926-2-148

MACLEOD GEOTECHNICAL LTD.
soil mechanics and foundation engineering

1451 MARINE DRIVE, WEST VANCOUVER, B.C. V7T 1B8 TELEPHONE 922-0812

June 29, 1979
B42

B.C. BUILDINGS CORPORATION
400 - 910 Government St
Victoria, B.C.
V8W 2T4

Attn: Mr. P. Moyles

Re: PERMANENT DEWATERING SYSTEM
NEW WESTMINSTER COURTHOUSE
B.C.B.C. PROJECT NO.0309

Dear Sir,

Enclosed please find the following information relating to the final as-built condition of the permanent relief well system and building underdrainage.

- Report on Temporary Dewatering System Shut-down and Permanent Relief Well System Activation by Brown, Erdman & Associates Ltd. (Groundwater geologists)
- Water sample analysis (letter from Brown, Erdman & Associates dated Aug. 31/78)
- Drawing B42-L1: Grain size analyses of underdrainage material
- Filter Cloth Specification
- Drawing B42-AB1: As-Built Sections/Building Underdrainage

The above information is intended to be supplementary to the as-built design drawings and to collect in one report items relating to the construction and continuing performance of the permanent dewatering system for the New Westminster Courthouse.

PERMANENT DEWATERING SYSTEM DESIGN

The design of the permanent building underdrainage system consists of two main elements.

1. Permanent Relief Wells were installed that were designed to keep the piezometric water level in the underlying aquifer (Zone C) below elevation 72 ft. (22 m) i.e. 2 ft. above basement floor level. These wells are drained by means of pipes set at invert elevation 64 ft. (19.5 m) at the takeoff point leading to the common outlet manhole.

2. A secondary underdrainage system was constructed under the basement floor slab consisting of approximately 13 ins. (.33 m) of free draining gravel (pea gravel) set on a filter layer of pump sand (m.f. sand) and filter cloth (Staff type ISS 1). The intent of this loaded filter zone is to control potential upward seepage flow in areas not fully covered by the relief wells for the design piezometric elevation of 72 ft. (22 m).

All service lines including those from the relief wells are located in a common grid of service trenches approximately 6 ft. (1.8 m) in depth below basement floor level and located well clear of all major building foundations. These service trenches, which are lined with filter cloth and backfilled with pea gravel, also serve as an additional underdrainage system in the deep area of the basement as well as draining all seepage water to the common outlet manhole at the south end of the building. From the manhole the flow from the relief wells plus drainage gravel and perimeter subdrainage flows by gravity into the City of New Westminster sewer system down Carnarvon Street.

It was noted during excavation that some of the service trenches in the north east corner of the basement had penetrated through the relatively impermeable CLAY-SILT (Zone B) into the underlying SAND aquifer (Zone C).

Flow from the upper perched aquifer in Zone A will be controlled by perimeter perforated drain lines around the building at basement floor level (Elevation 70') together with some additional perforated drains along Agnes St. at the two upper benches - see drawing B42-AB1.

Loss of ground is controlled by filter cloth placed against the timber lagging of the shoring system and the space between the building perimeter wall and the shoring is filled with free draining pea gravel. A concentrated continuous flow was encountered from the north west corner of the upper aquifer during excavation and was later conducted by additional piping directly into the perimeter drain system in that area - steady flow at the time was estimated to be in the order of 2 USGPM. All the perimeter drains run into the common outlet manhole.

CONCLUSIONS & RECOMMENDATIONS

1. Based on the results of the first 45 days of operation it is concluded that the combined permanent dewatering system consisting of permanent relief wells and building underdrainage will keep the piezometric water elevation of the underlying aquifer (Zone C) well below the basement floor elevation of 70 ft. (21.3m).

2. Recommendations concerning abandonment of temporary wells and piezometers are given in the enclosed report by Brown, Erdman & Associates Ltd. Completion of the work still requires final permanent installation of interior piezometers A & B.

Should you have any questions concerning the above please contact the undersigned or Mr. W. L. Brown (Brown, Erdman & Assoc. Ltd.)

Yours truly,

MACLEOD GEOTECHNICAL LTD
G. Macleod, P. Eng.

GM/dk
Encl.
cc: Carlberg Jackson
Read Jones Christofferson
PCL Construction Ltd.

BROWN, ERDMAN & ASSOCIATES LTD.
1401 BEWICKE AVENUE, NORTH VANCOUVER, BRITISH COLUMBIA V7M 3C7
TELEPHONE 986-1557

78-082

June 21st, 1979

Macleod Geotechnical Ltd.
1451 Marine Drive
West Vancouver, B. C.
V7T 1B8

Attention: Mr. Graeme Macleod, P. Eng.

Subject: New Westminster Courthouse
B.C.B.C. Project No. 0309
Temporary Dewatering System Shut-down
Permanent Relief Well System Activation

Dear Sirs:

This letter will describe:

1. The long term operation and shut-down of the Temporary Dewatering System.

2. The behavior of the Permanent Relief Well System during its first 45.0 days (64,830 minutes) of operation.

3. Abandonment of the Temporary Dewatering Wells.

Attached to this letter are:

1. A Map of the foundation at elevation 68 feet (20.72 meters) showing the location of the Temporary Dewatering Wells, Permanent Relief Wells, and Piezometers.

2. An Arithmetic Chart showing water level response to dewatering system operation and shut-down in Piezometers 8 and A.

3. A Semi-log Chart of water levels in Permanent Piezometers A and B after shut-down of Temporary Dewatering System.

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June 21st, 1979

Macleod Geotechnical Ltd.

4. A Diagram of Permanent Relief Wells showing "as-constructed" details.

This letter could serve as a permanent record for the maintenance personnel of the Courthouse building.

Temporary Dewatering System

1. Pertinent Details

a) Start-up: July 21st, 1978, by 1530 hours.

b) Shut-down: May 7th, 1979, by 1240 hours.

c) Total water pumped: 31.07 million US gallons (117.6 million litres).

d) Total time in operation: 259 days (372,960 minutes).

e) Average discharge: $31.07 \times 10^6/372,960 = 83.3$ US gallons per minute or 5.2 litres per second.

f) Average static water level elevation before system was started: 100 feet (30.49 meters).

g) Average drawndown water level elevation beneath the excavation after the system was in operation:

Summer	60 feet (18.29 meters)
Spring	64 feet (19.51 meters).

h) Elevation top of final subgrade: 68 feet (20.73 meters).

i) Elevation of average bottom of plumbing trenches: 64 feet (19.51 meters).

j) Elevation of top of lowest floor slab: 70 feet (21.34 meters).

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June 21st, 1979

Macleod Geotechnical Ltd.

Temporary Dewatering System, continued

2. Design

The Well Location Map (Drawing 1) shows the location of the nine Temporary Dewatering Wells and three Piezometers in relation to the outline of the foundations at elevation 68 feet (20.72 meters). It will be noted that these nine wells form a "U" around the northern sides of the excavation to intercept groundwater that naturally flowed southward beneath the site. The dewatering system was designed to lower the groundwater pressure head beneath the excavation from an average elevation of 100 feet (30.5 meters) to elevation 64 feet (19.51 meters). The total discharge from the system was expected to average 54 US gallons per minute (3.4 litres per second) based upon the hydrogeologic conditions observed in the test well which became Piezometer 8. A section of sands and gravels was encountered in the wells drilled in the eastern part of the system which was much more permeable than those encountered at Piezometer 8. The average flow from the system was increased by the presence of this high permeability section to 83.3 US gallons per minute (5.2 litres per second).

3. Operation

The Temporary Dewatering System operated from July 21st, 1978, to May 7th, 1979, or a period 259 days. Two standby generators (one automatic, the other manual) and an alarm were incorporated into the system for protection against a Hydro power failure. Hydro power did not fail during the 259 day period. During the critical period when the excavation was below 80 feet (24.39 meters) and before the walls were completed to the first floor (October 10th, 1978 to May 7th, 1979) the dewatering system was under constant surveillance.

78-082

June 21st, 1979

Macleod Geotechnical Ltd.

Temporary Dewatering System, continued

4. Water Levels

The Arithmetic Chart (Drawing 2) shows the water levels in Piezometer 8 during the operation of the dewatering system. It will be noted that the water level dropped quickly to a depth of 57 feet (17.37 meters) or an elevation of 57 feet (17.37 meters) over a period of 2½ days. Fluctuations occurred over the next month as the system was tuned to get maximum drawdown in each well with a minimum of pump on and off cycling. Fluctuations of one to two feet (0.30 to 0.61 meters) can be observed during the construction of the Permament Relief Wells as water was added to and bailed from these wells during the construction and development (cleaning) processes. The water level inside the excavation was approximately at elevation 60 feet (18.29 meters) when the elevation of the water level in Piezometer 8 was at elevation 57 feet (17.37 meters). This rise of 3 feet (0.92 meters) as one proceeds inwards from the line of dewatering wells into the central area of the "U" is normal. Groundwater is able to flow into the central area through the open southerly part of the "U".

The Permanent Relief Wells were connected to the sewer by January 15th, 1979, so that they acted as a back-up system from this time onwards. The water level in Piezometer 8 gradually rose 9 feet (2.7 meters) from January 15th, 1979, to May 4th, 1979, in response to the infiltration of the winter and spring rains. The rise could have been checked by retuning the dewatering system but in view of the stage of construction during this period retuning was not considered necessary.

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June 21st, 1979

Macleod Geotechnical Ltd.

Permanent Relief Well System

1. Design

The "as-constructed" details of the Permanent Relief Wells are shown on Drawing 4. It will be noted that stainless steel screens with the appropriate lengths of stainless steel pipe extends from the bottom of the well to the invert of the discharge line at elevation 64 feet (19.51 meters). Clean-out and access plugs are present at floor level. The depths of the wells vary from 32 to 42 feet (9.76 to 12.80 meters) according to the depths of the bottom of the main sand and gravel water-bearing zones.

The location of the Permanent Relief Wells are shown on Drawing 1. It will be noted that 12 wells are located within the foundation of the building. The design flow of these 12 wells is 36 US gallons per minute (2.25 litres per second). The total flow measured at the sewer sump was 30 US gallons per minute (1.89 litres per second) on May 29th, 1979, 22 days after the Temporary Dewatering System was turned off.

The Permanent Relief Well System is designed to keep the piezometric water level in the underlying aquifer (called Zone "C" in previous soil reports) below an elevation of 72 feet (21.95 meters) or 2 feet (0.6 meters) above the basement floor level, in order to prevent heaving of the floor slab bearing strata and undermining of the foundations of the building.

2. Water Levels

The water levels in the Permanent Piezometers A and B rose the following distances during the first 45 days after the Temporary Dewatering Wells were turned off.

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June 21st, 1979

Macleod Geotechnical Ltd.

Permanent Relief Well System, continued

2. Water Levels, continued

Piezometer	May 4th, 1979 Depth to Water	June 18th, 1979 Depth to Water	Rise Feet (Meters)
A (North)	6.24 feet (1.90 meters)	4.08 feet (1.24 meters)	2.16 feet (0.66 meters)
A (South)	7.0 feet (2.13 meters)	5.83 feet (1.78 meters)	1.17 feet (0.36 meters)

The recovery water levels are shown on the attached table.

The Semi-logarithmic Chart (Drawing 3) of the recovery of the water levels in the Permanent Piezometers A and B after the Temporary Dewatering System was turned off shows:

a) The rate of rise of the water level is gradually slowing down.

b) The stabilized water level will probably be at a depth of 4 feet (1.22 meters) in Piezometer A and a depth of 5.7 feet (1.74 meters) in Piezometer B below the floor slab. Since the piezometric water level was over 6 feet (1.83 meters) below the design level at elevation 72 feet (21.95 meters) on June 18th, 1979, it appears that adequate reserve exists to protect against a series of abnormally wet years with the attendant higher than normal rain water infiltration rate.

c) The scattering of readings in the middle of the chart could be caused by:

   i) readings by several people,

   ii) loading and readjustment when large concrete pours occur.

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June 21st, 1979

Macleod Geotechnical Ltd.

Permanent Relief Well System, continued

2. Water Levels, continued

The scattering is only obvious because the scale on the depth to water axis is large at 6 inches per inch (6 centimeters per centimeter).

Abandonment

1. Piezometers P7 and P8 - These piezometers should be kept for observation purposes during the construction of other government buildings in the area. They should be cut off a future landscaped or sidewalk level and capped with waterproof access parts.

2. Piezometer P9 - This piezometer should be cut off 3 to 5 feet (0.91 to 1.52 meters) below final landscaped grade, capped with a piece of ¼-inch (0.64 centimeter) thick steel plate welded to the casing and buried.

3. Temporary Dewatering Wells - These should be cut off, capped and buried as described for P9 above.

Conclusions

1. The Temporary Dewatering System functioned as required for 259 days with no operational problems.

2. Based upon the first 45 days of operation, the Permanent Relief Well System will keep the piezometric water elevation in the underlying aquifer (Zone "C") well below the design elevation of 72 feet (21.95 meters).

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June 21st, 1979

Macleod Geotechnical Ltd.

If any of the above needs amplification or clarification please do not hesitate to call.

Yours truly

BROWN, ERDMAN & ASSOCIATES LTD.

W. L. BROWN, P. Eng.

WLB/sa
Encls:

RECOVERY OF PIEZOMETERS A & B

A - North

B - South

Time	Elapsed Time (min)	Depth to Water (feet) from floor elevation 70' A	B	Remarks
4/5/79				Dewatering Wells
10:00	0	6.24	7.00	1 & 9 off
10:10	10	6.21	6.97	
10:30	30	6.07	6.86	
12:05	125	5.77	6.60	2 & 8 off
12:35	155	5.70	6.58	
14:45	285	5.60	6.52	4 & 6 off
17:08	428	5.33	6.42	
18:30	510	5.29	6.39	
19:20	560	5.26	6.36	
20:10	610	5.23	6.38	
23:20	800	5.21	6.35	
5/5/79				
00:30	870	5.13	6.21	
03:05	1025	4.96	6.10	
04:35	1115	4.93	6.10	
06:40	1240	4.91	5.80	
10:35	1475	4.91	5.79	
16:45	1950	4.91	5.65	
18:50	2075	4.89	5.82	
22:30	2295	4.87	5.99	
6/5/79				
04:10	2735	4.85	6.00	
08:10	2975	4.80	6.04	
12:10	3215	4.73	5.99	
16:10	3455	4.66	5.89	
20:10	3695	4.65	5.89	
24:00	3825	4.67	5.88	
7/5/79				
03:00	4005	4.67	----	
06:15	4200	4.67	5.95	
12:30	4575	4.73	----	3, 5, 7 & 10 off
13:50	4655	4.63	5.95	
23:45	5250	4.53	5.92	

RECOVERY OF PIEZOMETERS A & B

(continued)

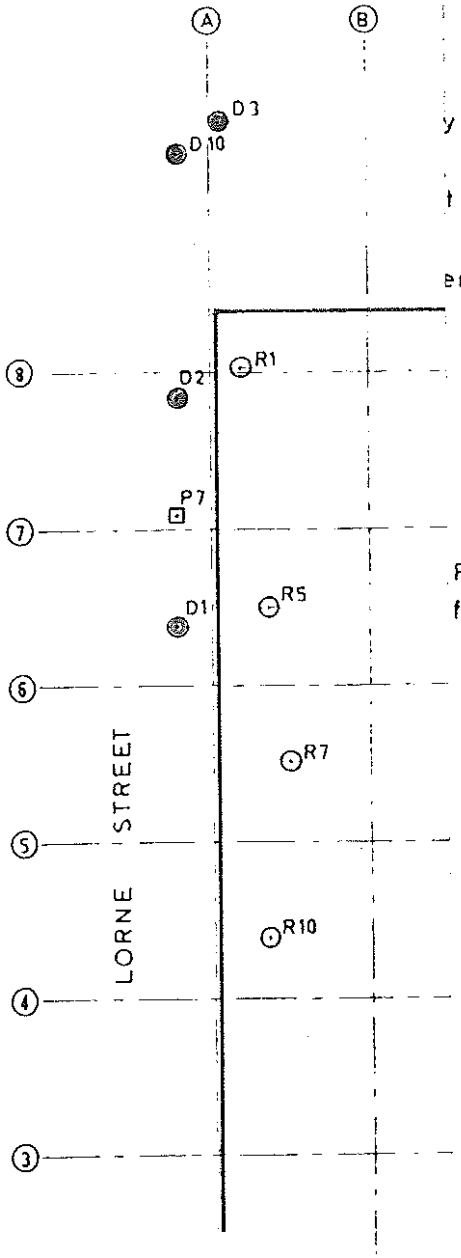
Time	Elapsed Time (min)	Depth to Water (feet) from floor elevation 70' A	B	Remarks
8/5/79				
07:00	5685	4.53	5.93	
23:30	6675	4.45	5.89	
9/5/79				
06:30	7095	4.44	5.92	
22/5/79				
08:00	25,905	4.17	6.00	
29/5/79				
12:00	36,225	4.20	6.00	
12/6/79				
13:00	56,445	4.13	5.77	
18/6/79				
08:45	64,830	4.08	5.83	

RECOVERY OF PIEZOMETERS A & B

(continued)

Elapsed Time (minutes since system off)	* t/t'	Depth to Water (feet) below slab top at elevation 70' A	B
10	37,297	6.21	6.97
30	12,433	6.07	6.86
125	2,985	5.77	6.60
155	2,407	5.70	6.58
285	1,310	5.60	6.52
610	612	5.23	6.38
870	430	5.13	6.21
1,025	365	4.96	6.10
1,475	254	4.91	5.79
2,075	180	4.89	5.82
2,975	126	4.80	6.04
4,005	94	4.67	5.88
7,095	54	4.44	5.92
25,905	15	4.17	6.00
36,225	11	4.20	6.00
56,449	8	4.13	5.77
64,830	6.8	4.08	5.83

* t - Total time since system started - on for 372,960 minutes.
t' - Time since system off.



y dewatering well

t relief well

er

P7, P8, PA and PB are to be retained for monitoring purposes.

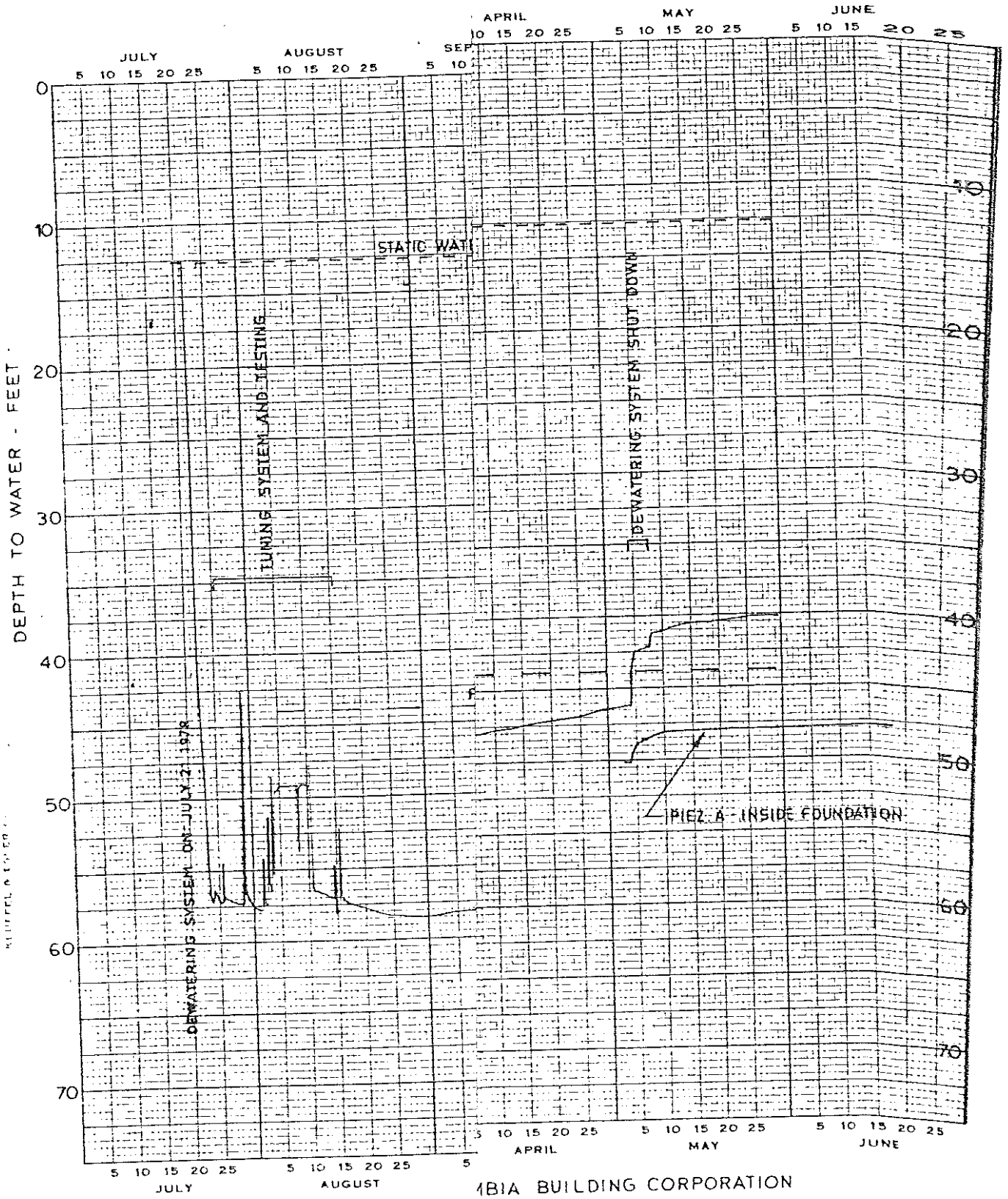
ILUMBIA BUILDING CORPORATION
MINSTER COURTHOUSE

TION PLAN AT ELEVATION 68 FEET

DMAN & ASSOCIATES LTD.
GEOTECHNICAL LTD.

HWR 78-082

DWG. 1

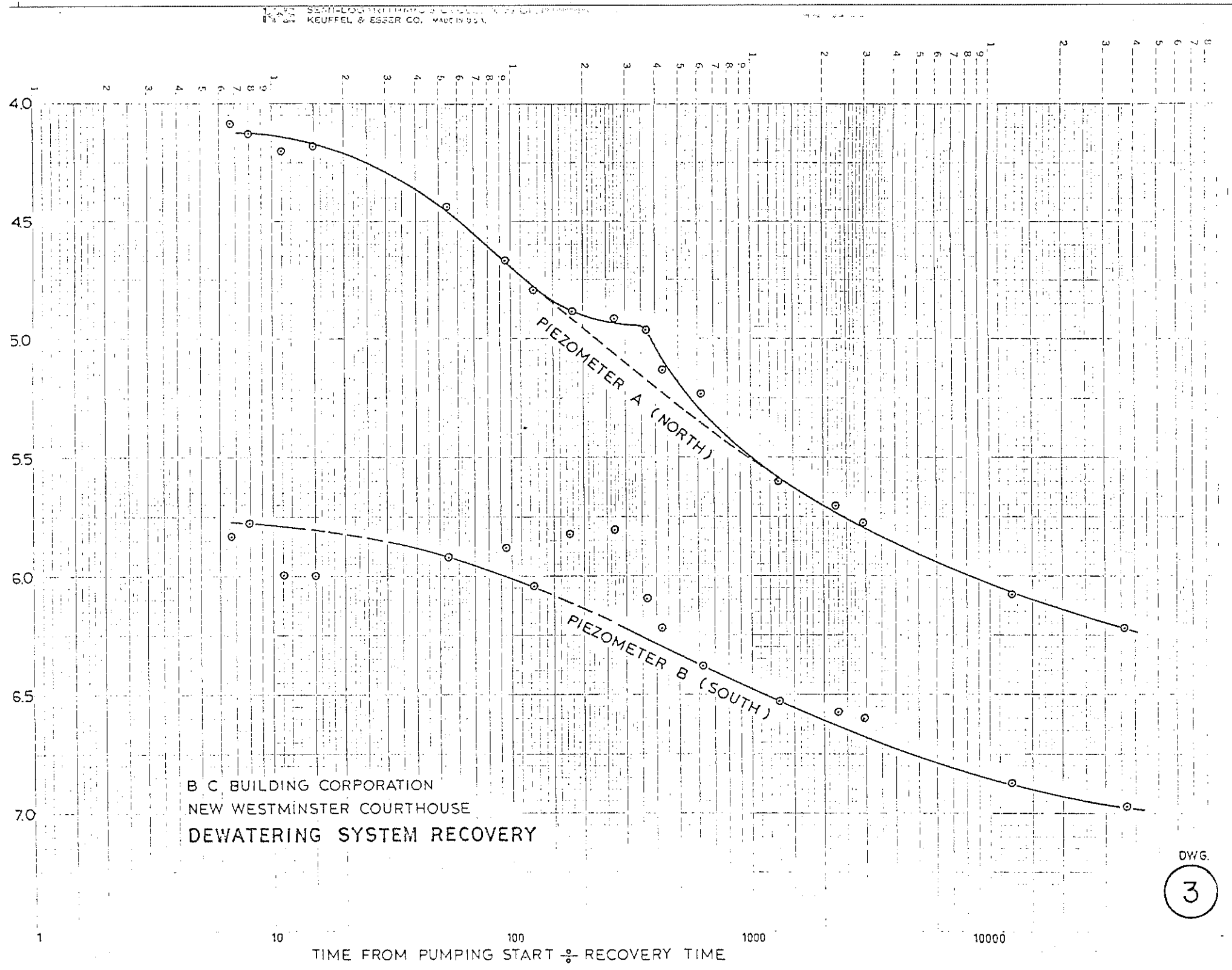


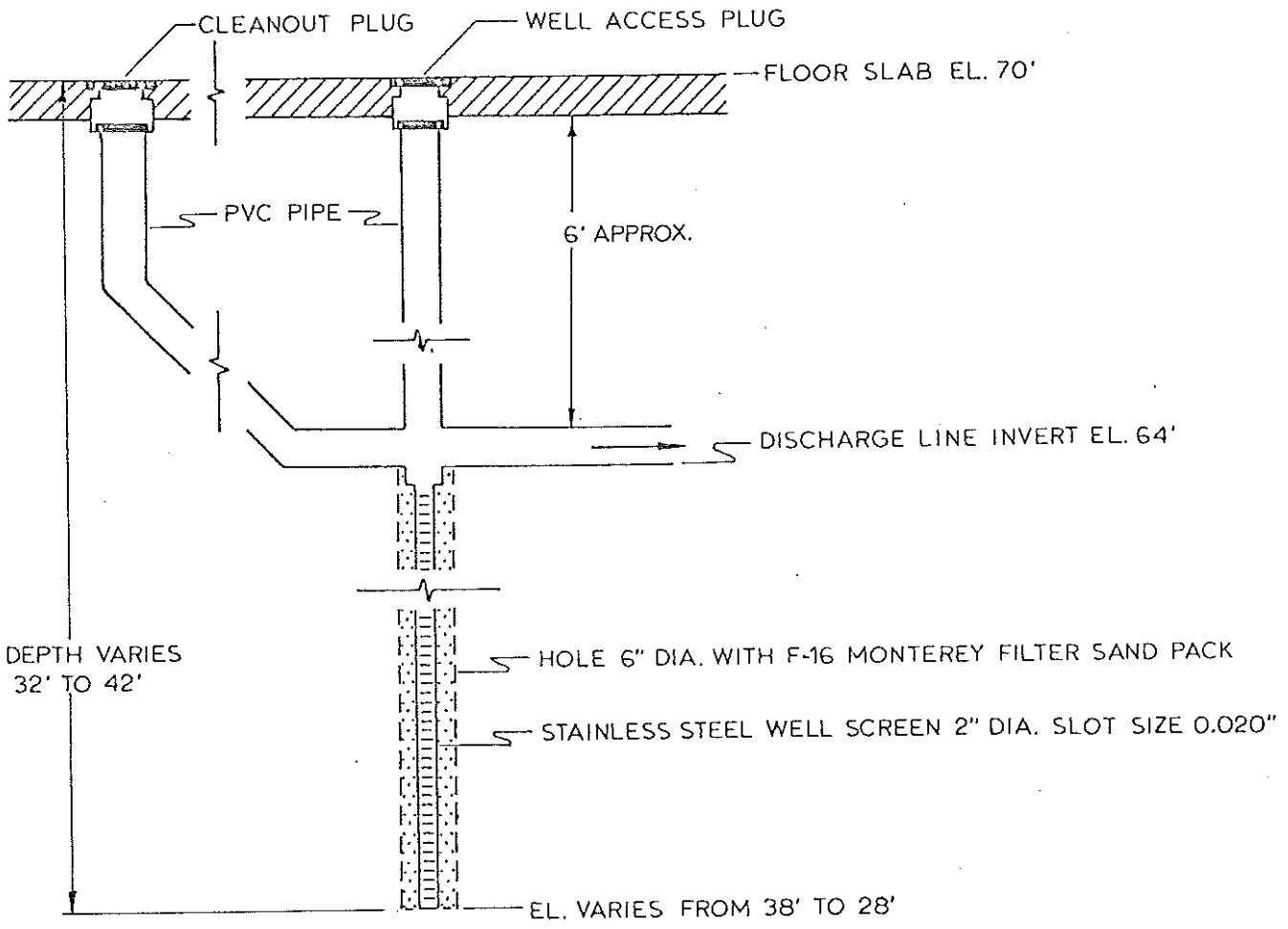
47 2813
1 YEAR BY DAYS
X 150 DIVISION

1978

MBIA BUILDING CORPORATION
STER COURTHOUSE
L RECORD PIEZOMETER 8
N & ASSOCIATES LTD.
ITECHNICAL LTD.

DWG
2


KEUFFEL & ESSER CO.
4.0
4.5
5.0
5.5
6.0
6.5
7.0
PIEZOMETER A (NORTH)
PIEZOMETER B (SOUTH)
B C BUILDING CORPORATION
NEW WESTMINSTER COURTHOUSE
DEWATERING SYSTEM RECOVERY
DWG.
3
1
10
100
1000
10000
TIME FROM PUMPING START ÷ RECOVERY TIME



BRITISH COLUMBIA BUILDING CORPORATION

NEW WESTMINSTER COURTHOUSE

RELIEF WELL DETAILS

JUNE 1979

78 082

HWR

BROWN, ERDMAN & ASSOCIATES LTD.

MACLEOD GEOTECHNICAL LTD.

DWG. 4

BROWN, ERDMAN & ASSOCIATES LTD.
1401 BEWICKE AVENUE, NORTH VANCOUVER, BRITISH COLUMBIA V7M 3C7
TELEPHONE 986-1557

78-082

August 31st, 1978

Macleod Geotechnical Ltd.
1451 Marine Drive
West Vancouver, B. C.
V7T 1B8

Attention: Mr. Graeme Macleod, P. Eng.

Subject: New Westminster Courthouse
B.C.B.C. Project No. 0309
Permanent Relief Wells

Dear Sirs:

Attached please find the results of a short chemical analysis run on samples of water collected from the temporary dewatering system. This was done to check whether or not the water would either encrust or corrode the Permanent Relief Wells.

You will note that the water has an almost neutral pH and a low iron and salt content. We therefore do not believe that the water will adversely affect the Relief Wells.

Yours truly

BROWN, ERDMAN & ASSOCIATES LTD.

W. L. BROWN, P. Eng.

WLB/sa
Encls:
cc: Poole Construction Ltd.
Attn: Messrs. Fraser & Langevin
cc: Pacific Water Wells (1969) Ltd.
Attn: Mr. R. F. McNichol

can test ltd.
1650 PANDORA STREET, VANCOUVER, B.C. V5L 1L6 • TELEPHONE 254-7278 • TELEX 04-54210

Report On Analysis of Water Samples File No. 6814C

Report No.

Reported to Brown, Erdman & Assoc. Date August 30, 1978

107 - 1401 Bewicke Avenue

North Vancouver, B.C.

We have tested the samples of water submitted by you on August 11, 1978 and report as follows:

SAMPLE IDENTIFICATION:

The samples were submitted in plastic bottles labelled:

#4 New Westminster Court House West Side Wells	1,2,3,4,5	10/8/78
#5 New Westminster Court House East Side	6,7,8,9	10/8/78

METHOD OF TESTING:

The analysis was carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater (14th Edition)" published by the American Public Health Association, 1975.

RESULTS OF TESTING

(on following page)

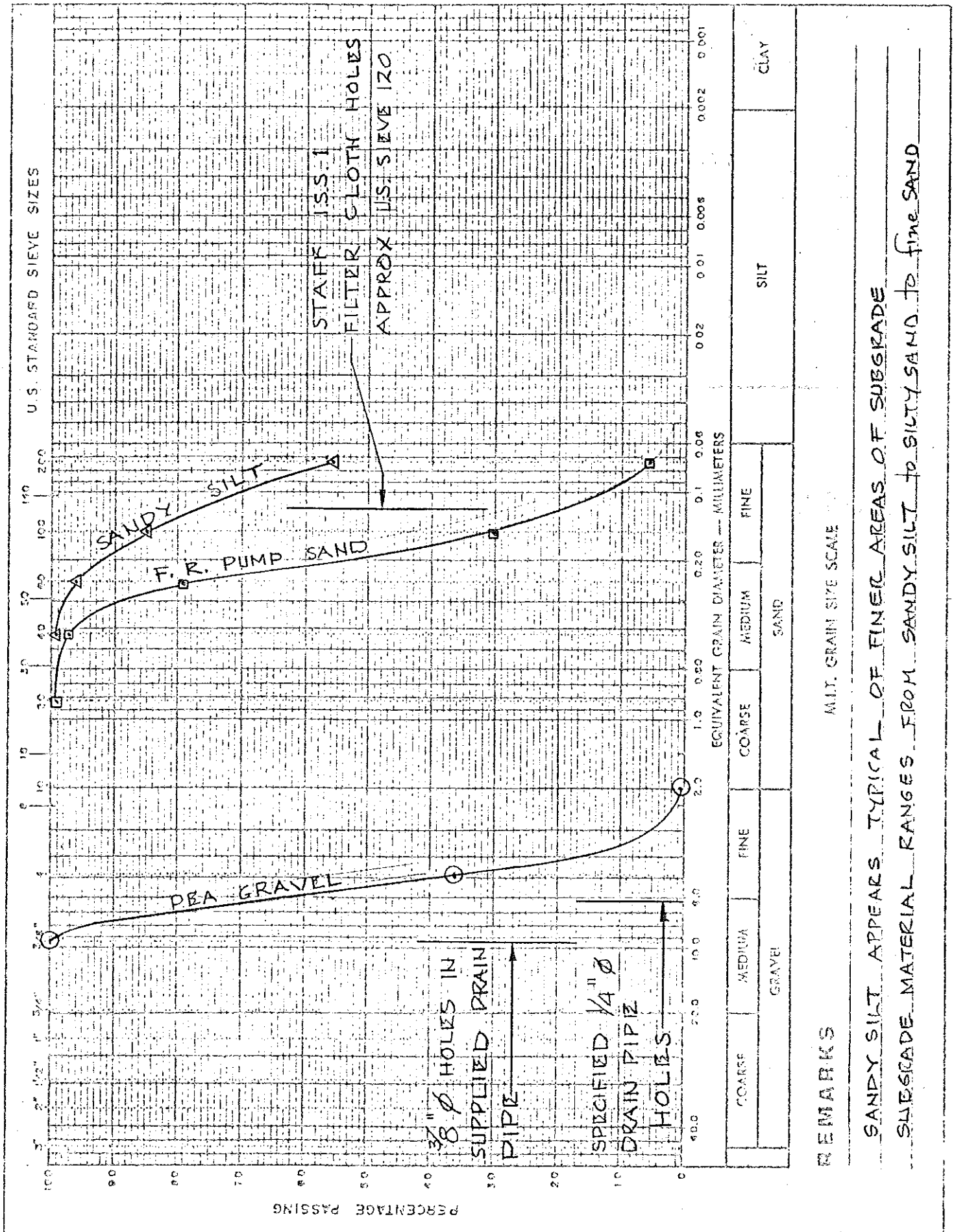
...ST LTD.

File No. 6814C
Page No. 2
Date: August 30, 1978

RESULTS OF TESTING:

TEST	SAMPLE IDENTIFICATION		
		#4	#5
Physical Tests			
Ph		7.70	7.50
Conductance (umhos/cm)		-	-
Color (CU)		-	-
Turbidity (JTU)		-	-
Total Dissolved Solids (mg/L)		-	-
Total Suspended Solids (mg/L)		-	-
Dissolved Anions (mg/L)			
Alkalinity		-	-
Bicarbonate HCO_3		-	-
Carbonate CO_3		-	-
Chloride Cl		-	-
Sulfate SO_4		-	-
Nitrate N		-	-
Phosphate PO_4		-	-
Fluoride F		-	-
Dissolved Cations (mg/L)			
Total Hardness $CaCO_3$		79.1	84.5
Calcium Ca		17.8	18.3
Magnesium Mg		8.45	9.45
Sodium Na		8.49	8.75
Potassium K		2.70	2.81
Iron Fe		0.21	0.31
Manganese Mn		-	-
Copper Cu		-	-
Cadmium Cd		-	-
Lead Pb		-	-
Zinc Zn		-	-
Others (mg/L)			
Total Iron Fe		-	-
Total Manganese Mn		-	-

L = Less than; mg/L = milligrams per liter (or parts per million for drinking water)



MACLEOD GEOTECHNICAL LTD.

NEW WESTMINSTER COURTHOUSE	GRAIN SIZE ANALYSIS UNDERDRAINAGE MATERIAL	By: E N	Date: DEC '78
		Job: B42	Dwg: B42-L1

STAFF INDUSTRIES (1973) LTD.

STAFF I.S.S. TYPE 1 ~~AND TYPE 2~~ - WOVEN FILTER FABRIC PROPERTIES:

Staff I.S.S. Polypropylene Filter Fabrics have been designed to prevent passage of fine particles between adjacent soil zones, however, allowing fluid to pass through. The material consists of polypropylene tape woven into a fabric, together with a nylon needle punched facing. Weaving of the polypropylene enables the fabric to have a constant pore size under varying head conditions. Staff I.S.S. Woven Filter Fabrics are made of chemically resistant polypropylene and are unaffected by prolonged exposure to fresh and salt water, are rot proof, and are chemically resistant to acidic or alkali soil conditions.

I.S.S. TYPE 1 - PHYSICAL DATA

PHYSICAL	PROPERTIES		TEST METHOD
Grab Tensile (lbs.)			
Warp	109	181	ASTM D1682
Fill	(66)	> 100	
Elongation %			
Warp	24.4		ASTM D1682
Fill	22.1		
Puncture Strength (lbs.)	62		
Mullen Burst Strength (lbs.)	277	>	ASTM D1682
Weight (oz./sq. yd.)	4.52		ASTM 1910
Air Permeability (cfm./s.f.)	45		ASTM D737
U.S. Sieve Size	Finer than U.S. 120		CE 1310
Water Permeability	(ML/Sec./CM^2)	(Gal./Min./Ft.^{2})	U.S. Fed. Test 191
6 CM. Head	Nil	Nil	(Suter Hydrostatic Tester 4.5" diameter cylinder)
10 CM. Head	0.6	0.8	
30 CM. Head	1.8	2.7	
50 CM. Head	2.6	3.9	