



**DETAIL DESIGN FOUNDATION INVESTIGATION AND DESIGN
REPORT**

for

WIDENING OF QUEEN STREET OVERPASSES

Site Nos. 06X-0051/B1 & B2

Highway 401 – Station 17+860

Township of Tilbury, Chatham-Kent, Ontario

GWP 3034-19-00, WP 3041-19-01 & 3043-19-01

Assignment No. 3017-E-0006/0007

Work Item No. 06

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DETAIL DESIGN FOUNDATION INVESTIGATION AND DESIGN REPORT

Widening of Queen Street Overpasses
Site No. 06X-0051/B1 & B2
Highway 401 – Station 17+860
Township of Tilbury, Chatham-Kent, Ontario
G.W.P. 3034-19-00, Assignment No. 3017-E-0006/0007, Work Item No. 06

PART A – DETAIL DESIGN FOUNDATION INVESTIGATION PORTION OF REPORT

1. INTRODUCTION

The Ministry of Transportation Ontario (MTO) has retained WSP as the Prime Consultant, to provide services for the widening of EBL and WBL structures at two sites on Highway 401 under MTO Assignment No. 3017-E-0006/0007, Work Item No. 06. WSP retained Peto MacCallum Ltd. (PML) on behalf of MTO to provide foundation engineering services for this assignment. The Terms of Reference and Scope of Work for the Foundation Engineering services are outlined in MTO Assignment No. 3017-E-0006/0007, Work Item No. 06.

This report is a Detail Design Foundation Investigation and Design Report for Queen Street EBL and WBL Overpasses located along Highway 401 at the crossing of Queen Street in the Township of Tilbury, Chatham-Kent, Ontario. The subsurface investigation was limited to previously available boreholes supplemented by an additional two (2) boreholes drilled for the current assignment.

2. SITE DESCRIPTION

Highway 401 in the area of the bridge site is elevated slightly above the natural topography, and accommodates two (2) lanes of vehicular traffic in each direction. The site is generally a flat area, with the exception of the highway embankments. The study area is surrounded by residential, commercial and agricultural developments, and is located approximately 1.2 km north of the residential community of Tilbury.

3. FIELD INVESTIGATION PROCEDURES

The field work for the current foundation investigation involved two (2) boreholes drilled to supplement subsurface information from the previous investigation. The new boreholes are identified as QEB and QWB, located within the Highway 401 median, east and west of Queen Street Overpass, respectively. The boreholes were drilled to depth of 30 m below the



existing ground surface. The locations, ground elevations and depths of drilling are summarized in Table 3.

Table 3: Borehole Location and Termination Depth

Borehole No.	LOCATION				Depth (m)	Ground Elevation (m)
	Northing	Easting	Latitude	Longitude		
QEB	4 681 197.2	310 477.4	42.270321	-82.431176	30.0	182.5
QWB	4 681 187.4	310 434.6	42.270233	-82.431695	30.0	182.5

PML staff visited the site on August 17, 2019 to mark out the borehole locations. The appropriate utility companies cleared the underground services at the borehole locations. Public and private utility authorities were informed and all of the utility clearance documents were obtained before the commencement of drilling work.

PML staff used a portable GPS device to establish the borehole locations in the field. Subsequently, PML carried out the survey of the as-drilled borehole locations using a Sokkia SHC5000 Differential GPS unit, equipped with a GCX3 (Network RTK rover) GNSS Receiver. The vertical and horizontal accuracy of this equipment are within 0.1 m and 0.5 m, respectively. All elevations reported in this report are referred to in MTM NAD 83 Northing and Easting (MTM Zone - ON11) Geodetic datum and expressed in meters.

The equipment used for the borehole drilling work was owned and operated by London Soil Test Inc. (London Soil), of London, Ontario. London Soil is a specialist drilling contractor and worked under the full-time supervision of a PML field supervisor. Boreholes QEB and QWB were drilled between October 1 and 4, 2019. The boreholes were advanced using a D50-Turbo Track-mounted drilling rig equipped with 200 mm diameter hollow stem augers.

Refer to Drawings QS-1 and QS-2 in Appendix A for borehole location details.

Representative soil samples were recovered from the boreholes at 0.75 m intervals to a depth of 6.0 m and at 1.5 m intervals to a depth of 20 m, and at 3.0 m interval to the termination depth, using a conventional 51 mm OD split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In addition, attempt was made to measure in-situ



vane shear strength of clayey soil at depths where SPT values were below about 8 blows/300 mm, using a N-size (MTO) vane.

The groundwater conditions at the borehole locations were observed during the drilling operations by visual examination of the soil samples, sampler and drill rods as the samples were retrieved. In addition, water level measurements were taken in the open boreholes upon completion of drilling. A monitoring well, consisting of 50 mm outside diameter rigid PVC pipe, was installed adjacent to each borehole for groundwater level measurement. Water levels were measured using a Solinst flat tape water level reader.

The boreholes and monitoring wells were constructed and abandoned/decommissioned in conformance with the requirements of MTO guidelines and Ontario Regulation 903, amended by Ontario Regulation 372.

The recovered soil samples were returned to the PML laboratory for detailed visual examination, and index tests.

4. LABORATORY TEST PROCEDURES

Laboratory testing was carried out on representative SPT samples recovered during the fieldwork at PML's laboratory facility in Toronto, Ontario. The laboratory testing program included the following:

- Natural moisture content determinations (42)
- Grain size distribution analyses (12)
- Atterberg limit tests (11)
- Consolidation test (1)

All the laboratory tests to determine index properties were performed in accordance with the MTO test procedures, which follow the American Society for Testing Materials (ASTM) standards, with the exception of hydrometer tests (LS-702). The results of the grain size distribution analyses are presented in Figures GS-QS-1 to GS-QS-4. The results of the Atterberg Limit tests are presented in Figures PC-QS-1 to PC-QS-3. One-dimensional consolidation (ASTM D-2435) test was conducted on one Shelby tube sample from borehole QWB and the results are presented in



Figure Q-1. All of the test results are summarized in the attached Record of Borehole Logs provided in Appendix A.

5. SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Site Geology

In general, the project area is located within the St. Clair Clay Plains physiographic region. The Quaternary Geology map published by the Ontario Ministry of Northern Development and Mines (MNDM), indicates that the surface conditions in the area of the bridge site consist of Tavistock Till deposits; silty clay matrix. Based on the Bedrock Geology map (MRD126-REV1, 2011) published by the MNDM, the project area consists of Middle Devonian limestone, dolostone and shale of the Hamilton Group rock formation.

5.2 Previous Investigation

The field investigation for the existing bridges was carried out between January 5 and 16, 1959, and consisted of three (3) boreholes drilled to depths ranging from 12.7 m (EL. 164.3) to 14.2 m (EL. 162.8) below the ground surface existed at the time of investigation. Fourth borehole was advanced adjacent to Borehole 3 to a maximum depth of 23.5 m (EL. 153.3), to verify whether the subsoil conditions were similar to that was encountered in other three boreholes. This borehole was not sampled and there is no Record of Borehole sheet. All three sampled boreholes were complemented with Dynamic Cone Penetration Test (DCPT) adjacent to these boreholes and a fourth DCPT located in northwest corner. Based on the foundation investigation and design report (Geocres No. 40J08-002), representative soil samples were recovered from the boreholes at 1.5 m intervals to the termination depth of the boreholes, using a conventional 51 mm OD split spoon sampler, simultaneously conducting Standard Penetration Tests (SPT) to assess the strength characteristics of the substrata. In addition, 51 mm diameter thin wall tube (Shelby) undisturbed samples were also recovered to conduct complex laboratory tests. The laboratory tests consisted of index tests such as moisture content, Atterberg limits and grain size distribution. The report indicates that complex tests on undisturbed samples consisted of one-dimensional consolidation and shear strength measurements. However, laboratory records are not available with the report to evaluate or verify the test results.



Based on the previous investigation, the subsoil conditions in the area of the proposed structure is expected to consist of about 300 mm of topsoil followed by upper stiff to hard brown silty clay deposit to a depth of 7.6 m (EL. 169.2), which is underlain by soft to stiff grey silty clay stratum to the maximum borehole depth of 23.5 m (EL. 153.3). The upper most part of this silty clay deposit to a depth of about 7.6 m (EL. 169.2) appears to be desiccated and the SPT 'N'-values reported were ranging from 9 blows to as high as 45 blows, indicating stiff to hard consistency. Below these depths, the SPT 'N'-values reported range from as low as 2 blows to 16 blows, indicating soft to stiff consistency.

Based on the report, groundwater was not encountered in any of the three boreholes during and upon completion of drilling. The water level of Lake St. Clair at the time of investigation was at approximate EL.175.0

5.3 Current Investigation

The subsurface conditions encountered during the current investigation along with the field and laboratory test results are shown on the attached Record of Borehole Sheets. The borehole locations and stratigraphic profile sections are shown on Drawings QS-1 and QS-2. The boundaries between soil strata have been established at the borehole locations only. The boundaries of soil strata between and beyond the boreholes are assumed and may vary from location to location.

In general, the subsoil conditions immediately below the ground surface on the proposed structures consist of fill, approximately 6.7 m thick, composed of gravelly sand and followed by clayey silt to silty clay, with varying proportions of sand and gravel, which is underlain by approximately 23.5 m thick deposit of very stiff to stiff silty clay to clayey silt till deposit. Boreholes QEB and QWB were terminated to firm clayey silt till at a maximum depth of 30.0 m below the existing ground surface. For classification purposes, the soils encountered at this site can be divided into two (2) distinct zones:



- a) Fill
 - i) Gravelly Sand, Trace Silt, Trace Clay
 - ii) Silty Clay to Clayey Silt, some Sand, Trace Clay
- b) Silty Clay to Clayey Silt, Some Sand, Trace Gravel (Till)

5.3.1 Fill

i) Gravelly Sand, Trace Silt, Trace Clay

A layer of gravelly sand fill is encountered just below the existing ground surface. The layer extends to depth of 3.1 m (EL.179.4) to 4.6 m (EL.177.9) below the existing ground surface in boreholes QEB and QWB, respectively.

The SPT 'N'-values recorded in this fill ranged between 7 and 23 blows, indicating loose to compact state of compactness. The moisture content of samples tested from this fill ranged between 5.7% and 9.2%.

The grain size distribution result of selected sample from borehole QWB is provided on Figure GS-QS-2 in Appendix A. Sieve analysis test was performed on representative sample from this fill and the test result indicates that this fill consists of 16% gravel, 73%% sand, 7% silt, and 4% clay size particles.

ii) Silty Clay to Clayey Silt, Some Sand, Trace Gravel

A layer of silty clay to clayey silt fill is encountered below the gravelly sand fill in both boreholes. This layer extends to depth of 6.7 m (EL.175.8) below the existing ground surface in both boreholes. A thin layer of silty sand is encountered in the bottom of silty clay fill in borehole QWB at a depth of 6.4 m (EL.176.1) and extends to a depth of 6.7 m (EL. 175.8) from the existing ground surface.

The SPT 'N'-values recorded in this fill ranged between 6 and 10 blows, indicating firm to stiff consistency. The moisture content of samples tested from this fill ranged between 18.3% and 27.1%.

The grain size distribution results of selected silty clay samples from this fill are provided on Figures GS-QS-1, and the results of Atterberg limits for the same samples are provided on Figures PC-QS-1 in Appendix A.



Sieve analysis tests were performed on two (2) representative samples and the test results indicate that this fill consists of 2 to 6% gravel, 17% sand, 37% silt, and 40% to 44% clay. Atterberg limit tests were performed on two (2) representative samples and the test results indicate liquid limit values were 41 and 47, plastic limit values were 21 and 23, and corresponding plasticity index values were 20 and 24. Based on the test results, the clayey soil may be classified as clay of medium plasticity (CI) in the Unified Soil Classification System (USCS), i.e., silty clay and classified as silty clay in the MTO Soil Classification.

5.3.2 Silty Clay to Clayey Silt, Some Sand, Trace Gravel (Till)

The fill in boreholes QEB and QWB is underlain by this silty clay to clayey silt till with varying proportions of sand and gravel. This till deposit is encountered at depth of 6.7 m (EL.175.8) and extends to the termination depths of 30.0 m (EL. 152.5) below the existing ground surface. The SPT 'N'-values in this deposit generally varies from 8 to 16 blows from EL. 175.8 to EL. 170.0, indicating stiff to very stiff consistency. Between EL. 170.0 and EL. 152.5, the SPT 'N'-values ranges from 4 to 10 blows. Within this depth, in-situ vane shear tests were carried out. The test was performed at thirteen (13) locations and the uncorrected vane shear strengths (C_u) measured ranged from 77 kPa to more than 120 kPa, with a sensitivity ratio value between 1 and 2, indicating stiff to very stiff consistency, compared to firm to stiff based on SPT 'N'-values. Generally, from El. 175.8 to El. 165.5, the C_u measured was more than 100 kPa, indicating very stiff consistency. Below El. 16.5, the C_u measured typically ranged between 77 kPa and 100 kPa, indicating stiff consistency. The moisture content of the samples tested from this till deposit were between 18.4% and 24.9%.

The grain size distribution results of selected silty clay to clayey silt samples from this till deposit are provided on Figures GS-QS-3 and GS-QS-4, and the results of Atterberg limits for the same samples are provided on Figures PC-QS-2 and PC-QS-3 in Appendix A.

Sieve analysis tests were performed on nine (9) representative samples and the test results indicate that this deposit consists of 1 to 4% gravel, 15% to 20% sand, 37% to 41% silt, and 38% to 45% clay. Atterberg limit tests were performed on nine (9) representative samples and the test results indicate liquid limit values range from 34 to 39, plastic limit values of 18, and corresponding plasticity index values range from 16 to 21. Based on the test results, the clayey soil may be classified as clay of low to



medium plasticity (CL/CI) in the Unified Soil Classification System (USCS), i.e., clayey silt/silty clay and classified as clayey silt to silty clay in the MTO Soil Classification.

One-dimensional consolidation testing was conducted on one Shelby tube sample obtained from borehole QWB that was considered to be representative of the site conditions. As part of the one-dimensional consolidation and particle size analysis of soils (LS-702), specific gravity test was performed on one sample from the clayey silt till deposit. The specific gravity of the clayey silt sample determined was 2.709. Bulk unit weight of sample determined was 19.9 kN/m^3 and corresponding dry unit weight of the sample was 16.2 kN/m^3 .

The test results are provided in Appendix A. The following table summarizes the consolidation characteristics of the sample.

BOREHOLE NO./ DEPTH (m)	EFFECTIVE OVERBURDEN PRESSURE (kPa)	PRE- CONSOLIDATION PRESSURE (kPa)	OVER CONSOLIDATION RATIO (OCR)	INITIAL VOID RATIO (e_o)	COMPRESSION INDEX (C_c)
QWB/14.0	183	365	2.0	0.637	0.170

5.3.3 Groundwater

Groundwater was not encountered in boreholes QWB and QEB during and upon completion of drilling.

A monitoring well consisting of 50 mm diameter PVC pipe was installed adjacent to boreholes QEB and QWB. Water level readings from the monitoring wells are summarized in Table 5.3.3.

Table 5.3.3: Water Level Readings in Monitoring Wells

MONITORING WELL (MW)	GROUND SURFACE ELEVATION (m)	TOP OF CASING ELEVATION (m)	MID-SCREEN DEPTH (m) (ELEVATION, (m)	WATER LEVEL MEASURED IN MONITORING WELL, DEPTH (m) (ELEVATION, m)		
				2019/10/11	2019/10/24	2019/10/28
QEB	182.5	183.2	7.8 (EL. 174.7)	Dry	7.0 (EL. 175.5)	7.0 (EL. 175.5)
QWB	182.5	183.2	7.8 (EL. 174.7)	Dry	4.8 (EL. 177.7)	5.6 (EL. 176.9)



Groundwater levels may fluctuate due to the influence of precipitation and seasonal change. The groundwater measurements were observed and measured prior to backfilling the boreholes. Groundwater levels are shown on the Borehole Logs in Appendix A.

5.3.4 Soil Corrosivity

Four (4) representative soil samples were sent to SGS Canada Inc. located in Toronto, Ontario, which is accredited by Canadian Analytical Laboratory Association (CALA). The corrosivity test results provided by SGS are presented in Appendix A. A summary of the test results is presented in the Table 5.3.4.



Table 5.3.4: Summary of Corrosivity Results

BOREHOLE ID	SAMPLE NO.	CORROSIVITY INDEX	SULPHIDE (%)	SOIL REDOX POTENTIAL (mV)	pH	RESISTIVITY (Ohm-cm)	CONDUCTIVITY (µS/cm)	SULPHATE (µg/g)	CHLORIDE (µg/g)
QWB	4	7.5	0.03	452	8.62	8870	113	3.2	11
QWB	6	4.0	<0.02	416	8.61	5690	176	6.9	26
QEB	5	6.5	0.10	290	8.33	2160	464	290	130
QEB	7	9.5	0.08	275	7.75	2060	485	270	100

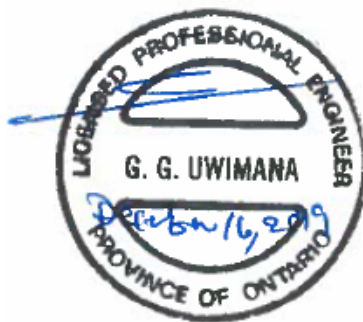
The Foundation Investigation portion of the report was prepared by Mr. K. Amatya, P.Eng. and Mr. N. Rahman P. Eng., Project Engineers and reviewed by Mr. G. Uwimana, MEng, P.Eng., Senior Engineer. Mr. R. Ng, MBA, PhD, P.Eng. Principal Consultant conducted an independent review of the report.

Yours very truly

Peto MacCallum Ltd.



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MTO Designated Principal Contact

NR/GU/RN.ka-nr-nk



APPENDIX A

Borehole Locations Plan and Soil Strata Drawings QS-1 and QS-2

Explanation of Terms Used in Report

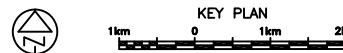
Record of Borehole Sheets

Results of Grain Size Distribution Analyses – Figures GS-QS-1 to GS-QS-4

Results of Atterberg Limit Tests – Figures PC-QS-1 to PC-QS-3

Consolidation Test Results – Figure No. Q-1

Results of Chemical Tests provided by SGS Canada Inc.



LEGEND

- Borehole Location
- Blows/0.3m (Std. Pen Test, 475 J/blow)
- Monitoring Well
- Water Level in Monitoring Well (October 2019)

BH No	ELEVATION	NORTHINGS	EASTINGS
QWB	182.5	4 681 187.4	310 434.6
QEB	182.5	4 681 197.2	310 477.4

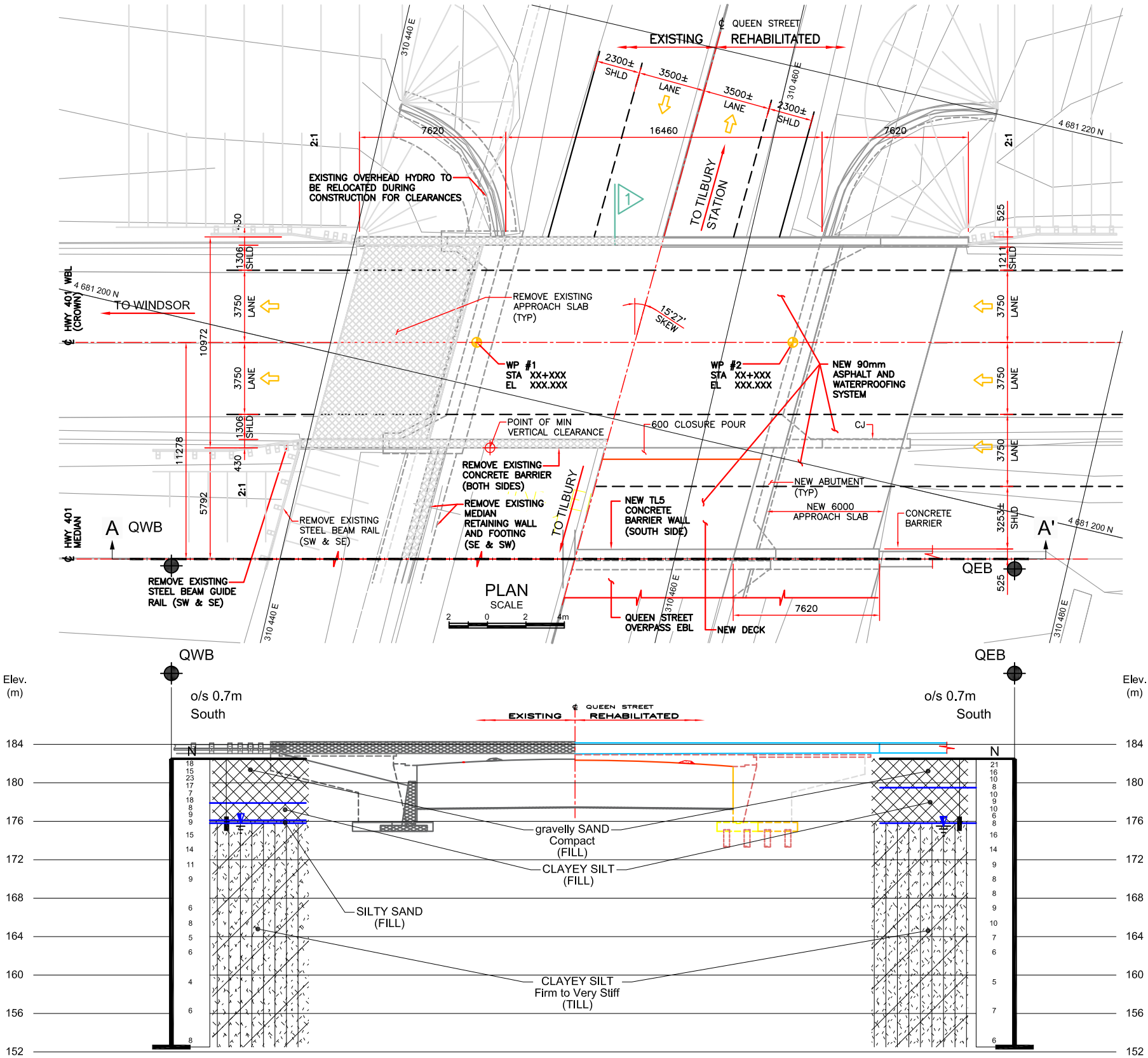
NOTE

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

DATE	BY	DESCRIPTION

Geocres No. 40J8-75

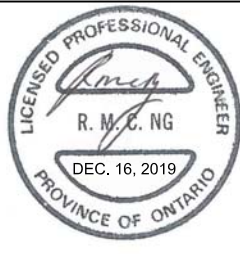
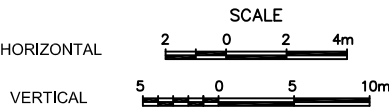
HWY No	401	DIST	WEST REGION
SUBM'D	NL	CHECKED	KA
DATE	DEC. 16, 2019	SITE	6-51/1
DRAWN	NL	CHECKED	NR
APPROVED	RN	DWG	QS-1



NOTES:

- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

PROFILE ALONG A-A'



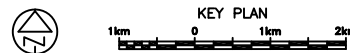
Reference WSP Ltd. Drawing: S18M-02111-06-302-001GA-WBL.dwg, dated October 2019.

Work Item No. 6
GWP No 3034-19-00

HIGHWAY 401 WIDENING
QUEEN STREET OVERPASS - EASTBOUND
BOREHOLE LOCATION PLAN AND SOIL STRATA



SHEET



LEGEND

- Borehole Location
- Blows/0.3m (Std. Pen Test, 475 J/blow)
- Monitoring Well
- Water Level in Monitoring Well (October 2019)

BH No	ELEVATION	NORTHINGS	EASTINGS
QWB	182.5	4 681 187.4	310 434.6
QEB	182.5	4 681 197.2	310 477.4

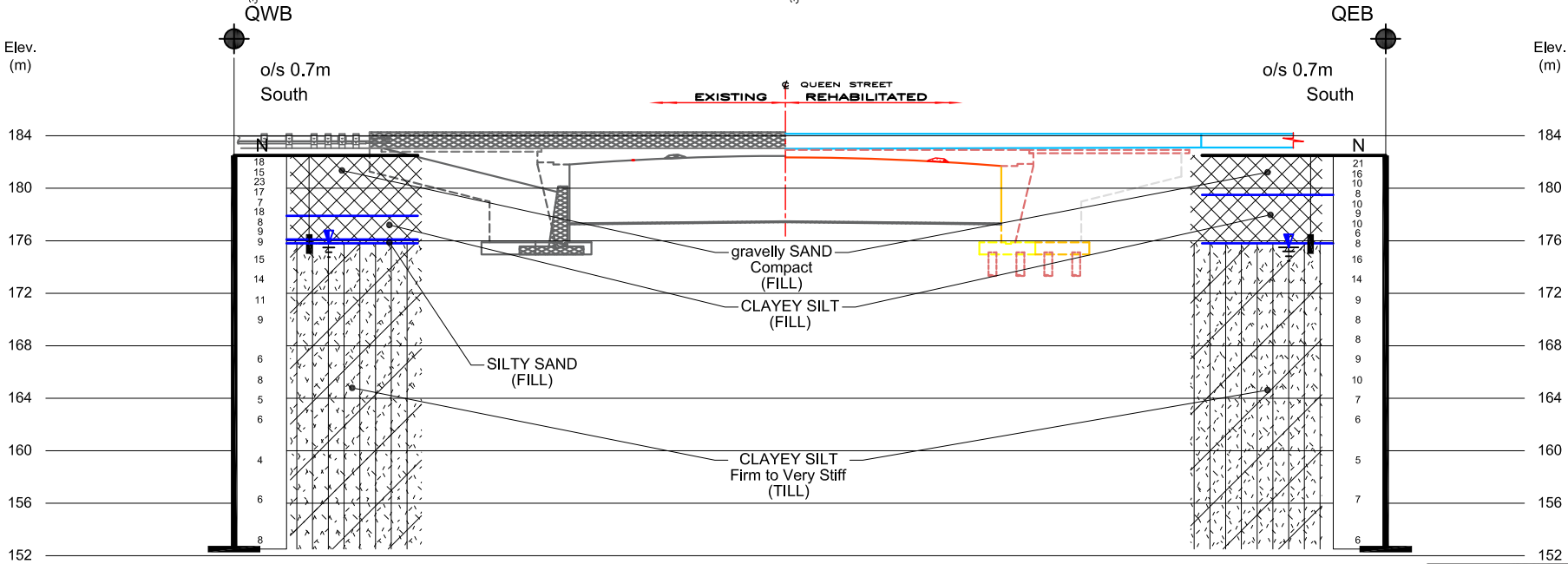
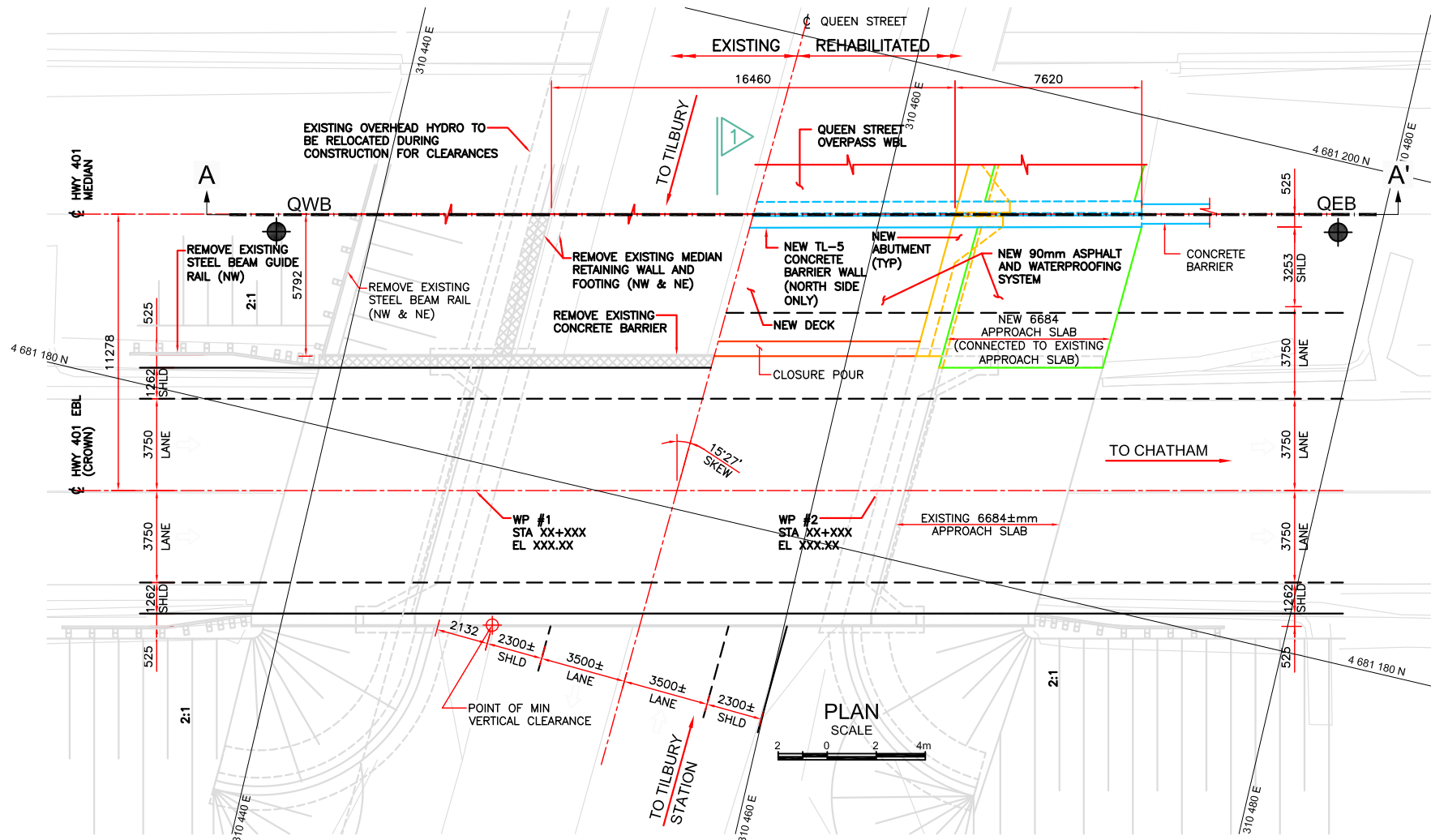
NOTE

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

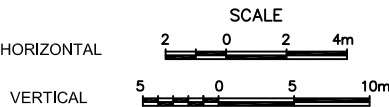
DATE	BY	DESCRIPTION

Geocres No. 40J8-75

HWY No	401	DIST	WEST REGION
SUBM'D	NL	CHECKED	KA
DATE	DEC. 16, 2019	SITE	6-51/2
DRAWN	NL	CHECKED	NR
APPROVED	RN	DWG	QS-2



PROFILE ALONG A-A'



NOTES:

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Reference WSP Ltd. Drawing: S18M-02111-06-302-001GA-EBL.dwg, dated October 2019.

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.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILT)

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:

R Q D (%)	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
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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_i	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No QEB

1 OF 3

METRIC

G.W.P. 3034-19-00 LOCATION Coords: 4 681 197.2 N; 310 477.4 E ORIGINATED BY J.O.
DIST West Region HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY K.A.
DATUM Geodetic DATE 2019.10.01 - 2019.10.02 LATITUDE 42.270321 LONGITUDE -82.431176 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa		WATER CONTENT (%)		W _p	W	W _L	GR		SA	SI	CL	
182.5	Ground								20	40	60	80	100								
0.0	gravelly SAND		1	SS	21				20	40	60	80	100								
	Compact, Brown, Moist (FILL)		2	SS	16																
			3	SS	10																
			4	SS	8																
			5	SS	10																
			6	SS	9																
			7	SS	10																
			8	SS	6																
			9	SS	8																
175.8	SILTY CLAY TO CLAYEY SILT, some sand, trace gravel			VANE																	
6.7	Stiff to very stiff, Grey, Moist (TILL)		10	SS	16																
			11	SS	14																
			12	SS	9																
			13	SS	8																
				VANE																	
			14	SS	8																
				VANE																	
167.5																					

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No QEB

2 OF 3

METRIC

G.W.P. 3034-19-00 LOCATION Coords: 4 681 197.2 N; 310 477.4 E ORIGINATED BY J.O.
DIST West Region HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY K.A.
DATUM Geodetic DATE 2019.10.01 - 2019.10.02 LATITUDE 42.270321 LONGITUDE -82.431176 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						w _p	w	w _L	GR	SA	SI	CL
167.5 15.0	(Cont'd) SILTY CLAY TO CLAYEY SILT, some sand, trace gravel Stiff, Grey, Moist (TILL)																			
			15	SS	9		167													
							166													
			16	SS	10		165													
							164													
			17	SS	7		163													
				VANE			162													
			18	SS	6		161													
				VANE			160													
							159													
			19	SS	5		158													
				VANE			157													
							156													
			20	SS	7		155													
				VANE			154													
							153													
152.5			21	SS	6															
				VANE																

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




+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No QEB

3 OF 3

METRIC

G.W.P. 3034-19-00 LOCATION Coords: 4 681 197.2 N; 310 477.4 E ORIGINATED BY J.O.
 DIST West Region HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY K.A.
 DATUM Geodetic DATE 2019.10.01 - 2019.10.02 LATITUDE 42.270321 LONGITUDE -82.431176 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																		
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																				
						20	40	60	80	100																
152.5 30.0	End of borehole																									
	 Groundwater level measured in monitoring well NOTES: 1. Groundwater was not encountered during or upon completion of drilling. 2. No cave-in was noted upon extraction of hollow stem augers. <u>Monitoring Well Readings:</u> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev.</th> </tr> </thead> <tbody> <tr> <td>Oct.11/'19</td> <td>DRY</td> <td>-</td> </tr> <tr> <td>Oct.24/'19</td> <td>7.0</td> <td>175.5</td> </tr> <tr> <td>Oct.28/'19</td> <td>7.0</td> <td>175.5</td> </tr> </tbody> </table> <u>Monitoring Well Legend:</u>  Stick-up Monument  Bentonite  Filter Sand  19 mm PVC Screen  Filter Bottom	Date	Depth (m)	Elev.	Oct.11/'19	DRY	-	Oct.24/'19	7.0	175.5	Oct.28/'19	7.0	175.5													
Date	Depth (m)	Elev.																								
Oct.11/'19	DRY	-																								
Oct.24/'19	7.0	175.5																								
Oct.28/'19	7.0	175.5																								

RECORD OF BOREHOLE No QWB

1 OF 3

METRIC

G.W.P. 3034-19-00 LOCATION Coords: 4 681 187.4 N; 310 434.6 E ORIGINATED BY J.O.
 DIST West Region HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY K.A.
 DATUM Geodetic DATE 2019.10.03 - 2019.10.04 LATITUDE 42.270233 LONGITUDE -82.431695 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa		W _p	W	W _L		WATER CONTENT (%)	GR	SA	SI	CL
182.5	Ground								20	40	60	80	100						
0.0	gravelly SAND		1	SS	18				20	40	60	80	100	○					
	Compact, Brown, Moist		2	SS	15									○					
	(FILL)		3	SS	23									○					
			4	SS	17									○					
			5	SS	7									○					
			6	SS	18									○					
			7	SS	8									○					
			8	SS	9									○					
			9	SS	9									○					
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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No QWB

2 OF 3

METRIC

G.W.P. 3034-19-00 LOCATION Coords: 4 681 187.4 N; 310 434.6 E ORIGINATED BY J.O.
DIST West Region HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY K.A.
DATUM Geodetic DATE 2019.10.03 - 2019.10.04 LATITUDE 42.270233 LONGITUDE -82.431695 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L		GR	SA	SI	CL		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE											
167.5 15.0	(Cont'd) CLAYEY SILT TO SILTY CLAY, some sand, trace gravel Stiff, Grey, Moist (TILL)		15	SS	6		167						10				2	17	39	42
				VANE			166				>>									
			16	SS	8		165						10							
				VANE			164						10				2	17	37	44
			17	SS	5		163						10							
				VANE			162						10							
			18	SS	6		161						10							
				VANE			160						10							
			19	SS	4		159						10							
				VANE			158						10							
			20	SS	6		157						10							
				VANE			156						10							
			21	SS	8		155						10							
				VANE			154						10							
152.5							153						10				0	19	38	43
				VANE									10							

Continued Next Page







+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No QWB

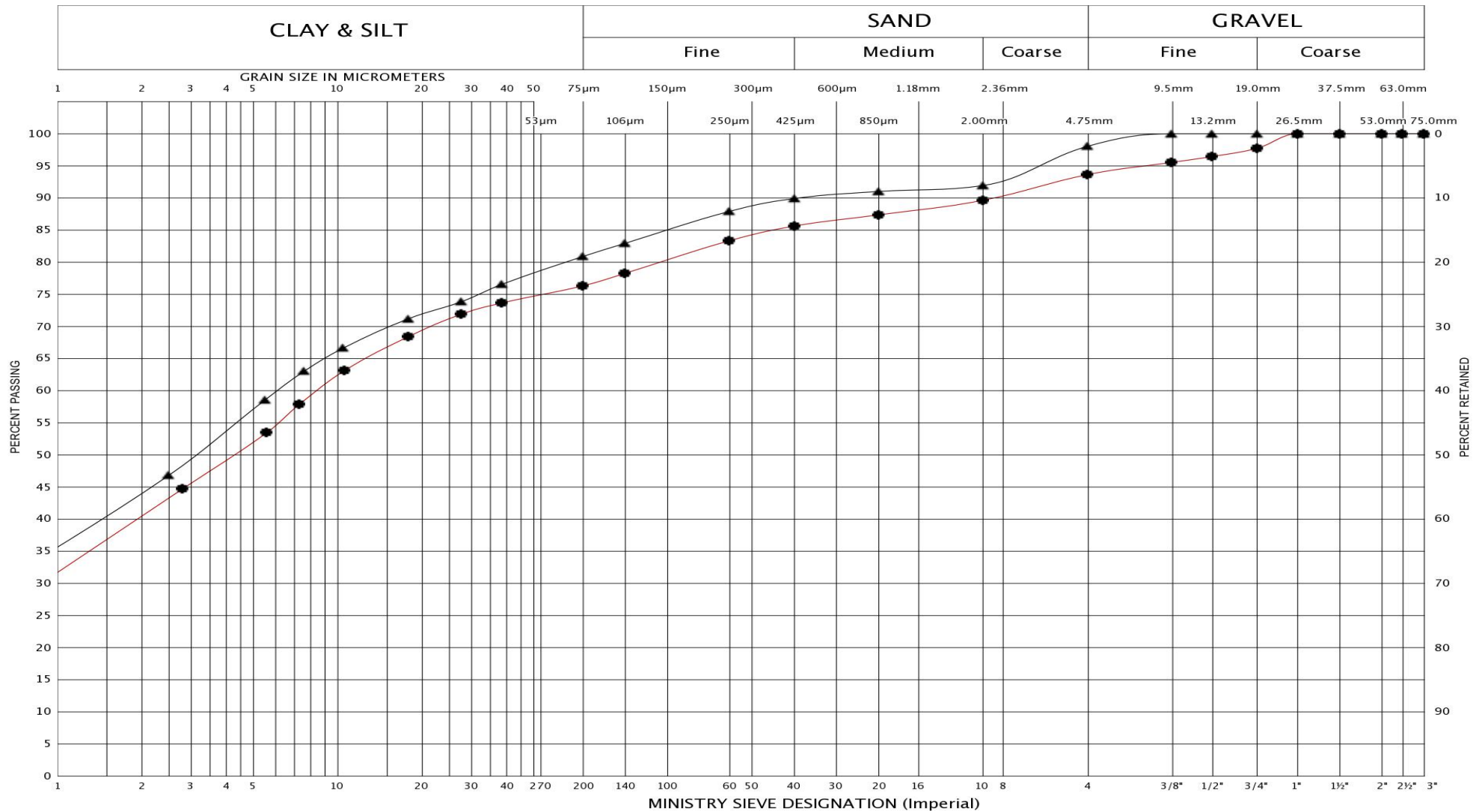
3 OF 3

METRIC

G.W.P. 3034-19-00 LOCATION Coords: 4 681 187.4 N; 310 434.6 E ORIGINATED BY J.O.
 DIST West Region HWY 401 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY K.A.
 DATUM Geodetic DATE 2019.10.03 - 2019.10.04 LATITUDE 42.270233 LONGITUDE -82.431695 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L												
152.5 30.0	End of borehole  Groundwater level measured in monitoring well NOTES: 1. Groundwater was not encountered during or upon completion of drilling. 2. No cave-in was noted upon extraction of hollow stem augers. <u>Monitoring Well Readings:</u> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev.</th> </tr> </thead> <tbody> <tr> <td>Oct.11/'19</td> <td>DRY</td> <td>-</td> </tr> <tr> <td>Oct.24/'19</td> <td>4.8</td> <td>177.7</td> </tr> <tr> <td>Oct.28/'19</td> <td>5.6</td> <td>176.9</td> </tr> </tbody> </table> <u>Monitoring Well Legend:</u>  Stick-up Monument  Bentonite  Filter Sand  19 mm PVC Screen  Filter Bottom	Date	Depth (m)	Elev.	Oct.11/'19	DRY	-	Oct.24/'19	4.8	177.7	Oct.28/'19	5.6	176.9														
Date	Depth (m)	Elev.																									
Oct.11/'19	DRY	-																									
Oct.24/'19	4.8	177.7																									
Oct.28/'19	5.6	176.9																									

UNIFIED SOIL CLASSIFICATION SYSTEM



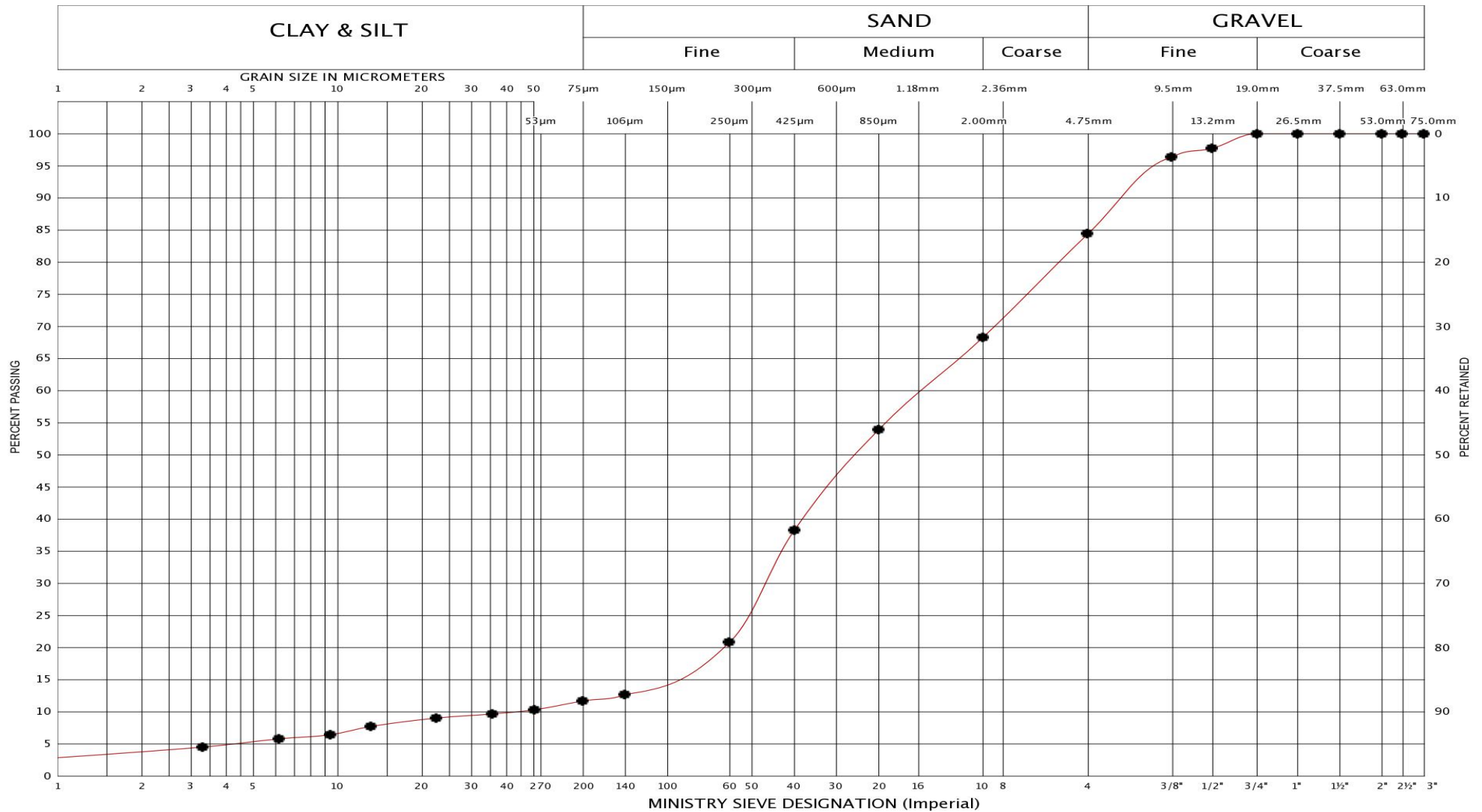
LEGEND	BH	QEB	QWB
	SAMPLE	6	8
	SYMBOL	●	▲



GRAIN SIZE DISTRIBUTION
 SILTY CLAY, Some Sand , Trace Gravel (Fill)

FIG No.: GS-QS-1
 HWY : 401
 GWP 3034-19-00

UNIFIED SOIL CLASSIFICATION SYSTEM



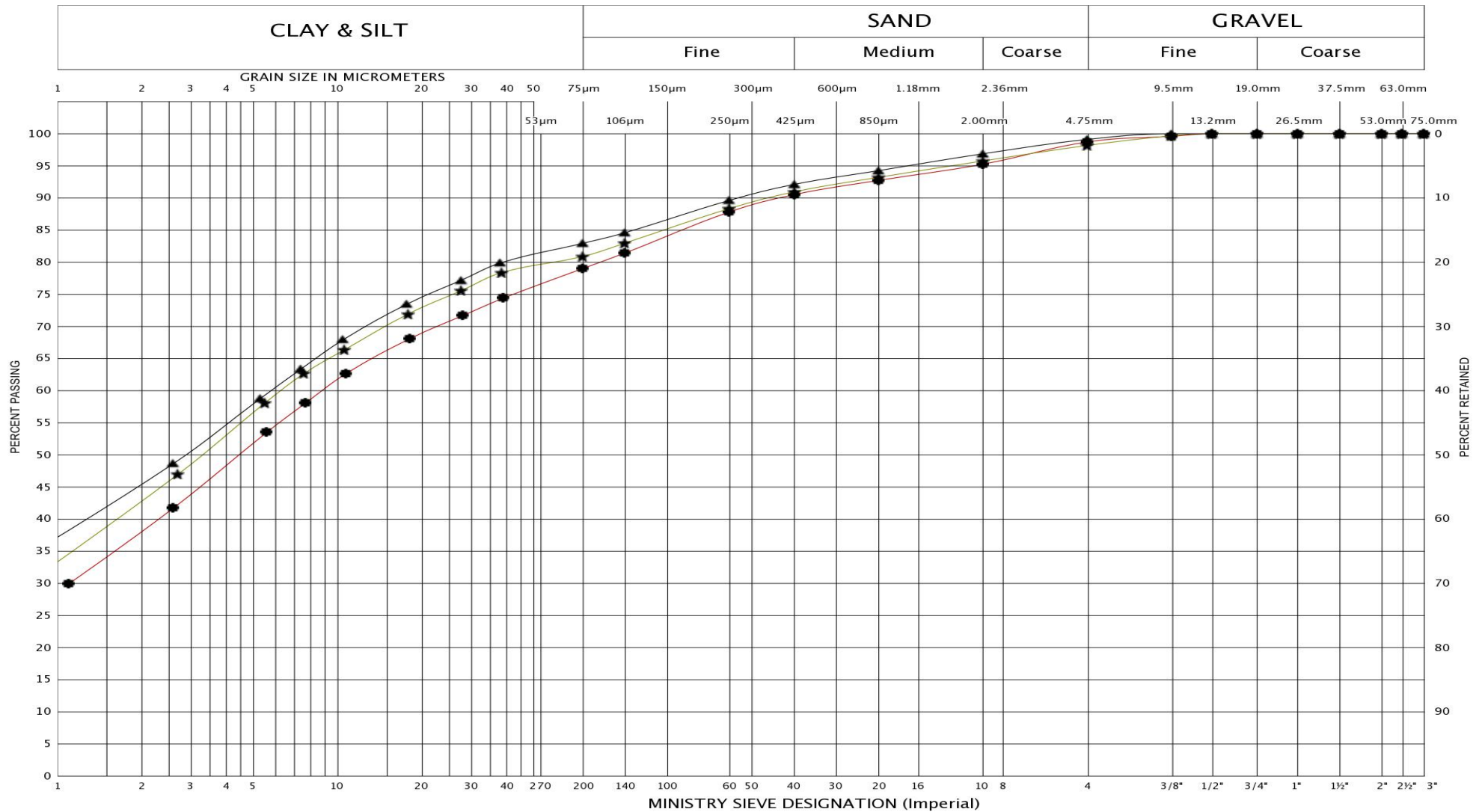
LEGEND	BH	QWB
	SAMPLE	5
	SYMBOL	•



GRAIN SIZE DISTRIBUTION
Gravelly Sand, Trace Silt and Trace Clay (Fill)

FIG No.:	GS-QS-2
HWY :	401
GWP	3034-19-00

UNIFIED SOIL CLASSIFICATION SYSTEM



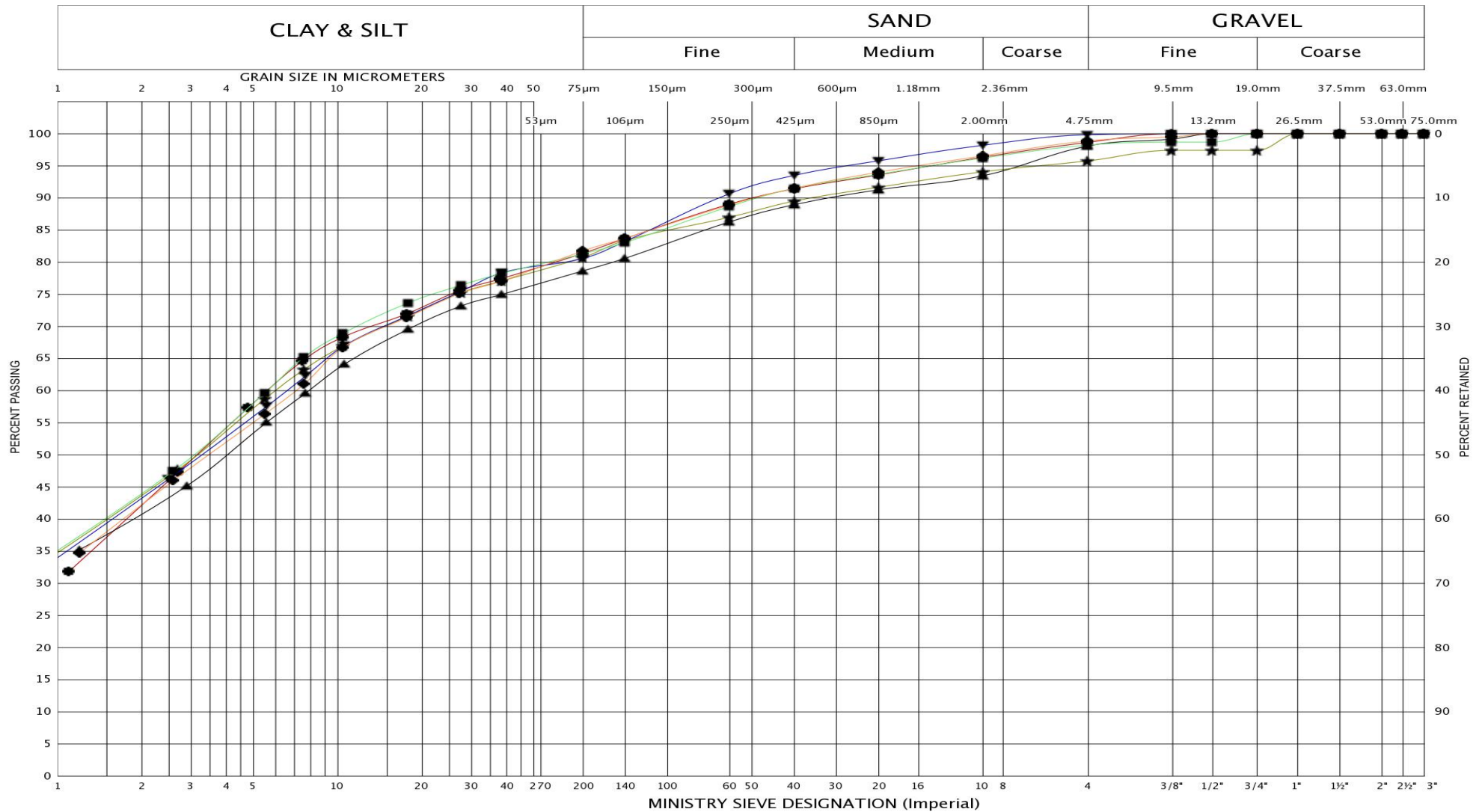
LEGEND	BH	QEB	QWB	QWB
SAMPLE	10	11	15	
SYMBOL	●	▲	★	



GRAIN SIZE DISTRIBUTION
 SILTY CLAY, Some Sand, Trace Gravel (Till)

FIG No.: GS-QS-3
 HWY : 401
 GWP 3034-19-00

UNIFIED SOIL CLASSIFICATION SYSTEM

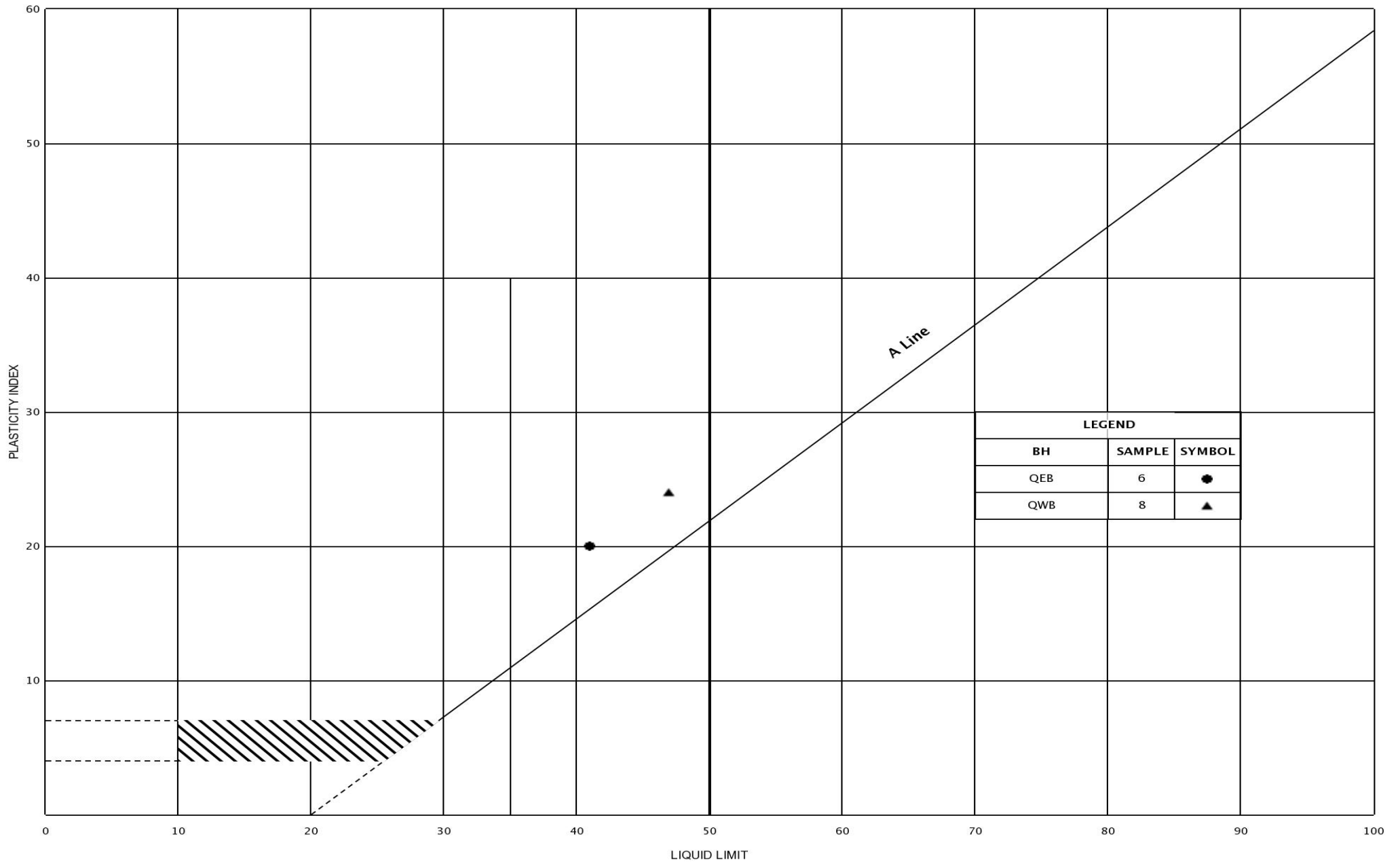


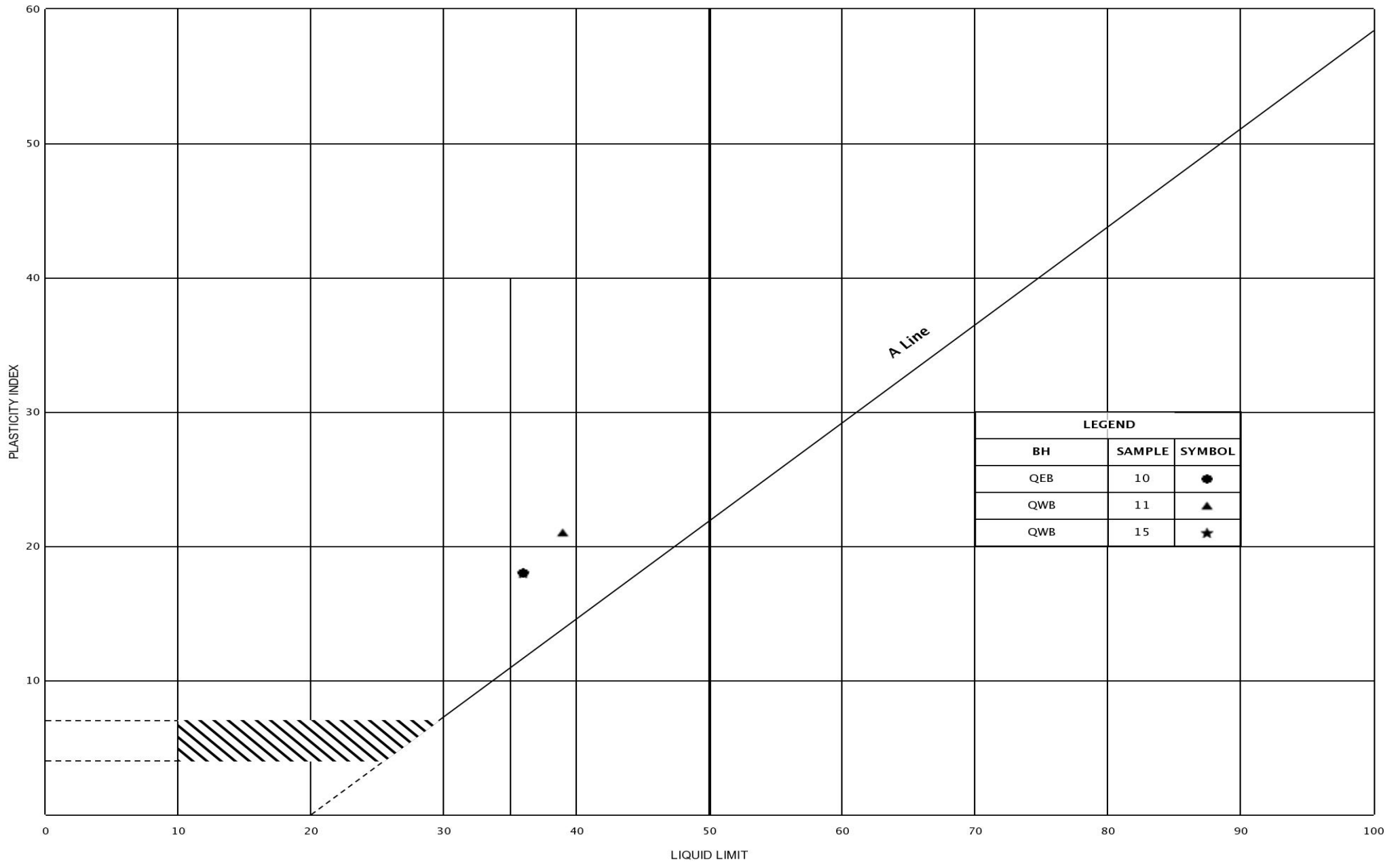
LEGEND	BH	QEB	QEB	QEB	QWB	QWB	QWB
SAMPLE	14	18	20	21	17	14	
SYMBOL	●	▲	★	▼	■	◆	



GRAIN SIZE DISTRIBUTION
CLAYEY SILT, Some Sand, Trace Gravel (Till)

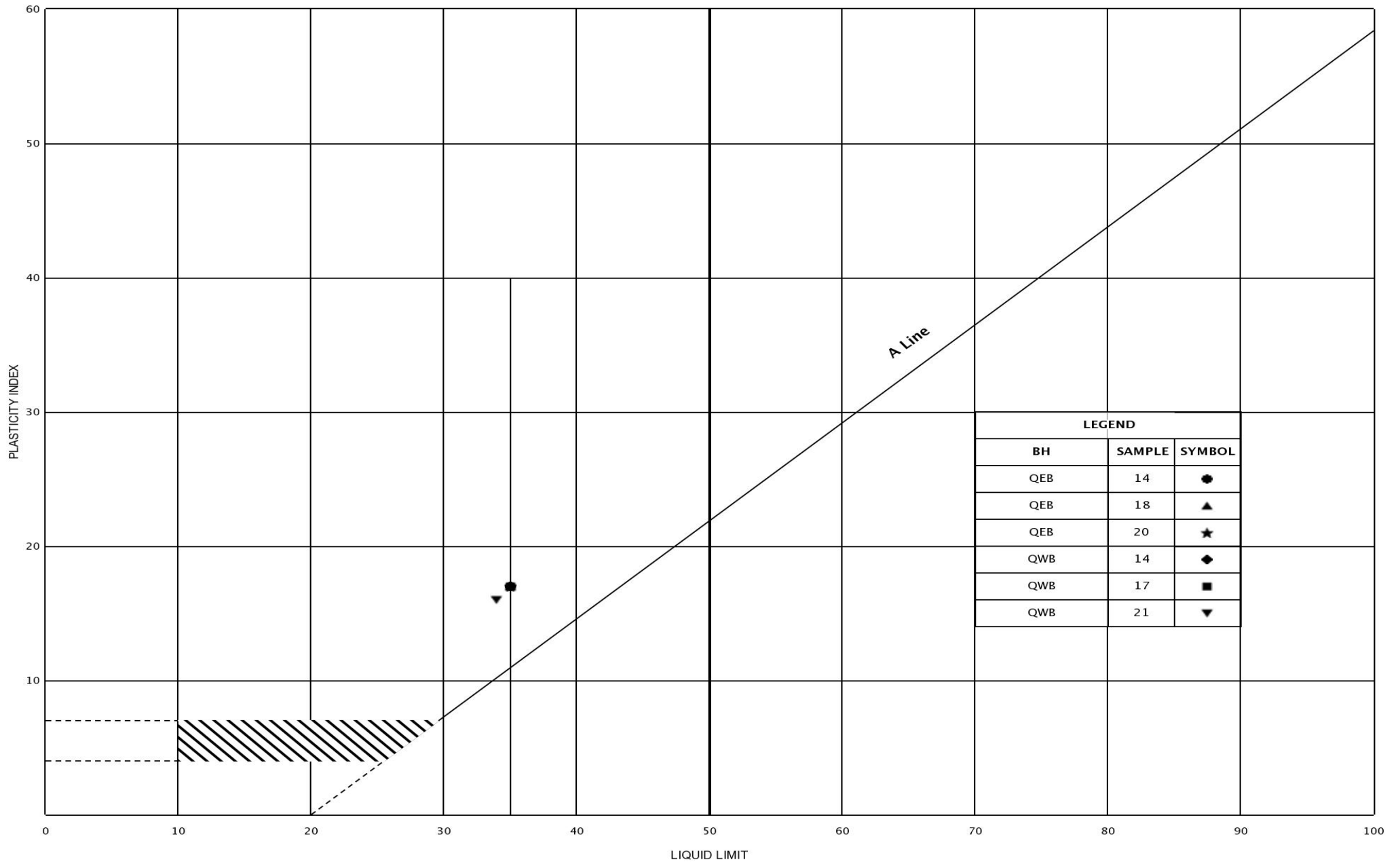
FIG No.: GS-QS-4
HWY : 401
GWP 3034-19-00





PLASTICITY CHART
 SILTY CLAY, Some Sand, Trace Gravel (Till)

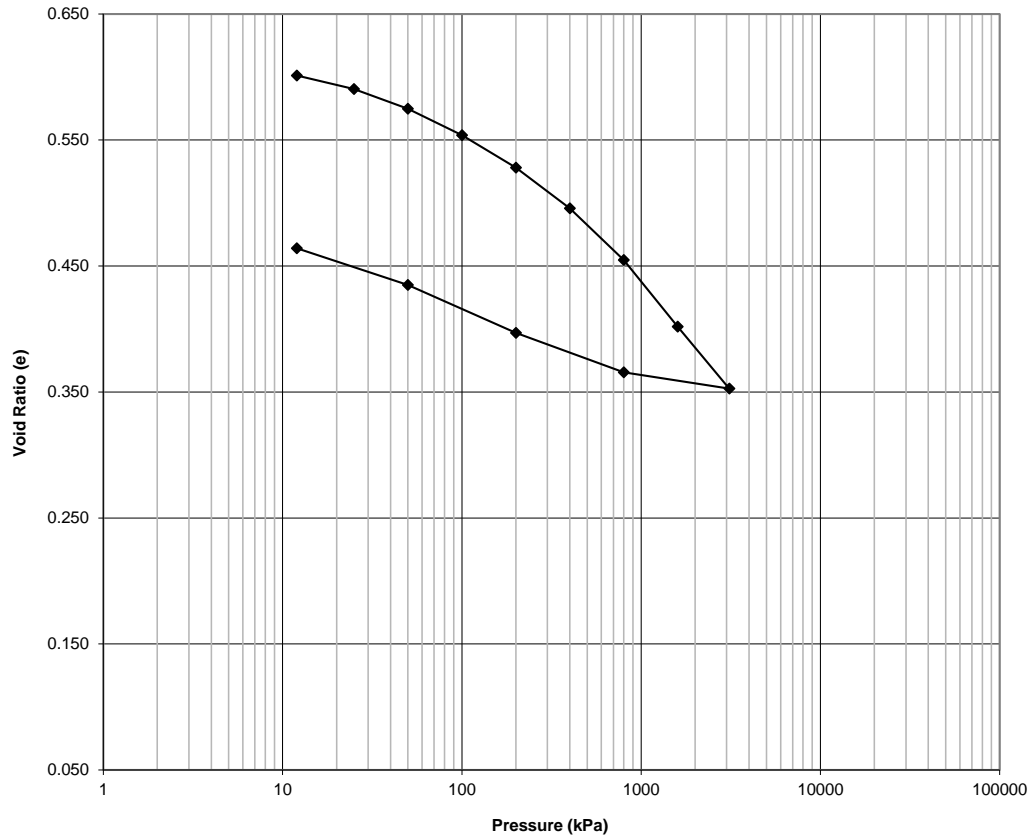
FIG No.:	PC- QS-2
HWY.:	401
GWP	3034-19-00



Consolidation Test Results
(ASTM D2435)
Highway 401, CA 3017-E-0006, Task 006-4 Bridges Detail Design

Borehole QWB, Sample TW 14, Depth 13.7-14.3 m

Void Ratio versus Log of Pressure



SOIL TYPE: Grey Clayey Silt			
e_0	= 0.637	W_L	= 35
W_0	= 22.8 %	W_P	= 18
γ	= 19.9 kN/m ³	PI	= 17
FIGURE No: Q-1			
Highway 401, CA 3017-E-0006, Task 006-4 Bridges Detail Design			
PML Ref: 19KF029A			



FINAL REPORT

CA14407-OCT19 R1

19KF029A Hwy 401, Tilbury (M/Q)

Prepared for

Peto MacCallum Ltd

First Page

CLIENT DETAILS

Client Peto MacCallum Ltd

Address 165 Cartwright Ave
Toronto, ON
M6A 1V5, Canada

Contact Nazibur Rahman

Telephone 416-785-5110

Facsimile 416-785-5120

Email nrahman@petomacallum.com

Project 19KF029A Hwy 401, Tilbury (M/Q)

Order Number

Samples Soil (8)

LABORATORY DETAILS

Project Specialist Brad Moore Hon. B.Sc

Laboratory SGS Canada Inc.

Address 185 Concession St., Lakefield ON, K0L 2H0

Telephone 705-652-2143

Facsimile 705-652-6365

Email brad.moore@sgs.com

SGS Reference CA14407-OCT19

Received 10/11/2019

Approved 10/17/2019

Report Number CA14407-OCT19 R1

Date Reported 10/17/2019

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C

Cooling Agent Present: Yes

Custody Seal Present: Yes

Chain of Custody Number: 007603

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Brad Moore Hon. B.Sc

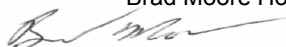




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Legend..... 8

Annexes..... 9



FINAL REPORT

CA14407-OCT19 R1

Client: Peto MacCallum Ltd

Project: 19KF029A Hwy 401, Tilbury (M/Q)

Project Manager: Nazibur Rahman

Samplers: Jinsuko

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	MEB, SS3 (5'-7')	MEB, SS5 (10'-12')	MWB, SS4 (7.5'-9.5')	MWB, SS6 (12.5'-14.5')	QWB, SS4 (7.5'-9.5')	QWB, SS6 (12.5'-14.5')	QEB, SS5 (10'-12')	QEB, SS7 (15'-17')
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result	Result
Corrosivity Index											
Corrosivity Index	none	1		2	1	1	4.5	7.5	4	6.5	9.5
Soil Redox Potential	mV	-		228	222	280	383	452	416	290	275
Sulphide	%	0.02		< 0.02	< 0.02	< 0.02	0.30	0.03	< 0.02	0.10	0.08
pH	pH Units	0.05		7.79	7.98	8.01	8.08	8.62	8.61	8.33	7.75
Resistivity (calculated)	ohms.cm	-9999		2520	3100	3340	3160	8870	5690	2160	2060

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	MEB, SS3 (5'-7')	MEB, SS5 (10'-12')	MWB, SS4 (7.5'-9.5')	MWB, SS6 (12.5'-14.5')	QWB, SS4 (7.5'-9.5')	QWB, SS6 (12.5'-14.5')	QEB, SS5 (10'-12')	QEB, SS7 (15'-17')
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result	Result
General Chemistry											
Conductivity	uS/cm	2		397	323	299	316	113	176	464	485

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	MEB, SS3 (5'-7')	MEB, SS5 (10'-12')	MWB, SS4 (7.5'-9.5')	MWB, SS6 (12.5'-14.5')	QWB, SS4 (7.5'-9.5')	QWB, SS6 (12.5'-14.5')	QEB, SS5 (10'-12')	QEB, SS7 (15'-17')
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result	
Metals and Inorganics											
Moisture Content	%	0.1		17.5	14.2	14.1	13.8	7.0	8.2	16.6	17.4



FINAL REPORT

CA14407-OCT19 R1

Client: Peto MacCallum Ltd

Project: 19KF029A Hwy 401, Tilbury (M/Q)

Project Manager: Nazibur Rahman

Samplers: Jinsuko

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	MEB, SS3 (5'-7')	MEB, SS5 (10'-12')	MWB, SS4 (7.5'-9.5')	MWB, SS6 (12.5'-14.5')	QWB, SS4 (7.5'-9.5')	QWB, SS6 (12.5'-14.5')	QEB, SS5 (10'-12')	QEB, SS7 (15'-17')
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result
-----------	-------	----	--	--------	--------	--------	--------	--------	--------	--------

Metals and Inorganics (continued)

Sulphate	µg/g	0.4		130	70	52	340	3.2	6.9	290	270
----------	------	-----	--	-----	----	----	-----	-----	-----	-----	-----

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	MEB, SS3 (5'-7')	MEB, SS5 (10'-12')	MWB, SS4 (7.5'-9.5')	MWB, SS6 (12.5'-14.5')	QWB, SS4 (7.5'-9.5')	QWB, SS6 (12.5'-14.5')	QEB, SS5 (10'-12')	QEB, SS7 (15'-17')
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019	10/10/2019

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result
-----------	-------	----	--	--------	--------	--------	--------	--------	--------	--------

Other (ORP)

Chloride	µg/g	0.4		210	130	140	54	11	26	130	100
----------	------	-----	--	-----	-----	-----	----	----	----	-----	-----



FINAL REPORT

CA14407-OCT19 R1

QC SUMMARY

Anions by IC
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0296-OCT19	µg/g	0.4	<0.4	1	20	99	80	120	106	75	125
Sulphate	DIO0296-OCT19	µg/g	0.4	<0.4	6	20	97	80	120	97	75	125

Carbon/Sulphur
Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0023-OCT19	%	0.02	<0.02	3	20	116	80	120			



FINAL REPORT

CA14407-OCT19 R1

QC SUMMARY

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-1ENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0294-OCT19	uS/cm	2	0.002	0	10	99	90	110	NA		
Conductivity	EWL0295-OCT19	uS/cm	2	0.002	0	10	98	90	110	NA		

pH

Method: SM 4500 | Internal ref.: ME-CA-1ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0294-OCT19	pH Units	0.05	NA	0		100			NA		
pH	EWL0295-OCT19	pH Units	0.05	NA	0		100			NA		

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.

RL Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

NA The sample was not analysed for this analyte

ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --



APPENDIX B

Previous Borehole Logs and Drawings (GEOCRES No. 40J08-002)

59-F-2
W.P.# 161-58
Hwy. # 401 E
QUEEN ST.
CROSSING AT
TILBURY

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATIONDRILL RIG 54-6 OPERATION BORE & PENETRATION JOB F-59-2 WP. 161-59 BORING 1 STA. 358+65.45' RT.
CASING B X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB. 1959
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 7 JAN. 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_c - TRIAXIAL CONSOLIDATED QUICKQ - TRIAXIAL QUICK
S - TRIAXIAL SLOW
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOILK - PERMIABILITY
C - CONSOLIDATION
CA - CASING
γ - UNIT WEIGHT

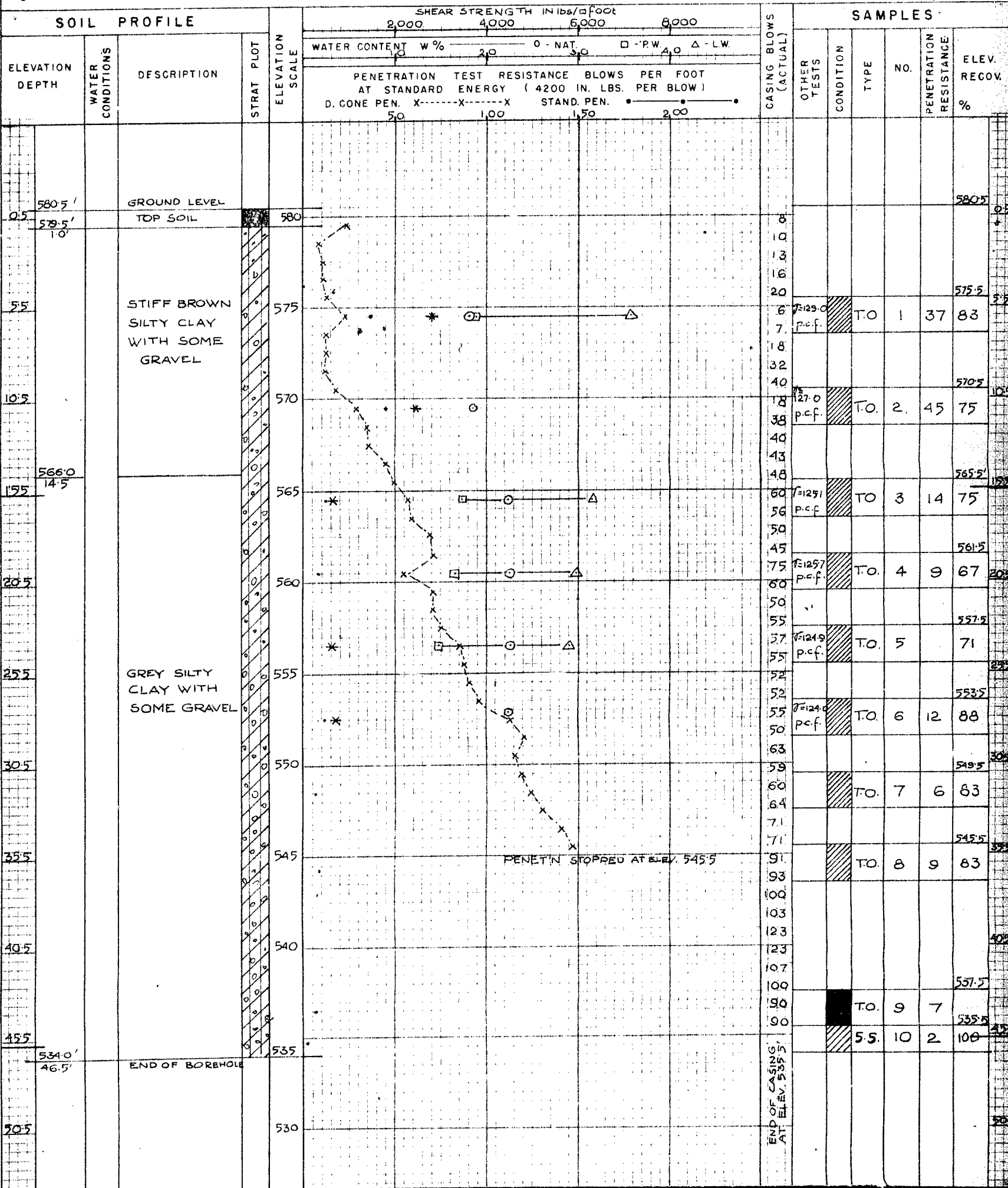
SAMPLE TYPES

C.S. - CHUNK
D.O. - DRIVE OPEN
D.F. - DRIVE FOOT VALVE
T.O. - THIN WALLED OPEN
SS - SLEEVE SAMPLE
PS - PISTON SAMPLE
WS - WASHED SAMPLE
RC - ROCK CORE

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE



DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION BORE & PENETRATION JOB F-59-2 WP 161-58 BORING 2 STA 359+00 45' LT
 CASING B X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB 1959
 SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 9 JAN 1959

ABBREVIATIONS

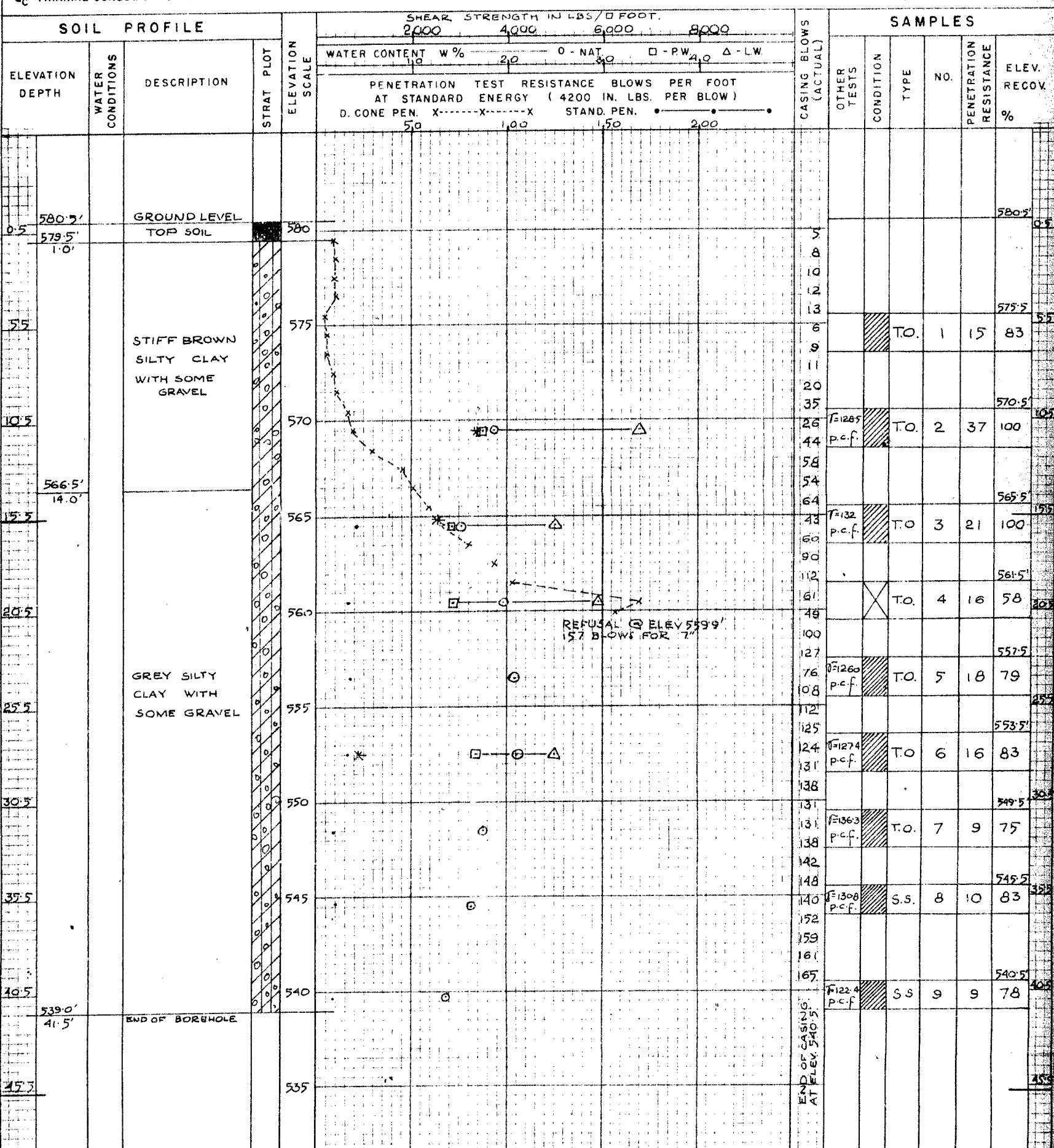
V - INSITU VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY
 M - MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION
 U - UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING
 QC - TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK SS - SLEEVE SAMPLE
 D.O. - DRIVE OPEN PS - PISTON SAMPLE
 D.F. - DRIVE FOOT VALVE WS - WASHED SAMPLE
 T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION

 - DISTURBED
 - FAIR
 - GOOD
 - LOST



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION BORE & PENETRATION JOB F-59-2 WP 161-50 BORING 3 STA. 00+55.47 LT
CASING B-X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB 1955
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 13 JAN. 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_c - TRIAXIAL CONSOLIDATED QUICK

Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

K - PERMIABILITY
C - CONSOLIDATION
CA - CASING
γ - UNIT WEIGHT

SAMPLE TYPES

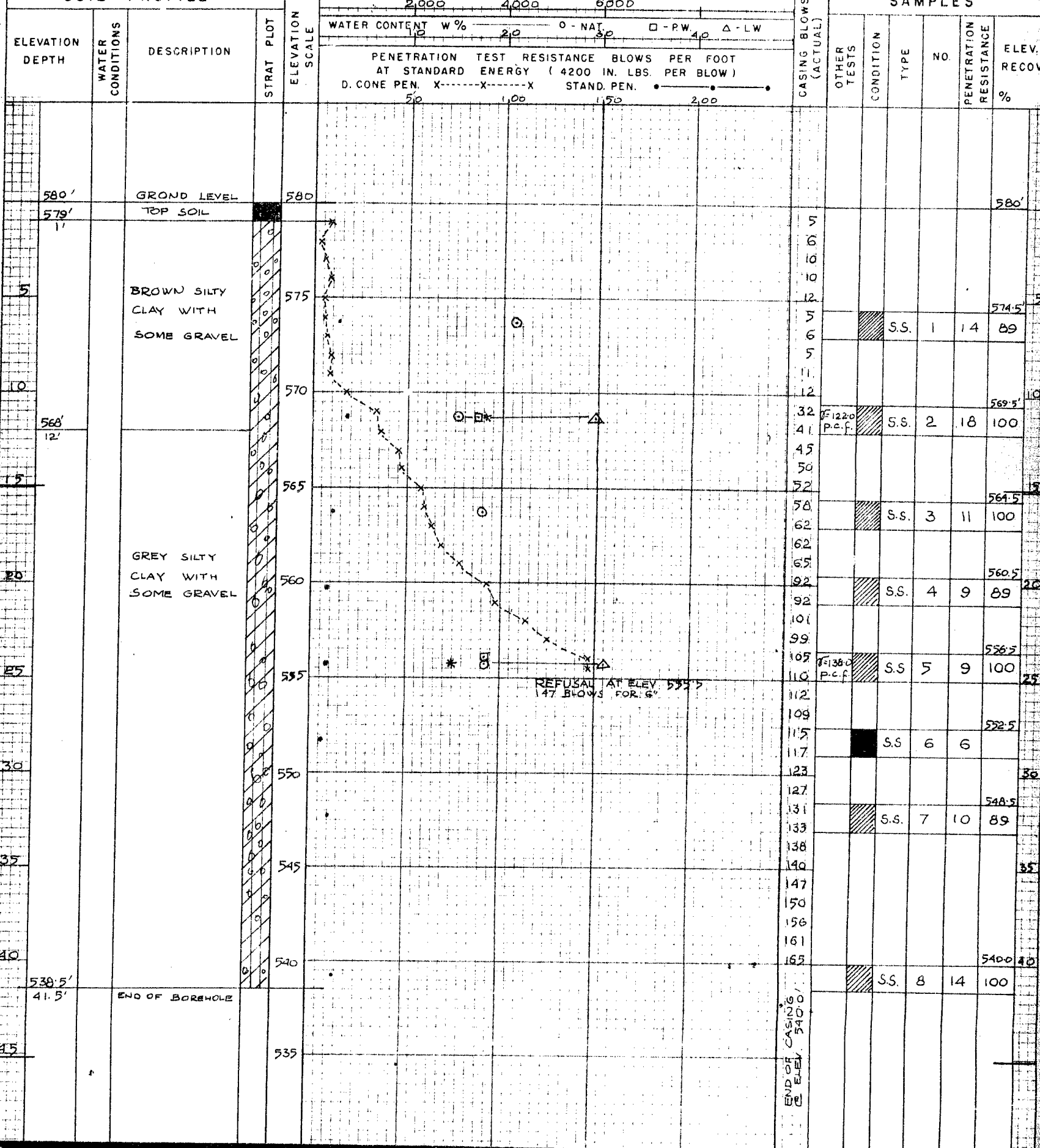
C.S. - CHUNK
D.O. - DRIVE OPEN
D.F. - DRIVE FOOT VALVE
T.O. - THIN WALLED OPEN

S.S. - SLEEVE SAMPLE
P.S. - PISTON SAMPLE
W.S. - WASHED SAMPLE
R.C. - ROCK CORE

SAMPLE CONDITION

 - DISTURBED
 - FAIR
 - GOOD
 - LOST

SOIL PROFILE



DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION PENETRATION JOB F-59-2 W.P. 161-5B BORING 4 STA. 00+20 45' RT.
 CASING B X (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT FEB. 1959
 SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY V.K. DATE BORING 20 JAN. 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY
 M - MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION
 U - UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING
 QC - TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK S.S. - SLEEVE SAMPLE
 D.O. - DRIVE OPEN PS - PISTON SAMPLE
 D.F. - DRIVE FOOT VALVE WS - WASHED SAMPLE
 T.O. - THIN WALLED OPEN R.C. - ROCK CORE

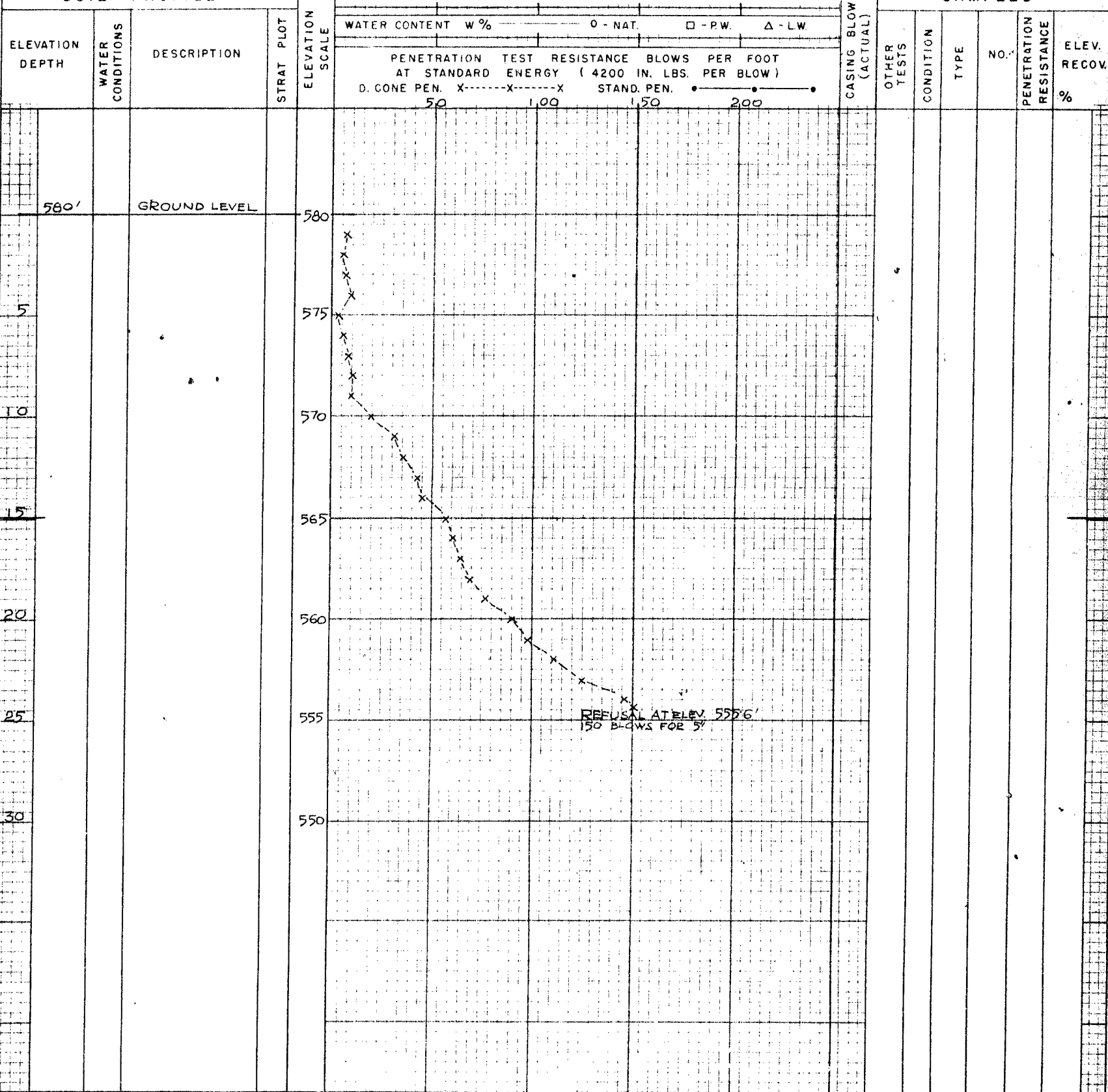
SAMPLE CONDITION

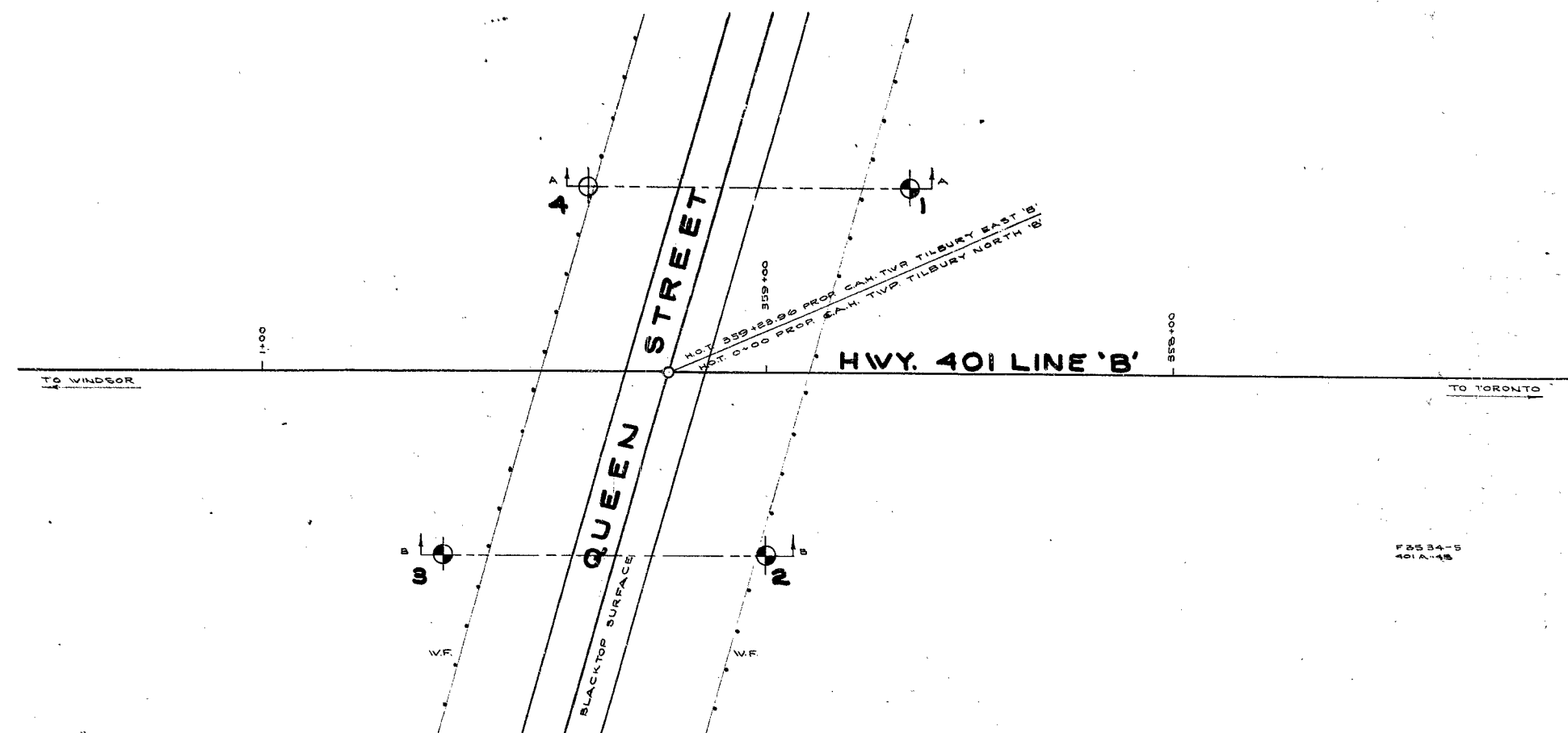


- DISTURBED
 - FAIR
 - GOOD
 - LOST

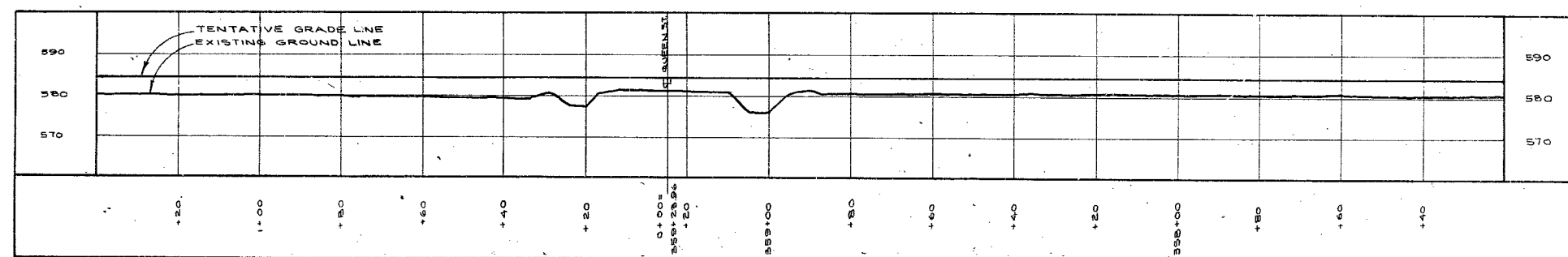
SOIL PROFILE

SAMPLES

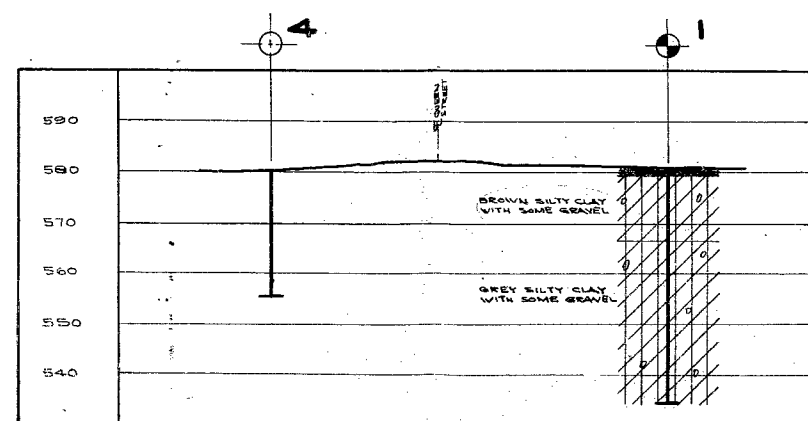




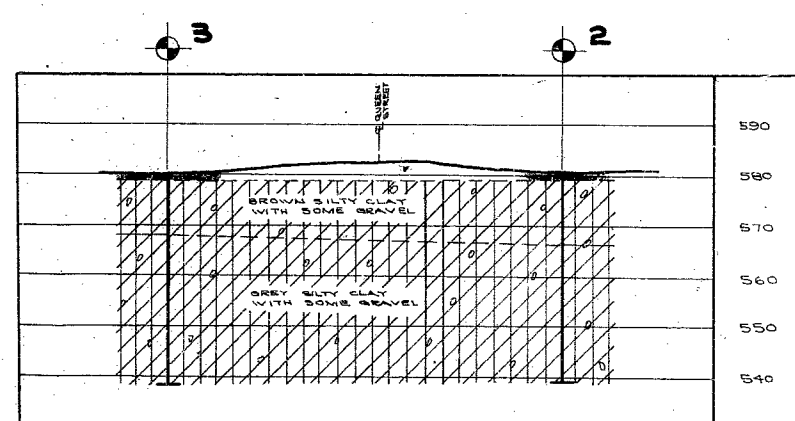
PLAN



PROFILE



A-A



B-B

LEGEND

- BORE HOLE
- PENETRATION HOLE
- BORE & PENETRATION HOLE

HOLE NO.	ELEVATION	STATION	DISTANCE FROM E.
1	580.5'	358+65	45' RT.
2	580.5'	359+00	45' LT.
3	580.0'	00+55	45' LT.
4	580.0'	00+20	45' RT.

NOTE

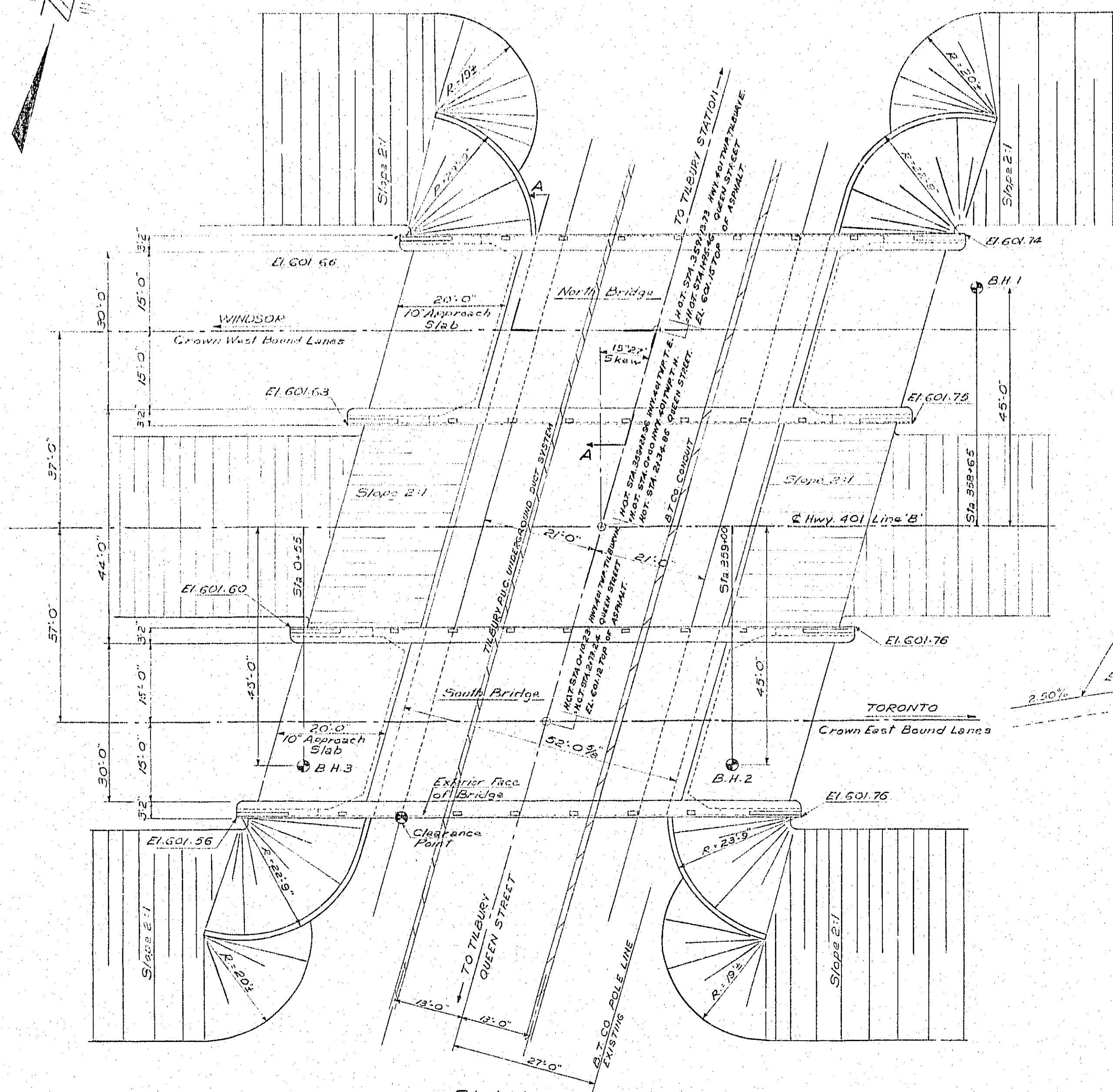
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS-ONTARIO
MATERIALS & RESEARCH SECTION

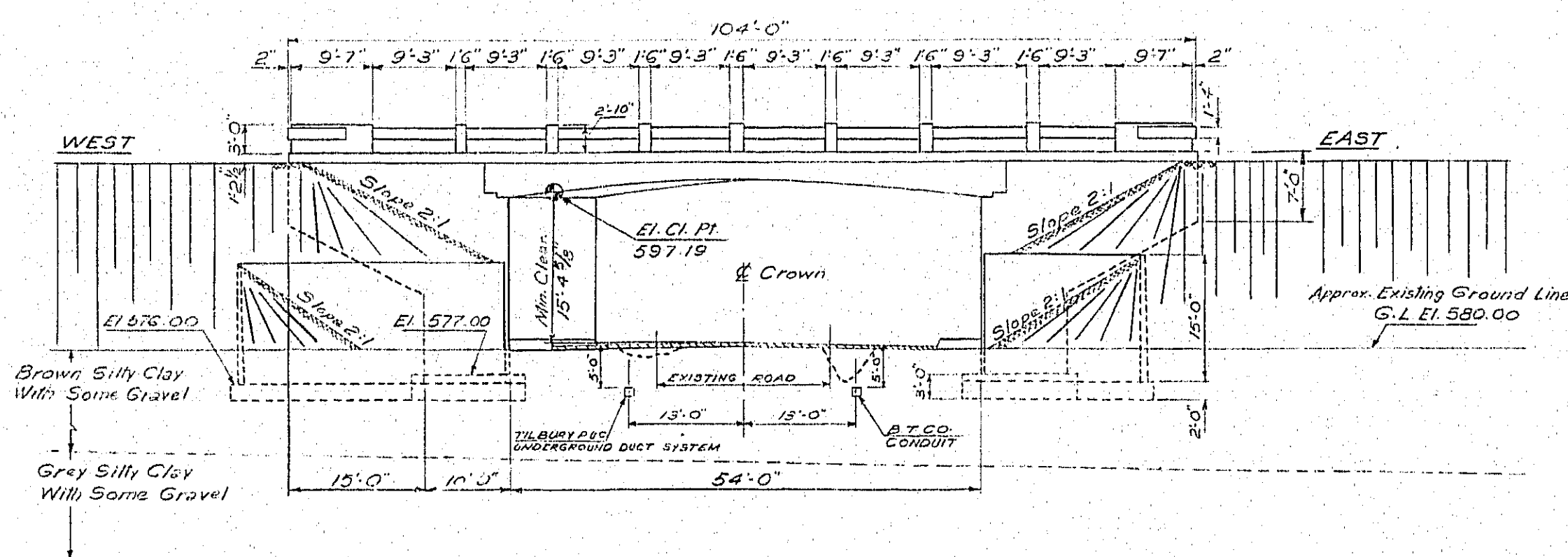
QUEEN STREET
PROPOSED CROSSING

SHOWING POSITIONS & ELEVATIONS OF HOLES

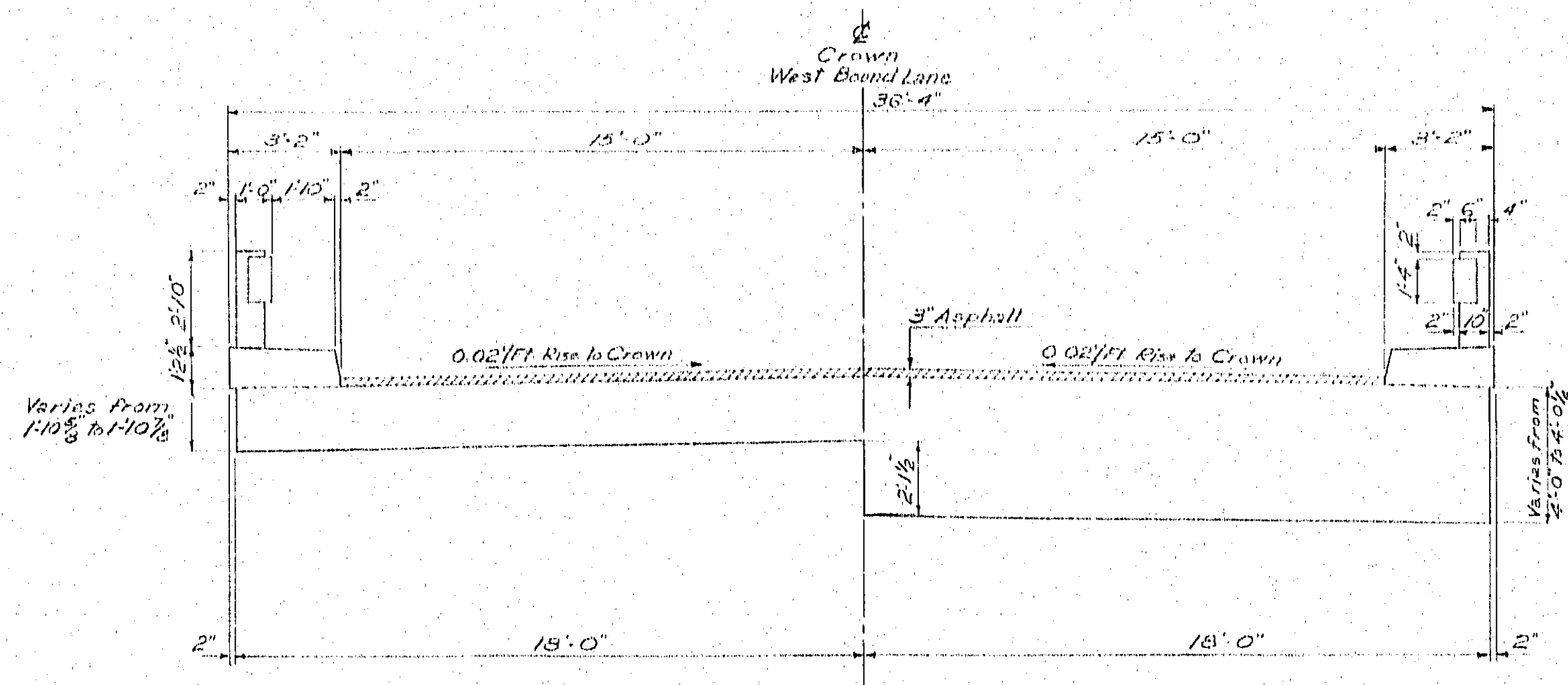
HWY 401 DISTRICT 1 COUNTY ESSEX & KENT
TOWNSHIP TILBURY EAST & NORTH LOT 22 CON. 4
LOCATION AT TILBURY
DRAWN BY: T. MELLORES CHECKED BY: W.P. 161-59
DATE MARCH 12/59 APPROVED BY: DRAWING NO.
SCALE 1"=20' F 59-2A



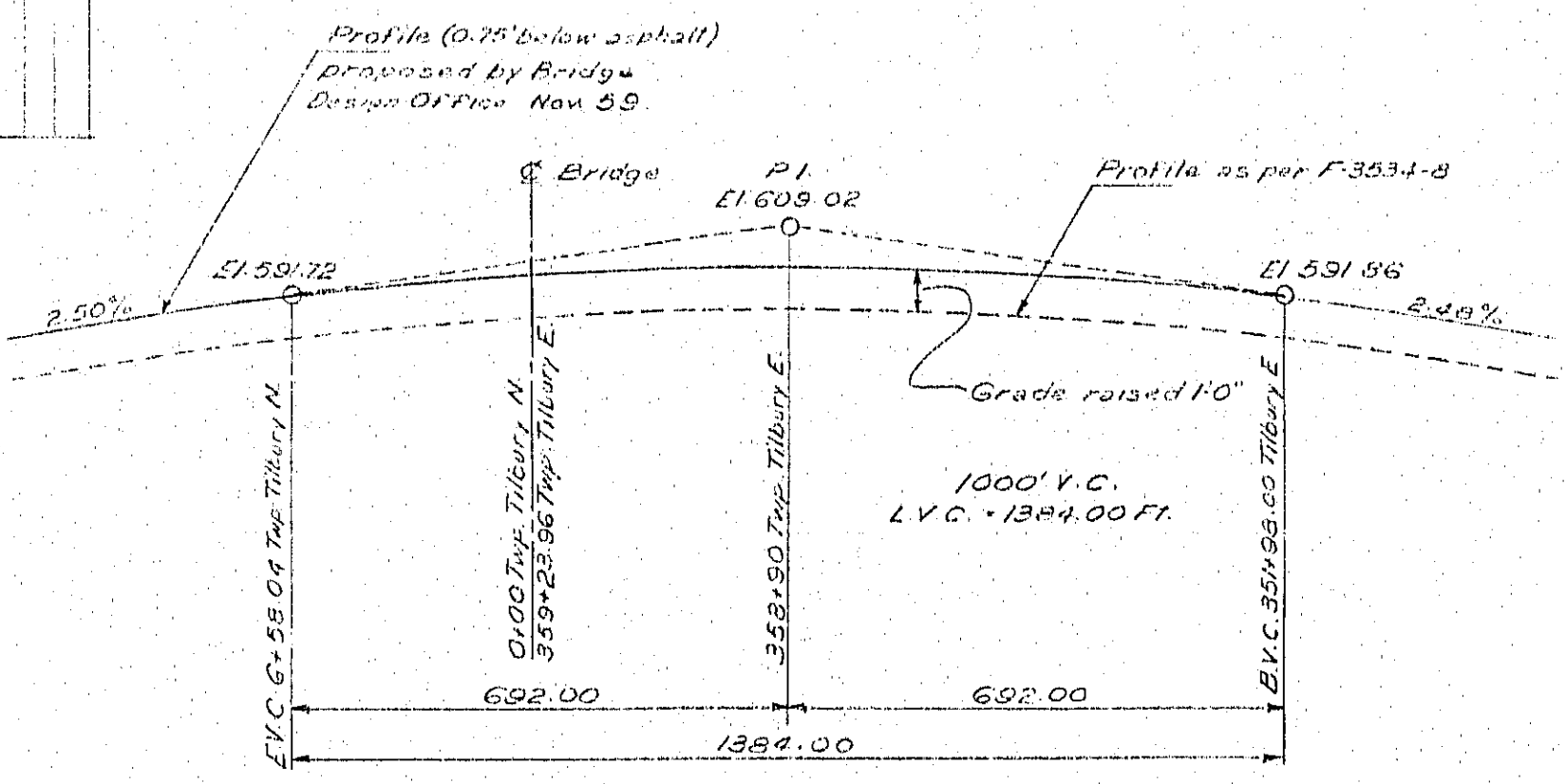
PLAN
Scale: 1/4" = 1'-0"



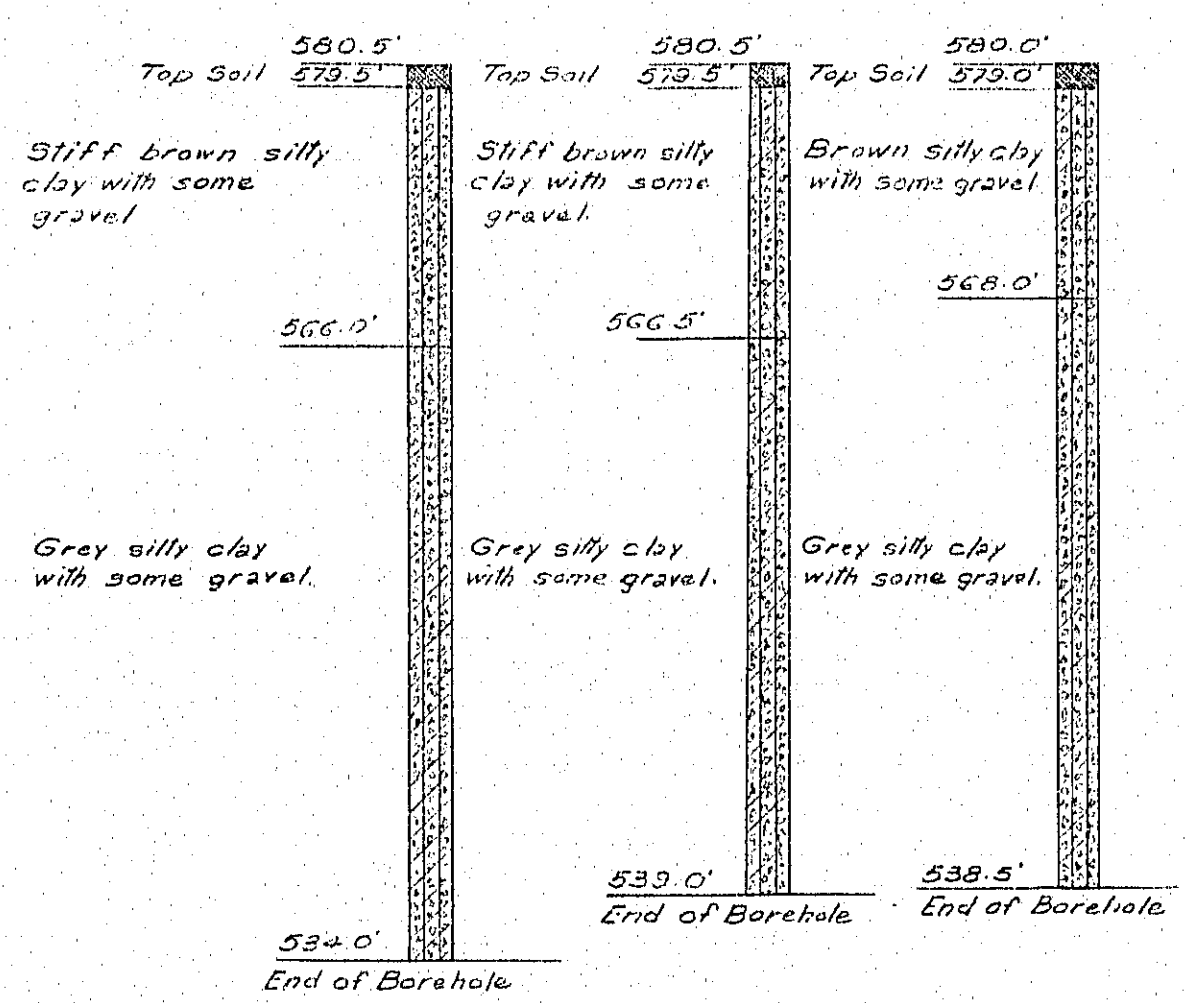
SOUTH ELEVATION
Scale: 1/16" = 1'-0"



SECTION A-A
Scale: 1/4" = 1'-0"



PROFILE HWY 401 LINE 'B'
0.75' Below Top of Asphalt at Crown



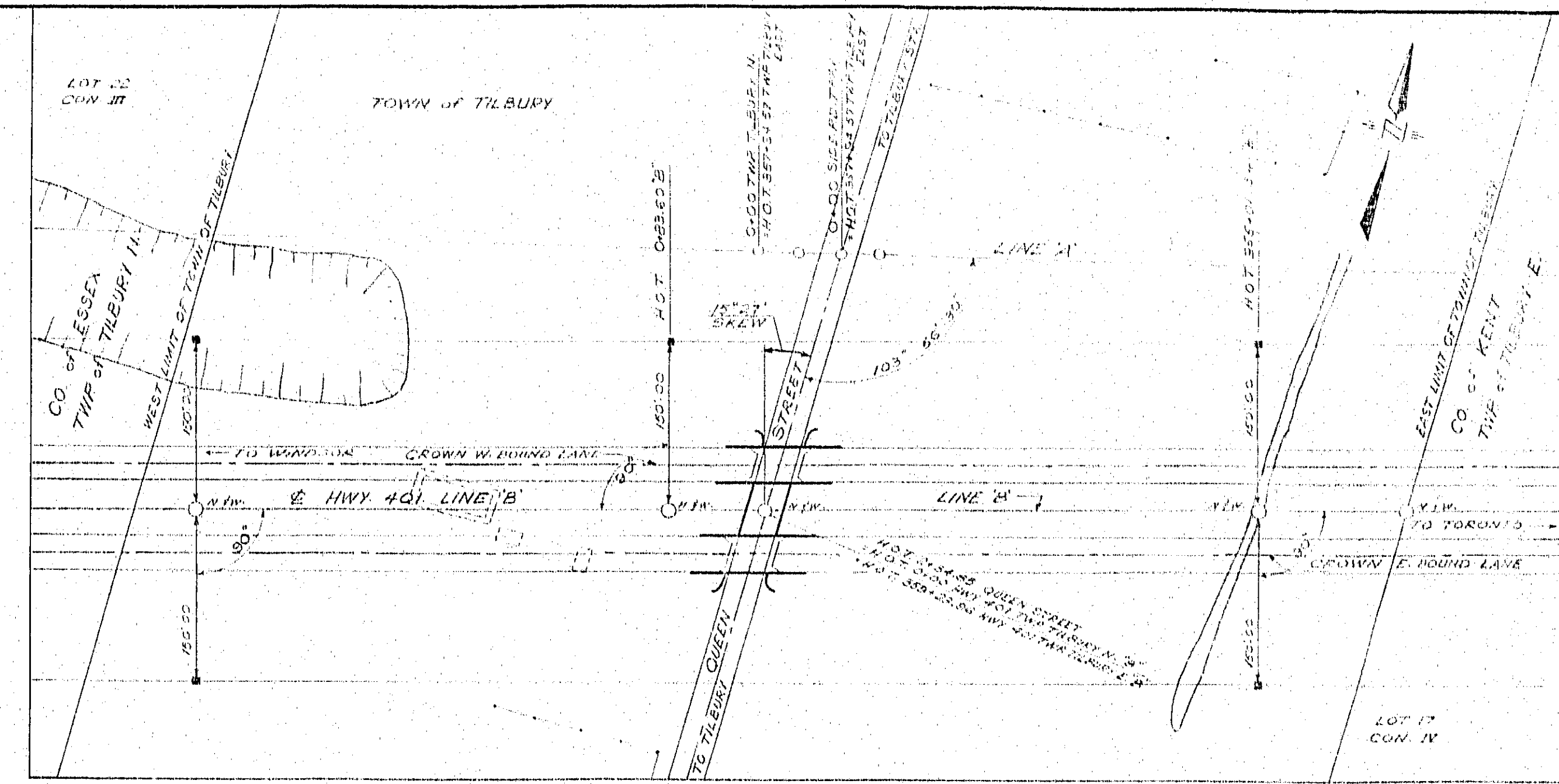
PROFILE OF QUEEN STREET
TOP OF ASPHALT AT CROWN

SKEW 15°27'

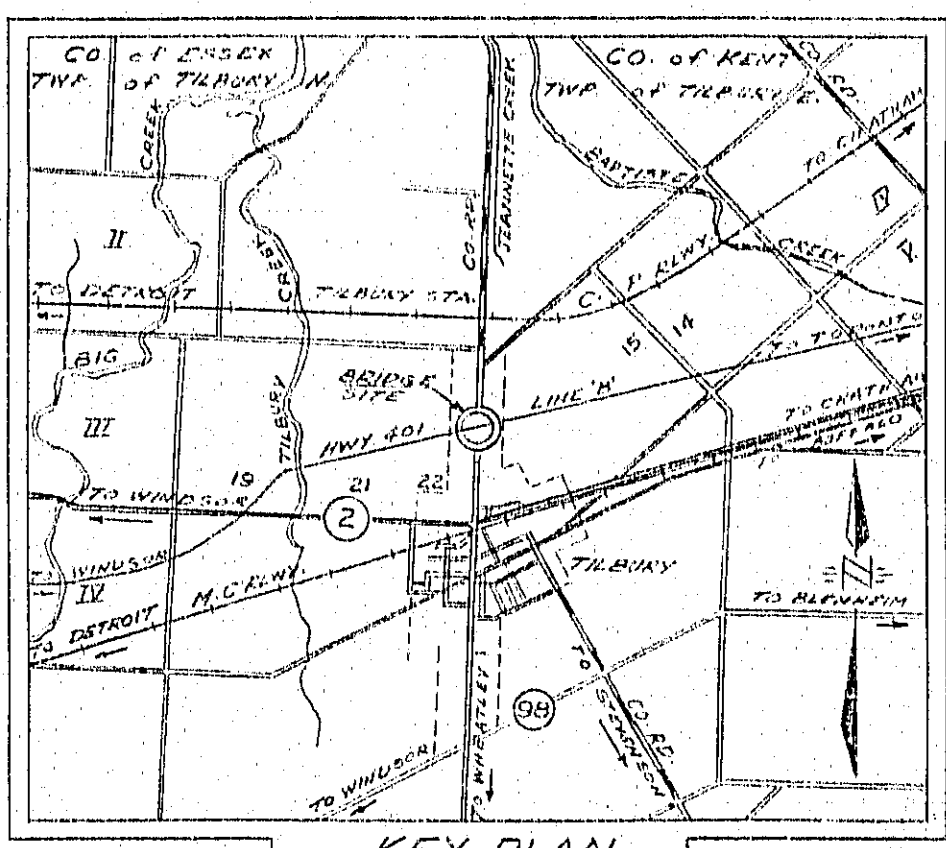
Sin. 0.2663973
Cos. 0.9636633
Tan. 0.2763820
Sec. 1.0374915

LIST OF DRAWINGS

- D-4420-1 General Plan
- 2 Footings, Abutments & Wing Walls
- 3 Reinforcing Details
- 4 Retaining Walls
- 5 Approach Slab - Hard Grade
- 6 Steel Table - Structural Grade
- 7 Steel Table - Structural Grade



SITE PLAN
Scale: 1" = 100'-0"



KEY PLAN
Scale: 1/4" = 1'-0"

NOTES

To District Engineer - Concrete work on this structure must not be commenced until monuments to fix control points have been surveyed and checked by the District Engineer.

To Contractor - Structure to be built in accordance with Form 9 revised March 1957 and the special provisions, extra copies of which may be obtained from the District Engineer. All construction joints must be approved by the Bridge Engineer.

Concrete Mix - Minimum strength at 28 days: 2500 P.S.I. (Footings), 3000 P.S.I. (Structure). Maximum size of aggregate: 1 1/2" (Footings), 1" (Structure).

Reinforcing Steel - Retaining Walls: 3000 P.S.I. (Structure). Retaining Walls: 1" (Structure).

Clear Cover: 2" (Deck), 1 1/2" (Abutments), 3" (Retaining Walls), 3" (Footings).

Construction Notes - All exposed edges to be chamfered 1/4". Formwork supporting wing walls not to be removed until the curb concrete has reached a strength of 2400 P.S.I. Footings to be excavated to neat dimensions as shown and concrete placed against undisturbed ground.

PRINT RECORD		
NO.	FOR	DATE
10	REVISION	11/1/60
10	REVISION	5/1/61
10	REVISION	8/3/61
10	REVISION	11/1/61

REVISIONS	DATE	BY	DESCRIPTION

REFERENCE PLANS			
DESIGN	K.G.B.	CHECK	L.N.F.
DRAWING	F.W.	CHECK	L.N.F.
TRACING		CHECK	
DATE	JAN 1960		

DEPARTMENT OF HIGHWAYS-ONTARIO	
BRIDGE OFFICE-TORONTO	
TILBURY NORTH TWP. BR. 1	
QUEEN ST. OVERPASS	
THE KING'S HIGHWAY No. 401	DIST. No. 1
CO. Essex & Kent	
TWP. Tilbury N. & Tilbury E.	LOT CON.
GENERAL PLAN	
APPROVED	
DESIGN ENGINEER	
CONTRACT NUMBER	
LOADING	
DRAWING	

TWP #105-51-1-A