

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 31F-111

DIST. 10 REGION

W.P. No. 81-83-01

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 41

LOCATION CULVERT, TOWNSHIP OF

DENBIGH

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
of
Transportation

FILE No. _____ **DATE** _____

REMARKS _____

(613) 545-4862 Ted Phillips

From: Ted Phillips
To: MTOHO3.TES.Dundas
Date: 1/10/96 5:37pm
Subject: Culvert Recommendations - Highway 41

As a followup to the recent technical review for W.P. 293-63-02, could you please examine the recommendations provided in a memo dated 91 09 26 addressed to Sam Cheng of this office, and signed by D. Kwok & D. Dundas. The title was Culvert Review, Township of Denbigh, W.P.81-83-01, Site N/A, Hwy. 41, Dist.10, Bancroft.

On Page 5 of this memo 0.6 m rock protection as per OPSD 810.01 Type A is requested to extend for 10 m along the channel, at both ends, to prevent undercutting of the culvert bed. Environmental Unit has expressed a concern that this length may actually be deemed as significant fish habitat alteration and require some sort of compensation under the Fisheries Act. Before they proceed with negotiations I have been asked to enquire if we could live with a shorter length of protection at this site. For example, P&D often uses a total length of 3.0 m of protection from the High water level.

FYI we have already received a number of concessions from Environmental regarding construction staging, maintenance of water flow etc. that allow us to proceed as designed.

CC: McLatchi, Rose

(613) 544-2220

I telephoned Ted Phillips and advised him that a hydrological review would be required to accurately determine the extent of scour protection.

As a general guideline, I informed Ted that the extent should be a minimum of 2 x culvert width.

96 01 16
Tony Sanguineto

memorandum



To: Mr. Sam Cheng
Head
Geotechnical Section
Eastern Region
Attention : Mr. Robert Scott

Date: 91 09 26

From : Foundation Design Section
Room 315, Central Building

Re : Culvert Review
Township of Denbigh
W.P.81-83-01, Site N/A
Hwy. 41, District 10, Bancroft

The field investigation for the above-noted project has been completed. This is a memo-report to summarize the subsurface conditions encountered at the site and to provide engineering discussions regarding the existing condition of the culvert. Recommendations pertaining to the design and construction of a replacement culvert are also given.

The site is located on Highway 41, about 5 km south of Denbigh, in the District of Bancroft. It lies in the physiographical region known as Algonquin Highlands (after Chapman and Putnam, 1984) and consists of mainly bare rock ridges and shallow sandy till, and valleys floored with sand and gravel outwash.

According to the information provided by your section, this portion of the roadway was constructed under Contract 59-211, paved under Contract 61-30 and resurfaced under Contract 74-14. The existing embankment is about 2.5 m high with 2H:1V to 3H:1V slopes. An existing culvert runs across the highway and connects the ponds on each side of the embankment. Strata Engineering Corp produced a culvert review report for your Section in March, 1991. As described in their report, the pavement on the south bound lane at the culvert location has shown signs of distress including cracks and settlements. A borehole sunk at the distressed area indicated layers of asphalt patches laid in the past, suggesting some progressive settlements occurring at this location. The area has now been patched up.

The existing culvert is a 1.22 m X 25.0 m (measured to be 1.524 m by MTO surveyors) corrugated steel pipe and runs from Station 17+238 left to 17+242 right. The gradient of the culvert is generally flat and it is apparently there to balance the water levels of the ponds on the two sides. As observed on site, the pipe has buckled under the area where settlement of the roadway has taken place. Apparently, the pipe is broken at that point as a pile of granular fill material has accumulated inside the pipe below the buckled area.

The field work was conducted between 91 08 13 and 91 08 15 and consisted of two (2) sampled boreholes taken down to 6.7 m and 9.4 m depths. Dynamic cone penetration tests were carried out in each of the holes to assess the strength of the subsoil. The locations of the holes are shown in Figure 1.

Reference is made to Figure 2 for the stratigraphical profile at the culvert location and the Record of Borehole sheets for subsurface details and laboratory test results. The subsurface stratigraphy typically comprised a 4.3 m to 8.1 m of granular fill overlying a thin layer (about 1 to 2 m) of organic material. Underlying the organic layer was the native sand/silt deposit. The overburden was not penetrated at the maximum depth of 9.4 m in the two boreholes advanced.

BH 1 was located at mid-slope on the east side of Highway 41, at about elevation 393.7 m. The granular fill was found to extend to 389.4 m, some 2 m below the bottom of the culvert. The material was a non-cohesive fill composed of fine to coarse sand, some gravel and scattered boulders and cobbles, and was generally in a loose to compact state according to the Dynamic Cone Penetration test results. Underlying the granular fill was a 1.8 m layer of compressible organic silt with wood fibres. It was intermixed with some granular fill material. During construction of the roadway, granular fill was probably dumped in to displace the weak organic material, and this was probably an organic pocket left behind. The consistency of the material was firm to stiff based on the insitu test results. A competent stratum of dense silty fine to coarse sand was encountered below the organic layer at 387.6 m. It was not penetrated at the terminal depth (387.0 m) of the borehole.

BH 2 was situated at the toe of the embankment (about 392.3 m) on the west side of Highway 41 and at the location of the problem area. The granular fill at this location was found to extend to elevation 384.2 m, some 6.5 m below the bottom of the culvert. The composition of the material was the same as in BH 1 and it was also in a loose to compact state. Underlying the fill stratum at 384.2 m was a native silt deposit. There were numerous organic inclusions in the top 1 m of the deposit. The material was very loose near the top of the layer but becomes compact below 383.3 m based on Standard Penetration test and Dynamic Cone Penetration test results. It was not penetrated at the terminal depth (382.9 m) of the borehole.

Ground water level in the ponds and in the open boreholes was at about 391.5 m. Seasonal variations are expected.

Based on the investigation results, a thin layer of compressible organic silt was encountered in the boreholes advanced. The material was either mixed with the granular fill above or the native non-cohesive material below. The extent and thickness of this compressible layer underneath the existing culvert is unknown and cannot easily be determined as they depend on the method adopted during construction of the highway and the direction of the filling process. However, it is in the order of 1 to 2 m thick based on the limited information available. In view that the weak soils were contacted at more than 6 m below the culvert at the distressed area (BH 2) and the mixed nature of the material, it is not envisaged that they were the main cause of the pavement settlement. The continuous loss of fine grained materials through the crack in the pipe below the problem area may be the cause of the settlements. The crack is located at the crown of the pipe appears to be due to construction damage.

We understand that it is intended to replace the existing culvert while repairing the distress to the roadway. Consideration was given to removing all organic material below the new structure and replacing it with suitable materials. However, this would be an expensive operation and in our opinion, the prevailing subsurface conditions do not warrant this method.

Instead 2 alternatives are proposed:

- 1) replacement of culvert with concrete box culvert
- 2) repair of culvert with CSP

Proposal 1 will provide a more certain solution of longer duration while Proposal 2 will be considerably less expensive and cause less interruption to traffic. Obviously, the cost and effectiveness of each proposal will have to be considered in the selection process.

Proposal 1 Culvert Replacement

The steel pipe can be replaced by a concrete box culvert resting on a granular pad. The following bearing capacities recommended as per the O.H.B.D.C. are as follows :

Factored Bearing Capacity at U.L.S. = 375 kPa
Bearing Capacity at S.L.S. Type II = 150 kPa

It is recommended to construct a 1.0 m minimum thick Granular A pad. This will involve excavation to elevation 390.0 m approximately. The excavation should then be filled with Granular A material to 1 m above the ultimate culvert invert elevation. No dewatering is required and the lifts above prevailing groundwater elevation should be compacted in accordance with MTO standards. Then the fill should be reexcavated to the elevation of the culvert base. Temporary slopes should be maintained at 1H:1V gradient above water and 1.5H:1V gradient below water. Typical subexcavation profile is shown in Figure 3. Without dewatering, the base of the culvert will be below water. It is recommended to construct prefabricated culvert panels and lift them in place. Construction could be carried out in stages allowing at least one lane open for traffic. The founding base should be lined without fabrics to prevent loss of fines at joint locations. The joints should also be properly sealed.

Proposal 2 Culvert Repair

Alternatively, remedial work can be carried out on the damaged portion of the pipe only. In our opinion, the installation of a short section of pipe inside the existing pipe beyond the damaged area is not a satisfactory solution as it cannot positively prevent loss of fines through the crack. Instead it is recommended that the damaged section of the pipe be completely removed and a granular pad be constructed in the same manner as described above. A replacement pipe of the same size but higher gauge should then be placed on the pad and properly connected to the existing pipe.

General Recommendations

For either alternative outlined above, the recommendations described below apply.

Backfill to the culvert may consist of granular material. Reference is made to OPSD 803 standards for details. Only relatively free draining granular material should be used below the water table. For a concrete culvert rockfill could be used as backfill provided that a 500 mm cushion around the culvert consisting of well graded rockfill with particle sizes less than 300 mm is specified.

Final embankment slopes can be constructed to a gradient of 2H:1V or flatter. The minimum earth cover required for frost protection is 2.2 m, unless the culvert is structurally designed to withstand frost pressures.

For culvert protection, there are two treatment zones to be considered. They are the embankment and the channel. In this case, since the culvert acts as an equalizer for the two ponds, flow of water is possible in either direction. Accordingly, culvert treatment should be the same for both ends.

For a rockfill embankment, protection is only required for the channel. The culvert should be protected with 0.6 m rock protection as per OPSD 810.01 Type 'A'. The treatment should extend for 10 m along the channel to prevent undercutting of the bed.

For earthfill, protection of the channel is required as described above. In addition, protection is needed for the embankment. A seal of cohesive material with a minimum thickness of 0.6 m should be constructed at the culvert ends. The material can either be a CI-CH clay or an artificial mixture of bentonite and granular material produced as per OPSS 1205.05.03. The intent of the clay seal is to protect the granular backfill. The seal should extend a minimum of 1 m beyond the backfill, and from 0.5 m above the high water level down to 1 m below the base of the culvert or 5 m along the creek bottom as a cutoff. The culvert should also be protected with 0.6 m of rock protection extending a minimum of 1 m beyond the clay seal.

We believe the above is sufficient for your present purposes. If you require further information, please contact our office.

MISCELLANEOUS

The report was prepared by D. Kwok, Project Foundation Engineer, reviewed by D. Dundas, Sr. Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.

cc:

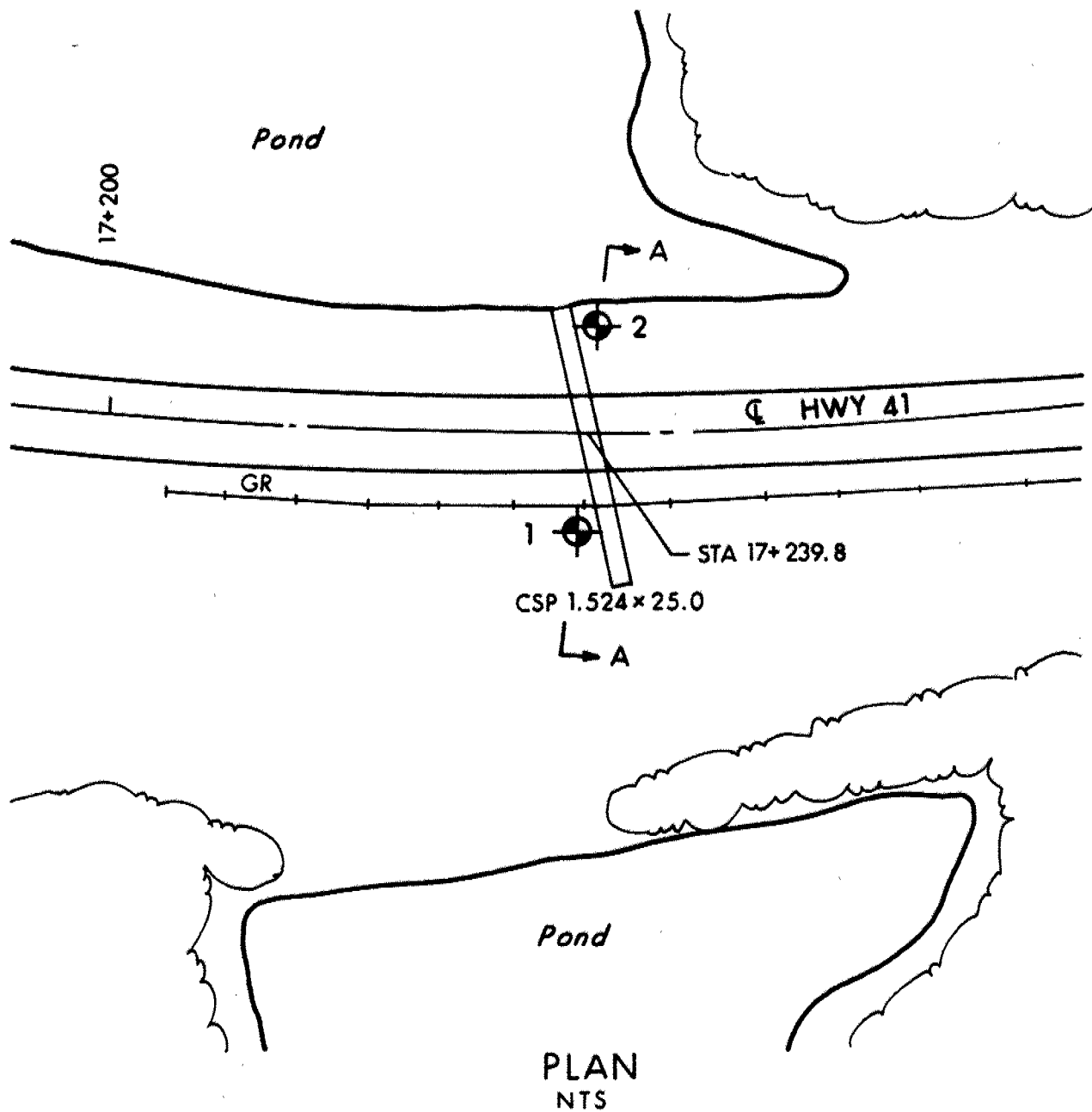
S. Cheng (2)
E.C. Lane
D.J. Kimmett (2)
D. Hogg (2)
K.G. Bassi
S.J. Dunham
E.A. Joseph
T.A. Hickey (Cover Only)
F. Bacchus (Cover Only)
File Copy ✓



D.D. for
D. Kwok, P. Eng.
Project Foundation Engineer

D. Dundas
D. Dundas, P. Eng.
Senior Foundation Engineer

Attach.



⊕ Bore Hole & Cone

| | | | |
|------|------------|--------------|-----------------|
| BH 1 | Elev 393.7 | Sta 17+239.0 | Offset 8.3 m Rt |
| " 2 | " 392.3 | " 17+240.8 | " 9.5 m Lt |

FIG 1

WP 81-83-01
HWY 41 DIST 10
GEO NO 31F-111

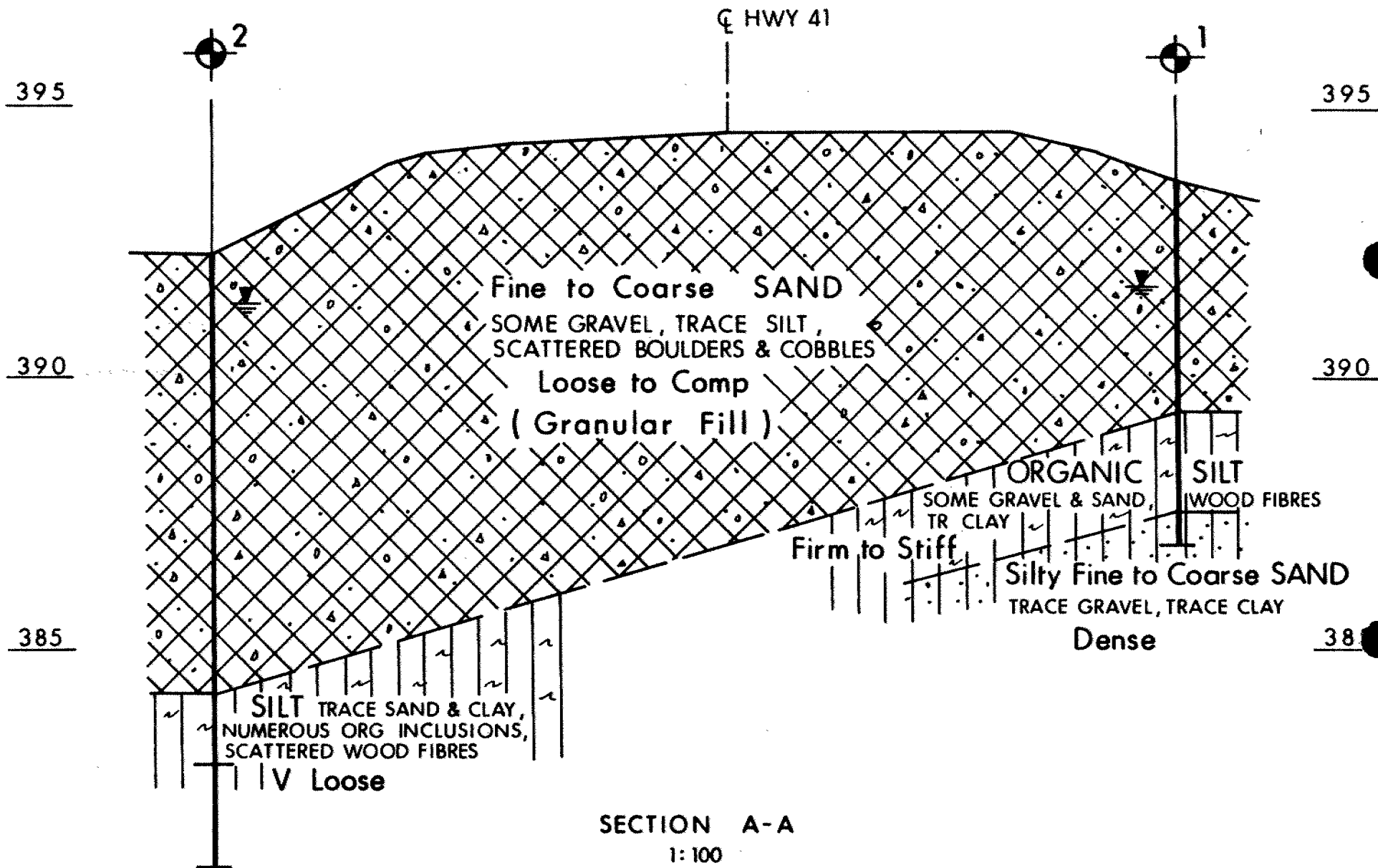


FIG 2

WP 81-83-01
 HWY 41 DIST 10
 GEO NO 31F-111

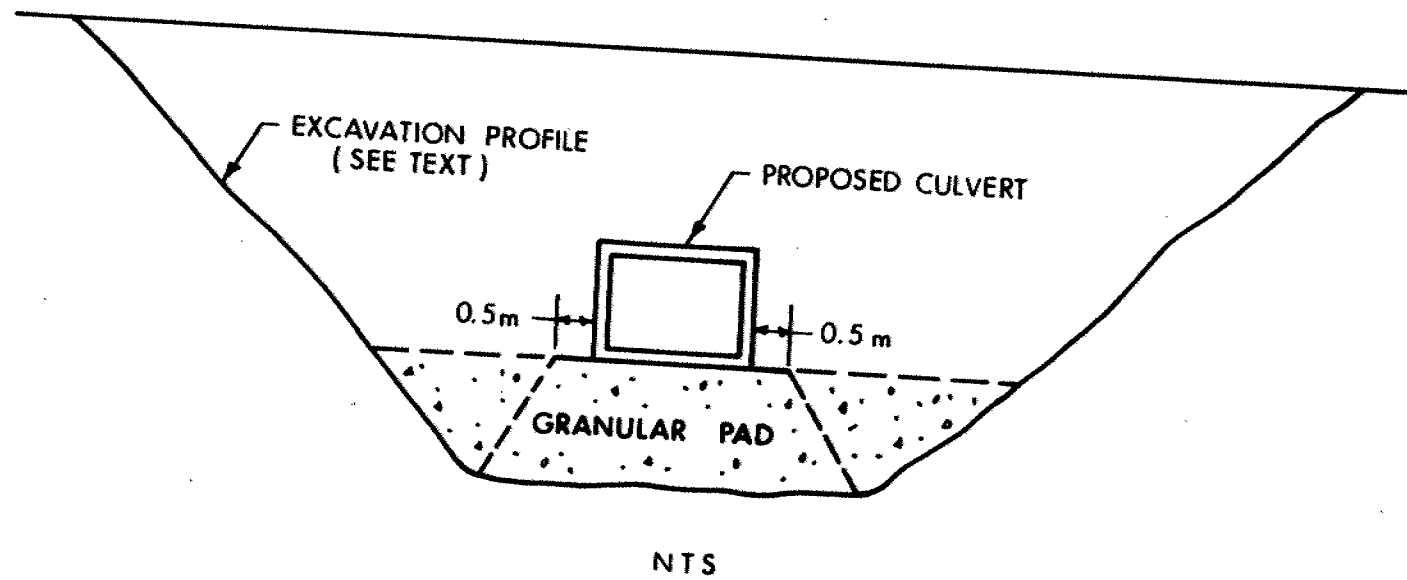


FIG 3 - CROSS-SECTION SHOWING SUBEXCAVATION

WP 81-83-01
HWY 41 DIST 10
GEO NO 31F-111

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 81-83-01 LOCATION Sta 17+239 Rt 8.30 m ORIGINATED BY DK
 DIST 10 HWY 41 BOREHOLE TYPE NX casing, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 08 13 - 91 08 14 CHECKED BY DD

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC NATURAL LIQUID UNIT MOISTURE CONTENT UNIT | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--------------------------------|------------|---------|------|------------|----------------------------|--------------------|---|--|--|--|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | | W _p W W _L | | | |
| 393.7 | Ground Surface | | | | | | | | | | | | |
| 0.0 | | | | | | | | | | | | | |
| | Fine to Coarse Sand | | | | | | | | | | | | |
| | Some Gravel, Trace Silt | | 1 | SS | 4 | | | | | | | | |
| | Scattered Boulders and Cobbles | | 2 | SS | 34 | | | | | | | | |
| | Brown, Loose to Compact | | 3 | SS | 26 | | | | | | | | |
| | (Granular Fill) | | 4 | SS | 50 | | | | | | | | |
| 389.4 | | | | | /8cm | | | | | | | | |
| 4.3 | Organic Silt with Wood Fibres | | 5 | SS | 9 | | | | | | | | 37 32 27 4 |
| | Some Gravel and Sand | | 6 | SS | 31 | | | | | | | | |
| | Trace Clay | | 7 | SS | 71 | | | | | | | | 52 33 13 2 |
| 387.8 | Firm to Stiff, Dark Brown | | | | | | | | | | | | |
| 6.1 | Silty Fine to Coarse Sand | | 8 | SS | 31 | | | | | | | | 3 58 34 5 |
| 387.0 | Trace Gravel, Trace Clay | | | | | | | | | | | | |
| | Grey, Dense | | | | | | | | | | | | |
| 6.7 | End of Borehole | | | | | | | | | | | | |
| | • 91 08 14 | | | | | | | | | | | | |
| | •• bouncing on cobbles | | | | | | | | | | | | |

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 81-83-01 LOCATION Sta 17+240.8 Lt 9.5 m ORIGINATED BY OK
 DIST 10 HWY 41 BOREHOLE TYPE NX casing, Cone COMPILED BY OK
 DATUM Geodetic DATE 91 08 14 - 91 08 15 CHECKED BY DD

| 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 (%) GR SA SI CL |
|---------------|--------------------------------|------------|---------|------|------------|----------------------------|--------------------|---|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | | | | | |
| 382.3 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | | | | | | | | | | | | | | |
| | Fine to Coarse Sand | | 1 | SS | 1 | | | | | | | | | |
| | with Gravel | | 2 | SS | 2 | | | | | | | | | |
| | Scattered Boulders and Cobbles | | 3 | SS | 1 | | | | | | | | | |
| | Brown and Grey, Loose | | 4 | SS | 1 | | | | | | | | | |
| | (Granular Fill) | | 5 | SS | 5 | | | | | | | | | |
| | | | 6 | SS | 4 | | | | | | | | | |
| | | | 7 | SS | 26 | | | | | | | | | |
| 384.2 | | | 8 | SS | 4 | | | | | | | | | |
| 8.1 | Silt, Trace Sand and Clay | | | | | | | | | | | | | |
| | Numerous Organic Inclusions | | 9 | SS | 2 | | | | | | | | | 29 30 36 5 |
| | Scattered Wood Fibres | | | | | | | | | | | | | |
| 382.9 | Grey, Very Loose | | 10 | SS | 15 | | | | | | | | | 0 13 80 7 |
| | Trace Organics Compact | | | | | | | | | | | | | |
| 9.4 | End of Borehole | | | | | | | | | | | | | |
| 381.0 | | | | | | | | | | | | | | |
| 11.3 | End of Cone Test | | | | | | | | | | | | | |
| | • 91 08 14 | | | | | | | | | | | | | |

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE 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

| | | | |
|-----|---------------------|-----|----------------------------|
| S S | SPLIT SPOON | T P | THINWALL PISTON |
| W S | WASH SAMPLE | O S | OSTERBERG SAMPLE |
| S T | SLOTTED TUBE SAMPLE | R C | ROCK CORE |
| B S | BLOCK SAMPLE | P H | T W ADVANCED HYDRAULICALLY |
| C S | CHUNK SAMPLE | P M | T W ADVANCED MANUALLY |
| T W | THINWALL OPEN | F S | 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 | | | | | | |

SEND
TO

Head of Geotechnical Section
Eastern Region
Attention: Mr. Robert Scott

FROM

David Kwok

DEPT.

Foundation Design Section

DATE

Nov-28, 1991

SUBJECT

Memo report on Culvert Review, Town of Pembigh, WP 81-83-01

We refer to the above report dated 91 09 26. On page 4 of the report, the second last sentence of the first paragraph should read "The founding base should be lined with fabrics to". It was inadvertently typed as "..... lined without fabrics".

Please take note of this. Sorry for any inconvenience caused.

REPLY

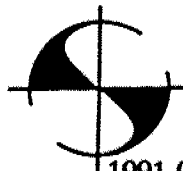
REPLY FROM

REPLY DATE









STRATA ENGINEERING CORP.

RESEARCH . ENGINEERING . SCIENCE

Tel.: (416) 441-2560
Fax: (416) 441-4161

Suite 410, 170 The Donway West,
Don Mills, Ontario, Canada M3C 2G3

1991 03 25

Geotechnical Section
Ministry of Transportation, Ontario
Eastern Region
Postal Bag 4000
355 Counter Street
Kingston, Ontario
K7L 5A3

Attention: Mr. R. Scott, Soils Unit Supervisor

RE: Culvert Review, Work Project 81-83-01, Highway 41 Vicinity Station 17+240, MTO Plate 438-41/18-0, Township of Denbigh

Introduction

At the request of the MTO Eastern Region Geotechnical Section, the 1.22 metre x 25.0 metre Corrugated Steel Pipe (CSP) located from Station 17+238 Left to Station 17+242 Right was reviewed in the field with Bancroft District Maintenance personnel.

The culvert site is located within the limits of an organic deposit, Station 17+190 to Station 17+270, Township of Denbigh, near the north limit of an R436.594 curve to the left. The exact depth of the organic deposit is unknown but a borehole placed in the vicinity indicates the roadbed has settled and been patched several times and as recently as 1990.

Background Information

A borehole was placed at Station 17+220, 3.3 metres left of centre-line, in September 1990, with the following details logged:

| | | |
|---------|---|---------------------|
| 0-800 | - | Asphalt |
| 800-940 | - | Crushed Gravel |
| 940-1.1 | - | Asphalt |
| 1.1-2.7 | - | Fine to Medium Sand |
| 2.7 | - | NFP Rockfill |

The borehole log indicates the original embankment has settled approximately 1.0 metres with the following interpolated maintenance repair sequence:

- a) Original 50mm hot mix pavement patched with hot mix to a depth of 110mm.
- b) Subsequent distortion required a granular levelling course of 60mm prior to resurfacing with an estimated 50mm depth of hot mix.
- c) Embankment settlement, with corrective hot mix patching to an accumulated depth of 750mm, has occurred over time and is still occurring with the latest patch being placed in 1990.

Observations

A slight concentric crack was noted in the outer half of the newly patched southbound lane during the pavement structure investigation carried out in September 1990. This crack verifies that movement of the existing embankment is still occurring and the crack configuration indicates there is a minor shear type failure in the southbound lane with movement to the west. This is further verified by an observed 0.25 metre drop in the existing west embankment slope beyond the edge of shoulder, some evidence of a mud wave beyond the existing toe-of-slope and a minor buckling with some damage to the existing 1.22m CSP at the approximate location of the embankment slope failure area (Photo 3).

Drainage Observations

The existing 1.22 metre Corrugated Steel Pipe (CSP) provides for movement of the surface water from the catchment area west of Highway 41 (Photo 1) to the east (Photo 5). The flow gradient is basically flat with the culvert acting as an equalizer from the west to east during the spring run-off season or during heavy rainfalls.

The culvert inlet, though slightly elevated, is still functioning properly (Photo 2) as is the outlet although there is some end damage which probably occurred during construction (Photo 4).

District Maintenance information indicates that water ponding in the west catchment area (Photo 1) has not been a problem except when beaver activity blocked the pipe (note grate at pipe entrance/exit Photos 2 and 4).

Culvert Observations

The existing 1.22 metre CSP has buckled slightly at the approximate location of the existing slope failure area. Also the culvert has apparently been broken based on District Maintenance information which indicates there has been some filtration of material into the culvert at the approximate buckled area site which required flushing out.

There is also some corrosion of the bottom half of the CSP (Photo 3). Although it does not appear to have affected the culvert performance or structural integrity, the MTO Eastern Region Structural Section should review the condition during 1991.

Recommendations

1. The MTO Eastern Region Structural Section should review the existing 1.22 metre CSP to ascertain structural integrity.
2. If the culvert is structurally sound and does not require immediate replacement, then a short section of pipe placed inside the existing culvert from the inlet (west) to beyond the buckled area could be considered as a short term solution until the culvert must be replaced for structural reasons.
3. If the culvert requires replacement then a foundation type investigation should be carried out to ascertain the extent of the shear failure problems and the overall remedial treatments required. Failure to address the stability/fill movement problems during the culvert replacement will almost certainly result in similar type of culvert problems in the future.

The placement of boreholes through the existing embankment (2 minimum) will be expensive due to the presence of an undetermined depth of rockfill which requires casing during the drilling operation. However, there is no way to ascertain the exact problem extent or remedial treatments required without knowing the depths of fill and organic/soft mineral soil remaining under the existing embankment.

Submitted for your consideration.

Yours truly,
STRATA ENGINEERING CORP.


R.D. Gunter



Photo (1) Inlet (West) Area
Vic. Sta. 17+240 - TWP Of Denbigh



Photo (2) Inlet (West) to 1.2m CSP
Sta. 17+238 - TWP Of Denbigh

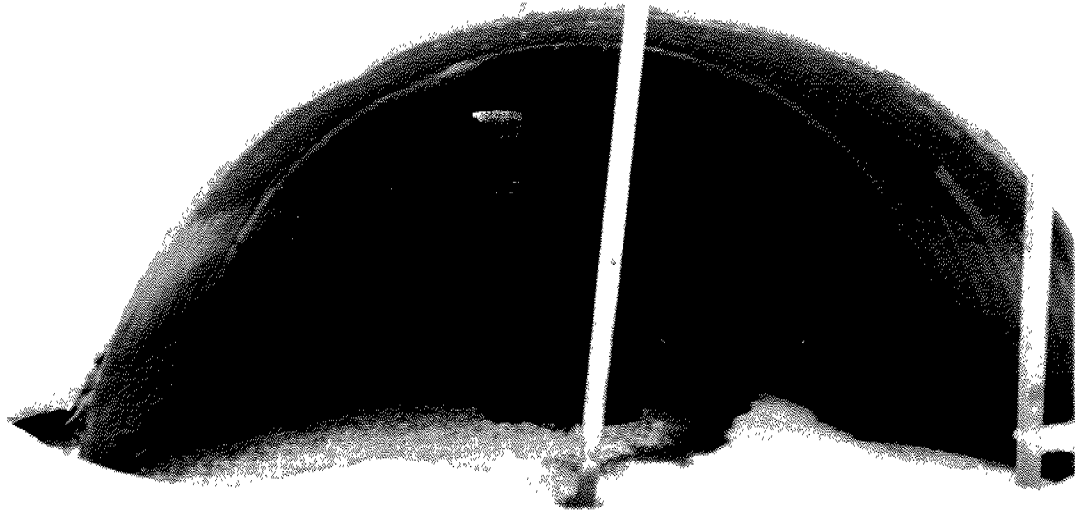


Photo (3) View through 1.2m CSP
Sta. 17+238 - TWP Of Denbigh



Photo (4) Outlet (East) 1.2m CSP
Sta. 17+242 - TWP Of Denbigh

W.P 81-83-01
HWY 41



Photo (5) Outlet (East)
Vic. Sta. 17+240 - TWP Of Denbigh

PRIORITY 2.

- open file
- review
- Discuss with Dave