RM. 110 - LAB. BLDG.

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. M. R. Ernesaks,
Functional Planning Engineer,
Eastern Region,
KINGSTON, Ontario.

From: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg.

Attention:

Date: February 24, 1970

Our File Ref.

In reply to MAR - 6 1970

Subject:

PRELIMINARY FOUNDATION REPORT
For
Structure Crossings of Revised
Hwy. #17 (North and South Alignments)
Eastern Limits of McNab Twp. to
Haley Station, County of Renfrew
District No. 9 (Ottawa)
W.J. 69-F-73 -- W.P. 5-67

Attached, we are forwarding to you our Preliminary Foundation Investigation Report pertaining to the above sites. Presented in this report are the results of the investigation, together with our general comments pertaining to the stability of the approaches and recommendations regarding structure foundations at various crossings.

We believe that the information contained therein, will prove adequate for your immediate use. Should you require further data, or clarification of the report, please do not hesitate to contact this Office.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. M. R. Ernesaks (2)
B. R. Davis
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Foundations Files
Gen. Files

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1. INTRODUCTION:

The Foundation Section was requested to carry out a preliminary foundation investigation at the possible structure locations to be situated within the aforementioned portion of Hwy. #17. Two possible alignments, designated as the North and South Alignments, were investigated. Specifically, the following crossings are included in this report:

i) Bonnechère River.

ii) C.N.R. and C.P.R. overheads.

iii) A number of township and country road crossings; and

iv) A number of natural valley crossings.

The request for this foundation investigation was contained in a memo from Mr. B. B. Khojajian, Project Planning Engineer, Functional Planning Section, Eastern Region, dated August 5, 1969. An investigation was subsequently carried out by this Section to determine the subsoil, bedrock and groundwater conditions at the structure sites.

This report presents information on the subsoil, bedrock and groundwater conditions encountered at the proposed crossings, along both alignments. Included are recommendations pertaining to foundation design, as well as the stability and settlement of the fills specified.

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2. DESCRIPTION OF THE SITE AND GEOLOGY:

The portions of the alternate North and South alignments under consideration, are located immediately north and south of the Town of Renfrew, respectively. They are bounded by the boundary between the Townships of Horton and McNab on the east, Haley Station on the west, County Rd. #4 on the north, and the Township of Admanston on the south.

The relief in the area is very rolling and rugged; along the North alignment the terrain varies randomly between elevation 410 and 650, being highest west of the Bonnechère River. The Bonnechère River is deeply incised into the topography in this area. The river valley is very tortuous, being approximately 2,500 feet wide from crest to crest, with the water level being at about elevation 274 - i.e., about 140 to 150 feet below the high ground. The slope of the banks varies from 2:1 to 5:1, being typically of the order of 3:1.

Along the Southern alignment the rolling terrain varies from elevation 390 to 580, being highest east of the Bonnechère River. In this area the Bonnechère River valley is approximately 550 feet wide from crest to crest, with the water level being at about elevation 365 - i.e., about 15 to 20 feet below the valley banks. The slope of the banks varies from 2-1/2:1 to 4:1.

The major portion of the alignments being considered is in non-built-up areas, which are cultivated and being used for farming purposes.

In Renfrew County there are prominent east-west trending scarps (fault zones) on both sides of a valley which encompasses the alignments being investigated. The southwesterly one, lying south of Calabogie Lake and Clear Lake, is known as the St. Patrick fault, while on the northeastern side the Coulonge fault separates the valley from the Laurentian Plateau. Thus a block, 35 miles in width, has been downdropped, forming a depression which is geologically known as the "Ottawa-Bonnechère" graben. The Ottawa River is located within this downdropped block. Within it are

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2. DESCRIPTION OF THE SITE AND GEOLOGY: (cont'd.) ...

many minor breaks and disconformities.

The majority of this valley is situated in the physiographic region known as the "Ottawa Valley Clay Plains". Here extensive clay deposits are interrupted by ridges of rock and sand. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies markedly in thickness over the region; in some localized areas it is known to extend to depths in excess of 200 feet. The clay is generally underlain by glacial till and/or interglacial sand and gravel deposits, followed in turn by bedrock of Precambrian Age.

In the vicinity of Haley Station, northwest of the Town of Renfrew, the valley is interrupted by one of the aforementioned rock ridges. Here the steep scarp dips gently away in a northeast direction, under a cover of sand and gravel. This region is physiographically known as the "Muskrat Lake Ridges".

The drainage in the area is provided by the Bonnechere River.

3. FIELD AND LABORATORY WORK:

Ten boreholes were put down at each of the alternate alignments (North and South). Seven additional borings were put down along a possible revision of the Northern alignment, in the vicinity of the Bonnechere River. The borings were advanced by using a conventional diamond drill rig adapted for soil sampling purposes.

Samples of the overburden were obtained, at specified intervals, in a 2" O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. In the cohesive portion of the overburden, the testing programme was supplemented by taking 2" I.D. Shelby tubes, which were manually pushed into the soil.

3. FIELD AND LABORATORY WORK: (cont'd.) ...

In addition, field vane tests were carried out, where possible, to determine the undrained shear strength of the clay stratum. Bedrock was proven in 7 of the boreholes by obtaining AXT size rock core samples.

Groundwater level observations were carried out, during the period of the investigation, in the open boreholes. Artesian groundwater conditions were encountered at Site #4B. Following completion of the drilling operations, the artesian flow was stopped by sealing the borehole with bentonite.

The soil conditions, encountered at the boring locations, are presented on the Record of Borelog sheets. The location and elevation of the various boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to a geodetic datum. Boring locations and elevations, for the alternate alignments, are shown on Drawings No. 69-F-73A and B. The estimated stratigraphical profile, along the North and South alignments, is shown on Drawing No. 69-F-73A and B, respectively.

All the samples were subjected to a careful visual examination in the field, and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following engineering properties of the overburden:

Bulk Densities
Natural Water Contents
Atterberg Limits
Grain-Size Distributions
Undrained Shear Strengths
Consolidation Characteristics

The results of this testing are plotted on the Record of Borelog sheets and summarized on Figures 1 to 7, inclusive, contained in Appendix I of this report.

4. SUBSOIL AND BEDROCK CONDITIONS:

4.1) General:

The extent and composition of the overburden, within the area under investigation, varies markedly. The predominant deposits, however, are composed of cohesive strata.

Along the southern alignment, cohesive strata, the overall thickness of which vary from 12 feet to 239 feet, were generally encountered. These strata can be sub-divided into two sheets. The upper sheet is composed of a firm to stiff highly compressible clay to silty clay followed by a stiff to very stiff silty clay to clayey silt. The cohesive strata are underlain by a thin (5 to 15 feet thick) competent glacial till deposit.

Along the more northerly of the alignments under investigation the upper compressible cohesive sheet is not present. The lower sheet was, however, encountered; in this area its thickness ranges from 3 to 132 feet. West of the Bonnechere River the cohesive deposit is overlain by up to 19 feet of compact to dense sand and gravel. Further, it is generally underlain by a compact to dense granular deposit and/or a competent glacial till.

The aforementioned stratigraphical sequences are underlain by Precambrian bedrock, the surface elevation of which is quite variable, due to the geologically complex history of this area (refer to Section #2).

The stratigraphy encountered in the borings is plotted on the Record of Borelog sheets. Stratigraphical profiles, along the alternate alignments (North and South), have been inferred from this data and plotted on Drawings No's 69-P-73A and B, respectively. The subsoil and bedrock, encountered from ground surface downward, is presented in the following sub-sections.

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.2) Sand and Gravel - Surficial Deposit:

The area west of the Bonnechère River, along the Northern alignment, is surficially covered with a deposit composed of compact to dense ('N' values between 12 and 52 blows/ft.) silty sand to sand and gravel. The thickness of the granular material varies from 10 to 19 feet. At B.H. #2A a trace of organic matter is present in the upper 6 feet. Grain-size distribution curves, obtained on representative samples of the deposit, are plotted on Figure #1 in Appendix I.

4.3) Cohesive Strata:

Over the majority of the area, cohesive strata are present either: i) at a shallow depth below ground surface, or ii) immediately beneath the surficial deposit encountered along the Northern alignment (Sub-section 4.2)).

Along the Southern alignment the strata can be sub-divided into two distinct sheets. The upper sheet is composed of a relatively compressible clay to silty clay; this sheet is no doubt of marine origin. This, in turn, is followed by a sheet composed of silty clay to clayey silt. It is inferred that this lower sheet may have a markedly different depositional origin from that of the overlying sheet. The overall thickness of the cohesive strata, along this alignment, varies from 12 to 239 feet, being most extensive west of the Bonnechère River. The upper 7 to 21 feet of the strata has been subjected to desiccation, thus forming a 'crust'.

Along the Northern alignment the upper compressible cohesive sheet is not present. The lower sheet, however, was encountered at the majority of the boring locations (exception - Sites #1A and #6A where the cohesive strata were not encountered). The thickness of the sheet, along this alignment, varies from 8 to 132 feet.

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.3) Cohesive Strata: (cont'd.) ...

Numerous seams and layers of sand and silt are present throughout the strata, particularly in the lower cohesive sheet. The thickness of such seams generally ranges from 1/2 to 5 inches; at some random locations, however, granular layers up to 5 feet thick are present (Sites #5A and #5B). Grain-size distribution curves were obtained on samples from both the cohesive sheets. A relative comparison of the variation in gradation can be made by referring to the envelopes plotted on Figure #2.

The engineering properties, of that portion of the cohesive subsoil, encountered below the upper desiccated 'crust', are summarized in the following table:

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.3) Cohesive Strata: (cont'd.) ...

			Clay to Silty Clay (Upper Sheet along Southern Alignment)	Silty Clay to Clayey Silt - (Lower Sheet)
			Range (Average)	Range (Average)
Bulk Density (p.c.f.)	(γ)		99 - 117 (105)	109 - 129 (118)
Liquid Limit (%)	(W_L)		39 - 64 (56)	21 - 50 (32)
Plastic Limit (%)	(W_P)		19 - 27 (23)	15 - 25 (20)
Natural Water Content (%)	(W)		41 - 75 (60)	22 - 45 (23)
Liquidity Index	(I_L)		0.6 - 2.0 (1.3)	0.6 - 3.0 (1.1)
Compressibility Characteristics				
Void Ratio	(e_o)	5 Tests	1.2 - 1.9 (1.6)	2 Tests: 1.0 - 1.1
Compression Index	(C_c)	5 Tests	0.7 - 2.4 (1.7)	2 Tests: 0.4 - 0.7
Degree of Preconsolidation ($P_c - P_o$)	(P_c) (p.s.f.)	5 Tests	1,100 to 2,000	2 Tests: 6,000 to 10,000
Undrained Shear Strengths (p.s.f.)	(C_u)			
In-situ Field Vane Tests			700 - >2,000	1,000 - >2,000
Laboratory Tests			600 - >2,000	900 - >2,000

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.3) Cohesive Strata: (cont'd.) ...

The Atterberg limit test results, given in the table, are also summarized on the Plasticity Chart, Figure #5. The testing indicates that the clay, located in the zone designated as the upper sheet (encountered along the Southern alignment), is inorganic with a plasticity in the intermediate to high range. The cohesive stratum below this zone is of low to intermediate plasticity. The corresponding liquidity indices, of both sheets, are consistently greater than 1.0.

The field and laboratory undrained shear strength results are plotted on the Record of Borelog sheets. The results indicate that the consistency of the upper clay, where it is most extensive, varies typically from firm, immediately below the 'crust', to very stiff with depth, while the underlying silty clay to clayey silt is in the stiff to very stiff range. The consistency of the upper desiccated zone ranges from very stiff to hard.

The consolidation characteristics of the cohesive strata were determined by carrying out a series of laboratory consolidation tests, the results of which are shown as Void Ratio vs. Pressure plots, on Figures #6 and #7. Referring to the table, it can be seen that the clay in the upper sheet i) is much less preconsolidated in excess of existing overburden pressure, and ii) is more compressible, than that in the lower sheet.

4.4) Sand to Sandy Gravel:

At the majority of the boring locations, put down along the Northern alignment, a compact to very dense ('N' values typically between 12 and greater than 100 blows/ft.) granular deposit was encountered beneath the cohesive stratum. The predominant composition of this material is a sand with a trace of

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.4) Sand to Sandy Gravel: (cont'd.) ...

silt and gravel. At a few locations, however, namely, at Sites #5A, #5B and #6A, the deposit is coarser in nature, ranging from a gravelly sand to a sandy gravel. The deposit was not fully penetrated at any of the boring locations where it was encountered; it was, however, proven to extend for thicknesses up to 50 feet (Site #5A - B.H. #2). In areas where the deposit is most extensive the lower portion is often quite bouldery, the boulders being up to 8 inches in size. Grain-size distribution testing was carried out on samples, obtained from this material, using 2" O.D. sampling equipment. The results are plotted in envelope form on Figure #3.

4.5) Glacial Till:

The granular deposits and/or the cohesive strata, are generally underlain by a glacial till. This deposit was fully penetrated in only two borings; at these locations the thickness was of the order of 4 to 5 feet. Elsewhere, however, it was found to extend for a depth of up to 24 feet (Site #7A). The matrix of the till is generally cohesive - i.e., a clayey silt binding sand and gravel. There are random zones within the deposit where the matrix is basically granular (silt, sand and gravel); such areas are non-cohesive in nature. The range in the grain-size gradation of this subsoil is indicated by the curves plotted on Figure #4. Where the deposit is most extensive the lower portion is often quite bouldery (refer to Sub-section 4.4).

Atterberg limit tests, carried out on the more cohesive portions of the glacial till, are plotted on the Plasticity Chart, Figure #5. The results of this testing indicate that such areas are representative of an inorganic clayey silt of low plasticity. The natural moisture content is consistently less than the plastic limit.

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4. SUBSOIL AND BEDROCK CONDITIONS: (cont'd.) ...

4.5) Glacial Till: (cont'd.) ...

Based on the results of the standard penetration resistance testing carried out within the deposit, it is estimated that the consistency of the cohesive portions is in the very stiff to hard range. The relative density of the non-cohesive portions is considered to be dense to very dense.

4.6) Bedrock:

Bedrock was proven at 7 of the boring locations by obtaining between 3 and 8 feet of AXT size rock core samples. The surface of the bedrock was found to vary from elevation 206 (Site #5B - B.H. #2) to 525 (Site #7). In general, the surface of the bedrock increases in elevation moving in an easterly direction from the Bonnechère River. West of the river, except in the vicinity of Haley Station, where a bedrock ridge exists, the bedrock is at a much lower elevation (particularly along the Southern alignment).

The bedrock, which is of Precambrian Age, is quite variable in composition. It ranges from granite gneiss - (metamorphic origin) to crystalline dolomite (sedimentary origin). In general, bedrock is sound throughout; however, some signs of fracturing and jointing were observed in the upper 2 to 3 feet at a few of the boring locations.

5. GROUNDWATER CONDITIONS:

Groundwater level observations have been carried out during the period of the investigation by recording the water level in the open borings. The observations are recorded on the borelog sheets and summarized on Drawings No. 69-F-73A and B. The results of the measurements indicate that the piezometric groundwater level, within the overburden deposits, generally varies between 2 and 15 feet below existing ground surface. An

5. GROUNDWATER CONDITIONS: (cont'd.) ...

exception to this pattern occurs in areas where there are ridges (composed of basically granular materials) extending above the surrounding terrain, such as in the vicinity of Haley Station. In such areas it was not uncommon for the groundwater level to be up to 40 feet below the elevation at the borehole locations. Along the Northern alignment the groundwater level varies from as high as elevation 569 (Site #2A) to as low as elevation 269, in the vicinity of the Bonnechère River - i.e., there is a natural hydrostatic gradient towards the river. This was found to be the case along the Southern alignment as well. This indicates that the Bonnechère River does, in fact, control the drainage in the immediate area under investigation.

At Site #4B, located between the North and South alignments, an artesian condition was encountered. When the casing was advanced through the upper cohesive deposit down into a lower zone containing numerous granular layers, the water rose instantaneously in the casing. This condition was encountered at about elevation 442; the groundwater stabilized itself at elevation 520 - i.e., some 8 feet above the existing ground level. It is inferred that these relatively pervious granular layers are acting as a confined aquifer; such layers are probably being charged with groundwater from the surrounding terrain, which is at a higher elevation.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to realign Hwy. #17 between the eastern limits of McNab Township westerly to Haley Station; this section will form the Renfrew By-pass network. The proposed highway will incorporate 4 lanes with a wide median. Two possible alignments are being considered: namely, the Northern and Southern alignments. A possible minor revision of the Northern alignment, in the vicinity of the Bonnechère River, is also a possibility.

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6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.1) General: (cont'd.) ...

A number of structure crossings are proposed along the alternate alignments. In addition, natural valleys will have to be bridged. At this stage the profile grades of these crossings, as well as other pertinent design data, have not been finalized. Preliminary drawings and profiles (unnumbered) have, however, been provided by the Functional Planning Section (Eastern Region).

The subsoil, bedrock and groundwater conditions, encountered along the Northern and Southern alignments, are shown on Drawings No. 69-P-73A and B, respectively.

The alternate alignments will be discussed in the following sub-sections:

6.2) Southern Alignment

6.3) Northern Alignment

6.4) Possible Minor Revision - Northern Alignment

A comparison of the merits of the alternate alignments will be given in Section #7 of this report.

6.2) Southern Alignment:

6.2.1) Structure Crossings -

Structures will be required at strategically located sites along revised Hwy. #17. Specifically,

i) Underpass Structures - Sites #1, 7, 8 & 9,

ii) An Overpass Structure - Site #6,

iii) C.N.R. or C.P.R. Overhead Structures - Sites #2, 4 & 5, and

iv) Bonnechere River Structure Crossing - Site #3.

The location of these structures is shown on Drawing No. 69-P-73B.

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6. DISCUSSION AND RECOMMENDATIONS:

6.2) Southern Alignment: (cont'd.) ...

6.2.1) Structure Crossings - (cont'd.) ...

Preliminary design data, recommendations pertaining to the structures, as well as the stability and settlement considerations for the approach fills, will be presented in the tables which immediately follow:

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FOUNDATION RECOMMENDATIONS - SITE #1

Underpass Structure - Revised Hwy. #17 and Existing Hwy. #17

Approx. Exist. Ground Elev. Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - Longitudinal Direction - 21') (Height - Transverse Direction - 23')	
431 ± (433 ±)	Clay to Clayey Silt - Firm to Stiff - (104') Underlain by Glacial Till - (Hard)	Abutments End-bearing piles driven to practical refusal within glacial till - estimated tip elev. 323. - designed for max. capacity of the pile section chosen. Piers Spread footings, founded at about elev. 428, in the upper desiccated zone of the cohesive strata, allowable bearing pressure up to 2.0 t.s.f. Alternatively, end-bearing piles driven to practical refusal within glacial till, as above. Note: Differential settlements between the pile-supported abutments and adjacent pier spread footings are anticipated.	Stability Fills up to 23' (with 2:1 slopes) will be stable (F.S. ≧ 1.3). Probable Consolidation Settlement 23' fill (2:1 slopes) - 10" to 12" in 2½ years. 18" to 21" in 15 years - (max.)	Consideration should be given to: i) constructing the approach fills prior to construction of the structure foundations in order to minimize the post-construction settlements. ii) Surcharging the approaches in order to accelerate the settlements prior to construction of the structure elements.

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FOUNDATION RECOMMENDATIONS - SITE #2

C.P.R. Overhead Structure - At Revised Hwy. #17

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 29')	
405 ± (434.5 ±)	Clay to Silty Clay (Firm to Stiff) - (239') Underlain by Glacial Till (Very Stiff to Hard)	Piers and Abutments End-bearing piles driven to bedrock. - designed for max. capacity of the pile section chosen at pier locations. Note: Capacity of piles supporting abutments may have to be reduced in order to allow for negative skin frictional effects.	Stability 1) Fills up to 26' (with 2:1 slopes) will be stable 2) Fills in excess of 26' will require berms in all directions. - mid-height berm of 25' will be required for a fill height of 29' (F.S. ≧ 1.3) Probable Consolidation Settlement 29' fill with a berm length of 25' at mid-height - 3 to 3.5 ft. in 3 years. 6 to 6.5 ft. in 20 years. (max.)	Consideration should be given to constructing the approach fills prior to construction of the structure foundations, in order to minimize the post-construction settlements. Consideration should also be given to lengthening the structure - (multi-span), thus limiting the heights of fill. This would: i) reduce the magnitude of the settlements; and ii) Minimize post-construction maintenance costs.

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FOUNDATION RECOMMENDATIONS - SITE #3

Revised Hwy. #17 Crossing of the Bonnechère River

Approx. Height of River Banks Above River Level - (Approx. Width of Valley)	Predominant Overburden Strata Approx. Thickness (ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Approx. Height of Fill - 16')	
15' to 20' (550')	Clay to Silty Clay (Firm to Stiff) - (80 ft.) Glacial Till (Very Stiff) - (3.5') Underlain by Bedrock - (Sound)	Piers and Abutments End-bearing piles driven to bedrock. - designed for max. capacity of the pile section chosen. Note: Dewatering scheme will be required for those piers placed within river channel.	Stability No stability problems for the proposed 16' high fills (with 2:1 slopes). Probable Consolidation Settlement 16' Fill (with 2:1 slopes) 10" to 12" in 2 years. 18" to 24" in 10 years. (max.)	Consideration should be given to: i) constructing the approach fills prior to construction of the structure foundations, in order to minimiz the post-construction settlements;and ii) surcharging the approaches in order to accelerate the settlements prior to construction of the structure elements.

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FOUNDATION RECOMMENDATIONS - SITE #4

C.N.R. Overhead Structure - At Revised Hwy. #17

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height in Vicinity of Structure - 28' - Max. Height along East Approach - 34')	
395 ± (423 ±)	Silty Clay - (Firm to Stiff) - (67') Underlain by Glacial Till - (Very Dense)	Abutments End-bearing piles driven to practical refusal within glacial till - estimated tip elev. 320 - designed for max. capacity of the pile section chosen. Piers Spread footings founded at about elev. 390, in the upper desiccated zone of the cohesive strata, allowable bearing pressure up to 2.0 t.s.f. Alternatively, end-bearing piles driven to practical refusal within glacial till, as above.	Stability 1) In vicinity of structure - Fills up to 28' (with 2:1 slopes) will be stable. 2) Along East Approach - Fills up to 31' will be stable. - Fills in excess of 31' will require berms in all directions. Mid-height berm of 15' will be required for a fill of 34'. Probable Consolidation Settlement 1) In immediate vicinity of structure - - 28' fill (with 2:1 slopes) 12" to 14" in 2 years. 24" to 30" in 10 years.- (max.) 2) Along East Approach - -34' fill with mid-height berm of 15 ft. 17" to 20" in 12 Months. 34" to 38" in 6 Years. (max.)	Consideration should be given to: i) constructing the approach fill prior to construction of the structure foundations, in order to minimize the post-construction settlements; and ii) surcharging the approaches in order to accelerate the settlements prior to construction of the structure elements.

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FOUNDATION RECOMMENDATIONS - SITE #5

C.P.R. Overhead Structure - At Revised Hwy. #17

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height in Vicinity of Structure - 28')	
407 ± (435 ±)	Silty Clay (Firm to Stiff) - (35')	Abutments End-bearing piles driven to bedrock. - designed for max. capacity of the pile section chosen. Piers Spread footings founded at about elev. 405, in the upper desiccated zone of the cohesvie strata, allowable bearing pressure of 2.5 t.s.f. Note: Differential settlement between the pile-supported abutments and adjacent pier spread footings should be about 1 to 1-1/2 inches.	Stability 28' high fills (with 2:1 slopes) will be stable (F.S. ≥ 1.3). Probable Consolidation Settlement 7" to 9" in 1 year. 14" to 18" in 6 years. (max.)	Consideration should be given to constructing the approach fills prior to construction of the structure foundations, in order to minimiz the post-con-struction settlements.

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FOUNDATION RECOMMENDATIONS - SITE #6

Overpass Structure - Revised Hwy. #17 and Existing Hwy. #132

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 20' to 21')	
410 ± (430 ±)	Silty Clay (Desiccated - Very Stiff) - (12') Underlain by Bedrock - (Sound)	Piers Spread footings founded within the desiccated cohesive stratum, or on bedrock, allowable bearing values of 2.5 t.s.f., and up to 20.0 t.s.f., respectively. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. in design. Alternatively, end-bearing piles driven to bedrock - designed for max. capacity of the pile section chosen.	Stability 20' to 21' Fills (with 2:1 slopes) will be stable. Probable Consolidation Settlement 21' Fills (with 2:1 slopes). 2" to 3" (max.) (recompression) - will take place during or immediately following the construction period.	--

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FOUNDATION RECOMMENDATIONS - SITE #7

Underpass Structure - Revised Hwy. #17 and Existing Twp. Road

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - Longitudinal Direction - 20') (Height - Transverse Direction - 24')	
530 ± (534 ±)	Glacial Till - (Very Dense) - (5') Underlain by Bedrock - (Sound)	Piers Spread footings founded within the glacial till, or on bedrock - allowable bearing values, 5.0 t.s.f. and up to 20.0 t.s.f., respectively. Abutments 'Perched' within the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. in design.	Stability No stability problems anticipated. Estimated Settlement Negligible.	--

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FOUNDATION RECOMMENDATIONS - SITE #8

Underpass Structure - Revised Hwy. #17 and County Rd. #2

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height- Longitudinal Direction - 20') (Height- Transverse Direction - 22')	
485 ± (487 ±)	Silty Clay to Clayey Silt - (Very Stiff to Stiff) - (15') Underlain by Glacial Till (Very Dense)	Piers Spread footings founded at as high an elev. as possible in the desiccated portion of the cohesive stratum, allowable bearing value of 2.5 t.s.f. Alternatively, end-bearing piles driven to practical refusal within the glacial till - estimated tip elev. 450 to 455 - - designed for the max. capacity of the pile section chosen. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Alternatively, on end-bearing piles driven to practical refusal within the glacial till, as above.	Stability No stability problems are anticipated. Estimated Settlement 2" to 3" max. - (recompression) - will take place during or immediately following the construction period.	--

cont'd. ... 23

FOUNDATION RECOMMENDATIONS - SITE #9

Underpass Structure - Revised Hwy. #17 and Twp. Road

Approx. Exist. Ground Elev. (Approx. Grade of Revised Hwy. #17)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - Longitudinal Direction - 20') (Height - Transverse Direction - 22')	
494 ± (496 ±)	Silty Clay to Clayey Silt - (Very Stiff) - (17') Underlain by Glacial Till (Compact to Dense)	Piers Spread footings founded at as high as elev. as possible within the desiccated portion of the cohesive stratum - allowable bearing pressure up to 2.5 t.s.f. Alternatively, footings carried down to the glacial till stratum, allowable bearing value 3.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.5 t.s.f. Alternatively, on end-bearing piles driven to practical refusal within the glacial till - estimated tip elev. 471 - designed for the max. capacity of the pile section chosen.	Stability No stability problems anticipated. Estimated Settlement 2" to 3" max. - (recompression) - will take place during or immediately following the construction period.	If abutments are constructed on compacted granular materi consideration should be given to preloading the approaches for a period of 3 to 6 months, prior to construction of the structure foundations.

cont'd. ... 24

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Southern Alignment: (cont'd.) ...

6.2.2) Natural Valley Crossings -

If this alignment is adopted, revised Hwy. #17 will cross a number of natural valleys, which are underlain by compressible cohesive subsoil. It is proposed to construct earth fills within the confines of the valley banks. The drainage course, along the valley floor, would be maintained by having culverts located within the fill.

The feasibility of employing earth fills will be dependent on the following co-related factors:

i) the depth of the valley - i.e., the height of fill required; and

ii) the overall thickness and strength-compressibility characteristics of the subsoil.

Stability and settlement analyses were carried out, based on the contemplated height of fill at the most critical of the crossings; these are presented in the following table:

RECOMMENDATIONS - NATURAL VALLEY CROSSINGS

Location of Valley	Est. Thickness of Clay beneath Valley Floor - (Consistency)	-- EMBANKMENT --			Remarks
		Height of Fill Proposed - (2:1 Slopes)	Stability (Length of Mid-height Berm Required)	Consolidation Settlements (Max. under Centre-Line)	
Approx. 1,050 ft. West of Site #1	75 ft. (firm to stiff)	36 ft. (approx.)	30 ft.	18" to 20" in 2½ years 34" to 38" in 15 years (max.)	Recommendations were based on the data obtained from the B.H. at Site #1
Approx. 1,400 ft. East of Site #1	200 ± ft. (firm to stiff)	38 ft. (approx.)	70 ft.	4 to 4.5 ft. in 3 yrs. 7 to 7.5 ft. in 20 yrs.	Recommendations were based on the data obtained from the B.H.'s at Sites #1 and #2
Approx. 2,550 ft. East of Site #2	200 ± ft. (firm to stiff)	20 ft. (approx.)	Nil	12" to 14" in 3 years 24" to 26" in 15 years (max.)	Recommendations were based on the data obtained from the B.H.'s at Sites #2 and #3
County Rd. #2 Site #8N.	20 ft. (Very Stiff)	35 ft. (approx.)	Nil	3" to 5" (Recompression) Will take place during or immediately following the construction period.	Refer to B.H. at Site 8N.

cont'd. ... 26

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Southern Alignment: (cont'd.) ...

6.2.2) Natural Valley Crossings: (cont'd.) ...

Based on the stability and settlement computations, carried out at the respective valley crossings, the following conclusions can be drawn:

a) The cohesive foundation subsoil, located beneath the valleys east and west of Site #1 and east of Site #2, will undergo excessive settlement if surcharged to the magnitude proposed. If consolidation settlements of the order of magnitude predicted cannot be tolerated on revised Hwy. #17, the above mentioned valleys could be bridged by multi-span structures. The structure foundations should be supported on end-bearing piles driven to practical refusal within the competent glacial till deposit. The length of piles required, as well as stability and settlement considerations for the approach fills required, will be determined during the final investigation phase.

b) At the remaining crossing (Site #3N) it would be possible to construct an earth fill with an associated culvert. If a flexible type of culvert is proposed, sufficient camber should be provided to accommodate the anticipated differential settlements.

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6 DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.3) Northern Alignment:

6.3.1) Structure Crossings -

Structures will be required along revised Hwy. #17. Specifically,

i) Underpass Structures - Sites #1A, 2A, 3A, 4A, 6A and 8A

ii) A C.P. and C.N.R. Overhead Structure - Sites #7A and 9A, respectively, and

iii) Bonnechère River Structure Crossing - Site #5A.

The location of these structures is shown on Drawing No. 69-F-73A.

Recommendations, pertaining to the structures, are presented in the tables to follow.

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FOUNDATION RECOMMENDATIONS - SITE #1A

Underpass Structure - Revised #17 and Hwy. #653 (Haley Station)

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
534 ±	Sand and Gravel (Compact to Very Dense) - (56') Underlain by Bedrock - (Sound)	Piers Spread footings founded within the upper granular deposit, allowable bearing pressure up to 4.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems are anticipated at this site. Estimated Settlement 1 to 2 inches (max.) - will take place during or immediately following the construction period.	

cont'd. ... 29

FOUNDATION RECOMMENDATIONS - SITE #2A

Underpass Structure - Revised Hwy. #17 and County Rd. No. 4

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
574 ±	Sand (Loose to Dense) - (19') Clay to Silty Clay (Stiff to Very Stiff) - (75') Underlain by Sand (Compact to Dense)	Piers Spread footings founded at or below elev. 569, in the upper granular stratum, allowable bearing value up to 2.5 t.s.f. Abutments 'Perched' on spread footings, in the approach fills within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems for fills 22' in height (with 2:1 side slopes). Estimated Settlement 1" to 2" (max.) - will take place during or immediately following the construction period.	A dewatering scheme may be required if footings are situated at or below the groundwater level

cont'd. ... 30

FOUNDATION RECOMMENDATIONS - SITE #3A (Alternate to Site #2A)

Underpass Structure - Revised Hwy. #17 and Co. Rd. #4

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
567 ±	Sand (Compact) - (10') Clay to Silty Clay (Very Stiff) - (75') Underlain by Glacial Till (Dense)	Piers Spread footings founded within the upper sand deposit, allowable bearing value of 2.0 t.s.f. Alternatively, end-bearing piles driven to refusal in the glacial till stratum. Abutments 'Perched' on spread footings, in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f.	Stability No stability problems for fills 22' in height (with 2:1 side slopes) Estimated Settlement 2" to 3" (Max.) (recompression) - will take place during or immediately following the construction period.	--

cont'd. ... 31

FOUNDATION RECOMMENDATIONS - SITE #4A

Underpass Structure - Revised Hwy. #17 and County Rd. No. 20

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
493 ±	Clay to Silty Clay (Very Stiff) - (130') Underlain by Sand and Gravel (Very Dense)	Piers Spread footings founded at as high an elev. as possible within the desiccated zone of the cohesive stratum, allowable bearing value of 2.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems for fills 22' in height (with 2:1 side slopes). Estimated Settlement 2" to 3" (Max.) (recompression) - will take place during or immediately following the construction period.	--

cont'd. ... 32

FOUNDATION RECOMMENDATIONS - SITE #5A

Bonnechère River Crossing - Revised Hwy. #17

Approx. Height of River Banks Above River Water Level - (Approx. Width of Valley)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments	
150 ± (2,500')	Clay to Clayey Silt (Stiff to Very Stiff) - (50') Underlain by Sand (Compact to Very Dense)	Piers Spread footings founded at as high an elev. as possible within the upper desiccated zone of the cohesive stratum, allowable bearing pressure up to 2.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Alternatively, end-bearing piles driven to practical refusal in the sand stratum - designed for the max. allowable load for the pile section chosen.	Stability Fills 45' to 50' in height (with 2:1 side slopes) will be stable. Probable Settlement 2" to 4" (Max.) (recompression) - will take place during or immediately following the construction period.	Stability of embankment fills will be governed by: i) the finalized profile grade of revised Hwy. #17; and ii) the position of the fills related to the existing river banks. These aspects will be defined during the final design phase. Note: Dewatering may be a problem, depending on the location of the pier footings - (particularly within the river channel.

cont'd. ... 33

FOUNDATION RECOMMENDATIONS - SITE # 6A

Underpass Structure - Revised Hwy. #17 and County Rd.

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
430 ±	Sand and Gravel (Dense to Very Dense) - (41+ ft.)	Piers Spread footings founded in the upper portion of the granular deposit, allowable bearing pressure up to 5.0 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems for fills 22' in height (with 2:1 slopes). Estimated Settlement Negligible.	--

cont'd. ... 34

FOUNDATION RECOMMENDATIONS - SITE #7A

C.P.R. Overhead Structure - Revised Hwy. #17

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 27' to 29')	
427 ±	Clayey Silt (Stiff to Very Stiff) - (14') Underlain by Glacial Till (Competent)	Piers Spread footings founded in the upper cohesive stratum, allowable bearing pressure of 2.5 t.s.f. Abutments 'Perched' on spread footings, in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems are anticipated at this site for fills 29' in height (with 2:1 slopes). Estimated Settlement 1" to 2" (max.) (recompression) - will take place during or immediately following the construction period.	--

cont'd. ... 35

FOUNDATION RECOMMENDATIONS - SITE # 8A

Underpass Structure - Revised Hwy. #17 and Existing Hwy. #17

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
449 ±	Organic Silt - (2') Clayey Silt (Stiff) - (6') Sand (Loose to Dense) - (8') Underlain by Bedrock (Sound)	Piers and Abutments End-bearing piles driven to bedrock - designed for the max. capacity of the pile section chosen.	Stability No stability problems are anticipated for fills 22' in height (with 2:1 slopes). Estimated Settlement 1" to 2" (max.) - will take place during or immediately following the construction period.	The surficial organic silt layer (approx. 2' thick) should be completely sub-excavated from within the plan limits of the approach fills.

cont'd. ... 36

FOUNDATION RECOMMENDATIONS - SITE #9A

C.N.R. Overhead Structure - Revised Hwy. #17

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 27' to 29')	
493 ±	Clayey Silt (Stiff to Very Stiff) -(37') Sand and Gravel -(2') Underlain by bedrock. (Sound)	Piers Spread footings founded within upper desiccated portion of the clayey silt stratum (at elev. 488), allowable bearing pressure 3.0 t.s.f. Abutments 'Perched' on spread footings, in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems are anticipated for fills 29' in height - (with 2:1 slopes). Estimated Settlement 1" to 2" (max.) (recompression) - will take place during, or immediately following, the construction period.	--

cont'd. ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.3) Northern Alignment: (cont'd.) ...

6.3.2) Associated Structure -

If the Northern alignment is adopted, a new road will be constructed to link revised Hwy. #17 to existing Hwy. #17. An interchange at the junction of this new road and an existing County road will be required. The structure required at the above mentioned interchange is designated as Site #4B (refer to Drawing No. W.J. 69-F-73A). The recommendations, pertaining to this structure, follow:

FOUNDATION RECOMMENDATIONS - SITE #4B

Structure - at the Crossing of the Proposed Co. Rd. (Linking Existing Hwy. #17 and Revised Hwy. #17) and a Co. Rd.

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
512 ±	Organic Clay (Soft to firm) - (8') Clay to Silty Clay (Firm to Stiff) - (33')	Piers and Abutments Friction piles driven into the cohesive strata - estimated pile capacity will depend on the pile type chosen (e.g., No. 14 tapered timber piles, approx. 50 ft. in length, could be designed for about 25 Tons/Pile). Alternatively, end-bearing piles driven to bedrock - designed for max. capacity of the pile section chosen.	Stability No stability problems are anticipated at this site for fill heights of 22' (with 2:1 slopes), provided the measures recommended in the 'Remarks' column are adopted. Estimated Settlement 2" to 3" (max.) (recompression) - will take place during, or immediately following the construction period.	It is recommended that the organic clay (approx. 8 ft thick) be sub-excavated from within the plan limits of the approach fills. The excavation should be back-filled with granular material up to the prevailing groundwater level, and any acceptable earth material above this level.

cont'd. ... 39

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.4) Possible Minor Revision - Northern Alignment:

It is understood that a minor revision of the Northern alignment, in the vicinity of the Bonnechère River, is also being considered. Structures will be required, along the revision, at the sites listed below:

i) Underpass Structure - Site #6C,

ii) a C.P. and C.N.R. Overhead Structure - Sites #7B and #8B, respectively,

iii) Bonnechère River Structure Crossing - Site #5B; and

iv) a natural Valley Crossing - Site #6B.

Recommendations, pertaining to the above mentioned sites, are presented in the tables to follow:

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FOUNDATION RECOMMENDATIONS - SITE # 5B (Alternate to #5A)

Bonnechère River Crossing - Revised Hwy. #17

Approx. Height of River Banks Above River Level - (Approx. Width of Valley)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments	
150' ± (2,500')	Clay to Silty Clay (Stiff to Very Stiff) - (132' +)	Piers Spread footings founded at as high an elevation as possible within the upper desiccated zone of the cohesive stratum, allowable bearing value 2.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular meterial, using an allowable bearing value of 2.0 t.s.f. Alternatively, friction piles (e.g., No. 14 timber piles driven 45' into original ground, could be designed for an allowable load of 25 tons/pile).	Stability Fills 45' to 50' in height (with 2:1 slopes) will be stable. Probable Settlement 2" to 4" (max.) (recompression) - will take place during or immediately following the construction period.	Stability of embankment slopes will be governed by: i) the finalized profile grade of revised Hwy. #17, and ii) the position of the fills related to the existing river banks. These aspects will be defined during the final design phase. Note: Dewatering may be a problem, depending on the location of the pier footings, particularly in the river channel.

cont'd. ... 41

FOUNDATION RECOMMENDATIONS - SITE # 5B (Alternate to #5A)

Bonnechère River Crossing - Revised Hwy. #17

Approx. Height of River Banks above River Level - (Approx. Width of Valley)	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments	
150' ± (2,500')	Clay to Silty Clay (Stiff to Very Stiff) - (132' +)	Piers Spread footings founded at as high an elevation as possible within the upper desiccated zone of the cohesive stratum, allowable bearing value 2.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Alternatively, friction piles (e.g., No. 14 timber piles driven 45' into original ground, could be designed for an allowable load of 25 tons/pile).	Stability Fills 45' to 50' in height (with 2:1 slopes) will be stable. Probable Settlement 2" to 4" (max.) (recompression) - will take place during or immediately following the construction period.	Stability of embankment slopes will be governed by: i) the finalized profile grade of revised Hwy. #17, and ii) the position of the fills related to the existing river banks. These aspects will be defined during the final design phase. Note: Dewatering may be a problem, depending on the location of the pier footings, particularly in the river channel.

cont'd. ... 41

FOUNDATION RECOMMENDATIONS - SITE #6C

Underpass Structure - Revised Hwy. #17 and Existing County Rd. East

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
418 ±	Clayey Silt to Silty Clay (Stiff to Very Stiff) - (27') Underlain by Sand and Gravel (Compact to Very Dense)	Piers Spread footings founded in the upper cohesive stratum, at or above elev. 414, allowable bearing value of 2.5 t.s.f. Abutments 'Perched' on spread footings in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems are anticipated at this site for fills 22' in height (with 2:1 slopes). Estimated Settlement 1" to 2" (Max.) (recompression) - will take place during, or immediately following, the construction period.	--

cont'd. ... 42

FOUNDATION RECOMMENDATIONS - SITE # 8B

C.N.R. - Existing Hwy. #17 Overhead Structure - Revised Hwy. #17

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 27' to 29')	
457 ±	Clayey Silt (Very Stiff) - (9') Underlain by Glacial Till (Very Dense)	Piers Spread footings founded within clayey silt stratum, allowable bearing value 2.5 t.s.f. Alternatively, footings carried down into the competent glacial till, allowable bearing value up to 5.0 t.s.f. Abutments 'Perched' on spread footings, in the approach fills, within a zone composed of well compacted granular material, using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems are anticipated at this site for fills 29' in height (with 2:1 slopes). Estimated Settlement 1" to 2" (Max.) (Recompression) - will take place during, or immediately following the construction period.	If footings are constructed, within the granular glacial till deposit, below the groundwater level, a dewatering scheme will be required.

cont'd. ... 44

RECOMMENDATIONS - NATURAL VALLEY CROSSING - SITE #6B

	E M B A N K M E N T		
Est. Thickness of Clay Beneath Valley Floor	Approx. Height of Fill Proposed (2:1 Slopes)	Stability	Estimated Settlement (Max. under Centre-Line)
22' (Stiff to Very Stiff)	22' to 25'	No stability problems anticipated for fills 25' in height - (with 2:1 slopes).	2" to 3" (Max.) (Recompression) - will take place during, or immediately following the construction period.

cont'd. ... 45

FOUNDATION RECOMMENDATIONS - SITE #7B

C.P.R. Overhead Structure - Revised Hwy. #17

Approx. Existing Ground Level	Predominant Overburden Strata Approx. Thickness (Ft.)	RECOMMENDATIONS		Remarks
		Structure	Embankments (Height - 21' to 22')	
440 ±	Clayey Silt to Silty Clay (Very Stiff) - (23') Underlain by Glacial Till (Very Dense)	Piers Spread footings founded at as high an elev. as possible, within cohesive stratum, allowable bearing value of 2.5 t.s.f. Abutments 'Perched' on spread footings, in the approach fills, within a zone composed of well compacted granular material using an allowable bearing value of 2.0 t.s.f. Note: Differential settlements between the spread footing supported abutments and piers will be negligible.	Stability No stability problems are anticipated at this site for fills 22' in height (with 2:1 slopes). Estimated Settlement 1" to 2" (Max.) (Recompression) - will take place during, or immediately following, the construction period.	--

cont'd. ... 43

7. CONCLUSIONS - FEASIBILITY OF ALTERNATE ALIGNMENTS - (NORTHERN and SOUTHERN):

Cohesive subsoil deposits, of quite variable thicknesses, are present at the majority of sites investigated along either alignment. From a foundation point of view, it would be advantageous to select the alignment, along which the overall thickness of the compressible clay is generally least and the strength-compressibility characteristics of the deposits are as favourable as possible.

Along the Southern alignment (as discussed in Section #4 of this report), the cohesive strata can be subdivided into an upper and lower sheet, the upper being relatively soft and more compressible than the lower sheet. The overall strata are most extensive west of the Bonnechère River, where thicknesses up to 239 feet were encountered (refer to Site #2). Along the Northern alignment the upper compressible sheet was not present; here the maximum thickness of the cohesive subsoil was found to be 132 feet (Site #5B).

Taking into consideration the aforementioned, it would appear that the Northern alignment would provide distinct advantages from a foundation point of view. This was substantiated by the computations carried out for the various structure and valley crossings, along the alternate alignments. West of the Bonnechère River, along the Southern alignment, for instance, it was found that: a) it would be necessary to construct berms to ensure the stability of the fills proposed at Site #2 and the natural valley crossings; b) consolidation settlements, of considerable magnitude, are estimated (e.g., up to 6.5 feet under 29 feet of fill at Site #2). Further, the settlements estimated at the natural valley crossings, located in the vicinity of Sites #1 and #2, will probably not be within tolerable limits. As discussed in Sub-section 6.2.2), these valleys will likely have to be bridged by multi-span structures; and c) the majority of the structures will have to be pile-supported.

At sites, along the Northern alignment, however, no major stability or settlement problems are anticipated; further, in most instances, the structure elements can be supported on spread footings.

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7. CONCLUSIONS - FEASIBILITY OF ALTERNATE ALIGNMENTS - (NORTHERN and SOUTHERN): (cont'd.) ...

An exception to the aforementioned trend occurs at the respective Bonnechère River crossings. Along the Northern alignment the profile of the river gorge is very tortuous when related to the Southern crossing.

The crossings are compared in the following table:

Alignment	Est. Total Span Length	Approx. Height of Structure Above River Water Level	Approx. Height of Approach Fills
Northern - (either Site #5A or #5B)	1,400 to 1,500 ft.	130 to 140 ft.	45 to 50 ft.
Southern - (Site #3)	400 to 450 ft.	25 ft.	16 ft.

Based on the data given in the table, it is concluded that the river structure crossing, along the Northern alignment, will be of major proportions when compared with that required at the Southern alignment.

In conclusion, it is considered that all the factors, discussed in the previous paragraphs, should be weighed in terms of their relative importance, prior to final selection of either the Southern or Northern alignment. The possible minor revision of the Northern alignment, being considered in the vicinity of the Bonnechère River, will not alter any of the comments made herein.

It should be stressed that this report is of a preliminary nature. A complete foundation investigation will be required at all the sites, when design details become available for the various sites along the selected alignment.

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8. MISCELLANEOUS:

The field work, performed during the period of August 28 to October 9, 1969, was under the supervision of Mr. W. Hutton, Project Foundation Engineer.

Equipment was owned and operated by the F. E. Johnston Drilling Co. Ltd., Ottawa, Ontario.

The preparation of this report was undertaken by Mr. B. T. Darch, Senior Foundation Engineer.

This project was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who also reviewed this report.

March, 1970

APPENDIX I

SOUTHERN ALIGNMENT

FORM OB-MT-126 (REV 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 1

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew - Southern Alignment ORIGINATED BY WH
W.P. 5-67 BORING DATE September 12, 15 and 16, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring-NX Casing-AXT Rock Core CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE (400 800 1200 1600 2000)	LIQUID LIMIT w_L — PLASTIC LIMIT w_p — WATER CONTENT w — WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
431+	Ground Level									
0.0	Topsoil					430				
1.0										
	Clay, trace of sand (Grey-brown)		1	SS	11		+			W.L. EL. 424·3
	(Desiccated Zone)		2	TW	PM	420	×s8 ●c +	3,765 2,595	113	
			3	TW	PM		+3		C	
410.0	Very stiff to stiff		4	TW	PM	410	×s4		104	0-4-43-53
21.0							+3			
	Silty Clay to Clayey Silt, trace of sand.		5	TW	PM		+5			
	(occasional seams		6	TW	PM	400				
	and partings of		6A	SS	-		1.5		C	
	silt up to 1/2"		7	TW	PM		● + 3		109	0-3-62-35
	thick throughout)		8	TW	PM	390	+ 5			
	(upper sheet above elev. 395) (Grey)						+ 6			
			9	TW	PM	380	+4			
	Firm to Stiff						+5			
			10	TW	PM	370	×s10 + 7		111	
							+ 6			
			11	TW	PM	360				
			12	SS	3		+ 7			
			13	TW	PM	350	● ×s13 +		114	
						340				
						330				
327.0										
104.0	Clayey silt with sand & some gravel (Glacial Till) Hard (Bouldery Zone) Boulders up to 8" in size		14	SS	42/6"					
				RC	10%					
320.0			15	AXT	Rec	320				
111.0	End of Borehole									

20
15 ⊹ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 2

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy 17- Renfrew (Southern Alignment) ORIGINATED BY WH
WP 5-67 BORING DATE Sept. 11, 12, 17 and 18, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring, NX, BX Casing CHECKED BY
Dynamic Cone Penetration Test

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
405+	Ground Level				
0.0	Topsoil				
1.0	(Grey-Brown)				
	(Desiccated Zone)				
398.0	Very Stiff to Stiff		1	TW	PM
7.0	Clay to				
	Silty Clay,		2	TW	PM
	trace of sand		3	TW	PM
	(occasional seams				
	and partings of		4	TW	PM
	silt up to 1/2"				
	thick, particularly		5	TW	PM
	below elev. 195)				
	(upper sheet above		6	TW	PM
	elev. 310)				
	(Grey)		7	TW	PM
	Firm to Stiff		8	TW	PM
			9	TW	PM
			10	TW	PM
			11	TW	PM
			12	TW	PM
166.0					
239.0	Clayey Silt, with sand and some gravel (Glacial Till)		13	SS	25
160.1	Very stiff to Hard				
244.9	End of Borehole				
	Probably Bedrock				

ELEV SCALE

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS
GR.SA.SI.CL.

W.L. EL. 390·4

C
102.5 0-1-36-63

200/7"

20
5 % STRAIN AT FAILURE

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 3

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 8-10, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring, NX, BX Casing - AXT Rock Core, Dynamic Cone Penetration Test CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20 40 60 80 100); SHEAR STRENGTH P.S.F. (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE; 400 800 1200 1600 2000)	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w; WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
369.5	Ground Level									
0.0	Topsoil		1	SS	16					
1.0	Clay, trace of sand (Grey-brown) (Desiccated zone) Very Stiff to Stiff		2	TW	PM					W.L. EL. 363·0
357.5			3	TW	PM	360	×s6		105	
12.0	Silty Clay to Clayey Silt, trace of sand (occasional seams and partings of silt and sand up to 1/2" thick throughout) (upper sheet above elev. 320) (Grey) Firm to Stiff		4	TW	PM		+s4			
							+s4			
			5	TW	PM	350	+s4			
			6	TW	PM		×s12 +s4		99	C-4-34-02
			7	TW	PM	340	+s6			
			8	TW	PM		+s6			
			9	TW	PM	330				
			9A	SS	O		+s2.5			
			10	TW	PM					
			10A	SS	PM		+s1.5			
			11	TW	PM	320	+s4		106	
			12	TW	PM					
			13	TW	PM		×s8 +s3		110	
			14	TW	PM	310				
			14A	SS	-					
			15	TW	PM					
			16	TW	PM	300	+s3			
			17	SS	-					
			18	TW	PM		×s2.5 +s2		112	
289.5										
80.0	Clayey silt, some sand & gr. (Glac. Till) V. Stf		19	TW	PM	290	100/7"			
287.2	Boulders up to 6" size									
82.3	Crystalline dolomite Bedrock		20	RC	50%		Note: Remainder of core lost in borehole.			
83.3	Grey Sound			AXT	Rec	280				
280.3										
89.2	End of Borehole					270				

20
1/2 ÷ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 4

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 9 and 10, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring NX, BX Casing CHECKED BY
Dynamic Cone Penetration Test

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
395.2	Ground Level				
0.0	Topsoil		1	SS	17
1.0	(Grey-Brown) (Desiccated Zone) Hard		2	SS	18
			3	SS	18
14.0	Silty Clay, trace of sand (occasional seams and partings of silt up to 1/4" thick throughout) (upper sheet) (Grey) Firm to Stiff		4	TW	PM
			5	TW	PM
			6	TW	PM
			7	TW	PM
			8	TW	PM
			9	TW	PM
			10	TW	PM
			11	TW	PM
328.2			12	TW	PM
67.0	Heterogeneous mixture of clay, silt, sand & gravel (Glacial Till) (Grey) Very Dense or Hard		13	SS	55
			14	SS	92/6"
314.9			15	SS	56/4"
80.3	End of Borehole				

ELEV. SCALE: 390, 380, 370, 360, 350, 340, 330, 320, 310

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F. — 400 800 1200 1600 2000
○ UNCONFINED ⊕ QUICK TRIAXIAL + FIELD VANE × LAB. VANE

s6, s7, s5, s9, s7, s8, s3, s9, s12, s7, s5, s5, s8, 100/6"

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w
WATER CONTENT % — 20 40 60

BULK DENSITY γ P.C.F.

C
98.5
103

REMARKS

GR. SA. SI. C

W.L. EL. 387.7

0-5-40-55

34-30-26-1

20
15 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 5

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17, - Renfrew - (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 16, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE) 400 800 1200 1600 2000	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w — WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
410.1	Ground Level									
0.0	Top Soil									
1.0	(Grey-Brown) (Desiccated Zone)		1	SS	11		+			▽ 403.6
	Very Stiff		2	SS	12	400	+			
396.1										
14.0	Silty Clay, trace of sand (occasional partings and seams of sand up to 1/4" thick throughout) (upper sheet) (Grey)		3	TW	PH	390	+ s5, × s6, ● s6, + s7, + s6	○	112	
	Firm to Stiff		4	TW	PH	380	+ s6			
375.1			5	SS	-		+			
35.0	End of Borehole Probably Bedrock		Hammer Bouncing			370				

FORM OS-MT-[illegible]6 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 6

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew- (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 11, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring-NX Casing-AXT Rock Core CHECKED BY
Dynamic Cone Penetration Test

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
413.6	Ground Level					
0.8	Topsoil					
1.0	Silty Clay, trace of sand (occasional partings and seams of silt up to 1/4" thick are encountered throughout) Upper sheet Very Stiff		1	SS	12	410
403.4			2	TW	PH	
			3	SS	-	
12.2			4	AXT	95%	
	Gneiss bedrock with distinct schistocity (grey) sound		5	RC	99%	400
397.2				AXT		
18.4	End of Borehole					390

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

REMARKS
GR. SA. SI. CL.
0-3-52-45
W.L. EL. 409.1

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 7

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 17, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring-NX, HX Casing-AXT Rock Core CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	REMARKS
530+	Ground Level						
0.0	Het. Mixture of clay, silt, sand & gravel (Glacial Till)		1	SS	66/10"		W.L. EL. 527·7
525.1	Very Dense or Hard			RC			
4.9	Granite gneiss Bedrock		2	AXT	70%		
				RC			
520.7	Pink Sound		3	AXT	72%	520	
9.3	End of Borehole						

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P — w — w_L
WATER CONTENT %

BULK DENSITY γ P.C.F.

REMARKS GR. SA. SI. CL.

FORM 08-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 8

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy.17 -Renfrew- (Southern Aligment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 17 & 18, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring - HX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
485+	Ground Level					
0.0	Topsoil		1	SS	8	
1.0	Silty Clay to Clayey Silt, trace of sand (occasional seams and partings of silt) Upper sheet Very Stiff		2	SS	9	480
			3	TW	PH	
470.0						
15.0	Heterogeneous mixture of clay, silt, sand & gravel (Glacial Till) (Grey) Very Dense or Very Stiff to Hard		4	SS	51	470
			5	SS	79	
			6	SS	28	460
			7	SS	103	
448.5			8	SS	108	450
36.5	End of Borehole					440

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

BULK DENSITY	REMARKS
	▼ W.L. EL. 479·0
124.5	
	9-48-38-5
	0- 35-53-12

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 8 N.

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew - (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 18, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring-NX, BX Casing CHECKED BY

ELEV. / DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
455±	Ground Level					
0.0	Topsoil					
1.0	Silty Clay, trace of sand (Occasional partings and seams of silt up to 1/8" thick) (Grey-Brown) Upper Sheet Very Stiff		1	TW	PM	450
			2	TW	PM	
			3	TW	PM	440
435.0			4	TW	-	
20.0	'Reworked Zone'		4A	SS	9	
	Compact		5	SS	9	430
	Ret. Mixture of silt, sand & gravel, some clay (Glacial Till) (Grey)		6	SS	137	
420.5	Very Dense		7	SS	102	420
34.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

REMARKS GR.SA.SI.CL.

▼ W.L. EL. 453·4

s_u 4.5 2,650

117

8-40-40-11

8-52-40

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 9

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17, - Renfrew - (Southern Alignment) ORIGINATED BY WH
W.P. 5-67 BORING DATE September 25, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring - BX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE (400 800 1200 1600 2000)	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w — WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
494+	Ground Level									
0.0	Topsoil		1	SS	10					
1.0	Clayey Silt to Silty Clay, trace of sand (occasional partings & seams of silt up to 1/4" thick) Very Stiff		2	SS	12	490				▽ W.L. El. 487.3
482.0			3	SS	8					
12.0	Heterogeneous Mixture of silt, sand & gravel trace of clay (Glacial Till) (Grey) Compact		4	SS	18	480				
			5	SS	100					
	Bouldery Zone (Boulders up to 8 inches in size)		6	RC EXT	33%	470				
468.0										
26.0	End of Borehole					460				

NORTHERN ALIGNMENT

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 1A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy #17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE Sept. 19 - 22, 1969 COMPILED BY WH
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring, NX, BX Casing - AXT Rock Core CHECKED BY

SOIL PROFILE ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE
534+	Ground Level					
0.0	**Sand & Gravel** trace of silt (grey) Dense to Very Dense		1	SS	52	530
			2	SS	41	
521.0						
13.0	**Sand**, trace to some silt, trace of gravel (Brown) Compact to Dense		3	SS	44	520
			4	SS	28	
			5	SS	33	510
			6	SS	39	
			7	SS	49	500
			8	SS	39	
			9	SS	38	490
			10	SS	19	
478.2						480
55.8	Gneiss Bedrock distinct schistocity			AXT	99%	
472.9	grey sound		11	RC	Rec	
61.1	End of Borehole					470

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

LIQUID LIMIT w_L
PLASTIC LIMIT w_p
WATER CONTENT w
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

REMARKS GR.SA.SI.CL.

6-84 (-10)
0-80 (-20)
W.L. Elev. 494·0
2-84- (-14)

20
15 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 2A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy. #17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE September 25, 1969 COMPILED BY WH
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
574+	Ground Level					
0.0	(Trace of organic matter) Loose		1	SS	3	570
	Sand, trace of silt and gravel (Brown)		2	SS	32	
	Dense		3	SS	31	560
555.0						
19.0	Clay to Silty Clay, trace of sand (occasional seams and partings of silt up to 1/4" thick)		4	TW	PM	
			5	SS	12	550
			6	TW	PM	
			7	SS	5	540
	(Grey)		8	TW	PM	
	Stiff to Very Stiff					530
			9	TW	PM	
						520
			10	TW	PM	
						510
			11	SS	6	
						500
			12	TW	PM	
						490
479.7						
94.3	Sand, trace of silt and gravel (Grey)		13	SS	19	480
473.8	Compact to Very Dense		14	SS	83/8"	
100.2	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w
w_p w w_L
WATER CONTENT %
20 40 60

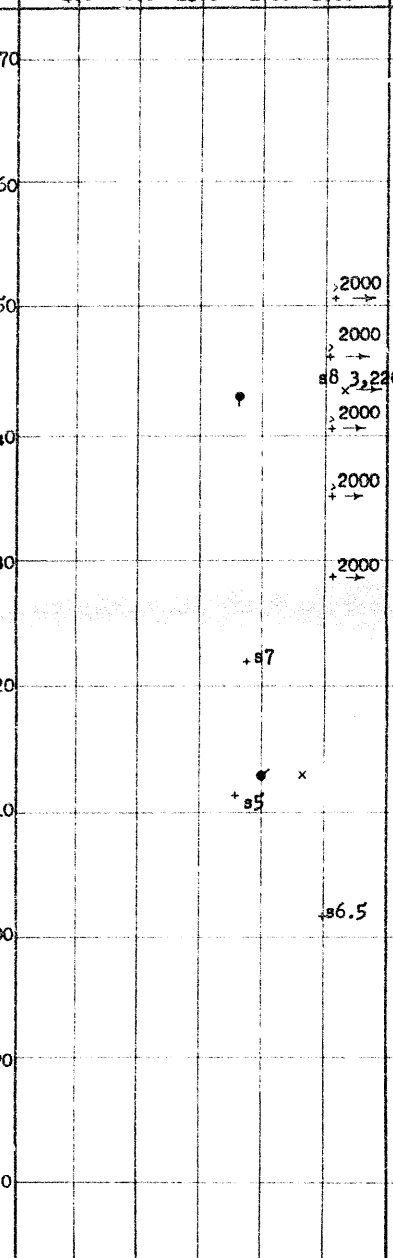
BULK DENSITY γ P.C.F.

REMARKS GR.SA.SI.CL.

W.L. Elev. 569.5

9-85--(6)

3-85-(-12)



119

11¼

20
15 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 3A

FOUNDATION SECTION

JOB 69-F-73	LOCATION New Hwy. #17 - North Alignment - Renfrew	ORIGINATED BY WH	
W.P. 5-67	BORING DATE September 22-23, 1969	COMPILED BY WH	
DATUM Contours-Geodetic	BOREHOLE TYPE Washboring - NX, BX Casing	CHECKED BY	

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE
567+	Ground Level					
0.0	Sand, trace of silt and gravel (Brown) Compact		1	SS	12	560
557.0						
10.0	Clay to Silty Clay, trace of sand (occasional seams and partings of silt and sand up to 1/2 inch thick, throughout)		2	SS	6	
			3	TW	PM	550
			4	TW	PM	
						540
	(Grey)		5	TW	PM	
	Very Stiff		6	SS	6	
			7	TW	PM	530
						520
			8	SS	8	
						510
			9	TW	PM	
						500
			10	SS	9	
						490
			11	TW	PM	
481.7						
85.3	Net. Mixt. of silt, sand & gravel trace of clay (Glacial Till)		12	SS	55	480
476.2	(Grey) Very Dense		13	SS	128/9"	
90.8	End of Borehole					470

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

400 800 1200 1600 2000

+ › 2000
+ › 2000
+ › 2000
+ › 2000
89 × 5,140
+ › 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w

w_p w w_L

WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS

▼ W.L. EL. 562·2

GR. SA. SI. CL.

45-44 (-11)

20
15 ⊣◇⊢ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 4A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy. #17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE September 19 - 23, 1969 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE
489.2	Ground Level					
0.0	(Grey-Brown) (Desiccated Zone)		1	SS	20	
	Clay to Silty Clay, trace of sand (Occasional seams of silt and sand up to 1/2" thick throughout) (Grey) Very Stiff		2	TW	PM	480
			3	TW	PM	
			4	TW	PM	470
			5	TW	PM	
			6	TW	PM	460
			7	TW	PM	
			8	TW	PM	450
			9	TW	PM	440
			10	TW	PM	430
			11	TW	PM	420
			12	TW	PM	410
			13	SS	25	400
359.2						390
130.0	Sand, with some gravel, and a trace of silt. (Grey) Very Dense		14	SS	67	380
						370
						360
	Bouldery Zone (Boulders up to 7" in size)		15	AXT	9% RC Rec	350
333.7						340
155.5	End of Borehole					330

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

400 800 1200 1600 2000

+>2000
s9 3,780
+>2000
+>2000
+>2000
+>2000
+>2000
+>2000
s7 3620
+s4
+>2000

LIQUID LIMIT w_L
PLASTIC LIMIT w_P
WATER CONTENT w
w_1 w w_2
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

117.5
116

REMARKS
GR.SA.SI.CL.

▼ W.L. EL. 485.0

20
12 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT 86 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 4 B

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE September 24, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring - NX, BX Casing CHECKED BY AK

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT; SHEAR STRENGTH P.S.F. (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE)	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT %	BULK DENSITY γ P.C.F.	▽ Art. Head REMARKS GR. SA. SI. CL.
512+	Ground Level						400 800 1200 1600 2000	20 40 60		
0.0	Organic Clay, trace of sand and gravel (Grey) Soft to Firm		1	SS	1	510	+4	○		8-16-61-15
504.0										
8.0	Clay to Silty Clay, trace of sand (occasional partings and seams of silt up up to 1/4" thick throughout)		2	TW	PM	500	+8			
			3	SS	1		+10			
			4	TW	PM	490	+10	○	116	
			5	SS	3		+8			
	(Grey) Firm to Stiff		6	SS	2	480	+10			
			7	SS	4		+8			
			8	SS	4	470	> +			
			9	SS	3		+11	○		0-18-58-24
			10	SS	5	460	> +			
			11	SS	5	450	+7			
444.0										
68.0	Layers of sandy silt up to 4" thick throughout		12	SS	6	440	+3.5			▽ Art Press. Elev 442 Encountered
			13	SS	3	430				
421.2										
90.8	End of Borehole hammer bouncing Probably Bedrock					420				

20
15 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1 SITE 5A

FOUNDATION SECTION

JOB 69-F-73	LOCATION New Hwy. 17 - North Alignment - Renfrew	ORIGINATED BY	WH
W.P. 5-67	BORING DATE August 28 - September 3, 1969	COMPILED BY	WH
DATUM Geodetic	BOREHOLE TYPE Washboring - NX, BX Casing	CHECKED BY	

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
395.9	Ground Level							
0.0	(Grey-Brown) (Desiccated Zone) Very Stiff to Hard		1	SS	18			
			2	SS	32	390		
	Clay to Clayey Silt, trace of sand (occasional seams and partings of silt and sand up to 1/2" thick, throughout)		3	SS	13			
			4	SS	15	380		
			5	SS	15			
			6	SS	12	370		0-1-63-36
	(Grey) Firm to Very Stiff		7	TW	PM		126	
			8	TW	PM	360	121	
			9	TW	PM			
			10	SS	12	350		
345.9								
50.0	Sand, some gravel, trace of silt (Brown) Very Dense		11	SS	114			25-63-(-12)
			12	SS	63	340		▼ W.L. EL. 339.9
			13	SS	132			
			14	SS	160	330		
325.1			15	SS	143/10"			1-86- -15
70.8	End of Borehole					320		

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

+ s11
×s5
+ 2000
+ 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_p
WATER CONTENT —— w
w_p w w_L
WATER CONTENT %
20 40 60

20
15 ✛ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2 SITE 5A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy. 17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE September 3-5, 1969 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Washboring-NX, HX Casing - AXT Rock Core Dynamic Cone Penetration Test CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS/FOOT	REMARKS
293.9	Ground Level					
0.0	Clayey Silt, trace of sand (occasional layers)		1	SS	21	
			2	SS	21	
	Sand Layer		3	SS	25	34-61-(-5)
	and seams of silt up to 3" thick throughout) (Grey-Brown)		4	SS	18	
			5	SS	34	
			6	SS	175/6"	
268.9	Very Stiff to Hard					NO WATER Hole Caved in EL 268.9
25.0	'Reworked Zone' Compact		7	SS	21	82-16-(-2)
			8	SS	9	
	Sandy Gravel to Gravelly Sand, trace of silt (Brown) Dense to Very Dense		9	SS	54	
			10	SS	83	26 62 (12)
			11	SS	79	
			12	SS	41	57-37-(-6)
			13	SS	83	
			14	SS	42	
			15	SS	112	
218.9	Bouldery Zone (Boulders up to 8" in size)		16	AXT RC	33% Rec	
75.0	End of Borehole					

Note: Washwater lost periodically below elev 268 during boring operations

ELEV SCALE: 290, 280, 270, 260, 250, 240, 230, 220, 210

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 20 40 60

BULK DENSITY γ P.C.F.

GR.SA.SI.CL.

20
15 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 6A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy. 17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE August 28 - September 3, 1969 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT / SHEAR STRENGTH P.S.F. (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB. VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
430.3	Ground Level									
0.0	Silty Fine Sand, Loose		1	SS	9	430				
2.0	Sand & gravel, trace of silt (Brown to Grey)		2	SS	47					
			3	SS	60	420		o		47-42- (-11) Hole Caved in EL. 416.3
			4	SS	83					
	Dense to Very Dense		5	SS	105	410		o		45-42- (-13)
			6	SS	132/4"					
			7	SS	150/3"	400				
			8	SS	150/0"					
388.9			9	SS	100/3"	390				
41.3	End of Borehole									

FORM OE-MT 426 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 7A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy. 17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE September 3 - 4, 1969 COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing BXT, Rock Core CHECKED BY
Dynamic Cone Penetration Test

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
426.5	Ground Level					
0.0	Topsoil		1A	SS	6	
	Clayey Silt, trace of sand (occasional seams and partings of silt up to 1/2 inch thick throughout) (Grey-Brown)		1	SS	15	420
			2	SS	13	
412.2	Stiff to Very Stiff					
14.3	Mat. Mixture of silt, sand & gravel, with some clay (Glacial Till) (Grey)		3	SS	21	410
	Compact		4	SS	24	
	Bouldery Zone (Boulders up to 7" in size below elev. 403)		5	SS	297	400
			6	SS	150/2	
388.4			7	SS	150/1"	390
38.1	End of Borehole					380

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w

WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS

W.L. EL. 419.5

6-33-46-15

0-37-52-11

GR. SA. SI. CL.

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 8A

FOUNDATION SECTION

JOB 69-F-73 LOCATION New Hwy. #17 - North Alignment - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE COMPILED BY WH
DATUM Geodetic BOREHOLE TYPE Washboring-NX, HX Casing-HXT Rock Core CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT / SHEAR STRENGTH P.S.F. (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS
448.7	Ground Level									
0.0	Organic silt (Black)									
446.7	Very Soft		1	SS	2					
2.0	Clayey Silt, trace of sand (Grey-Brown)									GR SA SI CL
			2	SS	5					▼ W.L. EL. 447.9
440.7	Stiff					440				
8.0	Sand, with a trace of silt and gravel Brown		3	SS	7					0-86— (-14)
432.2	Loose to Dense		4	SS	35					
16.5	Crystalline dolomite bedrock Light grey			HX	91%	430				
427.6	Sound		5	RC	Rec					
21.1										
						420				

FORM QB-MT 6 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 9A

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew - Northern Alignment ORIGINATED BY WH
W.P. 5-67 BORING DATE September 5, 8 and 9, 1969 COMPILED BY GP
DATUM Profile (Geodetic) BOREHOLE TYPE Washboring-NX, NX Casing - EXT & AXT Rock Core CHECKED BY
Dynamic Cone Penetration Test

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
493+	Ground Level					
0.0	Topsoil		1	SS	22	
1.0	**Clayey Silt** trace of sand (Occasional seams and partings of silt and sand up to 1/2" thick, throughout) (Grey-brown) Very Stiff to stiff		2	SS	35	490
			3	SS	37	
			4	TW	PM	480
			5	TW	PM	
			6	TW	PM	470
			7	TW	PM	
			8	TW	PM	460
456.0	Sand & Gravel (Brown) Very Dense		9	SS	185/6"	
454.0	Crystalline dolomite Bedrock		10	RC EXT	75%	
39.0				RC		450
446.3	Grey Sound		11	AXT	100%	
46.7	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F. — ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE — 400 800 1200 1600 2000
×s10 +s5 100/2"

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % — 20 40 60

BULK DENSITY γ P.C.F.

129
126

REMARKS

W.L. EL. 486·0

GR. SA. SI. CL.

0-1-75-24

MINOR REVISION - NORTH ALIGNMENT

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No 1 SITE 5B FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew ORIGINATED BY WH
W P 5-67 BORING DATE October 6 and 7, 1969 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE
363.2	Ground Level					
0.0	(Grey-Brown) (Desiccated Zone) Very Stiff to Hard		1	SS	19	360
	Clay to Silty Clay, trace of sand. (occasional seams and partings of silt and sand up to 1/2" thick throughout) (Grey) Stiff to Very Stiff		2	TW	PM	
			3	TW	PM	350
			4	TW	PM	
			5	TW	PM	340
			6	TW	PM	
			7	SS	7	330
			8	TW	PM	
			9	TW	PM	320
303.2						310
60.0	Layers of sandy silt to silty sand up to 5" thick throughout		10	TW	PM	
			11	TW	PM	300
			12	SS	9	
			13	TW	PM	290
			13A	SS	14	
			14	SS	33	280
			15	SS	25	270
			16	SS	68	260
	Very Stiff to Hard					250
231.2			17	SS	31	240
132.0	End of Borehole					230

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

111
123.5

REMARKS
GR. SA. SI. CL.

20
5 ⊹ 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No 2 SITE 5B FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE October 8 and 9, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing, AXT Rock Core CHECKED BY AC

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT
282.9	Ground Level				
0.0	Clayey Silt, trace of sand		1	SS	9
272.9					
10.0	Silty Sand Layer		2	SS	16
267.9					
15.0	(occasional layers and seams of silt up to 2" thick throughout) (Grey-Brown) Very Stiff		3	SS	4
			4	SS	10
			5	TW	PH
			6	SS	5
			7	SS	11
			8	TW	PH
242.9					
40.0	'Reworked Zone' Compact		9	SS	15
			10	SS	17
	Gravelly Sand, to silty sand (Brown) Dense to Very Dense		11	SS	31
			12	SS	50
			13	SS	30
206.3			14	SS	150/9"
76.6	Crystalline dolomite Bedrock Sound		15	RC	150/2"
203.8			16	AXT	70%
79.1	End of Borehole				

ELEV SCALE: 280, 270, 260, 250, 240, 230, 220, 210, 200

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT w_L
PLASTIC LIMIT w_p
WATER CONTENT w
w_p w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.

REMARKS	GR. SA. SI. CL.
▽ W.L. EL. 274·4	
	0 47 44 9
	1 51 40 8
	0 97 (3)

20
15 ⊹ 5 % STRAIN AT FAILURE
10

FORM OB-MT-[illegible] (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 6 B

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE October 2 and 3, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring, NX, BX Casing CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
420.6	Ground Level					420
0.0	Silty Clay to Clayey Silt, trace of sand (occasional layers of silt and sand up to 1" thick throughout) (Brown) Stiff to Very Stiff		1	SS	3	
			2	TW	PH	410
			3	SS	9	
398.6			4	TW	PH	400
22.0	Sand, with some silt and a trace of gravel (occasional seams of clayey silt up to 1/2" thick) (Brown) Compact to Very Dense		5	SS	24	
			6	SS	53	390
			7	SS	117	
380.6			8	SS	115/6"	
40.0	End of Borehole					380

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
C / 116	0-3-71-26
	0-37-58-5
	0-83- (-17
	W.L. 384.5

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 6C

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE October 3, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring, NX, BX Casing CHECKED BY

ELEV DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH PSF ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE 400 800 1200 1600 2000	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
418.2	Ground Level									
0.0	Clayey Silt to Silty Clay, trace of sand (occasional layers of silt and sand up to 1" thick throughout) (Brown) Stiff to Very Stiff		1	SS	10	410	s7 × 3540		123	
			2	TW	PM					
			3	SS	9	400	s4			
			4	SS	14					
391.2			5	TW	PM		s4.5 × 3300		119	
27.0	Sand, with a trace of silt and gravel Brown Compact to Very Dense		6	SS	28	390				NO WATER Hole Caved at EL. 385.2
			7	SS	100/4"					
			7A	SS	80/2"					
			8	SS	40	380				16 73 (11)
			9	SS	54					
			10	SS	102/2"	370				
			11	SS	69					
			12	SS	119/6"					
357.2			13	SS	162	360				
61.0	End of Borehole									
						350				

20
15 ⊕ 5 % STRAIN AT FAILURE
10

DRM OB-MT-6 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 7B

FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew ORIGINATED BY WH
W.P. 5-67 BORING DATE October 2, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring - NX, BX Casing CHECKED BY
Dynamic Cone Penetration Test

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE 400 800 1200 1600 2000	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 20 40 60	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
440.0	Ground Level									
0.0	Clayey Silt to Silty Clay, trace of sand (occasional layers of silt and sand up to 2" thick throughout) (Brown to Grey) Very Stiff		1	TW	PH					W.L. ▽ 433.0
			2	SS	18	430				
			3	SS	9					1-17-61-21
			4	SS	4	420				
17.0										
23.0	Met. Mix. of silt, sand & gravel, trace of clay (Glac. Till) Very Dense		5	SS	84					19-49- (-32)
12.0										
28.0	End of Borehole					410				

FORM OB-MT-4126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE SITE 8B

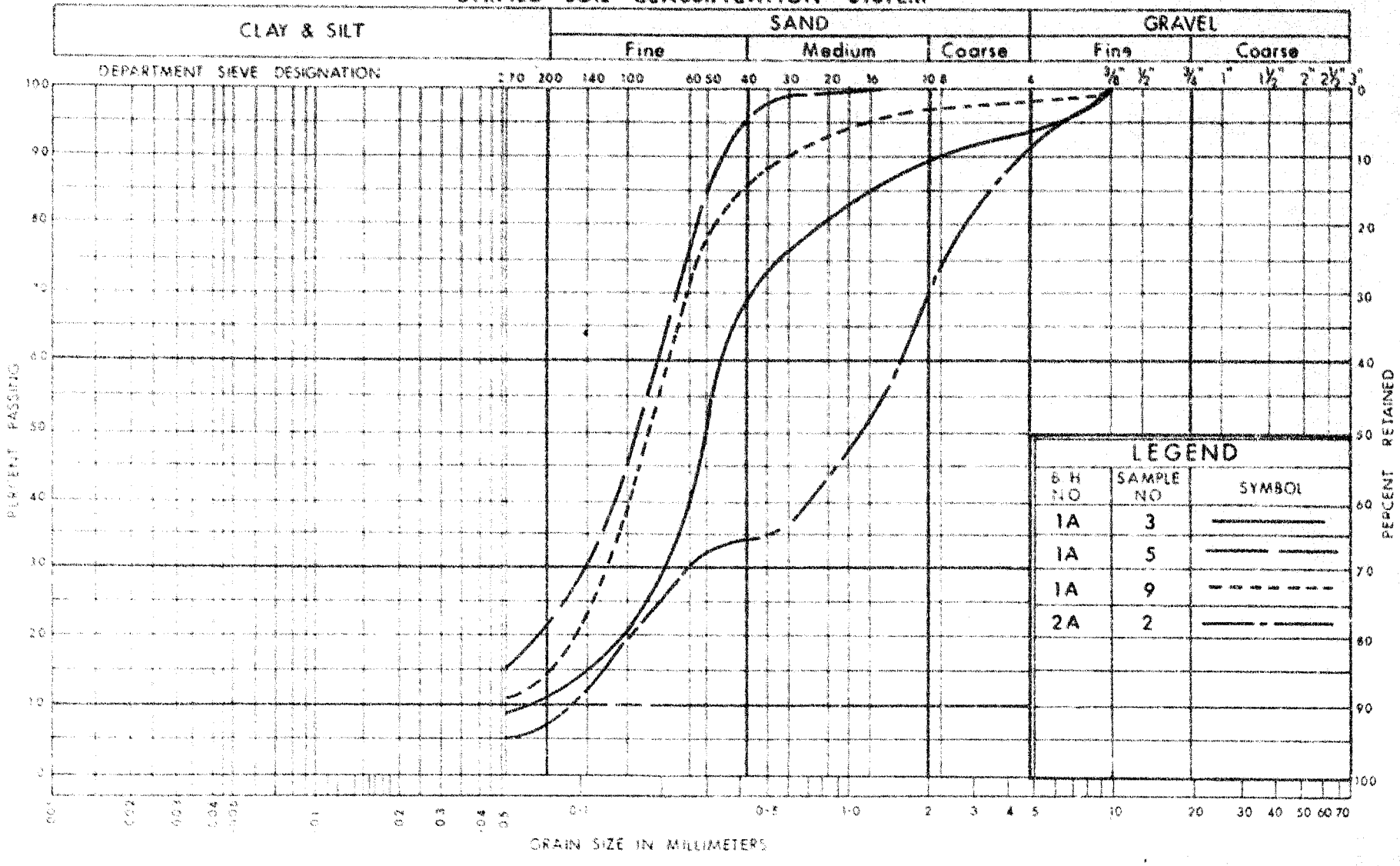
FOUNDATION SECTION

JOB 69-F-73 LOCATION Hwy. 17 - Renfrew - ORIGINATED BY WH
W.P. 5-67 BORING DATE October 1, 1969 COMPILED BY GP
DATUM Geodetic BOREHOLE TYPE Washboring-NX CASING-AXT Rock Core CHECKED BY

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE (400 800 1200 1600 2000)	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
0.0	Clayey Silt, trace of sand (occasional layers of silt) (Brown)		1	TW	PH	460				W.L. 461.0
458.6	Very Stiff									
8.9	Het. mixt. of silt, sand & gravel, trace of gravel (GLACIAL TILL)		2	SS	54			○		58-41- (-1)
			3	SS	109					
	Very Dense		4	SS	60/0"					
	Bouldery Zone (Boulders up to 9" in size throughout)		4A	RC AXT	25%	450				
445.5										
22.0	End of Borehole					440				

REV. APR. 1965

UNIFIED SOIL CLASSIFICATION SYSTEM

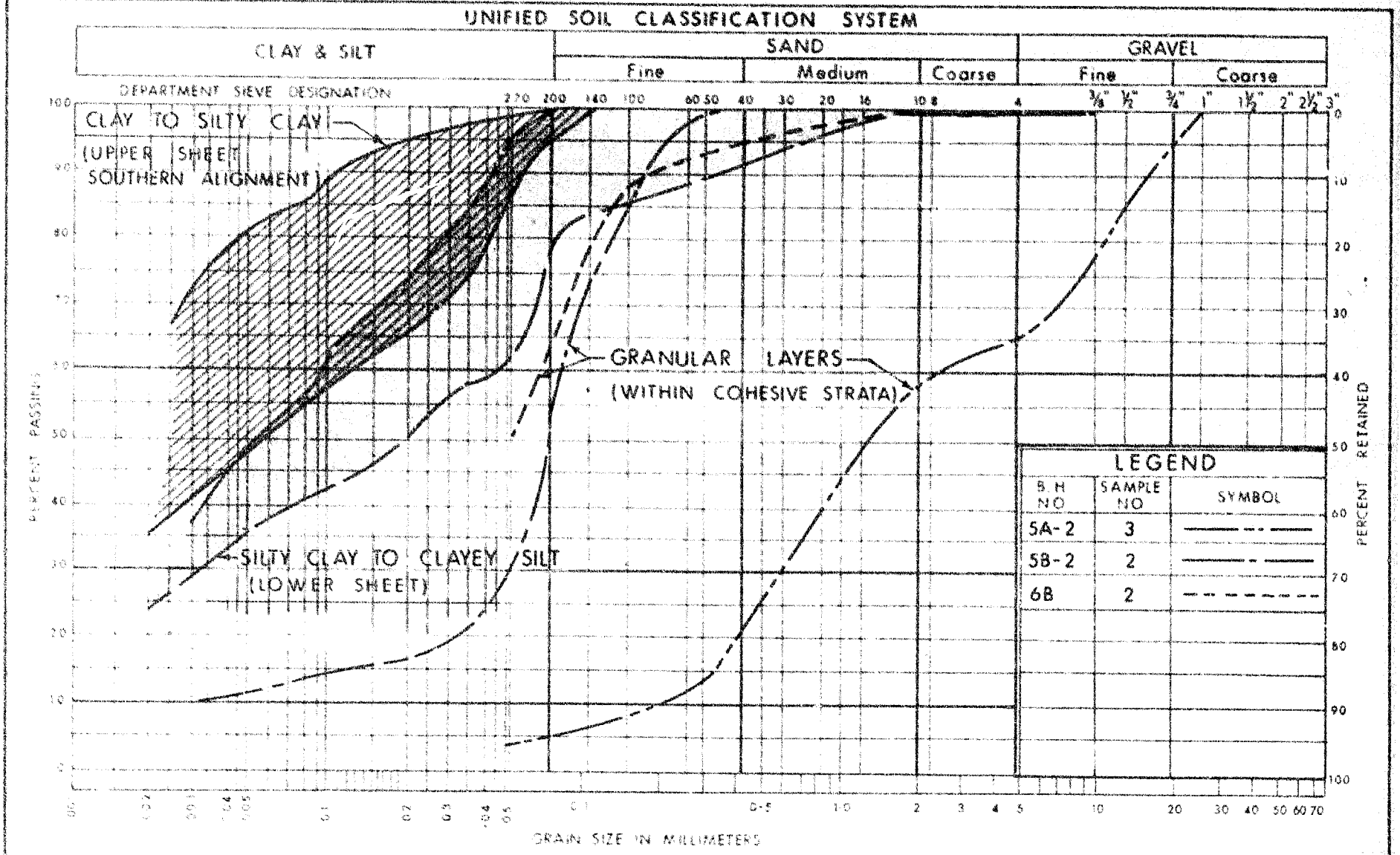


DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION
SAND
TRACE TO SOME SILT & GRAVEL
(UPPER DEPOSIT)

W.P No. 5 - 67
JOB No. 69 - F - 73
FIG 1

REV APR 1965



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

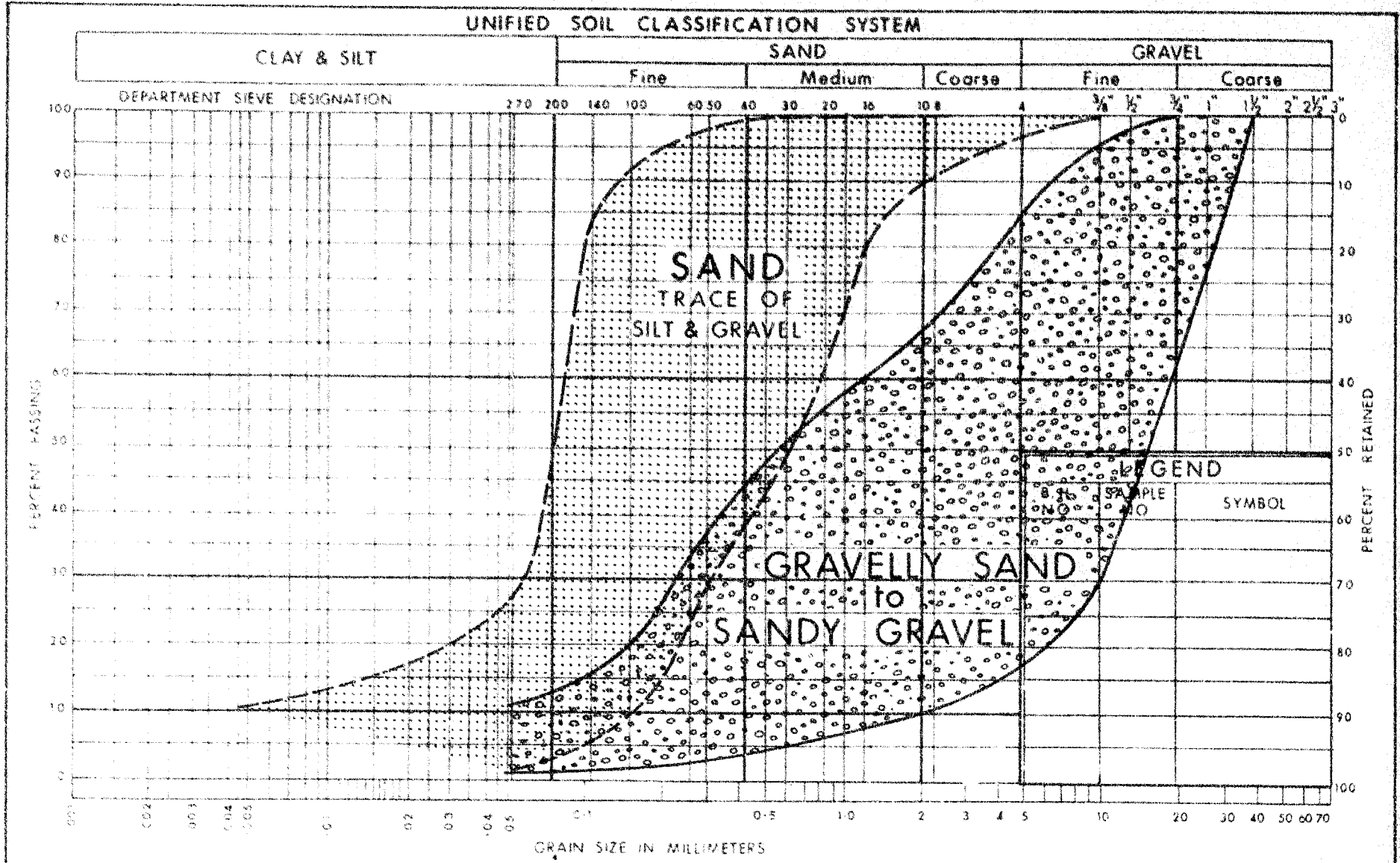
GRAIN SIZE DISTRIBUTION
COHESIVE STRATA

W.P. No. 5 - 67

JOB No. 69 - F - 73

FIG. 2

REV APR. 1965



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION

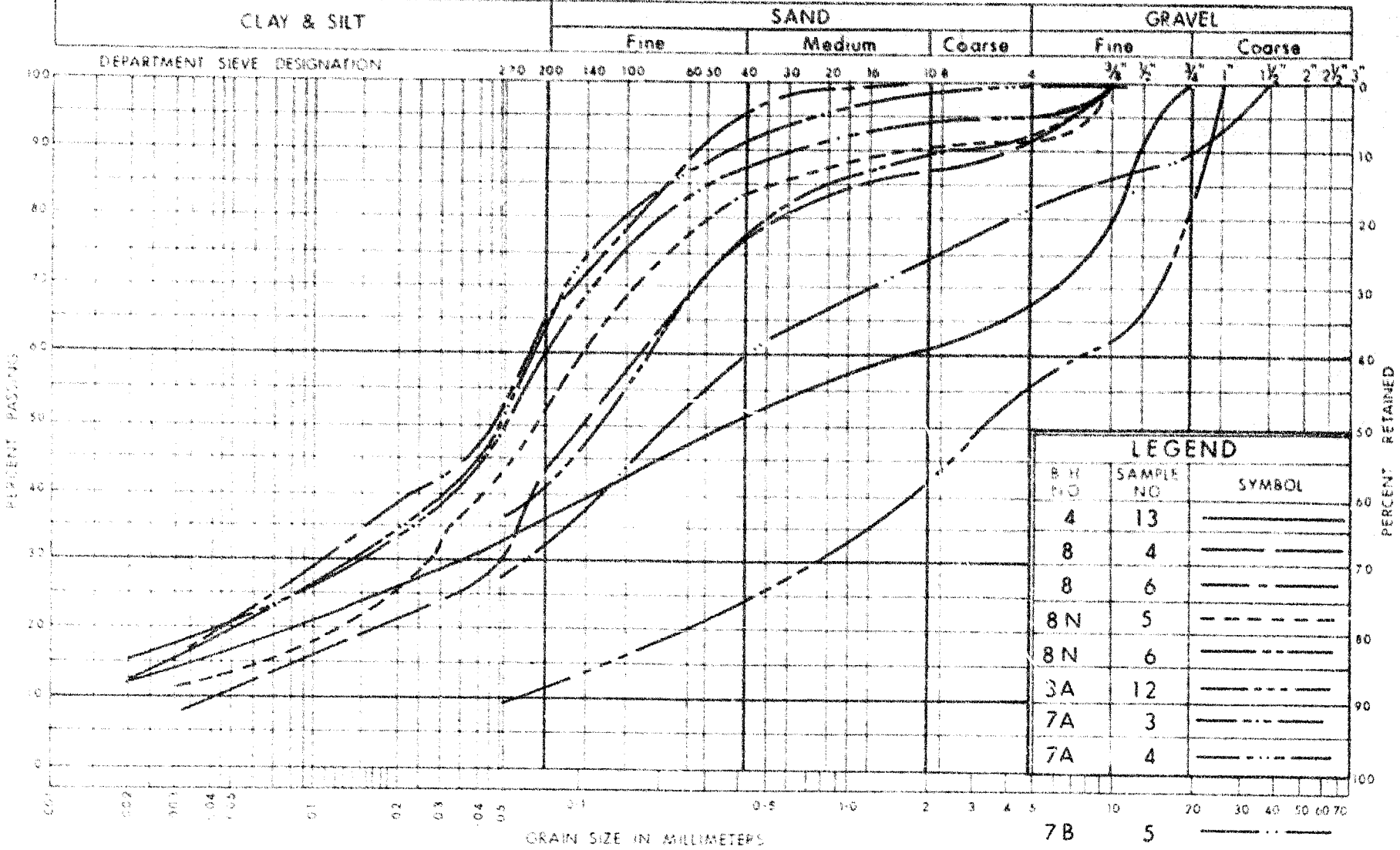
W.P No. 5 - 67

JOB No. 69-F-73

FIG. No. 3

REV. APR 1965

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

GRAIN SIZE DISTRIBUTION

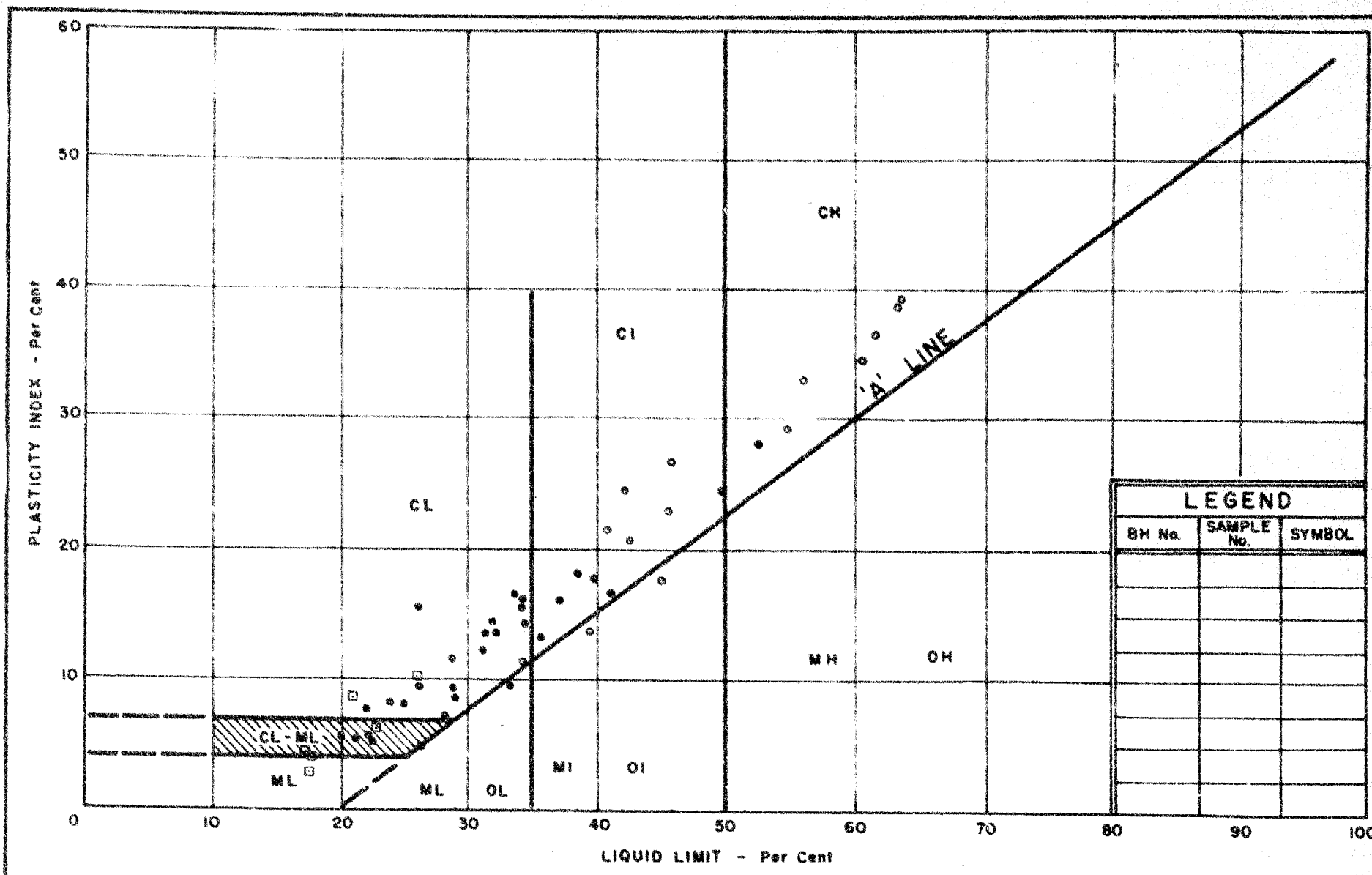
GLACIAL TILL

W.P. No. 5 - 67

JOB No. 69 - F - 73

FIG. 4

REVISED JUL 966



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

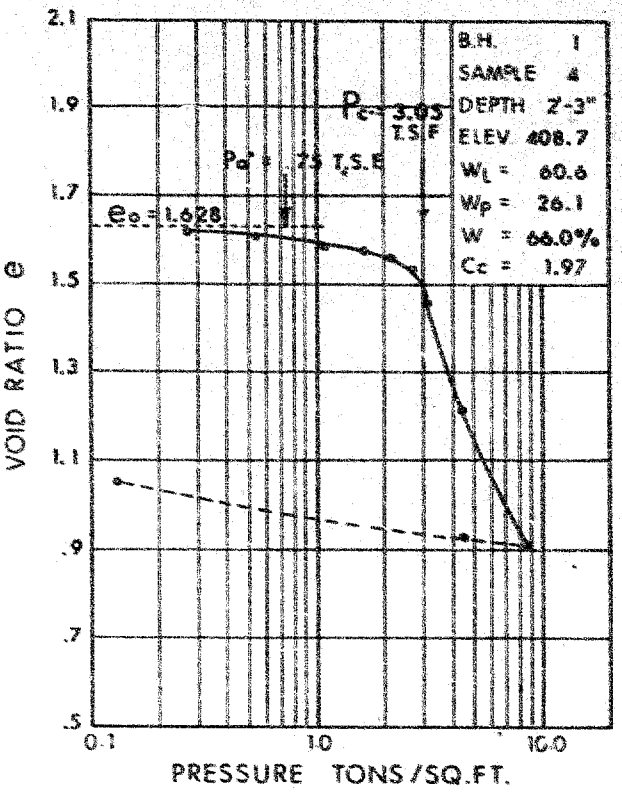
PLASTICITY CHART

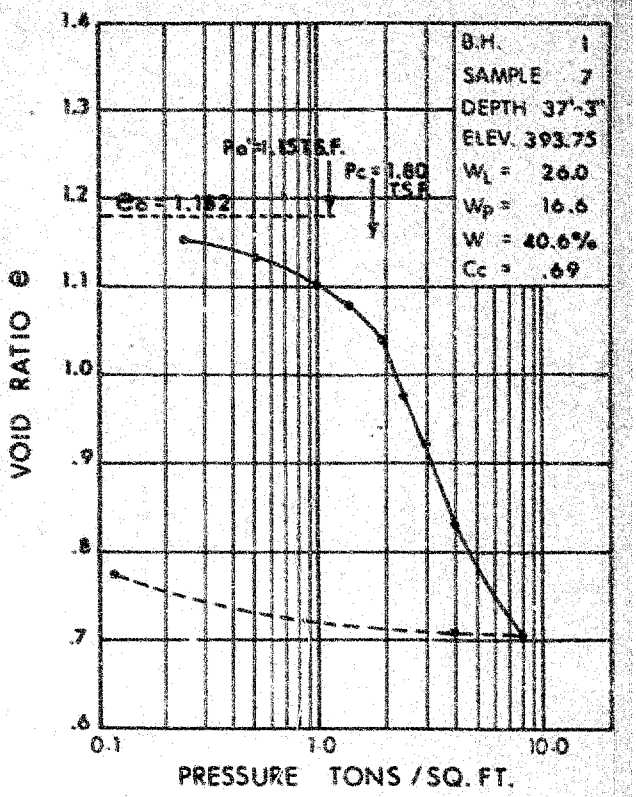
○ CLAY TO SILTY CLAY (UPPER SHEET)
● SILTY CLAY TO CLAYEY SILT (LOWER SHEET)
□ GLACIAL TILL

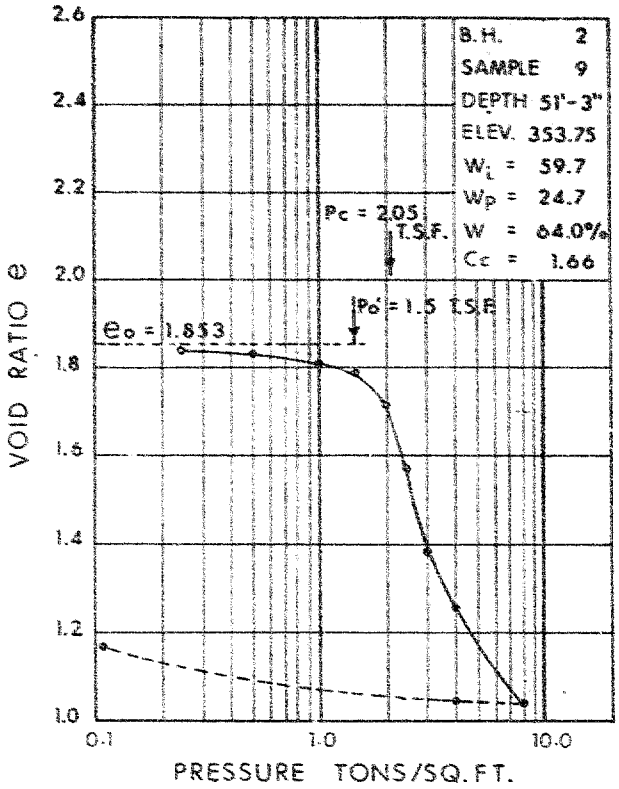
W.P. No. 5 - 67
JOB No. 69 - F - 73
FIG. 5

VOID RATIO – PRESSURE CURVES

JOB NO. 69 - F - 73







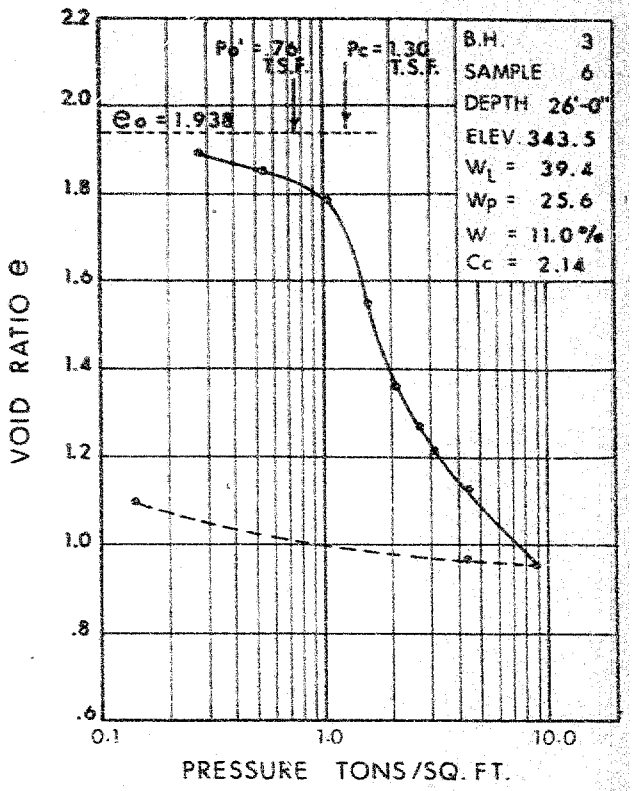
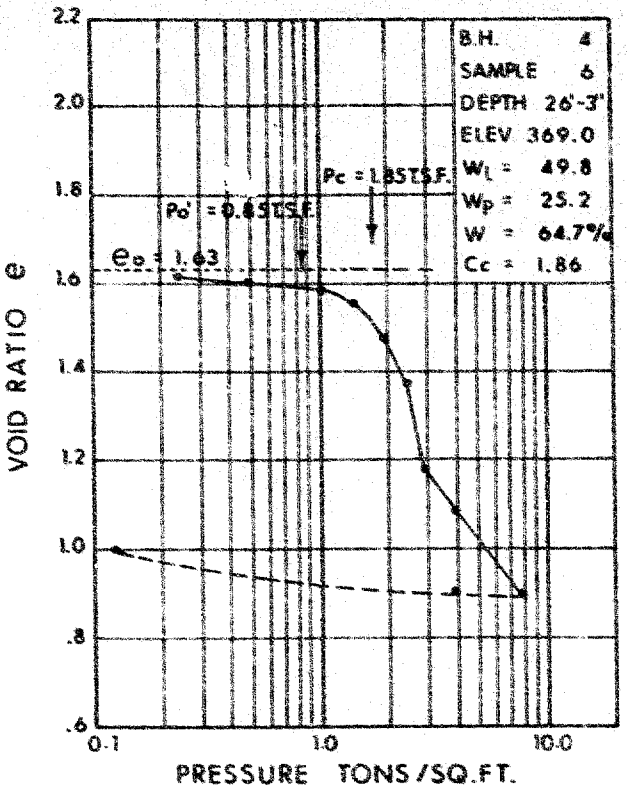
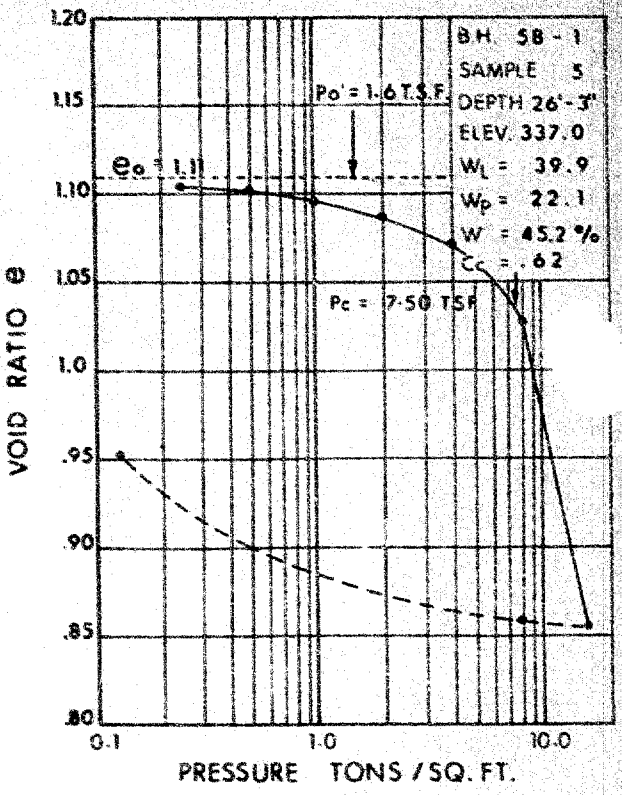


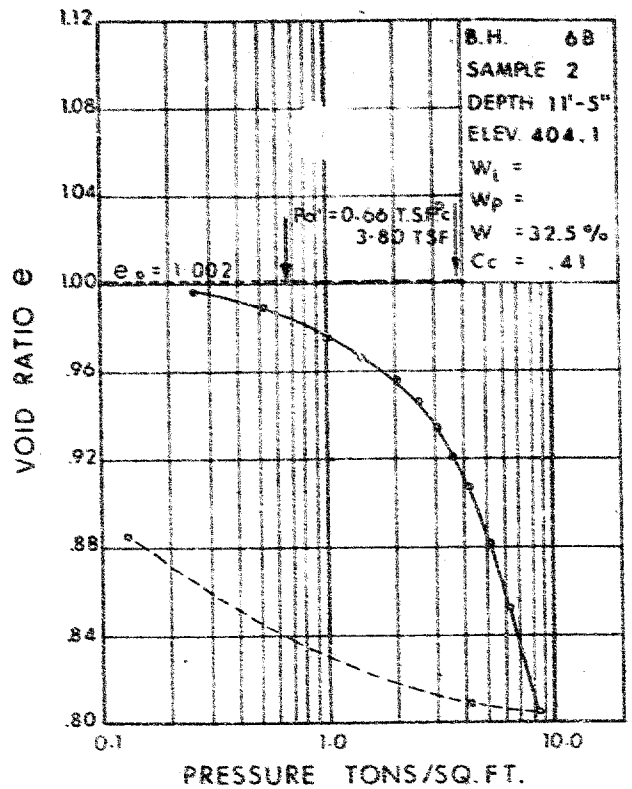
FIG. 6

VOID RATIO – PRESSURE CURVES

JOB NO. 69 - F - 73







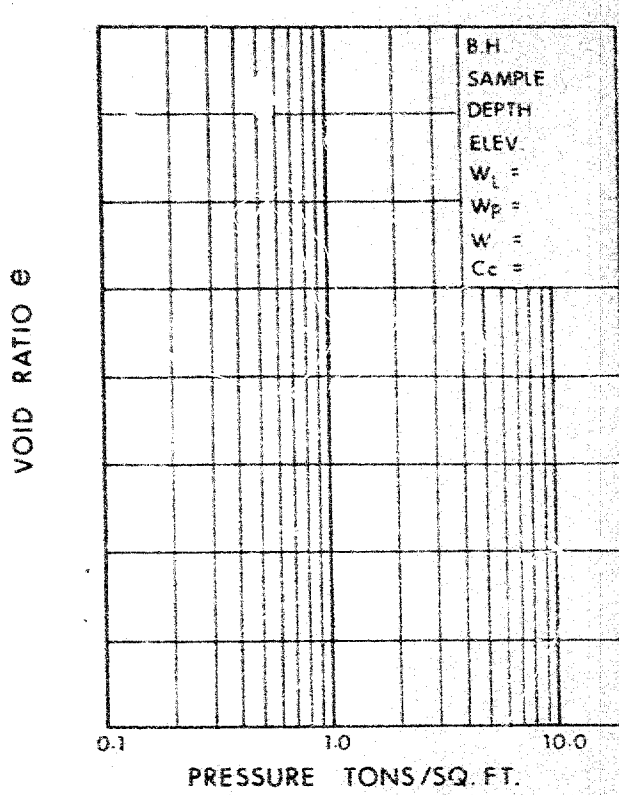


FIG. 7

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.
VERY SOFT	0 - 2	0 - 250
SOFT	2 - 4	250 - 500
FIRM	4 - 8	500 - 1000
STIFF	8 - 15	1000 - 2000
VERY STIFF	15 - 30	2000 - 4000
HARD	> 30	> 4000

DENSENESS	'N' BLOWS / FT.
VERY LOOSE	0 - 4
LOOSE	4 - 10
COMPACT	10 - 30
DENSE	30 - 50
VERY DENSE	> 50

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B	SCRAPER BUCKET SAMPLE	O.S	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE
S.T	SLOTTED TUBE SAMPLE		
	P.H SAMPLE ADVANCED HYDRAULICALLY		
	P.M SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q_u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V	FIELD VANE
Q_{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q_d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta \sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

DEPARTMENT OF HIGHWAYS ONTARIO

69-F73

MEMORANDUM

To: [illegible] N. Dervin,
Foundation Section,
Downsview, Ontario.

From: Functional Planning Section,
Kingston, Ontario.

Attention:

Date: Aug. 5, 1969

Our File Ref:

In reply to:

Subject: W.P. 190-67-00 and W.P. 5-[illegible]-3.
Hwy. 17(New), Hwy. 41 to Brockville
Stn., District 9 - Ottawa.

Further to the recent meeting between yourself and representatives of Functional Planning and Bridge Location from this region we hereby request a preliminary assessment of foundation conditions at proposed structure locations for alternative routes on the above project. At the time of this assessment and a field inspection with a representative of Foundation Section, preliminary foundation investigations will be undertaken at selected sites.

Aerial photography is available from Photogrammetry Section at Head Office and we would suggest that this be obtained from them. Their reference system utilizes militia maps such as was left with you at the meeting.

More detailed information of alignment and grades will be available next week and will be forwarded to you as soon as possible.

The well drilling information as presented to you is up until 1959, further information has been requested but it appears that it is unlikely to be available in time for your purposes.

Should you require further information do not hesitate to contact this office.

B.B. Khojajian,
Project Planning Engineer.

BBK/PRB/tl.

cc: T.A. Rinaldi
R. Forrest.

#69-F-73

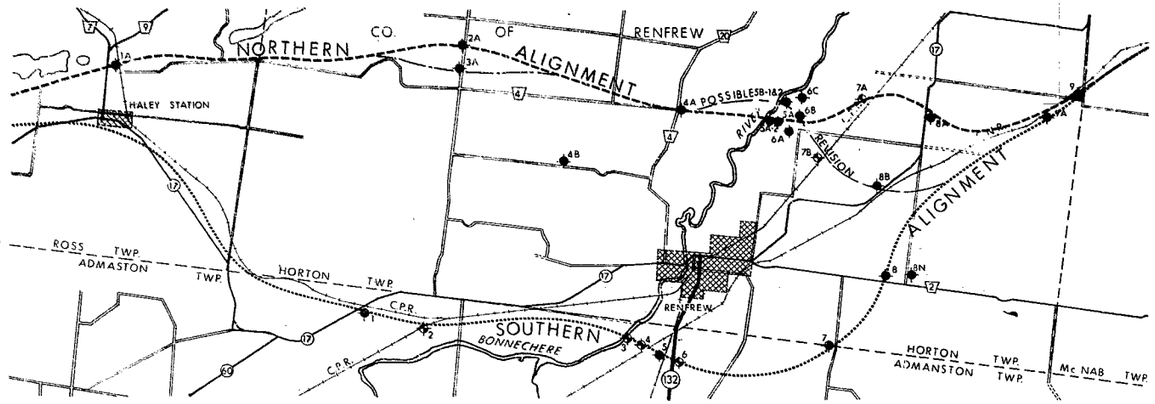
W.P. 5-67

H.W.Y. #17

(NORTH AND SOUTH ALIGNMENTS)

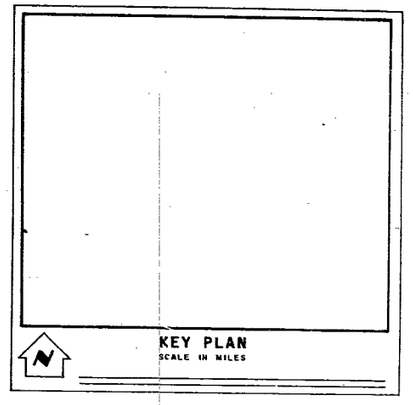
REVISED STRUCTURE

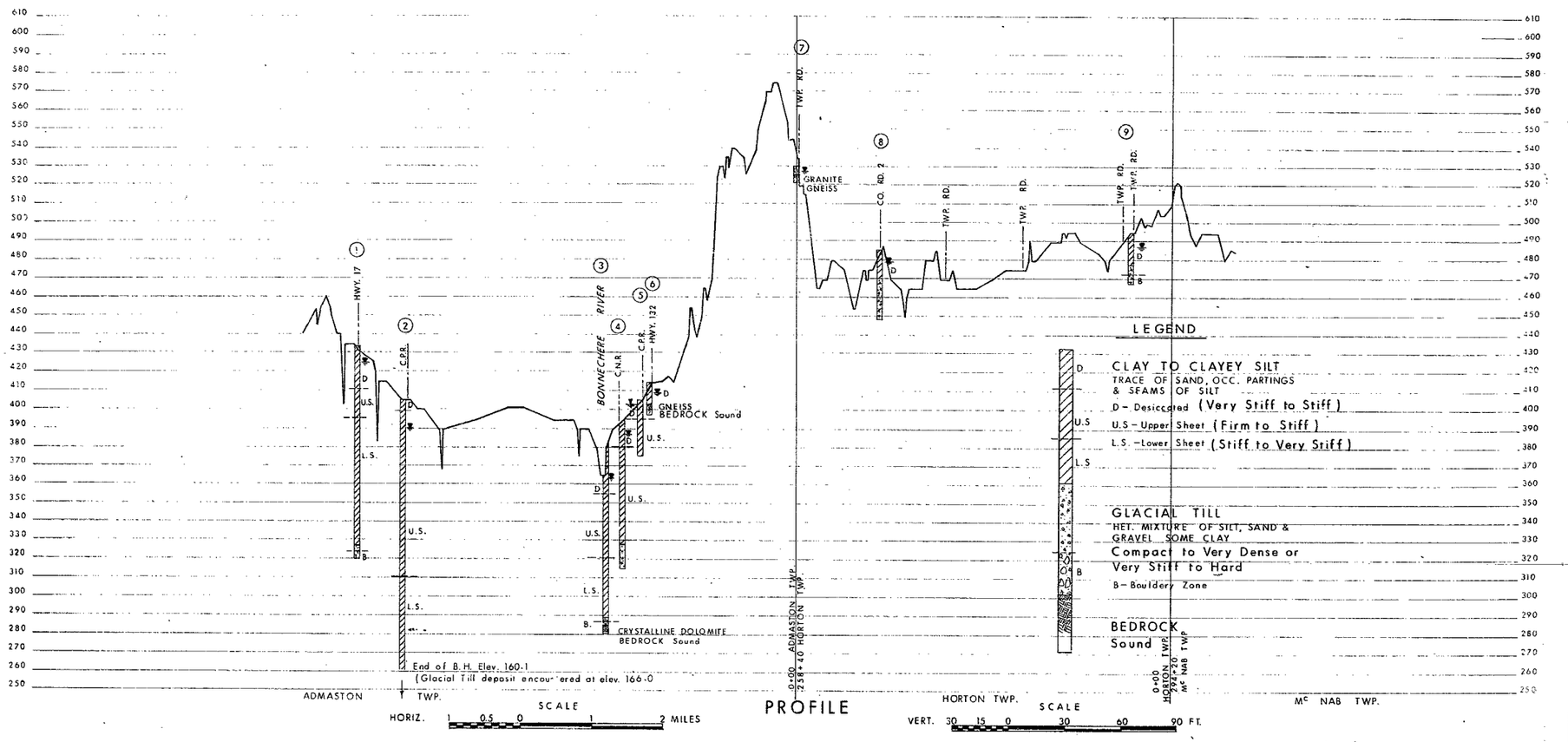
CROSSINGS



PLAN

SCALE 1 0.5 0 1 2 MILES





PROFILE

LEGEND

D CLAY TO CLAYEY SILT
TRACE OF SAND, OCC. PARTINGS & SEAMS OF SILT
D - Desiccated (Very Stiff to Stiff)
U.S - Upper Sheet (Firm to Stiff)
L.S. - Lower Sheet (Stiff to Very Stiff)

GLACIAL TILL
HET. MIXTURE OF SILT, SAND & GRAVEL SOME CLAY
Compact to Very Dense or Very Stiff to Hard
B - Bouldery Zone

BEDROCK
Sound

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. Sept 1969

SITE	ELEVATION	STATION	OFFSET
1	431.0		
2	405.0		
3	369.5		
4	395.2		
5	410.1	As	Shown
6	415.6		
7	530.0		
8	485.0		
8N	455.0		
9	494.0		

– NOTE –

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING OFFICE – FOUNDATION SECTION

PRELIMINARY INVESTIGATION

SOUTHERN ALIGNMENT

KING'S HIGHWAY NO. 17 RECONSTRUCTION DIST. NO. 9
CO. RENFREW
TWP. LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. B.T.D	CHECKED BTD	W.P. NO. 5 - 67	M.B.T. DRAWING NO. 69 - F - 73B
DRAWN A.N.	CHECKED	JOB NO. 69 - F - 73	
DATE Feb. 27, 1970		SITE NO.	BRIDGE DRAWING NO.
APPROVED A.B. Bowman PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	