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CONT. No. 94-28

W. O. No.

STR. SITE No. 16-310

HWY. No. 416

LOCATION Hwy 416 at County Rd. 44

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Golder Associates Ltd.

CONSULTING ENGINEERS

REPORT TO

TOTTEN SIMS HUBICKI ASSOCIATES

CONT. 94-28
FOUNDATION INVESTIGATION

PROPOSED COUNTY ROAD 44 UNDERPASS

HIGHWAY 416

W.P. 177-89-04 / *107* SITE 16-310

DISTRICT 9 (OTTAWA), EASTERN REGION

GEOCRE # 31B-61

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October 1990

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1. INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates, consultants to the Ministry of Transportation Ontario (MTO), to carry out a subsurface investigation at the site of a proposed underpass for County Road 44 at Highway 416 (see Key Plan, Figure 1). The purpose of the investigation was to determine the subsurface conditions at the site and, based on the factual information obtained, to provide recommendations on the geotechnical design aspects of the project, including construction considerations which could influence design decisions.

The proposed underpass structure and realigned County Road 44 are to be located about 40 metres north of the present roadway alignment. The underpass will consist of two single span bridges crossing the northbound and southbound lanes of Highway 416. Each bridge will have a length of about 37 metres. The approach embankments and the embankment between the two structures will have a maximum height of about 8 to 10 metres above ground surface. The abutments for the proposed bridges are to be perched above existing ground surface.

2. SITE DESCRIPTION AND GEOLOGY

The site is located along the existing Highway 16 about 1.0 to 1.5 kilometres south of Spencerville, Ontario. The topography across the site is relatively flat, rising slightly to the west of the proposed south bound lane bridge. Ponded water was present west of Highway 16 at the time of the investigation. The bridge area west of Highway 16 is presently treed.

Geology maps suggest that this area is underlain by deposits of marine sand. Bedrock is expected to consist of Oxford formation dolostone. Drift thickness maps suggest that the overburden thickness may be about 9 metres.

3. PROCEDURE

The field work for this investigation was carried out between April 17 and 23, 1990. During this time, one borehole was advanced at each of the four bridge abutment locations for foundation design purposes. In addition, two shallow boreholes were advanced about 30 metres from both the east abutment of the east bridge (north bound lanes) and the west abutment of the west bridge (south bound lanes) to evaluate the subgrade conditions for the approach embankments near the bridges. Three of the boreholes put down in the abutment areas were advanced to bedrock and the bedrock was cored using BXL size diamond drilling equipment; the remaining borehole was advanced to practical auger refusal. The boreholes advanced in the embankment area were taken to depths of between about 5.2 and 5.5 metres below existing ground surface. Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using drive open sampling equipment. In situ vane testing was carried out where possible to determine the undrained shear strength characteristics of the silty clay. Standpipes were sealed into most of the boreholes to determine the groundwater conditions at the site. One sample of groundwater was obtained from borehole 2-5 and was submitted for basic chemical testing to evaluate the corrosivity of the groundwater on exposed concrete and unprotected steel. The field work was supervised throughout by a member of our engineering staff.

Logs of the soil bedrock and groundwater conditions encountered in the borings are shown on the Record of Borehole sheets following the text of this report.

The locations of the boreholes are given on the Borehole Locations and Soil Strata, Drawing 1778904-A.

Samples of the soils encountered were taken to our laboratory for examination and classification testing. Samples of the soil were tested for moisture content, liquid and plastic limit, and grain size distribution. The results of the laboratory testing are given on the Record of Borehole sheets and on Figures 2 to 4.

The borehole locations and elevations were determined by Totten Sims Hubicki Associates personnel. The elevations are referenced to Geodetic datum.

4. SUBSURFACE CONDITIONS

4.1 General

The borehole logs indicate the approximate subsurface conditions only at the specific test locations. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of boring, the frequency of sampling, the method of sampling and the uniformity of the subsurface conditions.

Subsurface conditions between the boreholes may vary significantly from conditions encountered at the boreholes.

Groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities.

The soil and bedrock descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil and bedrock involves judgement and Golder Associates Ltd. does not guarantee descriptions as exact, but

infers accuracy to the extent that is common in current geotechnical practice.

The soil and rock conditions described in this report are those observed at the time of the study. Unless otherwise noted, those conditions form the basis of the recommendations in this report.

The condition of the soil may be significantly altered by construction activities such as construction traffic, excavation, pile driving, etc. Excavation may expose the soils to changes due to wetting, drying, or frost.

As previously indicated, the detailed soil, bedrock and groundwater conditions determined from the boreholes are given on the Record of Borehole sheets following the text of this report. The following sections present descriptions of the soil bedrock and groundwater conditions encountered in the boreholes.

4.2 Topsoil, Fill, Silt

With the exception of borehole 2-6, all of the boreholes encountered surficial deposits of topsoil. The topsoil has a thickness of between 0.1 to 0.3 metres.

Borehole 2-5, advanced on the east side of the north bound lane bridge, encountered about 1.0 metre of fill composed of brown sand with some gravel, silt and cobbles.

At borehole 2-6 and beneath the topsoil and fill at borehole 2-5, a layer of dark brown silt containing trace amounts of organic matter was encountered. The thickness of this deposit ranges from 0.4 metres (borehole 2-5) to 1.5 metres (borehole 2-6). One standard penetration test carried out at borehole 2-6 showed that the split spoon sank under the weight of the hammer, which reflects a very loose relative density. The organic content of one sample

of this material was found to be 3.6 percent. The water content was determined to be 45 percent.

4.3 Sandy Silt, Silty Sand, Sand

Deposits of sandy silt, silty sand and sand were encountered beneath the surficial topsoil, silt and/or fill deposits. These deposits were found to have a thickness ranging from 0.2 metres (borehole 2-1) to 3.6 metres (borehole 2-4) and to extend to depths ranging from 0.4 to 4.0 metres below ground surface (elevation 90.4 to 94.7 metres). Standard penetration N values obtained within these deposits range from 2 to 11 blows per 0.3 metres, which reflect a very loose to compact relative density.

Grain size distribution curves for samples of the sandy silt and sand recovered from borehole 2-4 are given on Figures 2 and 3. The natural water content of the sandy silt, silty sand and sand ranges from about 23 to 26 percent.

4.4 Silty Clay

The sandy silty, silty sand, and sand deposits at boreholes 2-3 to 2-6, inclusive are underlain by a deposit of sensitive grey silty clay. The silty clay was found to have a thickness ranging from 1.5 to 4.1 metres. Except for the silty clay encountered in borehole 2-6, the silty clay deposit was found to be mottled with black organic matter. Standard penetration testing in this deposit gave N values ranging from 1 to 8 blows per 0.3 metres. In situ vane testing carried out within the silty clay gave shear strengths ranging from about 78 kilopascals to more than 120 kilopascals, which reflect a stiff to very stiff consistency. One Atterberg limit test on the silty clay gave a liquid limit value of 50 and a plastic limit of 25, which is characteristic of a clay having medium to high plasticity. The moisture content of the silty clay is about 33 to 39 percent.

4.5 Glacial Till

Deposits of glacial till were encountered beneath the surficial silty sand and sand deposits at boreholes 2-1 and 2-2, and beneath the silty clay at boreholes 2-3, 2-4 and 2-5. The glacial till was encountered at depths ranging from 0.4 metres at borehole 2-1 to 8.1 metres at borehole 2-5 (elevation 86.3 to 94.7 metres).

The glacial till consists of a heterogeneous mixture of all grain sizes but may be generally described as a sandy silt with gravel, clay and cobbles; boulders should also be expected. The results of grain size distribution tests carried out on samples of the glacial till are given on Figure 4. It should be noted that the gradation tests were carried out on 38 millimetre I.D. split barrel samples and so do not reflect the presence of cobbles or boulders.

Standard penetration tests carried out within the glacial till gave N values of 11 to 116 blows per 0.3 metres, which reflect a compact to very dense relative density.

The moisture content of the glacial till ranges from about 8 to 9 percent.

4.6 Bedrock

Bedrock was encountered and proven by coring at boreholes 2-3, 2-4 and 2-5. The bedrock consists of medium to thickly bedded grey dolomitic limestone and was encountered at depths of between about 7.7 and 8.9 metres below ground surface (elevation 85.0 to 86.6 metres). Auger refusal was encountered in borehole 2-2 at 8.3 metres below ground surface (elevation 85.6 metres).

A measure of the quality of the bedrock retrieved from the boreholes is shown on the Record of Borehole sheets as the percent recovery (REC) and Rock Quality Designation (RQD); for definitions

of these parameters, reference should be made to the Explanation of Terms sheet following the text of this report. The amount of core lost during coring was very low, resulting in core recovery values of 99 to 100 percent. The RQD values range from 40 to 96 percent (average of 76 percent) which reflect, on average, a good quality bedrock.

4.7 Groundwater

Groundwater levels were obtained from standpipes sealed in the completed borings and by observing the water level in the open holes at the completion of drilling. Details on the standpipe installations and the groundwater information (elevation and time of measurement) are given on the Record of Borehole sheets. The boreholes advanced in the proposed underpass area showed water levels of between 0.3 and 1.2 metres below ground surface (elevation 93.1 to 93.6 metres). The groundwater level in borehole 2-1 was found to be somewhat higher (elevation 94.8 metres), which reflects a rise in ground surface elevation west of the overpass.

Groundwater samples from this site and other bridge sites along Highway 416 are submitted to Accutest Laboratories Ltd. for chemical analysis related to potential corrosion, the results of which are shown on the attached Report of Analyses No. A0-0708.

The results of the chemical analysis on the groundwater sample from this site are as follows:

pH	-	7.06
Conductivity	-	3020 umhos/cm
Sulphate (SO ₄)	-	25 mg/L
Chloride (Cl)	-	48 mg/L

5. PROPOSED COUNTY ROAD 44 UNDERPASS

5.1 Bridge Foundations

The proposed single span bridge structures are to be supported on abutments perched above existing ground surface. It is understood that these structures will be relatively insensitive to post construction differential movement. For a standard size conventional spread footing foundation, it is understood that the required bearing capacity would be about 300 to 400 kilopascals.

The subsurface conditions at this structure vary from west to east. At the west abutment for the west bridge (borehole 2-2), the subsurface conditions consist of compact to very dense glacial till. To the east, the boreholes encountered very loose to loose deposits of sandy silt, silty sand and sand, followed by grey silty clay, followed by glacial till.

The west abutment for the south bound lane bridge could be founded on or within the glacial till or on a pad of engineered fill placed on the glacial till. If the footings are placed directly on or within the glacial till, it is recommended that a thin mud mat (50 millimetres) of lean concrete be placed over the subgrade area as soon as the bearing surface has been reached and properly cleaned; this will avoid softening of the glacial till due to ponded water and during reinforcement placement. Alternatively, perched abutment footings should be constructed in accordance with the attached MTO Standard, Figure 5. If required, the engineered fill could also consist of well graded crushed stone conforming to Ontario Provincial Standard Specifications (OPSS) for Granular B Type II (50 millimetre minus crushed stone). As shown on Figure 5, to allow adequate spread of the footing load the granular material should be sized to extend horizontally about 1.0 metre from the sides of the footing and downward and outward from this point at a slope not steeper than 1 horizontal to 1 vertical. The granular

fill should be compacted in maximum 200 millimetre thick lifts to 100 percent of the standard Proctor density.

In both cases, the abutment footings could be proportioned using a Serviceability Limit State (SLS) bearing pressure of 350 kilopascals and an Ultimate Limit State (ULS) bearing pressure of 800 kilopascals. The settlement at SLS should be less than about 25 millimetres provided that all loose and disturbed soil is removed from the footing area and provided that the engineered fill (if used) is compacted to the required density.

Due to the very loose to loose nature of the silty and sandy deposits and the underlying silty clay material encountered in the area of the other abutments, spread footings may not be feasible and driven end bearing piles could be considered. If required, driven piles could also be used for the west abutment for the south bound lane bridge.

As a design example, the SLS load for a 245 millimetre diameter steel pipe pile having a wall thickness of 12 millimetres may be taken as 1150 kilonewtons; the factored capacity at ULS can be taken as 1350 kilonewtons. These values assume that 350 megapascal strength steel and 30 megapascal concrete are used. The pipe piles should be set to a final termination of 10 blows for the last 12 millimetres of penetration using a hammer transferring about 40 kilojoules of energy per blow.

Alternatively, for a HP 310x110 steel H pile, the SLS and ULS loads could be taken as 1150 and 1600 kilonewtons, respectively. In this case, the H-pile should be set to a termination of 10 blows for the last 12 millimetres of penetration using a hammer transferring about 60 kilojoules of energy per blow to the pile.

Based on the boring results, piles at this site driven as noted above should terminate at between about elevation 85.0 to 86.6

metres, provided that large boulders are not encountered by the piles during driving within the glacial till.

Based on piling experience in this area, it is possible that several rounds of restriking could be required to achieve permanence of the final set. Therefore, provision should be made for restriking all of the piles at least once to confirm the set. Piles that do not meet the design set criteria on the first or subsequent restrike would require additional restriking. A minimum of two days should be allowed before restriking a pile.

It is recommended that the piles be battered in a direction away from the structure, as well as in the normal direction towards the roadway.

Since the glacial till likely contains boulders, and showed a compact to very dense relative density, hard driving conditions should be expected for the south bound lane bridge. As such, the piles for this bridge should be equipped with cast steel driving shoes. Additional piles may have to be driven should piles be damaged, bent, or driven off plumb.

Allowance should be made for pile load testing at the time of construction.

For snow cleared or covered areas, the pile caps should be provided with at least 1.8 metres of earth cover for frost protection purposes. In protected areas where snow is allowed to accumulate, this frost protection cover could be reduced to 1.5 metres.

5.2 Abutment Wall Backfill and Earth Pressures

The abutments should be backfilled with compacted non frost susceptible, free draining backfill such as that meeting Ontario Provincial Standard Specifications (OPSS) for Granular B Type I or

II. The granular fill should extend at least 1.5 metres beyond the inside face of the abutments. The granular backfill should be compacted in thin lifts to at least 95 percent of standard Proctor density. If lateral movement at the top of the abutment of about 0.05 percent of the retained height is expected to occur, "active" earth pressure coefficients (K_a) should be used in determining the horizontal load on the abutments. If the wall movement is expected to be less, then "at rest" pressure coefficients (K_o) should be used.

Assuming that a well graded sand and gravel backfill material meeting OPSS Granular B Type I material is used behind the abutments, a material unit weight of 21.2 kilonewtons per cubic metre could be used together with the following earth pressure coefficients in determining the lateral load on the abutments.

Earth Pressure
Coefficient

At Ultimate Limit State (ULS)

"at rest" condition	0.55
"active" condition	0.38

At Serviceability Limit State (SLS)

"at rest" condition	0.47
"active" condition	0.31

Earth pressure parameters for other materials could be provided if necessary.

To reduce compaction induced stress on the abutment walls, the granular fill near the abutments should be compacted with walk behind compaction equipment.

Highway live loads should be considered on the abutments unless approach slabs are used.

5.3 Embankment Stability and Settlement

The approach embankments and the centre embankment will have a height of about 8 to 10 metres above existing ground surface. The silty clay soils at this site have a stiff to very stiff consistency, and initial calculations indicate that no short term or long term stability problems are expected for the embankments within 30 metres of the abutments. Embankment fill should meet the requirements of OPSS 212 for borrow material, and should be placed and compacted in accordance with OPSS 206. If sandy earth borrow, rock borrow, or select subgrade material is used, embankment side slopes may be constructed at 2 horizontal to 1 vertical. If silty or clayey earth borrow is used, embankment side slopes should be 2.5 horizontal to 1 vertical or flatter.

Prior to placing the embankment fill materials all topsoil and surficial organic material should be removed from the embankment area. The silt deposit encountered at ground surface in borehole 2-6 and beneath the existing fill at borehole 2-5, was found to extend to about elevation 92.5 metres at the borehole locations, to have a very loose to loose relative density, an organic content of about 4 percent, and a moisture content of about 45 percent. This material, if left in place, is expected to settle for some period of time after construction of the embankments. To reduce post construction settlement of the east approach embankments near the rigidly supported bridge, this material could either be removed from beneath the embankment or the embankment could be constructed several months in advance of the bridge to allow settlement to occur.

5.4 Corrosion of Buried Structures

As previously indicated, the sulphate content of the groundwater was found to be 25 milligrams per litre. According to CSA CAN 3 A23.1-M77, this measured level of sulphate should not be corrosive to concrete where normal Portland Type 10 cement is used.

Based on the elevated conductivity and low pH value of the groundwater, this site can be classified as aggressive toward unprotected steel. Corrosion of driven piles in the native homogenous and undisturbed soil below the groundwater level is not expected to be a problem. However, the potential exists at this site for corrosion of the driven piles along that portion of the pile within the perched abutment fill, at the interface of the abutment fill and the native subsoil, and within the groundwater fluctuation zone. To reduce this corrosion potential, it is suggested that all piles at this site be provided with a bituminous coating (such as Bakelite 700-1) and that the pile cap be designed such that the steel pile is electrically isolated from the remainder of the bridge structure i.e. no steel to steel contact with the piles in the pile cap.

5.5 Construction Considerations

It is recommended that the pile driving equipment proposed by the contractor be reviewed in light of the contract pile type and set criteria and be accepted by the geotechnical engineer well in advance of any pile driving operations. Also, all piling operations should be inspected throughout by qualified geotechnical personnel.

Groundwater and surface water control may be required while placing and compacting the lower lifts of fill for the embankments. To facilitate pile driving and to limit disturbance of the bituminous coating on the piles, the fill material used beneath the abutments

should consist of pit run sand, free of gravel, cobble or boulder size material.

The soils at this site are highly susceptible to frost heaving. Therefore, the native soils around the piles should be protected from freezing during construction to prevent pile jacking due to adfreeze effects.

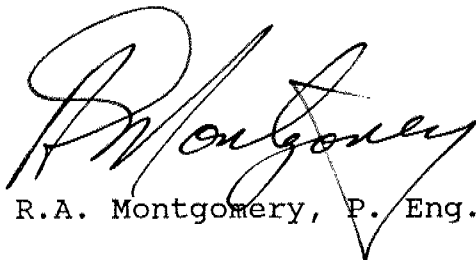
If welded pile splices are to be used, a licensed welding inspector should be retained during the pile driving to periodically inspect the welding procedures used by the contractor.

We trust that this report contains sufficient information for your purposes. Should you have any questions, please call us.

GOLDER ASSOCIATES LTD.



A.F. Chevrier, P. Eng.



R.A. Montgomery, P. Eng.



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Disk 15

Att.

REPORT OF ANALYSES

Client: Golder Associates

Date: May 8, 1990

Project: 891-2582

P. O. 15001

Report	Report	Report
891-2582-2	891-2582-3	891-2582-1
BH 2-5	BH 3-3	BH 1-5

[illegible]

ANALYST:

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 2-1

METRIC

W P 177-89-04 LOCATION Sta. 9 + 873.7 0.1 Rt. ORIGINATED BY P.H.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.
 DATUM Geodetic DATE April 17, 1990 CHECKED BY A.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		
							20	40	60	80	100						
95.1	Ground Surface																
0.0	Topsoil																
0.2	Silty sand Grey brown																
0.4	Sandy silt, some gravel, trace clay, occasional cobble (glacial till)		1	SS	27												
			2	SS	60												
			3	SS	15												
			4	SS	28												
			5	SS	25												
89.9	Compact Brown to grey		6	SS	11												
5.2	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2-2

METRIC

W P 177-89-04 LOCATION Sta. 9 + 903.9 0.2 Lt. ORIGINATED BY P.H.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.
 DATUM Geodetic DATE April 17, 1990 CHECKED BY A.C.

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				
93.9	Ground Surface															
0.0	Topsoil															
0.2	Sand, fine, some silt		1	AS*	-											
93.4	Brown															
0.5	Sandy silt and gravel, trace clay (glacial till)		2	SS	23											
92.9	Compact															
1.2	Sandy silt, and gravel, trace clay, some cobbles (glacial till)		3	SS	116											
			4	SS	58											
			5	SS	47											
89.3	Dense to very dense		6	SS	36											
	Brown to grey															
4.6	Sandy silt, some gravel, trace to some clay (glacial till)		7	SS	19											
			8	SS	19											
			9	SS	15											
			10	SS	13											
			11	SS	59											
P5.6	Compact															
	Grey															
8.3	End of Borehole															
	Auger Refusal															
	* AS: Auger Sample															

RECORD OF BOREHOLE No 2-3

METRIC

W P 177-R9-04 LOCATION Sta. 9 + 942.4 4.7 Rt. ORIGINATED BY P.H.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.
 DATUM Geodetic DATE April 18 and 19, 1990 CHECKED BY A.C.

OFFICE REPORT ON SOIL EXPLORATION

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 (%) GR SA SI CL		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80
93.6	Ground Surface															
93.3	Topsoil															
92.8	Sand, fine to medium, trace silt	Brown														
91.5	Sandy silt, some clayey silt and silty sand seams Very loose Grey brown to grey		1	SS	5											
90.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		2	SS	2											
89.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		3	SS	1											
88.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		4	SS	3											
87.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		5	SS	26											
86.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		6	SS	19											
85.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		7	SS	17											
84.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		8	SS	13											
83.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		9	SS	18											
82.0	Silty clay, some silty sand seams, trace black organic mottling Stiff Grey		10	SS	75 for 80 mm											
81.0	Dolomitic limestone bedrock, fresh, medium to thickly bedded, bedding horizontal, thin mud seam at 11.0 metres depth		11	RC BXL	REC=100% RQD=86%											
80.0	Dolomitic limestone bedrock, fresh, medium to thickly bedded, bedding horizontal, thin mud seam at 11.0 metres depth		12	RC BXL	REC=100% RQD=96%											
79.0	End of Borehole															

METRIC

W P 177-89-04 LOCATION Sta. 9 + 976.2 0.4 Lt. ORIGINATED BY P.H.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.
DATUM Geodetic DATE April 17, 1990 CHECKED BY A.C.

[illegible]

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

METRIC

W P 177-89-04 LOCATION Sta. 10 + 012.9 4.1 Lt. ORIGINATED BY P.H.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.
DATUM Geodetic DATE April 19 and 20, 1990 CHECKED BY A.C.

[illegible]

+3, x5: Numbers refer to Sensitivity

20
15 — 5 (%) STRAIN AT FAILURE
10



METRIC

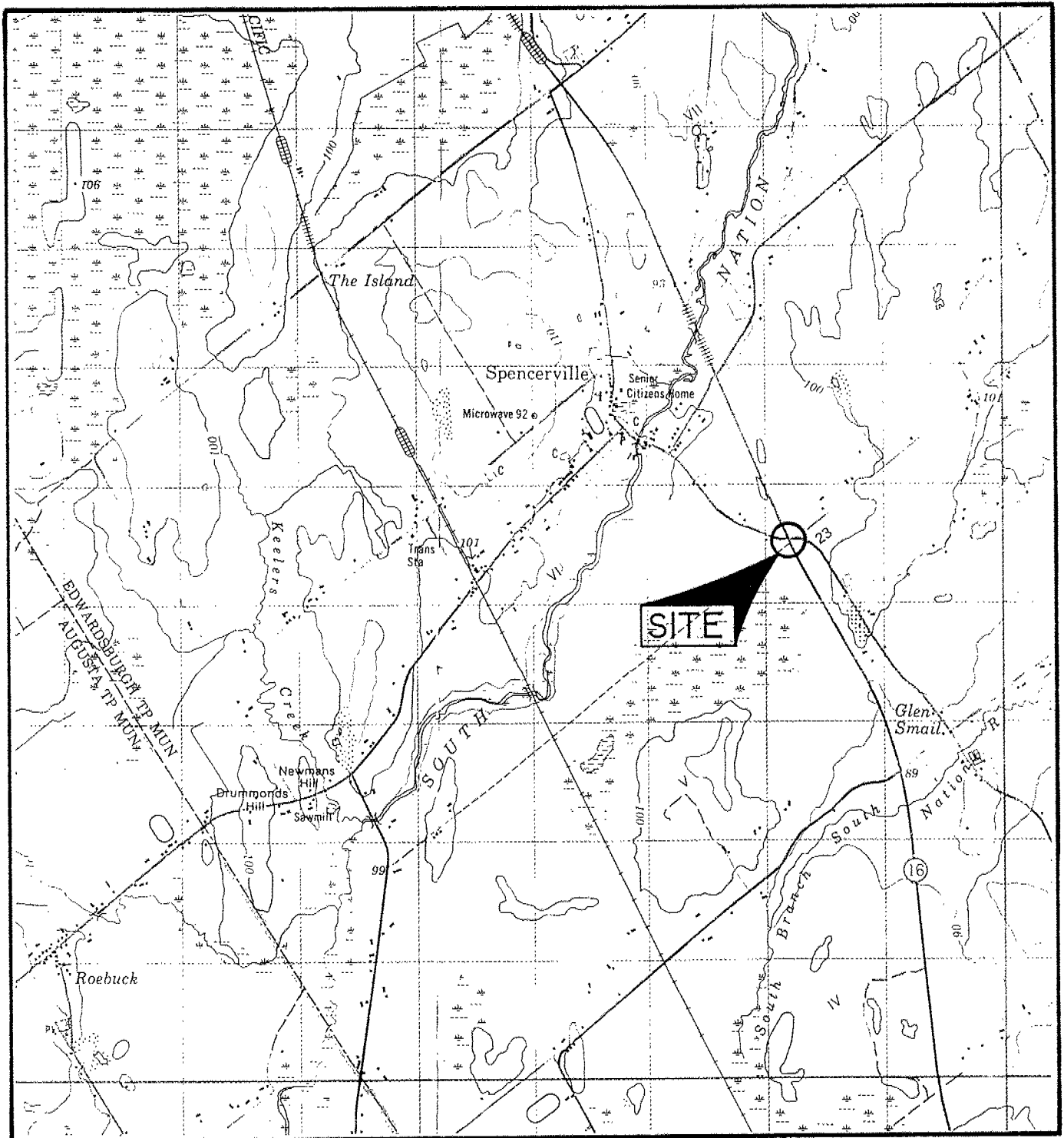
W P 177 - 89-04 LOCATION Sta. 10+044.9 0.6 Lt. ORIGINATED BY P.H.
1951 2 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.
DATUM Geodetic DATE April 20 and 23, 1990 CHECKED BY A.C.

[illegible]

+3, x5: Numbers refer to Sensitivity

KEY PLAN

FIGURE I
WP 177-89-04



SCALE
1: 50,000

Date AUG. 2, 1990

Project 89I-2582-2

Golder Associates

Drawn JC

Chkd. AC

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

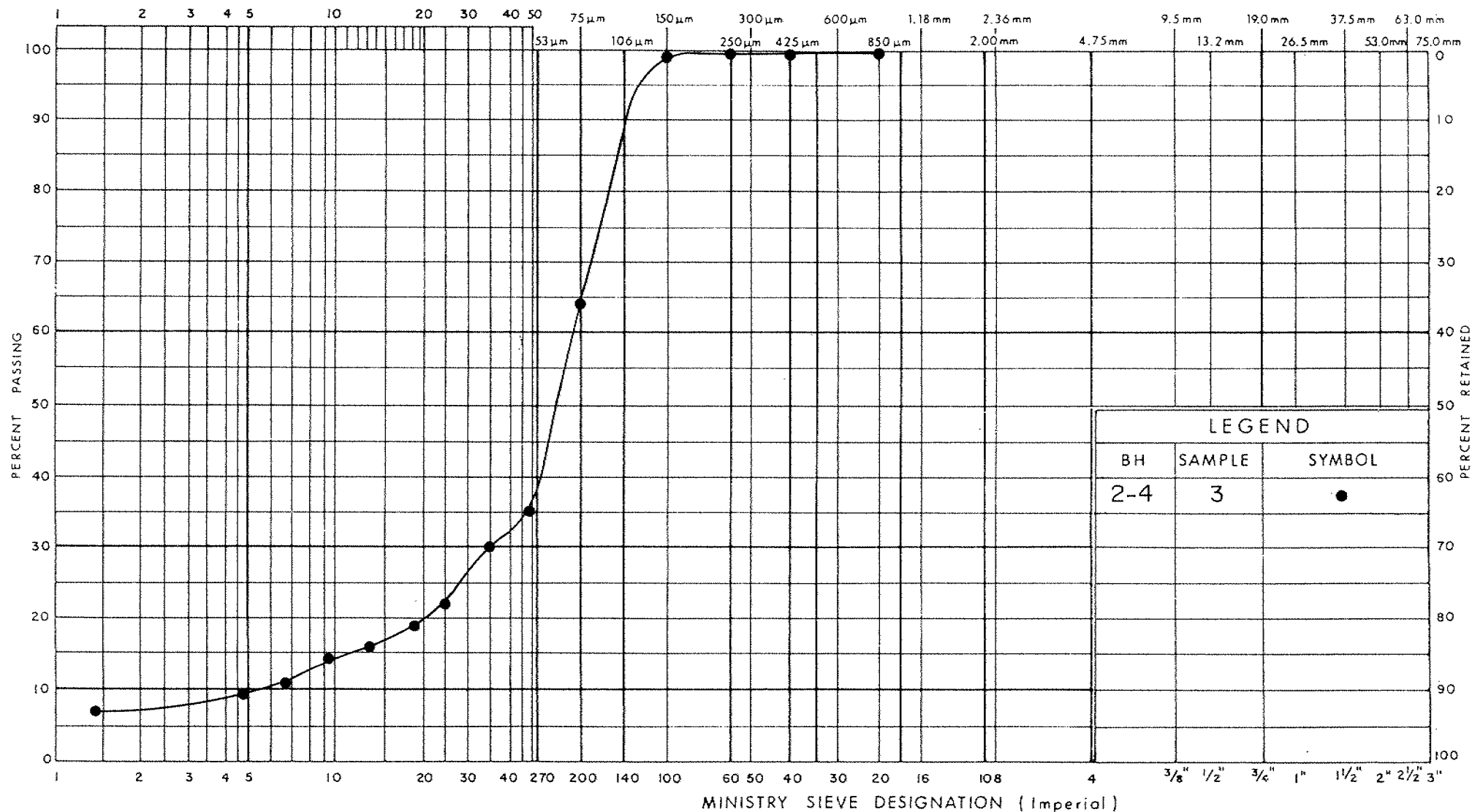
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

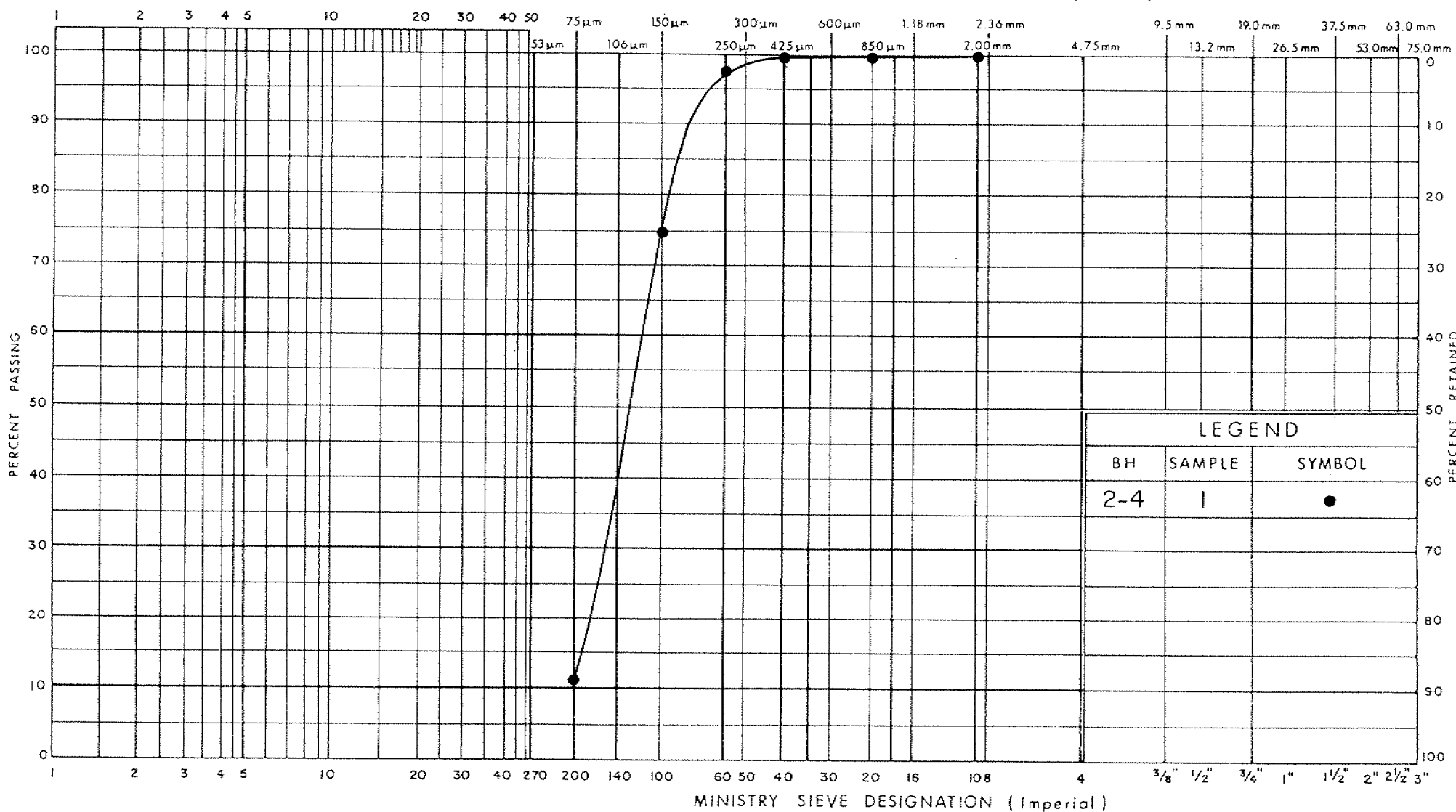
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH	SAMPLE	SYMBOL
2-4	I	●

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, some silt

FIG No 3

W P 177-89-04

UNIFIED SOIL CLASSIFICATION SYSTEM

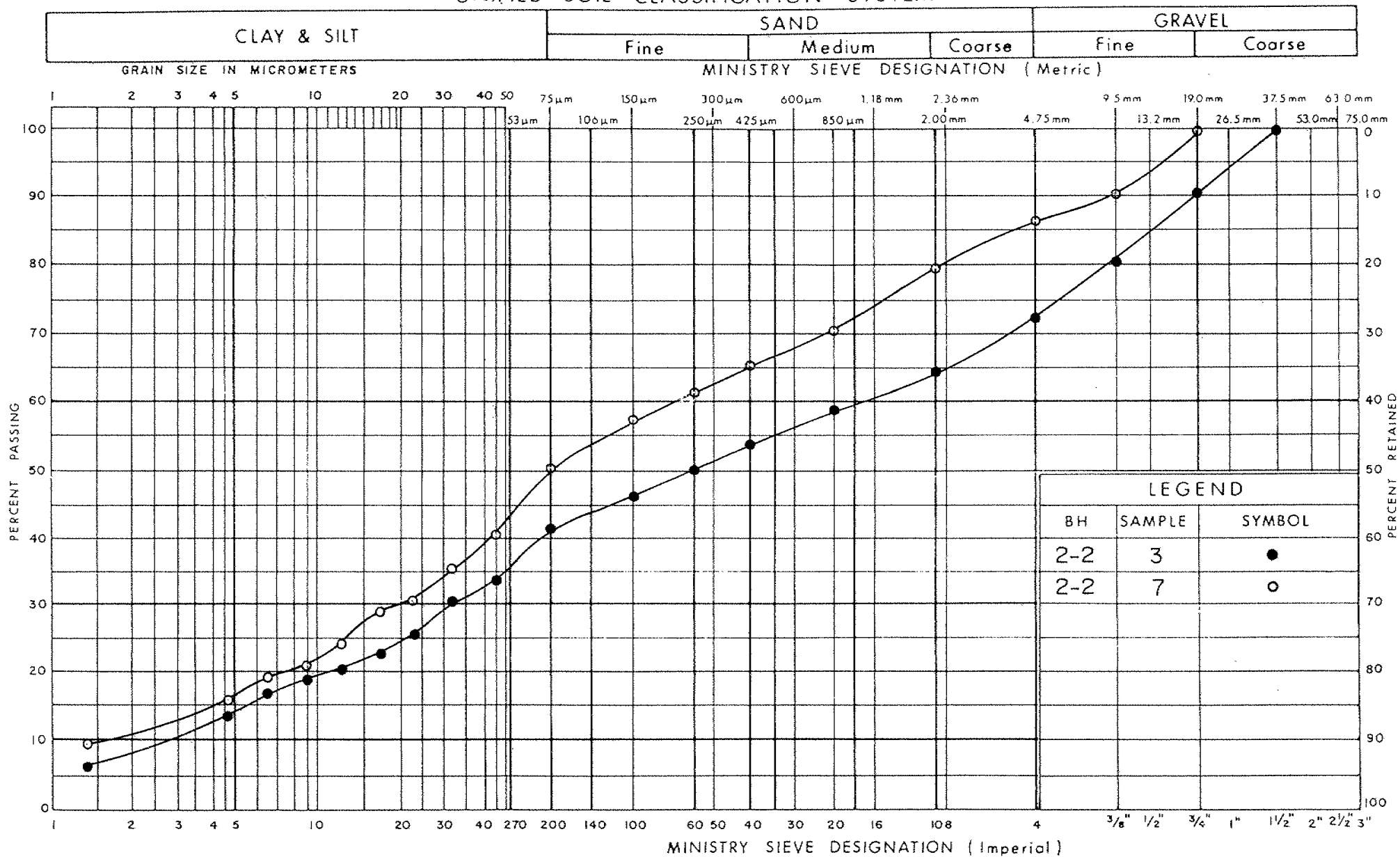
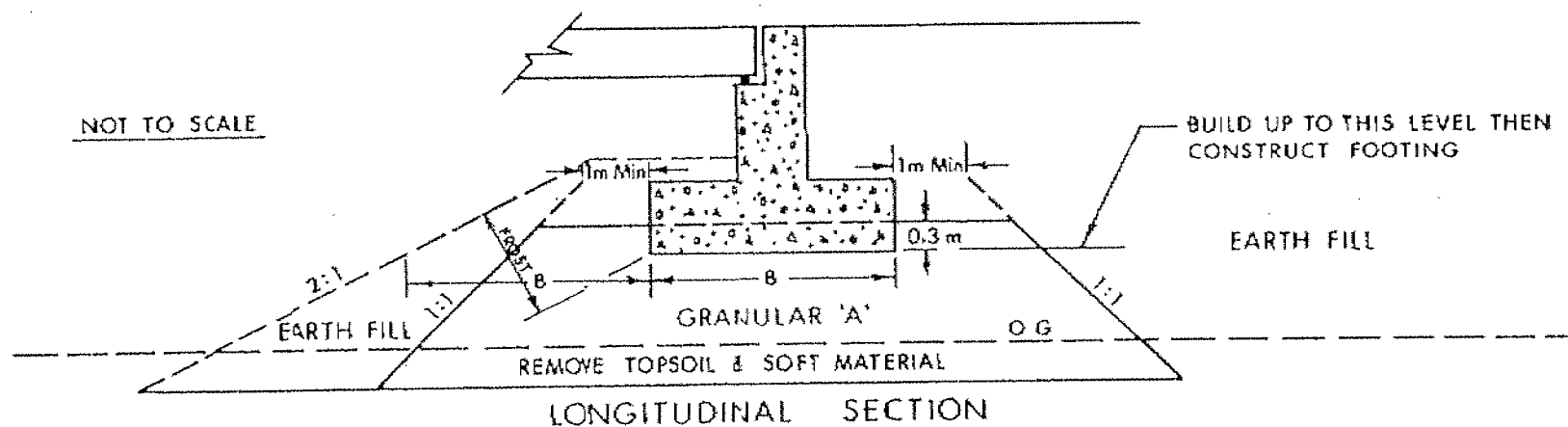
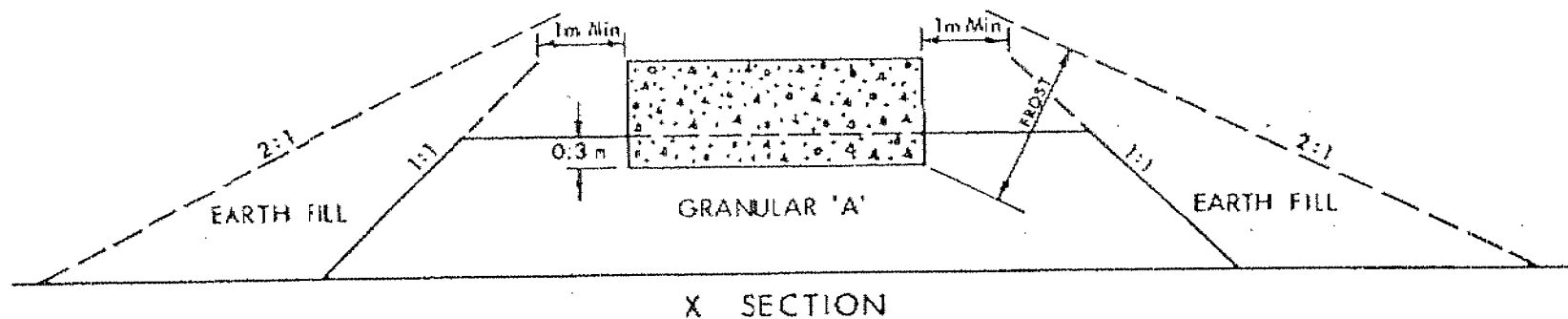
GRAIN SIZE DISTRIBUTION
GLACIAL TILL

FIG No 4

W P 177-89-04

Ministry of
Transportation



NOTES:

- 1- REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2- PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T O STANDARDS.
- 3- CONSTRUCT CONCRETE FOOTING.
- 4- PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



Ministry of
Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No. 5

WP 177 - 89 - 04

METRIC

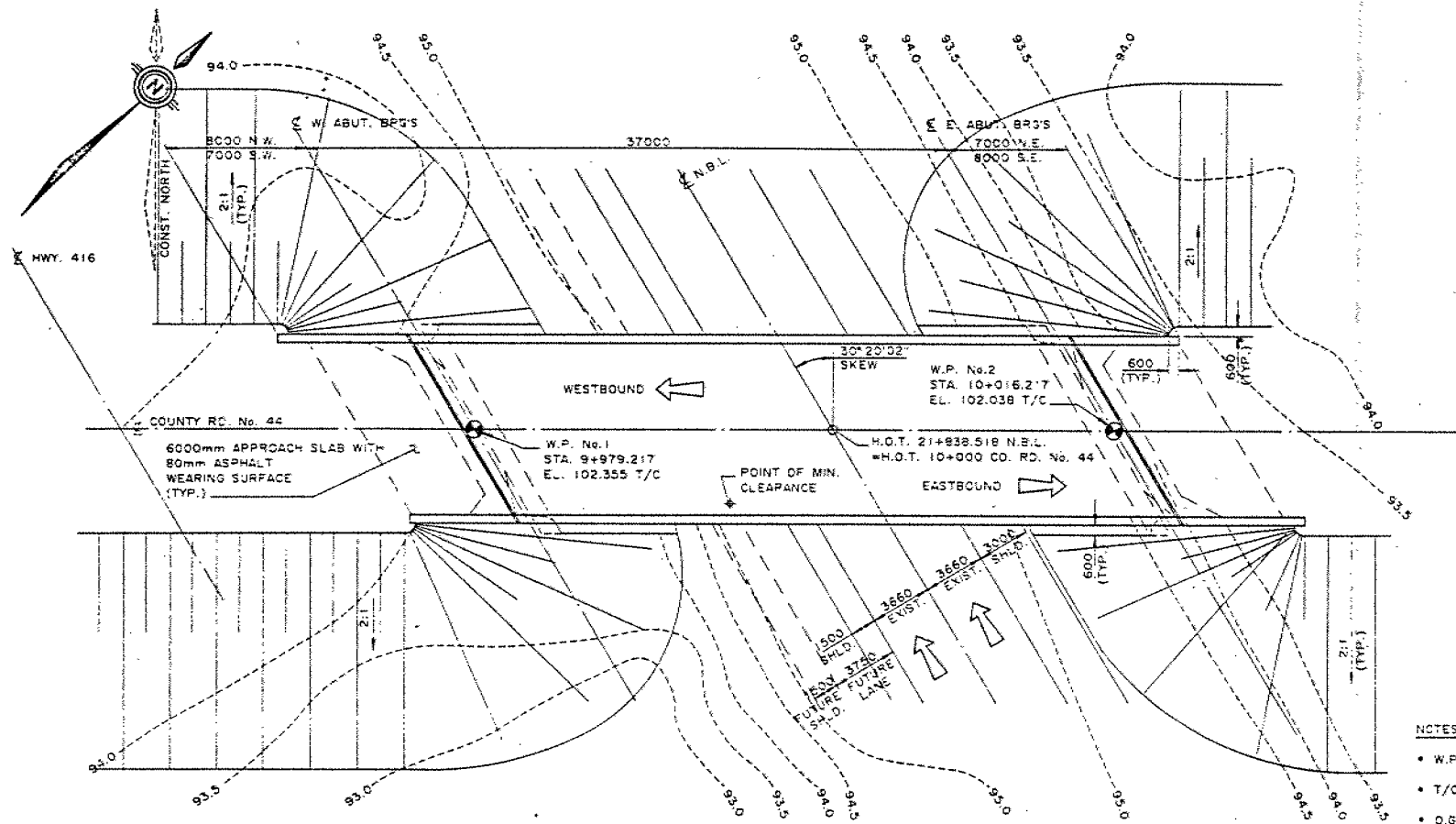
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT No. 9
CONT No 94-28
WP No 177-89-04

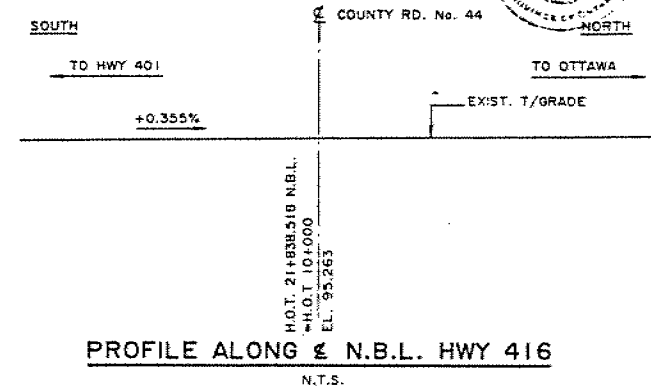
COUNTY ROAD No. 44 UNDERPASS
BRIDGE 2A(N.B.L.)
HWY. 416
GENERAL ARRANGEMENT

SHEET
244

totten sims hubicki associates
ENGINEERS ARCHITECTS AND PLANNERS

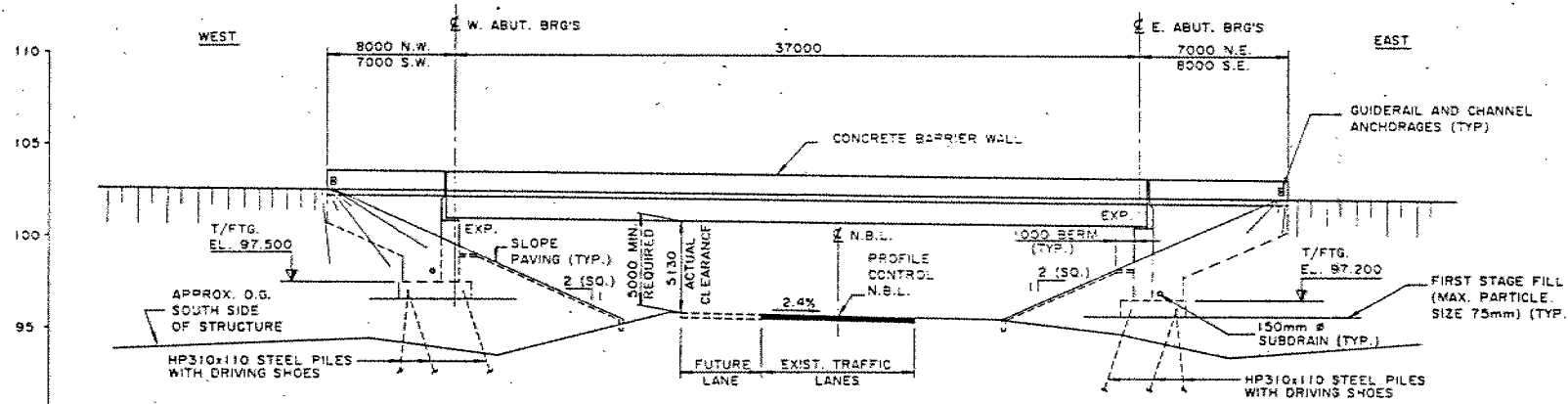


PLAN
SCALE 1:200

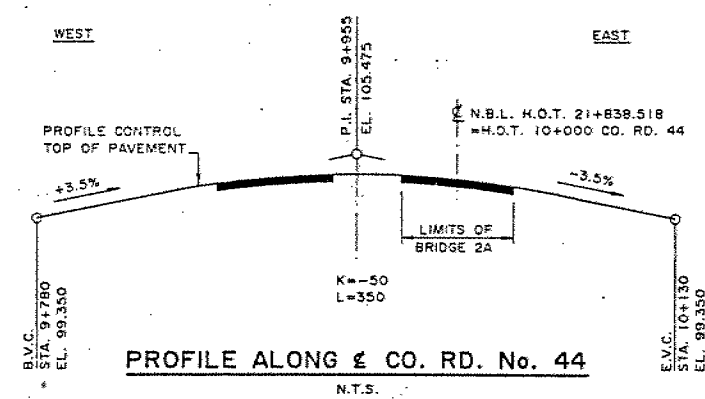


PROFILE ALONG & N.B.L. HWY 416
N.T.S.

- NOTES:
- W.P. DENOTES WORKING POINT
 - T/C DENOTES TOP OF CONCRETE DAM
 - O.G.L. DENOTES ORIGINAL GROUND LINE



ELEVATION
SCALE 1:200



PROFILE ALONG & CO. RD. No. 44
N.T.S.

GENERAL NOTES

CLASS OF CONCRETE

- ALL CONCRETE (UNLESS OTHERWISE NOTED) 30MPa

CLEAR COVER TO REINFORCING STEEL

- FOOTINGS 100 ±25mm
- ABUTMENTS & WINGWALLS: FRONT FACE 80 ±20mm, BACK FACE 70 ±20mm
- DECK: TOP 70 ±20mm, BOTTOM 40 ±10mm
- APPROACH SLABS 80 ±20mm
- REMAINDER (UNLESS OTHERWISE NOTED) 70 ±20mm

REINFORCING STEEL

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS NOTED OTHERWISE. BAR MARKS WITH SUFFIX "C" DENOTE COATED BAR.

CONSTRUCTION NOTES

- IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN IN THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT.
- BACKFILL SHALL NOT BE PLACED ABOVE BEARING SEAT ELEVATION UNTIL AFTER DECK CONCRETE HAS BEEN PLACED.

LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE DATA & SOIL STRATA
- FOOTINGS AND PILE DETAILS
- WEST ABUTMENT
- EAST ABUTMENT
- N.W. & S.W. WINGWALLS
- N.E. & S.E. WINGWALLS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II
- BEARING DETAILS
- DECK DETAILS
- DECK REINFORCING
- BARRIER WALLS
- JOINT ANCHORAGE & ARMOURING
- 6000 mm APPROACH SLAB
- DETAILS OF CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING-STEAM & DIESEL HAMMERS
- AS CONSTRUCTED ELEV. & DIM.
- ELECTRICAL EMBEDDED WORK
- QUANTITIES - STRUCTURE - I
- QUANTITIES - STRUCTURE - II

APPLICABLE STANDARD DRAWINGS

- OPSD 3501.00 GRANULAR BACKFILL REQUIREMENTS
- OPSD 4602.00 FALSEWORK CLEARANCES

B.M.
EL. 93.632

NAIL IN ROOT OF 0.20 POPLAR
20.5 RT. STA. 21+874

NOTE
DIMENSIONS SHOWN NORMAL TO
& COUNTY RD. No. 44

TYPICAL SECTION

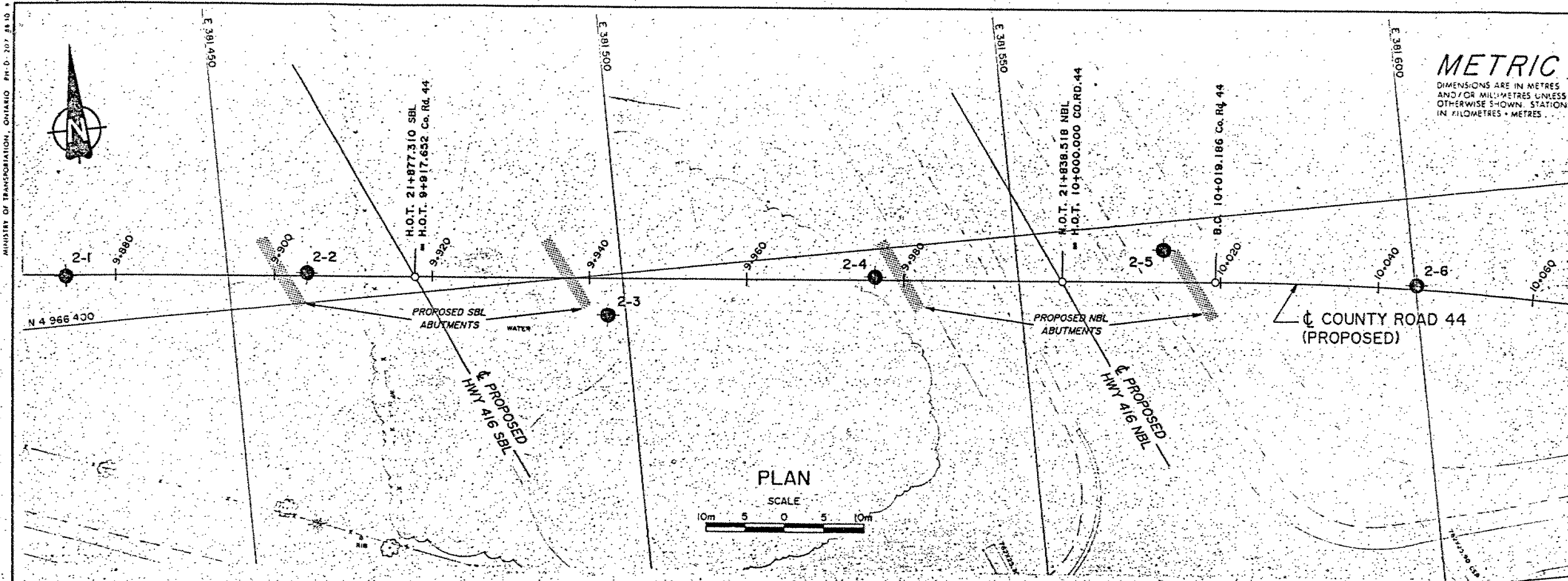
SCALE 1:50

FOR DECK SLOPES SEE
DECK DETAILS No. 11

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

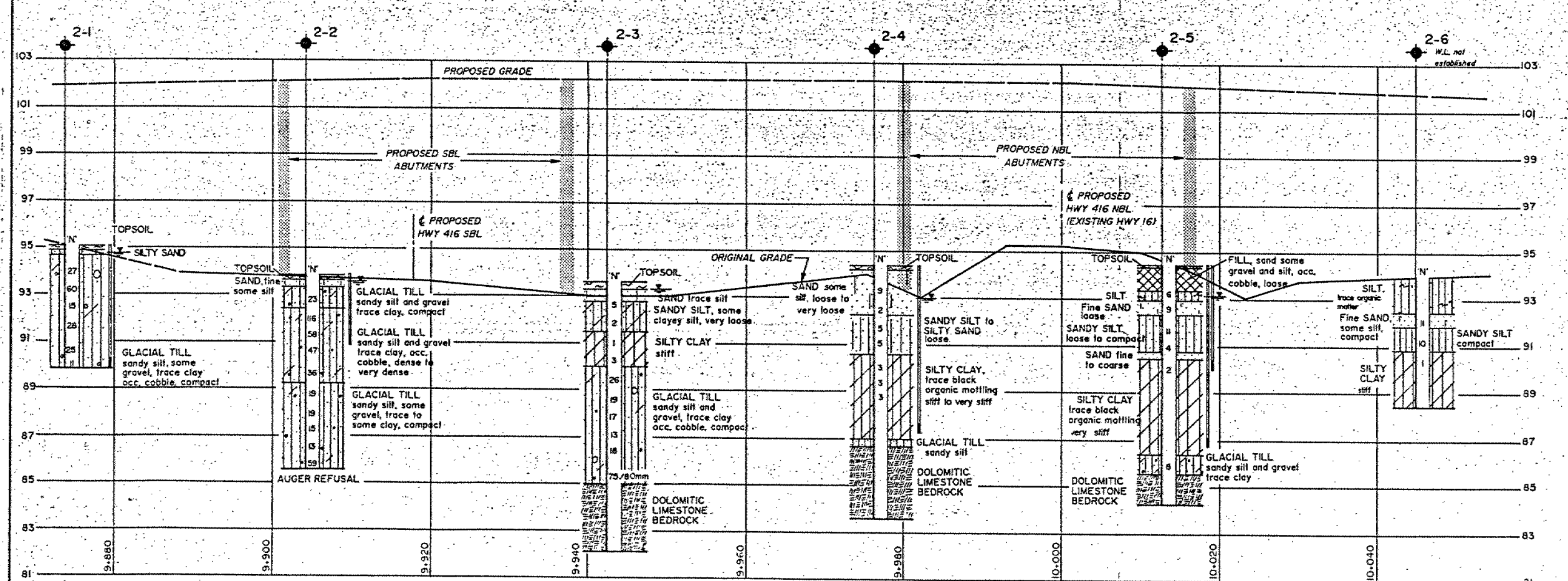
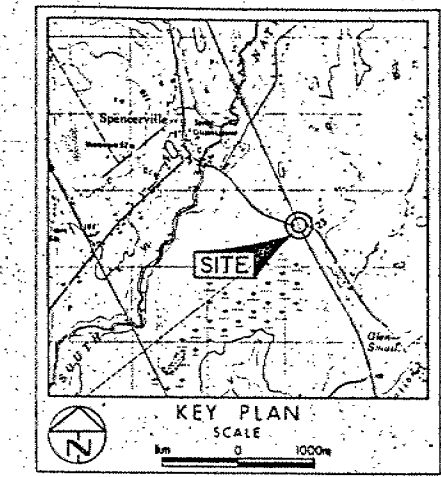
REVISIONS	DATE	BY	DESCRIPTION

DESIGN W.L. CHK F.L. CODE 04BDC 83ILCAD CLASS 4/1 DATE MAR. 9
DRAWN C.D.T. CHK G.L.A. SITE 16-310 STRUCT SCHEME DWG 1



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

Golder Associates Ltd.



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation (April & May 1990)
- Standpipe

No	ELEVATION	STATION	OFFSET
2-1	95.1	9+873.7	0.1m Rf
2-2	93.9	9+903.9	0.2m Lf
2-3	93.6	9+942.4	4.7m Rf
2-4	94.3	9+976.2	0.4m Lf
2-5	94.4	10+012.9	4.1m Lf
2-6	94.0	10+044.9	0.6m Lf

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 included in accordance with the conditions of Section 102-2 of Form 100.

REV. DATE BY DESCRIPTION

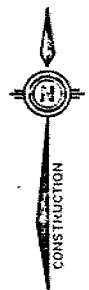
Geocres No 318-61

HWY No 416 DIST 9

SUBMIT AC CHECKED AC DATE 90/08/03 SITE 16-310

DRAWN JC CHECKED DATE 90/08/03 SITE 16-310

REF. No. E-27-416-16-310



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

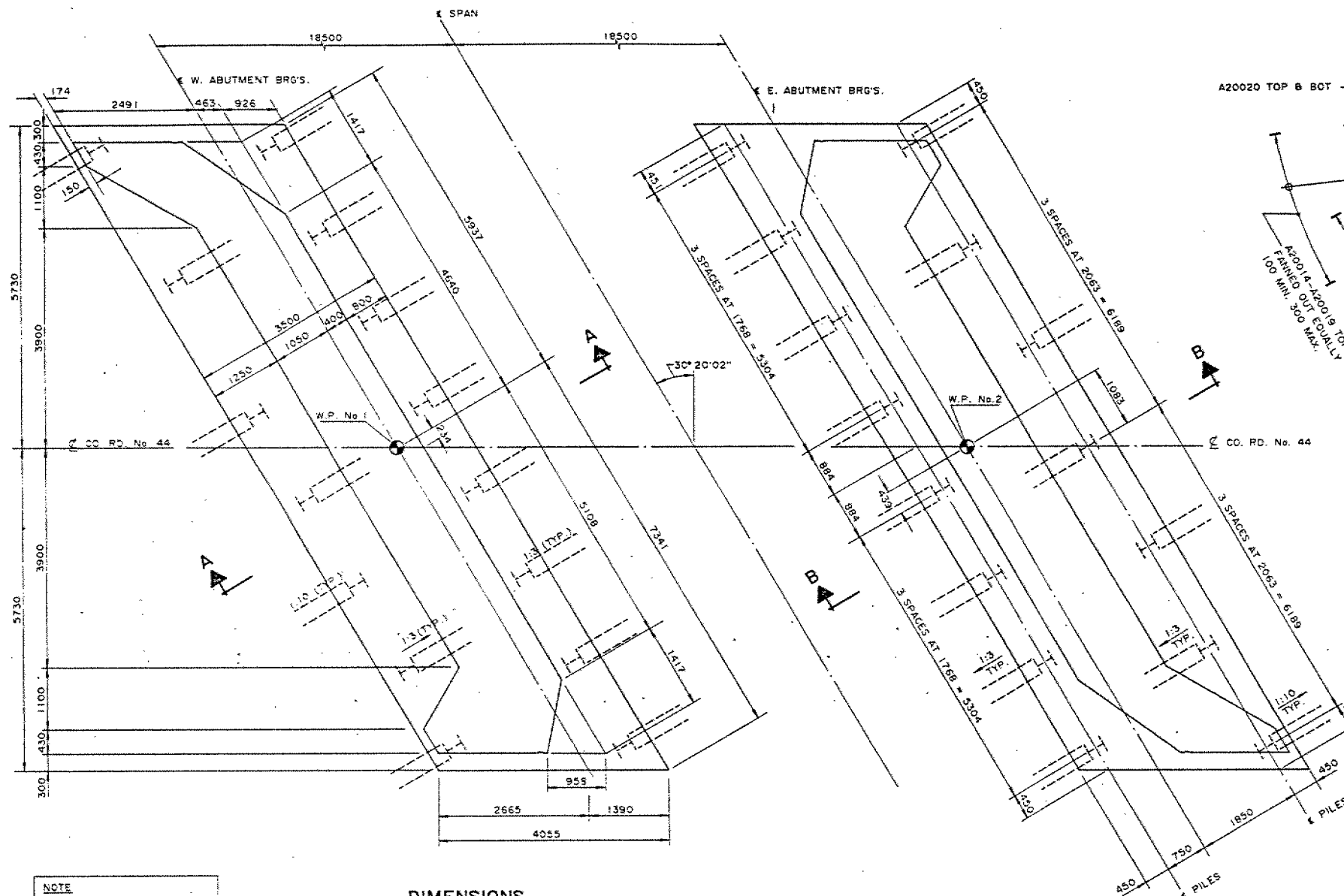
CONT No 94-28
WP No 177-89-04

COUNTY ROAD No. 44 UNDERPASS
BRIDGE 2A(N.B.L.)
HWY. 416
FOOTINGS AND PILE DETAILS



SHEET
246

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ENGINEERS ARCHITECTS AND PLANNERS

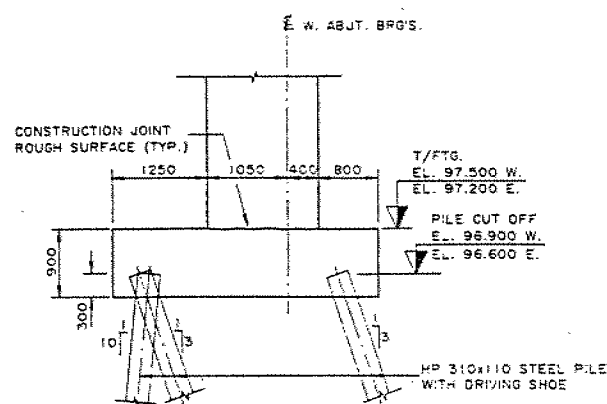


DIMENSIONS
SCALE 1:50

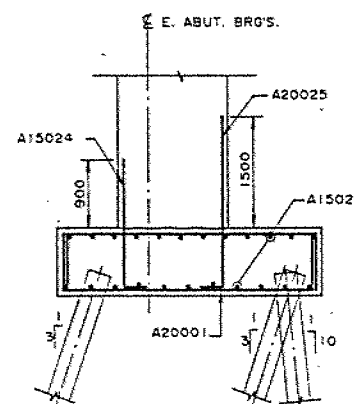
PILE LAYOUT
SCALE 1:50

REINFORCEMENT
SCALE 1:50

NOTE
EAST & WEST FOOTINGS ARE
SIMILAR EXCEPT AS NOTED.



DIMENSIONS
SECTION A-A
SCALE 1:50



REINFORCEMENT
SECTION B-B
SCALE 1:50

W.P. COORDINATES			
W.P. No.	STA.	NORTH	EAST
1	9+979.217	4966395.732	381534.867
2	10+016.217	4966391.966	381571.675

LIST OF PILES				
LOCATION	ROW	No.	LENGTH(m)	BATTER
W. ABUT.	FRONT	8	12.5	1:3
	BACK	3	12.5	1:3
	BACK	4	12.0	1:10
E. ABUT.	FRONT	8	12.5	1:3
	BACK	3	12.5	1:3
	BACK	4	12.0	1:10

- NOTE:
- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
 - PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.
 - PILES TO BE PROVIDED WITH DRIVING SHOES.
 - PILES TO BE DRIVEN IN ACCORDANCE WITH STD. SS 103-10 OR SS103-11 USING AN ULTIMATE CAPACITY OF 3450KN.
 - PILE DESIGN DATA
 - MAX. COMBINED FACTORED LOADS:
 - SLS TYPE II = 1150KN
 - ULS = 1600KN

APPLICABLE STANDARD DRAWINGS

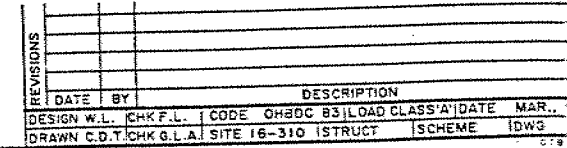
OPSD 3301.00 SPLICE AND DRIVING SHOE DETAIL FOR STEEL 'W' PILES.

REVISIONS	DATE	BY	DESCRIPTION

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

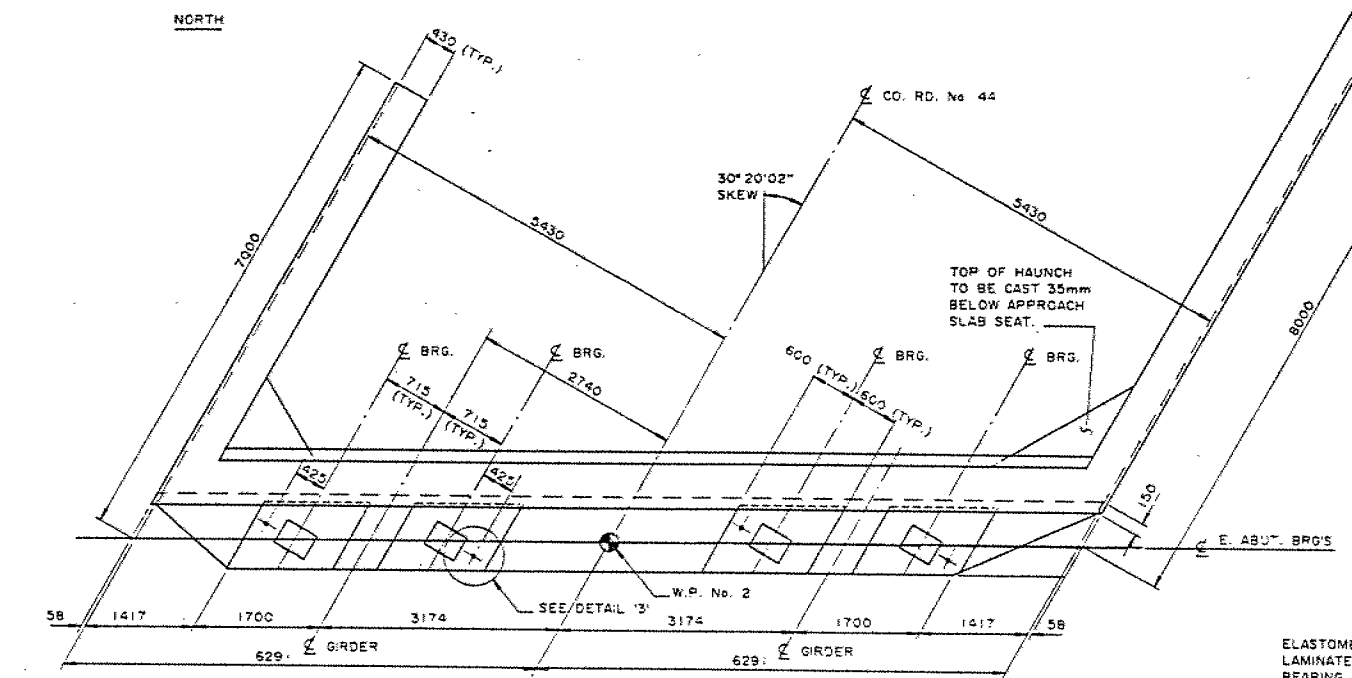


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ENGINEERS ARCHITECTS AND PLANNERS

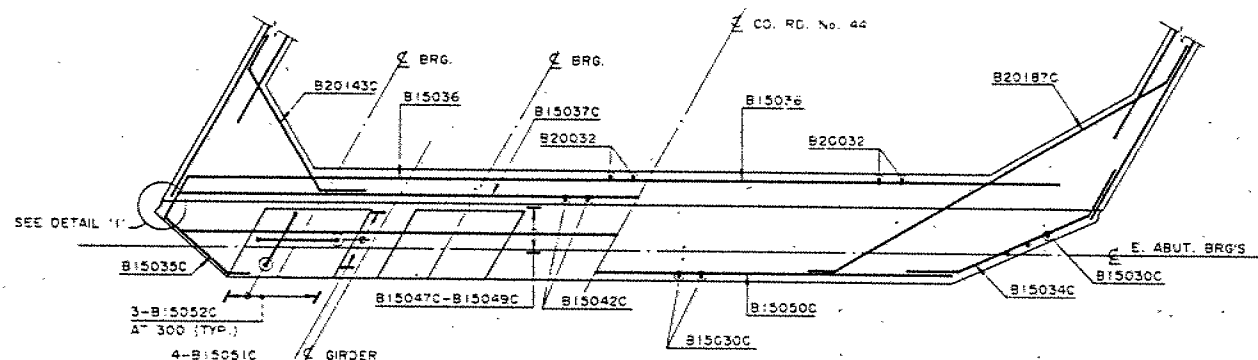


NOTES:
F.F. DENOTES FRONT FACE
B.F. DENOTES BACK FACE
E.F. DENOTES EACH FACE

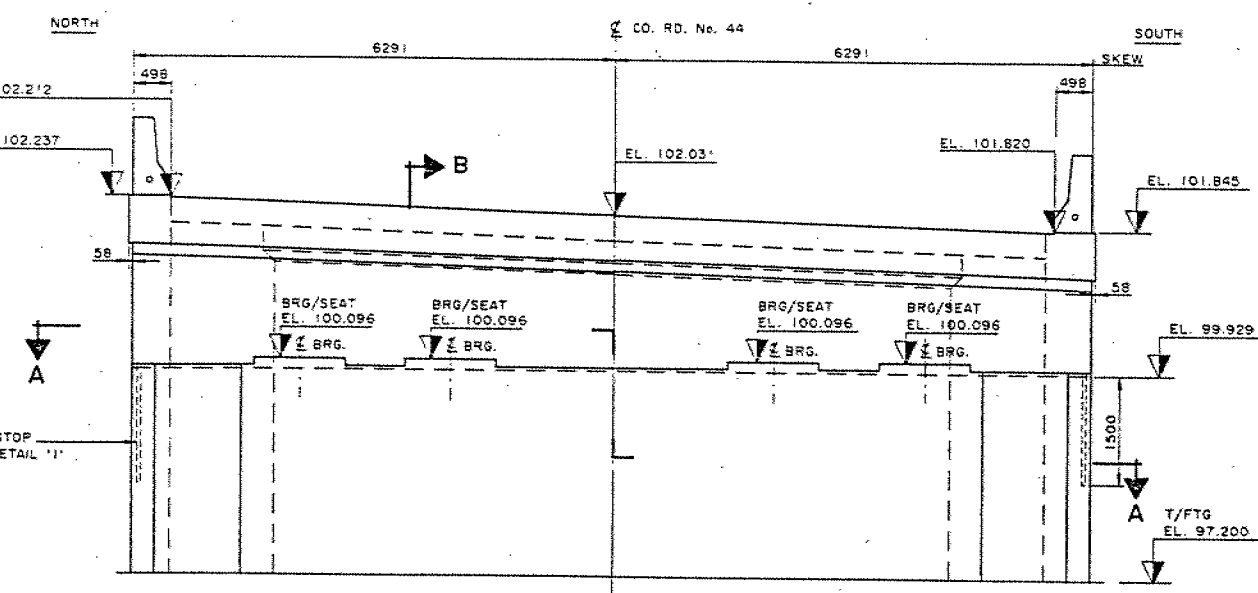
NORTH



PLAN
SCALE 1:50

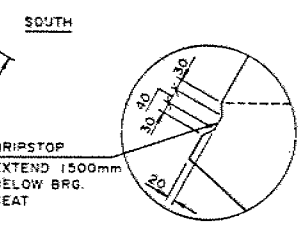


SECTION A-A
SCALE 1:50

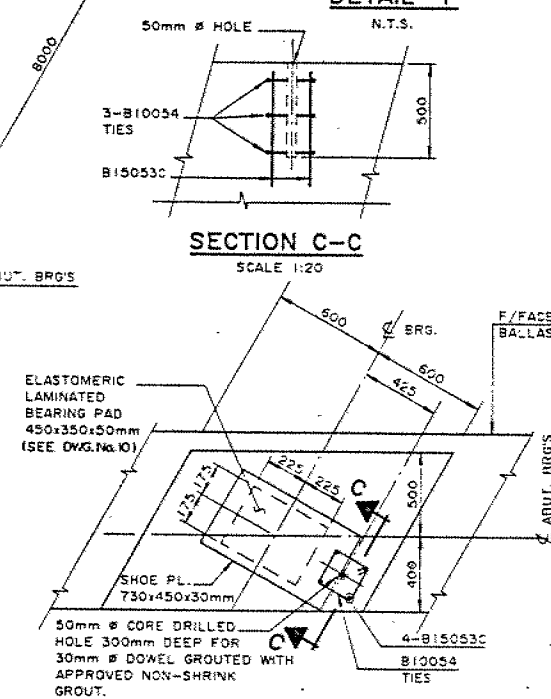


DIMENSIONS

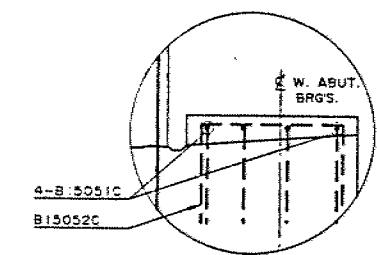
EAST ABUTMENT ELEVATION
SCALE 1:50



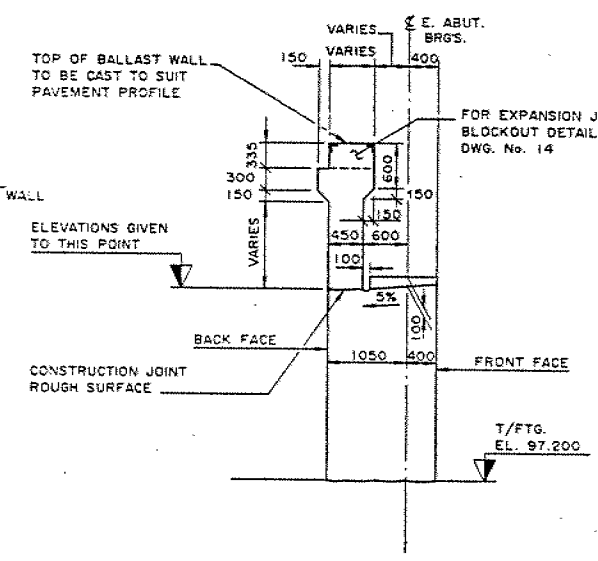
DETAIL '1'
N.T.S.



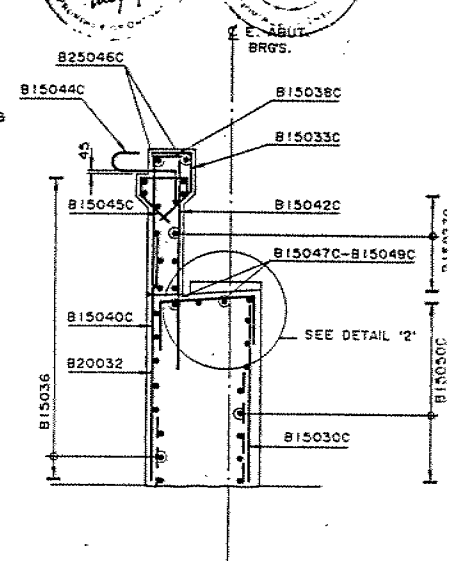
SECTION C-C
SCALE 1:20



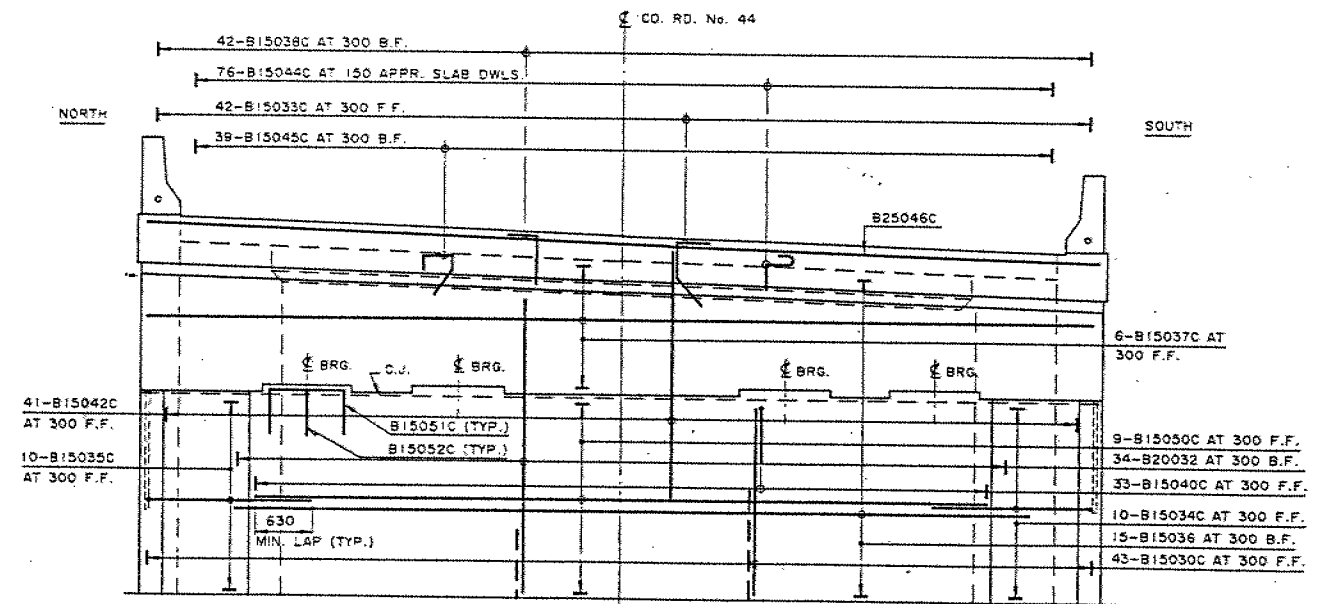
DETAIL '2'
N.T.S.



DIMENSIONS



REINFORCEMENT



REINFORCEMENT

METRIC

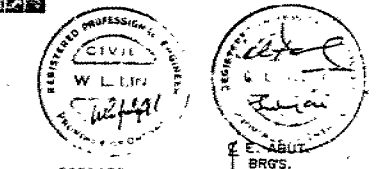
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 94-28
WP No 177-89-04

COUNTY ROAD No. 44 UNDERPASS
BRIDGE 2A(N.B.L.)
HWY. 416
EAST ABUTMENT

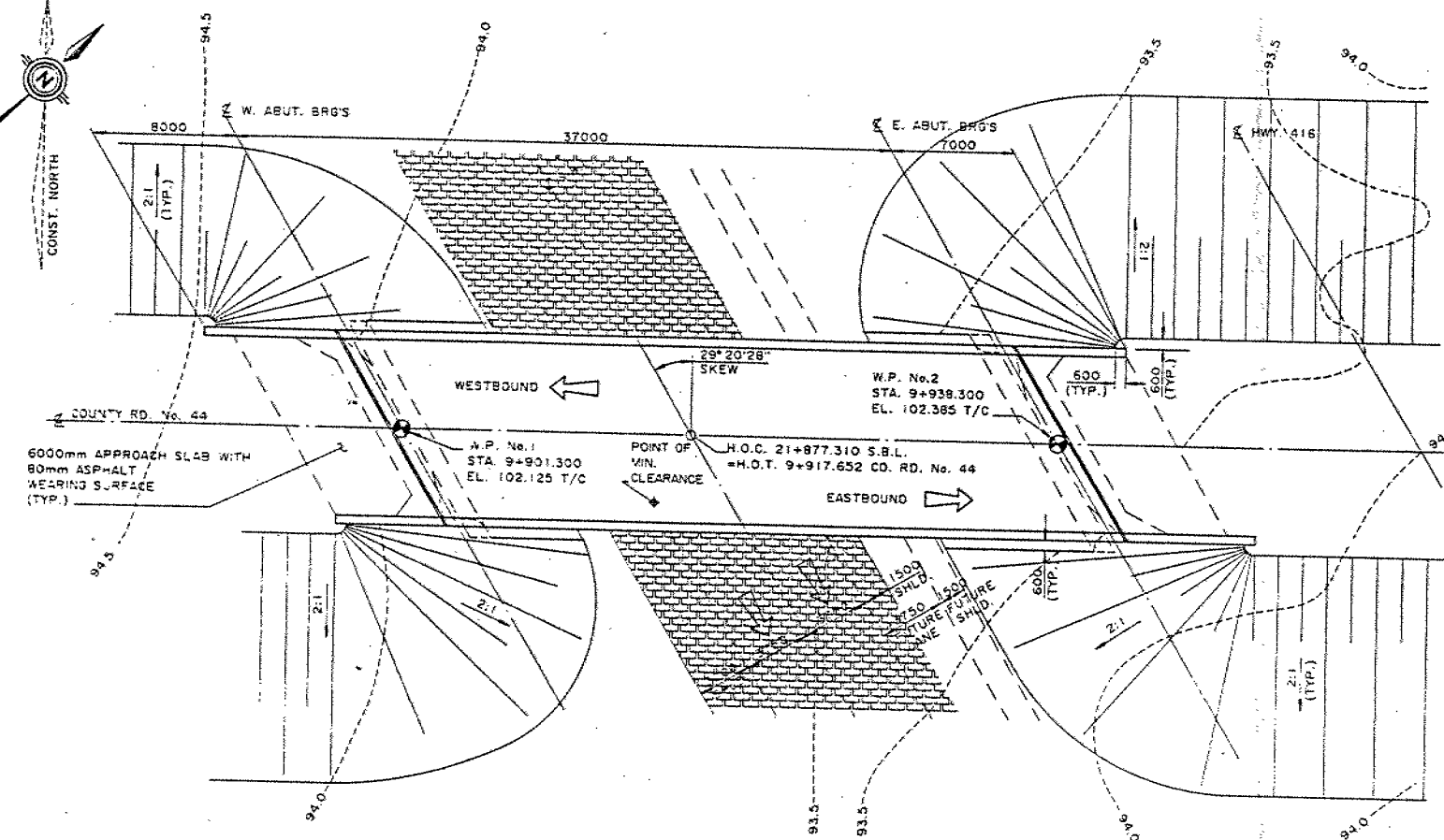
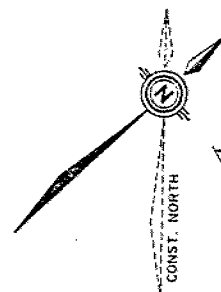
SHEET
248

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ENGINEERS ARCHITECTS AND PLANNERS

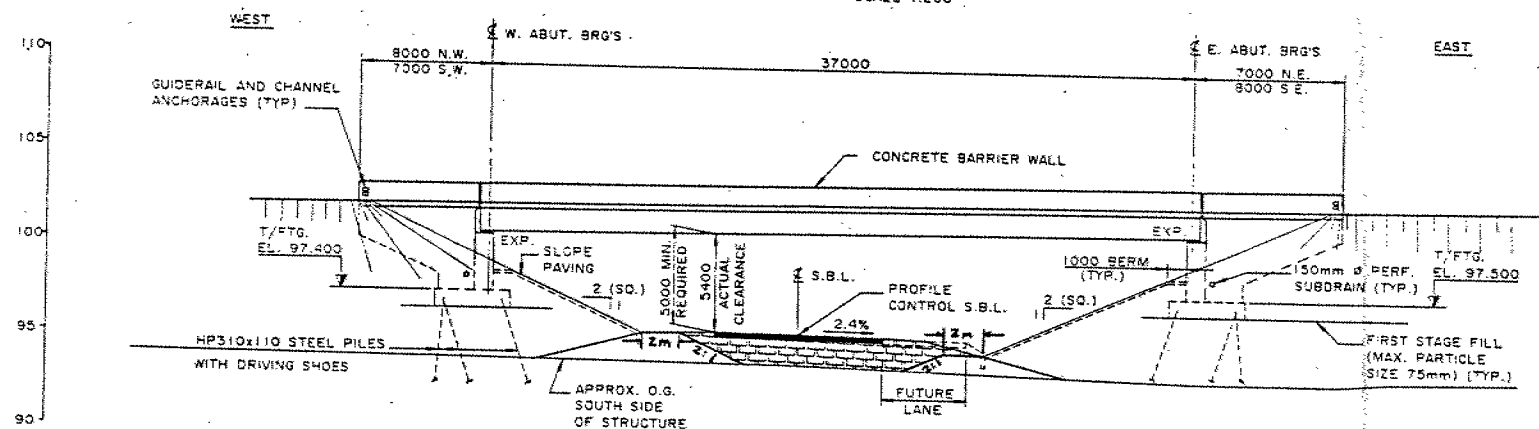


DRAWING NOT TO BE SCALED

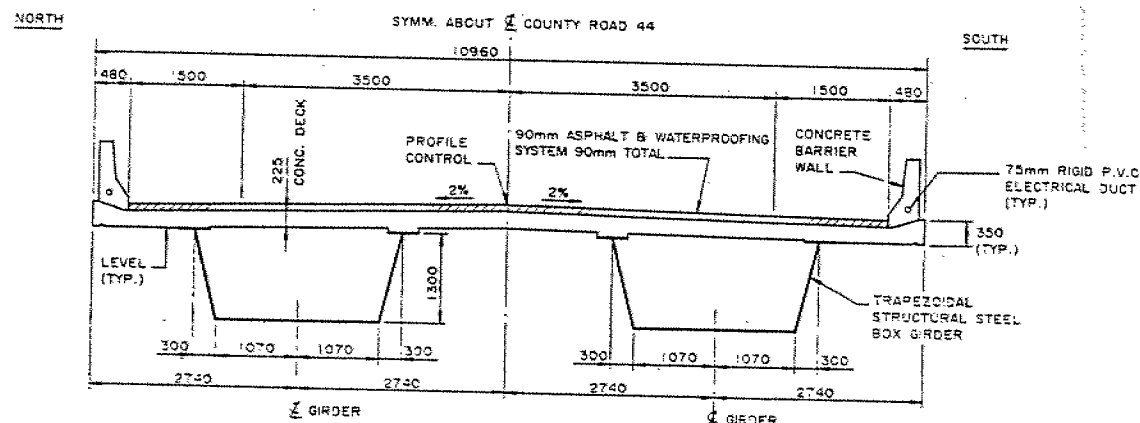
REVISIONS	DATE	BY	DESCRIPTION



PLAN
SCALE 1:200



ELEVATION
SCALE 1:200

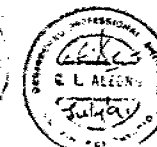


TYPICAL SECTION
SCALE 1:50

NOTE
DIMENSIONS SHOWN NORMAL TO
COUNTY RD. No. 44

B.M.
EL. 93.632
NAIL IN ROOT OF 0.20 POPLAR
20.5 RT. STA. 21+874

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



DISTRICT No. 9
CONT No 94-28
WP No 177-89-07
COUNTY ROAD No. 44 UNDERPASS
BRIDGE 2B(S.B.L.)
HWY. 416
GENERAL ARRANGEMENT



SHEET
267

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ENGINEERS ARCHITECTS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE

- ALL CONCRETE (UNLESS OTHERWISE NOTED) 30MPa

CLEAR COVER TO REINFORCING STEEL

- FOOTINGS 100 225mm
- ABUTMENTS & WINGWALLS
FRONT FACE 80 220mm
BACK FACE 70 220mm
- DECK TOP 70 220mm
BOTTOM 40 210mm
- APPROACH SLABS 80 220mm
- REMAINDER (UNLESS OTHERWISE NOTED) 70 220mm

REINFORCING STEEL

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS NOTED OTHERWISE. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

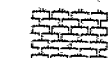
CONSTRUCTION NOTES

- IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN IN THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT.
- BACKFILL SHALL NOT BE PLACED ABOVE BEARING SEAT ELEVATION UNTIL AFTER DECK CONCRETE HAS BEEN PLACED.

LIST OF DRAWINGS

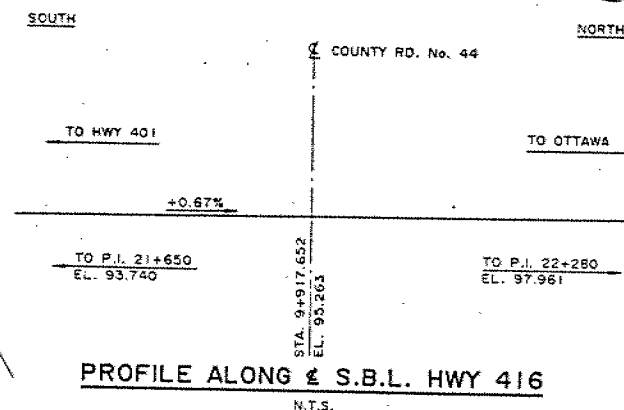
- GENERAL ARRANGEMENT
- BOREHOLE DATA & SOIL STRATA
- FOOTINGS AND PILE DETAILS
- WEST ABUTMENT
- EAST ABUTMENT
- N.W. & S.W. WINGWALLS
- N.E. & S.E. WINGWALLS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II
- BEARING DETAILS
- DECK DETAILS
- DECK REINFORCING
- BARRIER WALLS
- JOINT ANCHORAGE & ARMOURING
- 6000mm APPROACH SLAB
- DETAILS OF CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING-STEAM & DIESEL HAMMERS
- AS CONSTRUCTED ELEV. & DIM.
- ELECTRICAL EMBEDDED WORK
- QUANTITIES - STRUCTURE - I
- QUANTITIES - STRUCTURE - II

LEGEND

 DENOTES WORK TO BE DONE BY OTHERS.

APPLICABLE STANDARD DRAWINGS

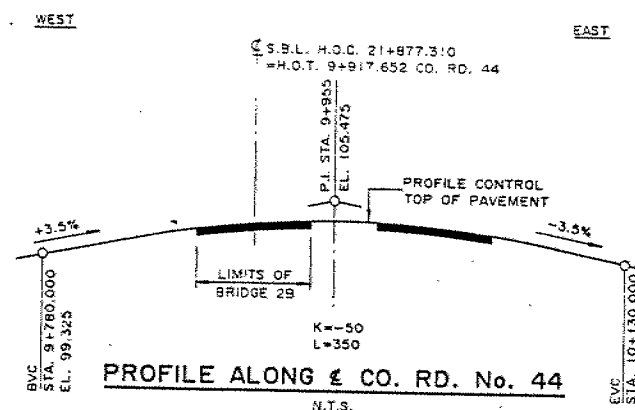
OPSD 3501.00 GRANULAR BACKFILL REQUIREMENTS



PROFILE ALONG S.B.L. HWY 416
N.T.S.

NOTES:

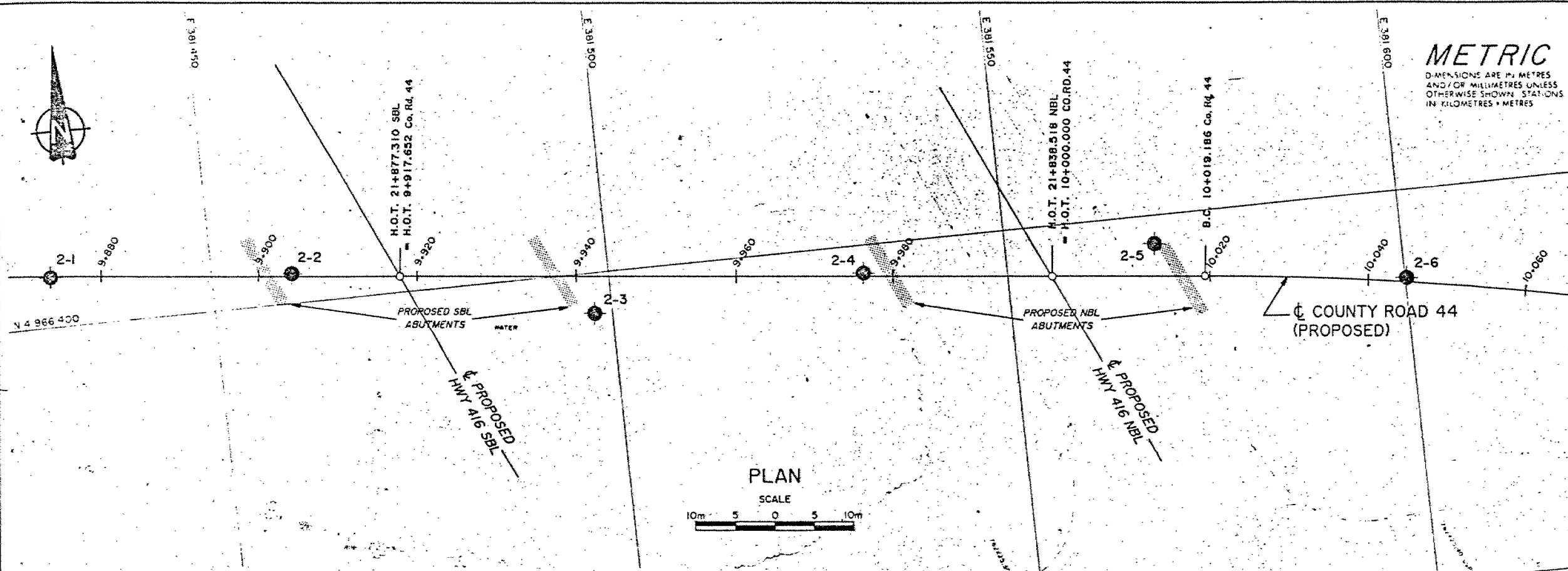
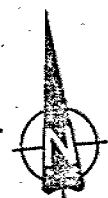
- W.P. DENOTES WORKING POINT
- T/C DENOTES TOP OF CONCRETE DAM
- O.G.L. DENOTES ORIGINAL GROUND LINE



PROFILE ALONG CO. RD. No. 44
N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION

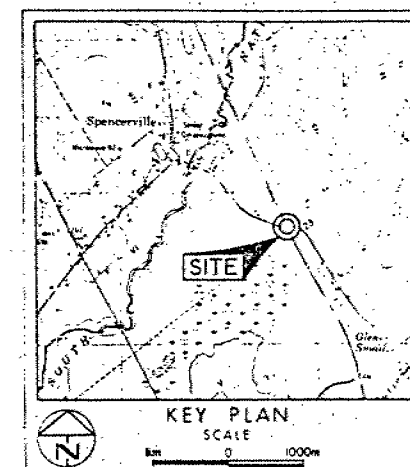


CONT No **94-28**
WP No **177-89-04**

COUNTY ROAD 44
BORE HOLE LOCATIONS & SOIL STRATA

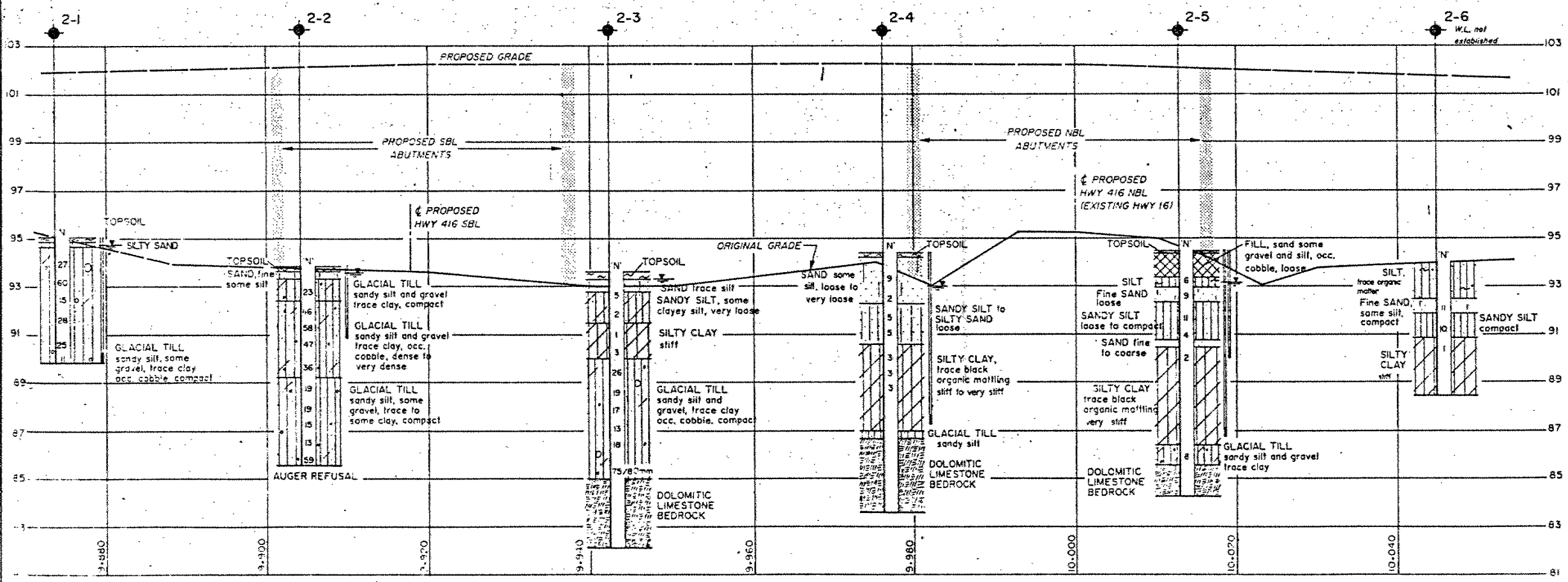
SHEET
268

Golder Associates Ltd.



LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Test (Cone)		
	Bore Hole & Cone		
N	Blows/0.3m (Std Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60° Cone, 475 J/blow)		
	W.L. at time of investigation (April & May 1990)		
	Standpipe		

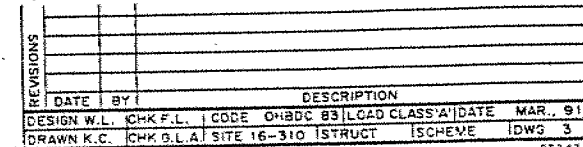
No	ELEVATION	STATION	OFFSET
2-1	95.1	9+873.7	0.1m Rt
2-2	93.9	9+903.9	0.2m Lt
2-3	93.6	9+942.4	4.7m Rt
2-4	94.3	9+976.2	0.4m Lt
2-5	94.4	10+012.9	4.1m Lt
2-6	94.0	10+044.9	0.6m Lt



PROFILE COUNTY ROAD 44 (PROPOSED)

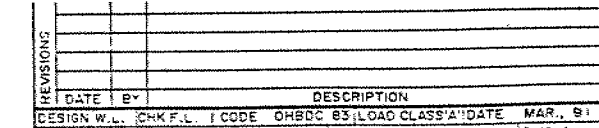
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, 100-1000 Highway 100, Galt, Ontario. Information contained in this report is for the use of the client only and is not to be used for any other purpose without the written consent of Golder Associates Ltd.





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ENGINEERS ARCHITECTS AND PLANNERS

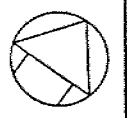


METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

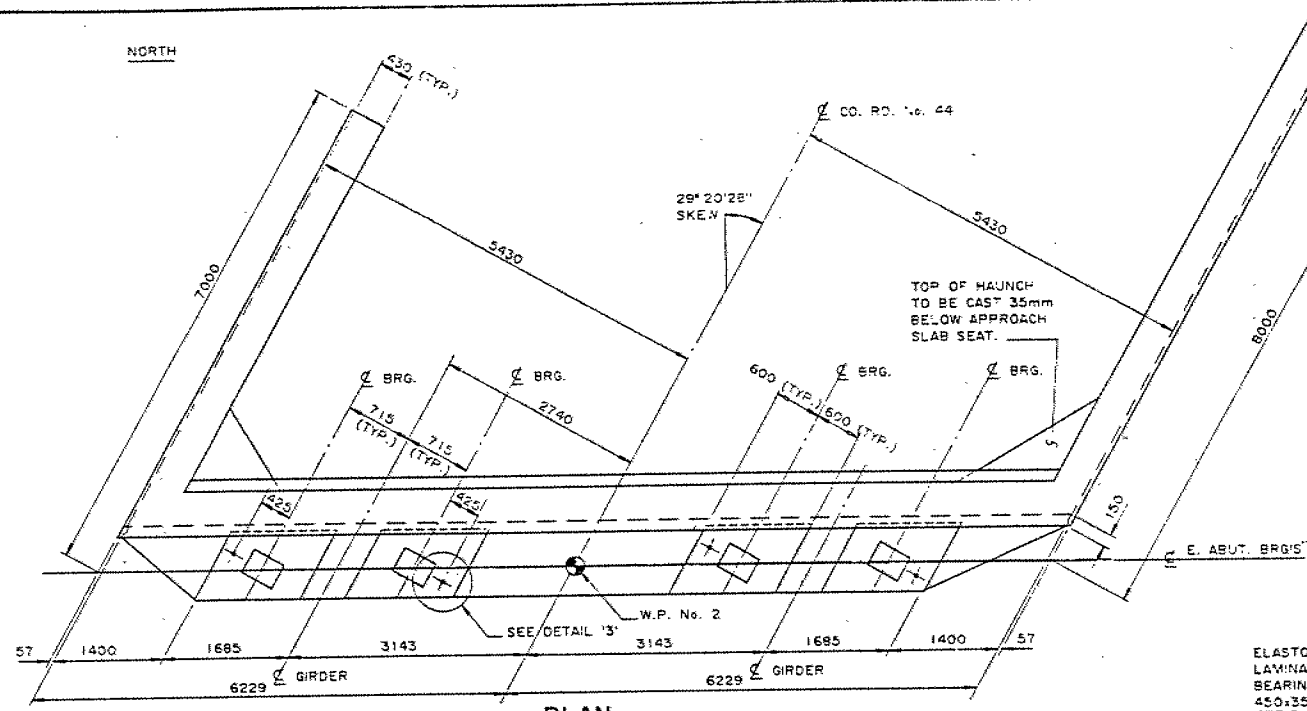
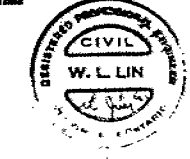
CONT No 94-28
WP No 177-89-07

COUNTY ROAD No. 44 UNDERPASS
BRIDGE 2B(S.B.L.)
HWY. 416
EAST ABUTMENT

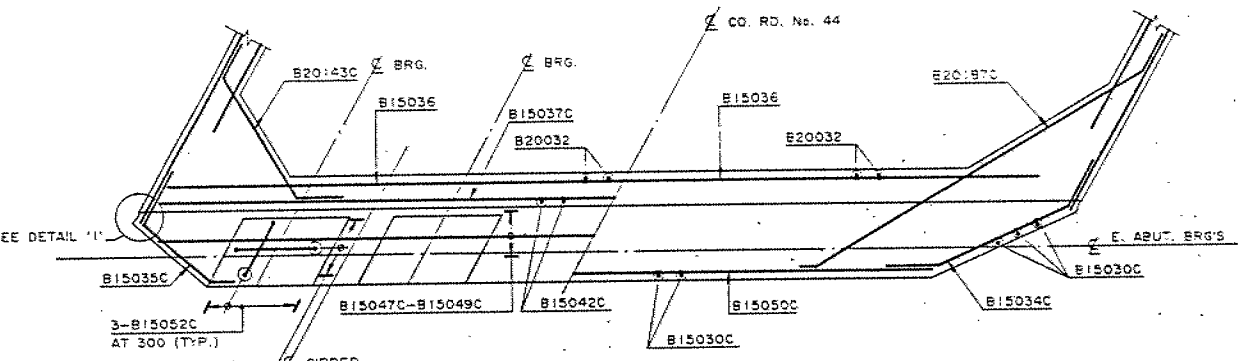


SHEET
271

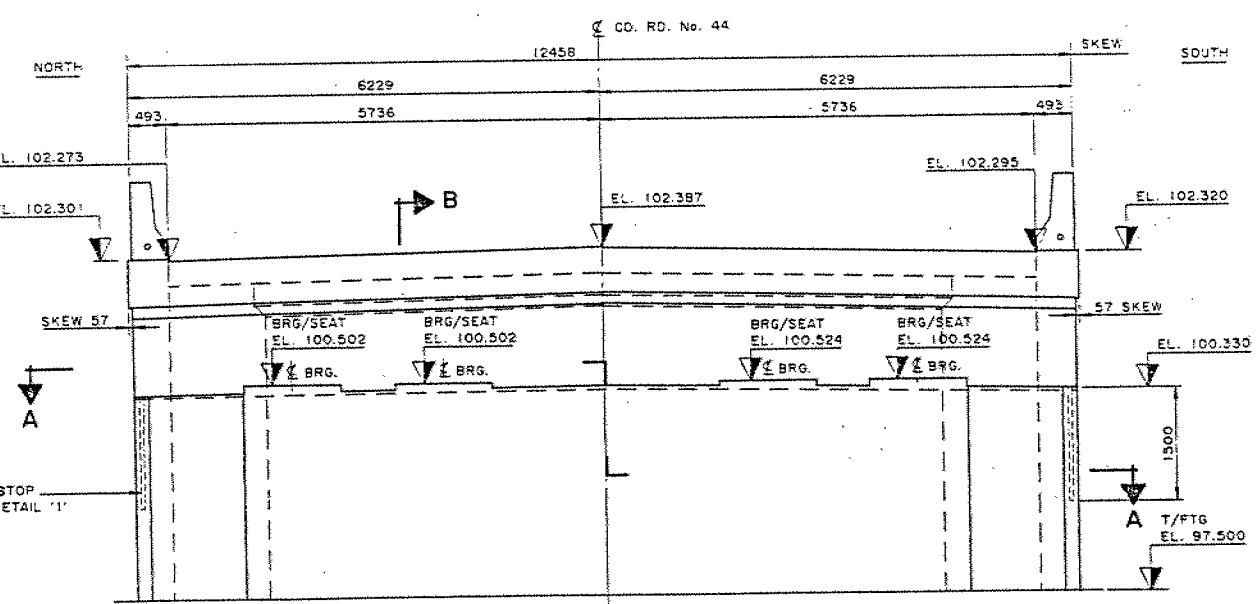
totten sims hubicki associates
ENGINEERS ARCHITECTS AND PLANNERS



PLAN
SCALE 1:50

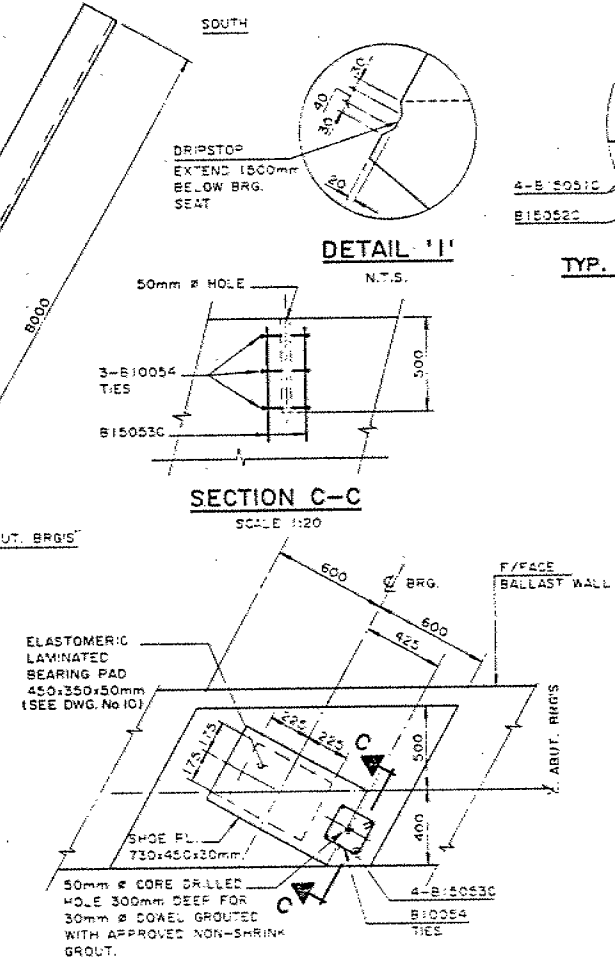


SECTION A-A
SCALE 1:50



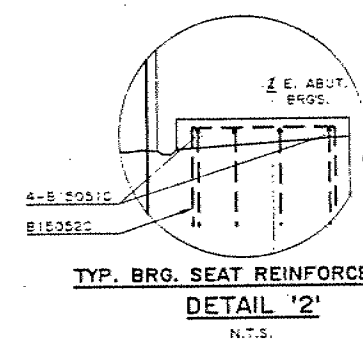
DIMENSIONS

EAST ABUTMENT ELEVATION
SCALE 1:50

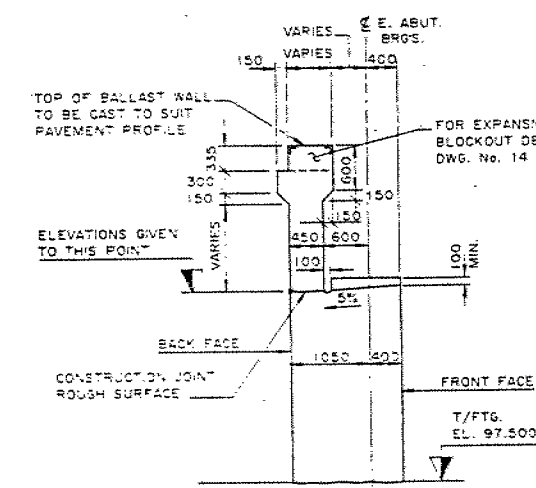


SECTION C-C
SCALE 1:20

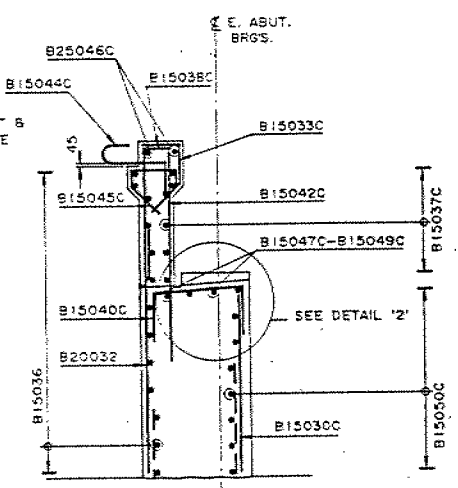
DETAIL 3'
SCALE 1:20



TYP. BRG. SEAT REINFORCEMENT
DETAIL 2'
N.T.S.

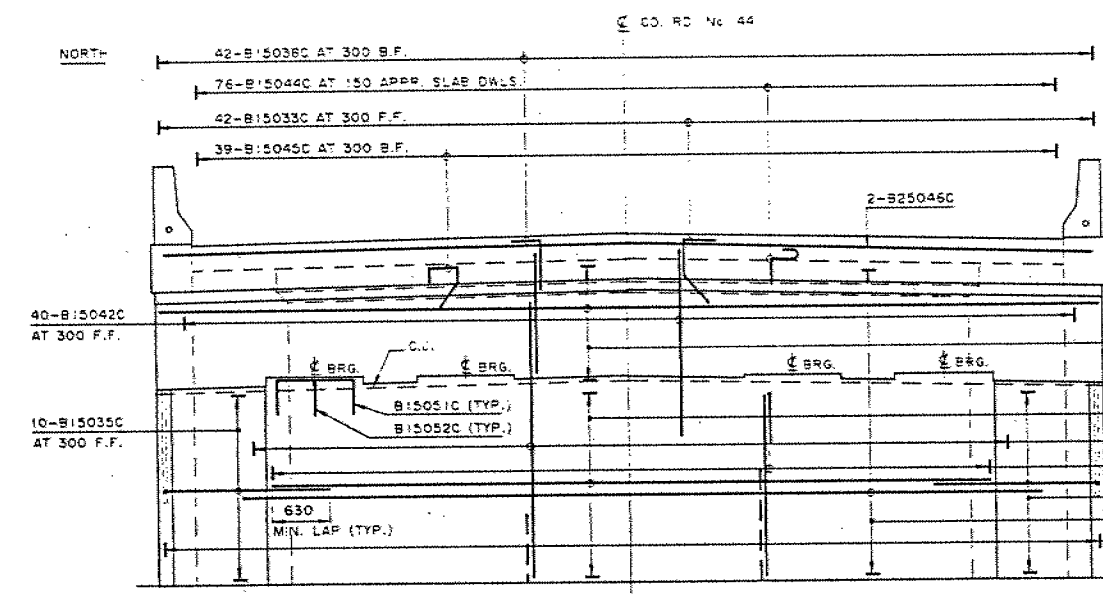


DIMENSIONS



REINFORCEMENT

SECTION B-B
SCALE 1:50



REINFORCEMENT

NOTES:
F.F. DENOTES FRONT FACE
B.F. DENOTES BACK FACE
E.F. DENOTES EACH FACE

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

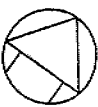
REVISIONS	DATE	BY	DESCRIPTION
1			DESIGN W.L. CHK F.L. CODE OHBDC 83 LOAD CLASS A DATE MAR. 91
2			DRAWN C.D. TCHK G.L. SITE 16-310 ISTRUCT IScheme DWG 5

OVERSIZE DRAWING

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT No.9
CONT No
WP No 177-89-04
CO. RD. No. 44 UNDERPASS
BRIDGE 2A N.B.L.
HWY. 416
GENERAL ARRANGEMENT



SHEET

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ENGINEERS ARCHITECTS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE

- ALL CONCRETE 30MPa

CLEAR COVER TO REINFORCING STEEL

- FOOTINGS 100 ±25mm
- ABUTMENTS & WINGWALLS
FRONT FACE 80 ±20mm
BACK FACE 70 ±20mm
- DECK TOP 70 ±20mm
BOTTOM 40 ±10mm
- APPROACH SLABS 80 ±20mm
- REMAINDER (UNLESS OTHERWISE NOTED) 70 ±20mm

REINFORCING STEEL

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS NOTED OTHERWISE. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

CONSTRUCTION NOTES

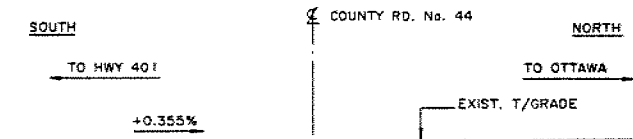
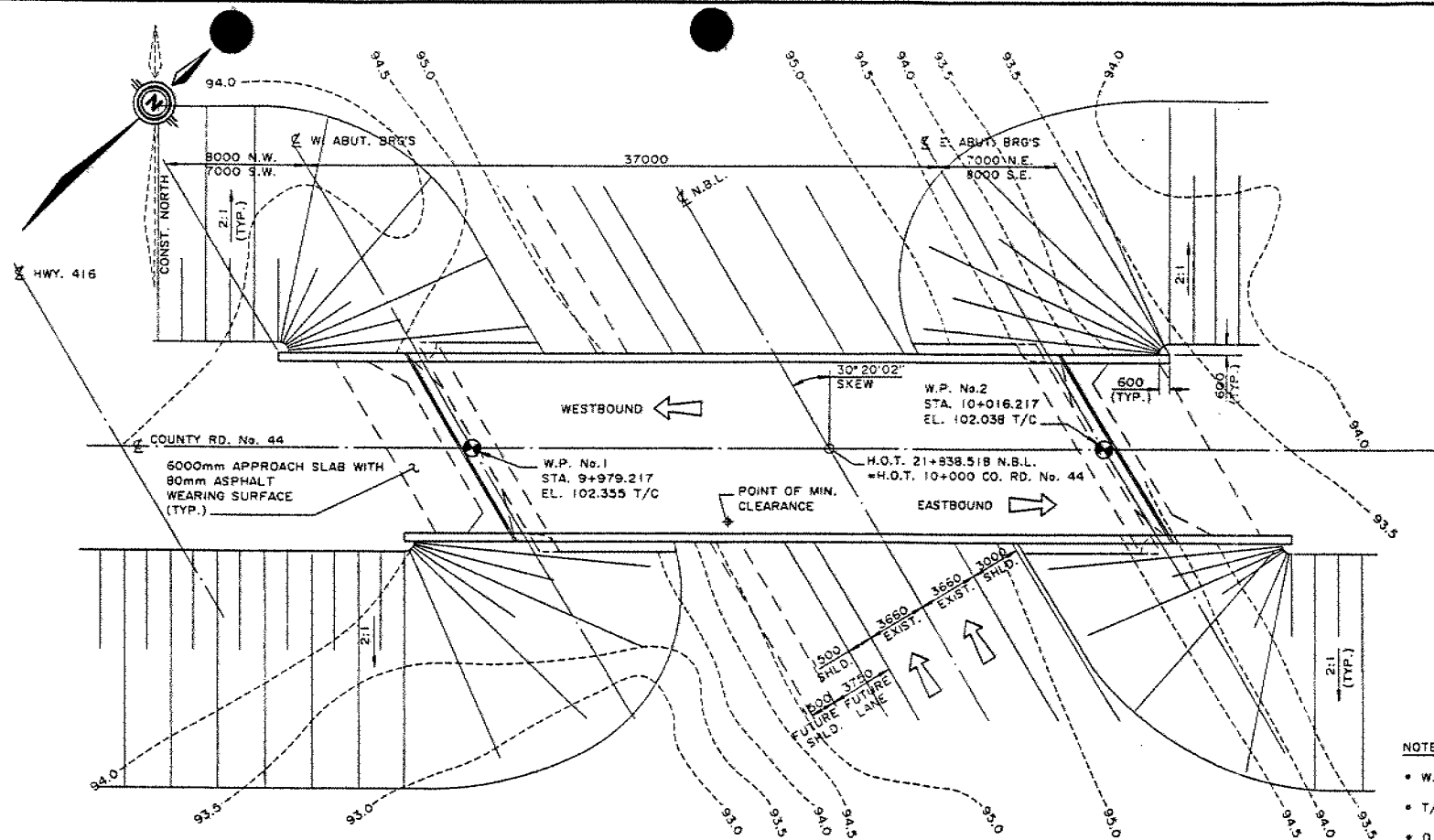
- IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN IN THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT.

LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE DATA & SOIL STRATA
- FOOTINGS
- WEST ABUTMENT
- EAST ABUTMENT
- N.W. & S.W. WINGWALLS
- N.E. & S.E. WINGWALLS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II
- DECK DETAILS
- DECK REINFORCEMENT
- BARRIER WALLS
- BEARING DETAILS
- JOINT ANCHORAGE & ARMOURING
- APPROACH SLABS
- CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING STEAM & DIESEL HAMMER
- AS CONSTRUCTED ELEV. & DIM.
- QUANTITIES - STRUCTURE
- QUANTITIES - STRUCTURE

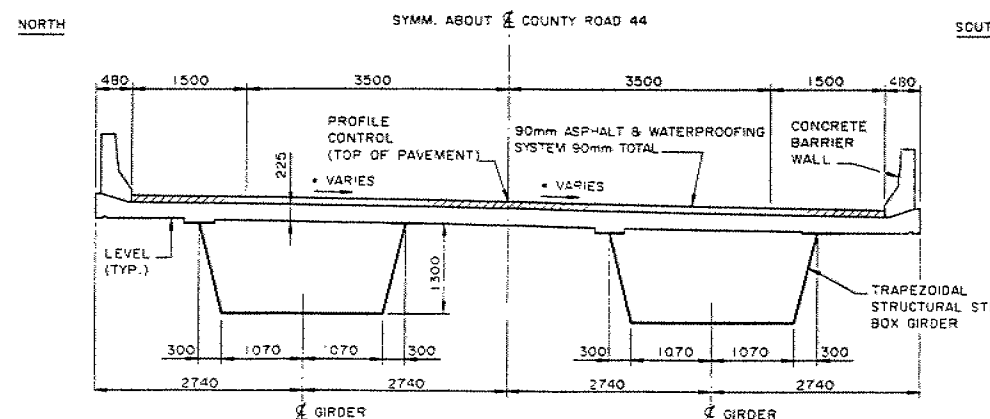
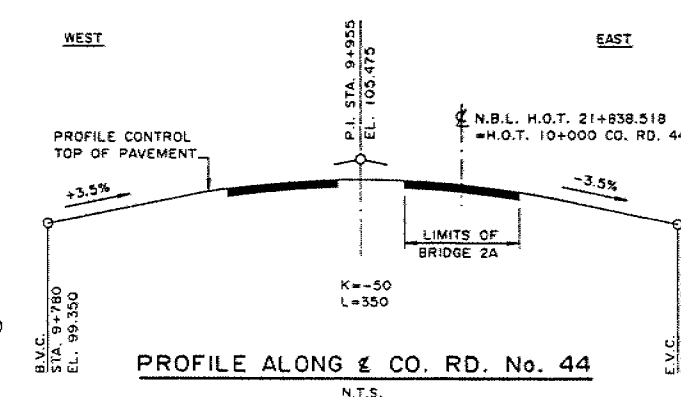
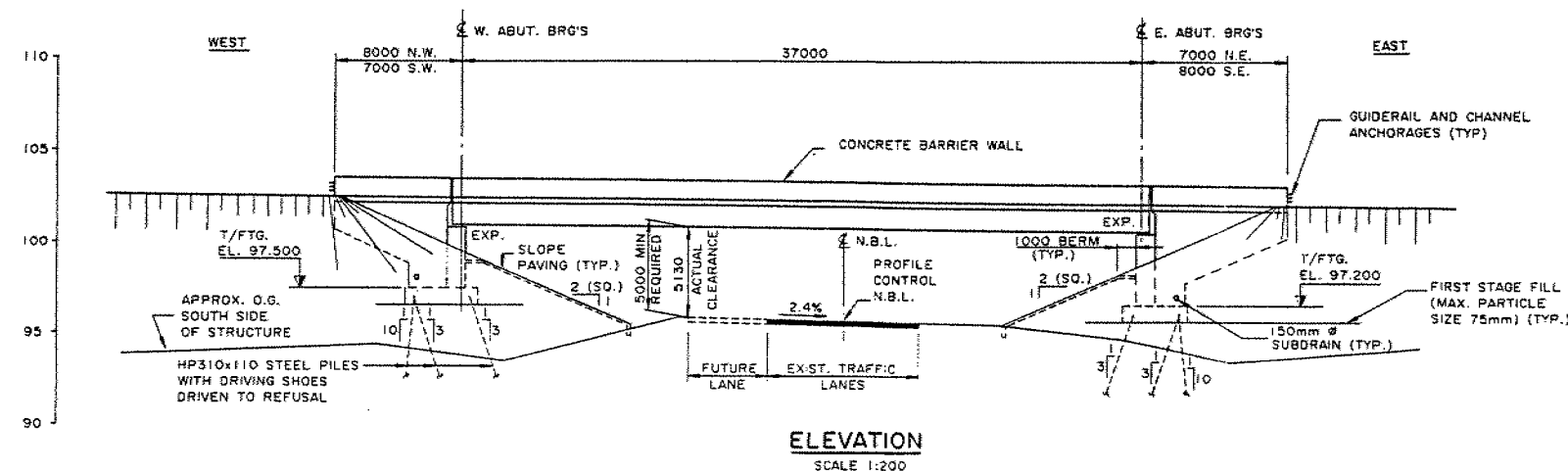
APPLICABLE STANDARD DRAWINGS

- DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS
- DD-4602 CONSTRUCTION CLEARANCE



NOTES:

- W.P. DENOTES WORKING POINT
- T/C DENOTES TOP OF CONCRETE DAM
- O.G.L. DENOTES ORIGINAL GROUND LINE



NOTE
DIMENSIONS SHOWN NORMAL TO
COUNTY RD. No. 44

FOR DECK SLOPES SEE
DECK DETAILS No. 1 & B

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

B.M. 93.632
EL.

NAIL IN ROOT OF 0.20 POPLAR
20.5 RT STA. 21+874

REVISIONS	DATE	BY	DESCRIPTION
DESIGN W.L. CHK F.L.	CODE CHBDC B3	LOAD CLASS A	DATE NOV. 90
DRAWN C.D.T. CHK G.L.A.	SITE 16-310	STRUCT	SCHEME DWG 1

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT No. 9
CONT No
WP No 177-89-07

SHEET

CO. RD. No. 44 UNDERPASS
BRIDGE 2B S.B.L.
HWY. 416
GENERAL ARRANGEMENT

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ENGINEERS ARCHITECTS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE

- ALL CONCRETE 30MPa

CLEAR COVER TO REINFORCING STEEL

- FOOTINGS 100 ± 25mm
- ABUTMENTS & WINGWALLS
FRONT FACE 80 ± 20mm
BACK FACE 70 ± 20mm
- DECK TOP 70 ± 20mm
BOTTOM 40 ± 10mm
- APPROACH SLABS 80 ± 20mm
- REMAINDER (UNLESS OTHERWISE NOTED) 70 ± 20mm

REINFORCING STEEL

- REINFORCING STEEL SHALL BE GRADE 400 UNLESS NOTED OTHERWISE. BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

CONSTRUCTION NOTES

- IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN IN THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT.

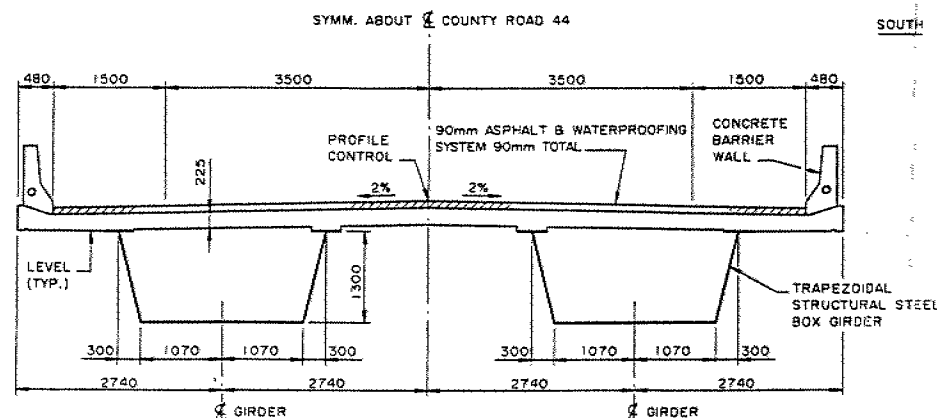
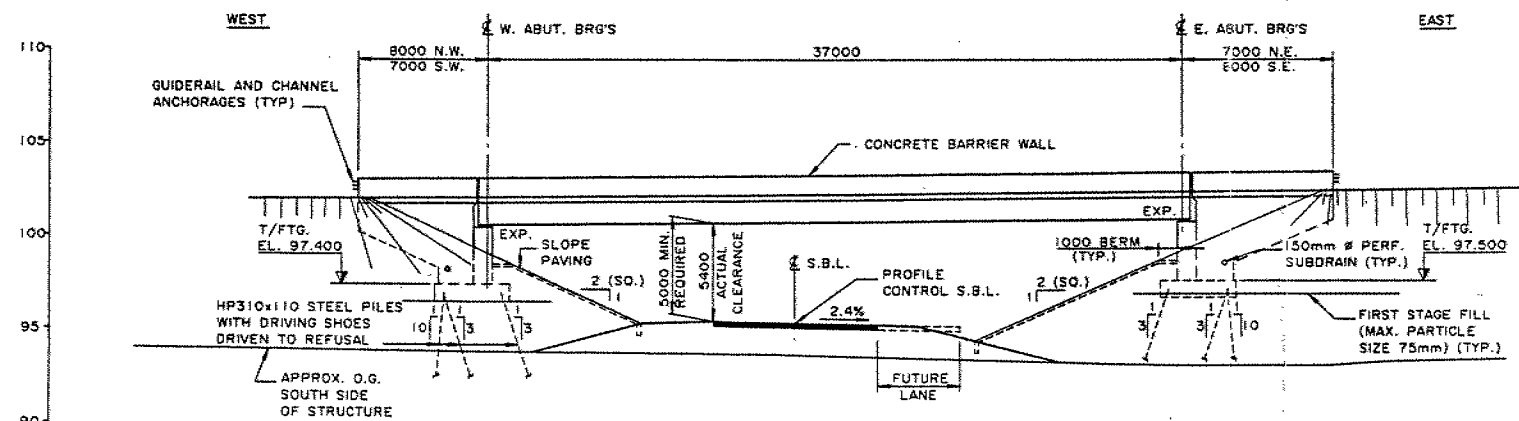
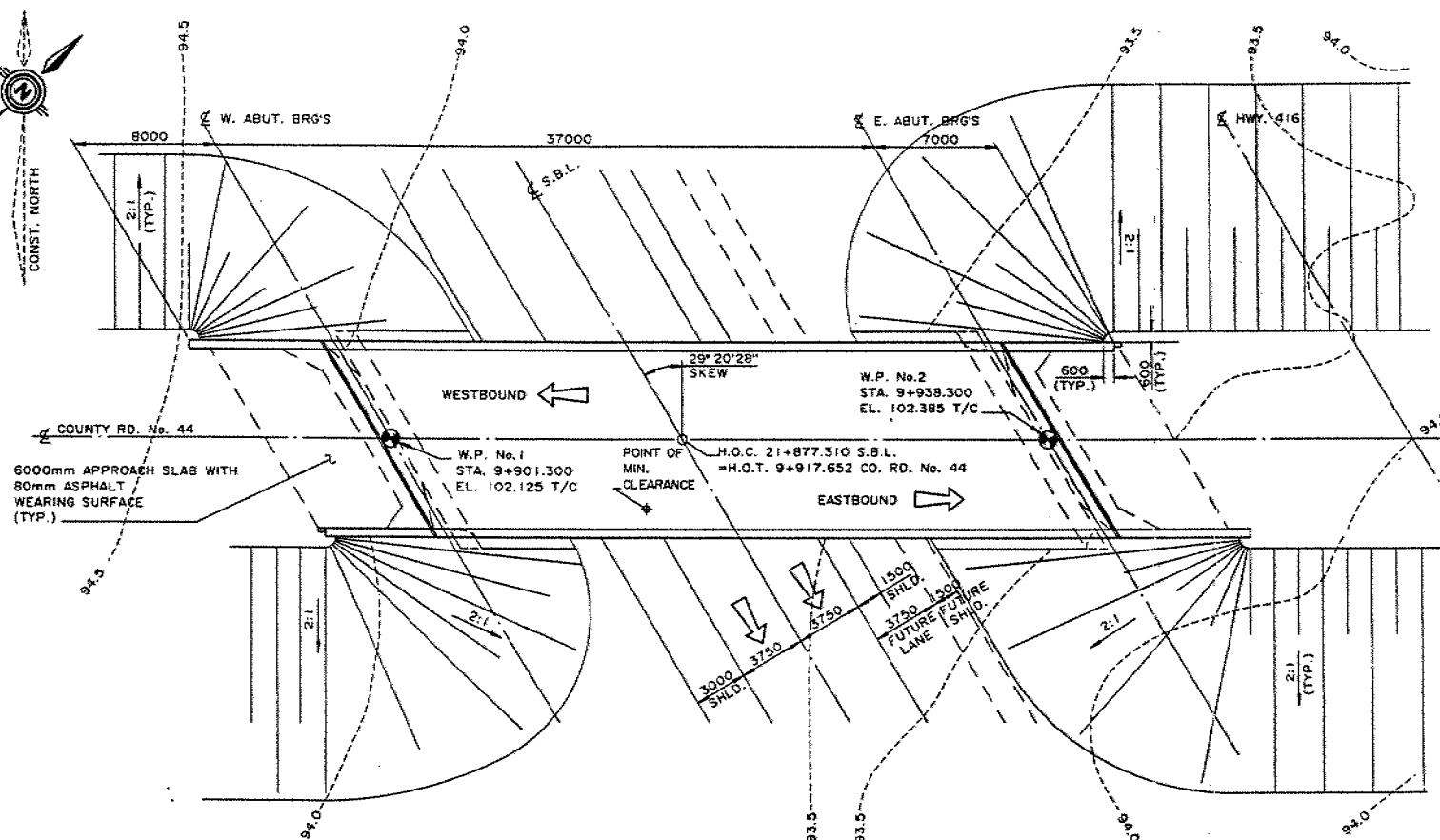
LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE DATA & SOIL STRATA
- FOOTINGS
- WEST ABUTMENT
- EAST ABUTMENT
- N.W. & S.W. WINGWALLS
- N.E. & S.E. WINGWALLS
- STRUCTURAL STEEL I
- STRUCTURAL STEEL II
- DECK DETAILS
- DECK REINFORCEMENT
- BARRIER WALLS
- BEARING DETAILS
- JOINT ANCHORAGE & ARMOURING
- APPROACH SLABS
- CONCRETE SLOPE PAVING
- STANDARDS I
- STANDARDS II
- PILE DRIVING STEAM & DIESEL HAMMER
- AS CONSTRUCTED ELEV. & DIM.
- QUANTITIES - STRUCTURE
- QUANTITIES - STRUCTURE

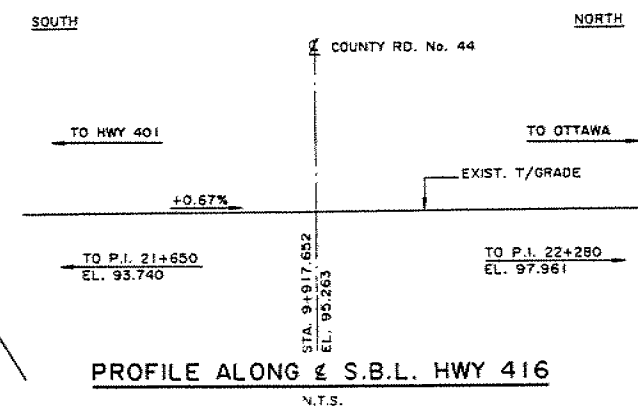
APPLICABLE STANDARD DRAWINGS

DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS

REVISIONS	DATE	BY	DESCRIPTION
DESIGN W.L. CHK F.L.	CODE	QMBDC 83	LOAD CLASS 'A' DATE DEC. 90
DRAWN C.D.T. CHK G.L.A.	SITE	16-310	STRUCT SCHEME DWG 1

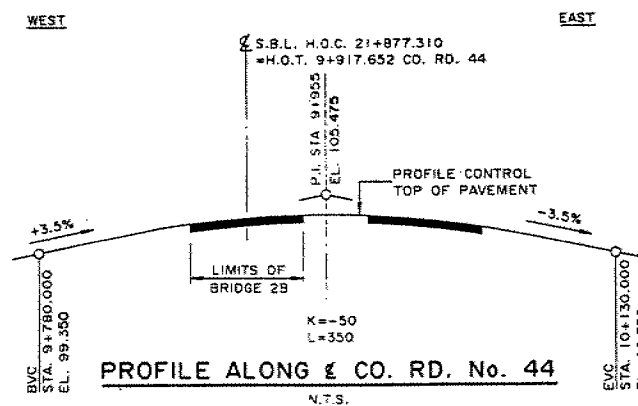


NOTE
DIMENSIONS SHOWN NORMAL TO
COUNTY RD. No. 44



NOTES:

- W.P. DENOTES WORKING POINT
- T/C DENOTES TOP OF CONCRETE DAM
- O.G.L. DENOTES ORIGINAL GROUND LINE



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

B.M. 93.632
EL.

NAIL IN ROOT OF 0.20 POPLAR
20.5 FT. STA. 21+874



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

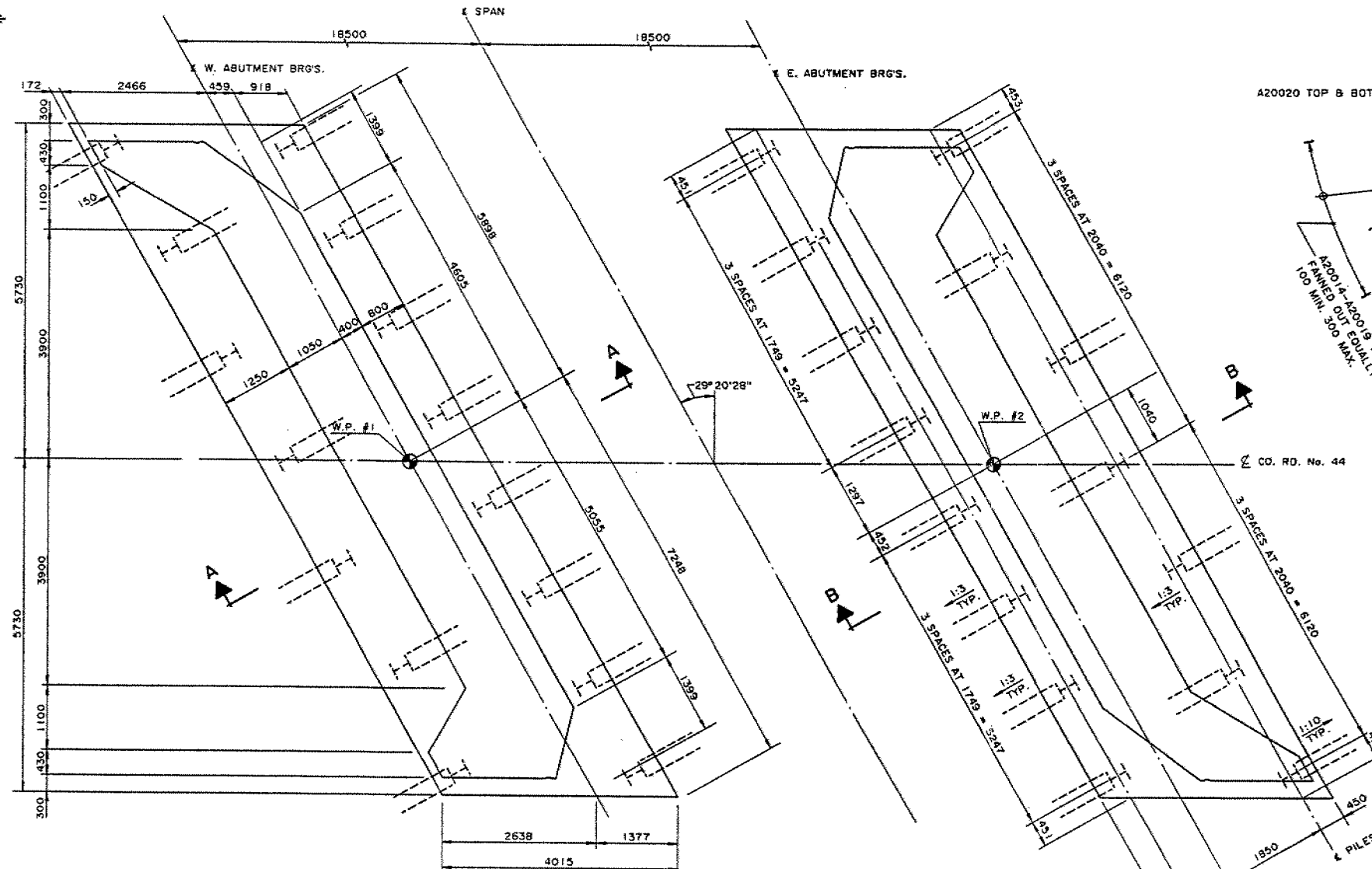
CONT No
WP No 177-89-07

CO. RD. No. 44 UNDERPASS
BRIDGE 2B S.B.L.
HWY. 416
FOOTINGS

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ENGINEERS ARCHITECTS AND PLANNERS



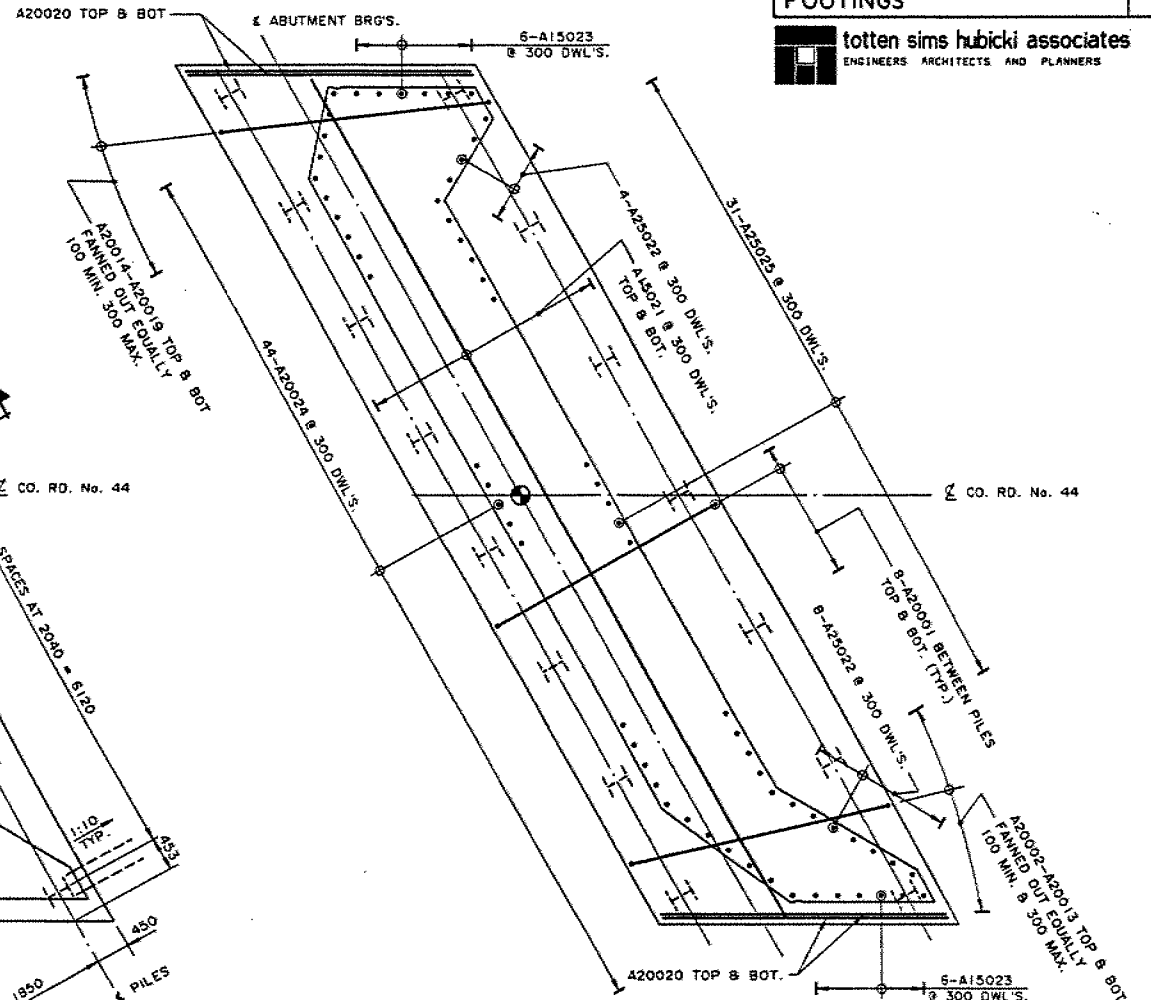
SHEET



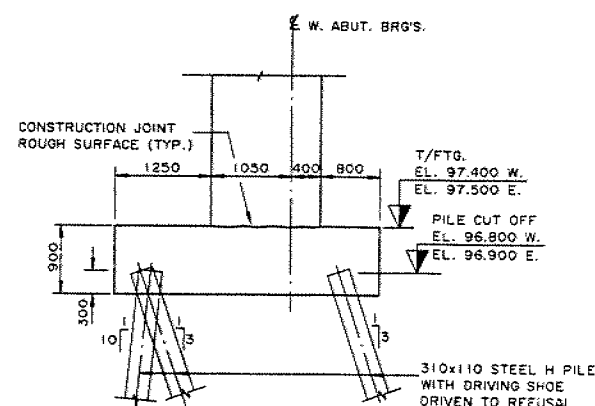
NOTE
EAST & WEST FOOTINGS ARE
SIMILAR EXCEPT AS NOTED.

DIMENSIONS
SCALE 1:50

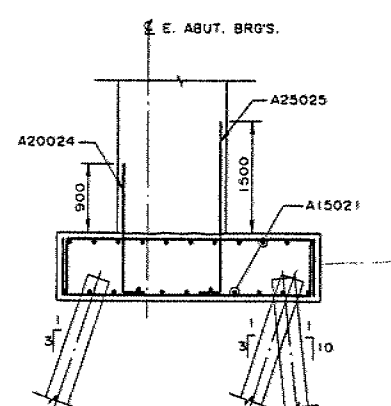
PILE LAYOUT
SCALE 1:50



REINFORCEMENT
SCALE 1:50



DIMENSIONS
SECTION A-A
SCALE 1:50



REINFORCEMENT
SECTION B-B
SCALE 1:50

LIST OF PILES					
LOCATION	No.	LENGTH	TYPE	PILE DESIGN DATA	
				LOAD AT SLS TYPE II	FACTORED CAPACITY AT ULS
W. ABUTMENT	15	14000	HP310x110	1150 KN	1600 KN
E. ABUTMENT	15	14000	HP310x110	1150 KN	1600 KN

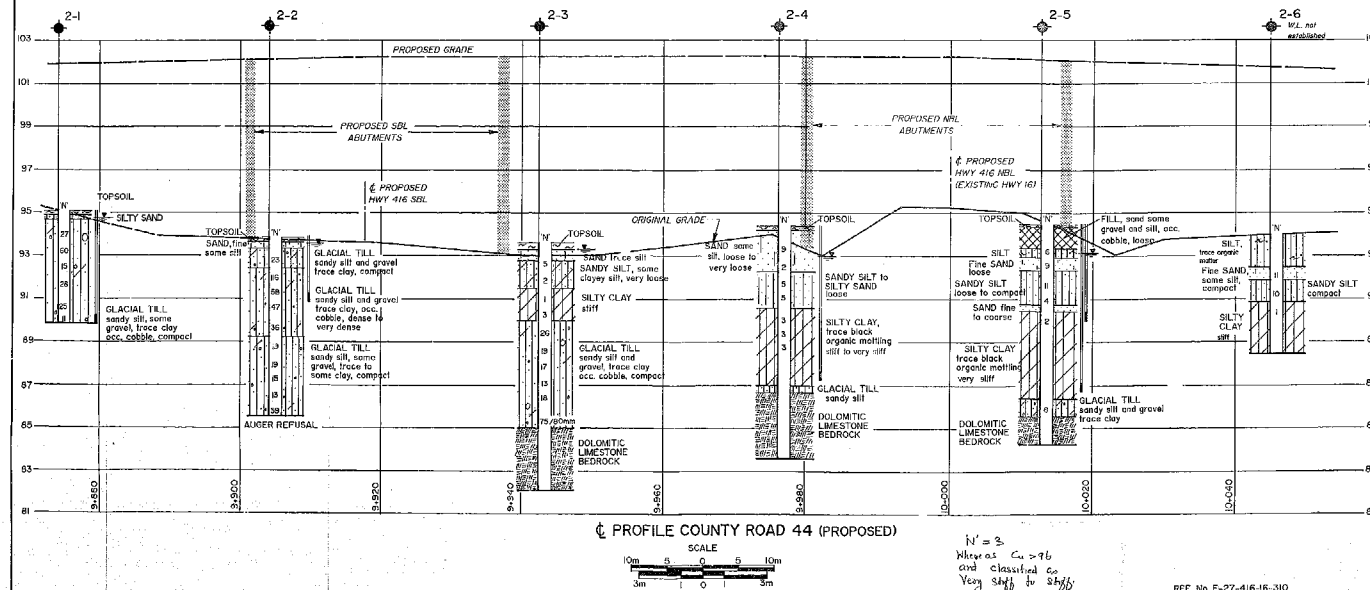
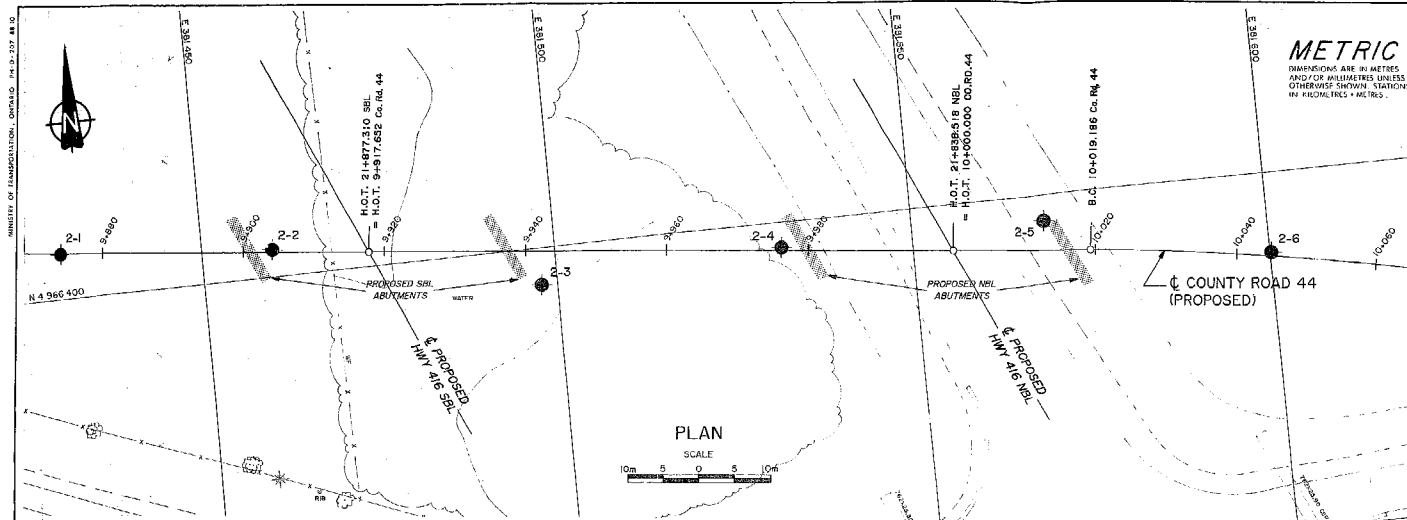
NOTES

- SPACING OF PILES TO BE MEASURED AT UNDERSIDE OF FOOTING.
- PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT-OFF ELEVATION.
- PILES TO BE DRIVEN IN ACCORDANCE WITH STD. SS-103-11.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN W.L.	CHK F.L.	CODE	QHBDC 83/LOAD CLASS A/DATE DEC. 90
DRAWN K.C.	CHK G.L.A.	SITE 16-310	STRUCT. SCHEME DWG 3

- 1) Page 9: For a single span bridge, it is recommended to support one abutment on shallow footing and the other on piles, is it ok for differential settlement.
- 2) Page 11: Recommendation for earth pressure calculation should be based on soil & soil structure interaction.
- 3) Page 12: The height of embankment is about 8m to 10m will exert 170 kpa to 210 kpa. Highest N-value in clayey strata is 3 But cu value reported greater than 100 kpa.
 - a) How $c_u > 100$ kpa was measured using 6"x3" Vane.
 - b) No stability analysis and reported no stability problem.
 - c) No beam recommended: Should the side slope be reduced to 2.5:1
- 4) Page 12: Recommended to delay the construction to avoid post construction settlement. How long it should be delayed.
- 5) Page 13: Corrosion protection is recommended: If you look at the chemical test; Cl^- & SO_4^{--} are high only in the upper 6'-0" to 8'-0" and this may be due to deicing salt. How any one can give recommendation for structure above ground water based on ground water test.



CONT No
WP No177-89-04

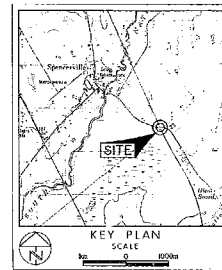
COUNTY ROAD 44

BORE HOLE LOCATIONS & SOIL STRATA



SHEET

Golder Associates Ltd.



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 47.5 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- Wt at time of investigation (April & May 1990)
- Standpipe

No	ELEVATION	STATION	OFFSET
2-1	951	9+673.7	0.3m RI
2-2	93.9	9+303.9	0.2m LI
2-3	93.6	9+942.4	4.7m RI
2-4	94.3	9+976.2	0.4m LI
2-5	94.6	10+012.9	4.1m LI
2-6	94.0	10+044.9	0.6m LI

NOTES

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

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DATE	BY	DESCRIPTION
Geotechnical No 318-61		
HWY No 416		Dist 9
Submittal No 1000000000	90/09/02	Site 16-310
Design No 1000000000	90/09/02	Dist 1778904-A

REF. No. E-27-416-16-310