

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 31E-100

DIST. 11 REGION

W.P. No. 7615-84-01/02

CONT. No. 87-79

W. O. No.

STR. SITE No. 44-128

HWY. No. 518

LOCATION MAGNETAWAN RIVER

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 87-79



Ministry of
Transportation and
Communications

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NOTE: For purposes of the contract, this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above-noted project.

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

| c_u (kPa) | 0 - 12 | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200 | > 200 |
|-------------|-----------|---------|---------|----------|------------|-------|
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3 m) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | > 50 |
|-----------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINTING AND BEDDING:

| SPACING | 50mm | 50 - 300mm | 0.3m - 1m | 1m - 3m | > 3m |
|----------|------------|------------|------------|---------|------------|
| JOINTING | VERY CLOSE | CLOSE | MOD. CLOSE | WIDE | VERY WIDE |
| BEDDING | VERY THIN | THIN | MEDIUM | THICK | VERY THICK |

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

| | | | |
|----|---------------------|----|---------------------------|
| SS | SPLIT SPOON | TP | THINWALL PISTON |
| WS | WASH SAMPLE | OS | OSTERBERG SAMPLE |
| ST | SLOTTED TUBE SAMPLE | RC | ROCK CORE |
| BS | BLOCK SAMPLE | PH | TW ADVANCED HYDRAULICALLY |
| CS | CHUNK SAMPLE | PM | TW ADVANCED MANUALLY |
| TW | THINWALL OPEN | FS | FOIL SAMPLE |

STRESS AND STRAIN

| | | |
|--------------------------------------|-----|-------------------------------|
| u_w | kPa | PORE WATER PRESSURE |
| u | 1 | PORE PRESSURE RATIO |
| σ | kPa | TOTAL NORMAL STRESS |
| σ' | kPa | EFFECTIVE NORMAL STRESS |
| τ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL STRESSES |
| ϵ | % | LINEAR STRAIN |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| μ | 1 | COEFFICIENT OF FRICTION |

MECHANICAL PROPERTIES OF SOIL

| | | |
|----------------|-------------------|--------------------------------------|
| m_v | kPa ⁻¹ | COEFFICIENT OF VOLUME CHANGE |
| C_c | 1 | COMPRESSION INDEX |
| C_s | 1 | SWELLING INDEX |
| C_α | 1 | RATE OF SECONDARY CONSOLIDATION |
| c_v | m ² /s | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| T_v | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| σ'_{vo} | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| σ'_p | kPa | PRECONSOLIDATION PRESSURE |
| τ_f | kPa | SHEAR STRENGTH |
| c' | kPa | EFFECTIVE COHESION INTERCEPT |
| ϕ' | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| c_u | kPa | APPARENT COHESION INTERCEPT |
| ϕ_u | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| τ_R | kPa | RESIDUAL SHEAR STRENGTH |
| τ_r | kPa | REMOULDED SHEAR STRENGTH |
| S_t | 1 | SENSITIVITY = $\frac{c_u}{\tau_r}$ |

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

For

Magnetawan River Structure

Geog. Twp. Proudfoot, Lot 9, Conc. 1

Geog. Twp. Bethune, Lot 9, Conc. 14

District Parry Sound, Hwy. #518

W.P. 7615-84-02; Site 44-1253-128

District #11, Huntsville

INTRODUCTION

This report contains the results of a foundation investigation carried out at the aforementioned site during the period of 86 04 09 and 86 04 23. The fieldwork consisted of three sampled boreholes with dynamic cone penetration tests and one dynamic cone penetration test without sampling. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle equipped with 83 mm (I.D.) hollow stem augers and BX size casings.

SITE DESCRIPTION

The site is located some 6.1 km east of Kearny at the crossing of Hwy. #518 and the Magnetawan River. The river, in this area, meanders and has changed course in the past. This is evidenced by the visible oxbow lakes. The terrain in the immediate vicinity of the proposed structure is flat, wet and marshy with light brush cover. The river channel is about 25 m wide and approx. 4.5 m deep. At the proposed crossing, the Magnetawan River flows in a southerly direction. The existing structure is a single lane bailey bridge, the approaches for which appear to be stable.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of a surficial deposit of 2 to 3 m of organic silt, followed by 8 to 13 m of sand and silt with trace organics. This is underlain by 2 to 3 m of silt with sand and organics. The underlying material consists of various proportions of sand and gravel. It should be noted that due to the meandering nature of the river the character and the extent of the deposits does vary at other locations as did the nature of gravel and sand underlying the silt.

The boundaries of the different strata encountered at the boring locations together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2 of the Contract Drawings. This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below.

Organic Silt

This stratum was encountered in all the sampled borings immediately below ground level for about 2 to 3 m. The material consists largely of silt with varying degrees of fine sand and organics. It is described as very loose to very soft. This layer is compressible and frost susceptible with a trace of plasticity due to the organic content. The natural moisture content varies from 40% to 107%.

Sand and Silt

Sand and silt were found in various proportions below the organic silt. In B.H. #2 there was about 8.7 m of fine sand and silt. In B.H. #3 the surficial deposit was underlain by fine sand with a trace of silt for 5.5 m, followed by approximately 7.4 m of fine sand and silt. Trace organics were encountered in all strata. There was no clear demarcation of the upper boundary of this layer. The material was grey to black in colour indicative of its organic content. The presence of organics also imparted very slight plasticity to the material when wet. The maximum thickness encountered was about 12.9 m. The natural moisture content ranges from 26% to 61% and the average unit weight is 15.0 kN/m^3 . The denseness is very loose.

Silt

This layer was encountered in B.H. #2 and B.H. #3 at different elevations. The material consisted of silt, some fine sand and trace organics. It was black and very slightly cohesive due to the organics. The nature moisture content varied from 37% and 54%. It is considered very loose with a unit weight of 16.3 kN/m^3 .

Fine Sand

This stratum was encountered below the silt layer in B.H. #2, for a minimum depth of 17.9 m. The lower boundary was not established since the boring was terminated within this deposit. The material in the deposit consists mainly of poorly graded sand and trace to some silt. The denseness varies from loose to compact.

Gravel and Coarse Sand

In B.H. #3, coarse sand and gravel was found to underlie the silt. Some fine sand was also detected. The maximum depth of sampling within this deposit was 9.4 m (El. 308.7). A dynamic cone test was continued from the bottom of the borehole to El. 290.0. No bedrock was encountered.

Groundwater Conditions

The following groundwater levels were observed during the field investigation:

| | <u>Groundwater Elevations</u> | <u>River Elevations</u> |
|---------|-----------------------------------|-----------------------------|
| B.H. #1 | El. 336.0 m | 336.0 m |
| B.H. #2 | El. 336.0 m | 336.0 m |
| B.H. #3 | El. 335.9 m | 335.9 m |

No artesian water conditions were encountered. The water levels in the borings matched the Magnetewan River level.

P. Payer

P. Payer, P. Eng.
Sr. Foundations Engineer



K. G. Selby

K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

APPENDIX



RECORD OF BOREHOLE No 1

METRIC

W P 7615-84-01 LOCATION STA. 14 + 773 °/s 7 m Lt. Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE Cont. Flt. H.S. COMPILED BY S.H.
DATUM Geodetic DATE 86 04 09 CHECKED BY _____

[illegible]

+3, x5: Numbers refer to Sensitivity


 Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 7615-84-01 LOCATION STA. 14 + 776 ⁰/s 10 m Rt. Proposed C
 DIST 11 HWY 518 BOREHOLE TYPE H.S. Cont. Flt. Augers / B Casing
 DATUM Geodetic DATE 86 04 10 / 15
 ORIGINATED BY SH
 COMPILED BY SH
 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-----------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | WATER CONTENT (%) | | | | | | |
| 336.2 | Ground Level | | | | | | | | | | | | | | |
| 333.3 | Silt with Fine Sand Trace of Organics Very Loose Grey Black | | 1 | SS | 2 | | | | | | | | om 7.6 | 0 13 83 4 | |
| | | | 2 | SS | 2 | | | | | | | | om 7.3 | 0 36 63 1 | |
| | | | 3 | SS | 1 | | | | | | | | | 0 39 57 4 | |
| | | | 4 | SS | 1 | | | | | | | | | om 4.1 | 0 43 56 1 |
| | | | 5 | SS | 2 | | | | | | | | | | |
| | | | 6 | SS | 1 | | | | | | | | | | |
| | | | 7 | SS | 0 | | | | | | | | | om 1.3 | 0 62 38 0 |
| | | | 8 | SS | 0 | | | | | | | | | | 0 50 50 0 |
| | | | 9 | SS | 2 | | | | | | | | | | |
| | | | 10 | SS | 1 | | | | | | | | | | |
| | | | 11 | SS | 1 | | | | | | | | | | |
| | | | 12 | SS | 1 | | | | | | | | | | 0 36 63 1 |
| 324.6 | | | | | | | | | | | | | | | |
| 11.6 | Silt, Some Fine Sand Trace of Organics Loose | | 13 | SS | 1 | | | | | | | om 4% | 0 22 76 2 | | |
| 323.0 | Black | | | | | | | | | | | 20.79 | | | |
| 13.2 | Fine Sand, Trace to Some Silt Loose to Compact | | 14 | SS | 0 | | | | | | | | 0 72 28 0 | | |
| | Grey | | 15 | SS | 5 | | | | | | | | | | |
| 16 | | | SS | 8 | | | | | | | | | 20.59 | | |
| 17 | | | SS | 15 | | | | | | | | | | | |
| 18 | | | SS | 55 | | | | | | | | | | 0 98 0 2 | |
| 19 | | | SS | 8 | | | | | | | | | | | |
| 20 | | | SS | 13 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| 306 | | | | | | | | | | | | | | | |
| 30.2 | | | | | | | | | | | | | | | |

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 \pm 5 (%) STRAIN AT FAILURE
10

Continued



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 7615-84-01 LOCATION STA. 14 + 776 0/s 10 m Rt of Proposed C ORIGINATED BY S.H.
 DIST 11 HWY 518 BOREHOLE TYPE H.S. Cont. Flt. Augers/B Casing COMPILED BY S.H.
 DATUM Geodetic DATE 86 04 10/15 CHECKED BY _____

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|---|------------|--------|------|-------------------------|-----------------|--|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 | | | | | |
| 306 | Continued | | | | | | | | | | | | |
| 305.1 | Sand, Fine to Medium Loose to Compact Grey | ... | 21 | SS | 5 | | | | | | | | GR SA SI CL 0 98 0 2 |
| 31.2 | End of Borehole End of Cone Test | 304 | 8 | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10


 Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 7615-84-01 LOCATION STA. 14 + 739 0/a 4 m Lt. Proposed C
 DIST 11 HWY 518 BOREHOLE TYPE H.S. Cont. Flt. Auger / B Casing ORIGINATED BY S.H.
 DATUM Geodetic DATE 86 04 16/22 COMPILED BY S.H.
 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|--------------------|---|----------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 20 40 60 | | | | | |
| 335.9 | Organic Silt Very Soft | | 1 | SS | 4 | | 334 | | | | | | | |
| 333.9 | | | 2 | SS | 2 | | 332 | | | | | | | |
| 2.0 | Fine Sand Trace to Some Silt Trace of Organics Very Loose | | 3 | SS | 2 | | 330 | | | | | | | |
| | | | 4 | SS | 1 | | 328 | | | | | | | |
| | | | 5 | SS | 2 | | 326 | | | | | | | |
| | | | 6 | SS | 2 | | 324 | | | | | | | |
| | | | 7 | SS | 2 | | 322 | | | | | | | |
| | | | 8 | SS | 2 | | 320 | | | | | | | |
| | Grey-Black | | 9 | SS | 2 | | 318 | | | | | | | |
| 328.4 | | | 10 | SS | 3 | | 316 | | | | | | | |
| 7.5 | Fine Sand and Silt Trace Organics Very Loose Grey-Black | | 11 | SS | 5 | | 314 | | | | | | | |
| | | | 12 | SS | 4 | | 312 | | | | | | | |
| | | | 13 | SS | 2 | | 310 | | | | | | | |
| | | | 14 | SS | 2 | | 308 | | | | | | | |
| | | | 15 | SS | 3 | | 306 | | | | | | | |
| 321.0 | | | 16 | SS | 2 | | | | | | | | | |
| 14.9 | Silt, Some Fine Sand Very Loose Black | | 17 | SS | 3 | | | | | | | | | |
| | Trace of Organics | | 17A | | | | | | | | | | | |
| 318.1 | | | 18 | ST | 14 | | | | | | | | | |
| 17.8 | Gravel and Coarse Sand Loose to Compact | | 23 | SS | 100A 35mm | | | | | | | | | |
| | | | 24 | ST | 8 | | | | | | | | | |
| 308.7 | | | 25 | SS | 20 | | | | | | | | | |
| 27.2 | End of Borehole | | | | | | | | | | | | | |
| 305.7 | | | | | | | | | | | | | | |
| 30.2 | | | | | | | | | | | | | | |

Continued

 +³, x⁵: Numbers refer to
Sensitivity

 20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 3

METRIC

W P 7615-84-01 LOCATION STA. 14 + 739 °/s 4 m Lt Proposed C ORIGINATED BY SH
DIST 11 HWY 518 BOREHOLE TYPE Cone Test From Bottom B Casing COMPILED BY SH
DATUM Geodetic DATE 86 04 16 / 22 CHECKED BY _____

[illegible]

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 4

METRIC

W P 7615-84-01 LOCATION STA. 14 + 744 0/s 11 m Rt Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE Cone Test COMPILED BY S.H.
DATUM Geodetic DATE 86-04-23 CHECKED BY _____

[illegible]

Continued

+3, x5: Numbers refer to Sensitivity

Continued

METRIC

W P 7615-84-01 LOCATION STA. 14 + 744 °/s 11 m Rt Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE Cone Test COMPILED BY S.H.
DATUM Geodetic DATE 86 04 23 CHECKED BY _____

[illegible]

+3, x5: Numbers refer to Sensitivity

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 7615-84-01

DIST 11

HWY 518

STR SITE 44-128

MAGNETAWAN RIVER STRUCTURE

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FOUNDATION INVESTIGATION REPORT

For

Magnetawan River Structure
Geog. Twp. Proudfoot, Lot 9, Con 1
Geog. Twp. Bethune, Lot 9, Con 14
Dist. Parry Sound, Hwy. #518
WP 7615-84-01; Site 44-128
District #11, Huntsville

INTRODUCTION:

This report contains the results of a foundation investigation carried out at the aforementioned site during the period of 86 04 09 and 86 04 23. The fieldwork consisted of three sampled boreholes with dynamic cone penetration tests and one dynamic cone penetration test without sampling. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle equipped with 83 mm (I.D.) hollow stem augers and BX size casings.

SITE DESCRIPTION

The site is located some 6.1 km east of Kearny at the crossing of Hwy. #518 and the Magnetawan River. The river, in this area, meanders and has changed course in the past. This is evidenced by the visible oxbow lakes. The terrain in the immediate vicinity of the proposed structure is flat, wet and marshy with light brush cover. The river channel is about 25 m wide at El. 335.6 and approx. 4.5 m deep. At the proposed crossing, the Magnetawan River flows in a southerly direction. The existing structure is a single lane bailey bridge, the approaches for which appear to be stable.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of a surficial deposit of 2 to 3 m of organic silt, followed by 8 to 13 m of sand and silt with trace organics. This is underlain by 2 to 3 m of silt with sand and organics. The underlying material consists of various proportions of sand and gravel. It should be noted that due to the meandering nature of the river the character and the extent of the deposits does vary at other locations as did the nature of gravel and sand underlying the silt.

The boundaries of the different strata encountered at the boring locations together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 7615-84-01-A. This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below.

Organic Silt

This stratum was encountered in all the sampled borings immediately below ground level for about 2 to 3 m. The material consists largely of silt with varying degrees of fine sand and organics. It is described as very loose to very soft. This layer is compressible and frost susceptible with a trace of plasticity due to the organic content. The natural moisture content varies from 40% to 107%.

Sand and Silt

Sand and silt were found in various proportions below the silt. In BH#2 there was about 8.7 m of fine sand and silt. In BH#3 the surficial silt deposit was underlain by fine sand with a trace of silt for 5.5 m, followed by approximately 7.4 m of fine sand and silt. Trace organics were encountered in all strata. There was no clear demarcation of the upper boundary of this layer. The material was grey to black in colour indicative of its organic content. The presence of organics also imparted very slight plasticity to the material when wet. The maximum thickness encountered was about 12.9 m. Reference should be made to the Record of Borehole Sheets for lower boundary elevations at a particular boundary location. The natural moisture content ranges from 26% to 61% and the average unit weight is 15.0 kN/m^3 . The denseness is very loose.

Silt

This layer was encountered in BH#2 and BH#3 at different elevations. The material consisted of silt, some fine sand and trace organics. It was black and very slightly cohesive due to the organics. The natural moisture content varied from 37% and 54%. It is considered very loose with a unit weight of 16.3 kN/m^3 .

Mixture of Gravel and Sand

In BH#2 poorly graded fine sand was found to underlie the silt layer. The lower boundary was not established since the boring was terminated within the deposit. The maximum depth by sampling was 31.2 m and the average unit weight was 20.6 kN/m³. In BH#3 coarse sand and gravel was found to underlie the silt. Some fine sand was also detected. The maximum depth of sampling in BH#3 was 27.2 m. A dynamic cone was continued from the bottom of the BH to a depth of 43.9 m. No bedrock was encountered.

Groundwater Conditions

The following groundwater levels were observed during the field investigation:

| | Groundwater Elevations | River Elevations |
|------|------------------------|------------------|
| BH#1 | El. 336.0 m | 336.0 m |
| BH#2 | El. 336.0 m | 336.0 m |
| BH#3 | El. 335.9 m | 335.9 m |

No artesian water conditions were encountered. The water levels in the borings matched the Magnetewan River level.

DISCUSSION AND RECOMMENDATION

General

The existing structure at the site is to be replaced by a 30 m single span bridge. Profile grade will be raised slightly to elevation 339. The new will be approximately 3 m north of the existing. The height of the approach embankments will be about 8 m above the river bed. The average river bank level is about 4.5 m above the river bed.

Structure Foundations

In view of the encountered subsoil conditions it is recommended that the future structure be founded on steel 'H' piles driven to approximate elevation 305 m. For HP 310 x 79 steel 'H' piles, a design load of 535 kN is recommended. For the purposes of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S. 750 kN

Capacity at S.L.S. Type II 535 kN

The piles should be driven in accordance with MTC standards SS 103-10 or SS 103-11. The piles should be reinforced with pile tips. The required ultimate capacity of the piles is 1605 kN each.

Earth pressure should be computed as per Subsection 6.6.1.2.2 of the Code. A yielding foundation condition may be assumed. Backfill to the structure should consist of granular material for which the following properties may be assumed.

| | | | |
|-----------|--------------------------------|-------------------|---------------|
| Gran. 'A' | $\gamma = 22.8 \text{ kN/m}^3$ | $\phi = 35^\circ$ | $K_A = 0.271$ |
| Gran. 'B' | $\gamma = 21.3 \text{ kN/m}^3$ | $\phi = 30^\circ$ | $K_A = 0.333$ |

The pile caps should have a minimum of 1.8 m earth cover for frost protection.

Concrete should be placed in the 'dry'. A dewatering scheme will be required for footing excavations below the groundwater level. Subsoil at this site is highly susceptible to conditions of unbalanced hydrostatic head and will 'boil' under such conditions.

Approach Embankments

Approximately 2 to 3 m of organic soil is located immediately below the original ground surface. This material should be removed and replaced for the full width of the embankment with non-cohesive fill material from the toes of the river banks to 16 m behind the abutments of bearings. No fill containing grain sizes larger than 75 mm should be placed at locations where piles are to be driven. Subsoil in the river banks and bed is highly susceptible to scour action and rip-rap protection should be provided up to H.W.L. for a minimum distance of 50 m upstream and 25 m downstream. This protection should also extend into the river for a distance of at least 3 m front of the toes of the river banks. For the approaches constructed in accordance with the foregoing 2:1 side and forward slopes are recommended. $1 \frac{3}{4} : 1$ slopes may also be used provided that the outer 3 m of the embankments (including backfill to the subexcavations) above elevation 332 consists of Granular 'A'.

Scour Protection

Scour protection for the river banks should be provided in accordance with hydrological requirements. Rip-rap placed on the slopes for this purpose should be underlain by a 0.5 m blanket of Granular 'A'.

Bailey Bridge Detour

A 36.6 m single span bailey bridge, located 12 m to 15 m downstream from the existing crossing, is proposed as a temporary detour during the replacement of the existing structure.

The bailey bridge should be founded on timber cribs of 4 m width and 3 m length. The nature of the subsurface material requires that the excavated depth to the crib bottom be 3 m or more, i.e. at or below El. 333 m. The timber cribs should be backfilled with Granular 'A'. At the groundwater elevation and higher, the granular fill should be compacted.

Excavation for the bailey bridge foundations and approaches should proceed in the direction away from the river banks. For stability of the approaches, excavation to El. 333 m should extend horizontally 3 m from the crib location away from the river's edge. The excavation should then slope upwards at an incline of 4H : 1V to the desired road elevation. The adjacent side slopes should be constructed at 1H : 1V or flatter. This portion of the excavation should be backfilled with suitable non-cohesive material.

It should be noted that settlement is possible after construction of the bailey bridge. Therefore, it is advised that provisions for raising the temporary structure be incorporated in the design.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. S. Holmes, Foundation Design Section. The equipment used was owned and operated by Archer Drilling Limited. This report was written by Mr. S. Holmes and reviewed by Mr. K. G. Selby.



S. Holmes
Project Foundations Engineer



K. G. Selby, P. Eng.,
Chief Foundations Engineer
(West)

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

| c_u (kPa) | 0 - 12 | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200 | > 200 |
|-------------|-----------|---------|---------|----------|------------|-------|
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | > 50 |
|----------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINTING AND BEDDING:

| SPACING | 50mm | 50 - 300mm | 0.3m - 1m | 1m - 3m | > 3m |
|----------|------------|------------|------------|---------|------------|
| JOINTING | VERY CLOSE | CLOSE | MOD. CLOSE | WIDE | VERY WIDE |
| BEDDING | VERY THIN | THIN | MEDIUM | THICK | VERY THICK |

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

| | | | |
|----|---------------------|----|---------------------------|
| SS | SPLIT SPOON | TP | THINWALL PISTON |
| WS | WASH SAMPLE | OS | OSTERBERG SAMPLE |
| ST | SLOTTED TUBE SAMPLE | RC | ROCK CORE |
| BS | BLOCK SAMPLE | PH | TW ADVANCED HYDRAULICALLY |
| CS | CHUNK SAMPLE | PM | TW ADVANCED MANUALLY |
| TW | THINWALL OPEN | FS | FOIL SAMPLE |

STRESS AND STRAIN

| | | |
|--------------------------------------|-----|-------------------------------|
| u_w | kPa | PORE WATER PRESSURE |
| r_u | 1 | PORE PRESSURE RATIO |
| σ | kPa | TOTAL NORMAL STRESS |
| σ' | kPa | EFFECTIVE NORMAL STRESS |
| τ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL STRESSES |
| ϵ | % | LINEAR STRAIN |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| μ | 1 | COEFFICIENT OF FRICTION |

MECHANICAL PROPERTIES OF SOIL

| | | |
|----------------|-------------------|--------------------------------------|
| m_v | kPa ⁻¹ | COEFFICIENT OF VOLUME CHANGE |
| C_c | 1 | COMPRESSION INDEX |
| C_s | 1 | SWELLING INDEX |
| C_α | 1 | RATE OF SECONDARY CONSOLIDATION |
| c_v | m ² /s | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| T_v | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| σ'_{vo} | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| σ'_p | kPa | PRECONSOLIDATION PRESSURE |
| τ_f | kPa | SHEAR STRENGTH |
| c' | kPa | EFFECTIVE COHESION INTERCEPT |
| ϕ' | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| c_u | kPa | APPARENT COHESION INTERCEPT |
| ϕ_u | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| τ_R | kPa | RESIDUAL SHEAR STRENGTH |
| τ_r | kPa | REMOULDED SHEAR STRENGTH |
| S_t | 1 | SENSITIVITY = $\frac{c_u}{\tau_r}$ |

PHYSICAL PROPERTIES OF SOIL

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



METRIC

W P 7615-84-01 LOCATION STA. 14 + 773 ⁰/s 7 m Lt. Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE Cont. Flt. H.S. COMPILED BY S.H.
DATUM Geodetic DATE 86 04 09 CHECKED BY _____

[illegible]

+3, x⁵: Numbers refer to Sensitivity

OFFICE* REPORT* ON* SOIL EXPLORATION



RECORD OF BOREHOLE No 2

METRIC

W P 7615-84-01 LOCATION STA. 14 + 776 0/s 10 m Rt. Proposed C ORIGINATED BY SH
DIST 11 HWY 518 BOREHOLE TYPE H.S. Cont. Flt. Augers / B Casing COMPILED BY SH
DATUM Geodetic DATE 86 04 10 / 15 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|--------------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | | | | | | |
| 336.2 | Ground Level | | | | | | | | | | | | | |
| | Silt with Fine Sand Trace of Organics Very Loose Grey Black | | 1 | SS | 2 | | 336 | | | | | | om 7.6 | 0 13 83 4 |
| | | | 2 | SS | 2 | | | | | | | | om 7.3 | 0 36 63 1 |
| 333.3 | | | 3 | SS | 1 | | 334 | | | | | | | 0 39 57 4 |
| 2.9 | Fine Sand and Silt, Trace of Organics Very Loose-Loose Grey-Black | | 4 | SS | 1 | | | | | | | | om 4.1 | 0 43 56 1 |
| | | | 5 | SS | 2 | | 332 | | | | | | | |
| | | | 6 | SS | 1 | | | | | | | | om 1.3 | 0 62 38 0 |
| | | | 7 | SS | 0 | | 330 | | | | | | | 0 50 50 0 |
| | | | 8 | SS | 0 | | | | | | | | | |
| | | | 9 | SS | 2 | | 328 | | | | | | | |
| | | | 10 | SS | 1 | | | | | | | | | |
| | | | 11 | SS | 1 | | 326 | | | | | | | 0 36 63 1 |
| 324.6 | | | 12 | SS | 1 | | | | | | | | | |
| 11.6 | Silt, Some Fine Sand Trace of Organics Loose Black | | 13 | SS | 1 | | 324 | | | | | | om 4% | 0 22 76 2 |
| 323.0 | | | | | | | | | | | | | 20.79 | |
| 13.2 | Fine Sand, Trace to Some Silt Loose to Compact Grey | | 14 | SS | 0 | | 322 | | | | | | | 0 72 28 0 |
| | | | 15 | SS | 5 | | 320 | | | | | | 20.59 | |
| | | | 16 | SS | 8 | | | | | | | | | |
| | | | 17 | SS | 15 | | 318 | | | | | | | |
| | | | 18 | SS | 55 | | 316 | | | | | | | 0 98 0 2 |
| | | | 19 | SS | 8 | | | | | | | | | |
| | | | 20 | SS | 13 | | 314 | | | | | | | |
| | | | | | | | 312 | | | | | | | |
| | | | | | | | 310 | | | | | | | |
| | | | | | | | 308 | | | | | | | |
| 306 | | | | | | | 306 | | | | | | | |

Continued

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

METRIC

W P 7615-84-01 LOCATION STA. 14 + 776 o/s 10 m Rt of Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE H.S. Cont. Flt. Augers/B Casing COMPILED BY S.H.
DATUM Geodetic DATE 86 04 10/15 CHECKED BY _____

[illegible]

+3, x5: Numbers refer to Sensitivity



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 7615-84-01 LOCATION STA. 14 + 739 o/s 4 m Lt. Proposed C
DIST 11 HWY 518 BOREHOLE TYPE H.S. Cont. Flt. Auger / B Casing
DATUM Geodetic DATE 86 04 16/22
ORIGINATED BY S.H.
COMPILED BY S.H.
CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|-------------|--|---------|------|------------|----------------------------|-----------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | | | | | | |
| | | | | | | | | SHEAR STRENGTH | | | | | | |
| | | | | | | ○ UNCONFINED | + FIELD VANE | | | WATER CONTENT (%) | | | | |
| | | | | | | ● QUICK TRIAXIAL | x LAB VANE | | | 20 40 60 | | | | |
| 335.9 | 0.0 | Organic Silt Very Soft | | 1 | SS | 4 | | | | | | | | |
| 333.9 | 2.0 | Fine Sand Trace to Some Silt Trace of Organics Very Loose | | 2 | SS | 2 | | | | | | | | |
| | | | | 3 | SS | 2 | | | | | | | | |
| | | | | 4 | SS | 1 | | | | | | | | |
| | | | | 5 | SS | 2 | | | | | | | | |
| | | | | 6 | SS | 2 | | | | | | | | |
| | | | | 7 | SS | 2 | | | | | | | | |
| | | | | 8 | SS | 2 | | | | | | | | |
| | | Grey-Black | | 9 | SS | 2 | | | | | | | | |
| 328.4 | 7.5 | Fine Sand and Silt Trace Organics Very Loose Grey-Black | | 10 | SS | 3 | | | | | | | | |
| | | | | 11 | SS | 5 | | | | | | | | |
| | | | | 12 | SS | 4 | | | | | | | | |
| | | | | 13 | SS | 2 | | | | | | | | |
| | | | | 14 | SS | 2 | | | | | | | | |
| | | | | 15 | SS | 3 | | | | | | | | |
| 321.0 | 14.9 | Silt, Some Fine Sand Very Loose Black | | 16 | SS | 2 | | | | | | | | |
| | | Trace of Organics | | 17 | SS | 3 | | | | | | | | |
| 318.1 | 17.8 | Gravel and Coarse Sand Loose to Compact | | 18 | ST | 14 | | | | | | | | |
| | | | | 19 | | | | | | | | | | |
| | | | | 20 | | | | | | | | | | |
| | | | | 21 | | | | | | | | | | |
| | | | | 22 | | | | | | | | | | |
| | | | | 23 | SS | 100A 35mm | | | | | | | | |
| | | | | 24 | ST | 8 | | | | | | | | |
| | | | | 25 | SS | 20 | | | | | | | | |
| 308.7 | 27.2 | End of Borehole | | | | | | | | | | | | |
| 305.7 | | | | | | | | | | | | | | |

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3

METRIC

W P 7615-84-01 LOCATION STA. 14 + 739 °/s 4 m Lt Proposed C ORIGINATED BY SH
DIST 11 HWY 518 BOREHOLE TYPE Cone Test From Bottom B Casing COMPILED BY SH
DATUM Geodetic DATE 86 04 16 / 22 CHECKED BY _____

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|---------------|------------------|------------|---------|------|------------|----------------------------|--------------------|--|---|---------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | | |
| 305.7 | Continued | | | | | | | | | | | |
| | | | | | | | 304 | | | | | |
| | | | | | | | 302 | | | | | |
| | | | | | | | 300 | | | | | |
| | | | | | | | 298 | | | | | |
| | | | | | | | 296 | | | | | |
| | | | | | | | 294 | | | | | |
| 292.0 | | | | | | | | | | | | |
| 43.9 | End of Cone Test | | | | | | | | | | | |



METRIC

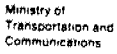
W P 7615-84-01 LOCATION STA. 14 + 744 o/s 11 m Rt Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE Cone Test COMPILED BY S.H.
DATUM Geodetic DATE 86-04-23 CHECKED BY _____

[illegible]

Continued

+3, x5: Numbers refer to Sensitivity

Continued



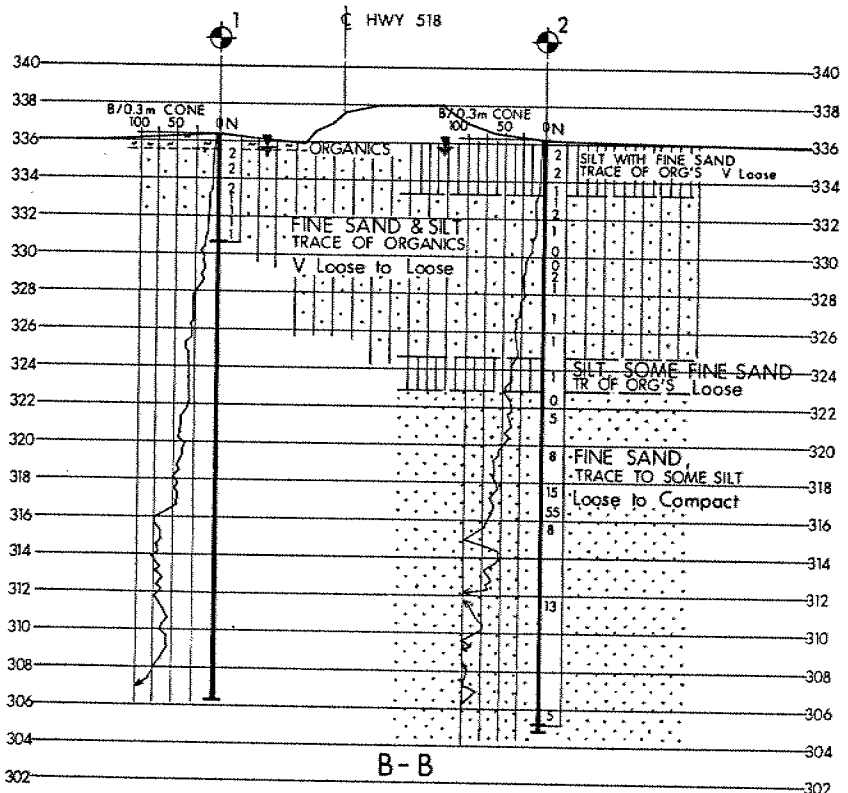
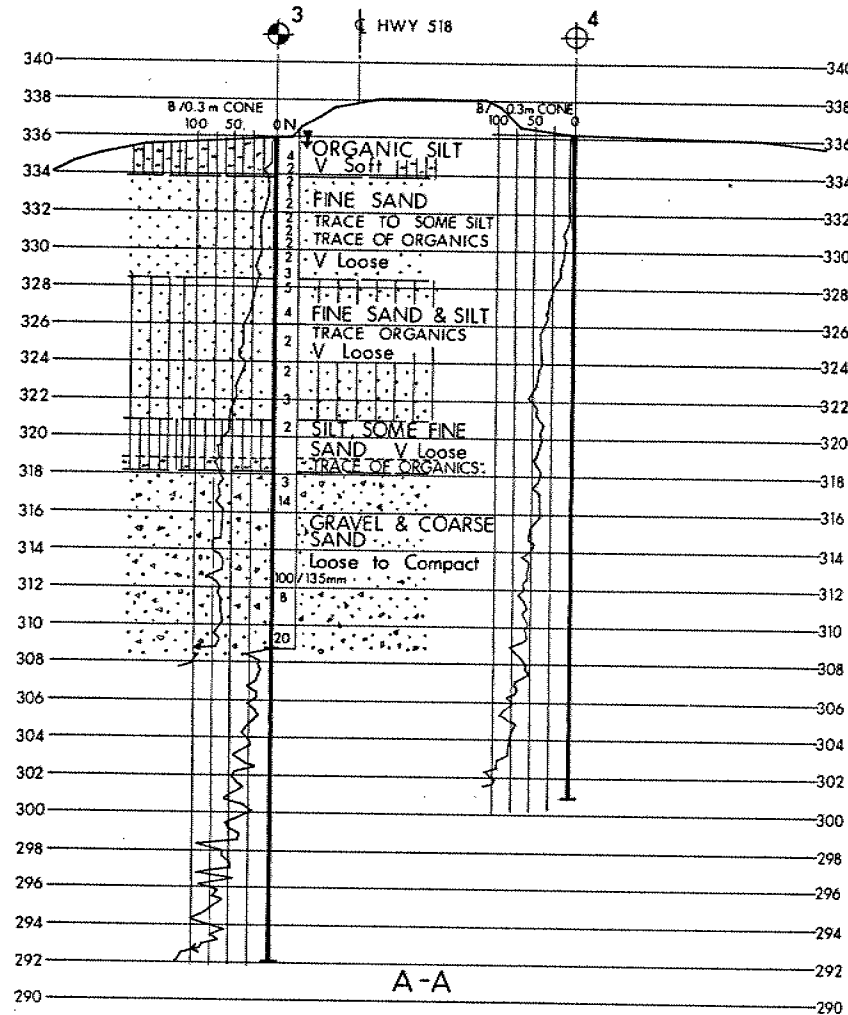
METRIC

W P 7615-84-01 LOCATION STA. 14 + 744 °/s 11 m Rt Proposed C ORIGINATED BY S.H.
DIST 11 HWY 518 BOREHOLE TYPE Cone Test COMPILED BY S.H.
DATUM Geodetic DATE 86 04 23 CHECKED BY _____

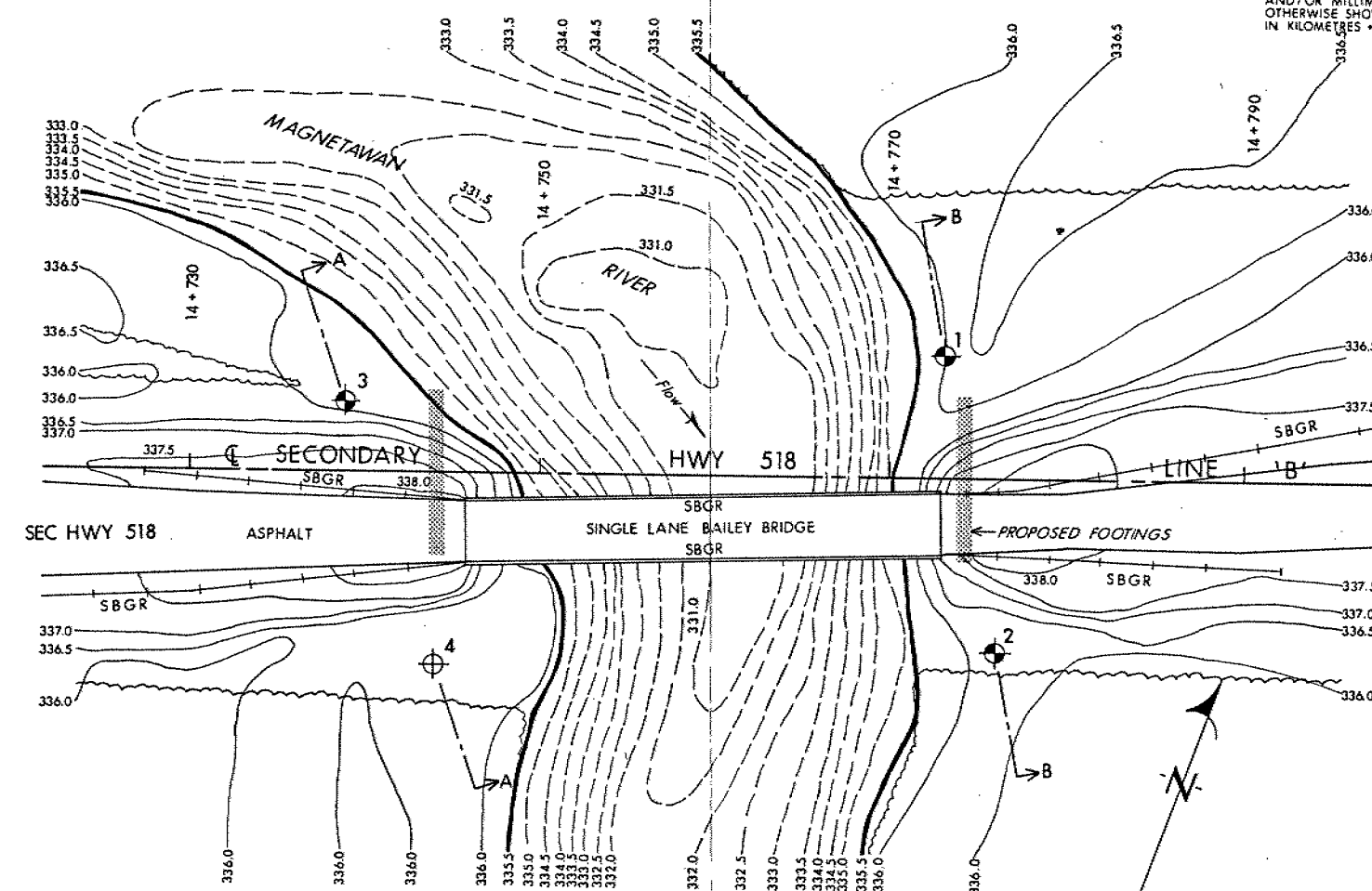
| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|------------------|------------|--------|------|-------------------------|-----------------|--|----|---|----|----|-------------|---------------------------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 | 40 | 60 | 80 | | |
| 306 | Continued | | | | | | SHEAR STRENGTH | | WATER CONTENT (%) | | | | |
| | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | | | |
| | | | | | | 304 | | | | | | | |
| | | | | | | 302 | | | | | | | |
| 300.8 | | | | | | | | | | | | | |
| 35.4 | End of Cone Test | | | | | | | | | | | | |

+3, x5: Numbers refer to Sensitivity

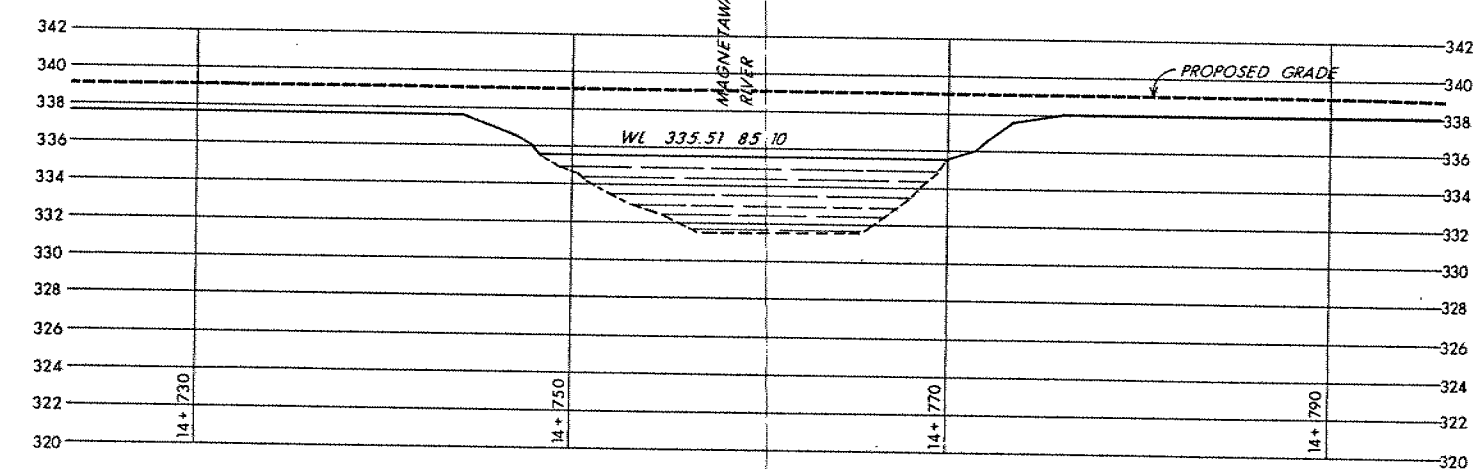
OFFICE 'REPORT' ON SOIL EXPLORATION



SECTIONS
SCALE
4m 2 0 4m



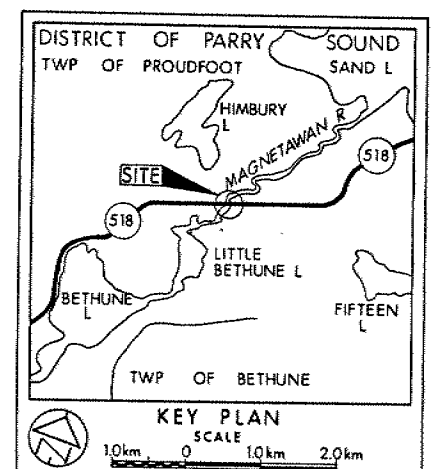
PLAN
SCALE
4m 2 0 4m



PROFILE HWY 518
SCALE
4m 2 0 4m

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 7615-84-01
MAGNETAWAN RIVER BRIDGE
BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 86 04

| No | ELEVATION | STATION | OFFSET |
|----|-----------|----------|----------|
| 1 | 336.4 | 14+773.0 | 7.0m Lt |
| 2 | 336.2 | 14+776.0 | 10.0m Rt |
| 3 | 335.9 | 14+739.0 | 4.0m Lt |
| 4 | 336.2 | 14+744.0 | 11.0m Rt |

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

| REV. | DATE | BY | DESCRIPTION |
|------|----------|----|-------------|
| 1 | 86 06 13 | | |

Geocres No 31E-100

| | | | |
|---------------------|---------|---------------|----------------|
| HWY No 518 LINE 'B' | CHECKED | DATE 86 06 13 | SITE 44-128 |
| SUBM'D SH | CHECKED | APPROVED | DWG 76158401-A |
| DRAWN DT | CHECKED | | |

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. 11

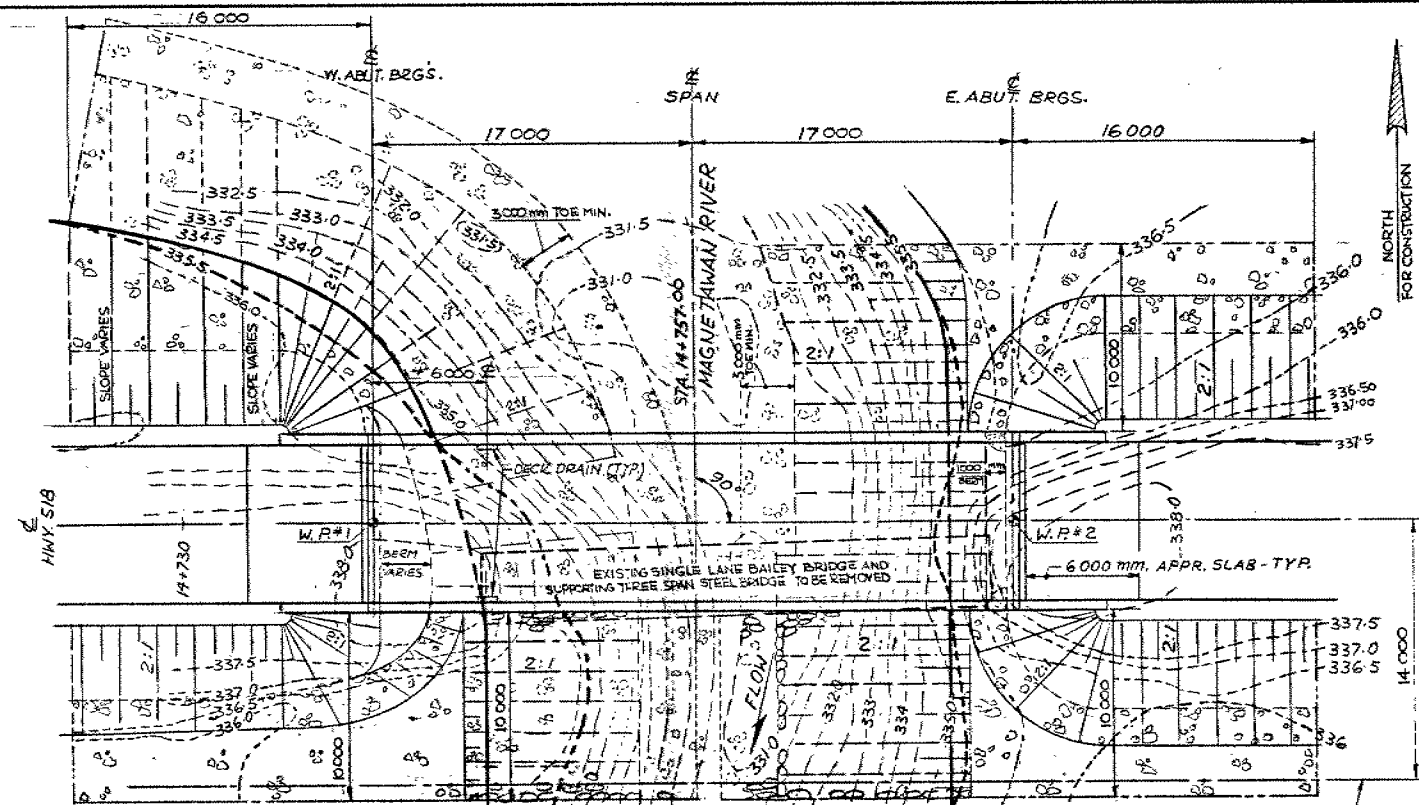
CONT No

WP No 7615-84-02

MAGNETAWAN RIVER BRIDGE
5.8 Km E. OF KEARNEY
GENERAL ARRANGEMENT



SHEET



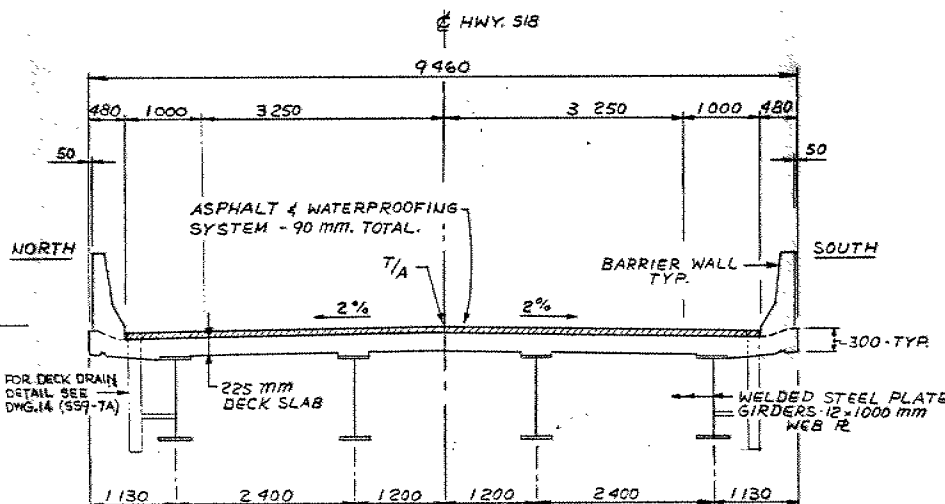
W.P. #1 STA. 14+740.000
EL. 339.003 T/A
W.P. #2 STA. 14+774.000
EL. 339.321 T/A

NOTE:
W.P. DENOTES WORKING POINT
T/A DENOTES TOP OF ASPHALT

PLAN

SCALE - 1:200

NOTE: FOR EXTENT OF EXCAVATION
SEE GRADING DRAWING.



CROSS SECTION

SCALE 1:50

GENERAL NOTES

CLASS OF CONCRETE:

FOOTINGS - 30 MPa
REMAINDER - 30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS - 100 ± 25 mm

ABUTMENTS & WINGWALLS:

FRONT FACE - 80 ± 20 mm
BACK FACE - 70 ± 20 mm

DECK:

TOP - 70 ± 20 mm
BOTTOM - 40 ± 10 mm

BARRIER WALLS

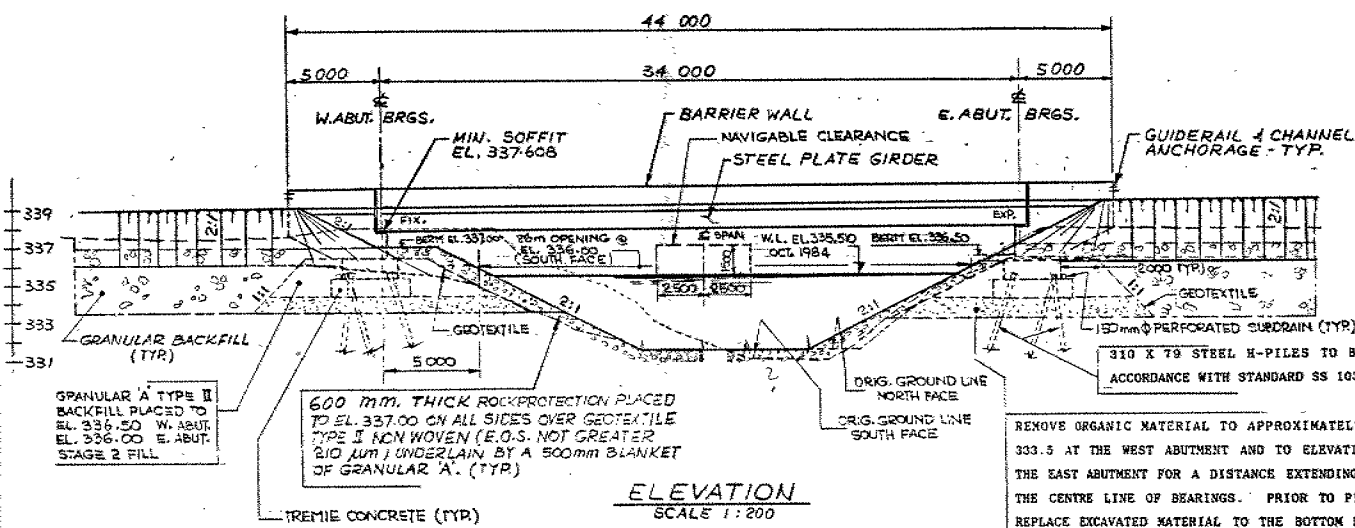
APPROACH SLABS - 70 ± 20 mm
UNLESS OTHERWISE NOTED ON DRAWINGS.

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.

CONSTRUCTION NOTES

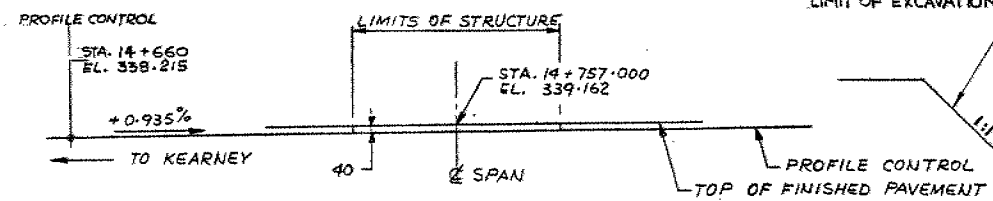
THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3 mm.



ELEVATION

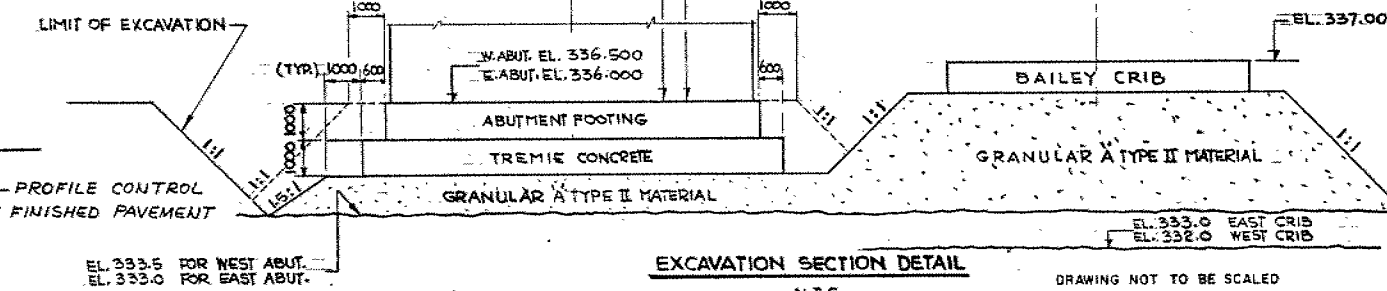
SCALE 1:200

M.T.C. B.M. 788-126
TABLET SET IN ROCK
9.9 R.I. 13+708.0
ROUTE 170



PROFILE OF HWY. 518

N.T.S.



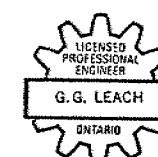
EXCAVATION SECTION DETAIL

N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

LIST OF DRAWINGS

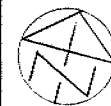
- 44-1253-128-1 GENERAL ARRANGEMENT
- 2 BORE HOLE LOCATION & SOIL STRATA
- 3 FOOTINGS
- 4 ABUTMENTS
- 5 STRUCTURAL STEEL
- 6 SPLICE DETAILS & BEARINGS
- 7 DECK
- 8 BARRIER WALL
- 9 JOINT ANCHORAGE AND ARMOURING
- 10 6000 mm APPROACH SLAB
- 11 BRIDGE DATE & SITE NUMBER DATA
- 12 PILE DRIVING - STEAM & DIESEL HAMMERS
- 13 AS CONSTRUCTED ELEV. & DIM.
- 14 STANDARD DETAILS
- 15 QUANTITIES - STRUCTURE I
- 16 QUANTITIES - STRUCTURE II



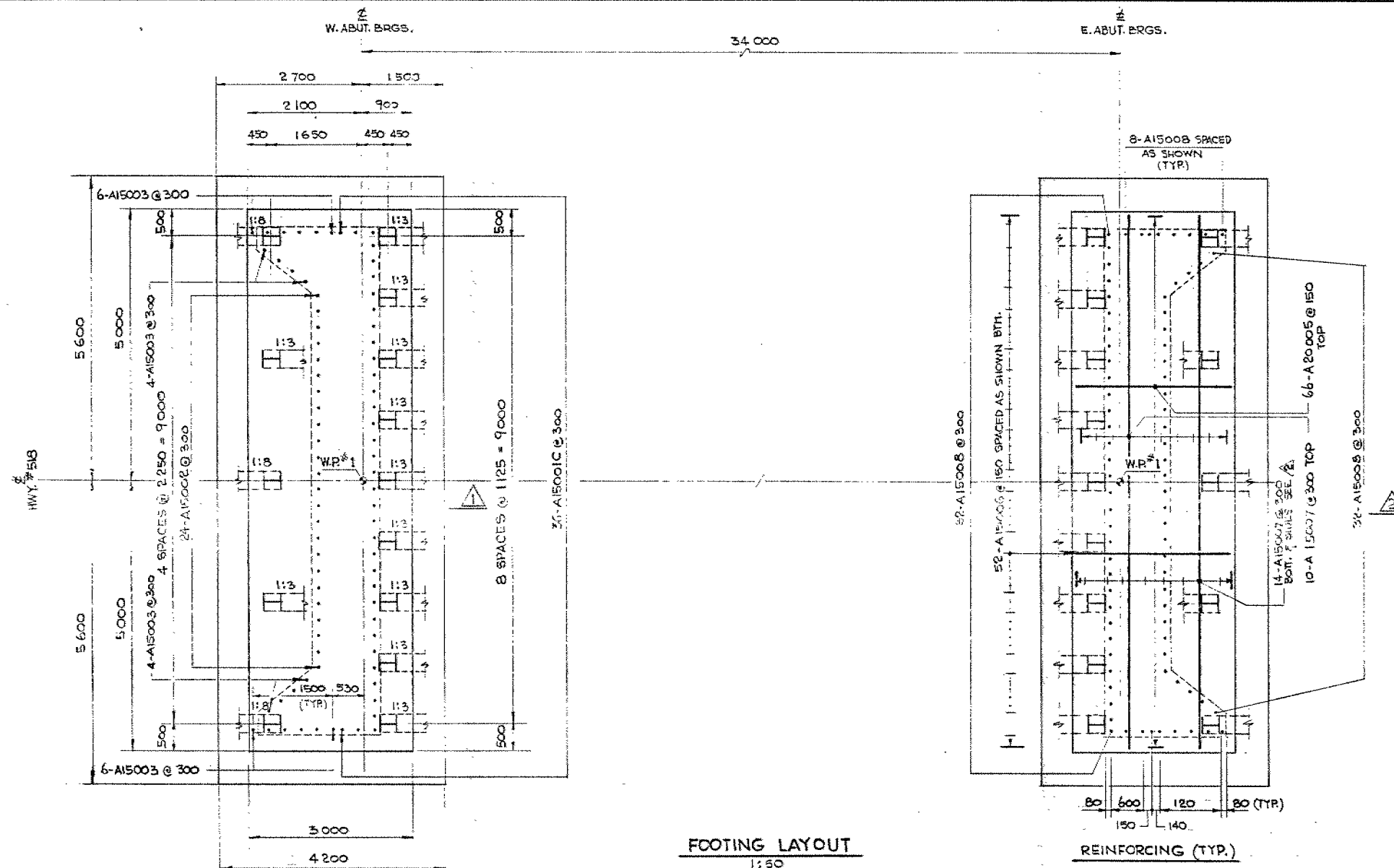
| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----|------------------------|
| DESIGN | | | LOADING O.H.B.D.C-1-83 |
| CHECK | | | SITE No 44-1253-128 |
| DWG | | | |

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. 11
CONT No
WP No 7615-84-02
MAGNETAWAN RIVER BRIDGE
5.8km E. OF KEARNEY
FOOTINGS



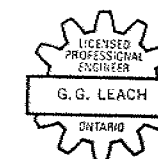
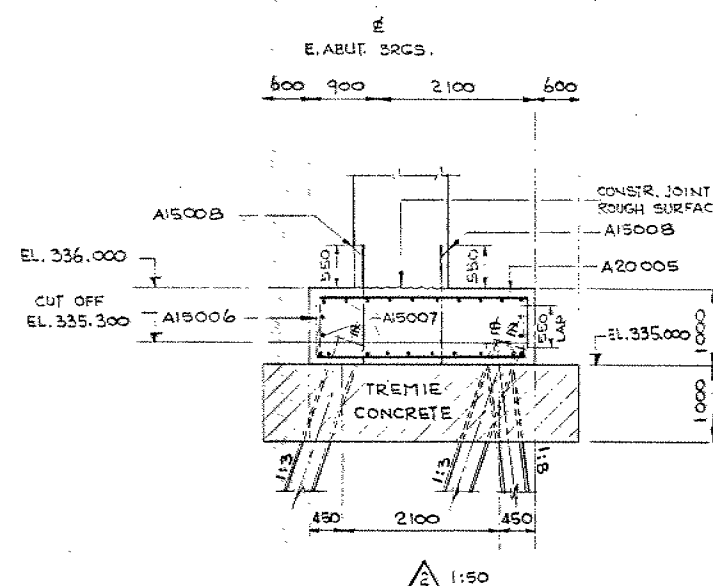
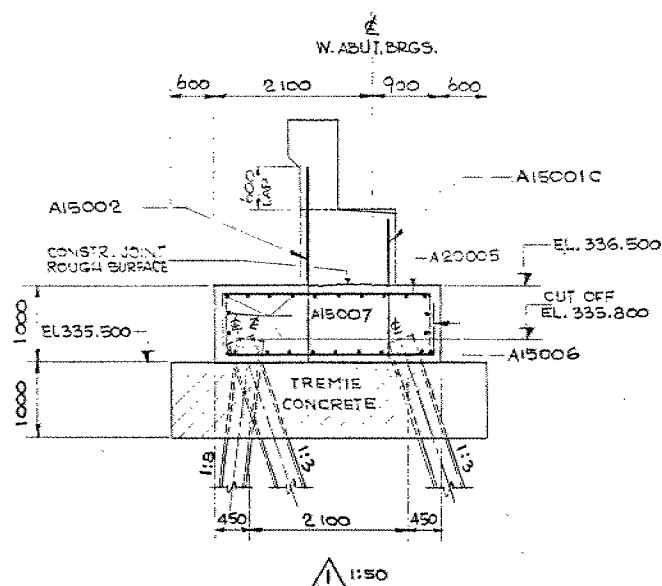
SHEET



| LOCATION | TYPE | N° REQ'D. | LENGTH | PILE DESIGN DATA | | REMARKS |
|---------------|-------------|-----------|--------|-----------------------|----------------------------|--------------------|
| | | | | LOAD @ S.L.S. TYPE II | FACTORED CAPACITY @ U.L.S. | |
| WEST ABUTMENT | HP 310 x 79 | 14 | 32 000 | 535 KN/PILE | 750 KN/PILE | WITH DRIVING SHOES |
| EAST ABUTMENT | HP 310 x 79 | 14 | 32 000 | 535 KN/PILE | 750 KN/PILE | WITH DRIVING SHOES |

NOTES:

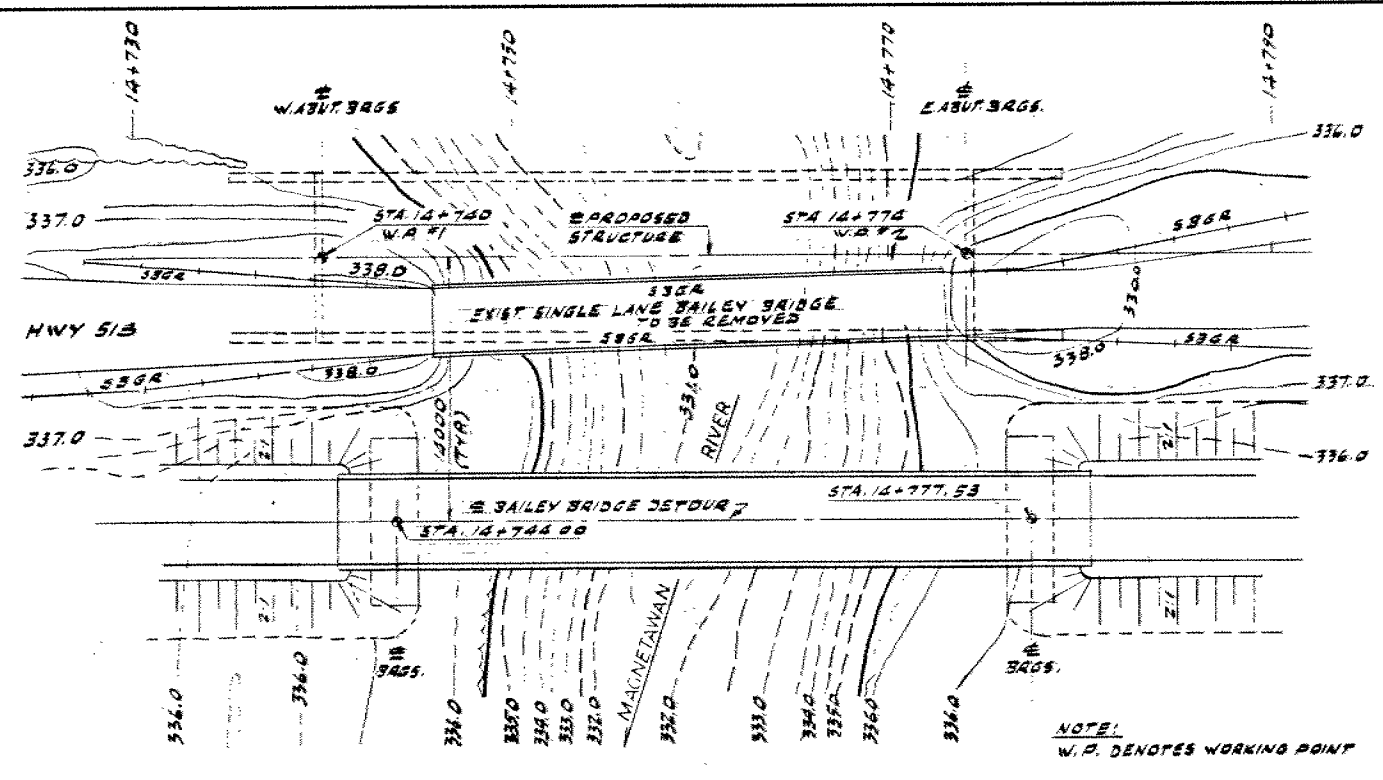
- FILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS 103-11 USING AN ULTIMATE CAPACITY OF 1605 KN PER PILE BUT MUST BE DRIVEN BELOW ELEVATION 305.000.
- DRIVING SHOES SHALL BE INSTALLED ON ALL PILES IN ACCORDANCE WITH STANDARD DD-3301.
- PILE SPACING IS MEASURED AT THE UNDERSIDE OF FOOTING.
- PILE LENGTH SHOWN IS THE THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.



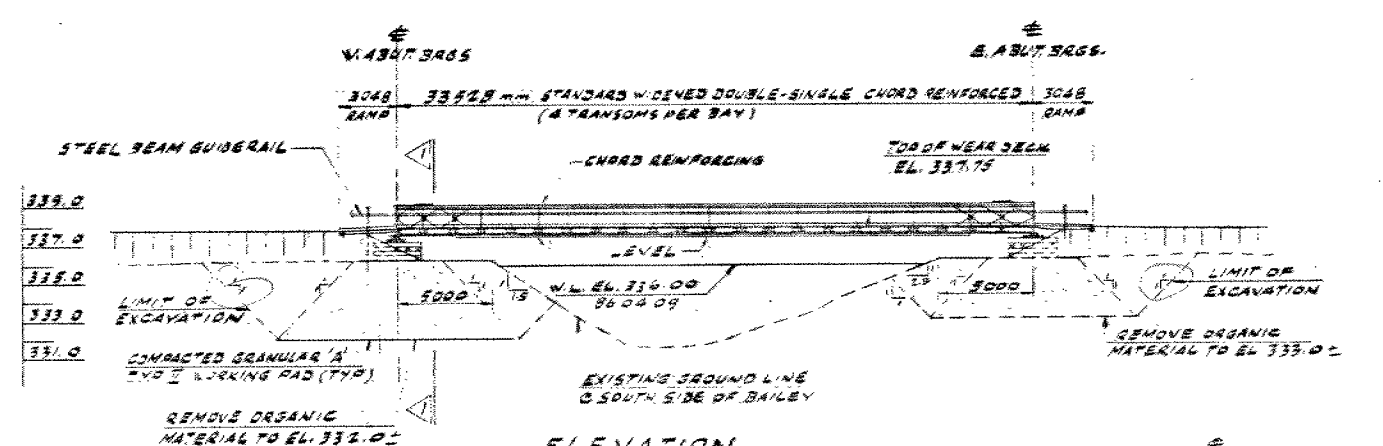
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|-------|----------------------------------|
| DESIGN | | CHECK | LOADING CHBDC-C1-83 DATE JAN. 87 |
| DRAWING | | CHECK | SITE No 44-1253-128 DWG 3 |

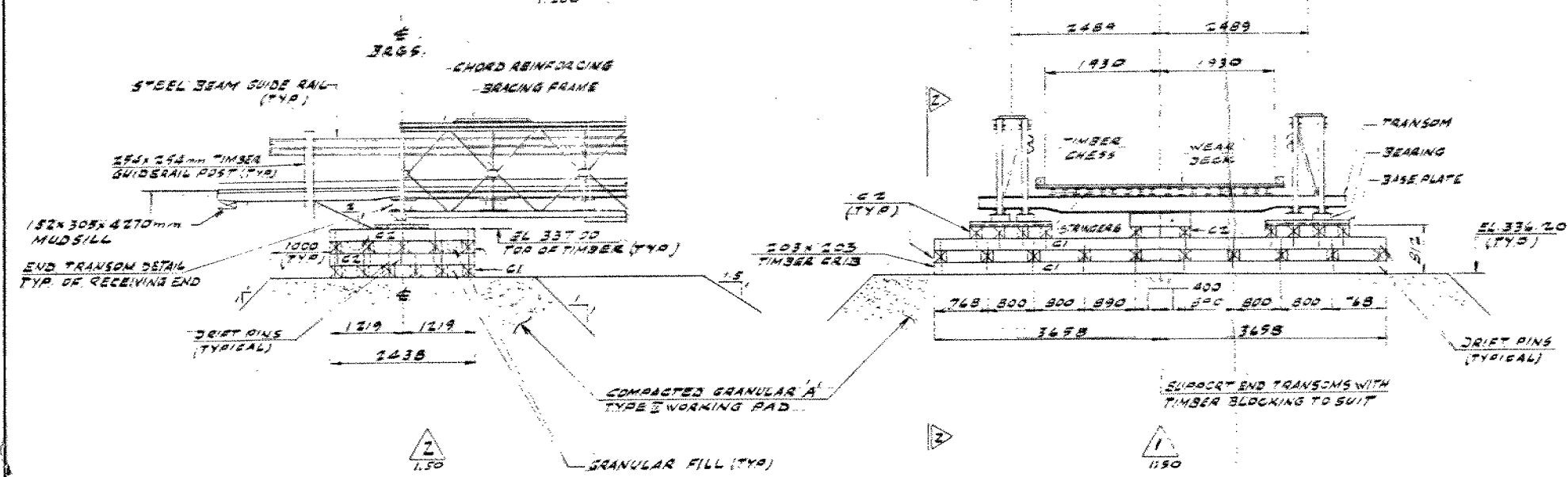
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO



PLAN
1:200



ELEVATION
1:200



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

| | | |
|---|---------------|-------|
| DIST. 11 | CONT No | SHEET |
| WP | No 7615-84-02 | |
| MAGNETAWAN RIVER BAILEY BRIDGE 5.9 km East of KEARNEY GENERAL ARRANGEMENT | | |

NOTES TO CONTRACTOR:

1. DECKING TO BE INSTALLED AS SHOWN ON DD-5001.
2. GUIDE RAIL TO BE INSTALLED (AS APPROVED BY THE ENGINEER).
3. TIMBER SHALL BE NO. 2 STRUCTURAL GRADE, TO BE SUPPLIED IN ACCORDANCE WITH CSA STD. D141, HEM-FIR SPECIES, OR EQUAL SHALL BE USED FOR CRIBS, WITH JACK PINE SPECIES, OR EQUAL USED FOR DECK, CHESSE AND CURBS.
4. DRIET PINS SHALL BE PLACED INTO PRE-DRILLED HOLES WITH THE DIAMETER 2 mm SMALLER THAN DRIET PIN DIAMETER (356 mm LENGTH).
5. GRANULAR FILL IN TIMBER CRIBS TO BE PLACED AS CRIB IS CONSTRUCTED.
6. BACKFILL NOT TO EXCEED EL. 337.0 PRIOR TO PLACING BAILEY.
7. ERECTION AND LAUNCHING
 - (i) THE CONTRACTOR SHALL NOT ASSEMBLE, LAUNCH OR DELAUNCH THE BAILEY UNTIL THE LAYOUT AND ELEVATIONS OF THE LAUNCHING AND CONSTRUCTION ROLLERS HAVE BEEN APPROVED BY THE ENGINEER. DOUBLE ROLLERS SHALL BE USED AT ALL LOCATIONS.
 - (ii) THE TOPS OF THE ROLLERS SHALL ALL BE AT THE SAME ELEVATION, UNLESS SPECIFIED OTHERWISE ON THE DRAWINGS.
 - (iii) THE TOPS OF THE ROLLERS SHALL BE LEVELLED ACROSS IN PAIRS AT RIGHT ANGLES TO THE CENTRE LINE OF THE STRUCTURE.
8. (i) THE LAUNCHING NOSE SHALL CONSIST OF 4 BAYS OF SINGLE-SINGLE SKELETON AND 1 BAY OF DOUBLE-SINGLE SKELETON CONSTRUCTION.
- (ii) THE LAUNCHING LINKS SHALL BE INSERTED 3 BAYS FROM TIP OF NOSE.
- (c) (i) ALL PINS, BOLTS AND THREADED PARTS SHALL BE FREE OF DIRT AND BE LUBRICATED AT THE TIME OF INSTALLATION.
- (ii) TRANSOM CLAMP TIGHTENING BARS SHALL BE WIRED TO THE PANEL VERTICALS. SWAY BRACES SHALL BE FULLY TIGHTENED TO GAUGE BLOCKS AND ALL LOCK NUTS SECURED.
- (iii) ALL PANEL PINS ON STRUCTURE SHALL BE KEYS.
- (d) WEAR DECK SHALL BE INSTALLED AFTER LAUNCHING.

5. ADDITIONAL NOTES FOR CHORD REINFORCED BRIDGES

- (A) BRACING FRAME BOLTS SHALL BE INSTALLED IN THE REINFORCING CHORDS PRIOR TO THE CHORDS BEING INSTALLED ON THE PANELS.
 - (B) TAPERED CHORDS SHALL BE USED FOR LAUNCHING AND DELAUNCHING.
- ## 9. MAINTENANCE
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE MAINTENANCE OF THE STRUCTURE AND APPROACHES, INCLUDING THE FOLLOWING:
- (A) CHECK THAT ALL BRACING BOLTS, CHORD BOLTS, TRANSOM CLAMPS ARE, AND REMAIN, FULLY TIGHTENED.
 - (B) KEEP BASEPLATES AND BEARINGS FREE OF DEBRIS, INSPECT BASEPLATES AND CRIBS PERIODICALLY AND CORRECT ANY UNEVEN SETTLEMENT TO THE SATISFACTION OF THE ENGINEER. PACKING UNDER END TRANSOM AND RAMPS MUST BE KEPT TIGHT.
 - (C) NOTIFY THE ENGINEER IMMEDIATELY OF ANY DAMAGES.

| REVISIONS | DATE | BY | DESCRIPTION | DATE |
|-----------|------|-------|--------------------|--------------|
| DESIGN | | CHECK | LOADING HS-20 | DATE 7/11/97 |
| DRAWING | | CHECK | SITE No 44-1233-24 | DWG 51 |

memorandum



Mr. K. L. Williams
To: Head, Planning & Design Section
Northern Region

Date: 87 05 26

Phone 1-705-472-7900
Ext. 286, 7

Attention: Wayne Barker

FROM: Geotechnical Section
Northern Region

Magnetawan River Bridge WP 7615-84-01

The Foundation Investigation and Design Report for this work project has been reviewed by this Office. The recommendations of the original Soils Design Report are amended as follows:-

Section 4.0, Organic Deposits - The revised limit of excavation shall be elevation 333.5 on the west approach and 333.0 on the east approach.

Section 13.0, Detour Construction - (iv) Support Crib Area

The limit of excavation shall be identical to Section 4.0 as noted above.

The Foundation Report recommends the excavation proceed from the river banks. The point was discussed with Mr. K. G. Selby, P. Eng., Chief Foundations Engineer, on 86 08 28. The intention of this recommendation was to define the area of excavation in relation to the stream banks and not necessarily the construction sequence.

This Office recommends that the excavation commence from the taper point to full depth approaching the river banks. The excavation and required backfill should be sequential to minimize side slope erosion. The existing river bank should be maintained, if possible, to prevent scour of the granular backfill as well as probable environmental concerns which would result from the excavated organics entering the river.

A handwritten signature in dark ink, appearing to read "K. W. Crowder".

K. W. Crowder
Pavement Design &
Evaluation officer

KWC/ap

cc: B. Roberts
D. F. Barnes
S. McCombie
D.O. White (2)
G. Szekreny
J. H. Peer
A. G. Kelly
G. A. Wrong
K. G. Selby
File (2)



memorandum



Tel: 3731

To: S. McCombie
Head, Structural Section
North Bay

Date: 1987 03 12

From: Foundation Design Section
Room 315, Central Building

RE: Magnetawan River Bridge
Secondary Hwy. #518
W.P. 7615-84-02; Site 44-1253-128
District #11 (Huntsville)

We have reviewed the final structural drawings (#1, #3 and B1) for the above project and have no comments to offer from the design viewpoint.

A handwritten signature in dark ink, appearing to read "K.G. Selby".

K.G. Selby, P. Eng.
Chief Foundations Engineer
(West)

c.c. - A. Radkowski

memorandum



Tel: (416) 248-3506

To: Mr. S. McCombie,
Head, Structural Section,
Northern Region, North Bay.

Date: Sept. 24, 1986.

SUBJECT: Site 44-1253-128, W.P. 7615-84-02,
Magnetawan River Bridge,
Secondary Road 518, District 11.

Attached is the General Arrangement Drawing 44-1253-128-P1
for the above-mentioned structure.

The estimated cost of the proposed structure is \$350,000.00
which includes tender, materials, engineering and sundry
construction. The cost of Bailey Bridge detour is not
included.

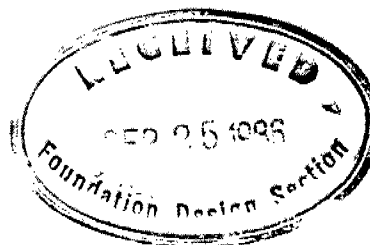
Any comments or revisions you may have should be submitted
at your earliest convenience.

AR/cf
Attch.

A. Radkowski

A. Radkowski,
Design Engineer (N/NW),
Structural Office.

c.c. R. Dorton
K. Bassi
K. Kleinsteinber
R. Reel
B. Richardson
W. McFarlane
W. Lin
M. Holowka
A. Radkowski
✓K. Selby
J. Anderson
L. Argo



COMMENTS

- 1.) THE DRAWING SHOULD INDICATE THE PILE SIZE AND DRIVING SHOES
- 2.) THE MATERIAL IN THE PAD UNDER THE PIER CONCRETE SHOULD BE GRANULAR 'A' TYPE II.
- 3.) THE SCOUR PROTECTION SHOULD EXTEND INTO THE RIVER FOR A MINIMUM DISTANCE OF 3m FROM THE TOES OF THE BANKS.
- 4.) IN OUR OPINION, THE GEOTEXTILE BETWEEN THE ROCK PROTECTION AND GRANULAR 'A' BLANKET NOT REQUIRED.
- 5.) A CONSTRUCTION SEQUENCE CONCERNING SUBEXCAVATION, BACK FILLING OPERATION AND FOOTING CONSTRUCTION SHOULD BE SHOWN ON DRAWING.

P. Taylor

memorandum



To: Mr. J. C. McAllister,
Senior Structural Engineer,
Structural Section,
NORTHERN REGION - North Bay

Date: 86 09 29

From: Engineering Materials Office,
Foundation Design Section,
Central Building, Room 315

Re: Foundation Investigation for W. P. 7615-84-01
Site No: 44-128, Magnetewan River Bridge,
6.1 km East of Kearney Secondary Road 518,
District #11, Huntsville

Further to our recent telephone conversation with Mr. S. McCombie we are providing you with a summary of the results of our foundation investigation at the above-mentioned site. We are also providing all recommendations required for purposes of foundation design of the structure and approaches. Should additional information be required however, please contact this office. Our complete report will be forwarded to you in the near future.

Subsurface Conditions:

Three sampled boreholes and four dynamic cone penetration tests were carried out at the site. Sampling was performed to a maximum depth of 31 m to elevation 305 m and cone tests to a maximum depth of 44 m to elevation 292 m. Subsoil was found to consist of deposits of fine sand and silt mixed in varied proportions. The denseness of the deposit was found to be very loose to loose in the upper part gradually increasing with depth to a compact to dense condition. The upper two to three metres contains substantial quantities of organic particles giving this zone a brown to black colour and a slight to low plasticity. Groundwater in the borings was found to be at the same level as the Magnetewan River at elevation 335.6.

Recommendations:

The existing structure at the site is to be replaced by a 30 m single span bridge. Profile grade will be raised slightly to elevation 339. The new \mathcal{Q} will be approximately 3 m north of the existing \mathcal{Q} . The height of the approach embankments will be about 8 m above the river bed. The average river bank level is about 4.5 m above the river bed.

Structure:

The new structure should be founded on Steel H Piles driven to approximate elevation 306 m. At this depth it is estimated that the piles will achieve a safe capacity of 535 kN each. Pile driving should be in accordance with MTC Standards SS 103-10 and SS 103-11.

Re: Foundation Investigation for W. P. 7615-84-01
Site No: 44-128, Magnetewan River Bridge,
6.1 km East of Kearney Secondary Road 518,
District #11, Huntsville

The required ultimate pile capacity is 1605 kN. For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S. 750 kN
Capacity at S.L.S. Type II 535 kN

Earth pressure should be computed as per Subsection 6.6.1.2.2 of the Code. A yielding foundation condition may be assumed. The following properties of granular backfill may be used for computations:


Granular 'A' $\gamma = 22.8 \text{ kN/m}^3$ $\phi = 35^\circ$ $K_A = 0.271$
Granular 'B' $\gamma = 21.2 \text{ kN/m}^3$ $\phi = 30^\circ$ $K_A = 0.333$

Pile caps should have a minimum of 1.8 m of earth cover for frost protection.

Concrete should be placed in the 'dry'. A dewatering scheme will be required for footing excavations below the groundwater level. Subsoil at this site is highly susceptible to conditions of unbalanced hydrostatic head and will 'boil' under such conditions.

Approaches:

Approximately 2 to 3 m of organic soil is located immediately below the original ground surface. This material should be removed and replaced for the full width of the embankment with non-cohesive fill material from the toes of the river banks to 16 m behind the abutments & of bearings. No fill containing grain sizes larger than 75 mm should be placed at locations where piles are to be driven. Subsoil in the river banks and bed is highly susceptible to scour action and rip-rap protection should be provided up to H.W.L. for a minimum distance of 50 m upstream and 25 m downstream. This protection should also extend into the river for a distance of at least 3 m in front of the toes of the river banks. For the approaches constructed in accordance with the foregoing 2:1 side and forward slopes are recommended. 1 3/4 : 1 slopes may also be used provided that the outer 3 m of the embankments (including backfill to the subexcavations) above elevation 332 consists of Granular 'A'.



K. G. Selby,
Chief Foundations Engineer
(West)

KGS:ma

cc: K. Bassi