



Memorandum

To: G.C.E. Burkhardt (3)
Reg. Structural Planning Engineer
Central Region
3501 Dufferin St., Downsview

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention:

Date: July 17, 1975

Our File Ref.

In Reply to

JUL 21 1975

Subject:

40P1-72
GEOCRES No.

FOUNDATION INVESTIGATION REPORT

For

Proposed Retaining Walls 'A' and 'B'
on Ramps W-NS and NS-E Between
Market St. and Erie Ave.
on the B.S.A.R.
City of Brantford, Dist.#4, (Hamilton)
W.P. 40-74-06; Site 1-R

Attached we are forwarding to you our detailed Foundation Investigation Report on the subsoil conditions existing at the above mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

K.G. Selby

K.G. SELBY
Supervising Engineer

c.c. E.J. Orr
B.R. Davis
B.J. Giroux
G.A. Wrong
R.S. Pillar
D. Gunter
C.R. Robertson
R. Hore
J. Anderson)
R. Fitzgibbon) memo only
G. Sloan
Files
Record Services

*also
Note: Refer to previous
report number
W.P. 40-74-06
(formerly W.P. 70-68-18)
which is for walls in
this area as well.*

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City of Brantford, District #4, (Hamilton)
W.P. 40-74-06; Site 1-R

1. INTRODUCTION

The Soil Mechanics Section was requested by Mr. G.C.E. Burkhardt, Regional Structural Planning Engineer, Central Region, to carry out an investigation at the site of proposed retaining walls 'A' and 'B' in the vicinity of Erie Ave. and B.S.A.R. The request was submitted in a memorandum dated May 26, 1975.

Presented in this report are the results of the investigation, together with recommendations concerning foundations.

2. DESCRIPTION OF THE SITE

The site of proposed retaining wall 'A' is situated between the existing ramp W-N, S and the future ramp N-S, E., for an approximate length of 33 ft.

Wall 'B' will be located just east of the future ramp N, S-E. The length is approx. 90 ft.

The adjacent area with the exception of the already completed portion of B.S.A.R. is flat and mainly used as parking lot.

Physiographically, the site is located somewhere around the boundary of the regions known as the 'Norfolk Sand Plain' and the 'Horseshoe Moraines'. The site is a deltaic deposition of varved silts and clayey silts deposited by Lake Warren, during the recession of the Wisconsin Glacier.

3. FIELD AND LABORATORY INVESTIGATION

A total of three sampled boreholes and three dynamic cone penetration tests was carried out during the course of the field work along the toe of the existing ramp W-NS. Boring was achieved by means of a continuous flight hollow stem auger mounted on a musked vehicle. During the field work, disturbed samples were obtained by means of a split-spoon sampler; the energy used in driving it, conformed to the requirements of the Standard Penetration Test. 'Undisturbed' samples were recovered using 2-inch I.D. Shelby Tubes which were pushed into the soil hydraulically. Field vane tests were performed in cohesive soils where possible at elevations 12 inches below the various sample depths. Dynamic cone penetration tests were carried out adjacent to each borehole. Driving energy to advance the cone was 350 ft.-lbs. per blow.

The boreholes were surveyed in the field by personnel from the Central Region Engineering Surveys Office. The locations and elevations of the borings are shown on Drawing No. 407406-B which accompanies this report.

All samples were visually examined and classified at the site as well as in the laboratory. Following this inspection, laboratory tests were carried out on selected samples to determine the following physical properties:

- Natural Moisture Content
- Atterberg Limits
- Grain-Size Distribution
- Undrained Shear Strength
- Bulk Density

The test results are summarized on the Record of Borehole Sheets in the Appendix of this report.

4. SOIL TYPES AND SOIL CONDITIONS

4.1 General

Generally uniform subsoil conditions were found to prevail over the site area. The subsoil consists of a surficial deposit of

fill material, followed sand and gravel with some silt and clay, followed by irregular layers of clayey silt and silt with occasional sand layers, followed by clayey silt to silt. Dolomite type bedrock was found to underlie the overburden. The estimated stratigraphical profile is shown on Drawing No. 407406-B.

A more detailed description of the subsoil with regard to soil types and soil properties follows:

4.2 Fill Material

This material was intersected from ground level to a maximum depth of 5.5 ft. The material is basically sand but contains organic matters.

4.3 Silty Sand, Traces of Clay

Under the fill material, silty sand with traces of clay deposit was encountered. The lower boundary was found to vary between elev. 651 and elev. 653. The material consists mainly of silts and sands with traces of clay. Standard Penetration Testing gave 'N' values ranging from 3 to 8 blows per foot. The relative density may be described as very loose to loose.

4.4 Sand and Gravel, Traces of Silt and Clay

The silty sand stratum is underlain by an approx. 10 - 12 ft. thick sand and gravel with traces of silt and clay zone. Throughout the entire depth, the deposit contains some 7 - 11% (silt and clay) fines, 33 - 40% sand and 49 - 58% gravel.

The relative density of the overall stratum ranges from dense to very dense, corresponding to Standard Penetration Test 'N' values of 31 to 177 blows per foot.

4.5 Irregular Layers of Clayey Silt and Silt

Under the granular deposits, a cohesive stratum, containing irregular layers of clayey silt and silt was intersected at all boring locations. The layers are generally horizontal with

thickness ranging anywhere from 1/8" to 3/4" or more. Occasional sand layers were also discovered. The thickness of the stratum is some 30 - 34 ft., extending to elev. 608 - 612. The average liquid and plastic limit of the clayey silt layers are 28% and 16%, while for the silt layers the corresponding figures are 21% and 15%. The average natural moisture of the overall deposit is about 20%. The bulk density ranges from 126 to 138 p.c.f. Limited number of in-situ vane test and laboratory unconfined compression test indicate a stiff to very stiff consistency, averaging about 1900 p.s.f.

4.6 Clayey Silt to Silt

This deposit was encountered below the irregularly layered cohesive deposit and extends to the bedrock. (elev. 598 - 601) Standard Penetration Test 'N' values ranged from 64 to over 100 blows per foot. The consistency is estimated to be hard.

4.7 Bedrock

Dolomite type bedrock of the Lockport Formation was proved in Boreholes #245 and 247. The bedrock surface varies between elev. 598 and elev. 601. Core recoveries were in excess of 95%. Examination of the recovered rock cores indicates that the bedrock is basically sound throughout.

5. GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #245	Elev. 639.1
B.H. #246	Elev. 644.3
B.H. #247	Elev. 647.2

No artesian conditions were encountered.

6. DISCUSSION AND RECOMMENDATIONS

6.1 General

It is proposed to construct retaining walls 'A' and 'B' east and west of the future ramp N, S-E. The location of these walls are shown on Drawing No. 407406-B.

6.2 Retaining Wall 'A'

This wall is located between the existing ramp W-N, S and future ramp N, S-E. The finished grade of ramp W-N, S varies from elev. 661 at Sta. 7+45 to elev. 675 at Sta. 4+25. The finished grade of ramp N, S-E will be about 2 - 3 ft. below the grade of ramp W-N, S. The entire length of wall 'A' foundation will be located within the existing embankment.

The following construction procedures are recommended for the wall foundation:

- a) Excavate trench for the footing, approx. 3 ft. wider on each side than the actual footing width.
- b) The depth of the trench should extend at least 2 ft. below the frost protection requirements (which is 4 ft. in this area).
- c) Backfill trench with well compacted Granular 'A' material up to 4 ft. below the finished ground surface.
- d) Place footing on Granular 'A' material and construct wall.
- e) The backfill to the wall should be in accordance with Standard SD-4-58.

Some form of roadway protection will be required for the existing ramp during construction.

For footings placed on compacted Granular 'A' overlying existing fill material a safe design load of 2.0 t.s.f. may be assumed for design purposes.

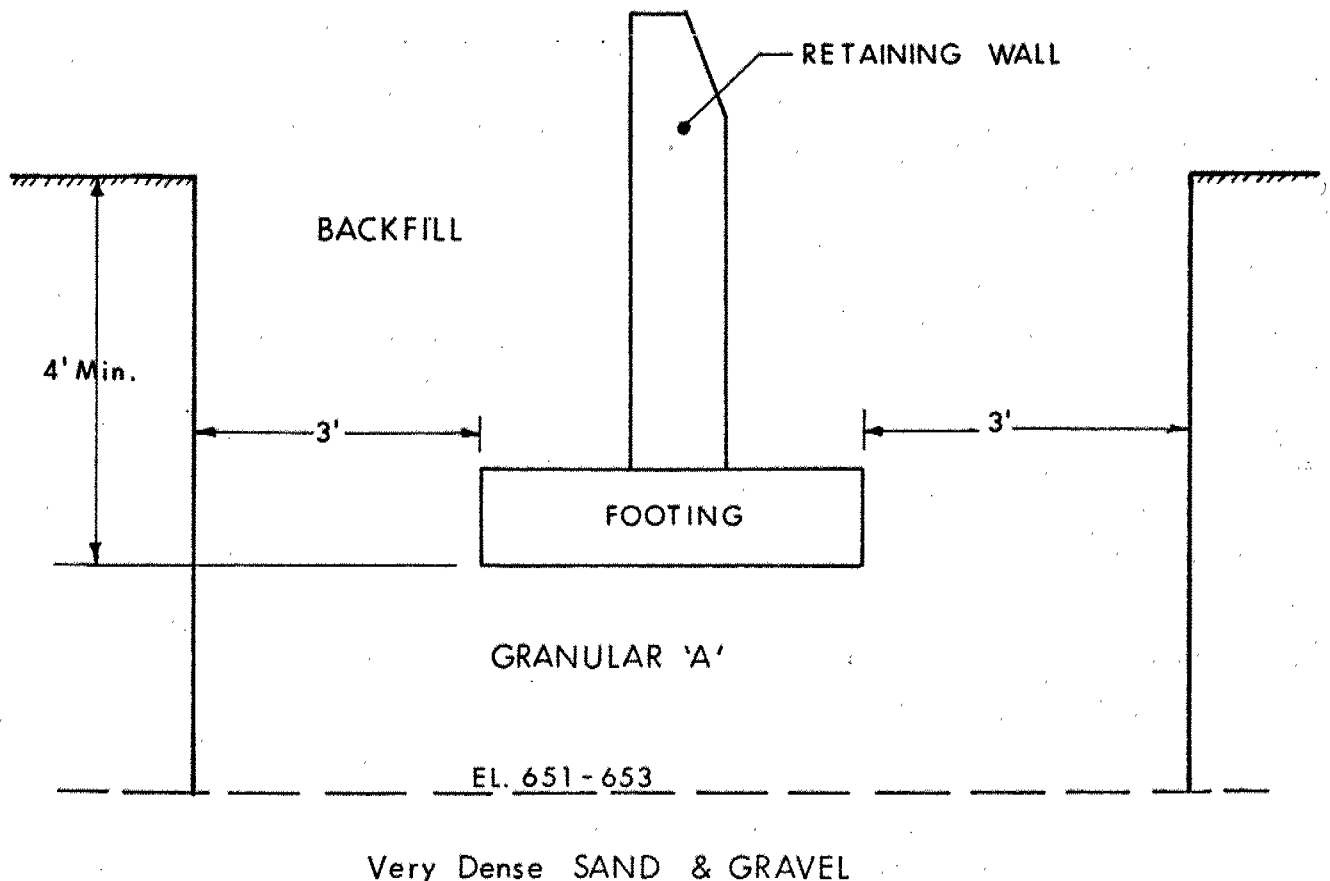
For computation of sliding resistance for the retaining wall founded on spread footings a friction coefficient of 0.55 may be assumed to apply between bases of footings and the underlying compacted granular fill.

6.3 Retaining Wall 'B' #2

An approx. 90 ft. long and 8 - 9 ft. high (above existing ground) retaining wall is proposed east of the future ramp N, S-E.

The subsoil at this location consists of up to 5.5 ft. thick fill material, followed by loose, silty sand at the south side of the proposed wall. A very dense, approx. 12 ft. thick sand and gravel zone was encountered between elev. 651 and elev. 653.

In view of the subsoil conditions, it is recommended that the fill material and the loose silty sand be replaced with Granular 'A' material as indicated below;



A safe design load of 2.5 t.s.f. may be assumed for design purposes.

A value of 0.55 (coefficient of friction) may be used in computation of the sliding resistance.

The backfilling of the retaining wall should comply with MTC Standard No. SD-4-58. No dewatering problems are anticipated.

6.4 Embankment

The proposed embankment should consist of well compacted acceptable material. Outside the retaining wall area 2:1 slopes are recommended.

The new fill should be keyed into the existing embankment.

Any soft or organic surficial material should be removed according to current MTC Standards.

7. MISCELLANEOUS

The field work was carried out during the period of June 2 - 6, 1975, under the supervision of Mr. G.R. Bardell, Project Engineer,

Equipment used was owned and operated by Atcost Soil Drilling Inc.

This report was written by Mr. P. Payer, Senior Engineer and reviewed by Mr. K.G. Selby, Supervising Engineer.

P. Payer
P. PAYER
Senior Engineer

K. G. Selby
K.G. SELBY
Supervising Engineer



July 1975

APPENDIX

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 245

W.P. 40-74-06 LOCATION Co-ords. 15,672,639 N; 796,920 E. ORIGINATED BY GB
 DIST. 4 HWY. B.S.A.R. BORING DATE June 2, 1975 COMPILED BY GB
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Hollow Stem Auger CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
658.8	Ground Level															
0.0	Fill material with organics.		1	SS	5											
653.3			2	SS	31											
5.5	Sand and gravel, trace of silt & clay.		3	SS	63											
	Dense to Very Dense		4	SS	128											
640.9			5	SS	54											
17.9	Irregular layers of clayey silt and silt, occasional sand layers		6	SS	8											
			7	TW	PH											
			8	SS	13											
	Stiff to Very Stiff		9	SS	23											
			10	SS	25											
			11	SS	11											
			12	TW	PH											
610.3																
48.5	Clayey silt to silt		13	SS	64											
	Hard		14	SS	101											
601.0																
57.8	Dolomite Bedrock		15	RC												
596.0	Sound			BX	100%											
62.8	End of Borehole															

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 246

W.P. 40-74-06

LOCATION Co-ords. 15,672,551 N; 796,991 E.

ORIGINATED BY GB

DIST. 4 HWY. B.S.A.R.

BORING DATE June 6, 1975

COMPILED BY GB

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Hollow Stem Auger

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N ^o VALUES		20	40	60	80	100	w_p	w	w_L		
659.5	Ground Level															
0.0	Fill material with organics															
656.9																
2.6	Silty sand, traces of clay.		1	SS	5											
			2	SS	8											
651.0	Loose		3	SS	44											
8.5	Sand and gravel, traces of silt & clay					650										0 84 (16)
	Very Dense		4	SS	177											49 40 (11)
641.6			5	SS	8											
17.9	Irregular layers of clayey silt and silt occ. sand layers.					640										
	Stiff to Very Stiff		6	SS	17											
						630										
			7	TW	PH											
			8	SS	42											
612.0						620										
47.5	Clayey silt to silt.					610										
	Hard		9	SS	166											
599.7						600										
59.8	Probable Bedrock End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 247

W.P. 40-74-06 LOCATION Co-ords. 15,672,432 N; 797,029 E. ORIGINATED BY GB
 DIST. 4 HWY. B.S.A.R. BORING DATE June 4, 1975 COMPILED BY GB
 DATUM Geodetic BOREHOLE TYPE Cont. Flight Hollow Stem Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
659.4	Ground Level															
0.0	Fill material with organics															
656.4			1	SS	7											1 44 (55)
3.0	Silty sand		2	SS	3											
652.4	Very Loose		3	SS	64											57 33 (10)
7.0	Sand and gravel, trace of silt & clay.		4	SS	128											
	Very Dense															
641.4			5	SS	13											
18.0	Irregular layers of clayey silt & silt		6	TW	PH											
	occ. layers of sand.		7	SS	16											
	Stiff to Very Stiff		8	TW	PH											
607.6			9	SS	218											
51.8	Clayey silt to silt		10	RC	98%											
	Hard															
598.6																
60.8	Dolomite Bedrock															
594.6	Sound															
64.8	End of Borehole															

OFFICE REPORT OF SOIL EXPLORATION

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" " ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTSOIL PROPERTIES

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

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

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

EARTH PRESSURE

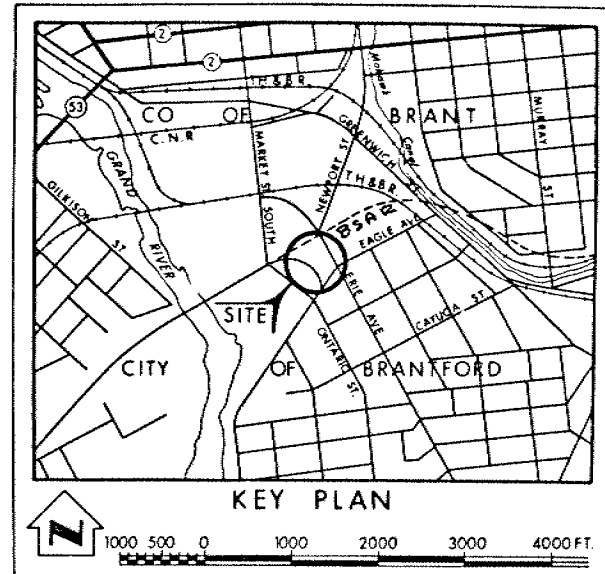
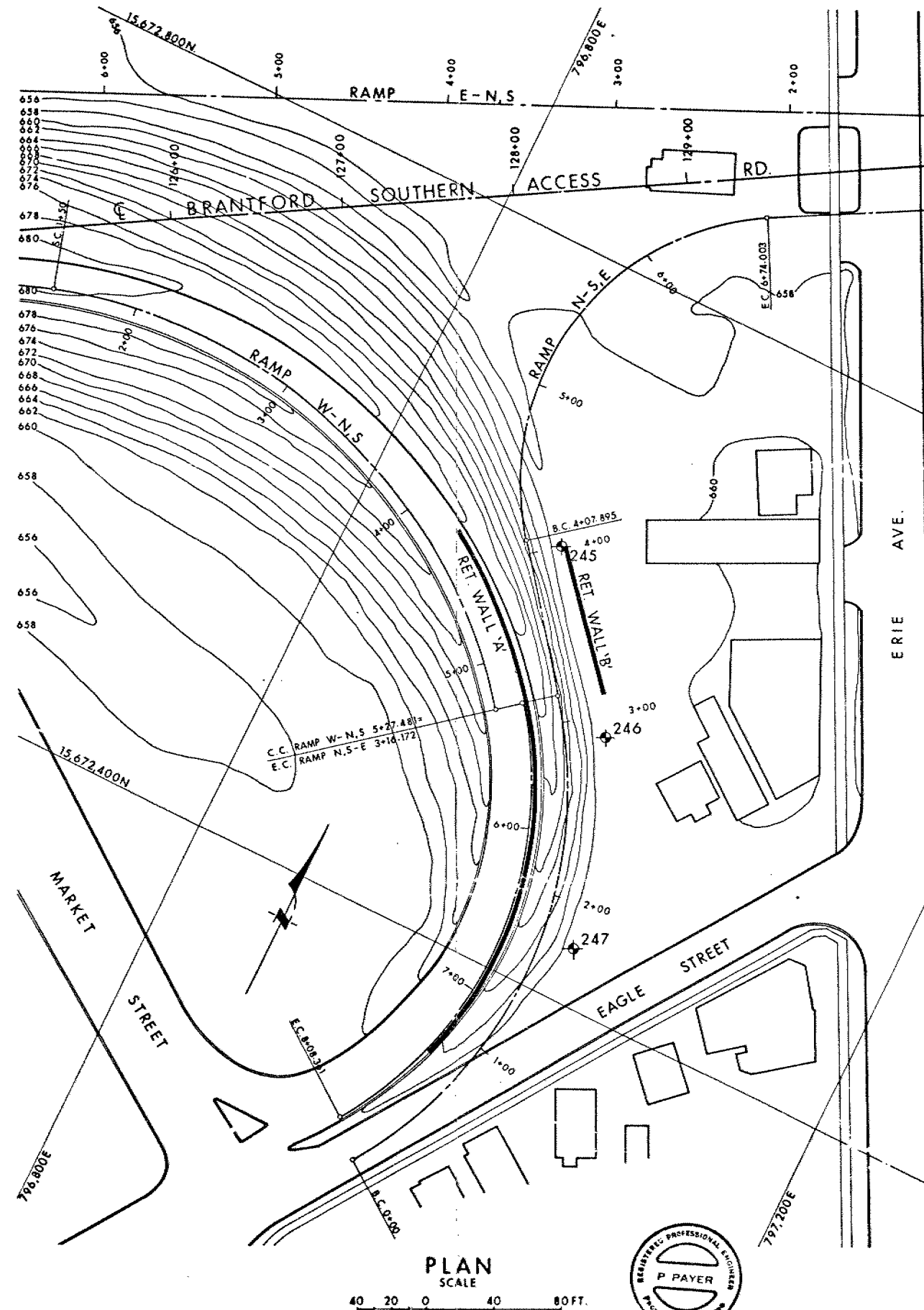
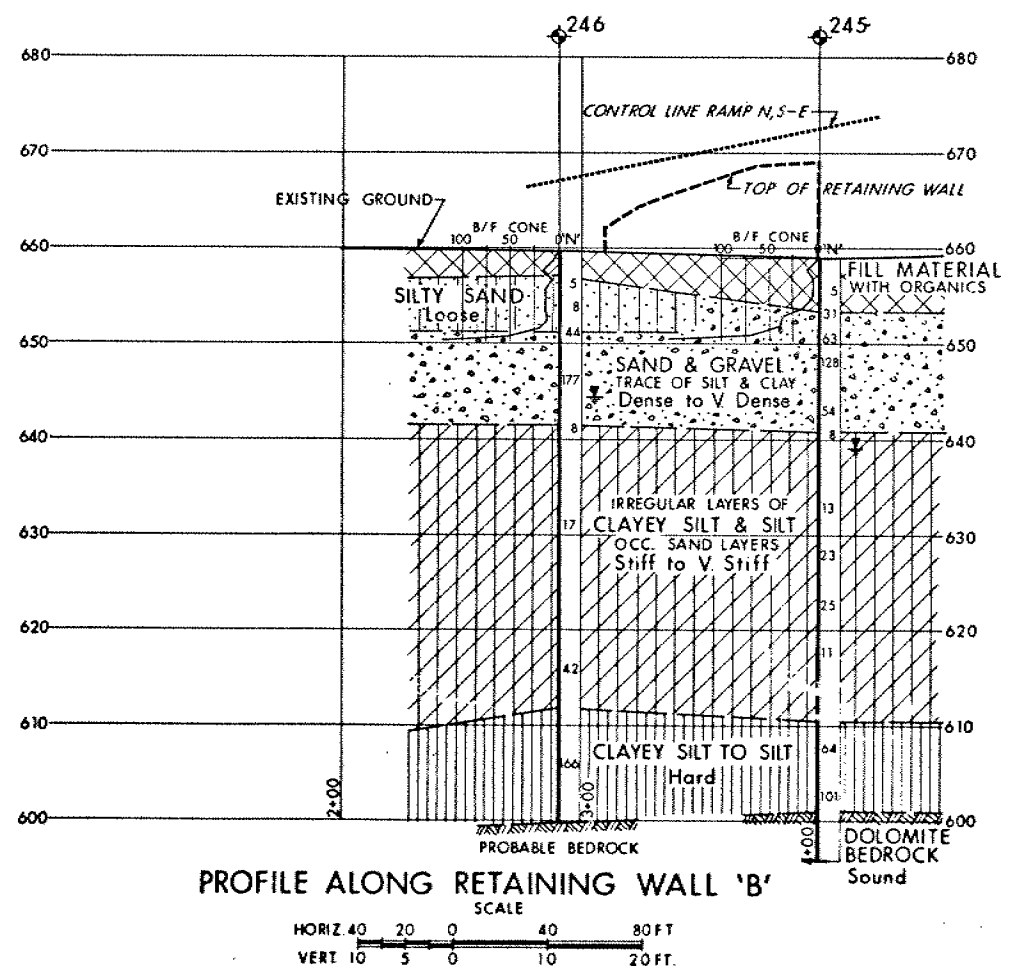
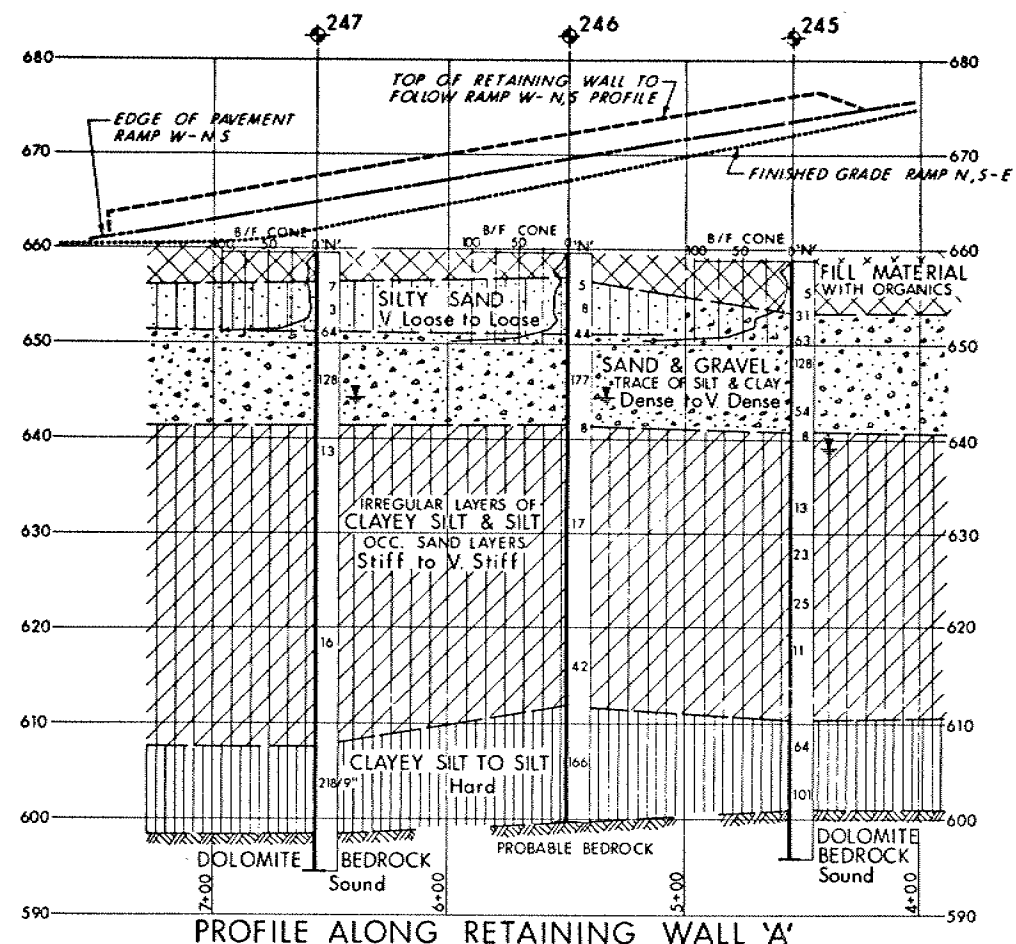
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

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

SLOPES

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



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Resistance Test
B/F CONE - Blows/Ft. Cone Test (350 ft. lbs. energy/blow)
- ⊕ Bore Hole & Cone Test
- ⊕ Water Levels established at time of field investigation, June 1975

NO.	ELEVATION	CO-ORDINATES NORTH	EAST
245	658.8	15,672,639	796,920
246	659.5	15,672,551	796,991
247	659.4	15,672,432	797,029

NOTE: FOR CONTRACT DOCUMENT
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HAMILTON District Office.

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

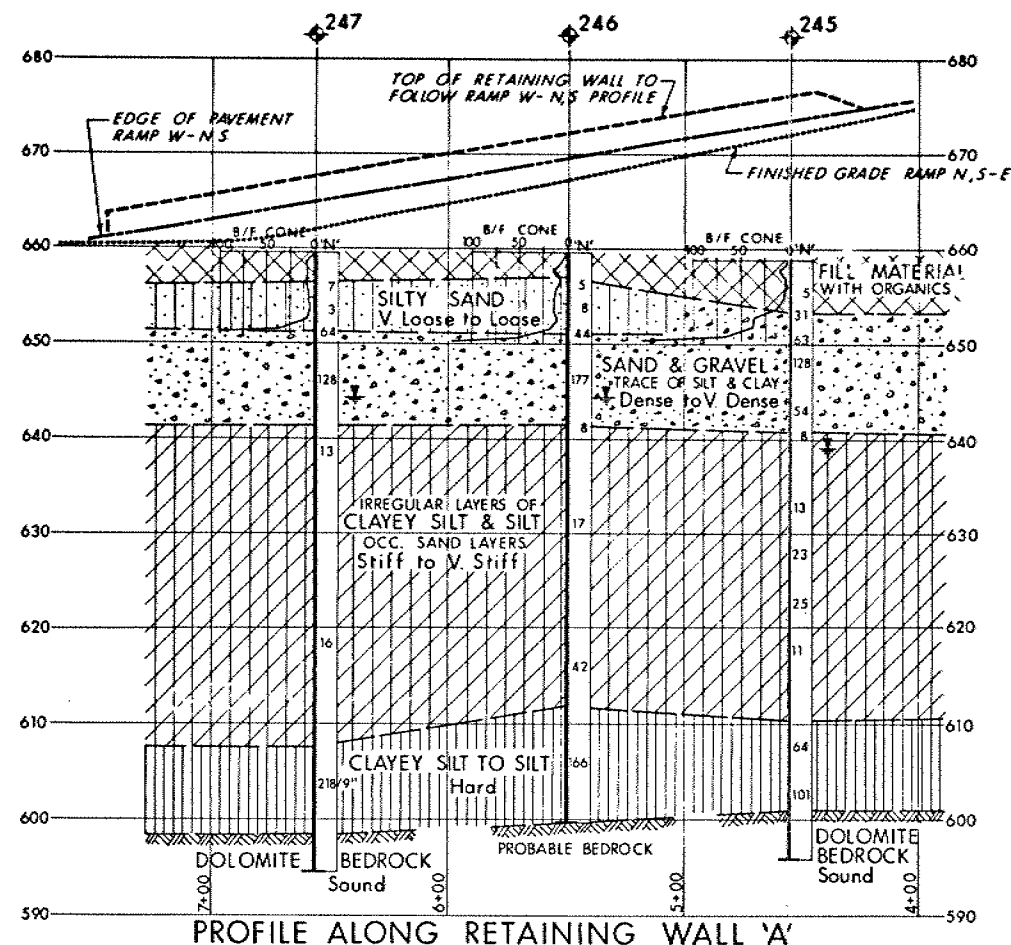
PROPOSED RETAINING WALLS 'A' & 'B'

HIGHWAY NO. Brantford Southern Access Road DIST NO. 4
CO. BRANT City of BRANTFORD
TWP. LOT. CON.

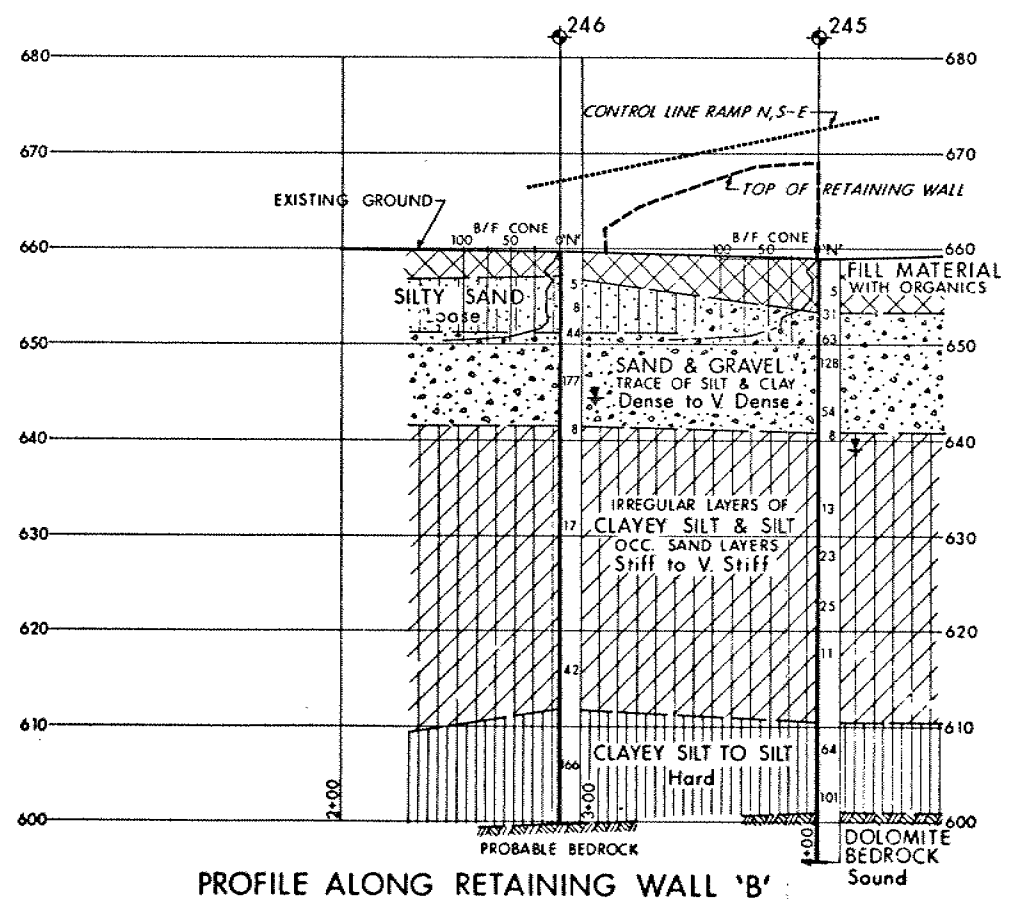
BORE HOLE LOCATIONS & SOIL STRATA

SUBMIT P.P.	CHECKED	WP NO. 40-74-06	DRAWING NO.
DRAWN	CHECKED	W.O. NO.	407406-B
DATE July 16, 1975	SITE NO. 1-R.W.	BRIDGE DRAWING NO.	
APPROVED	CONT NO.		

REF. NO. DILLON CONS. ENG.'S
7301-16-1 BSAR GEOM 75-2, May 6, 1975

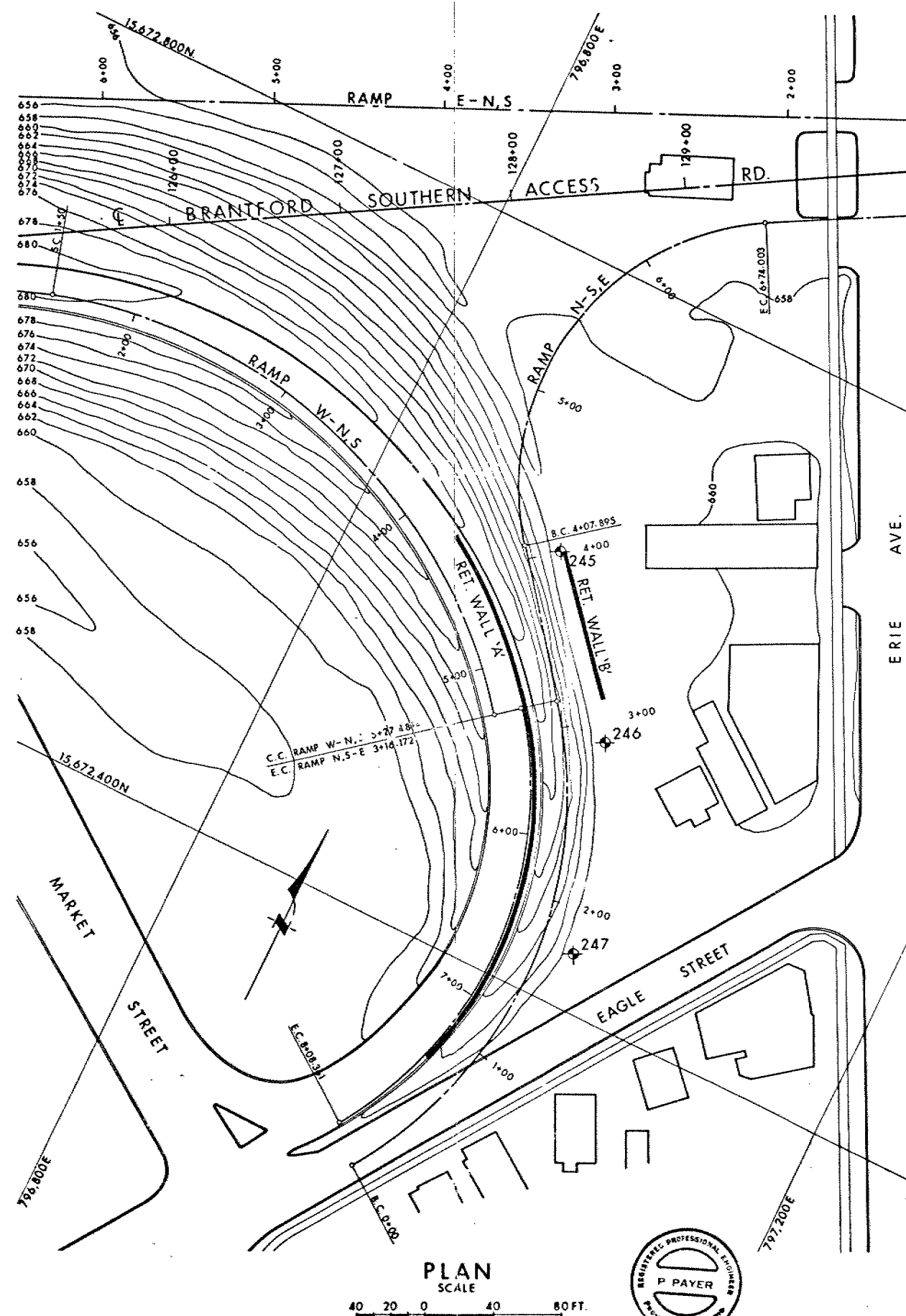


PROFILE ALONG RETAINING WALL 'A'



PROFILE ALONG RETAINING WALL 'B'

HORIZ. 40 20 0 40 80 FT.
VERT. 10 5 0 10 20 FT.

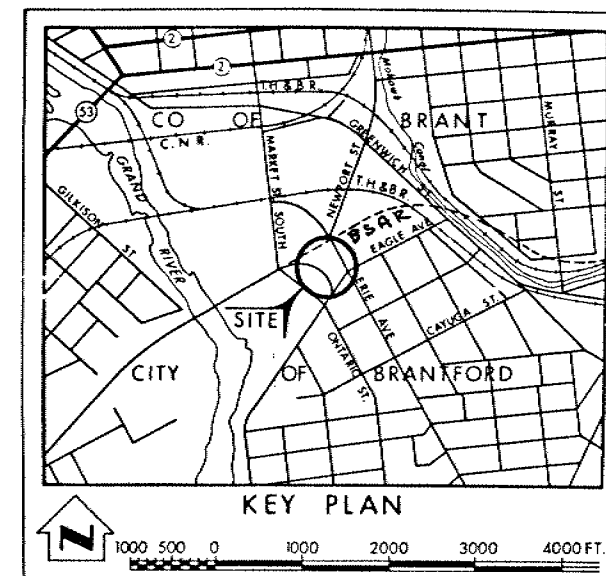


PLAN

SCALE 40 20 0 40 80 FT.



REF. NO. DILLON CONS. ENG'S
7301-16-1 BSAR GEOM. 75-2, May 6, 1975



LEGEND

- Bore Hole
- Dynamic Cone Penetration Resistance Test
B/F CONE - Blows/Ft. Cone Test (350 ft. lbs. energy/blow)
- Bore Hole & Cone Test
- Water Levels established at time of field investigation, June 1975

NO.	ELEVATION	CO-ORDINATES NORTH	EAST
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247	659.4	15,672,432	797,029

NOTE: FOR CONTRACT DOCUMENT
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HAMILTON District Office.

NOTE

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

DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

PROPOSED RETAINING WALLS 'A' & 'B'

HIGHWAY NO. Brantford Southern Access Road DIST. NO. 4
CO. BRANT City of BRANTFORD
TWP. LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMIT P.P.	CHECKED	W.P. NO. 40-74-06	DRAWING NO.
DRAWN	CHECKED	A.C. NO.	407406-B
DATE July 16, 1975	SITE NO. 1-R-W	BRIDGE DRAWING NO.	
APPROVED	CONF. NO.		

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. A. P. Watt, (2)
Regional Structural Planning Eng.,
Southwestern Region,
London, Ontario.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION: DATE: August 16, 1972.

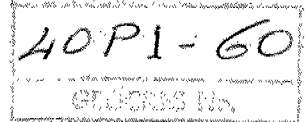
OUR FILE REF.

IN REPLY TO

AUG 18 1972

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Retaining Walls #4 and #5
At the Erie St. Overpass of Brantford
Expressway #2, District #4, Hamilton
W.O. 72-11081 --- ~~W.P. 70-68-18~~



NEW WP: 40-74-06 (PP)

MAR 10/75

Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

AGS/ao
Attch.


A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

cc: Messrs. D. W. Farren
B. R. Davis
A. Rutka
A. McConnell
C. R. Robertson
B. J. Giroux
G. A. Wrong
B. A. Singh
J. R. Roy
Foundations Files ✓
Documents

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-

FOUNDATION INVESTIGATION REPORT
For
Proposed Retaining Walls #4 and #5
At the Erie St. Overpass of Brantford
Expressway #2, District #4, Hamilton
W.O. 72-11081 -- W.P. 70-68-18

1. INTRODUCTION:

The Foundations Office was requested by Mr. A. P. Watt, Regional Structural Planning Engineer, Southwestern Region, to carry out an investigation at the site of proposed retaining Walls #4 and 5, north of the proposed Erie St. overpass of Brantford Expressway #2. The request was submitted in a memo dated June 28, 1972.

The subsequent field and laboratory investigations were implemented under the supervision of this Office. The boreholes were located in the field and surveyed by personnel of the Engineering Survey Office, Southwestern Region.

Presented in this report are the results of the investigations, together with recommendations concerning foundations.

2. DESCRIPTION OF THE SITE:

The site of proposed retaining Wall #4 is situated near the north property line of a drive-in restaurant (Kentucky Fried Chicken). The area is asphalt paved, and at the present time, it is used as a parking lot. Wall #5 will be located just north of the Brewers Retail Store, where the site is occupied by a sunken alley, used for loading and unloading. The ground level of the alley is about 8 ft. lower than the pavement of Erie St.

Geologically the area lies somewhere around the boundary of the physiographic regions known as the "Norfolk Sand Plain" and the "Horseshoe Moraines." The beds of silt and sand are considered to be deltaic in glacial lakes Whittlesey and Warren. The varved silts and clayey silts were also deposited by Lake Warren, during a recession of the Wisconsin glacier.

3. FIELD AND LABORATORY INVESTIGATIONS:

Some six boreholes and six dynamic cone penetration tests were implemented during the field work. Boreholes #1, 2 and 3 were placed at the location of proposed Wall #4 and Holes #4, 5 and 6 at Wall #5. A continuous hollow stem flight auger was used for the drilling, taking samples at regular intervals. Granular deposits were tested by means of split spoon samplers, which were advanced by a 140 lbs. hammer falling 30 inches. The number of hammer blows necessary to advance the split spoons 1 ft. into the soils, were marked as Standard Penetration N values. In the cohesive deposits thin walled Shelby tube samples were taken. The sampler was pushed into the undisturbed soil by means of the hydraulic head of the auger. Undrained shear strengths of the cohesive materials were measured by field vane tests, according to conventional methods. All the samples were subjected to visual examinations and classifications. Laboratory tests were performed on representative samples in order to determine natural moisture contents, Atterberg limits and grain size distributions. Further tests of unconfined compressions were carried out on "undisturbed" samples and the undrained shear strengths calculated.

Field and laboratory test results are compiled on the accompanying office borelogs. The locations and elevations of the boreholes as well as the estimated soil stratigraphy are shown on Drawing #72-11081 A in the Appendix.

4. SOIL CONDITIONS:

4.1) General:

The surficial deposit was found to be cinder and sand fill along both retaining walls, containing some organic matters, wood, etc. Underlying the fill a granular layer of sand and sandy gravel was noted, which in turn was followed by irregular seams and layers of clayey silt and silt. Bedrock was proven in two locations.

A brief description of the various deposits is given below.

4.2) Cinder and Sand Mixture (Fill):

Under the asphalt pavement along proposed Wall #4 the fill was found to be some 10 - 11 ft. deep, extending to elevation 646 ft. - 647 ft. Under Wall #5 the bottom of the fill was around elevation 641.8 ft. - 642.7 ft. The engineering quality of the fill is varied, portions of it containing a fair amount of acceptable sands; portions, however, being almost entirely cinder and other organic substances. Standard penetration tests, carried out within this material confirmed the non-uniform nature of the fill. 'N' values were measured to be between 3 blows/ft. and 47 blows/ft. indicating relative densities of very loose to dense. Occasionally the fill contains seams of fine grained material, mainly silts. A typical grain size analysis of the silts resulted in 0% gravel, 21% sand, 74% silt and 5% clay particles.

4.3) Sandy Gravel to Sand with Traces of Silt:

The fill is underlain by sands and sandy gravels with traces of silt. This granular deposit was found to be some 8 - 15 ft. thick under proposed Wall #4 and only 5 ft. thick under Wall #5. The relative density of the sands and gravels is considered to be dense to very dense. Since this layer lies partially under the ground water level, some loosening and boiling of the soils were noted on account of the unbalanced hydrostatic head. Throughout the entire depth, the stratum contains

some 5 - 11% fines, mainly belonging to the silt range. The rest of the particles were identified to be sands and gravels.

4.4) Irregular Seams of Clayey Silt and Silt:

Under the granular soils, cohesive deposits, identified to be irregular seams of clayey silts and silts were recorded in every borehole. The thickness of the stratum is some 27 - 36 ft. extending to geodetic elevation 600 - 605 ft. This cohesive deposit has stiff to very stiff consistency, corresponding to penetration 'N' values of 9 blows/ft. up to 25 blows/ft. Laboratory unconfined compression tests resulted in undrained shear strengths averaging 1500 p.s.f. The stratification of the stratum is near horizontal with irregular brown and grey colour seams of 1/8" - 1" thickness. The average plastic limit of the silt and clayey silt seams is estimated to be 20%, the liquid limits of the silt seams being 22% - 23% and the clayey silts approximately 30%. The natural moisture contents of the samples are near, or in some occasions above the liquid limits. The bulk density of the deposit is 123 - 125 p.c.f.

4.5) Bedrock:

Bedrock was proven by diamond drilling in B.H.'s #2 and 6. The surface of the rock was established at elevation 604.6 ft. in the location of B.H. #2 and at elevation 600.5 ft. in B.H. #6. The rock surface is believed to have a very slight dip towards east. Some 4 - 5 ft. thickness of the rock was drilled, resulting in good recoveries of 95 - 100%. The cores were identified to be dolomites of the Lockport formations.

4.6) Groundwater Conditions:

Groundwater levels were registered in the boreholes to lie within the granular aquifer, between elevation 642 ft. and 646 ft. There is a hydrostatic gradient towards east. No water level observations were carried out in B.H.'s #1 and 3, since these holes caved in upon withdrawal of the auger.

5. DISCUSSION AND RECOMMENDATIONS:

5.1) General:

Proposed Brantford Expressway #2 will cross Erie St. with an overpass structure. The north slopes of the approach embankments are designed to be laterally supported by two bin type retaining walls of various heights. Wall #4 at the west approach will be some 195 ft. long; Wall #5, retaining the east approach fill being some 295 ft.

Under the cinder and sand fill, some sand and gravel deposit, followed by seams of silt and clayey silt form the overburden. Dolomite bedrock was encountered around elevation 600 ft. - 604 ft.

5.2) Foundations:

Since the mixed surficial fill has very dubious engineering values, it should be replaced by well compacted GBC-A material, under the proposed crib walls.

For estimating purposes it may be assumed that the excavation should extend down to approximate elevation 646 ft. - 647 ft. under proposed Wall #4 and to elevation 642 ft. - 643 ft. under Wall #5. It is believed that excavations extending below the above elevations will encounter groundwater, which in turn will induce quick conditions at the excavation basis. Deeper excavations than the suggested ones, therefore, should not be carried out. The bottom of the excavations should be some 6 ft. wider than the width of the wall. Side slopes should be formed with 1 horizontal to 1 vertical. The GBC-A should be compacted to 100% Proctor density. The excavations should be refilled up to some 2 ft. below original ground surface, and then re-excavated for the walls. The bottom of the cribs should be placed directly on the GBC-A fill, some 4 ft. below finished ground level.

The recommended step by step construction of the wall foundations is shown on Figure #1 at the end of this report.

If above procedure is adhered to, then no stability problems or excess settlements are envisaged.

6. MISCELLANEOUS:

The field work was carried out during July 7 - 16, 1972, under the supervision of Mr. P. Martin, Engineering Student.

The equipment used was owned and operated by P.V.K. Drilling Company, Burford, Ontario.

This report was written by Mr. A. K. Barsvary, Senior Foundations Engineer.

A. K. Barsvary

AKB/ao

A. K. Barsvary, P. Eng.

August 14, 1972.



APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1

JOB 72-11081

LOCATION Co-ord's 15,672,847 N. 796,748 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 7, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger.

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					PLASTIC LIMIT — w_p				
							20 40 60 80 100					WATER CONTENT — w				
							SHEAR STRENGTH P.S.F.					w_p — w — w_L				
						○ UNCONFINED + FIELD VANE					WATER CONTENT %			γ		
						● QUICK TRIAXIAL × LAB VANE								P.C.F.	GR.SA.SI.CL.	
						1000 2000					10 20 30					
656.8	Ground level.															
0.0	Black cinder, sand and silt mixture. Fill.		1	SS	8										W.L. hole caved in July 10/72	
	Loose.		2	SS	5		650									0 21 74 5
646.8			3	SS	9											0 95 (5)
10.0	Poorly graded sandy gravel, traces of silt.		4	SS	12											53 38 (9)
	Loose to dense.		5	SS	51											
			6	SS	22											
			7	SS	7											
			8	SS	24											
631.3																
25.5	Irregular seams of clayey silt & silt.	9	SS	20												
	Stiff to very stiff.	10	SS	20												
	Grey and brown.	11	SS	16												
		12	TW	PM										128	0 3 87 10	
		13	TW	PH										127		
		14	SS	18												
604.3	End of borehole.															
52.5	Probable bedrock.															

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2

JOB 72-11081

LOCATION Co-ord's 15,672,893 N. 796,838 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 10, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger & AXT Rock Core.

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT W_L PLASTIC LIMIT W_p WATER CONTENT W		BULK DENSITY γ P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.						WATER CONTENT %	
657.6	Ground level.													
0.0	Black cinder, sand & silt fill. Compact to dense.		1	SS	13									
			2	SS	47									
			3	SS	16									
646.4			4	SS	10									
11.2	Sand to sandy gravel Traces of silt. Compact to very dense		5	SS	15							3 88 (9)		
			6	SS	20							57 37 (6)		
			7	SS	62									
635.6			8	SS	9									
22.0	Irregular seams of clayey silt & silt. Stiff. Grey and brown.		9	TW	PM							123		
			10	SS	13							1 4 66 29		
			11	TW	PM							125		
			12	SS	12									
			13	TW	PM							124.5		
604.6														
53.0	Dolomite bedrock.		14	AXT RC	Rec. 95%									
599.0														
58.6	End of borehole.													

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 3

JOB 72-11081

LOCATION Co-ord's 15,672,933 N. 796,918 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 11, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger.

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L		
657.9	Ground level.															
0.0	Black cinder and sand mixture.		1	SS	12											W.L. hole caved in July 11/72 0 89 (11) 122 123 0 4 86 10
	Fill.		2	SS	24											
	Compact.		3	SS	25	650										
647.0			4	SS	8											
10.9	Sand, traces of silt.		5	SS	9											
	Loose to compact.		6	SS	5											
639.1			7	SS	12	640										
18.8	Irregular seams of clayey silt & silt.		8	TW	PM											
	Stiff to very stiff.		9	SS	11	630										
	Grey and brown.		10	TW	PM											
			11	SS	10	620										
			12	SS	13											
			13	SS	25	610										
605.1			14	SS												
52.8	End of borehole. Probable bedrock.						End of cone El. 605.1									

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE № 4

JOB 72-11081

LOCATION Co-ord's 15,672,973 N. 797,030 E.

ORIGINATED BY P.M.

W.P. 70-68-18

BORING DATE July 12, 1972

COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT w_L	BULK DENSITY	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT	PLASTIC LIMIT w_p			
							20 40 60 80 100	WATER CONTENT w			
							SHEAR STRENGTH P.S.F.	$w_p \quad w \quad w_L$			
							○ UNCONFINED + FIELD VANE	WATER CONTENT %			
							● QUICK TRIAXIAL x LAB VANE	10 20 30			
							1000 2000				
658.7	Ground level.										
0.0	Black cinder, sand & silt mixture.		1	SS	10						
	Fill.		2	SS	6						
	Loose to compact.		3	SS	14						
			4	SS	13						
			5	SS	5						
642.7	Sandy gravel, traces of silt.		6	SS	15					0 74 25 1	
16.0			7	SS	37					60 33 (7)	
637.9			8	SS	10						
20.8			9	SS	11						
	Irregular seams of clayey silt & silt.		10	TW	PM.					124	
	Stiff.		11	SS	14						
	Grey and brown.		12	TW	PM					125	
			13	SS	14					0 0 86 14	
			14	SS	12						
			15	SS	13						
603.2						100/11'					
55.5	End of borehole. Probable bedrock.						End of cone EL. 603.2				

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 5

JOB 72-11081

LOCATION Co-ord's 15,673,016 N. 797,159 E.

ORIGINATED BY PM.

W.P. 70-68-18

BORING DATE July 14, 1972

COMPILED BY P.M.DATUM GeodeticBOREHOLE TYPE Hollow Stem Auger.CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT <u>W_L</u> PLASTIC LIMIT <u>W_p</u> WATER CONTENT <u>W</u>			BULK DENSITY <u>γ</u> P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	W _p	W	W _L		
650.0	Ground level.															
0.0	Black cinder & sand mixture. Fill. Loose to very loose.		1	SS	8											
642.5			2	SS	3											
7.5	Sandy gravel traces of silt. Very dense. to compact.		3	SS	54											
636.5			4	SS	41											
13.5			5	SS	15											
	Clayey silt, seams and small pockets of sand. Very stiff. Greyish brown.		6	SS	15											
			7	TW	PM											
			8	SS	19											
			9	TW	PH											
			10	SS	16											
			11	TW	PM											
			12	SS	16											
603.0																
47.0	End of borehole. Probable bedrock.															

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 6

JOB 72-11081

LOCATION Co-ord's 15,673,063 N. 797,287 E.

ORIGINATED BY P.M.


W.P. 70-68-18

BORING DATE July 13, 1972

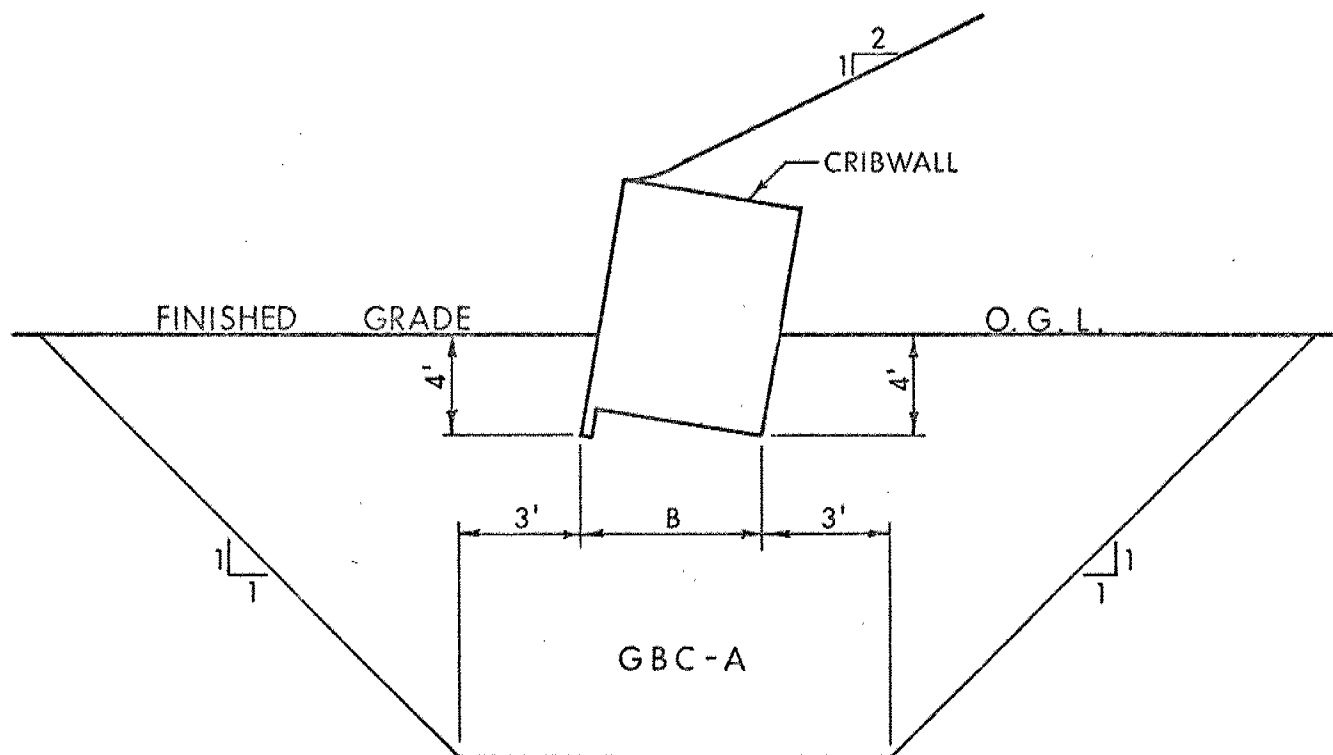
COMPILED BY P.M.

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger & AXT Rock Core.

CHECKED BY 

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w		BULK DENSITY γ P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.						WATER CONTENT %	
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
							1000 2000							
							w_p ——— w ——— w_L		10 20 30					
649.9	Ground level.													
0.0	Slightly org. sand some cinder. Fill. Loose.		1	SS	10									
			2	SS	7									
641.8			3	SS	31									
8.1	Gravelly sand.		4	SS	58									
636.6	Dense to very dense.		5	SS	7									
13.3	Irregular seams of clayey silt & silt.		6	SS	10									
	Stiff.		7	TW	PM									
	Grey and brown.		8	SS	9									
			9	TW	PM									
			10	SS	9									
			11	TW	PM									
			12	SS	14									
600.5	Boulders		13	SS	--									
49.4	Dolomite bedrock.		14	RC										
596.4			15	RC	Rec. 100%									
53.5	End of borehole.													



NOTES:

1. Excavate fill to approximate el. 646-647 under wall N^o 4 and el. 642-643 under wall N^o 5 as shown.
2. Refill hole up to 2' below original ground surface with well compacted GBC-A material.
3. Re-excavate for cribwall footings.

JOB NO. 72-11081

FIG. NO. 1

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

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

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

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

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

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

EARTH PRESSURE

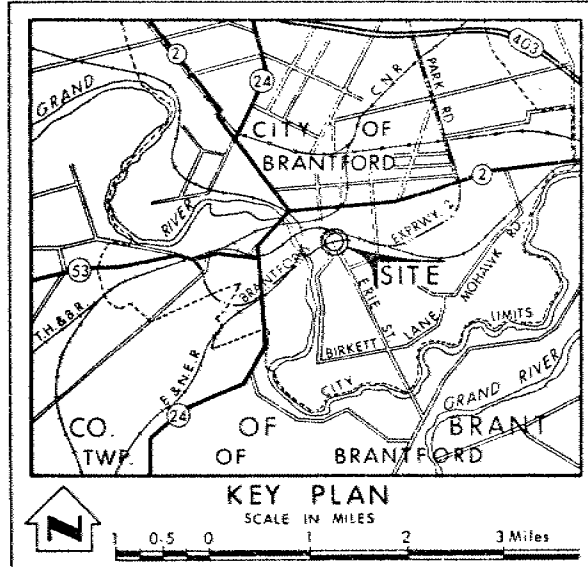
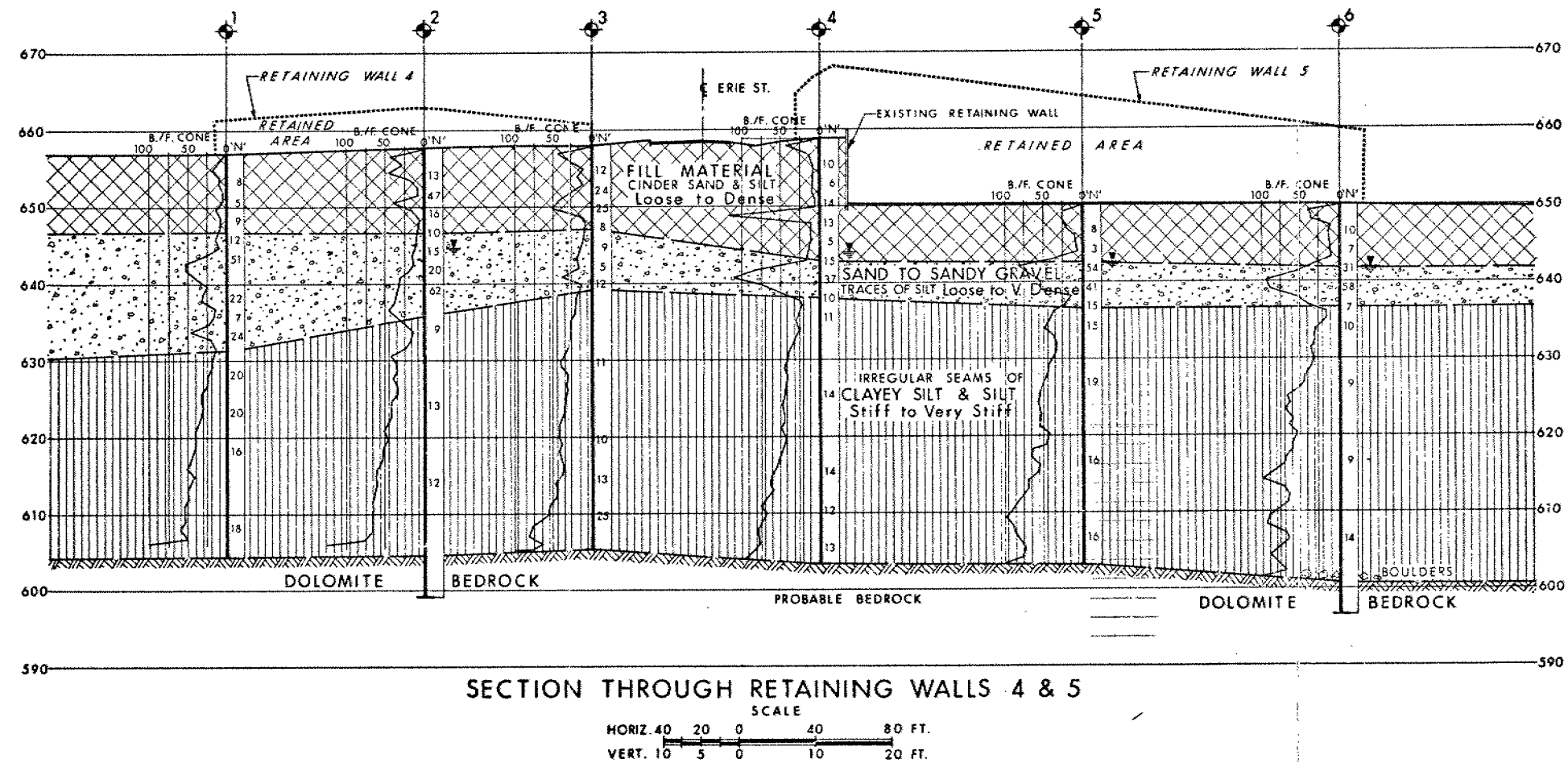
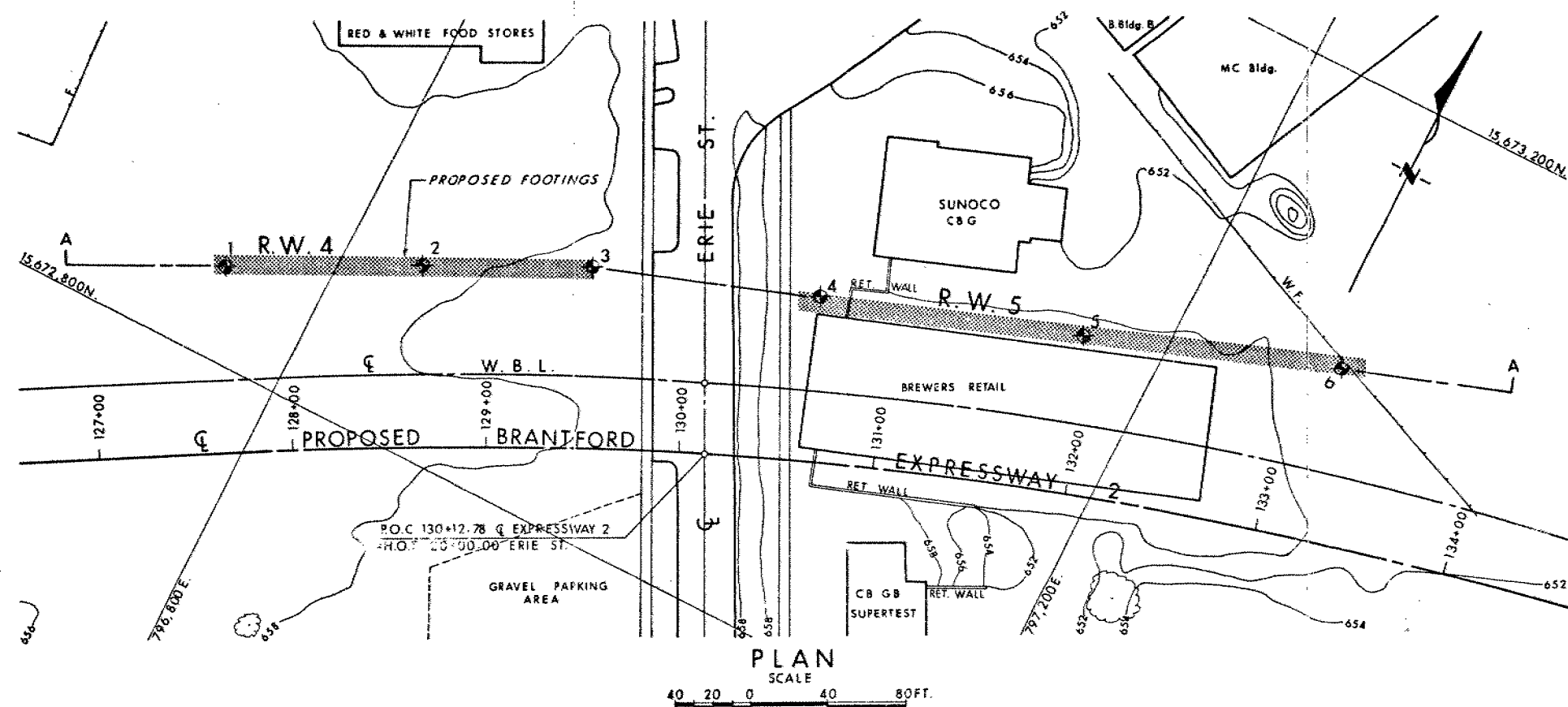
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

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

SLOPES

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



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation July 1972		
	Water Levels in Bore Holes 1 & 3 not established at time of field investigation.		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	656.8	15,672,847	796,748
2	657.6	15,672,893	796,838
3	657.9	15,672,933	796,918
4	658.7	15,672,973	797,030
5	650.0	15,673,016	797,159
6	649.9	15,673,063	797,287

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

REVISIONS	DATE	BY	DESCRIPTION

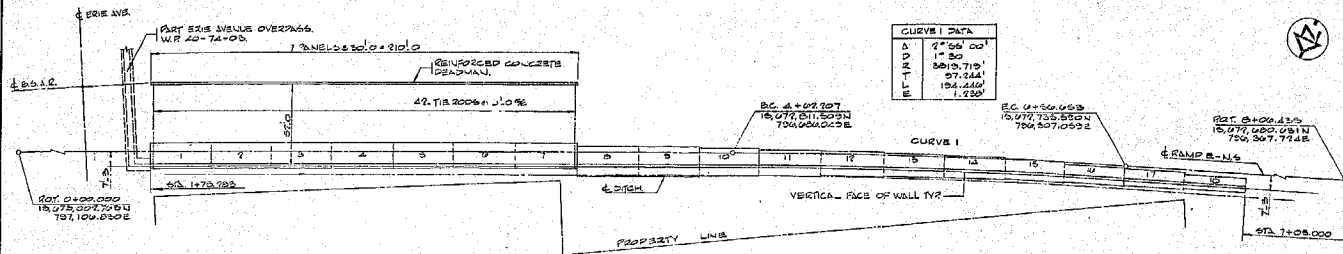
MINISTRY OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RETAINING WALLS 4 & 5
(ERIE STREET)

HIGHWAY NO. EXPRESSWAY 2 DIST. NO. 4
CO. BRANT City of BRANTFORD
TWP. BRANTFORD LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBWD. A. B. CHECKED <input checked="" type="checkbox"/>	W.P. NO. 70-68-18	DRAWING NO.
DRAWN <input checked="" type="checkbox"/>	JOB NO. 72-11081	72-11081A
DATE Aug. 8, 1972	SITE NO.	BRIDGE DRAWING NO.
APPROVED <input checked="" type="checkbox"/>	CONF. NO.	

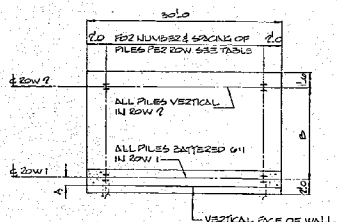


CURVE 1 DATA	
STATION	2755.00'
PI	17.80
EA	3015.715
EB	97.244
EC	194.440
ED	1.730

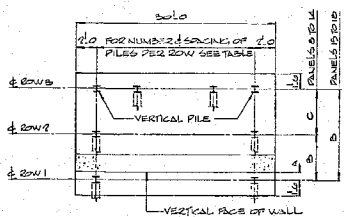
TABLE OF NUMBER AND SPACING OF PILES																	
PANEL																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PILES ROW 1	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24
PILES ROW 2	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24
PILES ROW 3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
DIMENSION A	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
DIMENSION B	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0
DIMENSION C	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PILE CUT OFF EL.	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00	004.00
VERTICAL PILES	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24
BATTERED PILES	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24
TOTAL LENGTH	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24	002.24

TO BE USED FOR ESTIMATING PURPOSES ONLY

DATE MAY 6, 1976



PLAN - TYPICAL PILE LAYOUT
PANEL NO. 1 TO PANEL NO. 18
NOT TO SCALE



PLAN - TYPICAL PILE LAYOUT
PANEL NO. 1 TO PANEL NO. 18
NOT TO SCALE

NOTE: PILE SIZE, PANELS 1 TO 7, 10 TO 12, 15 TO 17, 18 TO 19, 20 TO 21, 22 TO 23, 24 TO 25, 26 TO 27, 28 TO 29, 30 TO 31, 32 TO 33, 34 TO 35, 36 TO 37, 38 TO 39, 40 TO 41, 42 TO 43, 44 TO 45, 46 TO 47, 48 TO 49, 50 TO 51, 52 TO 53, 54 TO 55, 56 TO 57, 58 TO 59, 60 TO 61, 62 TO 63, 64 TO 65, 66 TO 67, 68 TO 69, 70 TO 71, 72 TO 73, 74 TO 75, 76 TO 77, 78 TO 79, 80 TO 81, 82 TO 83, 84 TO 85, 86 TO 87, 88 TO 89, 90 TO 91, 92 TO 93, 94 TO 95, 96 TO 97, 98 TO 99, 100 TO 101, 102 TO 103, 104 TO 105, 106 TO 107, 108 TO 109, 110 TO 111, 112 TO 113, 114 TO 115, 116 TO 117, 118 TO 119, 120 TO 121, 122 TO 123, 124 TO 125, 126 TO 127, 128 TO 129, 130 TO 131, 132 TO 133, 134 TO 135, 136 TO 137, 138 TO 139, 140 TO 141, 142 TO 143, 144 TO 145, 146 TO 147, 148 TO 149, 150 TO 151, 152 TO 153, 154 TO 155, 156 TO 157, 158 TO 159, 160 TO 161, 162 TO 163, 164 TO 165, 166 TO 167, 168 TO 169, 170 TO 171, 172 TO 173, 174 TO 175, 176 TO 177, 178 TO 179, 180 TO 181, 182 TO 183, 184 TO 185, 186 TO 187, 188 TO 189, 190 TO 191, 192 TO 193, 194 TO 195, 196 TO 197, 198 TO 199, 200 TO 201, 202 TO 203, 204 TO 205, 206 TO 207, 208 TO 209, 210 TO 211, 212 TO 213, 214 TO 215, 216 TO 217, 218 TO 219, 220 TO 221, 222 TO 223, 224 TO 225, 226 TO 227, 228 TO 229, 230 TO 231, 232 TO 233, 234 TO 235, 236 TO 237, 238 TO 239, 240 TO 241, 242 TO 243, 244 TO 245, 246 TO 247, 248 TO 249, 250 TO 251, 252 TO 253, 254 TO 255, 256 TO 257, 258 TO 259, 260 TO 261, 262 TO 263, 264 TO 265, 266 TO 267, 268 TO 269, 270 TO 271, 272 TO 273, 274 TO 275, 276 TO 277, 278 TO 279, 280 TO 281, 282 TO 283, 284 TO 285, 286 TO 287, 288 TO 289, 290 TO 291, 292 TO 293, 294 TO 295, 296 TO 297, 298 TO 299, 300 TO 301, 302 TO 303, 304 TO 305, 306 TO 307, 308 TO 309, 310 TO 311, 312 TO 313, 314 TO 315, 316 TO 317, 318 TO 319, 320 TO 321, 322 TO 323, 324 TO 325, 326 TO 327, 328 TO 329, 330 TO 331, 332 TO 333, 334 TO 335, 336 TO 337, 338 TO 339, 340 TO 341, 342 TO 343, 344 TO 345, 346 TO 347, 348 TO 349, 350 TO 351, 352 TO 353, 354 TO 355, 356 TO 357, 358 TO 359, 360 TO 361, 362 TO 363, 364 TO 365, 366 TO 367, 368 TO 369, 370 TO 371, 372 TO 373, 374 TO 375, 376 TO 377, 378 TO 379, 380 TO 381, 382 TO 383, 384 TO 385, 386 TO 387, 388 TO 389, 390 TO 391, 392 TO 393, 394 TO 395, 396 TO 397, 398 TO 399, 400 TO 401, 402 TO 403, 404 TO 405, 406 TO 407, 408 TO 409, 410 TO 411, 412 TO 413, 414 TO 415, 416 TO 417, 418 TO 419, 420 TO 421, 422 TO 423, 424 TO 425, 426 TO 427, 428 TO 429, 430 TO 431, 432 TO 433, 434 TO 435, 436 TO 437, 438 TO 439, 440 TO 441, 442 TO 443, 444 TO 445, 446 TO 447, 448 TO 449, 450 TO 451, 452 TO 453, 454 TO 455, 456 TO 457, 458 TO 459, 460 TO 461, 462 TO 463, 464 TO 465, 466 TO 467, 468 TO 469, 470 TO 471, 472 TO 473, 474 TO 475, 476 TO 477, 478 TO 479, 480 TO 481, 482 TO 483, 484 TO 485, 486 TO 487, 488 TO 489, 490 TO 491, 492 TO 493, 494 TO 495, 496 TO 497, 498 TO 499, 500 TO 501, 502 TO 503, 504 TO 505, 506 TO 507, 508 TO 509, 510 TO 511, 512 TO 513, 514 TO 515, 516 TO 517, 518 TO 519, 520 TO 521, 522 TO 523, 524 TO 525, 526 TO 527, 528 TO 529, 530 TO 531, 532 TO 533, 534 TO 535, 536 TO 537, 538 TO 539, 540 TO 541, 542 TO 543, 544 TO 545, 546 TO 547, 548 TO 549, 550 TO 551, 552 TO 553, 554 TO 555, 556 TO 557, 558 TO 559, 560 TO 561, 562 TO 563, 564 TO 565, 566 TO 567, 568 TO 569, 570 TO 571, 572 TO 573, 574 TO 575, 576 TO 577, 578 TO 579, 580 TO 581, 582 TO 583, 584 TO 585, 586 TO 587, 588 TO 589, 590 TO 591, 592 TO 593, 594 TO 595, 596 TO 597, 598 TO 599, 600 TO 601, 602 TO 603, 604 TO 605, 606 TO 607, 608 TO 609, 610 TO 611, 612 TO 613, 614 TO 615, 616 TO 617, 618 TO 619, 620 TO 621, 622 TO 623, 624 TO 625, 626 TO 627, 628 TO 629, 630 TO 631, 632 TO 633, 634 TO 635, 636 TO 637, 638 TO 639, 640 TO 641, 642 TO 643, 644 TO 645, 646 TO 647, 648 TO 649, 650 TO 651, 652 TO 653, 654 TO 655, 656 TO 657, 658 TO 659, 660 TO 661, 662 TO 663, 664 TO 665, 666 TO 667, 668 TO 669, 670 TO 671, 672 TO 673, 674 TO 675, 676 TO 677, 678 TO 679, 680 TO 681, 682 TO 683, 684 TO 685, 686 TO 687, 688 TO 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