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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 59

PART B, BORE-HOLES AT GRAND FALLS, N. B. ACROSS A BURIED CHANNEL OF ANCESTRAL SAINT JOHN RIVER

BY

HULBERT A. LEE

OTTAWA

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INTRODUCTION

Test borings in Grand Falls, New Brunswick were made in 1961 across the buried channel of the ancestral St. John River. The channel is known to have passed through Grand Falls along the topographic low between Main and Terrace Streets approximately following the same course as that of the Canadian Pacific Railway. It is a direct connection across the short neck of land separating the upper basin of the St. John River from the lower basin. Approximate boundaries of the old channel were first plotted on well-boring information supplied by Mr. Eugene Theriault of Grand Falls, and by the positions of basement walls that showed large cracks and offsets through major settling. Three test holes were placed to give a cross-section of this channel.

Results of test drilling have been released as they became available. Topical Report No. 33[1] gave the results obtained from the first 2 bore-holes, BH-1 and BH-4. Drilling of the third and last bore-hole, BH-2, is now completed and the cores have been examined.

The present report gives the results of drilling in BH-2, and also gives information now available on the groundwater chemistry of BH-1. As previously mentioned in topical report No. 33, some laws of nature governing in-filling of the old channel have been discerned and the information is released now on the last bore-hole as an immediate

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1 Lee, H.A. (1961): Bore-holes at Grand Falls, N.B. across a buried channel of ancestral St. John River; Geol. Surv., Canada, Topical Report No. 33.

service to officials of the Town of Grand Falls, and to the New Brunswick Hydro-Electric Power Commission, and to private industry that is immediately concerned, so that this information can be applied to the needs of man in terms of groundwater supply and foundation conditions. The scientific aspects will not be known until extensive laboratory studies of the cores have been completed and continuous water level measurements in an observation well have been recorded over an extended period of time. These results will be included in a comprehensive Geological Survey of Canada publication of the St. John River valley.

PURPOSE[1]

Test borings were carried out in the buried channel for 4 main reasons: first, to check in one continuous section the succession of soil strata established earlier both from the examination of many small cuts, and as a natural consequence of the history of the region as determined by the writer's geologic mapping.

Second, to prove the existence of the buried channel and establish its shape. Then to find the reason why the St. John River was deflected from its earlier course in the western part of the Town and was forced to carve out a new channel through bedrock. Numerous guesses

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1 This section of the report is reproduced from Geol. Surv., Canada, Topical Report No. 33.

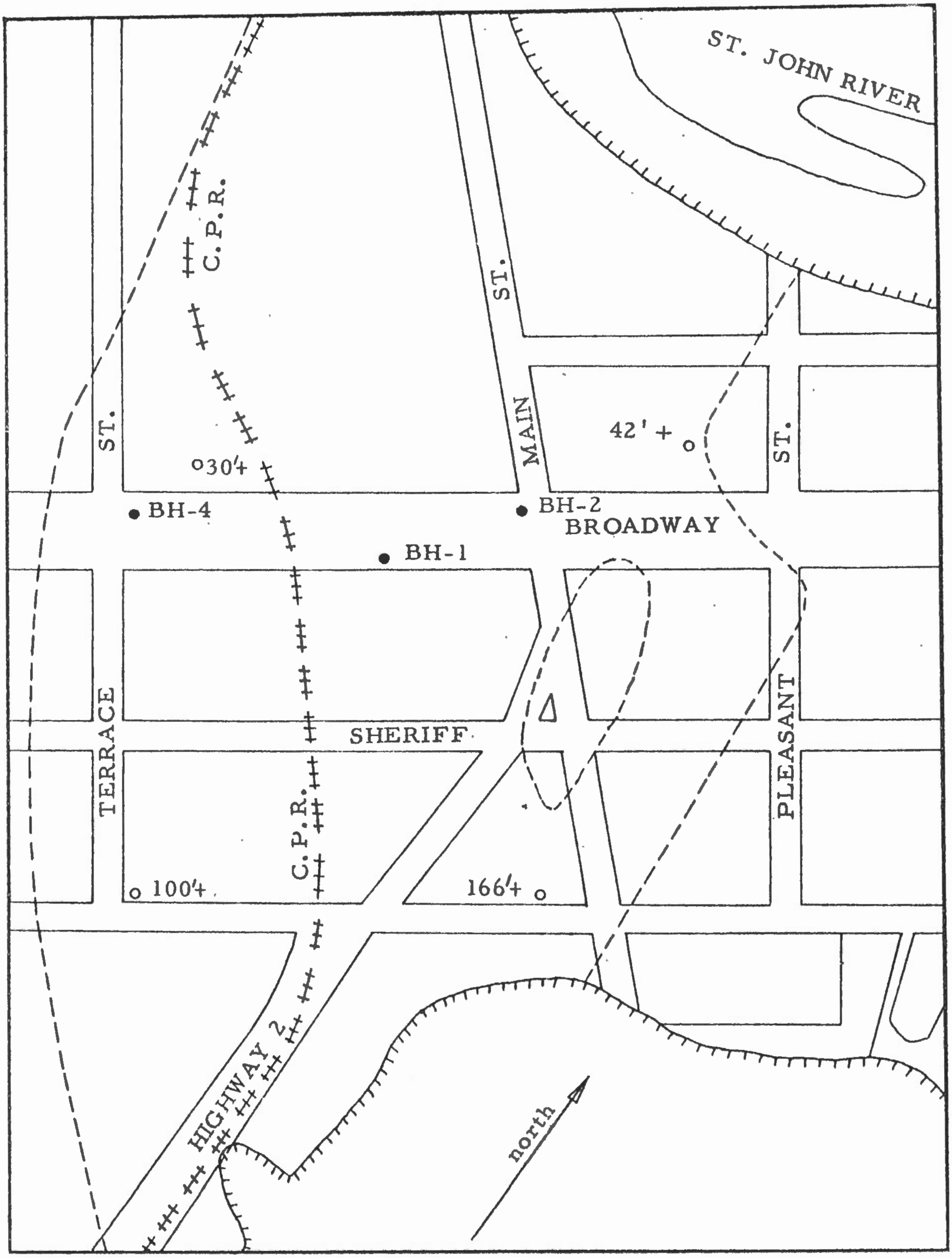

Fig. 1. —LOCATION OF BORE HOLES, GRAND FALLS, N.B.
(Approximate limits of deep buried channel are shown by dashed lines.)
Scale: 1 inch = 300 feet

Note: Holes drilled in 1961 .... ●
Holes drilled before 1961 .... o

have occurred in the literature as early as 1885.

Third, to establish a continuous reading water-level recorder on one well, BH-1, in the buried channel so as to compare over an extended period the water level in the upper basin of the river (the recharge area) with the water level in the buried channel and to see whether a direct connection exists.

Fourth, to provide basic data on the nature and succession of materials encountered, on the groundwater conditions and strengths of the soils, which will serve as pilot information for groundwater or foundation conditions; two problems of some importance along this buried channel. This topical report gives the results bearing on this fourth reason.

ACKNOWLEDGMENTS

Excellent co-operation was had with the Soil Testing Laboratories section of the Canada Department of Public Works who carried out the borings and strength tests; with the Council and others of the town of Grand Falls for their permission to drill on the town right-of-way and for their willingness to help on practical problems as they developed; and with the New Brunswick Electric Power Commission for their offer of aid in correlating water levels between the upper river basin and an observation well in the buried channel. The working together of these bodies is highly appreciated and most commendable.

REGIONAL GEOLOGY[1]

The regional geology around Grand Falls is shown on Geological Survey of Canada, Map 24-1959 (in pocket of Topical Report No. 33) and in the descriptive notes at the side of the map. Lee reports in the descriptive notes as follows: "The most important glacial feature in the area is the Grand Falls end moraine with associated alluvial fans. (These pass through Grand Falls and are best developed in the hills one mile northwest of Grand Falls C.N.R. station.) The Grand Falls moraine marks an ice-frontal position of a major lobe of the Wisconsin ice-sheet in the St. John River valley. This is indicated by the abundance of erratics such as granite gneiss, derived from north of the St. Lawrence River, and of fossiliferous limestone, similar to outcrops in the Temiscouata Lake region of Quebec. A readvance of the ice-margin is indicated by glacial till overlying proglacial outwash at Parents (47° 09' N; 67° 55' W)."

"Glacial rivers from the melting ice-sheet eroded and washed the glacial till south of the moraine, and deposited outwash chiefly in river valleys. When the ice-margin finally withdrew northward the gravel and glacial till of the moraine blocked the channel of the former St. John River, and gave rise to a lake northwest of the town of Grand Falls. This former lake has been named Glacial Lake Madawaska. The great thickness of

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1 This section of the report is reproduced from Geol. Surv., Canada, Topical Report No. 33.

outwash gravels, deposited by the glacial rivers south of Grand Falls, became terraced as the ancestral St. John River eroded its way laterally and downward to its present position. The numerous and prominent terraces along this part of the river mark the old slip-off slopes. A buried river channel passes under the western part of the town of Grand Falls and is nearly filled by about 170 feet of glacial drift. The post-glacial course of the river, is through a bedrock gorge that is still actively migrating headwards. Large potholes have been formed in the bedrock floor of the gorge. Well-rounded and nearly spherical cobbles can still be seen in some of the potholes. These cobbles and some sand were the abrading agents used by swirling waters to carve the 'wells in the rocks'."

Stratigraphy of the area is given from the surface down as:

(a) alluvial gravel, sand, and silt, or peat, or marl, or slope-wash colluvium, (geologic map-unit 7)

(b) peat, dated 10,200 years

(c) varved clay, buff silt, and black clay containing wood and manganese and giving off an odour of H_2S (geologic map-unit 6B)

(d) supra-till glacio-fluvial gravel and sand (geologic map-unit 2A)

(e) grey gravelly clay till, impervious (geologic map-unit 2A)

(f) sub-till gravel and sand (geologic map-unit 5A, 5B)

(g) non glacial gravels (not exposed on geologic map 24-1959)

(h) bedrock (Palaeozoic)

Knowledge of this stratigraphy not only lends much to the evaluation of the geologic history, but provides a framework to which the engineer and geologist can correlate bore-hole records for site foundation and groundwater investigations. Many of the units are lenticular in shape and their presence or absence can only be determined at any one place by bore-holes.

GROUNDWATER

The results tabulated in this report and the conditions stated below apply directly only to the individual bore-holes described, and a professional engineer should be consulted for extension or application of this formation.

Availability of Groundwater in BH-2

Bore-hole 2 was drilled on the north side of Broadway just west of Main Street. Water level was recorded in the hole each morning before drilling began. Hence the water level represents the aquifer open to the bottom of the drill casing at any one time. Higher impervious layers would be fairly effectively sealed off by the casing, and the lower aquifers would still not be penetrated.

Table I shows the water levels measured in the drill casing at different depths of penetration and lists the type of formation penetrated.

Table I

Water Levels In BH-2

Date	Water Level (below ground surface)	Depth of Hole	Formation* Penetrated
April 28, 1961	13'	35.9'	Unit 6B, clay, silt
April 29,	21'	61.0'	)
May 1,	26'	91.8'	) Unit 5A, gravels
May 2,	52'	101.8'(Aban.)	) and sands
Hole offset about 50 ft.			
May 3, 1961	11'	71.7'	)
May 4,	34'	101.9'	) Unit 5A, gravels
May 5,	60'	128.8'	) and sands
May 6,	67'	138.5'	)
May 8,	77'	169.7'	)
May 9,	76'	179.1'	) Non-glacial
May 10,	76'	189.0'	) gravels
May 11,	80' (steady)	189.0'	)
May 16,	45' (casing into bedrock)	201.0'	Bedrock

*Remarks: Formation unit refers to Geol. Surv., Canada, Map 24-1959 enclosed in Topical Report No. 33.

Several aquifers were encountered while drilling and they will now be described. The uppermost is composed of sands and gravels of unit 7, which is sealed by a basement of slightly pervious clay and impermeable (glacial) till. The first water level measurement shown in Table I was not taken until after the depth of hole and bottom of casing had passed below this aquifer. The aquifer is about 20 feet thick and is probably not of large areal extent, hence is relatively unimportant for a large commercial supply of groundwater.

The next lower aquifer, below the basement of till, is in gravels and sands of unit 5A. Table I shows that with increased penetration of the drill hole and casing into this formation, water levels continually dropped. This probably reflects a decreased transmissibility of groundwater vertically throughout the formation due to the presence of silt which is known from mechanical analyses of samples collected from this formation. During the short period of observation, just overnight, the water in the casing did not reach a stationary static level.

A third aquifer for consideration is in the unit of non-glacial gravels occurring between depths of 140 to 200 feet. This aquifer is composed of relatively uniform gravel-sand-silt mixture throughout its thickness. Table I shows that the groundwater level remained fairly constant at a depth of about 80 feet during penetration of the well through this formation (May 8th to May 11th) and this is the depth to the groundwater table shown on Figure 2.

Fractured limestone and slaty limestone form the lowest aquifer drilled. Table I shows that when the well casing entered bedrock, the water level in the casing rose to about 45 feet below ground surface.

CHEMISTRY OF GROUNDWATER IN BH-1

A chemical analysis of the groundwater is now available from a bore-hole drilled earlier, BH-1. Two aquifers separated by clay and impervious till have been described for BH-1 (Topical Report No. 33). The sample of groundwater analyzed for its chemical constituents was taken from the lower aquifer.

Sampling procedure included lowering a corked metal tube, sealed at one end, into the casing down to a depth of 60 feet below ground surface. The cork was then jerked free and the tube permitted to fill with groundwater.

Results of a chemical analysis on the sample collected in this manner are given in Table II.

The chemical analysis shows the water sample to be high in iron and manganese. This can in part be due to contamination from the overlying clays which are known to be enriched in these elements, and may have been transferred from the upper aquifer through water seepage. It is desirable to analyze a sample of water collected at a greater depth after pumping.

TABLE II

CHEMICAL ANALYSIS OF GROUNDWATER IN BH-1

Constituents		Parts per Million	
Hardness as	(Total	 370	
$CaCO_3$	(Non-carbonate	.... 34.4	
Calcium	(Ca)	 123	.....(6.15)*
Mangnesium	(Mg)	 15	.....(1.24)
Sodium	(Na)	.... 26.5	(1.15)
Potassium	(K)	.... 18.8	(0.48)
Iron (Fe)	Total	.... 29.	
	Dissolved	.... Trace	
Aluminum	(Al)	.... ----	
Manganese (Mn)	Total	.... 4.5	(0.146)
	Dissolved	.... 4.0	
Carbonate	(CO_3)	.... 0.0	(0)
Bicarbonate	(HCO_3)	 409	(6.70)
Sulphate	(SO_4)	.... 40.4	(0.84)
Chloride	(Cl)	 49	(1.37)
Nitrate	(NO_3)	.... Insuff. water	
Silica	(SiO_2)	 17	
Sum of constituents		 490	
Saturation index at test temperature		.... +1.3	
Stability index at test temperature		.... 5.6	
% sodium		 12	

Remarks * Values in brackets are epm
Date of sampling August 26, 1961.
Analysis by J.F.J. Thomas, Industrial Waters Section, Mines Branch, Canada, Dept. of Mines and Technical Surveys.

DESCRIPTIVE LOGS OF BORE-HOLES

Positions of BH-2 and the first two bore-holes drilled, BH-1 and BH-4, are shown on Figure 1, also included on this figure is information on other known bore-holes in the vicinity.

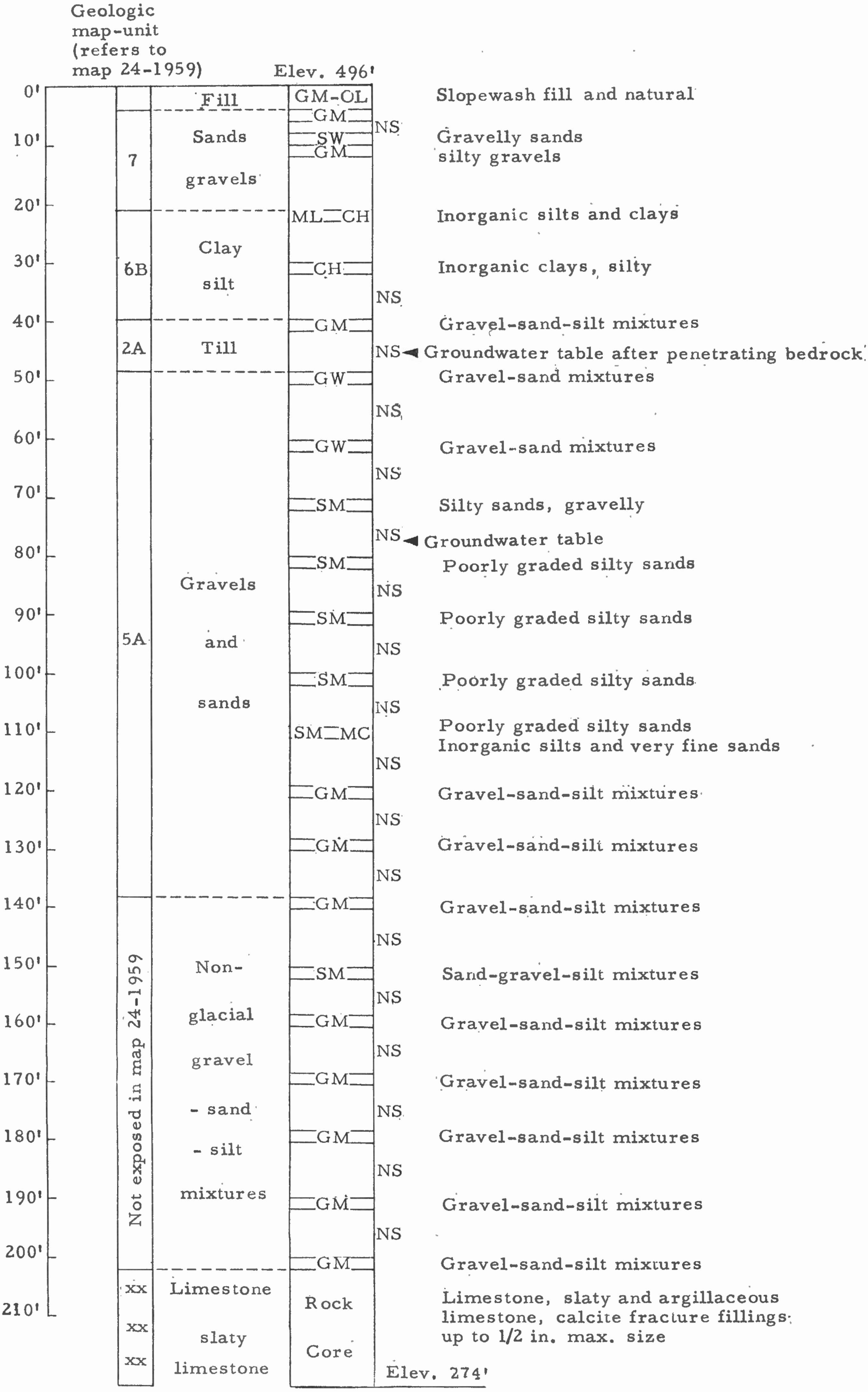
Graphic log of BH-2 is shown as Figure 2 and should be used in cross-reference to the descriptive logs that follow. The soils are described according to the "Unified Soil Classification System" (Corps of Engineers, U.S. Army, Technical Memorandum, No. 3-357, 1953).

Fig. 2

GRAPHIC LOGS

BH-2

Date 27/4/61



DESCRIPTIONS OF MATERIALS SAMPLED IN BH-2

Sample No.	Description of Sample	Depth of Sample	Progressive Depth
1 to 2	Fill and natural; grey-brown, gravel-sand-silt mixtures, some fragments of wood, particles up to 3-in. maximum size fissile slate, subrounded, about 10% non plastic fines, loosely compacted, moist in place, fill or unit 7 on geologic map (GM and OL).	0-4'	4'
3	Gravel-sand-silt mixtures; grey-brown some yellow oxides, particles up to 5-in. maximum size, hard granite and fissile siltstones, proportions 43% gravel, 42% sands, and 17% non plastic fines, medium compacted, moist in place, non calcareous, unit 7 on geologic map (GM)	4'-6'	6'
5	Gravelly sands; grey, particles up to 1 1/4-in. maximum size, hard sandstone and soft and hard slates, subrounded, proportions 37% gravel, 61% sand, and 2% non plastic fines, loose compacted, non calcareous, unit 7 on geologic map (SW)	8'-10'	10'
6	Silty gravels; grey, particles up to 4-in. maximum size, hard to fissile slate and sandstone, subrounded and angular, about 20% non plastic fines, partly cemented, non calcareous, unit 7 on geologic map (GM)	10'-12'	12'

Sample No.	Description of Sample	Depth of Sample	Progressive Depth
7	Inorganic silts and clays; dark grey, slightly plastic fines, calcareous, clay laminations about 1/8-in. thick at 1-in. intervals, unit 6B Lake Madawaska sediments on geologic map (ML and CH)	21'-23'	23'
8	Inorganic clays, silty; dark grey, scattered stones numerous, up to $1\frac{1}{2}$-in. maximum size, proportions 4% gravel, 24% sands, 53% silts and 19% clay, high plasticity, unit 6B on geologic map, moist in place, calcareous, (CH)	30'-32'	32'
9	Gravel-sand-silt mixtures; light grey, particles up to 3-in. maximum size, hard to fissile slate and sandstone, subrounded, proportions 52% gravel, 28% sands, and 20% non plastic fines, very compact, calcareous, glacial till, unit 2A on geologic map (GM)	40'-42'	42'
10	Gravel-sand mixtures; light grey, particles up to 4-in. maximum size, hard to fissile sandstone and slate, subrounded, proportions 79% gravel, 20% sands, and 1% non plastic fines, unit 5A on geologic map (GW)	48'-50'	50'
11	Gravel-sand mixtures; light grey, particles up to 2-in. maximum size, hard to fissile sandstone and slate, subrounded, proportions 53% gravel, 43% sands, and 4% non plastic fines, unit 5A on geologic map (GW)	60'-62'	62'

Sample No.	Description of Sample	Depth of Sample	Progressive Depth
12	Silty sands, gravelly; brownish grey, particles up to 3-in. maximum size, hard to fissile sandstone, quartz and slate, proportions 31% gravel, 55% sands, and 14% non plastic fines, moderate compaction, calcareous, unit 2A or 5A on geologic map (SM)	70'-72'	72'
13	Poorly-graded silty sands; brownish grey, fine size, occasional particle about 2-in. maximum size, proportions 68% sand, 32% non plastic fines, wet in place, calcareous, unit 5A on geologic map (SM)	80'-82'	82'
14-15	Poorly-graded silty sands; brownish to dark grey, fine size, wet in place, calcareous, unit 5A on geologic map (SM)	90'-92' 100'-102'	102'
16	Poorly-graded silty sands; buff grey, fine to medium size, wet in place, calcareous, unit 5A on geologic map (SM) Inorganic silts and very fine sands; whitish grey, occasional particle about ½-in. size, proportions 30% sand and 70% fines, slight plasticity, calcareous, unit 5A on geologic map (ML)	110'-112'	112'
17-18	Gravel-sand-silt mixtures; dark grey, particles up to 2½-in. maximum size, hard to fissile limestone, slate, sandstone, siltstone, about 10% non plastic fines, calcareous, unit 5A on geologic map (GM)	120'-122' 130'-132'	132'

Sample No.	Description of Sample	Depth of Sample	Progressive Depth
19	Gravel-sand-silt mixtures; dark grey, particles up to 1-in. maximum size, hard to moderate green fine-grained quartzites and yellow weathered limestones, proportions 59% gravels, 35% sands, and 6% non plastic fines, non-glacial gravels not exposed on geologic map (GM)	140'-142'	142'
20	Sand-gravel-silt mixtures; dark grey with yellow mottling, particles up to 3-in. maximum size, hard slates, proportions 39% gravel, 50% sands, and 11% non plastic fines, calcareous, non-glacial gravels not exposed on geologic map (SM)	150'-152'	152'
21-22	Gravel-sand-silt mixtures; dark grey, particles up to 1-in. maximum size, proportions 45% gravels, 37% sands, and 8% non plastic fines, calcareous, non-glacial gravels not exposed on geologic map (GM)	160'-162' 170'-172'	172'
23	Gravel-sand-silt mixtures; grey with yellow mottling, particles up to 2-in. maximum size, hard limestone, quartzite, slate, about 10% non plastic fines, calcareous, non-glacial gravels not exposed on geologic map (GM)	180'-182'	182'
24	Gravel-sand-silt mixtures; buff with yellow mottling, particles up to 1-in. maximum size, proportions 44% gravels, 41% sands, and 15% non plastic fines, semi-consolidated, calcareous, non-glacial gravels not exposed on geologic map (GM)	190'-192'	192'

Sample No.	Description of Sample	Depth of Sample	Progressive Depth
25	Gravel-sand-silt mixtures; grey particles up to 2-in. maximum size, moderately hard limestone, slate, and sandstone, proportions 45% gravel, 40% sands, and 15% non plastic fines, semi-consolidated, calcareous, non-glacial gravels not exposed on geologic map (GM)	200'-202'	202'
Rock core	Limestone, banded limestone, slaty and argillaceous limestone; dark grey, fine grained with calcite fracture fillings from a fraction of an inch up to 4-in. Rock at depth 202'.	212'-222'	222'