BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

ANNEX C

HAT CREEK PROJECT
WATER SUPPLY AND
ASH RETENTION DAMS
SITE INVESTIGATION DATA

by

KLOHN LEONOFF CONSULTANTS LTD

Our File: VA 2321

March 1978

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APPENDIX VII

Graphic Drill Hole and Test Pit Logs

Plate Nos. C1 to C16

LEGEND AND ABBREVIATIONS
ON DRILL HOLE AND TEST PIT LOGS

SYMBOL	DESCRIPTION	UNIT
SS	Split Spoon Sample (SPT), driven	
HW	Heavy Walled Shelby Tube Sample, driven	
C	Drill Cuttings from air or water return	
(24)	Standard Penetration Resistance (N Value) - 140 lb. Hammer, 30 in. drop	blows/30 cm
	Penetration Resistance for 5½ in. dia. Becker Drill casing driven open ended with 8000 ft-lb deisel hammer	blows/30 cm
o	Natural Water Content	percent
----------	Plastic and Liquid Limits	percent
	3/4 in. dia. PVC standpipe Sand-cement grout Pea gravel Bentonite clay seal #16 Silica Sand 1½ in. dia. slotted PVC pipe	
▼	Water level in standpipe at date shown	
✳	Location of falling head permeability test	
■	Location of pressure (packer permeability test)	
	Sand & Gravel	
	Silt	
	Clay	
	Till	
	Bedrock	
bdrk	Bedrock	
bldr(s)	Boulder(s)	
cbl(s)	Cobble(s)	
fgmt(s)	Fragment(s)	
lyrd	Layered	
org	Organic	
pkt	Pocket	
Rt	Root	
tpsl	Topsoil	
sm(s)	Seam(s)	
wx	Weathered bedrock	

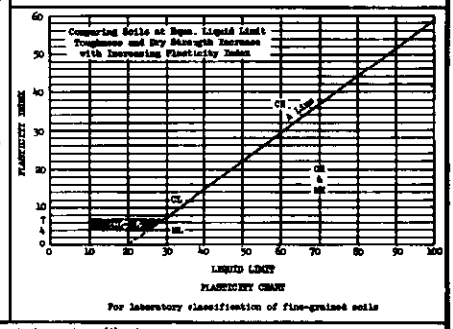
UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)	Information Required for Describing Soils	Laboratory Classification Criteria
1	2		3	4	5	6	7
Coarse-grained Soils: More than half of material is larger than No. 200 sieve size.	Gravels: More than half of coarse fraction is larger than No. 4 sieve size.	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3 Not meeting all gradation requirements for GW
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		Atterberg limits below "A" line or PI less than 4 / Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (For identification procedures see ML below).	Give typical name; indicate approximate percentages of sand and gravel, max. size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses.	Atterberg limits above "A" line with PI greater than 7
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
	Sands: More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3 Not meeting all gradation requirements for SW
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		Atterberg limits below "A" line or PI less than 4 / Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (For identification procedures see ML below).		Atterberg limits above "A" line with PI greater than 7
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
Fine-grained Soils: More than half of material is smaller than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Silts and Clays: Liquid limit less than 50				Identification Procedures on Fraction Smaller than No. 40 Sieve Size		
					Dry Strength (Crushing characteristics) / Dilatancy (Reaction to shaking) / Toughness (Consistency near PL)		
			ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight / Quick to slow / None	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses.	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high / None to very slow / Medium		
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium / Slow / Slight		
	Silts and Clays: Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium / Slow to none / Slight to medium	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions.	
			CH	Inorganic clays of high plasticity, fat clays.	High to very high / None / High		
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high / None to very slow / Slight to medium	Example: Clayey silt, brown, slightly plastic, small percentages of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).	
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.		

Use grain-size curve in identifying the fractions as given under field identification.

Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows:

Less than 5%	More than 12%	5% to 12%
GW, GP, SW, SP, GM, GC, SM, SC		Borderline cases requiring use of dual symbols.



PLASTICITY CHART

For laboratory classification of fine-grained soils

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U. S. standard.

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a medium quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Toughness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Adapted by Corps of Engineers and Bureau of Reclamation, January 1952

3-0119539

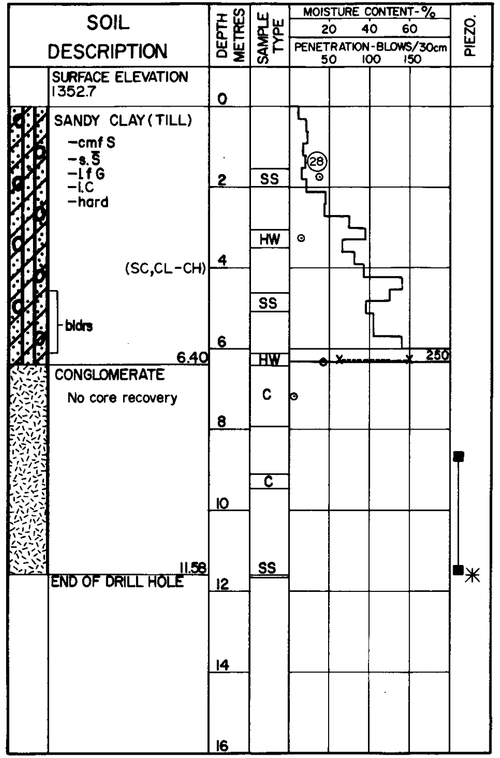
Ref: Corps of Engineers, U.S. Army, Technical Memorandum No. 3 - 357

DEFINITIONS OF TERMS IDENTIFYING THE COMPOSITION OF SOILS						DEFINITIONS OF TERMS IDENTIFYING THE GRADATION COMPONENTS		
Component	Identification		Terms Identifying Proportions		Defining Range of Percentages by Weight	Gradation Designation for Identification		Defining Proportions
	Written	Symbol	Written	Symbol		As Written	Symbol	
Principal Component	GRAVEL	G			50 or more	coarse to fine	cf	All fractions greater than 10% of the component, but the medium component predominates
	SAND	S				or		
	SILT	$\bar{S}$				coarse medium to fine	cmf	
	CLAY	C				coarse to medium	cm	less than 10% fine
Minor Component	Gravel	G	and	a.	35 to 50			
	Sand	S	some	s.	20 to 35	medium to fine	mf	less than 10% coarse
	Silt	$\bar{S}$	little	l.	10 to 20			
	Clay	C	trace	t.	1 to 10	medium	m	less than 10% coarse and fine
						fine	f	less than 10% coarse and medium

modified from Burmister, D.M. (1964) "Suggested Methods of Test for Identification of Soils", ASTM Procedures for Testing Soils, 4th Ed.

P77-31

N 5626 362
E 605 101



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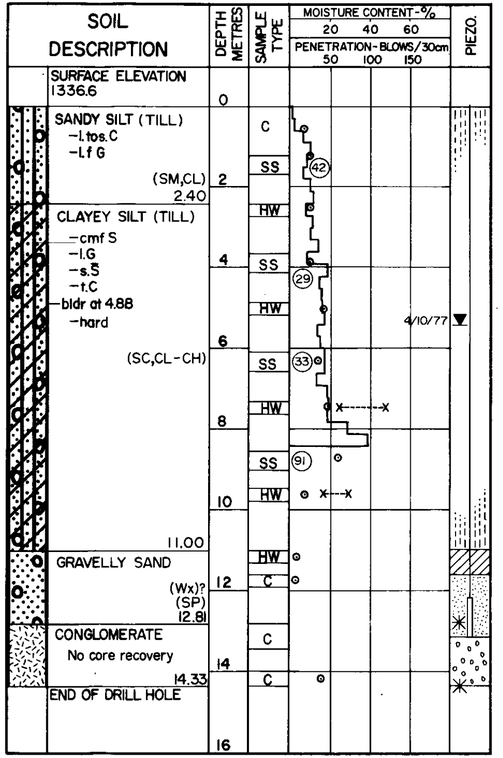
E 604 974



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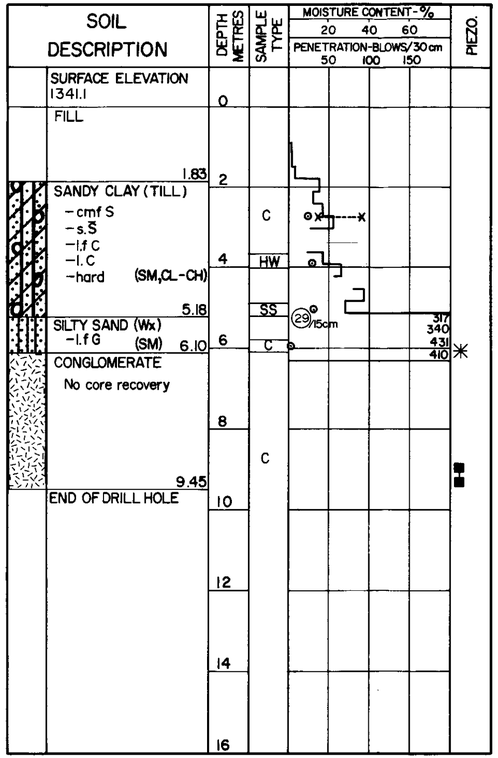
E 604 900



P77-34

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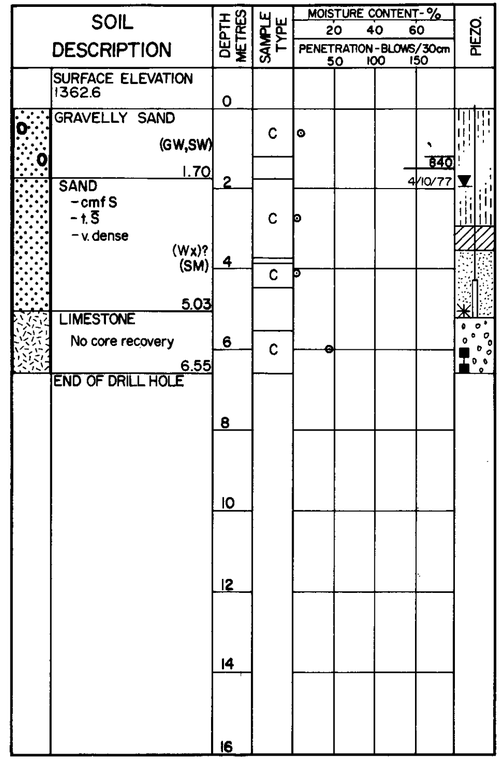
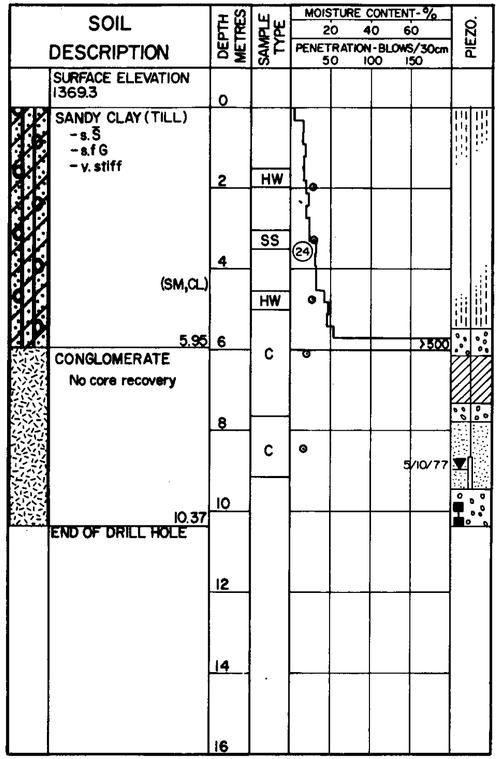
E 604 737



KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	PERCUSSION DRILL HOLES P77-31 to P77-34
APPROVED	PROJECT NO. VA 2321
	DATE JAN, 1978
	PLATE C1

P77-35

N 5627 349
E 604 516



P77-36

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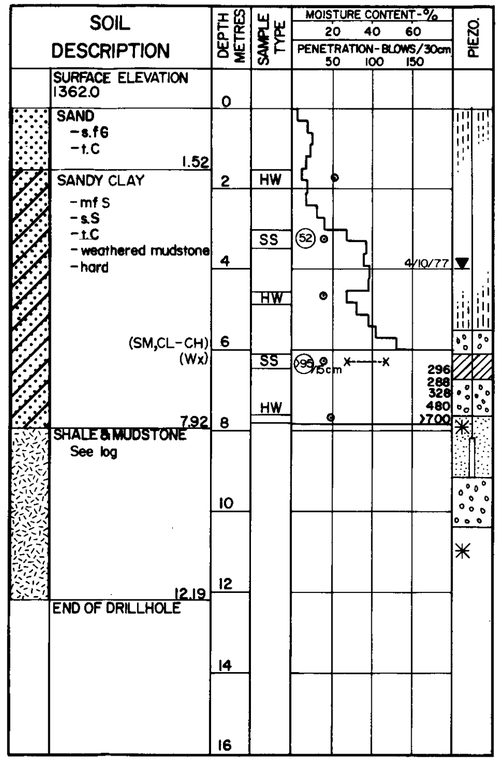
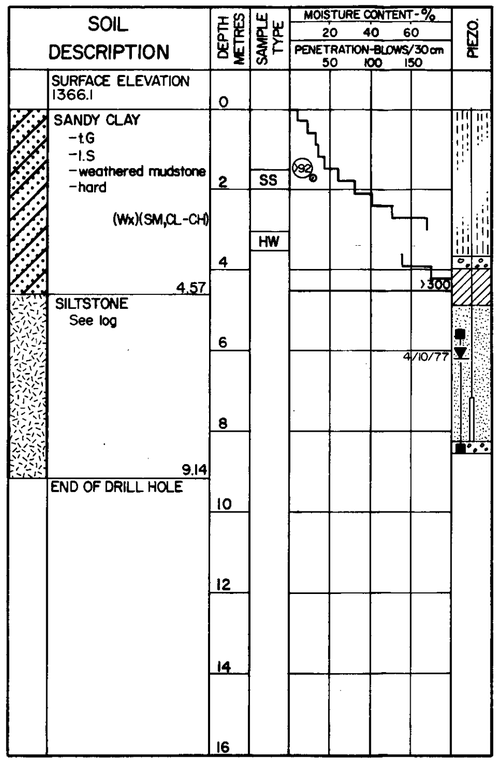
E 604 486



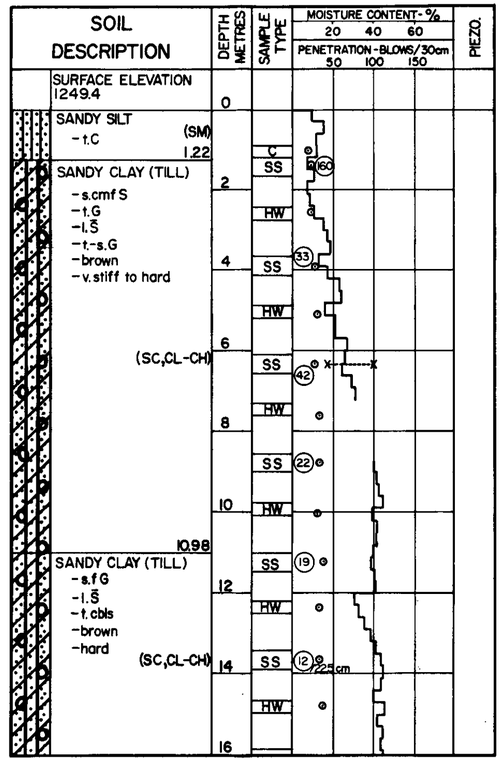
P77-37

N 5627 246
E 604 434



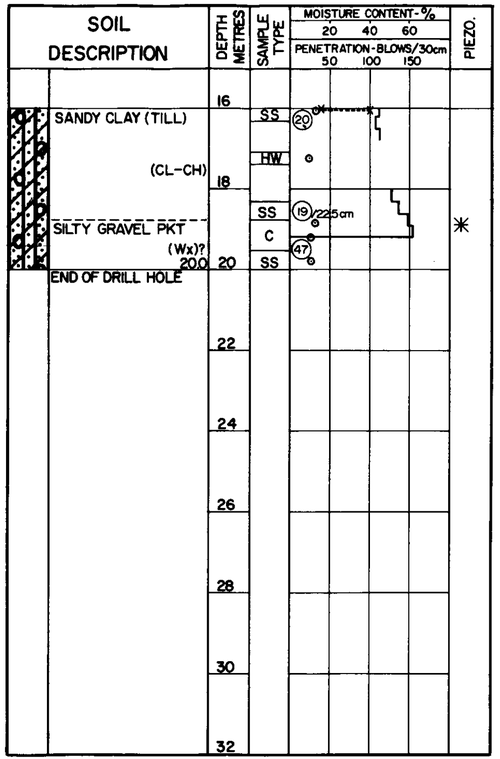
P77-38

N 5624 833
E 604 419



KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	PERCUSSION DRILL HOLES P77-35 to P77-38
APPROVED	PROJECT NO. VA 2321
DATE JAN., 1978	PLATE C2

P77-38 CONT.



P77-39

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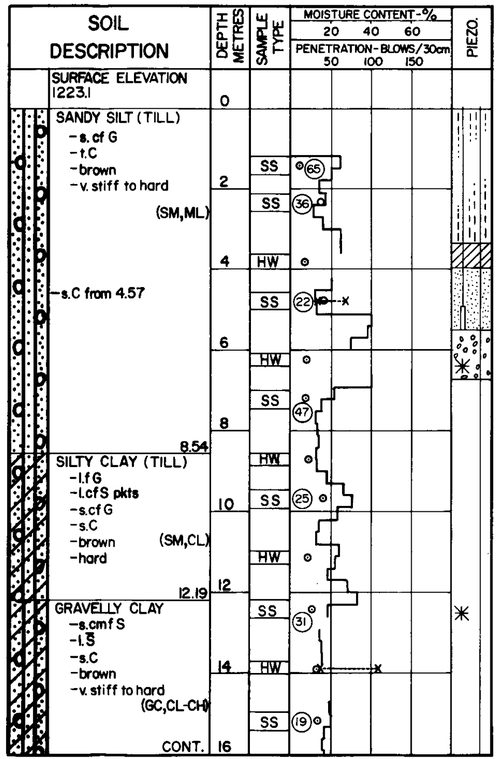
E 604 441



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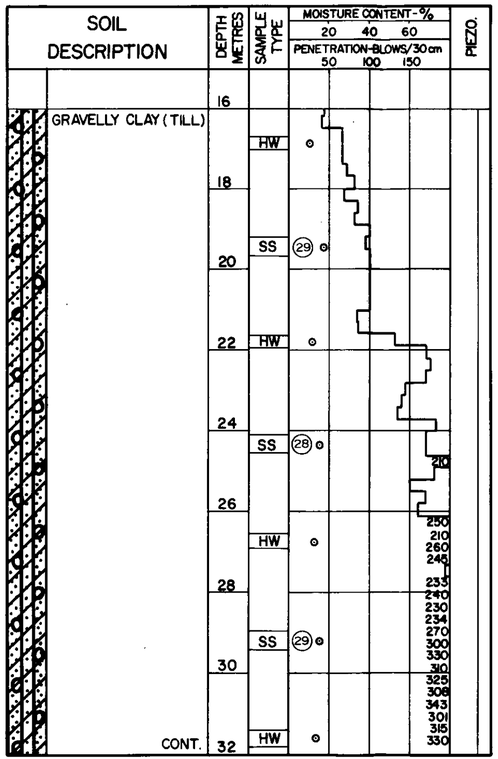

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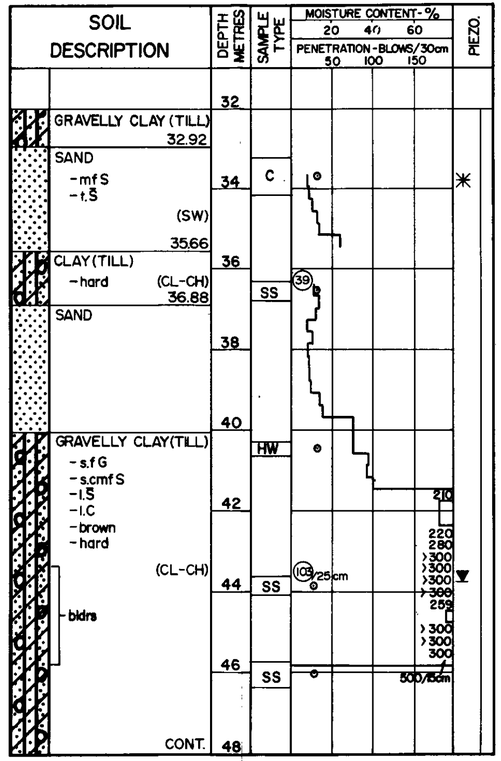

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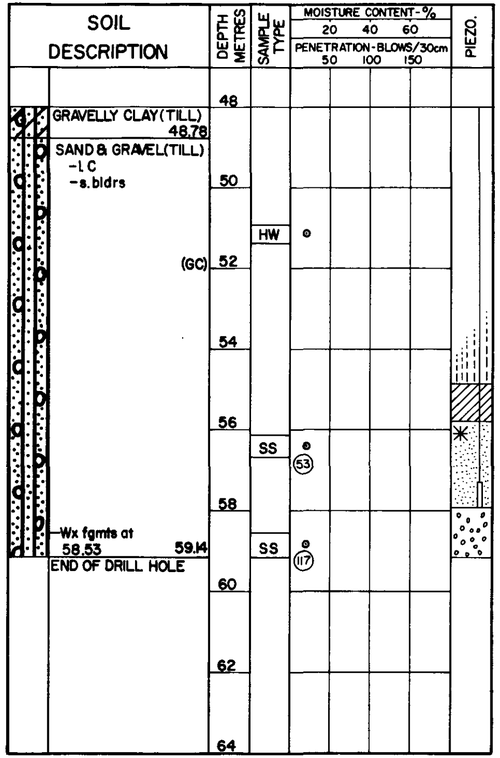
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	PERCUSSION DRILL HOLES P77-38 to P77-39
APPROVED	PROJECT NO. VA 2321
DATE JAN., 1978	PLATE C3

P77-39 CONT.



P77-40 & 40A

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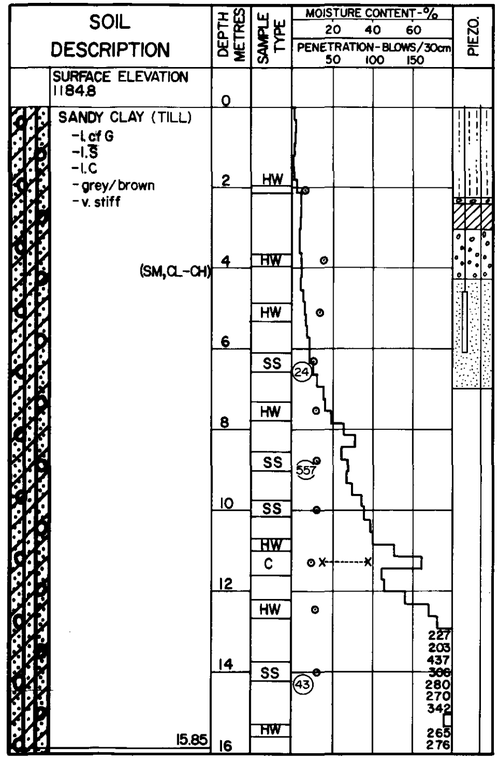
E 604 441



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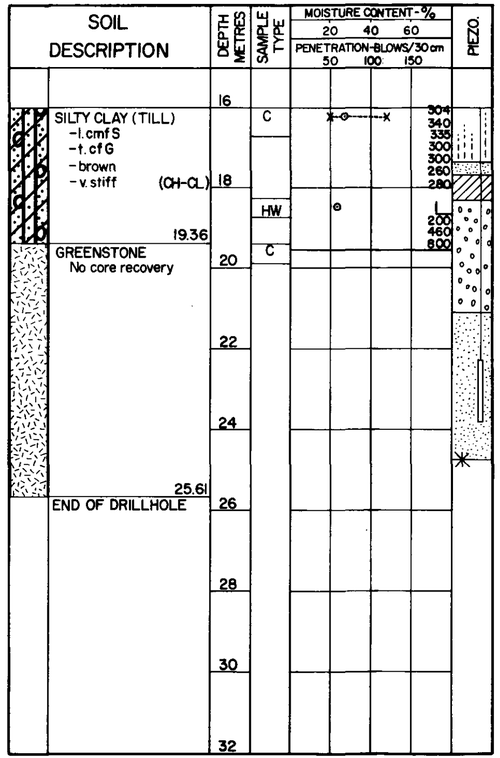
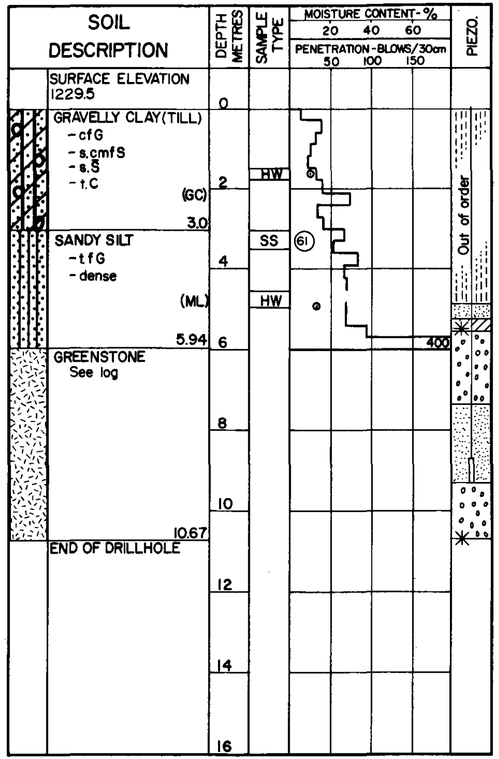


P77-41

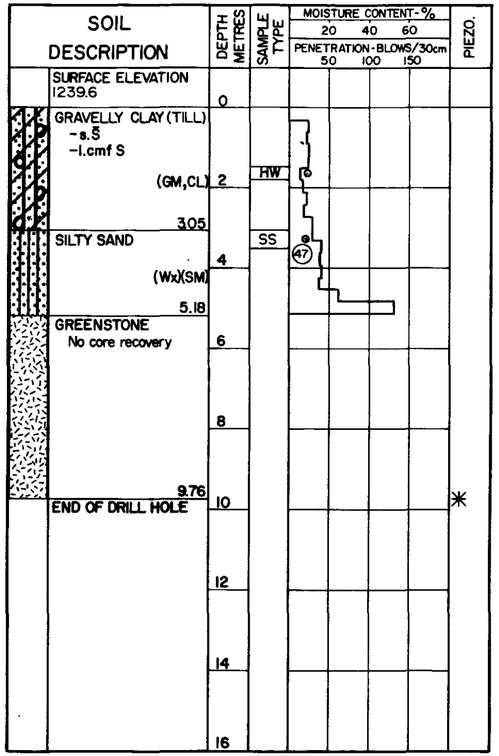
N 5624 513
E 604 558



KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	PERCUSSION DRILL HOLES P77-39 to P77-41
APPROVED	PROJECT NO. VA 2321
DATE JAN., 1978	PLATE C4

P77-42

N 5624 576
E 604 073



P77-42A

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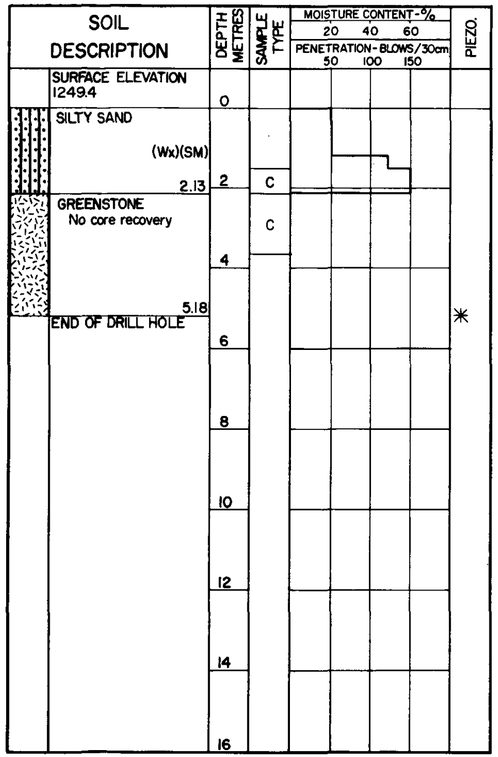
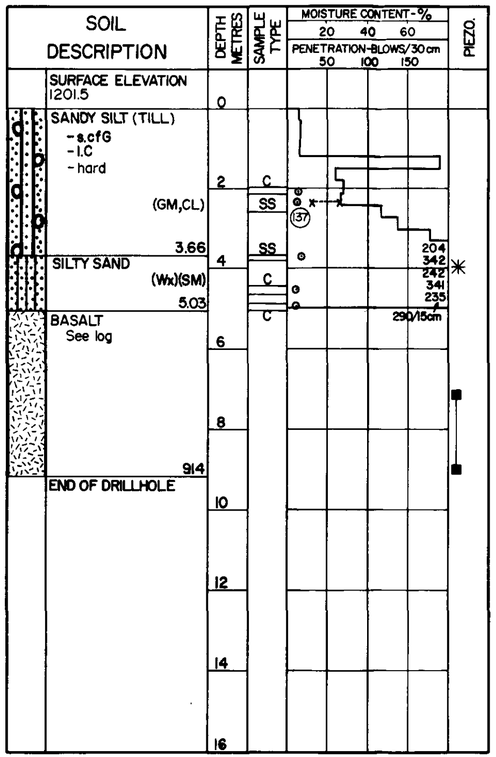
E 604 019



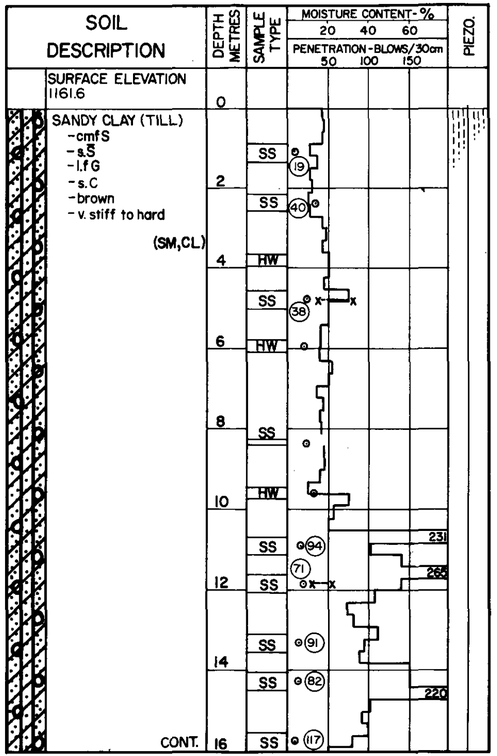
P77-43

N 5624 482
E 603 052



P77-44

N 5624 341
E 603 061



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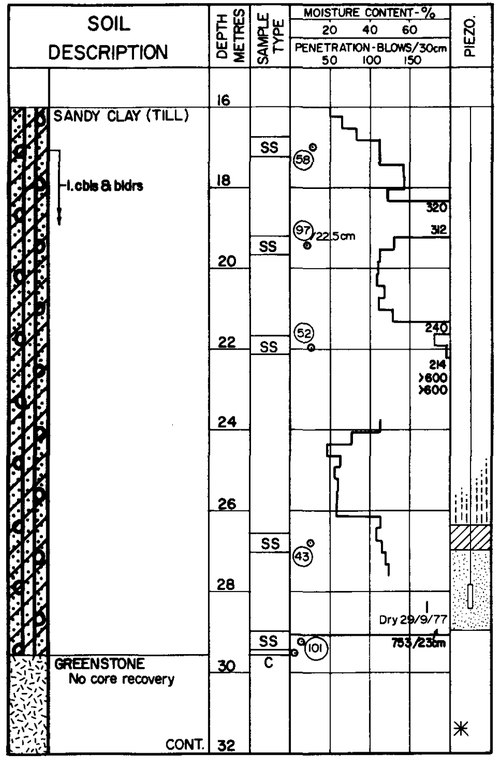
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	PERCUSSION DRILL HOLES P77-42 to P77-44
APPROVED	PROJECT NO. VA 2321
	DATE JAN., 1978
	PLATE C5

P77-44 CONT.



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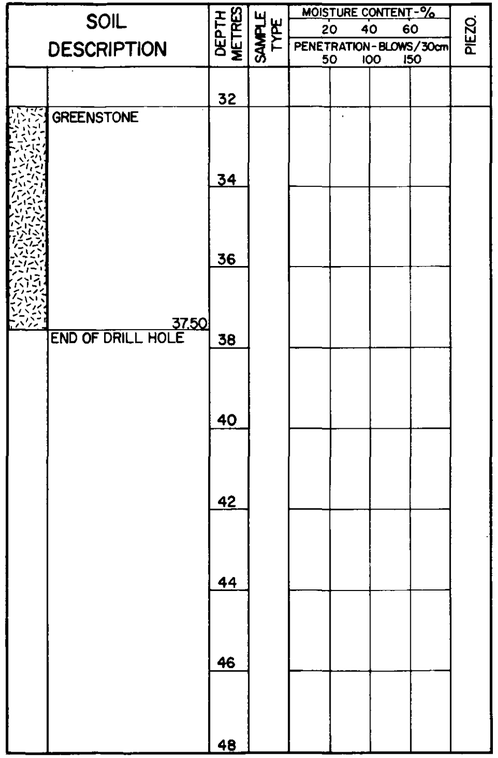
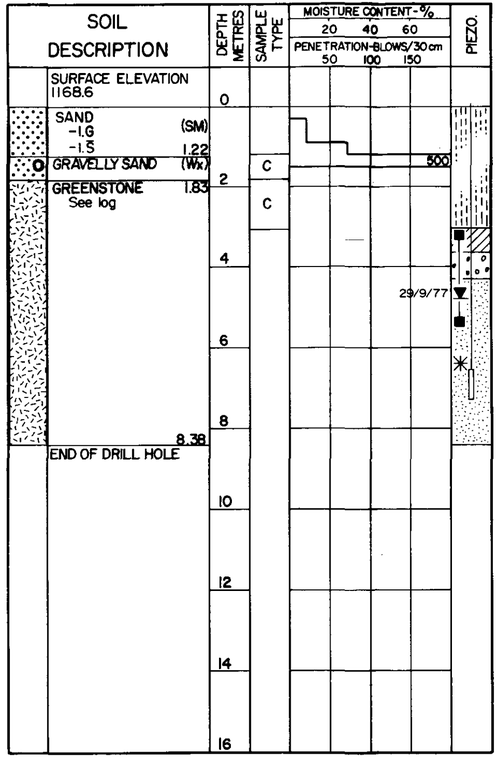


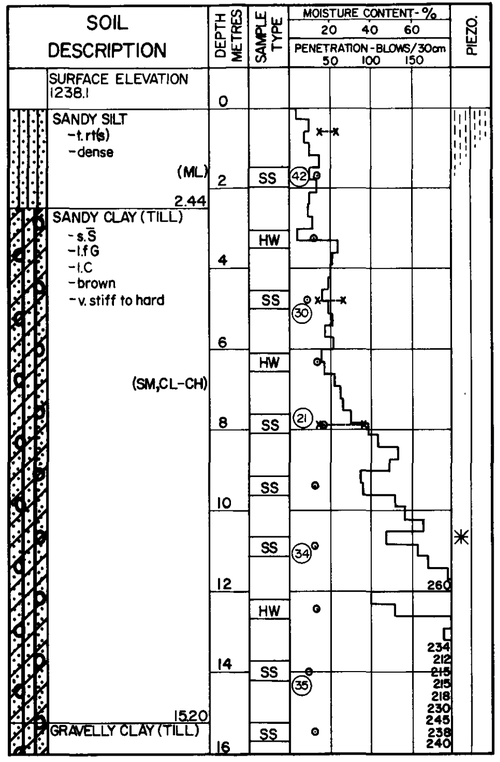
P77-45

N 5624 046
E 603 119



P77-46

N 5625 137
E 605 475



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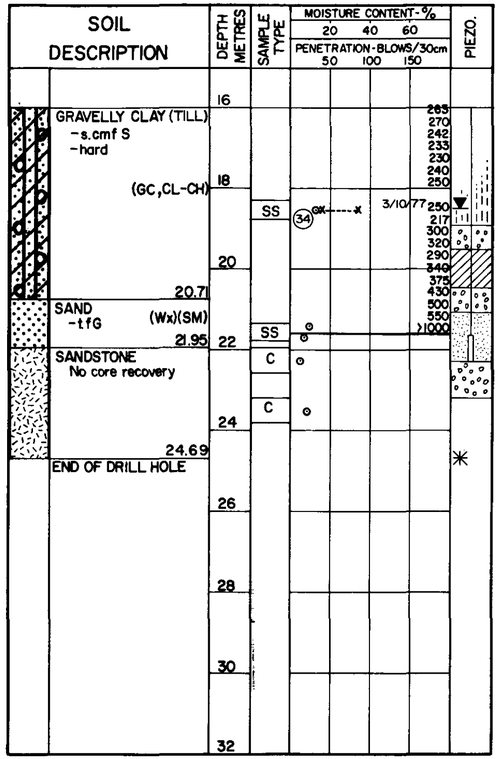
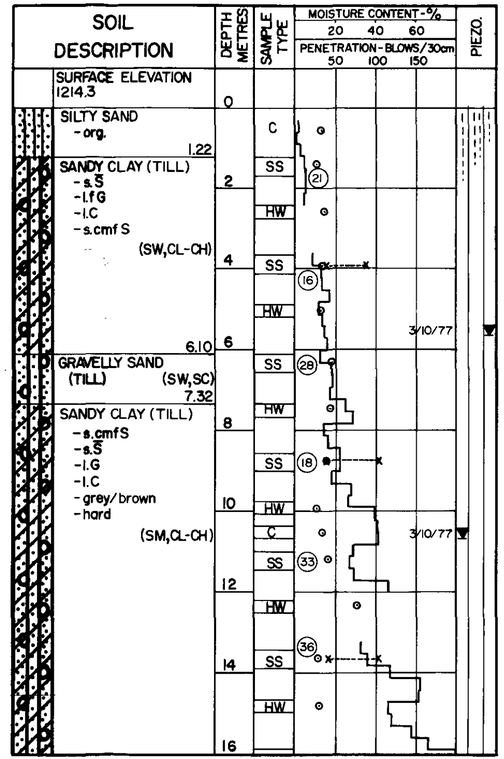
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	PERCUSSION DRILL HOLES P77-44 to P77-46
APPROVED	PROJECT NO. VA 2321
DATE JAN., 1978	PLATE C6

P77-46 CONT.



P77-47

N 5624 883
E 605 559



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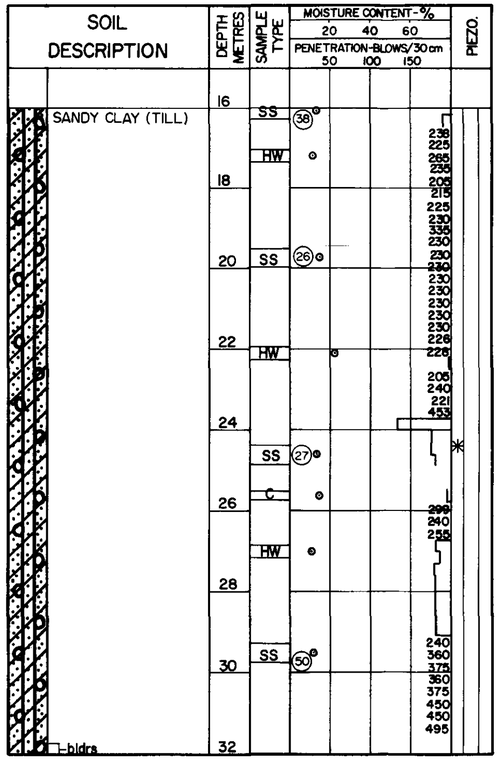

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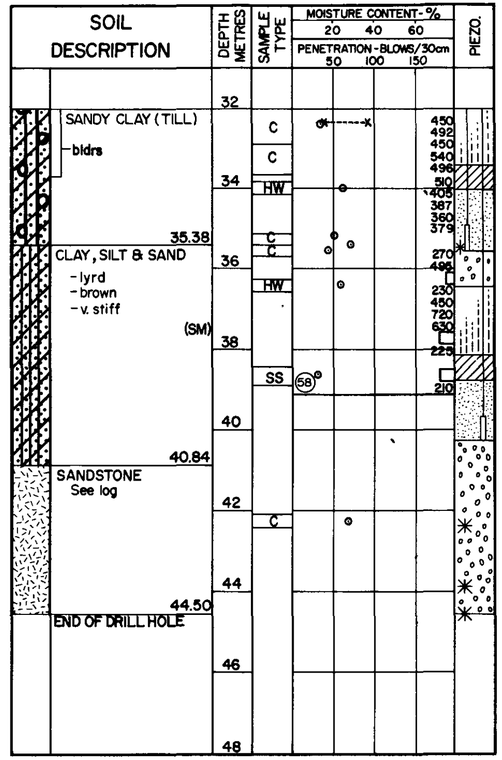

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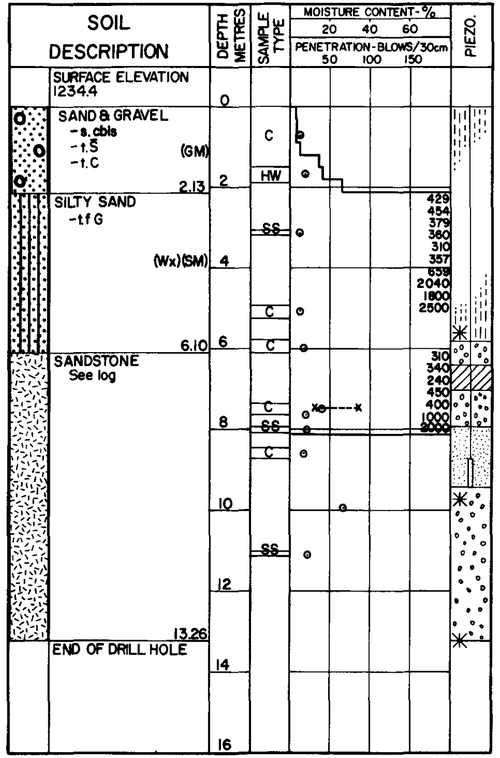
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	PERCUSSION DRILL HOLES P77-46 to P77-47
APPROVED	PROJECT NO. VA 2321
	DATE JAN., 1978
	PLATE C7

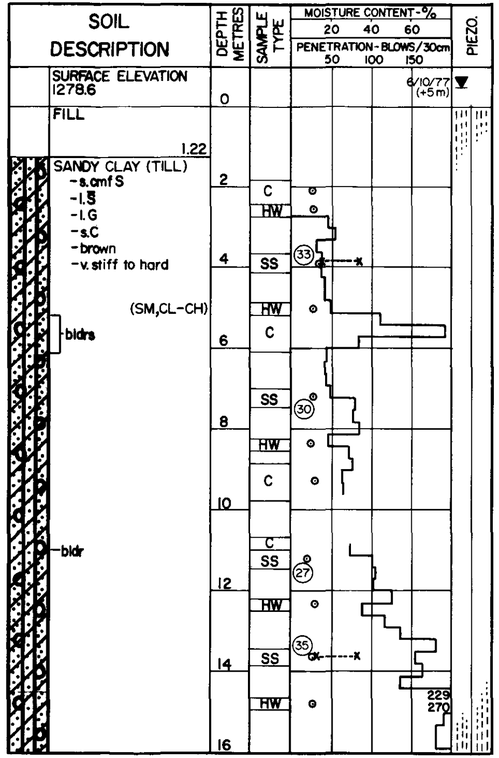
P77-48

N 5624 688
E 605 675

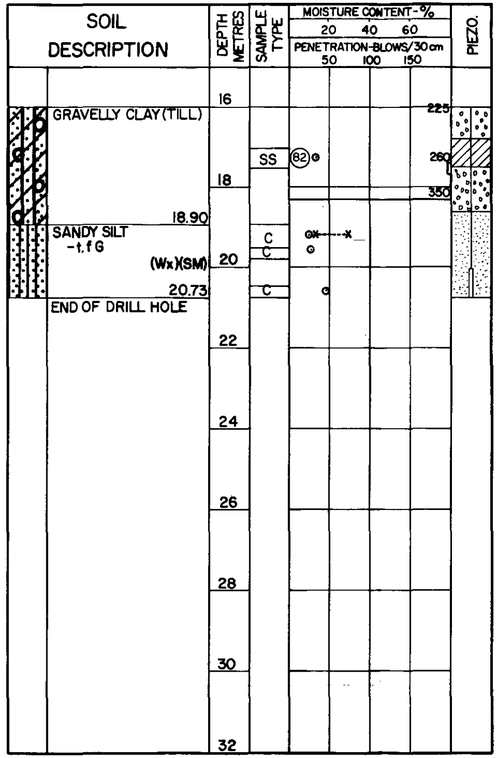


P77-67

N 5624 864
E 608 429

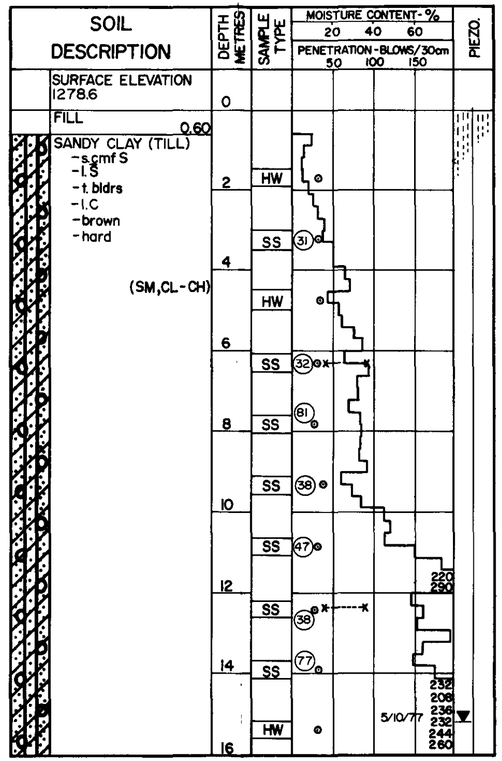


P77-67 CONT.



P77-68

N 5624 884
E 608 673



KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	PERCUSSION DRILL HOLES P77-48 to P77-68
APPROVED	PROJECT NO. VA 2321
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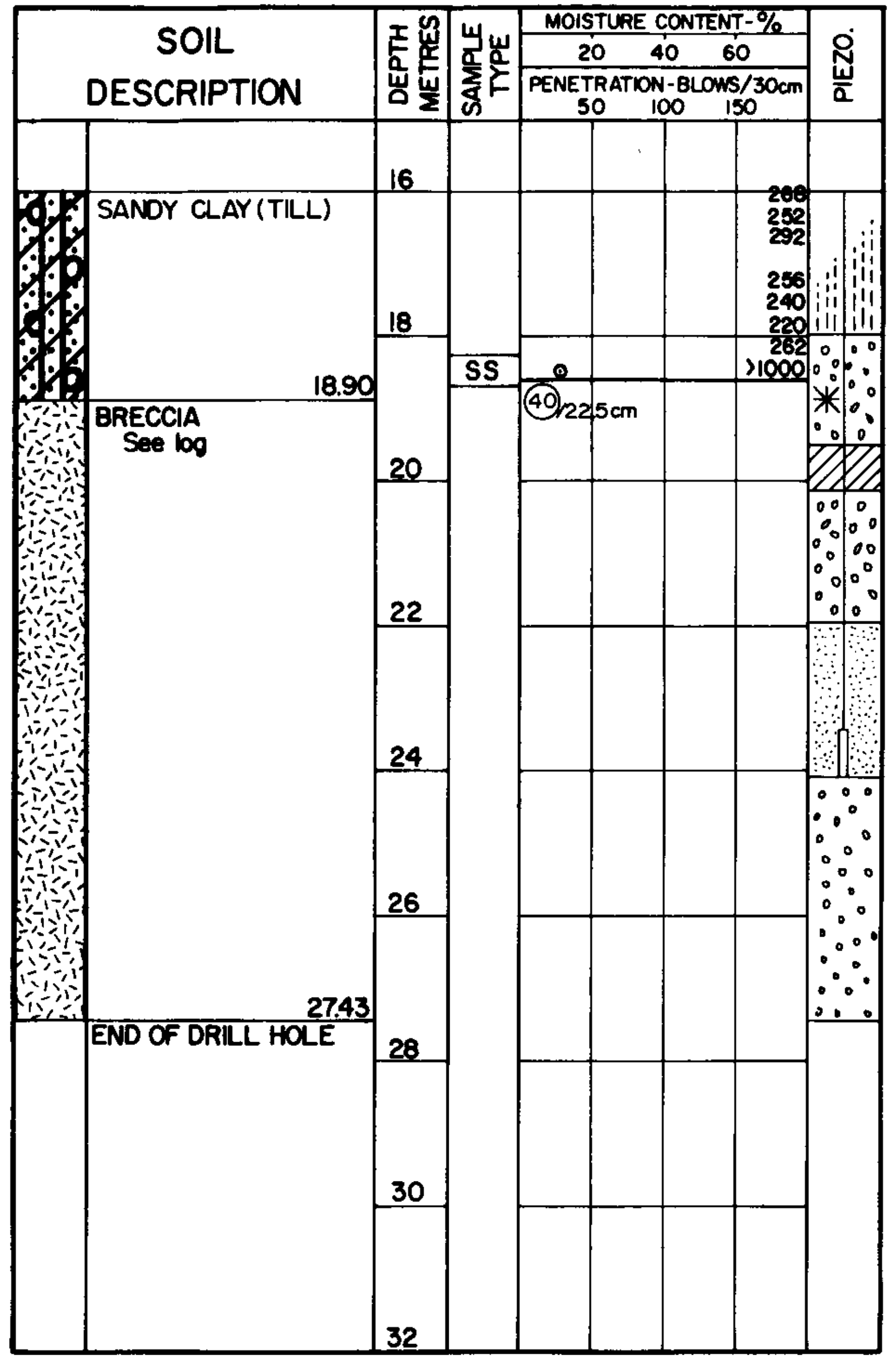
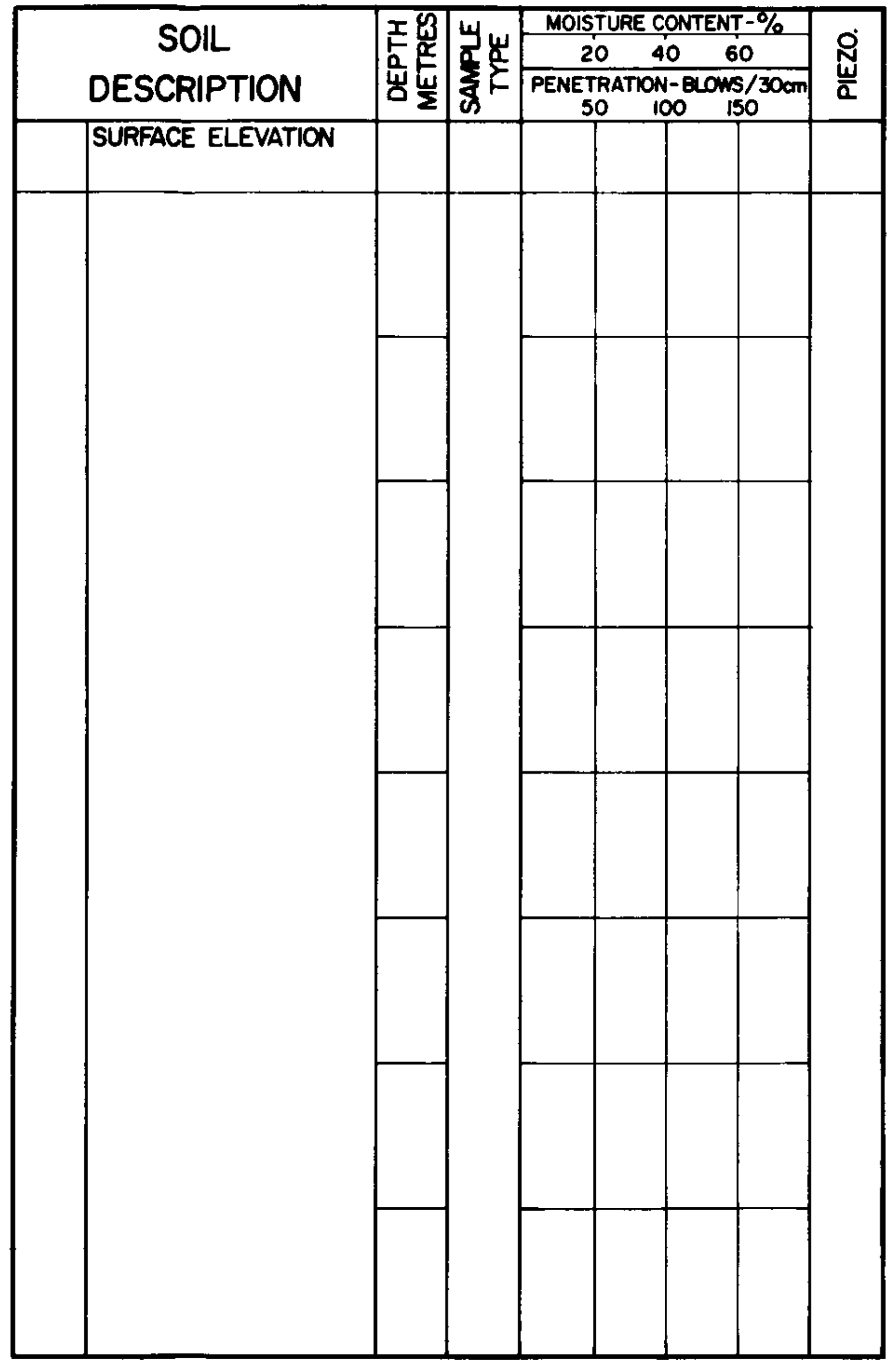
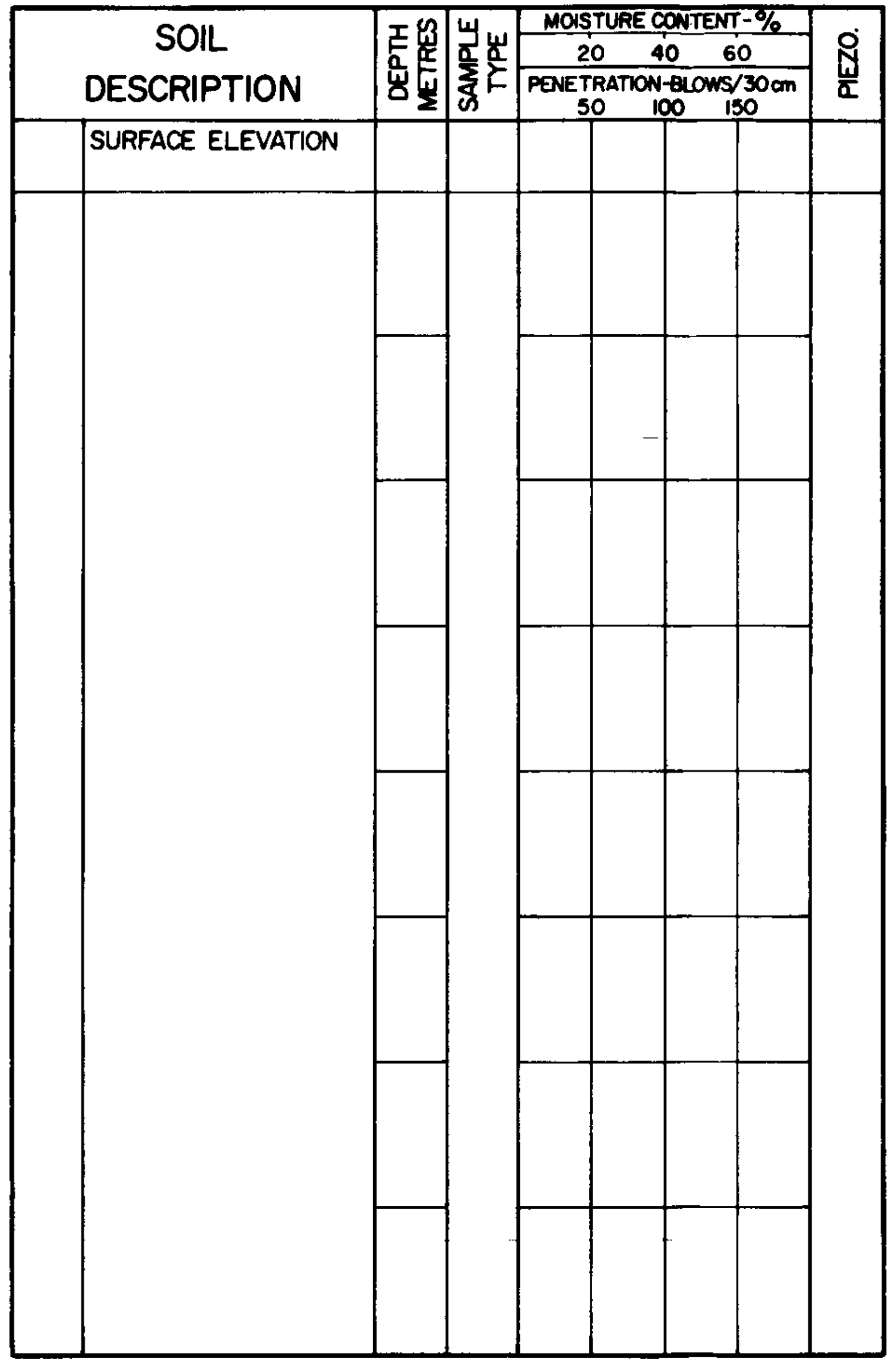
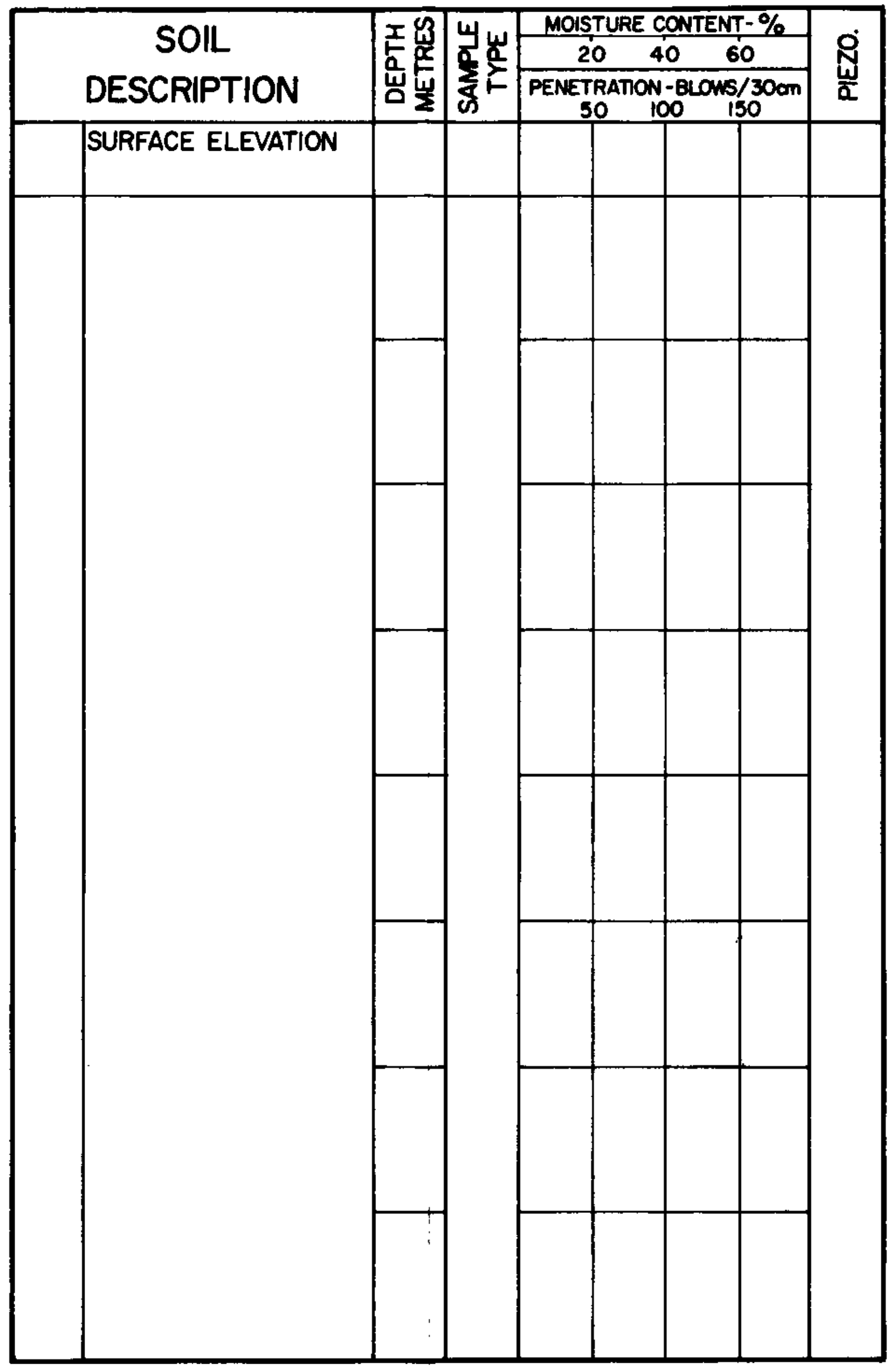
P77-68 CONT.





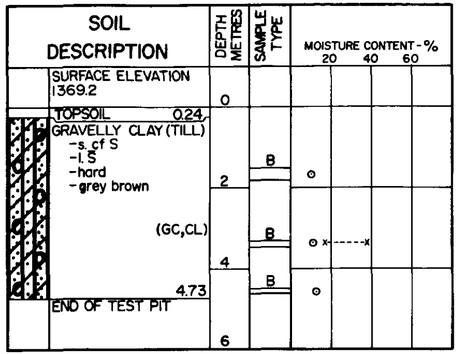




KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	PERCUSSION DRILL HOLES P77-68
APPROVED [signature]	PROJECT NO. VA 2321
DATE JAN., 1978	PLATE C9

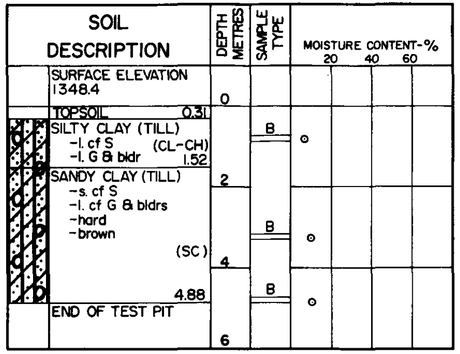
TP 101

N 5626 876
E 602 688



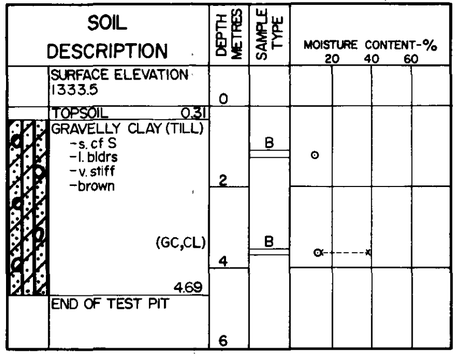
TP 102

N 5626 635
E 602 858



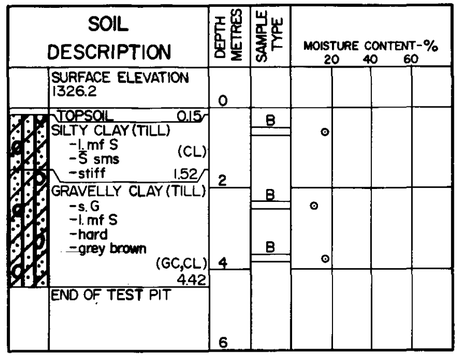
TP 103

N 5626 622
E 602 594



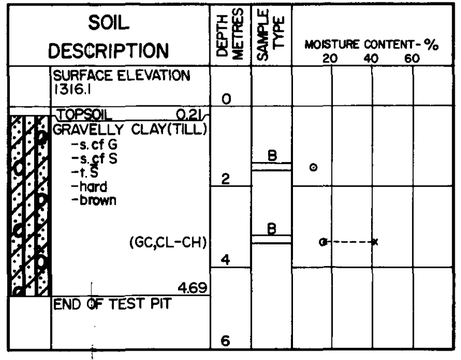
TP 104

N 5626 574
E 602 450



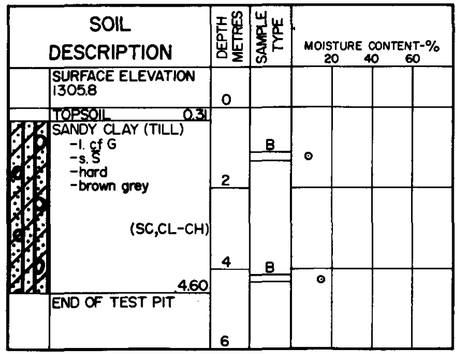
TP 105

N 5626 390
E 602 571



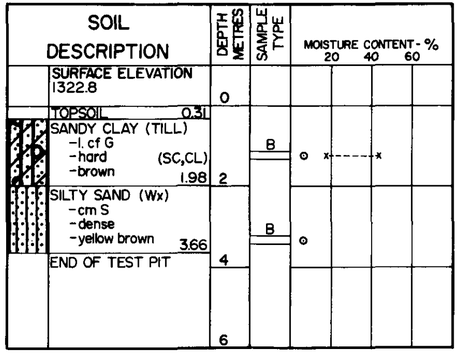
TP 106

N 5626 365
E 602 222



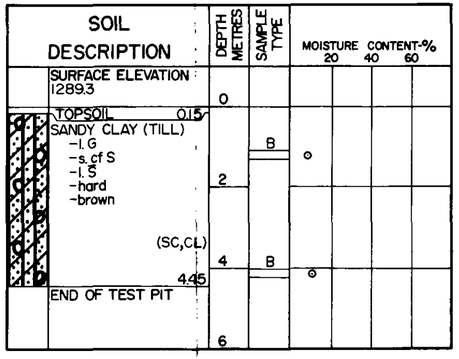
TP 107

N 5626 557
E 602 043



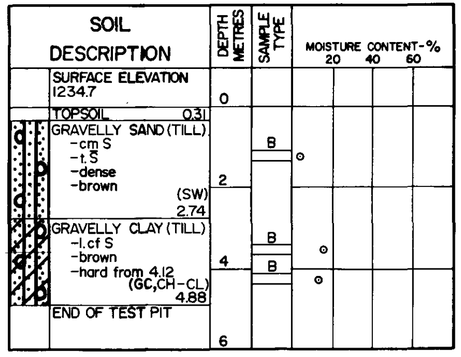
TP 108

N 5626 216
E 602 039



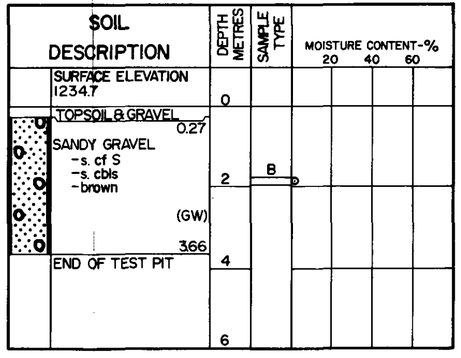
TP 111

N 5624 926
E 604 965



TP 112

N 5624 925
E 605 021



KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	TEST PITS TP 101 to TP 112
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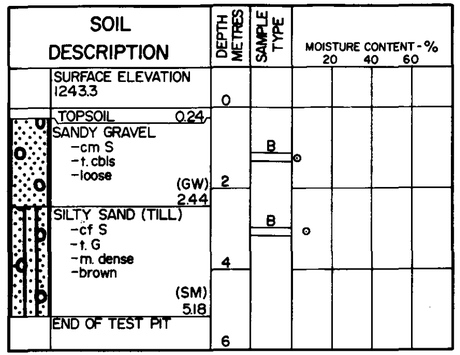
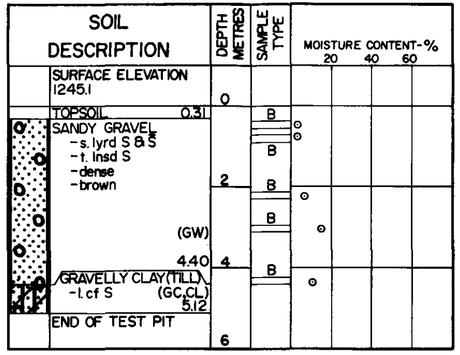
TP 113

N 5624 980
E 605 025



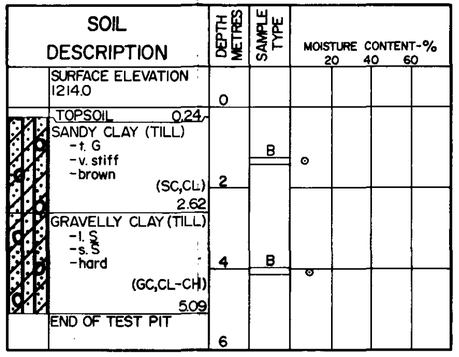
TP 114

N 5625 023
E 605 062



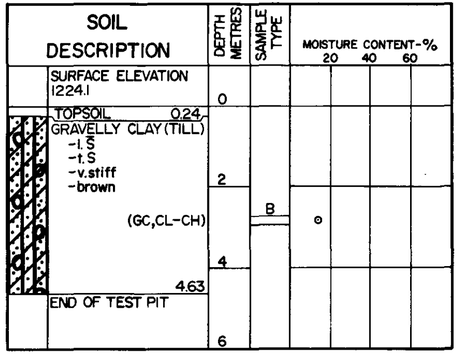
TP 115

N 5624 838
E 604 835



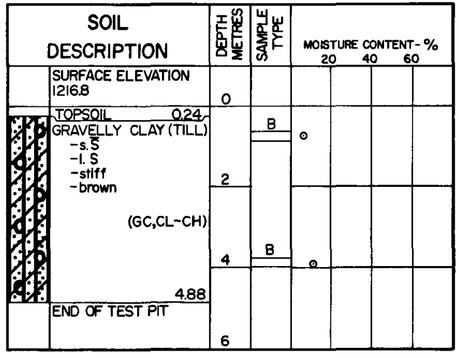
TP 116

N 5624 856
E 604 937



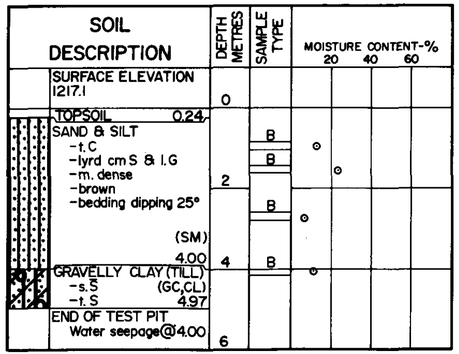
TP 117

N 5624 787
E 605 144



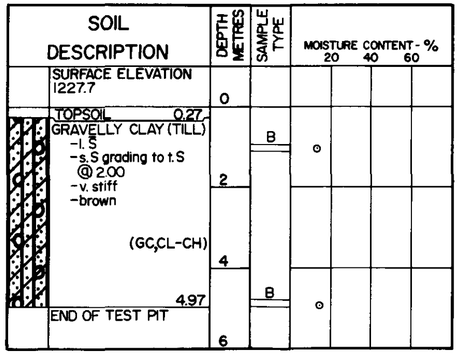
TP 118

N 5624 844
E 605 236



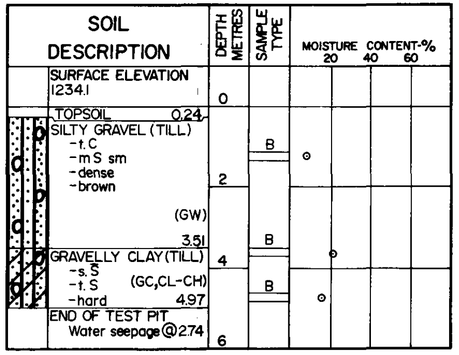
TP 119

N 5624 926
E 605 207



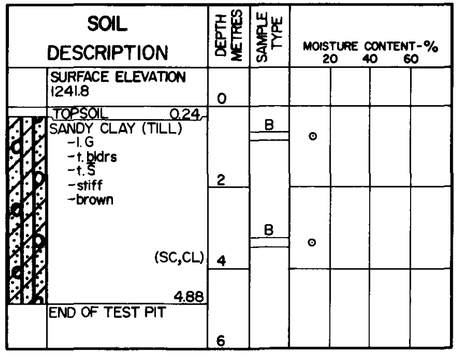
TP 120

N 5624 977
E 605 128



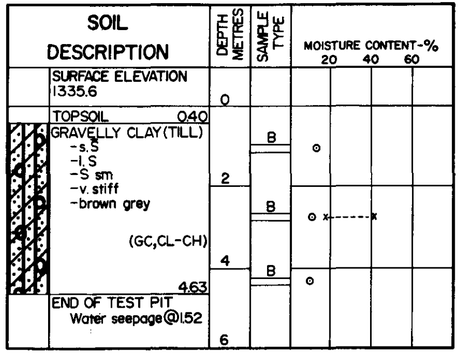
TP 121

N 5625 089
E 605 373



TP 122

N 5626 211
E 602 847



KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
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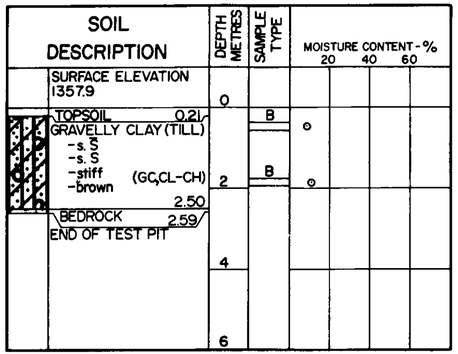
	PLATE C11

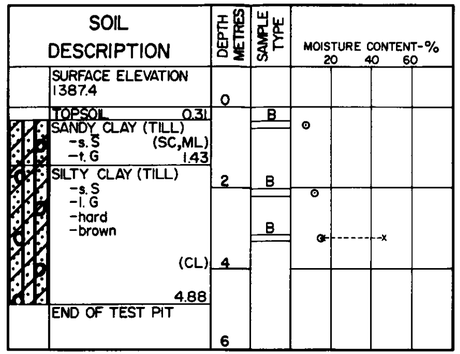
TP 123

N 5625 906
E 602 817



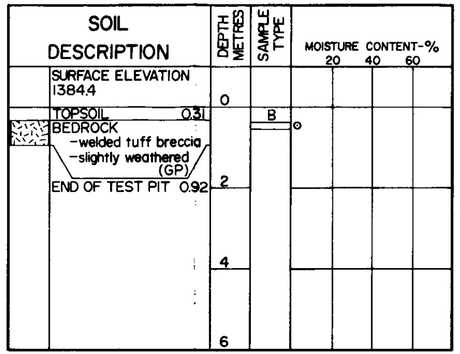
TP 124

N 5626 060
E 603 138



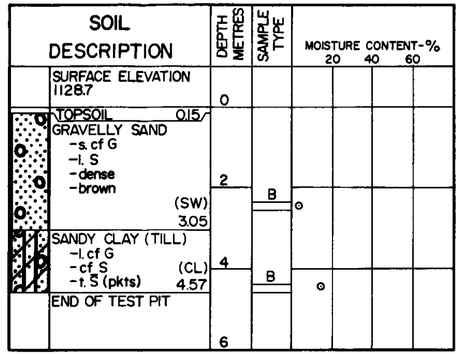
TP 125

N 5625 845
E 603 090



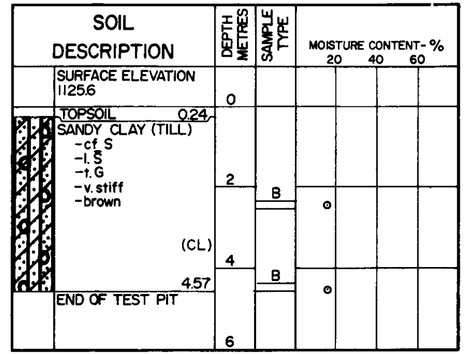
TP 126

N 5620 431
E 600 715



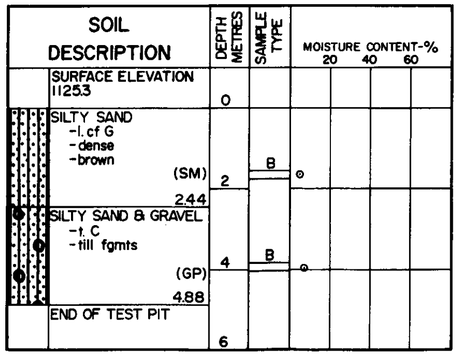
TP 127

N 5620 409
E 600 712



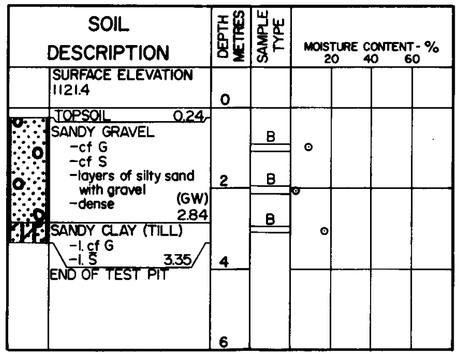
TP 128

N 5620 395
E 600 804



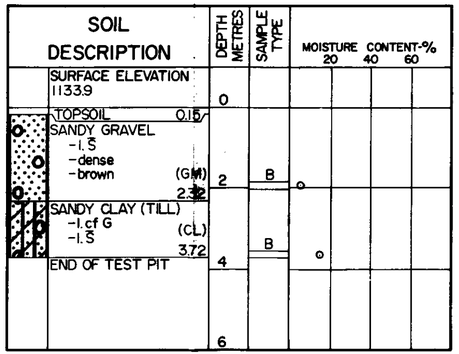
TP 129

N 5620 374
E 600 806



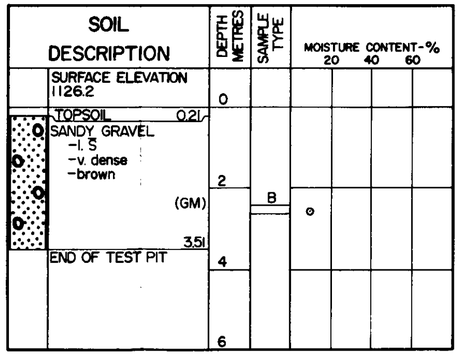
TP 130

N 5620 169
E 600 848



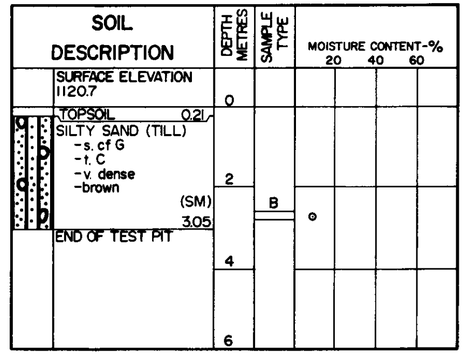
TP 131

N 5620 152
E 600 958



TP 133

N 5620 322
E 601 044



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B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

WATER SUPPLY AND ASH RETENTION DAMS

TEST PITS
TP 123 to TP 133

APPROVED

PROJECT NO. VA 2321

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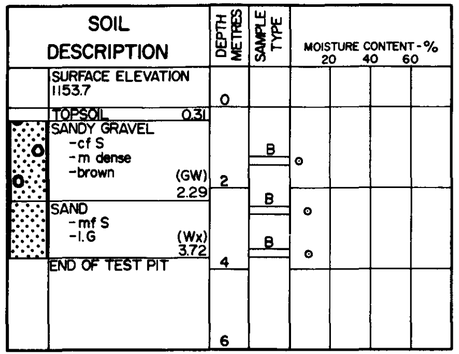
PLATE C12

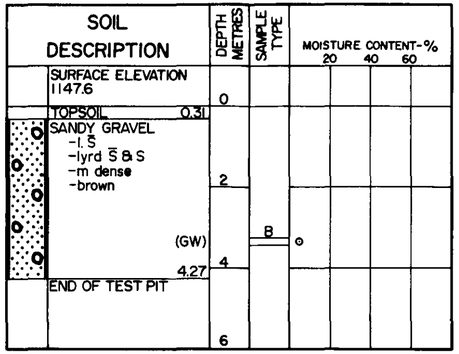
TP 134

N 5619 971
E 601 644



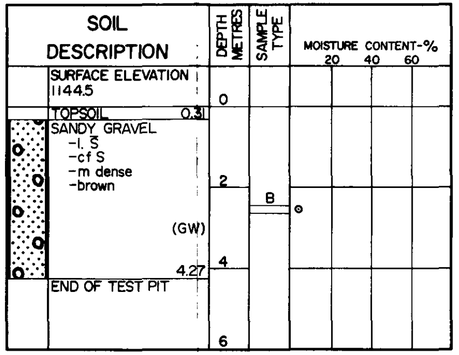
TP 135

N 5619 928
E 601 602



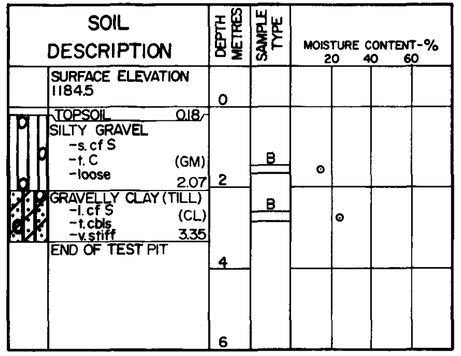
TP 136

N 5619 810
E 601 552



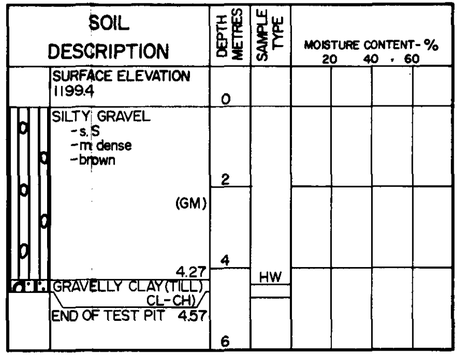
TP 137

N 5624 604
E 604 460



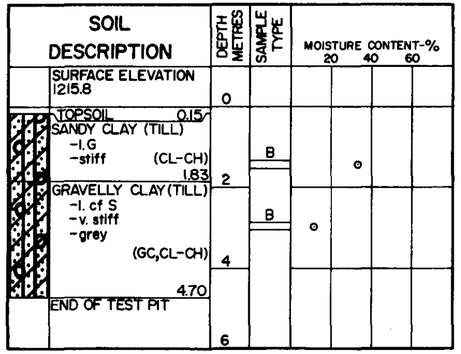
TP 138

N 5624 641
E 604 444



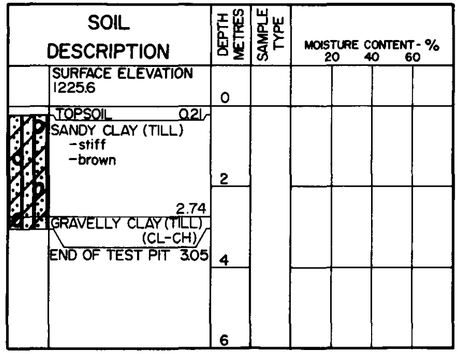
TP 139

N 5624 855
E 605 582



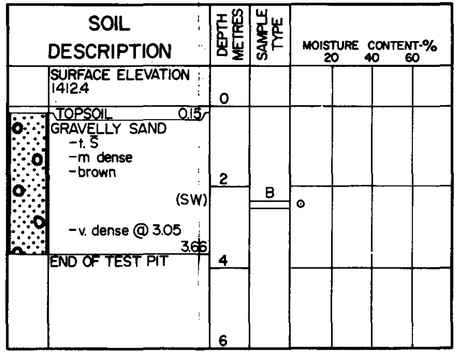
TP 140

N 5625 063
E 605 521



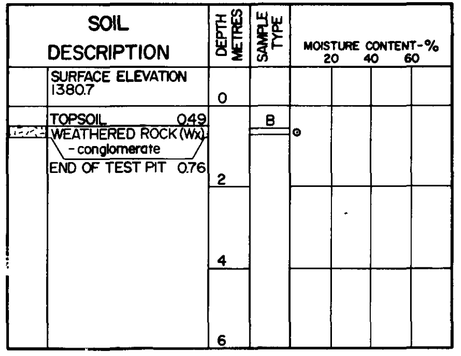
TP 141

N 5627 387
E 605 241



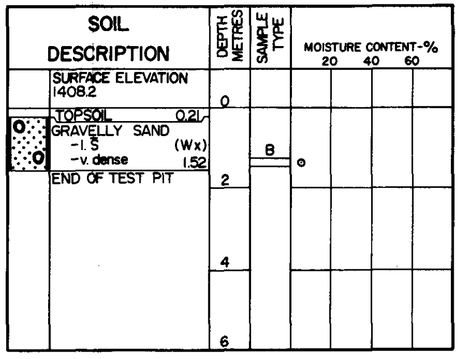
TP 142A

N 5626 837
E 605 340



TP 142

N 5627 271
E 605 336



KLOHN LEONOFF CONSULTANTS LTD.

B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

WATER SUPPLY AND ASH RETENTION DAMS

TEST PITS
TP 134 to TP 142

APPROVED

PROJECT NO. VA 2321

DATE JAN., 1978

PLATE C13

TP 143

N 5626 747
E 605 140

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1375.0	0		
TOPSOIL 0.43			
SILTY CLAY (TILL) -s. cf S -t. G -v. stiff -grey (CL) 2.62	2	B	o
GRAVELLY CLAY (TILL) -l. cf S -hard (GC,CL-CH) 4.57	4	B B	o o
END OF TEST PIT	6		

TP 144

N 5627 276
E 604 433

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1364.0	0		
TOPSOIL 0.43			
SHALE -slightly weathered -highly jointed -bedding dips approx. 30° N 3.35	2	B	o
END OF TEST PIT	4		
	6		

TP 145

N 5627 707
E 605 948

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1427.7	0		
TOPSOIL 0.15			
SAND -l. G (SW) -t. C 1.34		B	o
GRAVELLY CLAY (TILL) -l. cf S -l. S (pkts) -v. stiff (GC,CL-CH) 3.66	2	B B	o o
END OF TEST PIT	4		
	6		

TP 147

N 5627 539
E 606 009

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1414.9	0		
TOPSOIL 0.15		B	o
GRAVELLY SAND -lyrd S & S (SW) 1.83	2	B	o
SANDY GRAVEL (GW) 2.96		B	o
SAND -mf S -m dense -brown 4.54	4	B	o
SANDY CLAY (TILL) -l. G (CL)			
END OF TEST PIT 4.88	6		

TP 148

N 5627 472
E 606 105

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1411.2	0		
FILL (Logging debris) 0.31		B	o
GRAVELLY SAND TO SILT -(SW) to 0.82 -(SM) to 1.50 1.92 -(ML) to 1.92 -bedding dips appr. 30° N	2	B B	o o
GRAVELLY CLAY (TILL) -l. cf S -v. stiff (GC,CL-CH) -brown -lyrd S 4.63	4	B	o
END OF TEST PIT Water seepage @ 3.00	6		

TP 150

N 5626 269
E 605 038

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1328.9	0		
TOPSOIL 0.55			
SILTY CLAY (TILL) -s. S -l. G -v. stiff (CL) 3.05	2	B	o
GRAVELLY CLAY (TILL) -t. cm S -t. S (GC,CH-CL) 4.88	4	HW B	o
END OF TEST PIT	6		

TP 151

N 5626 330
E 605 025

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1338.7	0		
TOPSOIL 0.21			
GRAVELLY CLAY (TILL) -l. cm S -v. stiff -grey brown (GC,CL-CH) 4.42	2	HW	
END OF TEST PIT	4	B	o
	6		

TP 152

N 5626 409
E 604 792

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1340.8	0		
TOPSOIL 0.31			
SILT & SAND -f S -t. G -t. C 2.44	2	B	o
SHALE -weathered to 4.20 -v. slight seepage @ 3.20 4.48	4	B	
END OF TEST PIT	6		

TP 153

N 5626 741
E 604 650

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1356.7	0		
TOPSOIL 0.21		B	
SAND & GRAVEL -lyrd S a. f S -m dense (SW) -brown 2.13	2	B	o
GRAVELLY CLAY (TILL) -s. S -t. S (GC,CL-CH) 4.42	4	B B	o
END OF TEST PIT	6		

TP 154

N 5625 167
E 606 466

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT-% 20 40 60
SURFACE ELEVATION 1239.0	0		
TOPSOIL 0.12		B	o
SANDY GRAVEL 0.92 -cf S -t. S -S a. f S band	2		
GRAVELLY CLAY (TILL) -s. cf S -v. stiff -brown (GC,CL) 4.51	4	B	o
END OF TEST PIT	6		

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B.C. HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT

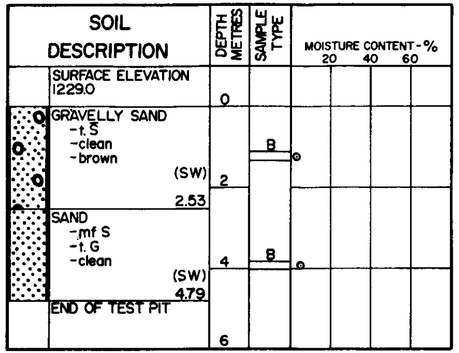
WATER SUPPLY AND ASH RETENTION DAMS

TEST PITS
TP 143 to TP 154

APPROVED	PROJECT NO.	DATE
	VA 2321	JAN., 1978
		PLATE C14

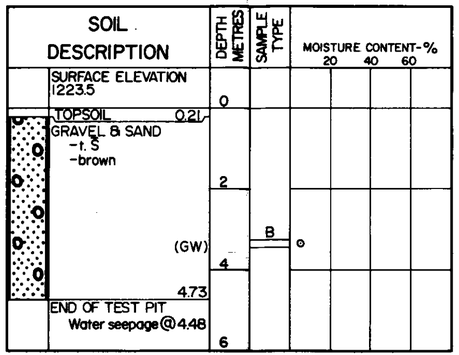
TP 155

N 5624 978
E 606 346



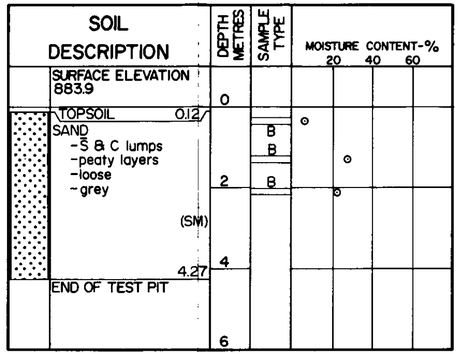
TP 156

N 5624 884.2
E 606 134.7



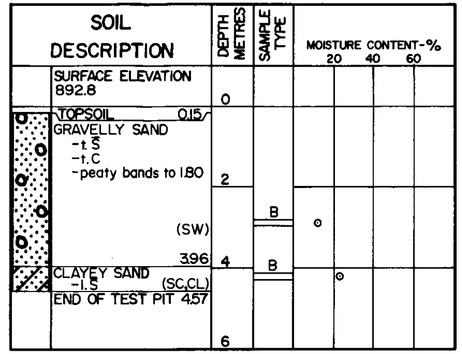
TP 157

N 5626 774.1
E 596 913.5



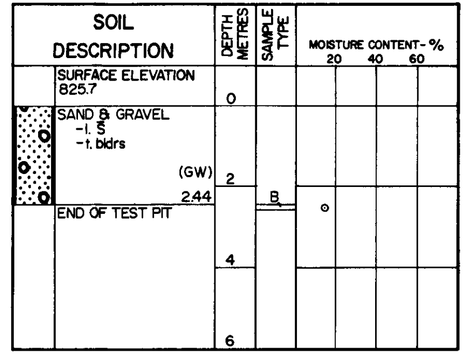
TP 158

N 5626 745.2
E 596 671.7



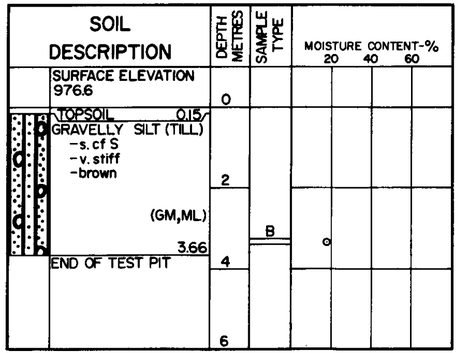
TP 159

N 5627 357.3
E 598 097.1



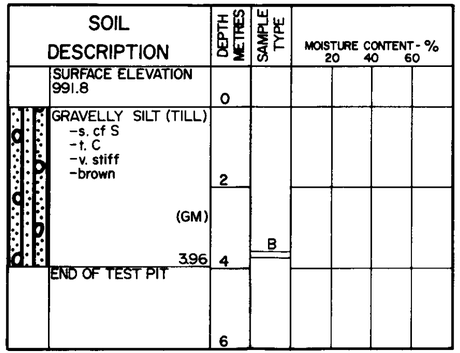
TP 160

N 5625 225
E 599 850



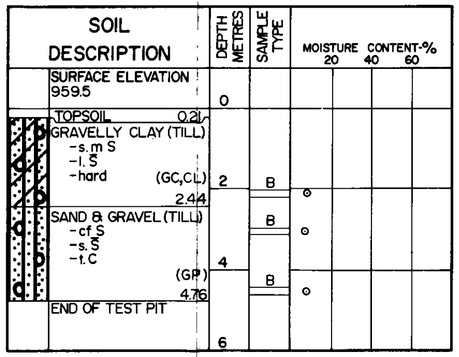
TP 161

N 5625 732
E 600 067



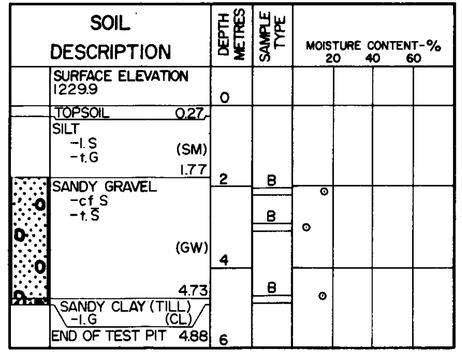
TP 162

N 5626 228
E 599 153



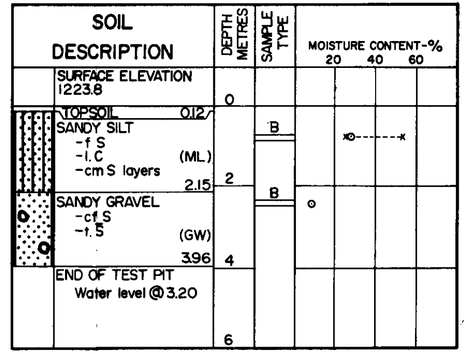
TP 163

N 5624 639
E 606 183



TP 164

N 5624 869
E 605 988



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B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

WATER SUPPLY AND ASH RETENTION DAMS

TEST PITS
TP 155 to TP 164

APPROVED

PROJECT NO. VA 2321

DATE JAN., 1978

PLATE C15

TP 165

N 5624 701
E 606 308

SOIL DESCRIPTION	DEPTH METRES	SAMPLE TYPE	MOISTURE CONTENT - % (20 40 60)
SURFACE ELEVATION 1226.8	0		
TOPSOIL (SILT) 0.49			
SANDY GRAVEL -cf S -t. S -dense -brown (GW) 2.44	2	B	o
GRAVELLY CLAY (TILL) -l. cf S -t. S (GC,CL-CH) 4.45	4	B	o
END OF TEST PIT	6		

KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	TEST PITS TP 165
APPROVED [signature]	PROJECT NO. VA 2321
DATE JAN. 1978	PLATE C16

APPENDIX VIII

Written Geologic Drill Hole Logs

Plate No. C17

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CIVIL & GEOTECHNICAL ENGINEERS

GEOLOGIC DRILL HOLE LOG

CLIENT: B.C. Hydro — JOB No.: VA 2321

PROJECT: HAT CREEK — HOLE No.: P-77-36

SITE: Axis of Saddle Dam — SHEET No.: 1 OF 2

CONTRACTOR: Becker

STARTED .M. Sept. 1 19 77

FINISHED .M. Sept. 2 19 77

METHOD OF DRILLING: SOIL Hammer Drilling; ROCK Diamond Coring

CASING DIA. 140 mm

CASING DEPTH 7.92 m

CORE DIA. BW

LOCATION: LATITUDE; DEPARTURE; BEARING; INITIAL DIP; OTHER DIPS

ELEVATIONS: DATUM; DRILL PLATFORM; GROUND SURFACE; ROCK SURFACE; BOTTOM OF HOLE; WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
7.92						
7.92	Shale &	Shale and Mudstone 7.92 - 8.53. Shale,		1.22	0	50
9.14	Mudstone	dark, flat grey, poorly to moderately fissile.				
		Some small pieces of core show fine laminations. In general, core splits normal to c/a along smooth, irregular to conchoidal fractures.				
		Very slightly calcareous.				
		Core rubbly from poweder to 1 inch size. One or two discs of core about 5 mm thick. Some fracture surfaces show a very slight sheen (probably mica). Medium hard. 8.53 - 9.14. mudstone powdery with a few fragments up to 5 mm. Crumbles under fine pressure.				
9.14	Mudstone	Mudstone, same as 8.53 - 9.14. Medium		1.52	0	17
10.66		to dark grey, slight to moderately calcareous.				
		Core has been softened by drill water but tends to split into disc - like pieces along surfaces ±80 to core axes. About 15 mm of recovered material near bottom of run is shaley, same as 7.92 to 8.53				

LOGGED BY R. Lopez

DATE 28/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-36

SITE Axis of Saddle Dam — SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
10.66		Mudstone, same as 9.14 to 10.66. Sandy		1.52	0	17
12.19		to gravelly near top of run, softened by drill water throughout.				
12.19		End of Drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-37

SITE Axis of Saddle Dam — SHEET No. 1 OF 2

CONTRACTOR: Becker

STARTED ____ .M. Sept. 2 19 77

FINISHED ____ .M. Sept. 3 19 77

METHOD OF DRILLING: SOIL Hammer Drilling — CASING DIA. 140 mm; CASING DEPTH 4.57 m

ROCK Diamond Coring — CORE DIA. BW

LOCATION: LATITUDE ____ DEPARTURE ____ BEARING ____ INITIAL DIP ____ OTHER DIPS ____

ELEVATIONS: DATUM ____ DRILL PLATFORM ____ GROUND SURFACE ____ ROCK SURFACE ____ BOTTOM OF HOLE ____ WATER TABLE ____

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
15.0						
4.57	Siltstone	Siltstone medium to dark grey, massive, medium specific gravity, soft (easily scratched with knife, can be scratched with fingernail with difficulty)		1.52	0	40
6.10		Colour is flat and uniform throughout the core.				
		Core breaks in discs normal to c/a from 10 to 50 mm thick. Some of the fractures are irregular to conchoidal, exhibiting a smooth, flat surface. The irregularity might be caused by fossil casts but there is no clear evidence of this. Some surfaces are flat, smooth and apparently ground up by core rotation, these could represent bedding planes.				
		Fresh broken surfaces are finely gritty with small quartz fragments visible to the naked eye. In some pieces, composition is silty fine sand, with substantial amounts of sand fractions. In these portions, needles of dark minerals, up to 5 mm long can be observed. These are probably amphiboles or fragments of volcanic ejecta.				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-37

SITE Axis of Saddle Dam — SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		It appears as if this rock is derived directly from a volcanic source and represents an underwater deposit of volcanic ash.				
		Weathering: 4.57 - 5.33 - Moderately weathered. 5.33 - 6.10 - Slightly weathered.				
		Very mildly calcareous (slight reaction to HCl.				
6.10	Siltstone	Finely grained sandstone		1.52	0	46
7.62		7.32 - 7.62 changing gradually to mudstone				
7.62	Mudstone	Mudstone. Colour and appearance same as previous runs but apparently some clay content in this section.		1.52	0	56
9.14		Core breaks into pieces of up to 50 mm length with rounded-off edges, probably washed by drill water.				
		Core is soft and can be easily indented with fingernail.				
		Rock mass has minor to moderate amounts of disseminated calcite.				
9.14		End of Drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-41

SITE Axis of Ash Dam No 3 — SHEET No. 1 OF 2

CONTRACTOR: Becker

STARTED ____ .M. Aug. 24 19 77

FINISHED ____ .M. Aug. 24 19 77

METHOD OF DRILLING: SOIL Hammer Drilling; ROCK Diamond Coring

CASING DIA. 140 mm

CASING DEPTH 5.94 m

CORE DIA. BW

LOCATION: LATITUDE ____ DEPARTURE ____ BEARING ____ INITIAL DIP ____ OTHER DIPS ____

ELEVATIONS: DATUM ____ DRILL PLATFORM ____ GROUND SURFACE ____ ROCK SURFACE ____ BOTTOM OF HOLE ____ WATER TABLE ____

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
19.5						
5.94	Greenstone (altered volcanics)	Greenstone. (Altered intermediate or basic Volcanics), altered and highly weathered, greenish grey on fresh surfaces, rusty on fracture surfaces.		1.37	0	39
7.32		Core fragments from fine gravel to 75mm bound by irregular rusty surfaces. There is a very poorly developed foliation subparallel to core which seems to control fracturing. Rock reacts weakly to acid due to finely disseminated calcite in rock mass. Some calcite veins from hairline to 2 or 3 mm. One sub-rounded fragment of calcite about 20 mm mixed with core.				
		This core appears to have been brecciated by tectonic action and recemented by calcite-rich solutions.				
7.32	Greenstone (altered volcanics)	Greenstone. Recovered only 2 or 3 fragments of same material as above.		1.10	0	0
8.41						

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DATE 27/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro

PROJECT HAT CREEK

SITE Axis of Ash Dam No 3

JOB No. VA 2321

HOLE No. P-77-41

SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
8.41	Greenstone	Greenstone. Approximately upper 1/3 of		0.79	0	57
9.20		recovered portion, same as 5.94 to 7.32 m. Below the rock is thoroughly weathered and pulverized to finely broken (coarse sand to fine gravel size).				
		Colour is rusty brown with only occasional speckles of greenish grey.				
		Upper one third of core has a waxy appearance as if the rock has been altered to talc or chlorite.				
		Throughout the core, in fresh pieces and surfaces, the rock appears as finely crystalline but not quite aphanitic (individual crystals may be picked up with 10X lens). Composition appears to be mainly Ca-feldspar, with significant amounts of quartz (±10%) and amphiboles dominating as the Fe-Mg minerals. Some rare large phenocrysts of epidote can also be seen.				
		This rock is probably the greenstone member of the Cache Creek group.				
9.20		End of Drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-43

SITE Axis of Ash Dam No 1A — SHEET No. 1 OF 2

CONTRACTOR: Becker

STARTED ____ .M. Aug. 23 19 77

FINISHED ____ .M. Aug. 25 19 77

METHOD OF DRILLING: SOIL Hammer Drilling; ROCK Diamond Coring

CASING DIA. 140 mm

CASING DEPTH 5.03 m

CORE DIA. BW

LOCATION: LATITUDE ____ DEPARTURE ____ BEARING ____ INITIAL DIP ____ OTHER DIPS ____

ELEVATIONS: DATUM ____ DRILL PLATFORM ____ GROUND SURFACE ____ ROCK SURFACE ____ BOTTOM OF HOLE ____ WATER TABLE ____

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
5.03						
5.03	Basalt	Basalt		1.52	0	40
6.55		Dark green to greenish grey, yellow to rusty along fracture surfaces.				
		Core is composed of fragments rounded to subangular, from 6 mm to 40 mm.				
		Recovered fragments are moderately weathered but they probably represent the fragmental portion of a deeply weathered saprolitic profile with the deeply weathered products having been washed out by drill water.				
		Structure is dense and massive with no indication of shearing. Texture is finely crystalline to slightly porphyritic.				
		Mild reaction to HCl due to thin calcite coatings on surfaces. Thin (hairline) calcite - filled irregular cracks criss-crossing the rock mass. Rock appears to have been brecciated and recemented by calcite.				

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DATE 28/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-43

SITE Axis of Ash Dam No 1 A — SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
6.55	Basalt	Basalt. Same as 5.03 to 6.55.		1.52	0	50
8.08		Core pieces increase in size up to 60 - 90 mm.				
8.08	Basalt	Basalt. Same as 7.77 to 8.08.		1.07	0	73
9.14		One half core piece 10 cm long with a 6 to 12 mm thick calcite vein. Vein dips at 10° with core axis. One side of the vein appears slickensided but the surface is quite weathered and weathering is masking the striations.				
		One subhorizontal calcite vein ± 20 mm thick near bottom of run and several irregular calcite veins around. It appears as if the rock has been brecciated and recemented by calcite-rich solutions.				
		Mild to moderate reaction to HCl due to increased abundance of calcite-filled hairline cracks. The degree of weathering is slowly decreasing with depth.				
9.14		End of Drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT: B.C. Hydro — JOB No.: VA 2321

PROJECT: HAT CREEK — HOLE No.: P-77-45

SITE: Axis of Ash Dam No IA — SHEET No.: 1 OF 2

CONTRACTOR: Becker

STARTED: 2:30p.m. Aug. 20 19 77

FINISHED: .m. Aug. 22 19 77

METHOD OF DRILLING: SOIL: Hammer Drilling; ROCK: Diamond Coring

CASING DIA.: 140 mm

CASING DEPTH: 1.83 m

CORE DIA.: BW

LOCATION: LATITUDE; DEPARTURE; BEARING; INITIAL DIP; OTHER DIPS

ELEVATIONS: DATUM; DRILL PLATFORM; GROUND SURFACE; ROCK SURFACE; BOTTOM OF HOLE; WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
3.05						
3.05	Greenstone (altered volcanics)	Greenstone. Altered intermediate or basic volcanics representing the greenstone member of the Cache Creek group.		0.61	0	100
3.66		Dark greenish grey to grey, hard (cannot be scratched with knife)				
		Rock minerals partly altered to chlorite and/or epidote.				
		Slightly to moderately weathered. Rust stained along joint surfaces.				
		Rock mass has been subjected to shearing and exhibits a moderately developed schistosity (phyllitic structure). Some crudely developed mineral segregation with contorted dark bands (probably biotite). Core splits in places along these bands, with the split surface exhibiting a silky lustre and some slickensiding.				
		Very slight reaction to HCl caused by thin calcite coatings on joint and foliation surfaces.				

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DATE: 28/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-45

SITE Axis of Ash Dam No 1 A — SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
3.66	Greenstone	Same as 3.05 to 3.66, moderately weathered.		1.31	0	85
4.97	(altered volcanics)	3.96 - 4.27 contored foliation, slickensided surfaces.				
4.97	Greenstone	Greenstone. Same as 3.05 to 3.66. Highly		1.43	0	75
6.40	(phyllitic structure)	contorted foliation throughout this run.				
6.40	Greenstone	Greenstone. Same as 4.97 to 6.40		0.61	0	50
7.01	(phyllitic structure)	moderately to strongly weathered in parts. Recovered only fragments up to 50 mm. Some of these fragments indicate that the rock has been crushed and recrystallized.				
7.01	Greenstone	Greenstone. Recovered only a few pebbles.		1.37	0	0
8.38	(phyllitic structure)	Rest of core probably lost in hole. Same as 6.40 to 7.01				
		The entire core shows strong evidence of being a fault zone.				
8.38		End of Drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT: B.C. Hydro — JOB No.: VA 2321

PROJECT: HAT CREEK — HOLE No.: P-77-47

SITE: Axis of Ash Dam No 4 — SHEET No. 1 OF 2

CONTRACTOR: Becker

STARTED ____ .M. Aug. 25 19 77

FINISHED ____ .M. Aug. 28 19 77

METHOD OF DRILLING: SOIL: Hammer Drilling; ROCK: Diamond Coring & Rotary

CASING DIA.: 140 mm

CASING DEPTH: 40.84 m

CORE DIA.: BW

LOCATION: LATITUDE ____ DEPARTURE ____ BEARING ____ INITIAL DIP ____ OTHER DIPS ____

ELEVATIONS: DATUM ____ DRILL PLATFORM ____ GROUND SURFACE ____ ROCK SURFACE ____ BOTTOM OF HOLE ____ WATER TABLE ____

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
40.84						
40.84	Sandstone, possibly greywacke	Sandstone and silty sandstone. Sand up to medium sand size and uniform (well sorted).		1.52	0	17
42.37		Moderately cemented (can be scratched with finerganil.				
		Medium grey. Medium dense				
		Moderately weathered.				
		Bedding not noticeable. Rock is quite broken and no fracture patterns are apparent.				
		Rock consists mainly of fragments of quartz, calcic feldspar and some dark minerals.				
		One angular fragment (±20mm) of dark rock (probably andesite or basalt) showing pyrite coating on a fracture surface.				
		This rock is probably a reworked tuff or ash deposit, and probably should be defined as a greywacke.				

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DATE 28/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-47

SITE Axis of Ash Dam No 4 — SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
42.37	Sandstone	Same as 40.84 to 42.37. Core is		1.52	0	60
43.89	(possiby	relatively intact with pieces from 25				
	greywacke)	to 100 mm long.				
		At top of core, one joint at 45° with core axis.				
		At 43.43 one joint at 45° with c/a. Joint surface shows laminations (bedding) less than 1 mm thick, showing graded bedding.				
		Laminations are subvertical indicating that rock may have been upset tectonically.				
		From 43.43 to 43.89 the core is split along a vertical fracture, which is probably a lamination surface. One half of core is broken up; the other half is relatively intact.				
		Rock is medium grey, medium dense, and moderately weathered in this run.				
43.89		End of Drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-48

SITE Axis of Ash Dam No 4 — SHEET No. 1 OF 2

CONTRACTOR: Becker

STARTED ____ .M. Aug. 26 19 77

FINISHED ____ .M. Aug. 28 19 77

METHOD OF DRILLING: SOIL Hammer Drilling; ROCK Diamond Coring

CASING DIA. 140 mm

CASING DEPTH 8.23 m

CORE DIA. BW

LOCATION: LATITUDE ____ DEPARTURE ____ BEARING ____ INITIAL DIP ____ OTHER DIPS ____

ELEVATIONS: DATUM ____ DRILL PLATFORM ____ GROUND SURFACE ____ ROCK SURFACE ____ BOTTOM OF HOLE ____ WATER TABLE ____

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
6.10						
6.10	Sandstone and silty sandstone	Fine to medium grained, uniform (well sorted). Moderately cemented (can be broken with strong finger pressure and grains rub off easily)		1.37	0	60
7.48		6.10 - 6.40. Moderately weathered. Core consists of rounded pebbles up to 25 mm.				
		6.40 - 7.48. Slightly to moderately weathered, intact core pieces up to 100 mm long.				
		7.31 - 7.41 Same as 6.10 to 6.40. Colour medium to dark yellowish orange to yellowish brown.				
		Generally medium dense and massive with no apparent bedding or fracturing.				
		This run is thoroughly oxidized but not deeply weathered. Composition seems to be mainly quartz with some accessory K-spar and Na-spar.				
		This rock probably represents reworked deposits of volcanic ash and tuff. Very slight calcareous reaction.				
7.48	Clayey sandstone	Similar colour as 6.10 to 7.48 but core consists of irregular pieces of clayey sandstone softened by drill water.		0.46	0	95
7.92						
7.92	Pebbles	Pebbles of sandstone (similar to 6.10 to 7.48) and greenstone (Cache Creek Group). Only 4 round pebbles ±12 mm recovered. Probably a poorly cemented		1.83	0	0
9.75						

LOGGED BY R. Lopez

DATE 28/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-48

SITE Axis of Ash Dam No 4 — SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		conglomeratic layer				
9.75	Silty clayey	Silty-clayey sandstone (recovered only		0.31	0	10
10.06	sandstone	loose material), probably soft and poorly cemented, dark greenish grey, containing pebbles of dark greenish grey volcanics of (probably) Cache Creek greenstone. Mildly calcareous.				
10.06	Clayey	Clayey sandstone, recovered only 2 or 3				
10.97	sandstone	pieces of core about 25 mm long which are well indurated. Rest is loose sand and softened core representing probably clayey zones and zones of poor cementation. Eyeball composition is 60% quartz and 40% Na-Ca feldspar and dark minerals or fragments of dark aphanitic volcanic rocks.				
		Most fragments are subrounded and some		0.91	0	30
		are angular indicating only relatively short transport of the material. Medium greenish grey, very slightly calcareous.				
10.97	Clayey	Clayey sandstone. Same as 10.06 - 10.97.		2.29	0	10
13.26	sandstone	1 pebble rounded about 12mm size of hard cemented volcanic tuff consiting of 3 to 6 mm fragments of dark aphanitic volcanic rock in a cherty groundmass. There are other sparse, rounded 6 to 12 mm size pebbles of chert and volcanics. Slightly calcareous				
13.26		End of drillhole				

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GEOLOGIC DRILL HOLE LOG

CLIENT: B.C. Hydro — JOB No.: VA 2321

PROJECT: HAT CREEK — HOLE No.: P-77-68

SITE: Divide — SHEET No.: 1 OF 3

CONTRACTOR: Becker

STARTED .M. Sept. 5 19 77

FINISHED .M. Sept. 8 19 77

METHOD OF DRILLING: SOIL Hammer Drilling; ROCK Diamond Coring

CASING DIA. 140 mm

CASING DEPTH 18.90 m

CORE DIA. BW

LOCATION: LATITUDE; DEPARTURE; BEARING; INITIAL DIP; OTHER DIPS

ELEVATIONS: DATUM; DRILL PLATFORM; GROUND SURFACE; ROCK SURFACE; BOTTOM OF HOLE; WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0						
19.81						
19.81		Fragments of volcanic rock, acidic to		0.61	0	80
20.42	Breccia	intermediate, (rhyolite-andesite), in a well cemented, fine grained matrix. Fragments are angular, ranging in size from medium sand to ±20 mm. Rock is hard - moderately to highly weathered (1 core piece 25 mm long the rest is rubbly up to 25 mm). Colour reddish brown with yellowish mottling. Slight HCl reaction.				
20.42		Same as 19.81 to 20.42. Reddish brown		1.52	50	84
21.95	Breccia	from 20.42 to 20.57, greenish grey below. Hard, moderately to slightly weathered intact core pieces up to 20 cm long. Irregular fracturing. Strongly weathered along fractures. Slight HCl reaction caused by disseminated carbonate in rock mass.				

LOGGED BY R. Lopez

DATE 28/09/77

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-68

SITE Divide — SHEET No. 2 OF 3

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		Some calcite filling along joints.				
21.95		Same as 20.42 to 21.95. Greenish grey		1.68	0	59
23.62	Breccia	with rust or reddish brown coloured sections.				
		Rock mass moderately weathered, strongly weathered along joints. Hard. 3 core pieces 75 mm long. Rest is rubbly from fine gravel to 40 mm.				
23.62		Same as 21.95 to 23.62		1.52	0	96
24.80	Breccia					
		24.38 - 24.80 strongly weathered to a porous friable mass. This section exhibits slightly rounded pebbles and may represent a section having under gone some reworking and sorting by running water.				
		Rest of core is moderately to strongly weathered. 7 relatively intact core pieces from 25 to 75 mm long. Rest of core is rubbly from coarse sand to 25 to 40 mm fragments.				
24.80		Same as 23.62 to 24.80		0.91	0	95
25.76	Breccia	24.80 - 25.15 mudstone. Medium hard. Appears to have been softened and leached by drill water. Strongly weathered greyish red.				
		25.15 - 25.76 conglomerate to breccia texture. Tightly packed angular fragments from coarse sand to 75-100 mm in a dark greenish grey, well cemented matrix.				
		Rock mass slightly to moderately weathered joints moderately weathered. Very irregular fracturing. About 80% of core consists of intact pieces 25 to 75 mm long. Rest is rubbly in the 3mm to 6 mm				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK — HOLE No. P-77-68

SITE Divide — SHEET No. 3 OF 3

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		range.				
25.76		Same as 24.80 to 25.76. 25.76-26.06		0.76	0	73
26.52	Breccia	slightly weathered, intact core pieces 12 to 75 mm long.				
		26.06 - 26.53. Rubbly. Angular to sub-rounded fragments from 6 to 25 mm. Strongly to moderately weathered.				
26.52	Breccia	Breccia. Dark greenish grey. Moderately weathered.		0.91	0	33
		Recovered only rounded pebbles up to 40 mm size. Clasts seem to consist mainly of Permian greenstone types.				
27.43		End of Drillhole.				

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GEOLOGIC DRILL HOLE LOG

CLIENT B.C. Hydro — JOB No. VA 2321

PROJECT HAT CREEK ASH STORAGE DAMS — HOLE No DDH-77-501

SITE Medicine Creek Divide — SHEET No. 1 OF 8

CONTRACTOR: Tonto Drilling — STARTED 8:00 P.M. Oct. 21 19 77

FINISHED .M. 19

METHOD OF DRILLING: SOIL HQ Coring, Mud circulation — CASING DIA. HQ

ROCK HQ Coring, Water — CASING DEPTH

CORE DIA. HQ

LOCATION: LATITUDE, DEPARTURE, BEARING, INITIAL DIP, OTHER DIPS

ELEVATIONS: DATUM, DRILL PLATFORM, GROUND SURFACE, ROCK SURFACE, BOTTOM OF HOLE, WATER TABLE

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
0.0	Overburden	Drilled casing		1.52	N/A	0.0
1.52						
1.52	Overburden	1.52 - 2.44 Organic soil, dark brown		1.83	N/A	30
3.35		2.44 - 3.35 Rounded pebbles 1 core piece 50 mm long (boulder)				
3.35	Overburden	Recovered 1 core piece 75 mm long (boulder) - material is medium grained arkose or sandstone of the coldwater deposits		1.52	N/A	5
4.88						
4.88	Overburden	Angular to subrounded pebbles in matrix of medium chocolate brown, soft, medium plastic clay - 200 mm long core piece at bottom of row - sedimentary conglomerate of the coldwater beds.		1.22	N/A	31
6.10						
6.10	Overburden	Lost casing shoe in soft clay material - sample inside a casing tap is clay, sandy, medium chocolate brown, medium to high plasticity, soft to medium stiff.		N/A	N/A	N/A
6.40						
6.40	Overburden	CLAY, sandy to gravelly, medium chocolate brown, medium stiff to stiff, medium plasticity.		1.83	N/A	28
8.23						

LOGGED BY

DATE

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CIVIL & GEOTECHNICAL ENGINEERS

GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH-77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 2 OF 8

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
8.23	Overburden	Lost core		1.22	N/A	0
9.45						
9.45	Overburden	Lost core.		1.83	N/A	0
11.28						
11.28	Overburden	Lost core.		1.22	N/A	0
12.50						
12.50	Overburden	CLAY, sandy to gravelly, medium		1.52	N/A	50
14.02		chocolate brown, softened by circulation, medium plasticity.				
14.02	Overburden	Same as 12.50 to 14.02. Medium		1.52	N/A	13
15.54		stiff to stiff.				
15.54	Overburden	Same as 14.02 to 15.54		1.52	N/A	6
17.07						
17.07	Overburden	Same as 15.54 to 17.07 - large		1.52	N/A	13
18.59		(up to 38 mm) angular fragments of rock.				
18.59	Overburden	Same as 17.07 to 18.59		1.52	N.A	15
20.12						
20.12	Overburden &	20.12 - 21.24 - same as 18.59 - 20.12		1.52	15	28
21.64	Rock	21.24 - 21.64				
		Conglomerate (sedimentary), well cemented, hard, medium grey - clasts appear to be mainly dark coloured basic volcanic rocks. Probably a boulder overlying bedrock -				
		BEDROCK AT 21.64 m				
21.64	SILTSTONE	SILTSTONE, dark grey, dense, fissile		.61	30	90
22.25		core breaks easily along randomly oriented planar surfaces				
22.25	SILTSTONE	same as 21.64 - 22.25		.61	90	100
22.86						
22.86	SILTSTONE &	same as 22.25 - 22.86. Crumbles		1.52	30	100
24.38	MUDSTONE	easily				
		23.47 - 24.38 - Clayey, mudstone				

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GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH-77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 3 OF 8

DEPTH	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
24.38	Mudstone	MUDSTONE - same as 23.47 - 24.38		1.52	50	65
25.91						
25.91	SILTSTONE	SILTSTONE, dark grey, dense,		1.52	35	100
27.43		fissile, core breaks easily,				
		laminated				
27.43	SILTSTONE	SILTSTONE, dark brownish grey,		1.52	60	100
28.96		dense, medium hard to				
		hard towards bottom of run,				
		laminated. Core breaks easily				
		along two sets of planes, one				
		@80 degrees w.c.a. and the				
		other parallel to c.a.				
28.96	SILTSTONE	SILTSTONE, colour changing to		1.52	50	100
30.48		dark greyish brown, very dense,				
		hard, from 28.96 - 29.41 core				
		splits same as described for				
		27.43 - 28.96 - Massive from 29.41 to				
		30.48				
		29.41 - Sandy, calcareous zone				
		moderate reaction to HCl				
		29.41 - 30.48 - Clayey, mudstone-like				
		30.18 - Calcareous seam about				
		13 mm thick, normal to c.a.				
		irregular, soft, strong reaction to				
		HCl - calcareous seams between 30.18				
		and 30.48				
30.48	SILTSTONE	SILTSTONE, Medium to dark greenish		1.52	90	100
32.00		grey, dense, medium hard.				
		30.48 - 30.78 - Sandy zone, core breaks				

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GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH-77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 4 OF 8

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		easily dark grey				
		30.78 - 31.39. Thin hairline laminations				
		@ 10° W.C.A., probably calcareous				
		(rock mass does not react to HCl)				
		31.39 - 32.00. Clayey(mudstone				
		structure, massive). Trace of sand.				
32.00	SILTSTONE	SILTSTONE, dense, massive, medium		1.52	30	100
33.53		hard.				
		32.00 - 32.16. Fragments of volcanic				
		tuff (probably andesite tuff, or				
		breccia)				
		32.16 - 32.77. Medium greenish grey,				
		changing to greyish brown, trace of				
		sand.				
		32.77 - 33.53. Clayey massive (mud-				
		stone like)				
33.53	SILTSTONE	SILTSTONE, dense, massive, soft to		1.52	80	100
35.05		medium hard, medium to dark greyish				
		brown.				
		34.29 - 35.05. Gradually sandier				
		colour changing to greenish grey,				
		gradual transition to volcanic				
		breccia, interbedded sandy siltstone				
		and sandstone near bottom of run.				
35.05	BRECCIA	BRECCIA. Possibly of volcanic origin		1.52	60	100
36.58		or deposited very near a volcanic				
		source - irregular fragments up to				
		25 mm in cemented and welded sandy				
		groundmass, greyish green. Most of the				
		fragments seem to be of weathered				
		Cache Creek greenstone. Massive,				
		hard.				
		36.04 and 36.58. open, irregular joints				
		at 20° W.C.A.				
36.58	BRECCIA	BRECCIA - same as 35.05 - 36.58		1.52	35	100
38.10		37.03 - 38.10. Highly weathered. Very				
		friable. Core almost completely				
		destroyed when extruded from sleeve.				
		37.64 - 37.80. Layer of siltstone,				
		medium brown, very friable, dense.				
		37.34. Open irregular joint at				
		30° W.C.A.				

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GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH-77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 5 OF 8

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN m	% RQD	% CORE REC.
38.10	SILTSTONE	SILTSTONE, medium to dark brown, dense,		1.22	25	100
39.32		medium hard, friable.				
		38.56 - 38.80 - Breccia layer, same as				
		35.05 - 36.58				
		One 50 mm chert pebble at top of run				
		(may have fallen from above)				
		38.65 - 38.86 - open joints at 30° W.C.A.				
39.32	SILTSTONE	SILTSTONE, medium to dark brown, very		.61	75	75
39.93		dense, massive, medium hard. Intact				
		core piece 450 mm long.				
39.93	SILTSTONE	39.93 - 40-08, siltstone, same as		1.52	45	100
41.45	BRECCIA	39.32 - 39.93				
	SANDSTONE	40.08 - 40.84, breccia, same as				
		35.05 - 36.58, from 40.39 - 40.84				
		highly weathered to a plastic, probably				
		montmorillonite - rich clay, soft				
		40.39 - open joint at 30° W.C.A.				
		40.84 - 41.45, sandstone, medium grey,				
		fine, uniform grained, dense, massive,				
		hard. Contact between weathered breccia				
		and sandstone is sharp.				
41.45	BRECCIA and	BRECCIA, probably of sedimentary origin-		1.52	100	100
42.98	SANDSTONE	clash of chert and intermediate to				
		basic volcanics, dense, hard to very				
		hard, very well cemented, unweathered,				
		grey to greenish grey.				
		41.94 - 42.03 and 42.06 - 42.82				
		finer grained, sandstone, very hard,				
		well cemented.				
		41.54, 41.82, 42.06 and 42.82. Open				
		fractures normal to c/a.				
42.98	BRECCIA and	Same as 41.45 - 42.98. Sandstone from		1.52	80	100
44.50	SANDSTONE	43.46 - 44.07.				
		44.07 - 44.50. Partially weathered,				
		medium hard, friable.				
		44.38, Seam of soft, plastic clay				
		(probably weathering product of breccia				
		material).				
44.50	SANDSTONE and	SANDSTONE, similar composition and		1.52	98	100
46.02	BRECCIA	colour as the breccia but fine to				
		medium sand grain size dominating, with				
		an occassional fragment of chert or				

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GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 6 OF 8

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		volcanic rock, dense, massive, hard unweathered.				
		44.40 - 44.65 and 45.11 - 45.41				
		Breccia, hard, massive, unweathered.				
46.02	BRECCIA	BRECCIA, same as 45.11 - 45.41		1.52	100	100
47.55						
47.55	BRECCIA and	47.55 - 47.85, same as 46.02 - 47.55		1.68	90	100
49.23	SANDSTONE	47.55, open joint at 30° W.C.A.				
		47.85 - 49.23, sandstone, same as 44.50 - 46.02				
49.23	SANDSTONE	49.23 - 50.47, sandstone same as		1.52	95	100
50.75		44.50 - 46.02				
		50.47 - 50.75, breccia, same as 45.11 - 45.41, finer grains near 50.47 grading into coarser grains.				
50.75	BRECCIA and	Interbeddings of medium grained		1.52	95	100
52.27	SANDSTONE	sandstone at 50.90, 51.36, open joint at 52.12 30° W.C.A.				
		Breccia characteristically fine grained beneath sandstone beds.				
52.27	BRECCIA	BRECCIA, hard unweathered, massive		1.37	95	100
53.64		53.19 open fracture @ 90° W.C.A.				
		53.49 - 150 mm sandstone layer, brownish red, medium grained.				
53.64	BRECCIA	BRECCIA, same as 52.27 - 53.64		1.52	95	95
55.17		53.80 - one open joint and one conjugate calcite healed joint at 45° W.C.A.				
		54.56 - open, irregular joint at 20° W.C.A.				
55.17	BRECCIA	BRECCIA, same as 52.27 - 53.64 very				
56.69		coarse grained.				
56.59	BRECCIA	BRECCIA, moderately weathered, soft		1.52	40	80
58.22		and brecciated beginning at 56.69 m.				
		Some portions of the rock are fragmented or weathered to gravel size pebbles and show advanced kaolinization - kaolinized zones appear to correspond with zones of pumice clasts. Numerous slickensided joints exhibiting advance weathering of the joint surface. Secondary Pyrite				

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GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH-77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 7 OF 8

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
		deposits along joint suffaces. Hole was flowing about 1 g.p.m. between 56.69 and 58.22.				
		57.45 - broken up core, advanced kaolinization.				
		57.61, slickensided joint at 20° W.C.A. slickenside traces at app. 20° w/horizontal.				
		58.06, slickenside joint @ 10° W.C.A.				
		56.69 is the beginning of a fault zone.				
58.22	BRECCIA	Highly weathered, rubbly, mainly sand		.61	0	100
58.83		and gravel sizes. Lost core probably represents kaolinized material.				
58.83	BRECCIA	58.83 - 59.13, same as 58.22 - 58.83		.92	15	100
59.74		59.13 - 59.74, slightly to moderately weathered, relatively intact core pieces.				
		59.13 - 59.44., broken core, rust stained along fractures. 6 mm thick calcite or dolomite vein at 80° W.C.A. at 59.28.				
59.74	BRECCIA	59.75 - 60.50, same as 59.13 - 59.74		1.52	15	75
61.26		60.50 - 61.26, highly weathered and kaolinized core.				
		60.05, iron stained joint at 20° W.C.A. Calcite or dolomite-coated joint at 10° W.C.A.				
61.26	BRECCIA	Same as 59.74 - 60.50, secondary Pyrite				
62.79		on fractures. 62.33 - 62.48. Fragmented, kaolinized.				
62.79	BRECCIA	Slightly to moderately weathered.		1.37	40	100
64.16		Highly fractured, numerous clasts of pumice with little or no kaolinization.				
		63.70 - 64.01. Open joint @ 30° W.C.A.				
		64.01. End of fault zone.				
64.16	BRECCIA	Unweathered, hard, dense.		1.52	90	100
65.68		64.31 - small fractured zone				
		64.77 - open joint at 40° W.C.A.				
		64.77 - 65.68, core rust stained.				
		65.53 - 100 mm zone moderately weathered and kaolinized.				

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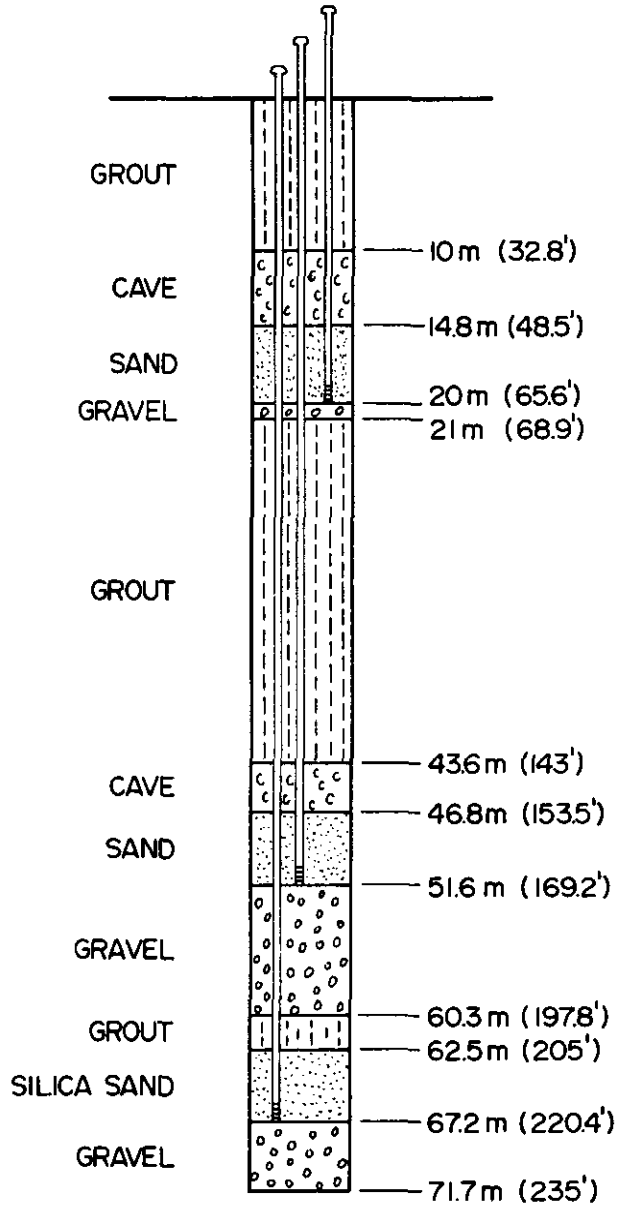
GEOLOGIC DRILL HOLE LOG

CLIENT BRITISH COLUMBIA HYDRO — JOB No. VA 2321

PROJECT HAT CREEK-ASH STORAGE DAMS — HOLE No. DDH-77-501

SITE MEDICINE CREEK DIVIDE — SHEET No. 8 OF 8

DEPTH m	ROCK TYPE	DESCRIPTION	WATER PRESS. TEST	LENGTH OF RUN	% RQD	% CORE REC.
65.68	BRECCIA	Breccia, hard, dense, massive		1.52	90	100
67.21		unweathered, rust-stained core alternating fine and coarse grained layers.				
		65.99 - slickensided joint @ 20° W.C.A.				
		Slickensides dipping 20° with horizontal.				
		Joint surface weathered, rust-stained.				
67.21	BRECCIA	Same as 65.68 - 67.21		.92	60	100
68.12		Somewhat more fractured.				
		67.21 - 67.51, fractured. Fracture surfaces polished or slickensided.				
68.12	BRECCIA	68.12 - 69.04, Breccia, same as		1.52	95	100
69.65		67.21 - 68.12				
		68.88 - irregular open joint @ 10° W.C.A.				
		69.04 - 69.65 - sandstone - dense, massive, unweathered, dark greenish brown. 3 to 6 mm thick, subvertical calcite veins in core.				
		69.65 - END OF HOLE				
		NOTES:				
		1. All depths from drill platform, 380 mm above ground.				
		2. Drill hole located halfway between sta. 15 and sta. 16 of Seismic Line.				



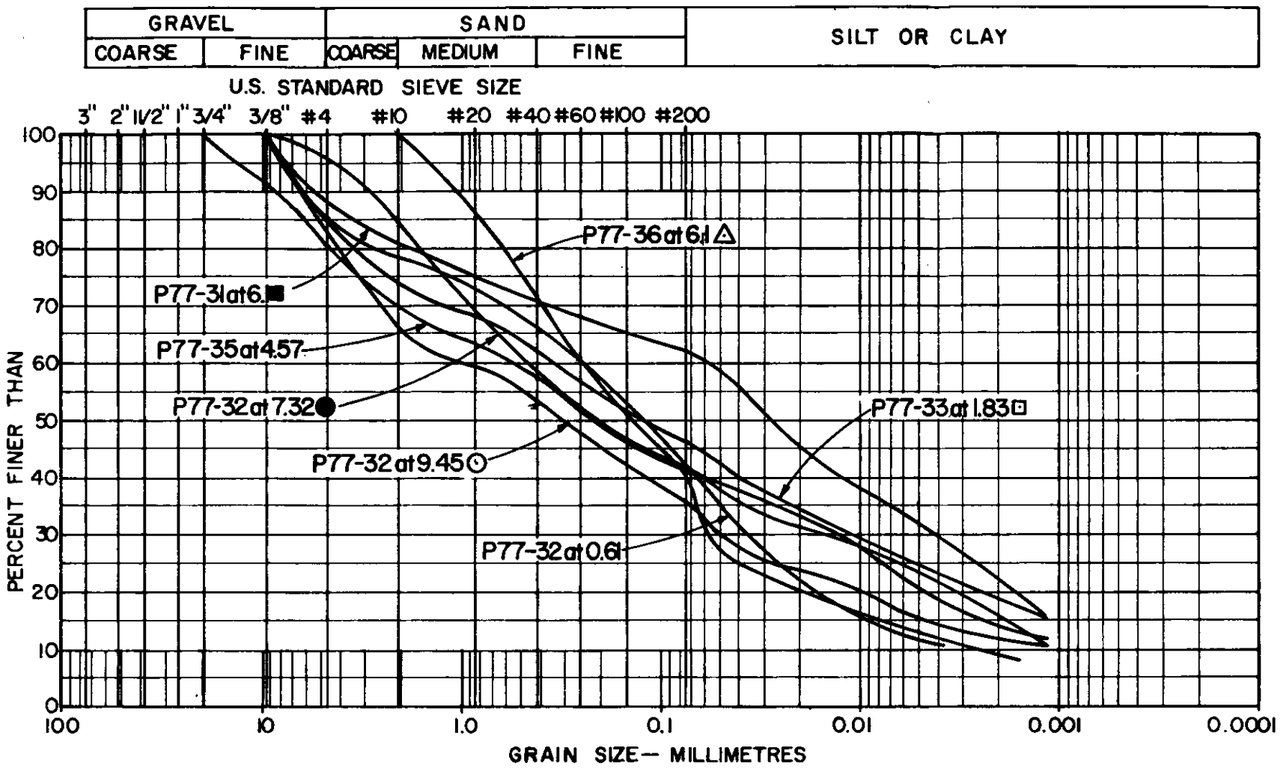
NOTE : PIEZOMETER TIPS ARE 3/4 IN. SLOTTED PVC PIPE, 4 FT. LONG, WRAPPED WITH FILTER CLOTH.

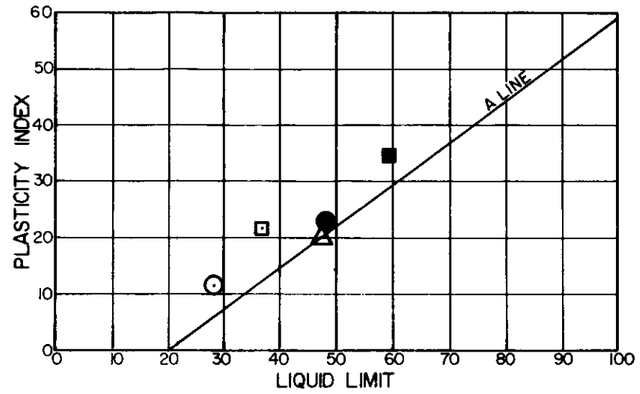
KLOHN LEONOFF CONSULTANTS LTD.	**WATER SUPPLY AND ASH RETENTION DAMS**
B.C. HYDRO AND POWER AUTHORITY **HAT CREEK PROJECT**	STANDPIPE PIEZOMETER INSTALLATION DDH 77-501
APPROVED	PROJECT NO. VA 2321
	DATE JAN., 1978
	PLATE C17

APPENDIX IX

Grain Size and Atterberg Limit Test Data

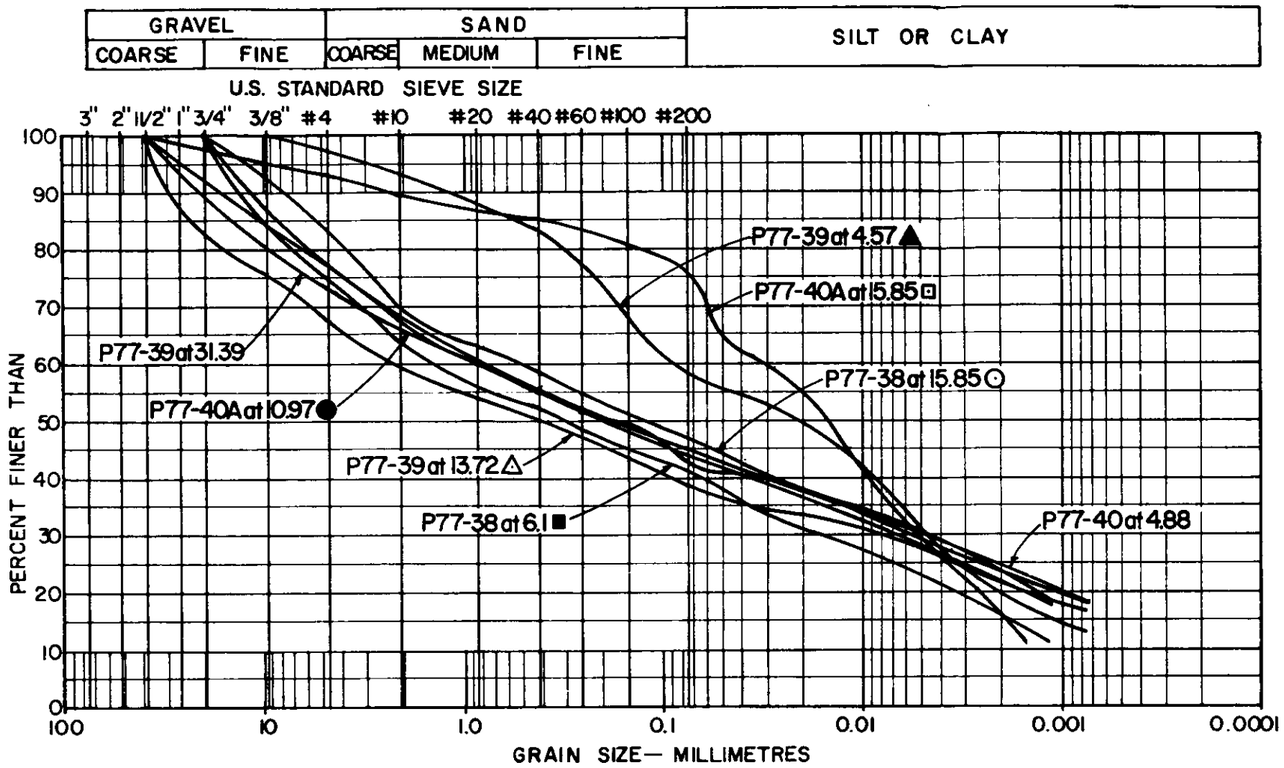
Plate Nos. C18 to C22

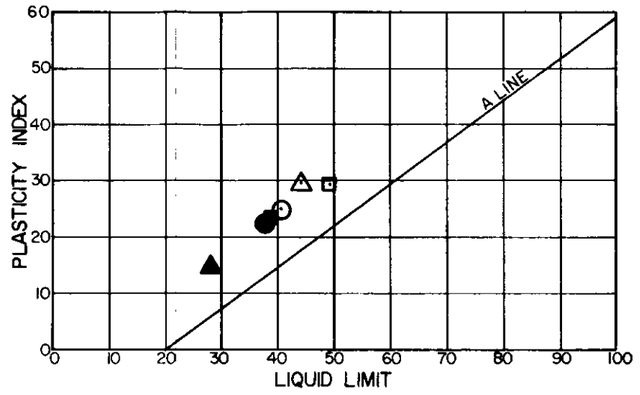




PLASTICITY CHART

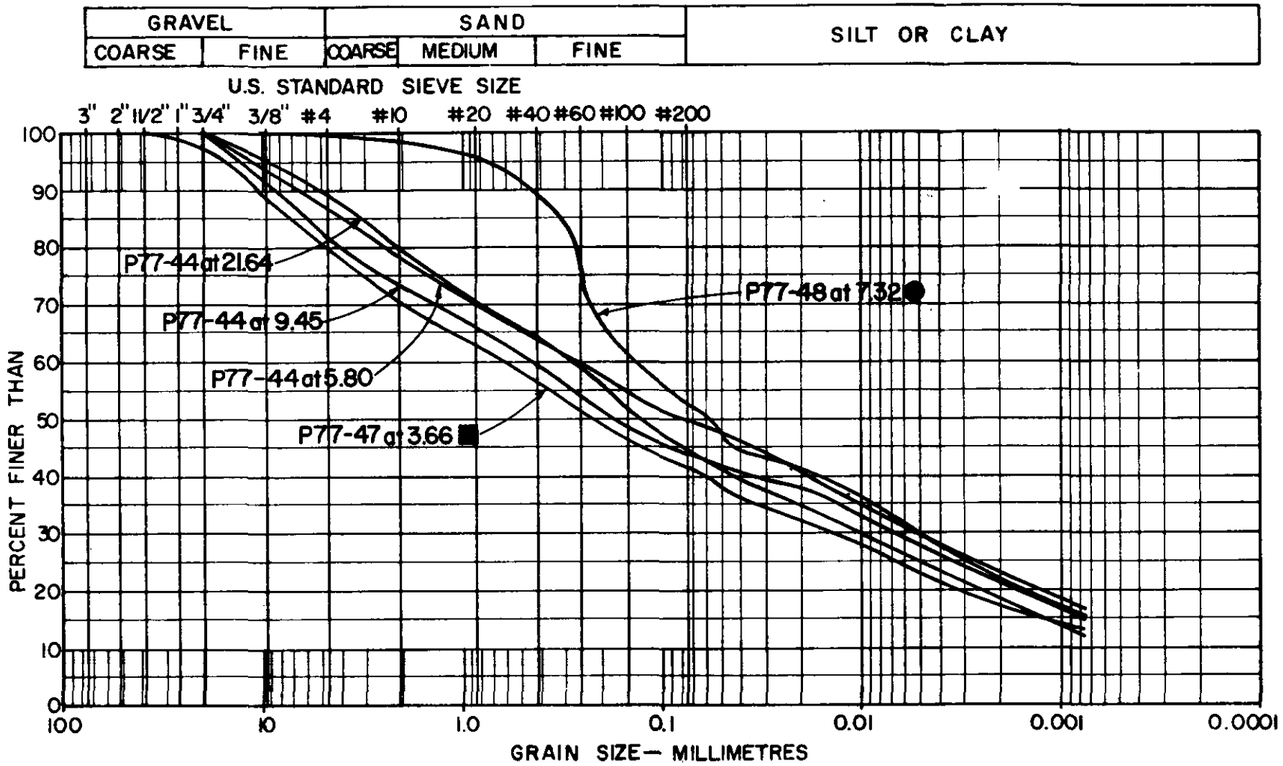
KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	INDEX TEST DATA WATER SUPPLY DAM
APPROVED	PROJECT NO. VA 2321
	DATE JAN, 1978
	PLATE C 18

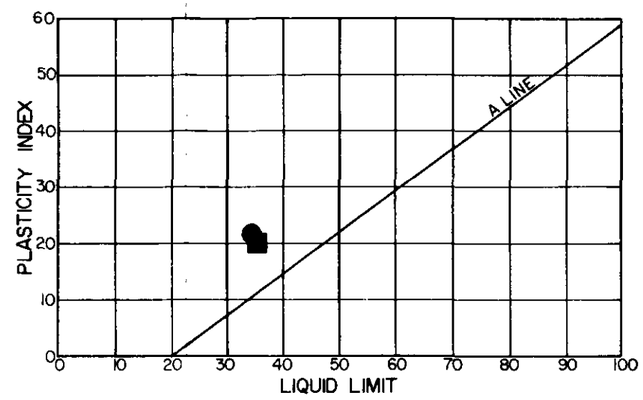




PLASTICITY CHART

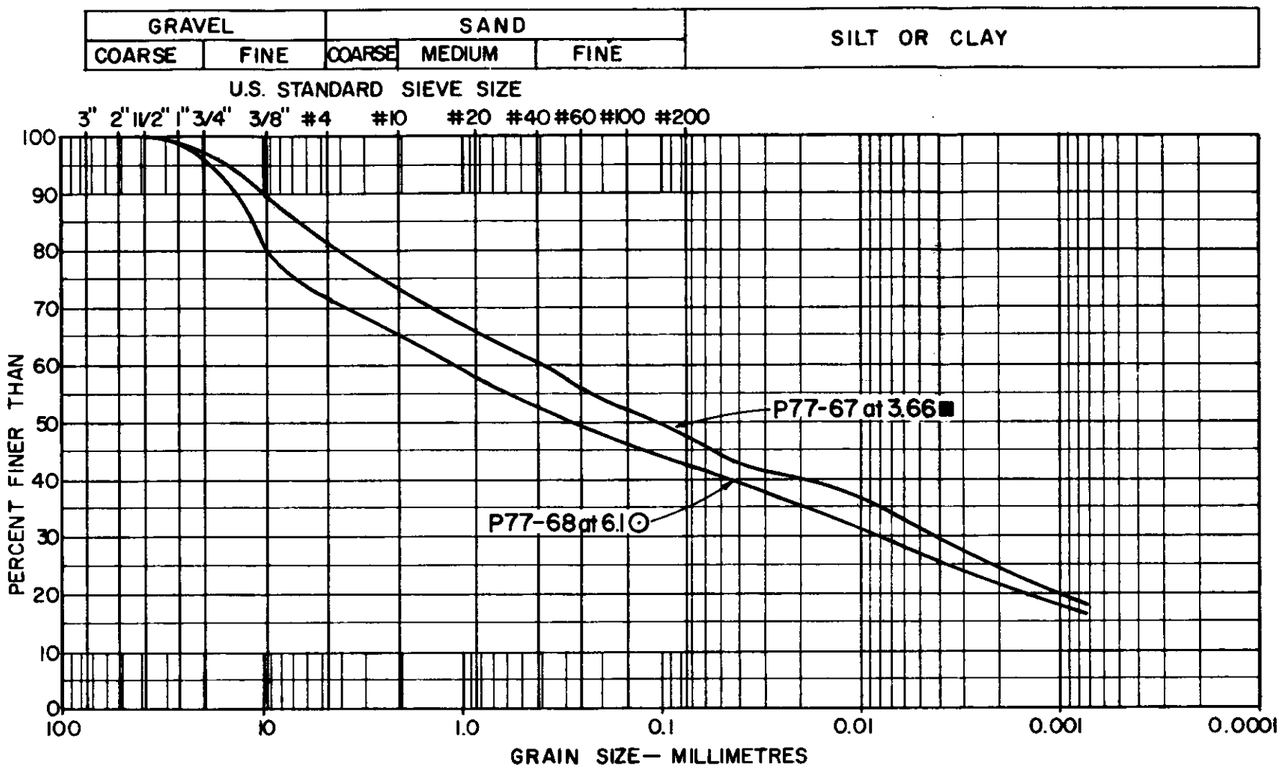
KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS	
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	INDEX TEST DATA ASH RETENTION DAM	
	APPROVED	PROJECT NO. VA 2321
		DATE JAN, 1978 PLATE C19

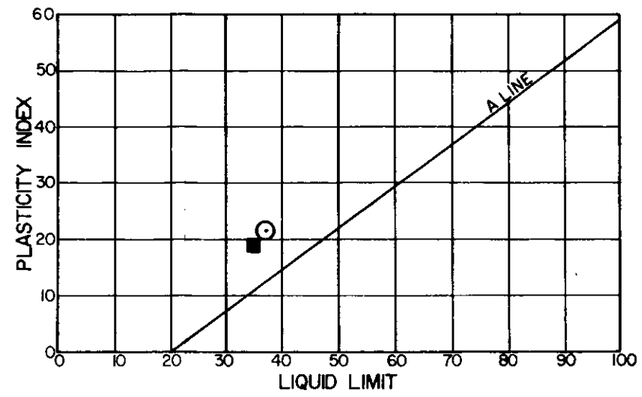




PLASTICITY CHART

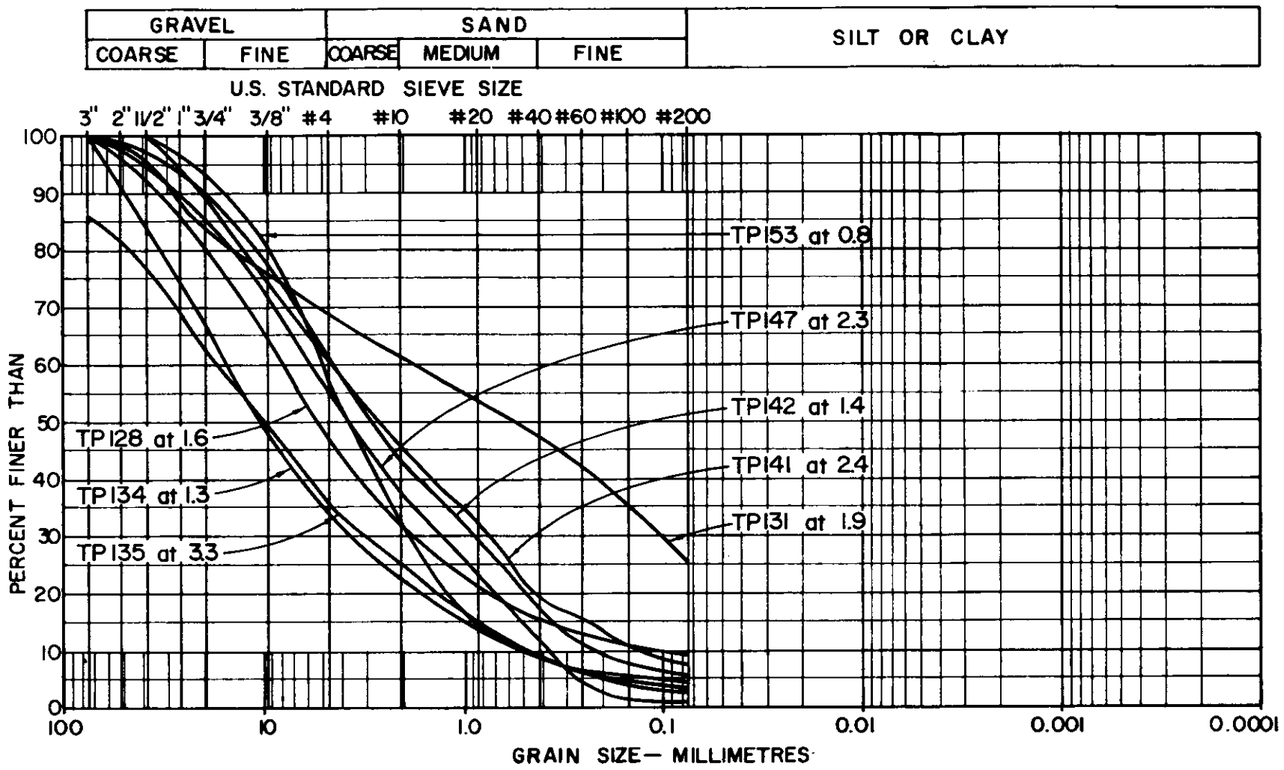
KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY NAT CREEK PROJECT	INDEX TEST DATA ALTERNATE ASH DAMS 1A & 4
APPROVED A Lightman	PROJECT NO. VA 2321
	DATE JAN, 1978
	PLATE C20

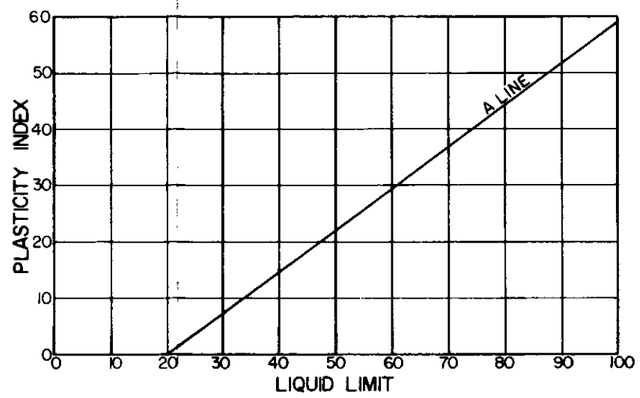




PLASTICITY CHART

KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	INDEX TEST DATA MEDICINE CREEK DIVIDE
APPROVED H Lightstone	PROJECT NO. VA 2321
DATE JAN, 1978	PLATE C21





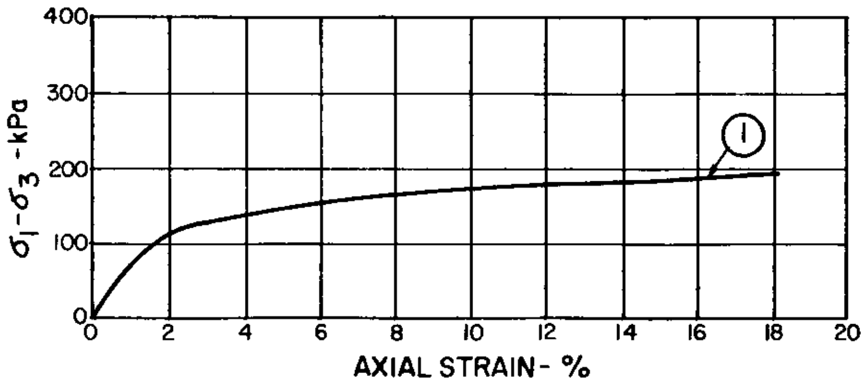
PLASTICITY CHART

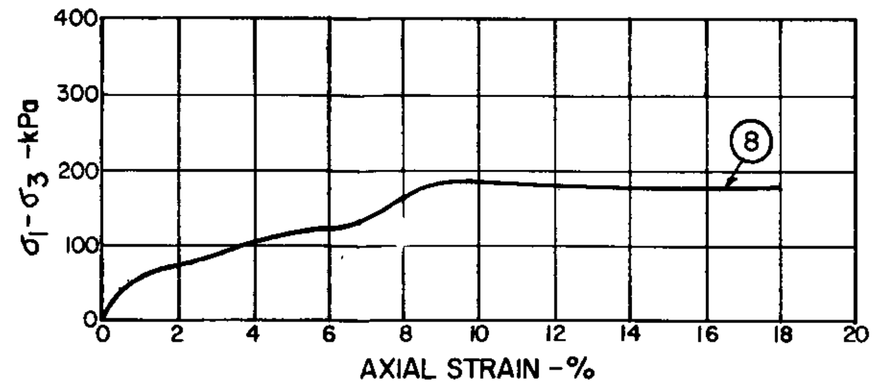
KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	ADDITIONAL GRAIN SIZE DATA
APPROVED	PROJECT NO. VA 2321
	DATE JAN., 1978
	PLATE C22

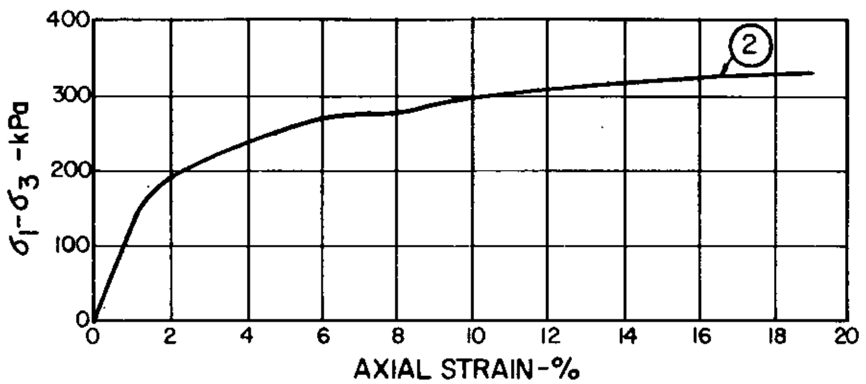
APPENDIX X

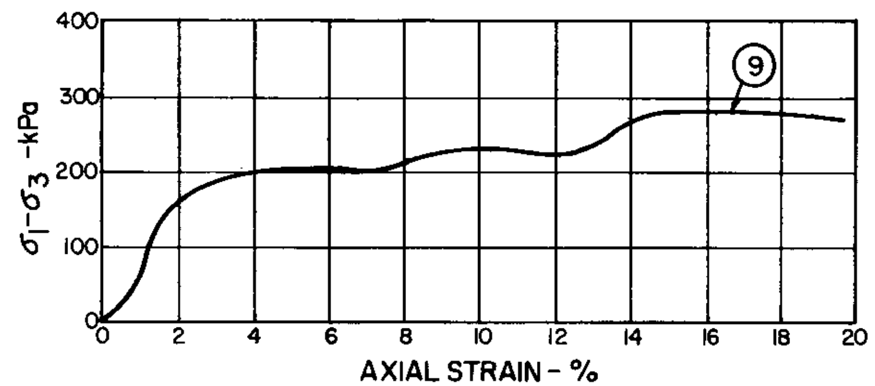
Triaxial Test Results

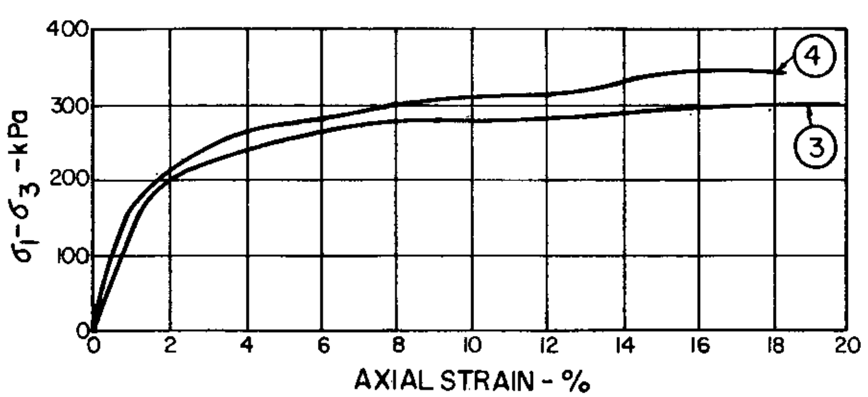
Plate Nos. C23 and C24

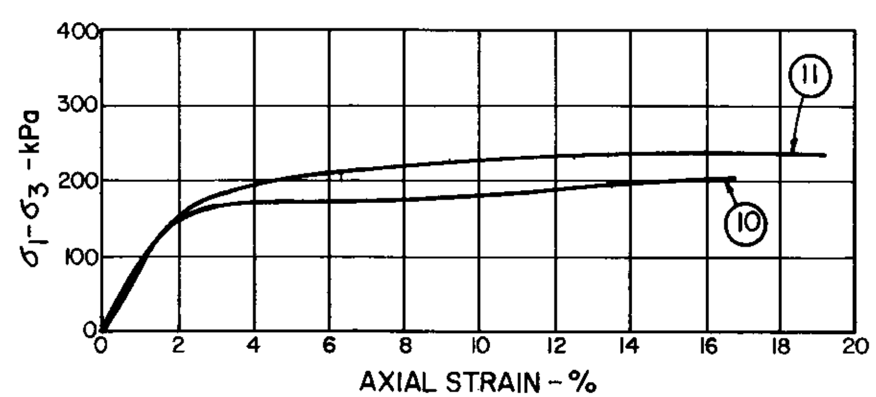








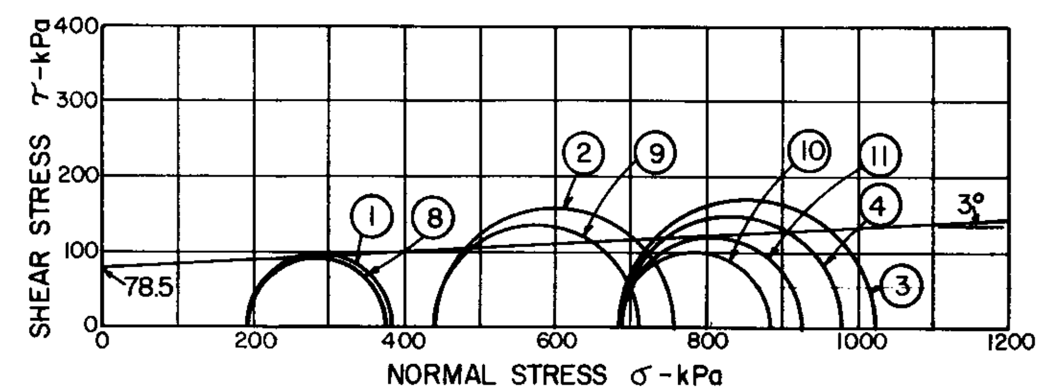




TEST NO.	INITIAL W/C -%-	γ d t/m³	CELL PRESSURE kPa
1	13.7	1.88	196
2	14.0	1.89	441
3	14.0	1.89	686
4	14.0	1.90	686
8	15.0	1.86	196
9	15.0	1.88	441
10	15.3	1.88	686
11	15.0	1.86	686

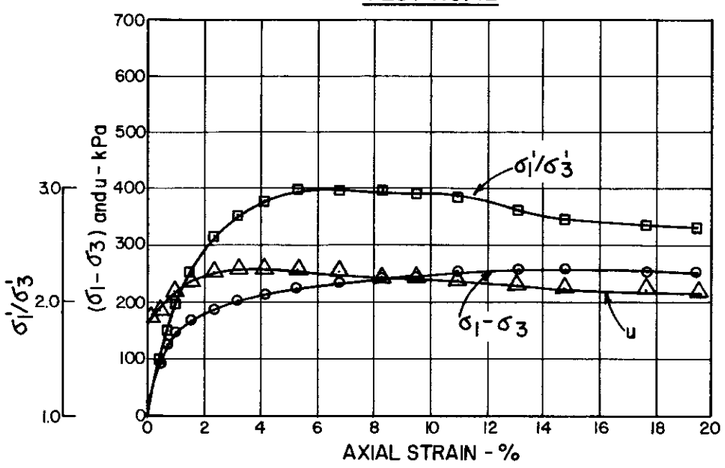
NOTES:

1. SAMPLES WERE 71mm LONG BY 33mm DIA. FORMED BY COMPACTION IN MINITURE HARVARD APPARATUS.
2. SAMPLES WERE SHEARED AT A STRAIN RATE OF 0.033mm/MIN.
3. SAMPLE FORMED FROM COMPOSITE SAMPLE FROM TEST PITS 115, 116, 117, 119 & 120.

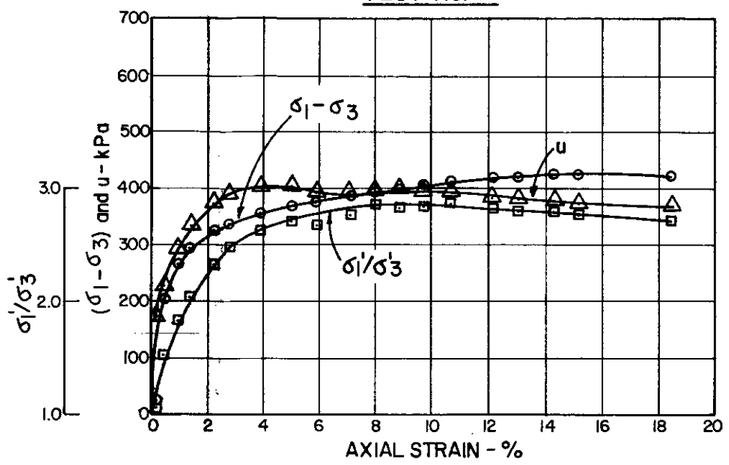


KLOHN LEONOFF CONSULTANTS LTD.	WATER SUPPLY AND ASH RETENTION DAMS
B.C. HYDRO AND POWER AUTHORITY HAT CREEK PROJECT	UNCONSOLIDATED UNDRAINED TRIAXIAL TESTS ON IMPERVIOUS FILL MATERIAL
APPROVED [signature]	PROJECT NO. VA 2321
DATE JAN., 1978	PLATE C23

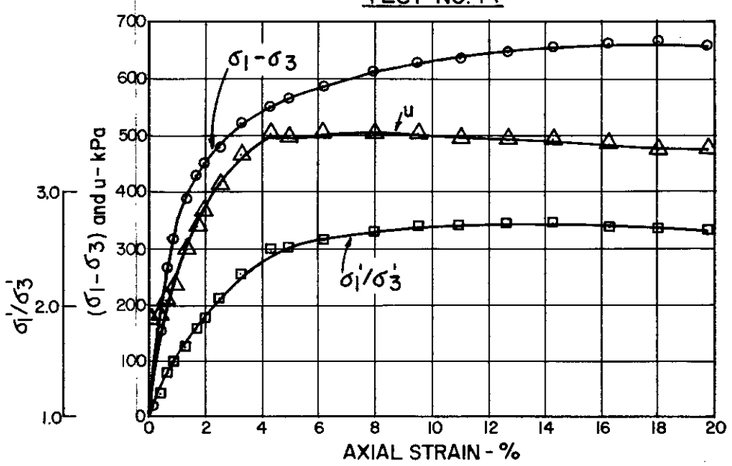
TEST NO. 12

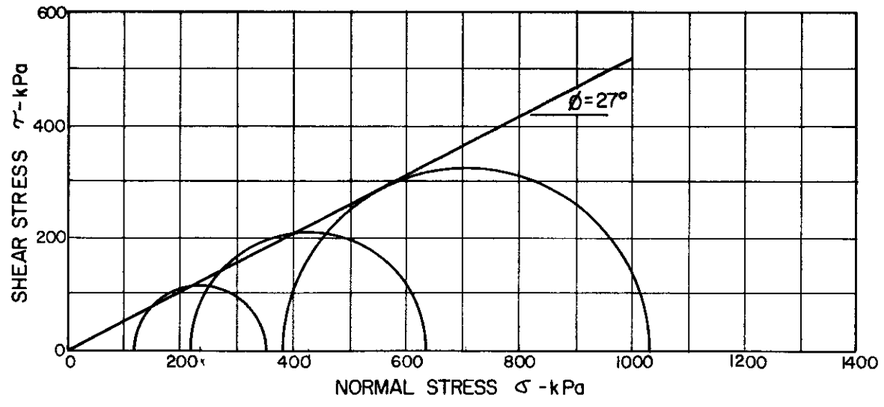


TEST NO. 13



TEST NO. 14





TEST NO.	INITIAL W/C -%-	FINAL W/C -%-	γ_d t/m^3	CELL PRESSURE kPa	BACK PRESSURE kPa
12	12.7	15.8	1.89	372.6	176.5
13	13.1	14.3	1.89	617.8	173.5
14	13.0	14.1	1.89	870.8	173.5

NOTES:

1. SAMPLES WERE 71mm LONG BY 33mm DIA. FORMED BY COMPACTION IN THE MINIATURE HARVARD APPARATUS.
2. SAMPLES WERE SHEARED AT A STRAIN RATE OF 0.033 mm/MIN.
3. SAMPLES FORMED FROM MATERIAL FROM TEST PIT 105.

KLOHN LEONOFF CONSULTANTS LTD.

WATER SUPPLY AND ASH RETENTION DAMS

B.C. HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

CONSOLIDATED DRAINED TRIAXIAL TESTS WITH PORE PRESSURE MEASUREMENT ON IMPERVIOUS FILL MATERIAL

APPROVED A Wightman | PROJECT NO. VA 2321 | DATE JAN., 1978 | PLATE C24

APPENDIX XI

Pin Hole Test Results

PIN HOLE TESTS

TEST DESCRIPTION

Three samples of Clay Till were tested for erodibility (dispersibility) in accordance with the procedure outlined by Sherard et al. (1976). Samples 1 and 2 were obtained from a combined sample from Test Pits 115, 116, 117, 119, and 120, and were air-dried prior to testing. Sample 3 was a grab sample from Test Pit 102 at a depth of 3.26m stored at its natural moisture content (11.6%). Since samples 1 and 2 were previously air-dried and it is not certain how the dispersive nature of the clay is affected by drying and rewetting (Sherard et al, 1976), sample three was tested at its natural water content to confirm that the clay is truly nondispersive.

All samples were screened through a #10 sieve and water was added to bring the water content of the sample to approximately that of its plastic limit prior to compaction with the Harvard miniature compactor.

Distilled water was passed through a 1.1 mm diameter pinhole punched in the 30 mm long specimen. Initially the water was caused to flow under a hydraulic head of 50 mm for 5 minutes. The hydraulic head was then progressively raised to 180, 380 and 1020 mm incrementally for 5 minute durations at each head. The dispersive nature of the soil was classified depending on the measured flow rates at each head and by the colour of the water emerging from the pinhole.

RESULTS AND DISCUSSIONS

All three samples were found to be nondispersive (classification ND1) according to the three criteria set forth by Sherard et al. (1976).

For the samples tested,

1) the water emitted from the pinholes was clear at all hydraulic heads.

2) the flow rate was constant at each head and was less than 40 ml/sec at the maximum head tested (1020 mm). Table XI-1 summarizes the flow rate data.

3) negligible enlargement of the pinhole resulted from the flow.

TABLE XI-I

FLOW RATE SUMMARY

HEAD -mm-	FLOW RATE (ml/sec)		
	Sample #1	#2	#3
50 mm	0.38	0.23	0.24
180 mm	0.81	0.62	0.60
380 mm	1.44	1.22	1.04
1020 mm	2.71	2.34	2.23