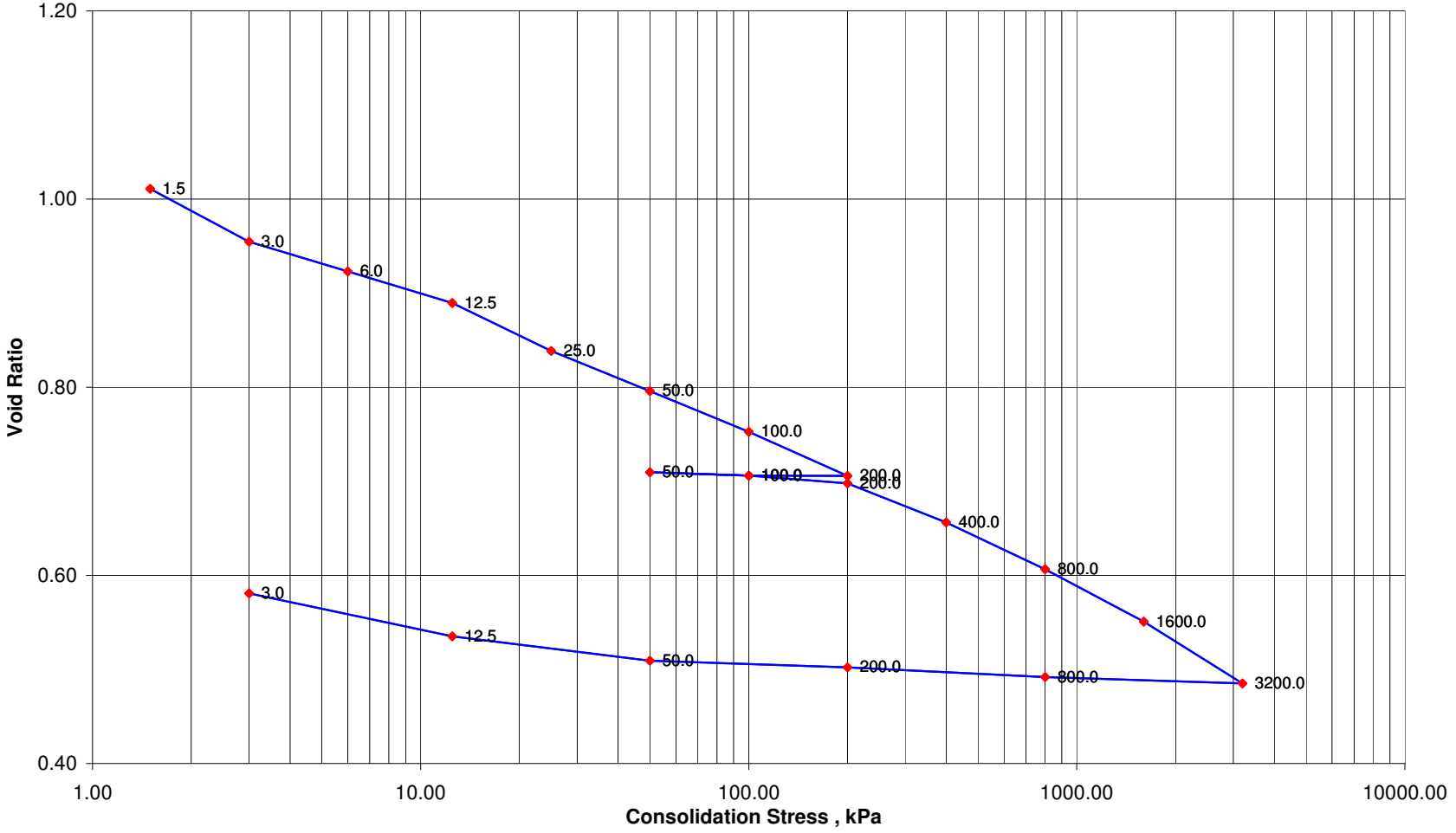
Klohn Crippen Berger

PROJECT NO.: M09480A01
PROJECT: Seabridge Kerr Sulphurets
LOCATION: B.C.
FIGURE:
DRAWN BY: AC **CHECKED BY:** BY

KCB_GRAIN_SIZE-SI M09480A01_KSM TAILINGS.GPJ SIEVE.GDT 1/15/10

Consolidation Test #1

e - log(p)



Klohn Crippen Berger

PROJECT NO.:	M09480A01		
PROJECT:	Seabridge Kerr Sulphurets		
LOCATION:	BC	DATE TESTED:	Aug 7 to Aug 17, 2009
SAMPLE NO.:	Tailings - Pilot Plant Composite 1	DEPTH:	
TESTED BY:	BY	CHECKED BY:	JG

CONSOLIDATION

PROJECT NO.: M09480A01
PROJECT: Seabridge Kerr Sulphurets
SAMPLE NO.: Tailings - Pilot Plant Composite 1
DEPTH:
TEST NO.: Consolidation Test #1
LOADING MACHINE NO.: TX-ID65

Initial water content : 47.55 % (based on final dry weight)
Final water content : 20.90 % (based on sample at end of test)

Initial Specimen Height (mm): 25.60
Height of Solid (mm): 11.067 (dry mass = 96.24 g, Specimen area =3160.9 mm^2, SG=2.751)
Initial void ratio: 1.313
Void Ratio Factor 0.0904

* Calibration to be done after test
** Estimated t_{50}

Pressure (kPa)		Change in Height	Final	Change in	Change in	Void	t_{50}**	Cv	Mv	k	Cc
From	To	Corrected (mm)	Height (mm)	Void Ratio	Void Ratio Acc	Ratio	(min)	(cm^2/sec)	(cm^2/N)	(cm/sec)	
0.0	**1.5**	3.340	22.259	0.3018	0.3018	**1.011**					
1.5	**3.0**	0.623	21.636	0.0563	0.3581	**0.955**	1.80	2.2E-03	1.9E-01	4.1E-06	**0.180**
3.0	**6.0**	0.349	21.287	0.0315	0.3896	**0.923**	1.80	2.1E-03	1.1E-01	2.2E-06	**0.105**
6.0	**12.5**	0.371	20.916	0.0335	0.4231	**0.890**	0.40	9.1E-03	5.8E-02	5.2E-06	**0.105**
12.5	**25.0**	0.563	20.352	0.0509	0.4741	**0.839**	0.27	1.3E-02	4.1E-02	5.3E-06	**0.169**
25.0	**50.0**	0.475	19.877	0.0429	0.5169	**0.796**	0.19	1.7E-02	1.9E-02	3.2E-06	**0.142**
50.0	**100.0**	0.479	19.399	0.0432	0.5602	**0.753**	0.12	2.6E-02	9.6E-03	2.5E-06	**0.144**
100.0	**200.0**	0.518	18.881	0.0468	0.6070	**0.706**	0.09	3.4E-02	5.3E-03	1.8E-06	**0.156**
200.0	**100.0**	-0.002	18.882	-0.0001	0.6069	**0.706**					
100.0	**50.0**	-0.041	18.923	-0.0037	0.6032	**0.710**					
50.0	**100.0**	0.041	18.882	0.0037	0.6069	**0.706**					
100.0	**200.0**	0.089	18.793	0.0080	0.6149	**0.698**	0.04	7.9E-02	9.4E-04	7.3E-07	**0.027**
200.0	**400.0**	0.461	18.332	0.0417	0.6566	**0.656**	0.06	4.9E-02	2.5E-03	1.2E-06	**0.138**
400.0	**800.0**	0.551	17.781	0.0498	0.7064	**0.606**	0.05	5.7E-02	1.5E-03	8.4E-07	**0.165**
800.0	**1600.0**	0.615	17.166	0.0556	0.7620	**0.551**	0.04	6.6E-02	8.7E-04	5.6E-07	**0.185**
1600.0	**3200.0**	0.725	16.440	0.0656	0.8275	**0.485**	0.03	7.5E-02	5.3E-04	3.9E-07	**0.218**
3200.0	**800.0**	-0.073	16.513	-0.0066	0.8210	**0.492**					
800.0	**200.0**	-0.114	16.627	-0.0103	0.8106	**0.502**					
200.0	**50.0**	-0.079	16.707	-0.0072	0.8035	**0.509**					
50.0	**12.5**	-0.287	16.993	-0.0259	0.7775	**0.535**					
12.5	**3.0**	-0.507	17.500	-0.0458	0.7318	**0.581**					

Klohn Crippen Berger

PROJECT NO.:	M09480A01		
PROJECT:	Seabridge Kerr Sulphurets		
LOCATION:	BC	DATE TESTED:	Aug 7 to Aug 17, 2009
SAMPLE NO.:	Tailings - Pilot Plant Composite 1	DEPTH:	
TESTED BY:	BY	CHECKED BY:	JG

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	M-2000
Beaker Tare (g)	530.97
Proposed Solid Content (%)	30
Supernatant Density (g/cm^3)	1
Start Date	9-Aug-09
Start Time	5:16 PM
Temperature	22 °C

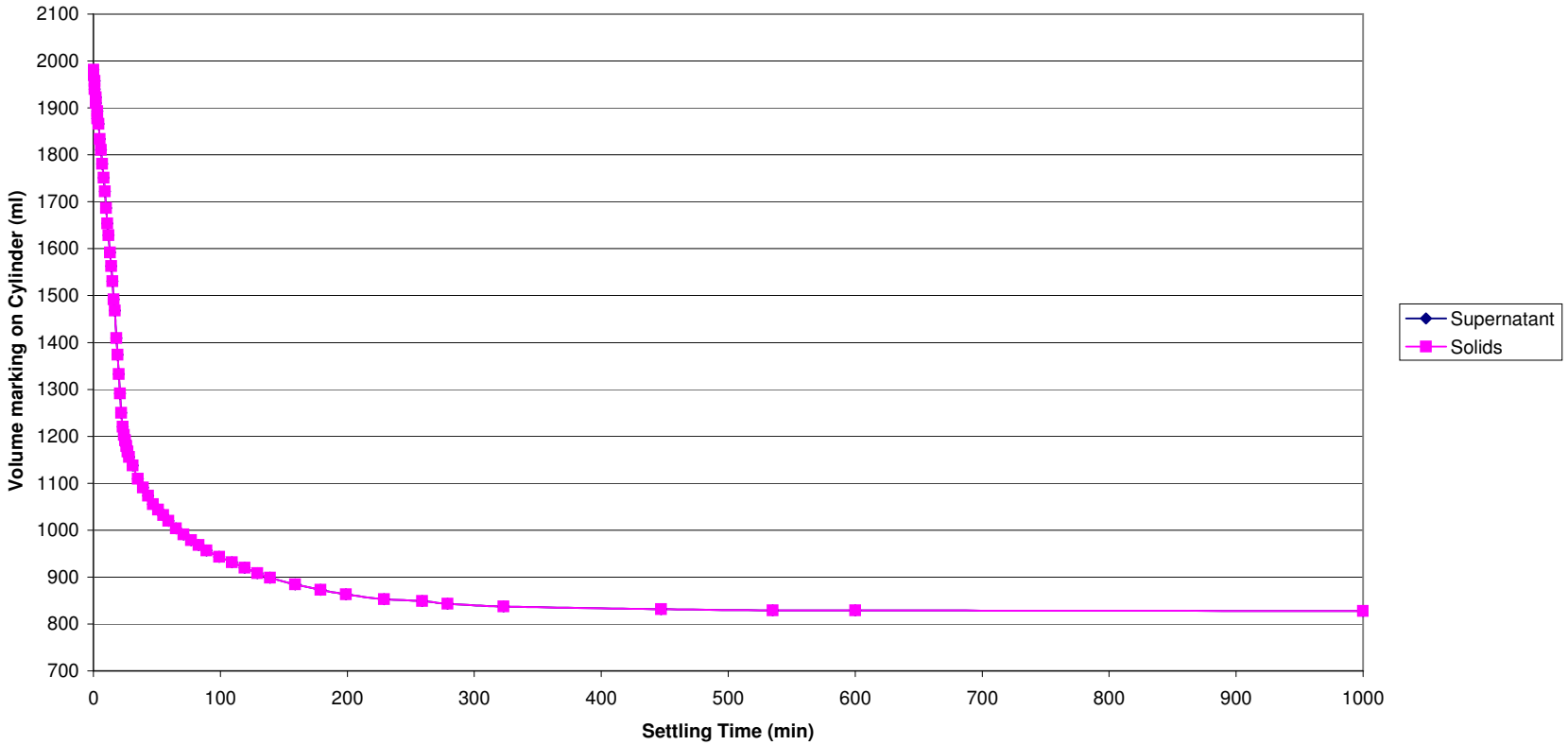
Initial Weight + Tare (g)	3000.98	Final Weight + Tare (g)	2997.4
Intial Dry weight (g)	770.64	Final Dry weight (g)	770.64
Initial Solid Volume (cm^3)	1981	Final Solid Volume (cm^3)	828
Initial Solid Content (%)	31.2	Final Solid Content (%)	58.5
Initial Water Content (%)	220.5	Final Water Content (%)	70.8
Initial Dry Density (g/cm^3)	0.39	Final Dry Density (g/cm^3)	0.93
Initial Wet Density (g/cm^3)	1.25	Final Wet Density (g/cm^3)	1.59

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant Readings	Top Solids Readings	Top Settlement Readings	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	22.0	231.5	231.5	231.5	0.00	0.00	1981.36	1981.36	1.25	0.39	220.51	31.20
0.5		231.5	230.5	230.5	1.00	11.80	1969.56	1969.56	1.25	0.39	218.98	31.35
1		231.5	229.5	229.5	2.00	23.59	1957.77	1957.77	1.25	0.39	217.45	31.50
1.5		231.5	228.0	228.0	3.50	41.28	1940.07	1940.07	1.25	0.40	215.16	31.73
2		231.5	226.5	226.5	5.00	58.98	1922.38	1922.38	1.25	0.40	212.86	31.96
2.5		231.5	225.5	225.5	6.00	70.77	1910.59	1910.59	1.26	0.40	211.33	32.12
3		231.5	224.0	224.0	7.50	88.46	1892.89	1892.89	1.26	0.41	209.03	32.36
3.5		231.5	222.7	222.7	8.80	103.80	1877.56	1877.56	1.26	0.41	207.05	32.57
4		231.5	221.7	221.7	9.80	115.59	1865.76	1865.76	1.26	0.41	205.51	32.73
5		231.5	219.0	219.0	12.50	147.44	1833.92	1833.92	1.27	0.42	201.38	33.18
6		231.5	217.0	217.0	14.50	171.03	1810.33	1810.33	1.27	0.43	198.32	33.52
7		231.5	214.5	214.5	17.00	200.52	1780.84	1780.84	1.27	0.43	194.49	33.96
8		231.5	212.0	212.0	19.50	230.01	1751.35	1751.35	1.28	0.44	190.67	34.40
9		231.5	209.5	209.5	22.00	259.50	1721.86	1721.86	1.28	0.45	186.84	34.86
10		231.5	206.5	206.5	25.00	294.88	1686.48	1686.48	1.29	0.46	182.25	35.43
11		231.5	203.7	203.7	27.80	327.91	1653.45	1653.45	1.30	0.47	177.96	35.98
12		231.5	201.6	201.6	29.90	352.68	1628.68	1628.68	1.30	0.47	174.75	36.40
13		231.5	198.5	198.5	33.00	389.24	1592.11	1592.11	1.31	0.48	170.01	37.04
14		231.5	196.0	196.0	35.50	418.73	1562.63	1562.63	1.31	0.49	166.18	37.57
15		231.5	193.3	193.3	38.20	450.58	1530.78	1530.78	1.32	0.50	162.05	38.16
16		231.5	190.0	190.0	41.50	489.50	1491.86	1491.86	1.33	0.52	157.00	38.91
17		231.5	188.0	188.0	43.50	513.09	1468.26	1468.26	1.33	0.52	153.93	39.38
18.5		231.5	183.0	183.0	48.50	572.07	1409.29	1409.29	1.35	0.55	146.28	40.60
19.5		231.5	180.0	180.0	51.50	607.45	1373.90	1373.90	1.36	0.56	141.69	41.38
20.5		231.5	176.5	176.5	55.00	648.74	1332.62	1332.62	1.37	0.58	136.33	42.31
21.5		231.5	173.0	173.0	58.50	690.02	1291.34	1291.34	1.38	0.60	130.98	43.29
22.5		231.5	169.5	169.5	62.00	731.30	1250.05	1250.05	1.39	0.62	125.62	44.32
23.5		231.5	167.0	167.0	64.50	760.79	1220.56	1220.56	1.40	0.63	121.79	45.09
24.5		231.5	165.5	165.5	66.00	778.49	1202.87	1202.87	1.41	0.64	119.50	45.56
25.5		231.5	164.5	164.5	67.00	790.28	1191.08	1191.08	1.41	0.65	117.97	45.88
26.5		231.5	163.5	163.5	68.00	802.08	1179.28	1179.28	1.41	0.65	116.43	46.20
27.5		231.5	162.5	162.5	69.00	813.87	1167.49	1167.49	1.42	0.66	114.90	46.53
28.5		231.5	161.5	161.5	70.00	825.67	1155.69	1155.69	1.42	0.67	113.37	46.87
31		231.5	160.0	160.0	71.50	843.36	1138.00	1138.00	1.43	0.68	111.08	47.38
35		231.5	157.6	157.6	73.90	871.67	1109.69	1109.69	1.44	0.69	107.40	48.21
39		231.5	156.0	156.0	75.50	890.54	1090.82	1090.82	1.45	0.71	104.96	48.79
43		231.5	154.5	154.5	77.00	908.23	1073.12	1073.12	1.46	0.72	102.66	49.34
47		231.5	153.0	153.0	78.50	925.93	1055.43	1055.43	1.46	0.73	100.36	49.91
51		231.5	152.0	152.0	79.50	937.72	1043.64	1043.64	1.47	0.74	98.83	50.29
55		231.5	151.0	151.0	80.50	949.52	1031.84	1031.84	1.47	0.75	97.30	50.68
59		231.5	150.0	150.0	81.50	961.31	1020.05	1020.05	1.48	0.76	95.77	51.08
65		231.5	148.6	148.6	82.90	977.82	1003.53	1003.53	1.49	0.77	93.63	51.65
71		231.5	147.5	147.5	84.00	990.80	990.56	990.56	1.49	0.78	91.95	52.10
77		231.5	146.5	146.5	85.00	1002.59	978.76	978.76	1.50	0.79	90.42	52.52
83		231.5	145.6	145.6	85.90	1013.21	968.15	968.15	1.50	0.80	89.04	52.90
89		231.5	144.6	144.6	86.90	1025.01	956.35	956.35	1.51	0.81	87.51	53.33
99		231.5	143.5	143.5	88.00	1037.98	943.38	943.38	1.52	0.82	85.82	53.81
109		231.5	142.5	142.5	89.00	1049.78	931.58	931.58	1.52	0.83	84.29	54.26
119		231.5	141.5	141.5	90.00	1061.57	919.79	919.79	1.53	0.84	82.76	54.72
129		231.5	140.5	140.5	91.00	1073.37	907.99	907.99	1.54	0.85	81.23	55.18
139		231.5	139.7	139.7	91.80	1082.80	898.55	898.55	1.54	0.86	80.01	55.55
159		231.5	138.5	138.5	93.00	1096.96	884.40	884.40	1.55	0.87	78.17	56.13
179		231.5	137.5	137.5	94.00	1108.75	872.61	872.61	1.56	0.88	76.64	56.61
199		231.5	136.7	136.7	94.80	1118.19	863.17	863.17	1.57	0.89	75.42	57.01
229		231.5	135.8	135.8	95.70	1128.80	852.55	852.55	1.57	0.90	74.04	57.46
259		231.5	135.5	135.5	96.00	1132.34	849.01	849.01	1.58	0.91	73.58	57.61
279		231.5	135.0	135.0	96.50	1138.24	843.12	843.12	1.58	0.91	72.81	57.87
323		231.5	134.5	134.5	97.00	1144.14	837.22	837.22	1.58	0.92	72.05	58.12
447		231.5	134.0	134.0	97.50	1150.04	831.32	831.32	1.59	0.93	71.28	58.38
535		231.5	133.8	133.8	97.70	1152.39	828.96	828.96	1.59	0.93	70.98	58.49
600		231.5	133.8	133.8	97.70	1152.39	828.96	828.96	1.59	0.93	70.98	58.49
1000		231.5	133.7	133.7	97.80	1153.57	827.78	827.78	1.59	0.93	70.82	58.54
1440		231.5	133.7	133.7	97.80	1153.57	827.78	827.78	1.59	0.93	70.82	58.54
2880		231.5	133.7	133.7	97.80	1153.57	827.78	827.78	1.59	0.93	70.82	58.54

Klohn Crippen Berger

JOB NO.:	M09480A01			DATE	24-Aug-09
PROJECT:	Seabridge Kerr Sulphurets			LOCATION:	BC
DETAIL:	30% solid content				
DESCRIPTION:	Rougher Tailings with Process water				
TESTED BY:	BY	CHECKED BY:	JG	SHEET	1 of 2

Settling Test for Tailings @ 30% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	24-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	30% solid content			
	DESCRIPTION:	Rougher Tailings with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET	2 of 2

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	M-2000
Beaker Tare (g)	530.97
Proposed Solid Content (%)	40
Supernatant Density (g/cm^3)	1
Start Date	6-Aug-09
Start Time	3:10 PM
Temperature	22 °C

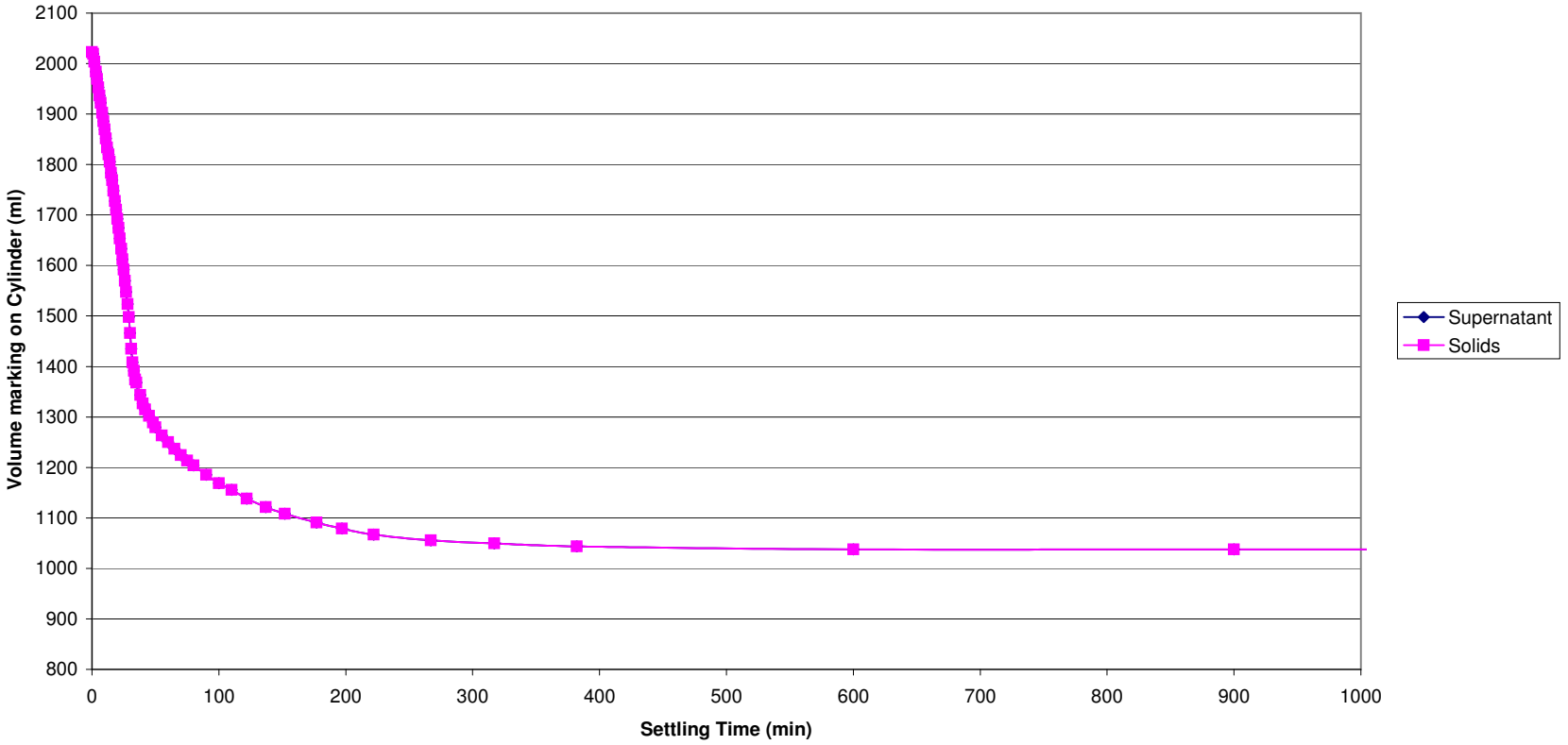
Initial Weight + Tare (g)	3233.04	Final Weight + Tare (g)	3233.0
Intial Dry weight (g)	1066.78	Final Dry weight (g)	1066.78
Initial Solid Volume (cm^3)	2023	Final Solid Volume (cm^3)	1032
Initial Solid Content (%)	39.5	Final Solid Content (%)	62.3
Initial Water Content (%)	153.3	Final Water Content (%)	60.4
Initial Dry Density (g/cm^3)	0.53	Final Dry Density (g/cm^3)	1.03
Initial Wet Density (g/cm^3)	1.34	Final Wet Density (g/cm^3)	1.66

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant Readings	Top Solids Readings	Top Settlement Readings	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	22.0	235.0	235.0	235.0	0.00	0.00	2022.64	2022.64	1.34	0.53	153.29	39.48
1		235.0	234.7	234.7	0.30	3.54	2019.10	2019.10	1.34	0.53	152.96	39.53
2		235.0	233.4	233.4	1.60	18.87	2003.77	2003.77	1.34	0.53	151.52	39.76
3		235.0	231.7	231.7	3.30	38.92	1983.72	1983.72	1.34	0.54	149.64	40.06
4		235.0	230.5	230.5	4.50	53.08	1969.56	1969.56	1.34	0.54	148.32	40.27
5		235.0	229.1	229.1	5.90	69.59	1953.05	1953.05	1.35	0.55	146.77	40.52
6		235.0	227.7	227.7	7.30	86.11	1936.54	1936.54	1.35	0.55	145.22	40.78
7		235.0	226.5	226.5	8.50	100.26	1922.38	1922.38	1.35	0.55	143.89	41.00
8		235.0	224.8	224.8	10.20	120.31	1902.33	1902.33	1.36	0.56	142.01	41.32
9		235.0	223.4	223.4	11.60	136.82	1885.82	1885.82	1.36	0.57	140.47	41.59
10		235.0	222.0	222.0	13.00	153.34	1869.30	1869.30	1.36	0.57	138.92	41.86
11		235.0	220.5	220.5	14.50	171.03	1851.61	1851.61	1.37	0.58	137.26	42.15
12		235.0	219.0	219.0	16.00	188.72	1833.92	1833.92	1.37	0.58	135.60	42.44
13		235.0	217.8	217.8	17.20	202.88	1819.76	1819.76	1.37	0.59	134.27	42.68
14		235.0	216.6	216.6	18.40	217.03	1805.61	1805.61	1.38	0.59	132.95	42.93
15		235.0	214.7	214.7	20.30	239.44	1783.20	1783.20	1.38	0.60	130.85	43.32
16		235.0	213.5	213.5	21.50	253.60	1769.04	1769.04	1.38	0.60	129.52	43.57
17		235.0	211.7	211.7	23.30	274.83	1747.81	1747.81	1.39	0.61	127.53	43.95
18		235.0	210.0	210.0	25.00	294.88	1727.76	1727.76	1.39	0.62	125.65	44.32
19		235.0	208.5	208.5	26.50	312.57	1710.07	1710.07	1.40	0.62	123.99	44.64
20		235.0	207.0	207.0	28.00	330.27	1692.37	1692.37	1.40	0.63	122.33	44.98
21		235.0	205.5	205.5	29.50	347.96	1674.68	1674.68	1.41	0.64	120.67	45.32
22		235.0	203.7	203.7	31.30	369.19	1653.45	1653.45	1.41	0.65	118.68	45.73
23		235.0	202.0	202.0	33.00	389.24	1633.40	1633.40	1.42	0.65	116.80	46.12
24		235.0	200.2	200.2	34.80	410.47	1612.17	1612.17	1.42	0.66	114.81	46.55
25		235.0	198.5	198.5	36.50	430.53	1592.11	1592.11	1.43	0.67	112.93	46.96
26		235.0	196.6	196.6	38.40	452.94	1569.70	1569.70	1.43	0.68	110.83	47.43
27		235.0	194.7	194.7	40.30	475.35	1547.29	1547.29	1.44	0.69	108.73	47.91
28		235.0	192.7	192.7	42.30	498.94	1523.70	1523.70	1.45	0.70	106.52	48.42
29		235.0	190.5	190.5	44.50	524.89	1497.75	1497.75	1.45	0.71	104.09	49.00
30		235.0	187.8	187.8	47.20	556.74	1465.91	1465.91	1.46	0.73	101.10	49.73
31		235.0	185.2	185.2	49.80	587.40	1435.24	1435.24	1.47	0.74	98.23	50.45
32		235.0	182.9	182.9	52.10	614.53	1408.11	1408.11	1.48	0.76	95.69	51.10
33		235.0	181.5	181.5	53.50	631.05	1391.60	1391.60	1.49	0.77	94.14	51.51
34		235.0	180.0	180.0	55.00	648.74	1373.90	1373.90	1.49	0.78	92.48	51.95
35		235.0	179.5	179.5	55.50	654.64	1368.01	1368.01	1.50	0.78	91.93	52.10
38		235.0	177.4	177.4	57.60	679.41	1343.24	1343.24	1.51	0.79	89.60	52.74
40		235.0	176.0	176.0	59.00	695.92	1326.72	1326.72	1.51	0.80	88.06	53.18
42		235.0	175.0	175.0	60.00	707.71	1314.93	1314.93	1.52	0.81	86.95	53.49
45		235.0	173.9	173.9	61.10	720.69	1301.95	1301.95	1.52	0.82	85.73	53.84
48		235.0	172.8	172.8	62.20	733.66	1288.98	1288.98	1.53	0.83	84.52	54.20
50		235.0	172.0	172.0	63.00	743.10	1279.54	1279.54	1.53	0.83	83.63	54.46
55		235.0	170.6	170.6	64.40	759.61	1263.03	1263.03	1.54	0.84	82.09	54.92
60		235.0	169.5	169.5	65.50	772.59	1250.05	1250.05	1.54	0.85	80.87	55.29
65		235.0	168.4	168.4	66.60	785.56	1237.08	1237.08	1.55	0.86	79.65	55.66
70		235.0	167.3	167.3	67.70	798.54	1224.10	1224.10	1.56	0.87	78.44	56.04
75		235.0	166.4	166.4	68.60	809.15	1213.49	1213.49	1.56	0.88	77.44	56.36
80		235.0	165.6	165.6	69.40	818.59	1204.05	1204.05	1.56	0.89	76.56	56.64
90		235.0	164.0	164.0	71.00	837.46	1185.18	1185.18	1.57	0.90	74.79	57.21
100		235.0	162.6	162.6	72.40	853.97	1168.67	1168.67	1.58	0.91	73.24	57.72
110		235.0	161.5	161.5	73.50	866.95	1155.69	1155.69	1.59	0.92	72.02	58.13
122		235.0	160.0	160.0	75.00	884.64	1138.00	1138.00	1.60	0.94	70.37	58.70
137		235.0	158.6	158.6	76.40	901.16	1121.48	1121.48	1.61	0.95	68.82	59.24
152		235.0	157.5	157.5	77.50	914.13	1108.51	1108.51	1.61	0.96	67.60	59.67
177		235.0	156.0	156.0	79.00	931.82	1090.82	1090.82	1.62	0.98	65.94	60.26
197		235.0	155.0	155.0	80.00	943.62	1079.02	1079.02	1.63	0.99	64.84	60.67
222		235.0	154.0	154.0	81.00	955.41	1067.23	1067.23	1.64	1.00	63.73	61.08
267		235.0	153.0	153.0	82.00	967.21	1055.43	1055.43	1.64	1.01	62.63	61.49
317		235.0	152.5	152.5	82.50	973.11	1049.53	1049.53	1.65	1.02	62.07	61.70
382		235.0	152.0	152.0	83.00	979.00	1043.64	1043.64	1.65	1.02	61.52	61.91
600		235.0	151.5	151.5	83.50	984.90	1037.74	1037.74	1.65	1.03	60.97	62.12
900		235.0	151.5	151.5	83.50	984.90	1037.74	1037.74	1.65	1.03	60.97	62.12
1440		235.0	151.5	151.5	83.50	984.90	1037.74	1037.74	1.65	1.03	60.97	62.12
2880		235.0	151.0	151.0	84.00	990.80	1031.84	1031.84	1.66	1.03	60.41	62.34

Klohn Crippen Berger

JOB NO.:	M09480A01			DATE	6-Aug-09
PROJECT:	Seabridge Kerr Sulphurets			LOCATION:	BC
DETAIL:	40% solid content				
DESCRIPTION:	Rougher Tailings with Process water				
TESTED BY:	BY	CHECKED BY:	JG	SHEET	1 of 2

Settling Test for Tailings @ 40% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	6-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	40% solid content			
	DESCRIPTION:	Rougher Tailings with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET	2 of 2

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	M-2000
Beaker Tare (g)	530.97
Proposed Solid Content (%)	50
Supernatant Density (g/cm^3)	1
Start Date	4-Aug-09
Start Time	4:00 PM
Temperature	23 °C

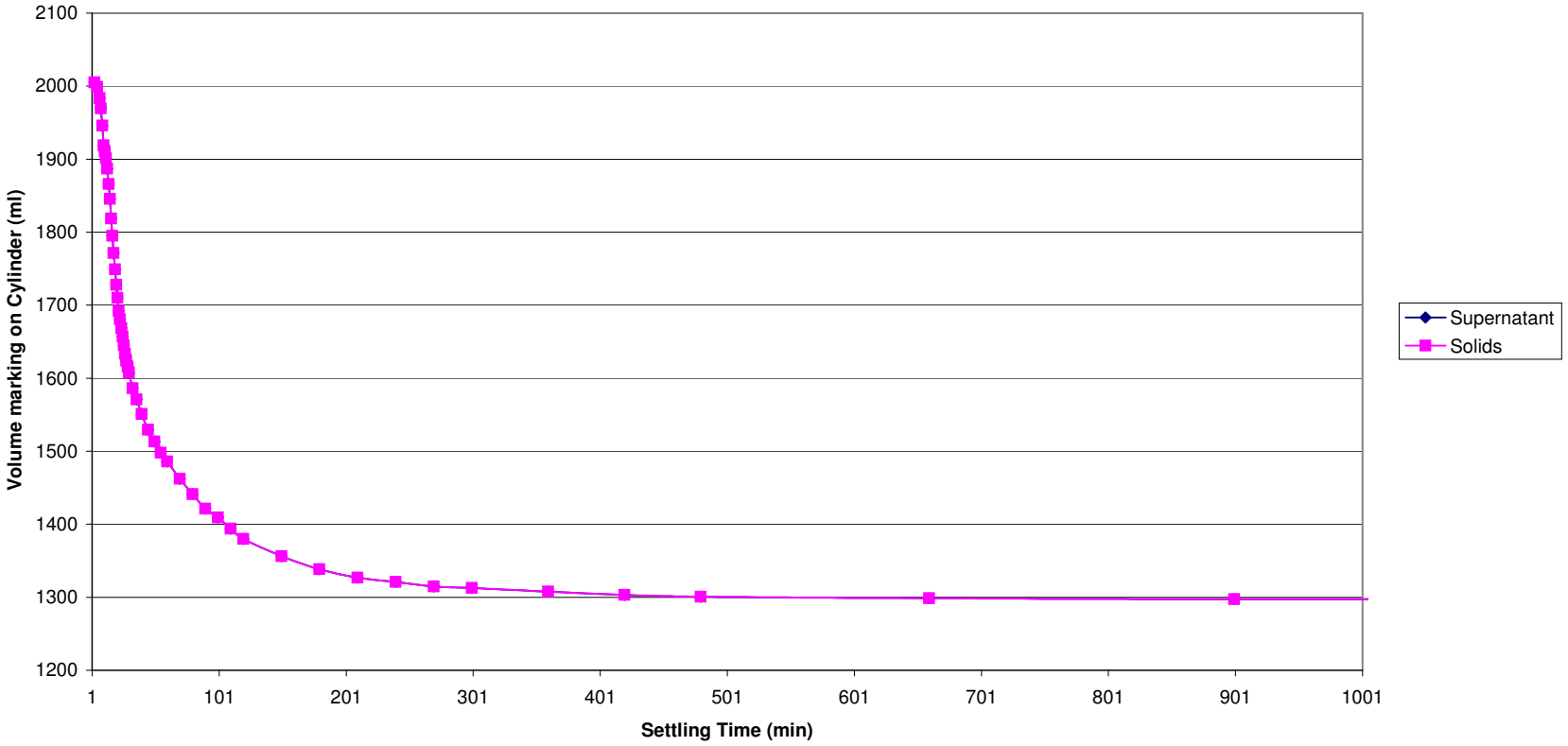
Initial Weight + Tare (g)	3450.42	Final Weight + Tare (g)	3446.8
Intial Dry weight (g)	1459.73	Final Dry weight (g)	1459.73
Initial Solid Volume (cm^3)	2005	Final Solid Volume (cm^3)	1297
Initial Solid Content (%)	50.0	Final Solid Content (%)	66.0
Initial Water Content (%)	100.0	Final Water Content (%)	51.5
Initial Dry Density (g/cm^3)	0.73	Final Dry Density (g/cm^3)	1.13
Initial Wet Density (g/cm^3)	1.46	Final Wet Density (g/cm^3)	1.70

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant Readings	Top Solids Readings	Top Settlement Readings	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	23.0	233.5	233.5	233.5	0.00	0.00	2004.95	2004.95	1.46	0.73	100.00	50.00
3		233.5	233.5	233.5	0.00	0.00	2004.95	2004.95	1.46	0.73	100.00	50.00
5		233.5	233.0	233.0	0.50	5.90	1999.05	1999.05	1.46	0.73	99.60	50.10
7		233.5	231.7	231.7	1.80	21.23	1983.72	1983.72	1.46	0.74	98.54	50.37
8		233.5	230.5	230.5	3.00	35.39	1969.56	1969.56	1.46	0.74	97.58	50.61
9		233.5	228.5	228.5	5.00	58.98	1945.97	1945.97	1.47	0.75	95.96	51.03
10		233.5	226.2	226.2	7.30	86.11	1918.84	1918.84	1.48	0.76	94.10	51.52
11		233.5	225.5	225.5	8.00	94.36	1910.59	1910.59	1.48	0.76	93.53	51.67
12		233.5	224.7	224.7	8.80	103.80	1901.15	1901.15	1.48	0.77	92.89	51.84
13		233.5	223.5	223.5	10.00	117.95	1887.00	1887.00	1.48	0.77	91.92	52.11
14		233.5	221.7	221.7	11.80	139.18	1865.76	1865.76	1.49	0.78	90.46	52.50
15		233.5	220.0	220.0	13.50	159.24	1845.71	1845.71	1.50	0.79	89.09	52.88
16		233.5	217.7	217.7	15.80	186.36	1818.58	1818.58	1.50	0.80	87.23	53.41
17		233.5	215.7	215.7	17.80	209.96	1794.99	1794.99	1.51	0.81	85.62	53.87
18		233.5	213.7	213.7	19.80	233.55	1771.40	1771.40	1.52	0.82	84.00	54.35
19		233.5	211.8	211.8	21.70	255.96	1748.99	1748.99	1.52	0.83	82.46	54.81
20		233.5	210.0	210.0	23.50	277.19	1727.76	1727.76	1.53	0.84	81.01	55.25
21		233.5	208.5	208.5	25.00	294.88	1710.07	1710.07	1.53	0.85	79.80	55.62
22		233.5	207.0	207.0	26.50	312.57	1692.37	1692.37	1.54	0.86	78.59	56.00
23		233.5	206.0	206.0	27.50	324.37	1680.58	1680.58	1.54	0.87	77.78	56.25
24		233.5	205.0	205.0	28.50	336.16	1668.78	1668.78	1.55	0.87	76.97	56.51
25		233.5	204.0	204.0	29.50	347.96	1656.99	1656.99	1.55	0.88	76.16	56.77
26		233.5	203.0	203.0	30.50	359.75	1645.19	1645.19	1.56	0.89	75.35	57.03
27		233.5	202.0	202.0	31.50	371.55	1633.40	1633.40	1.56	0.89	74.55	57.29
28		233.5	201.2	201.2	32.30	380.99	1623.96	1623.96	1.56	0.90	73.90	57.50
29		233.5	200.5	200.5	33.00	389.24	1615.71	1615.71	1.57	0.90	73.33	57.69
30		233.5	199.8	199.8	33.70	397.50	1607.45	1607.45	1.57	0.91	72.77	57.88
33		233.5	198.0	198.0	35.50	418.73	1586.22	1586.22	1.58	0.92	71.31	58.37
36		233.5	196.7	196.7	36.80	434.06	1570.88	1570.88	1.58	0.93	70.26	58.73
40		233.5	195.0	195.0	38.50	454.12	1550.83	1550.83	1.59	0.94	68.89	59.21
45		233.5	193.2	193.2	40.30	475.35	1529.60	1529.60	1.60	0.95	67.44	59.72
50		233.5	191.8	191.8	41.70	491.86	1513.09	1513.09	1.60	0.96	66.30	60.13
55		233.5	190.5	190.5	43.00	507.20	1497.75	1497.75	1.61	0.97	65.25	60.51
60		233.5	189.5	189.5	44.00	518.99	1485.96	1485.96	1.62	0.98	64.45	60.81
70		233.5	187.5	187.5	46.00	542.58	1462.37	1462.37	1.63	1.00	62.83	61.41
80		233.5	185.7	185.7	47.80	563.81	1441.14	1441.14	1.63	1.01	61.37	61.97
90		233.5	184.0	184.0	49.50	583.86	1421.08	1421.08	1.64	1.03	60.00	62.50
100		233.5	183.0	183.0	50.50	595.66	1409.29	1409.29	1.65	1.04	59.19	62.82
110		233.5	181.7	181.7	51.80	610.99	1393.95	1393.95	1.66	1.05	58.14	63.23
120		233.5	180.5	180.5	53.00	625.15	1379.80	1379.80	1.66	1.06	57.17	63.62
150		233.5	178.5	178.5	55.00	648.74	1356.21	1356.21	1.67	1.08	55.56	64.29
180		233.5	177.0	177.0	56.50	666.43	1338.52	1338.52	1.68	1.09	54.34	64.79
210		233.5	176.0	176.0	57.50	678.23	1326.72	1326.72	1.69	1.10	53.54	65.13
240		233.5	175.5	175.5	58.00	684.12	1320.82	1320.82	1.69	1.11	53.13	65.30
270		233.5	175.0	175.0	58.50	690.02	1314.93	1314.93	1.70	1.11	52.73	65.48
300		233.5	174.8	174.8	58.70	692.38	1312.57	1312.57	1.70	1.11	52.57	65.54
360		233.5	174.4	174.4	59.10	697.10	1307.85	1307.85	1.70	1.12	52.24	65.68
420		233.5	174.0	174.0	59.50	701.82	1303.13	1303.13	1.70	1.12	51.92	65.82
480		233.5	173.8	173.8	59.70	704.18	1300.77	1300.77	1.70	1.12	51.76	65.89
660		233.5	173.6	173.6	59.90	706.53	1298.41	1298.41	1.70	1.12	51.60	65.96
900		233.5	173.5	173.5	60.00	707.71	1297.23	1297.23	1.70	1.13	51.52	66.00
1440		233.5	173.5	173.5	60.00	707.71	1297.23	1297.23	1.70	1.13	51.52	66.00
2880		233.5	173.5	173.5	60.00	707.71	1297.23	1297.23	1.70	1.13	51.52	66.00

Klohn Crippen Berger

JOB NO.:	M0948A01			DATE	4-Aug-09
PROJECT:	Seabridge Kerr Sulphurets			LOCATION:	BC
DETAIL:	50% solid content				
DESCRIPTION:	Rougher Tailings with Process water				
TESTED BY:	BY	CHECKED BY:	JG	SHEET	1 of 2

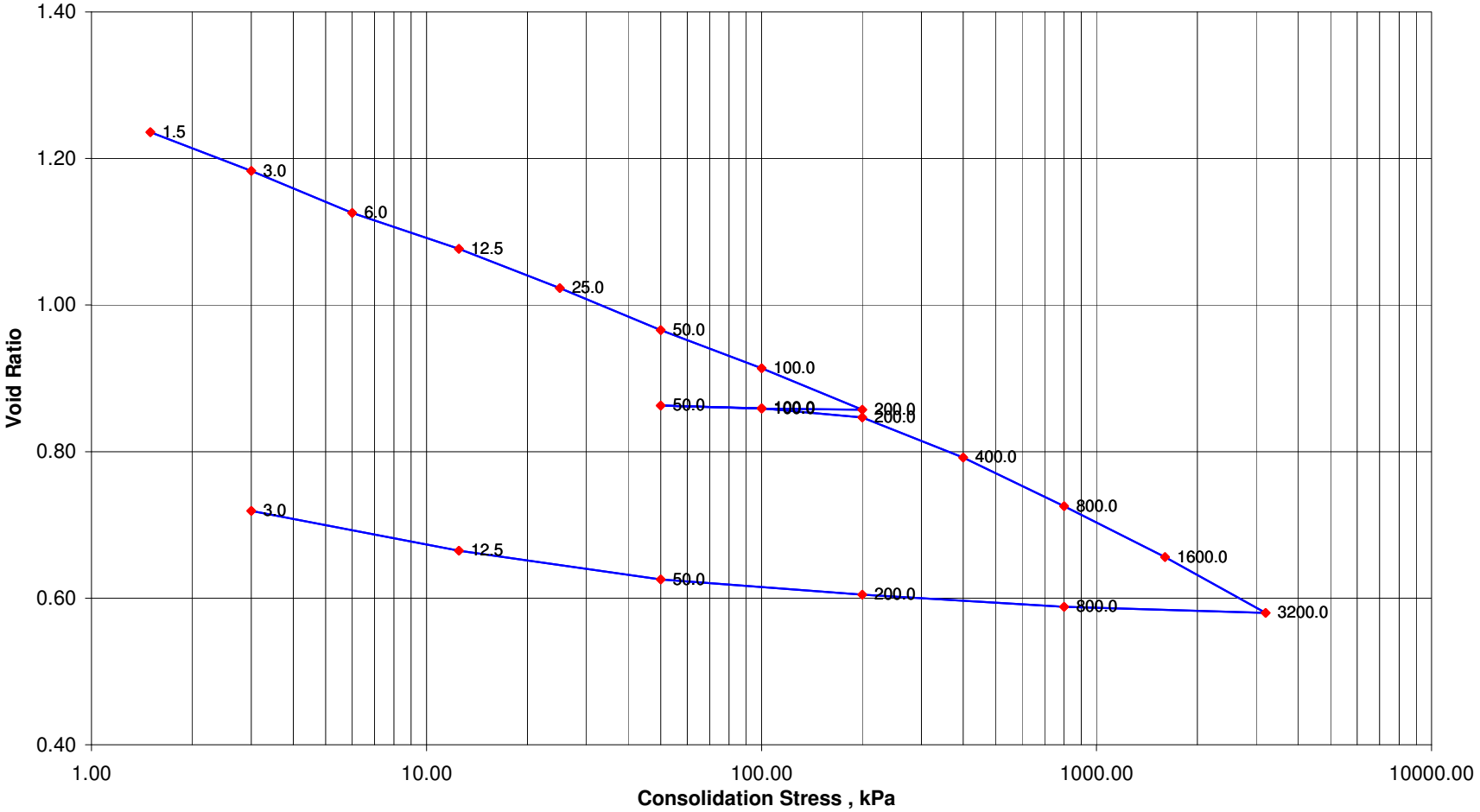
Settling Test for Tailings @ 50% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	4-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	50% solid content			
	DESCRIPTION:	Rougher Tailings with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET	2 of 2

Consolidation Test #2 - Tailing Fines

e - log(p)



Klohn Crippen Berger	PROJECT NO.:	M09480A01		
	PROJECT:	Seabridge Kerr Sulphurets		
	LOCATION:	BC	DATE TESTED:	Sep 29 to Oct 5, 2009
	SAMPLE NO.:	Tailings - Pilot Plant Composite 1 - fines	DEPTH:	
	TESTED BY:	BY	CHECKED BY:	JG

CONSOLIDATION

PROJECT NO.: M09480A01
PROJECT: Seabridge Kerr Sulphurets
SAMPLE NO.: Tailings - Pilot Plant Composite 1 - fines
DEPTH:
TEST NO.: Consolidation Test #2
LOADING MACHINE NO.: TX-ID65

Initial water content : 56.36 % (based on final dry weight)
Final water content : 26.28 % (based on sample at end of test)

Initial Specimen Height (mm): 25.25
Height of Solid (mm): 9.701 (dry mass = 86.47 g, Specimen area =3160.9 mm^2, SG=2.82***)
Initial void ratio: 1.603
Void Ratio Factor 0.1031

* Calibration to be done after test
** Estimated t_{50}
** Estimated specfic gravity

Pressure (kPa)		Change in Height	Final	Change in	Change in	Void	t_{50}**	Cv	Mv	k	Cc
From	To	Corrected (mm)	Height (mm)	Void Ratio	Void Ratio Acc	Ratio	(min)	(cm^2/sec)	(cm^2/N)	(cm/sec)	
0.0	**1.5**	3.686	21.564	0.3800	0.3800	**1.236**	1.85				
1.5	**3.0**	0.510	21.054	0.0526	0.4326	**1.183**	2.40	1.6E-03	1.6E-01	2.5E-06	**0.168**
3.0	**6.0**	0.558	20.496	0.0575	0.4901	**1.126**	0.53	6.7E-03	1.8E-01	1.2E-05	**0.191**
6.0	**12.5**	0.477	20.019	0.0492	0.5393	**1.077**	0.41	8.2E-03	7.7E-02	6.2E-06	**0.154**
12.5	**25.0**	0.519	19.499	0.0535	0.5928	**1.023**	0.29	1.1E-02	4.0E-02	4.3E-06	**0.178**
25.0	**50.0**	0.556	18.943	0.0573	0.6501	**0.966**	0.21	1.4E-02	2.3E-02	3.2E-06	**0.190**
50.0	**100.0**	0.504	18.440	0.0519	0.7020	**0.914**	0.14	2.0E-02	1.1E-02	2.1E-06	**0.172**
100.0	**200.0**	0.551	17.889	0.0568	0.7588	**0.857**	0.09	2.9E-02	5.9E-03	1.7E-06	**0.189**
200.0	**100.0**	-0.017	17.905	-0.0017	0.7571	**0.859**					
100.0	**50.0**	-0.039	17.944	-0.0040	0.7531	**0.863**					
50.0	**100.0**	0.036	17.908	0.0037	0.7568	**0.859**	0.04				
100.0	**200.0**	0.121	17.787	0.0125	0.7693	**0.847**	0.04	6.9E-02	1.3E-03	9.1E-07	**0.041**
200.0	**400.0**	0.531	17.256	0.0547	0.8240	**0.792**	0.06	4.4E-02	3.0E-03	1.3E-06	**0.182**
400.0	**800.0**	0.641	16.615	0.0661	0.8901	**0.726**	0.05	4.8E-02	1.8E-03	8.7E-07	**0.219**
800.0	**1600.0**	0.676	15.939	0.0697	0.9598	**0.656**	0.03	6.6E-02	1.0E-03	6.5E-07	**0.232**
1600.0	**3200.0**	0.739	15.199	0.0762	1.0361	**0.580**	0.03	7.1E-02	5.8E-04	4.0E-07	**0.253**
3200.0	**800.0**	-0.082	15.281	-0.0084	1.0277	**0.588**					
800.0	**200.0**	-0.160	15.441	-0.0165	1.0111	**0.605**					
200.0	**50.0**	-0.201	15.643	-0.0208	0.9904	**0.625**					
50.0	**12.5**	-0.381	16.023	-0.0393	0.9511	**0.665**					
12.5	**3.0**	-0.527	16.550	-0.0543	0.8968	**0.719**					

Klohn Crippen Berger

PROJECT NO.:	M09480A01		
PROJECT:	Seabridge Kerr Sulphurets		
LOCATION:	BC	DATE TESTED:	Sep 29 to Oct 5, 2009
SAMPLE NO.:	Tailings - Pilot Plant Composite 1 - fines	DEPTH:	
TESTED BY:	BY	CHECKED BY:	JG

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	P-2000
Beaker Tare (g)	532.18
Proposed Solid Content (%)	20
Supernatant Density (g/cm^3)	1
Start Date	12-Aug-09
Start Time	4:52 PM
Temperature	22 °C

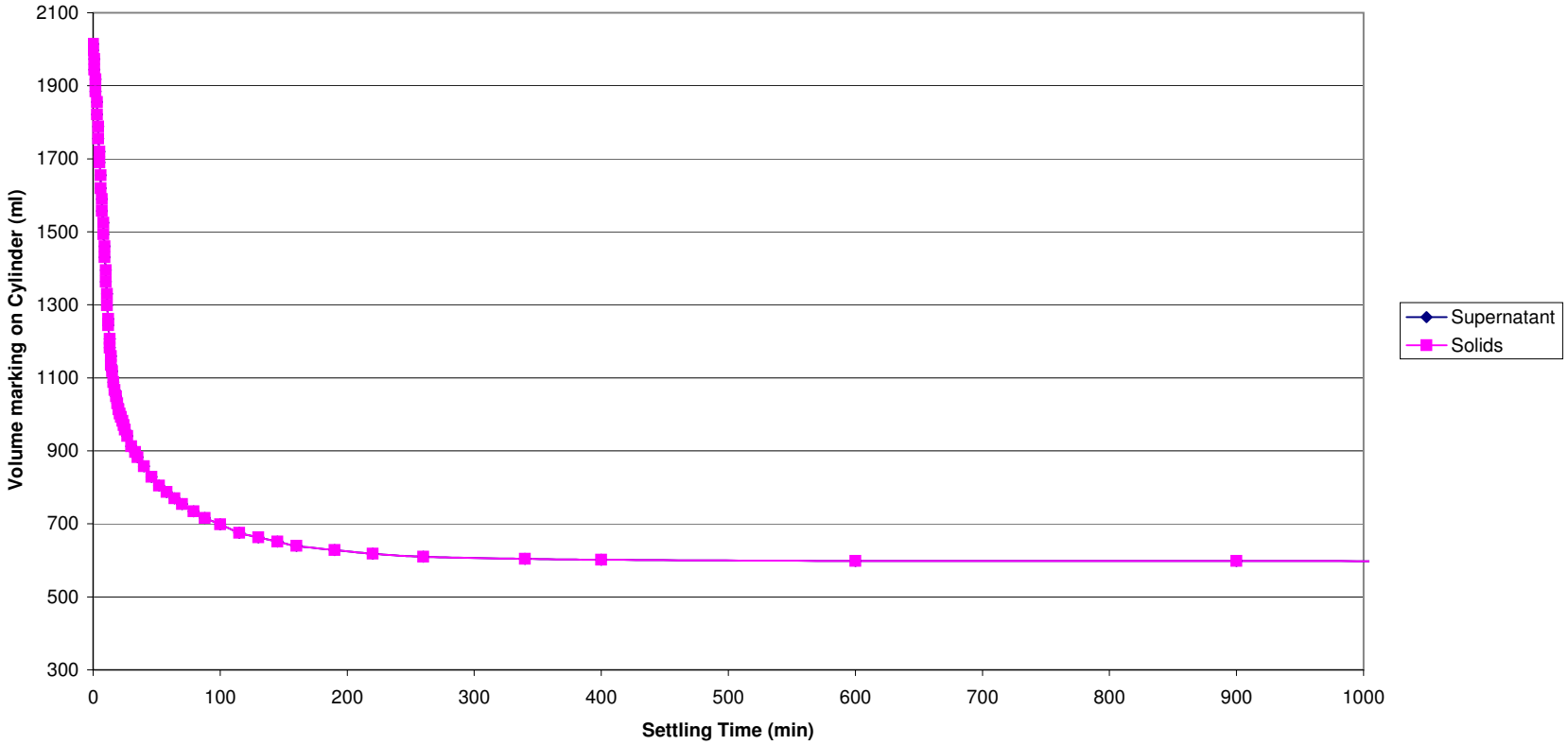
Initial Weight + Tare (g)	2859.57	Final Weight + Tare (g)	2856.7
Intial Dry weight (g)	465.48	Final Dry weight (g)	465.48
Initial Solid Volume (cm^3)	2015	Final Solid Volume (cm^3)	596
Initial Solid Content (%)	20.0	Final Solid Content (%)	51.2
Initial Water Content (%)	400.0	Final Water Content (%)	95.2
Initial Dry Density (g/cm^3)	0.23	Final Dry Density (g/cm^3)	0.78
Initial Wet Density (g/cm^3)	1.16	Final Wet Density (g/cm^3)	1.52

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant (mm)	Top Solids (mm)	Top Settlement (mm)	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	22.0	233.0	233.0	233.0	0.00	0.00	2014.77	2014.77	1.16	0.23	400.00	20.00
0.5		233.0	231.5	231.5	1.50	17.71	1997.06	1997.06	1.16	0.23	396.19	20.15
1		233.0	229.5	229.5	3.50	41.31	1973.45	1973.45	1.16	0.24	391.12	20.36
1.5		233.0	227.0	227.0	6.00	70.82	1943.95	1943.95	1.16	0.24	384.78	20.63
2		233.0	224.8	224.8	8.20	96.79	1917.98	1917.98	1.16	0.24	379.20	20.87
2.5		233.0	222.0	222.0	11.00	129.84	1884.93	1884.93	1.17	0.25	372.10	21.18
3		233.0	219.5	219.5	13.50	159.35	1855.42	1855.42	1.17	0.25	365.76	21.47
3.5		233.0	216.6	216.6	16.40	193.58	1821.19	1821.19	1.17	0.26	358.41	21.81
4		233.0	213.8	213.8	19.20	226.63	1788.14	1788.14	1.17	0.26	351.31	22.16
4.5		233.0	211.0	211.0	22.00	259.68	1755.09	1755.09	1.18	0.27	344.21	22.51
5		233.0	208.0	208.0	25.00	295.09	1719.68	1719.68	1.18	0.27	336.60	22.90
5.5		233.0	205.5	205.5	27.50	324.60	1690.17	1690.17	1.18	0.28	330.26	23.24
6		233.0	202.5	202.5	30.50	360.01	1654.76	1654.76	1.19	0.28	322.66	23.66
6.5		233.0	199.5	199.5	33.50	395.42	1619.35	1619.35	1.19	0.29	315.05	24.09
7		233.0	197.0	197.0	36.00	424.93	1589.84	1589.84	1.20	0.29	308.71	24.47
7.5		233.0	194.2	194.2	38.80	457.98	1556.79	1556.79	1.20	0.30	301.61	24.90
8		233.0	191.5	191.5	41.50	489.85	1524.92	1524.92	1.21	0.31	294.76	25.33
8.5		233.0	188.8	188.8	44.20	521.72	1493.05	1493.05	1.21	0.31	287.92	25.78
9		233.0	186.0	186.0	47.00	554.77	1460.00	1460.00	1.21	0.32	280.82	26.26
9.5		233.0	183.5	183.5	49.50	584.28	1430.49	1430.49	1.22	0.33	274.48	26.70
10		233.0	180.5	180.5	52.50	619.69	1395.08	1395.08	1.22	0.33	266.87	27.26
10.5		233.0	177.8	177.8	55.20	651.56	1363.21	1363.21	1.23	0.34	260.02	27.78
11		233.0	175.0	175.0	58.00	684.61	1330.16	1330.16	1.24	0.35	252.92	28.33
11.5		233.0	172.3	172.3	60.70	716.48	1298.29	1298.29	1.24	0.36	246.08	28.90
12		233.0	169.2	169.2	63.80	753.07	1261.70	1261.70	1.25	0.37	238.21	29.57
12.5		233.0	167.7	167.7	65.30	770.77	1243.99	1243.99	1.25	0.37	234.41	29.90
13		233.0	164.5	164.5	68.50	808.55	1206.22	1206.22	1.26	0.39	226.30	30.65
13.5		233.0	162.5	162.5	70.50	832.15	1182.61	1182.61	1.26	0.39	221.22	31.13
14		233.0	160.5	160.5	72.50	855.76	1159.01	1159.01	1.27	0.40	216.15	31.63
14.5		233.0	158.5	158.5	74.50	879.37	1135.40	1135.40	1.28	0.41	211.08	32.15
15		233.0	157.0	157.0	76.00	897.07	1117.69	1117.69	1.28	0.42	207.28	32.54
16		233.0	154.5	154.5	78.50	926.58	1088.19	1088.19	1.29	0.43	200.94	33.23
17		233.0	152.7	152.7	80.30	947.83	1066.94	1066.94	1.29	0.44	196.37	33.74
18		233.0	151.2	151.2	81.80	965.53	1049.23	1049.23	1.30	0.44	192.57	34.18
19		233.0	149.6	149.6	83.40	984.42	1030.35	1030.35	1.30	0.45	188.51	34.66
20		233.0	148.2	148.2	84.80	1000.94	1013.82	1013.82	1.31	0.46	184.96	35.09
21		233.0	147.2	147.2	85.80	1012.75	1002.02	1002.02	1.31	0.46	182.43	35.41
22		233.0	146.4	146.4	86.60	1022.19	992.58	992.58	1.31	0.47	180.40	35.66
23		233.0	145.5	145.5	87.50	1032.81	981.95	981.95	1.32	0.47	178.12	35.96
24		233.0	144.5	144.5	88.50	1044.62	970.15	970.15	1.32	0.48	175.58	36.29
25		233.0	143.5	143.5	89.50	1056.42	958.35	958.35	1.33	0.49	173.04	36.62
27		233.0	142.0	142.0	91.00	1074.13	940.64	940.64	1.33	0.49	169.24	37.14
30		233.0	139.6	139.6	93.40	1102.46	912.31	912.31	1.34	0.51	163.16	38.00
33		233.0	138.3	138.3	94.70	1117.80	896.97	896.97	1.35	0.52	159.86	38.48
35		233.0	137.1	137.1	95.90	1131.96	882.80	882.80	1.35	0.53	156.82	38.94
40		233.0	135.0	135.0	98.00	1156.75	858.02	858.02	1.36	0.54	151.49	39.76
46		233.0	132.5	132.5	100.50	1186.26	828.51	828.51	1.38	0.56	145.15	40.79
52		233.0	130.5	130.5	102.50	1209.87	804.90	804.90	1.39	0.58	140.08	41.65
58		233.0	129.0	129.0	104.00	1227.57	787.19	787.19	1.40	0.59	136.28	42.32
64		233.0	127.5	127.5	105.50	1245.28	769.49	769.49	1.41	0.60	132.47	43.02
70		233.0	126.2	126.2	106.80	1260.62	754.14	754.14	1.41	0.62	129.18	43.63
79		233.0	124.5	124.5	108.50	1280.69	734.08	734.08	1.43	0.63	124.86	44.47
88		233.0	123.0	123.0	110.00	1298.39	716.37	716.37	1.44	0.65	121.06	45.24
100		233.0	121.5	121.5	111.50	1316.10	698.67	698.67	1.45	0.67	117.26	46.03
115		233.0	119.5	119.5	113.50	1339.71	675.06	675.06	1.46	0.69	112.19	47.13
130		233.0	118.5	118.5	114.50	1351.51	663.26	663.26	1.47	0.70	109.65	47.70
145		233.0	117.5	117.5	115.50	1363.31	651.45	651.45	1.48	0.71	107.11	48.28
160		233.0	116.5	116.5	116.50	1375.12	639.65	639.65	1.49	0.73	104.58	48.88
190		233.0	115.5	115.5	117.50	1386.92	627.85	627.85	1.50	0.74	102.04	49.49
220		233.0	114.7	114.7	118.30	1396.36	618.40	618.40	1.51	0.75	100.01	50.00
260		233.0	114.0	114.0	119.00	1404.63	610.14	610.14	1.51	0.76	98.24	50.44
340		233.0	113.5	113.5	119.50	1410.53	604.24	604.24	1.52	0.77	96.97	50.77
400		233.0	113.3	113.3	119.70	1412.89	601.88	601.88	1.52	0.77	96.46	50.90
600		233.0	113.0	113.0	120.00	1416.43	598.34	598.34	1.52	0.78	95.70	51.10
900		233.0	113.0	113.0	120.00	1416.43	598.34	598.34	1.52	0.78	95.70	51.10
1440		233.0	112.8	112.8	120.20	1418.79	595.98	595.98	1.52	0.78	95.20	51.23
2880		233.0	112.8	112.8	120.20	1418.79	595.98	595.98	1.52	0.78	95.20	51.23

Klohn Crippen Berger

JOB NO.:	M09480A01			DATE	24-Aug-09
PROJECT:	Seabridge Kerr Sulphurets			LOCATION:	BC
DETAIL:	20% solid content				
DESCRIPTION:	Tailing Fines with Process water				
TESTED BY:	BY	CHECKED BY:	JG	SHEET	1 of 2

Settling Test for Tailing Fines @ 20% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	24-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	20% solid content			
	DESCRIPTION:	Tailing Fines with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET	2 of 2

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	P-2000
Beaker Tare (g)	532.18
Proposed Solid Content (%)	40
Supernatant Density (g/cm^3)	1
Start Date	7-Aug-09
Start Time	1:23 PM
Temperature	22 °C

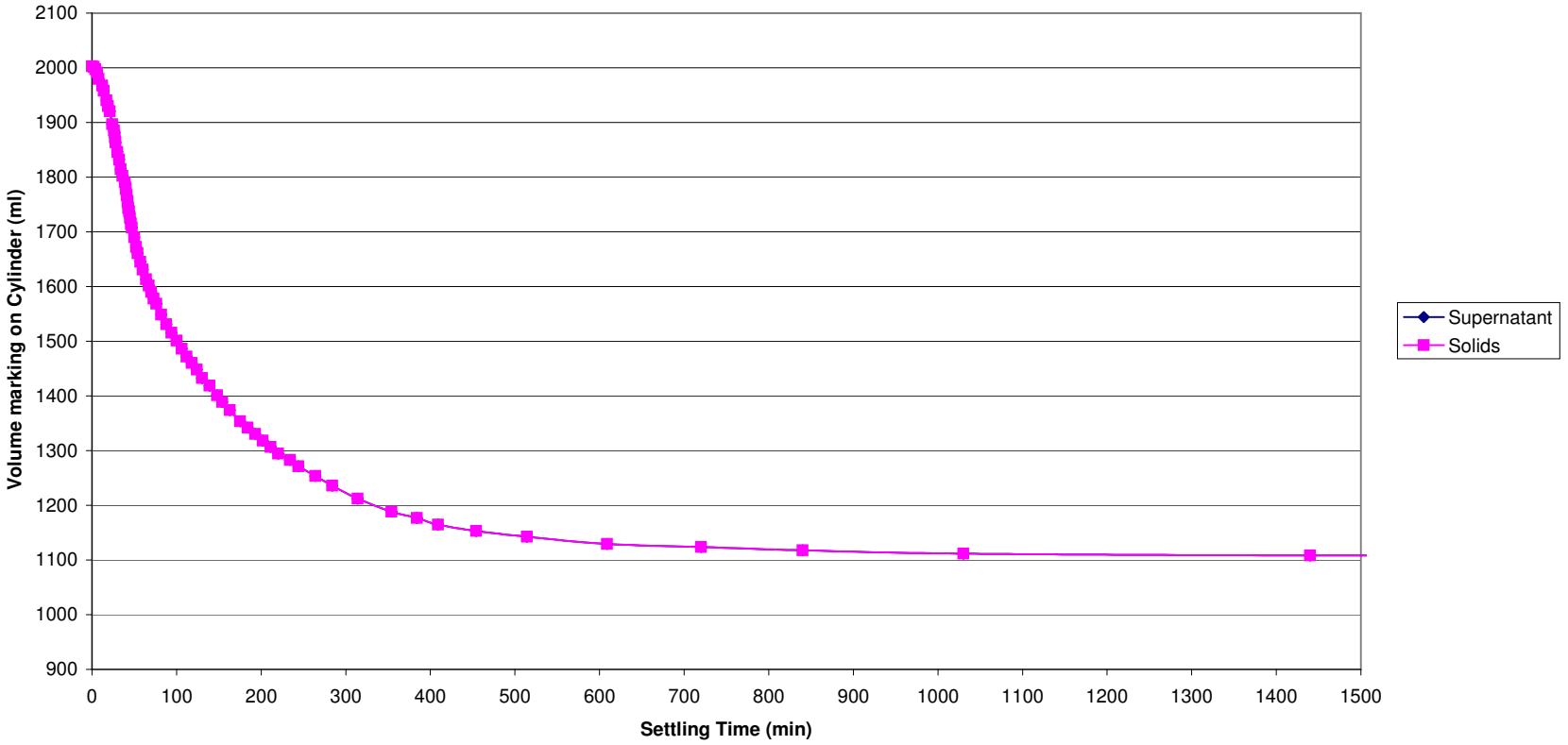
Initial Weight + Tare (g)	3207.89	Final Weight + Tare (g)	3203.8
Intial Dry weight (g)	1072.42	Final Dry weight (g)	1072.42
Initial Solid Volume (cm^3)	2003	Final Solid Volume (cm^3)	1106
Initial Solid Content (%)	40.1	Final Solid Content (%)	60.3
Initial Water Content (%)	149.5	Final Water Content (%)	65.9
Initial Dry Density (g/cm^3)	0.54	Final Dry Density (g/cm^3)	0.97
Initial Wet Density (g/cm^3)	1.34	Final Wet Density (g/cm^3)	1.61

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant Readings	Top Solids Readings	Top Settlement Readings	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	22.0	232.0	232.0	232.0	0.00	0.00	2002.96	2002.96	1.34	0.54	149.50	40.08
2		232.0	231.9	231.9	0.10	1.18	2001.78	2001.78	1.34	0.54	149.39	40.10
4		232.0	231.5	231.5	0.50	5.90	1997.06	1997.06	1.34	0.54	148.95	40.17
6		232.0	231.0	231.0	1.00	11.80	1991.16	1991.16	1.34	0.54	148.40	40.26
8		232.0	230.0	230.0	2.00	23.61	1979.36	1979.36	1.34	0.54	147.30	40.44
12		232.0	229.0	229.0	3.00	35.41	1967.55	1967.55	1.34	0.55	146.20	40.62
14		232.0	228.2	228.2	3.80	44.85	1958.11	1958.11	1.34	0.55	145.32	40.76
17		232.0	226.7	226.7	5.30	62.56	1940.40	1940.40	1.35	0.55	143.67	41.04
19		232.0	225.8	225.8	6.20	73.18	1929.78	1929.78	1.35	0.56	142.68	41.21
21		232.0	225.0	225.0	7.00	82.63	1920.34	1920.34	1.35	0.56	141.80	41.36
24		232.0	223.0	223.0	9.00	106.23	1896.73	1896.73	1.35	0.57	139.60	41.74
26		232.0	222.0	222.0	10.00	118.04	1884.93	1884.93	1.36	0.57	138.50	41.93
27		232.0	221.0	221.0	11.00	129.84	1873.12	1873.12	1.36	0.57	137.39	42.12
28		232.0	220.2	220.2	11.80	139.28	1863.68	1863.68	1.36	0.58	136.51	42.28
30		232.0	218.7	218.7	13.30	156.99	1845.98	1845.98	1.36	0.58	134.86	42.58
32		232.0	217.5	217.5	14.50	171.15	1831.81	1831.81	1.37	0.59	133.54	42.82
34		232.0	216.0	216.0	16.00	188.86	1814.11	1814.11	1.37	0.59	131.89	43.12
36		232.0	215.0	215.0	17.00	200.66	1802.30	1802.30	1.37	0.60	130.79	43.33
39		232.0	214.0	214.0	18.00	212.46	1790.50	1790.50	1.38	0.60	129.69	43.54
40		232.0	213.0	213.0	19.00	224.27	1778.70	1778.70	1.38	0.60	128.59	43.75
41		232.0	212.0	212.0	20.00	236.07	1766.89	1766.89	1.38	0.61	127.49	43.96
42		232.0	211.0	211.0	21.00	247.88	1755.09	1755.09	1.38	0.61	126.39	44.17
43		232.0	210.0	210.0	22.00	259.68	1743.28	1743.28	1.39	0.62	125.29	44.39
44		232.0	209.5	209.5	22.50	265.58	1737.38	1737.38	1.39	0.62	124.74	44.50
45		232.0	208.5	208.5	23.50	277.38	1725.58	1725.58	1.39	0.62	123.64	44.72
46		232.0	207.6	207.6	24.40	288.01	1714.96	1714.96	1.39	0.63	122.65	44.91
47		232.0	207.0	207.0	25.00	295.09	1707.87	1707.87	1.39	0.63	121.99	45.05
50		232.0	205.5	205.5	26.50	312.80	1690.17	1690.17	1.40	0.63	120.33	45.39
52		232.0	204.0	204.0	28.00	330.50	1672.46	1672.46	1.40	0.64	118.68	45.73
54		232.0	203.0	203.0	29.00	342.30	1660.66	1660.66	1.41	0.65	117.58	45.96
57		232.0	201.7	201.7	30.30	357.65	1645.31	1645.31	1.41	0.65	116.15	46.26
60		232.0	200.5	200.5	31.50	371.81	1631.15	1631.15	1.41	0.66	114.83	46.55
64		232.0	199.0	199.0	33.00	389.52	1613.44	1613.44	1.42	0.66	113.18	46.91
67		232.0	198.0	198.0	34.00	401.32	1601.64	1601.64	1.42	0.67	112.08	47.15
70		232.0	197.0	197.0	35.00	413.13	1589.84	1589.84	1.42	0.67	110.98	47.40
73		232.0	196.0	196.0	36.00	424.93	1578.03	1578.03	1.43	0.68	109.88	47.65
76		232.0	195.2	195.2	36.80	434.37	1568.59	1568.59	1.43	0.68	109.00	47.85
82		232.0	193.5	193.5	38.50	454.44	1548.53	1548.53	1.43	0.69	107.13	48.28
88		232.0	192.0	192.0	40.00	472.14	1530.82	1530.82	1.44	0.70	105.48	48.67
94		232.0	190.7	190.7	41.30	487.49	1515.48	1515.48	1.44	0.71	104.05	49.01
100		232.0	189.5	189.5	42.50	501.65	1501.31	1501.31	1.45	0.71	102.72	49.33
106		232.0	188.2	188.2	43.80	517.00	1485.97	1485.97	1.45	0.72	101.29	49.68
112		232.0	187.0	187.0	45.00	531.16	1471.80	1471.80	1.46	0.73	99.97	50.01
118		232.0	186.0	186.0	46.00	542.97	1460.00	1460.00	1.46	0.73	98.87	50.28
124		232.0	185.0	185.0	47.00	554.77	1448.19	1448.19	1.46	0.74	97.77	50.56
130		232.0	183.7	183.7	48.30	570.11	1432.85	1432.85	1.47	0.75	96.34	50.93
139		232.0	182.5	182.5	49.50	584.28	1418.69	1418.69	1.47	0.76	95.02	51.28
148		232.0	181.0	181.0	51.00	601.98	1400.98	1400.98	1.48	0.77	93.37	51.71
154		232.0	180.0	180.0	52.00	613.79	1389.18	1389.18	1.48	0.77	92.27	52.01
163		232.0	178.7	178.7	53.30	629.13	1373.83	1373.83	1.49	0.78	90.84	52.40
175		232.0	177.0	177.0	55.00	649.20	1353.77	1353.77	1.50	0.79	88.97	52.92
184		232.0	176.0	176.0	56.00	661.00	1341.96	1341.96	1.50	0.80	87.87	53.23
193		232.0	175.0	175.0	57.00	672.80	1330.16	1330.16	1.51	0.81	86.77	53.54
202		232.0	174.0	174.0	58.00	684.61	1318.36	1318.36	1.51	0.81	85.66	53.86
211		232.0	173.0	173.0	59.00	696.41	1306.55	1306.55	1.51	0.82	84.56	54.18
220		232.0	172.0	172.0	60.00	708.22	1294.75	1294.75	1.52	0.83	83.46	54.51
234		232.0	171.0	171.0	61.00	720.02	1282.94	1282.94	1.52	0.84	82.36	54.84
244		232.0	170.0	170.0	62.00	731.82	1271.14	1271.14	1.53	0.84	81.26	55.17
264		232.0	168.5	168.5	63.50	749.53	1253.44	1253.44	1.54	0.86	79.61	55.68
284		232.0	167.0	167.0	65.00	767.23	1235.73	1235.73	1.54	0.87	77.96	56.19
314		232.0	165.0	165.0	67.00	790.84	1212.12	1212.12	1.56	0.88	75.76	56.90
354		232.0	163.0	163.0	69.00	814.45	1188.52	1188.52	1.57	0.90	73.56	57.62
384		232.0	162.0	162.0	70.00	826.25	1176.71	1176.71	1.57	0.91	72.46	57.99
409		232.0	161.0	161.0	71.00	838.05	1164.91	1164.91	1.58	0.92	71.36	58.36
454		232.0	160.0	160.0	72.00	849.86	1153.10	1153.10	1.58	0.93	70.26	58.74
514		232.0	159.1	159.1	72.90	860.48	1142.48	1142.48	1.59	0.94	69.26	59.08
609		232.0	158.0	158.0	74.00	873.47	1129.50	1129.50	1.60	0.95	68.05	59.50
720		232.0	157.5	157.5	74.50	879.37	1123.60	1123.60	1.60	0.95	67.50	59.70
840		232.0	157.0	157.0	75.00	885.27	1117.69	1117.69	1.60	0.96	66.95	59.90
1030		232.0	156.5	156.5	75.50	891.17	1111.79	1111.79	1.61	0.96	66.40	60.10
1440		232.0	156.2	156.2	75.80	894.71	1108.25	1108.25	1.61	0.97	66.07	60.21
2880		232.0	156.0	156.0	76.00	897.07	1105.89	1105.89	1.61	0.97	65.85	60.29

Klohn Crippen Berger

JOB NO.:	M09480A01			DATE	7-Aug-09
PROJECT:	Seabridge Kerr Sulphurets			LOCATION:	BC
DETAIL:	40% solid content				
DESCRIPTION:	Tailing Fines with Process water				
TESTED BY:	BY	CHECKED BY:	JG	SHEET	1 of 2

Settling Test for Tailing Fines @ 40% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	7-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	40% solid content			
	DESCRIPTION:	Tailing Fines with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET 2 of 2	

SPECIFIC GRAVITY OF SOIL SOLIDS (ASTM-D854)

Sample No.		GT-KM2344 (Pyrite Tailings)					
Flask No.		1	2	KL-4			
Volume of Flask @ 20° C	ml	500	500	500			
Method of Air removal		Boiling	Boiling	Boiling			
De-airing Period	hr	2	2	2			
Test temperature	° C	20.3	20.3	20.3			
Mass of Flask+Water (M_a)	g	667.52	672.26	678.83			
Mass of Flask+Water+Soil (M_b)	g	706.62	711.24	717.66			
Mass of Dish/Flask+Soil		223.74	228.65	235.05			
Mass of Dish/Flask		168.84	173.78	180.10			
Mass of Dry Soil (M_o)	g	54.90	54.87	54.95			
Correction factor (K) @ Test Temperature		0.9999	0.9999	0.9999			
Specific Gravity of Solids @ 20° C		3.474	3.453	3.409			
Average Specific Gravity of Solids @ 20° C		3.45					

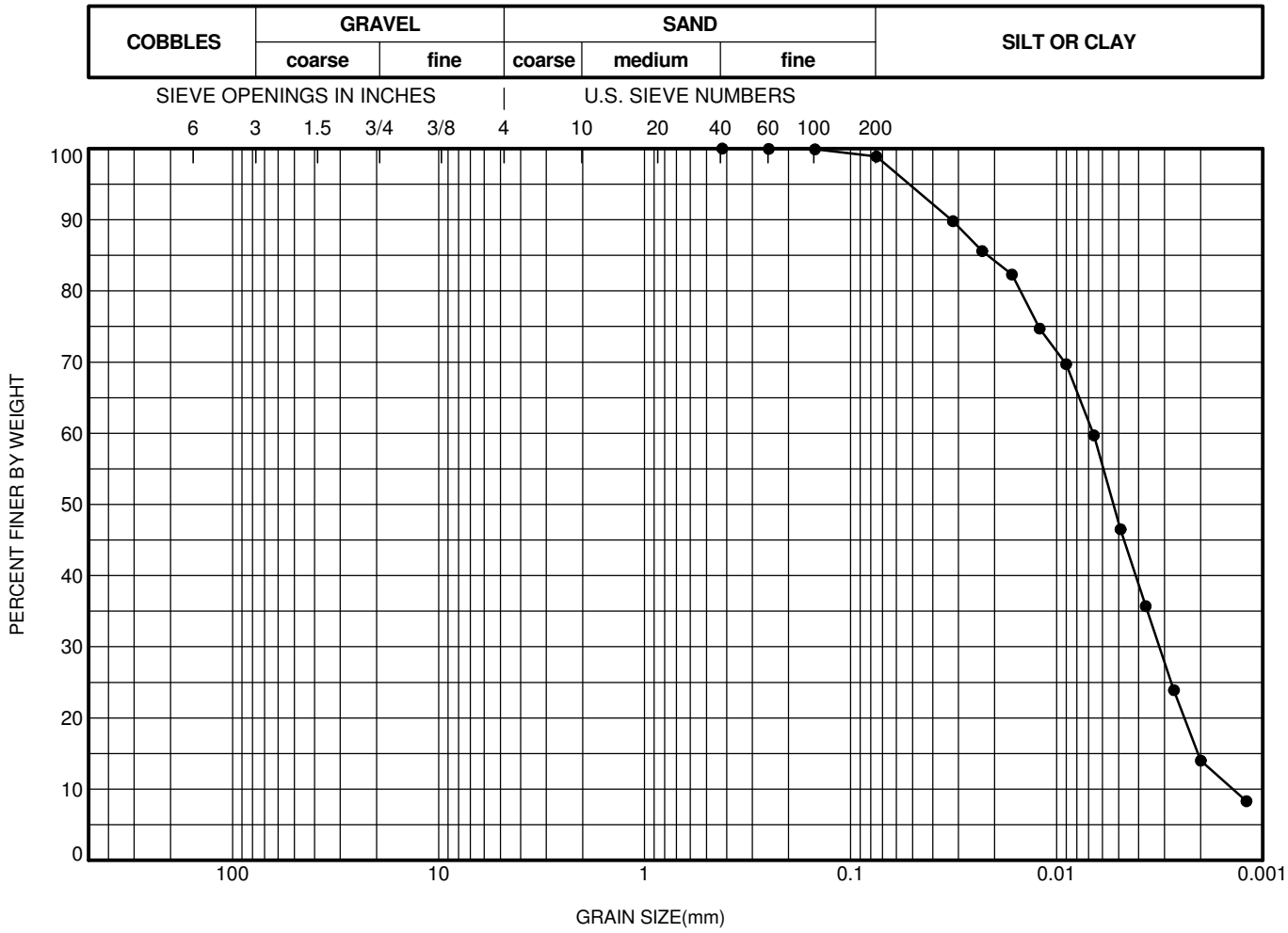
Sample No.							
Flask No.							
Volume of Flask @ 20° C	ml						
Method of Air removal							
De-airing Period	hr						
Test temperature	° C						
Mass of Flask+Water (M_a)	g						
Mass of Flask+Water+Soil (M_b)	g						
Mass of Dish/Flask+Soil							
Mass of Dish/Flask							
Mass of Dry Soil (M_o)	g						
Correction factor (K) @ Test Temperature							
Specific Gravity of Solids @ 20° C							
Average Specific Gravity of Solids @ 20° C							

Specific Gravity of Solids @ 20° C = $(K \times M_o)/(M_o + M_a - M_b)$

Klohn Crippen Berger

JOB NO.:	M09480A01		
PROJECT:	Kerr Sulphurets Mitchell		
LOCATION:	BC		
DATE:	8-Dec-09		
TESTED BY:	WSH	CHECKED BY:	BY

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	GT-KM2344	0.00							0.0	1.1	98.9

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	GT-KM2344	KM2344	0.00					

CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A01
PROJECT: Seabridge Kerr Sulphurets
LOCATION: BC
FIGURE:
DRAWN BY: WSH **CHECKED BY:** BY

SETTLING TEST (using 2L graduated standard beaker)

Beaker #	N-2000
Beaker Tare (g)	535.41
Proposed Solid Content (%)	50
Supernatant Density (g/cm^3)	1
Start Date	8-Dec-09
Start Time	12:00 PM
Temperature	20.5 °C

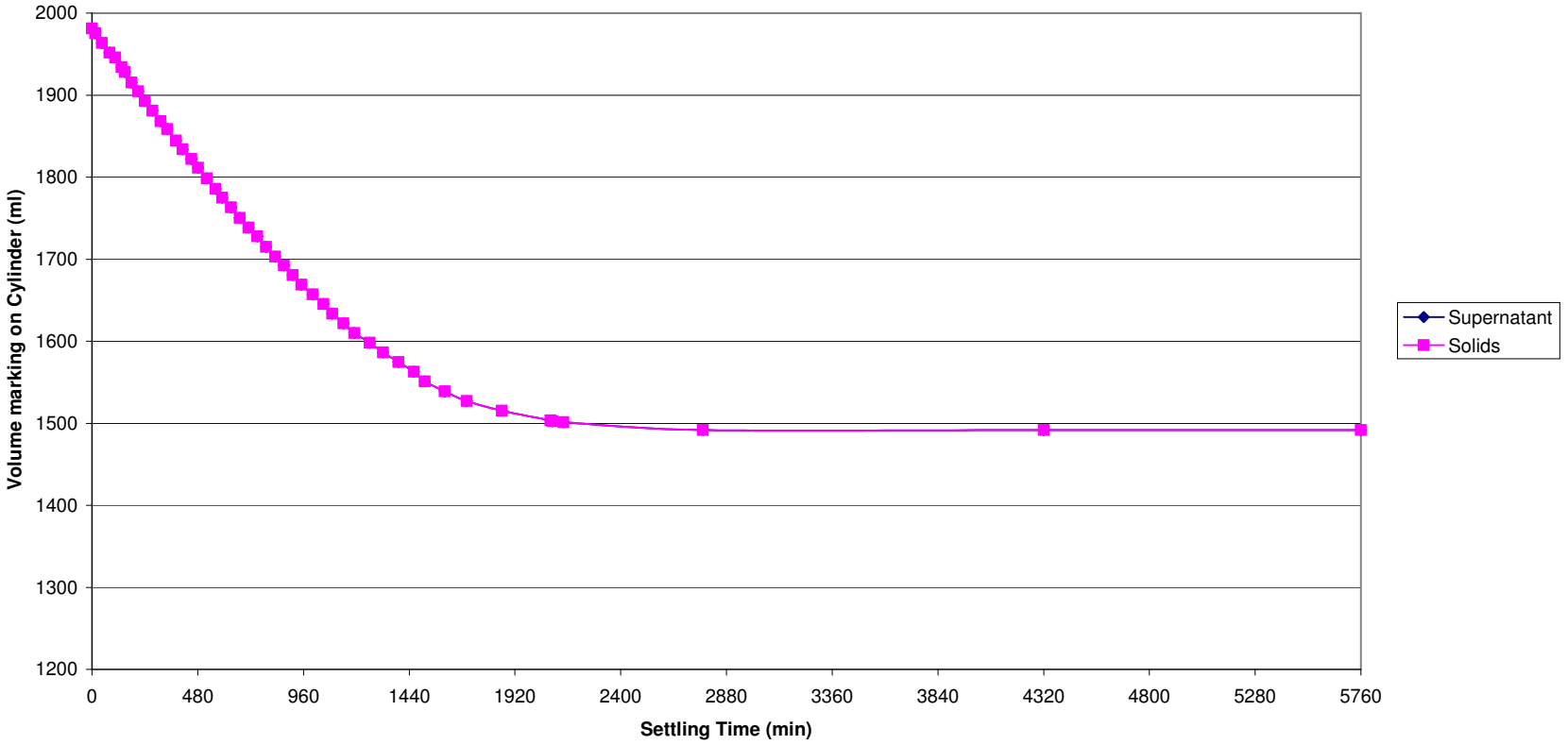
Initial Weight + Tare (g)	3636.22	Final Weight + Tare (g)	3634.1
Intial Dry weight (g)	1550.41	Final Dry weight (g)	1550.41
Initial Solid Volume (cm^3)	1981	Final Solid Volume (cm^3)	1492
Initial Solid Content (%)	50.0	Final Solid Content (%)	59.4
Initial Water Content (%)	100.0	Final Water Content (%)	68.4
Initial Dry Density (g/cm^3)	0.78	Final Dry Density (g/cm^3)	1.04
Initial Wet Density (g/cm^3)	1.56	Final Wet Density (g/cm^3)	1.75

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant Readings	Top Solids Readings	Top Settlement Readings	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0.0	20.5	231.5	231.5	231.5	0.00	0.00	1981.36	1981.36	1.56	0.78	100.00	50.00
15.0		231.5	231.0	231.0	0.50	5.90	1975.46	1975.46	1.57	0.78	99.62	50.10
45.0		231.5	230.0	230.0	1.50	17.69	1963.66	1963.66	1.57	0.79	98.86	50.29
80.0		231.5	229.0	229.0	2.50	29.49	1951.87	1951.87	1.57	0.79	98.10	50.48
105.0		231.5	228.5	228.5	3.00	35.39	1945.97	1945.97	1.58	0.80	97.72	50.58
135.0		231.5	227.5	227.5	4.00	47.18	1934.18	1934.18	1.58	0.80	96.96	50.77
150.0		231.5	227.0	227.0	4.50	53.08	1928.28	1928.28	1.58	0.80	96.58	50.87
180.0		231.5	225.9	225.9	5.60	66.05	1915.30	1915.30	1.58	0.81	95.74	51.09
210.0		231.5	225.0	225.0	6.50	76.67	1904.69	1904.69	1.59	0.81	95.05	51.27
240.0		231.5	224.0	224.0	7.50	88.46	1892.89	1892.89	1.59	0.82	94.29	51.47
275.0		231.5	223.0	223.0	8.50	100.26	1881.10	1881.10	1.60	0.82	93.53	51.67
311.0		231.5	221.9	221.9	9.60	113.23	1868.12	1868.12	1.60	0.83	92.70	51.90
341.0		231.5	221.1	221.1	10.40	122.67	1858.69	1858.69	1.60	0.83	92.09	52.06
381.0		231.5	219.9	219.9	11.60	136.82	1844.53	1844.53	1.61	0.84	91.17	52.31
411.0		231.5	219.0	219.0	12.50	147.44	1833.92	1833.92	1.61	0.85	90.49	52.50
451.0		231.5	218.0	218.0	13.50	159.24	1822.12	1822.12	1.61	0.85	89.73	52.71
481.0		231.5	217.1	217.1	14.40	169.85	1811.51	1811.51	1.62	0.86	89.04	52.90
521.0		231.5	216.0	216.0	15.50	182.83	1798.53	1798.53	1.62	0.86	88.21	53.13
561.0		231.5	214.9	214.9	16.60	195.80	1785.56	1785.56	1.63	0.87	87.37	53.37
591.0		231.5	214.0	214.0	17.50	206.42	1774.94	1774.94	1.63	0.87	86.69	53.57
631.0		231.5	213.0	213.0	18.50	218.21	1763.15	1763.15	1.63	0.88	85.92	53.79
671.0		231.5	211.9	211.9	19.60	231.19	1750.17	1750.17	1.64	0.89	85.09	54.03
711.0		231.5	210.9	210.9	20.60	242.98	1738.38	1738.38	1.64	0.89	84.33	54.25
751.0		231.5	210.0	210.0	21.50	253.60	1727.76	1727.76	1.65	0.90	83.64	54.45
791.0		231.5	208.9	208.9	22.60	266.57	1714.78	1714.78	1.65	0.90	82.81	54.70
831.0		231.5	207.9	207.9	23.60	278.37	1702.99	1702.99	1.66	0.91	82.04	54.93
871.0		231.5	207.0	207.0	24.50	288.98	1692.37	1692.37	1.66	0.92	81.36	55.14
911.0		231.5	206.0	206.0	25.50	300.78	1680.58	1680.58	1.67	0.92	80.60	55.37
951.0		231.5	205.0	205.0	26.50	312.57	1668.78	1668.78	1.67	0.93	79.84	55.61
1001.0		231.5	204.0	204.0	27.50	324.37	1656.99	1656.99	1.68	0.94	79.08	55.84
1051.0		231.5	203.0	203.0	28.50	336.16	1645.19	1645.19	1.68	0.94	78.32	56.08
1091.0		231.5	202.0	202.0	29.50	347.96	1633.40	1633.40	1.69	0.95	77.56	56.32
1141.0		231.5	201.0	201.0	30.50	359.75	1621.60	1621.60	1.69	0.96	76.80	56.56
1191.0		231.5	200.0	200.0	31.50	371.55	1609.81	1609.81	1.70	0.96	76.03	56.81
1261.0		231.5	199.0	199.0	32.50	383.35	1598.01	1598.01	1.70	0.97	75.27	57.05
1321.0		231.5	198.0	198.0	33.50	395.14	1586.22	1586.22	1.71	0.98	74.51	57.30
1391.0		231.5	197.0	197.0	34.50	406.94	1574.42	1574.42	1.71	0.98	73.75	57.55
1461.0		231.5	196.0	196.0	35.50	418.73	1562.63	1562.63	1.72	0.99	72.99	57.81
1511.0		231.5	195.0	195.0	36.50	430.53	1550.83	1550.83	1.72	1.00	72.23	58.06
1601.0		231.5	194.0	194.0	37.50	442.32	1539.04	1539.04	1.73	1.01	71.47	58.32
1701.0		231.5	193.0	193.0	38.50	454.12	1527.24	1527.24	1.73	1.02	70.71	58.58
1861.0		231.5	192.0	192.0	39.50	465.91	1515.45	1515.45	1.74	1.02	69.95	58.84
2081.0		231.5	191.0	191.0	40.50	477.71	1503.65	1503.65	1.74	1.03	69.19	59.11
2091.0		231.5	190.9	190.9	40.60	478.89	1502.47	1502.47	1.75	1.03	69.11	59.13
2141.0		231.5	190.8	190.8	40.70	480.07	1501.29	1501.29	1.75	1.03	69.04	59.16
2773.0		231.5	190.0	190.0	41.50	489.50	1491.86	1491.86	1.75	1.04	68.43	59.37
4320.0		231.5	190.0	190.0	41.50	489.50	1491.86	1491.86	1.75	1.04	68.43	59.37
5760.0		231.5	190.0	190.0	41.50	489.50	1491.86	1491.86	1.75	1.04	68.43	59.37

Klohn Crippen Berger

JOB NO.:	M09480A01			DATE	12-Dec-09
PROJECT:	Kerr Sulphurets Mitchell			LOCATION:	BC
DETAIL:	50% solid content				
DESCRIPTION:	GT-KM 2344 tailings with tap water				
TESTED BY:	WSH	CHECKED BY:	BY	SHEET	1 of 2

Settling Test for Tailings @ 50% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	12-Dec-09
	PROJECT:	Kerr Sulphurets Mitchell		LOCATION:	BC
	DETAIL:	50% solid content			
	DESCRIPTION:	GT-KM 2344 tailings with tap water			
	TESTED BY:	WSH	CHECKED BY: BY		SHEET 2 of 2

SETTLING TEST (using 2L graduated standard beaker)

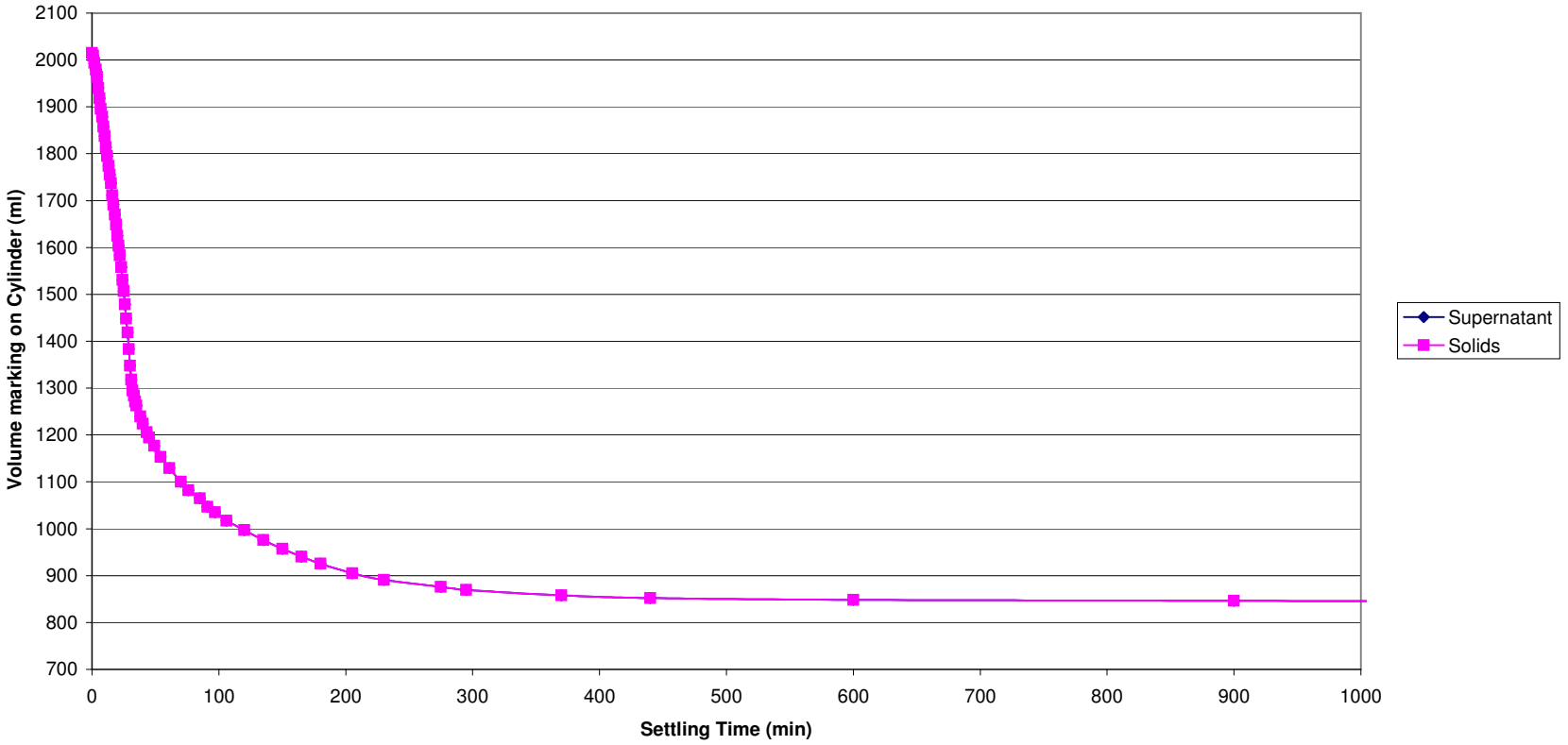
Beaker #	P-2000
Beaker Tare (g)	532.18
Proposed Solid Content (%)	30
Supernatant Density (g/cm^3)	1
Start Date	9-Aug-09
Start Time	2:28 PM
Temperature	22 °C

Initial Weight + Tare (g)	3045.19	Final Weight + Tare (g)	3042.3
Intial Dry weight (g)	746.36	Final Dry weight (g)	746.36
Initial Solid Volume (cm^3)	2015	Final Solid Volume (cm^3)	840
Initial Solid Content (%)	29.7	Final Solid Content (%)	55.8
Initial Water Content (%)	236.7	Final Water Content (%)	79.3
Initial Dry Density (g/cm^3)	0.37	Final Dry Density (g/cm^3)	0.89
Initial Wet Density (g/cm^3)	1.25	Final Wet Density (g/cm^3)	1.59

		Readings										
Elapsed Time (min)	Temp. (°C)	Top Supernatant Readings	Top Solids Readings	Top Settlement Readings	Height Supernatant (mm)	Volume Supernatant (cm^3)	Volume Supernatant Variation (cm^3)	Volume Solids (settlement) (cm^3)	Wet Density (g/cm^3)	Dry Density (g/cm^3)	Water Content (%)	Solid Content (%)
0	22.0	233.0	233.0	233.0	0.00	0.00	2014.77	2014.77	1.25	0.37	236.70	29.70
1		233.0	232.5	232.5	0.50	5.90	2008.87	2008.87	1.25	0.37	235.91	29.77
2		233.0	231.2	231.2	1.80	21.25	1993.52	1993.52	1.25	0.37	233.86	29.95
3		233.0	230.0	230.0	3.00	35.41	1979.36	1979.36	1.25	0.38	231.96	30.12
4		233.0	228.7	228.7	4.30	50.76	1964.01	1964.01	1.25	0.38	229.90	30.31
5		233.0	226.7	226.7	6.30	74.36	1940.40	1940.40	1.26	0.38	226.74	30.61
6		233.0	224.8	224.8	8.20	96.79	1917.98	1917.98	1.26	0.39	223.73	30.89
7		233.0	222.9	222.9	10.10	119.22	1895.55	1895.55	1.26	0.39	220.73	31.18
8		233.0	221.5	221.5	11.50	135.74	1879.03	1879.03	1.27	0.40	218.52	31.40
9		233.0	219.7	219.7	13.30	156.99	1857.78	1857.78	1.27	0.40	215.67	31.68
10		233.0	218.0	218.0	15.00	177.05	1837.71	1837.71	1.27	0.41	212.98	31.95
11		233.0	216.0	216.0	17.00	200.66	1814.11	1814.11	1.27	0.41	209.82	32.28
12		233.0	214.4	214.4	18.60	219.55	1795.22	1795.22	1.28	0.42	207.29	32.54
13		233.0	212.6	212.6	20.40	240.79	1773.97	1773.97	1.28	0.42	204.44	32.85
14		233.0	211.0	211.0	22.00	259.68	1755.09	1755.09	1.28	0.43	201.91	33.12
15		233.0	209.5	209.5	23.50	277.38	1737.38	1737.38	1.29	0.43	199.54	33.38
16		233.0	207.3	207.3	25.70	303.35	1711.41	1711.41	1.29	0.44	196.06	33.78
17		233.0	205.6	205.6	27.40	323.42	1691.35	1691.35	1.29	0.44	193.37	34.09
18		233.0	203.8	203.8	29.20	344.66	1670.10	1670.10	1.30	0.45	190.52	34.42
19		233.0	202.0	202.0	31.00	365.91	1648.86	1648.86	1.30	0.45	187.68	34.76
20		233.0	200.0	200.0	33.00	389.52	1625.25	1625.25	1.31	0.46	184.51	35.15
21		233.0	198.2	198.2	34.80	410.76	1604.00	1604.00	1.31	0.47	181.67	35.50
22		233.0	196.4	196.4	36.60	432.01	1582.76	1582.76	1.31	0.47	178.82	35.87
23		233.0	194.3	194.3	38.70	456.80	1557.97	1557.97	1.32	0.48	175.50	36.30
24		233.0	192.0	192.0	41.00	483.95	1530.82	1530.82	1.33	0.49	171.86	36.78
25		233.0	190.0	190.0	43.00	507.55	1507.21	1507.21	1.33	0.50	168.70	37.22
26		233.0	187.6	187.6	45.40	535.88	1478.88	1478.88	1.34	0.50	164.90	37.75
27		233.0	185.0	185.0	48.00	566.57	1448.19	1448.19	1.34	0.52	160.79	38.34
28		233.0	182.5	182.5	50.50	596.08	1418.69	1418.69	1.35	0.53	156.84	38.94
29		233.0	179.5	179.5	53.50	631.49	1383.27	1383.27	1.36	0.54	152.09	39.67
30		233.0	176.5	176.5	56.50	666.90	1347.86	1347.86	1.37	0.55	147.35	40.43
31		233.0	174.0	174.0	59.00	696.41	1318.36	1318.36	1.38	0.57	143.39	41.09
32		233.0	172.0	172.0	61.00	720.02	1294.75	1294.75	1.38	0.58	140.23	41.63
33		233.0	171.1	171.1	61.90	730.64	1284.12	1284.12	1.39	0.58	138.81	41.87
34		233.0	170.0	170.0	63.00	743.63	1271.14	1271.14	1.39	0.59	137.07	42.18
35		233.0	169.3	169.3	63.70	751.89	1262.88	1262.88	1.39	0.59	135.96	42.38
38		233.0	167.3	167.3	65.70	775.50	1239.27	1239.27	1.40	0.60	132.80	42.96
40		233.0	166.0	166.0	67.00	790.84	1223.93	1223.93	1.41	0.61	130.74	43.34
43		233.0	164.5	164.5	68.50	808.55	1206.22	1206.22	1.41	0.62	128.37	43.79
45		233.0	163.5	163.5	69.50	820.35	1194.42	1194.42	1.42	0.62	126.79	44.09
49		233.0	162.0	162.0	71.00	838.05	1176.71	1176.71	1.42	0.63	124.42	44.56
54		233.0	160.0	160.0	73.00	861.66	1153.10	1153.10	1.43	0.65	121.25	45.20
61		233.0	158.0	158.0	75.00	885.27	1129.50	1129.50	1.44	0.66	118.09	45.85
70		233.0	155.5	155.5	77.50	914.78	1099.99	1099.99	1.45	0.68	114.14	46.70
76		233.0	154.0	154.0	79.00	932.48	1082.28	1082.28	1.46	0.69	111.76	47.22
85		233.0	152.5	152.5	80.50	950.19	1064.58	1064.58	1.47	0.70	109.39	47.76
91		233.0	151.0	151.0	82.00	967.89	1046.87	1046.87	1.48	0.71	107.02	48.30
97		233.0	150.0	150.0	83.00	979.70	1035.07	1035.07	1.48	0.72	105.44	48.68
106		233.0	148.5	148.5	84.50	997.40	1017.36	1017.36	1.49	0.73	103.07	49.24
120		233.0	146.8	146.8	86.20	1017.47	997.30	997.30	1.50	0.75	100.38	49.91
135		233.0	145.0	145.0	88.00	1038.72	976.05	976.05	1.51	0.76	97.53	50.62
150		233.0	143.4	143.4	89.60	1057.60	957.17	957.17	1.52	0.78	95.00	51.28
165		233.0	142.0	142.0	91.00	1074.13	940.64	940.64	1.53	0.79	92.79	51.87
180		233.0	140.7	140.7	92.30	1089.47	925.30	925.30	1.54	0.81	90.73	52.43
205		233.0	139.0	139.0	94.00	1109.54	905.23	905.23	1.55	0.82	88.04	53.18
230		233.0	137.8	137.8	95.20	1123.70	891.07	891.07	1.56	0.84	86.14	53.72
275		233.0	136.5	136.5	96.50	1139.05	875.72	875.72	1.57	0.85	84.09	54.32
295		233.0	136.0	136.0	97.00	1144.95	869.82	869.82	1.57	0.86	83.30	54.56
370		233.0	135.0	135.0	98.00	1156.75	858.02	858.02	1.58	0.87	81.72	55.03
440		233.0	134.5	134.5	98.50	1162.65	852.11	852.11	1.58	0.88	80.93	55.27
600		233.0	134.2	134.2	98.80	1166.19	848.57	848.57	1.59	0.88	80.45	55.42
900		233.0	134.0	134.0	99.00	1168.56	846.21	846.21	1.59	0.88	80.13	55.51
1440		233.0	133.7	133.7	99.30	1172.10	842.67	842.67	1.59	0.89	79.66	55.66
2880		233.0	133.5	133.5	99.50	1174.46	840.31	840.31	1.59	0.89	79.34	55.76

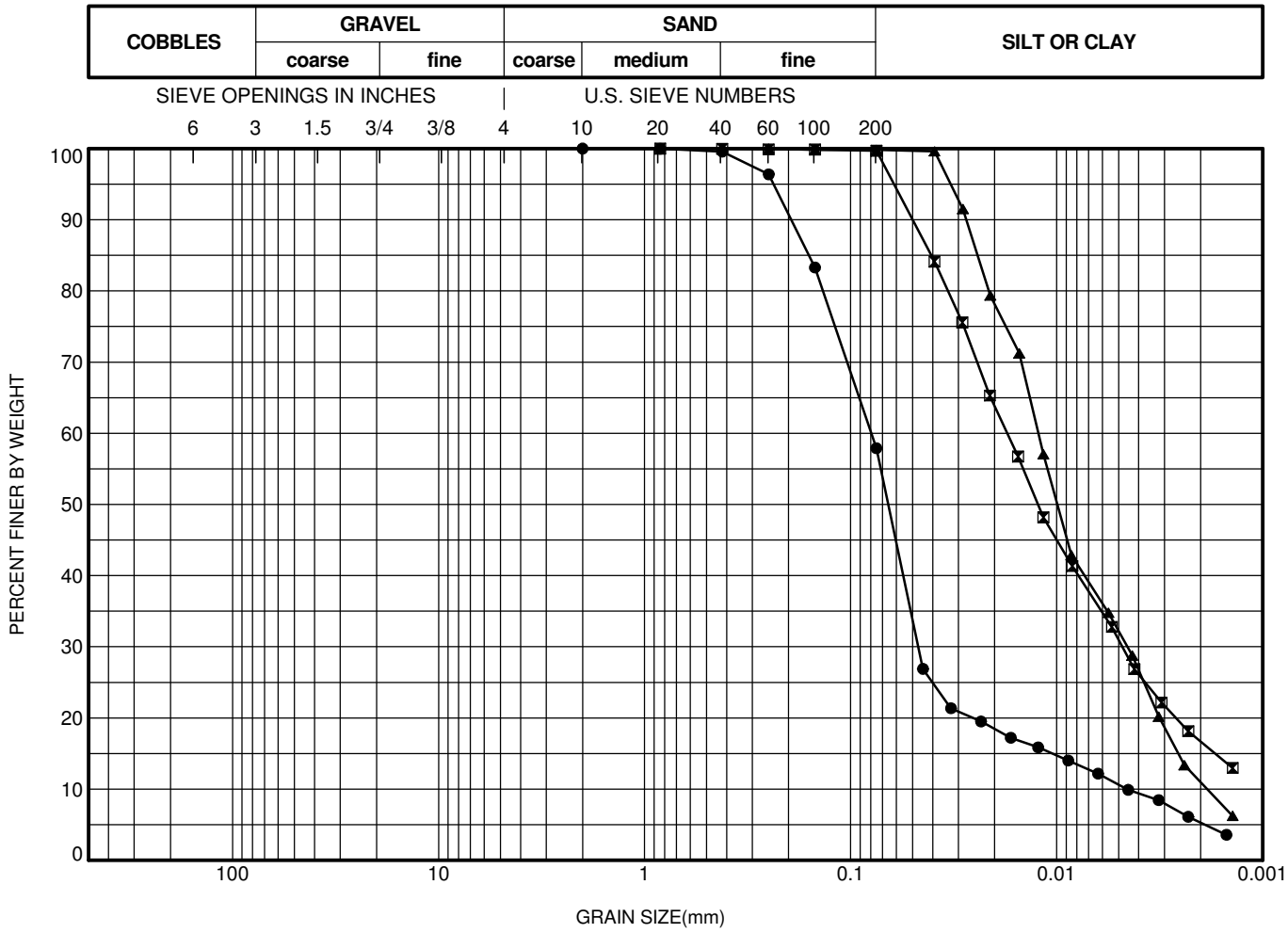
Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	9-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	30% solid content			
	DESCRIPTION:	Tailing Fines with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET 1 of 2	

Settling Test for Tailing Fines @ 30% solids



Klohn Crippen Berger	JOB NO.:	M09480A01		DATE	9-Aug-09
	PROJECT:	Seabridge Kerr Sulphurets		LOCATION:	BC
	DETAIL:	30% solid content			
	DESCRIPTION:	Tailing Fines with Process water			
	TESTED BY:	BY	CHECKED BY: JG	SHEET 2 of 2	

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D50	D15	D10	CU	%GRAVEL	%SAND	%FINES
●	Low Pyrite	0.00	0.159	0.079					0.0	42.1	57.9
⊠	P4 Cleaner	0.00							0.0	0.3	99.7
▲	P4 Pyrite	0.00							0.0	0.2	99.8

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Low Pyrite	1	0.00		21	17	4	Low Pyrite Rougher Tailings
⊠	P4 Cleaner	1	0.00		31	16	15	P4 Cleaner Tailings
▲	P4 Pyrite	1	0.00		30	23	7	P4 Pyrite Tailings

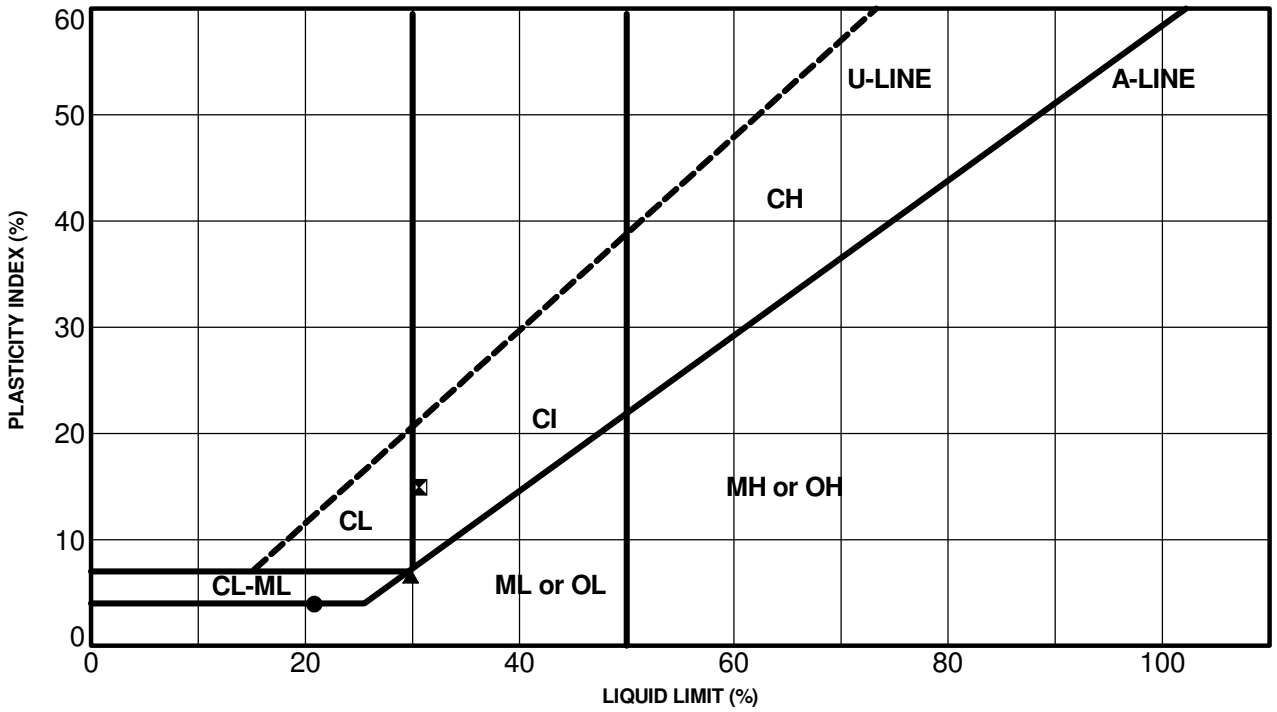
CU = COEFFICIENT OF UNIFORMITY = D60/D10 **PARTICLE SIZES, e.g. D85, in mm** **Tested by Wet Sieving Method (ASTM D1140 & D422)**

Klohn Crippen Berger

PROJECT NO.: M09480A02
PROJECT: Seabridge - KSM 2010
LOCATION: Northwestern BC
FIGURE:
DRAWN BY: NG **CHECKED BY:** JG

KCB_GRAIN_SIZE-SI M09480A02 KSM T1035 SEP 20, 2010.GPJ SIEVE.GDT 10/20/10

PLASTICITY CHART



	HOLE	SAMPLE	DEPTH (m)	W_L	W_P	PI	% FINES	REMARKS/SAMPLE DESCRIPTION
●	Low Pyrite	1	0.0	21	17	4	57.9	Low Pyrite Rougher Tailings
⊠	P4 Cleaner	1	0.0	31	16	15	99.7	P4 Cleaner Tailings
▲	P4 Pyrite	1	0.0	30	23	7	99.8	P4 Pyrite Tailings

Klohn Crippen Berger

PROJECT NO.: M09480A02
PROJECT: Seabridge - KSM 2010
LOCATION: Northwestern BC
FIGURE:
DRAWN BY: NG **CHECKED BY:** JG

KCB_ATTERBERG-SI M09480A02 KSM T1035 SEP 20, 2010.GPJ SIEVE.GDT 10/20/10

SPECIFIC GRAVITY OF SOIL SOLIDS (ASTM-D854)

Drill Hole Number						
Sample Number	P4 Pyrite			P4 Cleaner		
Depth (m)	N/A			N/A		
Sample Description	Tailings			Tailings		
Flask No.	1	2		KL-2	KL-3	
Volume of Flask @ 20° C ml	500	500		500	500	
Method of Air removal	Boiling	Boiling		Boiling	Boiling	
De-airing Period hr	2	2		2	2	
Test temperature ° C	20.9	20.9		20.9	20.9	
Mass of Flask+Water (M_a) g	667.45	672.18		675.70	676.10	
Mass of Flask+Water+Soil (M_b) g	713.85	719.09		721.86	721.97	
Mass of Dish/Flask+Soil	233.84	239.27		242.83	242.83	
Mass of Dish/Flask	168.83	173.76		177.15	177.44	
Mass of Dry Soil (M_o) g	65.01	65.51		65.68	65.39	
Correction factor (K) @ Test Temperature	1.000280	1.000280		1.000280	1.000280	
Specific Gravity of Solids @ 20° C	3.494	3.523		3.366	3.351	
Average Specific Gravity of Solids @ 20° C	**3.509**			**3.358**		

Drill Hole Number						
Sample Number	Low Pyrite Pougher					
Depth (m)	N/A					
Sample Description	Tailings					
Flask No.	SG4	SG5	SG6			
Volume of Flask @ 20° C ml	500	500	500			
Method of Air removal	Boiling	Boiling	Boiling			
De-airing Period hr	2	2	2			
Test temperature ° C	20.9	20.9	20.9			
Mass of Flask+Water (M_a) g	671.01	672.47	670.88			
Mass of Flask+Water+Soil (M_b) g	711.81	713.11	712.71			
Mass of Dish/Flask+Soil	236.67	237.76	237.94			
Mass of Dish/Flask	172.66	174.00	172.25			
Mass of Dry Soil (M_o) g	64.01	63.76	65.69			
Correction factor (K) @ Test Temperature	1.000280	1.000280	1.000280			
Specific Gravity of Solids @ 20° C	2.759	2.759	2.754			
Average Specific Gravity of Solids @ 20° C	**2.757**					

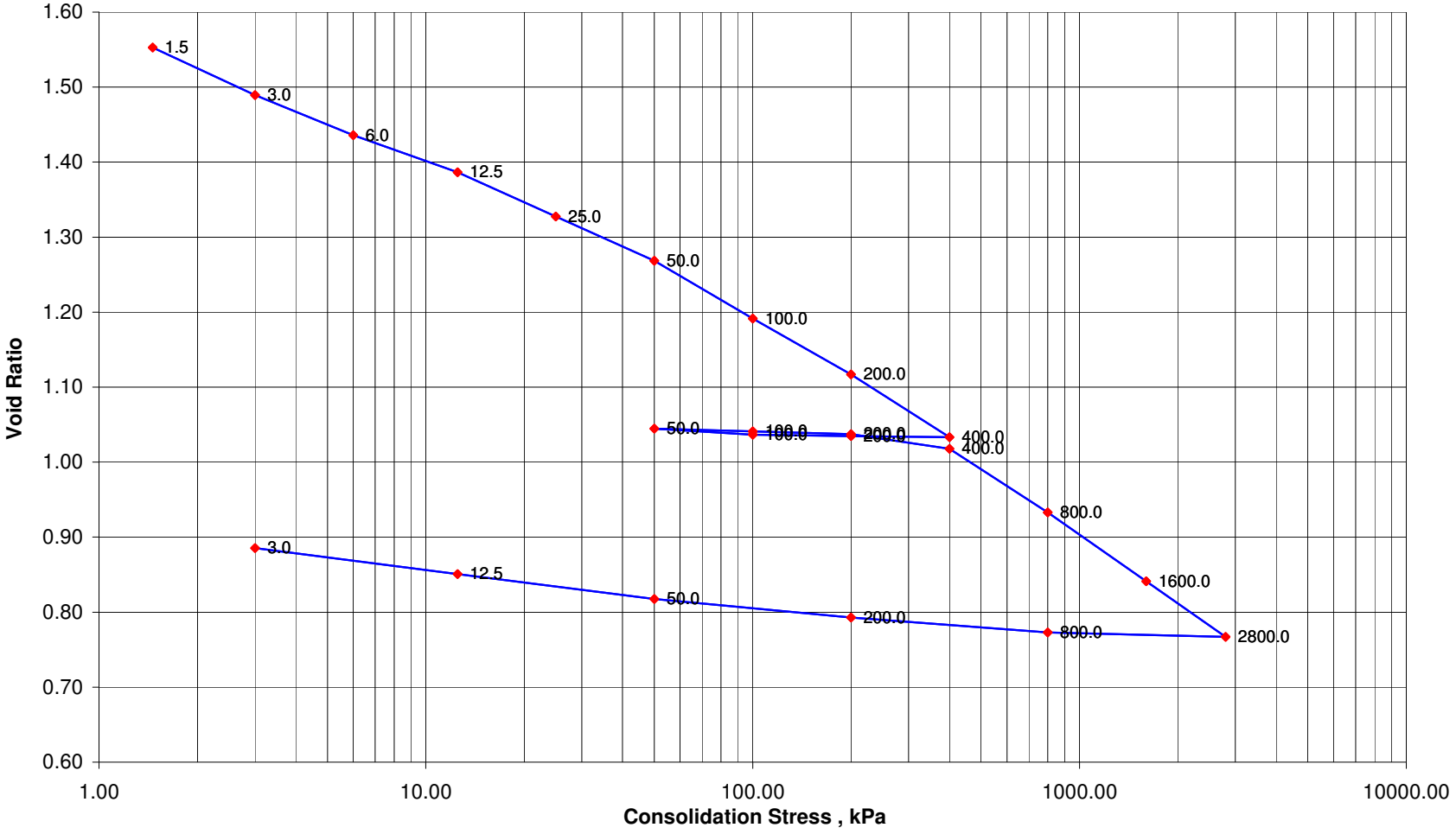
Specific Gravity of Solids @ 20° C = $(K \times M_o)/(M_o + M_a - M_b)$

Klohn Crippen Berger

JOB NO.:	M09480A02		
PROJECT:	Seabridge - KSM 2010		
LOCATION:	Northwestern BC		
DATE:	13-Oct-10		
TESTED BY:	NG	CHECKED BY:	JG

Consolidation Test #2 P4 Cleaner Tailings

e - log(p)



Klohn Crippen Berger	PROJECT NO.:	M09480A02		
	PROJECT:	Seabridge - KSM 2010		
	LOCATION:	Northwestern BC	DATE TESTED:	Oct 1 to Oct 9, 2010
	SAMPLE NO.:	P4 Cleaner Tailings	DEPTH:	
	TESTED BY:	BY	CHECKED BY:	JG

CONSOLIDATION

PROJECT NO.: M09480A02
PROJECT: Seabridge - KSM 2010
SAMPLE NO.: P4 Cleaner Tailings
DEPTH:
TEST NO.: Cons10-02
LOADING MACHINE NO.: OED4 / ID83

Initial solid cntent: 65.38%
Initial water content: 52.9 % (based on trimming)
Final water content: 27.14 % (based on sample at end of test)

Initial Specimen Height (mm): 24.63
Height of Solid (mm): 8.821 (dry mass =93.51 g, Specimen area =3155.0 mm^2, SG=3.36)
Initial void ratio: 1.792
Void Ratio Factor 0.1134

* Calibration to be done after test
** Estimated t_{50}

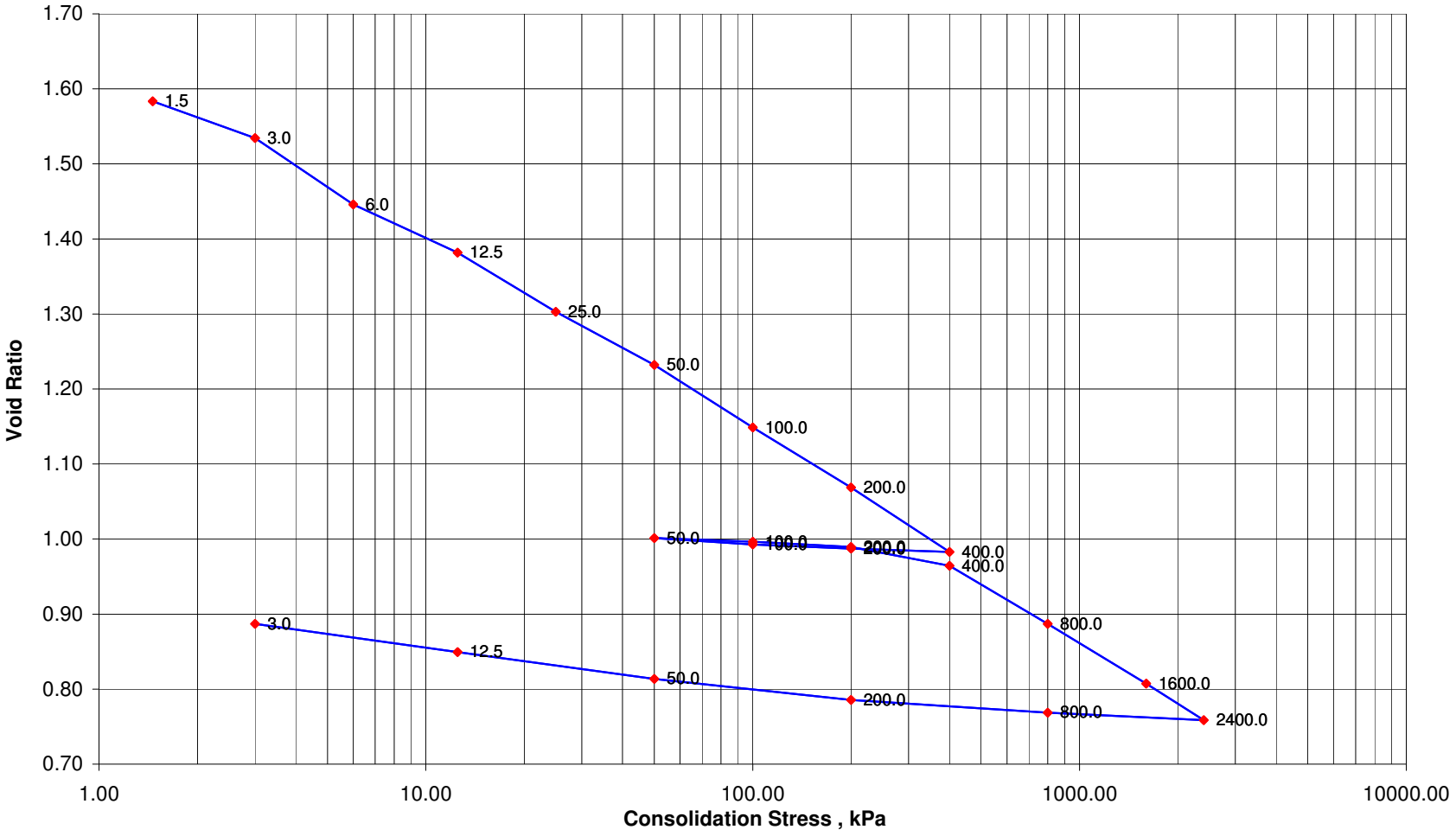
Pressure (kPa)		Change in Height	Final	Change in	Change in	Void	t_{50}**	Cv	Mv	k	Cc
From	To	Corrected (mm)	Height (mm)	Void Ratio	Void Ratio Acc	Ratio	(min)	(cm^2/sec)	(cm^2/N)	(cm/sec)	
0.0	**1.5**	2.111	22.519	0.2393	0.2393	**1.553**					
1.5	**3.0**	0.562	21.958	0.0637	0.3030	**1.489**	2.40	1.7E-03	1.7E-01	2.8E-06	**0.204**
3.0	**6.0**	0.471	21.487	0.0534	0.3564	**1.436**	0.62	6.2E-03	1.4E-01	8.8E-06	**0.177**
6.0	**12.5**	0.435	21.052	0.0493	0.4057	**1.387**	0.44	8.4E-03	6.7E-02	5.6E-06	**0.155**
12.5	**25.0**	0.519	20.533	0.0589	0.4645	**1.328**	0.26	1.4E-02	3.8E-02	5.1E-06	**0.196**
25.0	**50.0**	0.522	20.011	0.0592	0.5237	**1.269**	0.14	2.4E-02	2.0E-02	4.8E-06	**0.197**
50.0	**100.0**	0.679	19.332	0.0770	0.6007	**1.192**	0.10	3.3E-02	1.4E-02	4.5E-06	**0.256**
100.0	**200.0**	0.658	18.674	0.0745	0.6752	**1.117**	0.07	4.2E-02	6.8E-03	2.8E-06	**0.248**
200.0	**400.0**	0.740	17.934	0.0839	0.7591	**1.033**	0.05	5.9E-02	4.0E-03	2.3E-06	**0.279**
400.0	**200.0**	-0.013	17.947	-0.0015	0.7576	**1.035**					
200.0	**100.0**	-0.017	17.964	-0.0019	0.7557	**1.036**					
100.0	**50.0**	-0.072	18.036	-0.0081	0.7476	**1.045**					
50.0	**100.0**	0.034	18.002	0.0038	0.7514	**1.041**					
100.0	**200.0**	0.032	17.971	0.0036	0.7550	**1.037**	0.02	1.6E-01	3.5E-04	5.4E-07	**0.012**
200.0	**400.0**	0.173	17.798	0.0196	0.7746	**1.018**	0.02	1.8E-01	9.6E-04	1.7E-06	**0.065**
400.0	**800.0**	0.747	17.051	0.0847	0.8593	**0.933**	0.02	1.0E-01	2.1E-03	2.1E-06	**0.281**
800.0	**1600.0**	0.810	16.241	0.0918	0.9511	**0.841**	0.03	8.1E-02	1.2E-03	9.5E-07	**0.305**
1600.0	**2800.0**	0.652	15.589	0.0739	1.0250	**0.767**	0.03	8.3E-02	5.0E-04	4.1E-07	**0.304**
2800.0	**800.0**	-0.052	15.641	-0.0059	1.0191	**0.773**					
800.0	**200.0**	-0.175	15.816	-0.0199	0.9992	**0.793**					
200.0	**50.0**	-0.218	16.034	-0.0247	0.9745	**0.818**					
50.0	**12.5**	-0.290	16.324	-0.0329	0.9416	**0.851**					
12.5	**3.0**	-0.306	16.630	-0.0346	0.9070	**0.885**					

Klohn Crippen Berger

PROJECT NO.:	M09480A02		
PROJECT:	Seabridge - KSM 2010		
LOCATION:	Northwestern BC	DATE TESTED:	Oct 1 to Oct 9, 2010
SAMPLE NO.:	P4 Cleaner Tailings	DEPTH:	
TESTED BY:	BY	CHECKED BY:	JG

Consolidation Test #1 - P4 Pyrite Tailings

e - log(p)



Klohn Crippen Berger	PROJECT NO.:	M09480A02		
	PROJECT:	Seabridge - KSM 2010		
	LOCATION:	Northwestern BC	DATE TESTED:	Oct 1 to Oct 9, 2010
	SAMPLE NO.:	P4 Pyrite Tailings	DEPTH:	
	TESTED BY:	BY	CHECKED BY:	JG

CONSOLIDATION

PROJECT NO.: M09480A02
PROJECT: Seabridge - KSM 2010
SAMPLE NO.: P4 Pyrite Tailings
DEPTH:
TEST NO.: Cons10-01
LOADING MACHINE NO.: OED3 / ID82

Initial solid content: 65.48%
Initial water content:52.72 % (based on trimming)
Final water content: 25.93 % (based on sample at end of test)

Initial Specimen Height (mm): 25.47
Height of Solid (mm): 8.850 (dry mass =98.25 g, Specimen area =3162.9 mm^2, SG=3.51)
Initial void ratio: 1.878
Void Ratio Factor 0.1130

* Calibration to be done after test
** Estimated t_{50}

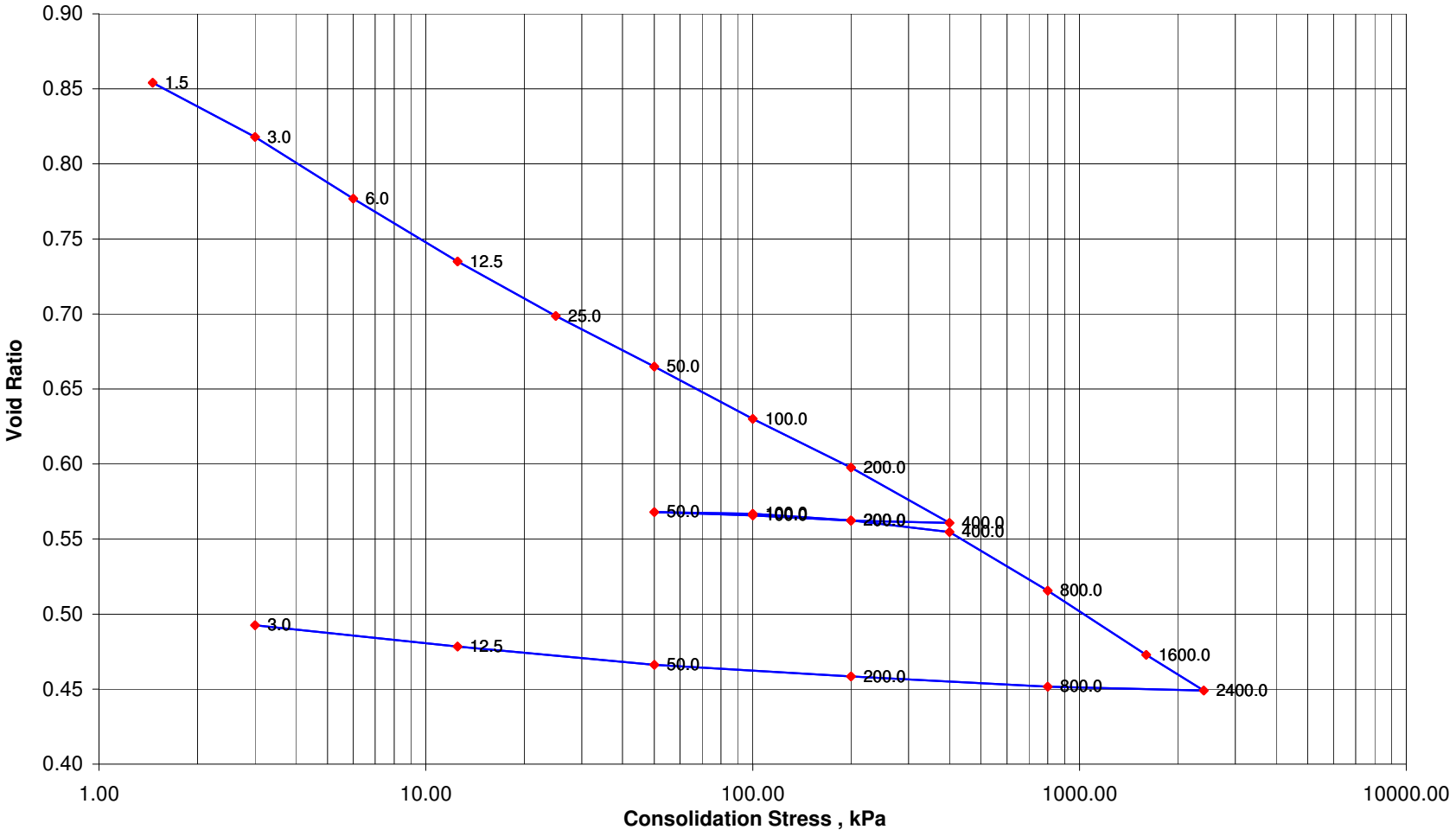
Pressure (kPa)		Change in Height	Final	Change in	Change in	Void	t_{50}**	Cv	Mv	k	Cc
From	To	Corrected (mm)	Height (mm)	Void Ratio	Void Ratio Acc	Ratio	(min)	(cm^2/sec)	(cm^2/N)	(cm/sec)	
0.0	**1.5**	2.563	22.905	0.2896	0.2896	**1.583**					
1.5	**3.0**	0.435	22.470	0.0491	0.3387	**1.534**	0.78	5.4E-03	1.3E-01	6.9E-06	**0.157**
3.0	**6.0**	0.782	21.688	0.0883	0.4270	**1.446**	0.97	4.1E-03	2.3E-01	9.4E-06	**0.293**
6.0	**12.5**	0.569	21.120	0.0642	0.4913	**1.382**	0.34	1.1E-02	8.8E-02	9.5E-06	**0.202**
12.5	**25.0**	0.698	20.422	0.0789	0.5702	**1.303**	0.24	1.5E-02	5.1E-02	7.4E-06	**0.262**
25.0	**50.0**	0.626	19.796	0.0707	0.6409	**1.232**	0.15	2.2E-02	2.5E-02	5.3E-06	**0.235**
50.0	**100.0**	0.736	19.060	0.0831	0.7240	**1.149**	0.15	2.1E-02	1.5E-02	3.0E-06	**0.276**
100.0	**200.0**	0.711	18.349	0.0804	0.8044	**1.069**	0.07	4.0E-02	7.5E-03	2.9E-06	**0.267**
200.0	**400.0**	0.758	17.591	0.0857	0.8900	**0.983**	0.06	4.8E-02	4.1E-03	2.0E-06	**0.285**
400.0	**200.0**	-0.040	17.630	-0.0045	0.8855	**0.987**					
200.0	**100.0**	-0.048	17.678	-0.0054	0.8801	**0.993**					
100.0	**50.0**	-0.074	17.752	-0.0083	0.8718	**1.001**					
50.0	**100.0**	0.042	17.711	0.0047	0.8765	**0.996**					
100.0	**200.0**	0.063	17.648	0.0071	0.8836	**0.989**	0.02	1.2E-01	7.1E-04	8.1E-07	**0.024**
200.0	**400.0**	0.220	17.428	0.0249	0.9084	**0.965**	0.03	9.0E-02	1.3E-03	1.1E-06	**0.083**
400.0	**800.0**	0.686	16.742	0.0775	0.9859	**0.887**	0.03	8.6E-02	2.0E-03	1.7E-06	**0.257**
800.0	**1600.0**	0.707	16.035	0.0799	1.0658	**0.807**	0.03	7.1E-02	1.1E-03	7.4E-07	**0.265**
1600.0	**2400.0**	0.431	15.605	0.0486	1.1145	**0.758**	0.02	1.2E-01	3.4E-04	4.0E-07	**0.276**
2400.0	**800.0**	-0.088	15.692	-0.0099	1.1046	**0.768**					
800.0	**200.0**	-0.152	15.844	-0.0171	1.0874	**0.786**					
200.0	**50.0**	-0.248	16.092	-0.0280	1.0594	**0.814**					
50.0	**12.5**	-0.317	16.408	-0.0358	1.0236	**0.849**					
12.5	**3.0**	-0.332	16.740	-0.0375	0.9862	**0.887**					

Klohn Crippen Berger

PROJECT NO.:	M09480A02		
PROJECT:	Seabridge - KSM 2010		
LOCATION:	Northwestern BC	DATE TESTED:	Oct 1 to Oct 9, 2010
SAMPLE NO.:	P4 Pyrite Tailings	DEPTH:	
TESTED BY:	BY	CHECKED BY:	JG

Consolidation Test #3 - Low Pyrite Rougher Tailings

e - log(p)



Klohn Crippen Berger	PROJECT NO.:	M09480A02		
	PROJECT:	Seabridge - KSM 2010		
	LOCATION:	Northwestern BC	DATE TESTED:	Oct 1 to Oct 9, 2010
	SAMPLE NO.:	Low Pyrite Rougher	DEPTH:	
	TESTED BY:	BY	CHECKED BY:	JG

CONSOLIDATION

PROJECT NO.: M09480A02
PROJECT: Seabridge - KSM 2010
SAMPLE NO.: Low Pyrite Rougher Tailings
DEPTH:
TEST NO.: Cons10-03
LOADING MACHINE NO.: OED2 / ID81

Initial solid cntent: 64.37%
Initial water content: 55.34 % (based on trimming)
Final water content: 19.22 % (based on sample at end of test)

Initial Specimen Height (mm): 25.10
Height of Solid (mm): 9.990 (dry mass =87.29 g, Specimen area =3165.9 mm^2, SG=2.76)
Initial void ratio: 1.513
Void Ratio Factor 0.1001

* Calibration to be done after test
** Estimated t_{50}

Pressure (kPa)		Change in Height	Final	Change in	Change in	Void	t_{50}**	Cv	Mv	k	Cc
From	To	Corrected (mm)	Height (mm)	Void Ratio	Void Ratio Acc	Ratio	(min)	(cm^2/sec)	(cm^2/N)	(cm/sec)	
0.0	**1.5**	6.578	18.522	0.6585	0.6585	**0.854**					
1.5	**3.0**	0.361	18.161	0.0362	0.6946	**0.818**	1.00	2.8E-03	1.3E-01	3.6E-06	**0.116**
3.0	**6.0**	0.412	17.749	0.0412	0.7358	**0.777**	0.68	3.9E-03	1.5E-01	5.8E-06	**0.137**
6.0	**12.5**	0.418	17.331	0.0419	0.7777	**0.735**	0.31	8.1E-03	7.9E-02	6.3E-06	**0.131**
12.5	**25.0**	0.362	16.970	0.0362	0.8139	**0.699**	0.20	1.2E-02	3.2E-02	3.8E-06	**0.120**
25.0	**50.0**	0.338	16.632	0.0338	0.8477	**0.665**	0.10	2.4E-02	1.6E-02	3.8E-06	**0.112**
50.0	**100.0**	0.348	16.284	0.0349	0.8826	**0.630**	0.08	2.8E-02	8.4E-03	2.3E-06	**0.116**
100.0	**200.0**	0.324	15.960	0.0324	0.9150	**0.598**	0.06	3.6E-02	4.0E-03	1.4E-06	**0.108**
200.0	**400.0**	0.369	15.591	0.0369	0.9519	**0.561**	0.04	4.9E-02	2.3E-03	1.1E-06	**0.123**
400.0	**200.0**	-0.015	15.606	-0.0015	0.9504	**0.562**					
200.0	**100.0**	-0.035	15.641	-0.0035	0.9469	**0.566**					
100.0	**50.0**	-0.023	15.663	-0.0023	0.9447	**0.568**					
50.0	**100.0**	0.011	15.653	0.0011	0.9457	**0.567**					
100.0	**200.0**	0.045	15.608	0.0045	0.9502	**0.562**	0.02	1.1E-01	5.7E-04	6.2E-07	**0.015**
200.0	**400.0**	0.077	15.531	0.0077	0.9579	**0.555**	0.02	1.2E-01	4.9E-04	5.7E-07	**0.026**
400.0	**800.0**	0.391	15.141	0.0391	0.9970	**0.516**	0.03	6.7E-02	1.3E-03	8.2E-07	**0.130**
800.0	**1600.0**	0.427	14.714	0.0427	1.0397	**0.473**	0.03	6.5E-02	7.0E-04	4.5E-07	**0.142**
1600.0	**2400.0**	0.239	14.475	0.0239	1.0636	**0.449**	0.02	8.7E-02	2.0E-04	1.7E-07	**0.136**
2400.0	**800.0**	-0.026	14.501	-0.0026	1.0610	**0.452**					
800.0	**200.0**	-0.068	14.569	-0.0068	1.0542	**0.458**					
200.0	**50.0**	-0.077	14.646	-0.0077	1.0465	**0.466**					
50.0	**12.5**	-0.122	14.768	-0.0122	1.0343	**0.478**					
12.5	**3.0**	-0.142	14.910	-0.0142	1.0201	**0.493**					

Klohn Crippen Berger

PROJECT NO.:	M09480A02		
PROJECT:	Seabridge - KSM 2010		
LOCATION:	Northwestern BC	DATE TESTED:	Oct 1 to Oct 9, 2010
SAMPLE NO.:	Low Pyrite Rougher Tailings	DEPTH:	
TESTED BY:	BY	CHECKED BY:	JG

APPENDIX V

Seismic Survey Report (Frontier)

KLOHN CRIPPEN BERGER LTD.

REPORT ON

SEISMIC REFRACTION INVESTIGATION

TAILINGS MANAGEMENT FACILITY

KERR SULPHURETS MITCHELL PROJECT

BELL II AREA, B.C.

by

Kevin Payne, P.Eng.

Russell Hillman, P.Eng.

July, 2012 **PROJECT FGI-1260**

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CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

In the period June 28 to July 12, 2012, Frontier Geosciences Inc. carried out a seismic refraction investigation for Klohn Crippen Berger Ltd. at Seabridge Gold Inc.'s Kerr Sulphurets Mitchell Project. The Site is located approximately 15 km southwest of Bell II on Highway 37 in northwestern B.C. A Survey Location Plan is shown at a scale of 1:250,000 in Figure 1.

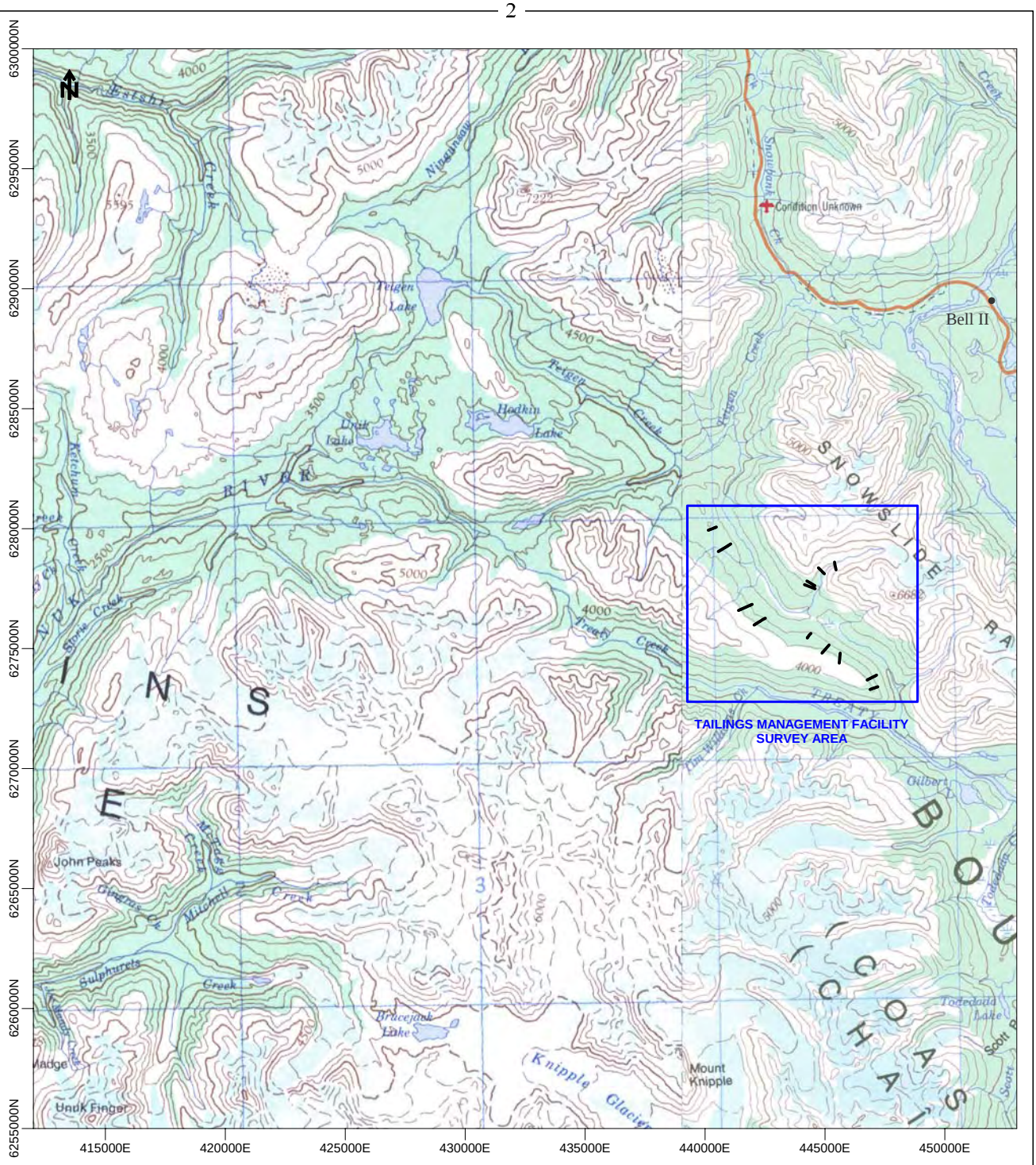
Thirteen seismic traverses were completed at the proposed Tailings Management Facility (TMF) area. A site plan of the TMF area is shown at 1:40,000 scale in Figure 2 of the Appendix. The purpose of the seismic refraction survey was to determine geological conditions at the proposed tailings and water diversion dams, and to aid in locating potential borrow areas for dam construction materials.

A total of approximately 6,090 metres of seismic surveying was carried out at the Tailings Management Facility during this investigation. The survey coverage augments and overlaps previous seismic refraction programs, conducted at the KSM site areas by Frontier Geosciences Inc. in August 2011 [1], August 2010 [2] and July 2009 [3].

[1] Klohn Crippen Berger Ltd. Report on Seismic Refraction Investigation; Kerr Sulphurets Mitchell Project; Bell II Area, B.C.; A. Smith, R. Hillman; August, 2011; FGI Project No. 1206.

[2] Klohn Crippen Berger Ltd. Report on Seismic Refraction, Ice Radar and Ground Penetrating Radar Investigation; Kerr Sulphurets Mitchell Project; Bell II Area, B.C.; A. Smith, R. Hillman; August, 2010**;** FGI Project No. 1150**.**

[3] Klohn Crippen Berger Ltd. Report on Seismic Refraction Investigation; Kerr Sulphurets Mitchell Project; Bell II Area, B.C.; A. Smith, R. Hillman; July, 2009**;** FGI Project No. 1081.



KLOHN CRIPPEN BERGER LTD.		
KERR SULPHURETS MITCHELL PROJECT		
GEOPHYSICAL SURVEY		
SURVEY LOCATION PLAN		
FRONTIER GEOSCIENCES INC.		
DATE: JULY 2012	SCALE 1:250,000	FIG. 1

2. THE SEISMIC REFRACTION SURVEY METHOD

2.1 Equipment

The seismic refraction investigation was carried out using a Geometrics, Geode, 24 channel, signal enhancement seismograph and Oyo Geo Space, 10 Hz geophones. Geophone intervals along the multicored seismic cables varied between 7.5 and 15 metres to ensure high resolution data on subsurface layering as well as to ensure adequate coverage of the basal, bedrock surface. Zero delay electric blasting caps were used to detonate the Geldyne, semi-gelatin dynamite charges. The blasting caps were detonated electrically with an Ideal, high voltage, capacitor- type blasting machine.

2.2 Survey Procedure

For each spread, the seismic cable was stretched out in a straight line and the geophones implanted. Six separate 'shots' were then initiated: one at either end of the geophone array, two at intermediate locations along the seismic cable, and one off each end of the line to ensure adequate coverage of the basal layer. The shots were detonated individually and arrival times for each geophone were recorded digitally in the seismograph. The data recorded during field surveying operations were generally of good to excellent quality.

Throughout the survey, notes were recorded regarding seismic line positions in relation to topographic and geological features in the area. Individual geophone locations were labelled in the field. Relative elevations on the seismic lines were recorded by chain and inclinometer with absolute elevations taken from digital maps provided by Klohn Crippen Berger Ltd.

2.3 Interpretive Method

The final interpretation of the seismic data was arrived at using the method of differences technique. This method utilises the time taken to travel to a geophone from shotpoints located to either side of the geophone. Using the total time, a small vertical time is computed which represents the time taken to travel from the refractor up to the ground surface. This time is then multiplied by the velocity of each overburden layer to obtain the thickness of each layer at that point.

3. GEOPHYSICAL RESULTS

3.1 General

The results of the seismic refraction survey for the Tailings Management Facility area are illustrated at a scale of 1:1000 in Figures 3 to 15, in the Appendix. A site plan displaying the location of the lines is presented at a scale of 1:40,000 in Figure 2 of the Appendix. Seismic lines KC12-SL-34 to KC12-SL-42 were surveyed with 7.5 metre geophone spacings, while seismic lines KC12-SL-43 and KC12-SL-44 were surveyed with 15 metre geophone spacings, and lines KC12-SL-45 and KC12-SL-46 were surveyed with 10 metre geophone spacings, as the latter four lines were anticipated to have greater depths to bedrock.

3.2 Discussion

Seismic line KC12-SL-34 is located in the TMF North Dam area. This line ends close to the beginning of line KC11-SL-23. Both lines are separated by a creek. Line KC12-SL-35 is located southeast of line KC12-SL-34, and intersects previous seismic line KC09-SL-8. These lines are underlain by three distinct velocity layers. The surficial, mostly thin, layer has compressional wave velocities between 375 m/s and 550 m/s. This layer is interpreted as loose sands and gravels, and correlates with the logs for drillholes KC10-23A, KC10-OVB5, and KC10-OVB4. The thickness of this layer ranges from less than a metre to a maximum of about 3.4 metres at the northeast end of seismic line KC12-SL-35.

The intermediate seismic layer has velocities that range from 2060 m/s to 2465 m/s, which indicates a compact layer of glacial till, such as the clayey-silty gravel and boulders encountered in drillhole KC10-OVB4. The depth to the competent bedrock layer varies from less than one metre around station 40NE on line KC12-SL-35, to a maximum depth of 29 metres at about station 450NE on line KC12-SL-35. The competent bedrock surface beneath line KC12-SL-34 averages 2.9 metres in depth. The compressional wave velocities of the basal layer range from 3175 m/s to 5500 m/s. The lower velocity is found along line KC12-SL-35 at the base of the valley, and is likely more weathered or fractured, whereas the higher compressional wave velocities of more than 4000 m/s is likely crystalline bedrock.

Seismic lines KC12-SL-36 and KC12-SL-37 are located in the TMF South Dam area and are extensions of previous seismic lines KC11-SL-15 and KC11-SL-16. The thin surficial layer, with compressional wave velocities between 400 m/s and 1300 m/s, is similar to the seismic velocities of lines KC11-SL-15 and KC11-SL-16, and correlates with the sand and gravel layers found in drillhole KC12-OVB44. The thickness of this layer has a narrow range of 0.3 to 3.7 metres. The intermediate layer varies in seismic velocity between 1800 m/s to 2400 m/s, and is likely composed of gravel colluvium or glacial till, like the dense gravels and hard clays encountered in drillhole KC12-OVB44. The velocity of 1800 m/s at the beginning of line KC12-SL-36 increases slightly to 2100 m/s in the valley bottom. The interpreted velocities for the intermediate layer of line KC12-SL-37 are slightly higher, but likely comprised of the same till materials or heavily fractured bedrock, as was encountered in drillhole KC12-OVB45. The thickness of this layer ranges from 1 metre at the beginning of line KC12-SL-36 to about 17 metres around station 165NE. The thickness variation of this layer is larger along line KC12-SL-37. The thinnest point of about 2.3 metres is located around station 230NE, and the thickest area can be found between stations 390NE and 430NE, with the thickest point of about 39 metres at station 410NE. The average thickness of the intermediate layer along line KC12-SL-37 is about 14 metres. The seismic velocities of the basal layer range from 3670 m/s to 5060 m/s and are interpreted as the competent bedrock layer. The lowest basal velocity is located around the deepest point to bedrock on line KC12-SL-37 at station 410NE, with a depth of 46 metres. The depth to bedrock along line KC12-SL-36 varies from 1.6 metres at station 575NE to 19 metres at station 165NE, and averages about 9 metres.

Seismic lines KC12-SL-38 through KC12-SL-42 are located in the TMF Southeast Dam area and are extensions to former lines KC11-SL-17 through KC11-SL-21, respectively. The compressional wave velocities of the surficial layer of all five seismic lines ranges between 330 m/s and 990 m/s and therefore is likely composed of sand and gravel alluvium or gravel colluvium. The drill log for KC12-OVB46 indicates compact sand for the first two metres. The surficial layer averages 1.5 metres in thickness. The intermediate layer for these lines has velocities between 1800 and 2500 m/s, which is interpreted as a compact sand, gravel and clay till, with the exception of line KC12-SL-42, where a section of the intermediate layer has a velocity of about 1500 m/s and is interpreted as saturated soils. This intermediate layer correlates well with the very dense gravels encountered in drillhole KC12-OVB46. The thickest areas of this intermediate layer are found at the northeast end of line KC12-SL-38 (about 18 metres), and at the southwest end of line KC12-SL-39 (about 27 metres). Elsewhere this layer is interpreted to be typically about 5 to 10 metres in thickness. At the northeast end of line KC12-SL-41, the interpretation of the thickness and velocities of the

intermediate layers for the first spread of line KC11-SL-20 were modified to reflect the additional information of the new line.

The interpreted bedrock velocities are relatively high, 4480 to 4555 m/s, on lines KC12-SL-38 and KC12-SL-39. Similar velocities are also found on seismic lines KC12-SL-40 to KC12-SL-42, although on these lines there is also indication of a lower velocity section of bedrock. Line KC12-SL-40 has an interpreted bedrock velocity of 3515 m/s for about 180 metres from station 0NE to station 180NE, and a velocity of about 4410 m/s from station 180NE to 420NE. Line KC12-SL-41 has an interpreted bedrock velocity of 4250 to 4370 m/s on the southwest end of the line, and a velocity of about 3350 m/s below the creek and adjacent slopes. Seismic line KC12-SL-42 has an interpreted bedrock velocity of about 4055 to 4145 m/s, except for the first 35 metres at the southwest end of the line where the interpreted velocity is 3220 m/s.

Seismic lines KC12-SL-43 to KC12-SL-46 are located in the valley to the north of the TMF area, where a water diversion dam is proposed. Line KC12-SL-43 is interpreted to have four seismic velocity layers. The surficial layer of loose materials has a velocity of 500 to 600 m/s, with a thickness of about 0.3 to 6.7 metres. Underlying this is a moderately dense or saturated layer with a velocity of about 1450 m/s to 1630 m/s, and a thickness of about 1.5 to 5.7 metres. The third seismic layer has a relatively high velocity of 2530 to 2580 m/s, which indicates a very compact till layer. The average thickness of this layer is about 40 metres on the southwest side of the line, and about 15 metres on the northeast side. The interpreted bedrock velocities are between 3930 and 4580 m/s, with the exception of a low velocity zone between about stations 190SE to 225SE, with a velocity of about 2700 m/s. This suggests an area of highly weathered, or fractured bedrock, and the possible presence of a fault at about station 190SE. In this area, the low contrast in seismic velocities between the bedrock and overlying till causes a depression in the interpreted bedrock surface. The depth of this depression may not be as accurate as the interpreted bedrock depths for the rest of this line.

Seismic line KC12-SL-44 is located about 150 metres further up the valley from line KC12-SL-43. The surficial layer of loose materials has a similar velocity of 500 to 600 m/s, and a thickness ranging from about 0.1 to 7.6 metres. However on this line the data did not indicate a sufficiently thick secondary layer overlying the till, and a three layer case was used to model the data. The velocity of the compact till was between 2200 and 2500 m/s, with a minimum thickness of 8 metres below the creek in the middle of the line, and a maximum thickness of 20 to 25 metres at each end of the line. The velocity of the interpreted bedrock

was between 3520 and 4335 m/s, and the lowest velocity bedrock was found in the middle of the line between about stations 120SE and 300SE.

The interpreted results for seismic line KC12-SL-45 are shown in Figure 14. The surficial layer with a seismic velocity of 400 to 550 m/s can be correlated with the dry gravel and sand found in the upper 4 metres of the overburden drillhole log for KC11-36. The second seismic layer with a velocity of 1145 to 1450 m/s correlates well with the moist to wet gravel and sand found in the drillhole log between the depths of 4 and 17.5 metres. The third seismic layer has a velocity of 2100 m/s, and correlates well with the denser gravel and sand layers with higher SPT blow counts, indicated in the drillhole log between the depths of 17.5 and 43 metres. The interpreted bedrock velocity is between 3365 and 4465 m/s. At station 120SE the drillhole log indicates weathered, fractured sandstone beginning at a depth of 43 metres, and fresh, hard sandstone beginning at about 53 metres depth. The interpreted depth to bedrock at this point is about 51 metres, which correlates well with the more competent sandstone layer.

The interpreted results for seismic line KC12-SL-46 are shown in Figure 15. The surficial layer of loose materials has a seismic velocity between 300 and 400 m/s, and a thickness that ranges between about 1.4 and 7.4 metres. The second seismic layer has a velocity of about 1320 m/s between stations 0SE and 120SE, which indicates moderately dense and/or partially saturated soils. Between stations 120SE and 210SE, the velocity of the second layer increases to 1600 m/s indicating fully saturated soils below the creek. On the hillside at the southeast end of this line, the velocity of the second layer reduces to 520 and 850 m/s, which indicates relatively loose, unsaturated materials. The third seismic layer has a velocity of about 1810 to 2100 m/s, which generally indicates a compact sand, gravel and clay till. This layer is very thin except for below the creek between stations 120SE and 210SE, with a maximum thickness of about 10 metres. The interpreted bedrock velocity is between 3700 and 4460 m/s, with the lowest velocity found below the creek.

4. LIMITATIONS

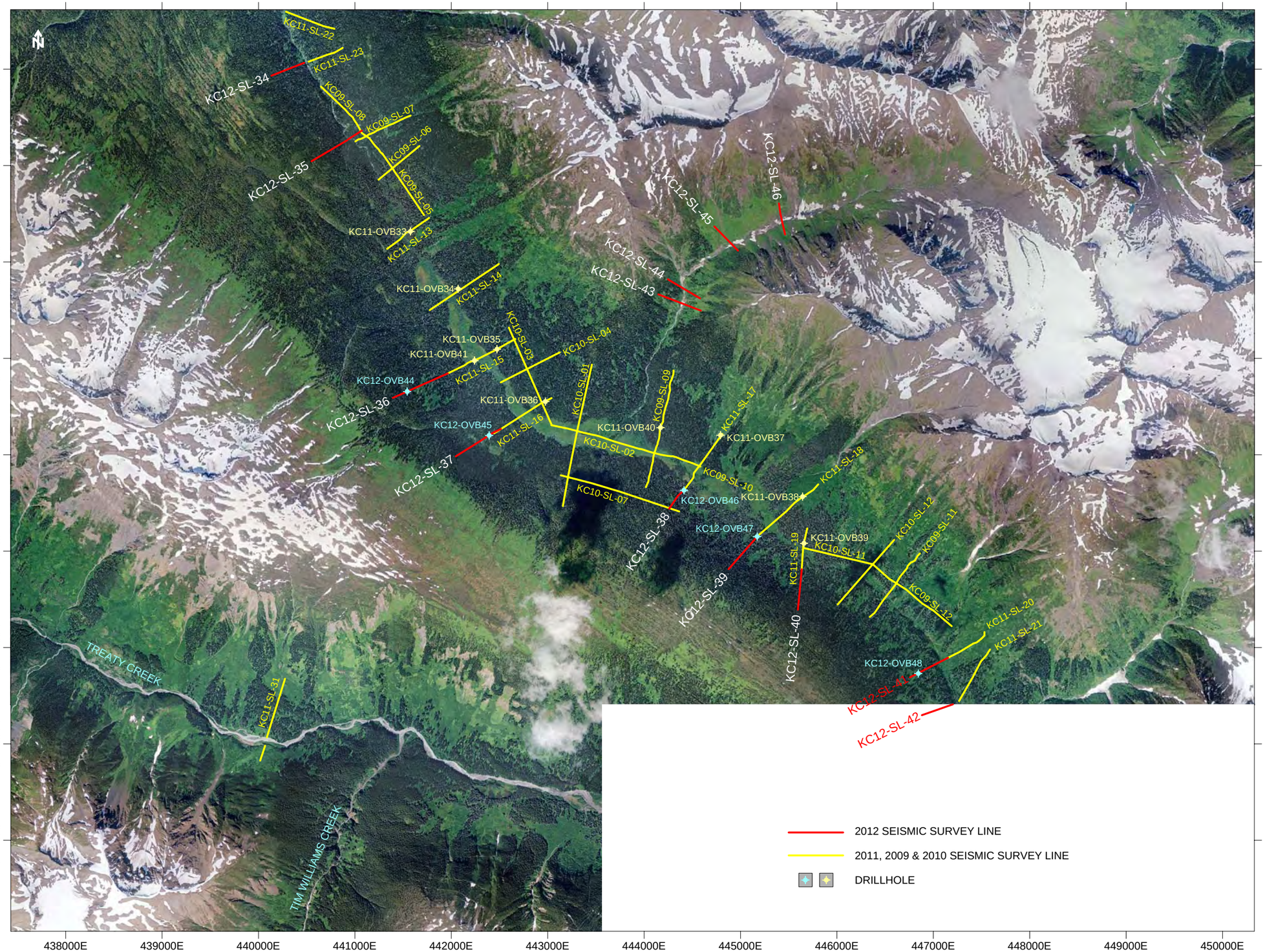
The depths to subsurface boundaries derived from seismic refraction surveys are generally accepted as accurate to within fifteen percent of the true depths to the boundaries. In some cases, unusual geological conditions may produce false or misleading data points with the result that computed depths to subsurface boundaries may be less accurate. In seismic refraction surveying difficulties with a 'hidden layer' or a velocity inversion may produce erroneous depths. The first condition is caused by the inability to detect the existence of a layer because of insufficient velocity contrasts or layer thicknesses. A velocity inversion exists when an underlying layer has a lower velocity than the layer directly above it. The interpreted depths shown on drawings are to the closest interface location, which may not be vertically below the measurement point if the refractor dip direction departs significantly from the survey line location.

The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the seismic refraction method.

For: Frontier Geosciences Inc.

Kevin Payne, P.Eng.

Russell Hillman, P.Eng.



KLOHN CRIPPEN BERGER LTD.

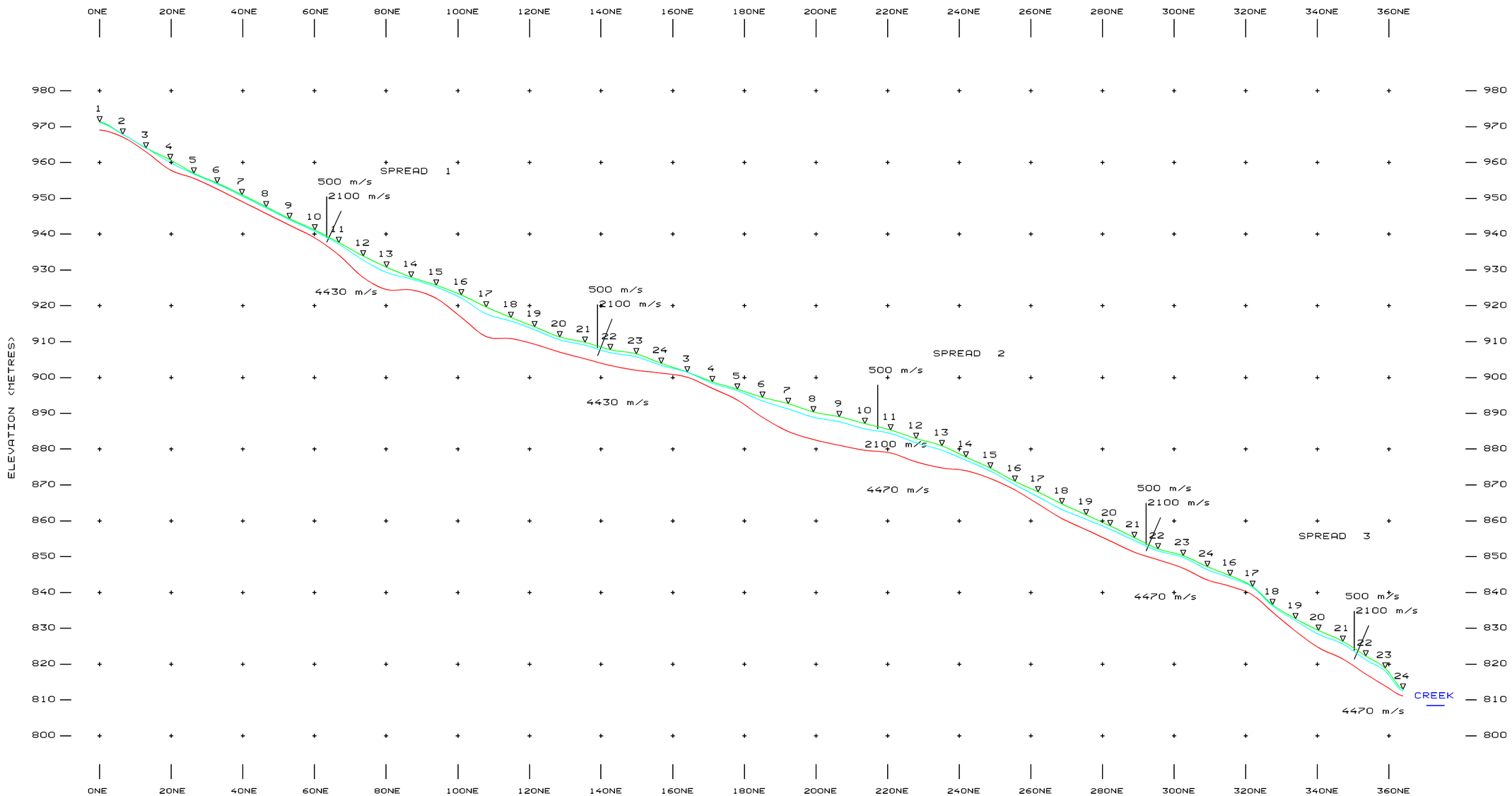
KERR SULPHURETS MITCHELL PROJECT

SEISMIC REFRACTION SURVEY

TAILINGS MANAGEMENT FACILITY SITE PLAN

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:40,000	FIG. 2



SEISMIC LINE KC12-SL-34

INSTRUMENT: GEOMETRICS GEODE

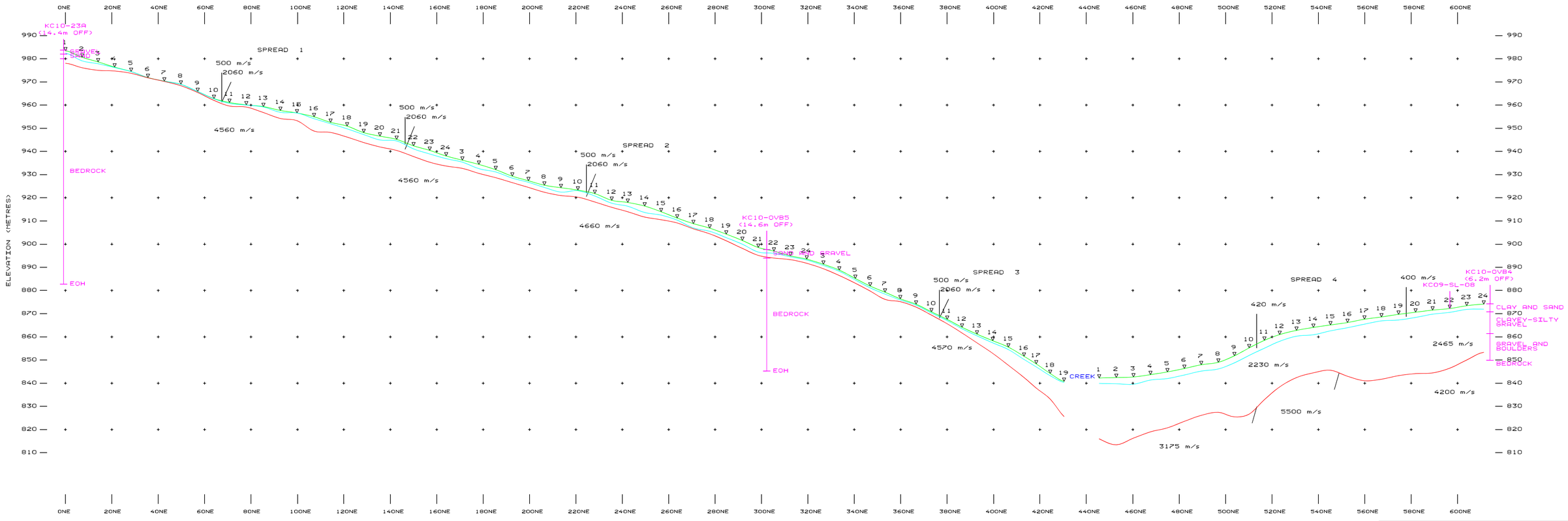
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-34

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 3



SEISMIC LINE KC12-SL-35

INSTRUMENT: GEOMETRICS GEODE

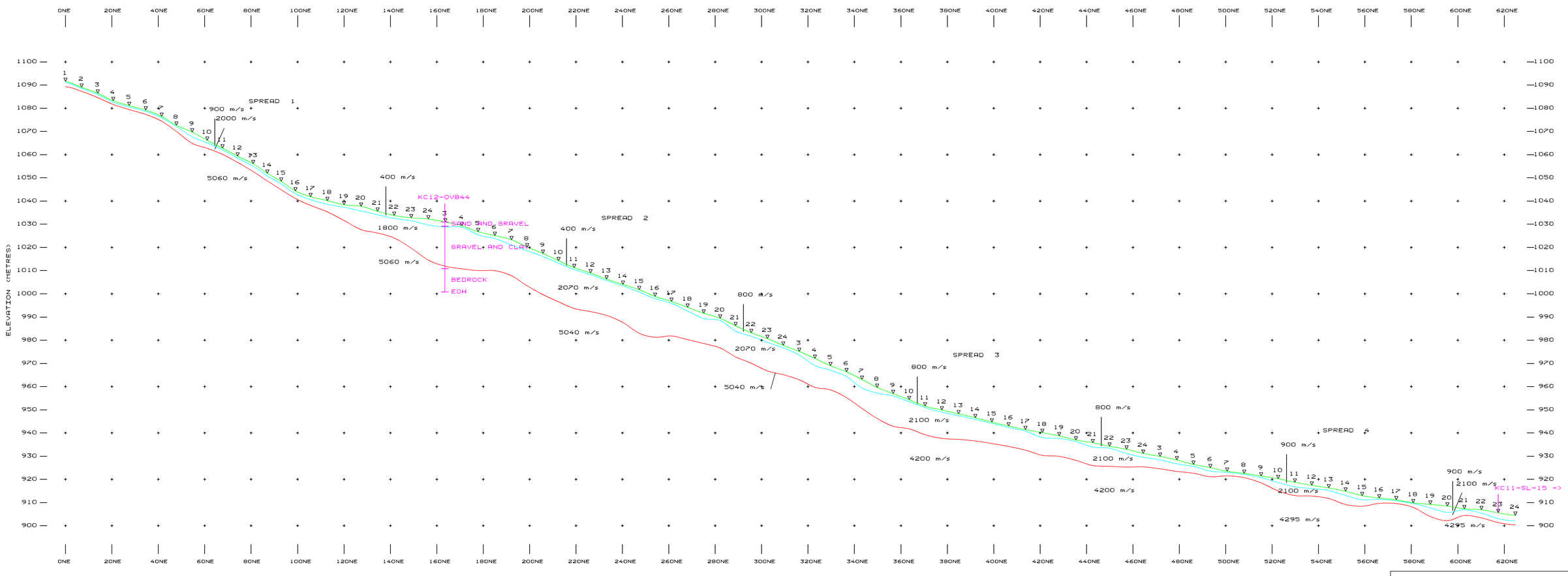
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-35

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 4



SEISMIC LINE KC12-SL-36

INSTRUMENT: GEOMETRICS GEODE

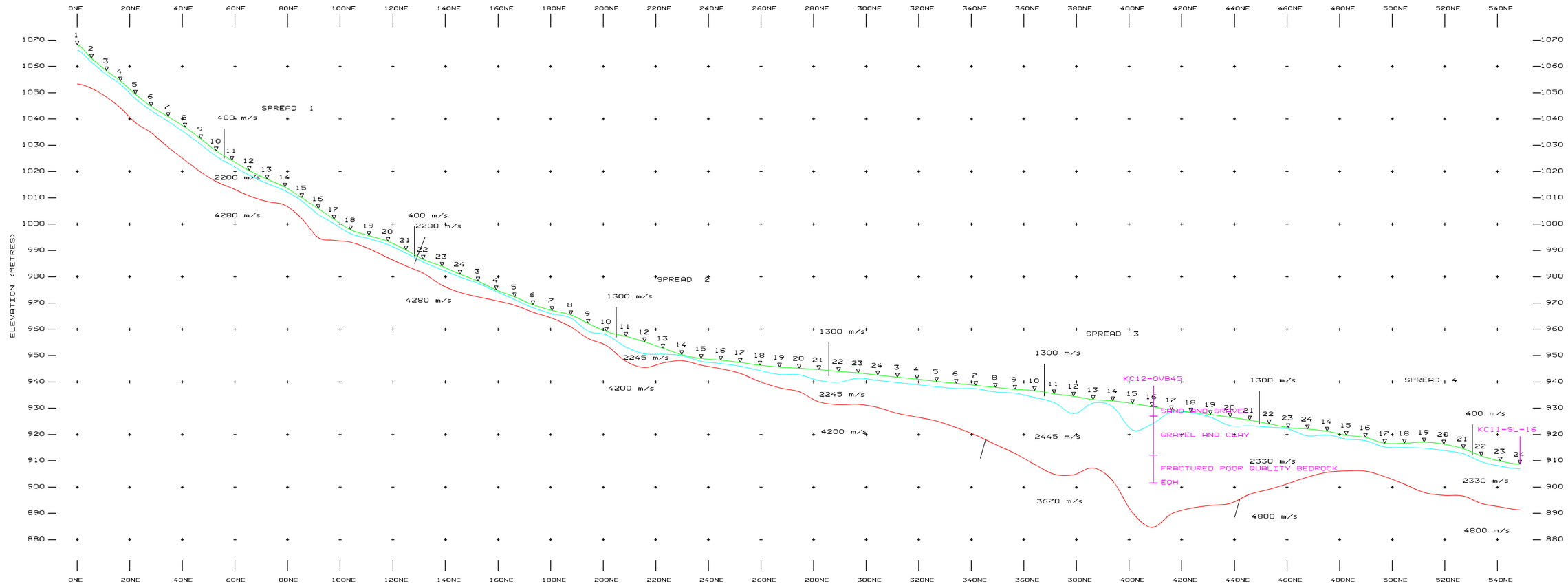
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-36

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 5



SEISMIC LINE KC12-SL-37

INSTRUMENT: GEOMETRICS GEODE

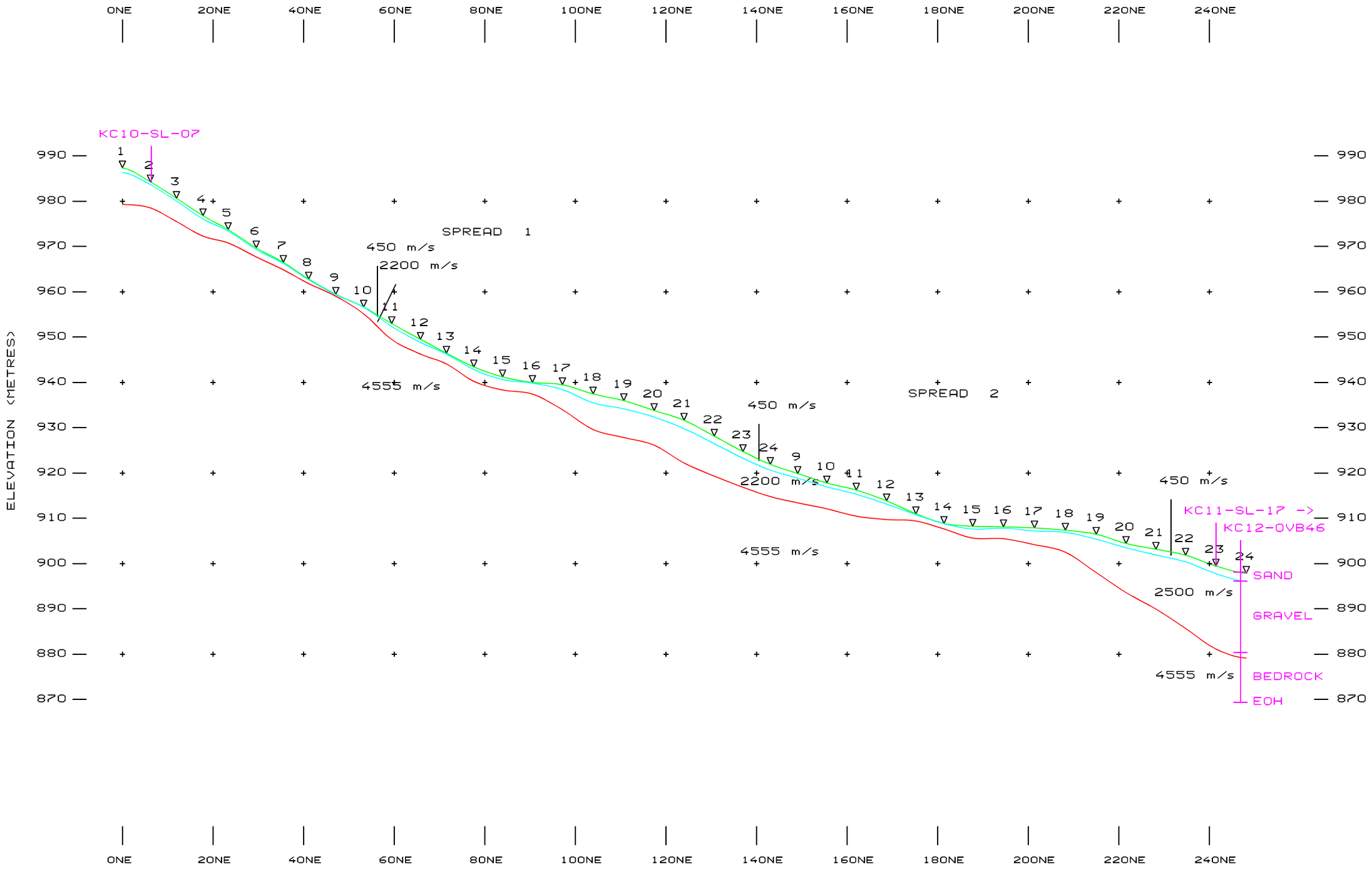
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-37

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 6



SEISMIC LINE KC12-SL-38

INSTRUMENT: GEOMETRICS GEODE

KLOHN CRIPPEN BERGER LTD.

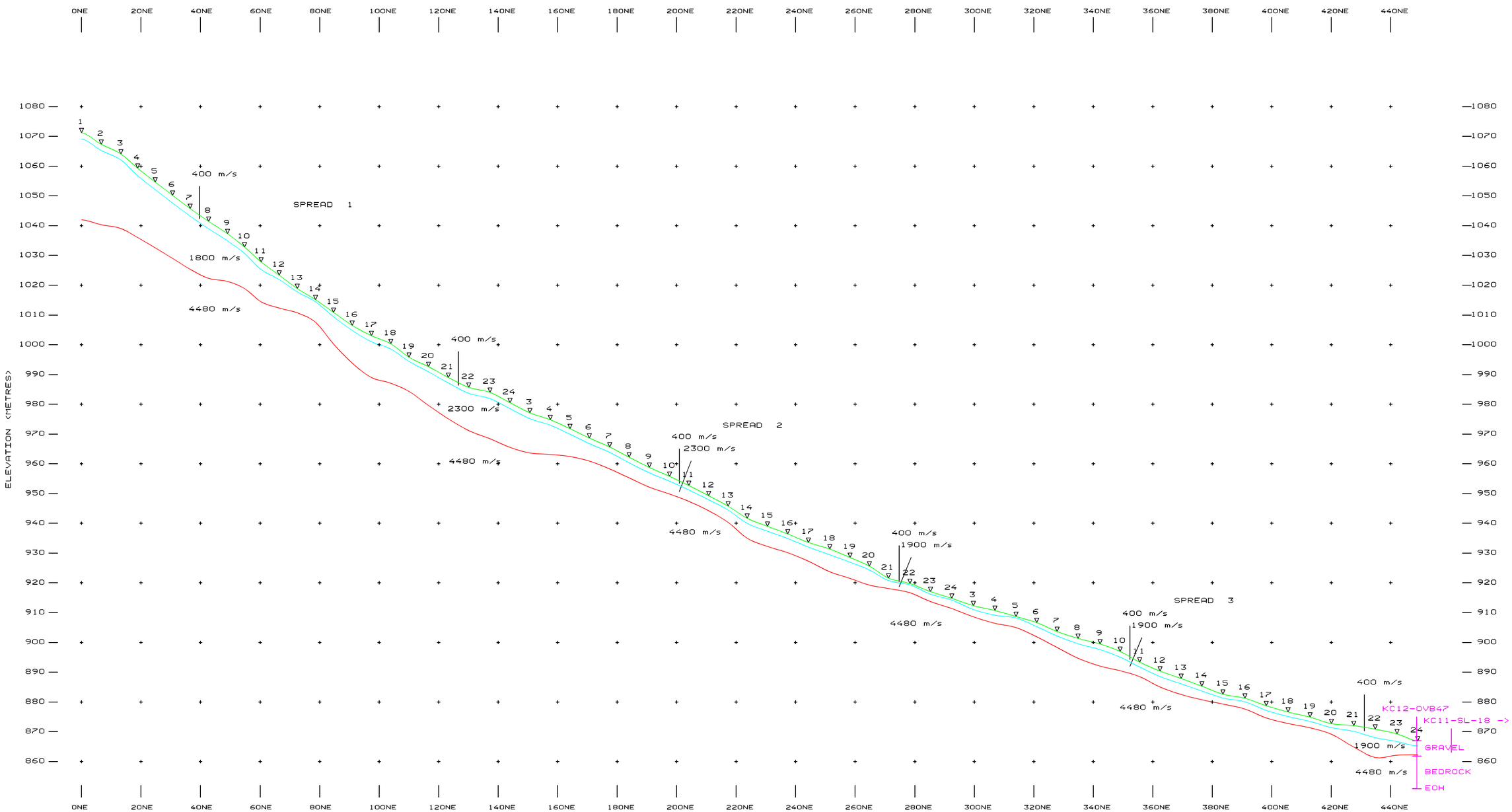
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-38

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 7



SEISMIC LINE KC12-SL-39

INSTRUMENT: GEOMETRICS GEODE

KLOHN CRIPPEN BERGER LTD.

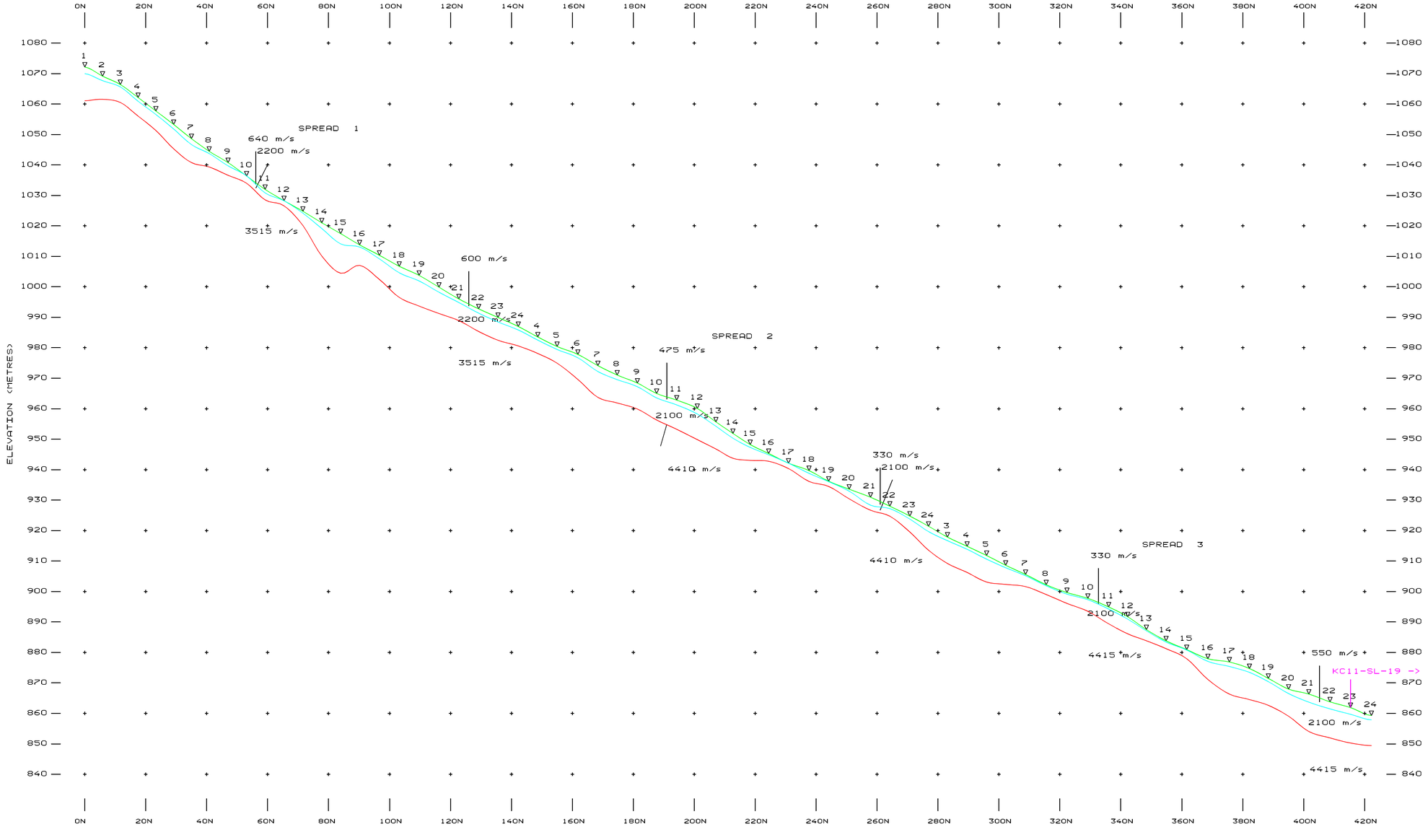
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-39

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 8



SEISMIC LINE KC12-SL-40

INSTRUMENT: GEOMETRICS GEODE

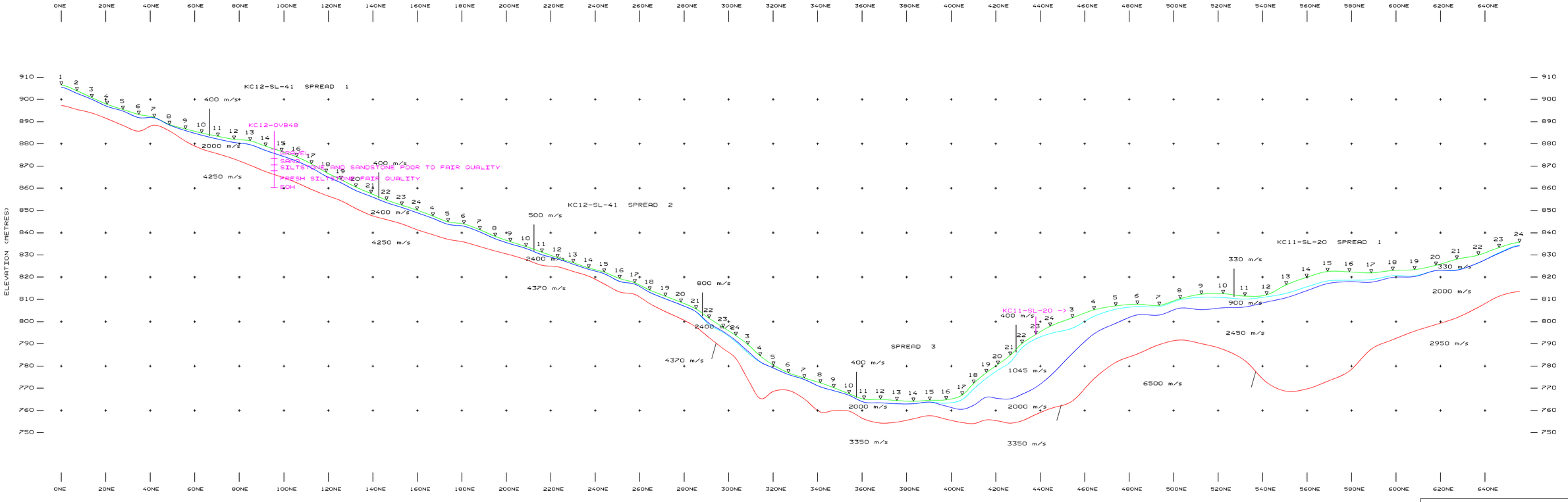
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-40

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 9



SEISMIC LINE KC12-SL-41 & KC11-SL-20

INSTRUMENT: GEOMETRICS GEODE

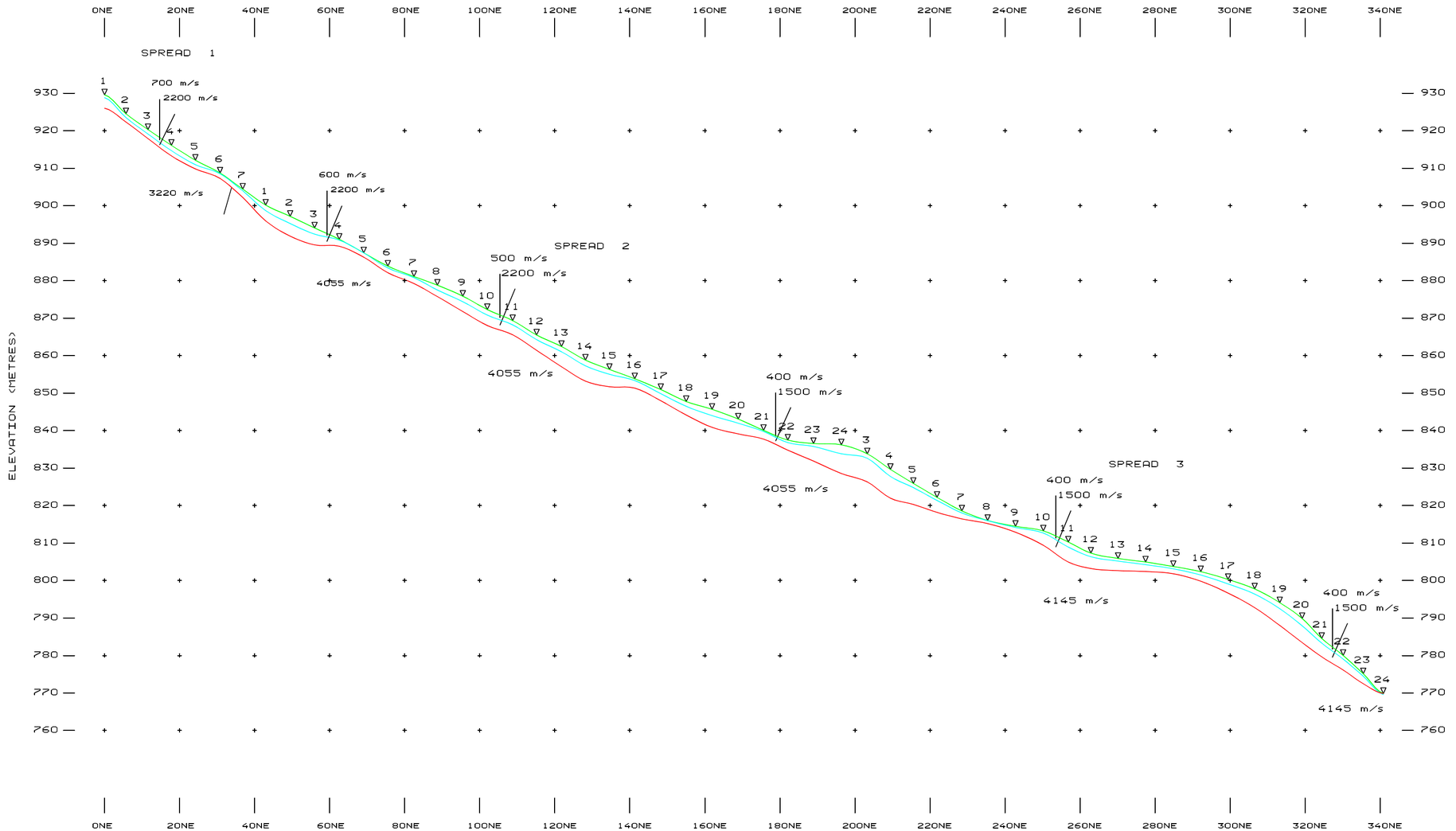
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
KC12-SL-41 & KC11-SL-20

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 10



SEISMIC LINE KC12-SL-42

INSTRUMENT: GEOMETRICS GEODE

KLOHN CRIPPEN BERGER LTD.

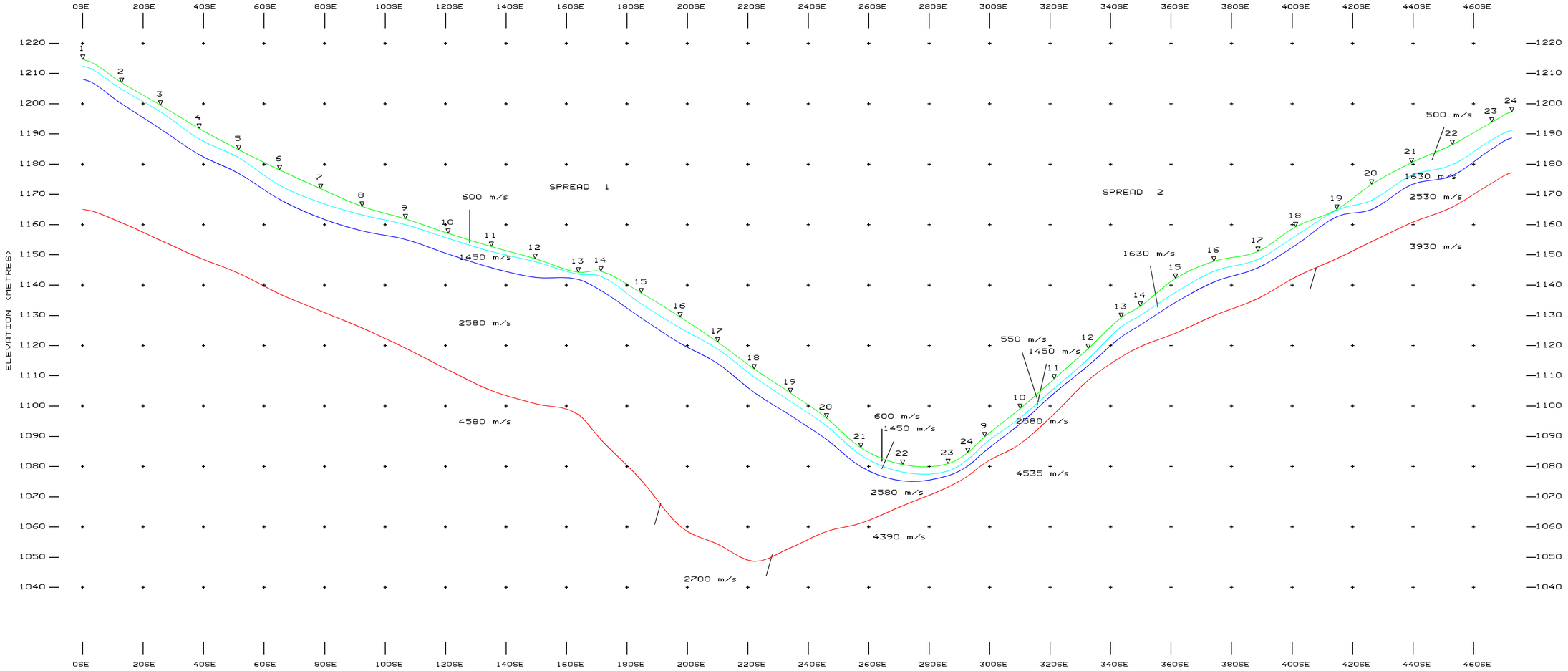
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-42

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 11



SEISMIC LINE KC12-SL-43

INSTRUMENT: GEOMETRICS GEODE

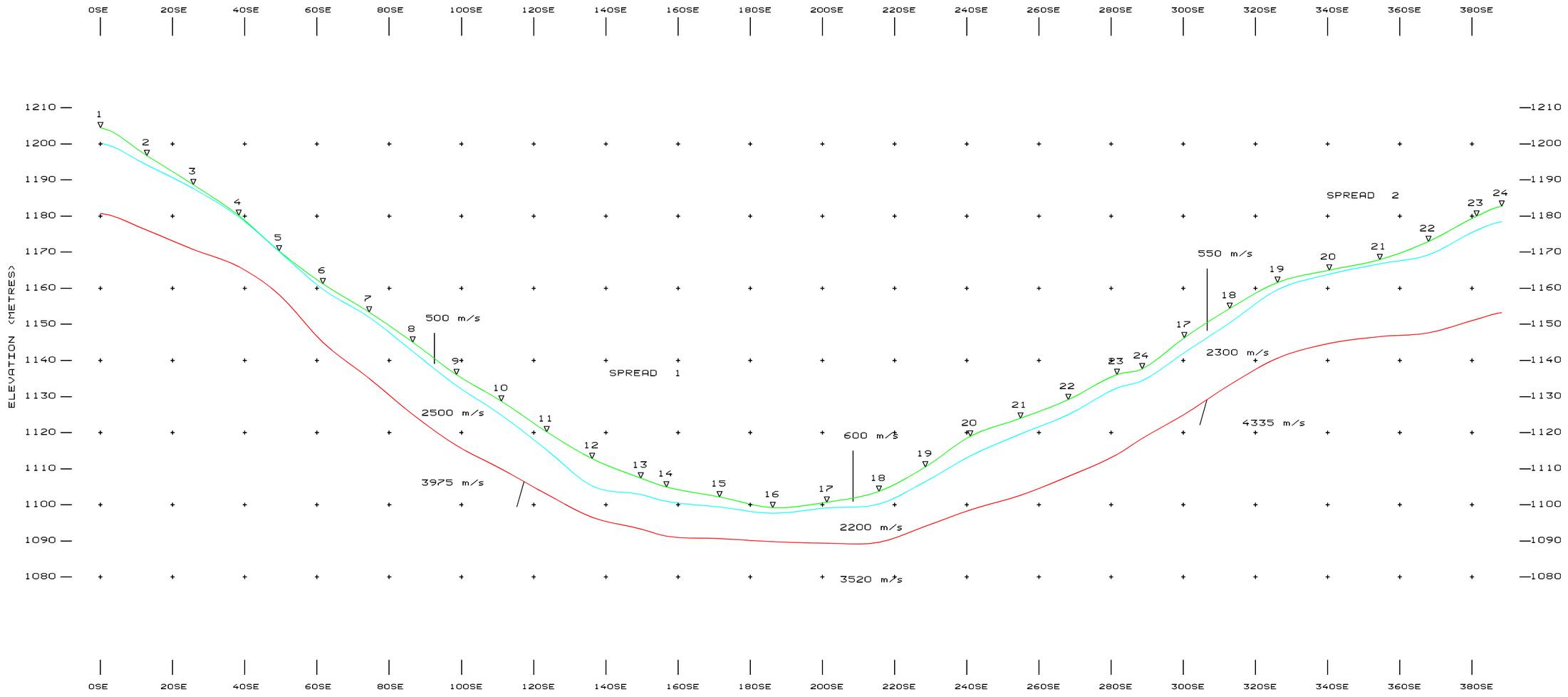
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-43

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 12



SEISMIC LINE KC12-SL-44

INSTRUMENT: GEOMETRICS GEODE

KLOHN CRIPPEN BERGER LTD.

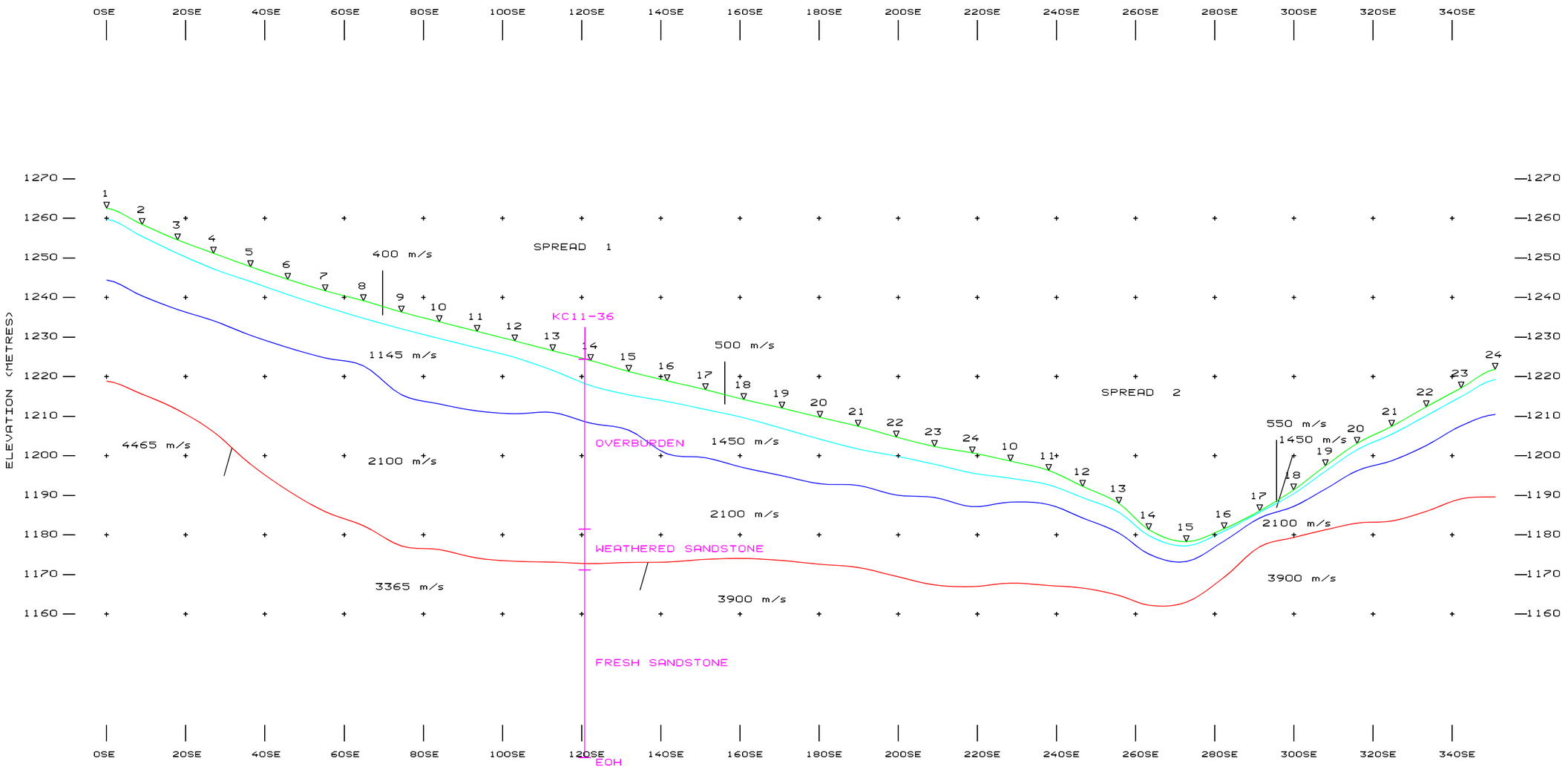
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-44

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 13



SEISMIC LINE KC12-SL-45

INSTRUMENT: GEOMETRICS GEODE

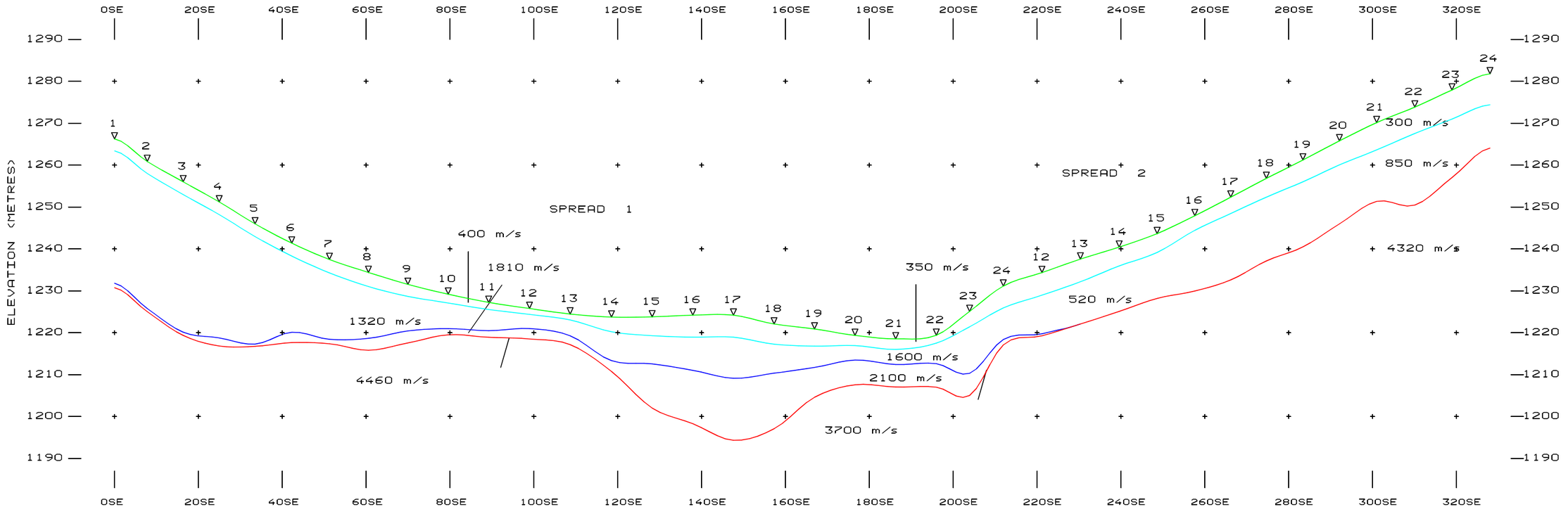
KLOHN CRIPPEN BERGER LTD.
KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-45

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 14



SEISMIC LINE KC12-SL-46

INSTRUMENT: GEOMETRICS GEODE

KLOHN CRIPPEN BERGER LTD.

KERR SULPHURETS MITCHELL

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION KC12-SL-46

FRONTIER GEOSCIENCES INC.

DATE: JULY 2012	SCALE 1:1000	FIG. 15