APPENDIX 4

SUB-SURFACE INVESTIGATION - DYKES

TABLE OF CONTENTS

SUB-SURFACE INVESTIGATION - DYKES

1. General

A sub-surface investigation was carried out along the Vedder Canal and Lower Sumas River dykes during the period January to May 1977. This investigation, which consisted of drill holes, in situ permeability testing and laboratory testing, was made to obtain sufficient information for the First Stage - Final Design of the dykes. The 1977 work supplemented earlier investigations carried out in 1918, 1948, 1963, and 1970 (4, 7, 18 - 22) *

2. Field Exploration

Thirteen holes were drilled by rotary methods at the locations shown on Fig. 4.1. The depths of the drill holes and descriptions of the soils encountered are given on the attached logs.

In general, disturbed and undisturbed soil samples were taken at 1.5 m (4.9 ft) intervals or at changes in soil type. Standard penetration tests were carried out in granular material by driving a 35 mm (1.4 in.) dia split sampling spoon. Undisturbed samples of the silt were obtained by means of hydraulically advanced 85 mm (3.3 in.) Shelby tubes. Prior to waxing the undisturbed samples, shear strength tests were carried out on any silt exposed in the bottom of the tubes using a "Torvane".

* These references are listed in Volume 1, Section 9.

Falling head permeability tests were carried out in several of the drill holes. Standpipe piezometers were installed in all the drill holes.

The results of the penetration, strength and permeability tests carried out in the field are given on the drill hole logs.

The drilling was carried out by Keller Soiltest Drilling Ltd. using a Mayhew 1000 rotary drill rig.

3. Strata

A profile along the dyke showing the soil strata encountered in the drill holes is given on Fig. 4.2.

The foundation soils beneath the dyke generally comprise a series of lacustrine and river flood plain deposits of silt and clay, and fine sand, except at the east end of the Vedder River dyke where fluvial sand and gravel is superimposed upon the lacustrine deposits.

Sand and gravel was encountered beneath the Vedder dykes in the holes drilled between Sta 0+00 (B. C. Hydro Railway) and approximately Sta 10+00 (First Street, Yarrow). The sand and gravel was encountered to the maximum depth of drill hole 3 of 14 m (50 ft) below natural ground level. The sand and gravel is overlain by 1.0 to 1.5 m (3.3 to 4.9 ft) of fine sand and minor silt.

Between Sta 10+00 and Sta 51+80 approximately the dyke is directly underlain by silty fine and fine to medium sand with

minor silt layers and with some coarse sand and occasional traces of organics. This material was encountered to the maximum depth of the drill holes of about 14 m (50 ft) below natural ground level. Previous investigations indicate that some zones of silt with layers of sand may be present within this stratum.

The dyke is directly underlain by a layer of silt or silt with fine sand, from 1.5 to 5 m (4.9 to 16.4 ft) in thickness between Sta 51+80 and Sumas Pump Station. This deposit is underlain by the stratum of sand with silty layers encountered from Sta 10+00 to 51+80 approximately and described above. The sand was encountered to the maximum depth of the drill holes of about 13 m (43 ft) below natural ground level.

The Vedder dyke fill generally consists of fine to coarse silty sand with minor layers or lenses of sandy silt. The dyke fill upstream of about First Street, Yarrow, is generally sand with some gravel. The Lower Sumas River dyke fill consists of fine sand with silt.

Groundwater levels measured in the drill holes each day prior to drilling were generally less than 1.0 m (3.3 ft) below natural ground level on the landside of the dykes.

4. Field Permeability

Falling head permeability tests were carried out in the foundation soils in several of the drill holes. The holes were drilled ahead of the casing for 2 to 3 m (7 to 10 ft), washed out with clean water and the rate of fall of the water level was measured and the permeabilities evaluated. The in-situ permeability values

measured are given on the drill hole logs. The calculated values range from 0.5×10^{-4} to 5×10^{-4} cm/sec.

In several of the holes permeability tests could not be carried out because the casing was loose in the hole and drill fluid returned outside the casing.

Several grain size analyses were carried out on samples in the vicinity of in-situ permeability tests. No correlation between grain size distribution and permeability is evident. This may be expected due to the variable nature of the soils and because the permeability test gives an average value over some 2 to 3 m (7 to 10 ft) of hole.

5. Laboratory Testing

a. Gradations

The gradations of several samples of the dyke fill and foundation soil were determined and the results are given in Table 4.1 and on Figs. 4.3 to 4.11.

b. Atterberg Limits

As will be noted from Table 4.1, all except one of the representative samples selected for Atterberg limit testing proved to be non-plastic and the exception is a silt of low plasticity.

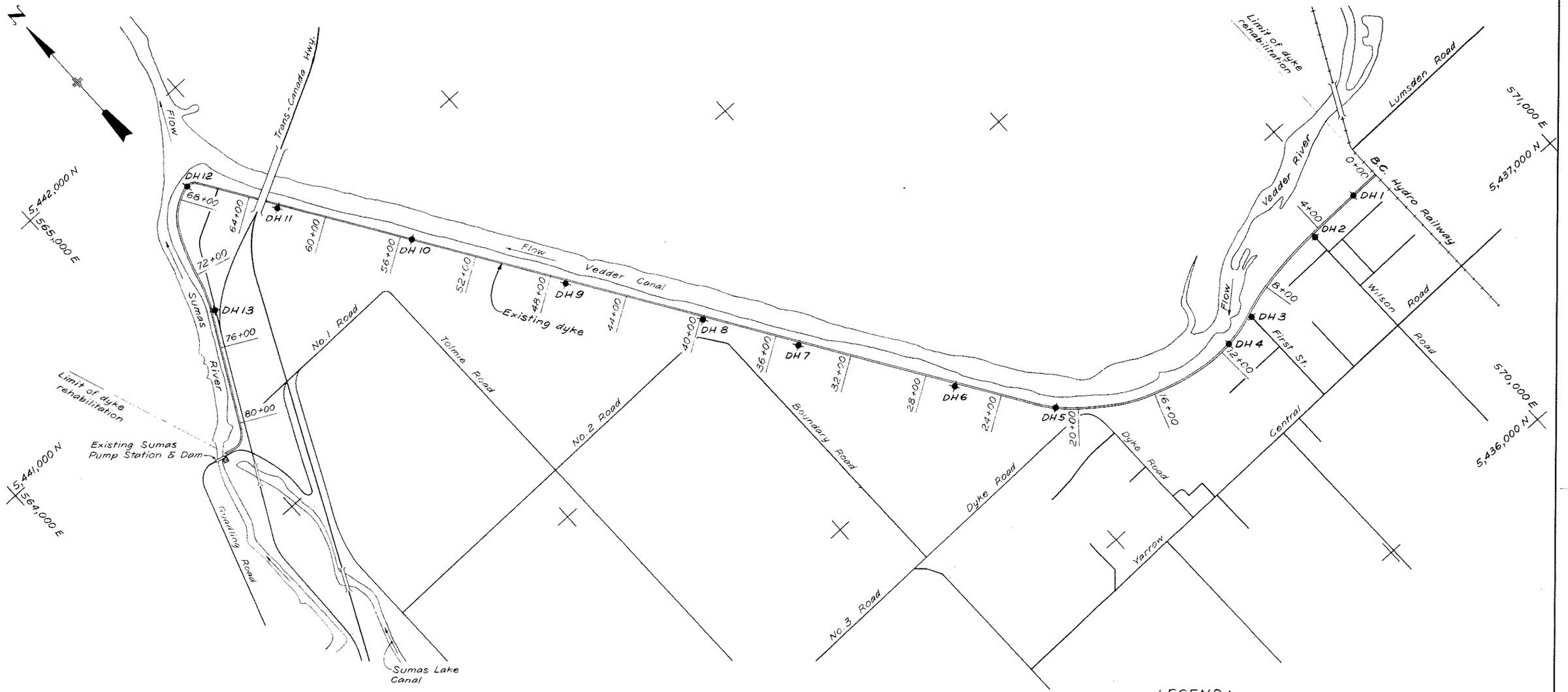
TABLE 4.1

ABBOTSFORD PROJECT - DYKES

RESULTS OF LABORATORY TESTS

Drill Hole No.	Sample Depth m	Index Properties			Grain Size Distribution			Remarks
		Liquid Limit %	Plastic Limit %	Plasticity Index %	Sand %	Silt %	Clay %	
		Non-plastic						
3	1.5	-	-		80		4	
4	1.5*	-	-		89	9	0	(2% gravel)
	7.6	-	-		91	9	0	
6	1.5	-	-		56	24	9	(11% gravel)
8	2.1	-	-		28	67	<5	
9	1.5	-	-		69	26	5	
10	3.0*	-	-		93	7	0	
11	5.0	-	-		89	9	< 2	
12	10.7	-	-		71	25	4	
13	1.5	43	26	17	<10	75	<15	

* These samples from dyke fill material, all others are from dyke foundation.



LEGEND :

◆ DH 5 Drillhole

NOTES

1. All stations in metres.
2. Drillholes 1, 4, 5, 10 & 12 drilled from crest of dyke. Drillholes 2, 3, 6, 7, 8, 9, 11 & 13 drilled from landside toe of dyke.

200 0 200 400 600 800 1000 m

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CRIPPEN ENGINEERING LTD.
NORTH VANCOUVER, B.C.
PROJECT NO. 10407

DEPARTMENT HEAD
PROJECT ENGINEER
CHIEF ENGINEER

NO.	DESCRIPTION	BY	CHD	APPR	DATE

REVISIONS

RECOMMENDED ..... PROJECT MANAGER
DATE .....
APPROVED ..... DIRECTOR, WATER INVESTIGATIONS
DATE .....

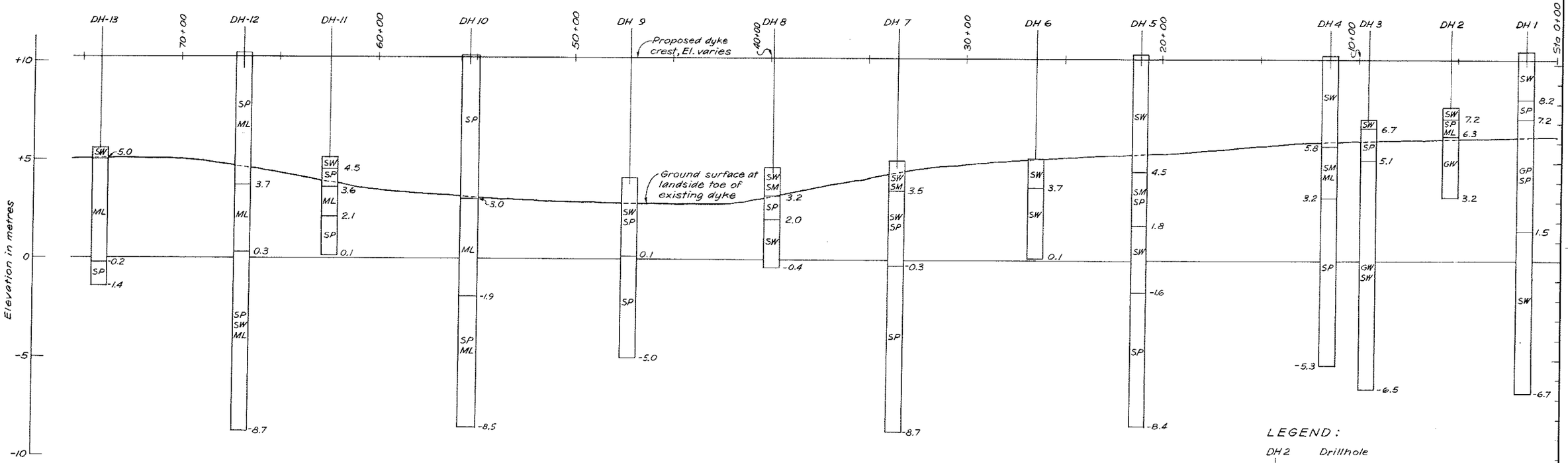
BRITISH COLUMBIA
MINISTRY OF THE ENVIRONMENT
WATER INVESTIGATIONS BRANCH
CANADA-BRITISH COLUMBIA
FRASER RIVER FLOOD CONTROL 1968 AGREEMENT

PROJECT NO. 8 — ABBOTSFORD PROJECT

DYKE REHABILITATION
LOCATION OF DRILLHOLES

DESIGNED	C. Stow-Lumb
DRAWN	A. A.
CHECKED	SFH
SCALE	As shown
DWG. NO.	4844-PR-D25
SURVEYED	
DATE	
FILE NO.	
DATE	
SHEET	OF SHEETS

FIG. 4.



LEGEND :

DH2 Drillhole

SW — Soil type
8.2

SP
6.3 Elevation in m

Soil Type
ML - Inorganic silt, low plasticity
SM - Silty sand
SW - Well graded sand with little or no fines
SP - Poorly graded sand with little or no fines
GW - Well graded gravel with little or no fines, gravel-sand mixtures
GP - Poorly graded gravel with little or no fines

NOTES :

1. All stations in metres.
2. For location of drillholes see Dwg. D 25.

Hor. scale 100 0 500 1000 m

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA G. W. STEVENSON

CRIPPEN ENGINEERING LTD.
NORTH VANCOUVER, B.C.
PROJECT NO. 10407

DEPARTMENT HEAD S.F. Hillen
PROJECT ENGINEER
CHIEF ENGINEER John S. Archer

NO.	DESCRIPTION	BY	CHD	APPR	DATE
	REVISIONS				

RECOMMENDED ..... PROJECT MANAGER
DATE .....
APPROVED ..... DIRECTOR, WATER INVESTIGATIONS
DATE .....

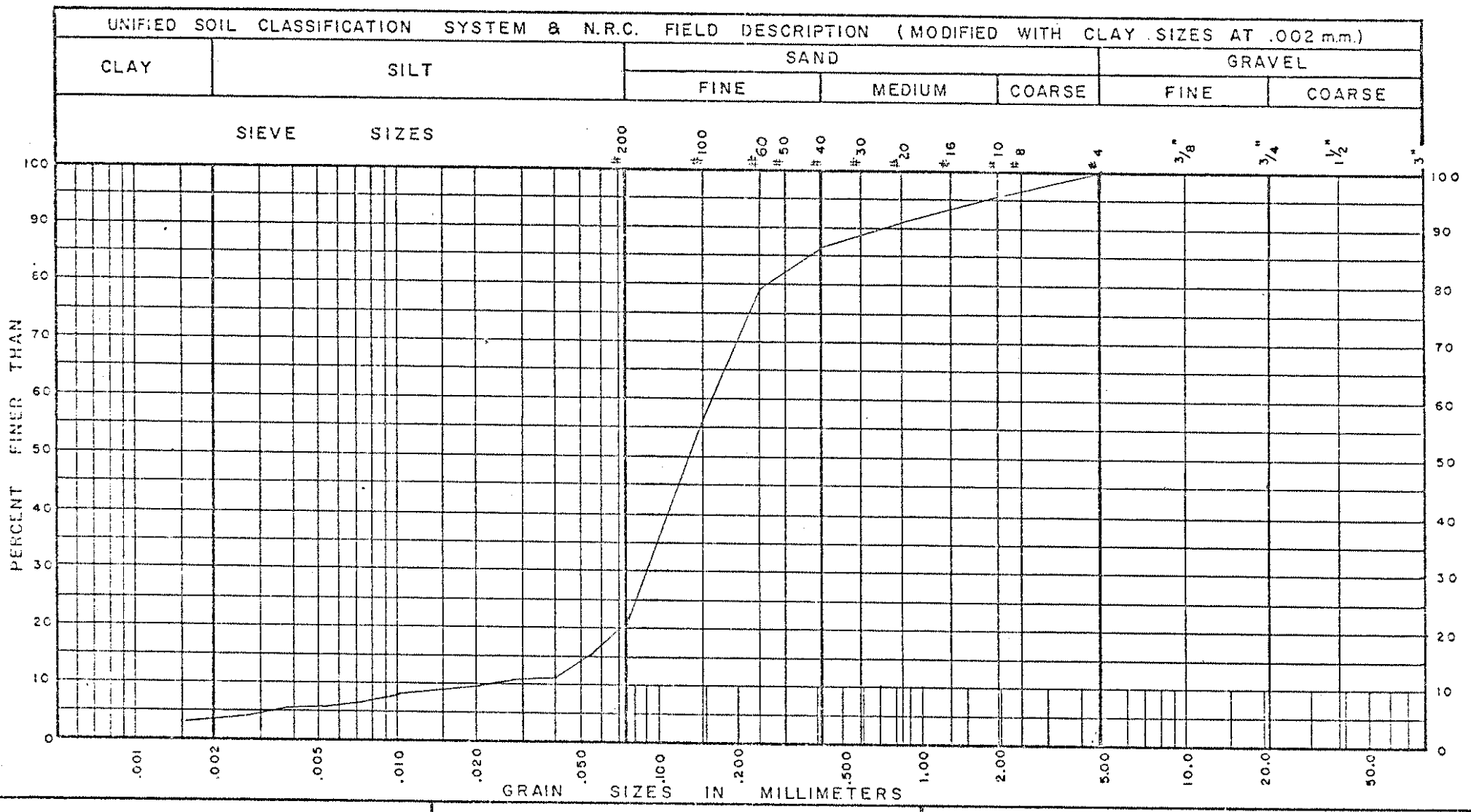
BRITISH COLUMBIA
MINISTRY OF THE ENVIRONMENT
WATER INVESTIGATIONS BRANCH
CANADA-BRITISH COLUMBIA
FRASER RIVER FLOOD CONTROL 1968 AGREEMENT

PROJECT NO. 8 ABBOTSFORD PROJECT

DYKE REHABILITATION
SOIL PROFILE ALONG CENTRE-LINE OF DYKE

DESIGNED	MW Stevenson	SURVEYED	
DRAWN	HDT	DATE	
CHECKED	GWS	FILE NO.	0281550 - B24
SCALE	As shown	DATE	8 June 1977
DWG. NO.	4844-PR-D26	SHEET	OF SHEETS

FIG. 4.2



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

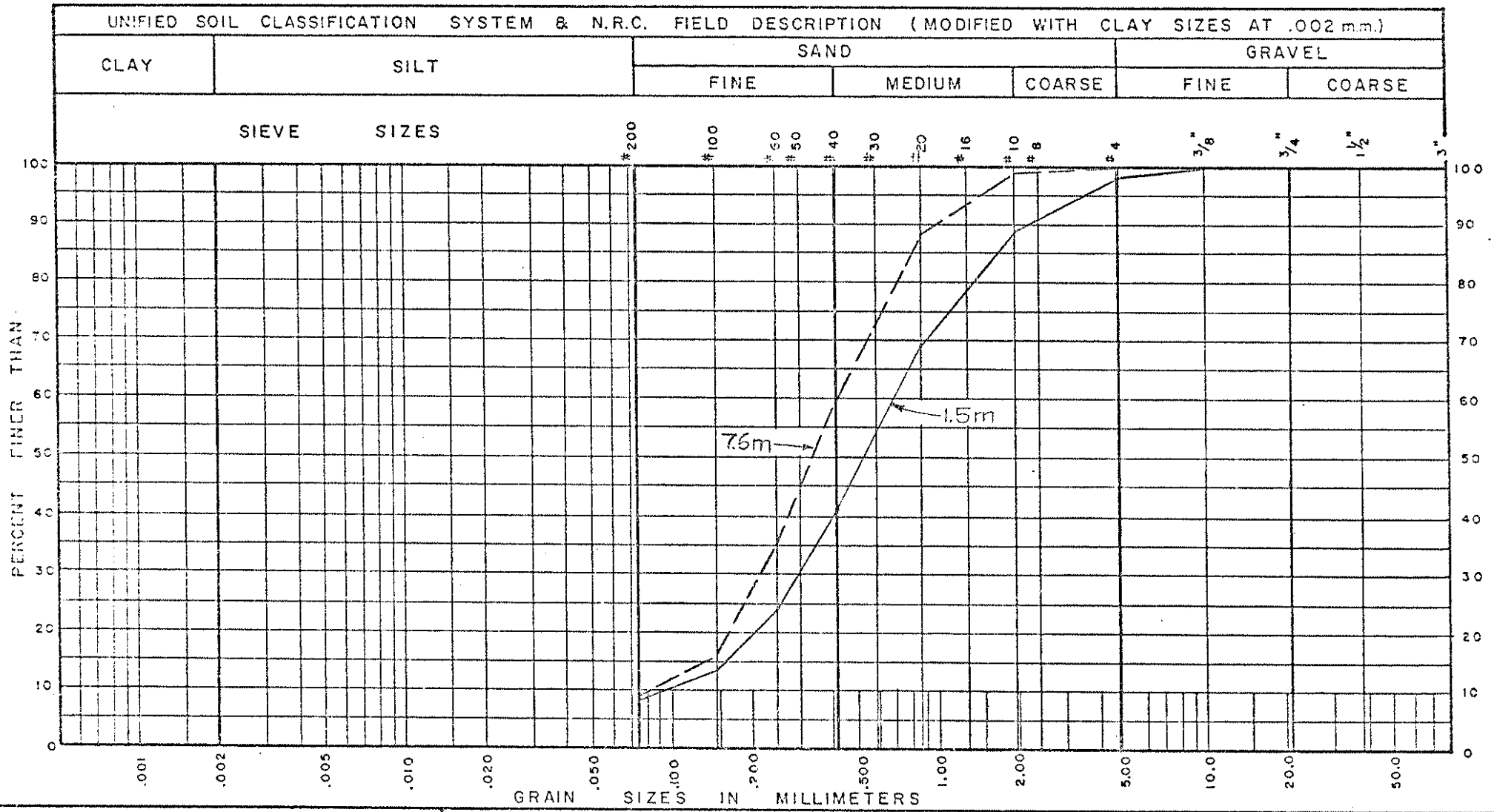
PROJECT ABBOTSFORD - DYKES

HOLE NO. DH3

DEPTH 1.5m

MATERIAL Silty Sand

COMPILED BY GWS Fig. 4.3



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

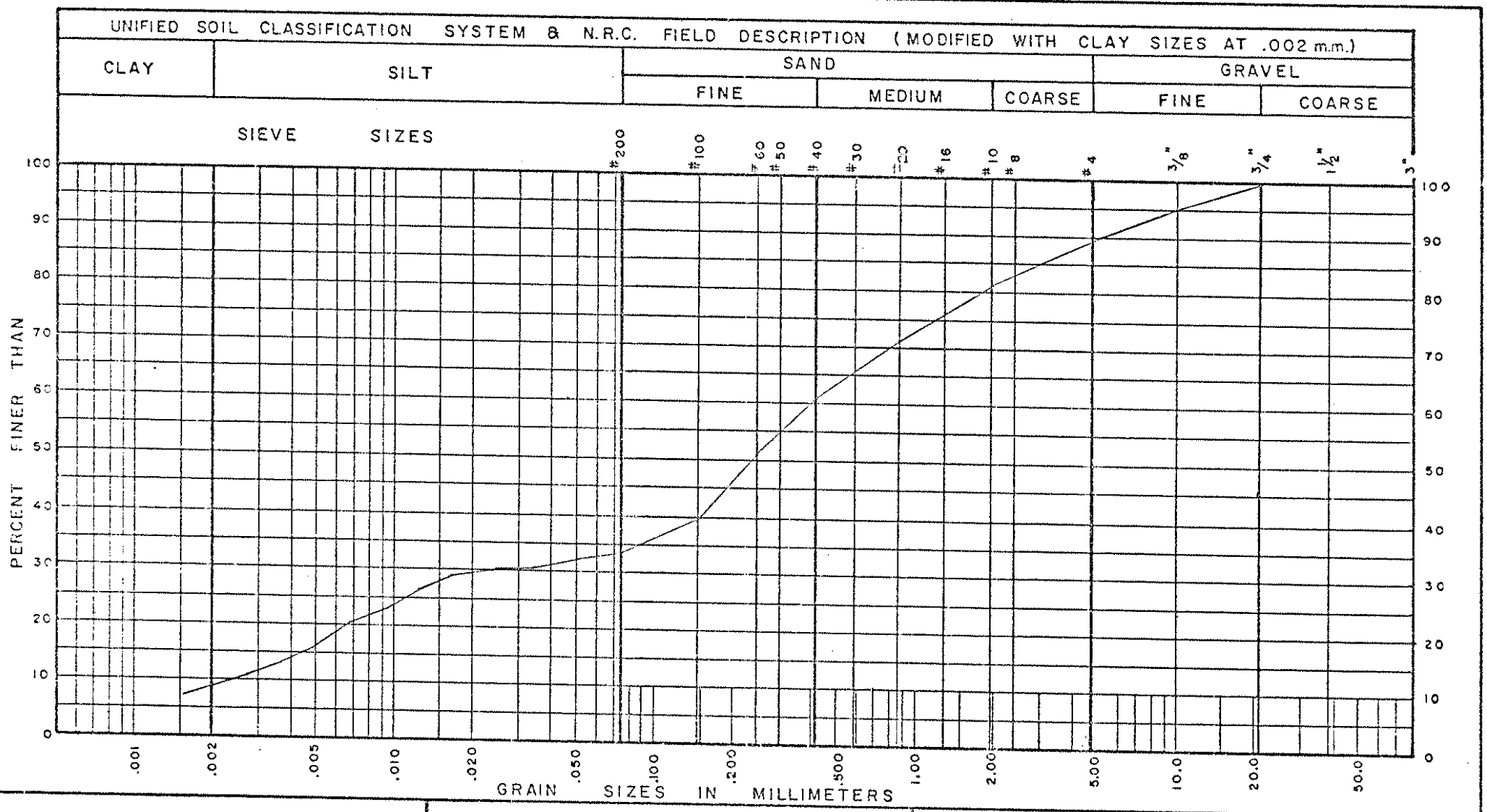
PROJECT ABBOTSFORD - DYKES

HOLE NO. DH4

DEPTH 1.5 & 7.6 m

MATERIAL Sand

COMPILED BY GWS Fig. 4.4



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

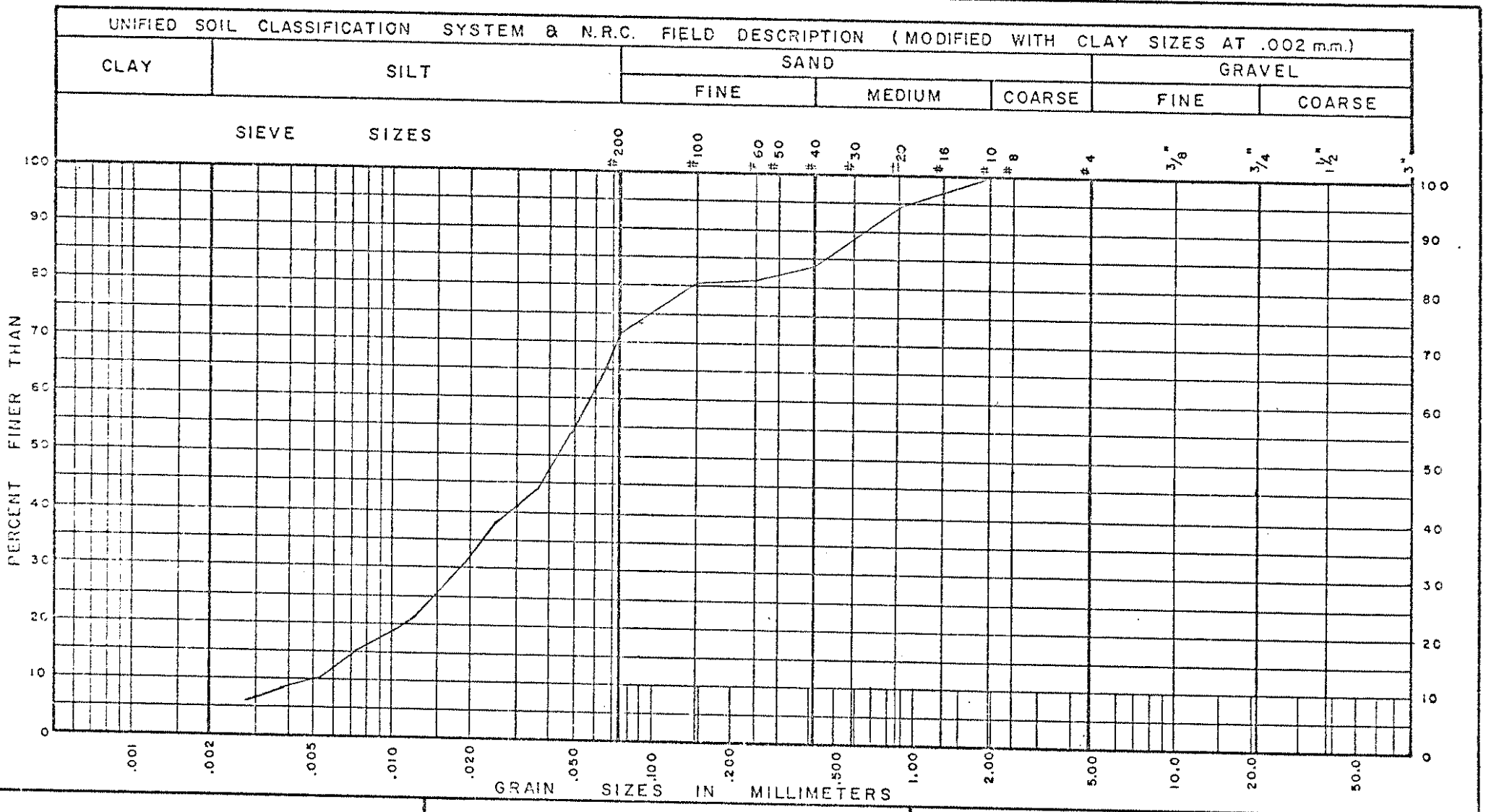
PROJECT ABBOTSFORD DYKES

HOLE NO. DH6

DEPTH 1.5m

MATERIAL Silty Sand

COMPILED BY GWS Fig. 4.5



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

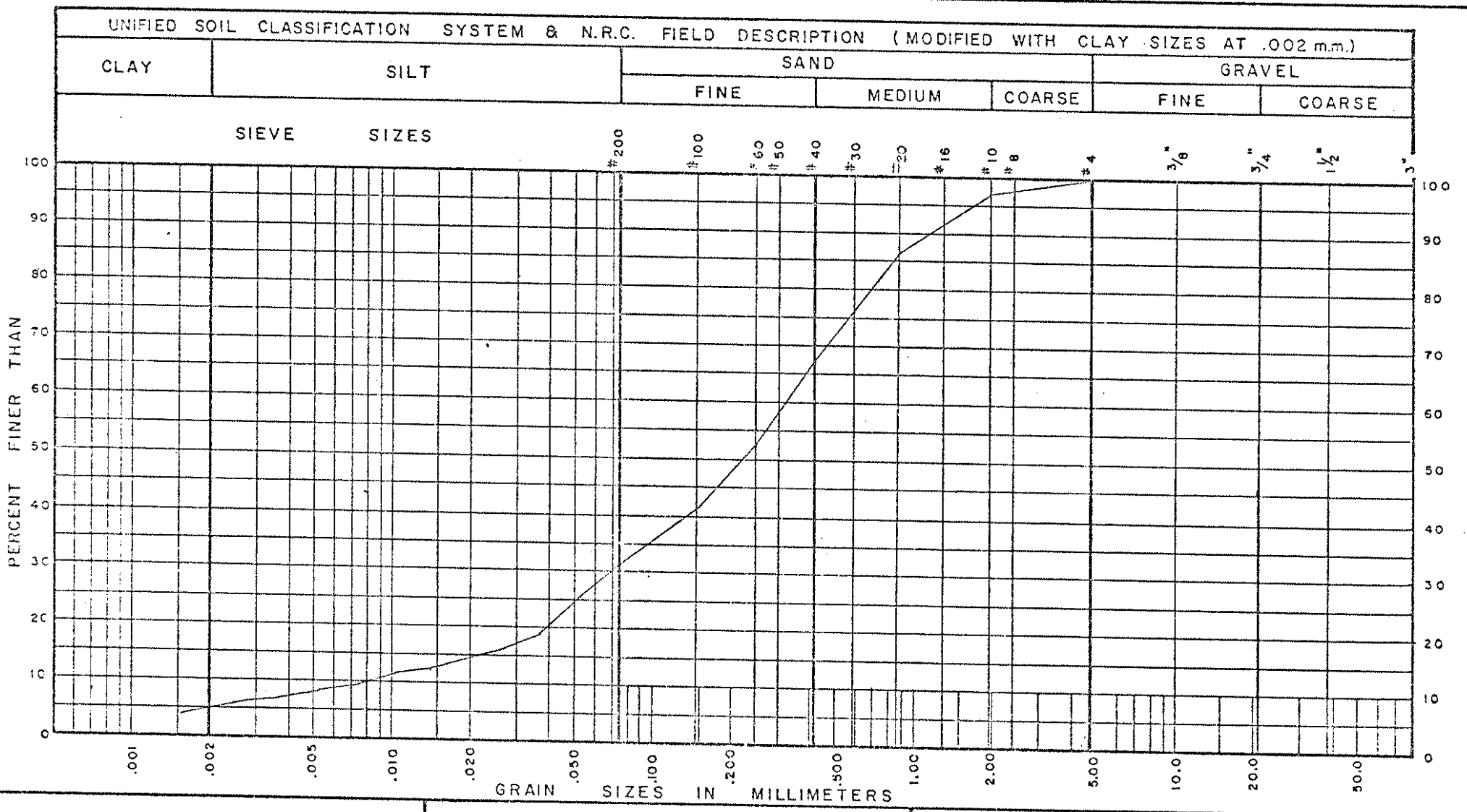
PROJECT ABBOTSFORD DYKES

HOLE NO. DH8

DEPTH 2.1m

MATERIAL Sandy Silt

COMPILED BY GWS Fig. 4.6



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

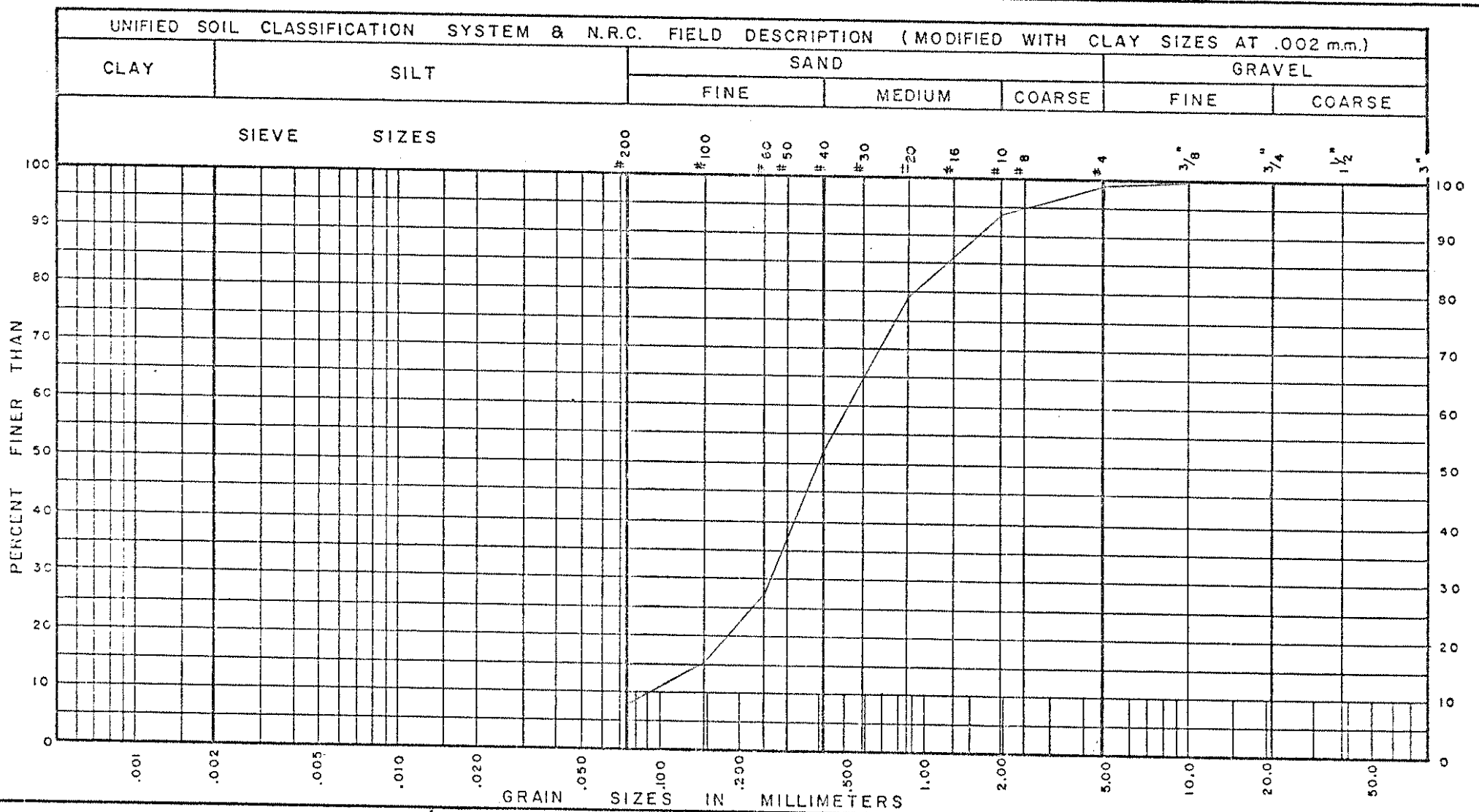
PROJECT ABBOTSFORD DYKES

HOLE NO. DH9

DEPTH 1.5m

MATERIAL Silty Sand

COMPILED BY GWS Fig. 4.7



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

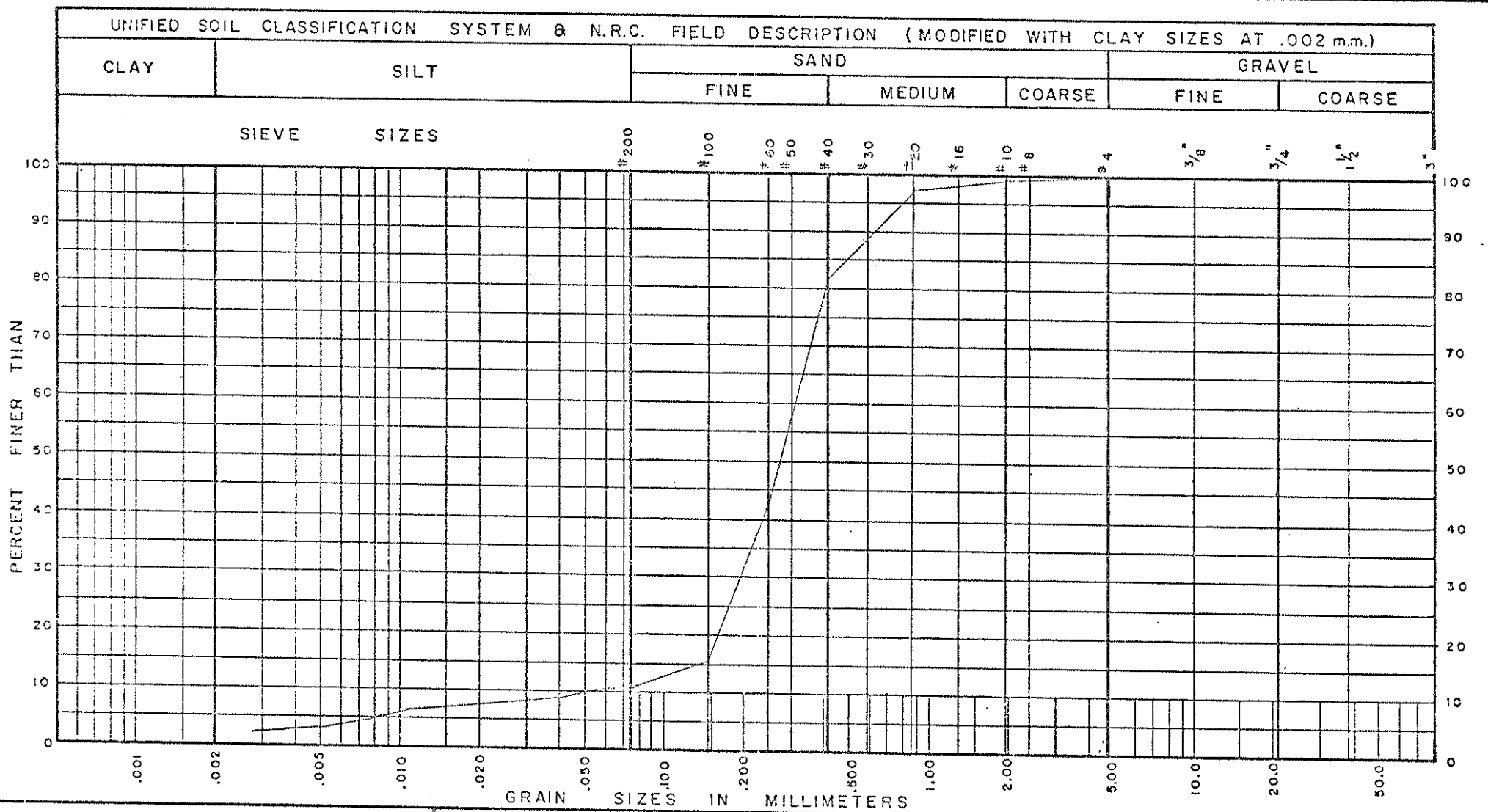
PROJECT ABBOTSFORD DYKES

HOLE NO. DH10

DEPTH 3.0m

MATERIAL Sand

COMPILED BY GWS Fig. 4.8



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

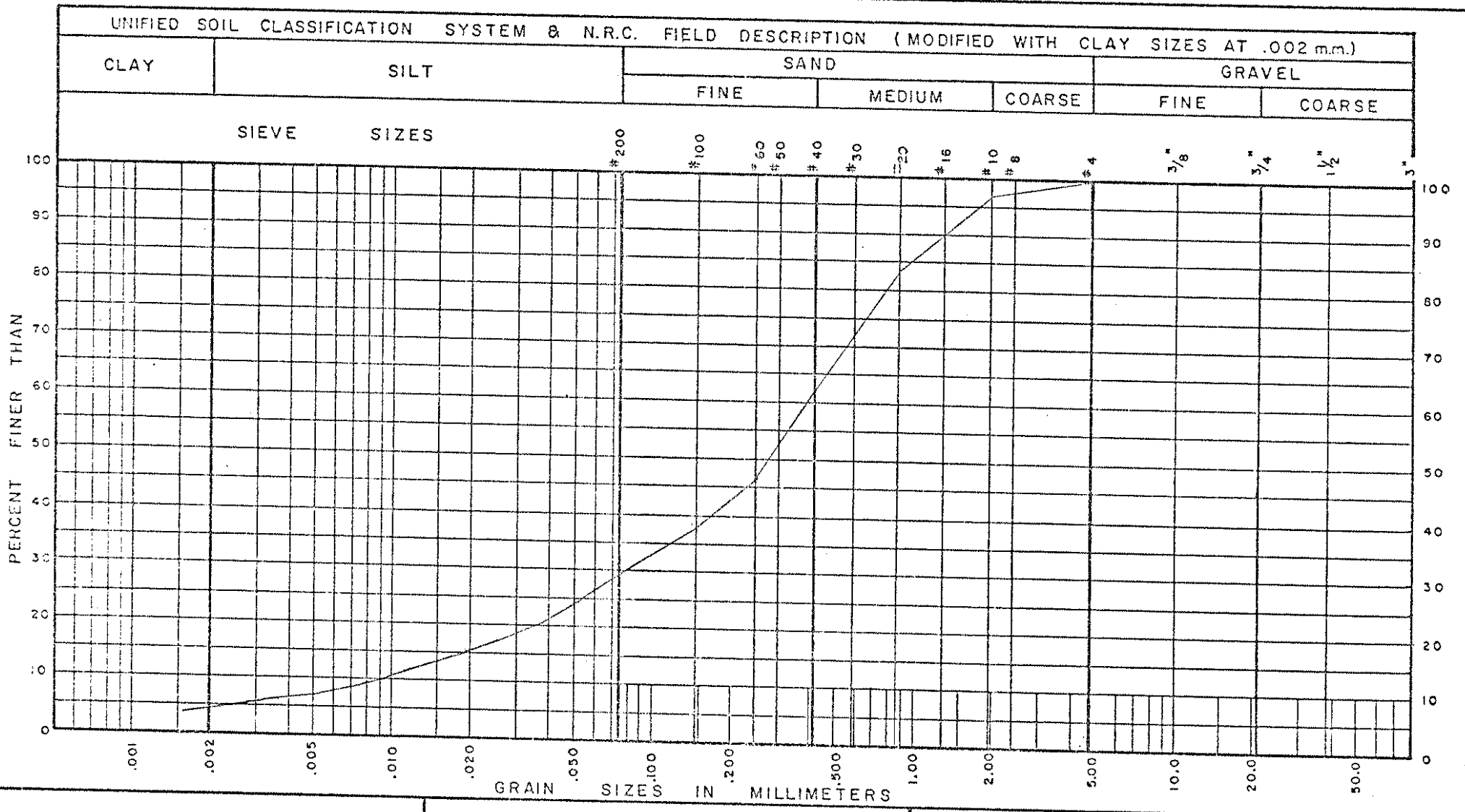
PROJECT ABBOTSFORD DYKES

HOLE NO. DH11

DEPTH 5.0m

MATERIAL Fine Sand

COMPILED BY GWS Fig. 4.9



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

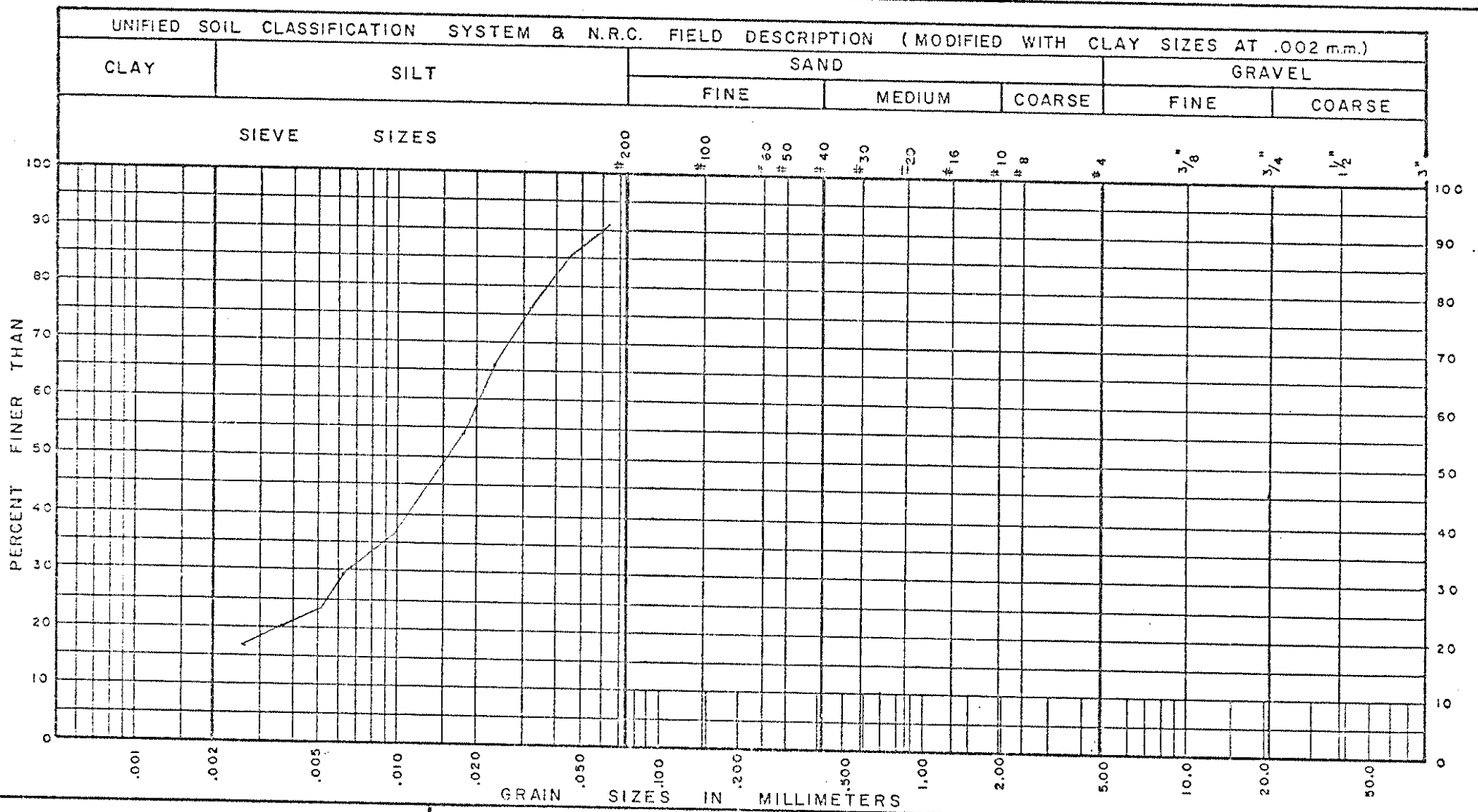
PROJECT ABBOTSFORD DYKES

HOLE NO. DH 12

DEPTH 10.7 m

MATERIAL Silty Sand

COMPILED BY GWS Fig. 4.10



REMARKS

CRIPPEN ENGINEERING LTD

GRAIN SIZE DISTRIBUTION

PROJECT ABBOTSFORD DYKES

HOLE NO. DH 13

DEPTH 4.5 m

MATERIAL Silt

COMPILED BY GWS Fig. 4.11

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NORTH VANCOUVER B.C.

HOLE NO. DH 1

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 1+53.5

ELEVATION 10.64

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 7 - 9 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ——×—— L.L.

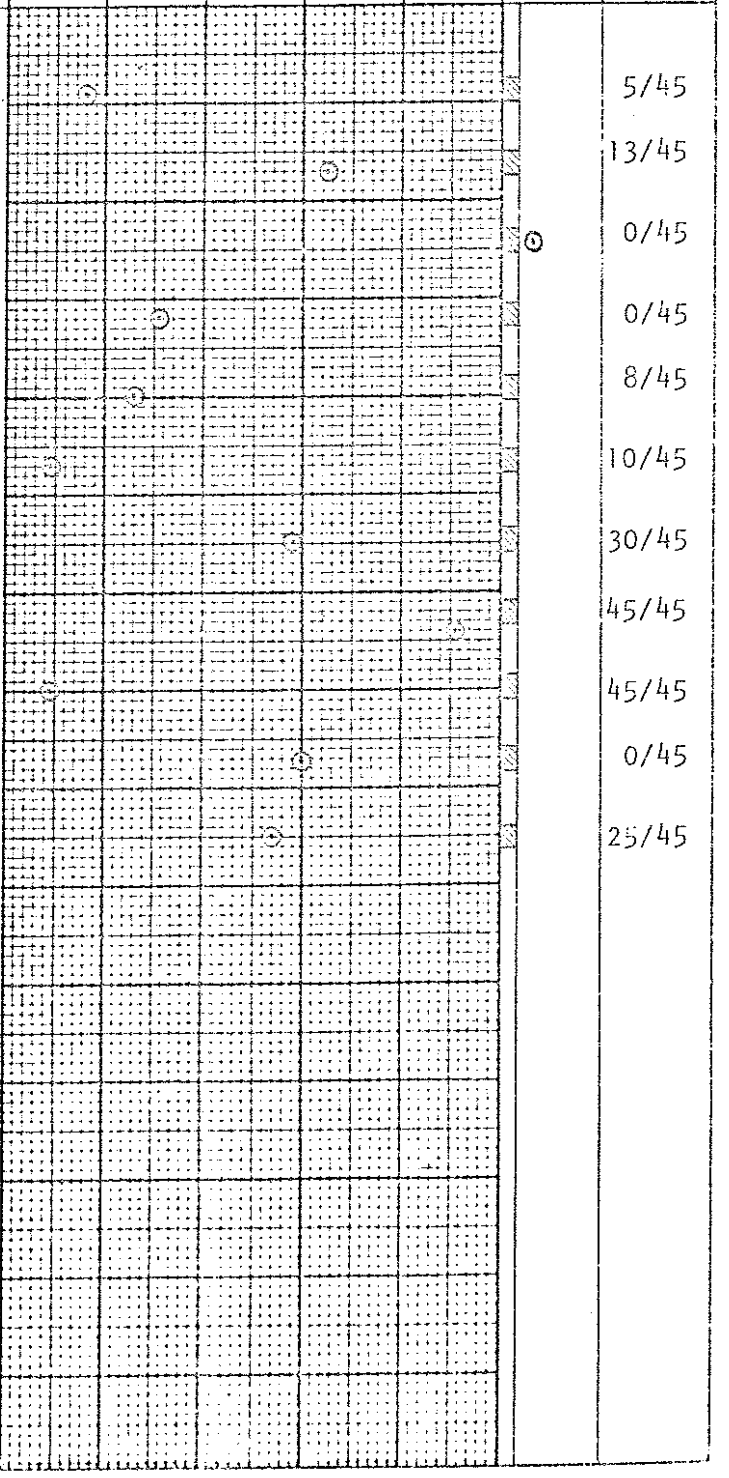
MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SW	SAND, medium to coarse, gravelly FILL	2.4	8.2		5/45
SP	SAND, silty, fine with thin layers of silt	3.4	7.2		13/45
GP SP	GRAVEL, sandy and SAND, gravelly, coarse Little or no fine sand and silt	6			0/45
		8			0/45
					8/45
SW	SAND, well-graded, medium to coarse. Silt layers at 9.1 to 9.8 and 13.4 to 14.3 m; elsewhere, occasional thin layers of silt	9.1	1.5		10/45
	Sample at 16.8 m was gravelly sand.	12			30/45
					45/45
		14			45/45
					0/45
		16			
	Bottom of hole, elev -6.7	17.3	-6.7		25/45
	Installed piezometer, tip at depth 6.5 to 7.4 m				
	No permeability test, as casing was loose in hole to 9 m (losing water down side of casing and out bottom of casing)				
	Very hard driving and cleaning out casing to 9 m				
	Used Revert mud to 9 m, water to 12 m, drill mud to 17 m Used casing to 11 m				

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)



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NORTH VANCOUVER B.C.

HOLE NO. DH 2

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 4+35.1

ELEVATION 7.83

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 4 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N-VALUE

ATTERBERG LIMITS

P.L. ⟝ L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	TEST RESULTS	SAMPLE NO.	RECOVERY cm
				10 20 30 40 kN/m² / 20 40 60 80 BLOWS/FT. (0.3 m)		
SW	SAND, medium to coarse, gravelly, Fill	0.6	7.2			
SP, ML	SAND, fine and SILT, brown	1.5	6.3			20/45
GM	GRAVEL, sandy, silty More sandy below 3 m depth	4				
	Bottom of hole, elev 3.2 Installed standpipe piezometer, tip at depth 1.8 to 2.7 m	4.6	3.2			
	Had great difficulty advancing casing beyond 1.5 m - ground kept caving - gravel and coarse sand jammed between casing and drill rod - tried 3 times to advance casing to 3 m					
	Advanced drill to 4.6 m without casing and without sampling - ground was very loose judging from drill advance rate - hole caved immediately behind drill					
	No permeability test attempted, as water was returning around casing					

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NORTH VANCOUVER B.C.

LOG OF DRILL HOLE

HOLE NO. DH 3

SHEET 1 OF 1

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 9+50.3

ELEVATION 7.20

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 4 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N-VALUE

ATTERBERG LIMITS

P.L. ——×—— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SW	SAND, coarse, gravelly, fill	0.5	6.7		30/45
SP	SAND, fine, silty, brown; some silt near top of layer; some fine to medium sand in sample at 1.5 m	2.1	5.1		0/45
		4			13/45
					18/45
		6			8/45
GW, SW	GRAVEL, sandy, grey, slightly silty and SAND, gravelly, coarse, grey, slightly silty	8			
	Below 4 m is sand with many gravelly layers	10			
	Below 12.2 m, sand becomes fine to medium	12			
		13.7	-6.5		
	Bottom of hole, elev -6.5				
	Hole drilled to 3 m with difficulty, using casing				
	Installed piezometer, tip at depth 2.5 to 3.4 m				
	Moved 3 m and drilled to 5 m using mud and sampled at 2 to 5 m. Drilled to 13.7 m using mud				
	No permeability test as casing was loose in hole				

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)

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NORTH VANCOUVER B.C.

HOLE NO. DH 4

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 11+47.3

ELEVATION 10.36

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 3 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N-VALUE

ATTERBERG LIMITS

P.L. ——— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SW	SAND, medium and medium to coarse; silty; gravelly near surface	2			23/45
		4			30/45
		4.6	5.8		0/45
SM, ML	SAND, fine, silty, grey; with layers of sandy grey silt	6			45/45
		7.2	3.2		60/60
SP	SAND, fine to medium; with minor layers of silt; most sand is clean, occasional layers of silty sand in samples	8			20/45
		10			20/45
	Trace of organics, usually wood in thin layers	12			25/45
		14			28/45
	Samples at 13.7 and 15.2 m were fine, silty sand, SP	15.7	-5.3		45/45
	Bottom of hole, elev -5.3				
	Conducted permeability test, casing to depth 7.5 m, hole open to 9.1 m. Calculated $k = 6.0 \times 10^{-5}$ cm/sec				
	Installed piezometer tip at depth 9.2 to 10.4 m				

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)

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LOG OF DRILL HOLE

HOLE NO. DH 5

SHEET 1 OF 1

PROJECT: ABBOTSFORD

LOCATION OF HOLE: Chainage 21+11.3

ELEVATION: 10.31

CONTRACTOR: Keller Soiltest

TYPE OF DRILL: Mayhew 1000

DATE OF DRILLING: 2 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

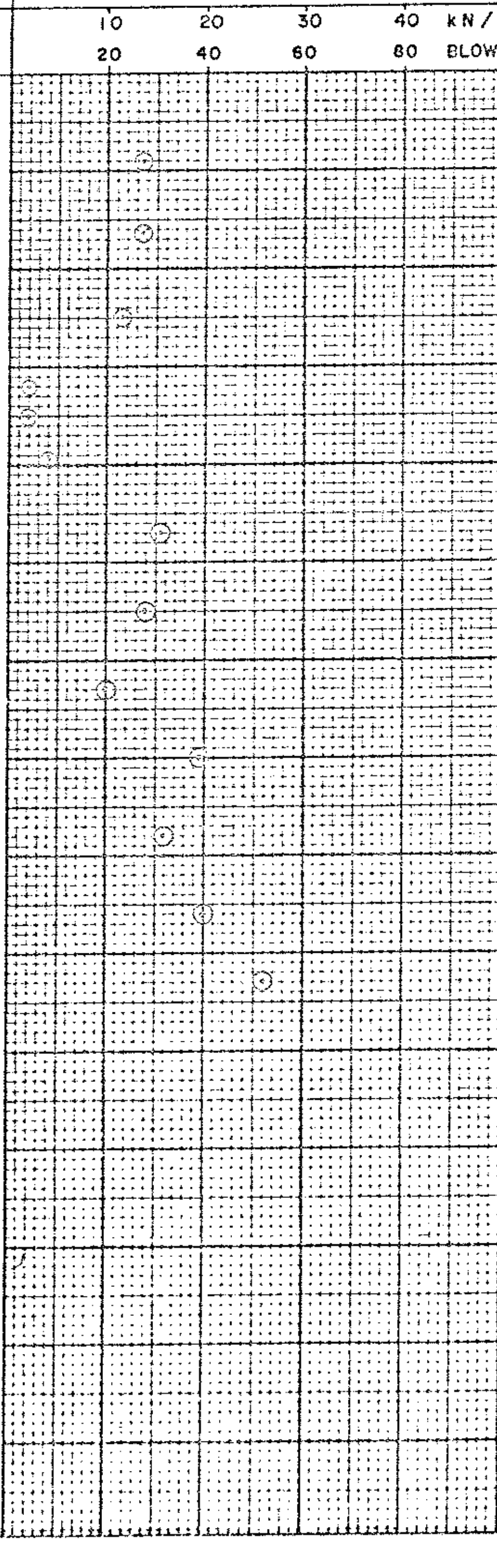
P.L. — L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES
SW	SAND, well-graded, gravelly, silty; cobbles near surface; brown at surface to grey at depth; sand is medium to coarse	5.8	4.5
SM, SP	SAND, fine, silty; many thin layers of organics (wood). Sample at 6.7 m had several thin layers of sandy silt	8.5	1.8
SW	SAND, well-graded, medium to coarse, gravelly; sample at 9.1 m was silty; trace of organic	11.9	-1.6
SP	SAND, fine and fine to medium, silty; trace of organics Minor silt layers, except in sample at 12.1 m, which had alternating layers of silt and silty fine sand in part of sample	18.7	-8.4

Depth scale (metres): 2, 4, 10, 14, 16, 18

TEST RESULTS



RECOVERY cm (top to bottom): 45/45, 15/45, 13/45, 0/45, 45/45, 45/45, 8/45, 28/45, 45/45, 30/45, 45/45, 45/45, 45/45

Bottom of hole, elev -8.4

Conducted permeability test, casing to depth 9.0 m, hole open to 10.5 m. Calculated $k = 1.0 \times 10^{-4}$ cm/sec

Installed standpipe piezometer, tip at depth 10.9 to 11.9 m

Hit cobble or boulder at 2.7 m in initial hole and could not get past it; moved 3 m and completed hole

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NORTH VANCOUVER B.C.

LOG OF DRILL HOLE

HOLE NO. DH 6

SHEET 1 OF 1

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 26+43.6

ELEVATION 5.17

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 1 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ——x—— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	TEST RESULTS	SAMPLE NO.	RECOVERY cm
				10 20 30 40 kN/m² 20 40 60 80 BLOWS/FT. (0.3 m)		
SW	SAND, well-graded, silty, gravelly, with cobbles; brown, FILL	1.5	-3.7			13/45
		2				
SW	SAND, well-graded, gravelly, silty					18/45
		4				
	Thin layer of silt at top of layer; some silty fine to medium sand in sample at 4.6 m	5.1	0.1			18/45
		6				
	Bottom of hole, elev 0.1					
	Installed standpipe piezometer, tip at depth 1.8 to 2.9 m					
	No permeability test carried out. Had much difficulty cleaning out casing, and return water flowed outside casing					

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LOG OF DRILL HOLE

HOLE NO. DH 7

SHEET 1 OF 1

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 34+78.2

ELEVATION 5.02

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 31 Jan-1 Feb 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ——×—— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SW-SM	SAND, well-graded, silty, gravelly, with cobbles; angular particles; brown, FILL	1.5	3.5		10/45
					20/60
					33/45
SW, SP	SAND, medium to coarse with trace gravel; and silty, fine and fine to medium sand	4			30/45
		5.3	-0.3		
SP	SAND, fine and fine to medium, silty; with occasional thin layers of Silt.	6			45/45
		8			45/45
	Very little silt from 5.3 to 7.6 m. Sample at 9.1 m had silt layers, typ 2 cm thick, on spacing of 5 cm. Very little silt in samples below 9.1 m. Trace organics	10			45/45
		12			45/45
		13.7	-8.7		
	Bottom of hole, elev -8.7				
	Conducted permeability test, casing to depth 5.9 m, hole open to 7.6 m. Calculated $k = 4 \times 10^{-4}$ cm/sec				
	Installed piezometer, tip at depth 2.7 to 3.7 m				

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)

CRIPPEN ENGINEERING LTD.

NORTH VANCOUVER B.C.

HOLE NO. DH 8

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 39+89.4

ELEVATION 4.68

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 31 Jan 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ×——— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	TEST RESULTS	SAMPLE NO.	RECOVERY cm
				10 20 30 40 kN/m² / 20 40 60 80 BLOWS/FT. (0.3 m)		
SW, SM	SAND, silty, gravelly, with cobbles, brown; angular particles; fill	1.5	3.2			5/45
SP	SAND, fine, silty, grey; with thin layers of silt	2.7	2.0			46/60
		4				0/45
SW	SAND, well graded, gravelly, coarse	5.1	-0.4			10/45
	Bottom of hole, elev -0.4 Installed standpipe piezometer, tip at depth 2.9 to 3.8 m					
	No permeability test; casing used to depth 4.4 m, but was loose in hole					
	Lost 1.5 m length of casing and casing shoe					
	Sample at 0 to 0.9 m taken from material dug out of hole by hand					

CRIPPEN ENGINEERING LTD.

NORTH VANCOUVER B.C.

LOG OF DRILL HOLE

HOLE NO. DH 9

SHEET 1 OF 1

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 47+18.7

ELEVATION 4.12

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 28 Jan 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ——— L.L.

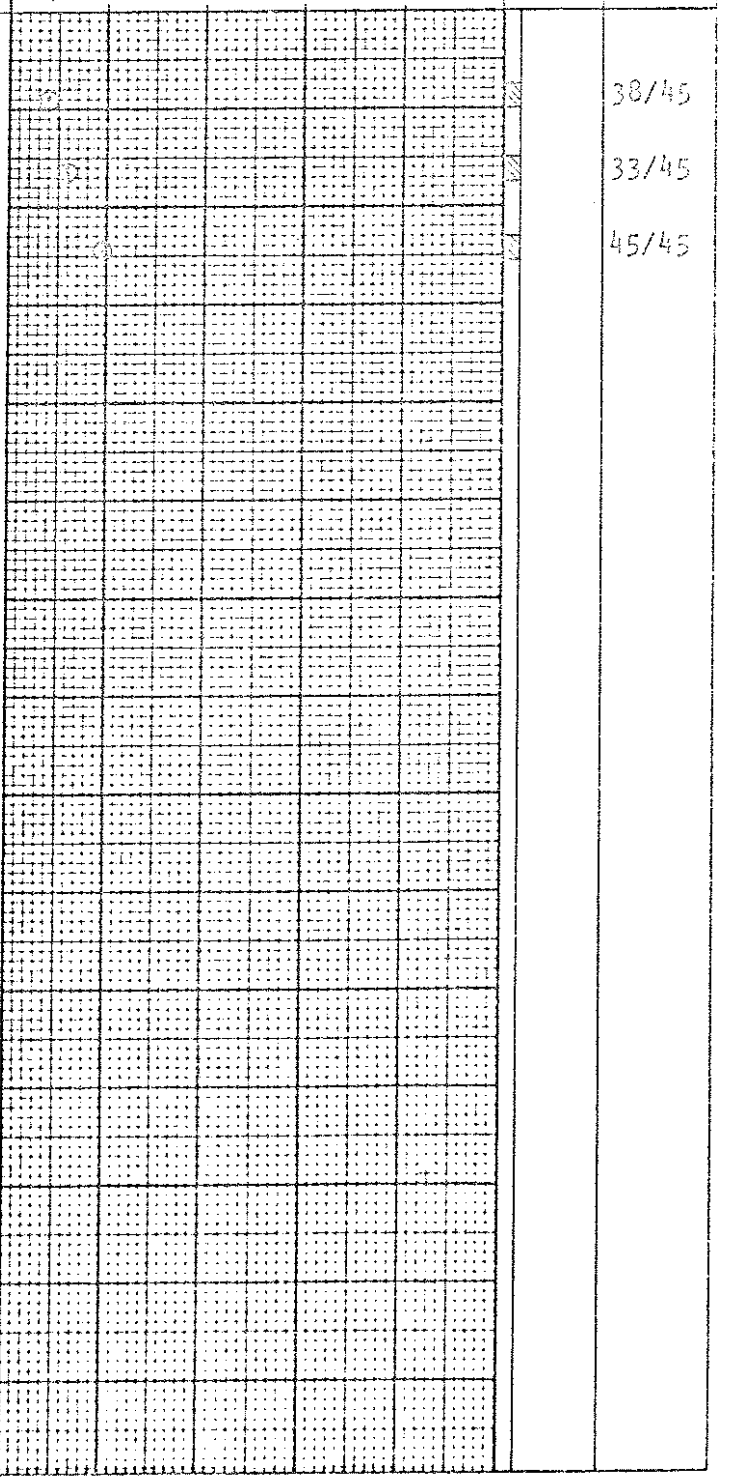
MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SW, SP	SAND, medium to coarse, well-graded, trace gravel. Some layers of silty fine sand.	2			38/45
					33/45
		4.0	0.1		
SP	SAND, fine, silty, with a few layers of grey sandy silt. Very silty drill return from 6.1 to 6.7 m.	6			45/45
		8			
		9.1	-5.0		
	Bottom of hole, Elev -5.0 Installed standpipe piezometer, tip at depth 3.0 to 4.0 m. Conducted permeability test, casing to depth 2.9 m, hole open to 4.0 m. Calculated k = 5.2×10^{-4} cm/sec.				

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)



CRIPPEN ENGINEERING LTD.

NORTH VANCOUVER B.C.

HOLE NO. DH 10

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 55+38.72

ELEVATION 10.27

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 27 Jan 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ——— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SP	SAND, fine to medium, silty, brown to grey at depth. Minor silt. Some medium to coarse sand and trace gravel.	2			20/45
		4			28/45
		6			25/45
		7.3	3.0		28/45
ML	SILT, low plasticity, grey, with thin layers of fine silty sand.	8			60/60
		10			60/60
		12.2	-1.9		0/60
SP, ML	SAND, fine, silty, with silt layers. Scattered organics in sample at 13.7 m. Gravelly at 14.9 to 15.2 m. Equal amounts of sand and silt in sample at 16.8 m.	14			45/45
		16			45/45
		18			45/45
	Bottom of hole, elev. -8.5	18.8	-8.5		
	Installed standpipe piezometer, tip at depth 14.2 m to 15.2 m.				
	Conducted permeability test, casing to depth 12.2 m, hole open to 15.2 m. Calculated $k = 1.3 \times 10^{-4}$ cm/sec.				

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)

CRIPPEN ENGINEERING LTD.

NORTH VANCOUVER B.C.

HOLE NO. DH 11

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 62+41.7

ELEVATION 5.10

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 25 Jan 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N-VALUE

ATTERBERG LIMITS

P.L. ——×—— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SG / SP	SAND, gravelly, with cobbles, silty, brown; fill	0.6	4.5		
	SAND, fine to medium, fill	1.5	3.6		30/45
CL	CLAY, brown to grey, many rust spots	3.0	2.1		10/60
SP	SAND, fine to medium; silty at top of layer, some coarse sand, trace roots, trace gravel	5.0	0.1		45/45

Bottom of hole, elev.0.1

Installed standpipe piezometer, tip at depth 4.0 to 4.8 m.

Conducted permeability test, casing to depth 2.7 m, hole open to 4.8 m; calculated $k = 1.1 \times 10^{-4}$ cm/sec.

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3 m)

CRIPPEN ENGINEERING LTD.

NORTH VANCOUVER B.C.

HOLE NO. DH 12

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 66+83.3

ELEVATION 10.37

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 25 Jan 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N-VALUE

ATTERBERG LIMITS

P.L. ——×—— L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	SAMPLE NO.	RECOVERY cm
SP, ML	SAND, fine to medium, silty; and medium to coarse and SILT, brown to grey. Silt is minor, except in sample at 3.0 m, where it comprises half of sample.	2 4 6			18/45 28/45 18/45 13/45
ML	SILT, low plasticity, with roots near top, trace organics at depth.	6.7 8	3.7		60/60 60/60
SP, SW, ML	SAND, Fine to medium, silty with minor silt. Sample at 15 m is well graded medium to coarse gravelly sand. Samples at 17 and 18.6 m contain equal amounts of fine to medium sand and silt.	10.1 12 14 16 18	0.3		30/45 1/45 20/45 33/45
	Bottom of hole, elev.-8.7 Installed standpipe piezometer, tip at depth 12.4 to 13.5 m. Conducted permeability test with casing to depth 10.4 m, hole open to 11.3 m. Calculated $k = 7.5 \times 10^{-5}$ cm/sec.	19.1	-8.7		43/45

TEST RESULTS

10 20 30 40 kN/m²

20 40 60 80 BLOWS/FT. (0.3m)

CRIPPEN ENGINEERING LTD.

NORTH VANCOUVER B.C.

HOLE NO. DH 13

SHEET 1 OF 1

LOG OF DRILL HOLE

PROJECT ABBOTSFORD

LOCATION OF HOLE Chainage 74+09.0

ELEVATION 5.56

CONTRACTOR Keller Soiltest

TYPE OF DRILL Mayhew 1000

DATE OF DRILLING 26 Jan 1977

LEGEND

- SPLIT SPOON
- WASH SAMPLE
- SHELBY TUBE
- CORE SAMPLE

SHEAR STRENGTH

- UNCONFINED COMPRESSION
- TORVANE

PENETRATION RESISTANCE

- STANDARD N - VALUE

ATTERBERG LIMITS

P.L. ⊢×⊣ L.L.

MOISTURE CONTENT

SYMBOL	DESCRIPTION	DEPTH METRES	ELEV. METRES	TEST RESULTS	SAMPLE NO.	RECOVERY cm
				10 20 30 40 kN/m² / 20 40 60 80 BLOWS/FT. (0.3 m)		
SG	SAND, brown, gravelly, silty, Fill	0.6	5.0			
ML	SILT, brown to grey at depth, trace roots; many rust coloured spots near top of layer. Many thin layers of fine sand at depth.	2				30/45 53/60 45/45
		4				60/60
SP	SAND, fine to medium, trace of roots. Gravelly below 6.7 m.	5.8	-0.2			30/45
		7.0	-1.4			
	Bottom of hole, elev.-1.4					
	Installed standpipe piezometer, tip at depth 5.7 to 7.0 m.					
	Falling head permeability test conducted with casing to depth 3.0 m, hole open to 7.0 m. Calculated $k = 4.2 \times 10^{-4}$ cm/sec					