

G.I.-30 SEPT. 1976

GEOCRES No. 40P9-39

DIST. 2 REGION

W.P. No. 535-91-01

CONT. No.

W. O. No.

STR. SITE No. 35-585

HWY. No. 6

LOCATION Northwest Drain Culvert
at W-S Ramp (Hwy 6 & Wellington St)

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



**Ministry of
Transportation and
Communications**

FILE No. _____

DATE _____

REMARKS _____

B41 310.298

B42 307.001

B43 304.670

B44 316.038

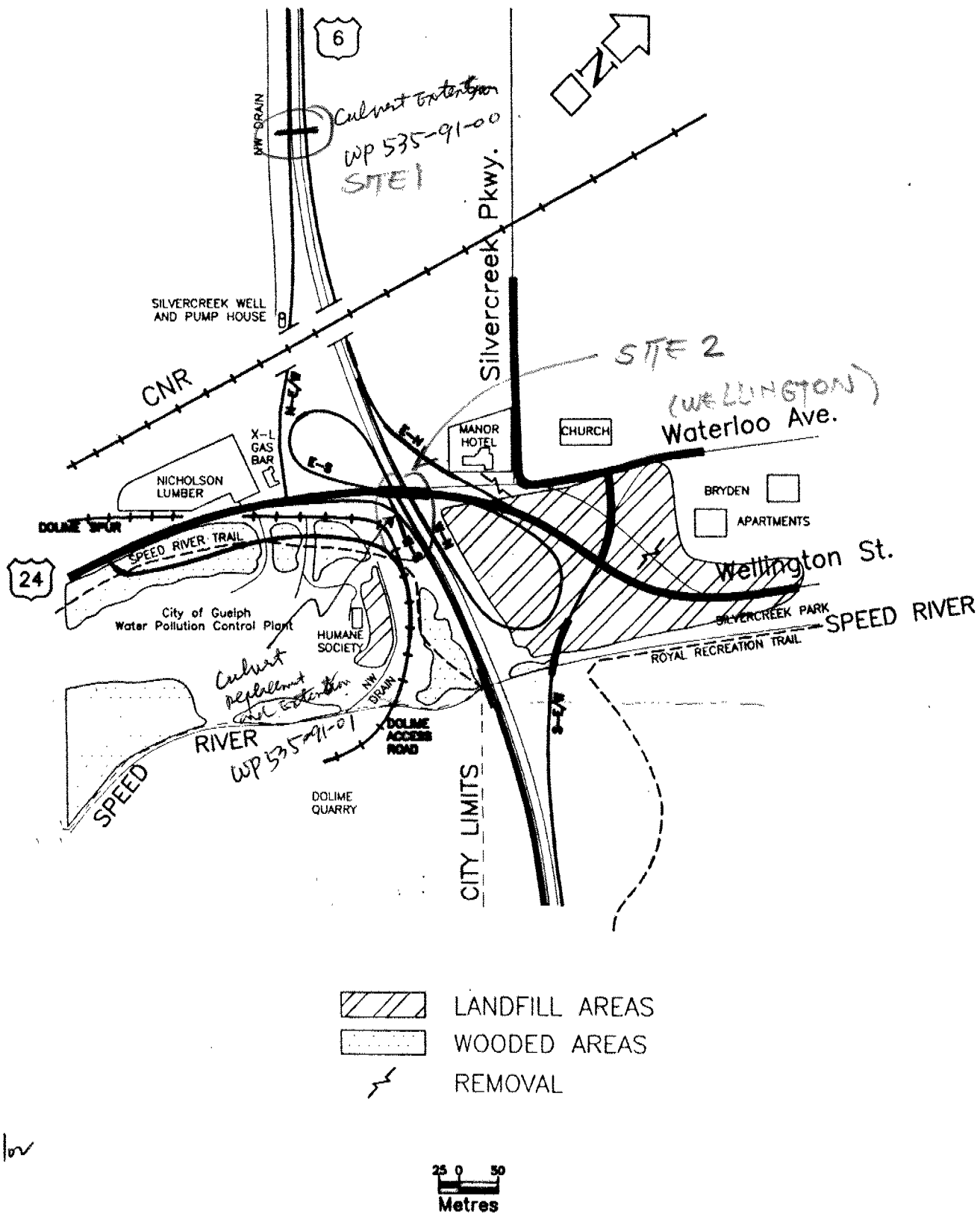


Fig. 1 PROPOSED HANLON/WELLINGTON ST. INTERCHANGE

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

DIST. 31 HWY. 6
CONT NO XX
WP NO 535-91-01



N-W DRAIN CULVERT
GENERAL ARRANGEMENT

SHEET
X

GENERAL NOTES:

1. CLASS OF CONCRETE
ALL CONCRETE 30 MPa
2. CLEAR COVER TO REINFORCING STEEL
BOTTOM OF TOP SLAB 50±10
BOTTOM OF FOOTING 100±10
REMAINDER 70±20 UNLESS OTHERWISE NOTED
3. REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH THE SUFFIX C DENOTE COATED BARS.

CONSTRUCTION NOTES:

1. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF THE CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
2. SIDES OF FOOTING TO BE CAST AGAINST UNDISTURBED SOIL.
3. NO CONCRETE SHALL BE PLACED FOR ANY FOOTINGS UNTIL THE DEPTH OF THE EXCAVATION AND THE CHARACTER OF THE FOUNDATION HAVE BEEN APPROVED BY THE ENGINEER.
4. SITE NO. AND DATE FIGURES SUPPLIED BY MTO.
5. CONSTRUCTION JOINTS SHALL BE PROVIDED AT EVERY 20m.
6. EXISTING CONCRETE FLOOR SLAB TO REMAIN.

STAGE CONSTRUCTION

STAGE 1

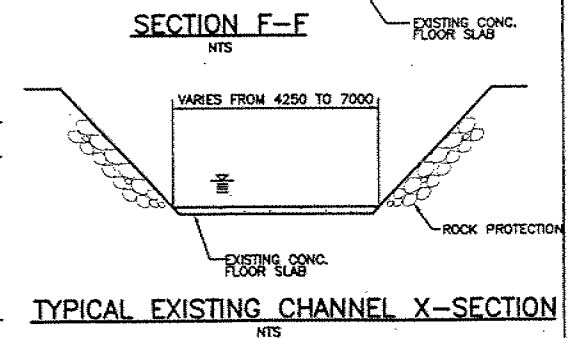
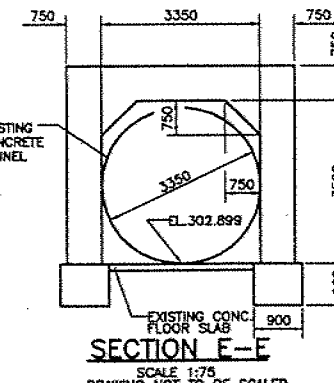
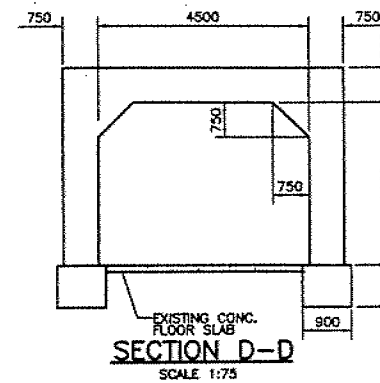
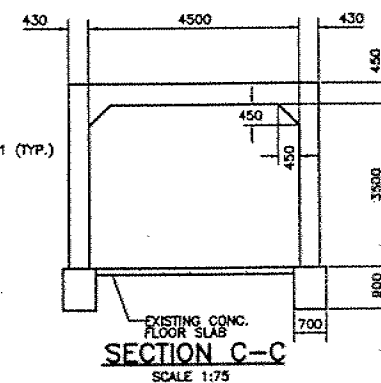
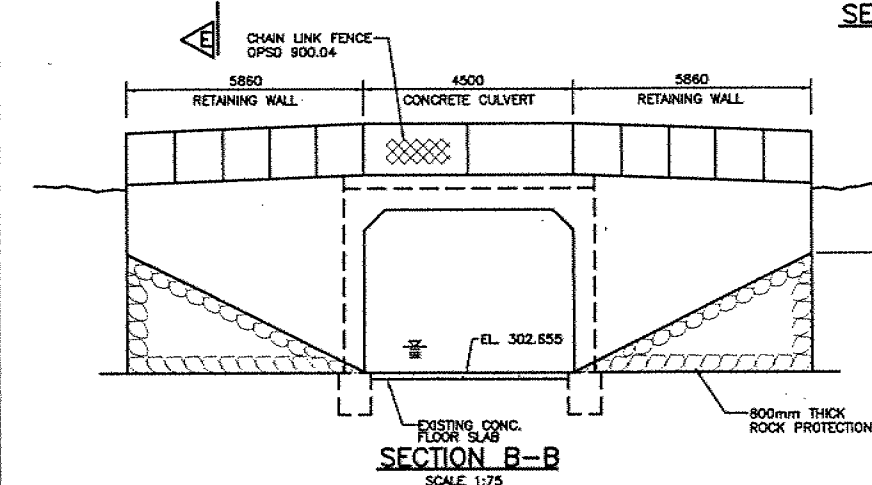
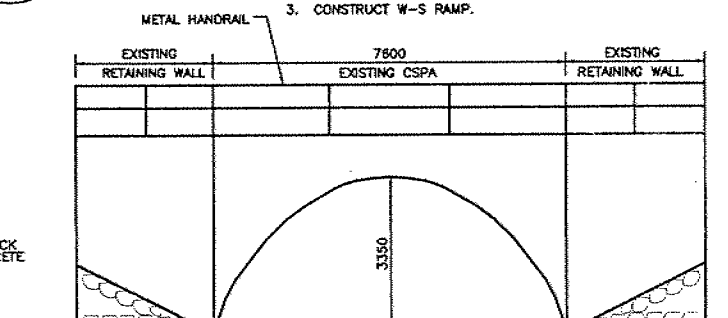
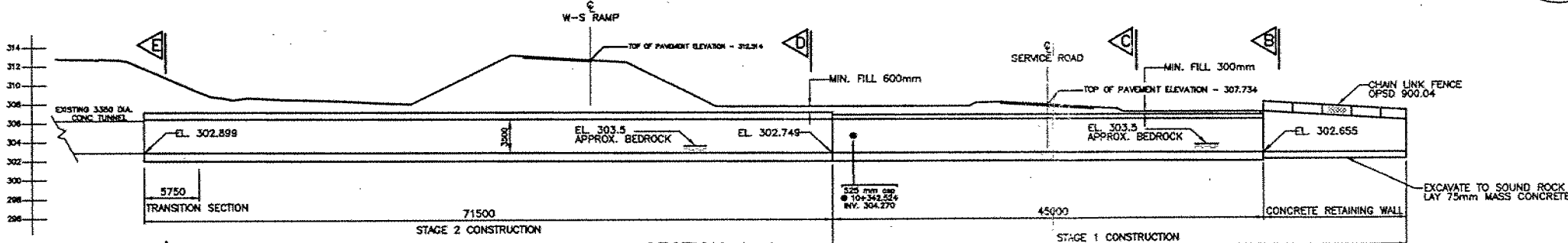
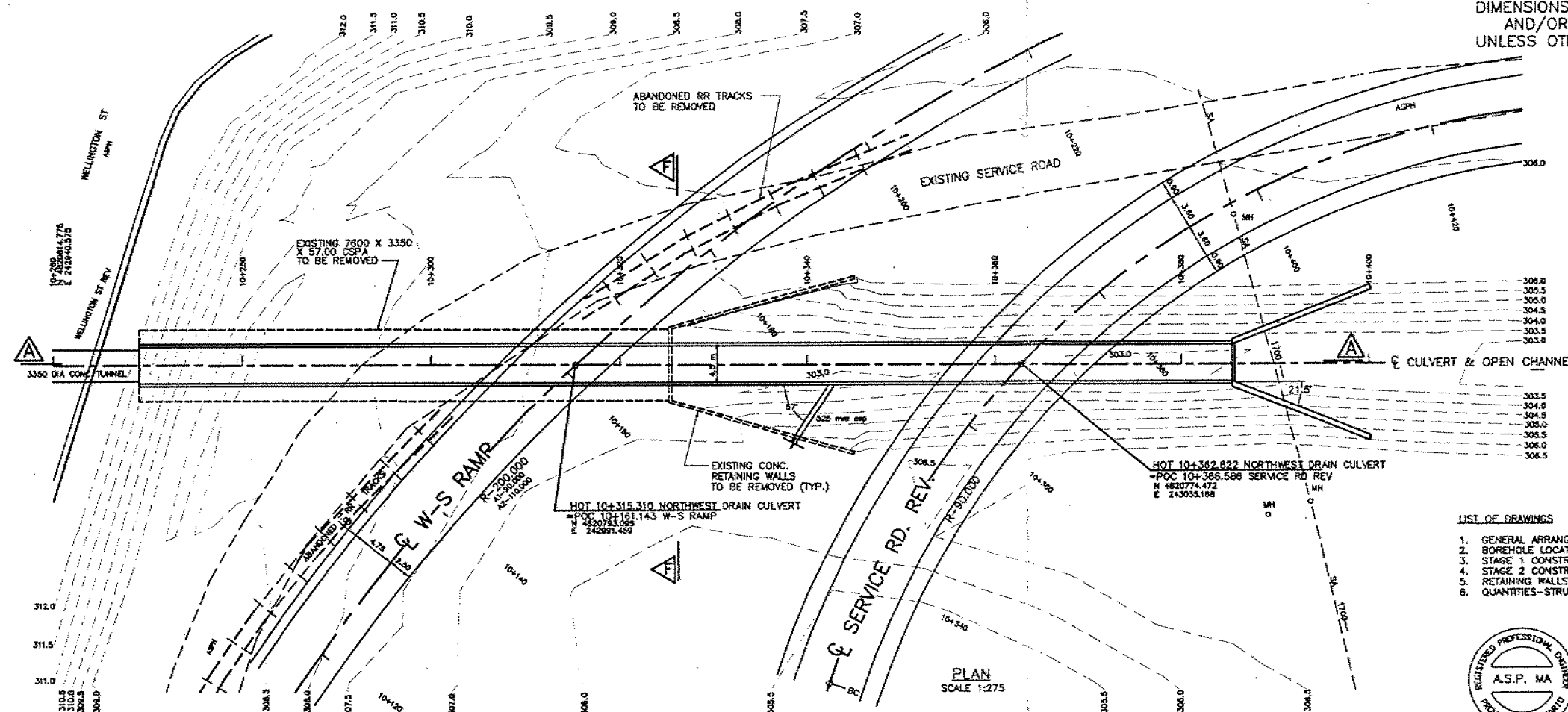
1. MAINTAIN TRAFFIC ON THE EXISTING SERVICE ROAD.
2. CONSTRUCT CONCRETE CULVERT AND RETAINING WALL.
3. CONSTRUCT NEW SERVICE ROAD.

STAGE 2

1. DIVERT TRAFFIC TO THE NEW SERVICE ROAD.
2. CONSTRUCT CONCRETE CULVERT.
3. CONSTRUCT W-S RAMP.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION AND SOIL STRATA
3. STAGE 1 CONSTRUCTION
4. STAGE 2 CONSTRUCTION
5. RETAINING WALLS
6. QUANTITIES-STRUCTURE



REVISIONS	DATE	BY	DESCRIPTION
DESIGN AM	CHK AM	CODE	LOAD
DRAWN CM	CHK AM	SITE 35-585c	STRUCT
		SCHEME	DWG 1

**ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION**

WP 535-91-01 DIST 31
HWY 6 STR SITE 35-585

Northwest Drain Culvert Replacement
Hwy. 6/Wellington St.

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FOUNDATION INVESTIGATION REPORT

FOR:

Northwest Drain Culvert Replacement

WP 535-91-01, Site 35-585

Hwy. 6/Wellington St.

District 31, London

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The field work was carried out between 94.12.12 to 94.12.14 and consisted of a total of three boreholes along the length of the proposed replacement culvert.

Boreholes were advanced to a maximum depth of 6.0 m below the existing ground level using 82 mm ID continuous flight augers together with a BQ core barrel.

SITE DESCRIPTION

The site is located at the southwest corner of the existing Hwy. 24 (Wellington St.) and Hwy. 6 intersection in the City of Guelph, Wellington County. The intersection is presently a level crossing with traffic lights controlling the flow of traffic in four directions. The existing culvert runs underneath Wellington Street just west of the intersection and along an access road running to the Guelph Dolime Quarry. It currently has a length of 57 m which then empties out into an existing open channel. Located near the proposed extension is a storm sewer line which runs underneath the open channel providing service to the city.

The terrain at the site slopes gently upward in a northerly direction. Hwy. 6 and Wellington Street are placed on raised grades with slopes present in the southwest and southeast with heights of approximately 3 to 4 metres and gradients of 2H:1V.

Physiographically the site is located within the region known as the "Guelph Drumlin Field". The drumlins in this area are not closely spaced with intervening low lying grounds between the drumlins. As a result, the dominant soil materials are the unstratified, unsorted drumlin tills consisting of a heterogeneous mixture of gravels, sands and silts.

Overburden in the site area is underlain by dolostone of the Guelph and Amabel formation with a depth of usually less than 5 metres.

INVESTIGATION PROCEDURE

The fieldwork for this project was conducted between 94 12 12 and 94 12 15 and consisted of a total of three boreholes. The borings were advanced to depths ranging from 4.1 m to 6.0 metres. All borings were advanced using a conventional truck mounted Central Mining Equipment (CME) 55 Drill unit. Solid stem augering techniques were used to penetrate the overburden at the site.

Disturbed subsoil samples were retrieved in the overburden using a 50 mm Diameter Split Spoon Sampler driven in accordance with the Standard Penetration Test (SPT - ASTM D1586). The samples were generally retrieved at 0.76 m intervals. Bedrock underlying the overburden was cored up to 2.2 metres in depth using conventional rock coring techniques. A BQ core barrel within BW casing was used in the coring process.

Rock core samples were measured in the field and transported to the laboratory where they were examined by a Ministry Petrographer.

Groundwater levels were determined by monitoring the water levels in the open boreholes throughout the duration of the field investigation. All boreholes were backfilled upon completion of the fieldwork.

The survey related to the location and elevation of the individual boreholes was provided by Southwestern Region Surveys and Plans.

Grain size analysis laboratory tests were carried out on select soil samples together with axial compression strength tests of the bedrock. Laboratory test results are given in the following section of this report and are illustrated on figures and borehole logs included in the appendix.

SUBSURFACE CONDITIONS

GENERAL

The subsoil condition across the site was generally consistent comprising of 2.1 m of a Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till). This layer contained organics and wood particles mixed in with the Till, together with varying sized chunks of gravel were found throughout. Underlying this Till was a 0.8 m to 1.9 m thick Sand with Gravel. This material was encountered throughout the site. The above overburden rests on a Dolostone Bedrock found to vary in depth between 2.9 m to 3.8 m below the ground surface. The rock surface appears to rise towards the north becoming more weaker and weathered. At one location the bedrock was augered with split spoon samples taken.

Hand augering and probing into the existing open channel, approximately 1 - 2 m deep indicated that the existing culvert and open channel appears to rest on bedrock.

The plan and location of borings and the stratigraphical profile are shown on Drawing No. 5359101-A in the attached appendix. The obtained field laboratory tests are plotted on the record of borehole sheets also in the appendix of this report. A brief description of the different soil types are given below.

Heterogeneous mixture of Gravel, Sand and Silt (Glacial Till)

Underlying the site and explored to depths ranging from the original ground surface to depths of 2.1 m is a non-cohesive deposit which is composed of a Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till). Encountered within this layer was traces of organics and wood particles. Results of the grain size distribution tests carried out on select samples are shown on Figure 1 in the appendix. The material contained 9 - 29 % gravel, 43 - 51 % sand, 16 - 42 % silt and 4 - 6 % clay with greater sand content near the bottom of this layer.

In this stratum the 'N' values ranged from 15 to 22 blows/0.3 m, having a compact state of denseness.

Sand with Gravel

A Sand with Gravel layer was encountered to rest between the stratum above and the bedrock below. This layer was 0.9 to 1.8 m thick. The the grain size distribution test on one sample indicated 1 % gravel, 57 % sand, 36 % silt and 6 % clay. Results of the grain size distribution tests carried out on select samples are shown on Figure 2 in the appendix.

The 'N' values ranged between 4 to 120 blows/0.3 m, indicating a very loose to dense state of denseness. These values may be somewhat high and low, primarily due to the presence of bedrock immediately below and the presence of groundwater within this layer causing disturbance during sampling.

Bedrock

The above strata are directly underlain by Dolostone bedrock of the Guelph Formation together with an underlying Eramosa member of the Amabel Formation. At the most northern borehole the bedrock was weak enough to auger through and take split spoon samples. Detailed descriptions of the rock are attached in the appendix.

Core recoveries (CR) and rock quality designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Axial Compression tests were conducted on two samples, one in the upper weak layer and another in the stronger formation below, to determine their strength with results of 40 MPa and 65 MPa respectively.

Examination of the Rock core samples by a MTO Petrographer reveal the bedrock to be a Dolostone of the Guelph Formation (BH 2) and Amabel Formation (BH 3). Depth to unweathered to slightly weathered bedrock was found to be 4.1 m in borehole 2 and 5.1 m in borehole 3. Rock core penetration rates were generally rapid which is indicative of the weaker nature of this sedimentary rock. Recoveries were generally high, however the rock was very broken with low RQD's. These values may be artificially low due to the nature of the rock and the size of rock core taken.

Groundwater conditions

Observations of the groundwater level was carried out by measuring the water levels in the open boreholes and monitoring these levels throughout the duration of the field investigation. The water level was generally at or slightly above the bedrock surface, approximately at the level found within the existing channel at elevations of 303.6 m and 304.2 metres.

Groundwater levels in generally are subject the seasonal fluctuations and hence can vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

It is proposed to remove the existing 57 m steel pipe arch culvert (7.6 m span, 3.35 rise) and replace and expand 67 m downstream with a concrete open culvert, span length of 4.5 m and height of 3.5 m. The Total length of the new culvert is approximately 124 m. The new culvert will carry the proposed W-S Ramp and the relocated Service Road over the existing Northwest Drain. The fill height of the W-S Ramp is about 6 to 8 m above the proposed culvert and the Service Road 0.5 to 1.0 m. The founding elevation of the culvert is to be El. 303.09 at the North end, El. 303.01 at the South end and at an elevation of 302.9 m for the proposed extension.

In consideration of the type of foundation and the depth (El. 302.9 - 303.01) at which it is proposed to be placed, it is recommended that the foundation be placed on the existing bedrock with a factored bearing capacity at U.L.S. of 3,000 kPa. Bearing capacity at S.L.S Type II will not govern because the loads required to produce detrimental settlement of the structure will be much larger than the recommended values for factored bearing capacity at U.L.S.

Earth pressure should be computed as per Section 6.6.1.2.2 of the code and an unyielding foundation condition may be assumed for the computations. The Granular 'A' or 'B' backfill should be in accordance with the current MTO Standards. The following parameters are recommended for the granular backfill.

	Granular 'A'	Granular 'B'
Angle of Internal Friction	35°	30°
Unit Weight (kN/m ³)	22.8	21.2

The earth pressure should be computed as per Section 6.1.2.2. of the O.H.B.D.C. assuming 'at rest' conditions.

An unfactored coefficient of friction value of $\tan 30^\circ$ may be assumed for the estimate of sliding resistance.

OTHER CONSIDERATIONS

The backfill operations should be carried out simultaneously on both sides of the proposed culvert.

The concrete for the culvert foundation should be placed in a dry base condition. During construction the bottom slab will be located below the ground water level, requiring a dewatering scheme. The presence of the Sand with Gravel layer and the permeable nature of the bedrock could make dewatering more difficult. Provisions should also be made for the creek diversion. Steps should be taken to prevent any surface water flow in to the excavations.

In the vicinity of the culvert bedrock appears to be weathered at the surface. The proposed culvert footing elevation of approximately 303 m should place it within the sounder rock below, however there could be localized areas of poor rock. Frost protection will not be required if all loose and/or weathered material is removed. If required mass concrete could be placed to provide a sound base. Any spongy areas or weathered rock observed in the channel bed should also be removed.

Based on the poor quality of rock encountered any additional excavations could be carried out by utilizing rippers, jackhammers or hydraulic rock splitters. The required excavation technique would be decided by the contractor.

If it is proposed to widen the culvert beyond the existing bedrock excavation limits than controlled blasting would be required. The OPSS 515 standard for the construction specification for rock excavation for pipelines and associated structures in open cut would be of help. In such a case this office would provide additional recommendations.

The culvert outlet should be treated with rock protection as per O.P.S.D. 810.01 type 'A'.

No major stability problems are anticipated for the excavation in the overburden material with 2H:1V side slopes, however the excavation in rock should be according to the current MTO practise. While the proposed extension further South will practically rest on or just below the existing bedrock surface, further North the bedrock surface appears to

rise slightly possibly requiring some removal of rock to place the culvert at the proposed elevation of 303.0 m.

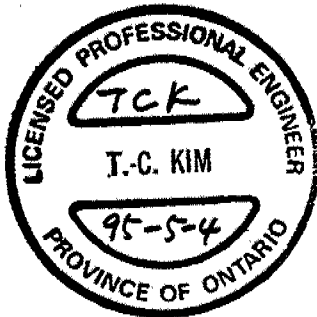
Miscellaneous

The fieldwork for this investigation was carried out under the supervision of M. Michalek, Foundation Engineer. The equipment was owned and operated by London Soils Investigations Ltd., London.

This report was written by M. Michalek, Foundation Engineer under the general supervision of T. C. Kim, Senior Foundation Engineer



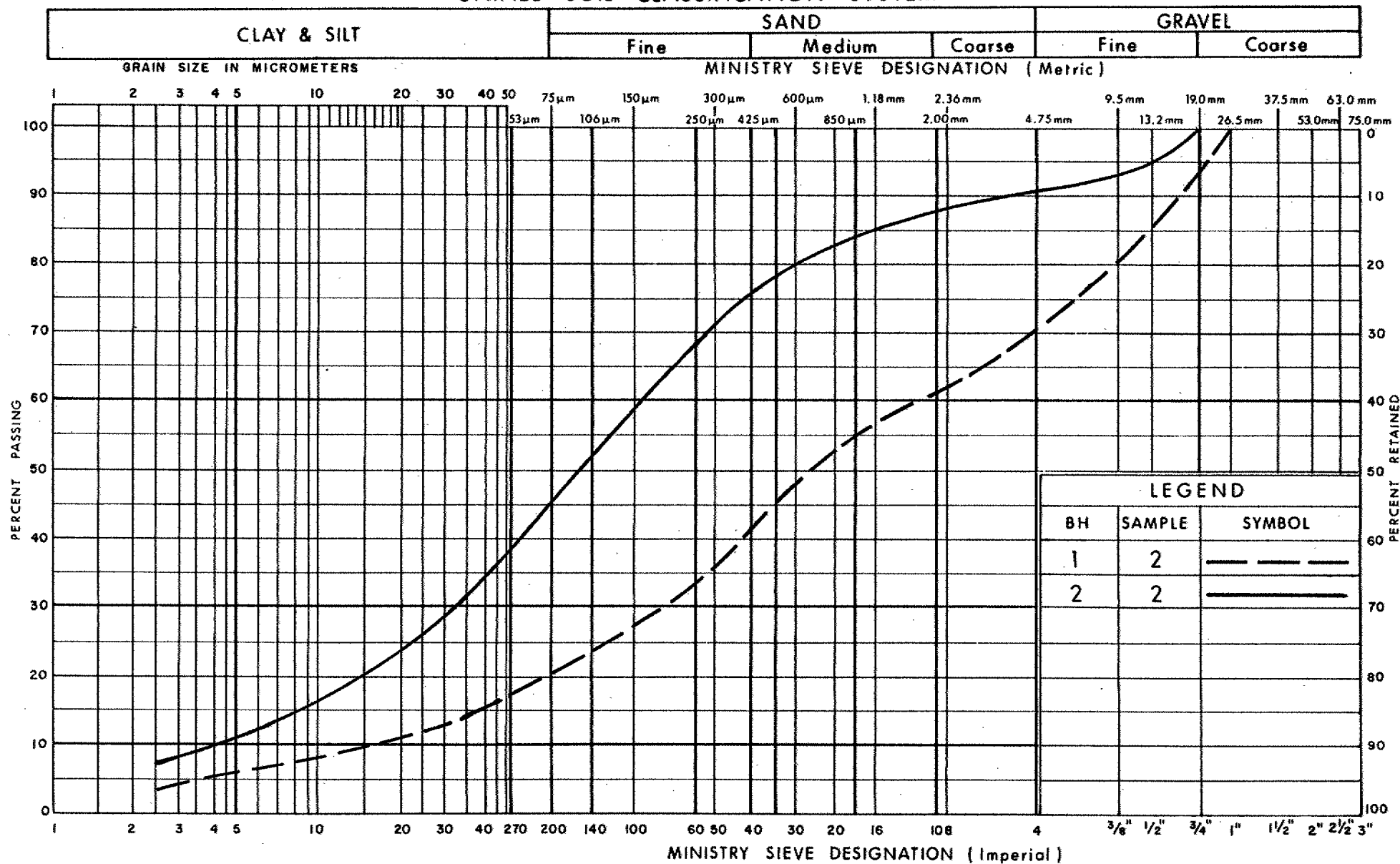
M. Michalek, P. Eng.
Foundation Engineer



T. Kim, P. Eng.
Senior Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



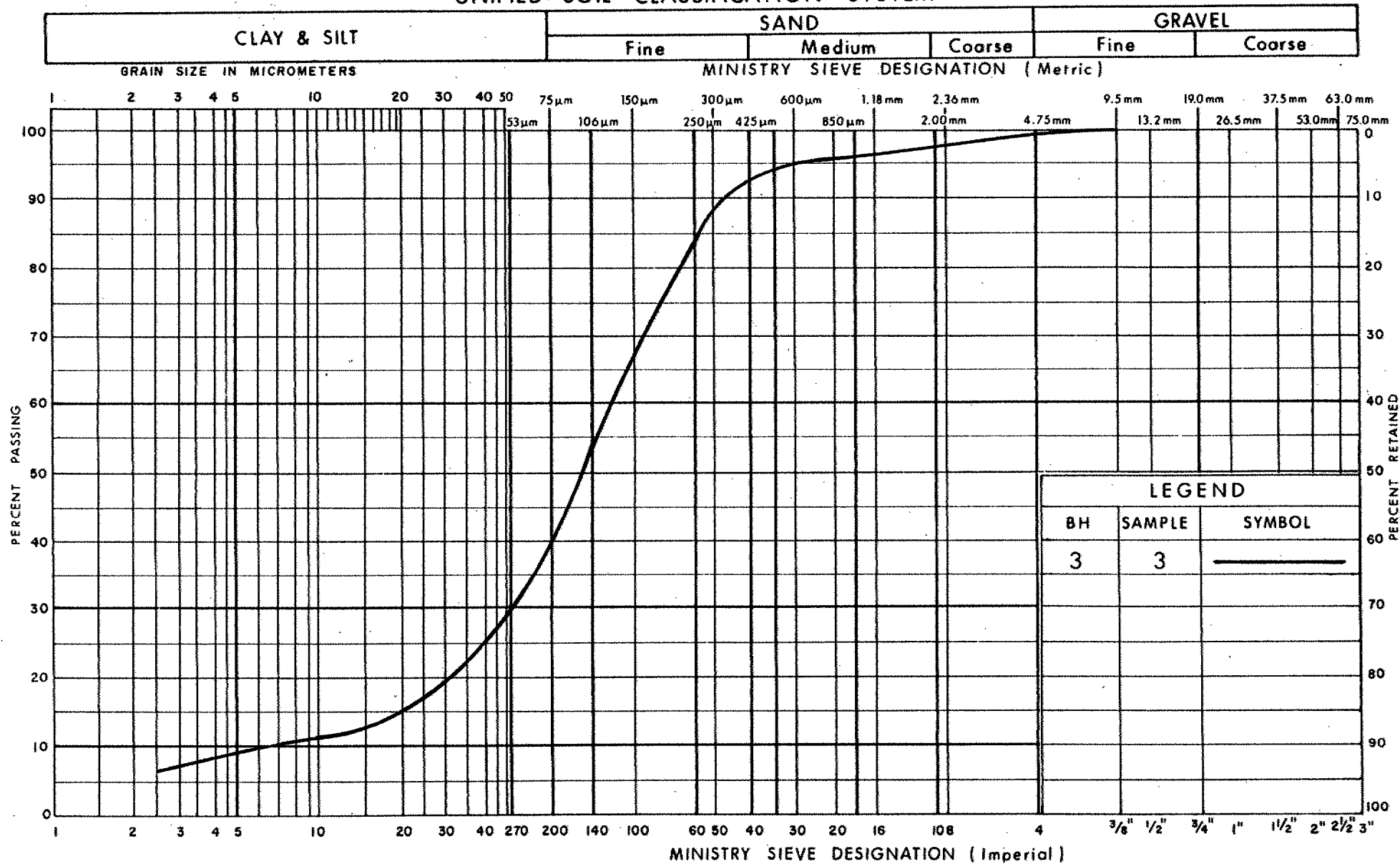
Ministry of
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GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF
GRAVEL, SAND & SILT (Glacial Till)

FIG No 1

W P 535 - 91 - 01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, WITH GRAVEL

FIG No 2

W P 535 - 91 - 01

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 535-91-01 LOCATION Co-ords: N 4 820 813; E 242 960 ORIGINATED BY M.M.
 DIST 31 HWY 6 BOREHOLE TYPE SS Auger, BQ Rock Core COMPILED BY M.M.
 DATUM Geodetic DATE 94 12 12 CHECKED BY T.K.

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	60	80	100					
308.5	Ground Surface																
0.0	Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, trace Black Organics Compact		1	SS	22	DRY *	308										29 51 16 4
306.4			2	SS	13		307										
2.1	Sand with Gravel Compact		3	SS	10		306										
305.8			4	SS	80		305										
2.9	Dolostone Bedrock Weak, Slightly Weathered		5	SS	120		305										
304.4																	
4.1	End of Borehole																

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 535-91-01 LOCATION Co-ords: N 4 820 782; E 242 995 ORIGINATED BY M.M.
 DIST 31 HWY 6 BOREHOLE TYPE SS Auger, BQ Rock Core COMPILED BY M.M.
 DATUM Geodetic DATE 94.12.14 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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		
307.0	Ground Surface																
0.0	Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, trace Black Organics Compact		1	SS	11		306										
			2	SS	11		305										9 43 42 6
304.9																	
2.1	Sand with Gravel Dense		3	SS	41		304										
			4	SS	120												
303.5																	
3.5	Dolostone Bedrock Weak, Slightly Weathered Note: RQD values are questionable due to the nature of the rock and the size of rock core taken. Bedrock may be somewhat permeable as water during the coring process was lost.		5	RC	REC 92%		303										RQD 19%
			6	RC	REC 85%		302										RQD 58%
301.6																	
5.4	End of Borehole																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 535-91-01 LOCATION Co-ords: N 4 820 772; E 243 080 ORIGINATED BY M.M.
 DIST 31 HWY 6 BOREHOLE TYPE SS Auger, BQ Rock Core COMPILED BY M.M.
 DATUM Geodetic DATE 94.12.13 CHECKED BY T.K.

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					
307.3	Ground Surface													
0.0	Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, trace Black Organics Compact		1	SS	10									
	Wood Particles		2	SS	14									
305.2														
2.1	Sand with Gravel Very Loose to Compact		3	SS	4									
			4	SS	24									
303.5														
3.8	Dolostone Bedrock Medium Strong, unweathered Note: RQD values are questionable due to the nature of the rock and the size of rock core taken. No material retrieved between RC 5 and RC 6 during coring process. Bedrock may be somewhat permeable as water during the rock coring process was lost down the hole.		5	RC	REC 75%									
			6	RC	REC 85%									
301.3														
6.0	End of Borehole													

ROCK CORE DESCRIPTION
WP 535-91-01

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
2	5	3.51-4.11	92	19	3.51-5.43	DOLOSTONE (with stylolites, stromatoporoids, abundant small vugs, and larger vugs up to 2 cm in diameter commonly containing calcite crystals), very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered (moderately weathered, 3.51-4.11 m); fractures moderate to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
	6	4.11-5.43	85	58		
3	5	3.81-4.42	75	0	3.81-6.04	DOLOSTONE (with abundant small vugs and larger vugs up to 2 cm in diameter commonly containing calcite crystals), dark yellowish brown to pale yellowish brown; medium grained; medium strong; unweathered to slightly weathered (moderately weathered, 3.81-5.05 m); fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
	6	5.05-6.04	85	10		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
Logged by: DAW, Soils and Aggregates Section

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

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

MECHANICAL PROPERTIES OF SOIL

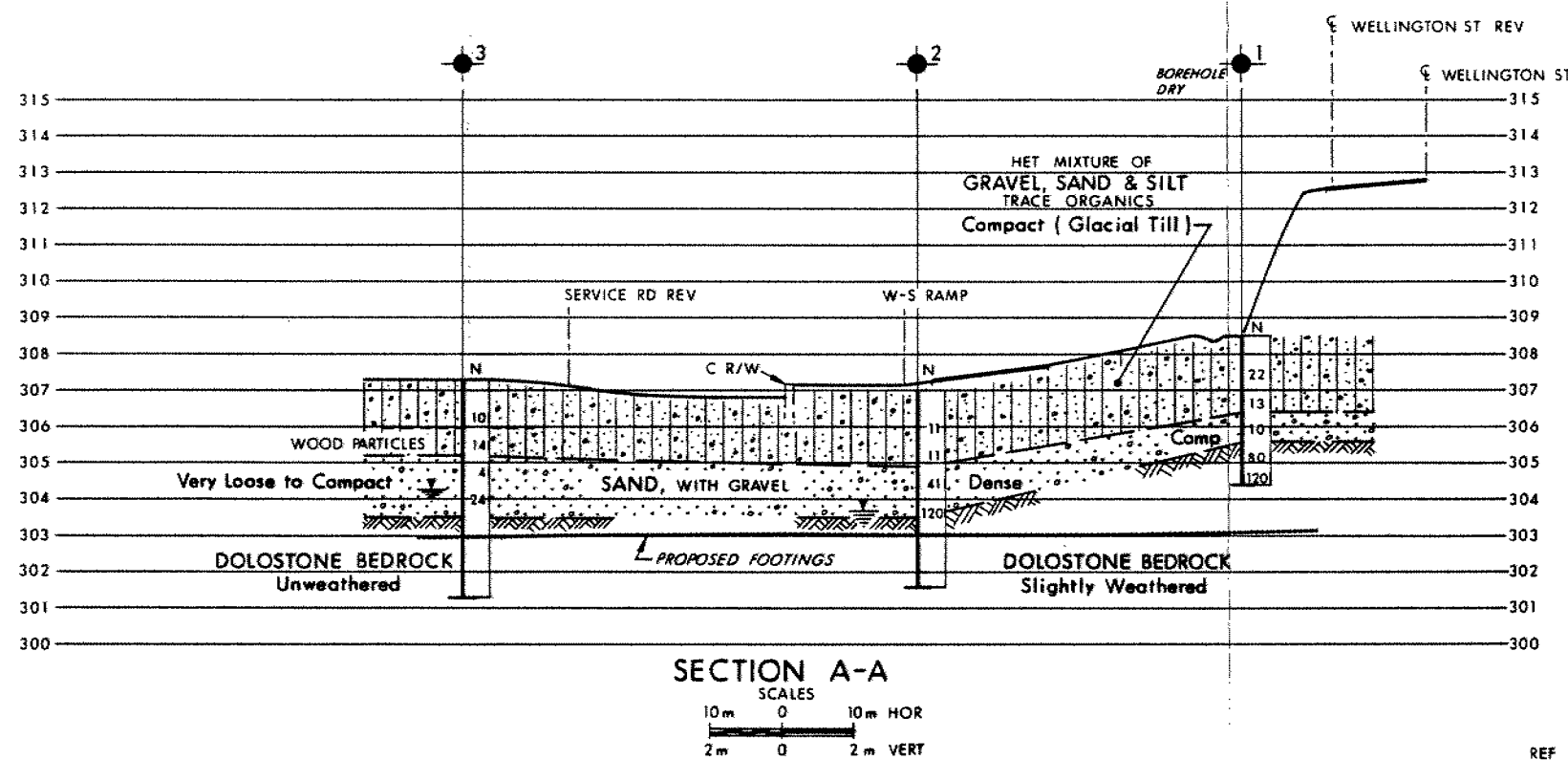
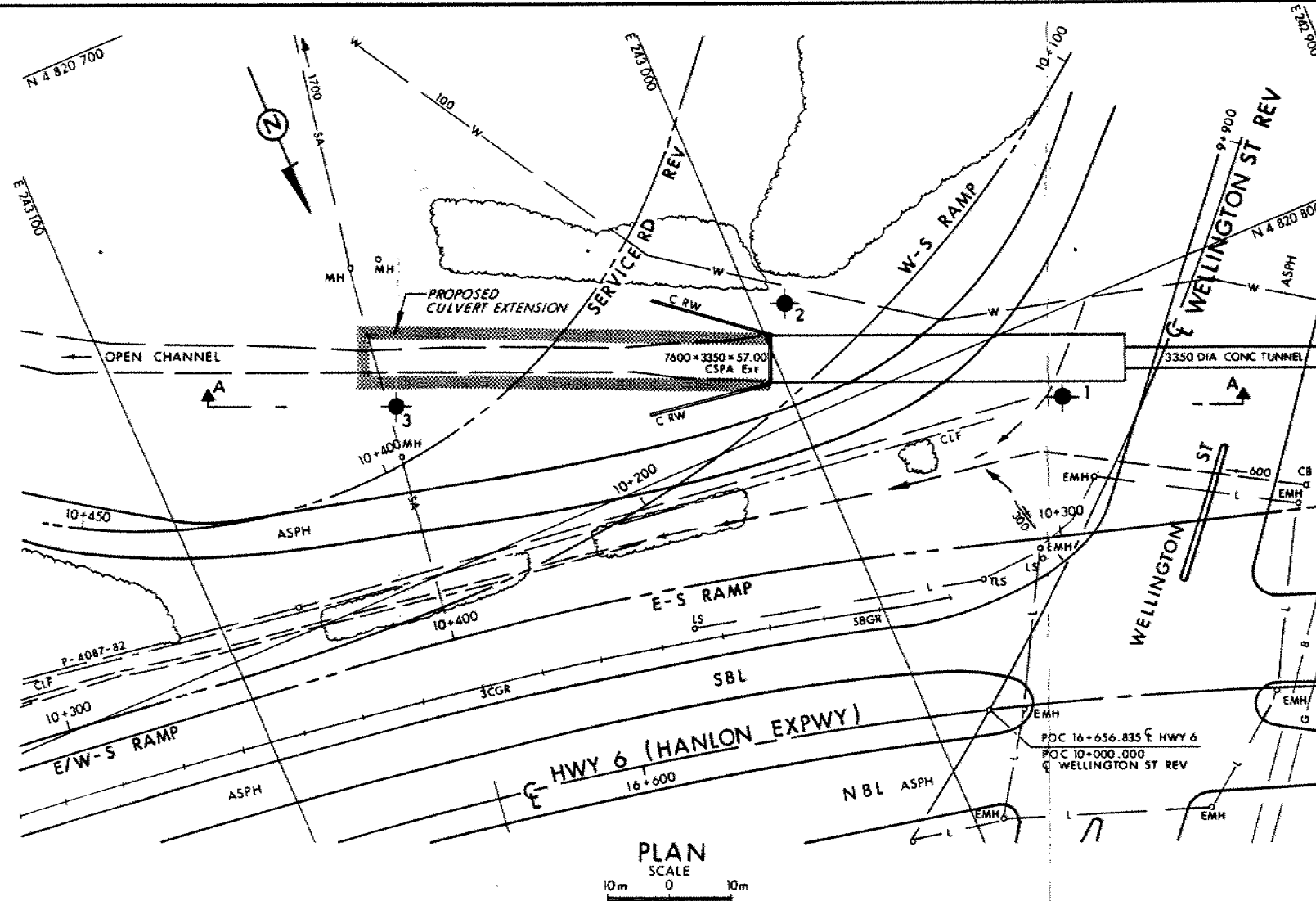
m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

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

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 ²	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						



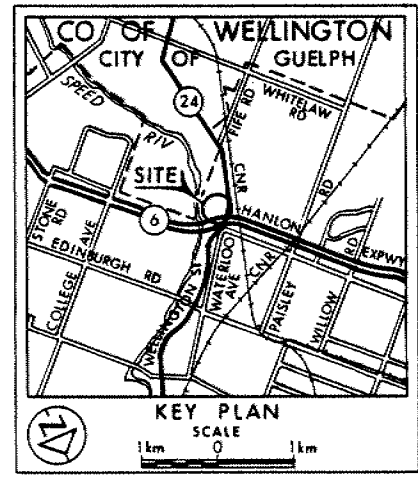
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 535-91-01

N-W DRAIN CULVERT REPLACEMENT
(Hwy 6 & Wellington St)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



- 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)
 - WL at time of investigation 1994 12

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	308.5	4820813	242960
2	307.0	4820782	242995
3	307.3	4820772	243060

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 GC 2.01 of OPS Gen. Cond.



REV.	DATE	BY	DESCRIPTION

Geacres No 40P9-39

HWY No 6 (HANLON EXPWY)	DIST 31
SUBAMD MM CHECKED MM DATE 1995 03 22	SITE 35-585
DRAWN RS CHECKED RS	DWG 5359101-A