

Our file: 92-530A

001957

November 10, 1992

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Mr. Bill Dunn, P.Eng.
Chief Engineer
Curragh Resources Inc.
P.O. Box 1000
Faro, Y.T.
Y0B 1K0

Dear Mr. Dunn:

Re: Engineering Geology Assessment
of Grum Main Waste Dump

In accordance with the scope of geotechnical work and associated budget outlined in our fax of September 29, 1992, Piteau Associates Engineering Ltd. (PAEL) has completed a review of waste dump foundation conditions and prepared recommendations regarding further investigations for the proposed Main Waste Dump area. Site inspections and test pit logging were conducted by Mr. A.F. Stewart on September 23 and 24, 1992.

BACKGROUND

An assessment of the Main Waste Dump stability and foundation conditions, summarized in our report of August 14, 1992, was based on an office evaluation of previously proposed dump configurations. All relevant data, plans, reports, etc., available at that time were reviewed. The suitability of the originally proposed dump design was assessed on the basis of subsurface data from a 1977 test pitting program and on the performance of an existing 30m high waste dump already constructed in the area. Preliminary stability analyses were conducted, alternate dump configurations assessed and recommendations made for lift thicknesses, overall slope angles and setbacks. However, the 1977 subsurface data, as summarized by Monenco in a 1979 report entitled "Feasibility Study of the Subsurface Conditions, Construction and Concrete Aggregates and Mine Waste Management Aspects at the Grum Deposit, Faro, Yukon", were limited in that the test pits were all located at the southeastern end of the Main Waste Dump, near Vangorda Creek.

During the recent field work to confirm the nature of the foundation materials under the Main Waste Dump, thirteen test pits were excavated throughout the dump area. Laboratory testing of samples obtained during this program included moisture content determination, plasticity characteristics and grain size analysis.

ENGINEERING GEOLOGY AND FOUNDATION CONDITIONS

The following discussions are based predominantly on data obtained from the test pitting program conducted on September 23 and 24, 1992. Locations of all test



Mr. Bill Dunn, P.Eng.,
Chief Engineer
Curragh Resources Inc.

-2-

November 10, 1992

pits excavated during this program are shown in Fig. 1, along with the locations of several representative test pits from the earlier Monenco investigation. Detailed engineering geology logs of recently excavated test pits are included in Appendix A.

Physiography

The bulk of the Main Waste Dump will lie on moderate slopes, generally dipping south-southeast towards Vangorda Creek (see Figs. 1 and 2). While topography in the area of the proposed waste dump generally dips from 6° to 10°, with occasional areas dipping up to 12°, some flat areas are also evident. These flat areas may be terraces related to glacial or post-glacial fluvial activity.

The present design toe of the Main Waste Dump is located approximately 200m from Vangorda Creek. As discussed in our August 14 report, it is recommended that the elevation of the dump toe not extend below 1100m-asl, while the upslope portion of the dump foundation could reach elevations as high as 1260m-asl.

Hydrology and Hydrogeology

Grum Creek, which discharges into Vangorda Creek, is the only perennial stream crossing the Main Waste Dump site. Three ephemeral streams also exist in the area; however, very little information is available on these drainage features and they appear to be relatively minor. While accurate flow values are not available for Grum Creek, a visual estimate of about 100 igpm at the 1200m elevation, in the vicinity of Test Pits TP-P25 and TP-P26, was made during the test pitting program. An additional 100 igpm was estimated to be discharging as groundwater seepage from the slopes along the creek in this area. However, as Grum Creek has essentially no catchment area at this location since the main Vangorda haulroad and the Grum Pit are immediately upslope, it is likely that most, if not all, of the discharge in Grum Creek originates as groundwater baseflow.

Besides the two test pits located on the flanks of Grum Creek, seepage was only observed in Test Pits TP-P14 and TP-P18, where it appeared as a very minor flow just below the bedrock contact. In Test pits TP-P25 and TP-P26, located on the eastern flank of the proposed waste dump and on either side of Grum Creek, considerable seepage was observed. Test Pit TP-P25, which was excavated in a clayey silt glacial till underlain by a water bearing silty sand with gravel, became flooded over a period of about 24 hours. Seepage into test pit TP-P26, which appears to be excavated in saturated fluvial sediments, was minor but steady.

Mr. Bill Dunn, P.Eng.,
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-3- November 10, 1992

Based on the above, it would appear that the area around Grum Creek is the only significant discharge area in the proposed waste dump site. While the full extent of the discharge area has not been defined, and there is insufficient information on which to base a firm conclusion, it is likely that the granular soils exposed in this discharge area belong to the same stratigraphic unit (identified as a 20m thick confined aquifer) as that encountered in drillholes in the Grum Pit. Supporting evidence for this conclusion is discussed in our report of January 1991, entitled "Grum Pit Review and Analysis of Hydrogeological Data and Design of Phase I Dewatering System".

Surficial Soils

Soil conditions encountered in the test pits are generally consistent with those described in our August 1992 report. Three distinct soil units are apparent in the area. In all test pits, a shallow (0.2 to 0.5m thick) layer of organic material containing silt and sand was encountered. Directly below this layer, either a well to poorly graded, medium dense to dense sand and gravel (possibly fluvial in origin) or a firm to hard, low to medium plasticity sandy silt to clayey silt (glacial till) was typically encountered. Grain size analysis results from samples in the sand and gravel are presented in Fig. 3. The results of Atterberg limit testing from samples in the glacial till are presented in Fig. 4.

In terms of general occurrence, the sand and gravel is typically found below the 1180m elevation and in areas proximal to Grum and Vangorda Creeks (see Fig. 1). In many instances, the upper portion of this unit is stained or oxidized, probably in response to groundwater level fluctuations or surface water recharge. Sand and gravel deposits ranged in thickness from 0.3m to greater than 5.5m.

With the exception of test pits TP-P15 and TP-P18, and possibly test pits TP-P20 and TP-P26 (i.e. where the sand and gravel was not completely penetrated), glacial till is present over nearly all of the site. This material, which typically underlies the other soil units, and also overlies the sand and gravel in some areas (i.e. in TP-P25), ranged in thickness from 0.2m to greater than 6.7m. While very thick till deposits have been encountered in the Grum Pit area, it is not anticipated that deep till deposits are present under the Main Waste Dump site.

Bedrock

Phyllite bedrock was encountered in six of the test pits, predominantly in the southwestern area of the proposed waste dump. The bedrock ranged from weathered

Mr. Bill Dunn, P.Eng.,
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-4-

November 10, 1992

to fresh, and was generally easily excavatable. Test pits were excavated between 0.1m and 3.7m into the bedrock, where it was encountered.

CONCLUSIONS AND RECOMMENDATIONS

Based on the above, it is concluded that foundation conditions are favourable for most of the Main Waste Dump area. In addition, the design criteria outlined in our August 14 report for this dump appear to be reasonable. However, in the area of Grum Creek, where groundwater was discharging onto the slope, further investigations and/or remedial measures are required.

As a minimum, it is recommended that site reconnaissance be carried out to determine the full extent of the discharge area in the vicinity of Grum Creek. It is also recommended that additional test pits be excavated and logged, particularly where dumping is likely to occur. If it is determined that the discharge area is not to be used as a dump site, and that it is only required that a causeway be constructed across Grum Creek to the more competent foundation area to the southwest, it is likely that this can be accomplished by taking special precautions during construction, such as by only using competent, coarse free draining waste rock to build the causeway. It may also be advisable to install one or more culverts through the causeway in the area of Grum Creek. However, if a more extensive filling of the Grum Creek area is desirable, careful consideration of the feasibility of building such a dump will be required. After test pitting and sampling the area in question, additional stability analyses may be required to arrive at a stable dump configuration and to determine guidelines and criteria under which the dump may be built.

We trust the above is sufficient for your needs at this time. If you have any questions, please do not hesitate to contact the undersigned.

Yours very truly,

PITEAU ASSOCIATES ENGINEERING LTD.


Alan F. Stewart, P.Eng.



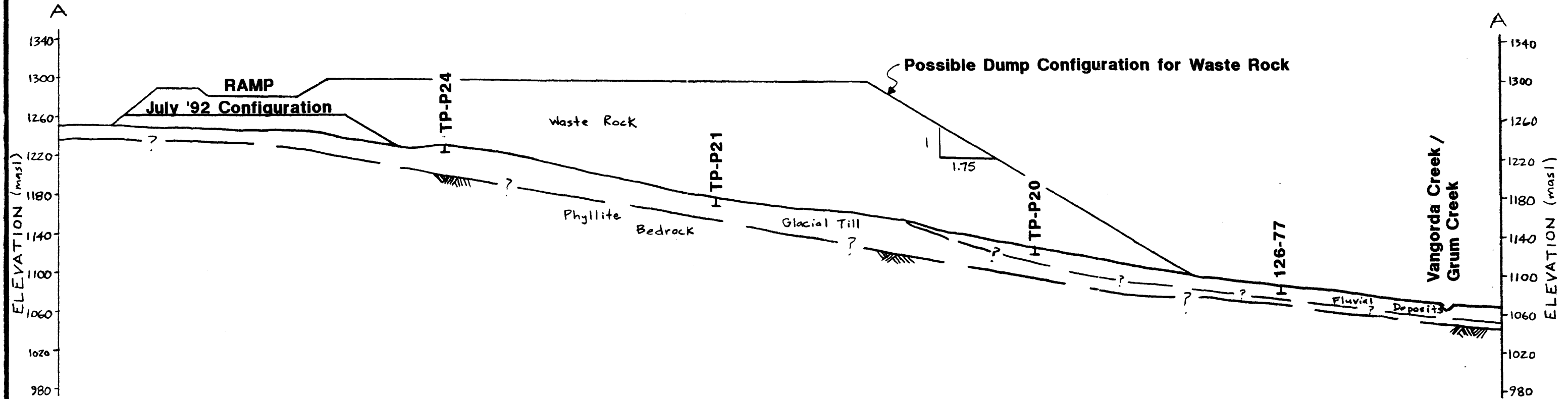

H. Warren Newcomen, P.Eng.

AFS/HWN/ef

Att.

Figures

MAIN WASTE DUMP AREA




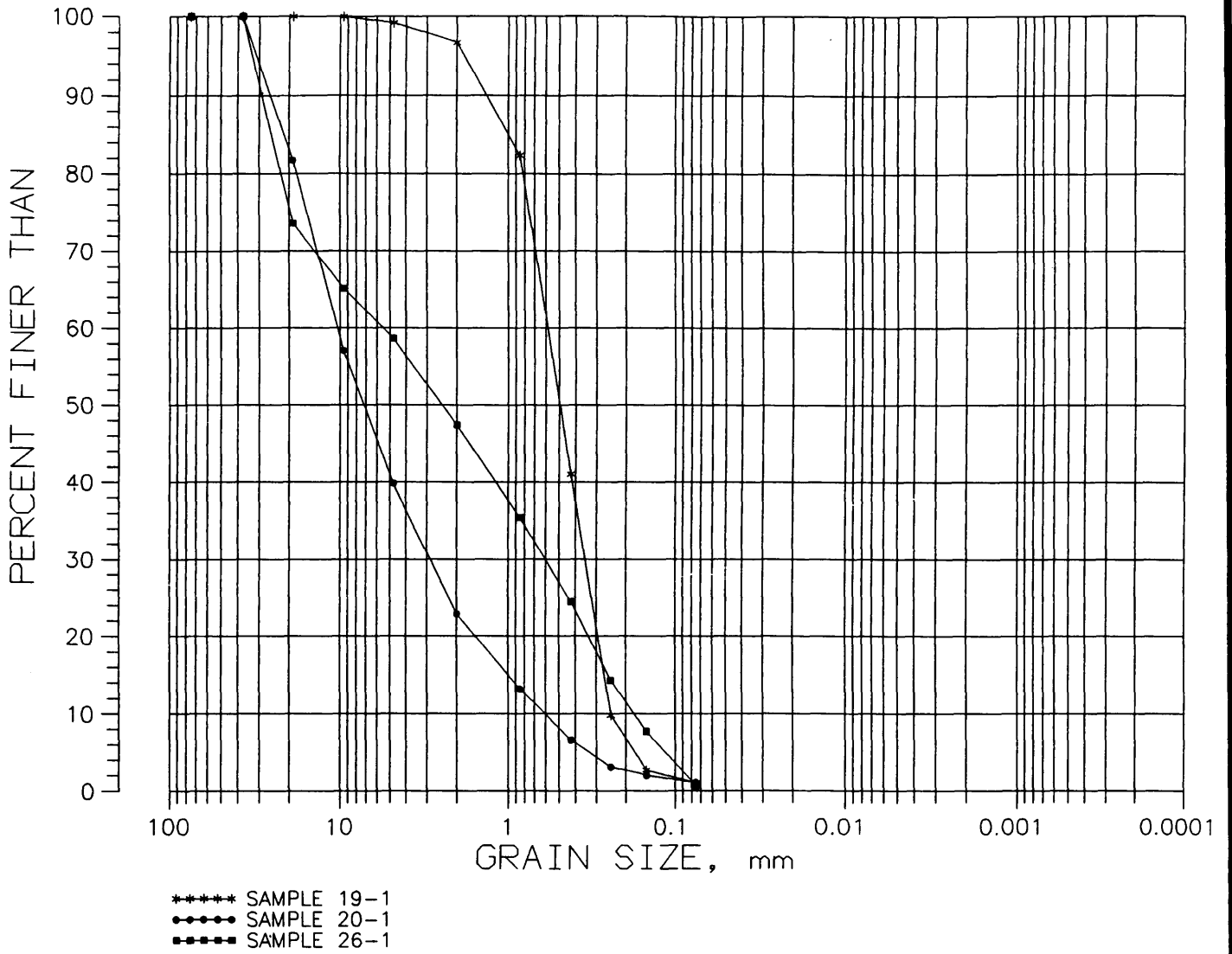
- NOTES: 1. See Fig. 1 for section location and Legend.
 2. See Appendix A for detailed test pit logging information.
 3. Stability assessments were conducted as part of Piteau Associates' August 1992 report.
 Dump to be constructed from bottom upwards in 30m lifts, as per the recommendations of that report.



SCALE 1:4000

FIG. 2

<p>CURRAGH RESOURCES LTD. GRUM DEPOSIT MAIN WASTE DUMP</p>	 <p>PITEAU ASSOCIATES GEOTECHNICAL CONSULTANTS VANCOUVER CALGARY</p>	BY:	DATE:
		HWN	NOV.92
<p>CROSS-SECTION A-A'</p>		APPROVED:	DWG:
		AFS	



MIT Scale	coarse	medium	fine	coarse	medium	fine	fine grained
COBBLE SIZE	GRAVEL SIZE		SAND SIZE			SILT SIZE	CLAY SIZE

NOTE: See Fig. 1 for sample locations

FIG. 3

**CURRAGH RESOURCES LTD.
GRUM DEPOSIT
MAIN WASTE DUMP**



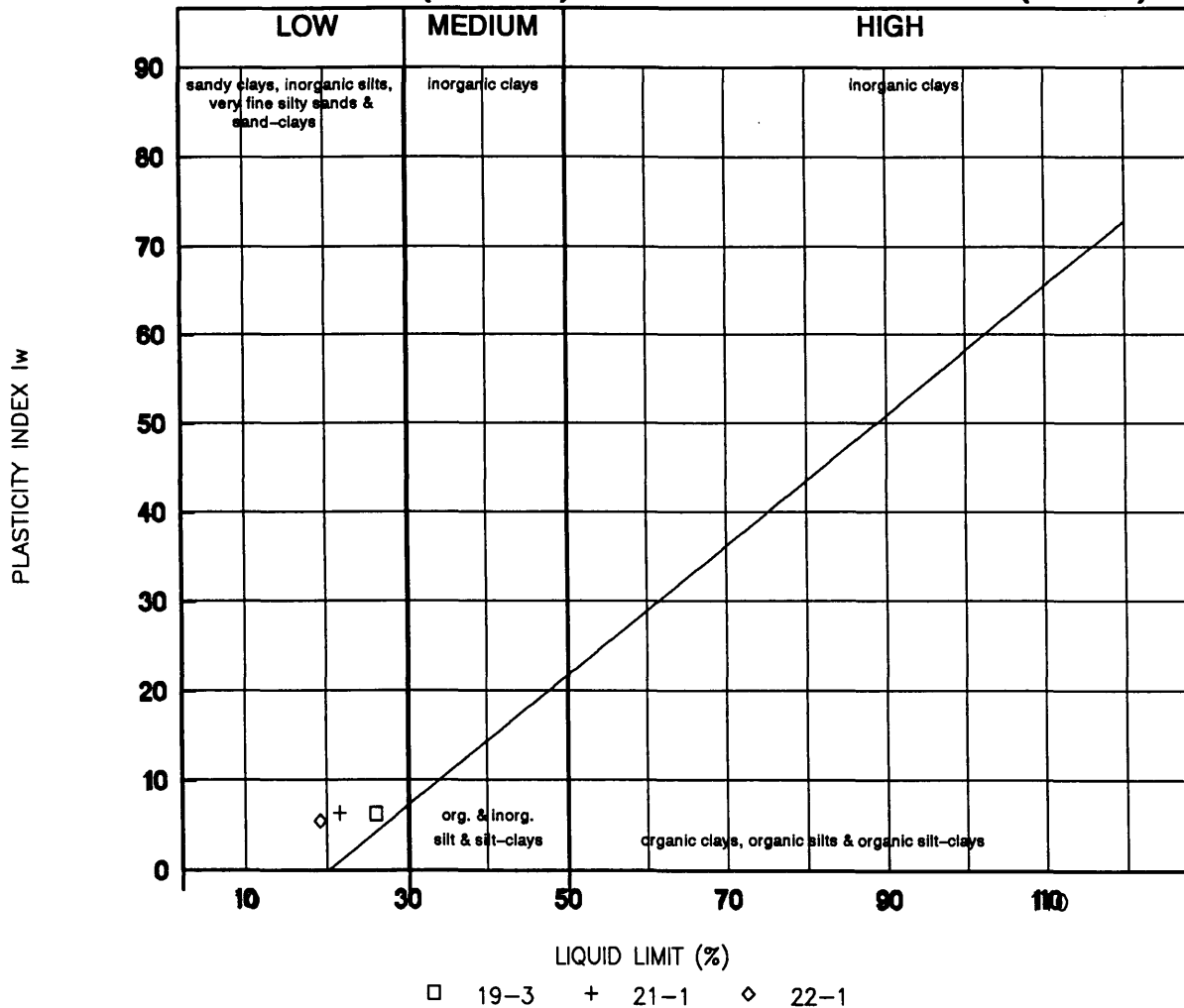
PITEAU ASSOCIATES
GEOTECHNICAL CONSULTANTS
VANCOUVER CALGARY

GRAIN SIZE DISTRIBUTION CURVES

BY: HWN	DATE: NOV.92
APPROVED: AFS	DWG:

SAMPLE No.	DEPTH (m)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX Iw	SOIL TYPE	UNIFIED CLASS
19-3	5.2	16.4	26.1	19.9	6.2	SILTY CLAY TO SANDY SILT	CL-ML
21-1	3.0	13.6	21.6	15.3	6.3	SILTY CLAY TO SANDY SILT	CL-ML
22-1	4.0	13.6	19.2	13.8	5.4	SILTY CLAY TO SANDY SILT	CL-ML

PLASTICITY (CLAYS) OR COMPRESSIBILITY (SILTS)



NOTE: See Fig. 1 for sample locations

FIG. 4

CURRAGH RESOURCES LTD.
GRUM DEPOSIT
MAIN WASTE DUMP



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PLASTICITY CHART

BY:	HWN	DATE:	NOV.92
APPROVED:	AFS	DWG:	

APPENDIX A
TEST PIT LOGS

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump


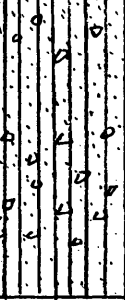
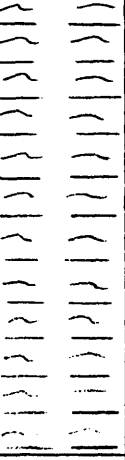
Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5472.9 N, 865.9 E

Excavation Method: CAT 235 Backhoe

Elev.: 1158.1 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL-ML		Dk. brn. to blk. fine Sandy SILT w/ numerous organics and roots.		
2.0			SM-GM		Brn. to rst. brn./grey v. stiff Sand, SILT w/ tr. to little clay, sand and gravel and occ. cobbles [Till]		P _p =3.0
6.0					PHYLLITE Bedrock (highly weathered surface)		
10.0					TD 3.0m? (pit flooded)		
14.0							



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LOG OF TEST PIT NO.

P14

BY: +HWN	DATE: 10/15/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

Date Logged: 09/24/92

Coordinates: 5473.0 N, 1152.5 E

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Elev.: 1182.3 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL-ML		Dk. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
	2.0		SW-GW		Brn. med dense to dense fine to cgs. SAND and GRAVEL w/ little silt, cobbles and boulders to 50 cm φ.		
	4.0				PHYLLITE Bedrock		
	6.0						
	8.0						
	10.0						
	12.0				TD 3.2 m		
	14.0				Dry		
					Photo 2-4		



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LOG OF TEST PIT NO.

P15

BY:	DATE:
HWN	10/15/92
APPROVED:	OWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5488.7 N, 1334.5 E

Excavation Method: CAT 235 Backhoe

Elev.: 1106.8 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ abdt. Organics and roots.		
2.0			ML		Brn. stiff Clayey SILT w/ little sand and gravel, occas. cobbles and boulders to 30 cm ϕ . [Till]	①	P _p = 1.5 - 2.0 W _n = 12.4%
1.0							
4.0							
6.0							
8.0					PHYLLITE Bedrock		
3.0	10.0				TD 3.1 m		
					Dry		
12.0							
4.0	14.0						



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LOG OF TEST PIT NO. P16

BY: HWN	DATE: 10/15/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5063.9 N, 1303.9 E

Excavation Method: CAT 235 Backhoe

Elev.: 1124.5 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
	2.0		SM-ML		Brn. firm to stiff Sandy SILT w/ tr. to little clay and gravel. [Till]		$P_f = 0.35 - 1.5$
1.0					PHYLLITE Bedrock		
4.0							
6.0							
2.0							
8.0							
3.0							
10.0							
12.0							
4.0							
4.5					TD 4.5m		Dry



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LOG OF TEST PIT NO.

P17

BY: HWN	DATE: 10/15/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5275.8 N, 1326.9 E

Excavation Method: CAT 235 Backhoe

Elev.: 1162.5 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ abdt. Organics and roots.		
4.0			SW-GW		Brn. med dense fine to crs. SAND and GRAVEL w/ tr. silt, occ. to abdt. Cobbles and boulders up to 25 cm φ. - bedding evident		
8.0							
12.0							
4.0					↓ becomes very silty (till?)		
16.0					PHYLLITE Bedrock - slight seepage		
6.0					TD 5.6 m		
20.0							
24.0							
8.0							



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LOG OF TEST PIT NO. P18

BY: HWN	DATE: 10/15/92
APPROVED:	DWG:

JOB NUMBER 22-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5226.5 N, 1622.0 E

Excavation Method: CAT 235 Backhoe

Elev.: 1160.2 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL-ML		DK. brn. to blk. fine Sandy SILT w/ abdt. organics and roots.		
	-4.0		SP-GP		Brn. to rst. brn loose to med. dense fine to crs. SAND and GRAVEL w/ tr. silt, cobbles and boulders to 25 cm φ.		
2.0	-8.0		SP		Brn. to gr. loose to med, dense fine to med. SAND w/ trace silt and occ. gravel.	(1)	G
4.0	-12.0		CL-ML		Brn. stiff to v. stiff Silty CLAY to Clayey SILT w/ tr. to little sand, gravel and cobbles. [Till]	(2)	$P_p = 1.5$ $W_n = 14.5\%$
	-16.0		CL-ML			(3)	$P_p = 3.0$ A $W_n = 16.4\%$ $W_L = 26.1\%$ $W_p = 19.9\%$
6.0	-20.0				PHYLLITE Bedrock TD 5.5 m Dry		
	-24.0						
	-28.0						
8.0	-32.0						



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LOG OF TEST PIT NO.

P19

BY:	DATE:
HWN	10/15/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

Date Logged: 09/24/92

Coordinates: 5014.1 N, 1761.6 E

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Elev.: 1131.9 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL		DK. brn. to blk ORGANICS		
	4.0		SW-GW		Brn. to rst. brn. med dense fine to crs. SAND and GRAVEL w/ some cobbles and boulders to 30 cm ϕ , tr. silt. - bedding evident.		
2.0	8.0				Gr. to brn. med. dense GRAVEL and SAND w/ little cobbles and tr. silt. - occ. beds of fine sand.		
4.0	12.0		GW-SW			(2)	G
	16.0						
6.0	20.0				TD 6.0m Photos 2-6, 7 & 8		
	24.0				Dry		
8.0							



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LOG OF TEST PIT NO.

P20

BY: HWN	DATE 10/16/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump






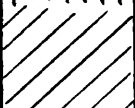


Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5337.2 N, 1796.6 E

Excavation Method: CAT 235 Backhoe

Elev.: 1178.2 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			DL		Brn. to blk. ORGANICS		
2.0			CL-ML		Dk. gr. to brn., stiff Silty CLAY to Sandy SILT w/ tr. sand, gravel and cobbles, occ. boulders to 25 cm ϕ . [Till] - lens of brn fine to crs. sand between 1-2 m depth on one side of pit.		
4.0							
6.0							
8.0							
10.0							
12.0							
4.0							
					Photo 2-9		
					TD = 5.7m		
					Dry		

$P_f = 1.0 - 2.0$

①

A
 $W_n = 13.6\%$
 $W_L = 21.6\%$
 $W_p = 15.3\%$



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LOG OF TEST PIT NO. P21

BY: HWN	DATE 10/16/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

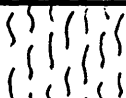
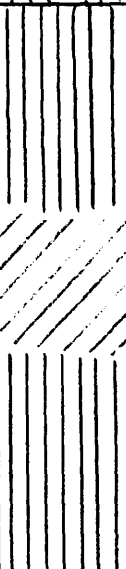
Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5513.8 N, 1568.7 E

Excavation Method: CAT 235 Backhoe

Elev.: 1198.6 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL		Brn. to blk. ORGANICS		
2.0			CL-ML		Dk. gr. stiff to v. stiff Silty CLAY to Sandy SILT w/ little sand and gravel, occ. cobbles and boulders to 50 cm φ. [Till] - slight sloughing		
1.0							
4.0							
6.0							
2.0							
8.0							
3.0							
10.0							
12.0							
4.0							
TD 5.7m					Dry	①	P _p = 2.0 - 3.0 A W _n = 13.6% W _L = 19.2% N _p = 13.8%



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LOG OF TEST PIT NO. P22

BY: HWN	DATE: 10/16/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

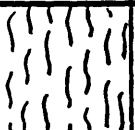





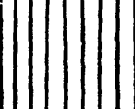


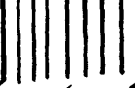
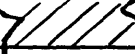
Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5510.8 N, 1656.1 E

Excavation Method: CAT 235 Backhoe

Elev.: 1206.7 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL		Brn. to blk. ORGANICS		
2.0			CL-ML		DK. gr. stiff to v. stiff Silty CLAY to Sandy SILT w/ little sand and gravel, occ. cobbles and boulders to 50 cm ϕ . [Till] - no sloughing		
1.0							
4.0							
6.0							
2.0							
8.0							
3.0							
10.0							
12.0							
4.0							

$P_p = 2.5 - 3.0$

Photo 2-10

TD 7.1 m

Dry



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 VANCOUVER CALGARY

LOG OF TEST PIT NO. P23

BY:	DATE:
HWN	10/16/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump

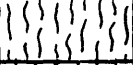

Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5548.2 N, 1981.9 E

Excavation Method: CAT 235 Backhoe

Elev.: 1231.6 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL		Brn. to blk. ORGANICS		
2.0			ML		Brn. to gr. v. stiff to hard Clayey SILT w/ little sand, gravel, cobbles and boulders to 50 cm ϕ . [Till]		Pp 73.0
1.0							
4.0							
6.0							
2.0							
8.0							
3.0							
10.0							
12.0							
4.0							
TD 5.9m					Dry		



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LOG OF TEST PIT NO. P24

BY: HWN	DATE: 10/16/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump




Date Logged: 09/24/92

Logged By: AFS

Coordinates: 5361.2 N, 2036.4 E

Excavation Method: CAT 235 Backhoe

Elev.: 1195.8 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL		Brn. to blk. ORGANICS		
2.0			ML		Brn. to gr. v. stiff to hard clayey SILT w/ little sand, gravel, cobbles and boulders to 50 cm ϕ . [Till]		
1.0							
4.0							
6.0							
2.0					Brn. Silty SAND w/ some gravel. ✓ gravel seeping TD=? (pit flooded)		
8.0							
3.0							
10.0							
12.0							
4.0							
14.0							



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LOG OF TEST PIT NO. P25

BY: HWN	DATE: 10/16/92
APPROVED:	DWG:

JOB NUMBER 92-530A

Date Excavated: 09/24/92

Location: Main Rock Dump



Date Logged: 09/24/92

Coordinates: 5284.2 N, 2284.2 E

Logged By: AFS

Excavation Method: CAT 235 Backhoe

Elev: 1199.3 m

DEPTH		SYMBOL	SOIL/ROCK CLASS	TERRAIN CLASS	DESCRIPTION/COMMENTS	SAMPLES	TESTS
m	ft						
			OL		Brn. to blk. ORGANICS.		
2.0			SP-GP		Brn. med dense Silty SAND and GRAVEL, w/ little cobbles and occ. boulders to 40 cm ϕ . Wet.		
1.0					- lenses of sandy silt throughout		
4.0					- pit sloughing steadily		
6.0							
2.0					← minor seepage		
8.0							
3.0							
10.0							
12.0							
4.0							
					TD 5.8 m		



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LOG OF TEST PIT NO. P26

BY: HWN	DATE: 10/16/92
APPROVED:	DWG: