

MEMORANDUM

23-65-55

TO: Mr. A. M. Toye,  
Bridge Engineer,  
Bridge Division.

FROM: Mr. A. G. Stermac,  
Principal Foundation Engr.,  
Foundation Section,  
Materials & Research Division.

Attention: Mr. S. McCombie

DATE: October 18, 1963

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION

For

Proposed Widening and Erection of  
New Structures at Hwy. 401 over  
the Humber River, Toronto By-Pass,  
District 6.

W.J. 63-F-96 -- W.P. 237-60

Attached, we are forwarding to you, our detailed foundation investigation report outlining the subsoil conditions existing at the above-noted structure sites.

We believe that you will find the factual data and recommendations pertaining to these structures, adequate for your future design work. Should clarification or additional information be required, please do not hesitate to contact our Office.

AGS/MdeF  
Attach.

cc: Messrs.

A. M. Toye (2)  
H. A. Tregaskes  
H. D. McMillan  
G. K. Hunter (2)  
C. Fraser  
T. J. Kovich  
A. Watt

*(Signature)*  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER

Foundations Office ✓  
Gen. Files

## TABLE OF CONTENTS

1. INTRODUCTION.
  2. DESCRIPTION AND HISTORY OF THE SITE.
  3. DESCRIPTION OF FIELD AND LABORATORY WORK.
  4. SUBSOIL CONDITIONS:
    - 4.1) General.
    - 4.2) Silty Fine Sand.
    - 4.3) Glacial Till.
    - 4.4) Bedrock.
  5. GROUND WATER CONDITIONS.
  6. DISCUSSION AND RECOMMENDATIONS:
    - a) North Ramp Bridge.
    - b) Widening of the Existing Structure.
    - c) South Ramp Bridge.
  7. SUMMARY.
  8. MISCELLANEOUS.
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# FOUNDATION INVESTIGATION

For

Proposed Widening and Erection of  
New Structures, at Hwy. 401 over  
the Humber River, Toronto By-Pass,  
District 6.

W.J. 63-F-96 -- W.P. 237-60.

## 1. INTRODUCTION:

A foundation investigation for the proposed widening and erection of new structures over the Humber River, in connection with the Hwy. 401 improvement program, was requested by the Bridge Location Engineer in a memorandum dated August 23, 1963.

An investigation was commenced at this site on August 29, 1963, to determine the soil properties and decide on the most suitable type of foundation for the various structures.

This report contains the field and laboratory findings, together with the recommendations for the foundations of the proposed structures.

Boreholes 1 to 5 refer to the bridge for the North ramp; boreholes 6 to 11 refer to the widening of the existing bridge, and boreholes 12 to 15, refer to the bridge for the South ramp.

## 2. DESCRIPTION AND HISTORY OF THE SITE:

The existing bridge carrying Hwy. 401 over the Humber River was built in 1955. It is a four-span concrete structure founded on steel H-piles. It appears to be in a stable condition.

Prior to the construction of the existing bridge, a three-span concrete structure was built at this site and was

2. DESCRIPTION AND HISTORY OF THE SITE: (cont'd.) ...

supported on spread footings. These footings were founded at el. 395 ± in a layer of highly scour susceptible fine granular material. With the rise in the river water level during the fall of 1954, the soil immediately below the footings was washed away, causing considerable damage to the structure. The bridge was then demolished and the present bridge constructed on piled foundations. The Humber River was found to be approximately 90 feet wide at the site, at the time of this investigation. The flow of the water is generally in a southerly direction. The depth of water in the river varies from one foot to four feet.

The site is located in the County of York. The material deposited by the melting ice during the Wisconsin glaciation, covers a large part of this County. The unsorted material deposited by ice is generally referred to as till and is an accumulation of particles of all sizes from clay and silt to sand and gravel. The depth of this deposited material is variable and is usually thick. In addition to this, the river, in its course over a period of years, has deposited fine-grained particles, due to denudation. For this reason, the existing subsoil in this area can be termed as glacio-fluvial deposits. Clay textured till is evident in the County of York.

3. DESCRIPTION OF FIELD AND LABORATORY WORK:

Field work consisted of fifteen sampled boreholes and twelve dynamic cone penetration tests. The locations of these boreholes were chosen from Drawing No. 38-189 (De Leuw, Cather Ltd.)

The exploration program was carried out by standard core drilling machines and a Pennsylvania auger - 4½" diameter.

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

Both types of machine are adaptable for soil sampling. Samples were recovered at required depths by means of a 2-inch O.D. split-spoon sampler. The dimensions of this sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test. A 1.75-inch O.D. split-spoon sampler was also used a few times, inside AX casing, when necessary.

Samples were visually examined and identified in the field before transportation to the laboratory. Tests were carried out in the laboratory on a selection of samples to determine the Atterberg limits and moisture contents. Laboratory and field test results have been summarized and are included in this report under Appendix I.

4. SUBSOIL CONDITIONS:

4.1) General:

Apart from a thin layer of topsoil or fill material, three distinct layers are encountered in the following order:

Silty fine sand

Glacial till

Shale bedrock

4.2) Silty Fine Sand:

This layer of fine-grained granular material of fluvial origin, was encountered in all boreholes except boreholes 1, 7, 10 and 11. The thickness of this material varies from a minimum of 4' in borehole 13 to a maximum of 18' in borehole 15. The average thickness of this layer is about 8'. The material in this layer is

cont'd. /4 ...

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

4.2) Silty Fine Sand: (cont'd.) ...

predominantly in a loose state of compaction. It contains traces of organic material and occasionally, fine gravel.

4.3) Glacial Till:

This layer of till material consisting of clayey silt, sand, gravel and occasional boulders, was encountered in all the boreholes and is the predominant subsoil material in this area.

It is slightly cohesive in places, especially at its upper surface, becoming granular and, therefore, non-cohesive at further depths. It exists in a compact to very dense state.

The size of the boulders encountered in this layer vary from 6" to 9" and it is also found to contain weathered shale above the bedrock contact. The thickness of this layer is quite irregular as can be seen from the borelogs appended to this report.

Average values of Atterberg limit are 20% and 14%, respectively, and moisture content averages 13%.

4.4) Bedrock:

Below the above-mentioned layer of glacial till material, grey shale and dolomitic shale type of bedrock was encountered.

It was proved in the following boreholes at the given elevations:

| <u>Borehole No.</u> | <u>Elevation</u> |
|---------------------|------------------|
| 4A                  | 336.1            |
| 5                   | 357.0            |
| 7                   | 355.3            |
| 8                   | 360.5            |
| 9                   | 365.0            |
| 12                  | 375.0            |
| 13                  | 368.0            |
| 14                  | 361.0            |

In the remaining boreholes, no effort was made to encounter bedrock and drilling was terminated in the glacial till stratum.

cont'd. /5 ...

5. GROUND WATER CONDITIONS:

Observations and measurements carried out during boring and sampling operations, indicate that the water table lies around elevation 393.0. Exact water levels in all the boreholes could not be measured, either due to the low permeability of the subsoil, or in some cases, due to caving in of the material after the drilling operation. Wherever possible, water levels in the boreholes were measured and are given on the borelogs appended to this report.

The level of water in the river was found to be between elevations 393.0 and 393.5 during the period of this investigation. It should be noted that the recorded ground water levels could easily change depending on the fluctuations in the river water level.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to widen the existing bridge carrying Hwy. 401 over the Humber River. In addition, two new bridges are proposed to be constructed to carry two ramps over the same river. This is in conjunction with the Hwy. 401 improvement program.

Subsoil at the site consists of a thin layer of silty fine sand followed by a layer of dense glacial till overlying shale bedrock. Boreholes 1 to 5 refer to the bridge for the North ramp; boreholes 6 to 11 refer to the widening of the existing bridge, and boreholes 12 to 15 refer to the bridge for the South ramp.

a) North Ramp Bridge -

Considering only the strength and compressibility characteristics of the subsoil as such, it is possible to support the structure on spread footings in the dense glacial till stratum.

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

a) North Ramp Bridge - (cont'd.) ...

It is estimated that a safe bearing capacity of 4 T.S.F. may be achieved at the elevations shown below for the various proposed footings. These proposed footing locations are shown and designated on Dwg. No. 63-F-96A.

|               |       |       | <u>Elevations</u> |
|---------------|-------|-------|-------------------|
| East Abutment | ..... |       | 420.0             |
| Pier No. 1    | ..... |       | 388.0             |
| " "           | 2     | ..... | 384.0             |
| " "           | 3     | ..... | 384.0             |
| " "           | 4     | ..... | 390.0             |
| " "           | 5     | ..... | 390.0             |
| West Abutment | ..... |       | 390.0             |

Since the thickness of the loose material at the top surface varies between the boreholes, and since the exact locations of the proposed footings are not yet available, it may be necessary during construction, to remove any loose material, if found, below the above elevations and replace it with mass concrete. Provision for this should, therefore, be made in the contract. In the light of past experience at this site, the footings should be placed at a sufficient depth to provide adequate scour protection. The proposed footing elevations should, therefore, be checked by the Bridge Hydrology Section.

As an alternative to spread footings, end-bearing steel H-piles driven to practical refusal into the till layer or to bedrock contact, are recommended. Due to the presence of occasional boulders

cont'd. /7 ...



6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

a) North Ramp Bridge - (cont'd.) ...

in the till layer, and due to the irregularity of the bedrock surface, it is impractical to determine in advance, the precise pile lengths. However, it is estimated that practical refusal may be met around elevation 360.0 or below. It is recommended that 12 BP 74 steel H-piles with standard reinforcing tips be used. Pile driving should be controlled in the field by means of the Hiley Formula according to D.H.O. Standards DD 1218 and 1219. Design loads for the piles should be the maximum allowable for the pile section.

b) Widening of the Existing Structure -

Referring to boreholes 6, 7, 8 and 9, it can be seen that the ground in the vicinity of the structure is underlain by 8' to 10' of loose, silty sand material at its top surface. The existing bridge is already founded on steel H-piles. Therefore, it is recommended to support the widened footings on end-bearing steel H-piles, as described in the previous section. It is believed that refusal will be met around elevation 365.0 or below. If it is required to lengthen the existing structure, reference may be made to boreholes 10 and 11. Spread footing support can be provided at this location. A safe bearing capacity of 4 T.S.F. may be achieved at any suitable depth, after providing adequate frost protection.

c) South Ramp Bridge -

Considering only the strength and compressibility characteristics of the subsoil, it is possible to found this structure on spread footings. Footings founded in the dense glacial

cont'd. /8 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

c) South Ramp Bridge - (cont'd.) ...

till stratum can provide a safe bearing capacity of 4 T.S.F. at elevations, as shown below:

|                     | <u>Elevations</u> |
|---------------------|-------------------|
| East Abutment ..... | 408.0             |
| Pier No. 1 .....    | 390.0             |
| " " 2 .....         | 390.0             |
| " " 3 .....         | 388.0             |
| West Abutment ..... | 388.0             |

Provision for excessive loose material, if encountered below these elevations, as well as for scour, should be applied, as in the case of the North ramp bridge.

Alternatively, end-bearing steel H-piles driven to practical refusal into the till material, or to bedrock contact, are recommended. Here again, recommendations made for the North ramp bridge should apply. It is estimated that refusal will be met around elevation 375.0 or below.

7. SUMMARY:

- 1) It is proposed to widen the existing bridge carrying Hwy. 401 over the Humber River. In addition, two new bridges are proposed to be constructed on the ramps on either side of the existing bridge.

A total of sixteen boreholes was put down in this area.

cont'd. /9 ...

7. SUMMARY: (cont'd.) ...

- 2) Subsoil consists of a layer of silty fine sand followed by a layer of glacial till and shale bedrock.
- 3) Recommendations are given in the preceding paragraphs for spread footings and/or piled foundations, for each of the following three cases:

North Ramp Bridge;

Widening of the existing structure; and

South Ramp Bridge.

Adequate scour protection is necessary if the recommendations pertaining to spread footings are followed.

8. MISCELLANEOUS:

The field work was commenced on August 28, 1963 and completed by September 20, 1963, under the supervision of Project Foundation Engineers Messrs. W. Kulmatickas, B. M. Ghadiali and P. Payer. This report was prepared by Mr. B. M. Ghadiali, under the general guidance of Mr. K. G. Selby, Senior Foundation Engineer.

Equipment and crew were supplied by Dominion Soil Investigation Ltd. and Canadian Longyear Ltd.

October 1963

APPENDIX I.

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## RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 63-F-96 LOCATION Stn. 380+91 & 236' to right of G. Hwy. 401 ORIGINATED BY B.M.G.  
W.P. 237-60 BORING DATE August 28, 1963. COMPILED BY B.M.G.  
DATUM G.S.C. BOREHOLE TYPE Washboring using BX Casing. CHECKED BY H.S.

| SOIL PROFILE |  | SAMPLES     |        |      | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE | Liquid Limit ——— $w_L$ | REMARKS |
|--------------|--|-------------|--------|------|-------------|--------------------------------|------------------------|---------|
| ELEV. DEPTH  | DESCRIPTION  | SFRAT. PLOT | NUMBER | TYPE |             | BLOWS / FOOT                   | BLOWS / FOOT           |         |
|              |  |             |        |      |             | SHEAR STRENGTH P.S.F.          | WATER CONTENT ——— $w$  |         |
|              |  |             |        |      |             |                                | $w_P$ ——— $w_L$        |         |
|              |  |             |        |      |             |                                | WATER CONTENT %        |         |
| 445.7        | Groundlevel  |             |        |      |             |                                |                        |         |
| 0.0          | Fill   |             |        |      |             |                                |                        |         |
|              | Sandy silt-organics-<br>pieces of brick & concrete   |             |        |      |             |                                |                        |         |
| 5.0          | Brown  |             | 1      | SS   | 22          | 440                            |                        |         |
|              |  |             | 2      | SS   | 41          |                                |                        |         |
|              | Clayey silt, sand,<br>gravel and occasional<br>boulder to 9" $\phi$ .<br>(Glacial till).<br>Compact to v. dense.<br>Brown changing to<br>grey at elev. 425.4 |             | 3      | TW   | H           | 430                            |                        |         |
|              |  |             | 4      | SS   | 28          |                                |                        |         |
|              |  |             | 5      | SS   | 21          | 420                            |                        |         |
|              |  |             | 6      | SS   | >100        |                                |                        |         |
| 410.6        |  |             | 7      | SS   | >100        | 410                            |                        |         |
| 35.1         | End of borehole.   |             |        |      |             |                                |                        |         |

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## RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 63-F-96 LOCATION Stn. 381+43 & 223' to right of E. Hwy. 401 ORIGINATED BY B.M.G.  
W.P. 237-60 BORING DATE Sept. 3, 1963. COMPILED BY B.M.G.  
DATUM G.S.C. BOREHOLE TYPE Washboring using BK Casing. CHECKED BY H.S.

| SOIL PROFILE |  |            | SAMPLES |      |              | DYNAMIC PENETRATION RESISTANCE |                       | LIQUID LIMIT — WL  |                   | BULK DENSITY | REMARKS |  |
|--------------|--|------------|---------|------|--------------|--------------------------------|-----------------------|--------------------|-------------------|--------------|---------|--|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLT | NUMBER  | TYPE | BLOWS / FOOT | ELEV. SCALE                    | BLOWS / FOOT          | PLASTIC LIMIT — WP | WATER CONTENT — W |              |         |  |
|              |  |            |         |      |              |                                | 20 40 60 80 100       | W P — W — W L      |                   |              |         |  |
|              |  |            |         |      |              |                                | SHEAR STRENGTH P.S.F. |                    | WATER CONTENT %   |              |         |  |
| 418.7        | Groundlevel  |            |         |      |              | 420                            |                       |                    |                   |              |         |  |
| 0.0          | Silty sand, traces of organics and gravel.                                       |            |         |      |              |                                |                       |                    |                   |              |         |  |
| 5.0          | Sand, gravel and clayey silt. (Glacial till). Brown changing to grey at El. 406. |            | 1       | SS   | 65           | 410                            |                       |                    |                   |              |         |  |
| 404.2        |  |            | 2       | SS   | 75           |                                |                       |                    |                   |              |         |  |
| 14.6         | End of borehole.   |            | 3       | SS   | >100         | 400                            |                       |                    |                   |              |         |  |

W.L. at El. 411.6 in casing after 24 hrs. Presumably washing water.

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## RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 63-7-96

LOCATION Stn. 381488 & 201' to right of E. Hwy. 401

ORIGINATED BY B.M.G.

W. P. 237-60

BORING DATE Sept. 4, 1963.

COMPILED BY B.M.G.

DATUM G.S.C.

BOREHOLE TYPE Washboring using BX Casing.

CHECKED BY            H.S.

| SOIL PROFILE   |  |             | SAMPLES |      |              | DYNAMIC PENETRATION RESISTANCE |                       | LIQUID LIMIT ——— WL  |                     | BULK DENSITY<br>P.C.T. | REMARKS |    |
|----------------|--|-------------|---------|------|--------------|--------------------------------|-----------------------|----------------------|---------------------|------------------------|---------|----|
| ELEV.<br>DEPTH | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT | ELEV. SCALE                    | BLOWS / FOOT          | PLASTIC LIMIT ——— WP | WATER CONTENT ——— W |                        |         |    |
|                |  |             |         |      |              |                                | SHEAR STRENGTH P.S.F. |                      | WATER CONTENT %     |                        |         |    |
|                |  |             |         |      |              |                                | 20                    | 40                   | 60                  |                        |         | 80 |
| 396.7          | Groundlevel  |             |         |      |              | 400                            |                       |                      |                     |                        |         |    |
| 0.0            | Sandy silt and muck.<br>Loose.   |             |         |      |              |                                |                       |                      |                     |                        |         |    |
| 390.7          | Brown and black.   |             | 1       | SS   | 16           | 390                            |                       |                      |                     |                        |         |    |
| 6.0            | Clayey silt, sand and<br>gravel.<br>(Glacial till).<br><br>Occasional layers of<br>silt and sand.<br><br>Compact to v. dense.<br><br>Grey. |             | 2       | SS   | 28           |                                |                       |                      |                     |                        |         |    |
|                |  |             | 3       | SS   | 42           |                                |                       |                      |                     |                        |         |    |
|                |  |             | 4       | SS   | 26           | 380                            |                       |                      |                     |                        |         |    |
|                |  |             | 5       | SS   | >100         |                                |                       |                      |                     |                        |         |    |
|                |  |             | 6       | SS   | 92           | 370                            |                       |                      |                     |                        |         |    |
|                |  |             | 7       | SS   | 85           |                                |                       |                      |                     |                        |         |    |
|                |  |             |         |      |              |                                |                       |                      |                     |                        |         |    |
| 361.7          |  |             |         |      |              |                                |                       |                      |                     |                        |         |    |
| 35.0           | End of borehole.   |             |         |      |              | 360                            |                       |                      |                     |                        |         |    |

ORIGINATED BY E.M.G.

COMPILED BY B.M.G.

CHECKED BY H.S.



JOB 63-F-96 LOCATION Stn. 382+98 & 192' to right of E. Hwy. 401 ORIGINATED BY B.M.G.  
W.P. 237-60 BORING DATE Sept. 9, 1963. COMPILED BY B.M.G.  
DATUM C.S.C. BOREHOLE TYPE Washboring using BX Casing. CHECKED BY H.S.

| SOIL PROFILE |   | SAMPLES     |        |      | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE | LIQUID LIMIT ——— w <sub>L</sub> | PLASTIC LIMIT ——— w <sub>P</sub> | WATER CONTENT ——— w | BULK DENSITY<br>P C F | REMARKS |
|--------------|---|-------------|--------|------|-------------|--------------------------------|---------------------------------|----------------------------------|---------------------|-----------------------|---------|
| ELEV. DEPTH  | DESCRIPTION   | STRAT. PLOT | NUMBER | TYPE |             | BLOWS / FOOT                   | BLOWS / FOOT<br>20 40 60 80 100 | WATER CONTENT %<br>15 30 45      |                     |                       |         |
| 393.9        | Groundlevel   |             |        |      |             |                                |                                 |                                  |                     |                       |         |
| 0.6          | Topsoil   |             |        |      |             |                                |                                 |                                  |                     |                       |         |
|              | Silty sand and gravel.<br>Loose. Brown.   |             | 1      | SS   | 4           | 390                            |                                 |                                  |                     |                       |         |
|              |   |             | 2      | SS   | 17          |                                |                                 |                                  |                     |                       |         |
| 7.0          |   |             | 3      | SS   | 25          |                                |                                 |                                  |                     |                       |         |
|              | Clayey silt, sand<br>gravel and occasional<br>boulder. Weathered<br>shale below elev. 348.<br><br>(Glacial till).<br><br>V. dense.<br><br>Grey. |             | 4      | SS   | 43          | 380                            |                                 |                                  |                     |                       |         |
|              |   |             | 5      | SS   | >100        |                                |                                 |                                  |                     |                       |         |
|              |   |             | 6      | SS   | 65          |                                |                                 |                                  |                     |                       |         |
|              |   |             | 7      | SS   | 67          |                                |                                 |                                  |                     |                       |         |
|              |   |             | 8      | SS   | 54          |                                |                                 |                                  |                     |                       |         |
|              |   |             | 9      | SS   | 42          |                                |                                 |                                  |                     |                       |         |
|              |   |             | 10     | SS   | >100        |                                |                                 |                                  |                     |                       |         |
|              |   |             |        |      |             | 350                            |                                 |                                  |                     |                       |         |
|              |   |             |        |      |             | 340                            |                                 |                                  |                     |                       |         |
| 336.1        |   |             | 11     | RC   | -           |                                |                                 |                                  |                     |                       |         |
| 57.9         | Bedrock.  |             | 12     | RC   | -           |                                |                                 |                                  |                     |                       |         |
| 331.3        | Shale. Grey.  |             | 13     | RC   | -           |                                |                                 |                                  |                     |                       |         |
| 62.7         | End of borehole.  |             |        |      |             | 330                            |                                 |                                  |                     |                       |         |

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 63-P-96 LOCATION Stn. 385+20 & 160' to right of E. Hwy. 401 ORIGINATED BY B.A.G.  
 W.P. 237-60 BORING DATE Sept. 13, 1963. COMPILED BY B.A.G.  
 DATUM G.S.C. BOREHOLE TYPE Washboring using BX Casing. CHECKED BY H.S.

| SOIL PROFILE |  | SAMPLES      |        |      | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT<br>20 40 60 80 100<br>SHEAR STRENGTH P.S.F. | LIQUID LIMIT ——— WL<br>PLASTIC LIMIT ——— WP<br>WATER CONTENT ——— W<br>WATER CONTENT %<br>15 30 45 | BULK DENSITY<br>P.C.F. | REMARKS |
|--------------|--|--------------|--------|------|-------------|--|---|------------------------|---------|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLLOT | NUMBER | TYPE |             |  |   |                        |         |
| 402.0        | Groundlevel  |              |        |      |             |  |   |                        |         |
|              | Topsoil  |              |        |      |             |  |   |                        |         |
| 0.6          | Silty fine sand.   |              | 1      | SS   | 5           |  |   |                        |         |
|              | Loose  |              | 2      | SS   | 6           |  |   |                        |         |
| 392.0        | Brown  |              | 3      | SS   | 29          | 390  |   |                        |         |
| 10.0         | Clayey silt, sand and gravel. Weathered shale below elev. 365. |              | 4      | SS   | 70          |  |   |                        |         |
|              | (Glacial till).  |              | 5      | SS   | 44          |  |   |                        |         |
|              | Compact to v. dense.   |              | 6      | SS   | 60          | 380  |   |                        |         |
|              | Grey.  |              | 7      | SS   | 77          |  |   |                        |         |
|              |  |              | 8      | SS   | >100        | 370  |   |                        |         |
|              |  |              | 9      | SS   | >100        |  |   |                        |         |
|              |  |              |        |      |             | 360  |   |                        |         |
| 357.0        |  |              |        |      |             |  |   |                        |         |
| 45.0         | Bedrock.   |              | 10     | RC   | -           |  |   |                        |         |
|              | (Shale and dolomitic shale).                                   |              | 11     | RC   | -           | 350  |   |                        |         |
|              | Grey.  |              | 12     | RC   | -           |  |   |                        |         |
| 342.0        |  |              |        |      |             |  |   |                        |         |
| 57.0         | End of borehole.   |              |        |      |             |  |   |                        |         |

W.L.  
at El. 395.0

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 63-F-96 LOCATION Stn. 382+03 and 95' to right of C<sub>1</sub>, Hwy. #401 ORIGINATED BY B.M.G.  
W.P. 237-60 BORING DATE September 5, 1963 COMPILED BY B.M.G.  
DATUM G.S.C. BOREHOLE TYPE Washboring, use BX casing CHECKED BY H.S.

| SOIL PROFILE   |  |             | SAMPLES |      |              | DYNAMIC PENETRATION RESISTANCE |                                 | LIQUID LIMIT ——— WL<br>PLASTIC LIMIT ——— WP<br>WATER CONTENT ——— W |                             | BULK DENSITY<br><br>P.C.F. | REMARKS |
|----------------|--|-------------|---------|------|--------------|--------------------------------|---------------------------------|--|-----------------------------|----------------------------|---------|
| ELEV.<br>DEPTH | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT | ELEV. SCALE                    | BLOWS / FOOT<br>20 40 60 80 100 | SHEAR STRENGTH P.S.F.  | WATER CONTENT %<br>15 30 45 |                            |         |
| 398.3          | Groundlevel  |             |         |      |              | 400                            |                                 |  |                             |                            |         |
|                | Topsoil  |             |         |      |              |                                |                                 |  |                             |                            |         |
| 1.0            | Sandy silt and traces of organics.                                   |             | 1       | SS   | 8            | 390                            |                                 |  |                             |                            |         |
|                | Loose. Brown.  |             | 2       | SS   | 18           |                                |                                 |  |                             |                            |         |
| 9.0            | Clayey silt, sand and gravel. (Glacial till).                        |             | 3       | SS   | 19           |                                |                                 |  |                             |                            |         |
|                | Occasional layers of silt and fine sand. V. stiff to hard and dense. |             | 4       | SS   | 17           |                                |                                 |  |                             |                            |         |
|                | Grey.  |             | 5       | SS   | 49           | 380                            |                                 |  |                             |                            |         |
|                |  |             | 6       | SS   | 38           |                                |                                 |  |                             |                            |         |
|                |  |             | 7       | SS   | >100         | 370                            |                                 |  |                             |                            |         |
| 361.8          |  |             | 8       | SS   | 66           |                                |                                 |  |                             |                            |         |
| 36.6           | End of borehole.   |             |         |      |              | 360                            |                                 |  |                             |                            |         |

FOUNDATION SECTION

JOB C.F-96 LOCATION Stn. 382+98 and 100' to left of C, Hwy. 401 ORIGINATED BY B.M.G.  
 W.P. 237-60 BORING DATE Sept. 9, 1963. COMPILED BY B.M.G.  
 DATUM G.S.C. BOREHOLE TYPE Washboring using BX Casing. CHECKED BY J.S.

| SOIL PROFILE   |   | SAMPLES     |        |      | DYNAMIC PENETRATION RESISTANCE |             | LIQUID LIMIT — WL<br>PLASTIC LIMIT — WP<br>WATER CONTENT — W |                             | BULK DENSITY<br>P.C.F. | REMARKS |
|----------------|---|-------------|--------|------|--------------------------------|-------------|--|-----------------------------|------------------------|---------|
| ELEV.<br>DEPTH | DESCRIPTION   | STRAT. PLOT | NUMBER | TYPE | BLOWS / FOOT                   | ELEV. SCALE | SHEAR STRENGTH P.S.F.  | WATER CONTENT %<br>15 30 45 |                        |         |
| 395.6          | Groundlevel<br>Topsoil  |             |        |      |                                | 400         |  |                             |                        |         |
| 1.0            | Clayey silt, sand and gravel.<br><br>(Glacial till).<br><br>Occasional layers of silt, fine sand and boulder.<br><br><br><br>Dense to v. dense<br><br><br><br>Brown changing to grey at El. 391.6 |             | 1      | SS   | 50                             | 390         |  |                             |                        |         |
|                |   |             | 2      | SS   | 51                             |             |  |                             |                        |         |
|                |   |             | 3      | SS   | 44                             |             |  |                             |                        |         |
|                |   |             | 4      | SS   | 39                             | 380         |  |                             |                        |         |
|                |   |             | 5      | SS   | >100                           |             |  |                             |                        |         |
|                |   |             | 6      | SS   | >100                           | 370         |  |                             |                        |         |
|                |   |             | 7      | SS   | >100                           | 360         |  |                             |                        |         |
| 355.3          | Bedrock,<br>(Shale and dolomite shale) Grey   |             | 8      | RC   | -                              |             |  |                             |                        |         |
| 349.6          |   |             | 9      | RC   | -                              | 350         |  |                             |                        |         |
| 46.0           | End of borehole   |             |        |      |                                |             |  |                             |                        |         |

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

# RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 63-F-96 LOCATION Stn. 384+28 & 103' to right of E. Hwy. 401 ORIGINATED BY B.M.G.  
W.P. 237-60 BORING DATE Sept. 18, 1963. COMPILED BY B.M.G.  
DATUM G.S.C. BOREHOLE TYPE Washboring using LX Casing. CHECKED BY H.S.

| SOIL PROFILE |  |            | SAMPLES |      |              | DYNAMIC PENETRATION RESISTANCE |              |    |    |    | LIQUID LIMIT — WL<br>PLASTIC LIMIT — WP<br>WATER CONTENT — W |     |    | BULK DENSITY<br>P.C.F. | REMARKS |
|--------------|--|------------|---------|------|--------------|--------------------------------|--------------|----|----|----|--|-----|----|------------------------|---------|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLT | NUMBER  | TYPE | BLOWS / FOOT | ELEV. SCALE                    | BLOWS / FOOT | 20 | 40 | 60 | 80   | 100 | WP |                        |         |
| 400.3        | Groundlevel  |            |         |      |              | 400                            |              |    |    |    |  |     |    |                        |         |
| 0.6          | Silty fine sand. Trace of fine gravel. Loose. Brown changing to grey at El. 393.3  |            | 1       | SS   | 10           |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 2       | SS   | 7            |                                |              |    |    |    |  |     |    |                        |         |
| 8.6          | Sand, gravel and clayey silt. (Glacial till). Occasional layers of silt and fine sand. Boulder below El. 369.0. Compact to v. dense. Grey. |            | 3       | SS   | 24           | 390                            |              |    |    |    |  |     |    |                        |         |
|              |  |            | 4       | SS   | >100         |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 5       | SS   | 59           |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 6       | SS   | 60           | 380                            |              |    |    |    |  |     |    |                        |         |
|              |  |            | 7       | SS   | 92           |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 8       | SS   | >100         | 370                            |              |    |    |    |  |     |    |                        |         |
|              |  |            | 9       | SS   | >100         |                                |              |    |    |    |  |     |    |                        |         |
| 360.5        |  |            | 10      | RC   | -            | 360                            |              |    |    |    |  |     |    |                        |         |
| 39.9         | Bedrock. (Shale and dolomitic shale). Grey.  |            | 11      | RC   | -            |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 12      | RC   | -            |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 13      | RC   | -            |                                |              |    |    |    |  |     |    |                        |         |
|              |  |            | 14      | RC   | -            |                                |              |    |    |    |  |     |    |                        |         |
| 348.4        |  |            | 15      | RC   | -            | 350                            |              |    |    |    |  |     |    |                        |         |
| 51.2         | End of borehole.   |            |         |      |              |                                |              |    |    |    |  |     |    |                        |         |

W.L. at  
El. 391.3

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

JCS 03-F-90 LOCATION Stn. 385+73 & 90' to left of Q. Hwy. 401 ORIGINATED BY B.A.G.  
W.P. 237-60 BORING DATE Sept. 18, 1963. COMPILED BY B.A.G.  
DATUM U.S.C. BOREHOLE TYPE Washboring using BK Casing. CHECKED BY H.S.

| SOIL PROFILE |  | SAMPLES    |        |      | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT |    |    |    |     | LIQUID LIMIT — WL<br>PLASTIC LIMIT — WP<br>WATER CONTENT — W |   |    | BULK DENSITY<br>P.C.F. | REMARKS |
|--------------|--|------------|--------|------|-------------|--|----|----|----|-----|--|---|----|------------------------|---------|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLT | NUMBER | TYPE |             | 20   | 40 | 60 | 80 | 100 | WP   | W | WL |                        |         |
| 401.0        | Groundlevel  |            |        |      | 400         |  |    |    |    |     |  |   |    |                        |         |
| 0.6          | Silty fine sand, trace of fine gravel and organics. Compact. Brown changing to grey at elev. 397.0   |            | 1      | SS   | 21          |  |    |    |    |     |  |   |    |                        |         |
| 9.0          | Clayey silt, sand and gravel.<br>(Glacial till).<br>Occasional layers of silt.<br>Occasional boulder below elev. 374.0<br>Dense to v. dense. |            | 2      | SS   | 46          |  |    |    |    |     |  |   |    |                        |         |
|              |  |            | 3      | SS   | 41          |  |    |    |    |     |  |   |    |                        |         |
|              |  |            | 4      | SS   | 65          |  |    |    |    |     |  |   |    |                        |         |
|              |  |            | 5      | SS   | 78          |  |    |    |    |     |  |   |    |                        |         |
|              |  |            | 6      | SS   | >100        |  |    |    |    |     |  |   |    |                        |         |
|              |  |            | 7      | SS   | >100        |  |    |    |    |     |  |   |    |                        |         |
| 365.0        | Grey.  |            | 8      | SS   | >100        |  |    |    |    |     |  |   |    |                        |         |
| 36.0         | Bedrock.   |            | 9      | RC   | -           |  |    |    |    |     |  |   |    |                        |         |
| 361.5        | (Dolomitic shale) Grey   |            |        |      |             |  |    |    |    |     |  |   |    |                        |         |
| 39.0         | End of borehole.   |            |        |      |             |  |    |    |    |     |  |   |    |                        |         |

W.L.  
at El.  
393.2

FOUNDATION SECTION

| SOIL PROFILE   |  | SAMPLES     |        |      | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT | SHEAR STRENGTH P.S.F. | LIQUID LIMIT ——— WL<br>PLASTIC LIMIT ——— WP<br>WATER CONTENT ——— W<br>WP ——— W ——— WL<br>WATER CONTENT %<br>15 30 45 | BULK DENSITY<br>P.C.F. | REMARKS |
|----------------|--|-------------|--------|------|-------------|--|-----------------------|--|------------------------|---------|
| ELEV.<br>DEPTH | DESCRIPTION  | STRAT. PLOT | NUMBER | TYPE |             |  |                       |  |                        |         |
| 420.8          | Groundlevel  |             |        |      |             |  |                       |  |                        |         |
| 1.6            | Topsoil and Sand   |             |        |      |             |  |                       |  |                        |         |
|                | Clayey silt, sand<br>and gravel.<br>(Glacial till).<br>Dense to v. dense.<br>Grey. |             | 1      | SS   | 28          |  |                       |  |                        |         |
|                |  |             | 2      | SS   | >100        | 410  |                       |  |                        |         |
|                |  |             | 3      | SS   | 67          |  |                       |  |                        |         |
|                |  |             | 4      | SS   | 92          | ✓  |                       |  |                        |         |
|                |  |             | 5      | SS   | >100        | ✓400   |                       |  |                        |         |
|                |  |             | 6      | SS   | 54          | ✓  |                       |  |                        |         |
|                |  |             | 7      | SS   | 51          | ✓  |                       |  |                        |         |
|                |  |             | 8      | SS   | 42          | ✓  |                       |  |                        |         |
|                |  |             | 9      | SS   | 41          | ✓390   |                       |  |                        |         |
|                |  |             | 10     | SS   | 69          | ✓  |                       |  |                        |         |
|                |  |             | 11     | SS   | 92          | ✓380   |                       |  |                        |         |
| 374.3          |  |             | 12     | SS   | 94          |  |                       |  |                        |         |
| 46.6           | End of borehole.   |             |        |      |             | 370  |                       |  |                        |         |

FOUNDATION SECTION

| SOIL PROFILE   |   |             | SAMPLES |      |              | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT |                       | LIQUID LIMIT ——— WL<br>PLASTIC LIMIT ——— WP<br>WATER CONTENT ——— W<br>wp ——— w ——— WL<br>WATER CONTENT % |  | BULK DENSITY<br>P.C.F. |  | REMARKS |
|----------------|---|-------------|---------|------|--------------|--|-----------------------|--|--|------------------------|--|---------|
| ELEV.<br>DEPTH | DESCRIPTION                                       | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT | ELEV. SCALE                                    | SHEAR STRENGTH P.S.F. |  |  |                        |  |         |
| 421.3          | Groundlevel                                       |             |         |      |              | 420  |                       |  |  |                        |  |         |
|                | Clayey silt, sand and gravel. Occasional boulder. |             |         |      |              |  |                       |  |  |                        |  |         |
|                | (Glacial till)                                    |             | 1       | SS   | 35           |  |                       |  |  |                        |  |         |
|                | Dense to v. dense.                                |             | 2       | SS   | 39           | 410  |                       |  |  |                        |  |         |
|                | Brown changing to grey at elev. 411.8             |             | 3       | SS   | 57           |  |                       |  |  |                        |  |         |
| 405.6          |   |             | 4       | SS   | >100         |  |                       |  |  |                        |  |         |
| 5.8            | End of borehole.                                  |             |         |      |              | 400  |                       |  |  |                        |  |         |



FOUNDATION SECTION

| SOIL PROFILE |  |             | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE | LIQUID LIMIT — WL     | PLASTIC LIMIT — WP | WATER CONTENT %<br>WP      W      WL<br>15    30    45 | BULK DENSITY<br>P.C.F. | REMARKS |
|--------------|--|-------------|---------|------|--------------|-------------|--------------------------------|-----------------------|--------------------|--|------------------------|---------|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT |             | BLOWS / FOOT                   | SHEAR STRENGTH P.S.F. |                    |  |                        |         |
| 395.5        | Groundlevel  |             |         |      |              |             |                                |                       |                    |  |                        |         |
| 1.0          | Topsoil  |             |         |      |              |             |                                |                       |                    |  |                        |         |
| 5.3          | Silty fine sand and traces of organics. Compact. Brown.                            |             | 1       | SS   | 40           | 390         |                                |                       |                    |  |                        |         |
|              | Clayey silt, sand and gravel. (Glacial till). Occasional boulder below elev. 380.3 |             | 2       | SS   | 78           |             |                                |                       |                    |  |                        |         |
|              |  |             | 3       | SS   | >100         |             |                                |                       |                    |  |                        |         |
|              |  |             | 4       | SS   | >100         | 380         |                                |                       |                    |  |                        |         |
| 375.0        | V. dense. Grey.  |             | 5       | SS   | >100         |             |                                |                       |                    |  |                        |         |
| 20.6         | Bedrock. (Shale and dolomitic shale).  |             | 6       | RC   | -            |             |                                |                       |                    |  |                        |         |
|              |  |             | 7       | RC   | -            |             |                                |                       |                    |  |                        |         |
|              |  |             | 8       | RC   | -            | 370         |                                |                       |                    |  |                        |         |
|              |  |             | 9       | RC   | -            |             |                                |                       |                    |  |                        |         |
|              |  |             | 10      | RC   | -            |             |                                |                       |                    |  |                        |         |
| 363.0        | Grey.  |             | 11      | RC   | -            |             |                                |                       |                    |  |                        |         |
| 32.6         | End of borehole.   |             |         |      |              | 360         |                                |                       |                    |  |                        |         |

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 13

FOUNDATION SECTION

JOB 63-F-96 LOCATION Stn. 385+64 & 222' to left of E, Hwy. 401 ORIGINATED BY B.M.G.  
W.P. 237-60 BORING DATE Sept. 16, 1963. COMPILED BY B.M.G.  
DATUM G.S.C. BOREHOLE TYPE Washboring using BX Casing. CHECKED BY H.S.

[illegible]

FOUNDATION SECTION

| SOIL PROFILE |  | STRAT. PLOT | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE |                       | LIQUID LIMIT ——— WL  |                     | BULK DENSITY | REMARKS |
|--------------|--|-------------|---------|------|--------------|-------------|--------------------------------|-----------------------|----------------------|---------------------|--------------|---------|
| ELEV. DEPTH  | DESCRIPTION  |             | NUMBER  | TYPE | BLOWS / FOOT |             | BLOWS / FOOT                   | SHEAR STRENGTH P.S.F. | PLASTIC LIMIT ——— WP | WATER CONTENT ——— W |              |         |
| 403.0        | Groundlevel  |             |         |      |              |             |                                |                       |                      |                     |              |         |
| 385.0        | Silty fine sand and trace of gravel with silt. Organics to elev. 390.0. Loose to dense.  |             | 1       | SS   | 12           | 400         |                                |                       |                      |                     |              |         |
|              |  |             | 2       | SS   | 9            |             |                                |                       |                      |                     |              |         |
|              | Brown changing to grey at elev. 394.7.   |             | 3       | SS   | 6            | 390         |                                |                       |                      |                     |              |         |
|              |  |             | 4       | SS   | 39           |             |                                |                       |                      |                     |              |         |
| 385.0        |  |             | 5       | SS   | >100         | 380         |                                |                       |                      |                     |              |         |
| 18.0         | Sand, gravel and clayey silt with occasional boulder. (Glacial till) Occasional layers of silt and sand. Weathered shale below elev. 367.3 |             | 6       | SS   | >100         |             |                                |                       |                      |                     |              |         |
|              |  |             | 7       | SS   | >100         |             |                                |                       |                      |                     |              |         |
|              |  |             | 8       | SS   | >100         |             |                                |                       |                      |                     |              |         |
|              |  |             | 9       | SS   | >100         | 370         |                                |                       |                      |                     |              |         |
|              | V. dense.  |             | 10      | SS   | >100         |             |                                |                       |                      |                     |              |         |
| 361.0        | Grey.  |             |         |      |              | 360         |                                |                       |                      |                     |              |         |
| 42.0         | Bedrock.   |             | 11      | RC   | -            |             |                                |                       |                      |                     |              |         |
| 355.0        | (Shale and dolomitic shale). Grey  |             | 12      | RC   | -            |             |                                |                       |                      |                     |              |         |
| 48.0         | End of borehole.   |             |         |      |              | 350         |                                |                       |                      |                     |              |         |

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

JOB 63-F-96

LOCATION Stn. 383/88 & 344<sup>1</sup> to left of C, Hwy. 401

ORIGINATED BY B.M.G.

W. P. 237-60

BORING DATE Sept. 20, 1963.

COMPILED BY B.M.G.

DATUM G.S.C.

BOREHOLE TYPE Pennsylvania Auger - 4 1/2" Ø

CHECKED BY H.S.

[illegible]

## 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 | UNCONSOLIDATED UNDRAINED TRIAXIAL | C    | CONSOLIDATION   |
| Qd  | DRAINED TRIAXIAL                  | S    | SENSITIVITY     |

# ABBREVIATIONS USED IN THIS REPORT

## SOIL PROPERTIES

|            |  |
|------------|--|
| $\gamma$   | UNIT WEIGHT OF SOIL (BULK DENSITY)                                   |
| $\gamma_s$ | UNIT WEIGHT OF SOLID PARTICLES                                       |
| $\gamma_w$ | UNIT WEIGHT OF WATER   |
| $\gamma_d$ | UNIT DRY WEIGHT OF SOIL (DRY DENSITY)                                |
| $\gamma'$  | 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  |
| $\tau_f$   | SHEAR STRENGTH   |
| $c'$       | EFFECTIVE COHESION   |
| $\phi'$    | EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION                  |
| $c_u$      | APPARENT COHESION  |
| $\phi_u$   | APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION                   |
| $\mu$      | COEFFICIENT OF FRICTION  |
| $S_i$      | SENSITIVITY  |

## GENERAL

|                           |                                   |
|---------------------------|-----------------------------------|
| $\pi$                     | = 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  |
| $\sigma$   | NORMAL STRESS  |
| $\sigma'$  | NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED) |
| $\tau$     | SHEAR STRESS   |
| $\epsilon$ | LINEAR STRAIN  |
| $\gamma$   | SHEAR STRAIN   |
| $\nu$      | POISSON'S RATIO ( $\mu$ IS ALSO USED)                  |
| E          | MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)        |
| G          | MODULUS OF SHEAR DEFORMATION                           |
| K          | MODULUS OF COMPRESSIBILITY                             |
| $\eta$     | COEFFICIENT OF VISCOSITY                               |

## EARTH PRESSURE

|          |   |
|----------|---|
| d        | DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE   |
| $\delta$ | 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 |
| $\beta$ | ANGLE OF SLOPE TO HORIZONTAL             |

Bridge Office,  
Admin. Building.

Attention: Mr. C. Greloski

Foundation Section,  
Materials and Research Div.,  
Room 107, Lab. Bldg.

October 26, 1964.

Proposed Humber River Bridges - Hwy # 401  
Piled Foundations - W.P. 237-60 W.J. 63-F-96

We have reviewed the preliminary plans for the above - mentioned structures as requested by you with particular regard to the proposed piled foundations. You will note that our foundation report gives the estimated tip elevations for a design load of 75 tons using 12 B.P. @ 74 steel H piles with reinforced tips. We have reviewed our report again with regard to this point and are of the opinion that the original recommendations are still generally applicable with the following addition:

Since a large number of piles are to be driven at this site it might be advisable to carry out some pile tests in order to more accurately assess the appropriate design load for a particular length of pile. This could result in some saving. The pile test programme that we have in mind should cost us around \$10,000.00.

Please advise us if you wish to go along with the latter recommendation and we will be pleased to make the necessary arrangements to carry out the work.

If you have any further queries with regard to this matter, please contact this office.

KS/PB

*A. G. Sternac*  
A. G. Sternac  
PRINCIPAL FOUNDATION ENGINEER

DE LEUW, CATHER & COMPANY  
OF CANADA LIMITED  
CONSULTING PROFESSIONAL ENGINEERS  
55 EGLINTON AVENUE, EAST  
TORONTO 12, ONTARIO  
HUDSON 1-5661

October 17th, 1963

Principal Foundations Engineer,  
Materials & Research Division,  
Dept. of Highways of Ontario,  
Parliament Buildings,  
TORONTO 2, Ontario

63-F-96

Attention: Mr. Selby

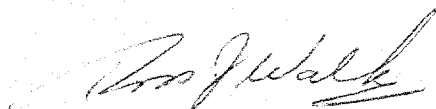
Re: Weston Road and Highway 401 Interchange

Dear Sir:

Further to your request, we are enclosing two prints and a sepia of our profiles for the Humber River bridges so that you may show your soils information on these.

Yours very truly,

DE LEUW, CATHER & COMPANY OF CANADA LIMITED



R.J. Walker,  
Project Manager

RJW:pb  
Encl.



# N-values

| Elev. | BH<br>10 | BH<br>6 | BH<br>4A | BH<br>8 | BH<br>5 | BH<br>7 | BH<br>9 | BH<br>4 | BH<br>3 | BH<br>1 |
|-------|----------|---------|----------|---------|---------|---------|---------|---------|---------|---------|
| 435   |          |         |          |         |         |         |         |         |         | 41      |
| 430   |          |         |          |         |         |         |         |         |         | 34      |
| 425   |          |         |          |         |         |         |         |         |         | 28      |
| 420   |          |         |          |         |         |         |         |         |         | 21      |
| 415   |          |         |          |         |         |         |         |         |         | >100    |
| 410   |          |         |          |         |         |         |         |         |         | >100    |
| 405   |          |         |          |         |         |         |         |         |         |         |
| 400   |          |         |          |         |         |         |         |         |         |         |
| 395   | 57       | 8       |          | 7       | 6       |         | 21      |         |         |         |
| 390   | 41       | 18      | 17       | 24      | 29      | 50      | 46      | 67      | 160     |         |
| 385   | 69       | 19      | 25       | 59      | 57      | 51      | 65      | 35      | 42      |         |
| 380   | 92       | 49      | 50       | 60      | 60      | 40      | 78      | 60      | 26      |         |
| 375   | 94       | 38      | 80       | 92      | 77      | >100    | >100    | >100    | >100    |         |
| 370   |          | >100    | 66       | >100    | >100    | >100    | >100    | 50      | 93      |         |
| 365   |          | 66      | 60       | >100    |         | >100    | >100    | >100    | 85      |         |
| 360   |          |         | 48       |         |         | >100    |         |         |         |         |
| 355   |          |         | >100     |         |         |         |         |         |         |         |

|   |   |
|---|---|
|   | 1 |
|   | 2 |
| 3 | 3 |
|   | 4 |
| 4 | 5 |
| 5 | 6 |

# Widening of main Structure (Bridges 2 & 3)

## North widening (Bridge 2)

| Top of piling elev. | Description   | Applicable Boreholes | Estimated pile tip elev. |
|---------------------|---------------|----------------------|--------------------------|
| 390                 | East abutment | 6 & 10               | 365 25'                  |
| 390                 | Pier A        | 4A, 6 & 8            | 360 30'                  |
| 390                 | Pier B        | 4A, 6, & 8           | 360 30'                  |
| 390                 | Pier C        | 8                    | 365 25'                  |
| 394                 | West abutment | 5 & 8                | 360 35'                  |

## South widening (Bridge 3)

| Top of piling elev. | Description   | Applicable Boreholes | Estimated pile tip elev. |
|---------------------|---------------|----------------------|--------------------------|
| 390                 | East abutment | 7                    | 365 25'                  |
| 390                 | Pier A        | 7                    | 365 25'                  |
| 390                 | Pier B        | 7 & 9                | 365 25'                  |
| 390                 | Pier C        | 9                    | 365 25'                  |
| 394                 | West abutment | 9                    | 365 29'                  |

# South to Westbound Ramp C (Bridge 1)

| Top of pty<br>elev. | Description   | Applicable<br>Boreholes | Estimated pile<br>tip elev |
|---------------------|---------------|-------------------------|----------------------------|
| 408                 | West abutment | 5                       | 365 43'                    |
| 398                 | Pier 1        | 4 & 5                   | 360 38'                    |
| 391                 | Pier 2        | 4 & 4A                  | 360 31'                    |
| 389                 | Pier 3        | 3                       | 365 23'                    |
| 431                 | East abutment | 1                       | 410 21'                    |

MEMORANDUM

*file  
up*

To: Mr. A. Stermac,  
Principal Foundation Engineer,  
Room 107, Lab. Bldg.

FROM: Bridge Division,  
Downsview, Ontario.

Att.: Mr. K. Selby      DATE: October 23, 1964.

OUR FILE REF.

IN REPLY TO

SUBJECT: Humber River Bridges,  
Hwy. #401 Dist. #6

W.P. 237-60

63-F-96

This will confirm our wish to have estimated pile lengths from you for the above named structures.

In your soil report you state that pile refusal will be met at elevation 360 for the north ramp bridge; elevation 365 for the widening of existing bridge and elevation 375 for the south ramp bridge. The soil strata varies somewhat at each pier and abutment hence estimated pile lengths should be given at each.

We have forwarded drawings of these bridges previously, however we will be pleased to give any further information required.

CSG:go

*C. S. Grebski*  
C. S. Grebski,  
Sr. Bridge Project Engineer.

Bridge Office,  
Admin. Building.

Attention: Mr. C. Greloski

Foundation Section,  
Materials and Research Div.,  
Room 107, Lab. Bldg.

October 26, 1964.

Proposed Humber River Bridges - Hwy # 401  
Piled Foundations - W.P. 237-60 W.J. 63-F-96

We have reviewed the preliminary plans for the above - mentioned structures as requested by you with particular regard to the proposed piled foundations. You will note that our foundation report gives the estimated tip elevations for a design load of 75 tons using 12 B.P. @ 74 steel H piles with reinforced tips. We have reviewed our report again with regard to this point and are of the opinion that the original recommendations are still generally applicable with the following addition:

Since a large number of piles are to be driven at this site it might be advisable to carry out some pile tests in order to more accurately assess the appropriate design load for a particular length of pile. This could result in some saving. The pile test programme that we have in mind should cost us around \$10,000.00.

Please advise us if you wish to go along with the latter recommendation and we will be pleased to make the necessary arrangements to carry out the work.

If you have any further queries with regard to this matter, please contact this office.

KS/PB

*A. G. Stermac*  
A. G. Stermac  
PRINCIPAL FOUNDATION ENGINEER

BY TELEPHONE B. DAVIS NOV. 2, 1964.

PILE LOADING TEST WILL NOT BE CARRIED OUT

AGS

#63-F-96

W.P. # 237-60

HWY # 401

OVER THE  
HUMBER R.



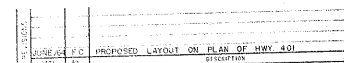


- Stations on Hwy. 401 Taken off  
Consultant's Plan.  
CRS LEGAL COUNSEL AND CO. LLC

| NO. | ELEVATION | STATION  | OFFSET  |
|-----|-----------|----------|---------|
| 1   | 448.7     | 360 + 91 | 2.36 RT |
| 2   | 451.7     | 361 + 42 | 0.23 RT |
| 3   | 454.7     | 361 + 88 | 101.81  |
| 4   | 456.6     | 363 + 85 | 65.81   |
| 5   | 457.9     | 365 + 22 | 102.82  |
| 6   | 459.2     | 365 + 20 | 160.87  |
| 7   | 464.3     | 362 + 02 | 96.87   |
| 8   | 464.6     | 362 + 30 | 170.17  |
| 9   | 464.7     | 364 + 29 | 113.81  |
| 10  | 465.7     | 365 + 75 | 95.17   |
| 11  | 470.6     | 361 + 35 | 10.17   |
| 12  | 471.3     | 362 + 41 | 294.13  |
| 13  | 473.0     | 361 + 35 | 294.13  |
| 14  | 473.0     | 363 + 64 | 232.17  |
| 15  | 473.0     | 466 + 71 | 158.17  |
| 16  | 482.0     | 363 + 64 | 544.17  |

NOTE.

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.



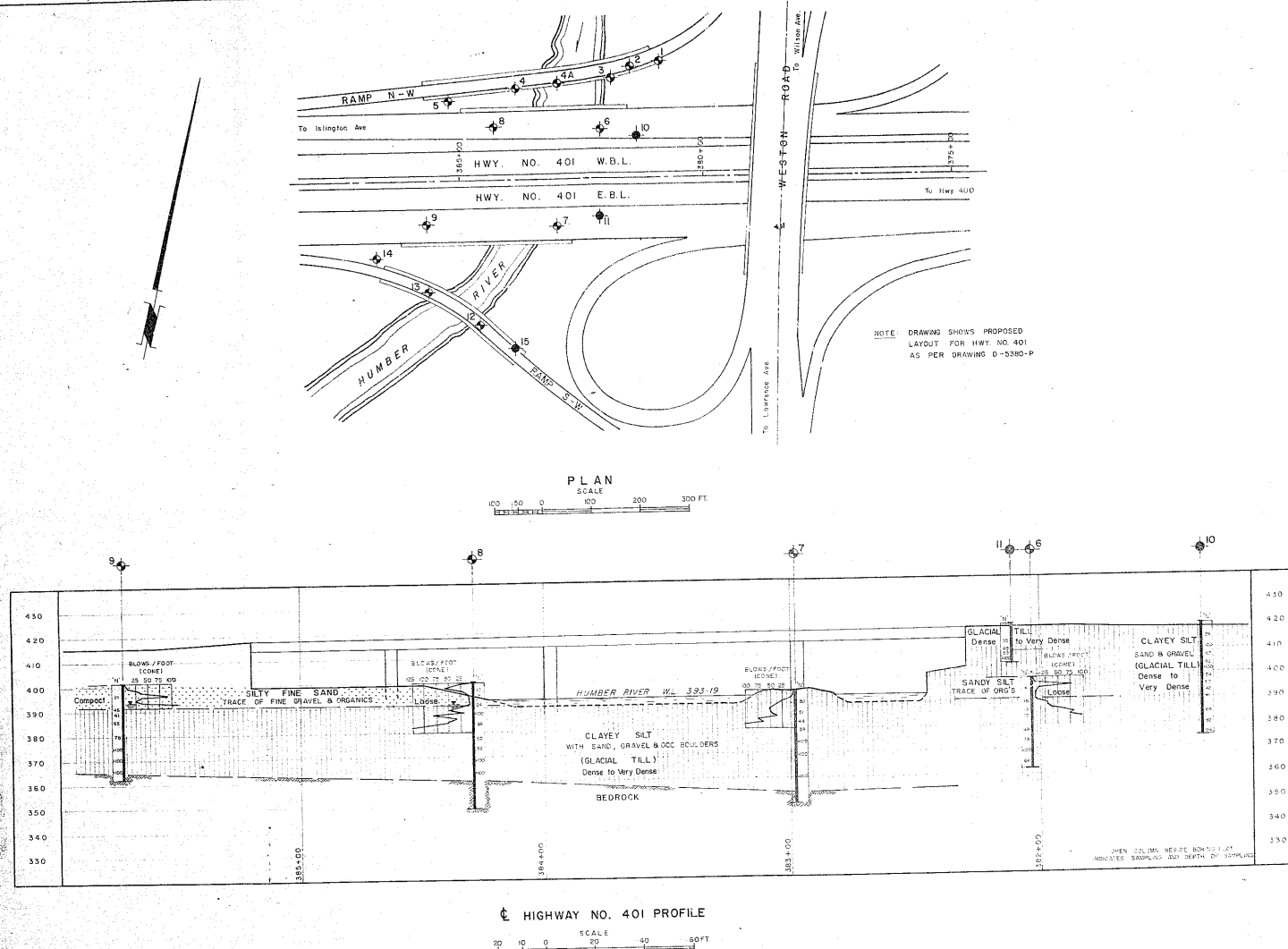
DEPARTMENT OF HIGHWAYS - ONTARIO  
MAINTENANCE & REPAIR DIVISION - FOUNDATION SECTION

## HUMBER RIVER

KING'S HIGHWAY NO. 401 DIST. NO. 6  
CO METROPOLITAN TORONTO  
TWP NORTH YORK LOT CON.

## BORE HOLE LOCATIONS &amp; SOIL STRATA

|              |                            |         |           |                                       |
|--------------|----------------------------|---------|-----------|---------------------------------------|
| SUBMIT B.G.  | CHECKED                    | WP NO.  | 237-60    | M.B.R. DRAWING NO.<br><b>63-F-96A</b> |
| DRAWING F.C. | CHECKED                    | JOB NO  | 63-F-96   |                                       |
| DATE OCT.    | 1963                       | SITE NO |           | BRIDGE DRAWING NO.                    |
| APPROVED     | U.S. Bureau of Reclamation |         | CONT. NO. |                                       |



REF. NO. 12 8 72



