DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40I14-38

DIST. 2 REGION

W.P. No. 32-73-00

CONT. No.

W. O. No. 73-11089

STR. SITE No. N/A

HWY. No. ACCESS ROAD

LOCATION LONDON EAST INDUSTRIAL ACCESS ROAD

No OF PAGES - 1

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

~~40I-187~~

MEMORANDUM

TO: Mr. J. G. Forster, (2)
Senior Soils Engineer,
Southwestern Region,
London, Ontario.

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

ATTENTION:

DATE: November 23, 1973.

OUR FILE REF.

IN REPLY TO DEC - 4 1973

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
London East Industrial Access Road
London District Feasibility Study
W.O. 73-11089 - W.P. 32-73

40IH-38
GEOCRES No.

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.

A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

AGS/ao
Attch.

c.c. E. J. Orr
B. R. Davis
A. Rutka
A. Wittenberg
L. E. Walker
B. J. Giroux
J. R. Roy
G. A. Wrong
B. A. Singh
A. P. Watt

Foundations Files
Documents

FOUNDATIONS INVESTIGATION REPORT
For
London East Industrial Access Road
London District Feasibility Study
W.O. 73-11089 -- W.P. 32-73

We have recently completed subsoil investigations at three locations where the proposed access routes cross the Thames River, as agreed upon with Mr. J. McKeown on October 30th, 1973. Presented in this report,are brief site and subsoil descriptions along with our tentative recommendations relating to the foundations and embankment fills for each location. Also attached are Record of Borehole log sheets and Drawing No. 73-11089A, showing the estimated subsoil stratigraphy at each crossing site.

Generally similar subsoil conditions were found at each location: very dense silty sand, overlain by 8-15 feet of fluvial sand and gravel deposits. No foundation or stability problems are foreseen for any crossing location.

2. *ROUTE '1' : CLARK ROAD TERMINUS - NORTH BANK OF THAMES RIVER*

SITE:

Borehole #1 was put down some 15 feet from the Thames River and 500 feet south of the end of Clark Road. At this place the river is approximately 100 feet wide and has moderate flow. In the vicinity of the site, along the north bank of the river, the ground is relatively flat and grass covered. The south bank of the river is flat and appeared to be marshy, Beyond the flat marshy area, the land rises gradually to the south.

SUBSOIL: (Ground Elevation : 792.1, River Surface Elevation 783.2)

0 - 13.5 feet SAND; well graded, some gravel traces of silt and clay, brown, compact.

.....2

13.5 - 22.5 feet SILTY SAND; traces of gravel and clay, grey, very dense.

Ground water level at elevation 787.1.

RECOMMENDATIONS:

A structure at this location may be supported on spread footing type foundations placed within the compact sand stratum. An allowable safe bearing capacity of 2.0 tsf may be assumed. If the footing bottom is placed above the prevailing groundwater level (elevation 787.1) consistent with maintaining a minimum of 4 feet of earth cover for frost protection purposes, no dewatering requirements are anticipated.

As an alternative, the structure may be supported on short end bearing piles driven to the very dense silty sand stratum at elevation 778±. In this case, the maximum allowable load for the particular section chosen may be used for design.

As a further alternative, the structure may be supported on spread footings placed within the very dense silty sand stratum some 14± feet below the ground level (elevation 778±). In this case a safe bearing pressure of 5.0 tsf may be used. However, for this alternative, dewatering will be required in order to pour the footings in the dry as well as to prevent 'boiling' at the bottom of the excavation which could occur under unbalanced hydrostatic head conditions.

No stability problems are anticipated at this site for embankment fills constructed with 2:1 slopes.

3. *ROUTE '2A - 2B' : NORTH BANK OF THAMES RIVER*

SITE:

Borehole #3 was put down on the flood plain some 30 feet north of the river, in the approximate vicinity of the proposed access alignment route 2A - 2B crossing . The land for about 700 feet north of the river at this place is flat. Ground

....3

cover consists of river type weeds and shrubs with occasional tree groves. North of the flood plain the land 'steps' up some 20 feet then again a further 40-60 feet. South of the river the land rises at 3:1 or flatter and the land is cultivated or brush and grass covered. At this place the Thames is approximately 100 feet wide and 5-10 feet deep. Flow is moderate to the west.

SUBSOIL : (Ground Elevation: 794.8, River Surface Elevation: 783.2)

0 - 5.0 feet	SAND; some silt, traces of gravel and varying amounts of organic material brown to black, compact.
5.0 - 7.0 feet	GRAVEL; some sand, traces of silt and clay, grey, compact.
7.0 - 15.0 feet	SAND; some gravel, traces of silt and clay, grey, very loose.
15.0 - 16.1 feet	SANDY GRAVEL; grey, very dense.

Groundwater level at elevation 789.3.

RECOMMENDATIONS:

A structure at this location may be supported on short end bearing piles driven to the very dense sandy gravel stratum at elevation 779±. In this case, maximum allowable loads for the particular section chosen may be assumed for design. No dewatering scheme is anticipated since the bottom of the pile caps can be placed above the groundwater table and still have a minimum 4 feet of earth cover for frost protection.

As an alternative, the structure may be supported on spread footings placed within the very dense sandy gravel layer. In this case a safe bearing pressure of 5.0 tsf may be assumed. With this scheme, dewatering will be necessary to prevent boiling or bottom heave during excavation and in order to

....4

pour the caps in the dry.

No stability problems are anticipated for embankment fills, provided that the surficial 5-6 feet of sand with organics is excavated beneath the fills.

4. *ROUTE '2C - 3A' : CRUMLIN ROAD TERMINUS, NORTH BANK OF THAMES RIVER*

SITE:

Borehole #2 was put down approximately 30 feet north of the river and some 800-900 feet south of the end of Crumlin Road. The river at this place is approximately 100-150 feet wide and 5-7 feet deep, with moderate flow to the west. The borehole was advanced through flood plain land, which was flat and overgrown with dense brush. Occasional trees were also observed. South of the river the land rises at 4:1 or flatter and is cultivated.

SUBSOIL: (Ground Elevation: 799, River Surface Elevation: 783.2)

0 - 5.5 feet	SAND; with silt and organics, brown/black, compact.
5.5 - 7.5 feet	GRAVEL; with sand, brown, dense.
7.5 - 21.0 feet	SILTY SAND; some gravel, grey, very dense.

Groundwater level at elevation 794.

RECOMMENDATIONS:

A structure at this location may be supported on spread footing placed within the very dense sandy silt till at approximate elevation 792±. A safe bearing capacity of 5.0 tsf may be assumed for design. No dewatering problems are anticipated.

Provided that the upper 5± feet of organic sand is excavated; embankments with 2:1 slopes may be safely built at this location.

....5

6. MISCELLANEOUS:

The field work was performed during the period of November 7-8, 1973. Equipment used was owned and operated by P.V.K. and Sons Drilling Company. Boring locations and elevations were surveyed in the field by personnel from London Region's Engineering Surveys Section. The field work was supervised by Mr. L. J. Hodge, Project Foundations Engineer, who also prepared this report. This report has been reviewed by Mr. K. G. Selby, Supervising Foundations Engineer.

L. J. Hodge, P. Eng.

K. G. Selby, P. Eng.

LJH/ji
Nov. 22, 1973.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 1

JOB 73-11089 LOCATION As Shown on Drawing No. 73-11089A ORIGINATED BY LJH

W.P. 32-73 BORING DATE November 9th, 1973 COMPILED BY LJH

DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. C
792.1	Ground Level									
0.0	Sand, well graded, some gravel, traces of silt and clay Compact, brown		1	SS	27	790		○		▼ 787.1 17 73 (10)
778.6			2	SS	22	780		○		21 69 (10)
13.5	Silty sand, trace of gravel and clay Grey, very dense		3	SS	100/4"					
769.6			4	AS	–	770		○		7 48 39 6
22.5	End of Borehole					760				

OFFICE REPORT ON SOIL EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS–ONTARIO

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE Nº 2

FOUNDATIONS OFFICE

JOB 73-11089 LOCATION As Shown on Drawing No. 73-11089A ORIGINATED BY LJH

W.P. 32-73 BORING DATE November 12th, 1973 COMPILED BY LJH

DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL
799.0	Ground Level									
0.0	Sand, with silt and organics Brown to black									
793.5	Compact		1	SS	29					0 65 31 4
5.5	Gravel with sand		2	SS	32					▼ 794.0
791.5	brown, dense									57 35 (8)
7.5	Silty sand, some gravel, traces of clay (Till)		3	SS	100/5"	790				
	Very dense		4	SS	100/2"					19 38 36 7
	Grey					780				
778.0			5	SS	100/6"					
21.0	End of Borehole					770				

OFFICE REPORT ON SOIL EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 3

JOB 73-11089 LOCATION As Shown on Drawing No. 73-11089A ORIGINATED BY LJH

W.P. 32-73 BORING DATE November 12th to 13th, 1973 COMPILED BY LJH

DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 — SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	LIQUID LIMIT W_L — PLASTIC LIMIT W_P — WATER CONTENT W — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. C
794.8	Ground Level									
0.0	Sand, some silt, traces of gravel with organics, brown to black, compact									789.3 ▼
788.8			1	SS	20	790		○		72 24 (4)
6.0	gr. some sa. trace of si. & cl. grey, compact									
786.8										
8.0	Sand, some gravel trace of silt and clay		2	SS	2			○		18 80 (2)
779.8	Grey, very dense									
15.1	Sandy gr. grey, v. dense		3	SS	100/4"	780		○		50 38 (12)
778.7			4	SS	150/5"			○		52 41 (7)
16.1	End of Borehole					770				

OFFICE REPORT ON SOIL EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

FD-9c (Rev. Jan. 73)

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION 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 :-

CONSISTENCY	c LB./SQ. FT.
VERY SOFT	0 - 250
SOFT	250 - 500
FIRM	500 - 1000
STIFF	1000 - 2000
VERY STIFF	2000 - 4000
HARD	> 4000

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

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 "		

FD-96 (Rev. 73)

ABBREVIATIONS & SYMBOLS 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
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
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e a$ 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 (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

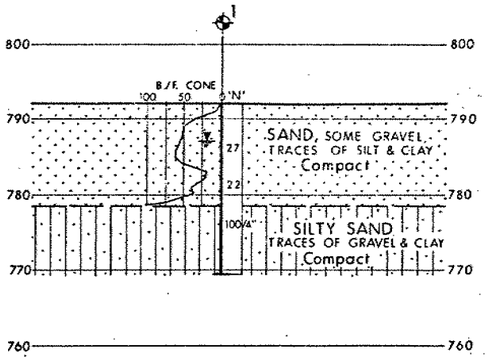
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

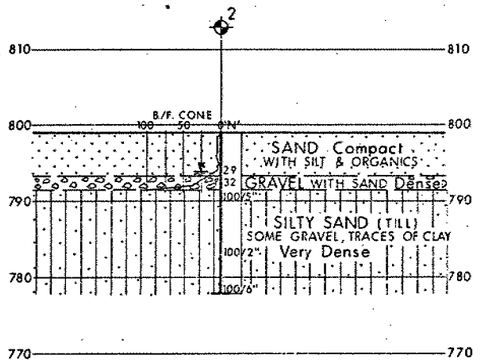
FOUNDATIONS

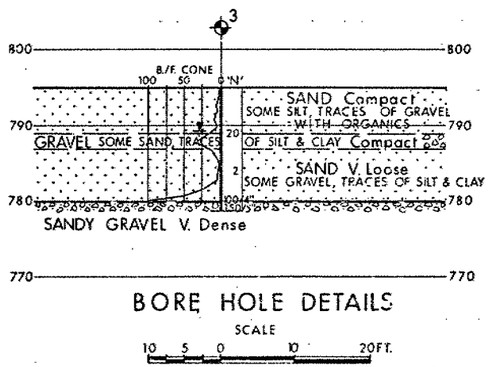
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

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



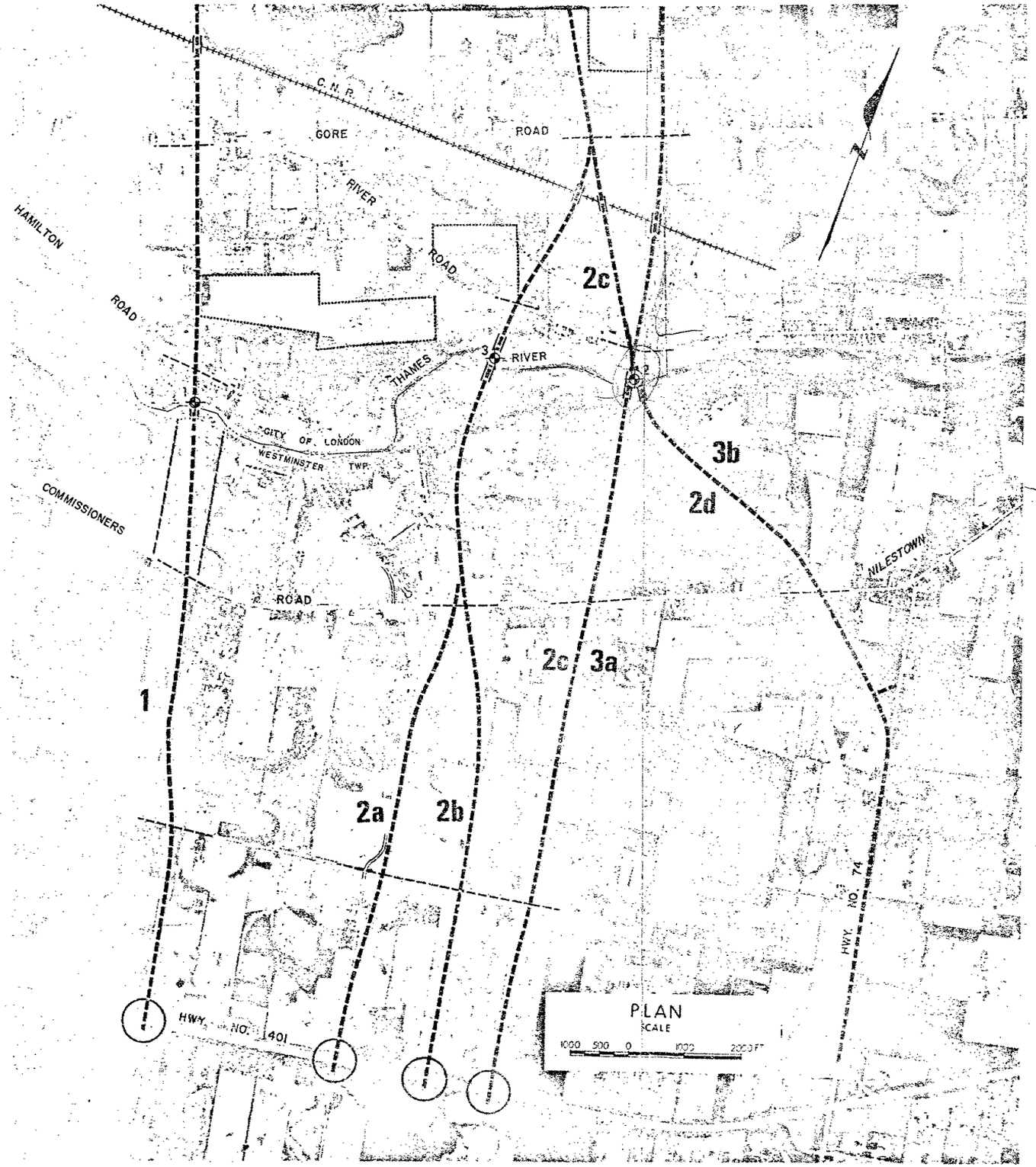


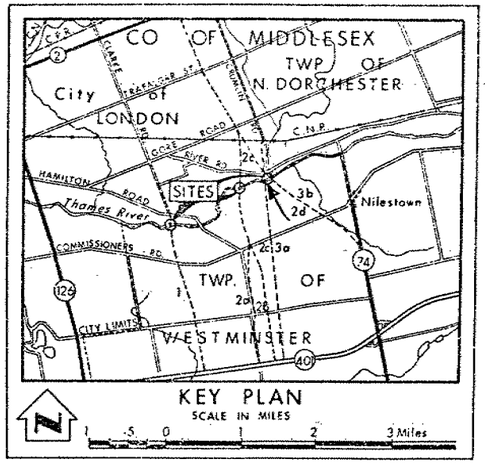


BORE HOLE DETAILS

SCALE

10 5 0 10 20FT.





LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation. Nov. 1973

NO.	ELEVATION	STATION	OFFSET
1	792.1	AS SHOWN ON PLAN	
2	799.0		
3	794.3		

— 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
DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

FEASIBILITY STUDY

HIGHWAY NO. Industrial Access Road DIST. NO. 2
CO. MIDDLESEX City of LONDON
TWP. LOT CON

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. J.H.	CHECKED	W.P. NO. 32-73	DRAWING NO. 73-11089A
DRAWN	CHECKED	W.O. NO. 73-11089	
DATE Nov 28, 1973		SITE NO.	BRIDGE DRAWING NO.
APPROVED PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	

73-11089

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. A. G. Stermac,
Principal Foundation Engineer,
Downsview.

FROM: Materials and Testing Office,
London.

ATTENTION: Mr. K. Selby.

DATE: October 23, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT: London East Industrial Access Road,
W.P. 32-73, London District Feasibility Study.

As discussed with you by telephone today, the proposed access routes (see attached map) cross the Thames River in several locations.

Preliminary borings at the crossing at the end of Crumlin Road arerequested.

Additional borings may be requested at the time of the above survey if further review of the routes reveal it necessary.

Please contact Mr. J. McKeown for further details when you are ready to carry out this work.

J. G. Forster

J. G. FORSTER,
SENIOR SOILS ENGINEER.

JGF:hp.
c.c. - J. McKeown,
File.

Compl. Date Dec 10/73.

MDD. DEC. 10/73