GEOTECHNICAL ASSESSMENT
NEW ACCESS ROAD AND PAVEMENT AREA
(EXCAVATED CONTAMINATION REPAIR)
BOWDEN INSTITUTION, BOWDEN, ALBERTA

Submitted to:
Associated Engineering
Red Deer, Alberta

Submitted by:

AMEC Earth & Environmental
A Division of AMEC Americas Ltd.
Red Deer, Alberta

February 2011

AMEC File No. RX07748

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1.0 INTRODUCTION

At the request of Mr. Steven Kennedy, C.Tech., of Associated Engineering, AMEC Earth & Environmental (AMEC) was retained to conduct a geotechnical investigation for a proposed new access road and pavement area (over a trench).

The purpose of the geotechnical investigation was to review the soils and groundwater conditions at the site, and to provide geotechnical design parameters, recommendations and discussion relative to:

- site grading and subgrade preparation; and
- flexible pavement design.

This report summarizes the results of the field and laboratory work and provides comments and recommendations with regard to the issues noted above.

2.0 PROJECT AND SITE DESCRIPTION

This project involves the construction of approximately 540 m of new access road on the north side of the existing Bowden Institution and a new pavement area (excavated contamination repair) near the Agribusiness centre. A location plan indicating the general expansion layouts is presented as Figure 1, in Appendix A.

The Bowden Institution is located in the NE ¼ of Section 1, Township 35, Range 1, West of the 5th Meridian. The new access road area is relatively flat with a very gentle slope downward to the north.

At the time of the field program the proposed development areas were snow covered.

3.0 GEOTECHNICAL PROGRAM

3.1 Field Investigation

On January 12, 2011, three boreholes were advanced at the site, and designated as BH 1 through BH 3 in the area of the proposed access roadway. The approximate locations of the test holes are shown on the site plan included as Figures 1, Appendix A. The boreholes in the new access road area were advanced to depths of approximately 3 m. The ground surface elevation at the location of the boreholes was provided by Associated Engineering. The elevations of the ground surface at the borehole locations varied between 943.923 m and 943.314 m geodetic. The drilling was conducted using a truck-mounted auger drill, with continuous flight 150 mm diameter solid-stem augers. Evergreen Drilling & Environmental Testing Limited of Wetaskiwin performed the drilling, and AMEC geotechnical personnel logged the soil samples and auger cuttings.

Disturbed soil samples were obtained from the excavated soil returned to the surface, for determination of the in-situ moisture profile in each borehole. Field classification of the soil types encountered was based on the conditions observed on the augers. The soils were logged according to the Modified Unified Soil Classification System, which is described on the explanation of terms and symbols in Appendix B.

3.2 Laboratory Testing Program

Selected soil samples were returned to AMEC's laboratory for further classification and index testing to aid in the determination of engineering properties. Laboratory test results included:

- Natural moisture content;
- Atterberg Limits;
- Grain size analysis; and
- California Bearing Ratio (CBR)

Laboratory test results are presented on the borehole logs, in Appendix A.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The borehole logs in Appendix A present the soil conditions as logged in the field at each borehole location. The following sections outline the general soils encountered. Specific details of subsurface soil conditions encountered are presented on the borehole logs.

The predominant subsurface soil at depth was very silty, and sandy clay. The surficial soils consisted of gravel in BH1 and topsoil in BH2 and BH3.

Topsoil was encountered at ground surface in BH2 and BH3. The thickness of the topsoil was 600 mm and 300 mm, in boreholes BH2 and BH3, respectively.

Clay was encountered below the surficial gravel in BH1 and below the topsoil in boreholes BH2 and BH3. The clay was encountered at depths of between 0.15 m and 0.6 m. The clay was generally, very sandy, very silty, low plastic, and varied in consistency between soft and firm, with the majority of the soils, soft. The moisture content ranged from approximately 20 to 31 percent, and was considered to be moist to wet. All boreholes were terminated in the clay at a depth of approximately 3 m.

4.2 Observed Groundwater Conditions

Groundwater seepage was noted in most of the boreholes during and upon drilling completion. On January 25, 2011, approximately 9 days after drilling, groundwater levels in the standpipes were measured. The measured groundwater levels at the site are shown in the table below:

Table 1: Measured Groundwater Depths below Grade (m)

Borehole No.	Depth (m) of Borehole	Ground geodetic elevation (m)	Geodetic Groundwater Level Upon Completion of Drilling (m)	Geodetic Groundwater Level on January 21, 2011
BH1	3.0	943.843	942.043	941.843
BH2	3.0	943.923	942.023	942.023
BH3	3.0	943.314	941.014	941.714

The volumes of groundwater encountered during construction will be dependent on seasonal conditions and the size and permeability of sand and silt soil layers and lenses intercepted by excavations.

The groundwater levels are expected to fluctuate seasonally, and to rise during periods of heavy precipitation and following snow melting. Additional groundwater measurements should be obtained prior to tendering the construction contract.

5.0 GEOTECHNICAL RECOMMENDATIONS

5.1 General

The subsurface conditions in the areas of the proposed new access road and excavated contamination repair would provide less than favorable subgrade support. AMEC was not on site and cannot comment on the condition of the subgrade in the excavated contamination repair area. Accordingly, AMEC accepts no liability for future performance of the subgrade in the repair area. The responsibility for any decision to construct the existing fill ultimately lies with the owner.

The following sections provide discussion and recommendations concerning geotechnical aspects of the proposed development.

5.2 Site Grading

Based on the geometric design provided by Associated Engineering, it is anticipated that the final design grade elevations are in the order of 0.1 m to 0.4 m above the existing ground elevations.

5.2.1 Topsoil

The existing surficial topsoil should be stripped from all site construction areas. It may be stockpiled for later reuse in landscaping areas. Topsoil depths varied from 0 to 600 mm in the new access road area.

5.3 Subgrade Preparation

Provisions for surface and subgrade drainage are important in maintaining favourable subgrade support conditions. It is understood that a crown surface will be provided for the pavement with cross grades in the order of 1 to 1.5 percent. AMEC recommends these grades be controlled and maintained at the subgrade elevation level.

Due to the less than favorable subgrade support, subgrade improvements will be required. An additional subcut in the order of 0.6 m will be required to improve the subgrade to allow for construction traffic. Once the subcut is made, woven geotextile should be installed (as per the manufacturer's recommendations) at the base of the subcut elevation to provide a separator prior to the placement of granular subgrade improvement material. The granular subgrade improvement material should be granular subbase course materials (GSBC) placed in one lift and compacted to a minimum of 98 percent of SPMDD at or within 3% below optimum moisture content.

It is also recommended that a trial test section be constructed using the above 0.6 m cut methodology then, the subgrade improvement test section should be proof-rolled using a fully loaded tandem axle truck to confirm that surface deflections are minimal under the influence of truck loadings in addition to an acceptable degree of compaction having been achieved. If the test section is determined to be successful then continue with the subcut regime. If excessive deflections are identified during the proofrolling then the subgrade should be over-excavated to sufficient depth below the original subcut, and backfilled with granular material. The depth of over-excavation should be determined by the Engineer in the field based on observation of subgrade conditions.

5.4 Pavement Design

5.4.1 New Access Road

Based on the laboratory testing conducted by AMEC, the soaked CBR test result for the native soils indicated a value of 5.2.

The existing clayey silty soils are considered frost susceptible. The site conditions overall are considered conducive to development of significant frost heave due to the shallow groundwater that was encountered during the field program for this investigation. Normally, frost mitigation measures are not incorporated into roadway construction on the basis of soil gradation, due to the cost of such measures and the large areas over which potentially frost susceptible conditions are encountered. Rather, normal practice is to construct the roadway and then monitor over several years to determine if frost heaving actually occurs. Where frost heaving occurs regularly, measures can be installed to prevent future occurrences. The performance of nearby paved surfaces can be used to provide some guidance as to the likelihood that frost heave will emerge as a consideration for the current section of roadway.

5.4.2 Flexible Pavement Design

It is understood that the proposed new access road and trench pave area will include a flexible asphalt concrete pavement. The recommended pavement structure is presented below. The design for the recommended pavement section assumes the following:

- The subgrade will be prepared in accordance to the recommendations noted in Section 5.3.
- All materials supplied and placement/construction methodologies meet the current Alberta Infrastructure Standard Specifications.
- 2×10^6 - 80 kN equivalent single axle loads (ESALs), over the design period;
- A drainage coefficient of 1.0;
- Reliability level of 75%; and
- M_r = 30 MPa.

The following pavement structure is recommended for the proposed new access road and pavement repair area:

- Hot Mix Asphalt Concrete Pavement (HMAC) – 100 mm minimum
- Granular base course (GBC) – 150 mm minimum
- Granular Subbase Course (GSBC) – 400 mm minimum

For all materials specifications for asphalt cement penetration grade, gradation for granular materials and compaction requirements for granular subgrade, granular subbase, granular base and asphalt refer to Alberta Infrastructure Highway specifications.

6.0 CONSTRUCTION TESTING AND MONITORING

All engineering design recommendations presented herein are based on the assumption that adequate monitoring will be provided by the geotechnical consultant during construction. An adequate level of testing and monitoring is considered to be:

- Earthworks: - full time monitoring and compaction testing
- Pavement Component - testing as per Alberta Infrastructure specifications

7.0 ALL CLOSURE AND LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings in three boreholes advanced on the site during the present investigation. If conditions other than those reported are noted during subsequent phases of the project, AMEC should be notified and given the opportunity to review the current recommendations in light of the new findings.

This report has been prepared for the exclusive use of Associated Engineering, and their designers for specific application to the project described in this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

Respectfully submitted,

AMEC Earth & Environmental,
a division of AMEC Americas Limited

REGISTERED ENGINEERING TECHNOLOGIST
DOUG HALLDORSON
3067
ALBERTA
11 Feb 2011

Doug Halldorson, R.E.T.
Red Deer Office Manager
Senior Materials Technologist

PROFESSIONAL ENGINEER
CRAIG S. SKRYNYK
ALBERTA
11 Feb 2011

Craig Skrynyk, M.Eng., P.Eng.
Senior Materials Engineer

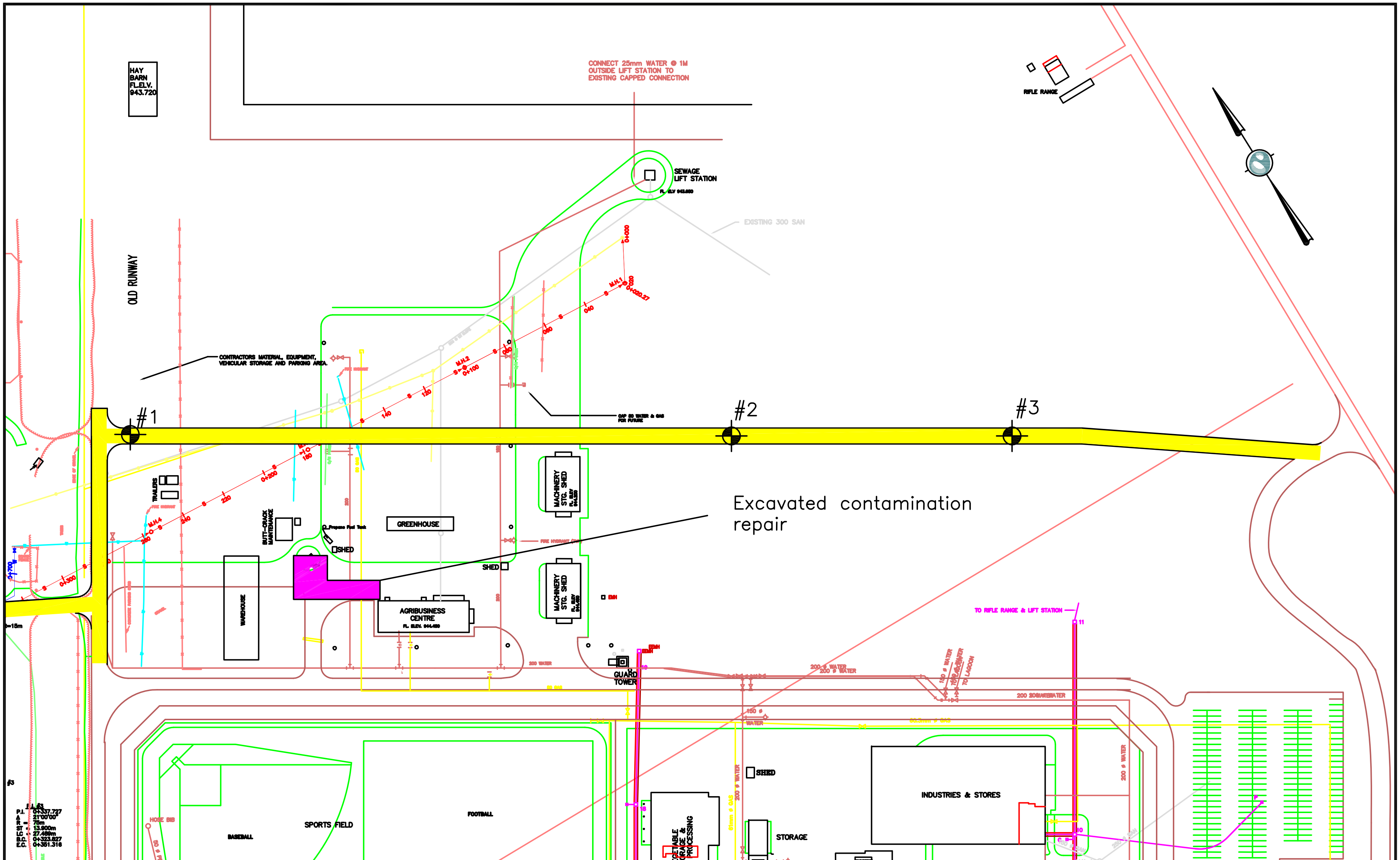
Reviewed by:

Kevin Spencer, M.Eng. P.Eng.,
Associate Geotechnical Engineer

PERMIT TO PRACTICE
AMEC Earth & Environmental
a Division of AMEC Americas Limited
Signature
Date 11 Feb 2011
PERMIT NUMBER: P-04546
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

APPENDIX A

Figure 1, Borehole Logs
And
Laboratory Results



CLIENT: Associated Engineering	DWN BY: DH	PROJECT: Bowden Institution North Site Road, Bowden, Alberta	REV. NO.: A
	CHK'D BY:		DATE: February 2011
AMEC Earth & Environmental, #4, 5551 45 Street, Red Deer, Alberta, T4N 1L2		TITLE: Borehole Location Plan	PROJECT NO: RX07748
	SCALE: N.T.S.		FIGURE No. FIGURE 1

Project: Bowden Institution	Geotechnical Investigation	Borehole No: 1
Associate Engineering		Project No: RX07748
Method: Solid Stem Auger		Elevation: 943.843 m

SAMPLE TYPE: Shelby Tube, Core, SPT Test (N), Grab Sample, Split-Pen

BACKFILL TYPE: Bentonite Grout, Pea Gravel, Drill Cuttings, Slough, Bentonite Chips, Sand

Column headings: Depth (m) | STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80 | SOIL SYMBOL | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | WELL INSTALLATION | OTHER TESTS COMMENTS | ELEVATION (m)

Depth (m)	Soil Description	Sample No	SPT (N)	Other Tests / Comments	Elevation (m)
0	FILL: gravel and sand, 20 mm crush, brown, moist.				
	Clay: very silty, very sandy, low plastic, firm, brown, moist				
		G1		Grain Size Analyses: Sand = 29% Silt = 66% Clay = 5% Frozen to 0 .6 mts.	
					943
1		D1	8		
		G2			
		B1			942
2					
	Very sandy				
		G3			
	CLAY: silty, sandy, low to medium plastic, firm, brown, moist	D2	4		
					941
3	End of hole at 3.0 meters. 25 mm standpipe installed to 3.0 m. Bottom 1.5 m hand slotted. Water at 1.8 m upon completion Water at 2.0 m on January 21, 2011.				
3.5					

amec	AMEC Earth and Environmental Red Deer, AB	LOGGED BY: DH	COMPLETION DEPTH: 3.00 m
		REVIEWED BY: CS	COMPLETION DATE: 1/12/11
		FIG #:	Page 1 of 1

Project: Bowden Institution	Geotechnical Investigation	Borehole No: 2
Associate Engineering		Project No: RX07748
Method: Solid Stem Auger		Elevation: 943.923 m

SAMPLE TYPE: Shelby Tube, Core, SPT Test (N), Grab Sample, Split-Pen

BACKFILL TYPE: Bentonite Grout, Pea Gravel, Drill Cuttings, Slough, Bentonite Chips, Sand

Depth (m)	STANDARD PEN (N) 20 40 60 80 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	WELL INSTALLATION	OTHER TESTS COMMENTS	ELEVATION (m)
0			TOPSOIL: grass covered, organic, black, moist.						
				Grab	G1				
			CLAY: very silty, very sandy, low plastic, firm, brown, moist					Frozen to 0 .6 mts.	
								Grain Size Analyses: Sand = 7% Silt = 89% Clay = 4%	943
1				SPT	D1	4			
				Grab	G2				
2			very sandy.						942
				Grab	G3				
			wet.	SPT	D2	4			
			CLAY: silty, sandy, low to medium plastic, firm, brown, moist						941
3			End of hole at 3.0 meters. 25 mm standpipe installed to 3.0 m. Bottom 1.5 m hand slotted. Water at 1.9m upon completion Water at 1.9 m on January 21, 2011.						
3.5									

AMEC Earth and Environmental Red Deer, AB	LOGGED BY: DH	COMPLETION DEPTH: 3.00 m
	REVIEWED BY: CS	COMPLETION DATE: 1/12/11
	FIG #:	Page 1 of 1

Project: Bowden Institution	Geotechnical Investigation	Borehole No: 3
Associate Engineering		Project No: RX07748
Method: Solid Stem Auger		Elevation: 943.314 m

SAMPLE TYPE: Shelby Tube, Core, SPT Test (N), Grab Sample, Split-Pen

BACKFILL TYPE: Bentonite Grout, Pea Gravel, Drill Cuttings, Slough, Bentonite Chips, Sand

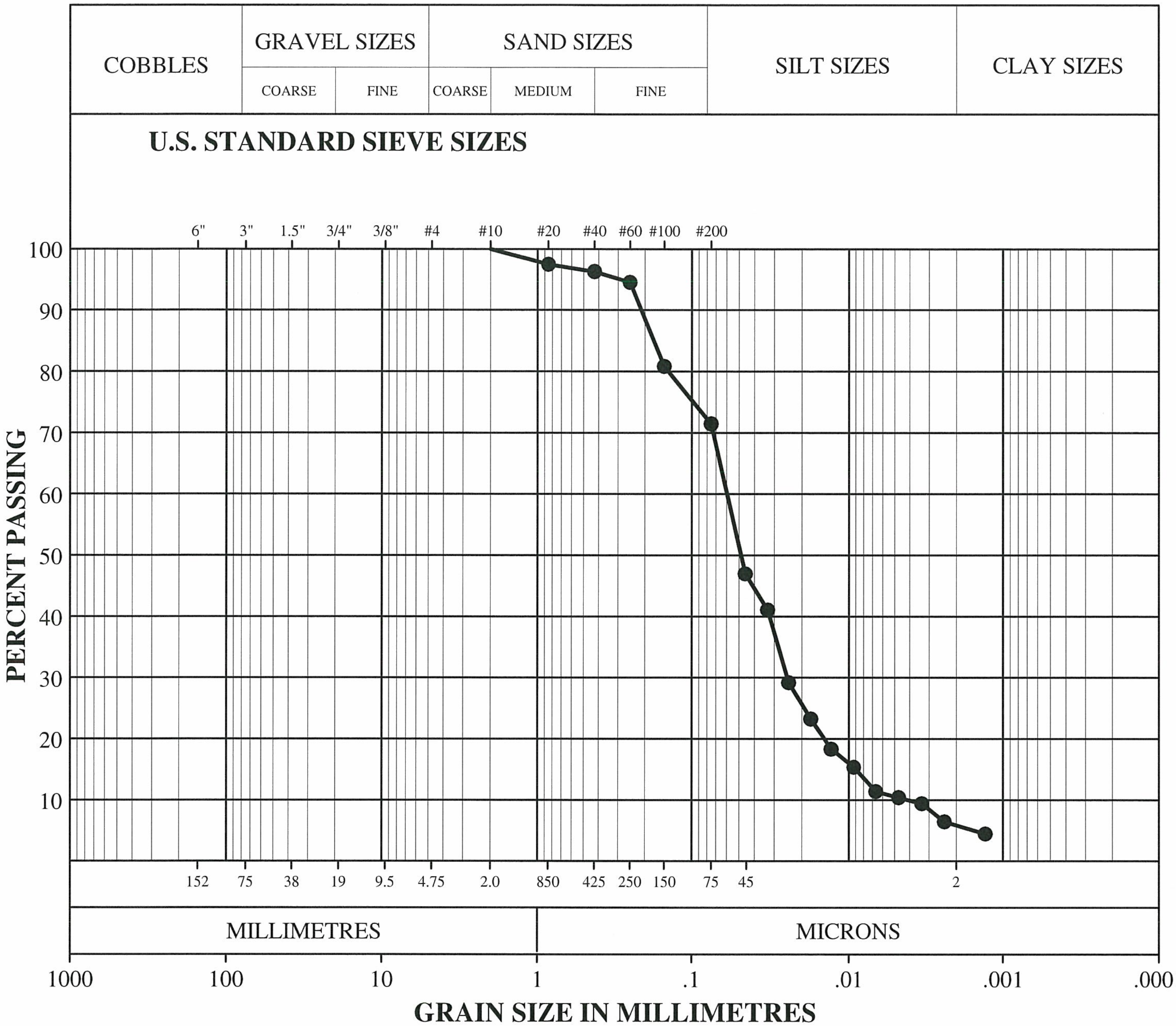
Depth (m)	SOIL DESCRIPTION	SAMPLE NO	OTHER TESTS COMMENTS	ELEVATION (m)
0	TOPSOIL: grass covered, organic, black, moist.			
	CLAY: very silty, very sandy, low plastic, soft, brown, moist	G1	Frozen to 0 .6 mts.	943
1		D1		
		G2		942
		B1		
2				
		G3		941
		D2		
	wet to saturated.			
3	End of hole at 3.0 meters. 25 mm standpipe installed to 3.0 m. Bottom 1.5 m hand slotted. Water at 2.3 m upon completion Water at 1.6 m on January 21, 2011.			940
3.5				

STANDARD PEN (N): 20 40 60 80

PLASTIC M.C. LIQUID: 20 40 60 80

SOIL SYMBOL | SAMPLE TYPE | SPT (N) | WELL INSTALLATION

amec	**AMEC** **Earth and Environmental** **Red Deer, AB**	LOGGED BY: DH REVIEWED BY: CS FIG #:
		COMPLETION DEPTH: 3.00 m COMPLETION DATE: 1/12/11



REMARKS:

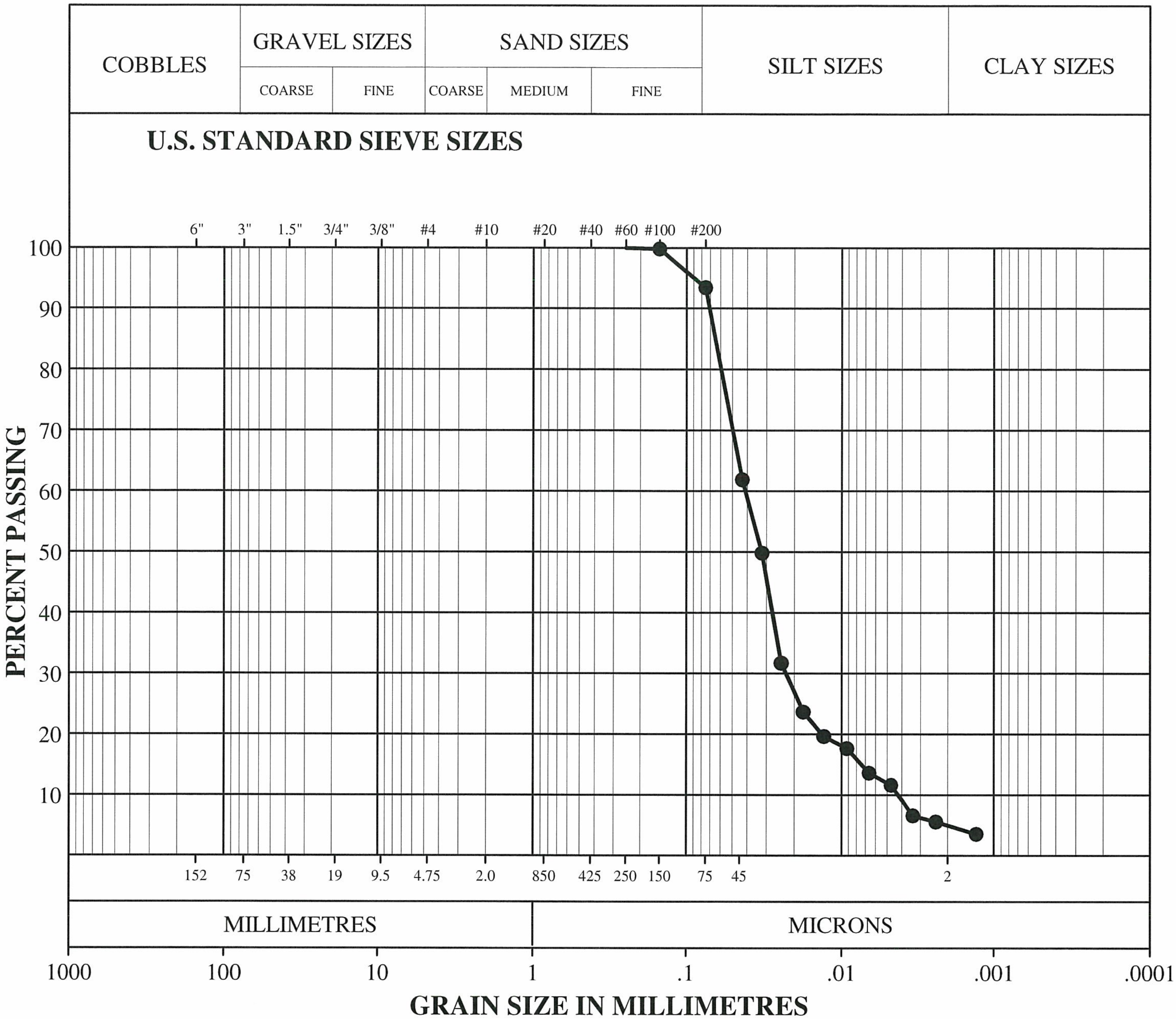
SUMMARY

D_{10} = 0.0042 mm	GRAVEL
D_{30} = 0.025 mm	SAND 29. %
D_{60} = 0.061 mm	SILT SIZES 66. %
C_U = 15.	CLAY SIZES 5. %
C_C = 2.4	

amec

GRAIN SIZE DISTRIBUTION

PROJECT No: RX07748 DATE: 2011-01-24
LOCATION: Borehole 1
HOLE: 1 SAMPLE: Grab
DEPTH: 0.5m
TECHNICIAN: RS



REMARKS:

SUMMARY	
D_{10} = 0.0043 mm	GRAVEL
D_{30} = 0.023 mm	SAND 7. %
D_{60} = 0.041 mm	SILT SIZES 89. %
C_U = 9.6	CLAY SIZES 4. %
C_C = 2.9	

amec

GRAIN SIZE DISTRIBUTION

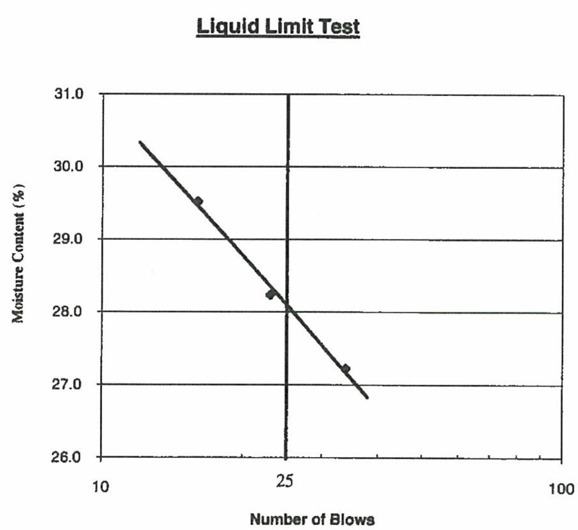
PROJECT No:	RX07748	DATE: 2011-01-24
LOCATION:	2D1	
HOLE:	Borehole 2	SAMPLE: SPT
DEPTH:		
TECHNICIAN:	RS	695

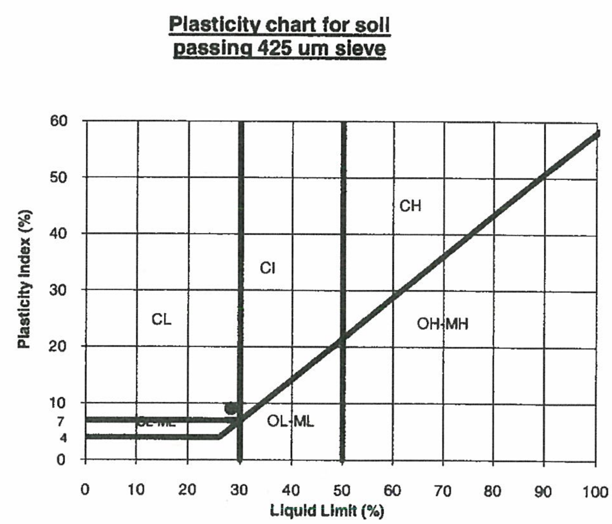
Atterberg Limits Test

AMEC Earth & Environmental
a Division of AMEC Americas Limited

Project No: RX07748
Project: Bowden Institute Access Rd.
Sample ID: BH 1&3 @1-2.0m
Date: Jan 18, 2011
Technician: JCS

Liquid Limit Test				Plastic Limit Test		
# of Blows	34	23	16			
Tare #	C7	C5	C1	Tare #	C8	B5
Wet Wt + Tare	29.21	27.41	29.00	Wet Wt + Tare	17.43	13.80
Dry Wt + Tare	25.23	24.29	25.44	Dry Wt + Tare	16.70	13.13
Wt of Tare	10.61	13.24	13.38	Wt of Tare	12.98	9.57
% Moisture	27.2	28.2	29.5	% Moisture	19.6	18.8





Liquid Limit 28.3 **Plastic Limit** 19.2 **Plasticity Index** 9.1

Classification CL

AMEC Earth & Environmental
1003 53 Avenue N.E.
Calgary, Alberta
Canada, T2E 6X9
Tel: (403) 248-4331
Fax: (403) 569-0737

MOISTURE-DENSITY RELATIONSHIP REPORT

Associated Engineering
1000 Pacific Plaza, 10909 Jasper Ave
Edmonton AB T5J 5B9
Attention:
Project: Bowden Institute Access Road

Project No: RX07748
Test Date: 18 January, 2011
Client P.O.:
CC:

Type Of Construction: Fill Material

Applicable Standard: ASTM D698-91

Method: A

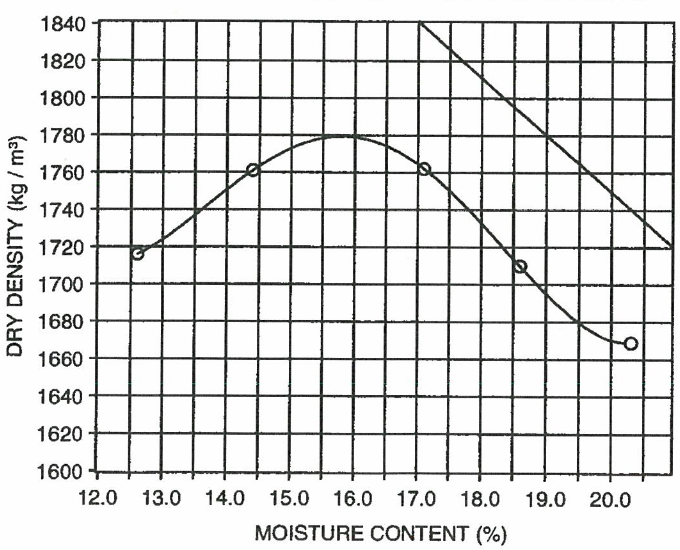
Wet Density (kg / m³):	1932	2015	2063	2028	2008		
Dry Density (kg / m³):	1716	1761	1762	1710	1669		
Moisture Content (%):	12.6	14.4	17.1	18.6	20.3		

Maximum Dry Density: 1780 kg / m³

Optimum Moisture: 16.0 %

Source: 1B1 & 3B1

MOISTURE-DENSITY RELATIONSHIP



Date Sampled: 17 January, 2011
Sampled By: Client
Date Received: 17 January, 2011
Tested By: JCS

Proctor No: 1
Rammer Type: Auto
Preparation: Moist

Soil Description: Silty Clay

Approved By: Jonathan

APPENDIX B

Explanation of Terms and Symbols

EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of field investigation and subsequent laboratory testing are described in these pages.

It should be noted that materials, boundaries and conditions have been established only at the borehole locations at the time of investigation and are not necessarily representative of subsurface conditions elsewhere across the site.

TEST DATA

Data obtained during the field investigation and from laboratory testing are shown at the appropriate depth interval.

Abbreviations, graphic symbols, and relevant test method designations are as follows:

*C	Consolidation test	*ST	Swelling test
D_R	Relative density	TV	Torvane shear strength
*k	Permeability coefficient	VS	Vane shear strength
*MA	Mechanical grain size analysis	w	Natural Moisture Content (ASTM D2216)
	and hydrometer test	w_l	Liquid limit (ASTM D 423)
N	Standard Penetration Test (CSA A119.1-60)	w_p	Plastic Limit (ASTM D 424)
N_d	Dynamic cone penetration test	E_f	Unit strain at failure
NP	Non plastic soil	γ	Unit weight of soil or rock
pp	Pocket penetrometer strength	γ_d	Dry unit weight of soil or rock
*q	Triaxial compression test	ρ	Density of soil or rock
q_u	Unconfined compressive strength	ρ_d	Dry Density of soil or rock
*SB	Shearbox test	C_u	Undrained shear strength
SO_4	Concentration of water-soluble sulphate	→	Seepage
		▼	Observed water level

* The results of these tests are usually reported separately

Soils are classified and described according to their engineering properties and behaviour.

The soil of each stratum is described using the Unified Soil Classification System[1] modified slightly so that an inorganic clay of "medium plasticity" is recognized.

The modifying adjectives used to define the actual or estimated percentage range by weight of minor components are consistent with the Canadian Foundation Engineering Manual[2].

<u>Relative Density and Consistency:</u>

Cohesionless Soils	
Relative Density	SPT (N) Value
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Cohesive Soils		
Consistency	Undrained Shear Strength c_u (kPa)	Approximate SPT (N) Value
Very Soft	0-12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

<u>Standard Penetration Resistance ("N" value)</u>
The number of blows by a 63.6kg hammer dropped 760 mm to drive a 50 mm diameter open sampler attached to "A" drill rods for a distance of 300 mm after an initial penetration of 150 mm.

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1 "Unified Soil Classification System", Technical Memorandum 36-357 prepared by Waterways Experiment Station, Vicksburg, Mississippi, Corps of Engineers, U.S. Army. Vol. 1 March 1953.

2 "Canadian Foundation Engineering Manual", 3rd Edition, Canadian Geotechnical Society, 1992.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOUR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75μm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		RED	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP		RED	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75mm	CLEAN SANDS (LITTLE OR NO FINES)	SW		RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{60})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP		RED	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12 %	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75μm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50\%$	MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDS OR SILTY SOILS		
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$W_L < 50\%$	OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINES CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L > 50\%$	OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBEROUS TEXTURE	

SPECIAL SYMBOLS

LIMESTONE		OILSAND	
SANDSTONE		SHALE	
SILTSTONE		FILL (UNDIFFERENTIATED)	

SOIL COMPONENTS

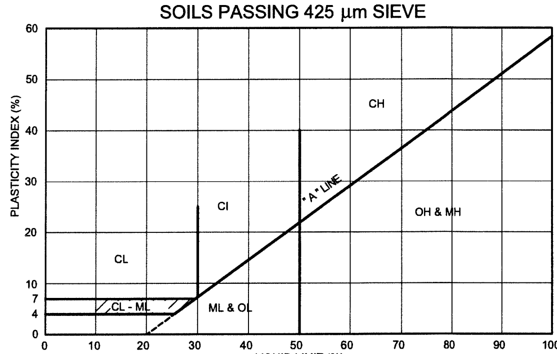
FRACTION	U.S. STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
GRAVEL	PASSING	RETAINED	PERCENT	DESCRIPTOR
COARSE	76mm	19mm		
FINE	19mm	4.75mm	35-50	AND
SAND				
COARSE	4.75mm	2.00mm	20-35	Y/EY
MEDIUM	2.00mm	425μm	10-20	SOME
FINE	425μm	75μm		
FINES (SILT OR CLAY BASED ON PLASTICITY)	75μm		1-10	TRACE

OVERSIZED MATERIAL

ROUNDED OR SUBROUNDED:
COBBLES 76mm TO 200mm
BOULDERS > 200mm

NOT ROUNDED:
ROCK FRAGMENTS > 76mm
ROCKS > 0.76 CUBIC METRE IN VOLUME

PLASTICITY CHART FOR SOILS PASSING 425 μm SIEVE



NOTES:

1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD A.S.T.M. E.11
2. COARSE GRAIN SOILS WITH 5 TO 12% FINES GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5 AND 12% FINES.

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