#67-F-243 M

COUNTY RD. #39

BRIDGE #167

CULVERTS C-159,

C-164, C-165, C-166

C-167.

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COUNTY OF MIDDLESEX
COUNTY BUILDINGS
LONDON ONTARIO

Report on

SOIL INVESTIGATION

for

COUNTY ROAD NO 39

FROM HIGHWAY 22 SOUTH

FOR 3 MILES

INCLUDING BRIDGE NO 167

AND CULVERTS C-159, C-164, C-165,

C-166 AND C-167.

by

DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue
LONDON ONTARIO

Reference No. 7-2-L8
April 12th, 1967

CONTENTS

		Page
I	INTRODUCTION	1
II	THE GEOLOGY OF THE AREA	2
III	FIELD WORK	2 & 3
IV	SUBSURFACE CONDITIONS	3
V	GROUNDWATER CONDITIONS	3
VI	DISCUSSION AND RECOMMENDATIONS	
	Bridge No. 197	3
	Culvert C-159	5
	Culvert C-164	6
	Culvert C-165	6 & 7
	Culvert C-166	7
	Culvert C-167	7 & 8
	Design & Construction of Road	8 to 10
	Appendix A : The Standard Penetration Test	
	Appendix B : Summaries of Subsurface Conditions	

ENCLOSURES

	No.
SYMBOLS, ABBREVIATIONS AND NOMENCLATURE	1
LOCATION OF BOREHOLES 1 to 10	2
SUBSURFACE PROFILES	
Bridge No. 197	3
Culvert C-159	4
Culvert C-164	5
Culvert C-165	6
Culvert C-166	7
Culvert C-167	8

ENCLOSURES

	No.
GEOTECHNICAL DATA SHEETS	9 to 19
GRAIN SIZE DISTRIBUTION CURVES	20 to 30

I INTRODUCTION

In accordance with a letter of authorization, dated March 1, 1967, a soil investigation has been carried out along a section of County Road 39 which is scheduled for reconstruction.

The reconstruction will commence at the intersection with Highway 22 and will continue south towards Strathroy for about 3 miles.

A construction plan showing the proposed realignment and road profile was supplied by the client and was used to locate the boreholes.

The objects of this investigation as defined in correspondence and in discussions with the client have been:-

(i) to reveal the subsurface conditions at the site of the proposed bridge crossing the Sydenham River, and to determine the relevant soil properties for the design of the foundations

(ii) to reveal the subsurface conditions in the low-lying flood plain areas immediately to the north and south of the proposed bridge location, and to determine their suitability for the support of embankments

(iii) to reveal the subsurface conditions at the sites of 5 proposed new culverts, referred to on the county road system as C-159, C-164, C-165, C-166 and C-167, and to determine the relevant soil properties for the design and construction of the new foundations

II THE GEOLOGY OF THE AREA

The physiographic region, known as the Caradoc Sand Plains, consists of a series of plains to the west of London which differ from the adjacent moraines and clay plains in that they are covered with sand or other light-textured, waterlaid deposits. These deposits originated from the earliest glacial spillways which discharged muddy water, laying down beds of silt and fine sand.

Reference to the records of the Ontario Water Resources Commission, Ground Water Bulletin No. 1, indicates that shale bedrock may be encountered between 120 and 140 feet below the ground surface.

III FIELD WORK

The field work, consisting of 14 boreholes, was carried out during the period March 2 to 11, 1967, at the locations indicated on the site plans, Enclosures 2 to 8. The holes were advanced to the sampling depths by washboring techniques and were lined with Bx size casing.

Standard penetration tests were carried out at frequent intervals of depth, as detailed on Appendix 'A', and the results are recorded on the Geotechnical Data Sheets as 'N' values.

Dynamic cone penetration tests were performed adjacent to many of the borehole locations to obtain an indication of soil density changes with depth. The same source of energy was used to drive the cone as was used for the standard penetration test.

Elevations were referred to Geodetic benchmarks along the existing road, which were indicated by the client.

IV SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the Geotechnical Data Sheets, comprising Enclosures 9 to 19, and a general picture of the subsurface conditions at the bridge and culvert locations is given in the form of Subsurface Profiles on Enclosures 3 to 8.

Summaries of the soil conditions at the bridge, culvert and along the low-lying areas of the road are presented in Appendix 'B' of this report.

V GROUNDWATER CONDITIONS

The groundwater and cave-in elevations were recorded for each borehole after completion of the drilling, and the results are recorded on the respective Geotechnical Data Sheets.

VI DISCUSSION AND RECOMMENDATIONS

BRIDGE NO. 197 (see Enclosure 3)

The sand stratum has a generally 'loose' relative density extending to a depth of 15 feet below the river bed, therefore the conditions are ideally suited for the use of a piled foundation. The most economical types of pile to use would appear to be timber and concrete filled steel pipe, and these will be discussed separately.

(a) Timber Piles

It is anticipated that nominal 12-inch diameter timber piles will achieve a satisfactory set corresponding to a safe working load of 20 tons at El. 713. If this pile tip elevation does not provide sufficient protection against scour, it will probably be necessary to use jetting to achieve the desired penetration without damaging the piles. Also because of the inconsistency of the penetration test results in the upper layers of the silt stratum, it is recommended that piles founded in this stratum be jetted and driven to El. 700.

In forming the excavation for the pile caps the sides may be expected to remain stable at a slope of 1 to 1 above the prevailing water table. It is usually possible to lower the groundwater table 2 to 3 feet by pumping from filtered sumps but if this becomes impracticable then well-points should be used.

(b) Steel Pipe Piles

The estimated safe working load for a 12-inch diameter steel pipe pile driven to about El. 700 is 60 tons. Deeper driving within the depth of the present exploration will not improve this value substantially.

It is anticipated that the piles will encounter high resistance to penetration in the lower part of the fine sand stratum therefore provision for jetting should be made to achieve the required penetration.

The foregoing estimates of length and bearing capacity of piles are only theoretical predictions, therefore in practice, the piles should be driven to a satisfactory set in accordance with a recognised dynamic pile driving formula, irrespective of the elevation at which such a set is achieved.

CULVERT C-159 (see Enclosure 4)

The creek bed extends to El. 738.6, therefore footings for a normal concrete culvert would be placed at about El. 734. Between this elevation and El. 720, the sand stratum has a 'loose' and variable relative density therefore it will be necessary to construct spread footings below the loose deposits to avoid differential settlement, which may be detrimental to the rigid concrete structure.

Under these circumstances, consideration should be given to the use of a multi-plate type of structure, which will reduce the bearing pressure consequently reducing the settlement. This type of structure will also permit some uneven settlement without disjointing or breaking.

The pipe should be supported on a sand, gravel or crushed stone base with the width of the base at least twice the diameter of the pipe. The soft clay material should also be excavated to a depth of at least 3 feet below the pipe invert prior to construction of the base.

Care should be taken when placing the backfill to ensure that adequate compaction is achieved up to three-quarters the height of the pipe.

CULVERT C-164 (see Enclosure 5

The existing creek bed extends to El. 752.3, therefore footings for a normal concrete culvert will be located at about El. 747. This grade lies w thin the stratum of compact fine sand and on the basis of the borehole results a maximum net soil pressure of 4000 p.s.f. may be used for the design of the foundation.

A major problem in constructing footings will be to control the groundwater and prevent 'boiling' or disturbance of the sand stratum. This can be achieved by lowering the water table with well-points prior to the excavation being carried out, or alternatively, carrying out the excavation inside closed sheeting which should be driven to at least El. 740.

Due to the above mentioned problem in constructing footings, consideration should be given to the use of a multi-plate structure which requires less depth of excavation, thus enabling the groundwater to be controlled by pumping from sumps dug below the footing grade.

A mat of well-graded granular material, 12-inches thick, supported in the stiff clayey silt stratum, will provide a satisfactory base for the pipe.

CULVERT C-165 (see Enclosure 6)

The existing creek bed extends to El. 756.2, therefore the footing for a normal concrete culvert would be located at about El. 751. A maximum net soil pressure of 6000 p.s.f. is appropriate

for the design of footings at this elevation, however due to the problems involved with maintaining stability of the bottom of the excavation, it will probably be more economical to use a multi-plate type of structure.

The design of a multi-plate culvert structure should be based on the criteria recommended for Culvert C-164.

CULVERT C-166 (see Enclosure 7)

The existing creek bed extends to El. 759.7, therefore the footings for a normal concrete culvert would be located at about El. 755. A maximum net soil pressure of 4000 p.s.f. is appropriate for the design of footings at this elevation, however due to the problems involved with maintaining stability of the bottom of the excavation, it will probably be more economical to use a multi-plate type of structure.

The design of the multi-plate structure should be based on the criteria recommended for Culvert C-164.

CULVERT C-167 (see Enclosure 8)

The existing creek bed extends to El. 755.1, therefore the footings for a normal concrete culvert would be located at about El. 770. A maximum net soil pressure of 2000 p.s.f. is appropriate for the design of footings at this elevation, however due to the problems involved with maintaining stability of the bottom of the excavation, it will probably be more economical to use a multi-plate type of structure.

The firm clay stratum should be removed to a depth 2 feet below the proposed invert level and replaced by a mat of well-graded sand, gravel or crushed stone.

DESIGN AND CONSTRUCTION OF ROAD

(a) Station 153+50 to Station 160+00

Boreholes 1 and 2 revealed a considerable thickness of very soft peat which is unsuitable for the support of a road embankment. The peat, average thickness 14 feet, should therefore be removed and replaced with suitable well-compacted granular fill over the entire width of the proposed embankment.

(b) South-west Approach Embankment to Bridge 19'

Borehole 3 revealed a 7.1/2 foot thick layer of peat at the west abutment location. This peat deposit and any extension of the layer below the approach embankment should be removed and replaced with suitable well-compacted fill material.

(c) Bridge 19' to Station 140+00

Boreholes 4, 5 and 6 revealed a thin layer of topsoil, average thickness 1 foot, extending over this flat low-lying area.

The topsoil layer should be removed prior to commencing the embankment construction.

(d) Stations 102+00 to 112+00 and Station 130+00

Boreholes 8 and 10 revealed peat layers which have been consolidated slightly by the existing road embankment. It must be assumed however that the peat outside the limits of the existing road construction has not been consolidated and will therefore be the critical factor in determining the stability of the new road shoulders.

To determine the stability of an embankment on the consolidated peat, an equivalent shear strength of 200 pounds per square foot has been assumed, which results in an allowable increase to the present height of 10 feet. However to maintain the stability of a 10 foot high embankment the side slopes will require an average slope angle of about 10 degrees, therefore it would appear to be more practical to reduce the height of the embankment thus increasing the allowable side slope which may be employed.

The following design data will apply to the above problem and allow a more economical embankment height to be obtained.

Increase in Embankment Height feet	Maximum Side Slope to be Employed degrees
10	10
9	12
8	15
7	18
6	33

On the basis of the above table, it appears that an increase in embankment height of 6 feet coupled with side slopes of 33 degrees (1.5 to 1) appears to be the most economical geometrical layout.

If the above design proves impractical, due to a higher embankment being necessary, it is recommended that the peat be removed across the entire width of the proposed road and a conventional embankment be constructed on the underlying fine sand stratum.

Settlement of Road Embankments

The greater part of settlement of road embankments supported on the predominantly fine sand material will occur immediately, and will therefore cause no unusual problems.

Settlement of embankments overlying peat deposits will take place more slowly, however it is anticipated that the greater part of the settlement will occur within the first year. Under these circumstances, it will be adviseable to wait one year after construction of the embankment before completing the final paving.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

C.J.W. Atkinson, M.Sc., P.Eng.,
Branch Manager

CJWA:jms

APPENDIX A

STANDARD PENETRATION TESTS

In order to determine the relative density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted. The test also gives an indication of the consistency of cohesive soils.

A two-inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30 in. The tube is first driven an initial 6 in. to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12 in. is recorded. The sample tube used is one originally developed by the Raymond Concrete Pile Company in the United States, where a sufficient number of tests have been made in conjunction with field investigations to show that the results, although essentially empirical, may be applied to foundation design.

For sands:

Values of N	Density
Less than 10	Loose
Between 10 and 30	Compact
Between 30 and 50	Dense
Greater than 50	Very dense

APPENDIX B

SUBSURFACE CONDITIONS

Road Section south of Bridge 197 (Boreholes 1 & 2)

The two boreholes were located in the low-lying area between Station 153+50 and Station 160+00. The soil profile was similar at both locations revealing a layer of peat, average thickness 14 feet, overlying a fine sand stratum. The consistency of the peat is described as 'very soft' as indicated by the advancement of the sampler being achieved by the weight of drill rods alone.

Bridge No. 197 (Boreholes 3 and 4)

Borehole 3 encountered a 7.1/2 foot depth of peat overlying the fine sand stratum whereas borehole 4 encountered a 1 foot thick layer of topsoil above the fine sand stratum.

The fine sand stratum has a variable relative density which can be described as 'loose' to 'compact' down to El. 715. Between El. 715 and the bottom of the stratum at El. 710±, the relative density changes to 'very dense' as estimated from 'N' values of 91 and 148 blows per foot.

The silt stratum encountered at El. 710 extends down to El. 645 and the relative density is described as 'dense' based on 'N' values ranging from 14 to 79 blows per foot. The average 'N' value in this stratum is 38 blows per foot.

Silty clay till was encountered at El. 645 and the deepest borehole was terminated in this stratum at El. 627. The consistency of the

silty clay is described as 'hard' as indicated by 'N' values ranging from 36 to 59 blows per foot.

Road Section north of Bridge 197 (Borehole 5 & 6)

Both boreholes encountered a thin layer of topsoil, 6-inches thick, overlying sandy silt and silty fine sand deposits. Traces of organics were observed down to a depth of 7 feet, indicating that this part of the deposit originated as a recent alluvial flood plain. The sand and silt strata have a generally 'loose' relative density extending down to El. 728, and below this elevation the density is described as 'dense' based on 'N' values of 38 and 62 blows per foot.

Culvert C-159 (Borehole 7)

The creek bed is located in the organic silty clay stratum which extends down to El. 736. Below this elevation the borehole penetrated successive fine sand and silt strata which extend to El. 709. The relative density of these deposits is described as 'loose' to 'compact' down to El. 725, and thereafter it can generally be described as 'dense'.

The borehole was terminated in a hard clayey silt stratum at El. 707.

Road Section - Station 130+00 (Borehole 8)

The borehole penetrated a 6 foot thick layer of silty fine sand fill associated with the construction of the existing road embankment. Natural soil was encountered at El. 741±, and the material down to El. 730 can be classified as flood plain deposits. Successive layers of clayey peat, sandy silt and a further layer of peat were encountered within these limits.

Below El. 730, silty fine sand was encountered and the borehole was terminated in this stratum at El. 721. The relative density of the sand stratum increases rapidiy with depth as indicated by 'N' values of 9 and 40 blows per foot.

Road Section - Station 105+00 to Station 110+00 (Boreholes 9 & 10)

The boreholes penetrated surface layers of gravelly sand and silty clay fill which are associated with the construction of the existing road grade.

At borehole 9 location a sandy silt stratum was encountered immediately below the fill and traces of peat were observed in the upper 2 feet. Below this level the relative density remains fairly uniform and is described as 'compact' based on 'N' values ranging from 10 to 29 blows per foot.

At borehole 10 location a layer of clayey peat was encountered below the fill and the borehole revealed a thickness of 6 feet. The consistency of the peat is described as 'soft' as indicated by an 'N' value of 3 blows per foot. The borehole was terminated in a silty fine sand stratum which was penetrated to a depth of 7.1/2 feet.

Culvert C-164 (Borehole 11)

The creek bed is located in a flood plain deposit consisting of slightly organic clayey silt. This material extends down to El. 751±.

Below El. 751 the borehole penetrated a fine sand stratum in which it was terminated at El. 734. The relative density of the sand stratum is described as 'compact' to 'dense' based on 'N' values ranging from 19 to 55 blows per foot.

Culvert C-165 (Borehole 12)

The creek bed is located in a layer of stiff silty clay which extends down to El. 756.

Below El. 756, the borehole penetrated a fine sand stratum in which it was terminated at El. 742. The relative density of the sand stratum is described as 'dense' based on 'N' values ranging from 32 to 56 blows per foot.

Culvert C-166 (Borehole 13)

The creek bed is located in a layer of stiff grey silty clay which contains a trace of organics and extends down to El. 756.

Below El. 756, the borehole penetrated a fine sand stratum in which it was terminated, at El. 735. The relative density of the fine sand stratum is described as 'very dense' based on 'N' values ranging from 26 to 104 blows per foot.

Culvert C-167 (Borehole 14)

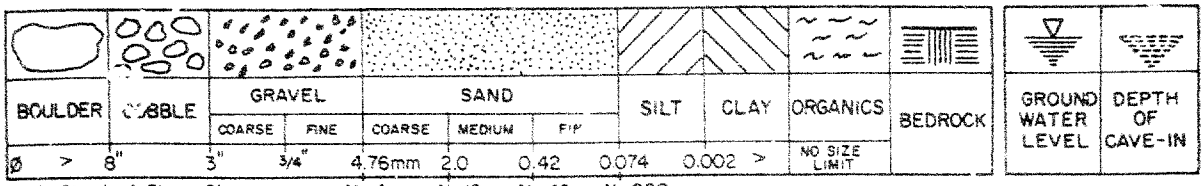
The creek bed is located in a layer of firm silty clay which contains a trace of organics and extends down to El. 770.

Below El. 770, the borehole penetrated a fine sand stratum in which it was terminated at El. 748. The relative density of the fine sand stratum is described as 'compact' to 'dense' based on 'N' values ranging from 7 to 37 blows per foot.

Enclosures

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.



SAMPLE TYPES.

AS	Auger sample	RC	Rock core	TP	Piston, thin walled tube sample
CS	Sample from casing	%	Recovery	TW	Open, thin walled tube sample
ChS	Chunk sample	SS	Split spoon sample	WS	Wash sample

SAMPLER ADVANCED BY static weight : w
" pressure : p
" tapping : t

OBSERVATIONS MADE WHILE CORING: Steady pressure; No pressure; Intermittent pressure; Washwater returns; Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2"ϕ, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

SYMBOL :

322

EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SOIL PROPERTIES.

W %	Water content	γ	Natural bulk density (unit weight)	k	Coeff. of permeability
LL %	Liquid limit	e	Void ratio	C	Shear strength — in terms of total stress
PL %	Plastic limit	RD	Relative density	ϕ	Angle of int. friction — in terms of total stress
PI %	Plasticity index	C_v	Coeff. of consolidation	C'	Cohesion — in terms of effective stress
LI	Liquidity index	m_v	Coeff of volume compressibility	ϕ'	Angle of int. friction — in terms of effective stress

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL COMPRESSION TEST — UNCONFINED — LABORATORY VANE TEST — FIELD VANE TEST — POCKET PENETROMETER TEST

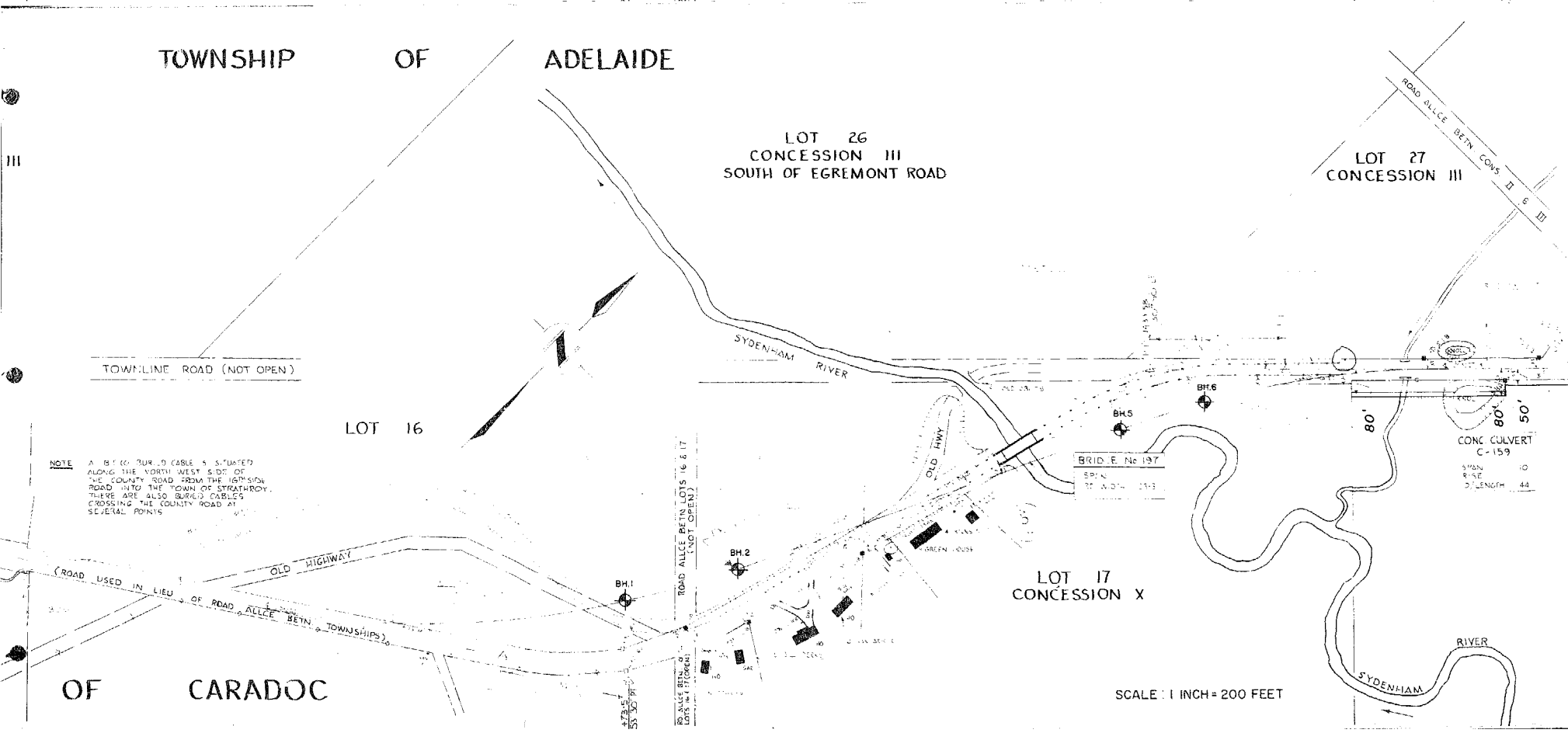
St

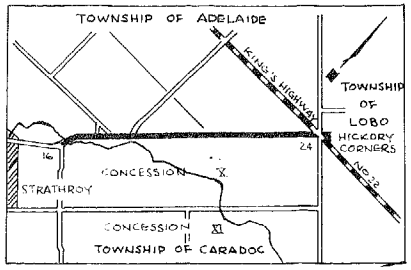
Strain at failure is represented by direction of stem: 20%, 15%, 5%, 10%

St : sensitivity = shear strength in undisturbed state / shear strength in remoulded state

SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq.ft.
Very loose	0 – 15 %	Very soft	less than 250
Loose	15 – 35 %	Soft	250 – 500
Compact	35 – 65 %	Firm	500 – 1000
Dense	65 – 85 %	Stiff	1000 – 2000
Very dense	85 – 100 %	Very stiff	2000 – 4000
		Hard	over 4000


TOWNSHIP OF ADELAIDE
III
LOT 26
CONCESSION III
SOUTH OF EGREMONT ROAD
ROAD ALLCE BETN CONS II & III
LOT 27
CONCESSION III
SYDENHAM RIVER
TOWNLINE ROAD (NOT OPEN)
LOT 16
NOTE A BELL CANADA BURIED CABLE IS SITUATED ALONG THE NORTH WEST SIDE OF THE COUNTY ROAD FROM THE HIGHSIDE ROAD INTO THE TOWN OF STRATHROY. THERE ARE ALSO BURIED CABLES CROSSING THE COUNTY ROAD AT SEVERAL POINTS
OLD HIGHWAY
(ROAD USED IN LIEU OF ROAD ALLCE BETN TOWNSHIPS)
BH.1
BH.2
BH.5
BH.6
ROAD ALLCE BETN LOTS 16 & 17 (NOT OPEN)
OLD HWY
BRIDGE No 197
SPAN
WIDTH
CONC CULVERT
C-159
SPAN 10
RISE 5
LENGTH 44
80'
80'
50'
LOT 17
CONCESSION X
OF CARADOC
SYDENHAM RIVER
SCALE : 1 INCH = 200 FEET



KEY PLAN
SCALE: 1 INCH = 1 MILE

LOT 27
CONCESSION II

LOT 28
CONCESSION II

ROAD ALLCE BETW CONS II & III

ROAD ALLCE BTWN LOTS 27 & 28

DOWNHAM TREE FARM

S.C. DE MARAY

LIMIT OF COUNTY ROAD AS WIDENED (MISC PLAN NO 15 LONDON)

COUNTY ROAD NO. 39

BH.8

BH.9

BH.10

LIMIT OF COUNTY ROAD AS WIDENED MISC PLAN NO 20 (GLENCOE)

CONC CULVERT
C-159
SPAN 10
RISE
C/LENGTH 44

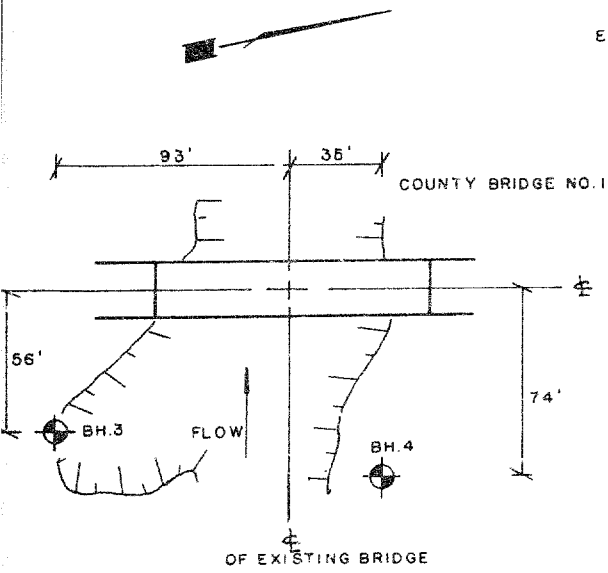
LOT 18

LOT 19

RIVER

RECONSTRUCTION COUNTY ROAD NO.39
FOR THE
COUNTY OF MIDDLESEX
LOCATION OF BOREHOLES
DOMINION SOIL INVESTIGATION LTD.

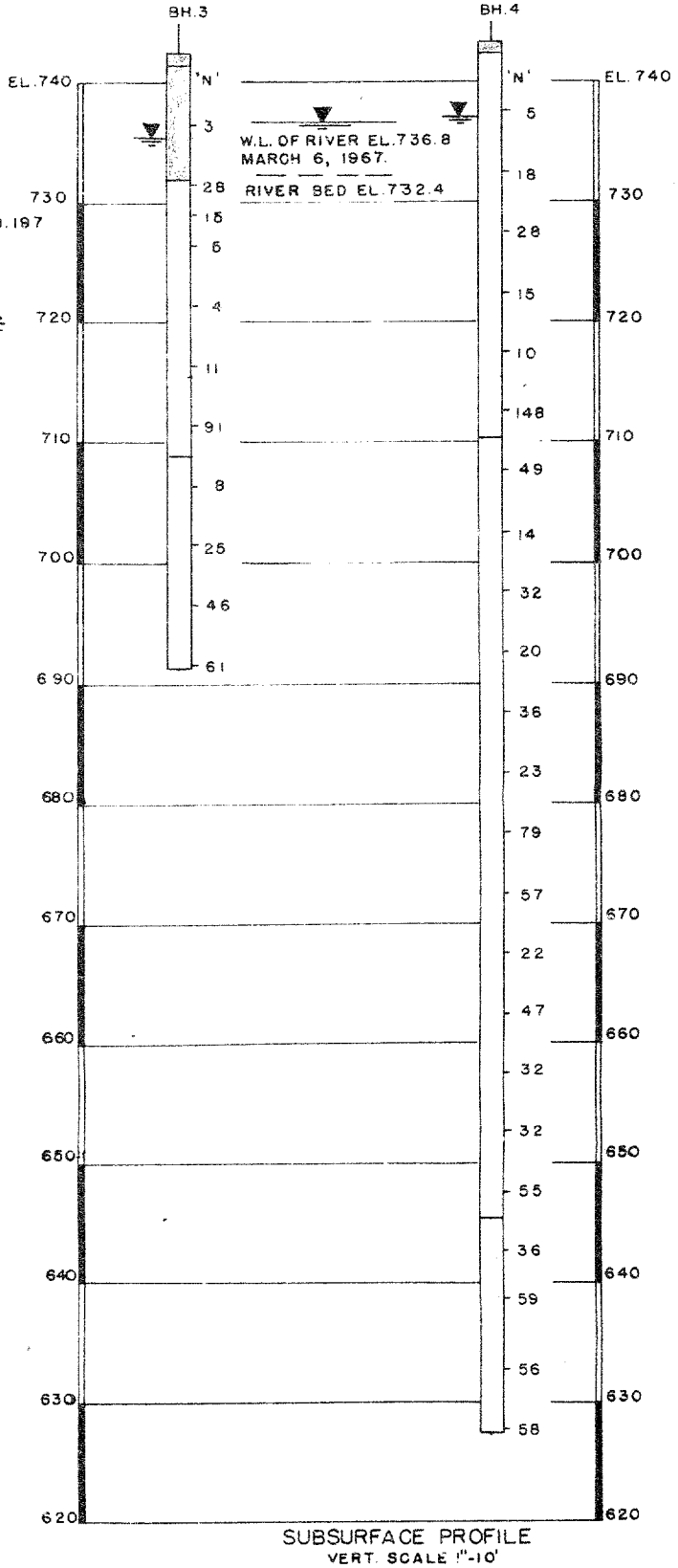
OUR REFERENCE NO.7-2-L8 ENCLOSURE NO. 2



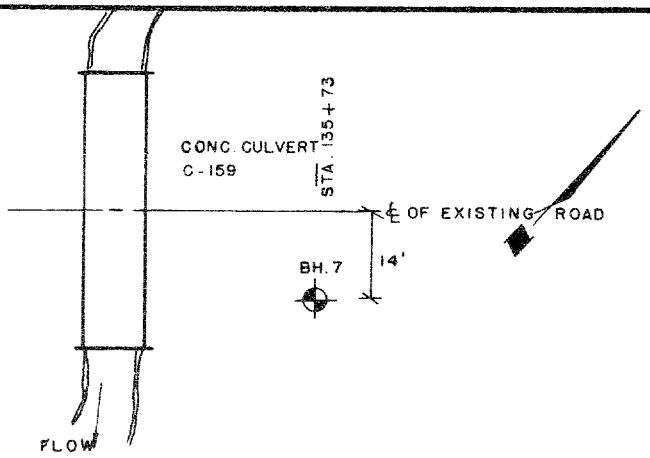
LOCATION OF BOREHOLES
SCALE 1" - 50'

LEGEND

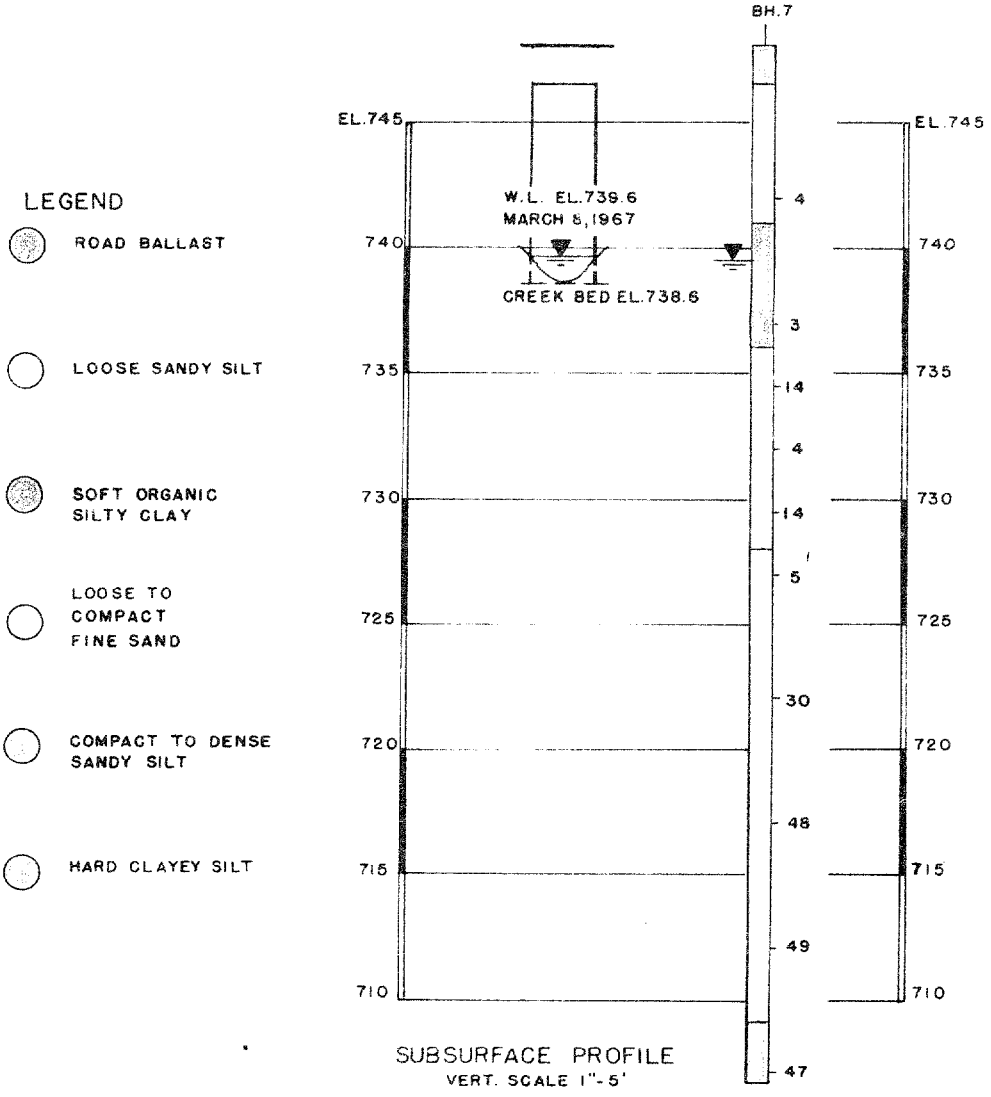
- TOPSOIL
- SOFT CLAYEY PEAT
- LOOSE TO VERY DENSE FINE SAND
- COMPACT TO VERY DENSE SILT
- HARD SILTY CLAY



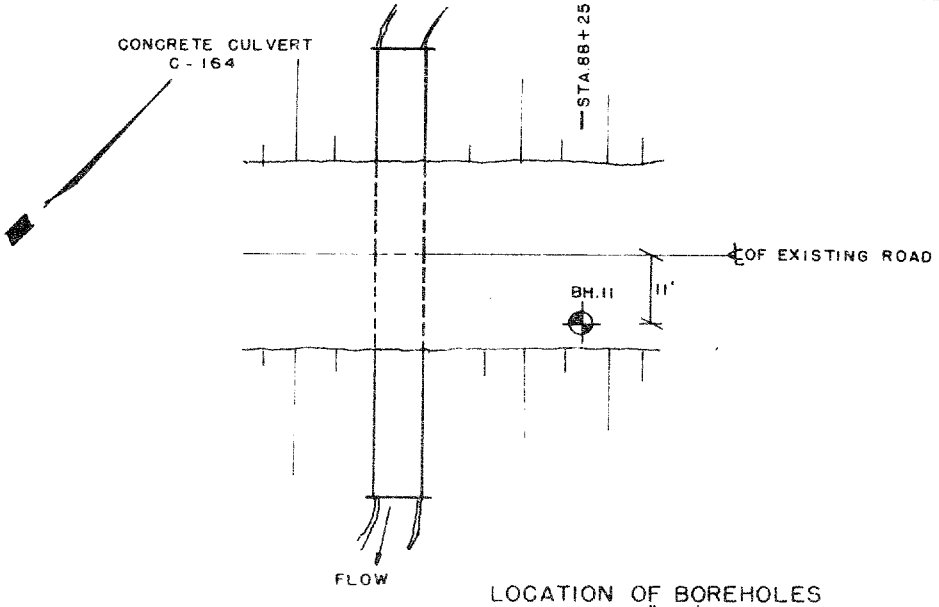
SUBSURFACE PROFILE
VERT. SCALE 1"-10'



LOCATION OF BOREHOLES
SCALE 1" - 20'



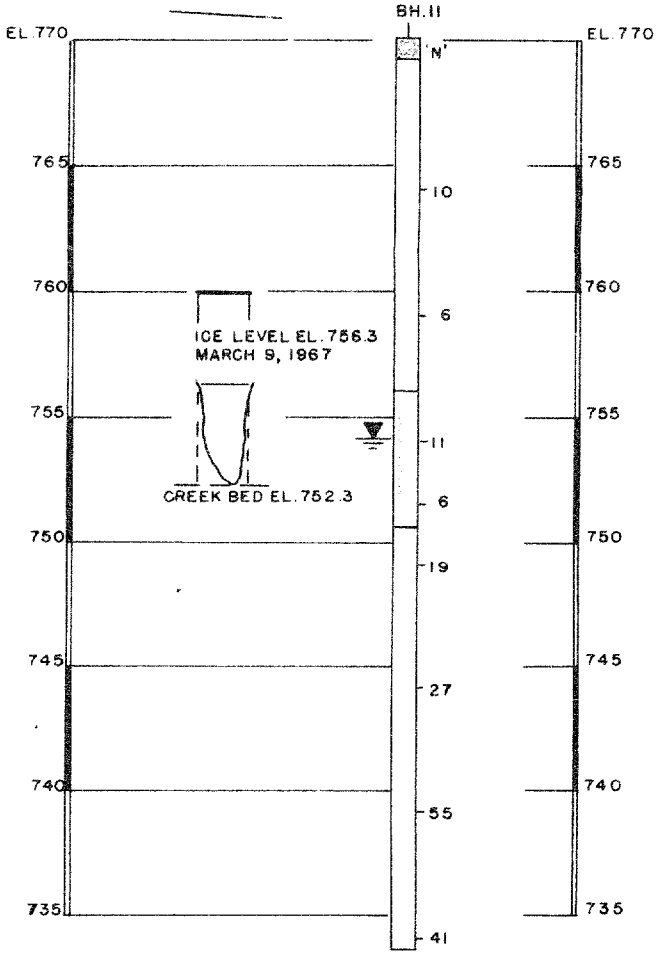
SUBSURFACE PROFILE
VERT. SCALE 1"-5'



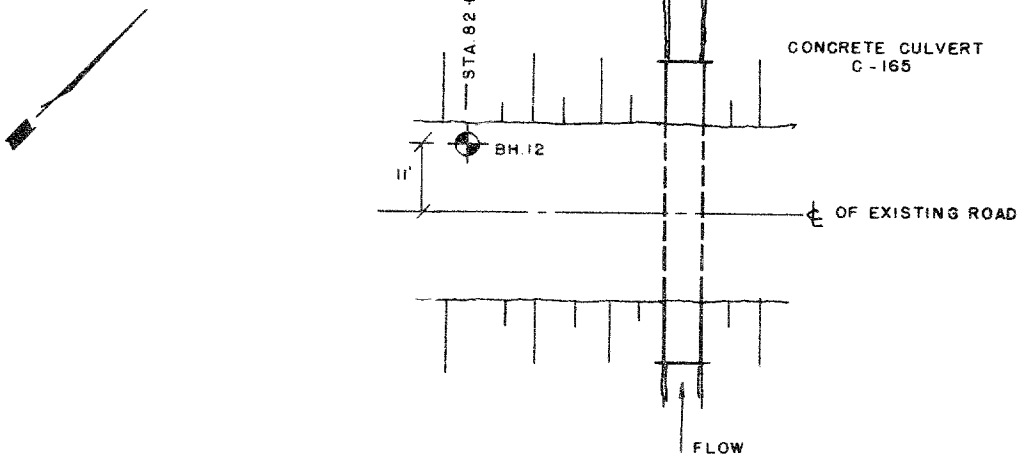
LOCATION OF BOREHOLES
SCALE 1"-20'

LEGEND

- ROAD BALLAST
- SANDY SILT, FILL
- STIFF CLAYEY SILT
- COMPACT TO DENSE SANDY SILT



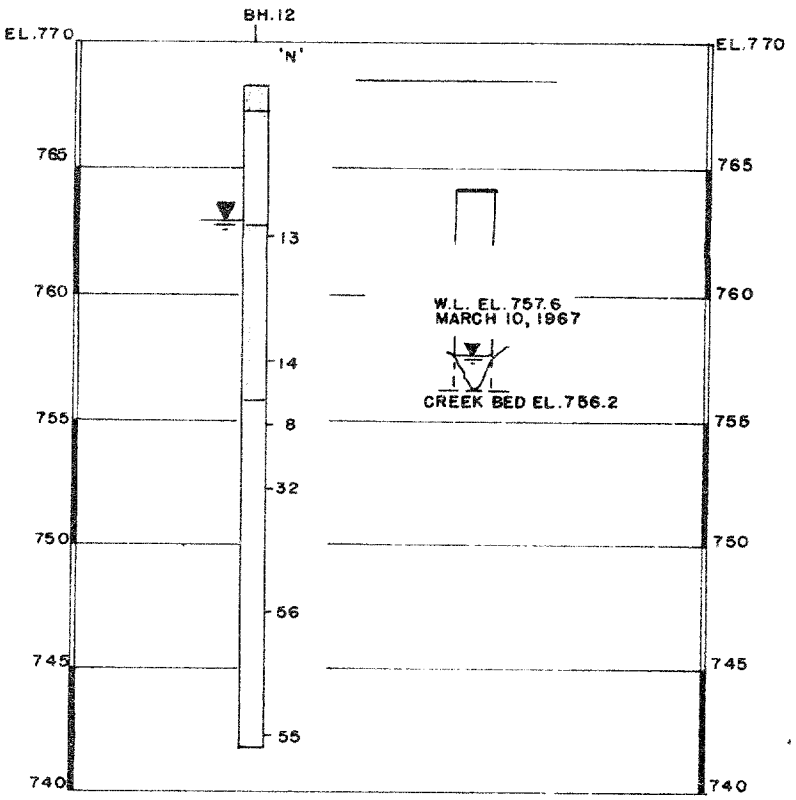
SUBSURFACE PROFILE
VERT. SCALE 1"-5'



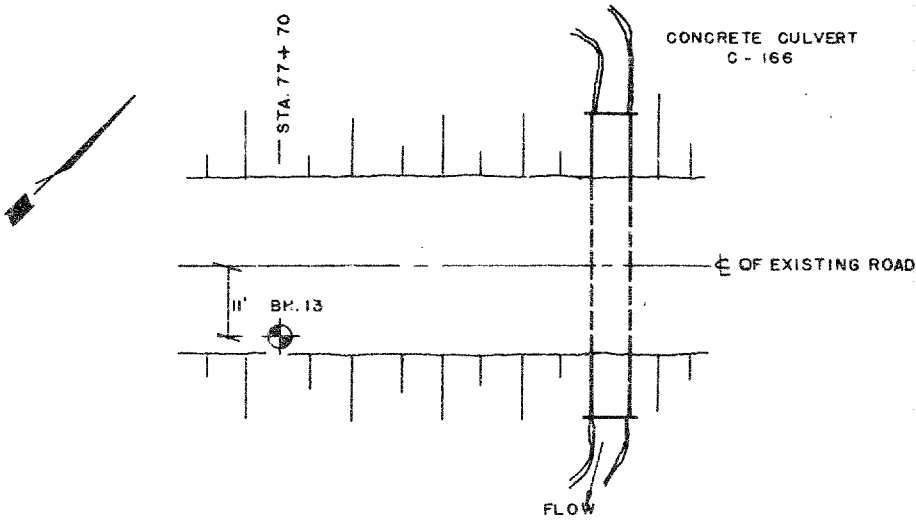
LOCATION OF BOREHOLES
SCALE 1" - 20'

LEGEND

- ROAD BALLAST
- FINE SAND
- STIFF SILTY CLAY
- DENSE SILTY FINE SAND



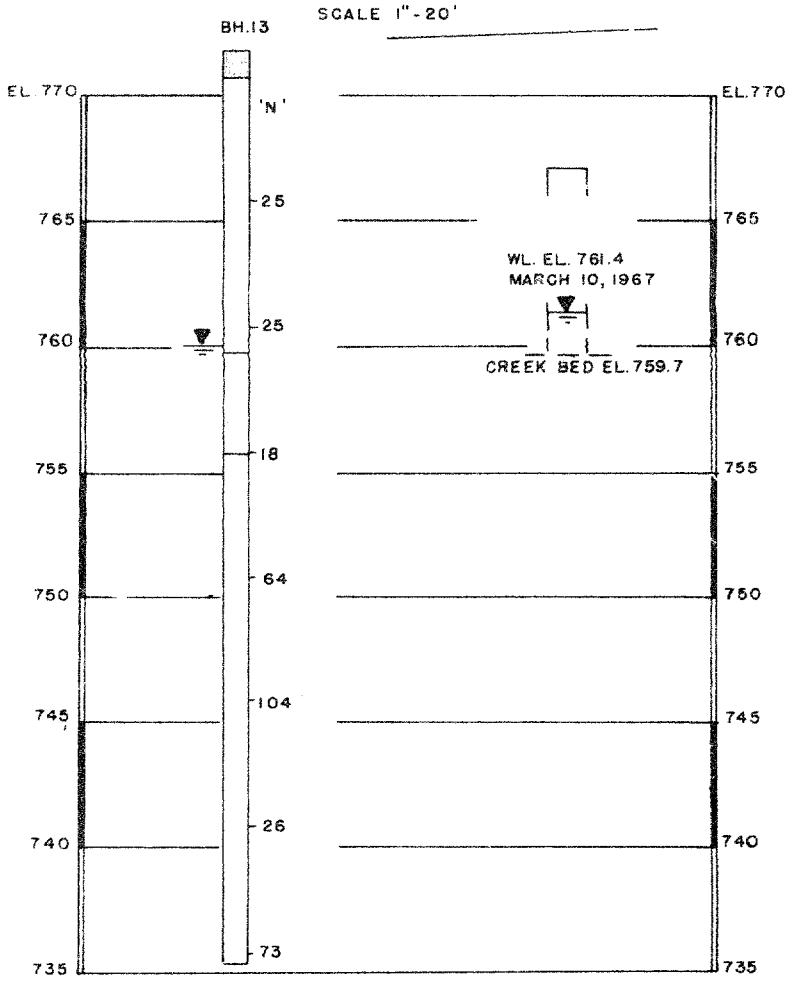
SUBSURFACE PROFILE
VERT. SCALE 1" - 5'



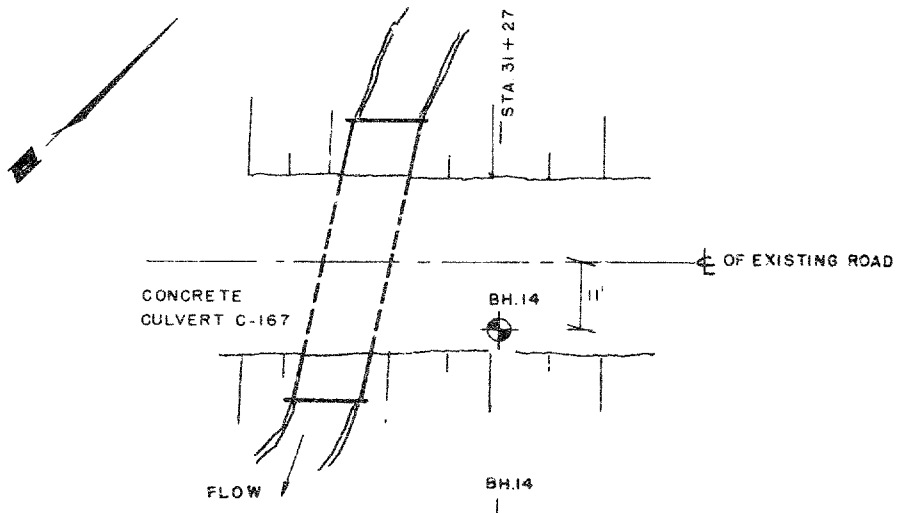
LOCATION OF BOREHOLES
SCALE 1"-20'

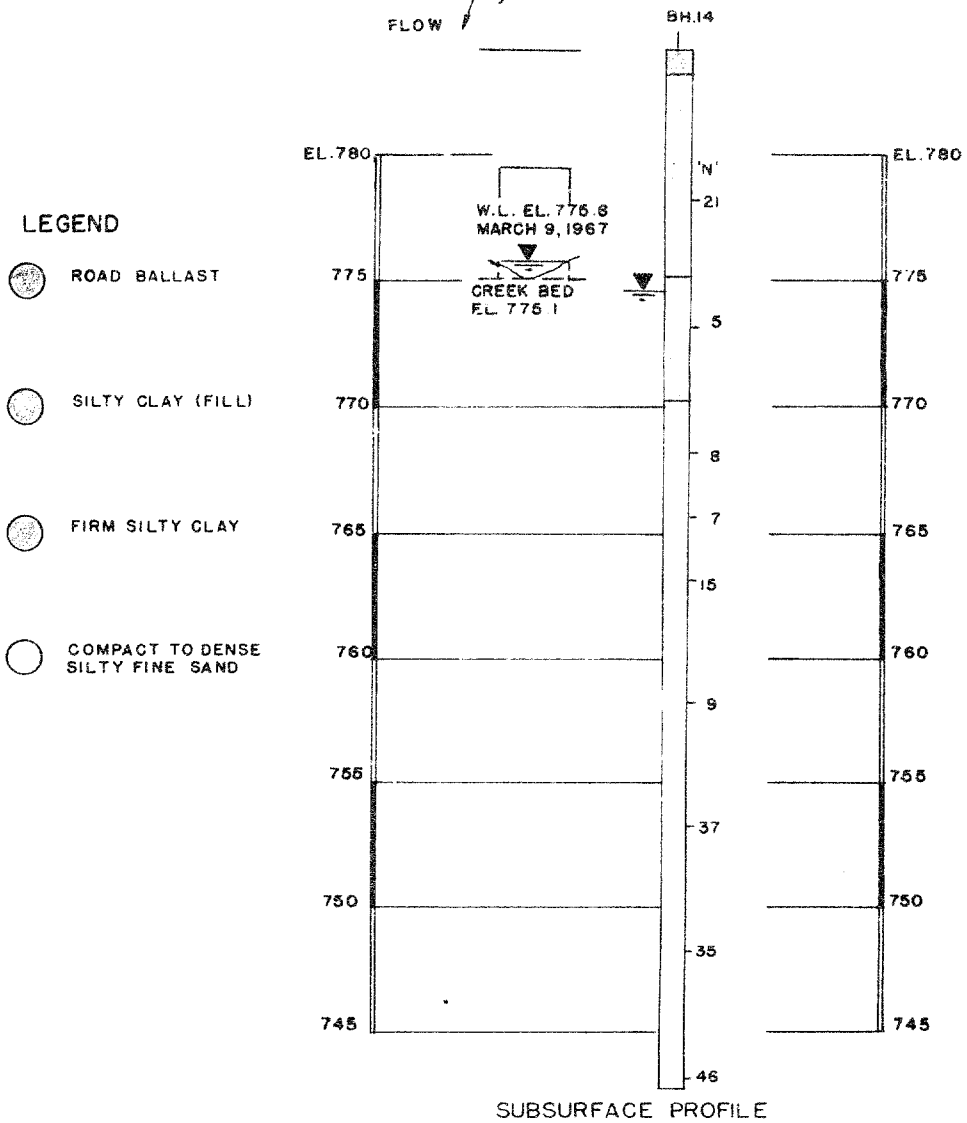
LEGEND

- ROAD BALLAST
- VERY STIFF SILTY CLAY
- STIFF CLAYEY SILT
- VERY DENSE SILTY FINE SAND



SUBSURFACE PROFILE
VERT. SCALE 1"-5'





SUBSURFACE PROFILE
VERT. SCALE 1"-5'

OUR REFERENCE NO. 7-2-L8

GEOTECHNICAL DATA SHEET FOR BOREHOLES 1 & 2.

CLIENT: County of Middlesex
PROJECT: County Road 39
LOCATION: Strathroy
DATUM ELEVATION: 744.04 feet

METHOD OF BORING: Dry-boring
DIAMETER OF BOREHOLE:
DATE: March 14, 1967

ENCLOSURE NO. 9

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES No. of Advancement of Sampler	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % PL W LL	REMARKS
744.1	0.0	Ground Surface					Borehole 1		
		Very soft dark brown fibrous peat		1	SS	W			W.L. El.743.3
				2	SS	W			
730	14.5	Compact brown fine sand trace of silt		3	SS	10			
725	21.0			4	SS	18			
		End of Borehole							
743.7	0.0	Ground Surface					Borehole 2		
		Very soft dark brown fibrous peat		1	SS	1			W. L. El.743.0
				2	SS	W			
730	13.5	Compact brown fine sand trace of silt		3	SS	5			
725	20.0			4	SS	18			
		End of Borehole							

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: CH'D:

GEOTECHNICAL DATA SHEET FOR BOREHOLE 3

OUR REFERENCE NO 7-2-L8

CLIENT: County of Middlesex
PROJECT: Bridge No. 197
LOCATION: County Road 39
DATUM ELEVATION 744.04 feet

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: Bx (3-inch)
DATE: March 1 & 2, 1967

ENCLOSURE NO 10

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N — Blows per foot Advancement of Sampler	REMARKS
742.4	0.0	Ground Surface				
	1.0	Topsoil				
740		Soft dark brown clayey peat and	1	SS	3	
735	7.5	decomposed wood				W. L. El. 735.4
		Loose to very dense fine sand, trace of silt (brown grey)	2	SS	28	
730			3	SS	15	
			4	SS	5	
725			5	SS	4	
720			6	SS	11	
715			7	SS	91	
710	33.5	Compact to very dense grey silt, with some fine sand and seams of silty clay.	8	SS	8	
705			9	SS	25	
700			10	SS	46	
695			11	SS	61	
690	51.5	End of Borehole				

PENETRATION RESISTANCE blows per foot: 20 40 60 80 100
SHEAR STRENGTH lbs sq ft

CONSISTENCY water content %: PL W LL

2" diameter cone

For grain size analysis of samples 3, 5 & 7 see Enclosures 20, 21 and 22

VERTICAL SCALE: 1 IN TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: CH'D:

GEOTECHNICAL DATA SHEET FOR BOREHOLE 4

OUR REFERENCE NO. 7-2-18

CLIENT County of Middlesex
PROJECT Bridge 197
LOCATION County Road 39
DATUM ELEVATION 744.04 feet

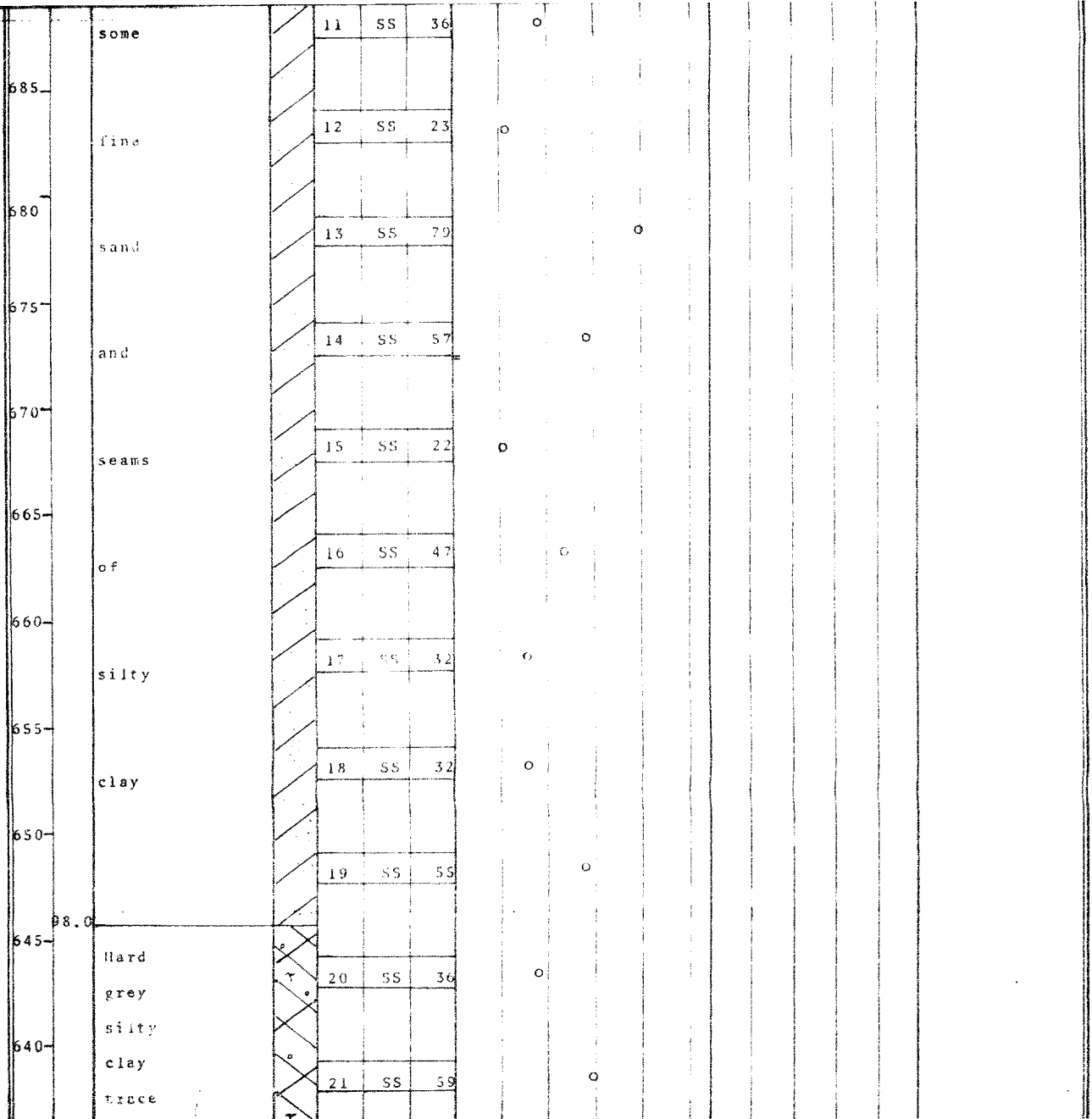
METHOD OF BORING Washboring
SAMPLER OR BOREHOLE Bx (3-inch)
DATE March 3 to 7, 1967

ENCLOSURE NO. 11

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATA SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100	CONSISTENCY W_P W W_L	REMARKS
743.5	0.0	Ground Surface							
	1.0	Topsoil							
740		Loose to decomposed wood		1	SS	5			W. L. El. 737.3
735		very dense grey fine sand, trace of silt		2	SS	18			
				3	SS	28			
730				4	SS	15			
725				5	SS	10			
720				6	SS	148			
715									
	33.0								
710		Dense grey silt, with		7	SS	49			
705				8	SS	14			
700				9	SS	32			
695				10	SS	20			

2" diameter cone

For grain size analyses of samples 3, 6 & 8, see Enclosures 23, 24 and 25.


some
fine
sand
and
seams
of
silty
clay
98.0
Hard
grey
silty
clay
trace
685
680
675
670
665
660
655
650
645
640
11 SS 36
12 SS 23
13 SS 79
14 SS 57
15 SS 22
16 SS 47
17 SS 32
18 SS 32
19 SS 55
20 SS 36
21 SS 59

		gravel		22	SS	56			0
630	16.5			23	SS	58			0
625		End of Borehole							

GEOTECHNICAL DATA SHEET FOR BOREHOLES 5 & 6.

OUR REFERENCE NO 7-2-L8

CLIENT County of Middlesex
PROJECT County Road 39
LOCATION Strathroy
DATUM ELEVATION 744.04 feet

METHOD OF BORING Dry-boring
DIAMETER OF BOREHOLE Bx (3-inch)
DATE March 7, 1967

ENCLOSURE NO 12

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N — or Advancement of Sampler	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs sq ft	CONSISTENCY water content % PL W LL	REMARKS
743.7	0.0	Ground Surface					Borehole 5		
	0.5	Topsoil							
		Loose grey sandy silt trace of					2" diameter cone		Cave-in El.739.7
740									
	7.0	organics		1	SS	4			
		Loose to dense grey silty fine sand		2	SS	7			
735									
730				3	SS	62			
	16.5	End of Borehole							
742.6	0.0	Ground Surface					Borehole 6		
	0.5	Topsoil							
		Loose brown silty fine sand, trace					2" diameter cone		W. L. El.737.3
740									
	7.0	of organics		1	SS	4			
		Loose to dense grey silty fine sand		2	SS	8			
735									
730				3	SS	38			
	16.5	End of Borehole							

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE CH'D:

GEOTECHNICAL DATA SHEET FOR BOREHOLE 7.....

OUR REFERENCE NO. 7-2-L8

CLIENT: County of Middlesex
PROJECT: Culvert C-159
LOCATION: County Road 39
DATUM ELEVATION: 732.67 feet

METHOD OF BORING: Auger
DIAMETER OF BOREHOLE: 4-inch
DATE: March 8, 1967

ENCLOSURE NO. 13

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N-or Ø-Measurement of Sample	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % PL W LL	REMARKS
748.0	0.0	Ground Surface							
	1.5	Road Ballast							
745		Loose reddish brown sandy silt		1	SS	4			
	7.0								
740		Soft grey organic silty clay, trace of peat		2	SS	3			
	12.0								
735		Loose to compact brown fine sand, trace of silt.		3	SS	14			
				4	SS	4			
730				5	SS	14			
	20.0			6	SS	5			
725		Compact to dense grey sandy silt		7	SS	30			
720				8	SS	48			
715				9	SS	49			
710	39.0								
		Hard grey clayey silt		10	SS	47			
	41.5								
705									

2" diameter cone

W. L. El. 739.5

Creek Bed

For grain size analysis of sample 3, see Enclosure 26

VERTICAL SCALE: 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE CH'D:

GEOTECHNICAL DATA SHEET FOR BOREHOLE .8. . . .

OUR REFERENCE NO. 7-2-L8

CLIENT: County of Middlesex
PROJECT: County Road 39
LOCATION: Strathroy
DATUM ELEVATION: 752.67 feet

METHOD OF BORING: Dry-boring
DIAMETER OF BOREHOLE: Bx (3-inch)
DATE: March 8, 1967

ENCLOSURE NO. 14

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N — or Advancement of Sampler	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % PL W LL	REMARKS
747.3	0.0	Ground Surface							
745		Loose brown silty fine sand (Fill).					2" diameter cone		W. L. El.742.1
	6.0			1	SS	3			
740	8.0	Soft brown clayey peat							
		Loose brown sandy silt trace of peat		2	SS	4			
735	14.5								
		Dark brown clayey peat		3	SS	5			
730	17.5								
		Compact to dense brown silty fine sand		4	SS	9			
725				5	SS	40			
	26.5								
720		End of Borehole							

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: CH'D:

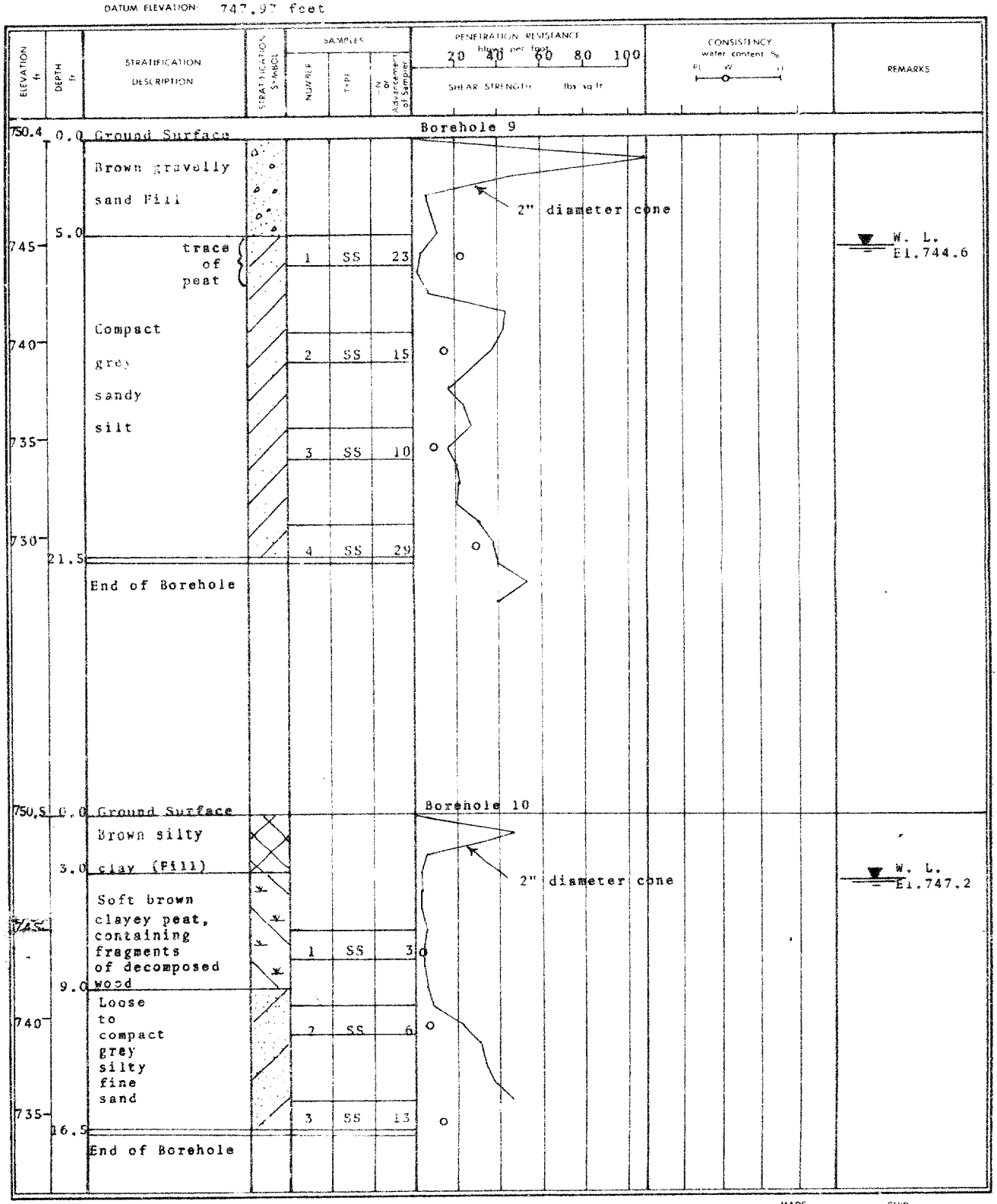
GEOTECHNICAL DATA SHEET FOR BOREHOLES 9 & 10

OUR REFERENCE NO 7-2-L8

CLIENT County of Middlesex
PROJECT County Road 39
LOCATION Strathroy
DATUM ELEVATION: 747.97 feet

METHOD OF BORING Dryboring
DIAMETER OF BOREHOLE 8x (3-inch)
DATE March 8 & 9, 1967

ENCLOSURE NO. 15



VERTICAL SCALE: 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE CH'D:

GEOTECHNICAL DATA SHEET FOR BOREHOLE 11 . . . .

OUR REFERENCE NO. 7-2-L8

CLIENT County of Middlesex
PROJECT Culvert C-164
LOCATION County Road 39
DATUM ELEVATION 770.38 feet

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx (3-inch)
DATE March 9, 1967

ENCLOSURE NO. 16

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N — or Advancement of Sample	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs sq ft	CONSISTENCY water content % PL W LL	REMARKS
770.1	0.0	Ground Surface							
	0.8	Road Ballast							
		Brown sandy silt, layers of silty clay		1	SS	10			
765				2	SS	6			
760									
	14.0	Stiff grey clayey silt containing roots and trace of peat		3	SS	11			
755				4	SS	6			
	19.5	Compact to dense grey fine sand some silt		5	SS	19			
750				6	SS	27			
745				7	SS	55			
740				8	SS	41			
735	36.5	End of Borehole							

2" diameter cone

Ice Level

N. L. El.754.1.

Creek Bed

For grain size analysis of sample 5, see Enclosure 27.

VERTICAL SCALE: 1 IN. TO FT

DOMINION SOIL INVESTIGATION LIMITED

MADE CH'D.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 12

OUR REFERENCE NO 7-2-L8

CLIENT County of Middlesex
PROJECT Culvert C-165
LOCATION County Road 39
DATUM ELEVATION 770.38 feet

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx (3-inch)
DATE March 10 & 11, 1967

ENCLOSURE NO 17

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES +/- Advancement of Sampler	REMARKS
768.3	0.0	Ground Surface				
	1.0	Road Ballast				
765		Brown silty fine sand				2" diameter cone
	5.5		1	SS	13	W. L. El.763.0
760		Stiff grey silty clay, trace of	2	SS	14	Creek W. L.
	12.5	fine gravel clayey	3	SS	8	Creek Bed
755		Dense brown fine sand with some silt	4	SS	32	For grain size analysis of sample 4, see Enclosure 28.
750			5	SS	56	
745			6	SS	55	
	26.5	End of Borehole				
740						

PENETRATION RESISTANCE blows per foot: 20 40 60 80 100
SHEAR STRENGTH lbs/sq ft

CONSISTENCY water content %: PL W LL

VERTICAL SCALE 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE CHD:

GEOTECHNICAL DATA SHEET FOR BOREHOLE 13

OUR REFERENCE NO. 7-2-L8

CLIENT: County of Middlesex
PROJECT: Culvert C-166
LOCATION: County Road 39
DATUM ELEVATION: 770.38 feet

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: Bx (3-inch)
DATE: March 10, 1967

ENCLOSURE NO. 18

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N — or Advancement of Sampler	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % PL W LL	REMARKS
771.8	0.0	Ground Surface							
	1.0	Road Ballast							
770		Very stiff brown silty clay		1	SS	25			
765				2	SS	25			
760	12.0	Stiff grey clayey silt trace of organics		3	SS	18			
755	16.0	Very dense brown fine sand with some silt		4	SS	64			
750				5	SS	104			
745				6	SS	26			
740				7	SS	73			
735	36.5	End of Borehole							

2" diameter cone

Creek W.L.

Creek Bed

W. L. El. 760.1

For grain size analysis of sample 4, see Enclosure 29

VERTICAL SCALE: 1 IN. TO 5FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: CH'D:

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 14 . . .

OUR REFERENCE NO 7-2-L8

CLIENT: County of Middlesex
PROJECT Culver C-167
LOCATION: County Road 39
DATUM ELEVATION: 781.16 feet. Cutcross, west curb of existing culvert.

METHOD OF BORING Auger
DIAMETER OF BOREHOLE 4-inch
DATE March 9, 1967

ENCLOSURE NO 19

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES N — or Advancement of Sampler	PENETRATION RESISTANCE blows per foot 20 40 60 80 100 / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % Pl W Ll	REMARKS
784.2	0.0	Ground Surface							
	1.0	Road Ballast							
		Brown silty clay (Fill)		1	SS	21			
780									
	9.0								
775		Firm grey silty clay, trace of organics		2	SS	5			
	14.0								
770		Compact		3	SS	8			
				4	SS	7			
		to							
765				5	SS	15			
		dense							
760		brown		6	SS	9			
		fine sand							
755				7	SS	37			
		with some							
750		silt		8	SS	35			
	36.5	End of Borehole							

2" diameter cone

W. L.
Creek Bed

W. L.
El.774.4

For grain size analysis of sample 3, see Enclosure 30

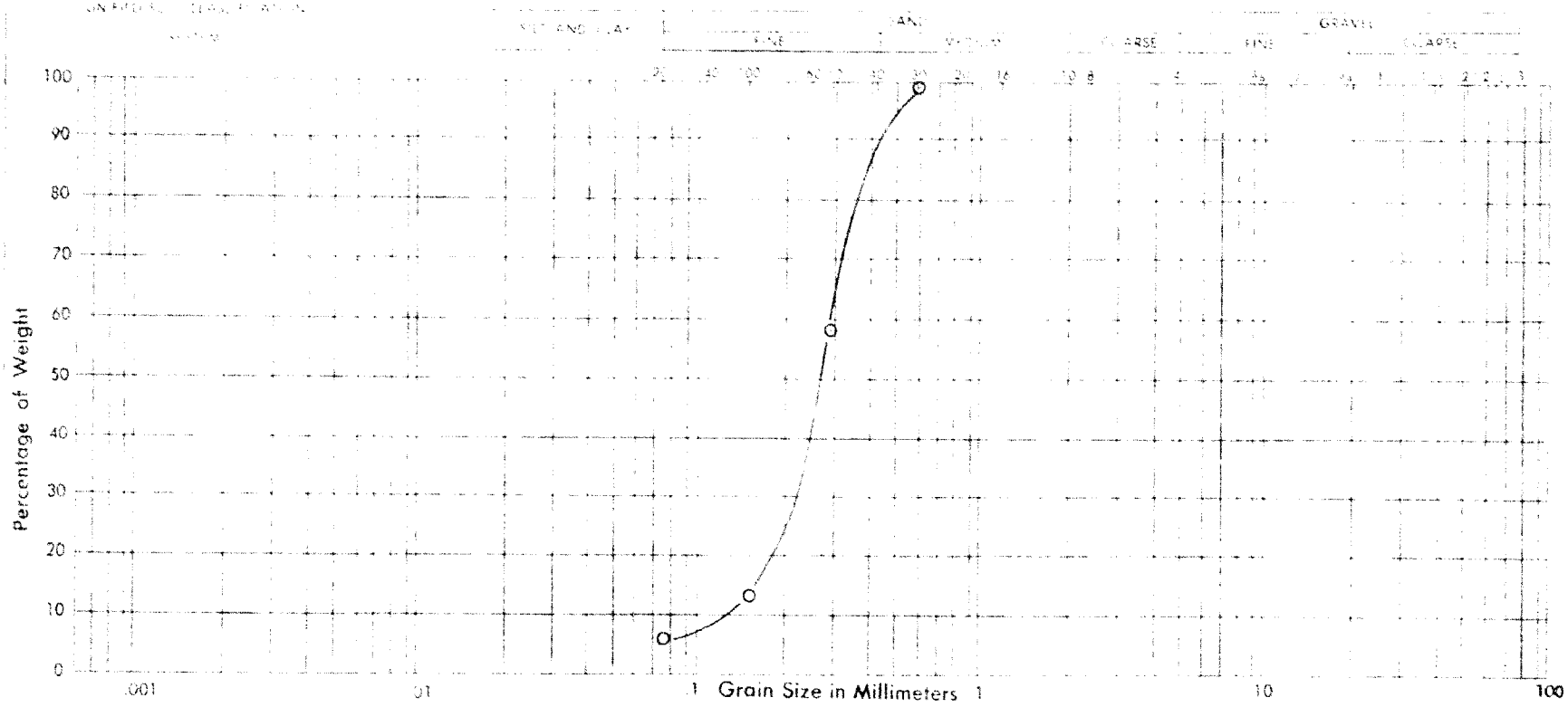
VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE CH'D:

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION



PROJECT Bridge No. 19
LOCATION County of Middlesex
BOREHOLE No. 3
SAMPLE NO. 3
DEPTH OF SAMPLE 12'-6" to 14'-0"
ELEVATION OF BOREHOLE 729±

CLASSIFICATION OF UNIFORMITY 2
COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:
FINE SAND WITH A TRACE OF SILT

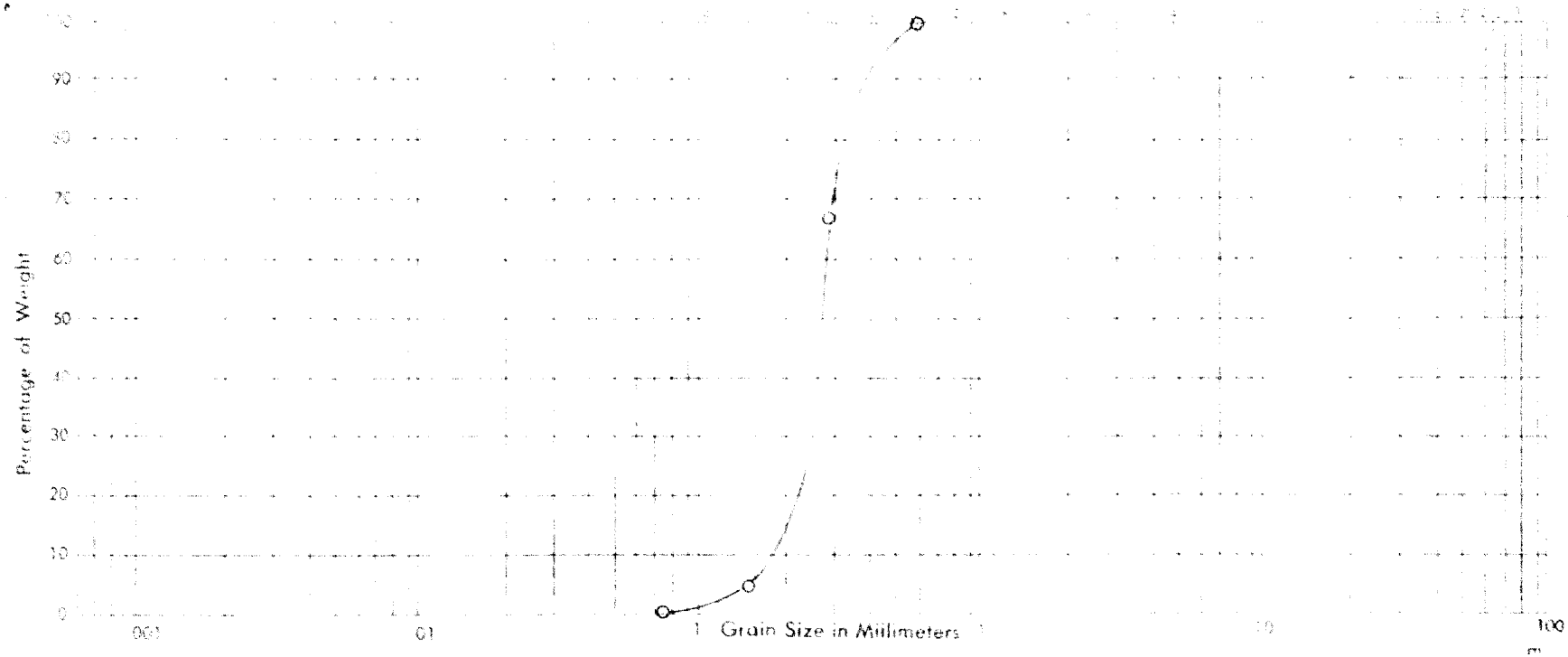
PLASTIC PROPERTIES
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MOISTURE CONTENT
SPECIFIC GRAVITY

Enclosure No. 20

Dominion Soil Investigation Limited

GRAIN SIZE DISTRIBUTION

7-2-L8



Bridge No. 197
County of Middlesex
3
5
20'-0" to 21'-6"
722±

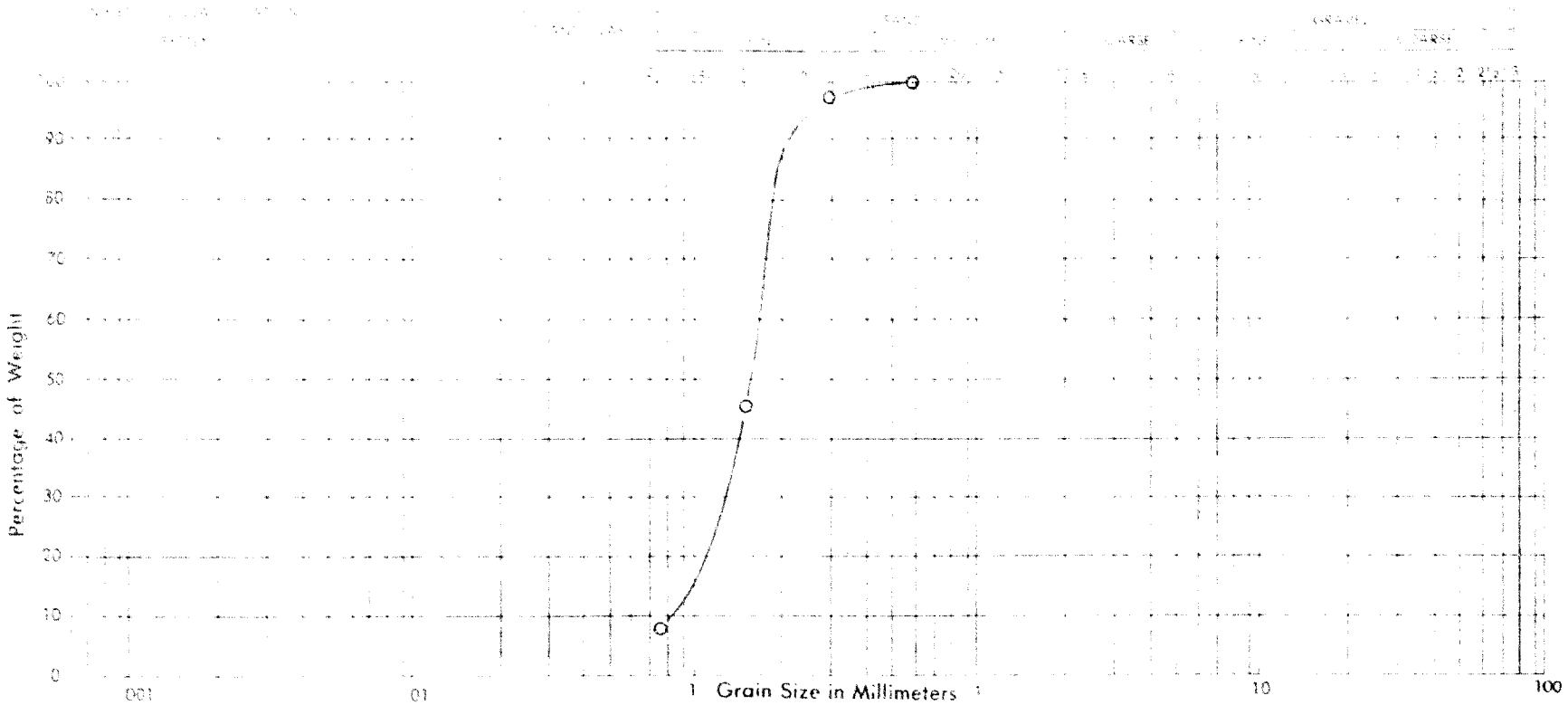
1.5

Classification of Sample and Group Symbol:
UNIFOR FINE SAND

Enclosure No. 21

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION



Bridge No. 197
County of Middlesex

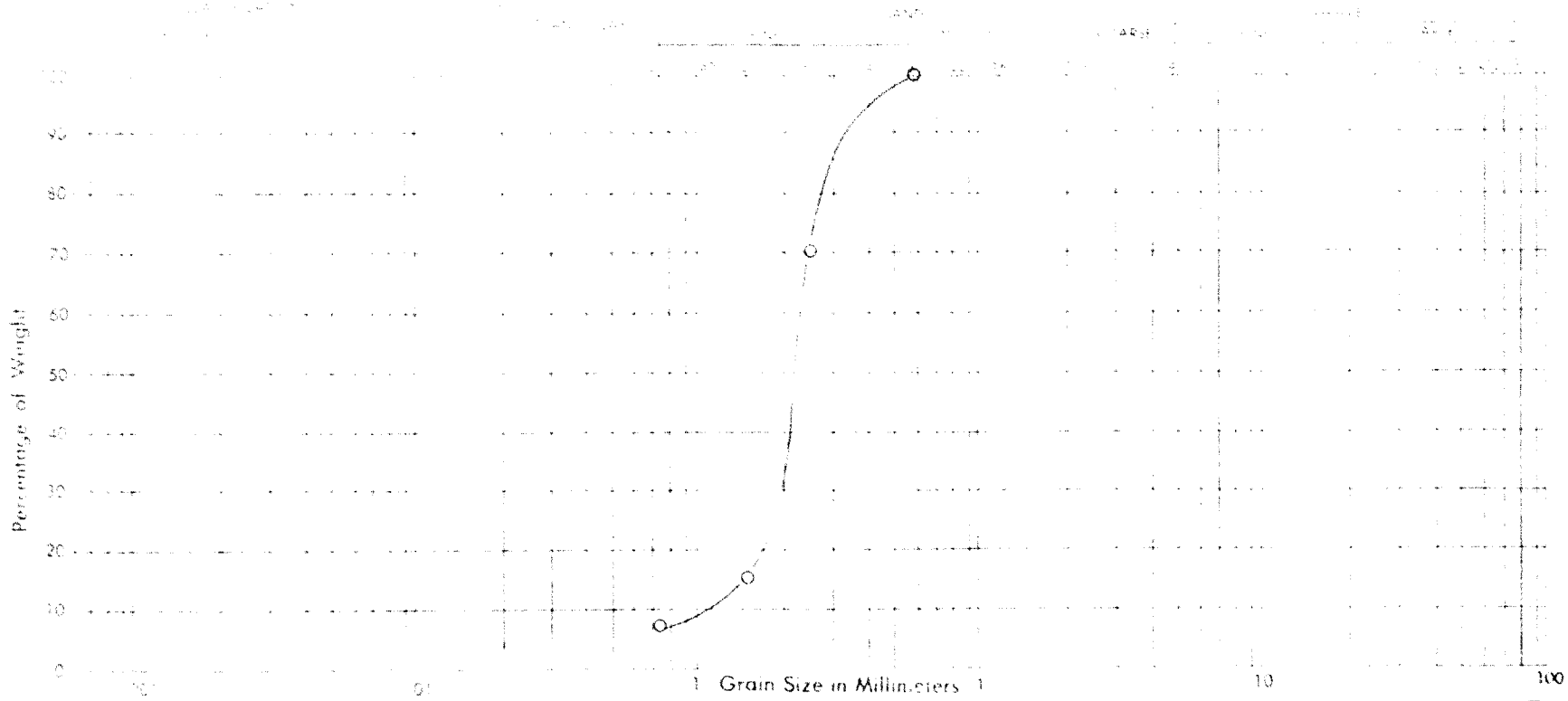
30'-0" to 31'-6"

Classification of Sample and Group Symbol
FINE SAND WITH A TRACE OF SILT

Enclosure No. 22

Dominion Soil Investigation Limited

GRAIN SIZE DISTRIBUTION



Bridge No. 19
County of Middlesex
4
3
15'-0" to 16'-6"
28±

Classification of Sample and Group Symbol:
FINE SAND WITH A TRACE OF SILT

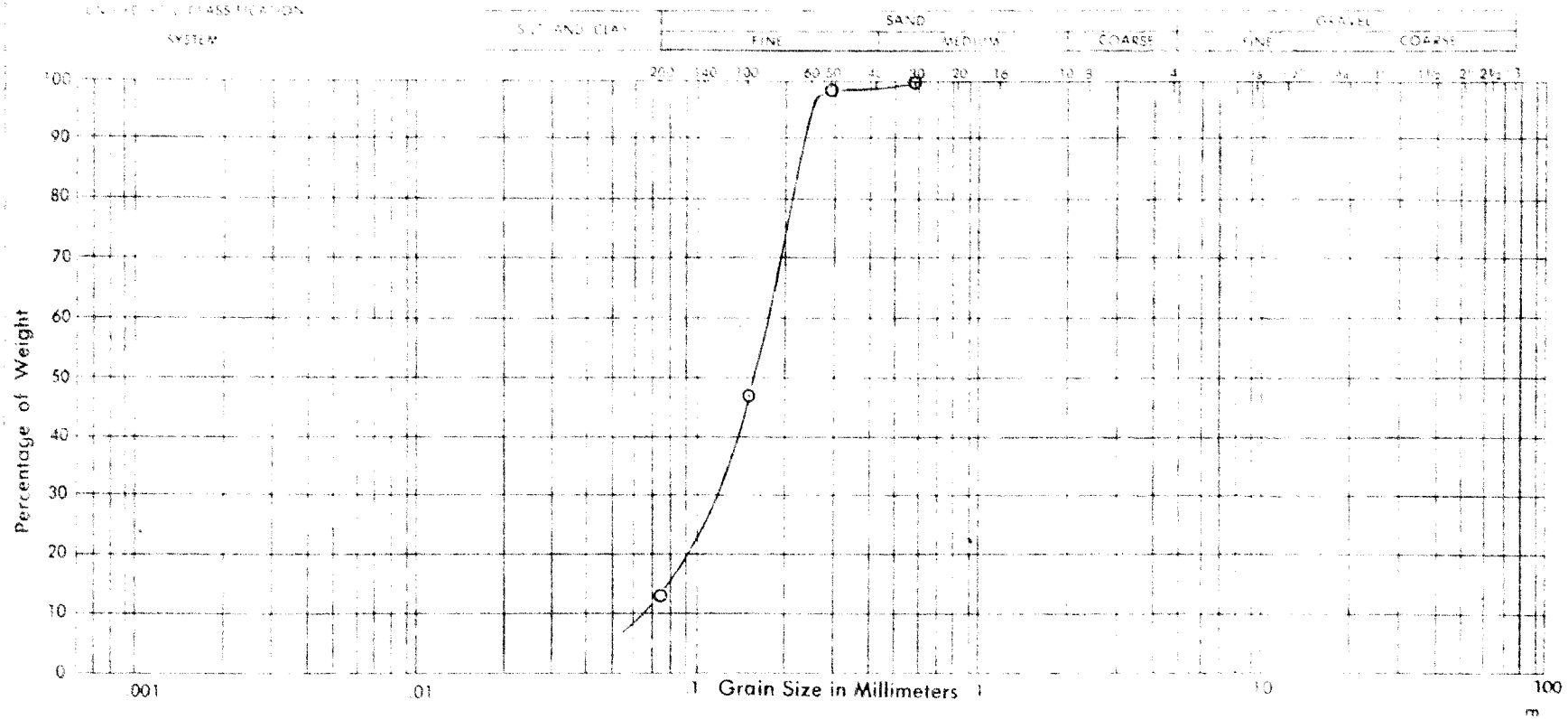
Enclosure No. 23

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

REFERENCE NO. 7-2-L8



Bridge No. 197
County of Middlesex
4
6
26'-0" to 21'-6"
723±

COEFFICIENT OF UNIFORMITY 3

COEFFICIENT OF CURVATURE

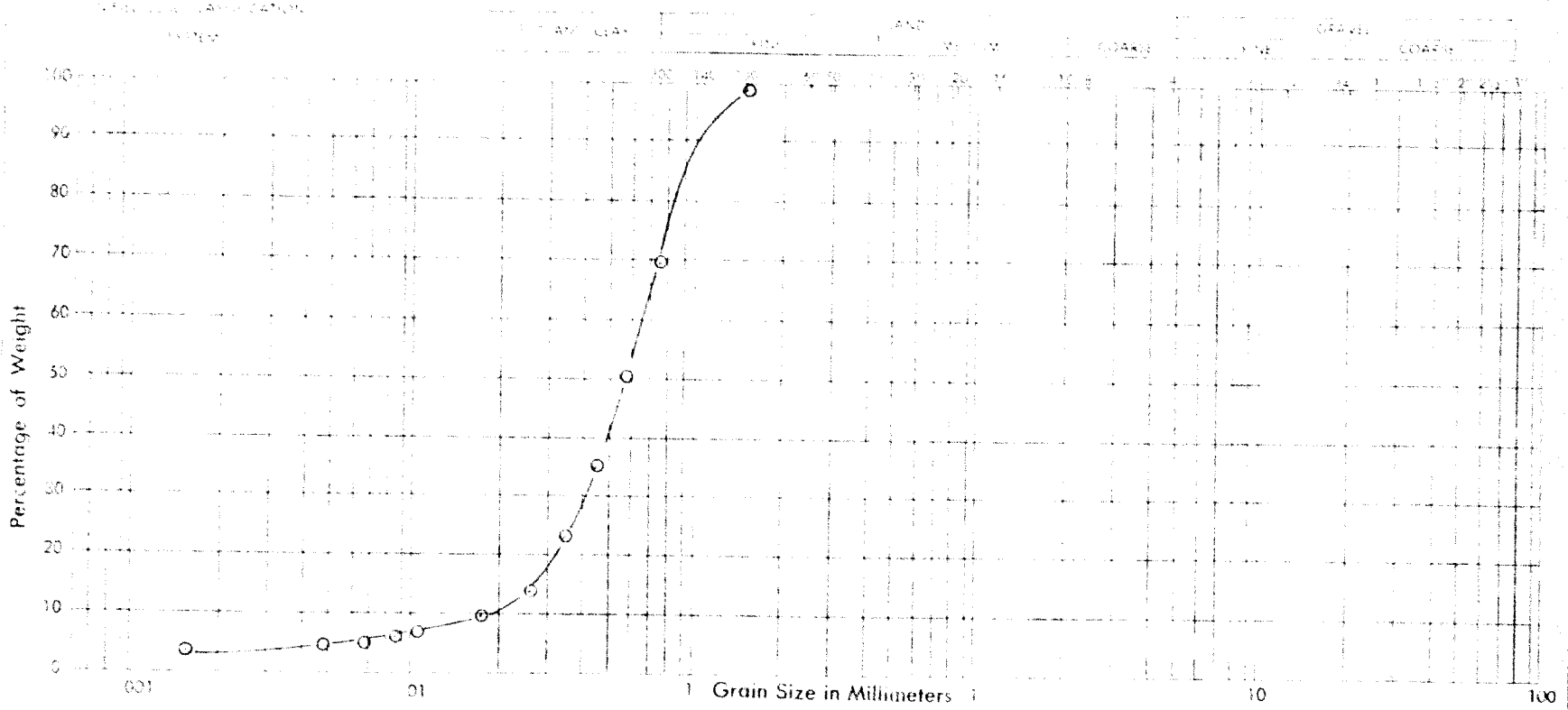
Classification of Sample and Group Symbol:
FINE SAND WITH SOME SILT

Enclosure No. 24

Dominion Soil Investigation Limited

GRAIN SIZE DISTRIBUTION

7-2-68



Project: Tridge No. 197

Location: County of Middlesex

Borehole No. 4

Sample No. 8

Depth: 40'-9" to 41'-6"

Elevation or Datum: 703±

Specimen Identification: 3

Classification of Sample and Group Symbol:

SILT WITH SOME FINE SAND, AND A TRACE OF CLAY

Liquid Limit:

Plastic Limit:

Plasticity Index:

Moisture Content:

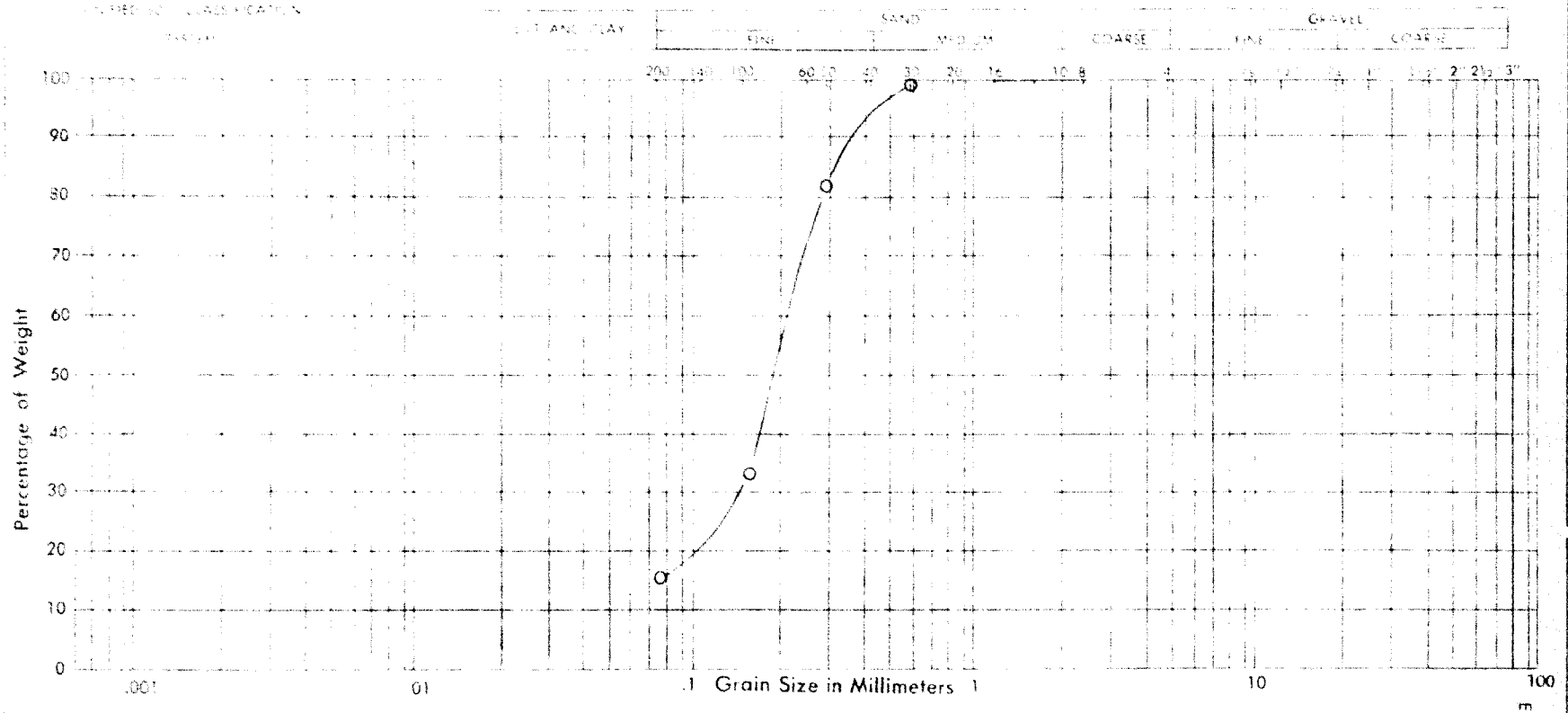
Activity:

Enclosure No. 25

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

D.S.I. REFERENCE NO. 7-2-L8



PROJECT Culvert C-159

LOCATION County of Middlesex

BOREHOLE NO. 7

SAMPLE NO. 3

DEPTH OF SAMPLE 12'-6" to 14'-0"

ELEVATION OF SAMPLE 735±

COEFFICIENT OF UNIFORMITY 4

COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:

FINE SAND WITH SOME SILT

PLASTIC PROPERTIES

LIQUID LIMIT %

PLASTIC LIMIT %

PLASTICITY INDEX %

MOISTURE CONTENT %

ACTIVITY

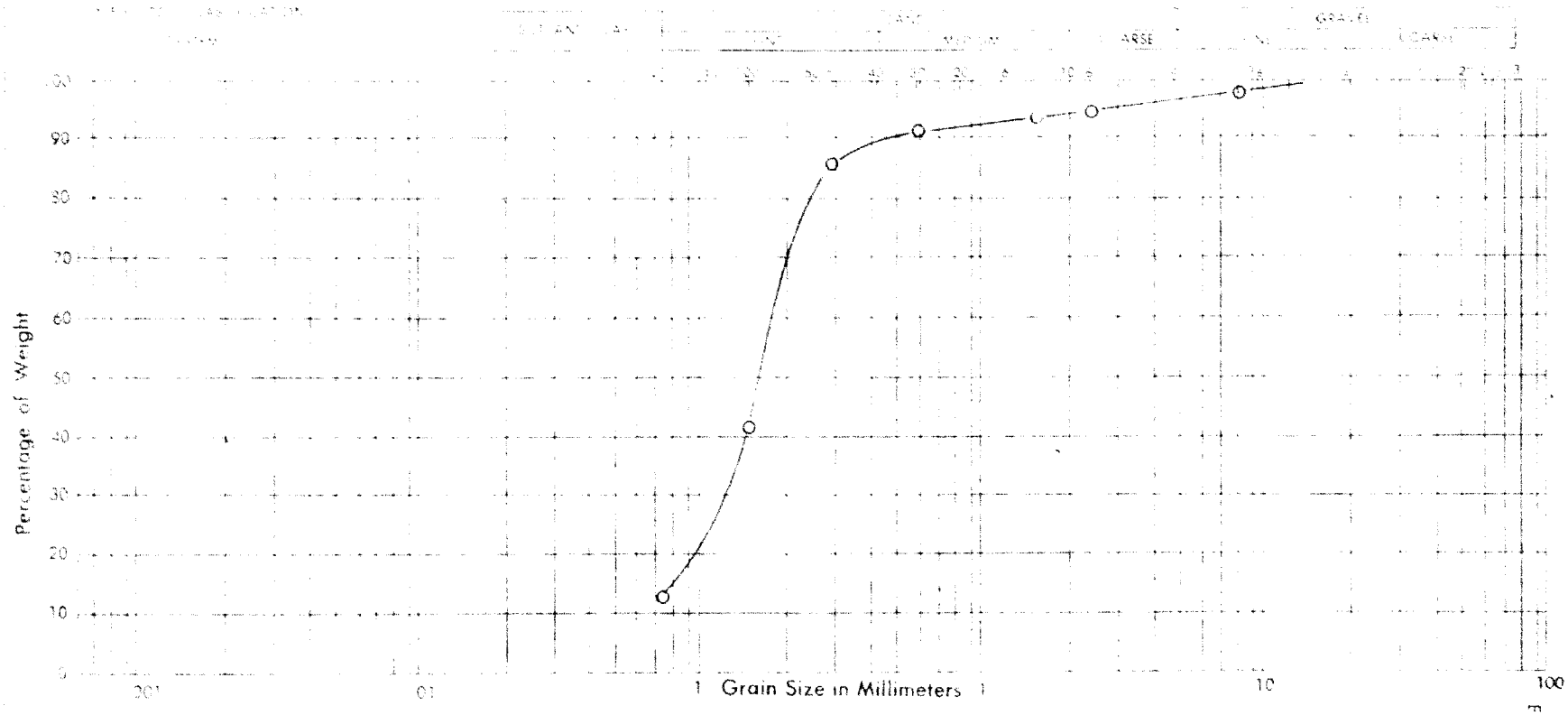
Enclosure No. 26

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

Dominion Soil Investigation Limited

GRAIN SIZE DISTRIBUTION

7-2-L8



Culvert C-164
County of Middlesex
11
5
20'-0" to 21'-6"
749±

Classification of Sample and Group Symbol:

FINE SAND, WITH SOME SILT TRACES OF MEDIUM TO COARSE SAND AND FINE GRAVEL

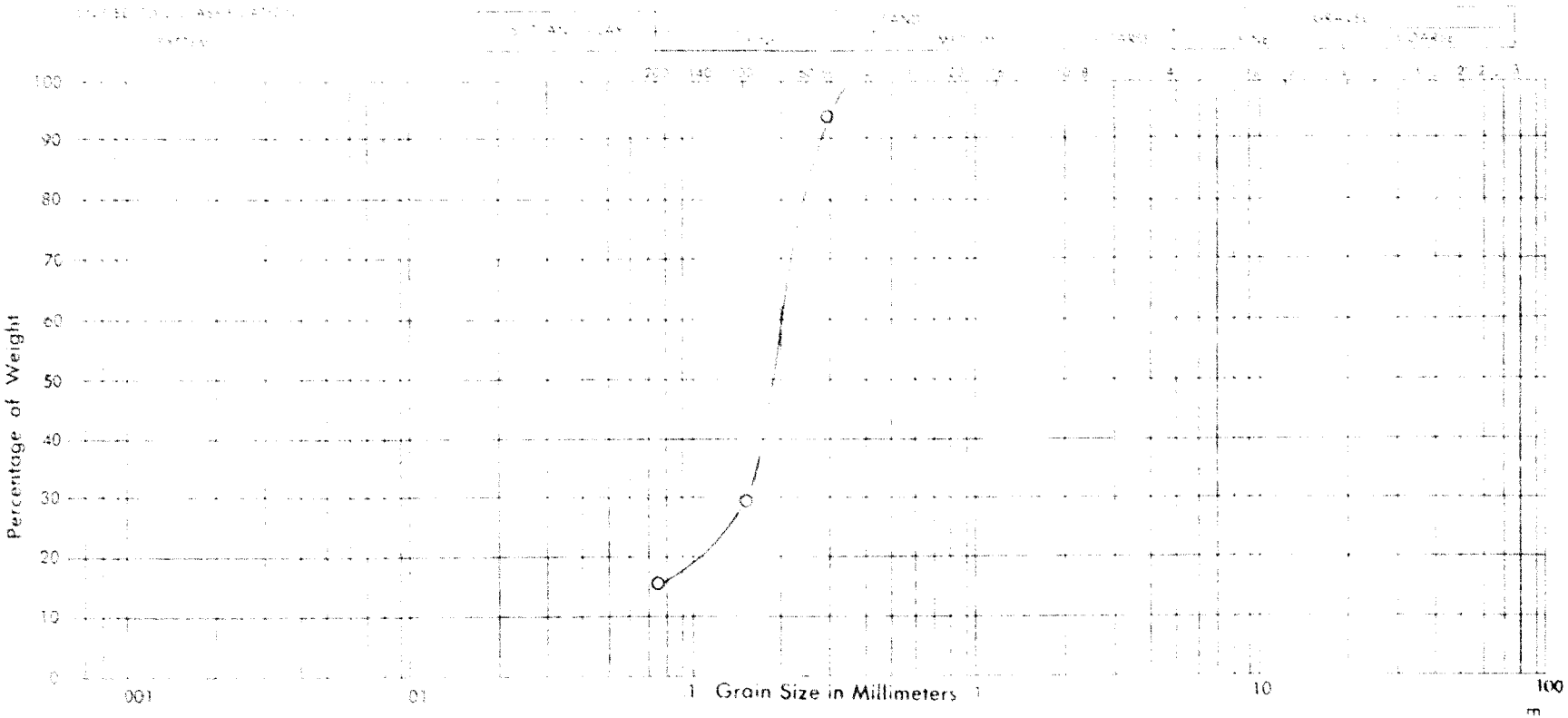
3

Enclosure No. 22

Dominion Soil Investigation Limited

GRAIN SIZE DISTRIBUTION

7-2-48



Project Culvert C-105

County of Middlesex

Boring No. 12

Sample No. 4

Depth of Sample 15'-0" to 16'-0"

Elevation of Sample 253'

Coefficient of Uniformity 5

Coefficient of Curvature

Classification of Sample and Group Symbol:

FINE SAND WITH SOME SILT

Plastic Properties

Liquid Limit

Plastic Limit

Plasticity Index

% Shrinkage Limit

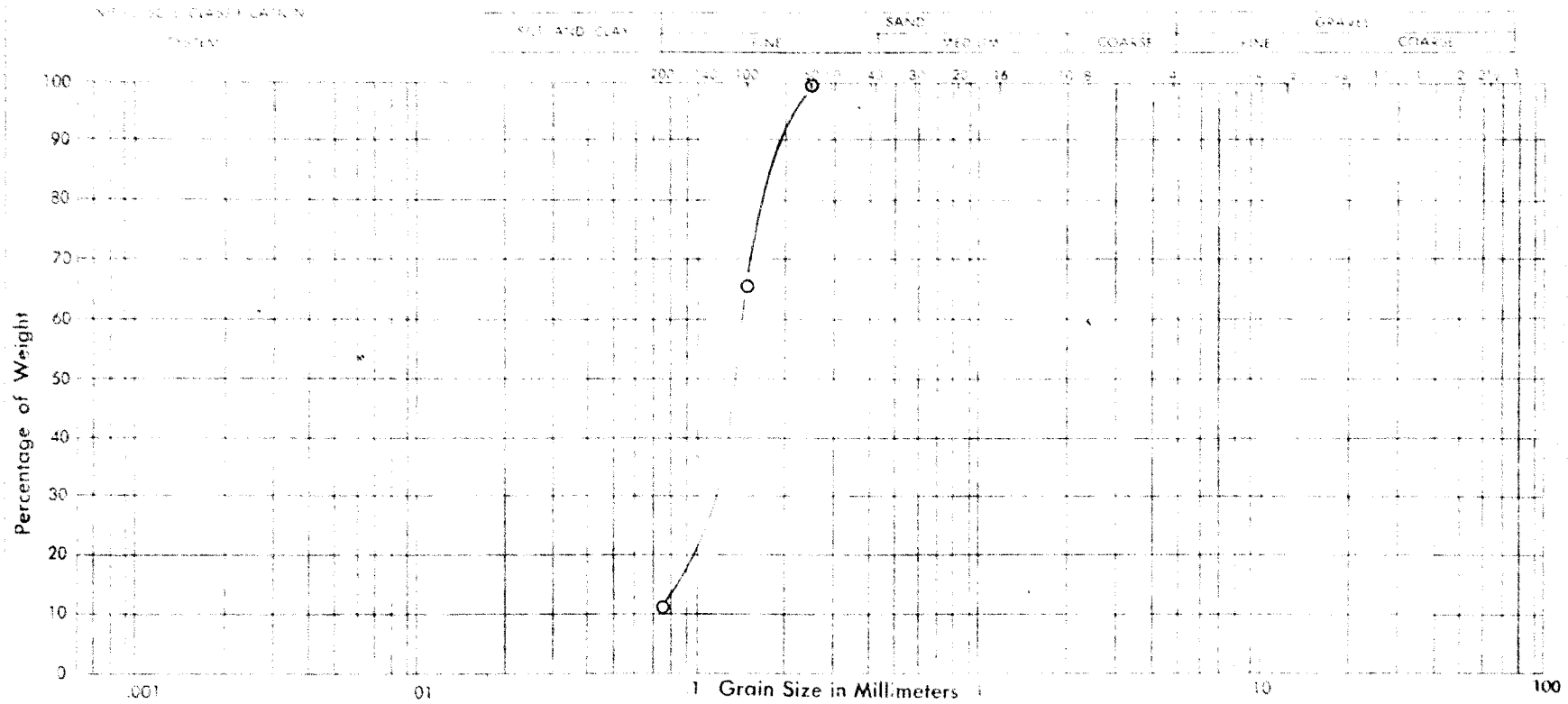
Activity

Enclosure No. 23

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

7-2-L8



PROJECT: Culvert C-166

LOCATION: County of Middlesex

BOREHOLE NO.: 13

SAMPLE NO.: 4

DEPTH OF SAMPLE: 20'-0" to 21'-6"

ELEVATION OF SAMPLE: 751±

COEFFICIENT OF UNIFORMITY: 2

COEFFICIENT OF CURVATURE:

PLASTIC PROPERTIES

LIQUID LIMIT:

PLASTIC LIMIT:

PLASTICITY INDEX:

MOISTURE CONTENT:

ACTIVITY:

Classification of Sample and Group Symbol:

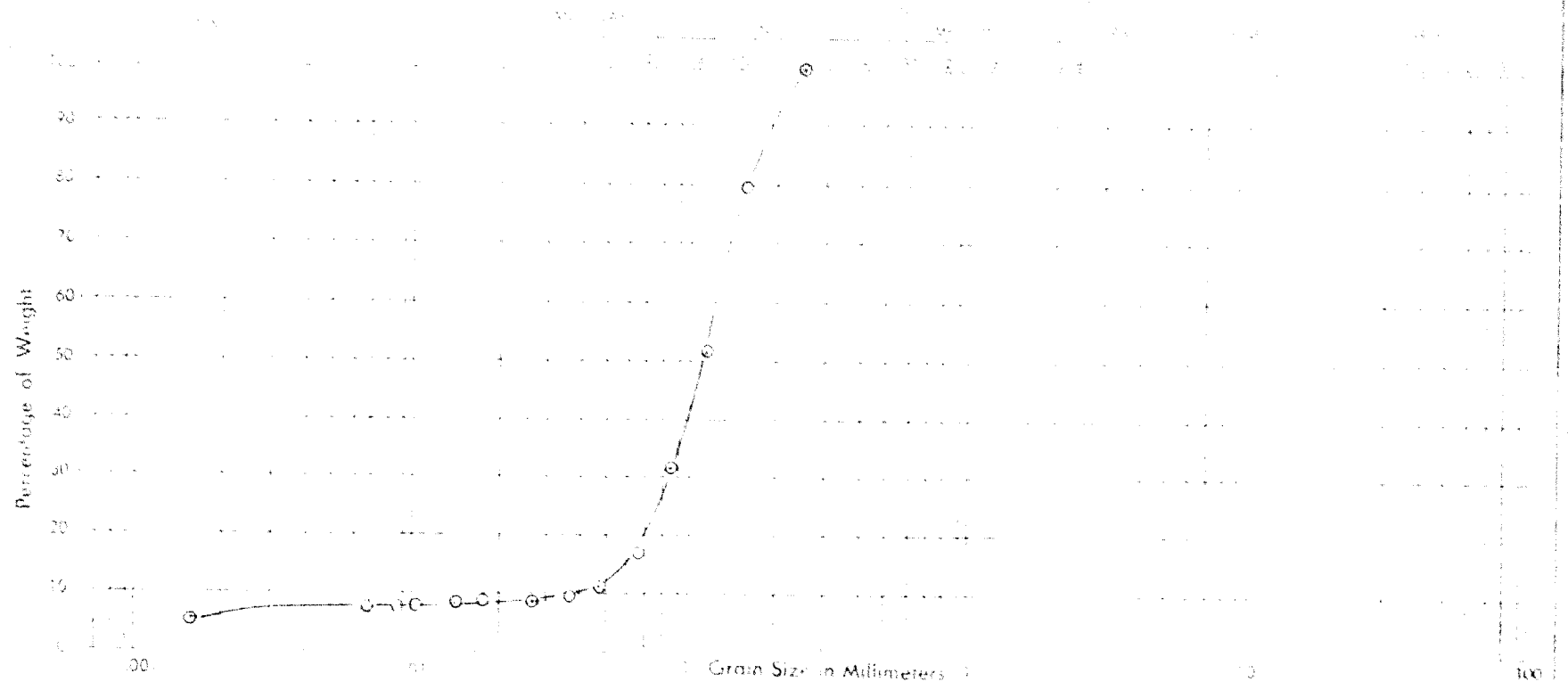
FINE SAND WITH SOME SILT

Enclosure No. 29

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMEN

Dominion Soil Investigation Limited

GRAIN SIZE DISTRIBUTION



3

14

3

15'-0" to 16'-6"

Classification of Sample and Group Symbol:

TRACE OF CLAY

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT