

#69-F-225 M

SITE #6-276

CONCESSION 9 AND 10,

LOT #2

SILVER CREEK BRIDGE



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SOIL INVESTIGATION

BRIDGE OVER SILVER CREEK

CONCESSION 9 AND 10, FARM LOT 2

TOWNSHIP OF MERSEA ESSEX

STRUCTURE SITE No. 6-276

Our Ref. No. 9-10-5

C. G. Russell Armstrong Assoc. Ltd.
Bartlet Building,
Windsor 12, Ontario.

DISTRIBUTION

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SUMMARY

A subsoil investigation consisting of two sampled boreholes and two dynamic cone penetration tests indicated the presence of extensively weathered or re-worked clayey subsoil followed by a very stiff clayey glacial till below elevation 615.5.

Soil conditions are suitable for the use of conventional spread footings bearing at or below elevation 614 and designed for a maximum soil pressure of 6.0 k.s.f.

The maximum total settlement is estimated to be 3/4 inch; differential settlements will be insignificant.

No major construction problems are anticipated.

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INTRODUCTION

Dominion Soil Investigation Limited was retained by C.G. Russell Armstrong Associates Limited, Consulting Engineers, to carry out a subsurface investigation at the site of the proposed Silver Creek bridge. It is to replace the existing structure over Silver Creek on Road between Concessions 9 and 10 in the Township of Mersea, Ontario.

Verbal authorization to proceed with the work was received on October 6th, 1969 followed by a letter dated October 15th, 1969 from Mr. R. Bezaire, C.E.T.. The letter also contained information concerning some structural details of the proposed structure.

This report contains the factual information obtained in the field and laboratory, along with discussions and recommendations pertaining to the design and construction of the foundations of the proposed structure.

FIELD AND LABORATORY WORK

Between October 9th and 14th a field investigation programme consisting of two sampled boreholes and two dynamic cone penetration tests was carried out. The test holes were situated on either side of the existing bridge at the locations shown on the site plan (Enclosure 1). The holes were advanced to 30 feet below the ground surface by a continuous flight power auger. Soil samples were recovered at frequent intervals of depth using a



2-inch o.d. split spoon sampler and conforming to the requirements of the Standard Penetration Test. The results of the borings, sampling and field tests are shown on the borehole logs (Enclosures 2 and 3).

Elevations at the boreholes have been referred to a bench mark given by the Consulting Engineers as indicated on the site plan.

In the laboratory the natural moisture contents, Atterberg Limits, and grain size distribution of the sub-soil were determined. The laboratory test results are shown on Enclosures 4 to 5.

SUBSURFACE CONDITIONS

A detailed description of the soil stratification at each borehole is given on the borehole logs which can be summed up briefly as follows. Fill or weathered clay extends to a depth of 9 feet below the ground surface (elevation 615.5), and is underlain by a very stiff clay glacial till.

a) Surficial Clay: Beneath a few inches of organic topsoil a brown and yellow mottled clay was encountered. The results of a grain size distribution analysis are shown on Enclosure 4. This clay which extends to elevation 615.5 in both boreholes has a reworked appearance which may be attributed to extreme weathering of the natural glacial till or alternatively the material may be fill. The Standard Penetration Tests within this zone gave values ranging from 9 to 40 blows per foot which indicate a stiff to hard consistency.



b) Glacial Till: At elevation 615.5 feet a glacial till of silty clay with some sand and occasional gravel was encountered. This stratum extends to at least 32 feet below the ground surface (elevation 593) where the boreholes were terminated.

The grain size distribution curve of the deposit as shown on Enclosure 5 is typical of the glacial till commonly encountered in the Windsor area.

Its natural water content was found to be around 20%, Liquid Limit 36% and Plastic Limit 17%. These values are indicative of a clay with intermediate plasticity and compressibility.

The visual inspection of the soil samples recovered indicate that the till is uniform throughout the depth of this exploration. This was further confirmed by the narrow range of values obtained for the natural moisture content and the Atterberg Limits. The N-values within this soil ranged between 22 and 42 indicating a very stiff to a hard consistency. In the upper 5 feet of the till several irregularly oriented planes were encountered along which the soil was extensively oxidized. The soil could easily be broken along these partings which therefore impart planes of weaknesses.



DISCUSSION

It is understood that the proposed structure will replace the existing bridge over Silver Creek. The estimated total loads were given as 480 kips per footing and approximately a quarter of this will be live load. The approximate length of footings will be 32 feet.

The subsurface consists of about 9 feet of weathered clay followed by a very stiff clay till.

Foundations

i) Bearing Capacity - The soil conditions are suitable for the use of conventional spread footings. Subject to scour considerations, as discussed in the following section, the footings should be placed at or below elevation 614. At this level, for continuous footings, a maximum allowable bearing pressure of 6.0 kips per square foot (factor of safety of 3) may be used. This value should not be exceeded under the edge of eccentrically loaded footings.

ii) Scour Considerations - When selecting the most suitable level for the foundations, the depth of influence of scour within the creek should be considered. As the clayey substratum is only slightly susceptible for scour the normal 4 to 5 feet of protection cover is believed to be adequate. This will also preclude any possible damage by frost heave. Consequently, the highest possible level for the foundations is elevation 614 feet or 5 feet below the creek bottom depending on whichever governs.

iii) Stability Against Horizontal Sliding - The adhesion between the clayey substratum and the base of the footing will be mobilized to resist horizontal sliding of the abutments. Provided the clayey sub-grade is roughened the effective adhesion between the base of the footing and the clayey subsoil can be taken as 1200 p.s.f..

To avoid the softening of the soil at the foundation level the excavations should be kept dry. It is also recommended that the last few inches of the excavation be carried out by hand immediately before pouring the concrete.

iv) Settlements - The settlement under the estimated dead load was calculated to be about $3/4$ inch. Due to the clayey nature of the subsoil a significant portion of this settlement will be time dependent consolidation settlement and will take place over a period of several years.

As uniform soil conditions were encountered at both boreholes no significant differential settlements between the abutments is expected.

Earth Pressures on Retaining Walls

For the calculation of the earth pressure exerted on the back of abutments and the wing walls the following expression, in which a triangular stress distribution is assumed, can be utilized:

$$p = k \gamma h$$

where, p is the pressure at any depth 'h' below the soil surface,

k is the coefficient of horizontal earth pressure,

and γ is the unit weight of the soil.

For a granular backfill the following parameters are recommended.

$$\gamma = 130 \text{ p.c.f.}$$

$$k = 0.45$$

For random fill

$$\gamma = 130 \text{ p.c.f.}$$

$$k = 0.50.$$

Provision for adequate drainage should be made. Water discharge from the backfill into the creek can be maintained through weeping holes.

Construction Considerations

Due to the weathered condition of the clayey soil above elevation 615 feet and the existence of open fissures in the top 5 feet of the clayey till some support should be provided to the faces of the excavations.

The subsoil has a relatively low permeability. The water seepage into the excavations through the subsoil will be moderate and could be collected and removed from open sumps.

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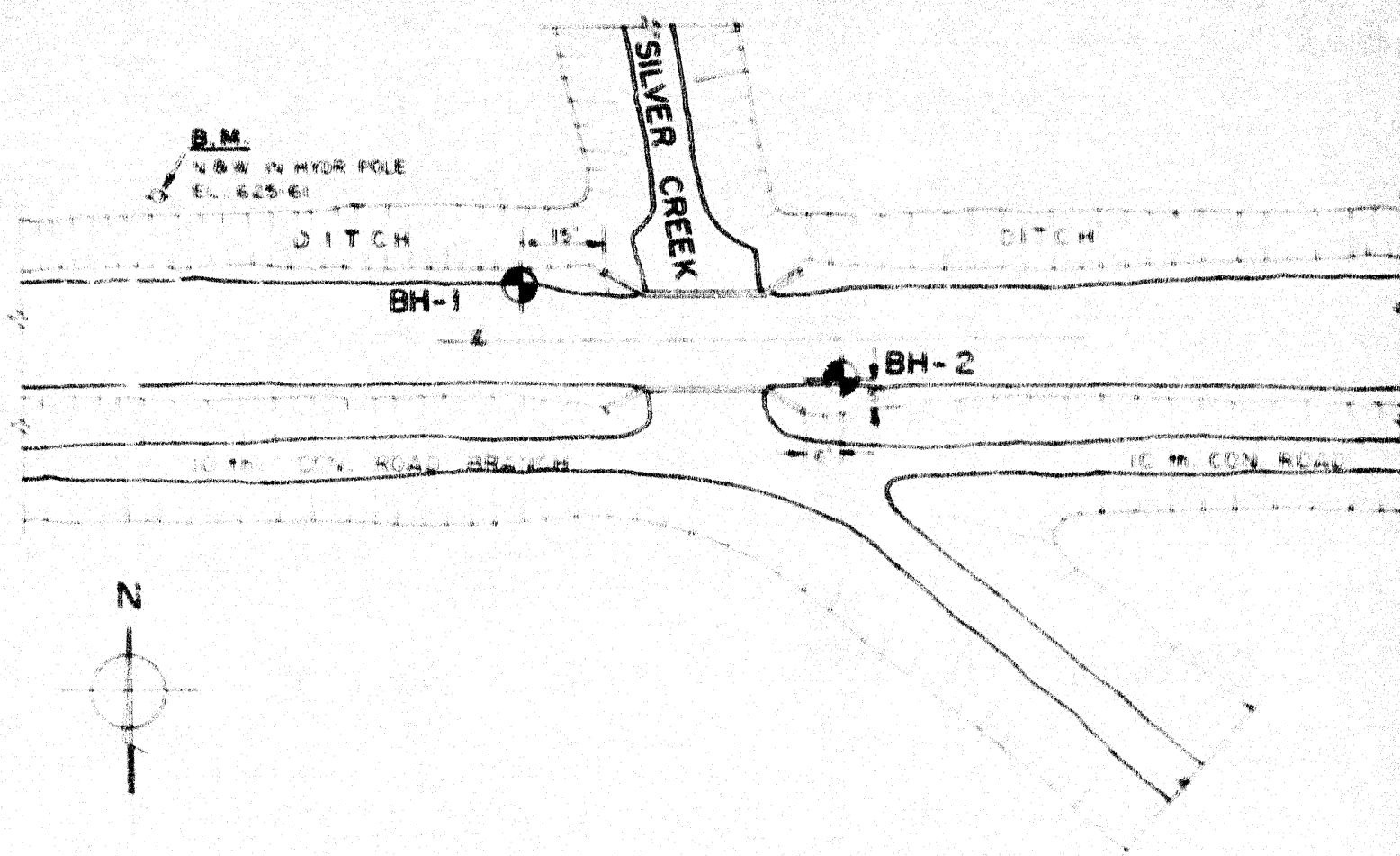
Z. S. Ozden
Z. S. Ozden, P. Eng.

ZSO/ns
Encl:

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Enclosures.



BOREHOLE LOCATION PLAN

SCALE 1" = 30'

LOG OF BOREHOLE.....1.....

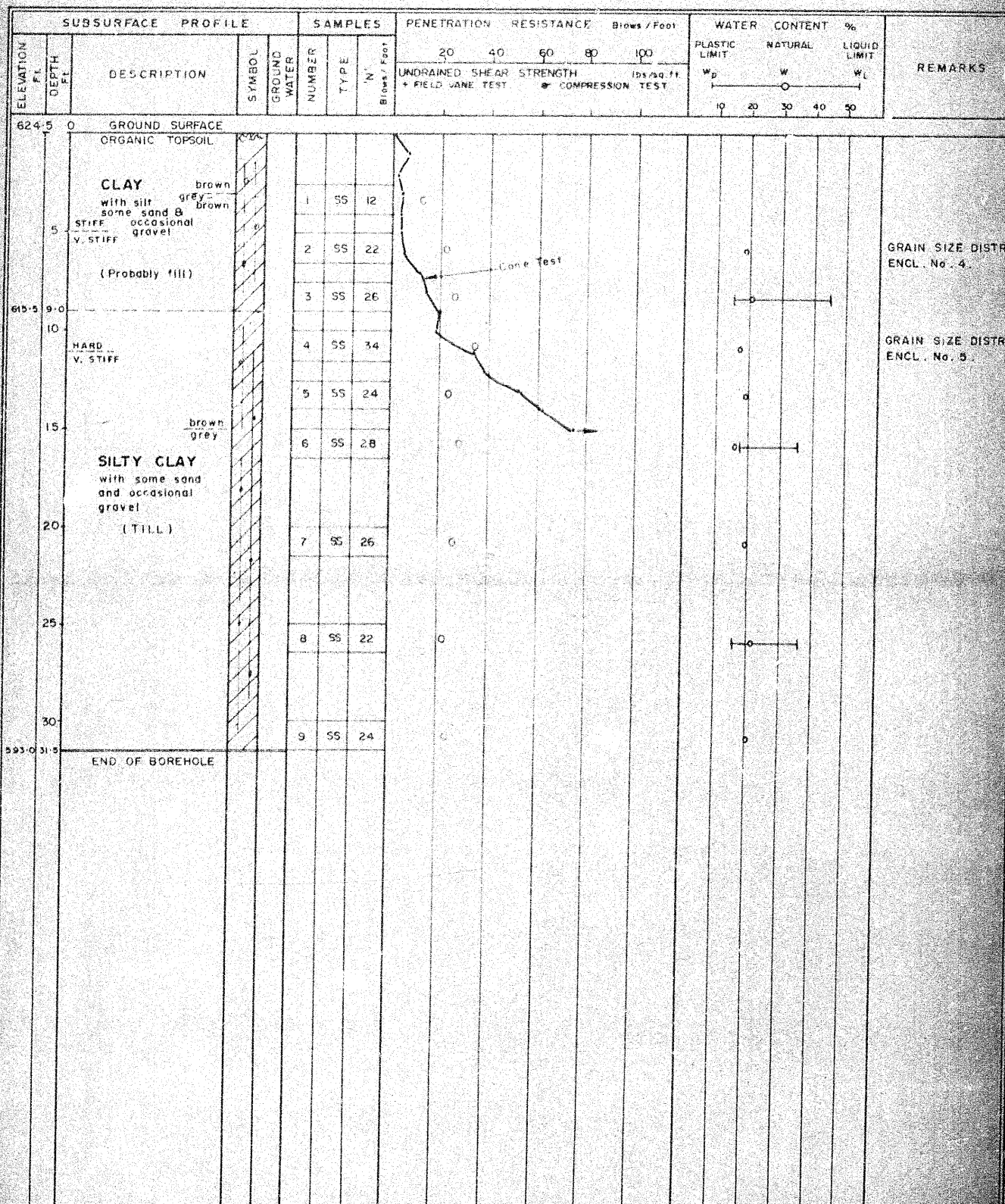
Our Reference No 9-10-5

Enclosure No 2

CLIENT: C.G. RUSSELL ARMSTRONG ASSOC.
PROJECT: BRIDGE OVER SILVER CREEK
LOCATION: CONC. 9 8 10 TWP. OF MERSEA
DATUM ELEVATION: G. S. C.

DRILLING DATA

Method: AUGERING
Diameter: 4 1/2"
Date: OCT. 10, 1969



VERTICAL SCALE: 1 inch to 5 feet

DOMINION SOIL INVESTIGATION LIMITED

MADE: Z. A. CHECKED:

LOG OF BOREHOLE 2

Our Reference No. 9-10-5

Enclosure No. 3

CLIENT C.G. RUSSELL ARMSTRONG ASSOC.
PROJECT BRIDGE OVER SILVER CREEK
LOCATION CONC. 9 & 10 TWP. OF MERSEA
DATUM ELEVATION:

DRILLING DATA
Method: AUGERING
Diameter: 4 1/2"
Date: OCT. 14, 1969

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT			REMARKS	
ELEVATION F.T.	DEPTH F.T.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	N Blows / Foot	Blows / Foot					PLASTIC LIMIT W _p	NATURAL W		LIQUID LIMIT W _L
								20	40	60	80	100				
								UNDRAINED SHEAR STRENGTH + FIELD VANE TEST								
W _p — W — W _L																

624.6	0	GROUND SURFACE														
		Brown TOPSOIL and gravelly FILL														
	5	FIRM CLAY V. STIFF with silt traces of sand and gravel			1	SS	9	0								
		HARD (Probably fill)			2	SS	26	0								
615.6	9.0				3	SS	10	0								
	10				4	SS	40	0								
		V. STIFF Grey			5	SS	27	0								
	15	SILTY CLAY with some sand and occasional gravel. (TILL)			6	SS	27	0								
	20	HARD V. STIFF			7	SS	36	0								
	25				8	SS	22	0								
	30				9	SS	30	0								
593.1	31.5	END OF BOREHOLE														

VERTICAL SCALE: 1 inch to 5 feet

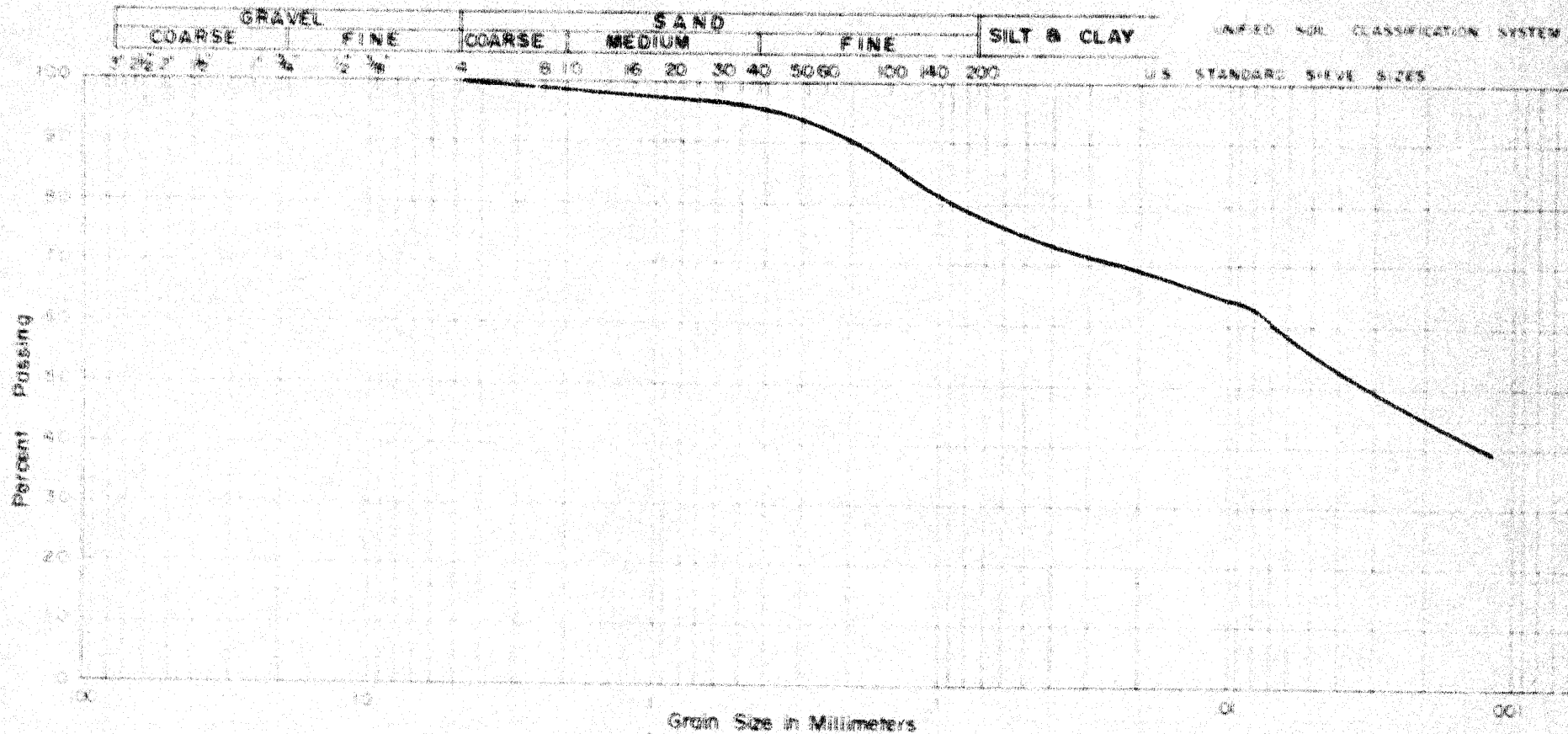
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MADE: Z. A. CHECKED:

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GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO 9-10-5



PROJECT BRIDGE OVER SILVER CREEK COEFFICIENT OF UNIFORMITY
 LOCATION CONC. 9 & 10 TWP. OF MERSEA COEFFICIENT OF CURVATURE
 BOREHOLE NO 1
 SAMPLE NO 2
 DEPTH 5'
 ELEVATION

Classification of Sample and Group Symbol.
CLAY & SANDY SILT

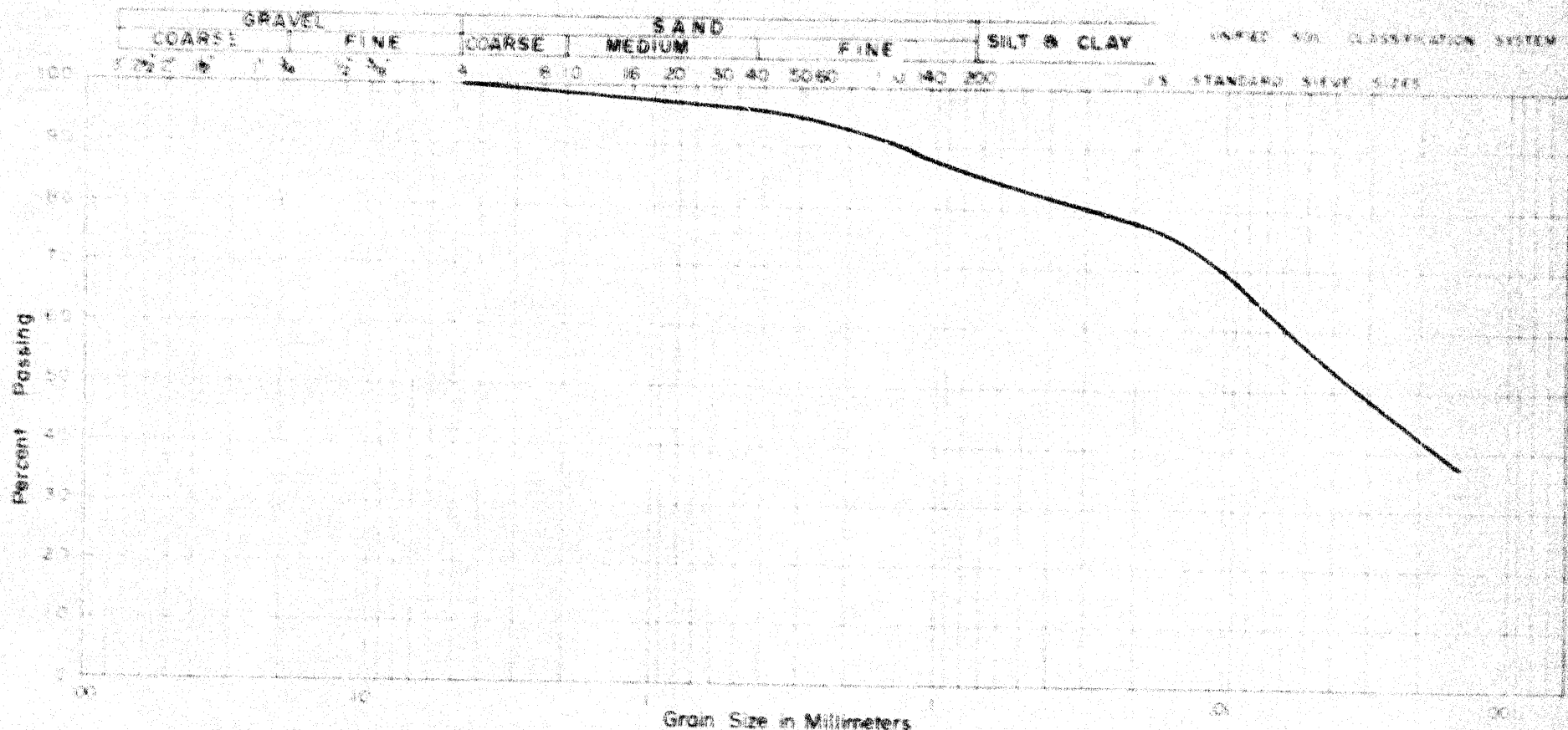
PLASTIC PROPERTIES
 LIQUID LIMIT %
 PLASTIC LIMIT %
 PLASTICITY INDEX %
 MOISTURE CONTENT %

ENCLOSURE NO 4

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 9-10-5



PROJECT BRIDGE OVER SILVER CREEK
 LOCATION CONC. 9 & 10 TWP. OF MERSEA
 BOREHOLE NO. 1
 SAMPLE NO. 4
 DEPTH 40'
 ELEVATION

COEFFICIENT OF UNIFORMITY
 COEFFICIENT OF CURVATURE

PLASTIC PROPERTIES

LIQUID LIMIT %
 PLASTIC LIMIT %
 PLASTICITY INDEX %
 MOISTURE CONTENT %

Classification of Sample and Group Symbol:

SILTY CLAY with some SAND

ENCLOSURE NO. 5