

**FOUNDATION INVESTIGATION AND DESIGN REPORT
FOR
CULVERTS
HIGHWAY 6 (NEW)
FROM HIGHWAY 403 SOUTHERLY TO EXISTING HIGHWAY 6
CITY OF HAMILTON, ONTARIO
G.W.P. 603-00-00**

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May 2002

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FOUNDATION INVESTIGATION REPORT
For
Culverts
Highway 6 (New)
From Highway 403 Southerly to Existing Highway 6
City of Hamilton, Ontario
G.W.P. 603-00-00

INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed culverts along the Highway 6 (new) alignment from Highway 403 in the former Town of Ancaster southerly to the existing Highway 6 in the former Township of Glanbrook, now in the City of Hamilton, Ontario, as well as Butter Road and the realigned section of White Church Road adjacent to the Highway 6 (New) alignment. The investigation was conducted for Delcan Corporation on behalf of the Ontario Ministry of Transportation.

Eleven culvert locations identified for foundation investigation are as follows:

CULVERT NO.	ROADWAY	PROPOSED CENTRELINE HIGHWAY CHAINAGE (m)
1B	Hwy 6 Connection (Initial)	Sta 10+485
35	Hwy 6 New (Initial)	Sta 16+775
50	Hwy 6 New (Initial)	Sta 18+570
52	Hwy 6 New (Initial)	Sta 18+950
58	Hwy 6 New (Initial)	Sta 19+545
70	Hwy 6 New (Initial)	Sta 20+760
75	Hwy 6 New (Initial)	Sta 21+370
79	Hwy 6 New (Initial)	Sta 21+780
34A	Realigned White Church Road	Sta 10+143
70A	Butter Road	Sta 9+940
10	Realigned White Church Road	Sta 9+700

This report pertains to the proposed culverts and associated bedding/backfill zones. Information regarding approach embankments is provided in the Pavement Design Report and/or Foundation Investigation Report for Deep Cuts and High Fills.

SITE DESCRIPTION

The site is situated in a rural agricultural setting southwest of the south end of Lake Ontario. It crosses the boundary between the Norfolk Sand Plain and the Haldimand Clay Plain. Topography on the plains is gently rolling with localized steeper slopes.

The overburden along the proposed highway alignment primarily consists of glaciolacustrine deposits of silt, interstratified locally with clay. Glaciolacustrine-deltaic sand is present north of a depositional scarp adjacent to the north side of Book Road. Clayey silt/silty clay till (Halton Till) is exposed locally in the south sections of the proposed roadway. The overburden thickness generally ranges from 20 to 30 m, locally up to 40 m above the scarp at Book Road.

INVESTIGATION PROCEDURES

The field work was carried out between January 18 and March 27, 2001 and continued between January 29 and April 8, 2002. The field work comprised 22 boreholes (two at each culvert location) drilled to a depth of 6.6 m below grade at the locations shown on Drawings 1 to 11. The borehole numbering system included the culvert number for ease of reference (example: boreholes at culvert 70 are numbered 70-1 and 70-2).

The boreholes were advanced using continuous flight solid stem augers, powered by truck and track-mounted CME-75 drill rigs, supplied and operated by specialist drilling contractors, working under the full-time supervision of a member of our engineering staff.

Representative samples of the overburden were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

The groundwater conditions in the boreholes were closely monitored during the course of the field work.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. Grain size distribution analyses and Atterberg Limits tests were carried out on selected samples.

The locations of the boreholes were established in the field by Peto MacCallum Ltd. relative to roadway centreline stakes positioned by J.D. Barnes Limited. The ground surface elevations were interpolated from contours shown on the digital base plans titled "The King's Highway 6 New", dated May and June 2000 provided by Delcan Corporation.

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, soil boundary elevations, standard penetration test "N" values, penetrometer shear strength test results, groundwater observations and the results of laboratory moisture content determinations. The order of the borehole sheets is consistent with the culvert numbers shown on page 1.

The results of particle size distribution analyses conducted on selected samples recovered during drilling are presented on Figures 1 to 3. The results of the Atterberg Limits testing conducted on cohesive soil samples are provided on the plasticity charts (Figures 4 to 9). The laboratory test results are also noted on the Record of Borehole sheets.

The subsurface stratigraphy encountered at the culvert locations generally comprised a surficial topsoil layer overlying native clays and silts. Localized units of fill, sand, clay till and silt till were encountered at a number of culvert locations.

Pavement/Shoulder Structure

Asphaltic concrete with a thickness of 275 mm was encountered in borehole 10-2 along White Church Road. The asphalt was underlain by sand and gravel fill to a depth of 750 mm. Sand and gravel fill was encountered surficially in borehole 10-1 along the shoulder of White Church Road to a depth of 900 mm.

Topsoil Fill

A 650 mm thick layer of topsoil fill was encountered beneath the pavement structure in borehole 10-2 along White Church Road.

Topsoil

A 180 to 1000 mm, typically 200 to 300 mm thick surficial layer of topsoil was encountered in the boreholes at all culvert locations except culvert 10 along White Church Road. A 500 and 700 mm thick layer of topsoil was encountered beneath the surficial pavement/shoulder structure and/or fill layer in boreholes 10-1 and 10-2 along White Church Road. The topsoil comprised dark brown cohesive clayey silt.

Silty Clay

A layer of firm to very stiff cohesive silty clay was encountered beneath the surficial topsoil in eight of the boreholes and below/within silts in a further eight boreholes. Where fully penetrated, the clay units ranged from 0.3 to 2.6 m, typically 1.0 to 2.0 m, in thickness. The moisture content of the clay ranged from 19 to 29%, typically 20 to 25%. The undrained shear strength of the clay as indicated by penetrometer testing ranged from 125 to 180 kPa, locally 60 kPa. The "N" values within the silty clay typically ranged from 6 to 23.

The liquid limits and plastic limits of selected samples were 28 to 49 and 17 to 24, respectively, indicating the clay material is low to medium plastic (Figures 4 and 5). The results of particle size distribution analyses conducted on selected samples of the clay recovered during drilling are presented on Figure 1. Drilling was terminated within the clay in five boreholes at a depth of 6.6 m.

Silt

Native non-cohesive silt and cohesive clayey silt were encountered in all of the boreholes except three boreholes at culverts 52 and 58. The silt was typically compact/stiff to very dense, locally loose/firm to depths of up to 2.5 m. The moisture content of the silt ranged from 15 to 27%, typically 18 to 24%. The "N" values of the silt ranged from 11 to 76, with localized "N" values ranging from 5 to 7 to a depth of 2.5 m.

The liquid limit and plastic limit of samples displaying plasticity were 23 to 28 and 17 to 22, respectively, indicating the silt material was slightly plastic (Figure 6). Atterberg Limits tests were also carried out on nine selected samples of silt and were determined to be non-plastic. The results of particle size distribution analyses conducted on selected samples of silt recovered during drilling are presented on Figure 2. The silt ranged in thickness from 0.7 to 5.5 m, typically 1.2 to 2.5 m (between elevation 224.0 and 206.9) where fully penetrated. Drilling was terminated within the silt in seven of the remaining boreholes at a depth of 6.6 m.

Silty Clay Till

A unit of very stiff to firm cohesive clay till was encountered beneath the clay layer in boreholes 52-1, 52-2, 58-2 and 75-2. The clay till had a moisture content of 16 to 24%. The "N" values of the till typically ranged from 7 to 21. The liquid limits and plastic limits of selected samples were 25 to 35 and 17 to 19, respectively, indicating the clay material is low plastic (Figure 7). The results of particle size distribution analyses conducted on selected samples of the silty clay till recovered during drilling are presented on Figure 3. Drilling was terminated within the clay till in all four boreholes at a depth of 6.6 m.

Clayey Silt Till

Stiff to very stiff cohesive clayey silt till was encountered in boreholes 70-1, 70-2 and 75-1 beneath the clay and/or silt layers. The moisture content ranged from 15 to 20%. The clayey silt till had "N" values ranging from 9 to 23. The results of Atterberg Limits tests on a sample of the silt till indicated liquid and plastic limits of 24 and 17 (Figure 8). Drilling was terminated within the silt till in all three boreholes at a depth of 6.6 m.

Isolated Deposits

A deposit of soft/very loose, layered clays, silts and sandy silts was revealed below the topsoil in borehole 70A-1. The layered deposit was penetrated at 1.4 m depth (elevation 218.1). Very loose non-cohesive silty fine sand was encountered below the topsoil in borehole 70A-2 and penetrated at 0.9 m depth (elevation 218.9). Drilling was terminated within the unit at a depth of 6.6 m.

A unit of stiff layered cohesive clayey silt and silty clay till was encountered beneath the silt deposit at a depth of 5.5 m (elevation 209.3) in boreholes 10-1 and 10-2. The moisture content of the unit was 23 and 27%. The undrained shear strength of the clay layers as indicated by penetrometer testing was 36 kPa, with "N" values of the deposit being 9 and 10.

The liquid and plastic limits of a selected sample were 36 and 20, indicating the clayey material is medium plastic (Figure 9). The results of a particle size distribution analysis conducted on the sample recovered during drilling are presented on Figure 3. Drilling was terminated within the deposit at a depth of 6.6 m.

Groundwater

During or upon completion of drilling, water was observed in the boreholes at the following depths:

Borehole	Highest Observed Water Level	
	Depth (m)	Elevation
1B-1	Surface	212.6
1B-2	0.9	211.9
35-1	surface	215.3
35-2	surface	215.5
50-1	0.6	217.8
50-2	-	-
52-1	-	-
52-2	3.0	215.9
58-1	-	-
58-2	-	-
70-1	0.1	220.2
70-2	1.0	219.2
75-1	0.3	223.9
75-2	0.3	224.0
79-1	-	-
79-2	Surface	226.5
34A-1	-	-
34A-2	3.0	211.0
70A-1	1.9	217.6
70A-2	0.9	218.9
10-1	2.5	212.3
10-2	3.0	211.8

Observed water levels are subject to seasonal fluctuations and rainfall patterns.

CLOSURE

The field work was carried out under the supervision of Mr. M. Rapsey and Mr. P. Cullen. The equipment was supplied by Malones Soil Sampling.

The report was prepared by Mr. P. Cullen, B.Eng. and Mr. M.R. Anderson, M.Eng., P.Eng., and reviewed by Mr. D.W. Kerr, P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, P.Eng. carried out an executive review of the report.



Yours very truly

Peto MacCallum Ltd.

A handwritten signature in black ink, appearing to read "D. W. Kerr", written over a horizontal line.

Dennis W. Kerr, M.Eng., P.Eng.
Chief Foundation Engineer



A handwritten signature in black ink, appearing to read "Brian R. Gray", written over a horizontal line.

Brian R. Gray, M.Eng., P.Eng.
President

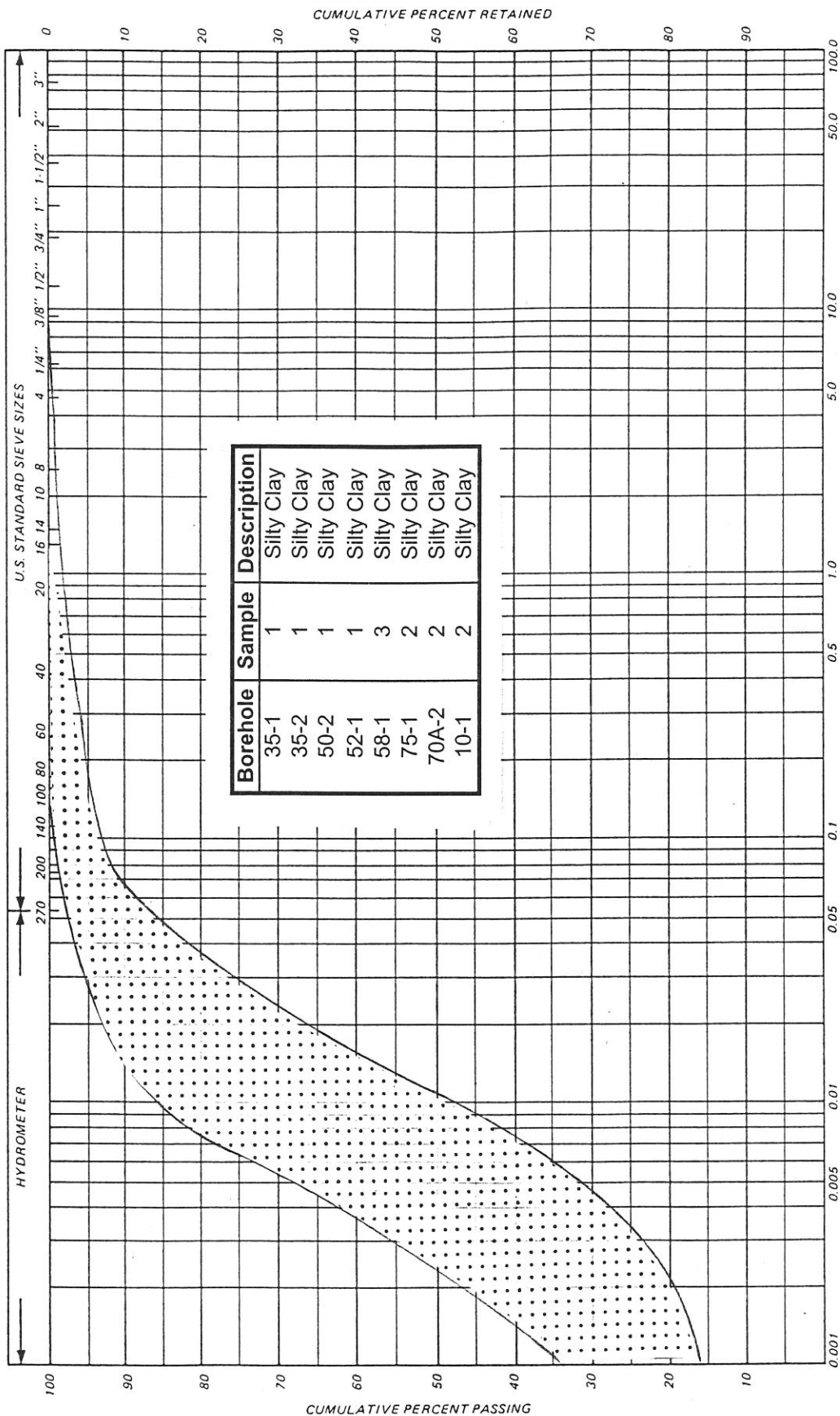
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APPENDIX A

FIGURES 1 TO 3 – PARTICLE SIZE DISTRIBUTION CHARTS

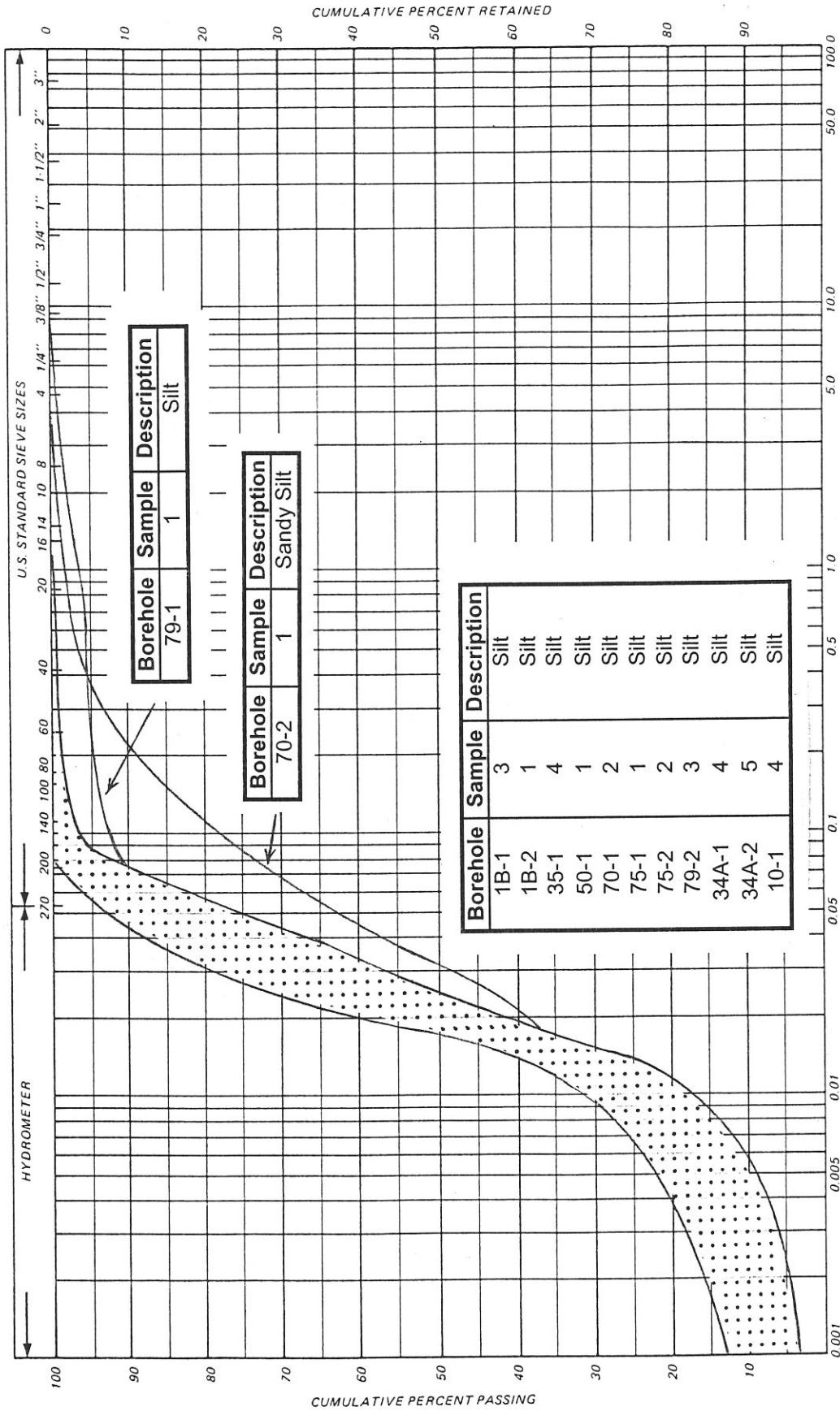
FIGURES 4 TO 9 – PLASTICITY CHARTS

PARTICLE SIZE DISTRIBUTION CHART



GRAIN SIZE IN MILLIMETERS												COBBLES			
SILT & CLAY						COARSE SAND		MEDIUM SAND		FINE SAND		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM SILT		COARSE		FINE		MEDIUM SAND		COARSE		GRAVEL	
CLAY		FINE		MEDIUM SILT		COARSE		FINE		MEDIUM SAND		COARSE		GRAVEL	
CLAY		FINE		MEDIUM SILT		COARSE		V. FINE		FINE		MED. SAND		COARSE	
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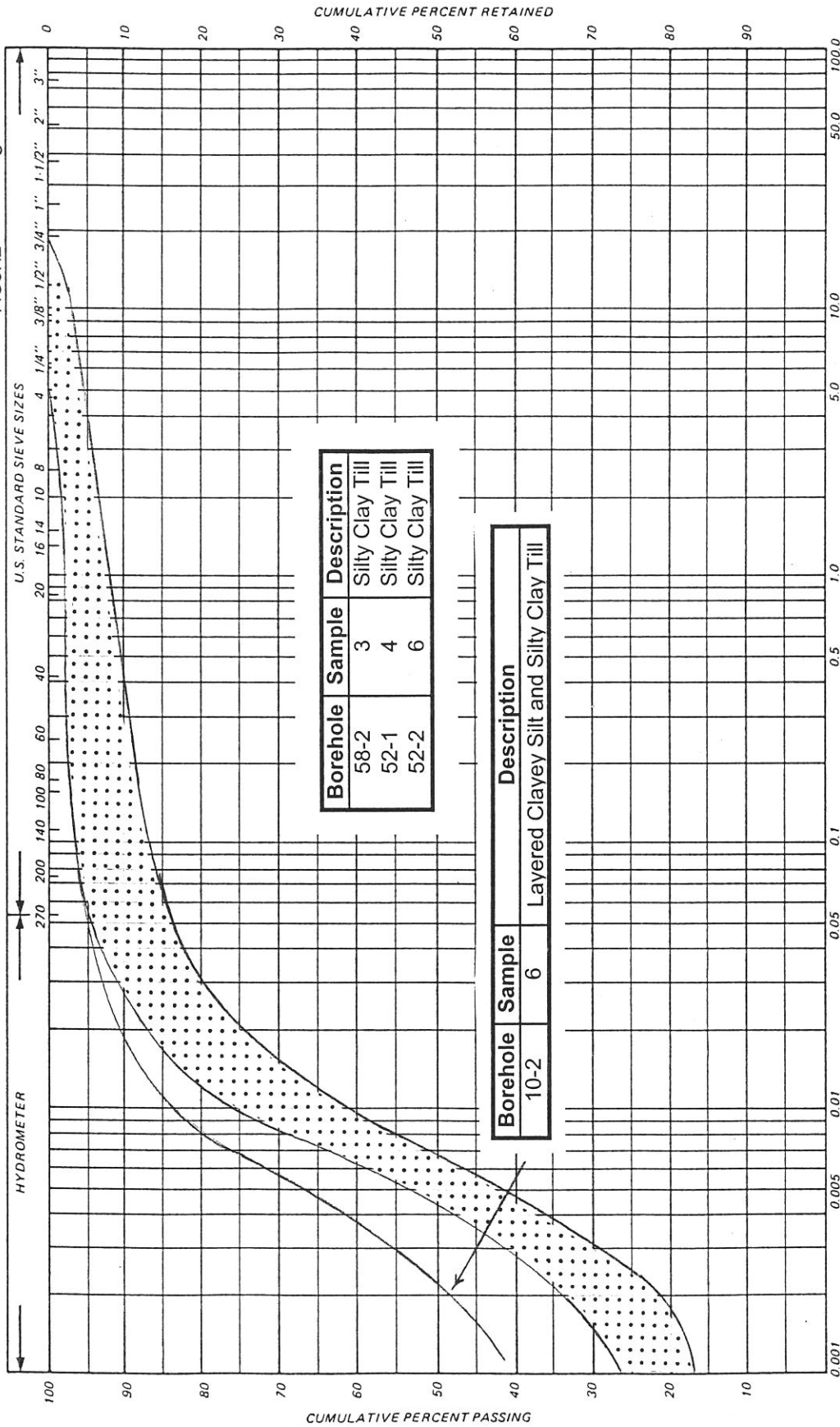
PARTICLE SIZE DISTRIBUTION CHART



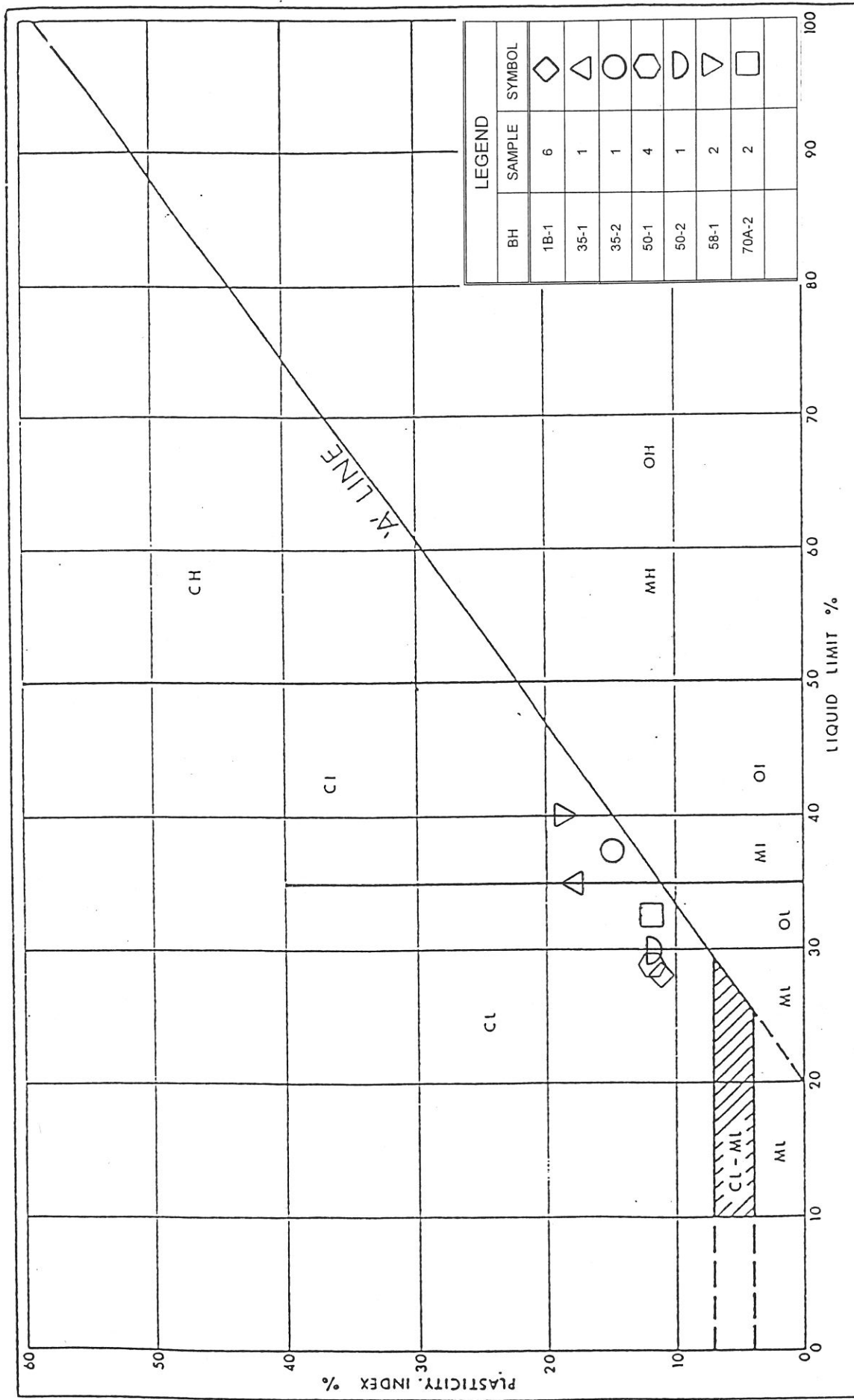
GRAIN SIZE IN MILLIMETERS										U.S. BUREAU	
										M.I.T.	
										UNIFIED	
										COBBLES	
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REMARKS

PARTICLE SIZE DISTRIBUTION CHART



CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	
CLAY											



LEGEND		
BH	SAMPLE	SYMBOL
1B-1	6	◇
35-1	1	△
35-2	1	○
50-1	4	⬡
50-2	1	⊖
58-1	2	▽
70A-2	2	□

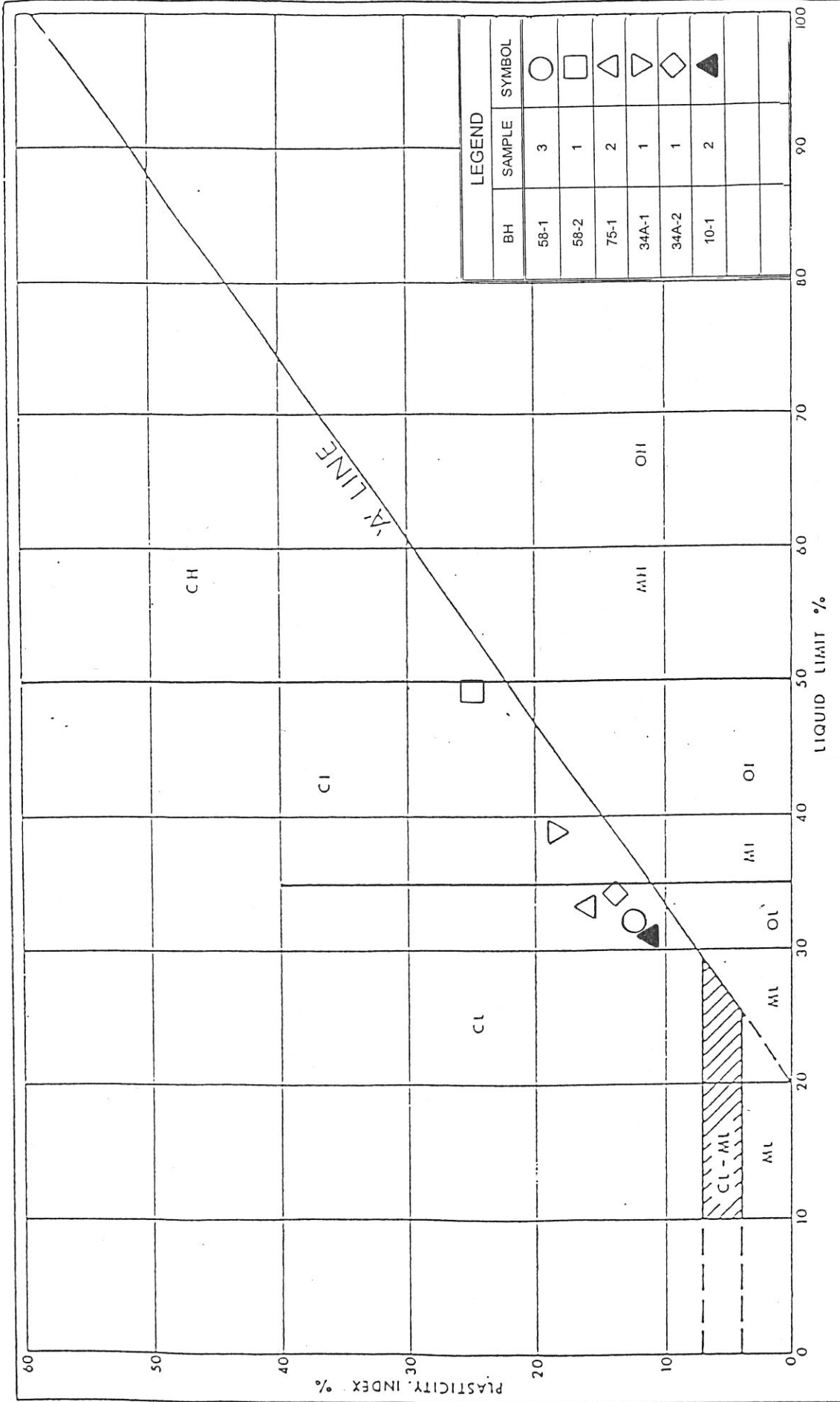
Ministry of Transportation
Ontario

FIG No 4

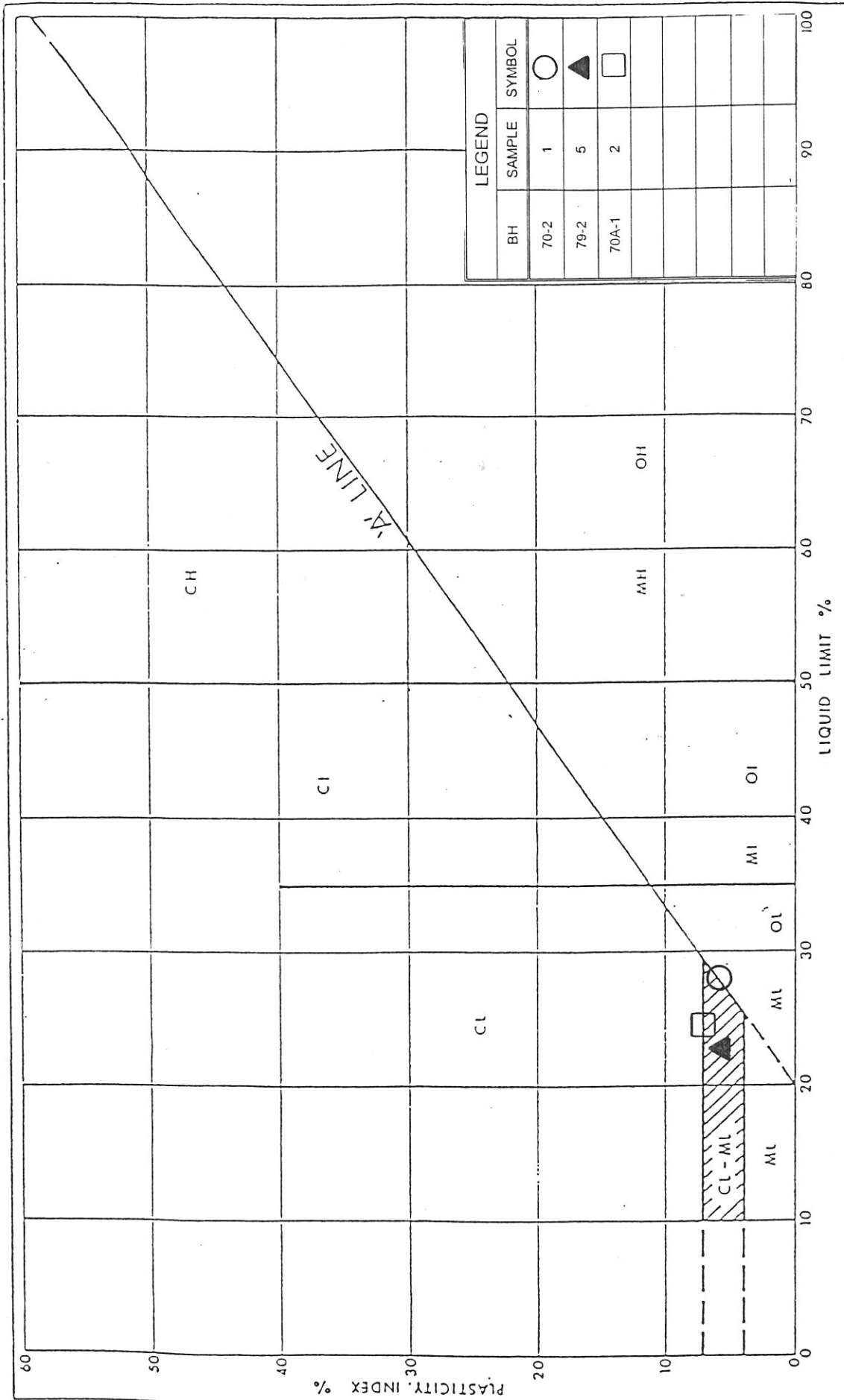
Hwy 6 (New) Culverts

PLASTICITY CHART

SILTY CLAY



LEGEND		
BH	SAMPLE	SYMBOL
58-1	3	○
58-2	1	□
75-1	2	△
34A-1	1	▽
34A-2	1	◇
10-1	2	▲



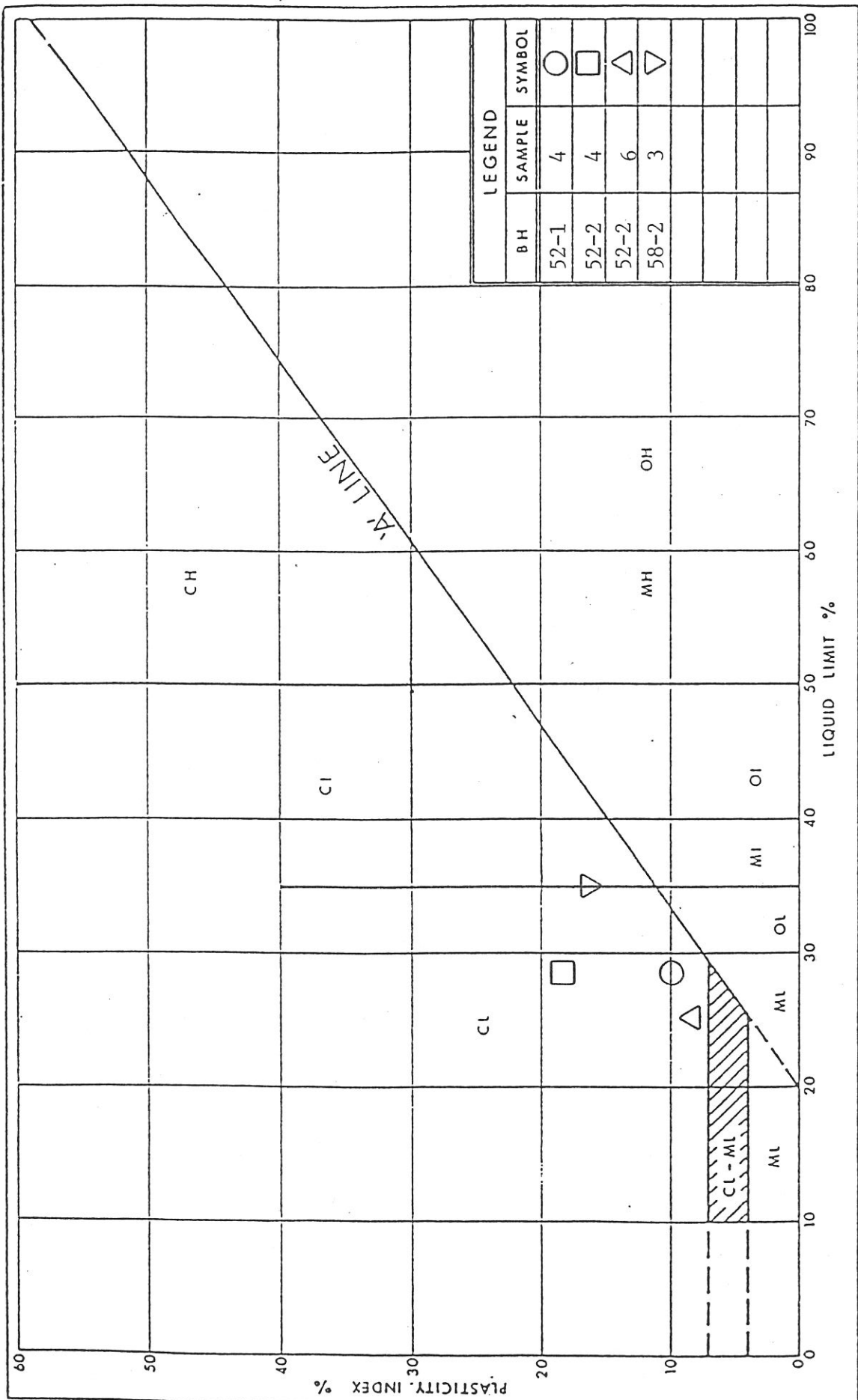


FIG No 7

PLASTICITY CHART

SILTY CLAY TILL

Ministry of Transportation
Ontario

Hwy 6 (New) Culverts

APPENDIX B
RECORD OF BOREHOLE LOGS

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N', - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 0.3m INTO THE SUBSOIL. DRIVEN BY MEANS OF A 63.5kg HAMMER FALLING FREELY A DISTANCE OF 0.76m.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 51mm, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS. 0.3m INTO THE SUBSOIL. THE DRIVING ENERGY BEING 475 J PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

CONSISTENCY	'N' BLOWS/0.3 m	c kPa	DENSENESS	'N' BLOWS/0.3 m
VERY SOFT	0 - 2	0 - 12	VERY LOOSE	0 - 4
SOFT	2 - 4	12 - 25	LOOSE	4 - 10
FIRM	4 - 8	25 - 50	COMPACT	10 - 30
STIFF	8 - 15	50 - 100	DENSE	30 - 50
VERY STIFF	15 - 30	100 - 200	VERY DENSE	> 50
HARD	> 30	> 200		
W.T.P.L.	WETTER THAN PLASTIC LIMIT		D.T.P.L. DRIER THAN PLASTIC LIMIT	
	A.P.L. ABOUT PLASTIC LIMIT			

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL		

▲, Δ - Undisturbed and remoulded shear strength determined from in situ vane test.

■ - Undrained shear strength determined from pocket penetrometer test.

RECORD OF BOREHOLE No 1B-1

1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 1B - Sta. 10+485, 14m Lt. CL Hwy 6 Connection
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers
DATUM Geodetic DATE March 14, 2001

ORIGINATED BY M.R.

COMPILED BY M.R.A.

CHECKED BY D.W.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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
212.60	Ground Surface															
212.40	Topsoil															
0.20	Silt, trace of clay and fine sand		1	SS	6	212										
	Loose Brown		2	SS	23	211										
	Compact to dense		3	SS	37	210										
	Grey		4	SS	47	209										
			5	SS	25	208										
206.90	Silty clay, with thin layers of silt		6	SS	9	207										
5.70	Stiff Grey															
206.05	End of borehole															
6.55																

[illegible]

+7, x⁵: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 35-1

1 of 1

METRIC

G W P 603-00-00

LOCATION

CULVERT 35 - Sta. 16+775, 15m Lt. CL Hwy 6 NEW
(initial)

ORIGINATED BY M.R.

DIST CR

HWY 6 (NEW)

BOREHOLE TYPE

Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM

Geodetic

DATE

March 14, 2001

CHECKED BY D.W.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	WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
215.30	Ground Surface																	
215.00	Topsoil						215											
0.30	Silty clay, trace of sand		1	SS	8													0 8 67 25
213.90	Stiff Brown						214											
1.40	Silt, trace of fine sand, trace of clay		2	SS	13													
	Compact Brown						213											
	Grey						212											
			3	SS	22													
							211											
			4	SS	26		210											0 1 94 5
	with layers of silty clay																	
208.75			5	SS	15		209											
6.55	End of borehole																	
	* 2001 03 14																	
	∇ WATER OBSERVED DURING DRILLING																	

RECORD OF BOREHOLE No 35-2

1 of 1

METRIC

G W P 603-00-00

LOCATION

CULVERT 35 - Sta. 16+775, 15m Rt. CL Hwy 6 NEW
(Initial)

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE

Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE

March 14, 2001

CHECKED BY D.W.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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		
215.50	Ground Surface																
215.20	Topsoil																
0.30	Silty clay, trace of sand		1	SS	6		215										0 5 69 26
	Firm Brown																
	Very stiff		2	SS	23		214										
213.70	Silt, trace of fine sand																
1.80	Very dense Brown		3	SS	76		213										
	Compact to dense Grey		4	SS	30		212										
			5	SS	30		211										
							210										
	with layers of silty clay		6	SS	16		209										
208.95	End of borehole																
6.55																	
	* 2001 03 14																
	WATER OBSERVED DURING DRILLING																



RECORD OF BOREHOLE No 50-1

1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 50 - Sta. 18+563, 16m Lt. CL Hwy 6 NEW ORIGINATED BY P.C.
 DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.R.A.
 DATUM Geodetic DATE January 19, 2001 CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
218.40	Ground Surface															
217.65	Topsoil															
0.75	Silt, some clay, trace of sand		1	SS	6											0 9 75 16
	Loose Brown		2	SS	7											
215.90			3	SS	17											
2.50	Silty clay, trace of sand															
	Brown															
	Grey		4	SS	9											
	Stiff to very stiff															
	with lenses of brown silt		5	SS	18											
211.85			6	SS	15											
6.55	End of borehole															
	* 2001 01 19															
	▽ WATER LEVEL OBSERVED DURING DRILLING															



1 of 1

METRIC

G W P 603-00-00

LOCATION CULVERT 50 - Sta. 18+570, 16m Rt. CL Hwy 6 NEW
(Initial)

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE January 22, 2001

CHECKED BY D.W.K.

+7, x⁵: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 52-1

1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 52 - Sta. 18+940, 16m Lt. CL Hwy 6 NEW
Co-ords. 4 779 711 N; 268 404 E.
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers
DUM Geodetic DATE January 22, 2001
ORIGINATED BY M.R.
COMPILED BY M.R.A.
CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100	W _p	W	W _L		
218.00	Ground Surface															GR SA SI CL
217.82	Topsoil															
0.18	Silty clay, trace of sand		1	SS	8											0 1 53 46
	Stiff															
	Hard		2	SS	33											
215.60																
2.40	Silty clay, trace of sand		3	SS	26											
	Very stiff to stiff		4	SS	13											0 3 69 28
	Grey (Till)															
			5	SS	11											
211.45			6	SS	12											
6.55	End of borehole															
	* GROUNDWATER LEVEL NOT DETERMINED															

RECORD OF BOREHOLE No 52-2

1 of 1

METRIC

G W P 603-00-00

LOCATION CULVERT 52 - Sta. 18+900, 16m Rt. CL Hwy 6 NEW

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE January 22, 2001

CHECKED BY D.W.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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		
218.90	Ground Surface																
218.00	Topsoil																
0.90	Silt, trace of sand Loose Brown to compact With clay Trace of clay		1	SS	9		218							o			
216.80			2	SS	11		217							o			
2.10	Silty clay, trace of sand		3	SS	20		216							o			
216.50	Very Brown stiff		4	SS	21		215										
2.40	Silty clay, trace of sand and gravel						214										
	Very stiff to stiff						213										
	Grey (Till)		5	SS	14									o			
			6	SS	14												
212.35																	
6.55	End of borehole																
	* 2001 01 22																
	∇ WATER LEVEL OBSERVED DURING DRILLING																

RECORD OF BOREHOLE No 58-1

1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 58 - Sta. 19+550, 18m Lt. CL Hwy 6 NEW
Co-ords. 4 779 958 N; 267 850 E.
(initials)
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers
DATUM Geodetic DATE January 22, 2001
ORIGINATED BY M.R.
COMPILED BY M.R.A.
CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
218.20	Ground Surface															
218.00 0.20	Topsoil					218										
	Silty clay, trace of sand, with thin lenses of silt		1	SS	14	217										
	Very Brown Stiff		2	SS	22	216										
			3	SS	19	215										0 3 67 30
	Stiff Grey		4	SS	11	214										
						213										
			5	SS	10	212										
211.65 6.55	End of borehole		6	SS	9											
	* GROUNDWATER LEVEL NOT DETERMINED															

RECORD OF BOREHOLE No 58-2

1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 58 - Sta. 19+555, 16m Rt. CL Hwy 6 NEW
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers
DATUM Geodetic DATE January 22, 2001

ORIGINATED BY M.R.

COMPILED BY M.R.A.

CHECKED BY D.W.K.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100	W _p	W	W _L		
216.60	Ground Surface															
216.40	Topsoil															
0.20																
	Silty clay, trace of sand, with thin lenses of silt		1	SS	6											
	Firm Brown		2	SS	18											
	Very stiff															
214.50																
2.10	Silty clay, trace of sand and gravel		3	SS	24											
	Very stiff Brown		4	SS	8											
	Firm to Grey															
	stiff															
	(Till)															
			5	SS	7											
			6	SS	10											
210.05																
6.55	End of borehole															
	* GROUNDWATER LEVEL NOT DETERMINED															

RECORD OF BOREHOLE No 70-1

1 of 1

METRIC

G W P 603-00-00

LOCATION

CULVERT 70 - Sta. 20+745, 21m Lt. CL Hwy 6 NEW
(Initial)

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE

Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE

January 23, 2001

CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100				
220.30	Ground Surface														
219.30	Topsoil					220									
1.00	Silt, trace of sand		1	SS	6	219									0 6 87 7
	Loose Brown with clay		2	SS	18	218									
	Compact, trace of clay					217									
217.90	Clayey silt, trace of sand		3	SS	15	216									
2.40	Stiff Grey (Till)		4	SS	11	215									
			5	SS	10	214									
			6	SS	9										
213.75	End of borehole														
6.55															
	* 2001 01 23														
	▽ WATER LEVEL OBSERVED DURING DRILLING														

RECORD OF BOREHOLE No 70-2

1 of 1

METRIC

G W P 603-00-00

LOCATION

CULVERT 70 - Sta. 20+780, 20m Rt. CL Hwy 6 NEW
(Initial)

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE

Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE

January 23, 2001

CHECKED BY D.W.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	WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100						
220.20	Ground Surface					220											
219.80	Topsoil					219											
0.40	Sandy silt, some clay, trace of gravel		1	SS	5	218											1 26 61 12
	Loose Brown		2	SS	28	217											
	Compact		3	SS	27	216											
	Grey		4	SS	11	215											
217.35	Clayey silt, trace of sand and gravel		5	SS	11	214											
2.85	Stiff Grey (Till)		6	SS	13												
213.65	End of borehole																
6.55																	
	* 2001 01 23																
	∇ WATER LEVEL OBSERVED DURING DRILLING																

RECORD OF BOREHOLE No 75-1

1 of 1

METRIC

G W P 603-00-00

LOCATION

CULVERT 75 - Sta. 21+370, 19m Lt. CL Hwy 6 NEW

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE

Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE

March 27, 2001

CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
224.20	Ground Surface															
223.92 0.28	Topsoil															
	Silt, trace of clay and sand															
	Compact Brown		1	SS	22											0 3 90 7
221.80																
2.40	Silty clay, trace of sand															
	Very stiff Brown		2	SS	18											0 1 59 40
220.20																
4.00	Silt, trace of fine sand															
	Dense Grey		3	SS	40											
219.20																
5.00	Clayey silt, trace of sand and gravel															
	Very stiff Brown (Till)		4	SS	23											
217.65 6.55	End of borehole															
	* 2001 03 27															
	▼ WATER LEVEL OBSERVED AFTER DRILLING															
	■ PENETROMETER															

RECORD OF BOREHOLE No 75-2

1 of 1

METRIC

G W P 603-00-00

LOCATION

CULVERT 75 - Sta. 21+370, 18m Rt. CL Hwy 6 NEW

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE

Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE

March 27, 2001

CHECKED BY D.W.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	WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100						
224.30	Ground Surface																
224.00 0.30	Topsoil																
	Clayey silt, trace of sand																
	Stiff Brown																
222.50 1.80	Silt, trace of fine sand and clay		1	SS	18												
	Compact Brown Grey																
			2	SS	23												
220.30 4.00	Silty clay, trace of sand																
	Stiff Grey																
219.30 5.00	Silty clay, trace of sand and gravel		3	SS	12												
	Very Brown stiff (Till)																
217.75 6.55	End of borehole		4	SS	16												
	* 2001 03 27																
	▼ WATER LEVEL OBSERVED AFTER DRILLING																
	■ PENETROMETER																

RECORD OF BOREHOLE No 79-1

1 of 1 METRIC

G.W.P. 603-00-00 LOCATION Culvert 79 - Sta. 21+780 16m Rt CL Hwy 6 New ORIGINATED BY P.C.

DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY P.C.

DATUM Geodetic DATE April 08, 2002 CHECKED BY M.R.A.

[illegible]

RECORD OF BOREHOLE No 79-2

1 of 1 METRIC

G.W.P. 603-00-00 LOCATION Co-ords. 4 782 021 N: 267 070 E Culvert 79 - Sta. 21+780 16m Lt CL Hwy 6 New ORIGINATED BY P.C.
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY P.C.
DATUM Geodetic DATE April 08, 2002 CHECKED BY M.R.A.

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			SHEAR STRENGTH kPa						
226.50	Ground Surface													
0.00	Topsoil													
226.15														
0.35	Silt, trace of clay, trace of fine sand, trace of gravel, with oxidized stains													
	Loose Brown moist to compact		1	SS	5									
			2	SS	20									
	Grey		3	SS	21									
			4	SS	17									
	with layer of clayey silt, trace of sand		5	SS	9									
	Stiff Grey													
	Compact Brown													
			6	SS	29									
219.90														
6.60	End of borehole													
	*2002 04 08													
	Water level measured after drilling													

RECORD OF BOREHOLE No 34A-1

1 of 1

METRIC

G W P 603-00-00

LOCATION CULVERT 34A - Sta. 10+140, 18m Lt. CL Realigned White Church Road

ORIGINATED BY M.R.

DIST CR HWY 6 (NEW)

BOREHOLE TYPE Continuous Flight Solid Stem Augers

COMPILED BY M.R.A.

DATUM Geodetic

DATE March 14, 2001

CHECKED BY D.W.K.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
214.05	Ground Surface															
213.75	Topsoil															
0.30	Silty clay, trace of sand		1	SS	10											
	Stiff Brown		2	SS	10											
			3	SS	15											
211.15	Silt, trace of fine sand, trace of clay		4	SS	28											
2.90	Compact Brown to dense to grey		5	SS	41											
			6	SS	48											
207.50	End of borehole															
6.55	* GROUNDWATER LEVEL NOT DETERMINED ■ PENETROMETER															

RECORD OF BOREHOLE No 34A-2 1 of 1										METRIC						
G W P 603-00-00		LOCATION CULVERT 34A - Sta. 10+145, 18m Rt. CL Realigned White Church Road				ORIGINATED BY M.R.										
DIST CR HWY 6 (NEW)		BOREHOLE TYPE Continuous Flight Solid Stem Augers				COMPILED BY M.R.A.										
DATUM Geodetic		DATE March 14, 2001				CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W		
213.95	Ground Surface															
213.75 0.20	Topsoil															
	Silty clay, trace of sand		1	SS	8											
	Stiff Brown		2	SS	10											
211.85 2.10	Silt, trace of fine sand, trace of clay		3	SS	28											
	Compact Grey to dense		4	SS	21											
			5	SS	40											
			6	SS	21											
207.40 6.55	End of borehole															
	* 2001 03 14															
	∇ WATER LEVEL OBSERVED DURING DRILLING															

RECORD OF BOREHOLE No 70A-1 1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 70A - Sta. 9+940, 32m Lt. CL Butter Road ORIGINATED BY P.C.
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.R.A.
DATUM Geodetic DATE January 18, 2001 CHECKED BY D.W.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					
219.50	Ground Surface															
	Topsoil															
218.90																
0.60	Layered silty clays, silt and sandy silt		1	SS	3											
218.10	Soft Brown very loose		2	SS	20											
1.40	Clayey silt, trace of sand		3	SS	23											
	Very Grey stiff		4	SS	19											
214.70			5	SS	13											
4.80	Silty clay, trace of sand and gravel															
	Stiff Grey		6	SS	11											
212.95																
6.55	End of borehole															
	* 2001 01 18															
	▽ WATER LEVEL OBSERVED DURING DRILLING															
	▽ WATER LEVEL MEASURED AFTER DRILLING															

RECORD OF BOREHOLE No 70A-2

1 of 1

METRIC

G W P 603-00-00 LOCATION CULVERT 70A - Sta. 9+940, 33m Rt. CL Butter Road ORIGINATED BY P.C.
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.R.A.
DATUM Geodetic DATE January 18, 2001 CHECKED BY D.W.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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100					
219.80	Ground Surface															
219.50	Topsoil															
0.30	Silty fine sand, trace of clay															
218.90	Very Brown loose		1	SS	4											
0.90	Silty clay, trace of sand and gravel		2	SS	21											
	Firm Brown															
	Very stiff		3	SS	24											
216.90	Brown															
2.90	Clayey silt, trace of sand and gravel		4	SS	24											
	Very Grey stiff															
	Very dense Silt, trace of clay and sand		5	SS	67											
	Compact															
213.25			6	SS	17											
6.55	End of borehole															
	* 2001 01 18															
	▽ WATER LEVEL OBSERVED DURING DRILLING															
	▽ WATER LEVEL MEASURED AFTER DRILLING															

RECORD OF BOREHOLE No 10-1

1 of 1 METRIC

G.W.P. 603-00-00 LOCATION Co-ords. 4 778 515 N; 269 728 E
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers
DATUM Geodetic DATE January 29, 2002

ORIGINATED BY P.C.

COMPILED BY P.C.

CHECKED BY M.R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
214.80 0.00	Ground Surface													
213.90 0.90	Shoulder Structure, sand and gravel fill, trace of silt Grey						214							
213.40 1.40	Topsoil		1	SS	7									
212.70 2.10	Silty clay, trace of sand Stiff Brown		2	SS	9		213							0 2 76 22
	Silt, trace of fine sand, trace of clay		3	SS	36		212							
	Dense Brown Moist to very to wet dense		4	SS	65		211							
	Grey		5	SS	58		210							0 5 89 6
209.30 5.50	Layered clayey silt and silty clays, trace of sand						209							
208.20 6.60	Stiff Grey (Till)		6	SS	9									
	End of borehole													
	*2002 01 29 Water level measured after drilling													

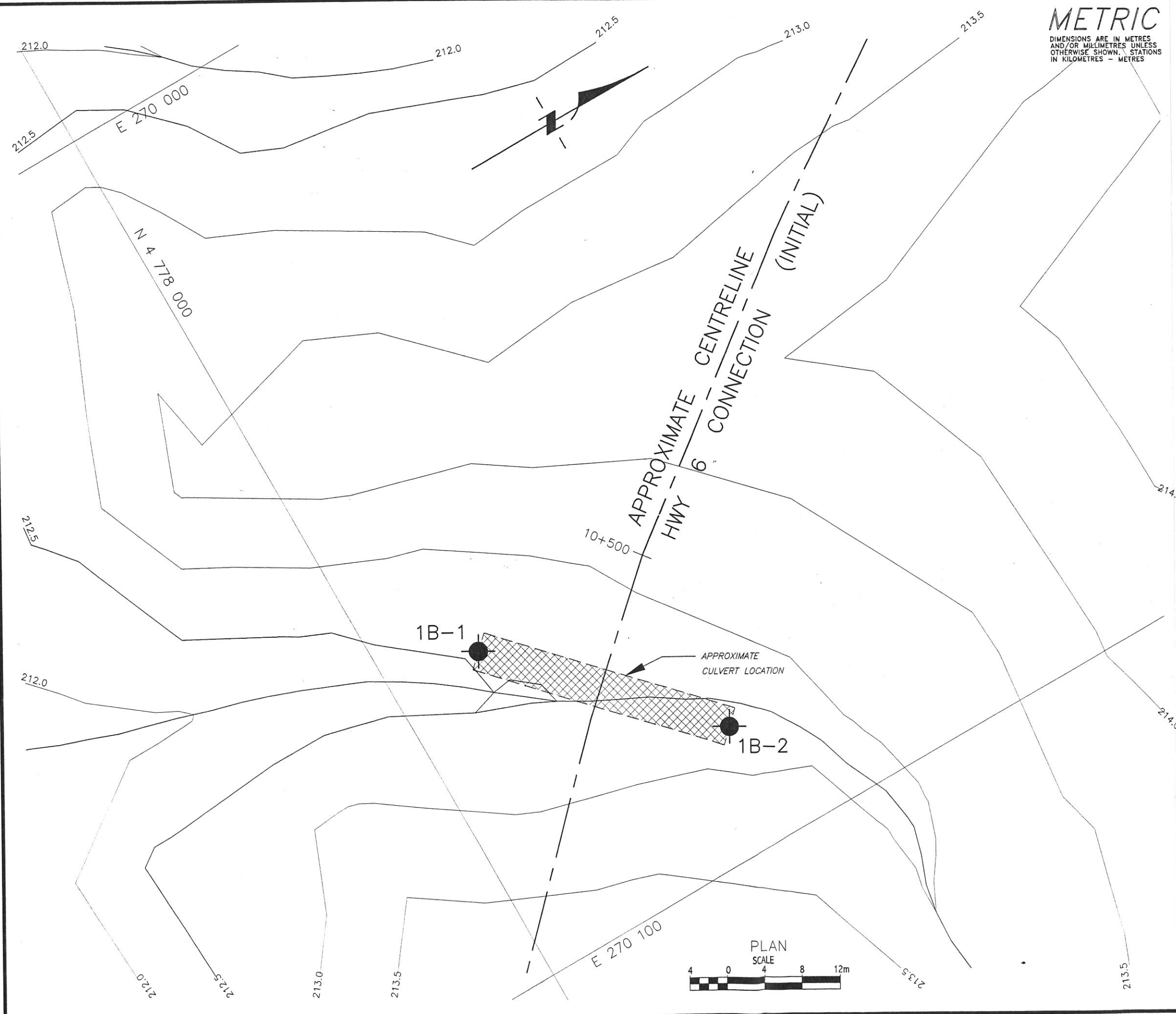
RECORD OF BOREHOLE No 10-2

1 of 1 METRIC

G.W.P. 603-00-00 LOCATION Co-ords. 4 778 509 N; 269 726 E Culvert 10 - Sta. 9+700 3.8m Rt CL White Church Rd ORIGINATED BY P.C.
DIST CR HWY 6 (NEW) BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY P.C.
DATUM Geodetic DATE January 29, 2002 CHECKED BY M.R.A.

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			SHEAR STRENGTH kPa									WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE						
214.80	Ground Surface																
0.00	Pavement structure, 275mm asphaltic concrete over sand and gravel fill, trace of silt																
214.05	Topsoil fill		1	SS	11		214										
213.40	Topsoil		2	SS	8		213										
212.70	Silt, some fine sand, trace of clay		3	SS	23		212										
2.10	Compact Brown Moist to wet		4	SS	56		211										
	Very dense to compact Grey						210										
			5	SS	22		209										
209.30	Layered clayey silt and silty clays, trace of fine sand and gravel																
5.50	Stiff Grey (Till)		6	SS	10											1 3 48 48	
208.20	End of borehole *2002 01 29 Water level measured after drilling																
6.60																	

APPENDIX C
DRAWINGS 1 TO 11



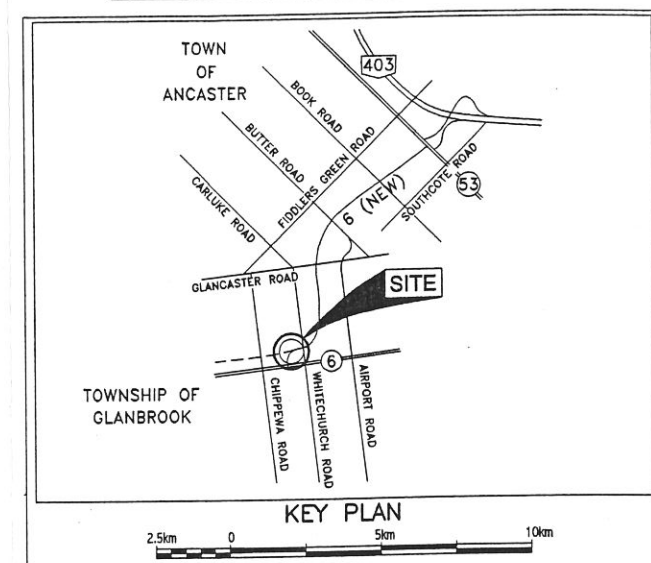
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES - METRES

CONT No.
GWP No. 603-00-00

HWY 6 (NEW)
Proposed Culvert 1B at
Station 10+485 (Hwy 6 Connection)
BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



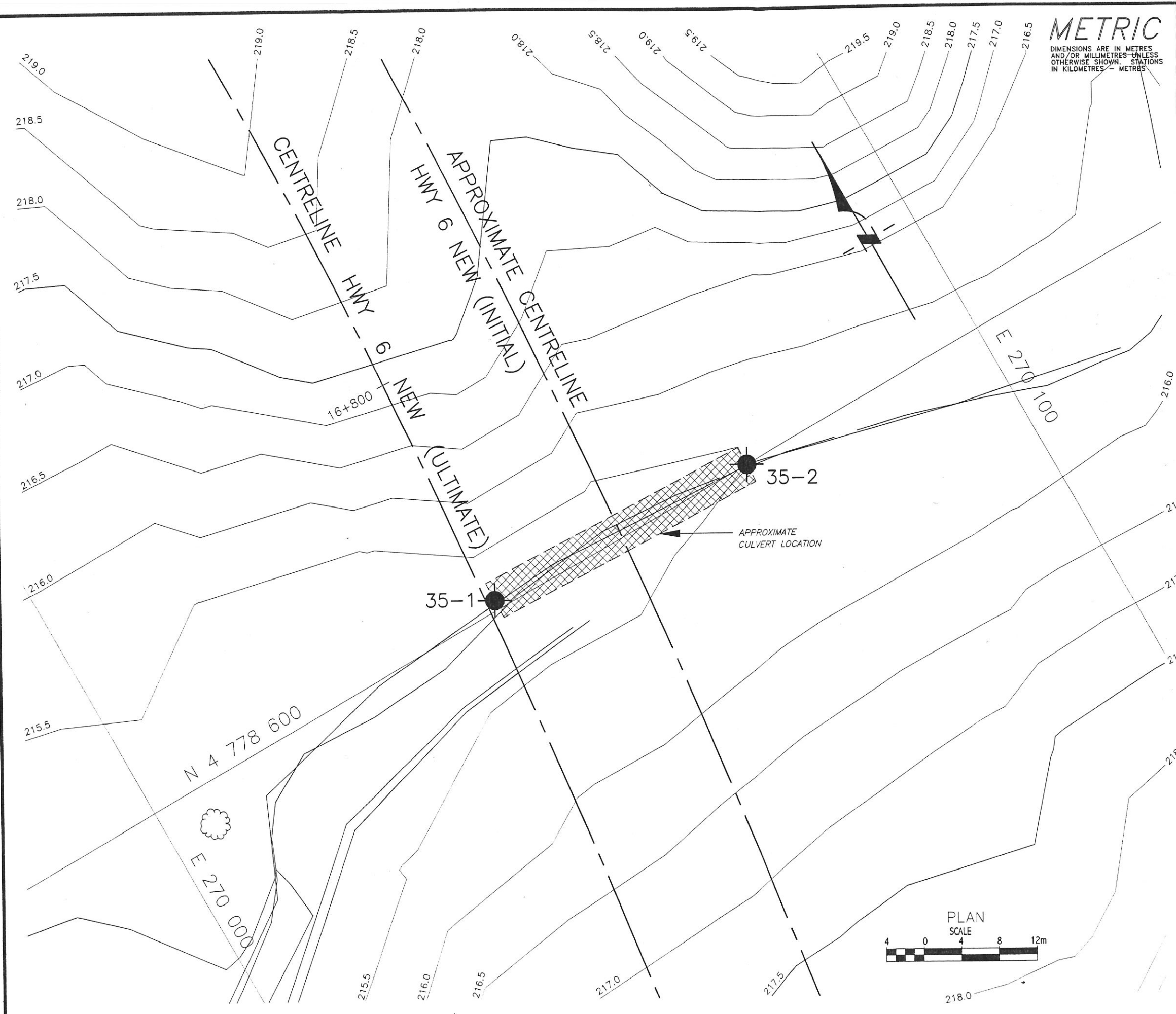
LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & 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 or in piezometer
- Head
- ARTESIAN WATER Encountered
- Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1B-1	212.60	4 778 010	270 067
1B-2	212.80	4 778 029	270 087

NOTE
Culvert and Centreline Alignment locations are derived from Drawing No. J1 of Pre-Design Report (WP 9-91-00) and are considered approximate.

REVISIONS		DATE		BY		DESCRIPTION	
16	APRIL 2002	PC					
11	APRIL 2002	PC					
Geocres No.		DATE		BY		DESCRIPTION	
HWY No. 6 (NEW)		APRIL 2002		D.W.K.		DWG 1	
SUBM'D P.C.		CHECKED P.C.		DATE		SITE	
DRAWN C.B.		CHECKED M.R.A.		APPROVED		DIST CR	



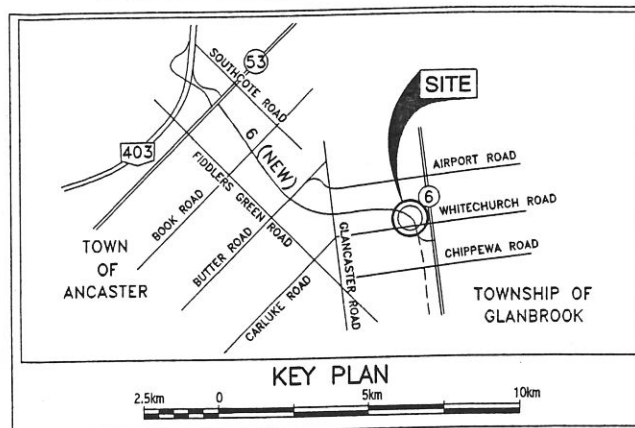
METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES UNLESS
 OTHERWISE SHOWN. STATIONS
 IN KILOMETRES - METRES

CONT No.
 GWP No. 603-00-00

HWY 6 (NEW)
 Proposed Culvert 35 at
 Station 16+775
 BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
 CONSULTING ENGINEERS



LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & 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 or in piezometer
- Head
- ARTESIAN WATER Encountered
- Piezometer

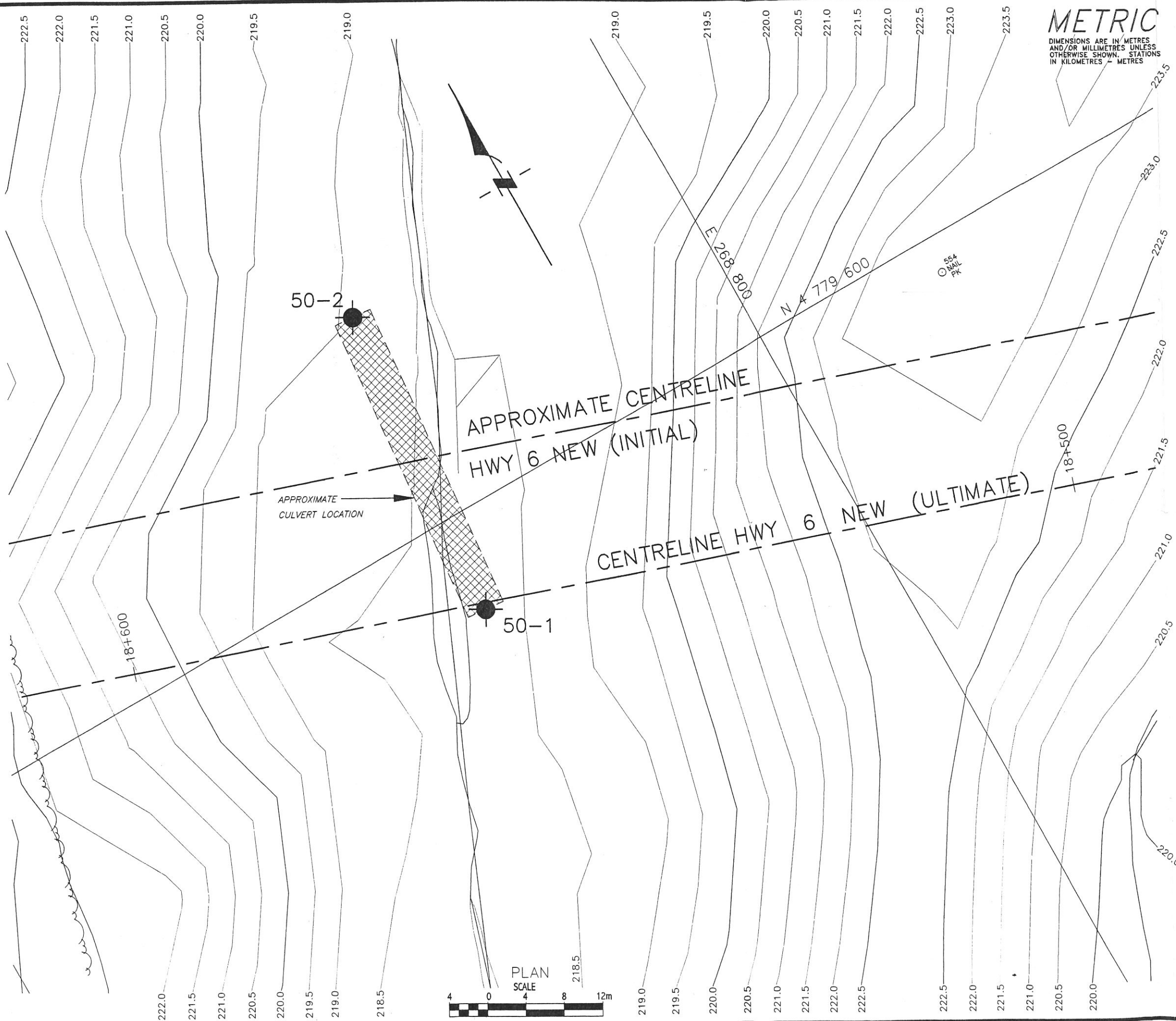
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
35-1	215.30	4 778 601	270 042
35-2	215.50	4 778 600	270 072

NOTE
 Culvert and Centreline Alignment locations are derived from Drawing No. J2 of Pre-Design Report (WP 9-91-00) and are considered approximate.




REVISIONS		DATE	BY	DESCRIPTION
16	APRIL 2002	PC		
11	APRIL 2002	PC		
		DATE	BY	DESCRIPTION

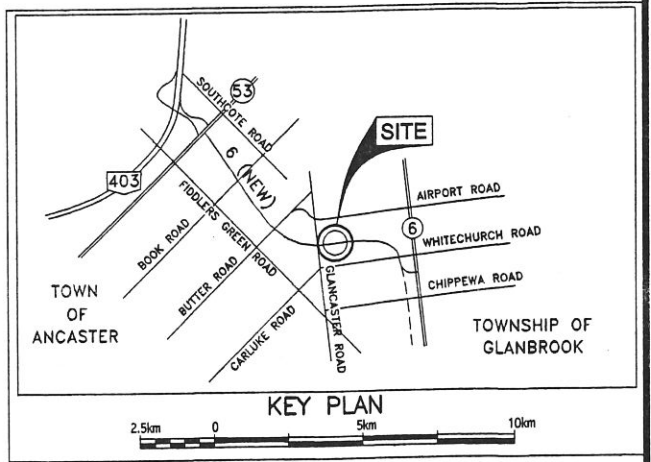
Geocres No.				
HWY No. 6 (NEW)			DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE	
DRAWN C.B.	CHECKED M.R.A.	APPROVED D.W.K.	DWG	2



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

CONT No.		
GWP No. 603-00-00		
HWY 6 (NEW) Proposed Culvert 50 at Station 18+570		
BOREHOLE LOCATIONS		
SHEET		

Peto MacCallum Ltd.
CONSULTING ENGINEERS

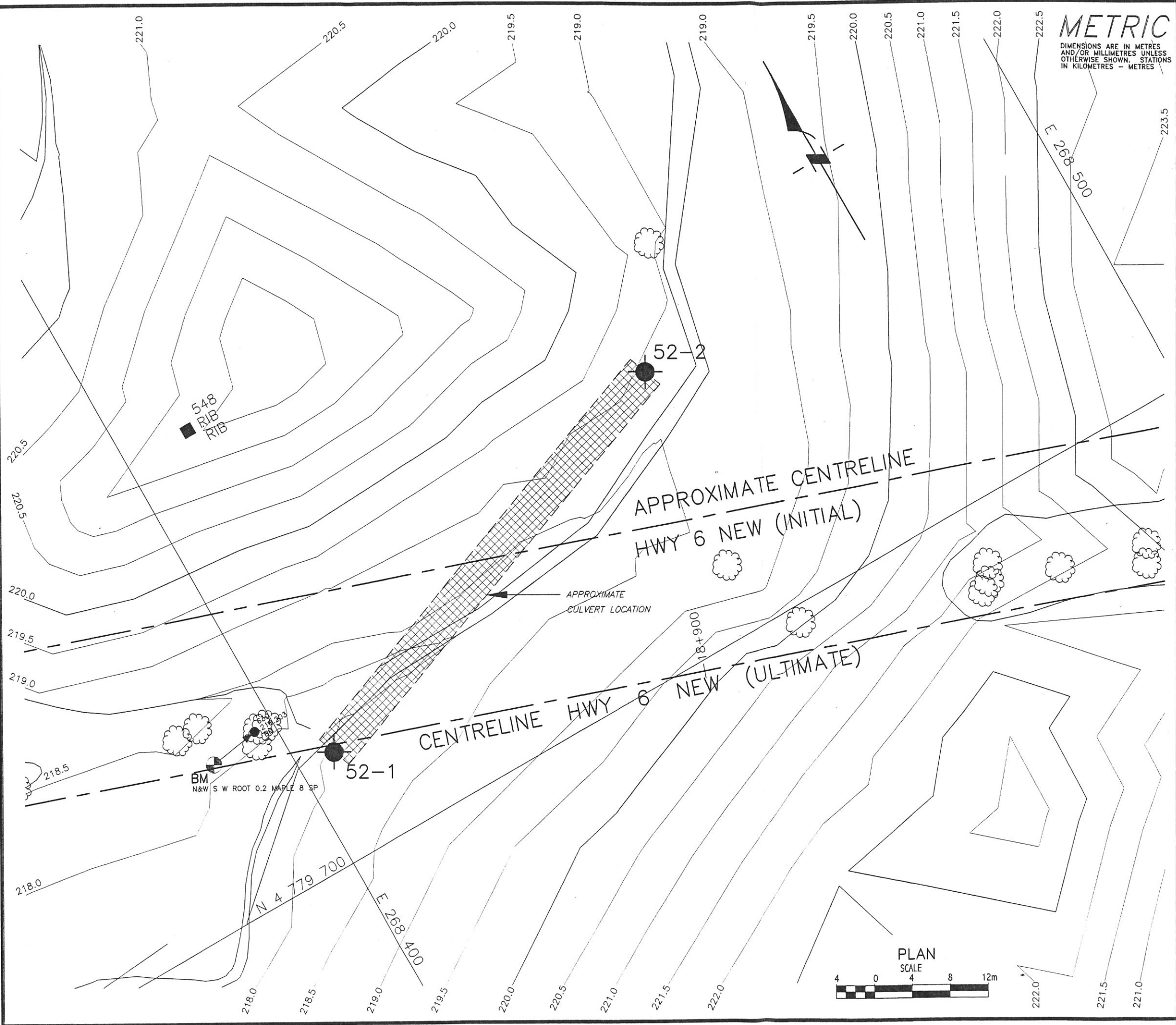


- LEGEND**
- Borehole
 - Dynamic Cone Penetration Test (Cone)
 - Borehole & Cone
 - 'N' Blows/0.3m (Std. Pen Test, 475 J / blow)
 - CONE Blows/0.3m (60° Cone, 475 J / blow)
 - W L at time of investigation or in piezometer
 - Head
 - ARTESIAN WATER Encountered
 - Piezometer


No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
50-1	218.40	4 779 590	268 761
50-2	218.60	4 779 623	268 764

NOTE
Culvert and Centreline Alignment locations are derived from Drawing No. J4 of Pre-Design Report (WP 9-91-00) and are considered approximate.

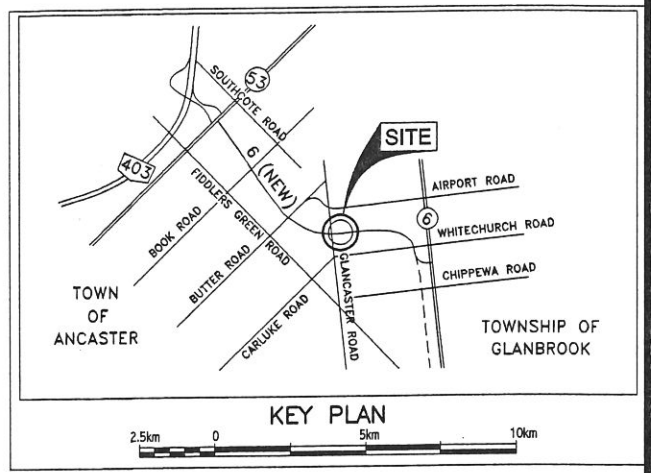
REVISIONS	16 APRIL 2002	PC	
	12 APRIL 2002	PC	
	DATE	BY	DESCRIPTION
Geocres No.			
HWY No. 6 (NEW)		DATE APRIL 2002	DIST CR
SUBM'D P.C.	CHECKED P.C.	APPROVED D.W.K.	SITE DWG 3
DRAWN C.B.	CHECKED M.R.A.		











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

CONT No.	
GWP No. 603-00-00	
HWY 6 (NEW) Proposed Culvert 52 at Station 18+950	
BOREHOLE LOCATIONS	
SHEET	

Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
	Blows/0.3m (Std. Pen Test, 475 l / blow)		
	Blows/0.3m (60° Cone, 475 l / blow)		
	W L at time of investigation or in piezometer		
	Head ARTESIAN WATER Encountered		
	Piezometer		

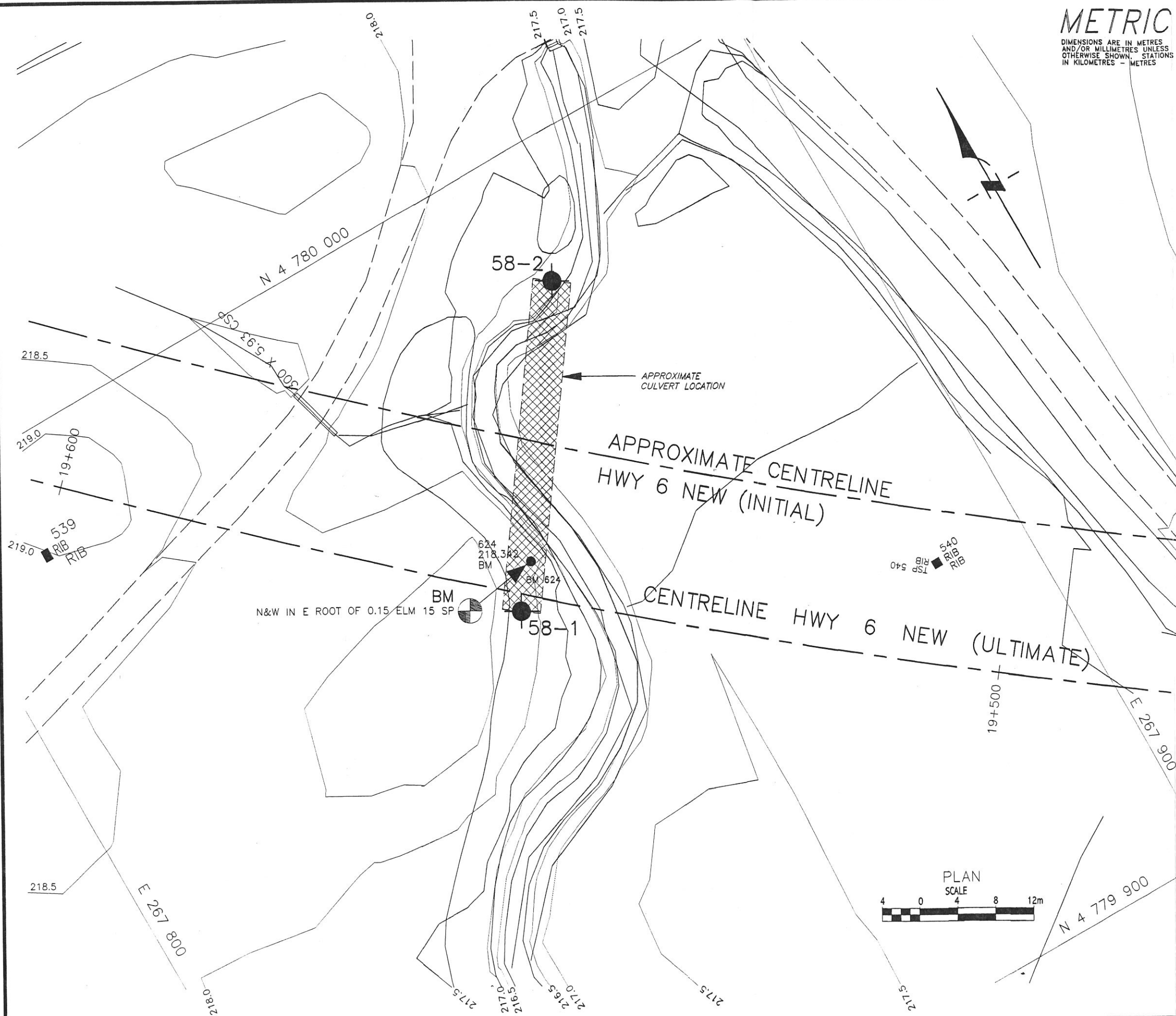
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
52-1	218.00	4 779 711	268 404
52-2	218.90	4 779 729	268 452

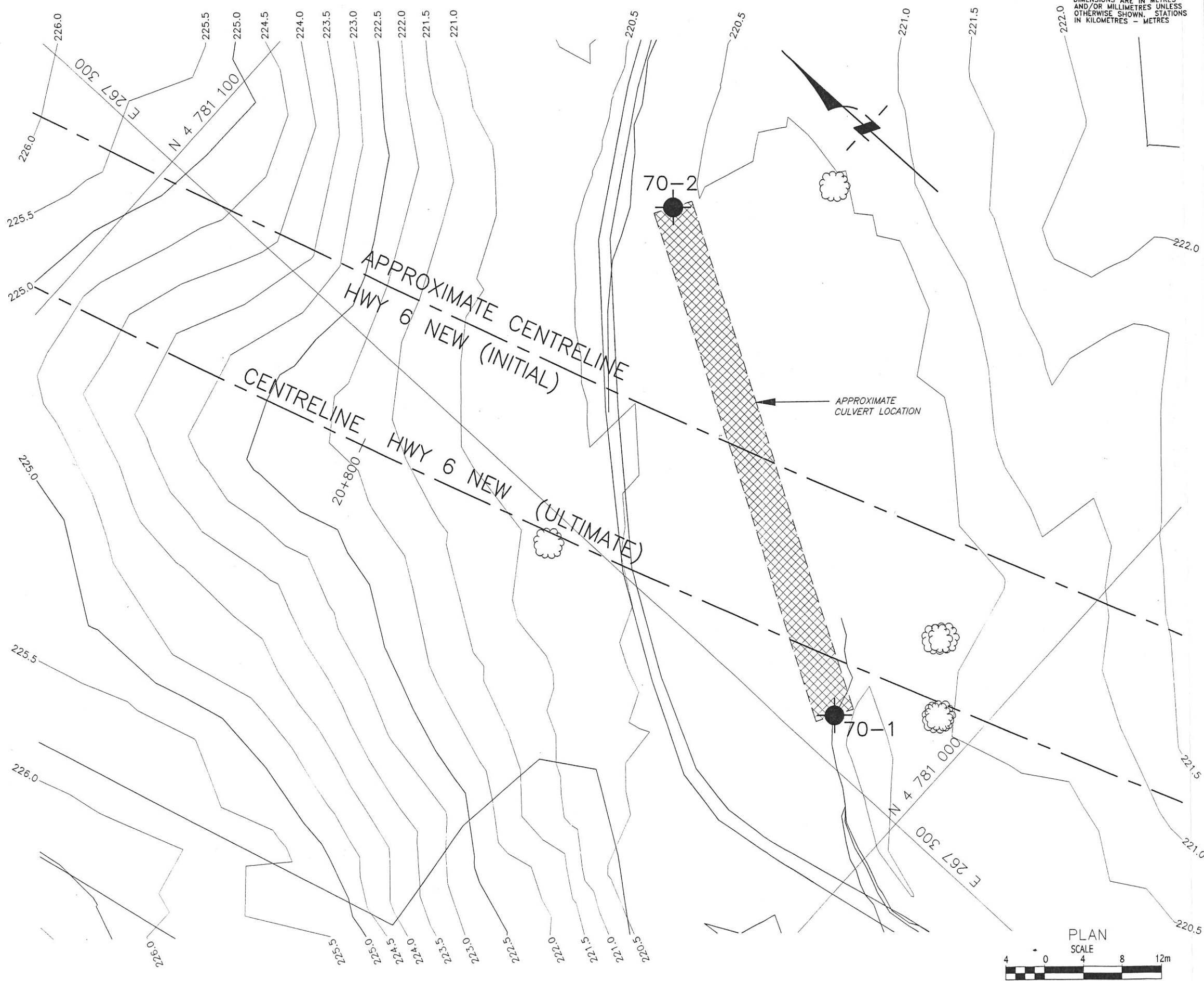
≡ NOTE ≡
Culvert and Centreline Alignment locations are derived from Drawing No. J6 of Pre-Design Report (WP 9-91-00) and are considered approximate.

REVISIONS		DATE	BY	DESCRIPTION
16	APRIL 2002	PC		
12	APRIL 2002	PC		

Geocres No.		HWY No. 6 (NEW)	DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE	
DRAWN C.B.	CHECKED M.R.A.	APPROVED D.W.K.	DWG	4

HWY No. 6 (NEW)			DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE	
DRAWN C.B.	CHECKED M.R.A.	APPROVED D.W.K.	DWG	5

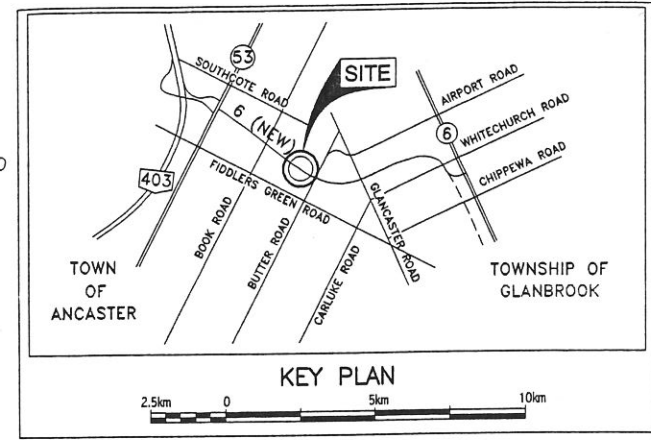




METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES UNLESS
 OTHERWISE SHOWN. STATIONS
 IN KILOMETRES - METRES

CONT No.		
GWP No. 603-00-00		
HWY 6 (NEW) Proposed Culvert 70 at Station 20+760		
BOREHOLE LOCATIONS		
SHEET		

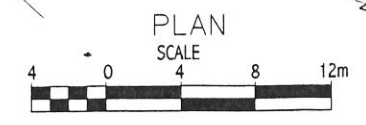
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 CONSULTING ENGINEERS



LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
	Blows/0.3m (Std. Pen Test, 475 J / blow)		
	Blows/0.3m (60° Cone, 475 J / blow)		
	W.L. at time of investigation or in piezometer		
	Head		
	ARTESIAN WATER		
	Encountered		
	Piezometer		

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
70-1	220.30	4 781 012	267 304
70-2	220.20	4 781 059	267 331

≡ NOTE ≡
 Culvert and Centreline Alignment locations are derived from Drawing No. J7 of Pre-Design Report (WP 9-91-00) and are considered approximate.



5

REVISIONS			
	16 APRIL 2002	PC	
	11 APRIL 2002	PC	
	DATE	BY	DESCRIPTION

Geocres No.

HWY No. 6 (NEW)			DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE	
DRAWN C.B.	CHECKED M.R.A.	APPROVED D.W.K.	DWG	6

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

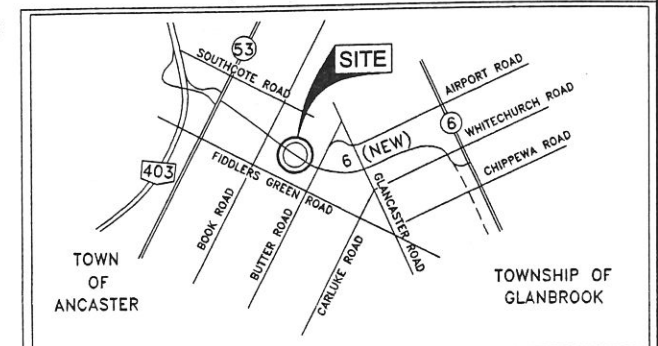
CONT No.
GWP No. 603-00-00



HWY 6 (NEW)
Proposed Culvert 75 at
Station 21+370
BOREHOLE LOCATIONS

SHEET

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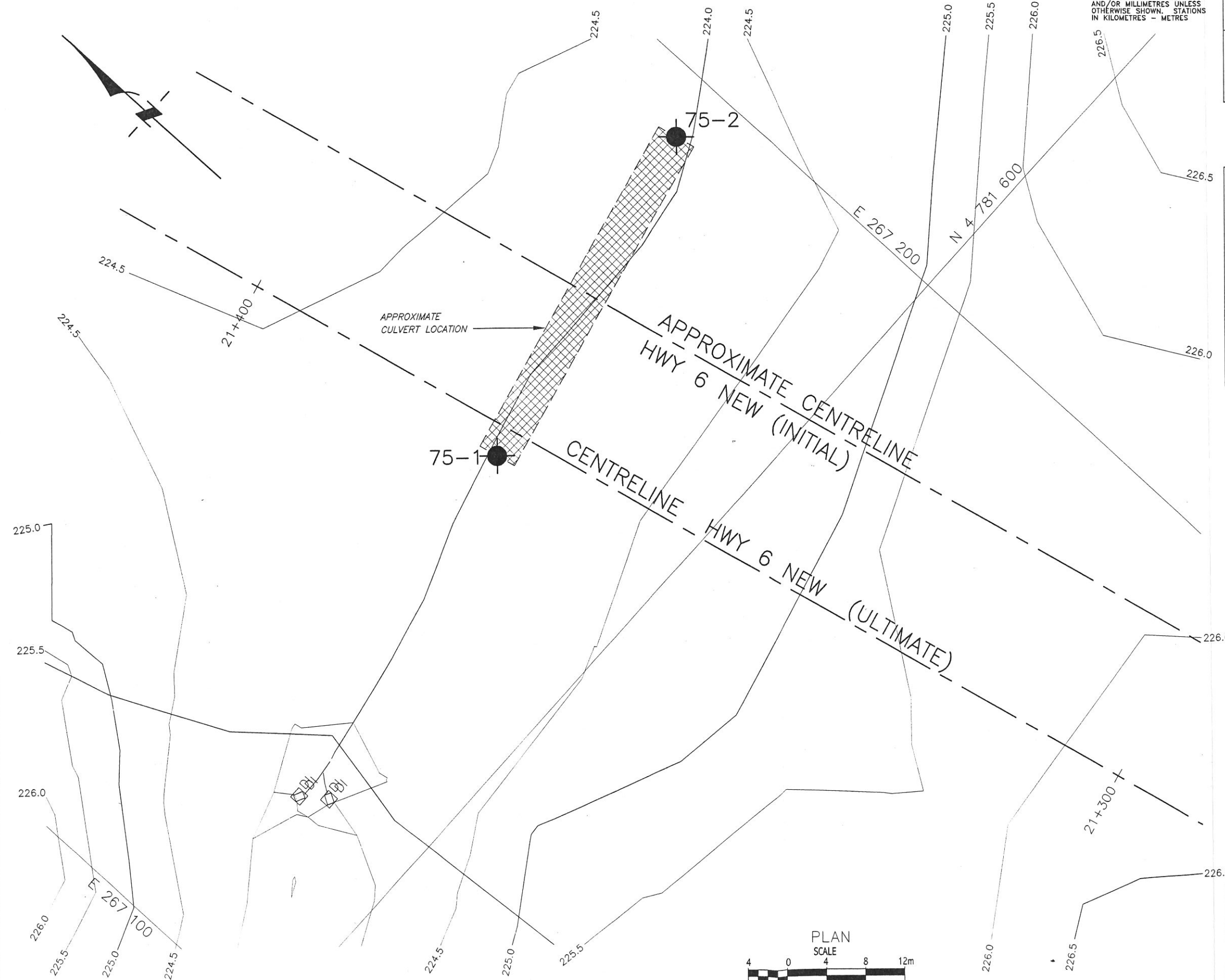


LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
	Blows/0.3m (Std. Pen Test, 475 l / blow)		
	Blows/0.3m (60° Cone, 475 l / blow)		
	WL at time of investigation or in piezometer		
	Head		
	ARTESIAN WATER Encountered		
	Piezometer		

CO-ORDINATES			
No	ELEVATION	NORTH	EAST
75-1	224.20	4 781 621	267 158
75-2	224.30	4 781 629	267 194

NOTE
Culvert and Centreline Alignment locations are derived from Drawing No. J7 of Pre-Design Report (WP 9-91-00) and are considered approximate.

REVISIONS		Geocres No.	
19 APRIL 2002	PC		
DATE	BY		DESCRIPTION
HWY No. 6 (NEW)		DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE
DRAWN C.B.	CHECKED M.R.A.	APPROVED D.W.K.	DWG 7



METRIC
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IN KILOMETRES - METRES

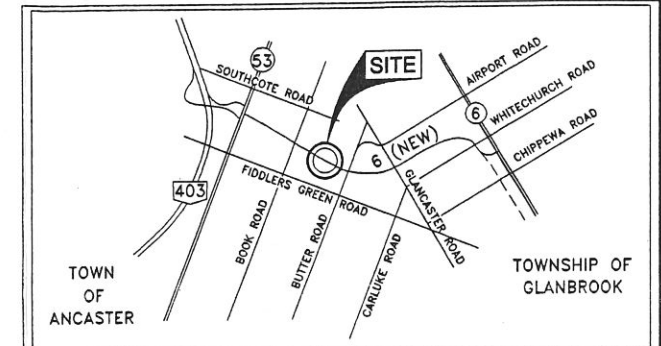
CONT No.
GWP No. 603-00-00



HWY 6 (NEW)
Proposed Culvert 79 at
Station 21+780
BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
2.5km 0 5km 10km

LEGEND

- Borehole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Borehole & Cone
- 'N' Blows/0.3m (Std. Pen Test, 475 l / blow)
- CONE Blows/0.3m (60° Cone, 475 l / blow)
- ▽ W.L. at time of investigation or in piezometer
- ▽ Head
- ▽ ARTESIAN WATER Encountered
- Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
79-1	226.1	4 782 028	267 102
79-2	226.5	4 782 021	267 070

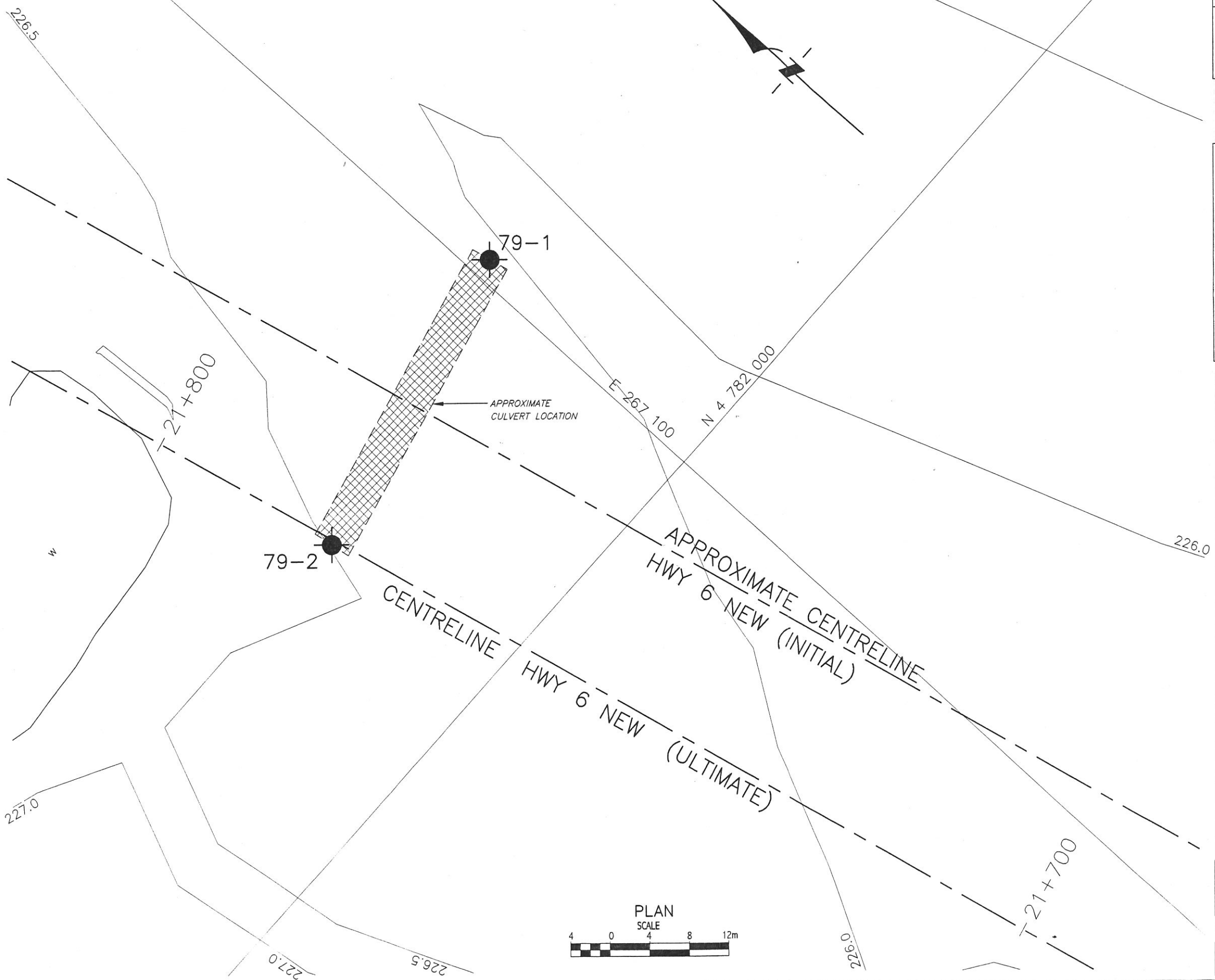
NOTE

Culvert and Centreline Alignment locations are derived from Drawing No. J8 of Pre-Design Report (WP 9-91-00) and are considered approximate.

REVISIONS	DATE	BY	DESCRIPTION
18 APRIL 2002	PC		
16 APRIL 2002	PC		

Geocres No.

HWY No. 6 (NEW)	CHECKED P.C.	DATE APRIL 2002	DIST	CR
SUBM'D P.C.	CHECKED M.R.A.	APPROVED D.W.K.	SITE	
DRAWN C.B.			DWG	8



METRIC
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AND/OR MILLIMETRES UNLESS
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IN KILOMETRES - METRES

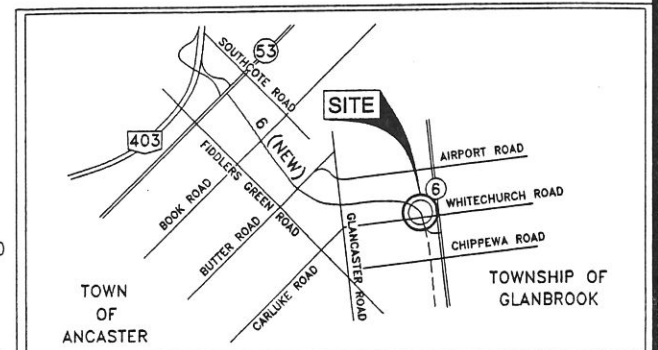
CONT No.
GWP No. 603-00-00



SHEET

HWY 6 (NEW)
Proposed Culvert 34A at
Station 10+143 White Church Road
BOREHOLE LOCATIONS

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CONSULTING ENGINEERS



LEGEND

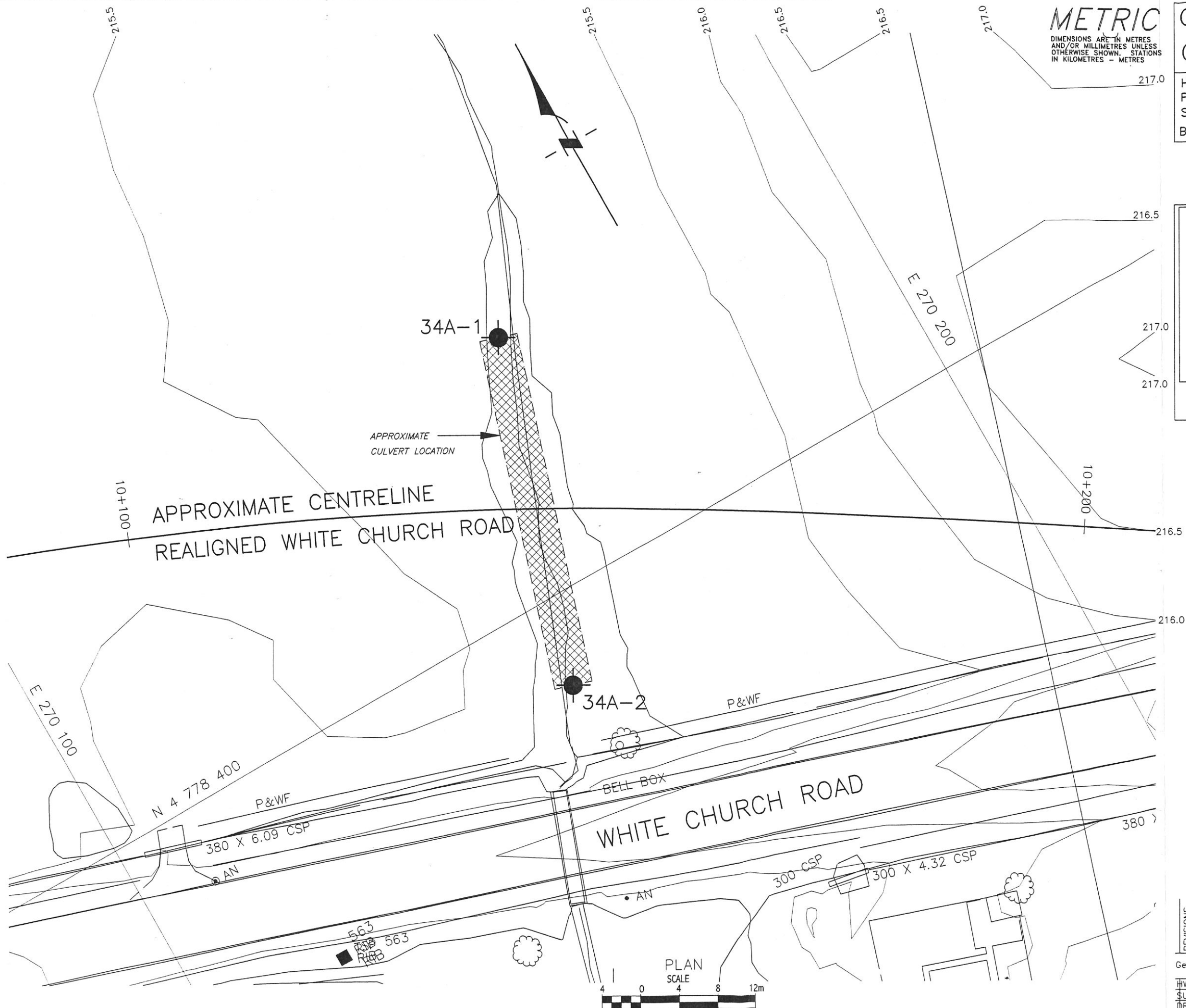
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- 'N' Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation or in piezometer
- Head
- ARTESIAN WATER Encountered
- Piezometer

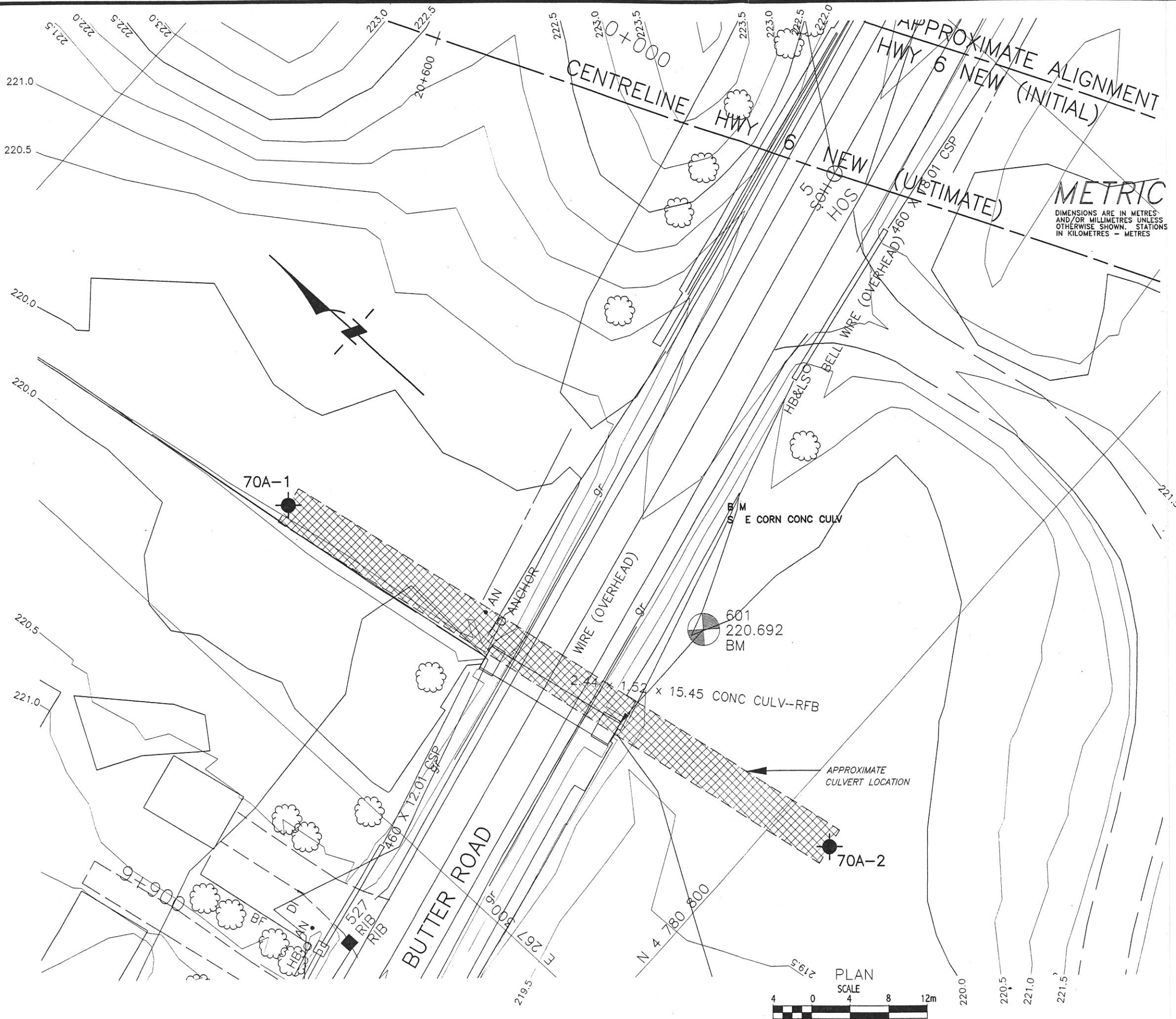
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
34A-1	214.05	4 778 426	270 161
34A-2	213.95	4 778 391	270 150

NOTE
Culvert and Centreline Alignment locations are derived from Drawing No. J2 of Pre-Design Report (WP 9-91-00) and are considered approximate.

REVISIONS	DATE	BY	DESCRIPTION
19	APRIL 2002	PC	

Geocres No.			
HWY No. 6 (NEW)		DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE
DRAWN C.B.	CHECKED M.R.A.	APPROVED D.W.K.	DWG 9





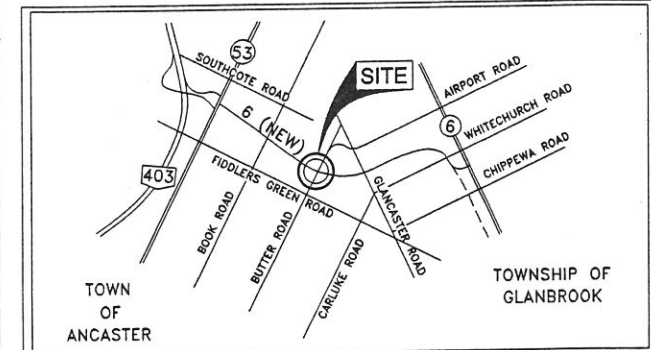
CONT No.
GWP No. 603-00-00



HWY 6 (NEW)
Proposed Culvert 70A at
Station 9+940 BUTTER ROAD
BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN

LEGEND

- Borehole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Borehole & 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 or in piezometer
- Head
- ARTESIAN WATER Encountered
- Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
70A-1	219.50	4 780 859	267 317
70A-2	219.80	4 780 794	267 329

NOTE

Culvert and Centreline Alignment locations are derived from Drawing No. J7 of Pre-Design Report (WP 9-91-00) and are considered approximate.

REVISIONS	DATE	BY	DESCRIPTION
19	APRIL 2002	PC	

Geocres No.				
HWY No. 6 (NEW)			DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002	SITE	
DRAWN C.B.	CHECKED D.W.K.	APPROVED D.W.K.	DWG	10

METRIC
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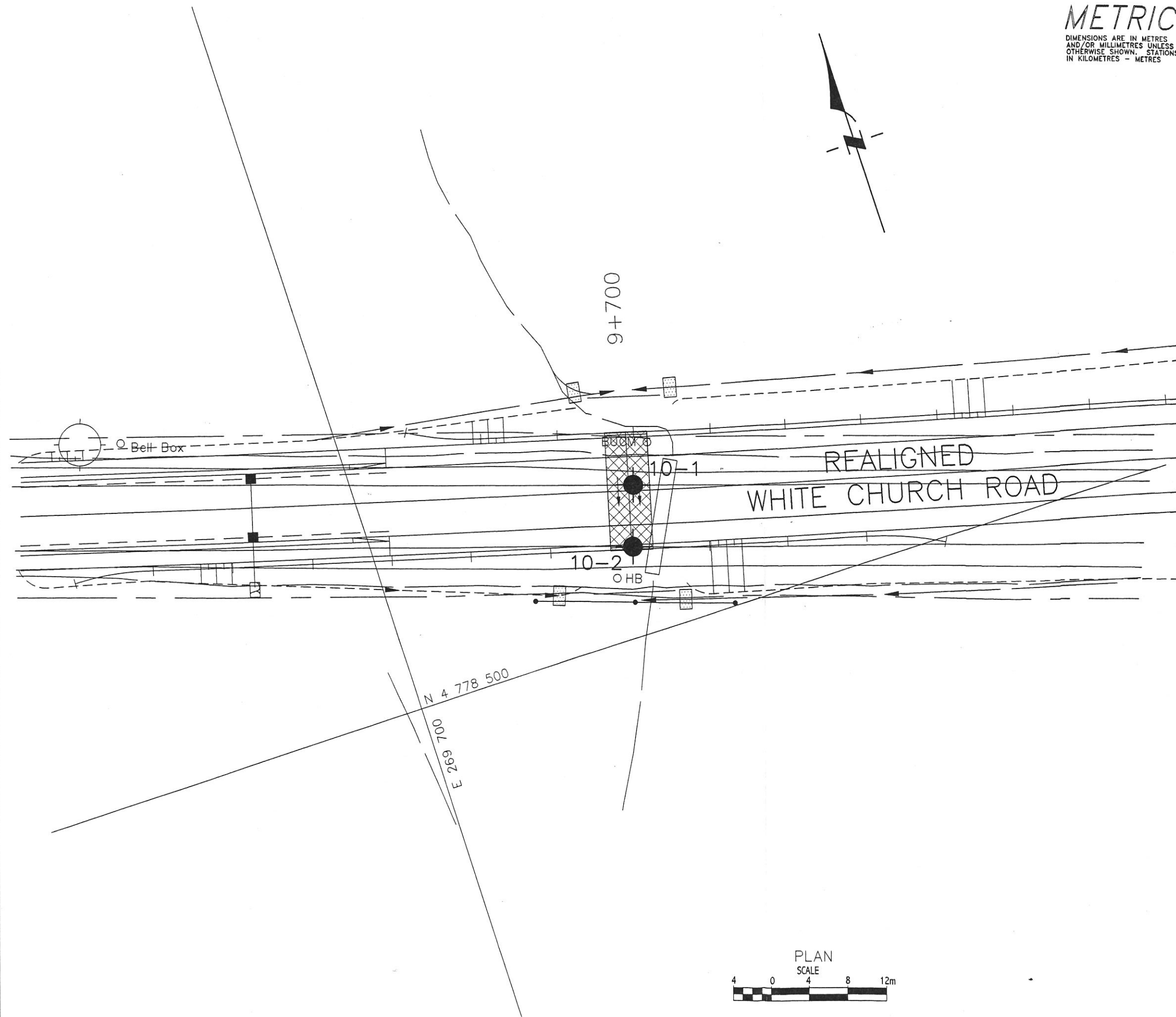
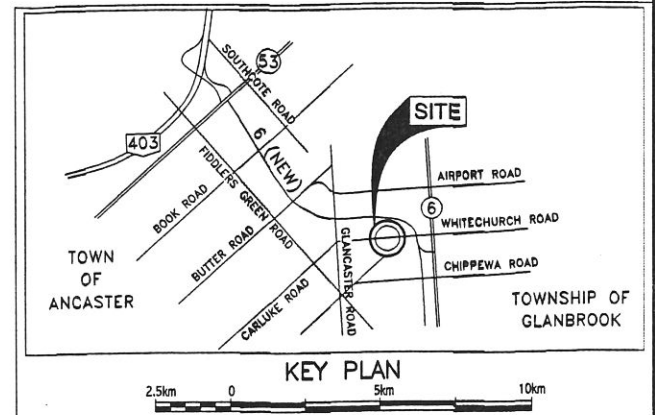
CONT No.
 GWP No. 603-00-00



HWY 6 (NEW)
 Proposed Culvert 10 at
 Station 9+700 White Church Road
 BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
 CONSULTING ENGINEERS



LEGEND

- Borehole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Borehole & 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 or in piezometer
- Head
- ARTESIAN WATER Encountered
- Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
10-1	214.80	4 778 515	269 728
10-2	214.80	4 778 509	269 726

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.					
HWY No. 6 (NEW)				DIST	CR
SUBM'D P.C.	CHECKED P.C.	DATE APRIL 2002		SITE	
DRAWN C.B.	CHECKED M.R.A.	APPROVED	D.W.K.	DWG	11

**FOUNDATION DESIGN REPORT
FOR
CULVERTS
HIGHWAY 6 (NEW)
FROM HIGHWAY 403 SOUTHERLY TO EXISTING HIGHWAY 6
CITY OF HAMILTON, ONTARIO
G.W.P. 603-00-00**

Distribution:

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1 cc: PML Hamilton
1 cc: PML Toronto

PML Ref: 00HF108
Geocres No. Not Assigned

May 2002

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INTRODUCTION	1
FOUNDATIONS	2
CULVERT BACKFILL	4
ROAD EMBANKMENT	5
EXCAVATION AND GROUNDWATER CONTROL	6
CLOSURE	8

TABLE I

**FOUNDATION DESIGN REPORT
For
Culverts
Highway 6 (New)
From Highway 403 Southerly to Existing Highway 6
City of Hamilton, Ontario
G.W.P. 603-00-00**

INTRODUCTION

This report provides geotechnical comments and recommendations regarding design and installation of eight culverts along the proposed alignment of Highway 6 (New) from Highway 403 in the former Town of Ancaster southerly to the existing Highway 6 in the former Township of Glanbrook, now in the City of Hamilton, Ontario, two along the realigned sections of White Church Road and one on Butter Road. The investigation was conducted for Delcan Corporation on behalf of the Ontario Ministry of Transportation.

Based on preliminary grade information presented in the Pre-Design Report (Drawings I11 to I20 and J3, "Highway 6 New Pre-Design Report, W.P. 9-91-00, prepared by Morrison Hershfield Limited), the proposed road grade at the culvert locations will be constructed some 2.6 to 6.0 m above existing grade, locally 12.2 m at the culvert location within the structure approach fill on Butter Road.

The proposed culvert locations and sizes indicated in the Request for Proposal document are as follows:

CULVERT NO.	LOCATION	CULVERT SIZE
1B	Sta 10+485 Hwy 6 Connection	2 – 2.0 x 1.2 Concrete Box
35	Sta 16+775 Hwy 6 New	2400 CSP and 1200 CSP
50	Sta 18+570 Hwy 6 New	2 – 1.88 x 1.26 CSPA
52	Sta 18+950 Hwy 6 New	2.13 x 1.4 CSPA
58	Sta 19+545 Hwy 6 New	2 – 2.5 x 1.6 Concrete Box
70	Sta 20+760 Hwy 6 New	3.0 x 1.6 Concrete Box
75	Sta 21+370 Hwy 6 New	2.13 x 1.4 CSPA
79	Sta 21+780 Hwy 6 New	2.13 X 1.4 CSPA
34A	Sta 10+143 Realigned White Church Road	2 – 2.4 x 1.2 Concrete Box
70A	Sta 9+940 Butter Road	2 – 2.4 x 1.2 Concrete Box
10	Sta 9+700 Realigned White Church Road	2 – 2.2 x 1.2 Concrete Box

The subsurface stratigraphy encountered at the culvert locations generally comprised a surficial topsoil layer overlying native clays and silts. Localized units of fill, sand, clay till and silt till were encountered at a number of culvert locations. Water was typically encountered in the boreholes at depths of 0.0 to 1.9 m, locally 2.5 to 3.0 m.

FOUNDATIONS

The invert level of the culverts has not been established. For the purposes of this report, it is assumed the culverts will be founded at or slightly below the level of the existing ground surface. Based on the borehole information, it is considered that the culverts may be supported on the native inorganic soils below the topsoil.

The anticipated subgrade material at the base/invert of the proposed box culverts and CSPs, as well as the bearing resistances recommended for design are presented on Table I, appended. Sub-excavation and replacement of surficial loose/firm materials is recommended at seven of the box culvert locations (culverts 50, 58, 70, 79, 34A, 70A and 10). The excavation depths are indicated on Table I. Alternatively, culverts 34A and 10 could be supported on special footings extended down to the native compact/dense soils at the subexcavation depths indicated on Table I and designed using the bearing resistance values shown in the table.

The resistance at serviceability limit states allows for 25 mm of settlement of the founding medium. Differential settlement along the length of the culvert is expected to be less than 75% of this value.

All excessively loose, soft, organic or otherwise deleterious materials along the alignment of the culvert must be removed prior to installation of the culvert. Potentially deeper organic deposits than indicated by the borehole data may be revealed at locations away from the boreholes and should also be excavated. The exposed subgrade should be examined by qualified geotechnical personnel prior to placement of bedding material and/or construction of the culvert to verify the competency of the founding materials.

Fill placed under the culverts should comprise granular material compacted to 100% standard Proctor maximum dry density in conformance with OPSS 501. The granular fill zone should extend beyond the culvert base a minimum 0.5 m and extend down to the subgrade at 1 horizontal to 1 vertical.

Subgrade preparation, cover, backfill and frost treatment for the culverts should be carried out in accordance with Ontario Provincial Standards OPSD – 802.014, 802.024, 802.034, 802.054, 803.01, 803.03, 803.031 and 808.01. The bedding material should be at least 300 mm thick. A frost penetration depth of 1.2 m should be employed.

CULVERT BACKFILL

Backfill adjacent to the culverts should be placed in accordance with the Ontario Provincial Standard specification and drawings OPSD 802.034, 802.054 and 803.01. Backfill should be brought up simultaneously on each side of the culvert to minimize the potential for movement of the culvert.

The walls of the box culverts must be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the walls. The lateral earth pressure, p , may be computed using the equivalent fluid pressures presented in Section 6-7.4 of the Ontario Highway Bridge Design Code (OHBDC, 3rd Edition, 1991) or employing the following equation, assuming a triangular pressure distribution, free draining granular backfill, and negligible build-up of hydrostatic pressure behind the wall:

$$p = K (\gamma h + q)$$

where K = lateral earth pressure coefficient

γ = unit weight of free draining granular material (kN/m^3)

h = depth below final grade (m)

q = surcharge load (kN/m^2), if present

The following parameters are recommended for design:

	Granular "A"	Granular "B"	On-Site Material
Angle of Internal Friction (degrees)	35	32	29
Unit Weight (kN/m^3)	22.8	21.2	19.0
Active Earth Pressure Coefficient (K_a)	0.27	0.31	0.35
At Rest Earth Pressure Coefficient (K_o)	0.43	0.47	0.52
Passive Earth Pressure Coefficient (K_p)	3.69	3.25	2.88

The at rest earth pressure coefficient should be employed if movement of the wall is restrained, the active earth pressure coefficient if the wall is designed to accommodate some movement.

The protective measures to deal with erosion (inlet/outlet treatment, headwalls, cut-off walls etc.) included in Ontario Provincial Standards OPSD 800 Series are considered to be appropriate. End treatment requirements for the culverts are similarly dictated by the stream hydraulics, stream configuration, culvert, and soil type.

A cut-off wall should be provided at each end of the concrete box culverts. A cut-off wall or other device should be considered for the inlet of the CSP culverts where uplift protection is required. The requirements of the OHBDC should be applied.

Provision of rip-rap for erosion/scour protection is recommended for all culvert outlets. A geotextile should be placed below the rip-rap in areas of silt subgrade to minimize the potential for erosion of fine particles from below the treatment.

The anticipated soil type at the culvert outlet and recommended K factors to assess the appropriate erosion control measures are as follows:

Culvert No.	Soil Type	K Factor
1B, 50, 70, 75, 79, 10	Silt	0.5
35, 52, 58, 34A, 70A	Silty Clay	0.4

ROAD EMBANKMENT

It is anticipated that the height of the embankment at the culvert locations will typically range from 1.1 to 6.0 m. A fill embankment up to 12.2 m high will be constructed for the underpass structure along Butter Road.

The anticipated subgrade for the road embankments comprises compact/firm silt and/or firm to stiff clay. All excessively loose, soft, organic or otherwise deleterious materials within the limits of the embankment fill should be subexcavated.

No problems with respect to bearing capacity or settlement are anticipated. Standard sideslopes inclined no steeper than 2 horizontal to 1 vertical should be stable. For fill embankments greater than 8 m in height, a 2.0 m wide mid-height berm should be provided for erosion control and slope maintenance purposes.

Additional comments and recommendations regarding fill embankment construction are provided in the Pavement Design Report, and the Foundation Investigation and Design Report for the Butter Road structure.

EXCAVATION AND GROUNDWATER CONTROL

In general, the relatively shallow excavations for culvert installation are expected to extend through the topsoil layer and into loose/firm to compact/very stiff native silts and clays. Excavation of the overburden should be relatively straightforward using conventional equipment. The in situ materials are typically classified as Type 3 soils according to Occupational Health and Safety Act criteria. Temporary cut slopes inclined at 1 horizontal to 1 vertical should generally be stable.

Depending on seasonal conditions and recent precipitation patterns, the loose silts may be saturated at the time of construction, and significant sloughing of the excavation sidewalls may be experienced. Further, very loose materials were revealed to depths of 1.4 m at culvert 70A (Butter Road). The saturated silts and the soils at culvert 70A are classified as Type 4 soils and temporary cut slopes of 3 horizontal to 1 vertical should be employed.

Cognizant of the water levels measured during the investigation (typically 0.0 to 1.9 m, locally 2.5 to 3.0 m below grade), the anticipated relatively shallow depth of excavation required to install the culverts, and subject to the season/precipitation patterns, it is expected that groundwater seepage or surface water entering the excavation can be readily handled by conventional sump pumping. It will be necessary to implement measures to control water flow in the streams. Conventional procedures such as perimeter ditches and/or diversion of the stream should be sufficient. Observed groundwater levels are subject to seasonal fluctuations and rainfall patterns.

It is recommended that the work be carried out during the dry summer months to minimize the potential for sloughing of the silts, the amount of groundwater inflow to be handled, and the volume of surface water, if any, to be diverted from the construction area.

All construction work should be carried out in accordance with the Occupational Health and Safety Act (Ontario Regulation 213/91) and with local/MTO regulations.

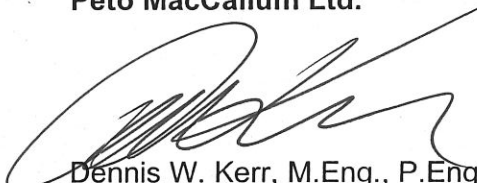
CLOSURE

This report was prepared by Mr. P. Cullen, B.Eng. and Mr. M.R. Anderson, M.Eng., P.Eng., and reviewed by Mr. D.W. Kerr, P.Eng., Chief Foundation Engineer. Mr. B.R. Gray, P.Eng. carried out an executive review of the report.

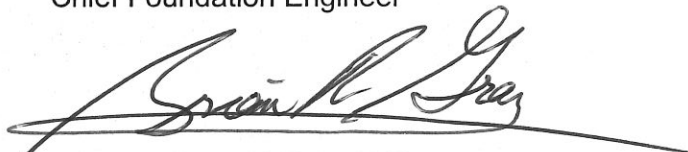


Yours very truly

Peto MacCallum Ltd.



Dennis W. Kerr, M.Eng., P.Eng.
Chief Foundation Engineer



Brian R. Gray, M.Eng., P.Eng.
President

PC:lad

TABLE I

TABLE I

ANTICIPATED FOUNDATION CONDITIONS
AT CULVERT CROSSINGS
HIGHWAY 6 (NEW)
G.W.P. 603-00-00
CITY OF HAMILTON, ONTARIO

CULVERT NO.	TYPE	HIGHWAY CHAINAGE (m)	PROPOSED ¹ ROAD GRADE ELEVATION (m)	AVERAGE ² EXISTING GROUND ELEVATION (m)	AVERAGE FILL DEPTH (m)	FOUNDING MATERIAL	FACTORED BEARING RESISTANCE AT ULS (kPa)	BEARING RESISTANCE AT SLS (kPa)	REMARKS
1B	BOX	10+485 Hwy 6 Connection	215.4	212.8	2.6	Loose Silt	300	90	
35	CSP	16+775	218.0	215.4	2.6	Firm to Stiff Silty Clay	150	100	
50	CSPA	18+570	223.0	218.5	4.5	Loose Silt Stiff Silty Clay	200	140	Sub-excavate loose/stiff material, 1 m depth
52	CSPA	18+950	222.0	218.5	3.5	Stiff Silty Clay/Silt	200	130	
58	BOX	19+545	222.8	217.4	5.4	Stiff to Very Stiff Silty Clay	300	200	Sub-excavate firm material at BH 58-2, 1.4 m depth
70	BOX	20+760	226.2	220.2	6.0	Compact Silt	300	150	Sub-excavate loose silt, 1.5 m depth
75	CSPA	21+370	229.0	224.2	4.8	Compact Silt/ Stiff Clayey Silt	225	150	
79	CSPA	21+780	231.0	226.5	4.5	Loose to Very Dense Silt	400	200	Sub-excavate loose silt, 1.4 m depth
34A	BOX	10+143 White Church Rd.	220.0	214.0	6.0	Compact to Dense Silt ³	500	250	Sub-excavate to elevation 211.5, 2.5 m depth
70A	BOX	9+940 Butter Rd.	231.8	219.7	12.2	Very Stiff Silty Clay/Clayey Silt	350	225	Sub-excavate very loose/firm material, 1.4 m depth
10	BOX	9+700 White Church Rd.	214.9	213.0 ⁴	1.9	Compact/Dense Silt	500	250	Sub-excavate fill, topsoil and silty clay, 2.1 m depth

¹ Based on Pre-Design Report data.

² Deduced from contour information on plans provided by Delcan Corporation.

³ Culvert could also be founded on stiff silty clay using a factored bearing resistance at ULS of 200 kPa and a bearing resistance at SLS of 130 kPa.

⁴ Boreholes were drilled from roadway shoulder, approximately 1.8 m above adjacent ground surface