DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M13-50

DIST. 6 REGION

W.P. No. 153-80-04/02

CONT. No. 88-30

W. O. No.

STR. SITE No. 37-1111

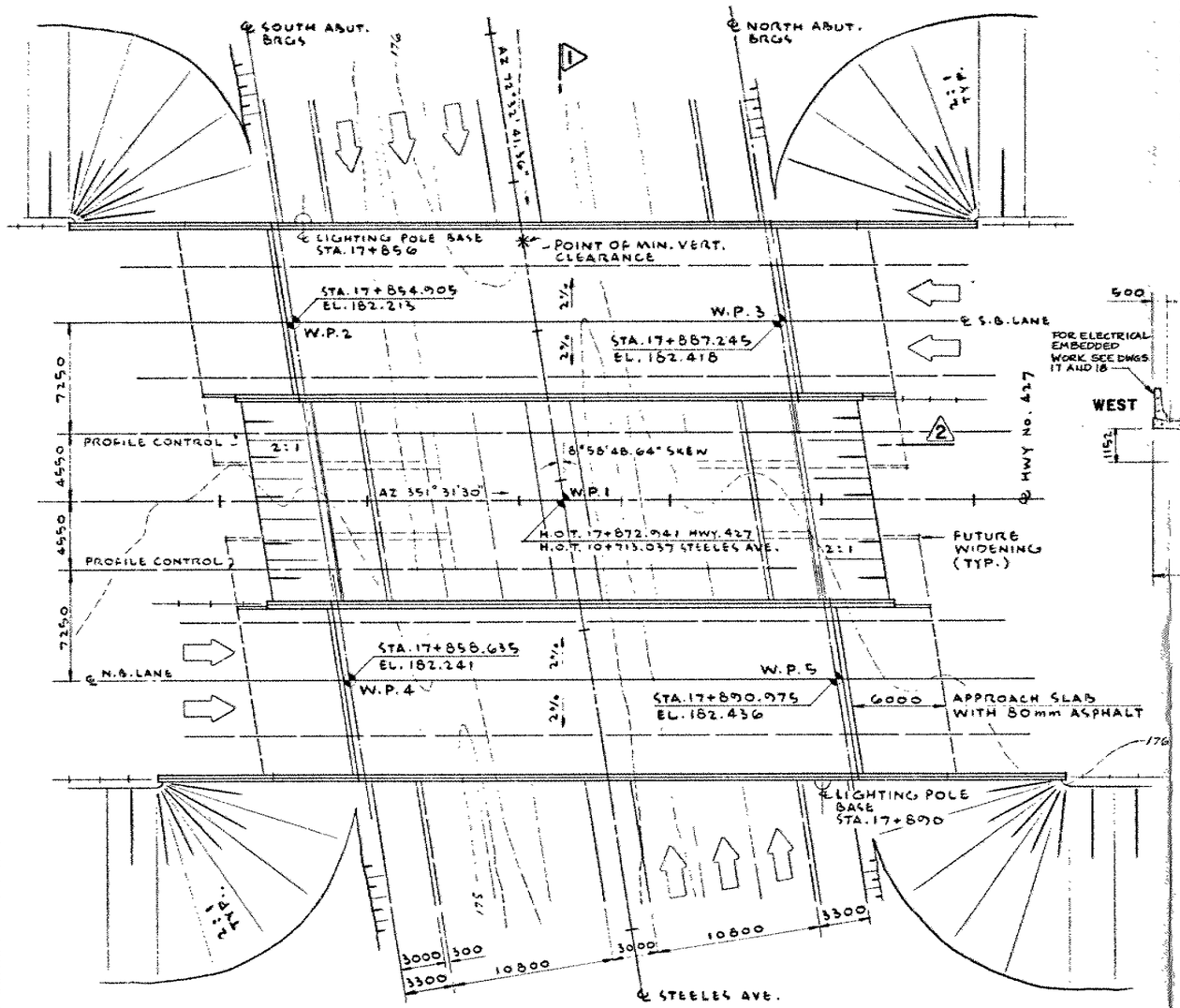
HWY. No.

LOCATION Steeles Ave. Overpass at Hwy 427

No. of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



PLAN
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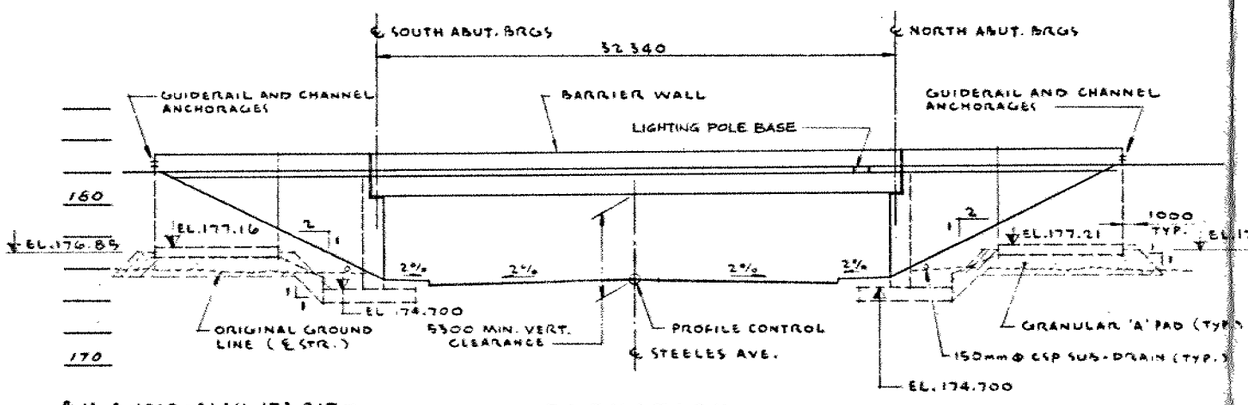


ELEVATION
1 : 200

B.M. E-1010 - ELEV. 173.217 m
GEODETIC DATUM:
TABLET IN CENTRE AT NORTH END OF WEST CONCRETE PIER OF BRIDGE OVER CNR TRACKS ON ALBION ROAD, 1.160 m ABOVE GROUND LEVEL.

CONCRETE QUANTITIES:

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM ITEMS

1. CONCRETE IN BRIDGE AND RETAINING WALL FOOTINGS	392 m³
2. CONCRETE IN ABUTMENTS, WINGWALLS AND RETAINING WALLS	662 m³
3. CONCRETE IN DECK	200 m³
4. CONCRETE IN BARRIER WALLS	83 m³
5. CONCRETE IN APPROACH SLABS	67 m³
STRUCTURAL STEEL QUANTITIES	139 tons

METRIC

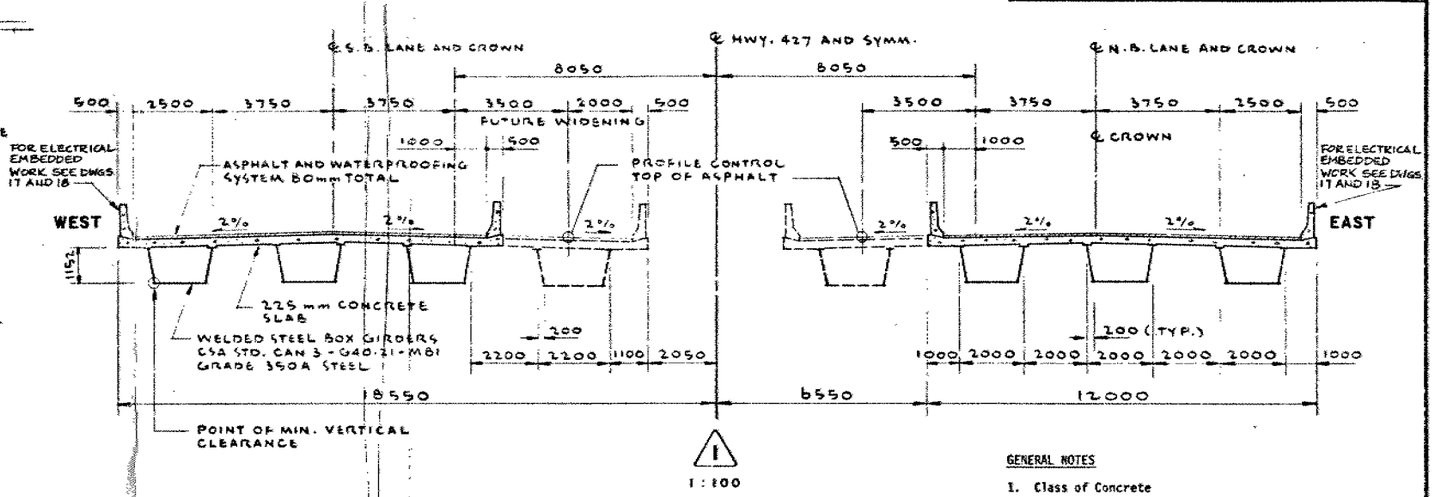
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DISTRICT No. 6
CONT No
WP No. 153-80-04

SHEET

STEELES AVE. OVERPASS AT HIGHWAY 427
GENERAL ARRANGEMENT

Proctor & Redfern Limited
Consulting Engineers and Planners
Toronto
E.O. 81239



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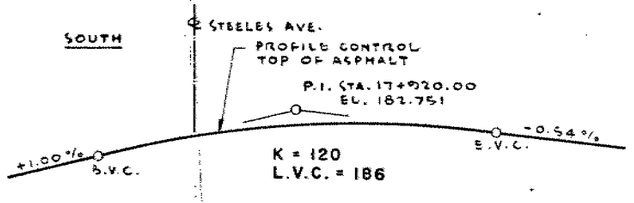
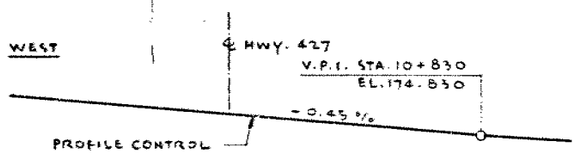
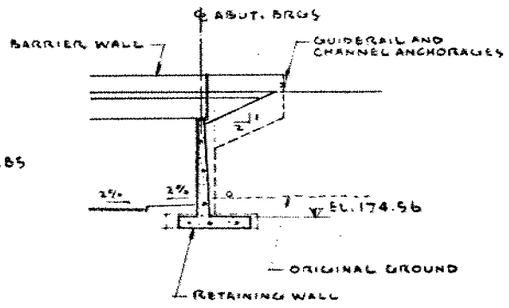


PROFILE HIGHWAY No. 427
N. T. S.



PROFILE STEELES AVE.
N. T. S.



2
1 : 200

GENERAL NOTES

1. Class of Concrete
   (a) Deck, Barrier Walls, Abutments, Retaining Walls & Footings 30 MPa
   (b) Remainder 20 MPa
2. Clear Cover to Reinforcing Steel
   (a) Footings 100 ± 25 mm;
   (b) Deck Bottom 40 ± 10 mm;
   (c) Deck Top 70 ± 20 mm;
   (d) Abutments, Wing Walls & Retaining Walls Front Surfaces 80 ± 20 mm;
   (e) Remainder 70 ± 20 mm; unless otherwise noted.
3. Reinforcing Steel shall be Grade 400, unless otherwise specified. Bars marked with suffix C shall be coated bars.
4. Construction Notes
   (a) The Contractor shall finish the bearing seats dead level to the specified elevations to a tolerance of ± 3 mm.
   (b) Concrete barrier walls on retaining walls shall not be cast until the retaining wall backfill has been completed.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BORE HOLE LOCATIONS & SOIL STRATA
3. FOOTING DETAILS
4. N.B.L. ABUTMENTS
5. S.B.L. ABUTMENTS
6. WINGWALLS
7. RETAINING WALLS
8. STRUCTURAL STEEL
9. DECK REINFORCING
10. DECK LAYOUT AND SCREED ELEV'S
11. BARRIER WALL
12. 6000 mm APPROACH SLAB
13. BRIDGE DATE & SITE NUMBER DATA
14. AS CONSTRUCTED ELEV. & DIM.
15. STANDARD DETAILS I
16. STANDARD DETAILS II
17. ELECTRICAL EMBEDDED WORK I
18. ELECTRICAL EMBEDDED WORK II

REGISTERED PROFESSIONAL ENGINEER J. H. S. VIERHUIS PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER T. F. WONG PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN T F W	CHECK H V	LOADING OHBDC-A79	DATE Dec. 1982
DRAWING S C K	CHECK C K	SITE 37-80-4111	DWG 1

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

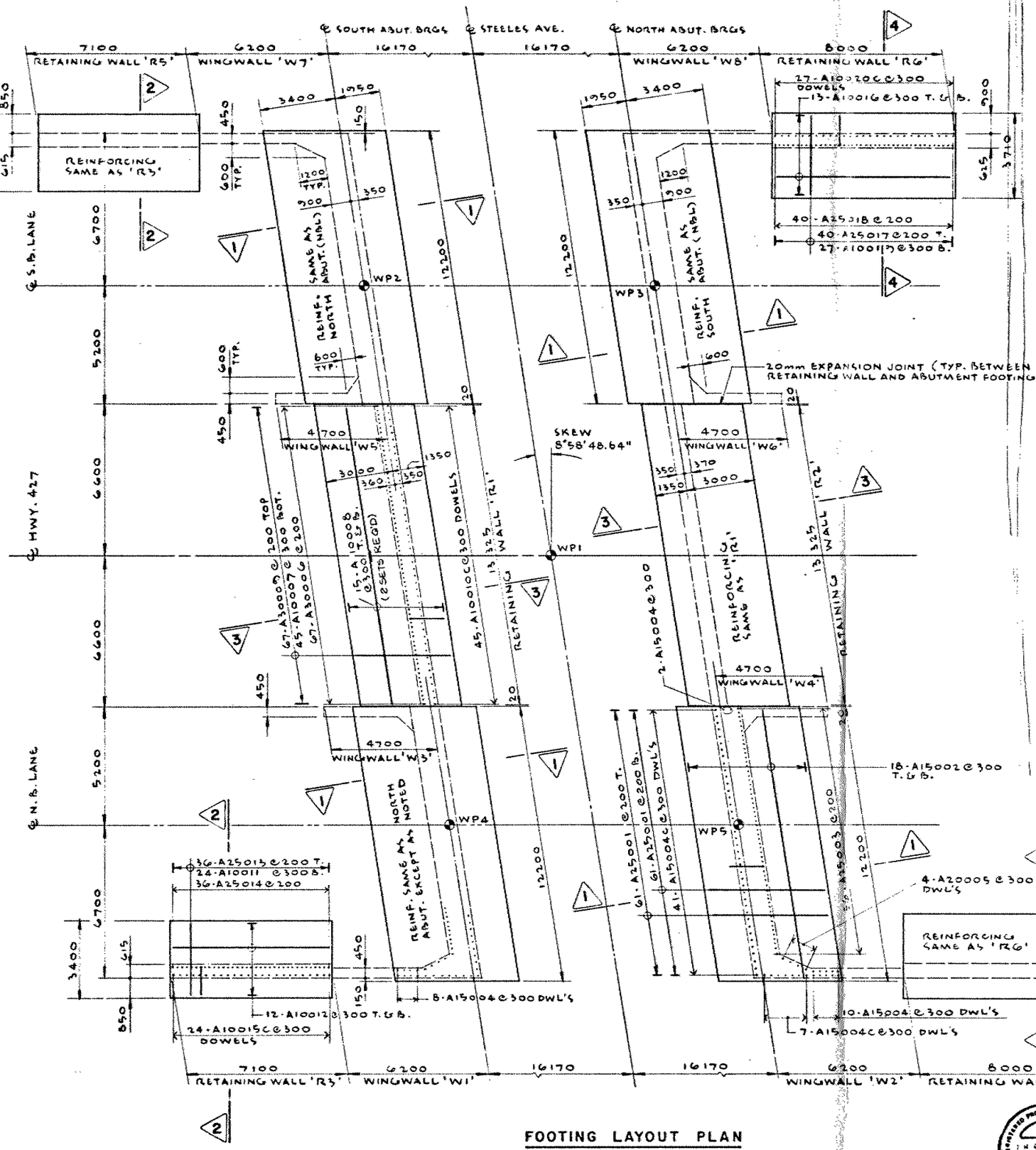
DISTRICT No. 6
CONT No
WP No. 153-80-04

SHEET

STEELES AVE. OVERPASS
AT HIGHWAY 427
FOOTING DETAILS

Proctor & Redfern Limited
Consulting Engineers and Planners
Toronto

E.O. 81239



FOOTING LAYOUT PLAN

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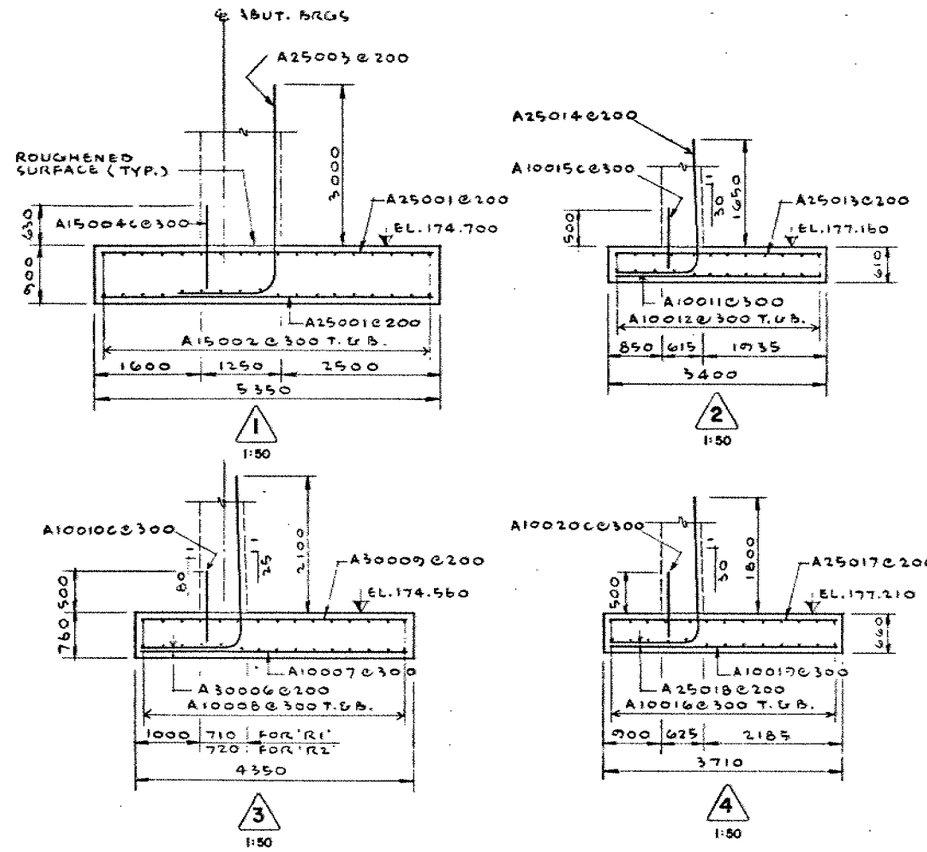

1 1:50 2 1:50 3 1:50 4 1:50

LOCATION OF WORKING POINTS

W.P.	STATIONS	CO-ORDINATES	
		NORTH	EAST
1	17+872.941	4,845,532.859	294,237.088
2	17+854.905	4,845,513.262	294,228.075
3	17+887.245	4,845,545.249	294,223.309
4	17+858.635	4,845,520.429	294,250.867
5	17+890.975	4,845,552.416	294,246.101

H. V. VIERHUIS — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

T. F. WONG — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN T.F.W.	CHECK H.V.	LOADING OHBDC-A79	DATE Dec. 1982
DRAWING SCK	CHECK C.K.	SITE 37-80-1111	DWG 3

Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

REPORT TO

MINISTRY OF
TRANSPORTATION AND COMMUNICATIONS

FOUNDATION INVESTIGATION
PROPOSED OVERPASS BRIDGE
AT HIGHWAY 427 AND STEELES AVENUE
W.P. 153-80-04 DISTRICT 6

Distribution:

12 copies - Ministry of Transportation
and Communications
Downsview, Ontario

2 copies - Golder Associates
Mississauga, Ontario

March, 1982

821-1050

ABSTRACT

A subsurface investigation was carried out by Golder Associates for the Ministry of Transportation and Communications at the site of a proposed overpass bridge on Highway 427 at Steeles Avenue in Etobicoke, Ontario.

The borings indicate that the site is underlain by very stiff to hard clayey silt till overlying very dense sand deposits. The sand deposits are in turn underlain by hard grey silt till. The static groundwater level is at a depth of about 7 metres below ground surface within the sand.

Several foundation alternatives are available, including spread footings, piles, and caissons, within the natural ground. Abutment footings may be placed on compacted granular fill within the proposed approach embankments.

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1.0 INTRODUCTION

Golder Associates have been retained by the Ontario Ministry of Transportation and Communications to carry out a foundation investigation at the site of a proposed overpass bridge at Highway 427 and Steeles Avenue in Etobicoke, Ontario. Authorization for the investigation was received in a letter dated February 2, 1982 from the Hon. James Snow, Minister of Transportation and Communications.

The purpose of the investigation was to determine the subsurface conditions at the site and based on an assessment and interpretation of these data, to provide engineering recommendations for the geotechnical aspects of the design of the foundations for the proposed structure and the approach embankments.

The field investigation was carried out and this report was prepared in accordance with the terms of reference outlined in Golder Associates proposal letter dated February 2, 1982 to Mr. M. S. Devata, P. Eng., Supervisory Engineer in the Soil Mechanics Section, Ministry of Transportation and Communications, Downsview, Ontario.

2.0 SITE AND PROJECT DESCRIPTION

The details and requirements of the project were provided during a meeting between Messrs. M. Devata and T. Kazmierowski of the Ministry of Transportation and Communications, and Messrs. F. Heffernan and M. Tanos of Golder Associates on January 27, 1982. Additional details were provided on a drawing titled "Highway No. 427 Over Steeles Ave., Preliminary Site Plan" dated November, 1981 (Dwg. No. X-81197-G3 by Proctor & Redfern Limited).

The project site is located on Steeles Avenue between Highway No. 27 and Highway No. 50 on the boundary between the Borough of Etobicoke and the Town of Vaughan (refer to Key Plan on Dwg. 1538004-A. The existing topography around the site is flat and level. The land is clear of vegetation and is currently in use as farm land. At present, Steeles Avenue is a 2 lane paved roadway with narrow gravel shoulders and side ditch drainage.

It is understood that at Site 37-1111, the proposed Highway 427 overpass across Steeles Avenue will be a reinforced concrete twin structure with two span, semi-continuous support across the central piers. Each structure will be about 12 metres wide by about 50 metres long with individual spans of about 22 metres. It is further understood that approach embankments will be constructed on both ends of the proposed overpass structure. The maximum height of the embankments will be about 6.3 m above the existing ground surface.

The preliminary design alignments of the overpass bridge and foundations (abutments and centre pier) are shown on the attached Dwg. 1538004-A - Borehole Locations and Soil Strata.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

From a review of available geological references*, the site is located in the Halton-Peel till plain which was spread over the area by the advance and retreat of the Wisconsinan ice sheet during the Pleistocene epoch (over 5,000 years ago). The till plain occupies the area east of the Niagara Escarpment and north of the Lake Iroquois shoreline. It consists mainly of a bevelled till plain with a gently undulating rolling surface and limited relief. In places the till is overlain by thin deposits of varved clay.

Indications are that there are four till sheets present. The uppermost material is described as s stony clay. The till sheets are usually separated from one another by a bed of stratified silt or sand of variable thickness. The middle till is a grey to brown, dense sandy till up to 6 m thick. The lowest till is a grey silty till which appears sandier than the surficial till. Grey shale bedrock has been found in the area at depths of 25 to 30 metres below ground surface.

3.2 Soil Stratigraphy

The detailed stratigraphy encountered in each of the boreholes put down during this investigation is given on the attached Record of Borehole sheets. It should be noted that the soil boundaries indicated on the Record of Borehole sheets are not exact planes of geological change but represent transitions

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* Watt, A.K., "Pleistocene Geology and Groundwater Resources, Township of Etobicoke", O.D.M. Geological Report 59, 1968.

Hewitt, D.F., "Industrial Mineral Resources of the Brampton Area", O.D.M. Industrial Mineral Report 23, 1969.

Chapman, L.J., and Putnam, D.F., "The Physiography of Southern Ontario", Ontario Research Foundation, 1966.

Hewitt, D.F., White, O.L., "Industrial Mineral Resources of the Bolton Area", O.D.M. Industrial Mineral Report 30, 1969.

from one soil type to another. Conditions will change between boreholes. The locations of the boreholes and stratigraphic sections showing the inferred subsurface conditions are given on the attached Dwg. 1538004-A. The results of laboratory testing carried out on representative samples are given on the Record of Borehole sheets and on Figures 1 to 5 inclusive.

3.2.1 Silty Clay Till

Beneath about 150 mm of topsoil, a mottled brown and grey silty clay till was encountered in all the borings, to depths of 2.9 to 4.3 metres below ground surface. The till is generally well-graded and contains sand as well as inclusions of rounded medium to fine gravel (see Figure 1). Towards its base, the stratum contains a higher proportion of sand. 'N'* values of 21 to 57 were measured in the till indicating the soil to be very stiff to hard.

The measured water content of the clayey silty clay till ranged from about 20 percent near the ground surface to about 10 percent at depth. Based on the 'N' values obtained and the correlations quoted by Terzaghi (1948)** and Hough (1969)***, it is estimated that the undrained shear strength of the soil is at least 200 kPa. The measured liquid limit of the material varied between 30 and 21 percent and the plastic limit varied between 18 and 16 percent. The plasticity index was found to be between 5 and 12 percent. These values classify the soil as inorganic clay and silt of low plasticity.

3.2.2 Interbedded Silty Sand and Sandy Silt

In all the boreholes, the silty clay till stratum is underlain by a 2 to 3 metre thick deposit of brown interbedded silty sand

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* 'N' - Standard Penetration Resistance - Refer to Explanation of Terms.

** Terzaghi, K. and Peck, R.B., "Soil Mechanics in Engineering Practice", J. Wiley & Sons, 1948.

*** Hough, B.K., "Basic Soils Engineering", Ronald Press Co., 1957.

and sandy silt layers extending to depths of 5.2 to 6.7 metres below ground surface. The layers are horizontal and their thickness varies from 10 to 55 mm. The results of grain size analyses carried out on samples of this deposit are shown on Figure 2. 'N' values measured in this deposit ranged from 59 to 120 which indicate it to be very dense.

The measured water content of the sand and silt layers ranges from about 2 to 19 percent. In boreholes 1, 3 and 4 the static water level is below the base of the deposit and the average water content is about 8 percent. In boreholes 2, 5 and 6, the static water level is within the deposit and the average water content is about 16.5 percent.

3.2.3 Silty Fine Sand and Sand with some Gravel

Beneath the interbedded silt and sand, a silty fine sand stratum was encountered in all the boreholes. In boreholes 2 to 6, the fine sand extended to the bottom of the boreholes at depths of about 9.5 and 11 metres below ground surface. In borehole 1 the silty fine sand was found to be about 8 metres thick, extending to a depth of about 13 metres below ground surface. In boreholes 4 and 6, a well graded sand deposit with gravel was encountered below the fine sand and this extended to the bottom of the boreholes. In borehole 3 a similar material was present as a 1 metre thick seam within the fine sand. The grain size distributions of this fine sand and the sand with gravel are given on Figures 3 and 4 respectively. The 'N' values recorded during sampling were similar for both the fine sand and the sand with gravel and ranged from 35 to more than 125 with an average value of about 70. Several of the lower 'N' values are considered to have resulted from disturbance caused by upward seepage during sampling operations.

The measured water content of this very dense sand strata ranged from 10 to 20 percent with an average of about 16 percent.

3.2.4 Hard Grey Till

Beneath the silty fine sand stratum in Borehole 1, a very hard, grey silty clay till with some gravel and sand was encountered to a depth of at least 21.5 metres below ground surface. The grain size distribution of this soil is shown on Figure 1. A 400 mm thick seam of silty fine sand was found within the hard till at a depth of about 20 metres below ground surface. The 'N' values recorded for this stratum were all greater than 100 per 225 mm of penetration, and the deposit can be described as very hard.

The measured water content of the till was between 7 and 9 percent. The measured liquid limit and plastic limit was 24 and 15 percent respectively, for a plasticity index of 9. The till can be classified as a clay of low plasticity.

3.3 Groundwater Conditions

Following completion of each borehole, piezometers were installed in all boreholes except No. 5, to allow monitoring of groundwater levels across the site. The details of piezometer installation are given on the Record of Borehole sheets.

The water levels in the piezometers were monitored on February 16 and 17 and March 1, 1982. The individual readings are given on the attached Table 1. The stabilized groundwater level within the confined sand strata was found to be at about elevation 170 metres which is 5 to 6 metres below ground surface. The piezometer in Borehole 1 was installed within the hard grey till beneath the sand strata and the measured water level was at about elevation 169.8 metres. Seasonal fluctuations of the groundwater level should be anticipated.

4.0 DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are addressed to the proposed overpass bridge structure as shown on the preliminary site plan by Proctor & Redfern Ltd. for W.P. 153-80-04 (Dwg. No. X-81197-G3, dated November, 1981). The proposed overpass bridge will be a two span twin structure, with semi-continuous support across the central pier. Each structure will be about 12 metres wide by 50 metres long with spans of 22 metres. The approach embankments will be up to 6.3 metres high.

This section of the report is for the guidance of the design engineer only. Contractors bidding on or undertaking the works should make their own interpretation of the factual information provided, as it affects their proposed construction methods, equipment selection, scheduling and the like.

4.1 Bridge Foundations

The natural soils found at the site are suitable for the support of bridge foundations and approach embankments. Depending on the most economical proportioning of foundation dimensions and excavation requirements, together with the tolerance of the proposed structure to differential settlement, various options may be considered. Bearing capacity and settlement calculations have been carried out in accordance with the current Ontario Highway Bridge Design Code (OHBDC).

4.1.1 Shallow Foundations

4.1.1.1 Spread Footings on Till

Spread footings for the abutments and/or the central pier support may be placed on the very stiff to hard, brown silty clay till. Figure 6 shows a plot of 'N' values against depth. Below a depth of 1.2 metres, 'N' values in the upper silty clay till are consistently higher than 30. Based on this (refer to Section 3.2.1), an undrained

shear strength of 200 kPa has been estimated for the deposit. Assuming ratios of depth to width and width to length of 0.5 for the foundations, a factual bearing capacity at ultimate limit states of 630 kPa can be used in design. It should be noted that for the case of inclined loading, this value should be corrected in accordance with the recommendations given in the OHBDC.

In the case of abutments, the settlement and therefore the bearing capacity at serviceability states Type II is dependent on the settlements induced by the approach embankments. It has been calculated that 6.3 metres high embankments will induce a settlement of about 15 mm at the bridge abutment location. Footings 2.5 metres wide, loaded to a net bearing pressure of 400 kPa are likely to induce about a further 10 mm of settlement. For a net pressure of 400 kPa applied at the base of abutment footings, the calculated settlement is 25 mm. Therefore 400 kPa is the bearing capacity at serviceability limit states Type II for the abutment founded on the silty clay till. For the piers with no embankment loading the bearing pressure at serviceability limit states will be about double this figure and the ultimate limit state criterion will govern.

At least 1.2 metres of soil cover must be provided to the foundations for frost protection.

4.1.1.2 Abutment Spread Footings on Granular Fill

Spread footings for slab abutments may be placed on M.T.C. Granular 'A' material compacted to 100 percent of standard Proctor density. The existing topsoil and loose or disturbed soil should first be removed from beneath the embankment area. It is important that the native subgrade be prepared properly and that the granular fill be placed and compacted uniformly. A soil cover of at least 1.2 metres must also be provided to the footings for frost protection. Figure 7 shows a typical arrangement of a spread footing on compacted granular

fill. For the dimensions given, the factored bearing capacity at Ultimate Limit States can be taken as 500 kPa. If the earth fill shown in the figure is specified as MTC Granular 'A' or 'B' compacted to 95 percent of the Standard Proctor Density, the Ultimate Bearing Capacity at Ultimate Limit States can be increased to 800 kPa. As in the case of foundations on the till, this capacity should be corrected for any inclination of load.

Settlement of abutment footings constructed within the embankment will depend on the settlement induced by the embankment plus that due to the load from the bridge. Using a similar calculation to that carried out for the abutment footings on till, the likely settlement at the abutment location has been calculated to be about 35 mm. However, in this case, some of the settlement due to embankment loading will have taken place before the bridge is constructed. It is estimated that the bridge will only experience about 25 mm settlement. The settlement is not sensitive to the bearing pressure applied and so design of footings should be based on the factored bearing capacity at Ultimate Limit States.

4.1.2 Deep Foundations

If the above bearing capacities are insufficient, then end bearing piled foundations founded in the very dense, sandy deposits underlying the brown silty clay till should be considered. Due to the very stiff to hard nature of the overlying till, a low displacement driven pile will be preferable or, as an alternative, pre-augered case-in-place caissons, founded in the sand above the water table, may be considered.

4.1.2.1 Driven Piles

Pipe piles or steel H-piles with a width or diameter of about 300 mm can be founded on the very dense sand deposits below a depth of 3 metres. The design factored pile capacity at Ultimate Limit States can be taken as 1270 kN. At the serviceability States Type II, the pile capacity is 900 kN. For preliminary design purposes, an HP 310 x 110 H-pile section will need to be driven to a final set of 20 blows per 25 mm

with a pile hammer energy of at least 40 kilojoules per blow. Care should be taken to avoid overdriving.

4.1.2.2 Pre-augered cast-in-place Caissons

By augering through the very stiff till to a depth of 3 to 4 metres below ground surface, caissons can be cast in place with the base resting on the very dense sand deposits. Due to the cohesive nature of the upper till, the augered hole will probably not require a liner to prevent soil collapse into the open hole. Furthermore, groundwater problems are not anticipated provided the groundwater level within the sand deposits is below the bottom of the augered hole. Prior to placing the concrete, the soil at the bottom of the open hole should be inspected by a qualified geotechnical engineer to ensure that each caisson will be founded on the very dense sand deposits. For caissons founded 1 metre into the dense sand, the factored bearing capacity at Ultimate Limit States is computed as 6 MPa. The bearing capacity at the Serviceability States Type II is computed as 4 MPa for caissons up to 1 metre in diameter.

4.2 Bridge Abutments

The bridge abutments can be supported on either:

a) deep foundations (piles or caissons) resting on the very dense sand deposits at depths of 3 to 4 metres below ground surface or,

b) shallow foundations (spread footings) resting on the native undisturbed, very stiff upper till or,

c) spread footings resting on compacted granular fill (see Figure 7).

The most economical type of abutment is likely spread footings on granular fill, due to the minimal excavation requirements. At the abutments, the embankment fill will be sloped at 2 horizontal to 1 vertical down to the underpass grade elevation

or a retaining wall will be constructed. The retaining wall backfill should consist of free-draining granular material within the area bounded by a plane rising at 60 degrees to the horizontal from a point 1.2 metres back from the wall at its base.

Where the abutments are required to act as retaining walls the lateral earth loads will depend on the type and method of placement of the fill materials. The following recommendations are made in respect to the design of the abutment retaining walls:

(i) Selected granular fill, such as M.T.C. Granular 'B' should be used as backfill immediately behind the structures. The granular fill should be placed in the wedge-shaped zone defined by a 60 degree line extending up and back from the rear face of the structures' footings;

(ii) All granular fill should be compacted in 200 mm thick lifts to 95 percent of the standard Proctor dry density of the material. However, heavy compaction equipment should not be used behind any structure within a lateral distance equal to the current height of the fill above the base of the structure.

(iii) Provided that the above criteria are satisfied, and the abutments are less than 10 metres high, an equivalent fluid pressure of 8 kPa/metre and 6.5 kPa/metre may be used to calculate earth pressure at Ultimate and Serviceability Limit States respectively if an outward deflection of approximately 1/2 percent of the wall height can be tolerated at the bridge bearings. If this amount of deflection cannot be absorbed, then fluid pressure of 10 kPa/metre and 8.5 kPa/metre should be used for Ultimate and Serviceability Limit States respectively. A coefficient of

friction equal to 0.4 may be assumed between the concrete footings and the till. A bulk unit weight of 20 kN/m^3 may be assumed for the Granular 'B' backfill.

An adequate drainage system should be provided behind the abutments to prevent build-up of hydrostatic forces. The drainage system should include a properly designed filter to prevent clogging of the pipes. Provision should be made to allow cleaning or rodding of the pipes, should they become clogged.

4.3 Approach Embankments

The topsoil and any loose surficial soil should be removed from the area of the approach embankments. The embankment fill should consist of clean, non-organic earth fill and should be compacted to at least 95 percent of Standard Proctor density in lifts not thicker than 200 mm. Provided the foregoing is carried out, no slope instability or settlement problems are anticipated. The embankment slopes should be protected against runoff erosion.

GOLDER ASSOCIATES

Michael Tanos, P. Eng.

J. R. Busbridge, P. Eng.

REGISTERED PROFESSIONAL ENGINEER J. R. BUSBRIDGE PROVINCE OF ONTARIO

MT/JRB/cg

APPENDIX A

FIELD WORK

FIELD WORK

The present boring program consisted of six boreholes (numbered 1 to 6) which were put down between February 12 and 16, 1982 at the locations shown on Sheet 1. A bombardier-mounted CME-75 power auger (supplied by Atcost Soil Drilling Inc.) was used with 175 mm diam. hollow-stem augers for all boreholes. A total of 70 metres of sampled borings were put down to depths of between 9 and 21 metres.

Soil samples were taken at 0.75 to 1.5 metre intervals of depth, using a standard 50 mm O.D. split-barrel sampler advanced by a 63.5 kg weight falling freely over 0.75 metre to determine 'N' values (blows per 0.3 metre penetration). Details of the drilling and sampling operations are summarized on the Record of Borehole sheets.

Piezometers were sealed into 5 of the 6 boreholes to allow monitoring of groundwater levels across the site. The remaining borehole was backfilled to the ground surface.

The field work was supervised throughout by a member of our engineering staff who located the borings in the field, cleared the site for buried services, directed the drilling and sampling operations, and logged the boreholes.

The borehole locations and ground elevations at the boreholes were surveyed by Golder Associates. The elevations were referred to Geodetic datum using BM E-1010 (Elev. 173.217 m) located at the north end of the west concrete pier of the bridge structure on Albion Road over the C.N.R. railway tracks.

All soil samples were shipped to our laboratory for detailed examination. Selected representative samples were tested for grain size distribution while all samples were subjected to a water content determination. The test results are summarized on the Record of Borehole sheets and on Figures 1 to 7.

TABLE 1

Monitoring of Piezometer Groundwater Levels

Borehole No.	Elevation of Water Level (metres)		
	Feb. 16, 1982	Feb. 17, 1982	Mar. 1, 1982
1	169.80	169.84	169.56
2	170.14	170.20	170.08
3	-	170.15	170.06
4	-	170.16	170.07
6	170.10	170.15	170.15

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS $\overline{N}$.

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

s_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER
THEY ARE CONSOLIDATED (C) OR NOT (U)
ISOTROPICALLY (I) OR NOT (A)
AND SHEARED DRAINED (D) OF UNDRAINED (U)
WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS)
EG. $\overline{CIU}$ = CONSOLIDATED ISOTROPIC UNDRAINED
TRIAXIAL WITH PORE PRESSURE MEASUREMENT
UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS
ARE IN COMPRESSION

FIELD SAMPLING

S S	SPLIT SPOON
W S	WASH SAMPLE
S T	SLOTTED TUBE SAMPLE
B S	BLOCK SAMPLE
C S	CHUNK SAMPLE
T W	THINWALL OPEN
T P	THINWALL PISTON
O S	OSTERBERG SAMPLE
F S	FOIL SAMPLE
R C	ROCK CORE
P H	T.W. ADVANCED HYDRAULICALLY
P M	T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ	COEFFICIENT OF FRICTION
δ	ANGLE OF WALL FRICTION
k_o	COEFFICIENT OF EARTH PRESSURE AT REST
k_A	COEFFICIENT OF ACTIVE EARTH PRESSURE
k_p	COEFFICIENT OF PASSIVE EARTH PRESSURE
i	ANGLE OF INCLINATION OF SURCHARGE
w	SLOPE ANGLE-BACKFACE OF WALL
β	ANGLE OF SLOPE
N_γ, N_q, N_c	BEARING CAPACITY FACTORS
D_f	DEPTH OF FOOTING
B,L	FOOTING DIMENSIONS

INDEX PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G_s	SPECIFIC GRAVITY OF SOLIDS
e	VOIDS RATIO
e_o	INITIAL VOIDS RATIO
e_{max}	e IN LOOSEST STATE
e_{min}	e IN DENSEST STATE
D_r	RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
n	POROSITY
w	WATER CONTENT
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
w_S	SHRINKAGE LIMIT
I_p	PLASTICITY INDEX = $w_L - w_P$
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
A_c	ACTIVITY = $\frac{I_p}{\%\text{ of } 2\mu\text{m size fraction}}$
OM	ORGANIC MATTER CONTENT
S_r	DEGREE OF SATURATION
S	SENSITIVITY = $\frac{s_u \text{ (undisturbed)}}{s_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

ϕ	ANGLE OF SHEARING RESISTANCE
τ_f	PEAK SHEAR STRENGTH
τ_R	RESIDUAL SHEAR STRENGTH
c	COHESION INTERCEPT
$\sigma_1, \sigma_2, \sigma_3$	NORMAL PRINCIPAL STRESSES
u	PORE WATER PRESSURE
u_e	EXCESS u
r_u	PORE PRESSURE RATIO
q_u	UNCONFINED COMPRESSIVE STRENGTH
s_u	UNDRAINED SHEAR STRENGTH
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO
E	MODULUS OF ELASTICITY
G	MODULUS OF SHEAR DEFORMATION
k_s	MODULUS OF SUBGRADE REACTION
m, n	STABILITY COEFFICIENTS
A,B	PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE AFTER THE SYMBOL, THUS:
ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX
C_r	RECOMPRESSION INDEX
d	DRAINAGE PATH DISTANCE
T_v	TIME FACTOR
U	DEGREE OF CONSOLIDATION
OCR	OVERCONSOLIDATION RATIO

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RECORD OF BOREHOLE No 1

W P 153-80-04 LOCATION Co-ords. 4, 845, 498 N; 294, 227.5 E. ORIGINATED BY MT
DIST 6 HWY 427 BOREHOLE TYPE Hollow-stem auger COMPILED BY RR
DATUM Geodetic DATE February 12, 1982 CHECKED BY JRB

Metres ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.63	Ground Level							
0.00	Topsoil 150 mm thick					Seal		
	Till, Silty Clay with some sand & gravel		1	SS	38			
			2	SS	29		174	5 18 49 28
	Very Stiff to Hard		3	SS	35			
172.73	Brown							
2.90	Interbedded Silty Sand and Sandy Silt, 10 to 50 mm thick layers		4	SS	108			
			5	SS	59		172	
170.45	Very Dense Brown		6	SS	115			
5.18	Fine Sand, silty		7	SS	78		170	
			8	SS	65	▽	Water Level Mar. 1/82	
			9	SS	73			
			10	SS	125/225 mm		168	
			11	SS	73			
	Very Dense		12	SS	35		166	
	Brown to Grey		13	SS	79			
			14	SS	72			
			15	SS	80/150 mm		164	
162.52								
13.11	Till, Silty Clay with some sand and gravel		16	SS	122/225 mm		162	
			17	SS	100/225 mm		160	9 28 40 23
			18	SS	100/150 mm			
	Very Hard Grey						158	
			19	SS	100/75 mm	Seal		
19.81	Fine Sand, silty Dense Grey		20	SS	W.H.	Piezometer	156	
20.42								
154.08			21	SS	100/200 mm			
21.55	End of Borehole						154	
							152	

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE
PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 2

W P 153-80-04 LOCATION Co-ords. 4, 845, 540 N; 294, 253 E. ORIGINATED BY MT
DIST 6 HWY 427 BOREHOLE TYPE Hollow-stem auger COMPILED BY RR
DATUM Geodetic DATE February 15, 1982 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Metres ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
175.41	Ground Level										
0.00	Topsoil 150 mm thick					Seal					
	Till, silty clay, with some sand and gravel		1	SS	21		174				
			2	SS	31						
	Very stiff to hard		3	SS	53	Seal					
171.75	Brown		4	SS	100/225 mm		172				
3.66	Interbedded silty sand and sandy silt		5	SS	100	Water Level Mar. 1/82					
	Very Dense Brown		6	SS	101						
169.47			7	SS	86		170				1 26 70 3
5.94	Fine Sand, Silty		8	SS	47						
	Very Dense Brown		9	SS	71						
			10	SS	113		168				
			11	SS	100	Piezometer					
165.81			12	SS	73		166				
9.60	End of Borehole						164				
							162				

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

W P 153-80-04 LOCATION Co-ords. 4,845,559 N; 294,218.5 E ORIGINATED BY MT
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RR
DATUM Geodetic DATE February 16, 1982 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Metres ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
176.28	Ground Level										
0.00	Topsoil, 150 mm thick						176				
	Till, silty clay, with some sand and gravel		1	SS	23		Seal				
			2	SS	38						
	Very Stiff to Hard		3	SS	41		174				
173.08	Brown						Seal				
3.20	Interbedded Silty Sand and Sandy Silt		4	SS	80						
	Very Dense Brown		5	SS	98		172				
			6	SS	85						
170.34			7	SS	60		Water Level Mar. 1/82				
5.94	Fine Sand, Silty		8	SS	46		170 Piezometer				
	Very Dense Brown		9	SS	50						
168.81											
7.47	Sand, with some Gravel and trace Silt		10	SS	72		168				10 78 9 3
166.83	Very Dense Brown		11	SS	65						
9.45	End of Borehole						166				
							164				

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 4

W P 153-80-04 LOCATION Co-ords. 4,845,572 N; 294,247 E. ORIGINATED BY MF
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RR
DATUM Geodetic DATE February 16, 1982 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Metres ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
175.98	Ground Level										
0.00	Topsoil, 150 mm thick						Seal				
	Till, silty clay, with some sand and gravel		1	SS	28						
			2	SS	39		174				6 31 49 14
	Very Stiff to Hard										
172.78	Brown		3	SS	42						
3.20	Interbedded Silty Sand and Sandy Silt		4	SS	85/150 mm		Seal				
			5	SS	120		172				
170.80	Very Dense Brown		6	SS	81						
5.18	Fine Sand, Silty						Water Level Mar. 1/82				
			7	SS	56	▽					
	Very Dense Brown		8	SS	48		170				
168.06			9	SS	61						
7.92	Sand, seam, some gravel		10	SS	92		168				
166.99	Very Dense Brown						Piezometer				
8.99			11	SS	118						
166.38			12	SS	50						
9.60	End of Borehole						166				
							164				

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 5

W P 153-80-04 LOCATION Co-ords. 4,845,533 N; 294,223 E. ORIGINATED BY MT
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RR
DATUM Geodetic DATE February 16, 1982 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
Metres ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE			GR SA SI CL
175.49 Ground Level											
0.00	Topsoil, 150 mm thick										
	Till, silty clay, with some sand and gravel		1	SS	32						
	Hard Brown		2	SS	31		174				
			3	SS	37						
			4	SS	57		172				
171.22			5	SS	53						
4.27	Interbedded Silty Sand and Sandy Silt		6	SS	64						
	Very Dense Brown		7	SS	71		170				3 21 72 4
169.24			8	SS	58						
6.25	Fine Sand, Silty		9	SS	36						
	Dense to Very Dense		10	SS	37		168				
	Brown										
165.89			11	SS	78		166				
9.60	End of Borehole										
							164				

+3, ×5 : Numbers refer to Sensitivity

15 20 10 ◇ 5 (%) STRAIN AT FAILURE

ON FOR EXPLANATION

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Ontario

RECORD OF BOREHOLE No 6

W P 153-80-04 LOCATION Co-ords. 4, 845, 514 N; 294, 256 E. ORIGINATED BY MT
DIST 6 HWY 427 BOREHOLE TYPE Hollw-stem auger COMPILED BY RR
DATUM Geodetic DATE February 15, 1982 CHECKED BY JRB

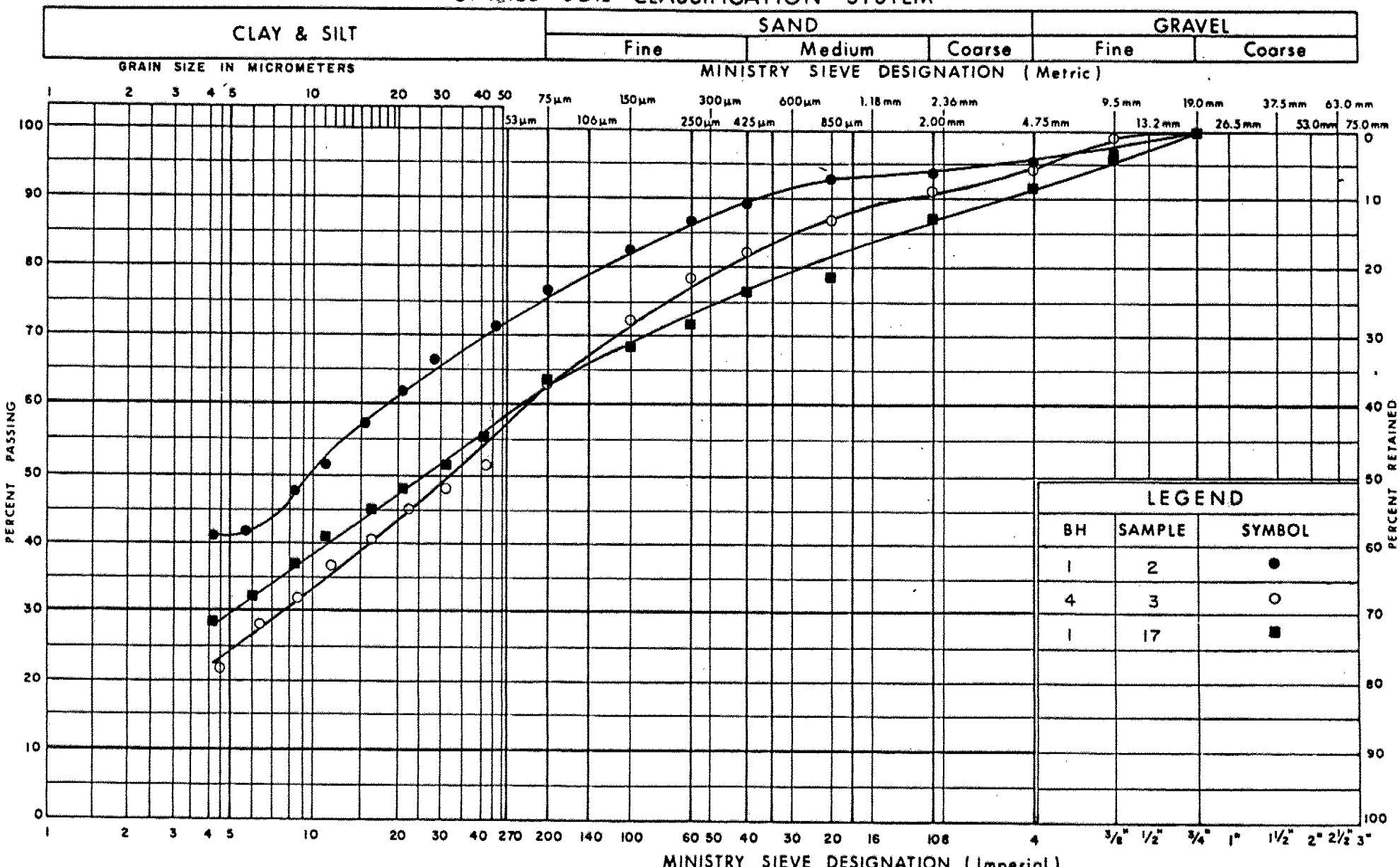
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Metres ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
175.33	Ground Level										
0.00	Topsoil, 150 mm thick						Seal				
	Till, silty clay, with some sand and gravel		1	SS	32						
			2	SS	30		174				
	Very Stiff to Hard		3	SS	45		Seal				
171.67	Brown		4	SS	35		172				
3.66	Interbedded Silty Sand and Sandy Silt		5	SS	73						
			6	SS	55		Water Level Mar. 1/82				
	Very Dense Brown		7	SS	89		170				0 35 62 3
168.62			8	SS	82						
6.71	Fine Sand, Silty		9	SS	76		168				
167.10	Very Dense Brown		10	SS	69						
8.23	Sand, with some Gravel		11	SS	69						
	Very Dense Grey		12	SS	34		166				
			13	SS	76		Piezometer				
164.20			14	SS	39						
11.13	End of Borehole						164				
							162				

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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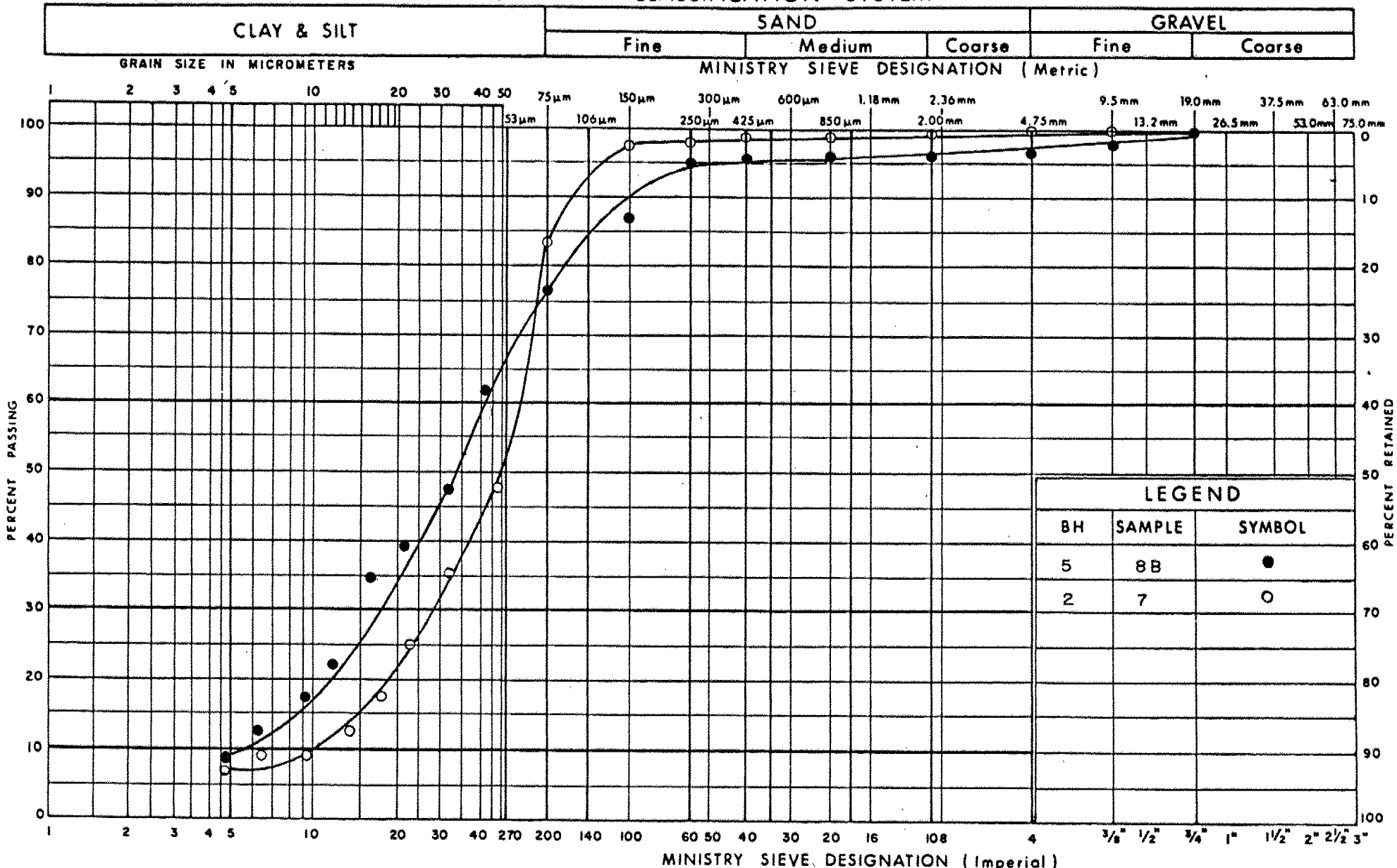
GRAIN SIZE DISTRIBUTION

SILTY CLAY TILL

FIG No 1

W P 153-80-04

UNIFIED SOIL CLASSIFICATION SYSTEM



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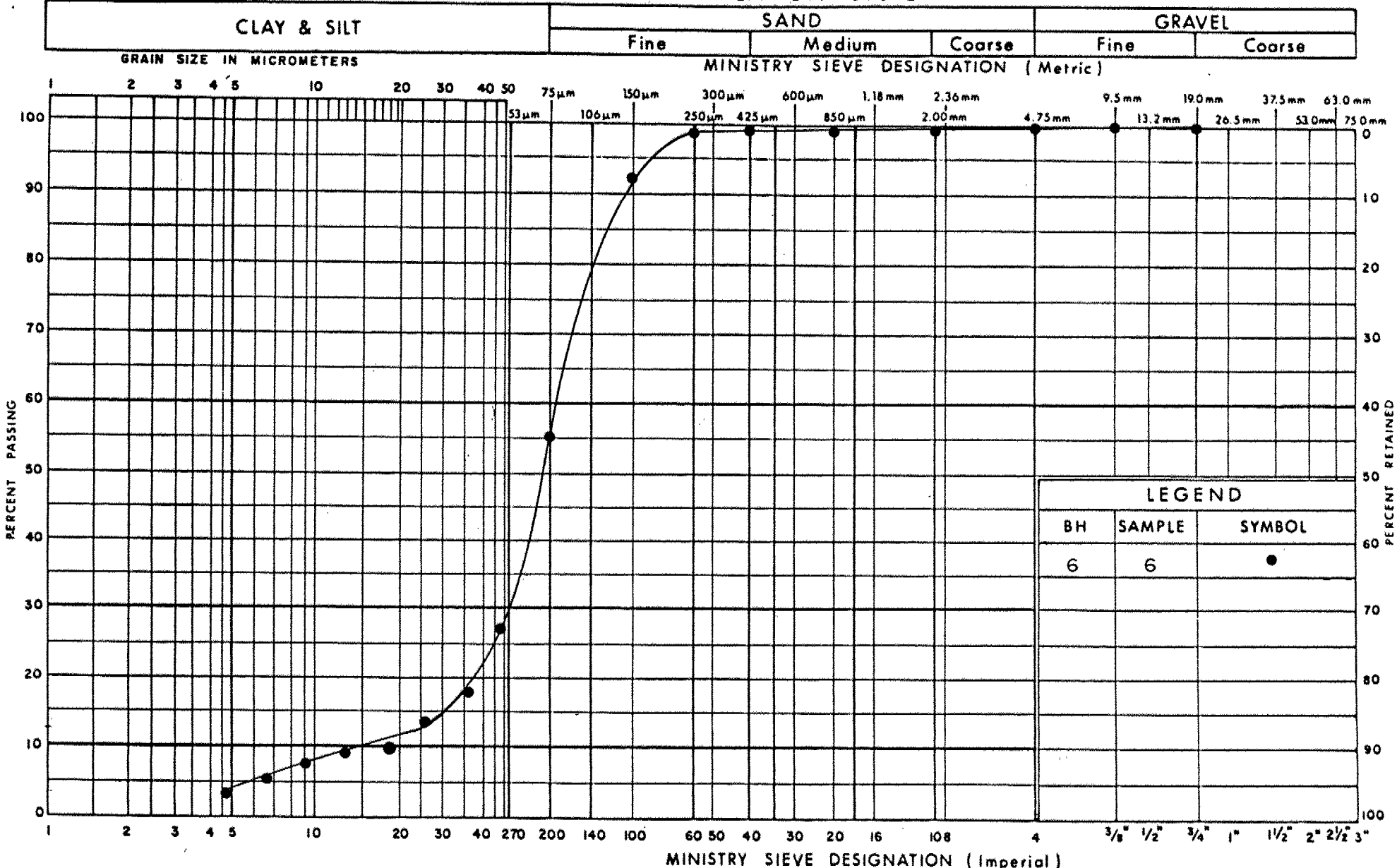
GRAIN SIZE DISTRIBUTION

SANDY SILT SEAM

FIG No 2

W P 153-80-04

UNIFIED SOIL CLASSIFICATION SYSTEM



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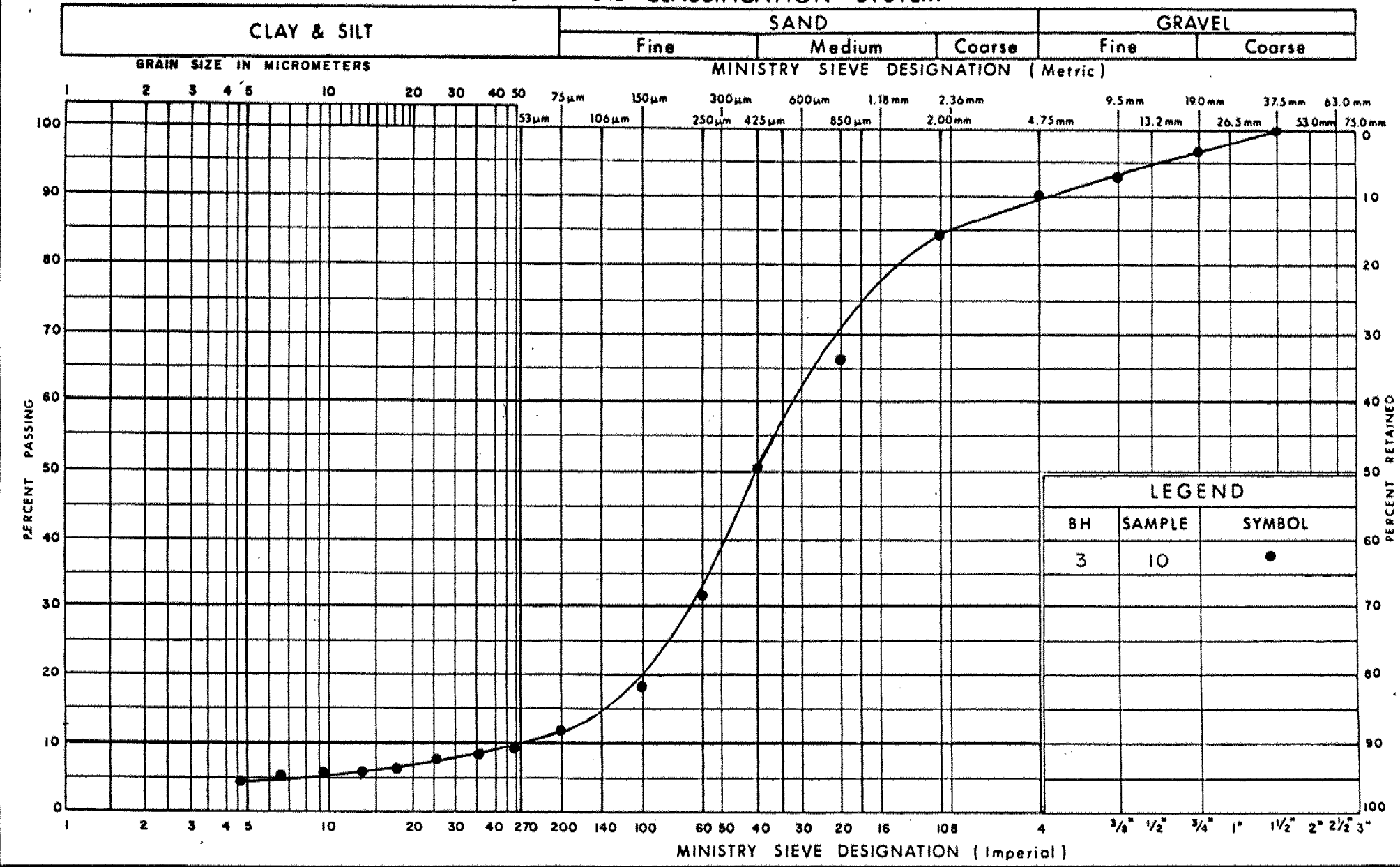
GRAIN SIZE DISTRIBUTION

SILTY FINE SAND

FIG No 3

W P 153-80-04

UNIFIED SOIL CLASSIFICATION SYSTEM



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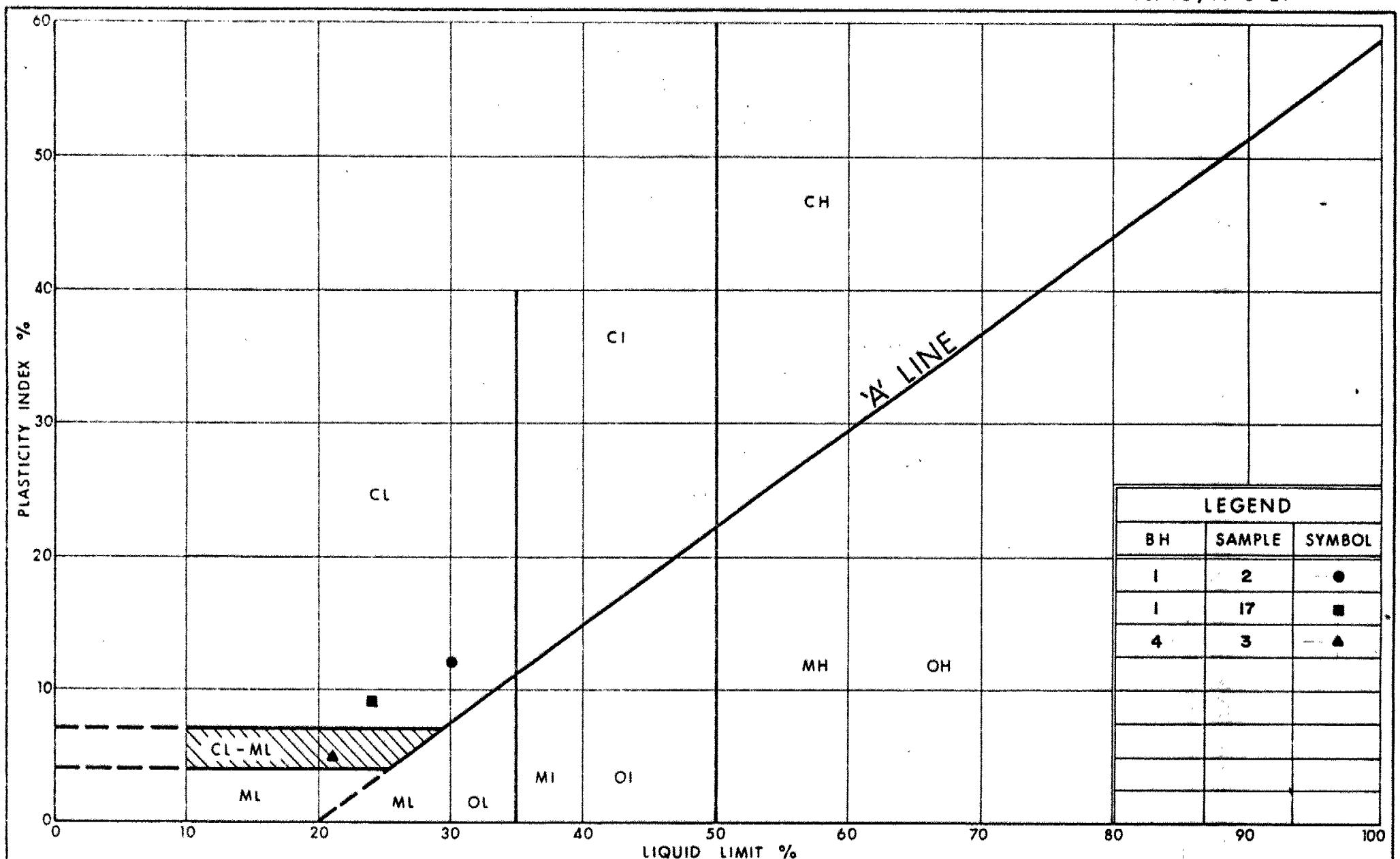
GRAIN SIZE DISTRIBUTION

SAND WITH SOME GRAVEL

FIG No 4

W P 153-80-04

Oct 75, FF-S-21



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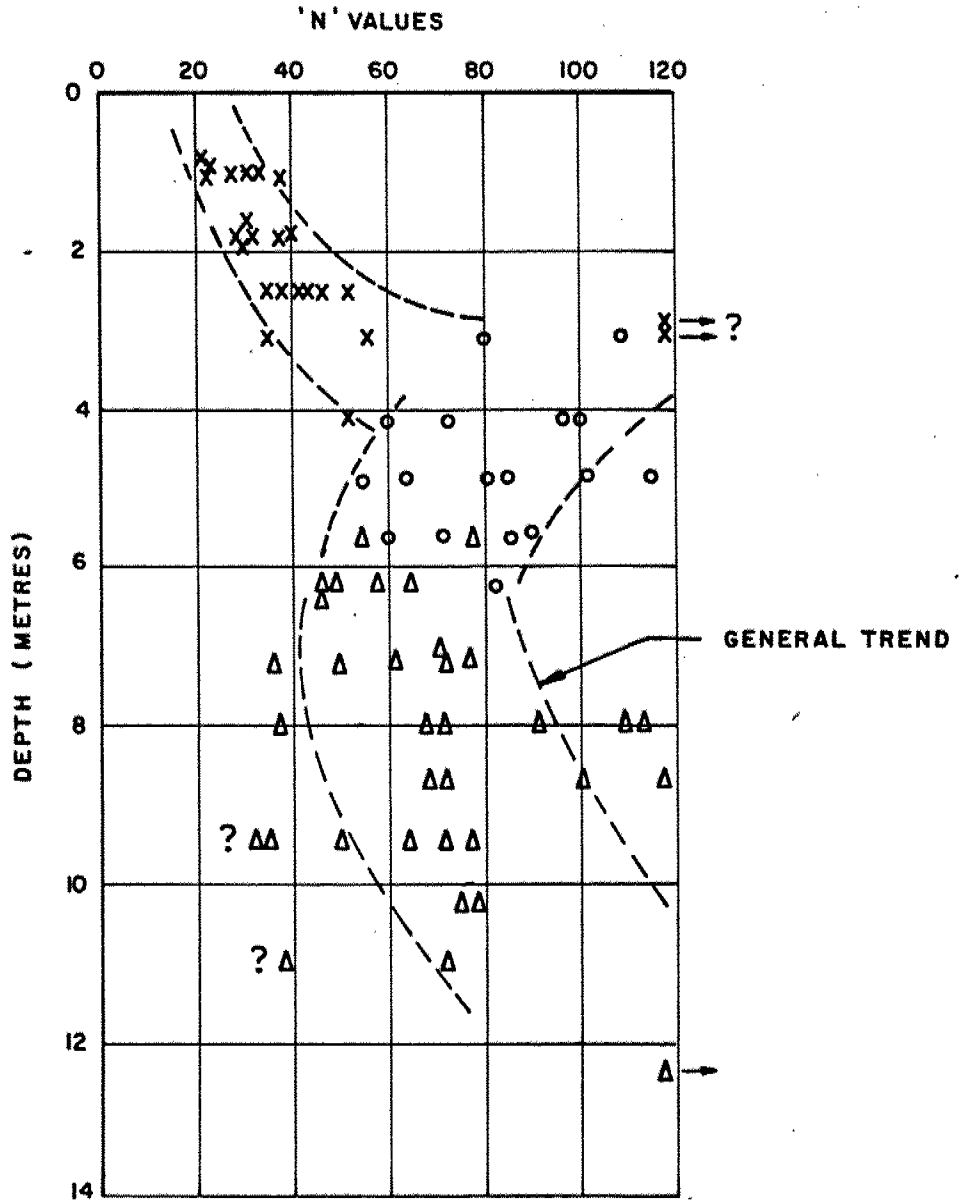
PLASTICITY CHART

FIG No 5

W P 153-80-04



LEGEND

X SILTY CLAY TILL

o INTERBEDDED SAND AND SILT

Δ SILTY FINE SAND AND SAND SOME GRAVEL

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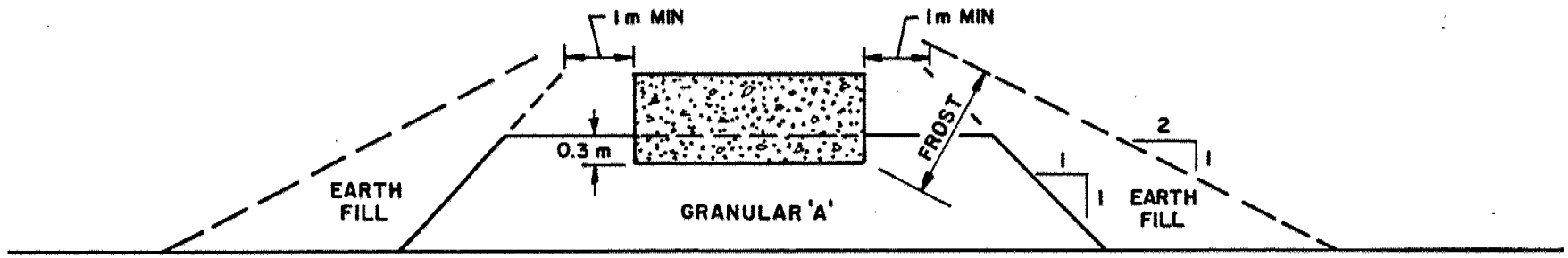
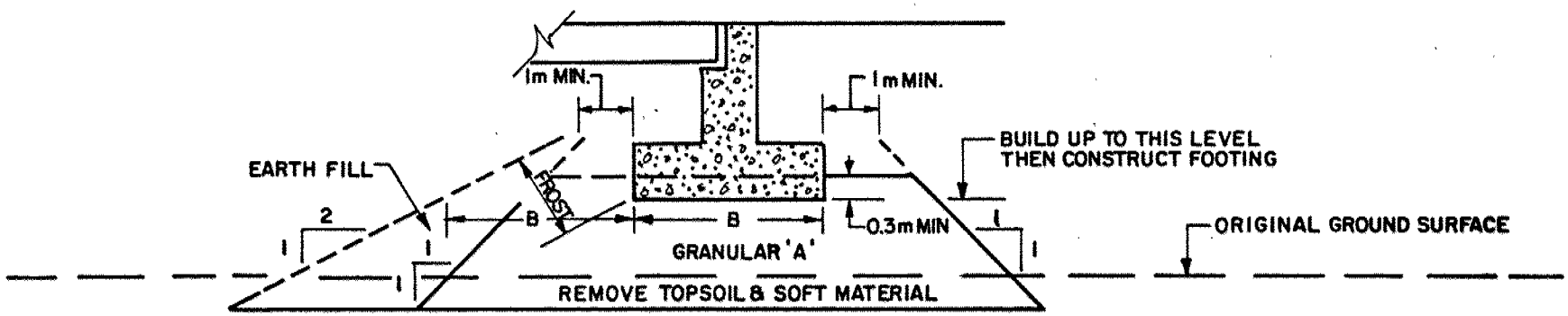
STANDARD PENETRATION RESISTANCE, 'N' VALUES VS DEPTH

FIG No 6

W P 153-80-04



CROSS - SECTION



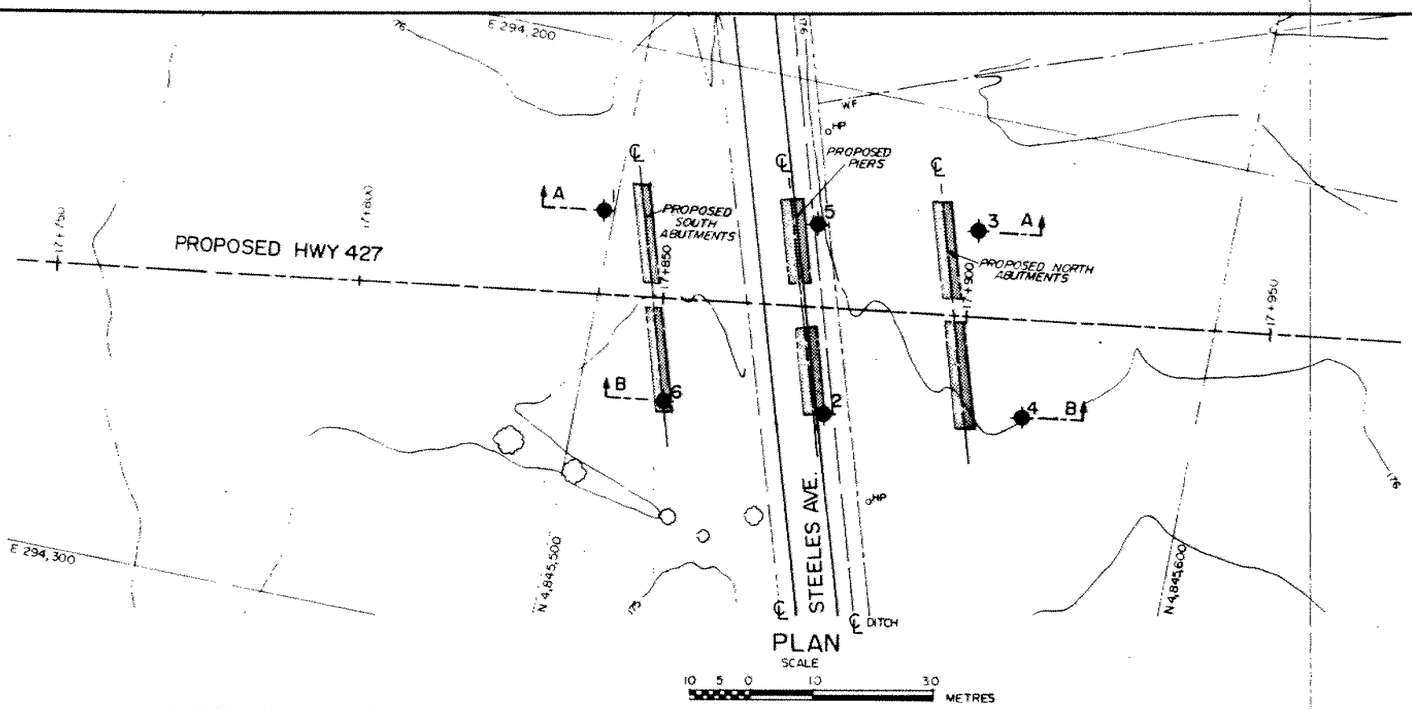
LONGITUDINAL SECTION

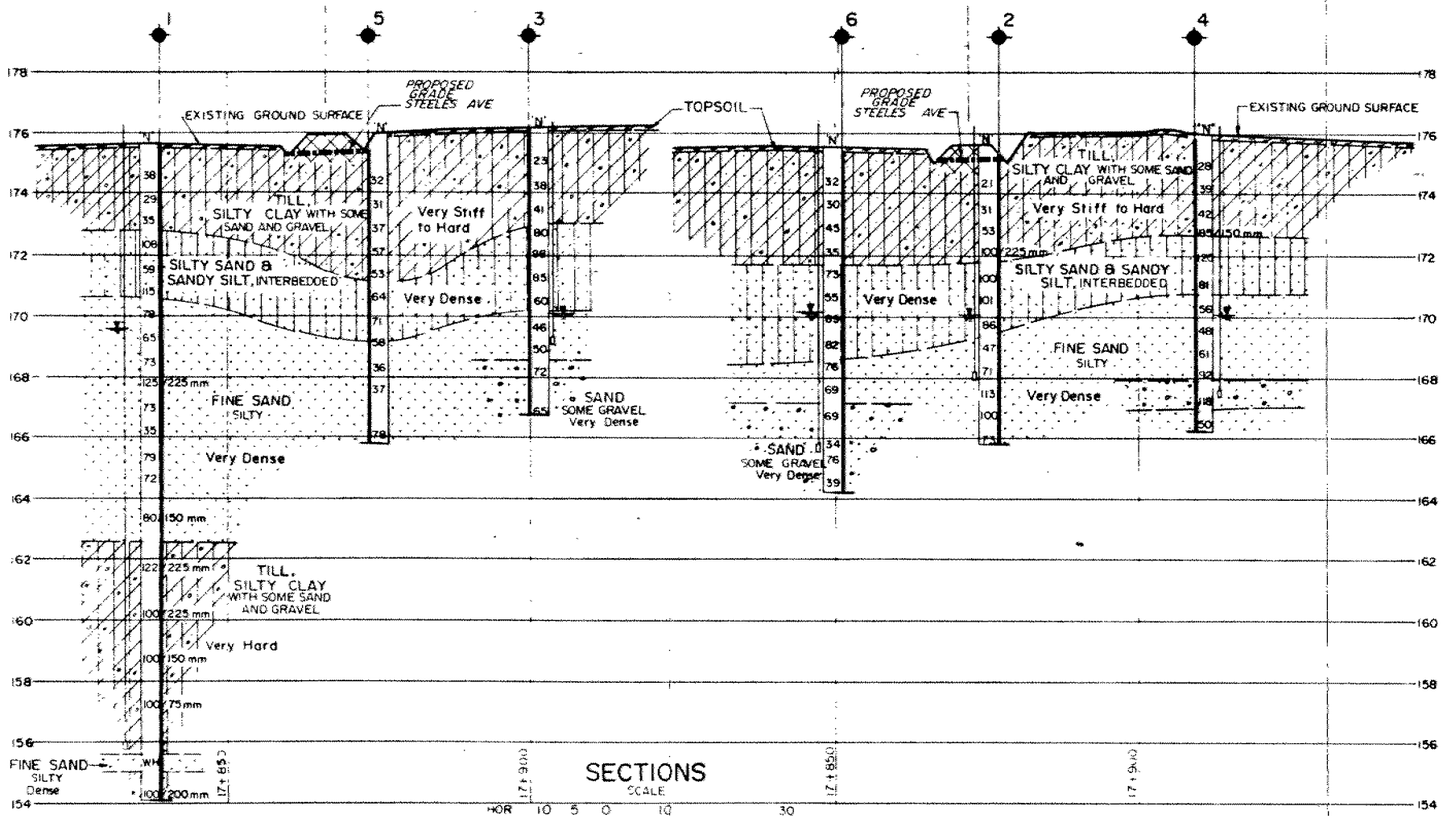
NOT TO SCALE

NOTES : 1. REMOVE TOPSOIL AND OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
3. CONSTRUCT CONCRETE FOOTING
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED
5. SOURCE M.T.C. 1982

Ministry of Transportation and Communications Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No 7 W P 153-80-04

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO OB-MT-308M 6-78





METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES & METRES

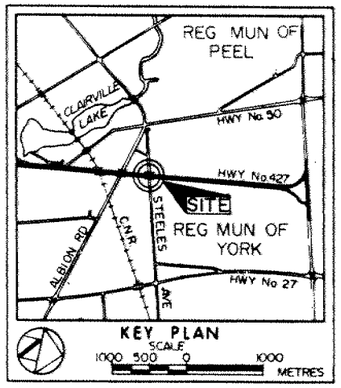
CONT No
WP No 153-80-04

HWY 427 OVERPASS BRIDGE AT STEELES AVE.

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

GOLDER ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation
- SEAL
- WATER LEVEL IN PIEZOMETER
- PIEZOMETER

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	175.63	4 845 498	294 227.5
2	175.41	4 845 540	294 253.0
3	176.28	4 845 559	294 218.5
4	175.98	4 845 572	294 247.0
5	175.49	4 845 533	294 223.0
6	175.33	4 845 514	294 256.0

NOTE
FOR DETAILED STRATIGRAPHY AT EACH BORE HOLE LOCATION REFER TO THE RECORD OF BOREHOLE SHEETS

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS			
DATE	BY	DESCRIPTION	

Geocres No 30M13-50

HWY No 427			DIST 6
SUBM'D	CHECKED	DATE 82 02 22	SITE 37-111
DRAWN RWR	CHECKED MT	APPROVED	DWG 1538004-A

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

CONT. 88-30

WP 153-80-02 DIST 6

HWY 427 STR SITE 37-1109

C.N.R. (Halton Subdivision) Overhead at Highway 427

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GEOCRES 30M12-152 DATE MAR 11 1982

FOUNDATION INVESTIGATION REPORT

For

C.N.R. (Halton Subdivision) Overhead

at Highway 427

W.P. 153-80-02, Site: 37-1109

Highway 427, District 6, Toronto

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site and provides detailed recommendations pertaining to the structure foundations and related earthworks. The fieldwork was carried out between 81-12-10 and 81-12-23, consisting of 8 sampled boreholes, 5 accompanied by dynamic cone penetration tests, advanced by means of hollow and solid stem continuous flight augers in addition to washboring techniques. Borings were advanced for depths ranging from 13.9 metres to 33.4 metres.

SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of the proposed Hwy. 427 and C.N.R. Halton Subdivision Tracks, some 0.3 kilometres east of Indian Line, 0.4 Kilometres west of Albion Road, and 0.7 kilometres south of Steeles Avenue in the Borough of Etobicoke, Municipality of Metropolitan Toronto.

The topography of the area is a flat to gently undulating till plain which is dissected in the immediate area by the West Branch of the Humber River. Generally, drainage is in a southerly to easterly direction. Land use in the area is rapidly changing from predominately farming to industrial subdivision development.

The site is located in the physiographic region known as the 'Peel Plain' characterized in this area by ground moraine till deposits of pleistocene origin. Generally, these silty clay till sheets are separated by beds of stratified clay, silt, or sand of variable thickness with occasional boulder concentrations present.

Bedrock, in excess of 30 metres depth at this location, consists of interbedded shale and limestone of the Dundas Formation, Ordivician Period.

SUBSURFACE CONDITIONS

In general, reasonably competent and uniform subsurface conditions were encountered across the site. The surficial deposit extending to a maximum depth of 11.9 metres is a stiff to hard cohesive glacial till consisting of silty clay with sand and a trace of gravel. Stratified silt and sand seams with occasional cobbles and boulders were encountered within this stratum.

Underlying the till deposit and explored for a maximum thickness of 23 metres is a dense to very dense silty sand grading to a sand of probable glaciolacustrine origin. Alternating seams and layers of silt, sand and gravel, with occasional cobbles and boulders were encountered throughout.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile showing a simplified stratigraphical summary are shown on Drawing No. 1538002-A. Four sections showing estimated stratigraphical details based on borehole data are shown on Drawing No. 1538002-B.

The various soil types encountered are briefly described in the following paragraph.

Silty Clay, Sand, and Gravel (Glacial Till)

The surficial deposit encountered across the site for depths ranging from 8.5 metres to 11.9 metres is a cohesive glacial till composed of silty clay with sand and a trace of gravel. Typical grain size distribution curves for representative samples of this deposit are plotted in envelope form on Figure 1 in the appendix. Stratified silt and sand seams with occasional cobbles and boulders were encountered within this deposit.

The results of Atterberg Limit and water content testing are plotted on the Plasticity Chart, Figure 2, and summarized as follows:

	Range	Average
Water Content (w) %	10-20	15
Liquid Limit (w_L) %	19-29	23
Plastic Limit (W_p) %	12-20	15
Plasticity Index (I_p) %	2-14	8

These results indicate the fine grained matrix of the glacial till to consist of an inorganic silty clay of low plasticity (CL to CL-ML).

Based on interpretation of Standard Penetration Test 'N' values and augering operations, the consistency of this silty clay till deposit is assessed as ranging from stiff to hard.

Silty Sand to Sand, Varying Amounts of Gravel

The cohesive surficial till deposit is underlain by a glaciolacustrine deposit consisting of silty sand to sand with varying amounts of gravel and a trace of clay-sized fractions. This deposit was explored for a maximum thickness of 23 metres corresponding to a maximum depth of 33.4 metres. Typical grain size distribution curves plotted in envelope form are shown on Figure 3a, 3b, and 3c, in the appendix, indicating the variable composition of this granular deposit. Alternating seams and layers of stratified silt, sand, and gravel were encountered within this deposit. In addition, based on augering operations, cobble and boulder sized fragments are well dispersed throughout this deposit probably accounting for refusal to advance augers at various depths within the borings.

Interpretation of Standard Penetration Test 'N' values generally in excess of 50 blows per 0.3 metres, suggests a denseness ranging from dense to very dense but consistently very dense below elevation 156.

Groundwater Condition

Based on water level readings taken in open boreholes over a period of time, a perched water table exists within the relatively impermeable silty clay till deposit which approximates, within a metre, the ground surface. 'Ponded' water and marshy surface conditions are apparent over some of the site.

In addition, slight subartesian conditions can be assumed within the silty sand to sand deposit based on sand and silt 'boiling-up' within the augers during borehole advancement operations.

DISCUSSION AND RECOMMENDATIONS

As part of the planned extension of Hwy. 427 north to Hwy. 7, it is proposed to construct N.B. and S.B. structures over the C.N.R. Halton Subdivision. Planning calls for triple span structures with spans of 21-24-21 metres and maximum approach fill heights in the order of 10.5 metres. The proposed geometry accommodates future widening of the overpasses and incorporation of a possible third railway track immediately south of the existing twin tracks.

In consideration of the reasonably competent cohesive glacial till deposit overlying the dense to very dense silty sand to sand deposit across the site, recommendations pertaining to the foundations of the new structure and related earthworks are summarized as follows:

Structure Foundations

Major consideration should be given to founding perched abutments on spread footings located on a well compacted Granular 'A' core within the embankment approaches as per current M.T.C. Standards. All surficial softened and/or organic material within the planned limits of the granular core must be subexcavated to a minimum elevation of 170 and backfilled with well compacted granular material prior to placement of the granular core. For spread footings founded on a Granular 'A' core and constructed to current M.T.C. Standards, an allowable capacity at the S.L.S. Type II of 280 kPa and a factored capacity at the U.L.S. of 850 kPa may be used for design purposes. Pier elements can be founded on shallow spread footings located at elevation 169.5 for an allowable capacity at the S.L.S. Type II of 280 kPa and a factored capacity at the U.L.S. of 750 kPa.

Resistance to sliding of the abutment footings can be calculated assuming a coefficient of friction of 0.6 between the underside of the concrete footing and the Granular 'A' core.

Alternatively, all abutment and pier elements for both structures can be founded on deep foundation units driven to endbearing in the very dense silty sand to sand deposit. For a steel 'H' section pile equipped with standard reinforced flange tip plates and driven to a minimum set of

Provide Van Bodegom with earth pressure coefficients $K_a = 0.35$ and $K_p = 3.0$ for sheet piling to elevation 165 on Dwg. 2/82 K.

15 blows per 25 mm for all the final 75 mm of placement using a minimum rated driving energy of 48,000 joules/blow, the following design parameters are suggested:

Pile Type	Factored Capacity at U.L.S. (kN)	Capacity at S.L.S. Type II (kN)
310 HP 79	800	1250
310 HP 110	980	1600

Pile driving should be controlled in the field through the use of the M.T.C. Modified Hiley Formula (Standard SS 103-11).

For design estimating purposes, theoretical pile embeddment lengths can be calculated assuming the following anticipated top elevations.

Pile Location	Tip Elevation
South Abutments	154
South Piers	155
North Piers	154
North Abutment	155

Other Considerations

All softened and/or organic material within the planned limits of the immediate approaches and pier pile caps should be excavated for their full depth and backfilled prior to fill placement and pile driving operations.

Fill material placed within the zone of pile penetration in the approaches must be restricted to a maximum grain size of 75 mm.

The underside of all abutment and pier caps or footings should be provided with a minimum 1.25 metres of earth cover for frost protection purposes.

Earth pressures against the back of the abutment wall should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. Manual, with provisions made for adequate drainage.

No major dewatering difficulties are anticipated for pile cap or footing excavations in consideration of the relatively low permeability of the glacial till deposit. Localized seepage into excavations can be controlled by perimeter ditches and pumping from corner sumps.

No stability problems are anticipated for permanent embankment slopes constructed to a 2:1 geometry.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. H. Sturm, Engineer-in-Training, and Mr. V. Parker, Field Technician, utilizing equipment owned and operated by Atcost Soil Investigation, Toronto. This report was written by Mr.T.J. Kazmierowski, Foundations Engineer and reviewed by Mr.M. Devata, Senior Foundations Engineer.

T. J. Kazmierowski, P. Eng.,
Project Foundations Engineer

M. Devata, P. Eng.,
Senior Foundations Engineer

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 821.2; E 294 328.3 ORIGINATED BY V.P.
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY V.P.
DATUM Geodetic DATE 81-12-10 to 81-12-11 CHECKED BY GP.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.9	Ground Surface										
0.0	Mottled		1	SS	9	*					
			2	SS	13		170				2-20-45-33
	Brown / Grey		3	SS	29			110/28 cm			
	(Glacial Till) Silty Clay with Sand trace of Gravel		4	SS	27						
			5	SS	21		168				3-20-57-20
			6	SS	35						
			7	SS	14		166				
	Stiff to Hard		8	SS	16		164				
			9	SS	53						
			10	SS	37		162				0-28-42-30
160.0											
11.9	Silty Sand Dense		11	SS	37		160				
158.0	Boulder		12	RC	-						
13.9	Break corebarrel in borehole Abandon hole End of Borehole										

* Borehole caved at shallow depth. Perched water level at 0.5 metres.

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 2 METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 846.8; E 294 360.0 ORIGINATED BY V.P.
DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY V.P.
DATUM Geodetic DATE 81-12-11, 81-12-14, 81-12-15 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.6	Ground Surface										
0.0	Brown Grey (Glacial Till) Silty Clay with Sand trace of Gravel		1	SS	27	*	170				
			2	SS	32						
			3	SS	51				○		5-28-52-15
			4	SS	32		168				
			5	SS	47				○		
			6	SS	43						
			7	SS	33		166		○		12-15-41-32
	Silty Sand Very Stiff to Hard		8	SS	40		164				
			9	SS	78						
161.5							162				
10.1	Grey Silty Sand to Sand		10	SS	91				○		25-37-35-3
			11	SS	40		160		○		25-43-30-2
			12	SS	52						
			13	SS	94						1-72-16-11
			14	SS	65		158				
	Sand and Gravel with varying Amounts of Gravel		15	SS	106/18 cm		156		○		31-53-(16)
	Occasional Cobbles and Boulders throughout		16	SS	70/15 cm		154				2-65-32-1
			17	SS	100/15 cm		152				30-56-(14)
	Dense to Very Dense						150				
148.2											
23.4	Refusal to Augering End of Borehole										

* Note: Perched water table, B.H. caved at 3.5 metres.

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 3 METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 869.0; E 294 354.2 ORIGINATED BY V.P.

DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Solid Stem Augers 24.4 m to 33.4 m and Cone Test COMPILED BY V.P.

DATUM Geodetic DATE 81-12-16, 81-12-17 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
171.5	Ground Surface										
0.0	(Glacial Till)		1	SS	9	▽ *	170				2-22-55-21
			2	SS	26						
			3	SS	49						
	Brown Grey		4	SS	50		168	100/17 cm			5-12-51-32
	Silty Clay with Sand trace of Gravel		5	SS	38						
			6	SS	21		166				
	occ. Cobbles and Boulders		7	SS	26						
			8	SS	30		164				
	Stiff to Hard		9	SS	44						
161.1							162				
10.4	boulder										
	Grey		10	SS	36		160				22-48-25-5
	Silty Sand to Sand Varying Amounts of Gravel		11	SS	105						
			12	SS	58		158				2-71-25-2
	Occasional Cobbles and Boulders throughout						156				
			13	SS	58/	15 cm					44-42-(14)
	Alternating Seams and Layers of Silt, Sand and Gravel						154				
			14	SS	105/	13 cm	152				
	Dense to Very Dense						150				
							140				
138.1											
33.4	Refusal to Solid Augers, Possible Boulder or Bedrock End of Borehole										

* Perched Water Table at 0.9 m
Borehole Caved at 3.5 m

Note: This borehole is a combination of two borings the first meeting refusal at 10.7 metres on a probable boulder.

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 4

METRIC

W P 153-80-02 LOCATION Co-ords N 4 844 838.7; E 294 313.7 ORIGINATED BY V.P.

DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY V.P.

DATUM Geodetic DATE 81-12-18 to 81-12-21 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.4	Ground Surface										
0.0	(Glacial Till)		1	SS	42	*	170				
	Brown Grey		2	SS	60		168				1-17-67-15
	Silty Sand		3	SS	46						
	Silty Clay some Sand trave of Gravel		4	SS	75		166				
			5	SS	33		164				5-15-60-20
	Hard		6	SS	83		162				
159.8			7	SS	45		160				
11.6	Cobbles										
	Grey Compact		8	SS	20						15-53-30-2
	Silty Sand		9	SS	84		158				
	to Gravel and Cobble layers						156				
	Sand Varying Amounts of Gravel		10	SS	105/	15 cm	154				6-75-(19)
	occasional Cobbles and Boulders throughout		11	SS	115/	13 cm	152				12-51-33-4
							150				
148.5	Very Dense		12	SS	120/	3 cm					
22.9	End of Borehole										
	* Borehole caved at 9.3 metres.										
	Perched Water Table										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 5 METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 920.5; E 294 356.5 ORIGINATED BY V.P.
DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Auger/BW Casing and Cone Test COMPILED BY V.P.
DATUM Geodetic DATE 81-12-16 to 81-12-17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.5	Ground Surface										
0.0	(Glacial Till)										
	Silty Clay		1	SS	12		170				
			2	SS	15						
	Brown Grey		3	SS	37				o		1-18-66-15
			4	SS	35		168	100/23 cm			
	with Sand trace of Gravel Stiff to Hard		5	SS	27						
			6	SS	15						
						▽	166				
	Cobble		7	SS	20	*			o		6-26-46-22
							164				
	Gravel Cobbles & Boulders		8	SS	41						
162.4											
9.1	Grey Silty Sand to Sand		9	SS	124		162				23-46-27-4
			10	SS	77						
							160				
			11	SS	53						0-85-11-4
	Varying Amounts of Gravel occasional Cobbles and Boulders throughout						158				
			12	SS	145		156				
							154				
			13	SS	148/	23 cm					43-46-(11)
	Very Dense						152				
149.8			14	SS	147/	23 cm	150				0-28-64-8
21.7	End of Borehole										
	* Note: W.L. after 24 hours										
	Refusal to augering at 8.2 metres Move BH 1.2 m south										
	Drive BW casing and run bi-cone 18.3 to 21.3 metres.										

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 6 METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 864.4; E 294 316.3 ORIGINATED BY V.P.
DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Auger/Drive "B" Casing COMPILED BY V.P.
DATUM Geodetic DATE 81-12-21 CHECKED BY

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.6	Ground Surface										
0.0	(Glacial Till)		1	SS	31	*	170				
			2	SS	44				o——		4-26-52-18
	Brown Grey		3	SS	47		168				
			4	SS	35				o—		2-4-82-12
	Silty Clay with Sand trace of Gravel		5	SS	40						
			6	SS	100/ 8 cm		166				
			7	SS	36		164				
	Hard										
			8	SS	40						
	Gravel & Cobbles						162				
160.5			9	SS	31				—o—		2-10-56-32
10.1											
	Grey		10	SS	36		160				24-47-25-4
	Silty Sand to		11	SS	74						3-56-35-6
	Cobbles						158				
	Sand										
							156				
			12	SS	149/ 23 cm						
	Varying Amounts of Gravel						154				
	Occasional Cobbles and Boulders throughout		13	SS	168/ 23 cm						
							152				
	Dense to Very Dense										
							150				
149.0			14	SS	145/ 23 cm						15-47-32-6
21.6	End of Borehole										

* Perched Water Level at Ground Surface. BH Caved at 6.9 m.

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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Ontario

RECORD OF BOREHOLE No 7

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 880.0; E 294 310.4 ORIGINATED BY V.P.

DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY V.P.

DATUM Geodetic DATE 81-12-22 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.7	Ground Surface										
0.0	(Glacial Till) Brown Grey		1	SS	27	*	170				
			2	SS	44		168				
	Silty Clay with Sand trace of Gravel occ. cobbles		3	SS	30		166				
			4	SS	75		164				
	Very Stiff to Hard		5	SS	122/ 22 cm						
161.6			6	SS	40		162				
10.1	Grey Silty Sand to Sand		7	SS	107		160				
			8	SS	79						
	Varying Amounts of Gravel		9	SS	103		158				
	occasional Cobbles and Boulders throughout		10	SS	102		156				
							154				
	Very Dense										
151.5			11	SS	157/ 20 cm		152				
20.2	End of Borehole										

* Note: W.L. not established at time of investigation.

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8 METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 895.5; E 294 357.7 ORIGINATED BY V.P.
DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Auger/"B" Casing COMPILED BY V.P.
DATUM Geodetic DATE 81-12-22 CHECKED BY

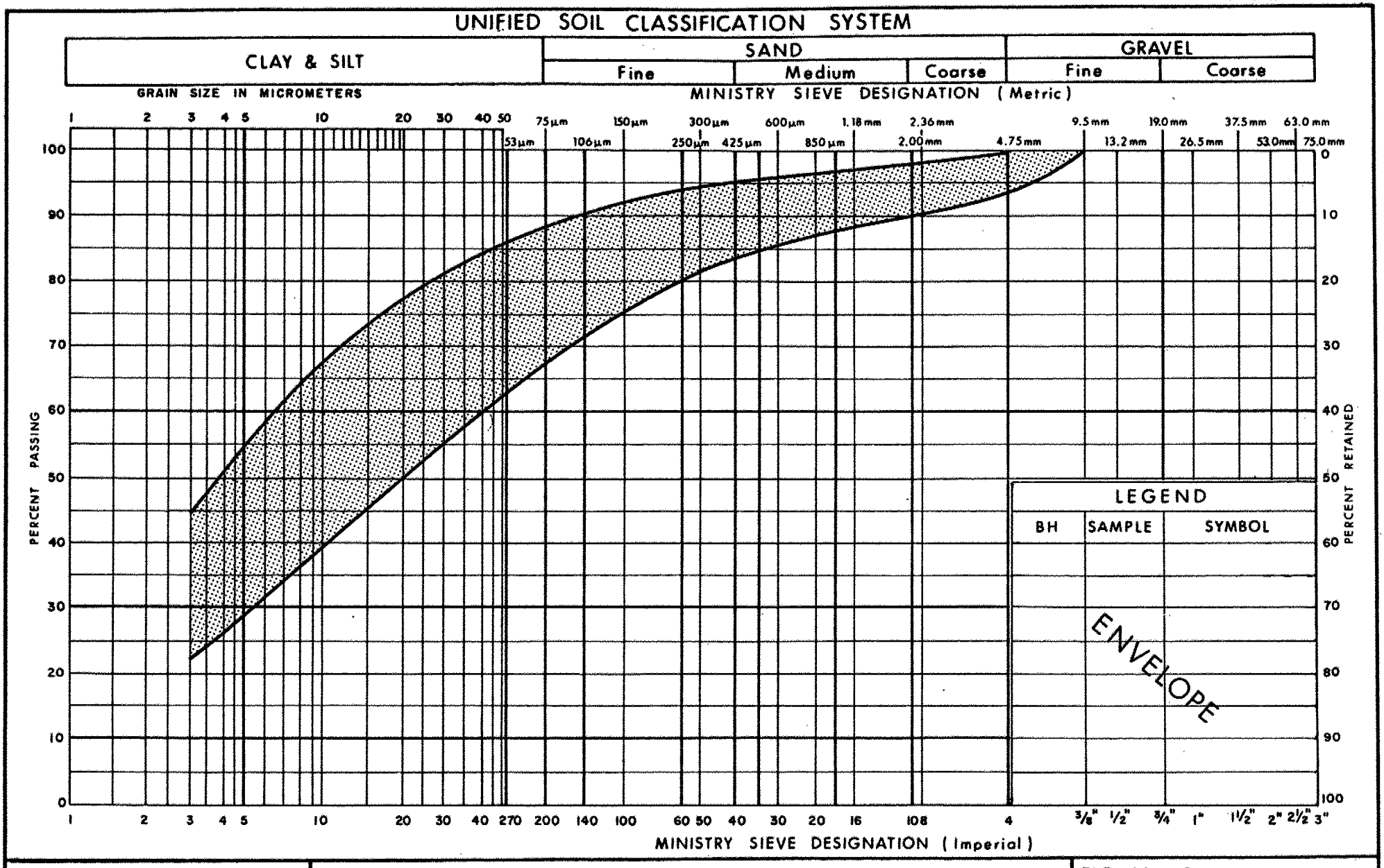
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
170.8	Ground Surface										
0.0	(Glacial Till)					*	170				
	Brown Grey		1	SS	31						
	Silty Clay with Sand trace of Gravel		2	SS	25		168				
			3	SS	23		166				
	Silty Sand		4	SS	27						
	Very Stiff to Hard		5	SS	109		164				
162.0											
8.8	Grey Silty Sand to Sand		6	SS	100		162				
			7	SS	118		160				
			8	SS	11		158				
	Varying Amounts of Gravel occasional Cobbles and Boulders Throughout		9	SS	156		156				
			10	SS	111		154				
	Very Dense		11	SS	100/ 15 cm		152				
							150				
147.7			12	SS	100/ 8 cm		148				
23.1	End of Borehole										

* W.L. not established at time of investigation.

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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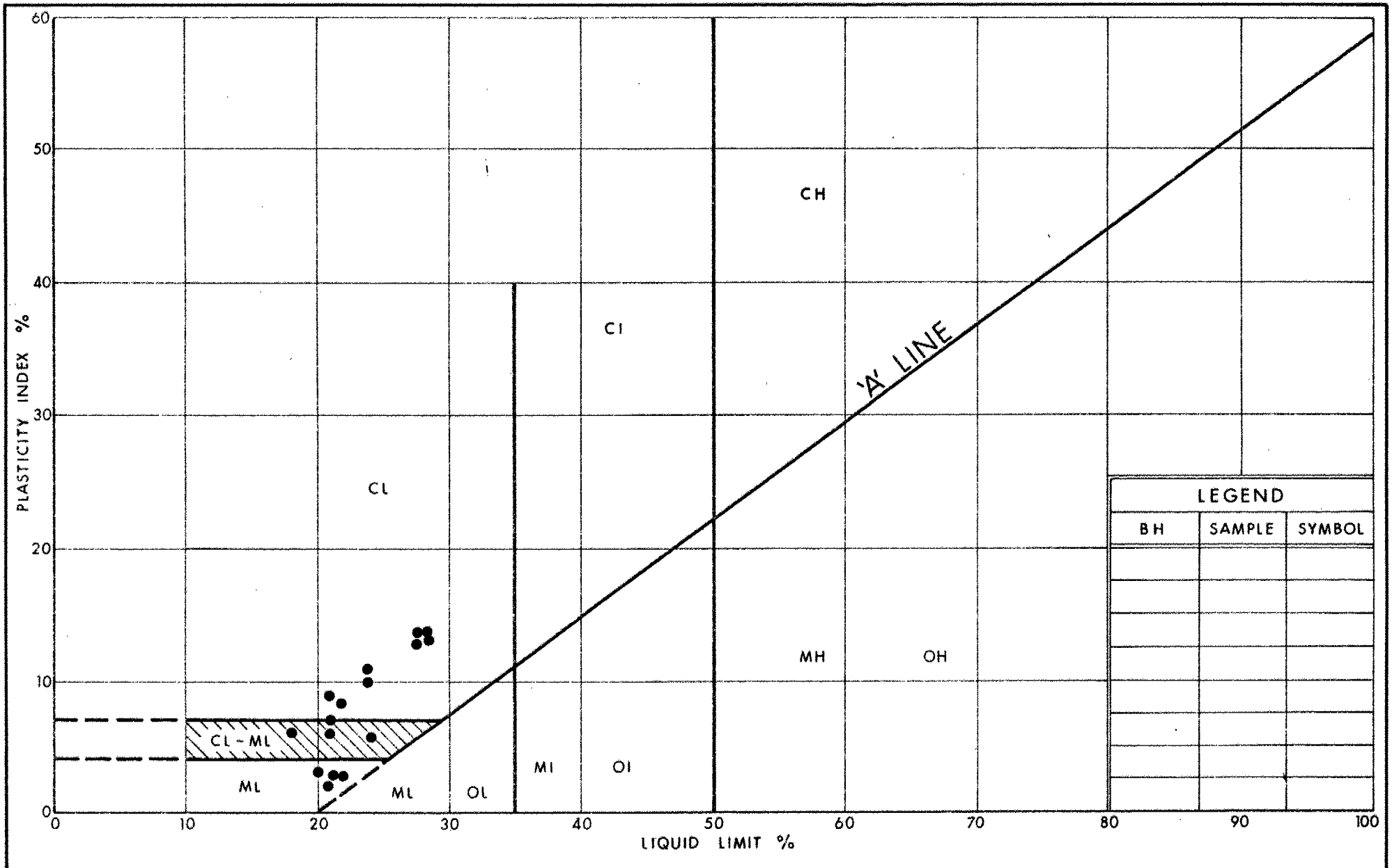
GRAIN SIZE DISTRIBUTION

SILTY CLAY, WITH SAND TRACE OF GRAVEL (Glacial Till)

FIG No 1

W P 153-80-02



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Ontario

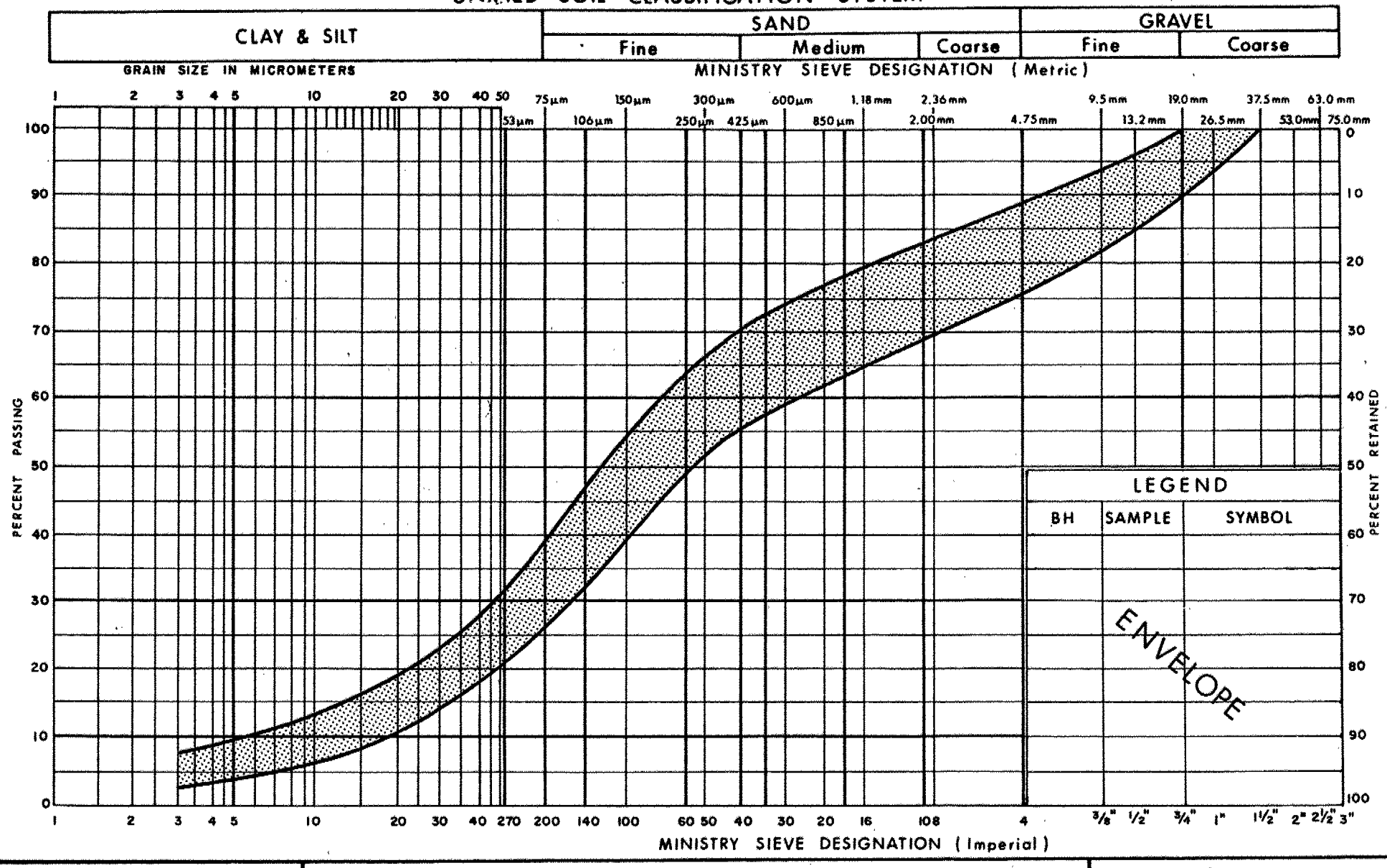
PLASTICITY CHART

SILTY CLAY Matrix (Glacial Till)

FIG No 2

W P 153-80-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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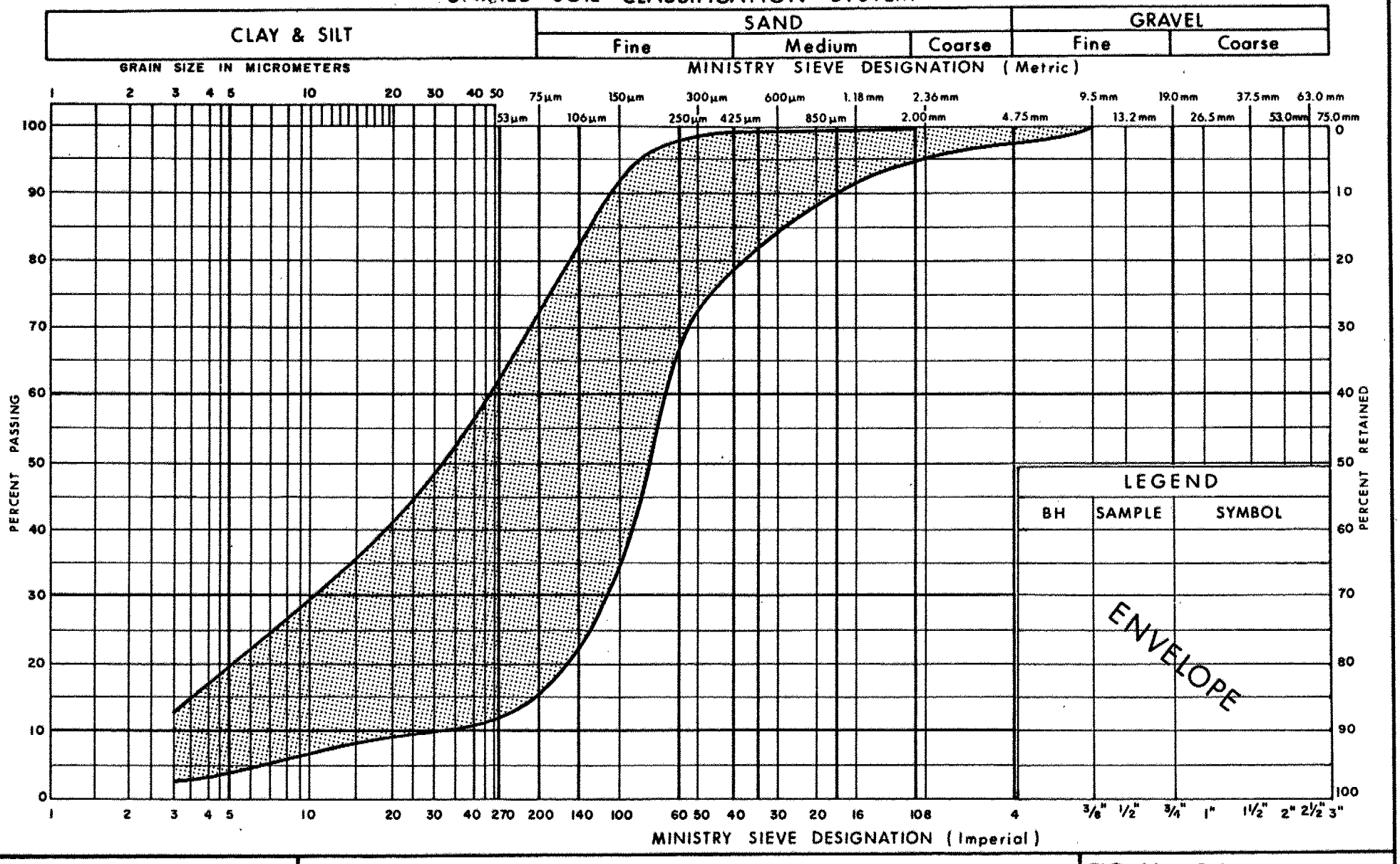
GRAIN SIZE DISTRIBUTION

SAND WITH SILT SOME GRAVEL

FIG No 3A

WP 153-80-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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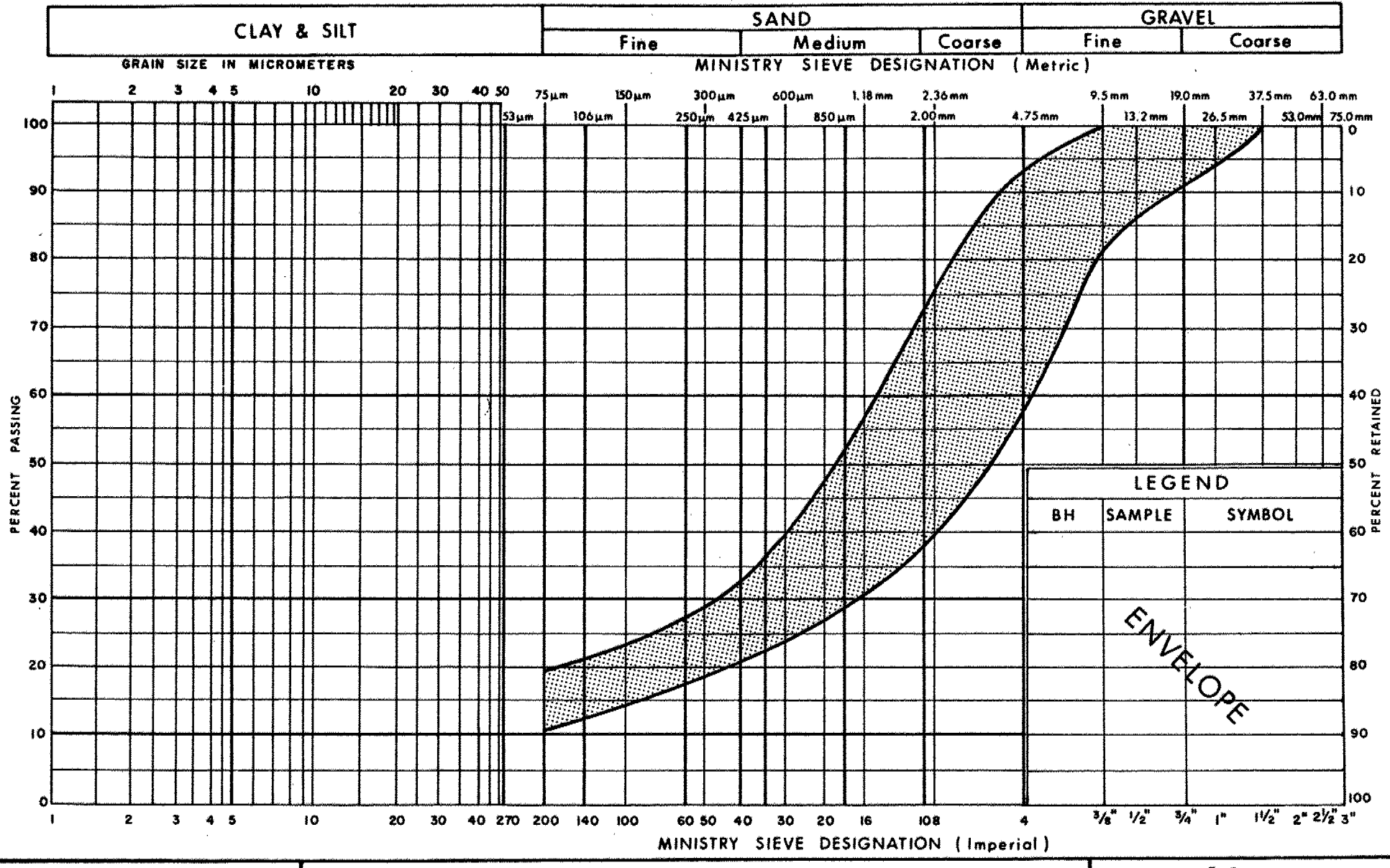
GRAIN SIZE DISTRIBUTION

SILTY SAND

FIG No 3 B

WP 153-80-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

SAND WITH VARYING AMOUNTS OF GRAVEL TRACE OF SILT

FIG No 3C

WP 153-80-02

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1,%	VOID RATIO	e_{min}	1,%	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1,%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1,%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_U	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_S	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL				k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL	e_{max}	1,%	VOID RATIO IN LOOSEST STATE			

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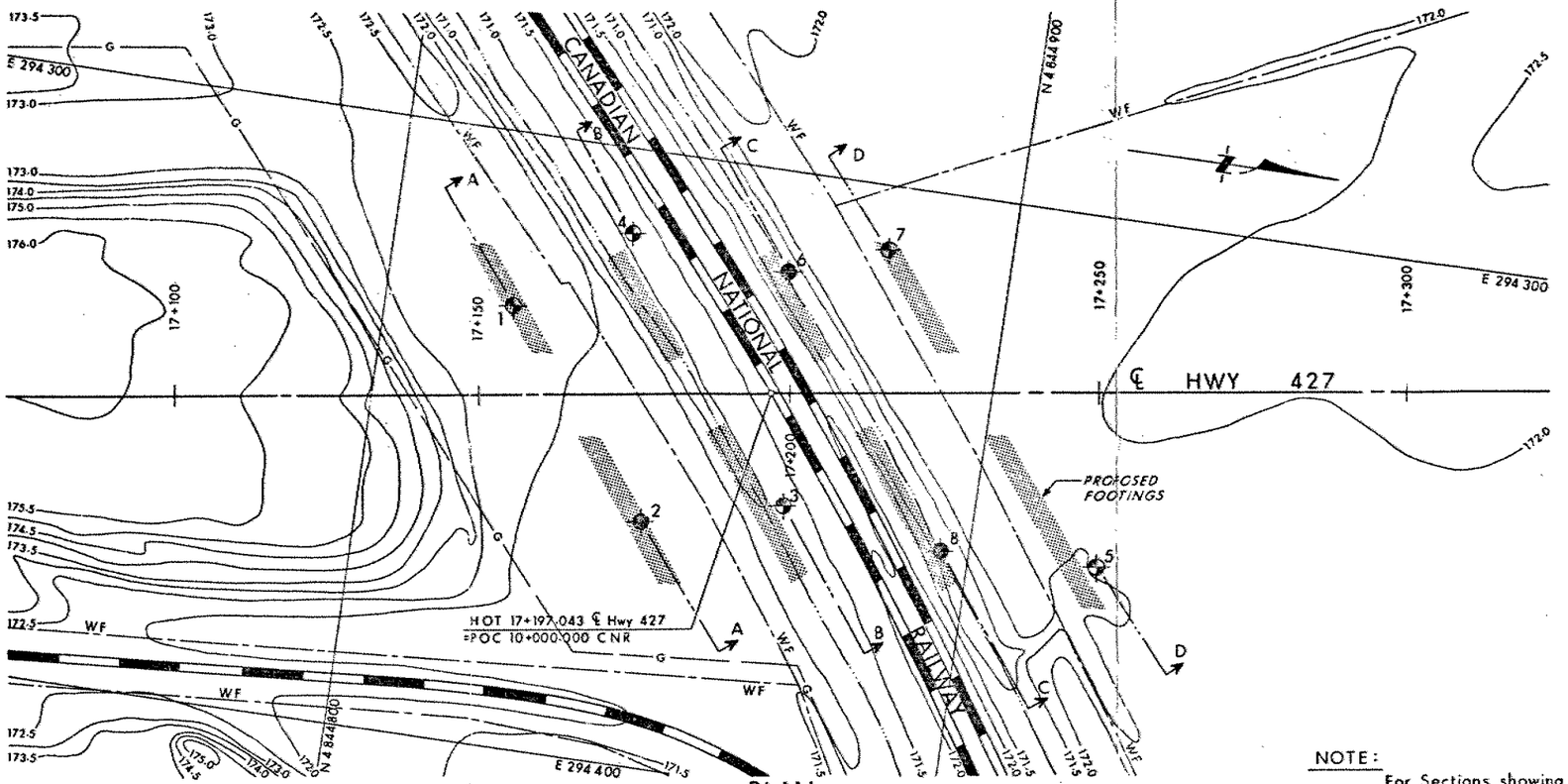
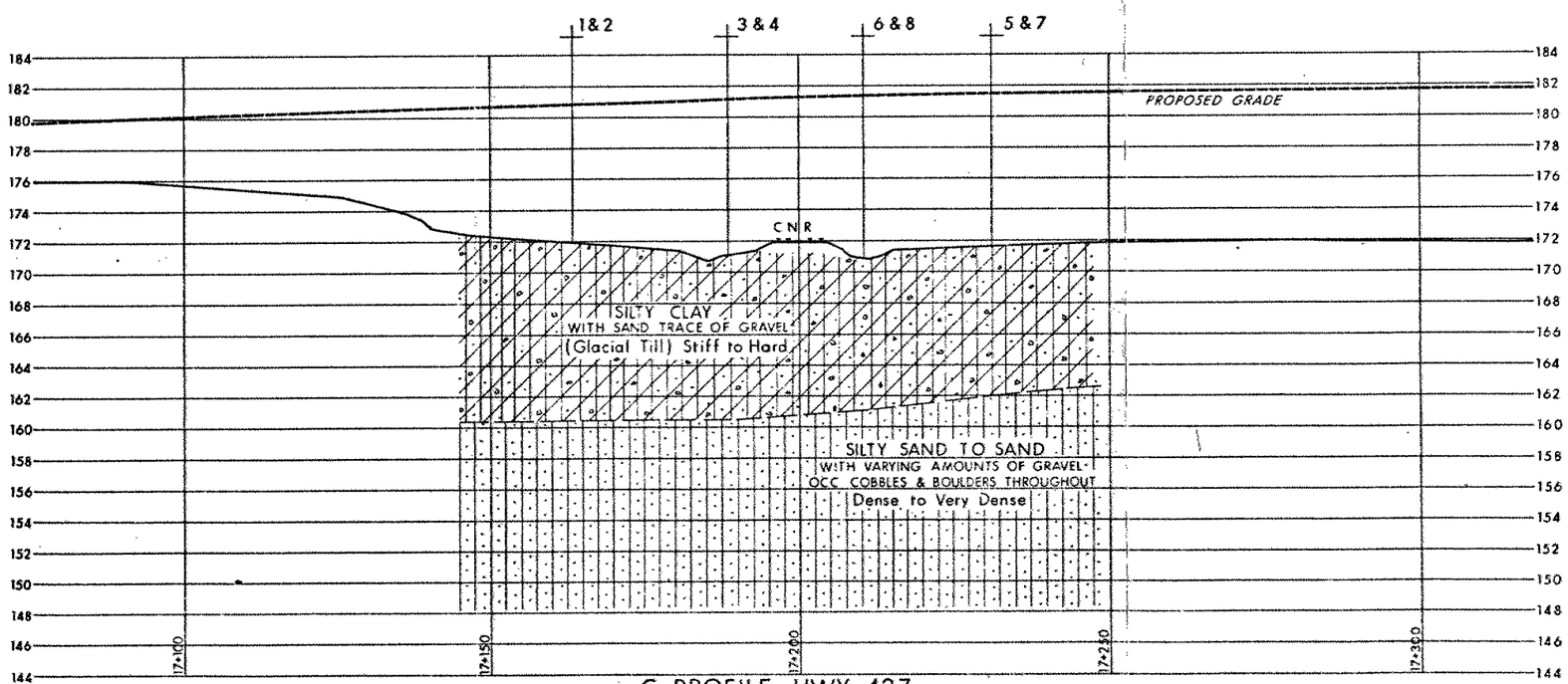


PLAN
SCALE
10m 5 0 10m



℄ PROFILE HWY 427
SCALE
HOR 10m 5 0 10m
VERT 4m 2 0 4m

METRIC

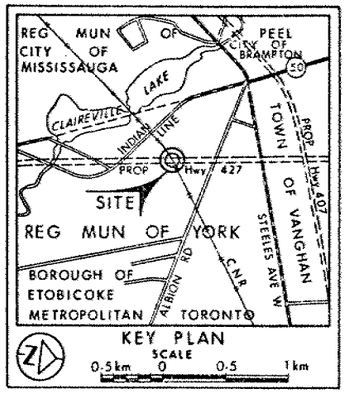
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETRES + METRES.

NOTE:
For Sections showing detailed stratigraphy, refer to Dwg No 1538002-B

CONT No
WP No 153-80-02

CNR OVERHEAD
(HALTON SUBDIVISION)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1981 12
- WL Not Established in Boreholes 7 and 8

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	171.9	4 844 821.2	294 328.3
2	171.6	4 844 846.8	294 360.0
3	171.5	4 844 869.0	294 354.3
4	171.4	4 844 838.7	294 313.7
5	171.5	4 844 920.5	294 356.5
6	170.6	4 844 864.4	294 316.3
7	171.7	4 844 880.0	294 310.4
8	170.8	4 844 895.5	294 357.7

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS

DATE	BY	DESCRIPTION

Geocres No 30M12-152

HWY No 427			DIST 6
SUBMD TJK	CHECKED	DATE 1982 03 05	SITE 37-1109
DRAWN	CHECKED	APPROVED	DWG 1538002-A

REF PROCTOR & REDFERN LTD
DWG No X-81197-S1 : 1981 11

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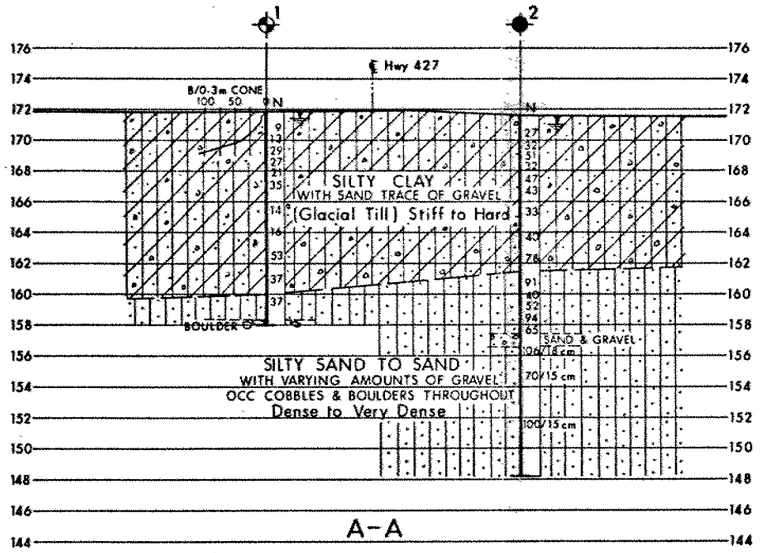
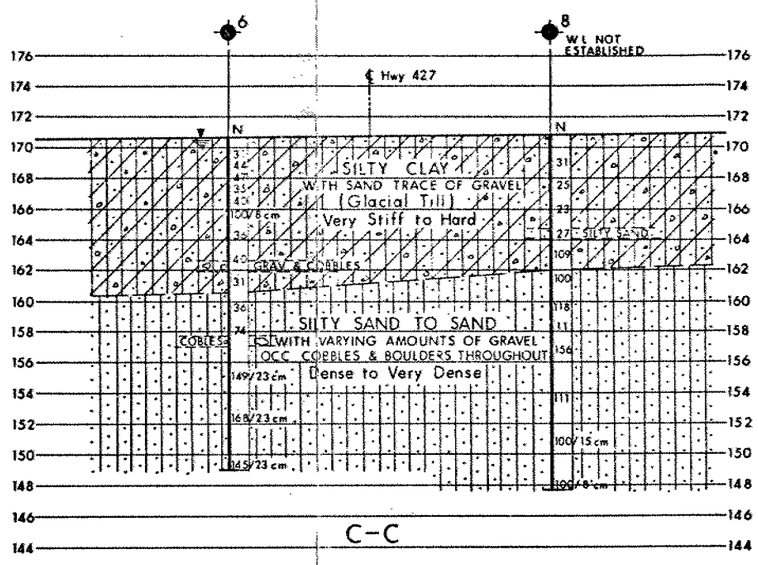
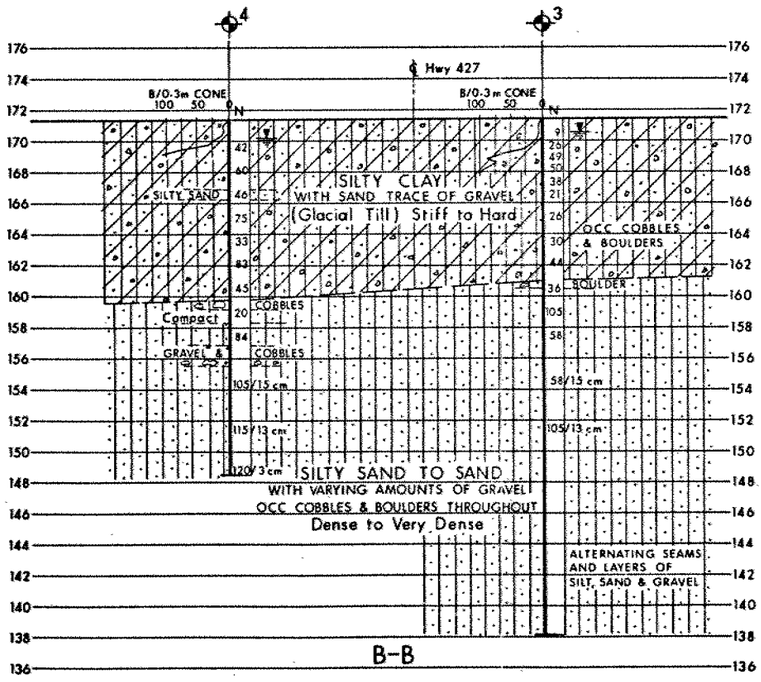


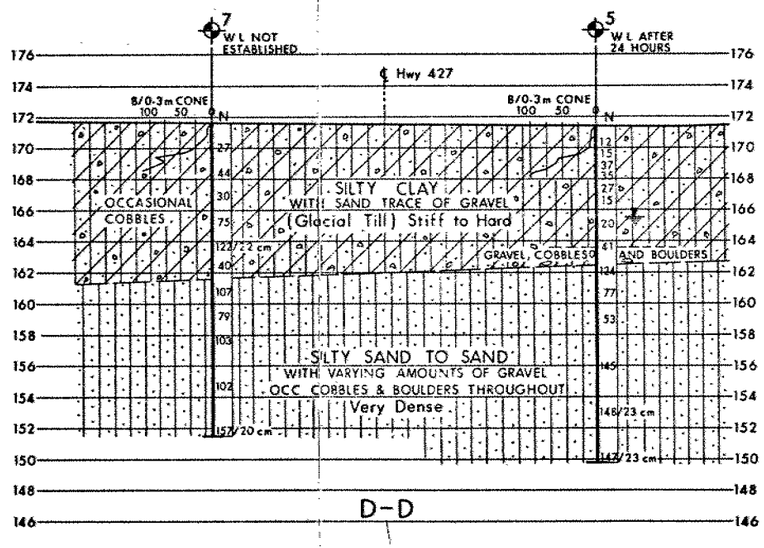
A-A



C-C



B-B



D-D

SECTIONS

SCALE

HOR 10m 5 0 10m

VERT 4m 2 0 4m

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 153-80-02

CNR OVERHEAD
(HALTON SUBDIVISION)
SECTIONS AND SOIL STRATA

SHEET

SEE DWG 1538002-A

KEY PLAN
SCALE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1981 12
  W L Not Established in Boreholes 7 and 8

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	171.9	SEE DWG	1538002-A
2	171.6		
3	171.5		
4	171.4		
5	171.5		
6	170.6		
7	171.7		
8	170.8		

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS

DATE	BY	DESCRIPTION

Geocres No 30M12-152

HWY No 427			DIST 6
SUBM'D TJK	CHECKED AL	DATE 1982 03 04	SITE 37-1109
DRAWN	CHECKED	APPROVED	DWG 1538002-B

memorandum

Ontario

To: Mr. W.L. Lin
Design Engineer
Structural Office
3501 Dufferin St., 4th Floor

Date: 83 03 15

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Steels Ave. Overpass at Hwy. 427
W.P. 153-80-04, Site 37-80-1111
District 6, Toronto

We have reviewed the final design drawings for the above project. A note should be included stating that any topsoil and loose surficial soils should be removed under the area of both Granular 'A' pads.

K.D. Chak
Trainee Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

KDC:syc

memorandum

Ontario

To: Mr. W.L. Lin
Design Engineer (Central)
Operating Section
Structural Office

Date: 82 08 26

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Steeles Avenue Overpass
W.P. 153-80-04, Site 37-1111
Hwy. 427, District 6, Toronto

We have reviewed the preliminary drawing (P1) for the above-mentioned structure and have noted the change from a twin two span structure to a single span with combined wing wall/retaining walls. We have no comments on the preliminary design at this time.

Tom Kazmierowski, P. Eng.
Foundations Engineer

TK:syc

memorandum

Ontario

To: Mr. G.C.E. Burkhardt
Head, Structural Office
Central (5000 Yonge St.) Region

Date: 82 03 22

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Proposed Overpass Bridge
At Highway 427 and Steeles Avenue
W.P. 153-80-04, District 6 (Toronto)

The foundation investigation program for the above-mentioned project has now been completed by Golder Associates, consulting geotechnical and mining engineers. Attached please find their final report and drawings describing the subsurface conditions at the site of the proposed overpass bridge at Highway 427 and Steeles Avenue, Toronto, Ontario. This report also contains geotechnical recommendations pertaining to the foundation design of the proposed bridge and associated approaches to the structure. This section has reviewed the draft report for content and format and have no further comments at this time.

We believe the data provided in the foundation report is adequate for your requirements. Should you require further clarification or additional information, please feel free to contact us.

M. Devata
Senior Foundations Engineer

MD/syc
Att.

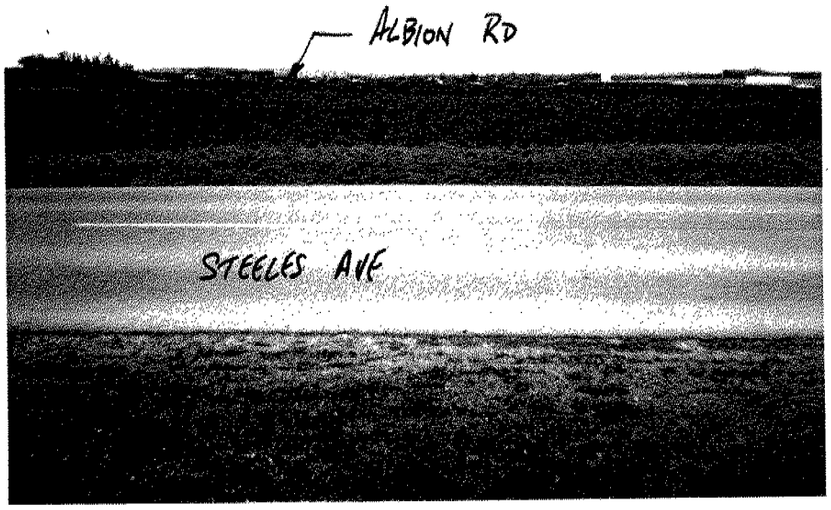
cc: R.D. Gunter
F. Norman
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore

R. Fitzgibbon (memo only)
J. Anderson (memo only)
T.J. Kovich (memo only)

Files

WEST ALONG STEELES AVE.

EAST ALONG STEELES AVE.



SOUTH ALONG PROPOSED HWY. 427
FROM NORTH SIDE OF STEELES AVE.