FOUNDATION TECHNICAL MEMORANDUM

For

MCDOUGALL DRAIN BRIDGE EBL ON HIGHWAY 401
MTO WEST REGION 59 STRUCTURE REHABILITATIONS
SITE 13-190-1, CONTRACT 7
GWP 3084-11-00
GEOGRAPHICAL TOWNSHIP OF TILBURY EAST
KENT COUNTY, ONTARIO

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June 17, 2015

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION TECHNICAL MEMORANDUM
For
McDougall Drain Bridge, EBL, Highway 401
MTO West Region 59 Structure Rehabilitations
Contract 7, GWP 3084-11-00
Township of Tilbury East
Kent County, Ontario

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1. INTRODUCTION

The Foundation Engineering Services for the present project involve the detail foundation investigation and design for the rehabilitation of 59 structures in MTO West Region along Highways 4, 6, 401, 402 and 403. Ten (10) Group Work Projects (GWP's) are contemplated to be completed between 2014 and 2020.

This technical memorandum summarizes the factual results of geotechnical data based on the review and compilation of existing subsurface information from relevant reports in the MTO GEOCRES Library for the McDougall Drain Bridge EBL on Highway 401. The Foundation Engineering recommendations from the existing bridge foundation reports are summarized with reference to the "Canadian Highway Bridge Design Code" (CHBDC) and follow in general the "Guidelines for Professional Engineers providing Geotechnical Engineering Services".

From the Minutes of Meeting Report, dated July 24, 2014, it is understood that the bridge will be rehabilitated in a single stage using median crossovers.

The purpose of the Technical Memorandum is to summarize the subsurface and groundwater conditions and foundation recommendations based on available reports at the bridge location for the design project team's reference.

The elevations in this report are expressed in meters, unless otherwise noted.

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BARRIE, HAMILTON, KITCHENER, TORONTO

2. PROJECT SITE BACKGROUND AND GEOLOGY

The McDougall Drain Bridge EBL on Highway 401 is located in the Geographic Township of Tilbury East, Kent County, Ontario. A key plan is shown in Figure 1.

The existing structure is a single span reinforced concrete rigid frame structure that carries two lanes of Highway 401 Eastbound traffic. The site and its surrounding area are generally flat farmland. The drain was originally a branch of Jeannette Creek and had been widened and dredged into a drainage channel.

Physiographically, the site is located on St. Clair Cay Plains. The plains are covered by deep deposit clay of glacial Lake Whittlesey and Warren underlain by limestone or shale bedrock. At this site, the upper zone of the clay stratum has been desiccated and exists in stiff condition for a depth of approximately 7.6 m (25 ft). The underlying shale or limestone bedrock at the site area belongs to Hamilton Group of Middle Devonian period.

3. SOURCE OF INFORMATION

The following foundation report and drawing, appended in Appendix A, were available for review and provided information for the bridge structure, subsoil information and original foundation recommendations.

1. Foundation Report on Highway 401 and Drain & Relocated Gravel Road Crossing, Lots 3 and 4, Concession VI, Township of Tilbury East, 5.5 Miles Northeast of Tilbury, W.P 9-59, W.J F-59-12, Department of Highways Ontario, dated March 24, 1959, GEOCRES No. 40J08-006. (Reference 1)

2. Tilbury East Township Bridge No. 4 – General Layout, The King's Highway 401, District No. 1, Lots 3 and 4, Concession VI, Township of Tilbury East, County of Kent, W.P 9-59, T.W.P 104-190-1-A. Department of Highways Ontario, dated October 1959. (Reference 2)

4. SITE RECONNAISSANCE

As part of the current foundation engineering assessment study, a site reconnaissance of the McDougall Drain Bridge EBL was carried out on October 20, 2013. A photographic record of the site visit is attached in Appendix B.

The adjacent slopes were heavily vegetated with grasses and bushes (Photographs 1, 4 and 5). The slopes were not affected by erosion. Sheet piles were observed in front of the abutments (Photographs 2, 3, and 4) that protected the foundation of the abutments from scouring effects. No obvious major cracks were observed on the abutment walls, except some surficial cracks. Open weep holes were observed in the abutment walls (Photographs 2 and 3).

5. PREVIOUS FIELD INVESTIGATION AND SUMMARIZED SUBSURFACE CONDITIONS

The site is located on Highway 401 in the Geographic Township of Tilbury East, Kent County, Ontario. The general subsurface conditions presented in this section are based on the Foundation Report, GEOCRES 40J08-006 dated March 24, 1959.

The original investigation was carried out to determine the competence of the subsoil layers for supporting the foundations of the proposed structures that would be located some 8.8 km (5.5 miles) northeast of Tilbury, where Highway 401 Line ‘A’ would cross the relocated County road and the drainage creek (McDougall Drain) between Lots 3 & 4 in Con. VI, Township of Tilbury East.

The foundation report includes the borehole location plan (Drawing No.F59-12A), Record of Borehole sheets (1 to 6) and summary of the Field and Laboratory tests.

The foundation investigation comprised six boreholes, which were drilled between February 5 and 9, 1959. The boreholes were drilled to depths of 6.7 to 11.3 m. Two dynamic cone penetration tests (DCPTs) were conducted. One DCPT was carried out directly adjacent to the location of borehole 3 which was advanced from the ground surface to 3.9 m, elevation 175.2. Another DCPT was carried out in borehole 4 from the borehole auger termination elevation 169.4 (555.8 ft.) to elevation 166.4 (545.8 ft.), where refusal was met. The field investigation was carried out by a trailer-mounted continuous flight auger adapted for soil sampling.

Conventional auger boring procedures were followed and samples were recovered at depths required. Samples were obtained using 50.8 mm (2 in.) I.D. thin walled Shelby tube samplers or 50.8 mm (2 in.) O.D. split barrelled spoon samplers.

Generally the site was underlain by a stiff crust of silty clay followed by the thick stratum of soft to medium silty clay.

Topsoil

A layer of about 60 to 300 mm thick surficial frozen topsoil was encountered in all boreholes.

Sandy Clay

A 0.6 to 0.9 m thick deposit of sandy clay was encountered beneath the topsoil in all boreholes, except in borehole 1, and extended to elevation 177.1 to 178.0.

Desiccated Silty Clay

Below the surficial topsoil in borehole 1 and below the sandy clay layer in the other boreholes, a stiff to hard silty clay layer was encountered which extended to 6.7 to 8.2 m, elevation 170.1 to 172.2. Boreholes 1, 2, 5 and 6 were terminated in the stiff to hard silty clay deposit between 6.7 and 8.2 m, between elevation 170.1 and 172.2. The stiff condition of the upper zone of clay was believed to be the result of desiccation, and has been subjected to oxidation resulting in its present brownish colour. The color changed to predominately grey below the oxidized layer. The silty clay layer contains approximately 47% clay, 25% silt, 20% sand and 8% fine to medium gravel.

N values recorded ranged between 12 and 31 with one low N value of 7 in the upper portion of the silty clay layer. The laboratory shear strength obtained for this layer ranged from 91.0 to 458.2 kPa.

The Atterberg liquid and plastic limits averaged 27 and 16, respectively, with an average moisture content of 17%. The Atterberg liquid limits ranged from 26.8 to 37.1 and plastic limits ranged between 21.1 and 15.5 for the silty clay samples. The plasticity index ranged from 10.1 to 16.0. The unit weight of the upper silty clay samples varied from 19.3 to 21.7 kN/m^3. Moisture content determinations ranged from 15.0 to 19.0%.

The coefficient of consolidation was 0.015 m^2/day (0.17 ft^2/day) and the compression index obtained was 0.10 with 95.8 kPa (1.0 tsf) preconsolidation pressure for the upper 7.6 m (25 ft.) silty clay subsoil. Further, the layer appeared to be saturated and pre-consolidated based on the consolidation test results.

Silty Clay

Below the desiccated silty clay stratum a layer of stiff to firm silty clay was encountered in boreholes 3 and 4 at 7.6 m, elevation 171.3 and 171.5 which extended to borehole termination depths 11.3 and 9.7 m, elevation 167.9 and 169.4, respectively. The silty clay layer contains approximately 47% clay, 25% silt, 20% sand and 8% fine to medium gravel.

Two laboratory shear strengths obtained for this layer were 25.2 and 44.8 kPa, which indicate that the consistency for this portion of silty clay is firm. Further, the layer appeared to be saturated and normally consolidated, which was confirmed by the consolidation test results.

The average unit weight was found to be between 19.4 and 21.2 kN/m^3. The moisture content determinations were between 17.1 and 28.9%. The Atterberg liquid limits ranged from 26.8 to 29.3 and plastic limit ranged from 16.1 to 16.9.

The coefficient of consolidation obtained was 0.006 m^2/day (0.06 ft^2/day) and the compression index obtained was 0.16 for the silty clay soil below 7.6 m (25 ft.).

Groundwater

No ground water was observed throughout the depth of boring during the investigation. Due to the impermeable nature of the silty clay stratum and absence of sand it was not possible to accurately establish the elevation of the ground water table. Based on fully saturated recovered samples, the ground water table was assumed at or slightly below the existing ground surface. No artesian conditions were noted during the field work and seepage into footing excavations was inferred to be local and of minor quantities.

6. FOUNDATION

6.1 Previous Foundation Recommendations

Foundation Support

The report (Reference 1) indicated that the upper crust of silty clay was competent to provide adequate foundation support. Based on the laboratory and field test results, the report indicated that spread footings could be placed between elevations 176.8 and 175.6 (elevation 580 and 576 ft.) to support the structures on the stiff to hard silty clay stratum with a bearing capacity of 191 kPa (2.0 tsf), incorporating a factor of safety of 3.0. The estimated bearing capacity was based on footing sizes of 30.5 to 32.9 m (100.0 to 108.0 ft.) long and 2.1 to 3.0 m (7.0 to 10.0 ft.) wide.

The report emphasized that the footings should not be founded below elevation 175.6 (576 ft.) to avoid overstressing of the underlying soft to firm silty clay layer. The report suggested to use protective measures such as sheet piling for footings founded at the minimum elevation of 175.6 (576 ft.), approximately 0.6 m below the stream bed to provide protection against erosion. Further, it was suggested that the footings should be founded at sufficient depth below the ground surface 1.2 to 1.5 m (4.0 to 5.0 ft.) to provide adequate protection for frost.

No seepage problems with respect to shallow footing excavations were anticipated since no water-bearing sand seams were encountered in the upper 6.1 to 7.6 m (20.0 to 25.0 ft.) of the subsoil. In addition, it was noted that the proposed grade line would not present any approach fill stability problems.

Settlement Analysis

Settlement under the footings due to the application of 191 kPa (2.0 tsf) bearing pressure on various footing sizes (30.5 to 32.9 m (100.0 to 108.0 ft.) long and 2.1 to 3.0 m (7.0 to 10.0 ft.) wide) was estimated and tabulated as follows:

FOOTING ELEVATION m (ft.)	**FOOTING SIZE m-m x m (ft.-ft. x ft.)**	**LOADING INTENSITY kPa (tsf)**	**MAXIMUM THEORETICAL SETTLEMENT CORRECTED FOR RIGIDITY AND DEPTH FACTORS mm (in.)**
176.8 (580)	30.5-32.9 x 2.1 (100-108 x 7)	191 (2)	99.1 (3.9)
175.6 (576)	30.5-32.9 x 2.1 (100-108 x 7)		99.1 (3.9)
175.6 (576)	30.5-32.9 x 3.0 (100-108 x 10)		119.4 (4.7)

The report indicated that based on the above estimated settlements, ultimate settlements upon application of 191 kPa (2.0 tsf) bearing pressure could result in as much as 127 mm mainly due to the fact that the stresses caused by the applied load would influence the deep deposit of soft clay for a considerable depth. The report suggested that a total settlement in the order of 76 mm (3 in.) may be anticipated for the lifetime that the structures were designed for in view of the long period of years required for the estimated consolidation settlements to take place. Further, it was indicated that the differential settlements could be taken in the order of 25 to 38 mm (1 to 1.5 in.).

Based on the Reference 2 general layout drawing, the footings were to be founded at about elevation 175.1. Further, it was indicated that steel sheet piles (Type AP3) were to be driven to approximate elevation 172.5±. The steel sheet piles were observed during the site reconnaissance. The proposed bottom of the drain ditch was at elevation 175.9 (577 ft.).

6.2 Assessment of Foundation Parameters

Based on the previous investigation and subsurface conditions encountered, the following table summarizes the foundation design parameters that were recommended in the previous report and the updated geotechnical reaction at SLS and factored geotechnical resistance at ULS are provided.

FOUNDATION DESIGN PARAMETERS

Foundation and Type	Elevation of Footings (m)	Previous Safe Bearing Resistance (tsf)[1]	Previous Equivalent Limit State Design Values		Limit State Design Values Updated to current industry practices[2]	
			SLS Geotechnical Reaction (kPa)	ULS Geotechnical Resistance Factored (kPa)	SLS Geotechnical Reaction (kPa)	ULS Geotechnical Resistance Factored (kPa)
East Abutment on Spread Footing	175.5 (576 ft.)	2.0	190	285	300	450
West Abutment on Spread Footing						

Notes: 1. Working stress design values. The Ultimate Limit State design values are based on the working stress. No field verifications were made.
2. Resistance Factor = 0.5 for shallow foundation (CFEM 4th edition)
Assumed Factor of Safety is 3 (CFEM 4th edition)

The seismic site coefficient for the conditions at this site is 1.0 (soil profile Type 1, Canadian Highway Bridge Design Code (CHBDC) 2006 Edition, clause 4.4.6). The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC. The foundation frost penetration depth at the site is 1.2 m according to OPSD 3090.101.

7. DISCUSSION

The Highway 401 McDougall Drain Bridge EBL is located in the Geographic Township of Tilbury East, Kent County, Ontario. The existing bridge is a single span reinforced concrete rigid frame structure that carries two lanes of Highway 401 Eastbound traffic.

From a geotechnical point of view, at the present time, foundation work for the McDougall Drain Bridge EBL is not expected provided that the dead load on the bridge does not increase or decrease by more than 10%.

It is understood that rehabilitation of the bridge structure is anticipated and that rehabilitation will be completed in a single stage using median crossovers.

Further, it is suggested that the weep holes in the abutment walls should be maintained and cleaned at a regular basis to prevent any clogging of the holes. Regular maintenance of the weep holes will keep the water flowing from behind the abutment walls and will mitigate hydrostatic pressure to build-up behind the abutment and retaining walls.

8. CLOSURE

This Technical Memorandum was prepared by Mr. Nazibur Rahman, P.Eng with the assistance of Mr. Mansoor Khorsand, EIT and was reviewed by Mr. Robert Ng, PhD, P.Eng. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Principal Contact conducted an independent review of the report.

We trust this memo is sufficient for your immediate needs. Please do not hesitate to contact us if you have any inquiries and/or comments.

Yours very truly,

Peto MacCallum Ltd.

Nazibur Rahman, P.Eng.
Project Engineer, Geotechnical Services

Robert Ng, MBA, PhD, P.Eng.
Senior Project Engineer

Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

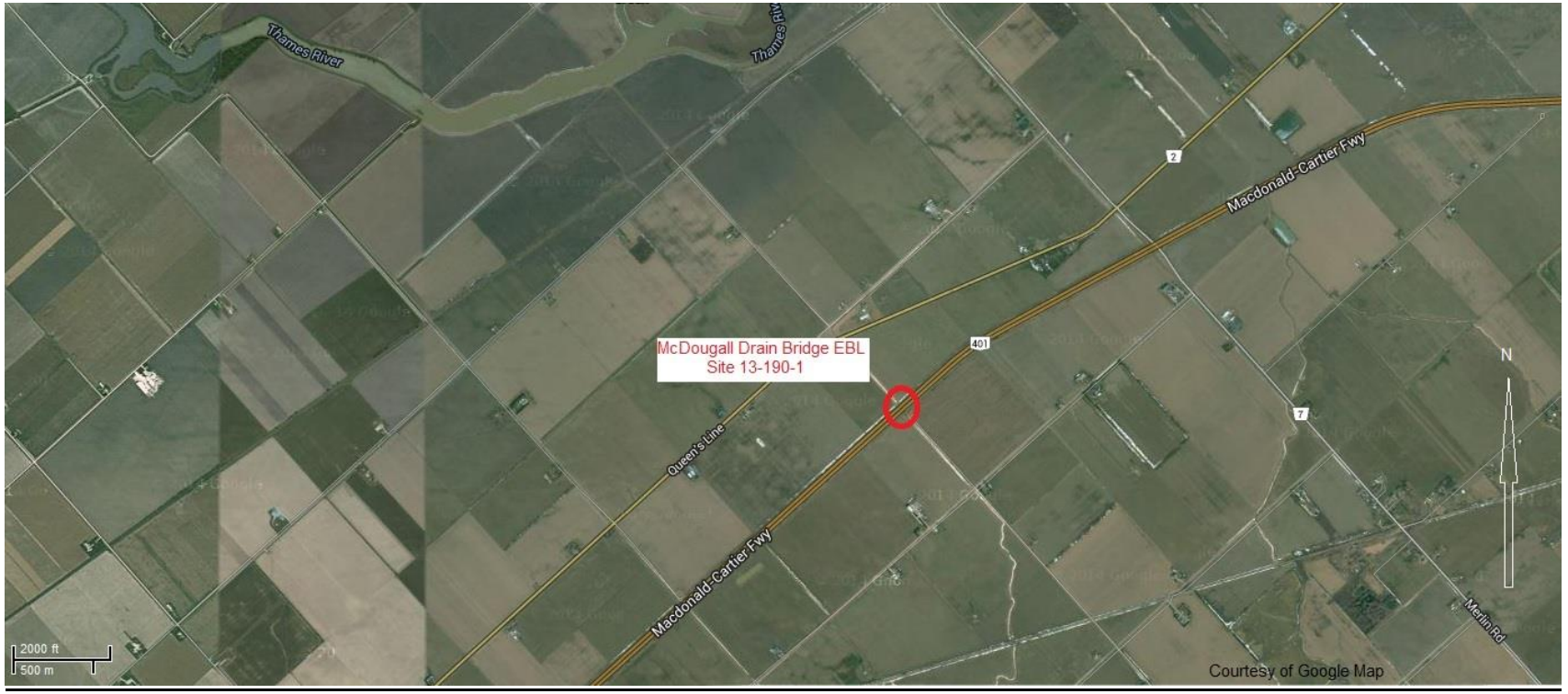
NR/RN/BRG:jk

TABLE 1

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSD 3090.101	Foundation Frost Depth for Southern Ontario

Figure 1 – Key Plan

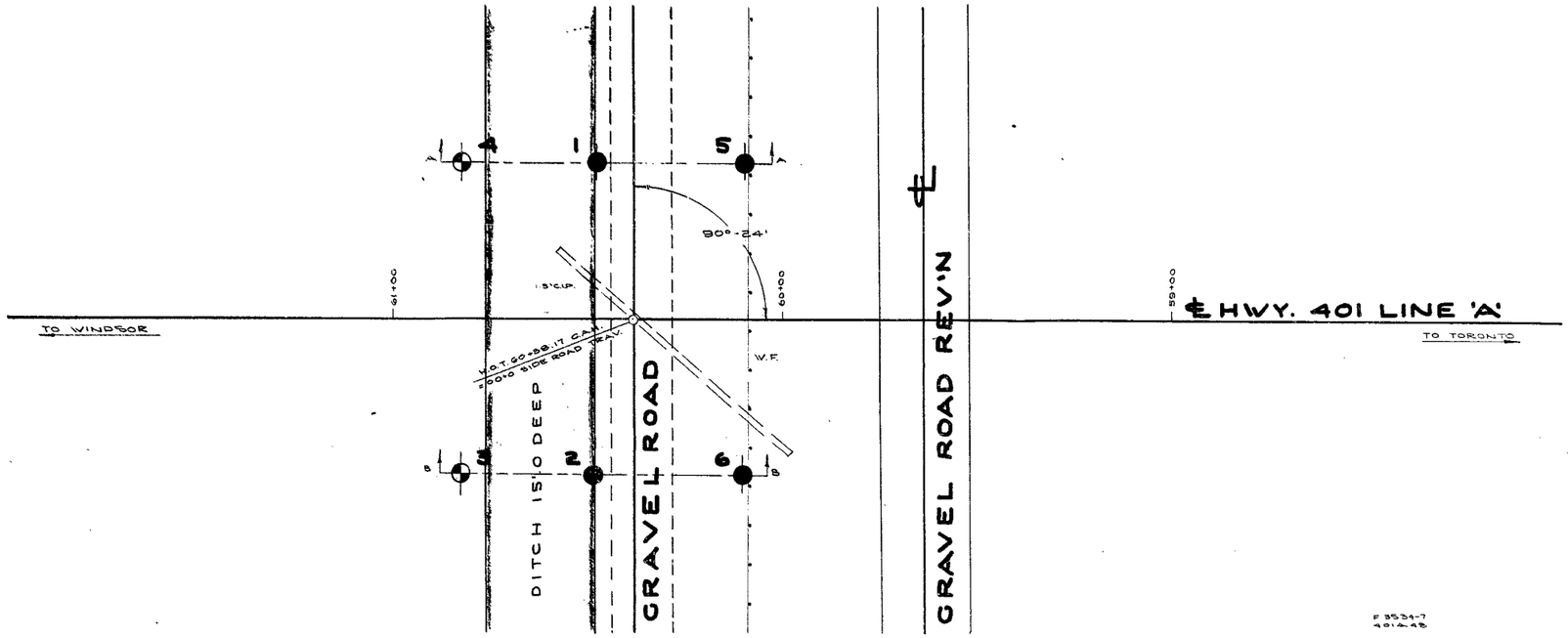


APPENDIX A

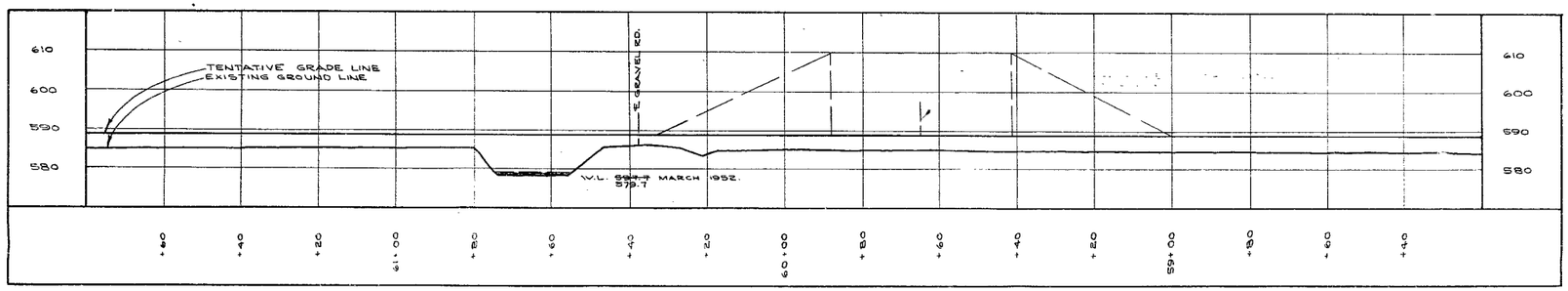
Foundation Report at McDougall Drain (GEOCRES 40J08-006)

General Layout – Tilbury East Township Bridge No. 4, dated October 1959

59-F-12
W.P. # 9-59
Hwy. # 401
CROSSING
GRAVEL RD.
CON. # 6
5½ MILES N.E.
OF TILBURY

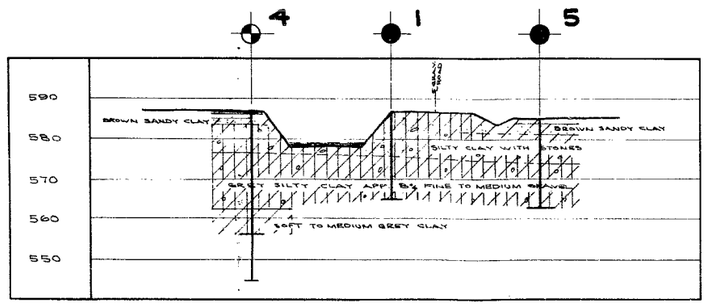


PLAN

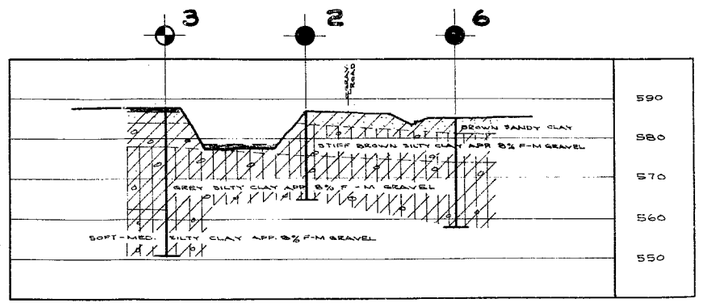


PROFILE

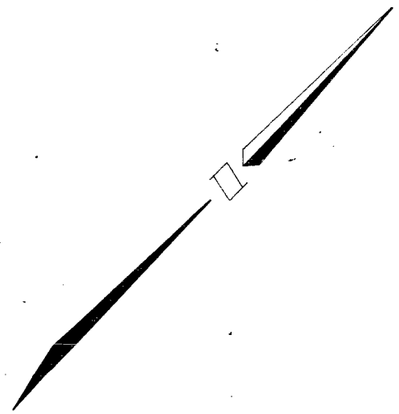
F 3534-3
401-A-39



A-A



B-B



LEGEND	
BORE HOLE	●
PENETRATION HOLE	⊕
BORE & PENETRATION HOLE	◒

HOLE NO.	ELEVATION	STATION	DISTANCE FROM ℄
1	587.0	60+48	40'RT.
2	587.0	60+48	40'LT
3	587.8	60+83	40'LT.
4	587.8	60+83	40'RT
5	585.0	60+10	40'RT.
6	585.0	60+10	40'LT

DEPARTMENT OF HIGHWAYS-ONTARIO
MATERIALS & RESEARCH SECTION

GRAVEL ROAD PROPOSED CROSSING

SHOWING POSITIONS & ELEVATIONS OF HOLES

HWY 401 DISTRICT 1 COUNTY KENT.
TOWNSHIP TILBURY EAST LOT 4 CON. II
LOCATION 5½ Mi. N.E. TILBURY
DRAWN BY: T. MELLORS | CHECKED BY: | W.P. 9-59
DATE MAR. 16/59 | APPROVED BY: | DRAWING NO. F59-12A
SCALE 1" = 20'

CC: Mr. A. M. Toye

BW879.

Mr. A. M. Toye,

Bridge Engineer,

Materials & Research Section.

April 23, 1959.

Re: Proposed Drain Crossing - Hwy. #401 - District #1, W.P. 9-59 BW 273.

Attention: Mr. S. McCombie.

We have been advised by your Mr. J. McAllister that, due to hydraulic conditions, footings for the above structure are to extend to Elevation 569. In addition, the proposed grade line is to be raised to 588.7. The foundation investigation carried out by our Section, indicated that footings should be founded at or about Elevation 576. Mr. McAllister requested that we review the subsoil conditions and comment on the effect of founding the footings at an elevation below that recommended in our report.

Our comments are as follows:-

(1) General subsoil conditions at this site consist of an upper desiccated stiff layer of silty clay, of the order of 24 feet in thickness. The bearing capacity of footings founded at Elevation 569 will be controlled by the shear strength of the upper stiff strata. A safe allowable bearing value of 2 tons/sq.ft. can be used for spread footings founded at this elevation.

(2) The effect of founding footings loaded with an intensity of 2 tons/sq.ft. at Elevation 569 will be to cause the seat of settlement to be located within the underlying soft, normally consolidated cohesive layer. This will give rise to settlements of the order of 4 to 6 inches.

(3) The magnitude of total settlement indicated above, appears to be such that a simply supported structure should be designed in preference to a rigid frame.

(4) The intended grade raise does not give rise to any approach fill stability problems.

We trust that the above comments adequately answer your queries with regard to this structure location, and if we can be of further assistance, please contact our office.

L. G. Soderman

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATION ENGINEER

LGS/MdeF

ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, Bridge Engineer. *Date* March 24, 1959.

From Materials & Research Section. *Subject* FOUNDATION REPORT -

Attention: Mr. S. McCombie.

Re: Hwy. 401 and Drain & Relocated Gravel Road Crossing, Lots 3 & 4, Concession VI, Township of Tilbury East, 5 1/2 Miles N.E. of Tilbury - District #1, W.P. 9-59.

Enclosed herewith, is our Foundation Report showing the subsoil conditions existing at the proposed structure location. Reference to the contents of this report shows that a deep deposit of silty clay underlies the site, the upper 25 feet of which has been subjected to desiccation, resulting in its stiff state.

Recommendations pertinent to the foundation design are summarized as follows:-

1. Subsoil conditions are such that the allowable bearing capacity of 2 tons per square foot can be used for spread footings, typically 7' to 10' in width, founded at or above Elevation 576'. Settlements resulting from the above load intensity, will be of the order of 3 inches.

2. The recommended minimum footing elevation of 576' will result in footings being placed approximately 2 feet below the stream bed. In view of the fact that the drainage creek is relatively inactive, footings placed at this elevation will provide adequate protection against scour and erosion. At the gravel road structure, footings should be provided with a minimum coverage of 4 to 5 feet.

3. An absolute determination of the ground water table elevation was not possible during the time at which the site work was carried out. The ground water table has been assumed at the elevation of the existing ground surface. Due to the absence of water-bearing sand seams, and due to the low permeability of the subsoil, seepage during footing excavations, should be of a minor amount.

cont'd. /2 ...

Recommendations - cont'd. ...

4. The subsoil has sufficient strength to safely support the proposed embankment loadings.

If you have any further questions regarding the foundation design of this site, please contact this office.

A. Rutka,
ACTING MAT'LS. & RESEARCH ENGR.

per:

L. G. Soderman

LGS/MdeF
Attach.

(L. G. Soderman,
PRINCIPAL SOILS & FOUNDATION ENGR.)

cc: Messrs. A. Toye
H. Tregaskes
D. Ramsay
G. Howell (Chatham)
A. Watt
Dr. P. Karrow
Foundation Section

File

FOUNDATION REPORT

on

Hwy. 401 and Drain & Relocated Gravel Road Crossing,
Lots 3 & 4, Concession VI, Township of Tilbury East,
5 1/2 Miles N.E. of Tilbury.

Plan No: F-3534

Profile No: F-3534-3

Distribution:

Mr. A. M. Toye, Bridge Engineer.	(2)
Mr. H. A. Tregaskes, Construction Engineer.	(1)
Mr. D. G. Ramsay, Design Engineer.	(1)
Mr. G. U. Howell, District Engineer, Chatham, Ontario.	(1)
Mr. A. Watt, Water Resources Commission,	(1)
Dr. P. Karrow, Department of Mines.	(1)
Foundation Section.	(1)
File.	(1)

W.P. 9-59

W.J. F-59-12.

INTRODUCTION:

An investigation has been carried out to determine the competence of the subsoil layers for supporting the foundations of the proposed structures located some 5 1/2 miles N.E. of Tilbury, where Hwy. 401 Line "A" crosses the relocated County road and the drainage creek between Lots 3 & 4 in Con. VI, Twp. of Tilbury East (Sta. 59+65 & Sta. 60+65, Profile No. F-3534-3).

The field work commenced on February 5, 1959 and was completed on February 9, 1959.

DESCRIPTION OF THE SITE & GEOLOGY:

The site and its surrounding areas are generally flat farmlands, the area on both sides of the existing gravel road and the drain being under harvested corn crops. The drain was originally a branch of the Jeannette Creek and had been widened and dredged into a drainage channel as at present. At the time of the investigation, the area was covered by ice and snow.

Physiographically, the site under consideration, is located on the St. Clair Clay Plains, which were covered by Glacial Lakes Whittlesey and Warren before. According to available geological information, these extensive plains covering a large area of South-Western Ontario, are covered by deep deposits of clay, underlain by limestone or shale bedrock. At this site, the upper zone of the clay stratum has been desiccated and exists in a stiff condition for a depth of approximately 25 feet.

DESCRIPTION OF FIELD & LABORATORY WORK:

Field work consisted of 6 sampled boreholes, carried out by a trailer-mounted continuous flight auger adapted for soil sampling. Conventional auger boring procedures were followed and

cont'd. /2 ...

DESCRIPTION OF FIELD & LABORATORY WORK: (cont'd.) ...

samples were recovered at depths required. In the cohesive material encountered, relatively undisturbed 2" I.D. thin walled shelby tube samples were used. In the granular material, samples were recovered by means of a 2" O.D. split barrelled spoon sampler. The dimensions of this sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test. In addition, a dynamic cone penetration profile was obtained adjacent to Boring 3.

Upon receipt in the laboratory, samples were visually examined and identified. Routine index tests were performed on selected representative samples. Laboratory test results have been presented in the borehole logs and detailed in tabular form.

The location plan and subsoil profile are presented in Drawing No. F-59-12A.

SUBSOIL CONDITIONS:

The site is underlain by a stiff crust of silty clay followed by the thick stratum of soft to medium silty clay.

In each of the sampled boreholes the frozen topsoil was found to be underlain by a 24 ft. stiff crust of silty clay extending from Elevation 586.0' to 562'. Underneath the stiff crust the stratum of soft to medium silty clay was encountered. This stratum was explored to a depth of 37' below the ground surface at approximately Elev. 551'. According to available geological information, this stratum of soft to medium clay extends to a considerable depth over bedrock. In general, the soil types encountered are as follows:-

cont'd. /3 ...

SUBSOIL CONDITIONS: (cont'd.) ...

1. Stiff Silty Clay:

This stiff condition of the upper zone of clay is believed to be the result of desiccation, and has been subjected to oxidation resulting in its present brownish colour. Below the oxidized zone the colour is predominantly grey. The material contains approximately 25% silt, 20% sand and 8% fine to medium gravel in it. The average unit weight and moisture content were found to be 131 p.c.f. and 17%, respectively. Liquid and plastic limits averaged 27% and 16%. Laboratory shear strength tests show an average of 3000 p.s.f. to be representative, for the 24 ft. layer. Judging from its moisture content and Atterberg limits, the stiff silty clay appears to be saturated and preconsolidated. This is borne out by the consolidation test results.

2. Soft to Medium Silty Clay:

Underneath the stiff clay crust the thick stratum of soft to medium silty clay was encountered. The colour is predominantly grey. It contains approximately 25% silt, 20% sand and 8% fine to medium gravel. The average unit weight was found to be 125 p.c.f. Its consistency is defined by moisture content of 28%, Liquid and plastic limits of 29% and 17%, respectively. Laboratory tests show that the shear strength of the silty clay decreases with depth and reaches a constant value of 500 p.s.f. below approximately Elev. 552'. Judging from its moisture content and Atterberg limits, the soft to medium silty clay appears to be saturated and normally consolidated. This is confirmed by the consolidation test results.

cont'd. /4 ...

SUBSOIL CONDITIONS: (cont'd.) ...

Laboratory and field test results have been summarized in Table No. 1 and are included in this report under Appendix I.

WATER CONDITIONS:

No ground water was detected throughout the depths of boring during the investigation. The water level of Lake St. Clair is presently at approximately Elev. 574.

Due to the impermeable nature of the subsoil strata and absence of sand seams it was not possible to accurately establish the elevation of the ground water table during the boring program. The samples obtained were fully saturated and the ground water table has been assumed at or slightly below the existing ground surface. No artesian conditions were noted during the field work, and seepage into footing excavations will be local and of minor quantities.

FOUNDATION SUPPORT:

The stiff upper crust of silty clay is competent to provide adequate foundation support for the proposed structures. Laboratory and field test results are such that spread footing support can be obtained in the stiff crust of silty clay between Elevations 580' and 576'. Between these elevations a bearing capacity of 2 t.s.f. can be provided. This allowable bearing pressure of 2 t.s.f., incorporating a factor of safety of 3, is estimated on the basis of footing sizes of 100' to 108' long, 7' to 10' wide and not wider than 10'. While the footings may be founded between Elevations 580' and 576', they should not be founded below Elev. 576' in order to avoid overstressing of the underlying soft to medium clay. For the proposed structure at the drain, consideration should be given to

cont'd. /5 ...

FOUNDATION SUPPORT: (cont'd.) ...

founding the footings below the stream bed elevation in order that they are protected from stream erosion. Protective measures, such as sheet piling, may be resorted to if footings founded at the minimum elevation of 576' (approximately 2 ft. below the stream bed) are considered as providing inadequate protection against erosion. In view of the fact that the drainage creek is relatively inactive, footings placed at Elevation 576' are believed to have sufficient protection from erosion. In the contemplated structure at the relocated gravel road, footings should be founded at sufficient depth below the ground surface (4 to 5 ft.) in order to provide adequate frost protection.

No seepage problems with respect to shallow footing excavations are anticipated since no water-bearing sand seams were encountered in the upper 20 to 25' of the subsoil.

The proposed grade line does not present any approach fill stability problems.

SETTLEMENT ANALYSIS:

Settlements under the footings as a result of the application of 2 t.s.f. bearing pressure, based on footing sizes of 100' to 108' long, 7' to 10' wide and not wider than 10', have been estimated and are tabulated as follows:-

Footing Elev. (in feet)	Footing Size	Loading Intensity (in t.s.f.)	Max. Theoretical Settlement Corrected for Rigidity and Depth Factors.
580	100'-108' x 7	2	3.9"
576	100'-108' x 7	2	3.9"
576	100'-108' x 10	2	4.7"

Reference to the above figures shows that ultimate settlements upon application of 2 t.s.f. bearing pressure on footing sizes as

cont'd. /6 ...

SETTLEMENT ANALYSIS: (cont/d).....

shown can be as much as 5 inches. This is mainly due to the fact that the stresses caused by the applied load will influence the deep deposits of soft clay for a considerable depth. In view of the long period of years required for the estimated consolidation settlements to take place, it is suggested that a total settlement of the order of 3 inches may be anticipated for the lifetime that the structures are designed for. Differential settlements can be taken as of the order of 1" to 1 1/2".

DISCUSSION ON BEARING PRESSURE & SETTLEMENT:

From the foregoing discussion, it can be seen that, in order to avoid undesirable overstressing of the soft clay underneath, an allowable bearing pressure of not greater than 2 t.s.f. has been recommended for spread footings of 100' to 108' in length, 7' to 10' in width and not wider than 10', founded between Elevations 580' and 576', and not below 576' in the stiff crust of clay. Settlements consequent upon application of this bearing pressure of 2 t.s.f. can be as much as 5 inches. In view of the slow rate of consolidation as expected of clay, it is suggested that for design purposes, a total settlement of the order of 3 inches may be anticipated. The differential settlements can be taken as of the order of 1" to 1 1/2". The actual loading intensity is not known at the present time, but it is anticipated that a decrease in loading intensity will result in a decrease of settlements. It appears that if rigid frame structure are contemplated, they are favourable only if they can tolerate the amount of differential settlements as mentioned above. If the estimated differential settlements are not within tolerable limits, freely-supported structures appear to be necessary.

cont'd. /7 ...

CONCLUSIONS & RECOMMENDATIONS:

1. The site is underlain by a stiff crust of silty clay, followed by a deep deposit of soft to medium silty clay.

2. Subsoil conditions are such that an allowable bearing pressure of not greater than 2 t.s.f. for spread footings of 7' to 10' wide and not wider than 10', can be obtained between Elevations 580' and 576' and not below 576'. For the proposed structure at the drain, consideration should be given to founding the footings below the stream bed elevation in order that they will be protected from stream erosion. Sheet pilings may be resorted to if footings founded at the minimum elevation of 576' (approximately 2 ft. below the stream bed) are considered as providing inadequate protection against erosion. In view of the fact that the drainage creek is relatively inactive, footings placed at Elevation 576' are believed to be deep enough to provide protection against erosion. For the contemplated structure at the relocated gravel road, footings should be founded at sufficient depth below the ground surface (4 to 5 ft.) in order to provide adequate frost protection.

3. Ultimate settlements consequent upon application of the recommended bearing pressure of 2 t.s.f. can be as much as 5 inches. However, for design purposes, as discussed under "Settlement Analysis", it has been suggested that a total settlement of the order of 3 inches may be anticipated. A decrease in loading intensity will, of course, result in a decrease of settlement. Rigid frame structures are favourable only if they can tolerate the estimated amount of settlement.

cont'd. /8 ...

CONCLUSIONS & RECOMMENDATIONS: (cont'd.) ...

4. No seepage problems with respect to shallow footing excavations are anticipated.

5. The subsoil is competent to support the proposed embankment loadings.

A. Loh,
Foundation Engr.

APPENDIX I.

TABLE I.

SUMMARY OF FIELD & LABORATORY TESTS

JOB F-59-12
W.P. 9-59

HOLE NO	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	T1	5 - 7	Stiff brown silty clay with some sand.	-	16.5	-	-	5620	132.3	Approximately 8% fine to medium gravel throughout.
	T2	10 - 12	Stiff grey silty clay.	31	15.3	-	-	-	135.2	
	T3	15 - 17	" " " "	20	16.3	-	-	2970	131.6	
	T4	20 - 22	" " " "	-	17.5	-	-	2450	131.6	
2	T1	5 - 7	Stiff brown silty clay.	28	15.1	-	-	9570	127.8	Approximately 8% fine to medium gravel throughout.
	T2	10 - 12	Stiff grey silty clay.	22	15.0	-	-	3550	133.7	
	T3	15 - 17	" " " "	19	16.7	-	-	-	130.5	
	T4	20 - 22	" " " "	-	17.1	-	-	2600	129.6	
3	S1	3 - 4½	Brown sandy clay.	13	21.3	-	-	-	123.0	Approximately 8% fine to medium gravel throughout.
	T2	6 - 8	Stiff brown silty clay.	-	15.5	21.1	37.1	5760	129.2	
	T3	10 - 12	Stiff grey silty clay.	23	15.3	15.9	26.9	4860	133.5	
	T4	15 - 17	" " " "	-	17.4	16.5	28.4	3330	132.2	
	T5	20 - 22	" " " "	-	18.2	15.5	26.8	2660	127.0	
	T6	27 - 29	Medium stiff grey silty clay.	-	21.3	16.1	28.5	937	125.5	
	T7	35 - 37	Soft " " "	-	28.9	16.9	29.3	527	121.0	
4	T1	5 - 7	Stiff brown silty clay with stones.	12	16.2	-	-	-	124.5	
	T2	10 - 12	Stiff brown silty clay with stones.	35	15.8	17.5	29.5	-	138.3	
	T3	15 - 17	Stiff grey silty clay.	23	16.4	16.1	27.4	3730	133.3	Approximately 8% fine to medium gravel throughout in the grey clay.
	T4	20 - 22	" " " "	-	16.8	16.2	27.2	4330	133.7	
	T5	30 - 32	Soft " " "	-	18.8	-	-	-	130.0	

cont'd. /2 ...

SUMMARY OF FIELD & LABORATORY TESTS

JOB F-59-12
W.P. 9-59.

DLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
5	T1	5 - 7	Stiff brown silty clay with stones.	7	-	-	-	-	-	Approximately 8% fine to medium gravel throughout in the grey clay.
	T2	10 - 12	Stiff brown silty clay.	20	15.6	16.0	26.1	4410	134.2	
	T3	15 - 17	" " " "	20	16.2	-	-	-	131.5	
	T4	20 - 22	" " " "	18	17.9	15.8	26.0	3020	134.0	
6	T1	5 - 7	Stiff brown silty clay.	-	19.0	-	-	1900	129.3	Approximately 8% fine to medium gravel throughout.
	T2	10 - 12	Stiff grey silty clay.	19	15.5	-	-	4870	131.5	
	T3	15 - 17	" " " "	23	17.2	-	-	-	132.3	
	T4	25 - 27	Med. Stiff grey silty clay.	-	17.1	16.7	26.8	-	129.3	

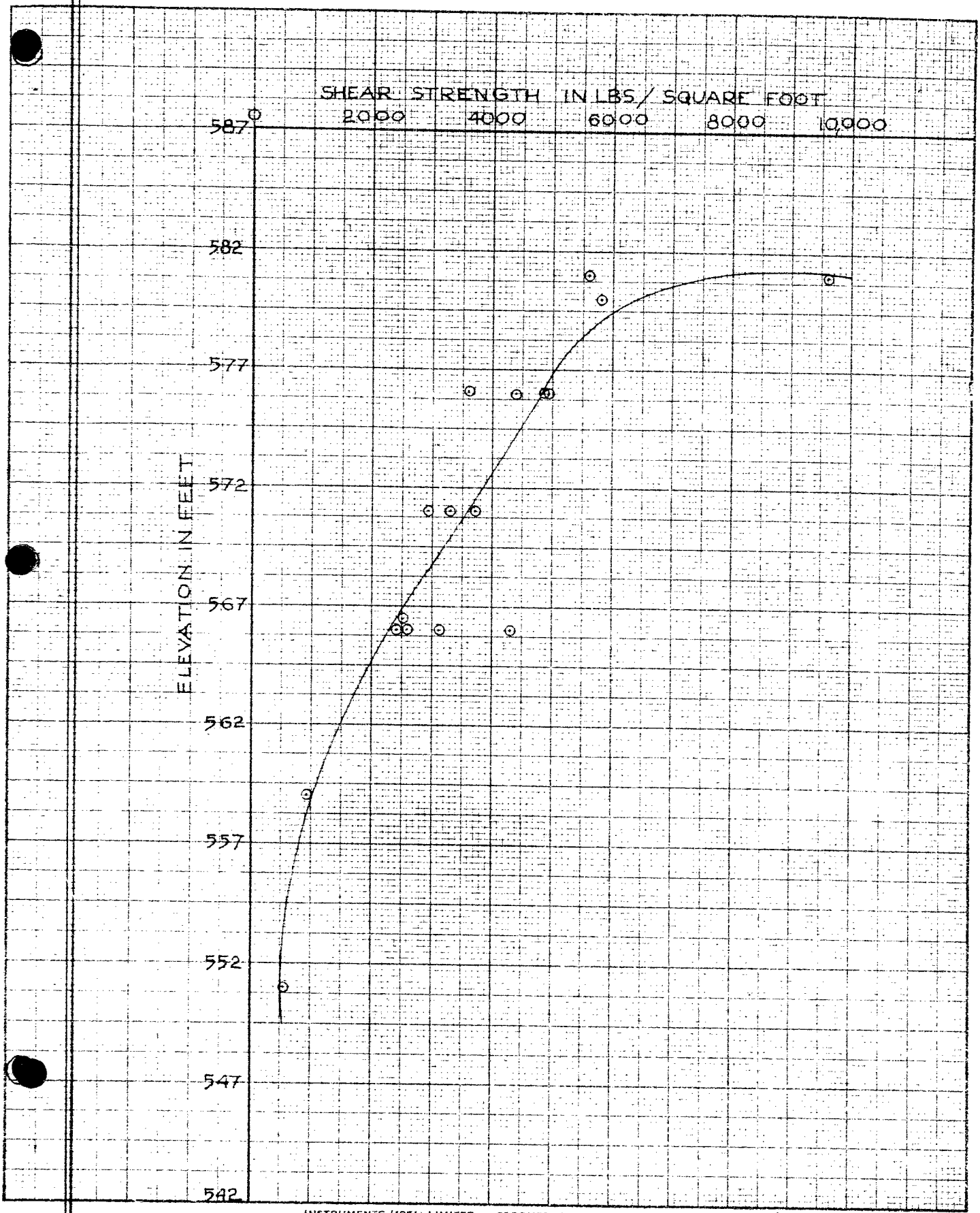
T1 Denotes thin walled shelby sample.
S1 Denotes split spoon sample.

Consolidation Characteristics:

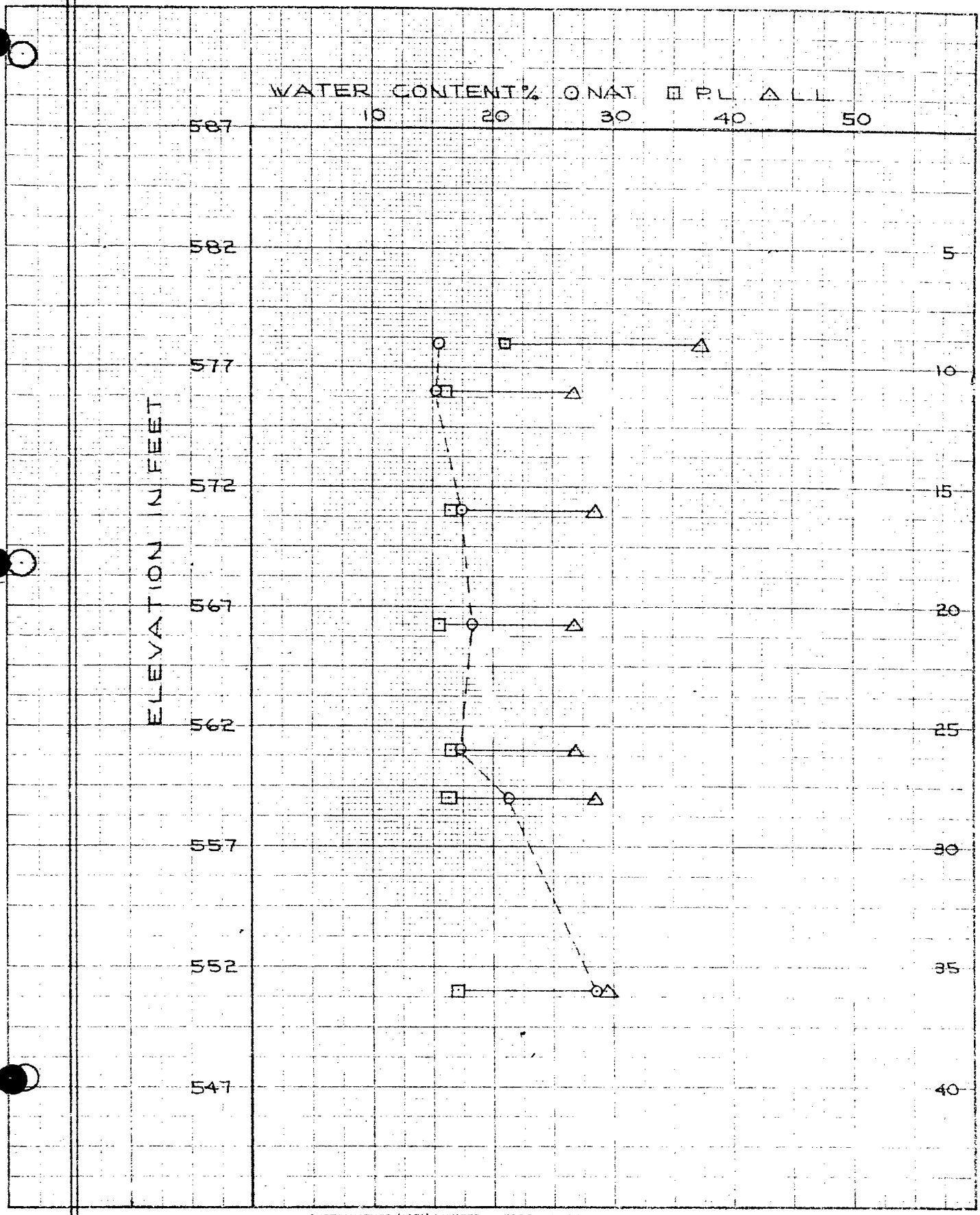
Depth 0 - 25' - Compression Index 0.10
Coeff. of Consolidation ..... 0.17 sq.ft./day.
Preconsolidation Pressure ..... 1 T/sq.ft.

Depth 25' and below. - Compression Index 0.16
Coeff. of Consolidation ..... 0.06 sq.ft./day.
Preconsolidation Pressure ..... = Submerged Unit Weight x Depth. - (Normally consolidated.

W.P. 9 - 59 JOB F-59-12



W.R. 9-59 JOB F59-12



FORM OB-ML-126

H.D.R.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG PENN DRILL JONSTON OPERATION BORE JOB F-58-12 W.P. 9-59 BORING 1 STA. 60+48 40RT

CASING (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MARCH 1959

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES COMPILED BY J.J CHECKED BY A.L. DATE BORING FEBRUARY 9 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_C - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
W.L. - WATER LEVEL IN CASING
W.T. - 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

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT
587.0		GROUND LEVEL	
		GRAVEL ROAD BED	
0.2'		STIFF BROWN SILTY CLAY WITH SOME SAND & APP. 8% FINE TO MEDIUM GRAVEL	
576.0			
11.0		STIFF GREY SILTY CLAY APPROX. 8% FINE TO MEDIUM GRAVEL	
565.0			
22.0		END OF BOREHOLE	

ELEVATION SCALE: 585, 580, 575, 570, 565

SHEAR STRENGTH IN Lbs/a Foot. 2,000 4,000 6,000 8,000

WATER CONTENT W % 10 20 30 40 — O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-------X-------X STAND. PEN. ●——●——●

50 100 150 200

CASING BLOWS (ACTUAL)

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					587.0
					582.0
γ=132.3		T.O.	1		63
					577.0
γ= 132.6		T.O.	2	31	40
					572.0
γ= 131.6		T.O.	3	20	80
					567.0
γ= 131.6		T.O.	4		68

FORM OB-ML-1

H.D.R.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG PENN DRILL JOHNSTON CO OPERATION BORE JOB E-59-12 W.P. 9-59 BORING 2 STA. 60+48 40'LT.

CASING _____ (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MARCH 1959

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES COMPILED BY IJJ CHECKED BY A.L. DATE BORING FEBRUARY 9 1959.

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_C - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
W.L. - WATER LEVEL IN CASING
W.T. - 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					SHEAR STRENGTH IN lbs./s FOOT. 2,000 4,000 6,000 8,000	CASING BLOWS (ACTUAL)	SAMPLES					
ELEVATION / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	WATER CONTENT W % 1.0 2.0 ○ - NAT. 3.0 □ - P.W. 4.0 △ - L.W.		OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW) D. CONE PEN. X-------X-------X STAND. PEN. 50 100 150 200							
587.00		GROUND LEVEL										587.0
		GRAVEL ROAD BED										
0.2		BROWN SANDY CLAY		585								
584.0												582.0
3.0		STIFF BROWN SILTY CLAY APPROX. 8% FINE TO MEDIUM GRAVEL		580			γ= 127.8		T.O.	1	28	100
												577.0
576.0							γ= 138.7		T.O.	2	22	100
11.0		STIFF GREY SILTY CLAY APPROX 8% FINE, TO MEDIUM GRAVEL		575								572.0
				570			γ= 130.5		T.O.	3	19	100
												567.0
565.0				565			γ= 129.6		T.O.	4		60
22.0		END OF BOREHOLE										

FORM OB-ML-1

R.D.H.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG PENN. DRILL JOHNSTON CO OPERATION BORE & PENETRATION JOB F-59-12 W.P. 9-59 BORING 3 STA. 60+83 (40' LT)

CASING (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MARCH 1959

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES COMPILED BY LW CHECKED BY A.L. DATE BORING FEBRUARY 5, 1959

ABBREVIATIONS

- INSITU VANE SHEAR TEST
- MECHANICAL ANALYSIS
- UNCONFINED COMPRESSION
- Q_c TRIAXIAL CONSOLIDATED QUICK
- Q - TRIAXIAL QUICK
- S - TRIAXIAL SLOW
- W.L. - WATER LEVEL IN CASING
- W.T. - 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

ELEVATION / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT
587.80		GROUND LEVEL	
		FROST	
1.0		BROWN SANDY CLAY	
586.80			
4.0		STIFF BROWN SILTY CLAY	
578.0			
9.0		STIFF GREY SILTY CLAY APPROX 8% FINE TO MEDIUM GRAVEL	
562.0			
25.0		SOFT TO MEDIUM GREY SILTY CLAY APPROX 8% FINE TO MEDIUM GRAVEL	
550.80		END OF BOREHOLE	
37.0			

ELEVATION SCALE: 585, 580, 575, 570, 565, 560, 555, 550

SHEAR STRENGTH: 2000, 4000, 6000, 8000

WATER CONTENT W % — 0 - NAT, □ - P.W., Δ - L.W. — 10, 20, 30, 40

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-------X-------X STAND. PEN. •——•——• — 50, 100, 150, 200

REFUSAL AT ELEV 574.00

CASING BLOWS (ACTUAL)

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					587.8
					584.8
γ = 123.0		D.O.	1	13	100
					582.8
γ = 129.2		T.O.	2		100
					577.8
γ = 133.5		T.O.	3	23	100
					572.8
γ = 132.2 p.c.f.		T.O.	4		100
					567.8
γ = 127.0		T.O.	5		100
					562.8
		T.O.			560.8
γ = 125.5		T.O.	6		100
					552.8
γ = 121.0		T.O.	7		100

FORM OB-ML-106

H.D.R.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG PEN. DRILL JOHNSTON OPERATION BORE & PENETRATION OBF-59-12 W.P. 9-59 BORING 4 STA. 60+83 (43' RT)

CASING - (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MARCH, 1959

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES COMPILED BY I.J.J. CHECKED BY A.L. DATE BORING FEBRUARY 6, 1959

ABBREVIATIONS

- INSITU VANE SHEAR TEST
- MECHANICAL ANALYSIS
- UNCONFINED COMPRESSION
- $\bar{\sigma}_c$ TRIAXIAL CONSOLIDATED QUICK
- Q - TRIAXIAL QUICK
- S - TRIAXIAL SLOW
- W.L. - WATER LEVEL IN CASING
- W.T. - 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

ELEVATION / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT
587.8		GROUND LEVEL	
		FROST	
1.0' / 586.8'		BROWN SANDY CLAY	
4.0		STIFF BROWN SILTY CLAY WITH STONES	
576.8 / 11.0		STIFF GREY SILTY CLAY APPROX 5% FINE TO MEDIUM GRAVEL CHANGED TO SOFT TO MEDIUM GREY CLAY BELOW ELEV. 562.8' (25' DEPTH)	
562.8 / 26.0			
555.8 / 32.0		END OF BOREHOLE	

ELEVATION SCALE: 585, 580, 575, 570, 565, 560, 555, 550, 545

SHEAR STRENGTH P.S.F. 2000, 4000, 6000, 8000

WATER CONTENT W % 10, 20, 30, 40 — O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X------X------X STAND. PEN. ●——●——● 50, 100, 150, 200

REFUSAL AT ELEV. 545.8'

CASING BLOWS (ACTUAL)

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					587.8
					582.8
$\bar{\sigma}$= 124.6		T.O.	1	12	100
					577.8
$\bar{\sigma}$= 138.3		T.O.	2	35	40
					572.8
$\bar{\sigma}$= 133.8		T.O.	3	23	100
					567.8
$\bar{\sigma}$= 133.7		T.O.	4		60
					557.8
$\bar{\sigma}$= 130.0		T.O.	5		100

FORM OB-ML-12

H.D.R.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG PENN DRILL JOHNSTON CO. OPERATION BORE JOB F-59-12 W.P. 9-59 BORING 5 STA. 60+10 (40' RT)

CASING ___ (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MARCH 1959

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES COMPILED BY L.L. CHECKED BY A.L. DATE BORING FEBRUARY 6, 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_C - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
W.L. - WATER LEVEL IN CASING
W.T. - 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

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT
585.0		GROUND LEVEL	
584.0 (1.0)		FROST	
		BROWN SANDY CLAY WITH STONES	
581.0 (4.0)			
		STIFF BROWN SILTY CLAY WITH STONES	
574.0 (11)			
		STIFF GREY SILTY CLAY APPROX 8% FINE TO MEDIUM GRAVEL	
563.0 (22.0)		END OF BOREHOLE	

ELEVATION SCALE: 585.0, 580, 575, 570, 565, 560

SHEAR STRENGTH P.S.F. 2000 4000 6000 8000

WATER CONTENT W % 10 20 30 40 — O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-------X-------X 50 100 150 200 STAND. PEN. •——•——• 200

CASING BLOWS (ACTUAL)

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					585.0
					580.0 (5)
		T.O.	1	7	25
					575.0 (10)
γ= 134.2		T.O.	2	20	100
					570.0 (15)
γ= 131.5		T.O.	3	20	100
					565.0 (20)
γ= 134.0		T.O.	4	18	100
					(25)

FORM OB-ML-1

H.D.R.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG PENN DRILL, JOHNSTON OPERATION BORE JOB F-59-12 W.P. 9-59 BORING 6 STA. 60+10 40'LT.

CASING — (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MARCH 1959

SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES COMPILED BY J.J. CHECKED BY A.L. DATE BORING FEBRUARY 9, 1959

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_C - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
W.L. - WATER LEVEL IN CASING
W.T. - 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

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE
595.0		GROUND LEVEL		
1.0		FROST		
582.0		BROWN SANDY CLAY		
3.0		STIFF BROWN SILTY CLAY APPROX 8% FINE TO MEDIUM GRAVEL		580
574.0				575
11.0		STIFF GREY SILTY CLAY APPROX 8% FINE TO MEDIUM GRAVEL		570
				565
558.0				560
27.0		END OF BOREHOLE		555

SHEAR STRENGTH LBS./□ FOOT — 2,000 — 4,000 — 6,000 — 8,000

WATER CONTENT W % — ○ - NAT. □ - P.W. △ - L.W.

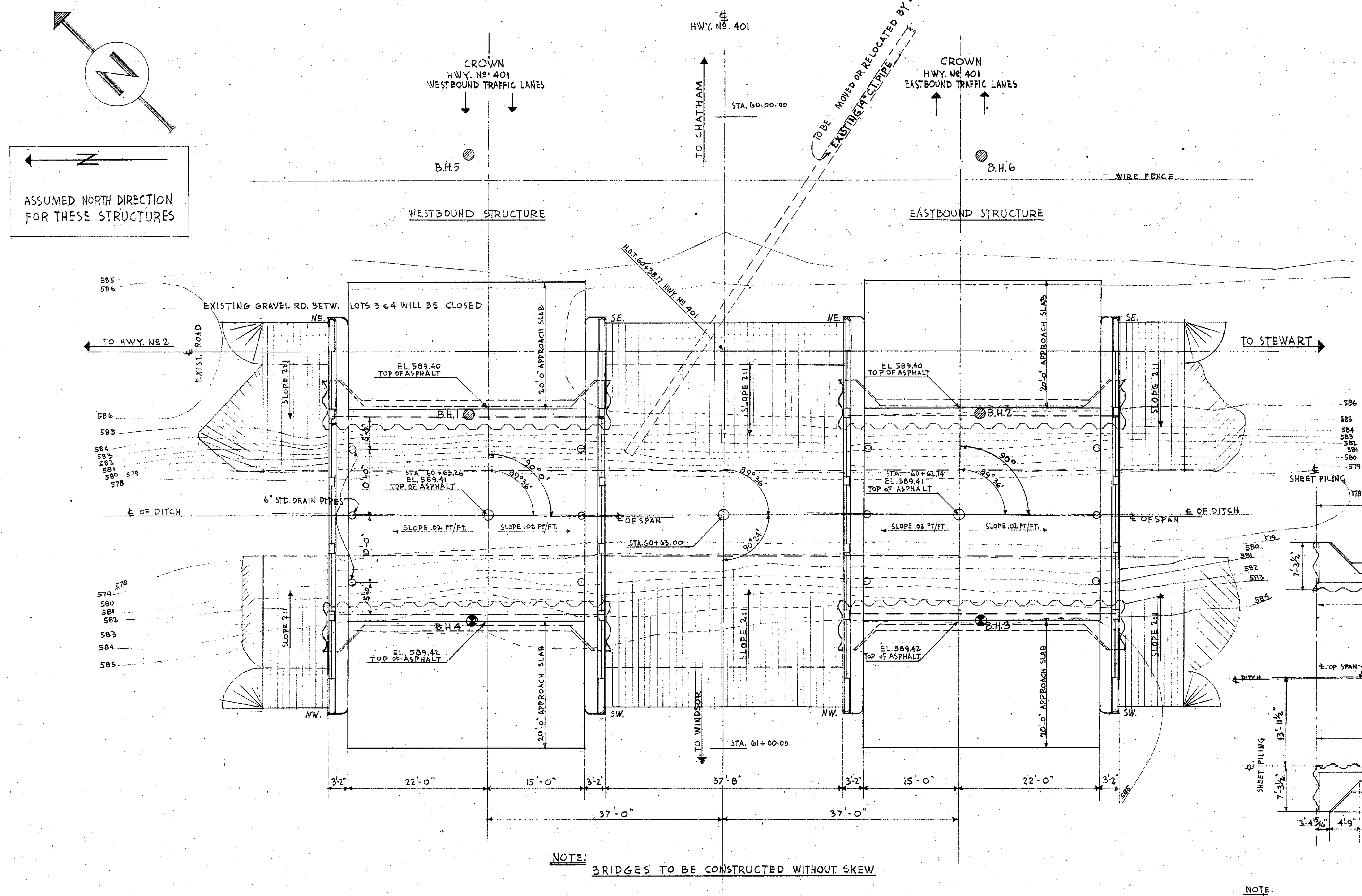
PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X------X------X STAND. PEN. •——•——• — 50 — 100 — 150 — 200

CASING BLOWS (ACTUAL)

SAMPLES

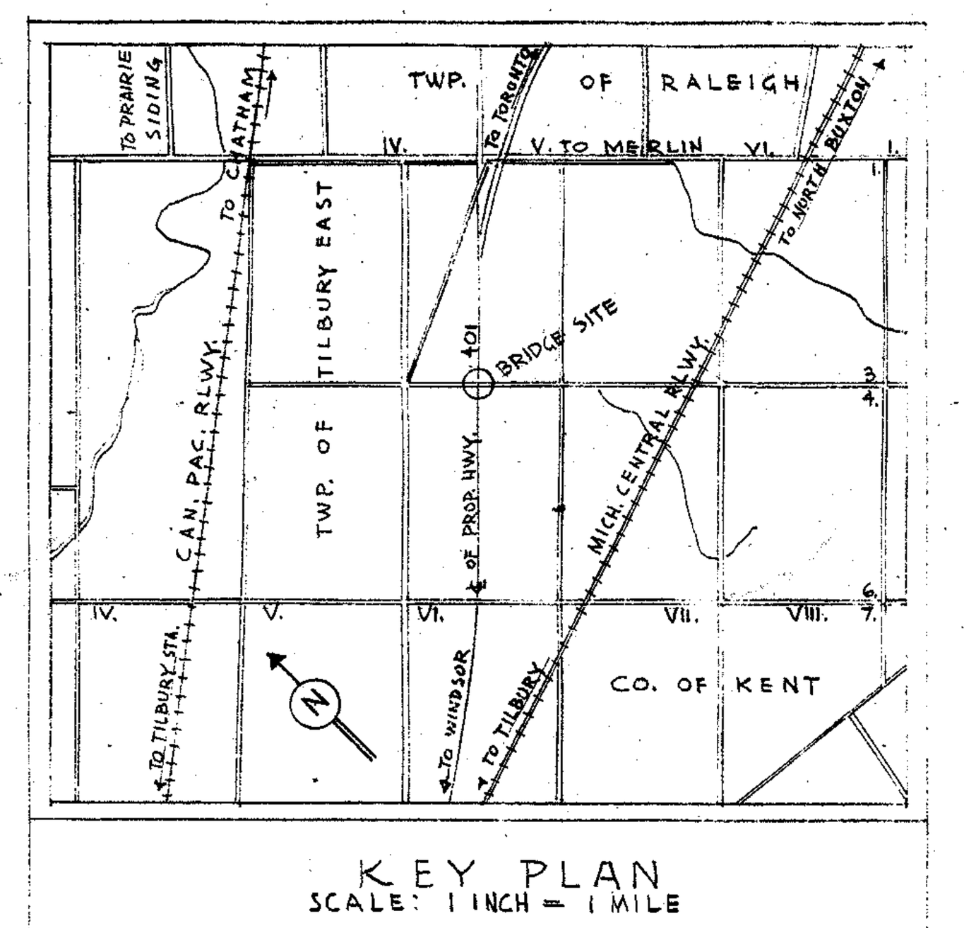
OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					595.0
					580.0
γ = 129.3		T.O.	1		90
					575.0
γ = 131.5		T.O.	2	19	100
					570.0
γ = 132.3		T.O.	3	23	100
					560.0
γ = 129.3		T.O.	4		100



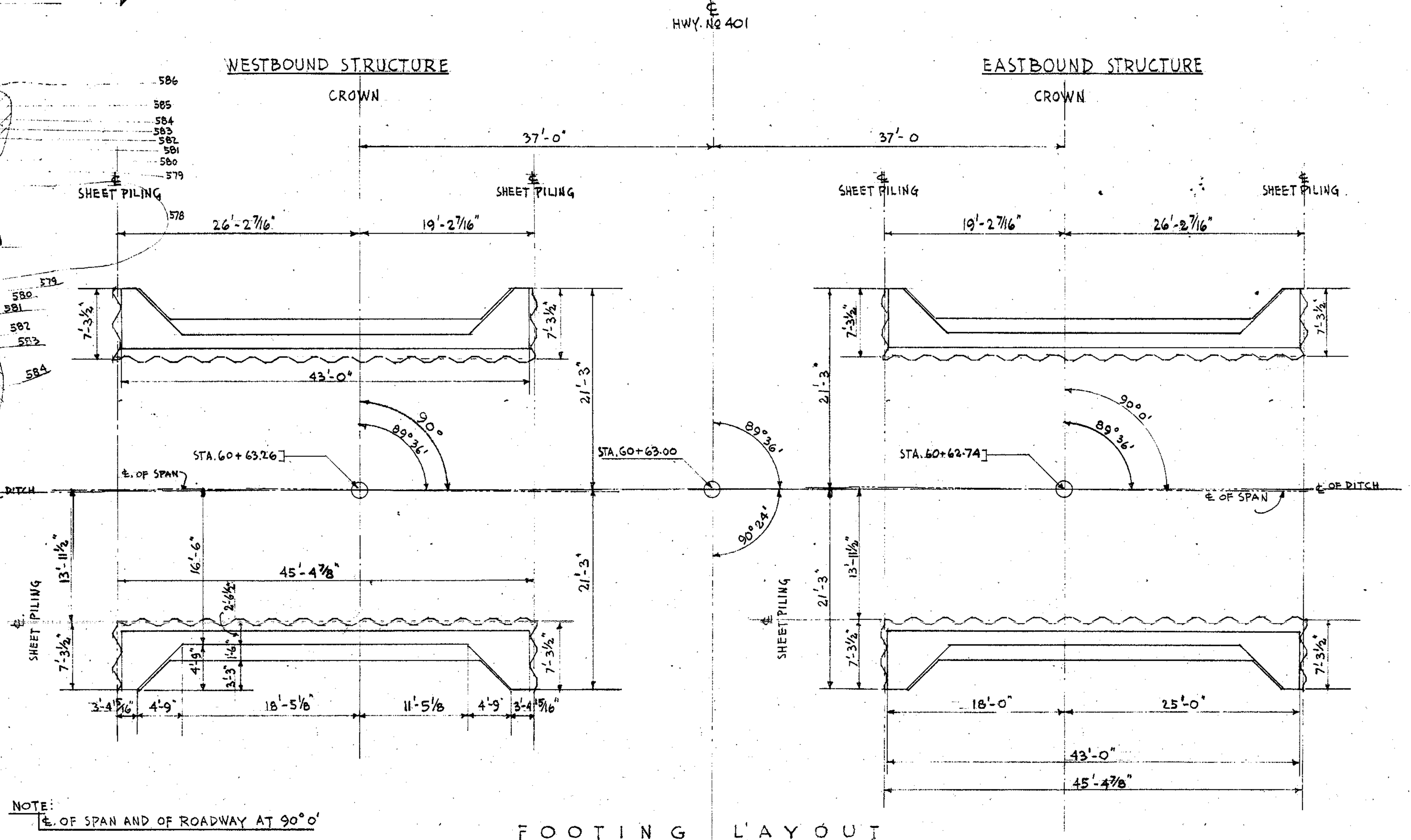
PLAN OF DECK
SCALE: 1 INCH = 10'-0"

CONSTRUCTION NOTES

1. ALL EXPOSED EDGES TO BE GIVEN 1" CHAMFER, OR AS SPECIFIED.
2. BACK OF FOOTING TO BE POURED AGAINST UNDISTUBED GROUND.
3. CONTRACTOR TO CUT OFF DRAINS 3" BELOW BOTTOM OF DECK.
4. FALSEWORK SUPPORTING THE DECK AND CANTILEVERED WINGWALLS MUST NOT BE REMOVED UNTIL THE CONCRETE HAS REACHED 80% OF THE DESIGN STRENGTH.
5. THE BACKFILL BEHIND BOTH ABUTMENTS SHALL BE PLACED SIMULTANEOUSLY AND BY THOROUGHLY COMPACTING 6 INCH HORIZONTAL LAYERS AS SPECIFIED IN FORM Nº.9 AND THE GENERAL GRADING SPECIFICATIONS Cl. 214.



KEY PLAN
SCALE: 1 INCH = 1 MILE



FOOTING LAYOUT
SCALE: 1 INCH = 10'-0"

NOTE TO DISTRICT ENGINEERS

CONCRETE WORK ON THIS STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED AND CHECKED BY THE DISTRICT ENGINEER.

NOTE TO CONTRACTOR

STRUCTURE TO BE BUILT IN ACCORDANCE WITH FORM 9 AND THE SPECIAL PROVISIONS, EXTRA C[illegible] OF WHICH MAY BE OBTAINED FROM THE DISTRICT [illegible] ALL CONSTRUCTION JOINTS MUST BE APP[illegible] BY THE BRIDGE ENGINEER.

CONCRETE MIX

FOOTINGS: MINIMUM STRENGTH AT 28 DAYS
REMAINDER: " " " " " " "
MAXIMUM SIZE AGGREGATE 3/4" FOR DECK, REMA[illegible] STRUCTURE NOT TO EXCEED 1½" IN SIZE.
AN APPROVED ADMIXTURE SUPPLIED BY THE DEPARTMENT BE ADDED TO ALL CONCRETE AS SPECIFIED BY THE ENGINEER.

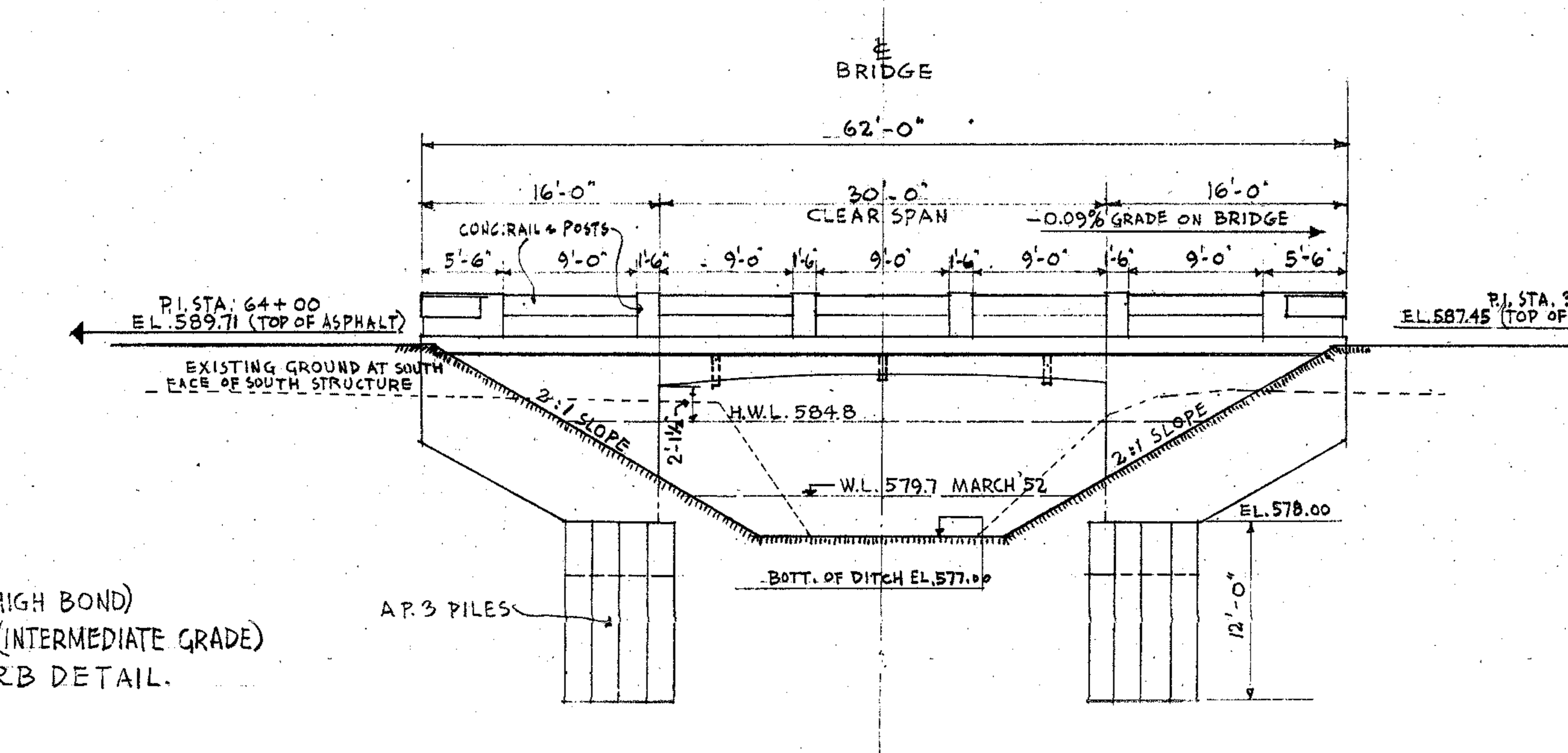
BORING DATA

THE COMPLETE SOIL INVESTIGATION REPORT BA 879 MAY BE EXAMINED AT THE BRIDGE OFFICE 280 DAVENPORT ROAD TORONTO. THE DEPARTMENT DOES NOT GUARANTEE THE ACCURACY OF THIS REPORT, OR THE ABRIDGED VERSION SHOWN ON THESE PLANS.

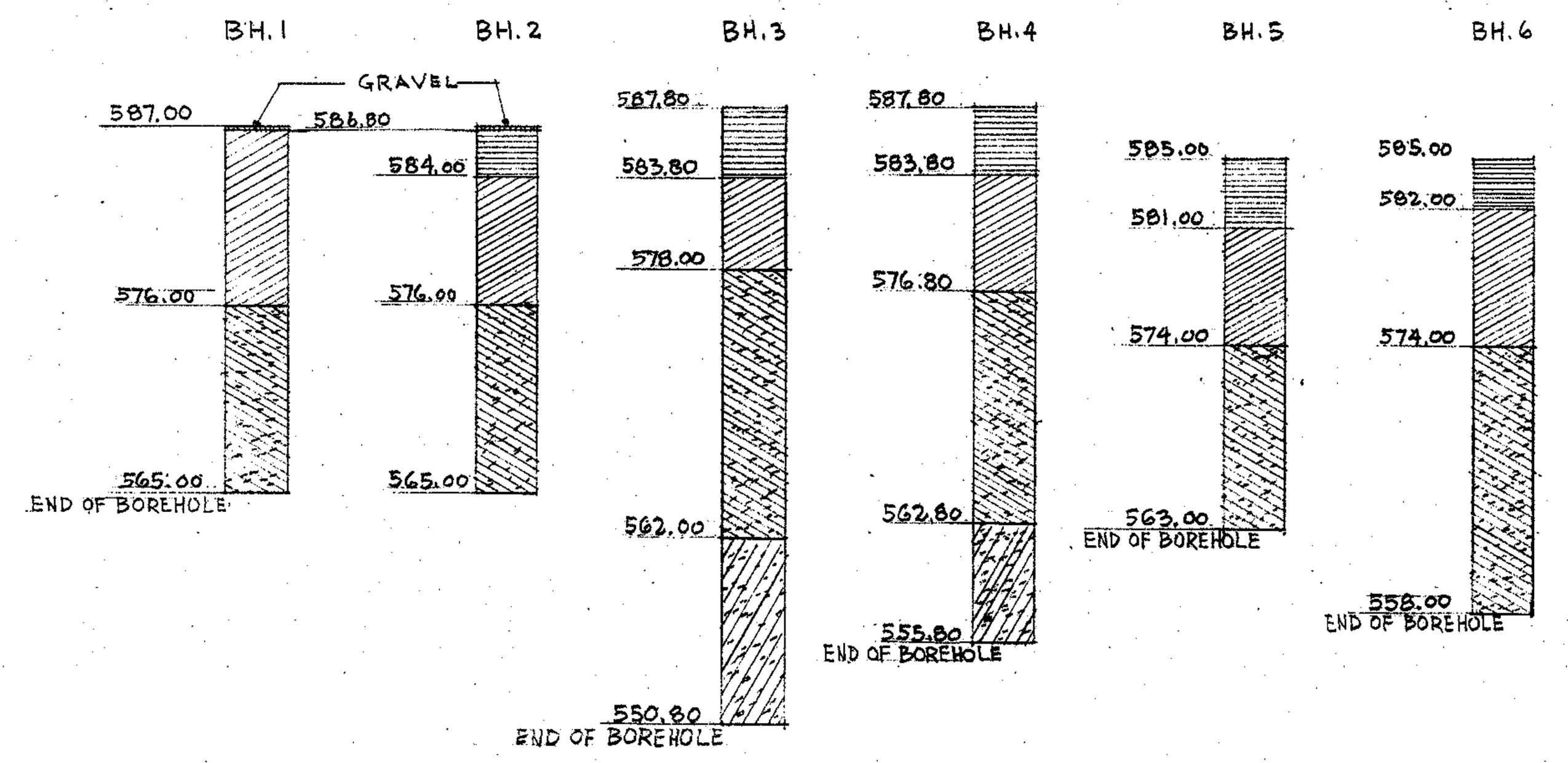
REINFORCING STEEL

CLEAR COVER IN: FOOTINGS, ABUTMENTS, 3"
DECK, 2"
ENDPOSTS, 1½"
OR AS SPECIFIED

SIN. 89°36' = 0.99998
COS. 89°36' = 0.00698
TAN. 89°36' = 143.23712



SOUTH ELEVATION OF SOUTH STRUCTURE
SCALE: 1 INCH = 10'-0"



BOREHOLE DETAILS
SCALE: 1 INCH = 10'-0"

LEGEND

- BROWN SANDY CLAY.
- STIFF BROWN SILTY CLAY.
- STIFF GREY SILTY CLAY APPROX. 8% FINE TO MEDIUM GRAVEL.
- SOFT TO MEDIUM GREY SILTY CLAY APPROX. 8% FINE TO MEDIUM GRAVEL.

LIST OF DRAWINGS

D 4368-1 GENERAL LAYOUT
D 4368-2 REINFORCEMENT DETAILS
D 4368-3 REINFORCING STEEL TABLE (HIGH BOND)
D 4368-4 REINFORCING STEEL TABLE (INTERMEDIATE GRADE)
D 4368-5 APPROACH SLABS & CURB DETAIL.

PRINT RECORD		
No.	FOR	DATE
7	Ing. 6 [illegible]	17.11.59
30	TENDER	14.6.60
10	D4 C4 F2	11.10.60
30	TENDER	28.9.61
10	D4 C4 F2	30.11.61

W.P. 9-59

DEPARTMENT OF HIGHWAYS:-ONTARIO-
BRIDGE OFFICE:-TORONTO

TILBURY EAST TWP. BRIDGE Nº 4

THE KING'S HIGHWAY No. 401 — DIST. No. 1.
CO. KENT
TWP. TILBURY EAST — LOT 3 & 4 — CON. VI.

GENERAL LAYOUT

APPROVED — BRIDGE ENGINEER — DESIGN ENGINEER
~~13-190~~ ~~D4368 1 to 5~~

DESIGN	B.E.O'M.	CHECK	G.Bt.	CONTRACT NUMBERS	APPROACH SLABS 61-207; APPR. SLAB 63-254; GENERAL 60-35
DRAWING	SIEGERT	CHECK	G.Bt.		
TRACING		CHECK		LOADING	H20 S16
DATE OCT. 1959				DRAWING NUMBER	~~D 4368-1~~

REVISIONS: DATE | BY | DESCRIPTION

REFERENCE PLANS
E. 3534-3
E. 3534-7
E. 3577-1

TWP 104-190-1-A

APPENDIX B

Site Photographs

Photograph 1: Looking northwest at the McDougall Drain Bridge EBL from south side of the bridge. The two adjacent slopes flanking the drain on the south side of the bridge were heavily vegetated. No erosion of the slope faces was observed. (October 20, 2013)

Photograph 2: Looking at the east abutment of the structure. The piling sheets driven were visible. The weep holes observed were open and wet. The exposed earth was affected by scouring. (October 20, 2013)

Photograph 3: Looking at the west abutment of the structure. The piling sheets driven were visible. The weep holes observed were open and wet. The exposed earth was affected by scouring. (October 20, 2013)

Photograph 4: Looking at the east abutment of the structure. The piling sheets driven were visible. The adjacent north slope of the abutment was vegetated and erosion of the slope face was not observed. (October 20, 2013)

Photograph 5: Looking at the west abutment of the structure. The piling sheets driven were visible. The adjacent north slope of the abutment was vegetated and erosion of the slope face was not observed. (October 20, 2013)