#66-F-225-C

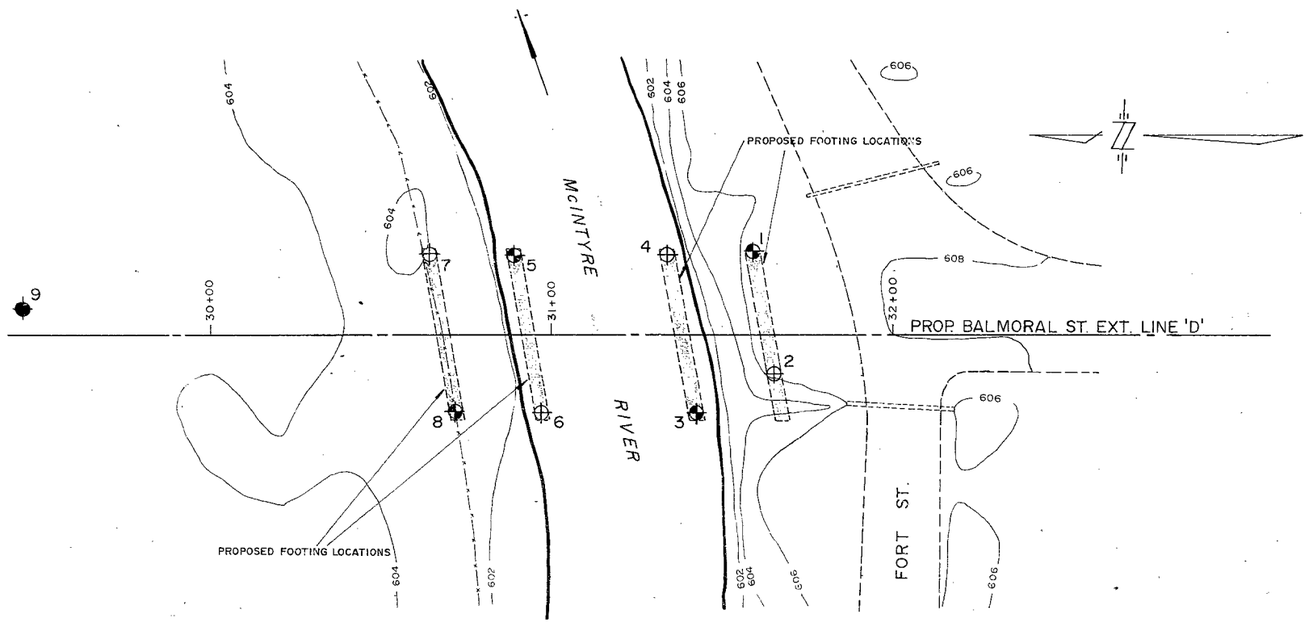
W.P. #919-64

LAKEHEAD

EXPRESSWAY

MCINTYRE

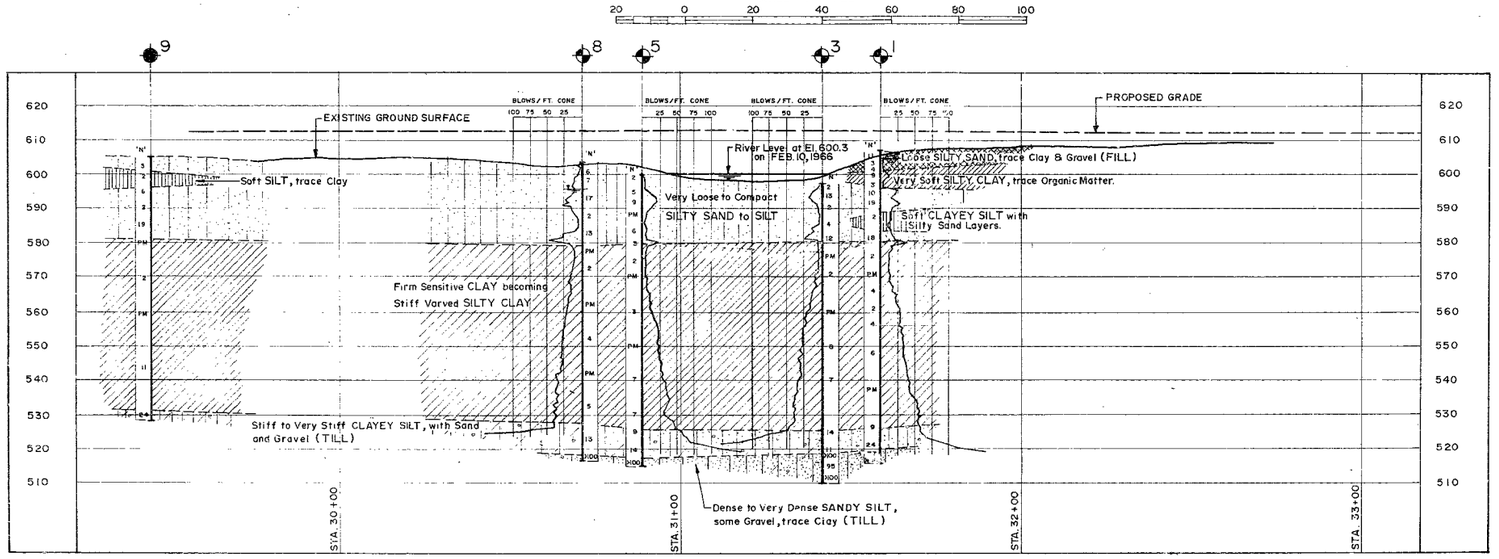
RIVER BRIDGE



PLAN

SCALE IN FEET

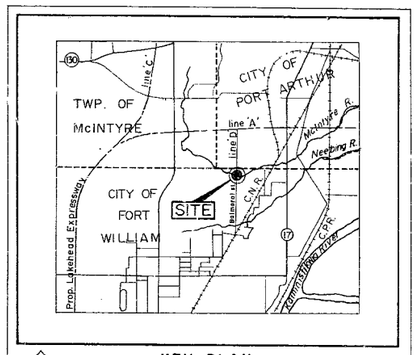
20 0 20 40 60 80 100



SECTION ALONG PROPOSED BALMORAL STREET EXTENSION LINE 'D'

SCALE IN FEET

20 0 20 40 60 80 100



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.

NO.	ELEVATION	STATION	OFFSET
1	607.0	31+59	24' LEFT
2	605.8	31+65	11.5' RIGHT
3	600.3	31+42	23' RIGHT
4	600.3	31+34	23' LEFT
5	600.3	30+89	23' LEFT
6	601.0	30+97	22.5' RIGHT
7	603.9	30+64	23.5' LEFT
8	603.5	30+72	22.5' RIGHT
9	605.0	29+45	8' LEFT

– NOTE –

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO	FOR	DATE

REVISIONS			
	DATE	BY	DESCRIPTION

H. Q. GOLDER & ASSOCIATES LTD.

DEPARTMENT OF HIGHWAYS – ONTARIO

MATERIALS & TESTING DIVISION – FOUNDATION SECTION

McINTYRE RIVER

BALMORAL STREET EXTENSION LINE 'D' DIST. NO. 19

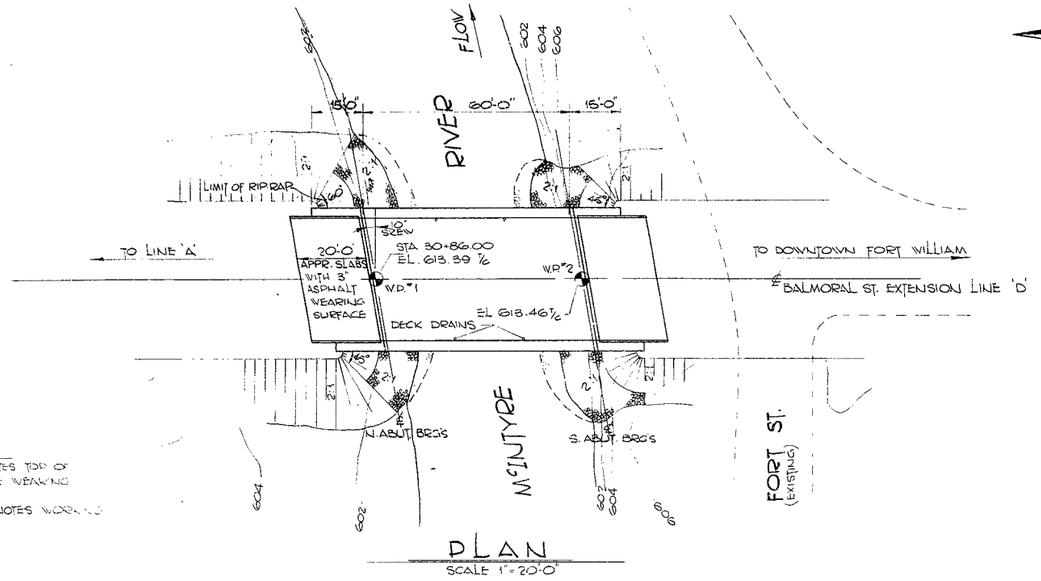
DISTRICT OF THUNDER BAY CITY OF FORT WILLIAM

TWP. OF McINTYRE LOT – CON. –

BORING PLAN & SOIL STRATIGRAPHY SECTION

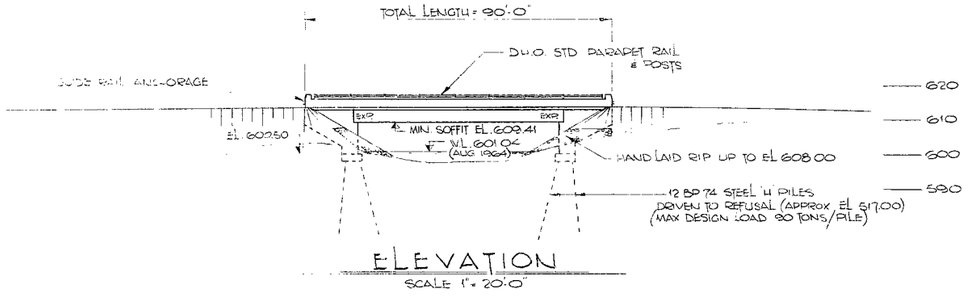
SUBM'D	CHECKED	W.P. NO. 919-64	DRAWING NO.
DRAWN M.W.	CHECKED	JOB NO. 66002	
DATE FEB. 16, 1966		SITE NO	BRIDGE DRAWING NO.
APPROVED PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	

REF. No. E-4532-1

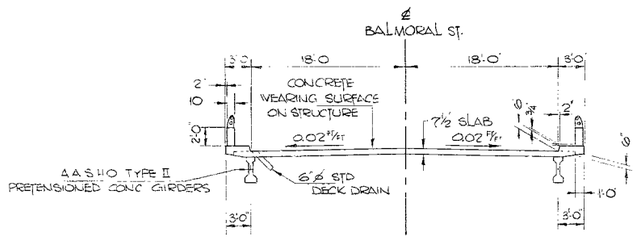


PLAN
SCALE 1" = 20'-0"

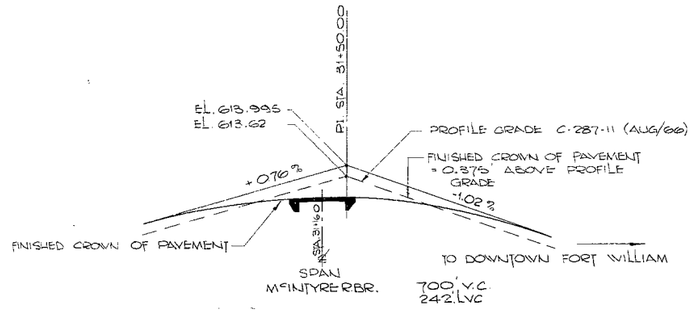
NOTES
- ℄ DENOTES TOP OF CONCRETE WEARING SURFACE
- W.P. DENOTES WORK POINT



ELEVATION
SCALE 1" = 20'-0"



TYPICAL DECK SECTION
SCALE ⅛" = 1'-0"



PROFILE OF BALMORAL ST.
N.T.S.

10° SKEW DATA

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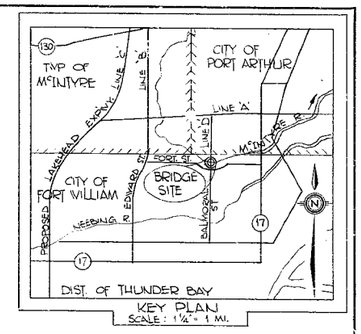
COS. 0.98480078
TAN. 0.17633270
SEC. 1.01542766



KEY PLAN
SCALE: 1¼" = 1 MI.

B.M. ELEV. 604.66
GEODETIC ORIGIN
TOP OF 1"Ø IRON BAR 50' LT. OF STA. 29+71.0

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

McINTYRE RIVER BRIDGE
ON BALMORAL ST. EXTENSION

KING'S HIGHWAY No. LAKEHEAD EXPWAY. LINE 'D' DIST. No. 19
DIST. OF THUNDER BAY
CITY OF FORT WILLIAM LOT CON.

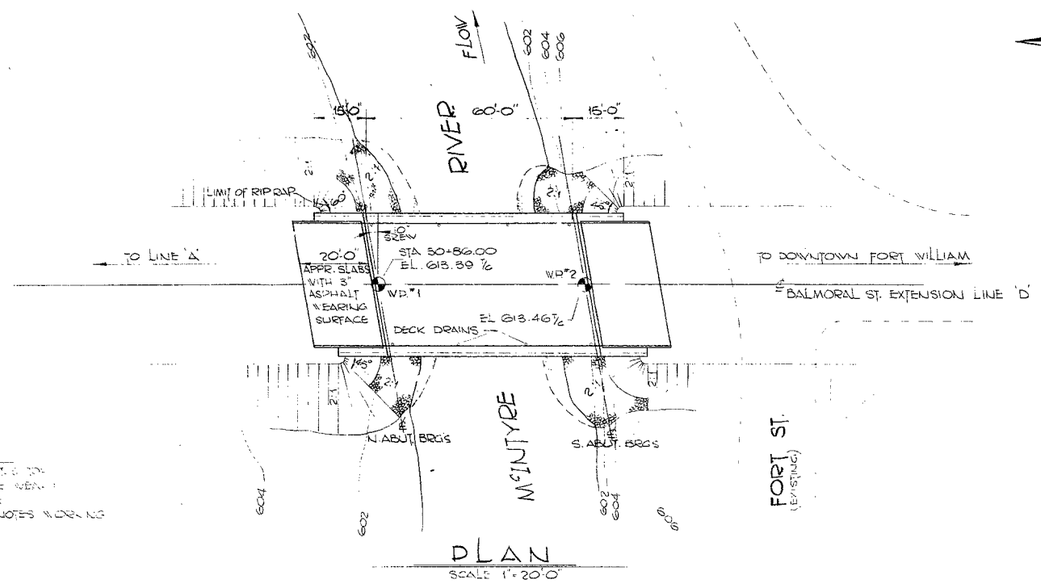
PRELIMINARY PLAN

APPROVED _____ BRIDGE ENGINEER

DESIGN	K.G.B.	CHECK	
DRAWING	G.T.	CHECK	
DATE	MAY '67	LOADING	H520-44

SITE No. 48C-103 | W.P. No. 319-64
CONTRACT Nos.
DRAWING No. D-5925-P1

PRINT RECORD	
FOR	DATE

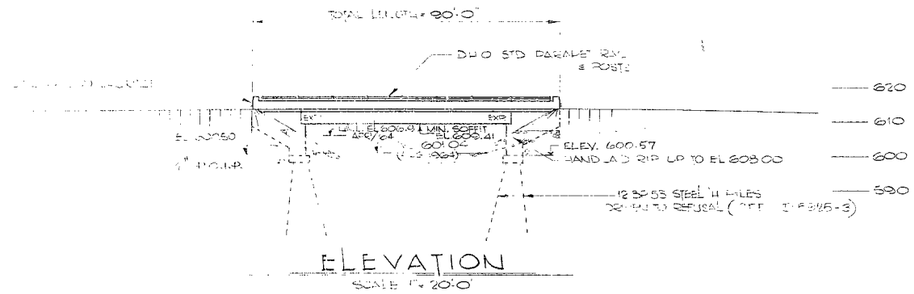


PLAN

SCALE 1"=20'-0"

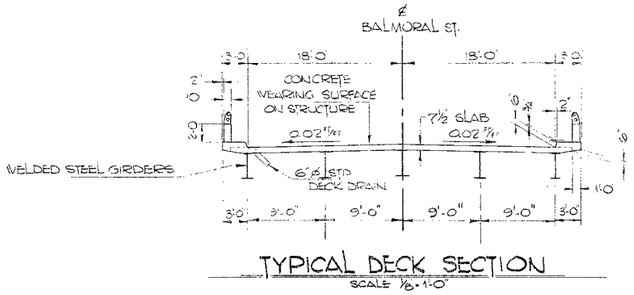
NOTES

- 1. DENOTES 8" CONCRETE WEARING SURFACE
- W.P. DENOTES WORKING POINT



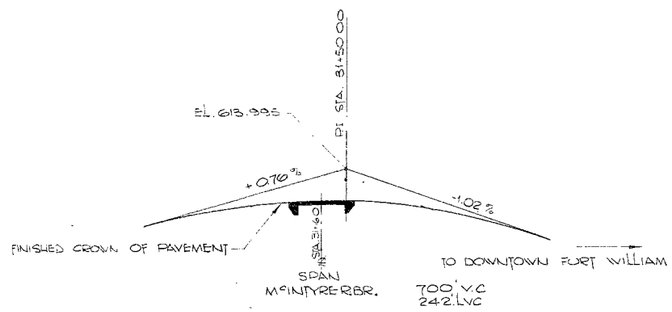
ELEVATION

SCALE 1"=20'-0"



TYPICAL DECK SECTION

SCALE ⅛"=1'-0"



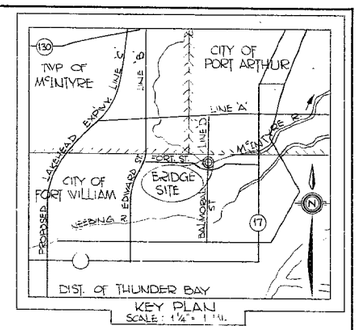
PROFILE OF BALMORAL ST.

N.T.S.

10° SKEW DATA

SIN. 0.1736482
COS. 0.9848078
TAN. 0.1763270
SEC. 1.0154266

LIST OF DRAWINGS



KEY PLAN

SCALE: 1½" = 1 MI.

GENERAL NOTES.

CLASS OF CONCRETE

- DECK, CURBS & CONCRETE ABOVE CURBS — 4000 P.S.I.
- REMAINDER — 3000 P.S.I.

CLEAR COVER ON REINFORCING STEEL

- FOOTINGS, ABUTMENTS - DECK TOP & BOTTOM: 3" 3" 1½" 1"
- CURBS, APPR. SLABS, END POSTS & PARAPET WALL: 2" 2" 1½"

CONSTRUCTION NOTES

- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± ⅛".
- NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED

BM ELEV. 604.66
GEODETIC ORIGIN
TOP OF 1" ø IRON BAR 50' LT. OF STA. 29+71.0

REVISIONS	DATE	BY	DESCRIPTION

12 Aug 66

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION
MICKELSON FRASER & BROWNE
CONSULTING ENGINEERS & ARCHITECTS

McINTYRE RIVER BRIDGE

ON BALMORAL ST. EXTENSION

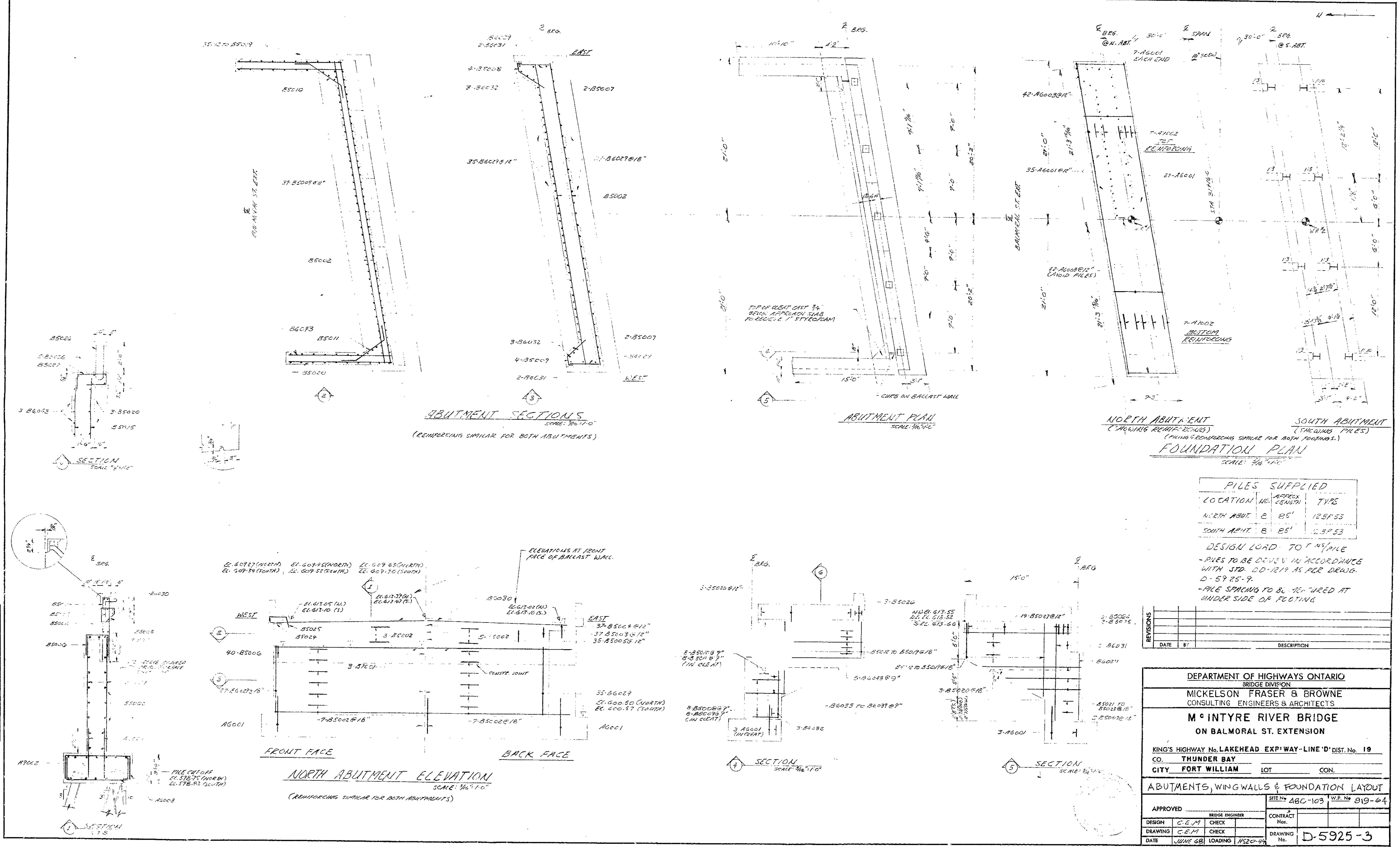
KING'S HIGHWAY No. LAKEHEAD EXPWY. LINE 'D' DIST. No. 19
DIST. OF THUNDER BAY
CITY OF FORT WILLIAM LOT CON.

GENERAL LAYOUT

APPROVED _____ BRIDGE ENGINEER

DESIGN	J.E.M.	CHECK		SITE No. 48C-103	W.P. No. 919-64
DRAWING	G.T.	CHECK	C.E.M.	CONTRACT Nos.	
DATE	JULY '68	LOADING	H520-44	DRAWING No.	D-5925-1

PRINT RECORD		
N	FOR	DATE



PILES SUPPLIED

LOCATION	NO.	APPROX LENGTH	TYPE
NORTH ABUT.	8	85'	12BP53
SOUTH ABUT.	8	85'	12BP53

DESIGN LOAD 70 TNS/PILE

- PILES TO BE DRIVEN IN ACCORDANCE WITH STD. DD-1219 AS PER DRWG. D-5925-9.
- PILE SPACING TO BE MEASURED AT UNDER SIDE OF FOOTING

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

MICKELSON FRASER & BROWNE
CONSULTING ENGINEERS & ARCHITECTS

McINTYRE RIVER BRIDGE
ON BALMORAL ST. EXTENSION

KING'S HIGHWAY No. LAKEHEAD EXP'WAY-LINE 'D' DIST. No. 19
CO. THUNDER BAY
CITY FORT WILLIAM LOT CON.

ABUTMENTS, WINGWALLS & FOUNDATION LAYOUT

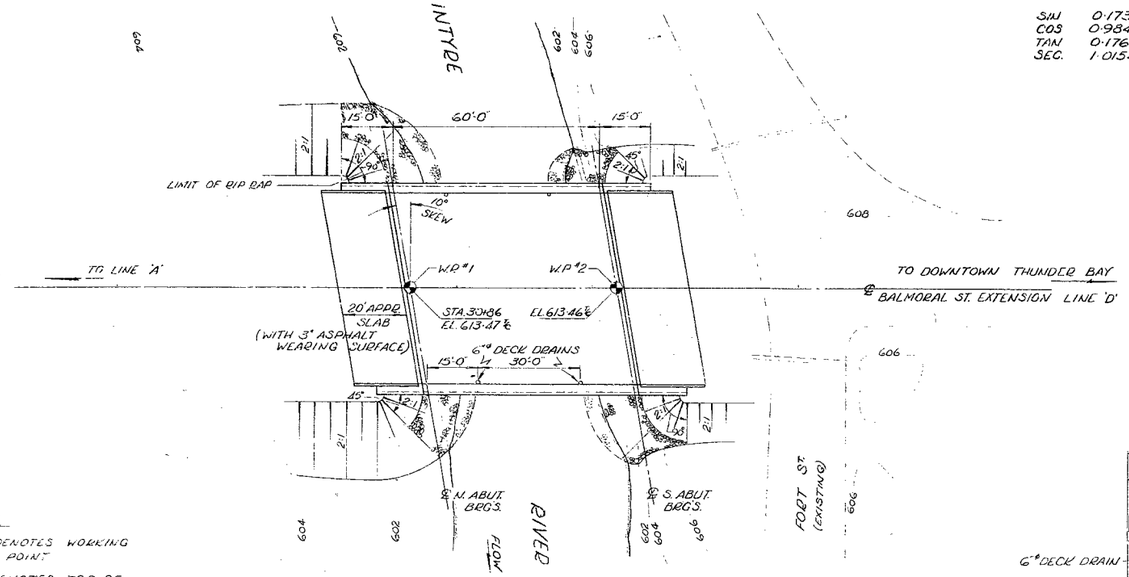
SITE No 48C-103 W.P. No 919-64

APPROVED ______ BRIDGE ENGINEER

DESIGN	C.E.M	CHECK	
DRAWING	C.E.M	CHECK	
DATE	JUNE 68	LOADING	HS20-44

CONTRACT Nos.

DRAWING No. D-5925-3



PLAN

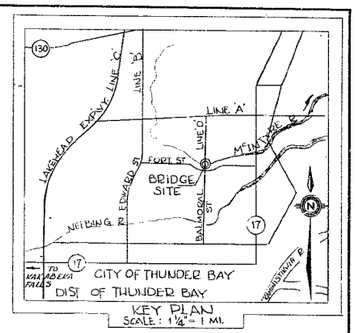
SCALE 20 FT. = 1 IN.

NOTE

- W.P. DENOTES WORKING POINT
- ℄ DENOTES TOP OF CONCRETE WEARING SURFACE

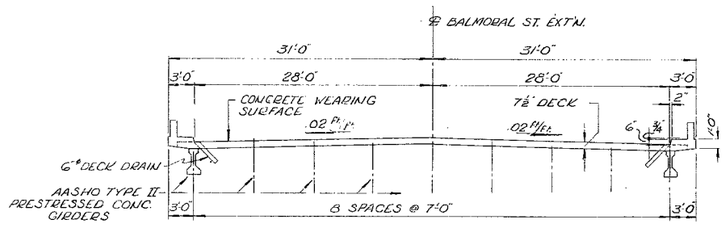
10° SKEW DATA

SIN	0·1736482
COS	0·9848078
TAN	0·1763270
SEC.	1·0154266



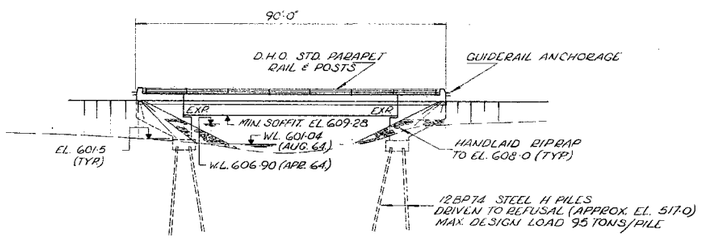
KEY PLAN

SCALE: 1 1/2" = 1 MI.



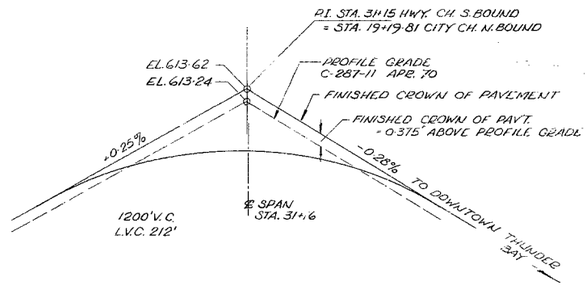
TYPICAL DECK SECTION

SCALE 1/8 IN. = 1 FT.



ELEVATION

SCALE 20 FT. = 1 IN.



PROFILE OF BALMORAL ST. EXT'N.

NOT TO SCALE

B.M. ELEV. 604·66

GEODETIC ORIGIN

- TOP OF 1" IRON BAR 50' LT. OF STA. 29+71·0

REVISIONS			
APR 70	M.J.O.	THIS DRAWING SUPERSEDES DWG'S D3925-1708 DUE TO DECK WIDENING & REV. PROFILE GRADES	
DATE	BY	DESCRIPTION	

PRINT RECORD		
No.	FOR	DATE

FOR REDUCED PLAN

USE SCALE BELOW

0 1 2 3

3 INCHES ON ORIGINAL PLAN

DEPARTMENT OF HIGHWAYS ONTARIO

BRIDGE DIVISION

McINTYRE RIVER BRIDGE

ON BALMORAL ST. EXTENSION

KING'S HIGHWAY No. LAKEHEAD EXP'WAY LINE 'D' DIST. No. 19

DIST - THUNDER BAY

CITY - THUNDER BAY LOT CON.

PRELIMINARY PLAN

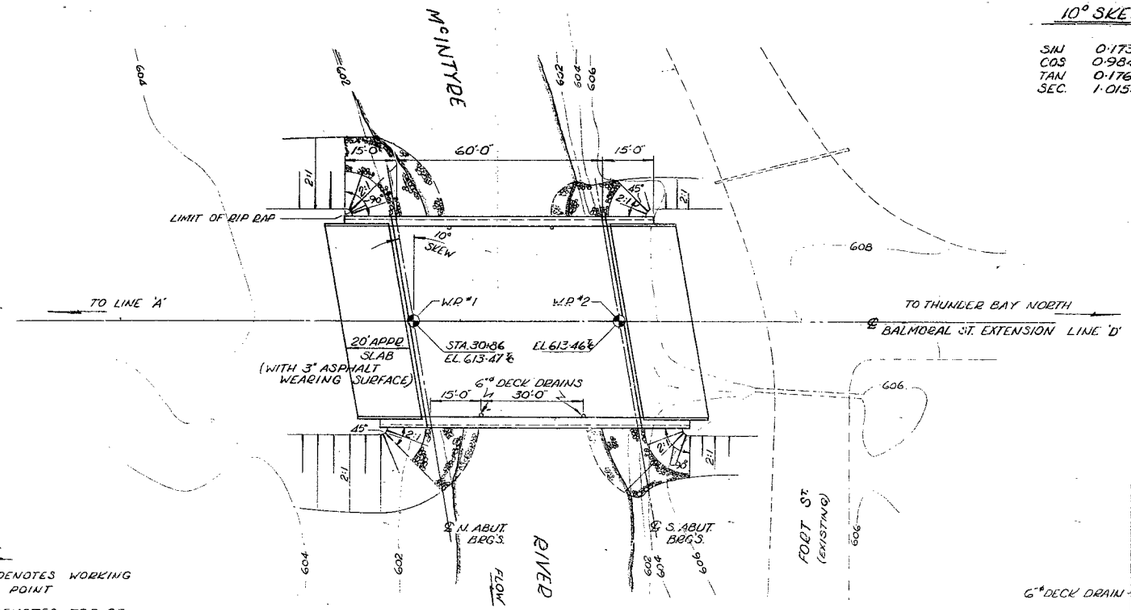
APPROVED _____ BRIDGE ENGINEER

DESIGN	M.J.O.	CHECK	E.G.B.
DRAWING	M.J.O.	CHECK	E.G.B.
DATE	APR 70	LOADING	1/S20-44

SITE No. 48C-103 W.P. No. 919-64

CONTRACT Nos.

DRAWING No. D6836-P1



PLAN

SCALE 20 FT. = 1 IN.

NOTE

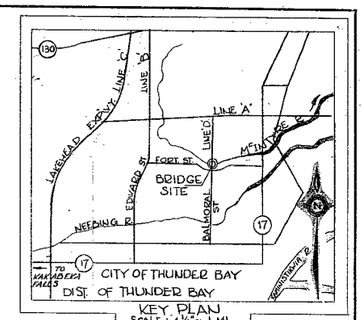
- W.P. DENOTES WORKING POINT
- ℄ DENOTES TOP OF CONCRETE WEARING SURFACE

10° SKEW DATA

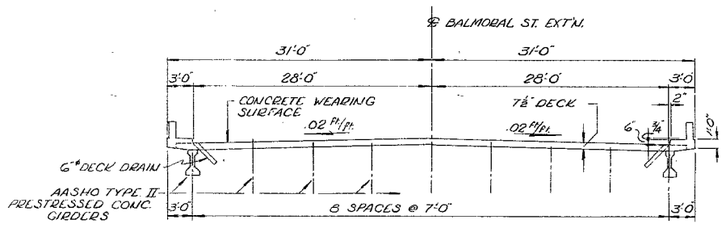
SIN	0·1736482
COS	0·9848078
TAN	0·1763270
SEC.	1·0154266

LIST OF DRAWINGS

D6836-1	GENERAL LAYOUT
-2	BOREHOLE LOCATION & SOIL STRATA
-3	FOOTING LAYOUT & DETAILS
-4	ABUTMENTS
-5	PRESTRESSED GIRDERS & BEARINGS
-6	DECK
-7	APPROACH SLABS
-8	PARAPET WALL DETAILS
-9	STANDARD STEEL PARAPET RAIL
-10	STANDARD DETAILS I
D6836-11	STANDARD DETAILS II

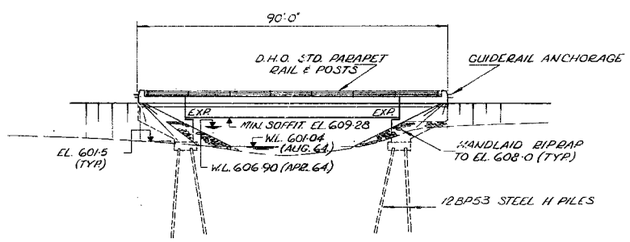


KEY PLAN
SCALE: 1¼" = 1 MI.



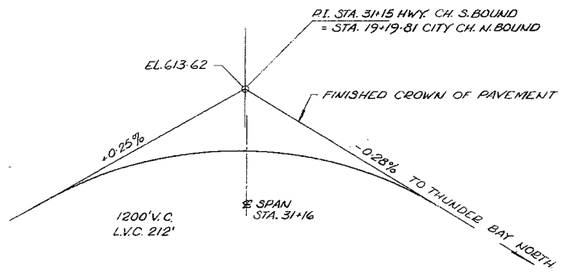
TYPICAL DECK SECTION

SCALE ⅛ IN. = 1 FT.



ELEVATION

SCALE 20 FT. = 1 IN.



PROFILE OF BALMORAL ST. EXT'N.

NOT TO SCALE

NOTES:

- CLASS OF CONCRETE
  - DECK & PARAPET WALLS — 4000 P.S.I.
  - PRESTRESSED GIRDERS — 5000 P.S.I.
  - REMAINDER — 3000 P.S.I.
- CLEAR COVER ON REINFORCING STEEL
  - FOOTINGS & ABUTMENTS — 3"
  - DECK TOP — 1½"
  - DECK BOTTOM — 1"
  - CURBS — 2"
  - PARAPET WALL — 1⅛"
- CONSTRUCTION NOTES
  - THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 1/8"
  - NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED

B.M. ELEV. 604·66

GEODETIC ORIGIN
- TOP OF 1" IRON BAR 50' LT. OF STA. 29+71·0

REVISIONS	DATE	BY	DESCRIPTION

PRINT RECORD	FOR	DATE

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

Order 166

McINTYRE RIVER BRIDGE

ON BALMORAL ST. EXTENSION

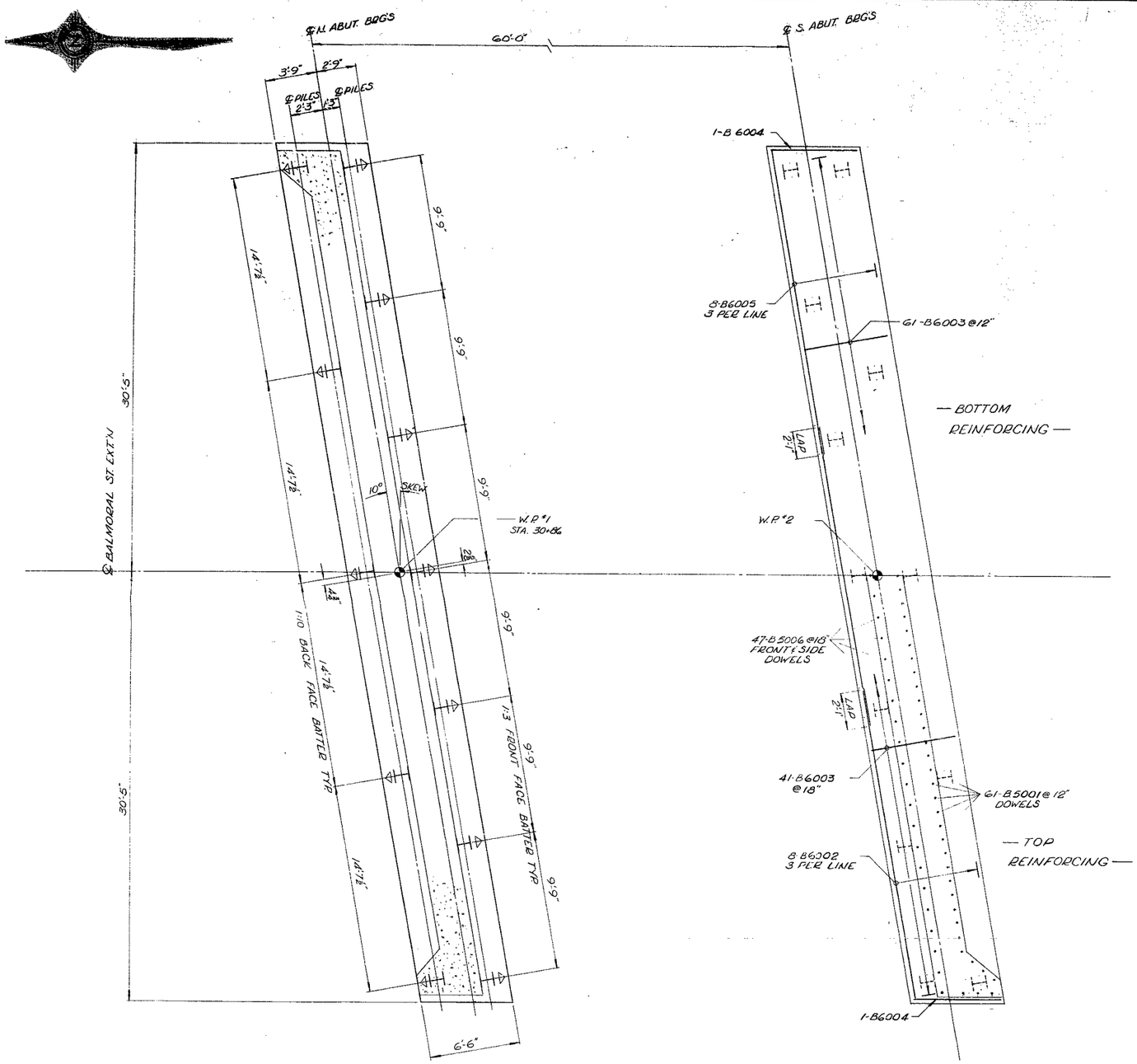
KING'S HIGHWAY No. LAKEHEAD EXPRESSWAY LINE 'D' DIST. No. 19

DIST - THUNDER BAY

CITY - THUNDER BAY LOT CON.

GENERAL LAYOUT

APPROVED	BRIDGE ENGINEER			SITE No. 48C-103	W.P. No. 919-64
DESIGN	M.J.O.	CHECK	R.S.R.	CONTRACT Nos.	
DRAWING	M.J.O.	CHECK	R.S.R.	DRAWING No.	D6836-1
DATE	JUN. 70	LOADING	H20-44		

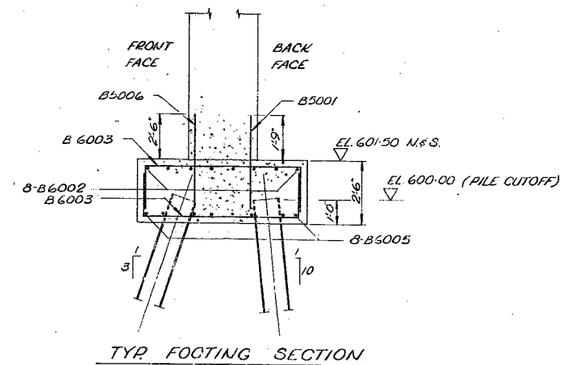


PILE LAYOUT

REINFORCING DETAILS

FOOTING LAYOUT

SCALE 1/4 IN. = 1 FT.



TYP. FOOTING SECTION

SCALE 3/8 IN. = 1 FT.

PILE DATA			
LOCATION	No	LENGTH	TYPE
N. ABUTMENT	12	83'0"	12 BP 53
S. ABUTMENT	12	83'0"	12 BP 53

- PILE DESIGN LOAD 70T PER PILE
- PILES SHALL BE DRIVEN TO REFUSAL IN ACCORDANCE WITH STD. 201219 DWG. D6836-10
- NORTH AND SOUTH ABUTMENTS ARE SIMILAR
- PILE DIMENSIONS MEASURED AT BOTTOM OF FOOTING

PRINT RECORD		
No.	FOR	DATE

REVISIONS			
	DATE	BY	DESCRIPTION

FOR REDUCED PLAN

USE SCALE BELOW

0 1 2 3

3 INCHES ON ORIGINAL PLAN

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

Original Signed

McINTYRE RIVER BRIDGE
ON BALMORAL ST. EXTENSION

KING'S HIGHWAY No. LAKEHEAD EXP'WAY LINE 'D' DIST. No. 19
DIST. THUNDER BAY
CITY. THUNDER BAY LOT CON.

FOOTING LAYOUT & DETAILS

APPROVED ____ BRIDGE ENGINEER				SITE No. 18C-103	W.P. No. 919-64
DESIGN	M.J.O.	CHECK	R.S.R.	CONTRACT Nos.	
DRAWING	M.J.O.	CHECK	R.S.R.	DRAWING No.	D6836-3
DATE	JUNE 70	LOADING	H520-44		

66-F-225C

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN
L. G. SODERMAN
J. L. SEYCHUK

2444 BLOOR STREET WEST
TORONTO 9, ONTARIO
763-4103
767-9201

W.P. 919-64

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SOIL CONDITIONS AND FOUNDATIONS

PROPOSED McINTYRE RIVER BRIDGE

BALMORAL STREET EXTENSION - LINE D

FORT WILLIAM ONTARIO

Distribution:

11 copies - Department of Highways, Ontario, Toronto, Ontario.

2 copies - H. Q. Golder & Associates Ltd., Toronto, Ontario.

March, 1966

66002

TABLE OF CONTENTS

ABSTRACT

The results of an investigation to determine the subsoil conditions at the proposed McIntyre River crossing along the extension of Balmoral Street in the City of Fort William, Ontario, are reported and recommendations are made for the foundation design and construction of the proposed bridge structure and roadway approach embankments.

It was found that the site is covered by some 20 to 25 feet of very loose to compact silty sand to silt which overlies a 55 foot thick deposit of firm sensitive clay becoming stiff varved silty clay with depth. Below the clay deposit there is a stiff to very stiff clayey silt till grading into dense to very dense sandy silt till at a depth of about 82 feet below the river bed.

It is recommended that the proposed bridge structure be founded on either steel "H" piles or cast-in-place concrete piles end bearing in the dense sandy silt till. Consideration is given to placing the structure on friction piles driven to various depths within the clay deposit. Computations show that settlements ranging from about 12 inches for 30 foot long timber piles and about 9 inches for 50 foot long precast concrete piles would take place. Friction piles are not considered a practical foundation solution for this site.

A series of flexible pipe culverts is considered as an alternative to a bridge structure for this crossing.

The roadway approach embankments, with 2 horizontal to 1 vertical side and end slopes, should be stable provided that all soft surficial deposits overlying the sands and silts are removed beneath the full base width of the proposed embankments. Long term settlement of a 10 foot high approach fill at the north end of the proposed structure, due to the consolidation of the underlying clay deposit, is estimated to be of the order of 12 inches.

INTRODUCTION

H. Q. Golder & Associates Ltd. have been retained by the Department of Highways, Ontario, to carry out a soil investigation for a proposed bridge over the McIntyre River adjacent to the intersection of Fort Street and Balmoral Street in the City of Fort William, Ontario. The proposed river crossing and subsequent extension of Balmoral Street, referred to as line 'D', will form part of the Lakehead Expressway. The purpose of this investigation was to determine the subsoil conditions at the site and to provide information for the foundation design and construction of the bridge structure.

PROCEDURE

The field work for this investigation was carried out during the period February 2 to 19, 1966. A total of five boreholes, numbered 1, 3, 5, 8 and 9, were put down by the wash-boring method using a diamond machine drillrig supplied and operated by Canadian Londyear Limited. Dynamic penetration tests were carried out adjacent to four of the boreholes as well as at four other locations as shown on Figure 1. Borings 1, 8 and 9 were put down on land while borings 3 and 5 were carried out from the river ice surface. The borings were advanced in NX and BX casing size to depths ranging from 77 to 91 feet below ground surface. Sealed standpipes were installed in

two of the borings to determine the groundwater level. The field work was supervised throughout by an engineer from our staff.

Detailed logs of each boring are given on the Records of Boreholes following the text of this report. The locations of the borings and the dynamic penetration tests, together with a section of the inferred soil stratigraphy across the site, are shown on Figure 1 located in a pocket following the Record of Borehole sheets.

Samples obtained during the investigation were shipped to our laboratory for detailed examination and testing. The results of the tests carried out are shown on the Records of Boreholes and on Figures 2 to 7, inclusive.

The elevations in this report were determined by means of a hand level from temporary bench marks established by the Department of Highways, Ontario, at the proposed north and south abutment locations and on the river ice level. It is understood that the elevations provided are referred to Geodetic datum.

SITE AND GEOLOGY

The site is located at the proposed Balmoral Street extension over the McIntyre River, immediately north of the intersection of Fort Street and Balmoral Street in the City of Fort William, Ontario.

The McIntyre River, which is some 50 to 60 feet wide at the proposed crossing location, flows in an easterly direction through a relatively flat plain having light tree growth, and empties into Lake Superior some 2 miles to the east.

Available geological information indicates that the overburden in the vicinity of the site consists of clays, silts and fine sands mainly of lacustrine and deltaic origin underlain by glacial till. Bedrock in this area consists mainly of shale, conglomerate or greywacke of the Animike series of Precambrian time with occasional occurrences of diabase sills.

SOIL CONDITIONS

The detailed stratigraphy encountered in each borehole is given on the Records of Boreholes and on Figure 1. A summary plot of the significant engineering properties of the subsoil determined from field and laboratory tests is given on Figure 7. Following is a summarized account of the soil conditions at the site.

Fill consisting of loose brown silty sand with a trace of clay and gravel and containing pieces of wood and cinders was encountered in borehole 1 for a depth of about 6 feet below ground surface. A grain size distribution curve obtained from a sample of the fill is shown on Figure 2.

In general, the upper 20 to 25 feet of the subsoil, that is down to about elevation 580, is comprised predominantly of silty sand to silt. In boreholes 1 and 9, very soft to soft clayey silt to silty clay layers or pockets, as much as 6 feet in thickness, were encountered within the very loose to compact essentially granular deposit. Several grain size distribution curves for samples of the sand and silt are given on Figure 2.

The surficial sand and silt deposit is underlain by an extensive stratum of firm clay becoming stiff varved silty clay with depth. This stratum is some 55 feet thick and extends down from about elevation 580 to 525. In general, the upper portion of the stratum is essentially a homogeneous clay but contains some ¼ to 1 inch thick clayey silt and fine sand layers. In the lower portion of the stratum the layering forms a uniform pattern consisting of alternating ¼ to 1 inch thick layers of clay and clayey silt. Several grain size distribution curves for samples of the clay are given on Figure 3. These curves represent the grading characteristics obtained from bulk samples of the clay without separation of individual layers.

The results of in situ vane and laboratory strength testing on the clay are given on the Records of Boreholes and summarized on Figure 7. As shown by the plot on Figure 7, there is a definite

trend for an increase in the undrained shear strength of the clay with depth.

The liquidity index of the clay, which is the ratio of natural water content minus the plastic limit to plasticity index, ranges from 0.5 to 1 and is generally of the order of 0.8. The sensitivity of the clay, as determined by the remoulded vane shear test results, decreases with depth from about 6 in the upper portion of the stratum to about 3 in the lower portion.

Two consolidation tests were carried out on samples of the clay taken from boreholes 1 and 3. The results of these tests, which are presented on Figures 5 and 6, show that the clay is normally consolidated with respect to existing overburden pressure.

Underlying the clay stratum there is a deposit of glacial till extending down to the full depth of exploration. The upper 6 to 8 feet of the till consists of a stiff to very stiff dark grey clayey silt with sand and gravel. Below about elevation 518 to 520 the till is more granular in composition being comprised of dense to very dense sandy silt with some gravel and a trace of clay. The presence of cobbles and boulders within the till necessitated the use of diamond drilling to advance boreholes 1 and 3. Typical grading curves for samples of the till, obtained using 1½ inch I.D. sampling equipment, are shown on Figure 4.

GROUNDWATER CONDITIONS

Standpipes were installed in boreholes 1 and 8, following completion of sampling, to determine the groundwater level at the proposed abutment locations. Details of these installations are given on the Records of Boreholes. Periodic water level readings were taken in the standpipes during the course of the field work and the latest results are given on the Records of Boreholes and on Figure 1.

The groundwater level, as measured in the borings following completion of the field work, was found to be within a few feet of the river water level, which was at elevation 600.3 at the time of the investigation.

DISCUSSION

General

It is understood that the proposed 3 span bridge structure will be about 95 feet long with 25 foot end spans and a 45 foot central span, to be located along the extension of Balmoral Street as shown on Figure 1. Structural details of the proposed bridge are not available at this time but it is understood that spill-through abutments will be used. The proposed roadway grade will be as much as 10 feet above existing ground surface.

This investigation shows that the site is covered by some 20 to 25 feet of very loose to compact silty sand to silt which overlies a 55 foot thick deposit of firm sensitive clay becoming stiff varved silty clay with depth. Below the clay deposit there is a stiff to very stiff clayey silt till grading into dense to very dense sandy silt till at a depth of about 82 feet below the river bed.

Foundations

Because of the generally loose nature of the surficial granular deposit and low strength of the underlying clay, it is recommended that the proposed structure be founded on steel "H" piles driven to practical refusal within the dense sandy silt till stratum. Cast-in-place concrete piles end bearing in the till would also be suitable. Taking a 12BP74 steel "H" section driven to a final set of about 15 blows/inch, and at least 100 blows for the last foot of driving, with a hammer delivering 22,500 ft.lb. of energy per blow, the allowable load per pile may be taken as 50 tons for design purposes. Settlement of the structure founded on piles driven to practical refusal in the till should be negligible.

As an alternative, consideration has been given to founding the proposed structure on friction piles. Since the upper

silty sand could be subject to erosion by river scour, timber piles driven to a minimum depth of 30 feet below the river bed have been considered. Based on an assumed angle of internal friction, ϕ, = 30° and a coefficient of lateral earth pressure, K, = 1.0 for the upper silty sand and using an average undrained shear strength of 600 lb/sq.ft. in the upper 10 feet of the clay deposit, the ultimate bearing capacity of a single timber pile having an average diameter of 10 inches is computed to be about 15 tons. The ultimate bearing capacity of a pile group, taking the piles to act as a deep footing having a width of 5 feet and a length of 50 feet in plan placed at a 30 foot depth and allowing for frictional resistance around the group perimeter, is computed to be 735 tons. Using a factor of safety of 3, this loading would impose a bearing pressure of about 1 ton/sq.ft. on the surface of the clay deposit.

The piers and abutments, if placed on timber piles as discussed above, would experience settlement due to long term consolidation of the underlying clay deposit. The total settlement of a pile group having a plan area of 5 feet by 50 feet has been computed to be of the order of 12 inches. This is considered to be excessive for the proposed structure.

Consideration has also been given to founding the structure on precast concrete piles driven to a depth of 50 feet below

the river bed. Using $\phi = 30^{o}$ and K = 1.0 for the upper silty sand, as for the timber piles, and an average undrained shear strength of 700 lb/sq.ft. in the clay deposit, the ultimate bearing capacity of a single pile 16 inches in diameter is computed to be about 50 tons. The settlement of a concrete pile group 5 feet by 50 feet in plan size, imposing an average loading of 2 tons/sq.ft. in the clay (factor of safety of 3 on the ultimate group capacity), is computed to be about 9 inches. This too is considered to be excessive for the proposed bridge and as settlement is virtually eliminated and the capacity of piles greatly increased by driving into the till, friction piles are not a practical foundation solution for this site.

An alternative to a bridge structure for this crossing is a series of corrugated steel pipe arches, provided that the maximum flow during flood conditions can be accommodated.

The culverts could be placed on 2 to 3 foot thick bedding pads consisting of free-draining sand and gravel, well compacted in 9 to 12 inch lifts. The granular pads may be founded within the silt and sand deposit which was encountered below the river bed in boreholes 3 and 5. Excavation into the sands and silts below the river water to place the granular pads should be carried out within close sheeted cofferdams to prevent a "quick-condition".

Considering the use of 16'-7" x 10'-1" corrugated steel pipe arch culverts placed at an invert elevation of 597, a depth of cover of about 5 feet would be provided if the proposed grade is maintained. With a small widening of the river channel at the crossing location and provision of a 5 foot space between culverts to permit proper compaction of backfill materials, three culverts of the above size could be used. According to the manufacturers specification, three 16'-7" x 10'-1" pipe arch culverts would provide a waterway area of about 390 sq.ft.

Settlement of the culverts will take place due to consolidation of the deep clay deposit underlying the site. It is estimated that the total settlement of each culvert under the central portion and at the ends of the embankment could be of the order of 12 inches and 6 inches, respectively. Consequently each culvert should be placed with a 6 inch camber in the middle in order to accommodate the estimated differential settlement.

Rip-rap cover should be placed over the side slopes of the roadway embankment for the full width of the river channel, extending from the river bottom to at least 3 feet above the high water level, in order to prevent undermining by erosion of the fill. Further, a lip such as steel sheet piling driven into the subsoil should be provided to prevent erosion undermining beneath the ends of the culvert.

Approach Embankments

It is understood that the approach fill to the north abutment will be about 10 feet in height above existing ground surface, while at the south approach the fill required will be of the order of 5 feet. The side and end slopes of the roadway embankments will be no steeper than 2 horizontal to 1 vertical.

There should be no overall stability problems with the proposed roadway approach embankments resting on the sand and silt deposit, provided they are constructed of suitable fill material properly compacted during placing. Prior to placement of the roadway fill, all topsoil, loose fill material and surficial soft clay deposits as in borehole 1 should be removed beneath the full base width of the proposed embankments.

To prevent surface water erosion and gullying of the embankment slopes, provision should be made for having the slopes sodded or seeded and mulched as soon as possible following construction. Rip-rap should be placed over the river banks in the abutment areas to prevent possible erosion undermining of the banks and roadway embankments.

Settlement of the approach embankments will take place due to consolidation of the deep clay deposit underlying the site. Based

on the results of two consolidation tests given on Figures 5 and 6, it is estimated that the total settlement of a 10 foot high approach fill could be of the order of 12 inches. The major portion of this consolidation settlement should take place within a period of about 5 years and will entail considerable maintenance over this period of time, particularly at the transition from the embankment to the bridge structure.

REGISTERED PROFESSIONAL ENGINEER
LEO R. LAHTI
PROVINCE OF ONTARIO

L. R. Lahti, P.Eng.

H. Q. Golder, P.Eng.

LRL:hdg
66002
March 30, 1966.

LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

Standard Penetration Resistance, *N*: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

WH sampler advanced by static weight—weight, hammer

PH sampler advanced by pressure—pressure, hydraulic

PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	*N, blows/ft.*
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	c_u, *lb./sq. ft.*
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer[1]
Q undrained triaxial[2]
R consolidated undrained triaxial[2]
S drained triaxial
U unconfined compression
V field vane test

NOTES:

[1]Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.
[2]Undrained triaxial tests in which pore pressures are measured are shown as $\bar{Q}$ or $\bar{R}$.

PROJECT No. 66202

RECORD OF BOREHOLE 1

LOCATION See Figure 1 BORING DATE FEB. 3-6, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER NX, BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS/FT.
	TOPSOIL				
607.0	GROUND LEVEL				
0.4	LOOSE BROWN SILTY SAND TRACE CLAY AND GRAVEL, PIECES OF WOOD, CINDERS (FILL).		1	6" D.O.	11
601.3			2	" "	3
			3	" "	4
			4	" "	9
5.7	VERY SOFT GREY SILTY CLAY, TRACE OF ORGANIC MATTER.		5	" "	3
596.0					
11.0	COMPACT GREY SILTY SAND, OCCASIONAL SMALL ROOTS.		6	"	10
			7	"	19
589.0					
18.0	SOFT GREY CLAYEY SILT WITH NUMEROUS SILTY SAND LAYERS.		8	"	2
583.0					
24.0	COMPACT GREY SILT AND FINE SAND.		9	T.O.	18
580.0					
27.0	FIRM GREY SENSITIVE CLAY BECOMING STIFF VARVED SILTY CLAY BELOW ABOUT EL. 560 WITH ALTERNATING 1/4" TO 3/4" THICK GREY CLAY LAYERS AND 1/4" TO 1/2" THICK LIGHT GREY CLAYEY SILT LAYERS.		10	D.O.	2
			11	T.O.	PM
			12	D.O.	4
			13	"	2
			14	"	4
			15	"	6
			16	T.O.	PM
526.0			17	D.O.	9
81.0	VERY STIFF DARK GREY CLAYEY SILT WITH SAND AND GRAVEL (TILL)		18	"	24
520.0			19	"	37
87.0	DENSE TO VERY DENSE DARK GREY SANDY SILT SOME GRAVEL TRACE CLAY (TILL)		20	AXT D.O.	100/ 21
515.5					
91.5	END OF HOLE				

ELEVATION SCALE: 610, 600, 590, 580, 570, 560, 550, 540, 530, 520

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT. + - VANE, ⊕ - REM. V. ● - Q. 500 1000 1500 2000 2500

155 — END OF PEN. TEST AT ELEV. 519.0

15 / 10 5 Percent axial strain at failure

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT W_P W W_L 20 40 60 80

ADDITIONAL LAB. TESTING: MH, MH, C H Y=107, H, H Y=124, MH

PIEZOMETER OR STANDPIPE INSTALLATION

CAP
GROUND LEVEL
SAND AND GRAVEL
BENTONITE SEAL
STANDPIPE

W.L. IN STANDPIPE AT ELEV. 605.3 FEB. 19, 1966

VERTICAL SCALE 1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN MW

CHECKED KJ

PROJECT No. 66002

RECORD OF PENETRATION TEST 2

LOCATION See Figure 1 BORING DATE FEB. 7, 1966 DATUM GEODETIC

BOREHOLE TYPE PEN. TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE ELEVN/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
605.8	GROUND LEVEL				
0.0 / 602.8	PROBABLY VERY LOOSE SILTY SAND.				
3.0 / 595.8	PROBABLY VERY SOFT SILTY CLAY				
10.0 / 589.8	PROBABLY COMPACT SILTY SAND				
16.0 / 581.8	PROBABLY SOFT CLAYEY SILT WITH SILTY SAND LAYERS.				
24.0 / 578.8	PROBABLY COMPACT SILT AND FINE SAND				
27.0 / 525.8	PROBABLY FIRM SENSITIVE CLAY BECOMING STIFF VARVED SILTY CLAY WITH DEPTH.				
80.0 / 517.8	PROBABLY VERY STIFF CLAYEY TILL BECOMING VERY DENSE SILTY SAND TILL BELOW EL. 520.				
88.0	END OF PEN. TEST				

ELEVATION SCALE: 610, 600, 590, 580, 570, 560, 550, 540, 530, 520

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. — 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT.

143

18 / 10 5 Percent axial strain at failure

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT W_P W W_L

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN MW

CHECKED

PROJECT No. 66002

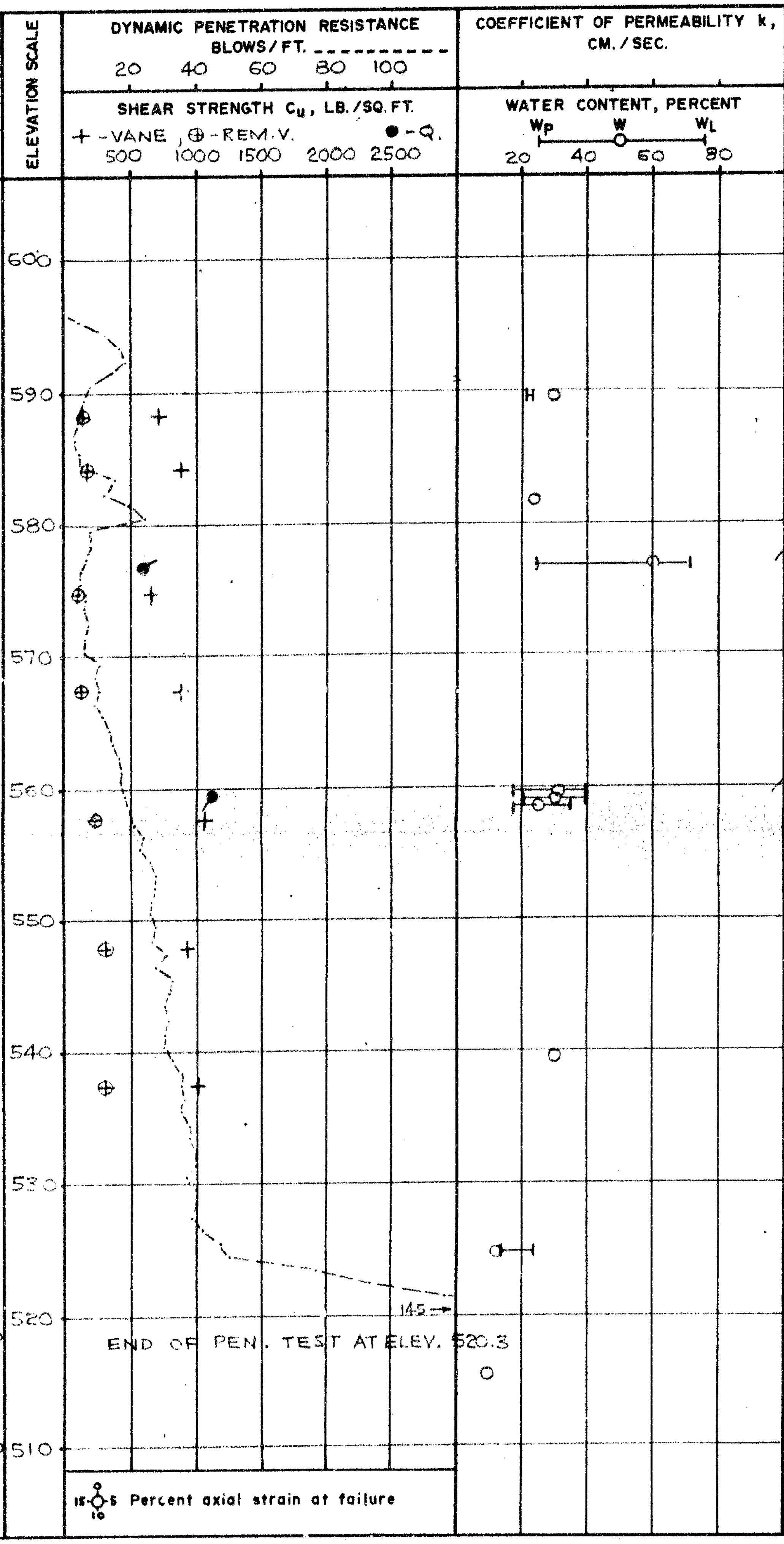
RECORD OF BOREHOLE 3

LOCATION See Figure 1 | BORING DATE FEB. 8-10, 1966 | DATUM GEODETIC

BOREHOLE TYPE WASH BORING | BOREHOLE DIAMETER NX, BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES | PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION (SOIL PROFILE)	SAMPLE NUMBER	TYPE	BLOWS / FT.	ADDITIONAL LAB. TESTING
600.3	RIVER LEVEL				
597.3 / 0.0	RIVER BOTTOM				
3.0	VERY LOOSE TO COMPACT GREY SILTY SAND.	1	2" D.O.	2	
		2	"	13	
591.3 / 9.0	VERY LOOSE GREY SILT TRACE CLAY SOME ROOTS NUMEROUS FINE SAND LAYERS.	3	"	2	
		4	"	4	
584.3 / 16.0	COMPACT GREY SILT AND FINE SAND, TRACE CLAY.	5	"	12	MH
580.3 / 20.0	FIRM GREY SENSITIVE CLAY BECOMING STIFF VARVED SILTY CLAY BELOW ABOUT EL. 560 WITH ALTERNATING 1/4 TO 1/2" THICK RED-GREY CLAY LAYERS AND 1/4" TO 1/2" THICK LIGHT GREY CLAY.	6	T.O.	PM	H, γ=104
		7	D.O.	2	
		8	T.O.	PM	C, γ=125
		9	D.O.	8	
		10	"	7	
525.3 / 75.0	STIFF DARK GREY CLAYEY SILT WITH SAND AND GRAVEL (TILL)	11	"	14	MH
		12	"	11	
518.4 / 81.9	VERY DENSE DARK GREY SANDY SILT WITH SOME GRAVEL TRACE CLAY AND GRANITIC COBBLES AND BOULDERS (TILL)	13		>100	
		14	AXT RC	—	MH
		15	D.O.	95	
		16	BX RC	—	
		17	D.O.	>100	
510.2 / 90.1	END OF HOLE				



PIEZOMETER OR STANDPIPE INSTALLATION

VERTICAL SCALE 1 INCH TO 10'.0"

GOLDER & ASSOCIATES

DRAWN ______ CHECKED ______

PROJECT No. 66002

RECORD OF PENETRATION TEST 4

LOCATION See Figure 1 BORING DATE FEB. 10, 1966 DATUM GEODETIC

BOREHOLE TYPE PEN. TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE ELEVN./DEPTH	SOIL PROFILE DESCRIPTION	SOIL PROFILE STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
600.3	RIVER LEVEL				
598.6	RIVER BOTTOM				
1.7 / 591.3	PROBABLY LOOSE TO COMPACT GREY SILTY SAND.				
9.0 / 584.3	PROBABLY VERY LOOSE GREY SILT.				
16.0 / 580.3	PROBABLY COMPACT SILT AND FINE SAND				
20.0	PROBABLY FIRM SENSITIVE CLAY BECOMING STIFF VARVED SILTY CLAY WITH DEPTH.				
525.3					
75.0 / 519.3	PROBABLY STIFF CLAYEY SILT TILL				
81.0	END OF PEN. TEST				

ELEVATION SCALE: 600, 590, 580, 570, 560, 550, 540, 530, 520

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT.

176

15-○-5 Percent axial strain at failure 10

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT W_P W W_L

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

VERTICAL SCALE 1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN MWG

CHECKED AJ

PROJECT No. 66002

RECORD OF BOREHOLE 5

LOCATION See Figure 1 BORING DATE FEB. 10 - 14, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER NX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
600.3	RIVER LEVEL			
599.9 / 0.4	WATER			
	VERY LOOSE TO LOOSE GREY SILT, TRACE CLAY TRACE SAND AND GRAVEL	1	2" D.O.	2
		2	"	5
590.3 / 10.0		3	"	9
	VERY LOOSE TO LOOSE GREY SILT, TRACE CLAY WITH NUMEROUS FINE SAND LAYERS.	4	T.O.	PM
		5	D.O.	6
580.3 / 20.0		6	"	3
	FIRM BECOMING STIFF BELOW ABOUT EL. 550 GREY SENSITIVE CLAY WITH OCCASIONAL 1/4" TO 1" THICK CLAYEY SILT AND FINE SAND LAYERS BECOMING VARVED SILTY CLAY BELOW ABOUT EL. 560 WITH RED-GREY CLAY LAYERS AND 1/4" TO 1" THICK GREY CLAYEY SILT LAYERS.	7	"	2
		8	T.O.	PM
		9	D.O.	3
		10	T.O.	PM
		11	D.O.	7
		12	"	7
526.3 / 74.0		13	"	9
	STIFF DARK GREY CLAYEY SILT WITH SAND & GRAVEL (TILL)	14	"	14
517.8 / 82.5	VERY DENSE LIGHT GREY SANDY SILT, SOME GRAVEL, TRACE CLAY (TILL)	15	"	>100
514.8 / 85.5	END OF HOLE			

ELEVATION SCALE: 600, 590, 580, 570, 560, 550, 540, 530, 520, 510

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT. +-VANE, ⊕-REM.V. ●-Q. 500 1000 1500 2000 2500

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT W_P W W_L 20 40 60 80

ADDITIONAL LAB. TESTING: MH; X=104; X=123

PIEZOMETER OR STANDPIPE INSTALLATION

END OF PEN. TEST AT ELEV. 512.3

15-◇-5 Percent axial strain at failure
10

VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.D.

CHECKED

PROJECT No. 66002

RECORD OF PENETRATION TEST 6

LOCATION See Figure 1 BORING DATE FEB. 15, 1966 DATUM GEODETIC

BOREHOLE TYPE PEN. TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 20 40 60 80 100 / SHEAR STRENGTH C_u, LB./SQ.FT.	COEFFICIENT OF PERMEABILITY k, CM./SEC. / WATER CONTENT, PERCENT W_P W W_L	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.					
601.0	RIVER LEVEL									
0.5	ICE					600				
	PROBABLY VERY LOOSE TO LOOSE GREY SILT.					590				
581.0										
20.0						580				
	PROBABLY FIRM SENSITIVE CLAY BECOMING STIFF VARVED SILTY CLAY WITH DEPTH.					570				
						560				
						550				
						540				
						530				
527.0										
74.0	PROBABLY STIFF CLAYEY SILT TILL					520				
518.5										
82.5	END OF PEN. TEST						135 BLOWS FOR LAST 6 INCHES			

15 ◇ 5 Percent axial strain at failure
10

VERTICAL SCALE
1 INCH TO 10' – 0"

GOLDER & ASSOCIATES

DRAWN MW

CHECKED

PROJECT No. 66002

RECORD OF PENETRATION TEST 7

LOCATION See Figure 1 BORING DATE FEB. 15, 1966 DATUM GEODETIC

BOREHOLE TYPE PEN. TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION
603.9	GROUND LEVEL
0.0	PROBABLY LOOSE TO COMPACT SILTY SAND TO SANDY SILT.
588.9	
15.0	PROBABLY FIRM SILT, TRACE CLAY WITH SAND LAYERS.
579.9	
24.0	PROBABLY FIRM TO STIFF SENSITIVE CLAY BECOMING VARVED SILTY CLAY WITH DEPTH.
527.9	
76.0	PROBABLY STIFF CLAYEY SILT TILL.
521.9	
82.0	END OF PEN. TEST

SOIL PROFILE | STRAT. PLOT | SAMPLES: NUMBER, TYPE, BLOWS/FT. | ELEVATION SCALE

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT.

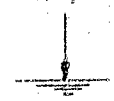
COEFFICIENT OF PERMEABILITY k, CM./SEC.

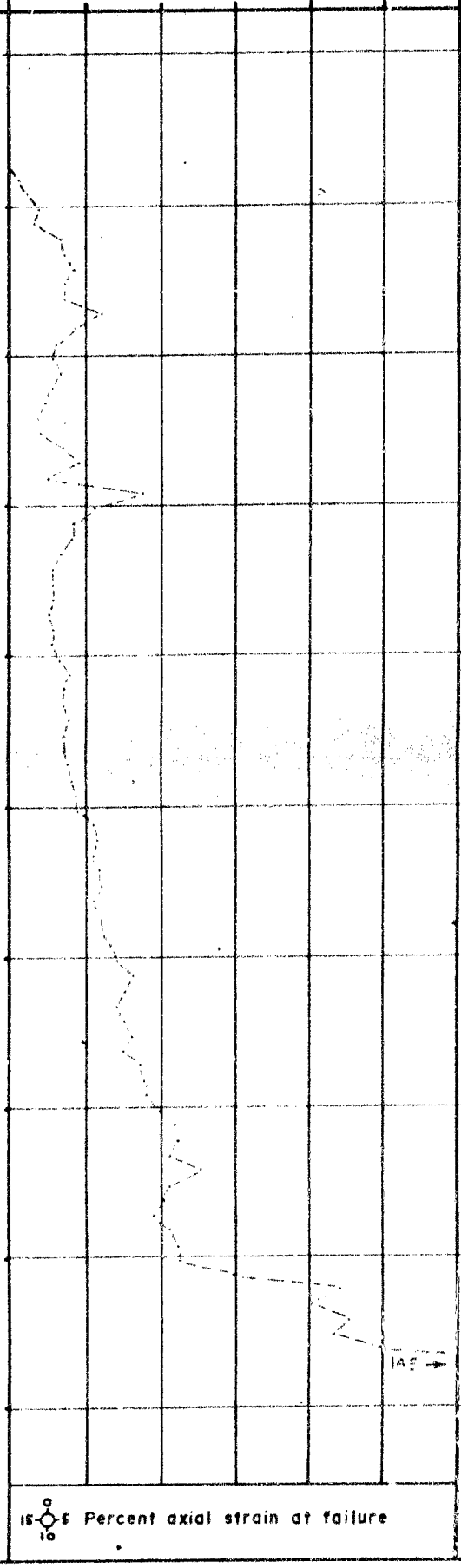
WATER CONTENT, PERCENT W_P W W_L

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

W.L. IN PEN. TEST HOLE AT ELEV. 600.4 FEB. 16, 1966.





VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN ...
CHECKED ...

PROJECT No. 66002

RECORD OF BOREHOLE 8

LOCATION See Figure 1 BORING DATE FEB. 16-18, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER NX, BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 40 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS/FT.
603.5 / 0.0	GROUND LEVEL				
	LOOSE TO COMPACT BROWN BECOMING GREY BELOW ELEV. 601, SILTY SAND TO FINE SANDY SILT		1	2" D.O.	6
			2	"	7
			3	"	17
588.5 / 15.0	FIRM GREY SILT, TRACE CLAY WITH NUMEROUS FINE SAND LAYERS.		4	"	2
			5	"	13
579.5 / 24.0	FIRM GREY SENSITIVE CLAY WITH NUMEROUS 1/4" THICK CLAYEY SILT TO SANDY SILT LAYERS BECOMING STIFF VARVED SILTY CLAY BELOW ABOUT EL. 550 WITH ALTERNATING 1/4" TO 1" THICK GREY CLAY LAYERS AND 1/4" TO 1" THICK LIGHT GREY CLAYEY SILT LAYERS.		6	T.O. PM	
			7	D.O.	2
			8	T.O. PM	
			9	D.O.	4
			10	T.O. PM	
			11	D.O.	5
527.5 / 76.0	STIFF DARK GREY CLAYEY SILT WITH SAND AND GRAVEL (TILL)		12	"	13
517.7 / 86.2	VERY DENSE DARK GREY SANDY SILT SOME GRAVEL (TILL)		13	"	>100
87.3	END OF HOLE				

ELEVATION SCALE: 610, 600, 590, 580, 570, 560, 550, 540, 530, 520

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT. + - VANE, ⊕ - REM.V., ● - Q. 500 1000 1500 2000 2500

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT W_P W W_L 20 40 60 80

ADDITIONAL LAB. TESTING: MH; MH; γ=106; H γ=120; MH

NOTE: DRILL RIG BROKE DOWN WHEN CONE DRIVEN TO 77 FT. DEPTH. DRIVING WAS RESUMED AFTER 2½ HRS. DELAY.

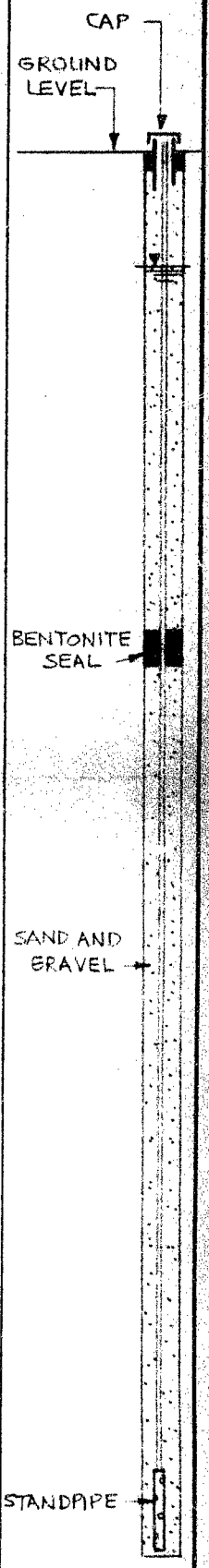
175 →

END OF PEN. TEST AT ELEV. 524.5

W.L. IN PEN. TEST HOLE AT ELEV. 600.3 ON FEB. 18, 1966 AND PRIOR TO USING WASH WATER IN BOREHOLE.

15-5 / 10 Percent axial strain at failure

PIEZOMETER OR STANDPIPE INSTALLATION



W.L. IN STANDPIPE AT ELEV. 596.5 FEB. 19, 1966.

VERTICAL SCALE 1 INCH TO 10'-0'

GOLDER & ASSOCIATES

DRAWN MC

CHECKED

PROJECT No. 66002

RECORD OF BOREHOLE 9

LOCATION See Figure 1 BORING DATE FEB. 18-19, 1966 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER NX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES

ELEVN / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE
	TOPSOIL					610
605.0	GROUND LE					
0.5 / 600.5	LOOSE BROWN SILTY SAND TRACE CLAY AND GRAVEL		1	2" D.O.	5	
4.5 / 596.0	SOFT GREY SILT, TRACE CLAY.		2	"	2	600
9.0			3	T.O.	6	
	LOOSE TO COMPACT GREY SILTY FINE SAND TO SILT WITH SOME SAND TRACE CLAY, SMALL ROOTS		4	D.O.	2	590
581.0			5	"	19	
24.0			6	T.O.	PM	580
	FIRM BECOMING STIFF BELOW ABOUT EL. 550, GREY SENSITIVE CLAY TO CLAYEY SILT, TRACE SAND.		7	D.O.	2	570
			8	T.O.	PM	560
						550
			9	D.O.	11	
						540
531.0						
74.0 / 528.0	VERY STIFF DARK GREY CLAYEY SILT SOME SAND AND GRAVEL (TILL)		10	"	24	530
77.0	END OF HOLE					520

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. ----------

SHEAR STRENGTH C_u, LB./SQ.FT. +-VANE, ⊕-REM.V. ●-Q. 500 1000 1500 2000 2500

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT W_P W W_L 20 40 60 80

ADDITIONAL LAB. TESTING: MH; MH; Y=10G

PIEZOMETER OR STANDPIPE INSTALLATION

15 10 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 10'-0"

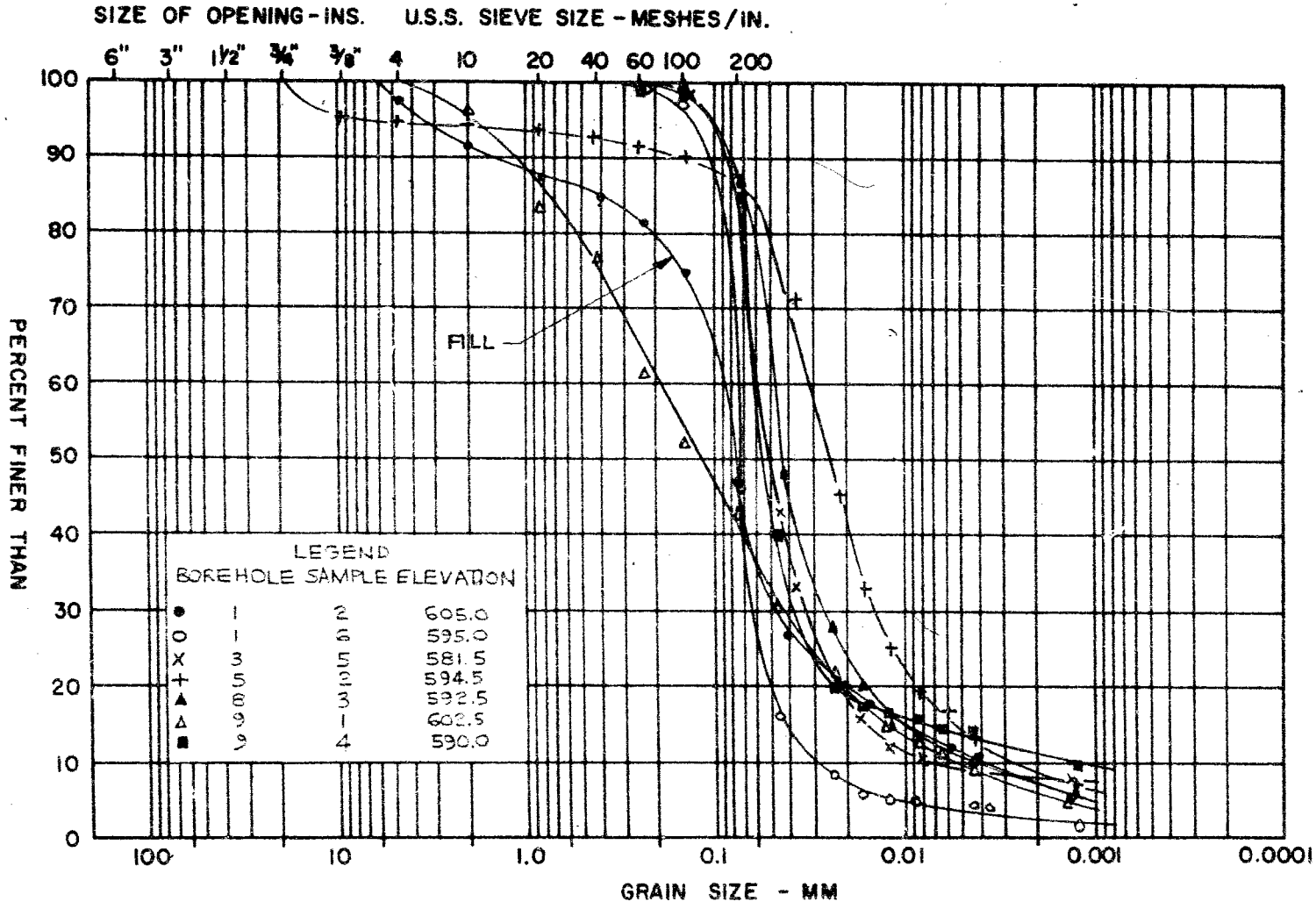
GOLDER & ASSOCIATES

DRAWN MW

CHECKED RJ

PROJECT No. 66002

M.I.T. GRAIN SIZE SCALE



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION
SURFICIAL SANDS & SILTS

FIGURE 2

PROJECT No. 56002

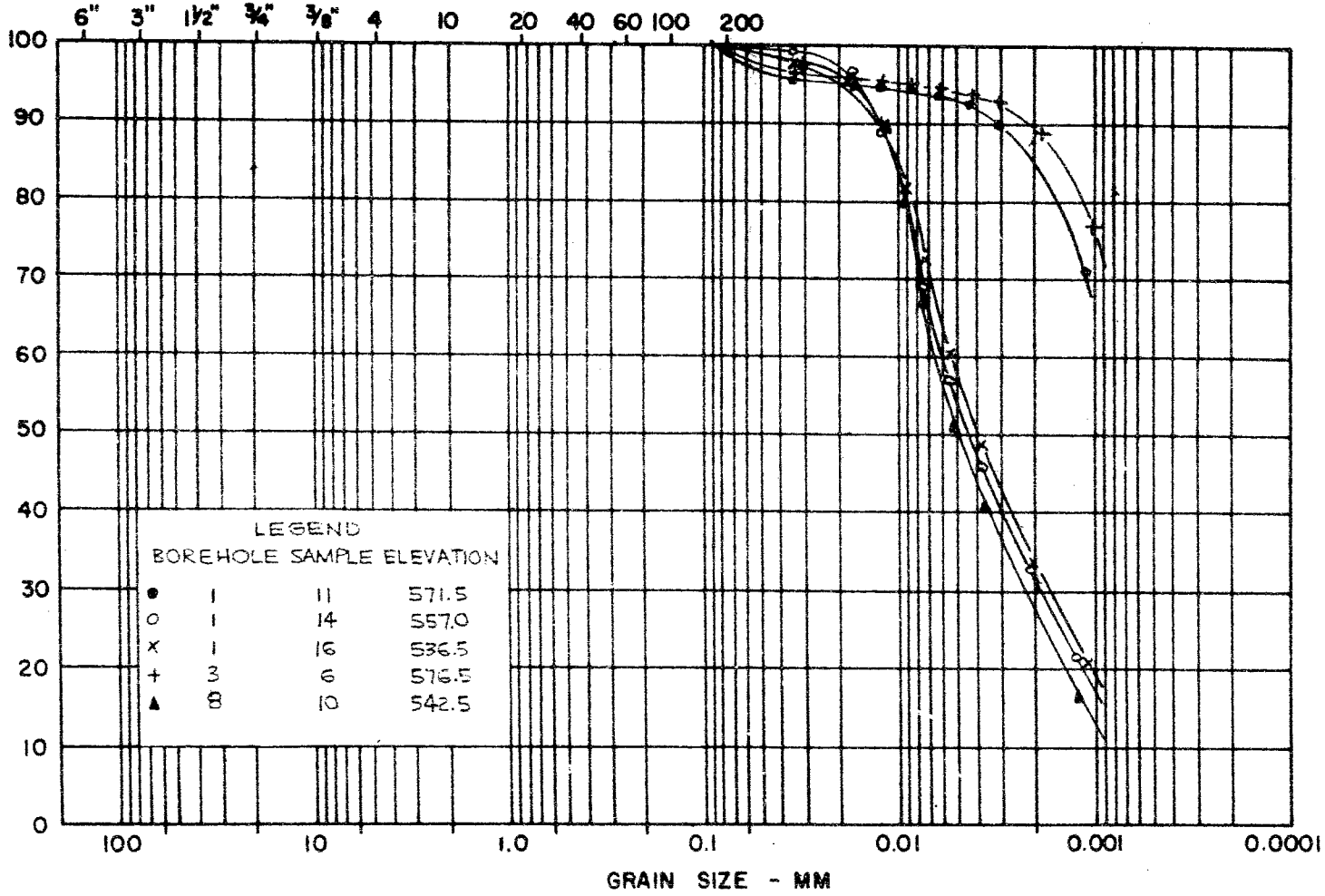
GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION

SENSITIVE CLAY BECOMING VARVED SILTY CLAY

FIGURE 3

M.I.T. GRAIN SIZE SCALE



COBBLE SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE

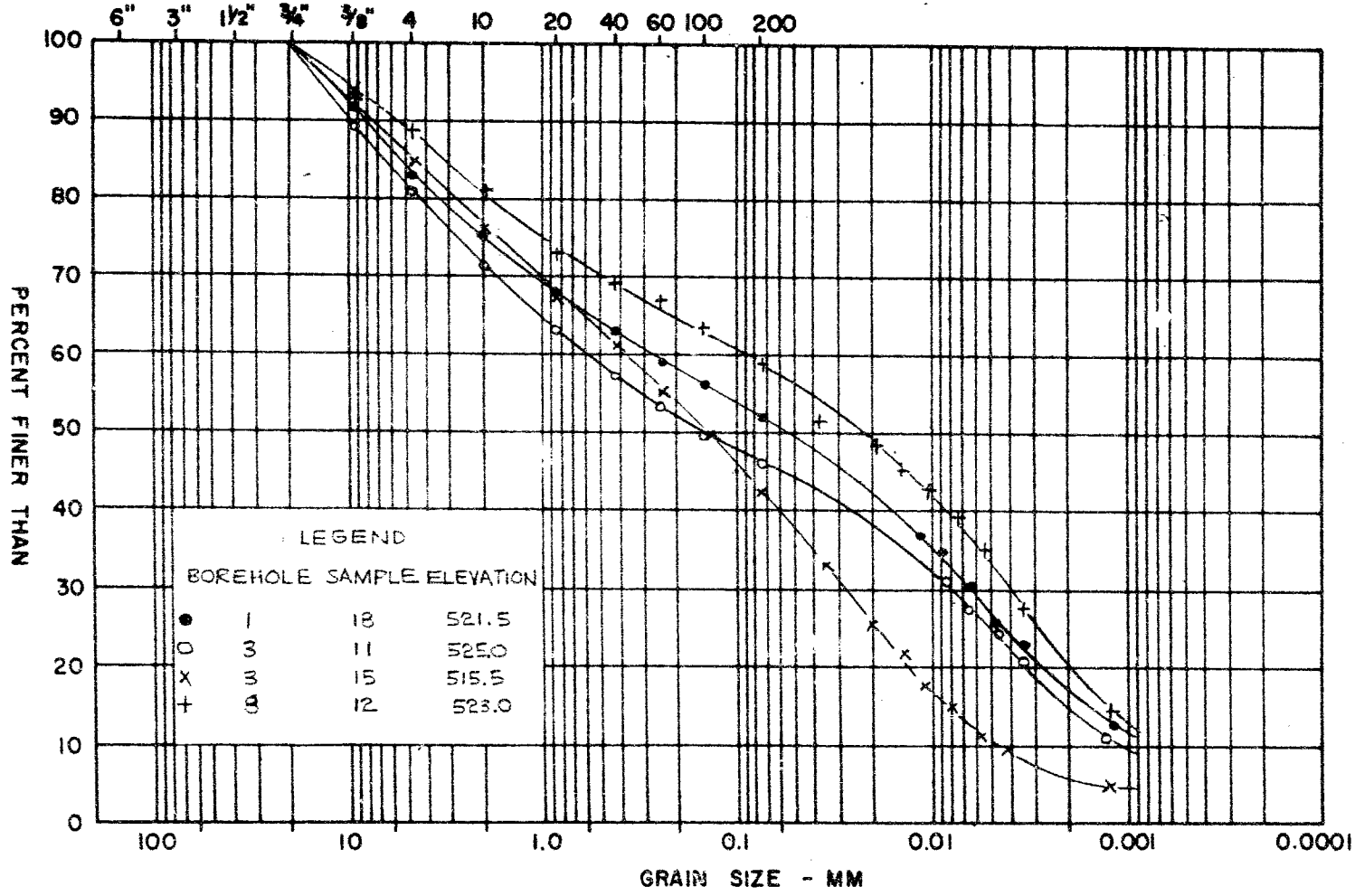
PROJECT No. 66002

GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION (TILL)

FIGURE 4

M.I.T. GRAIN SIZE SCALE

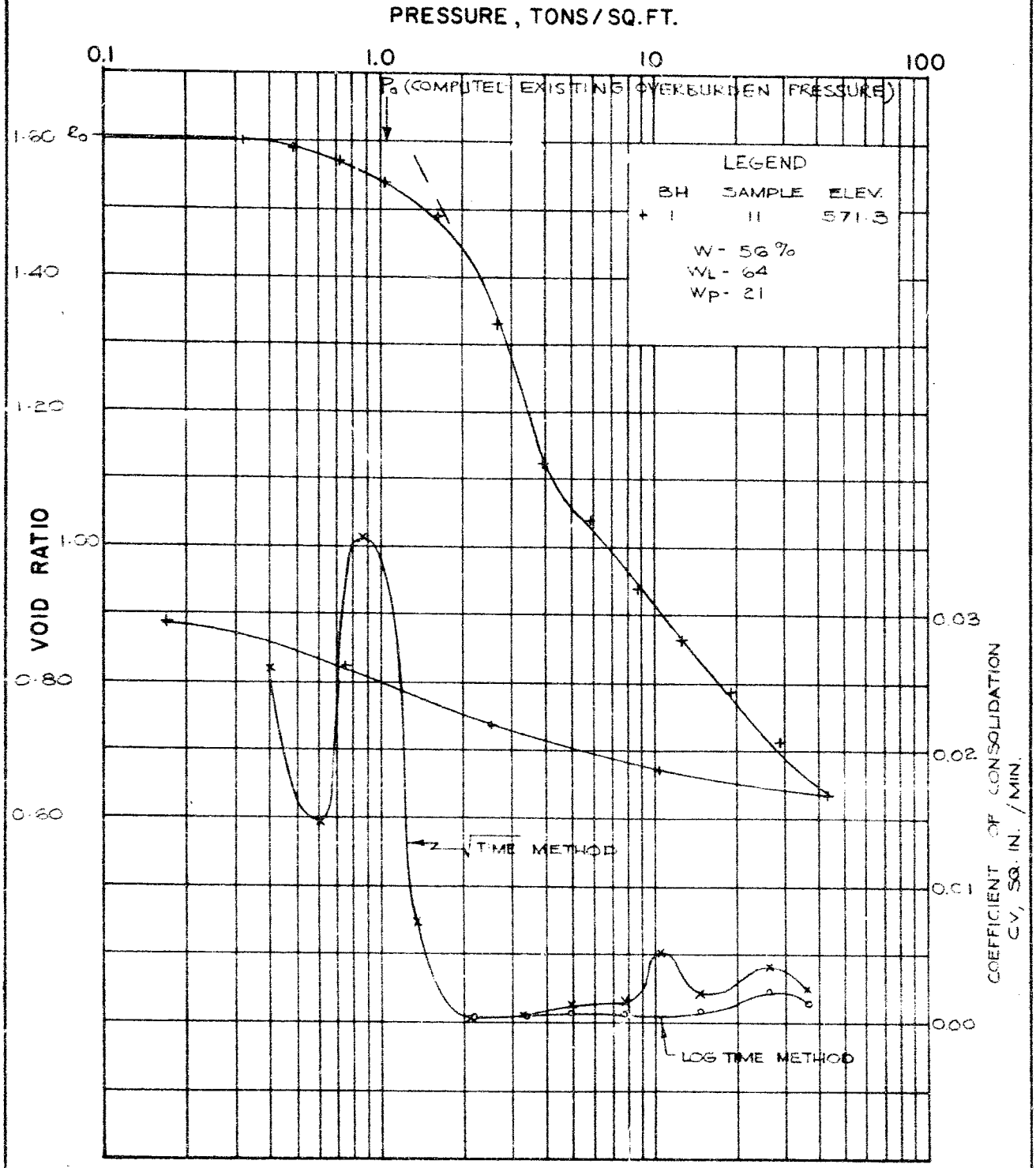


COBBLE SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE

PROJECT No. 66002

VOID RATIO - PRESSURE CURVES
CONSOLIDATION TEST

FIGURE 5

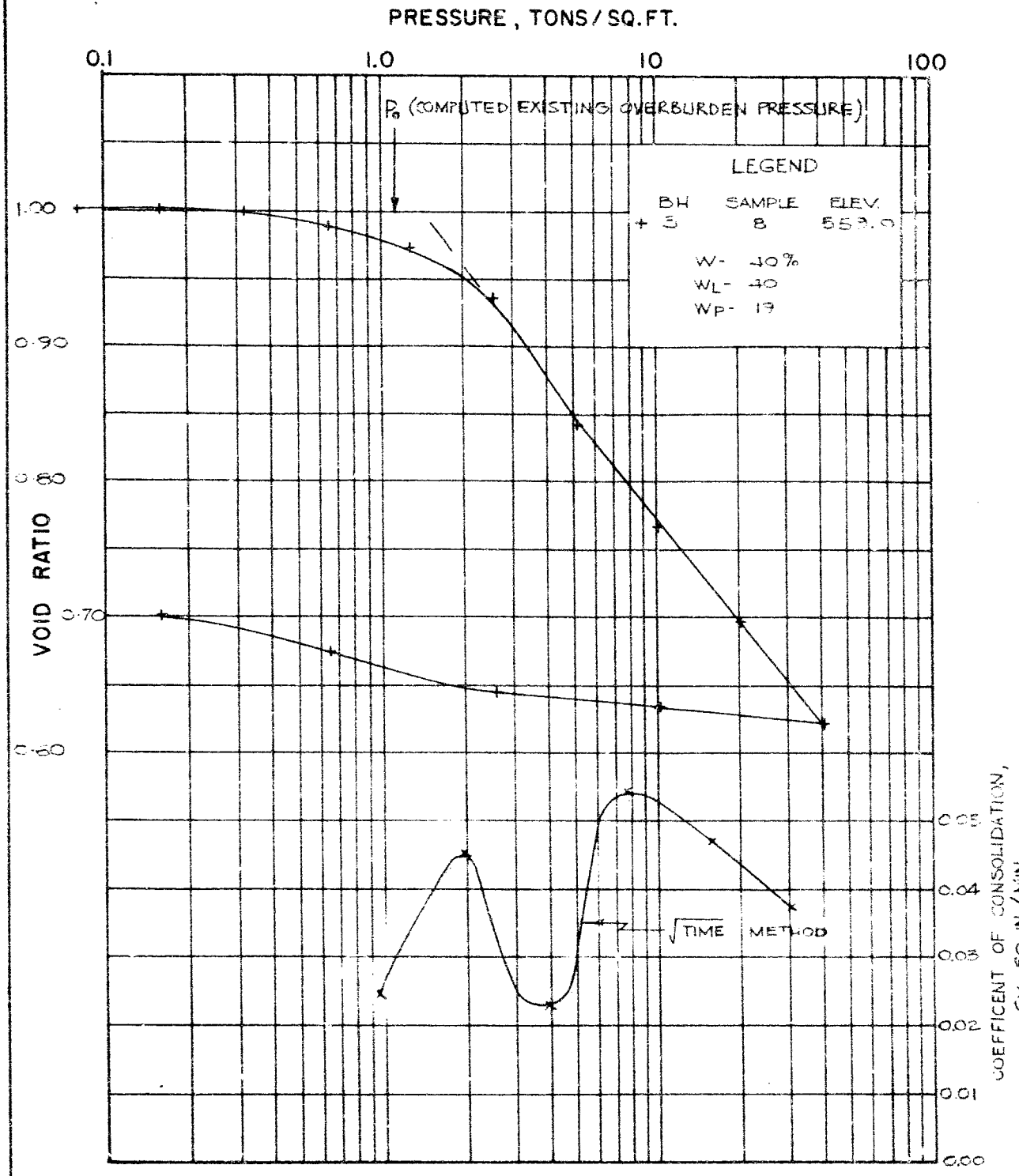


GOLDER & ASSOCIATES

PROJECT No. ... 66092

VOID RATIO - PRESSURE CURVES
CONSOLIDATION TEST

FIGURE 6

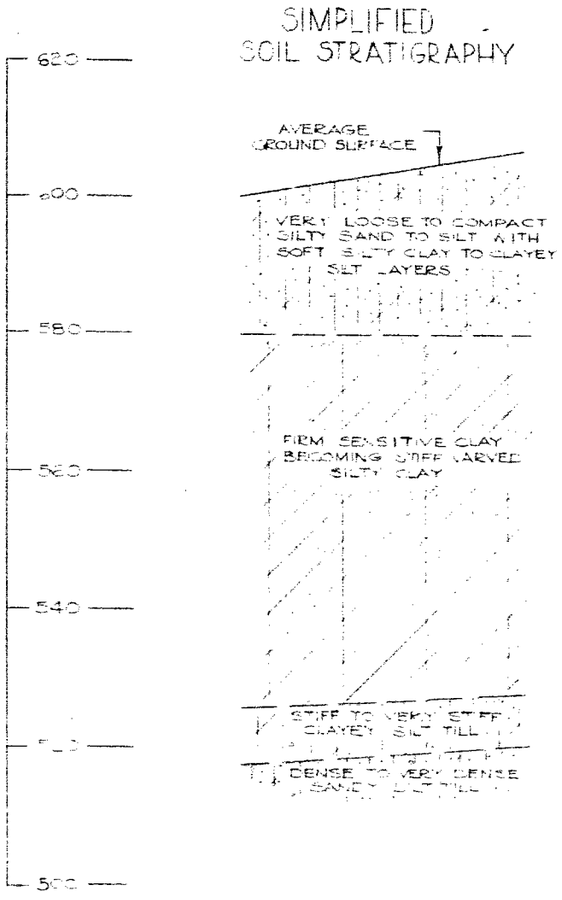


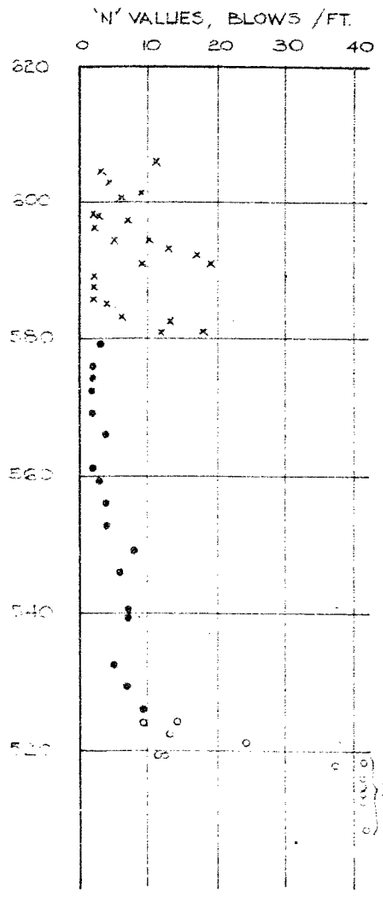
GOLDER & ASSOCIATES

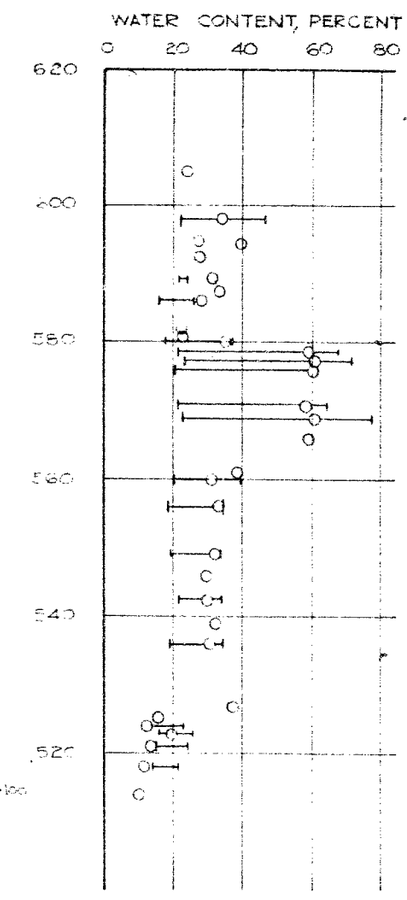
SUMMARIZED ENGINEERING PROPERTIES OF SUBSOIL

FIGURE 7

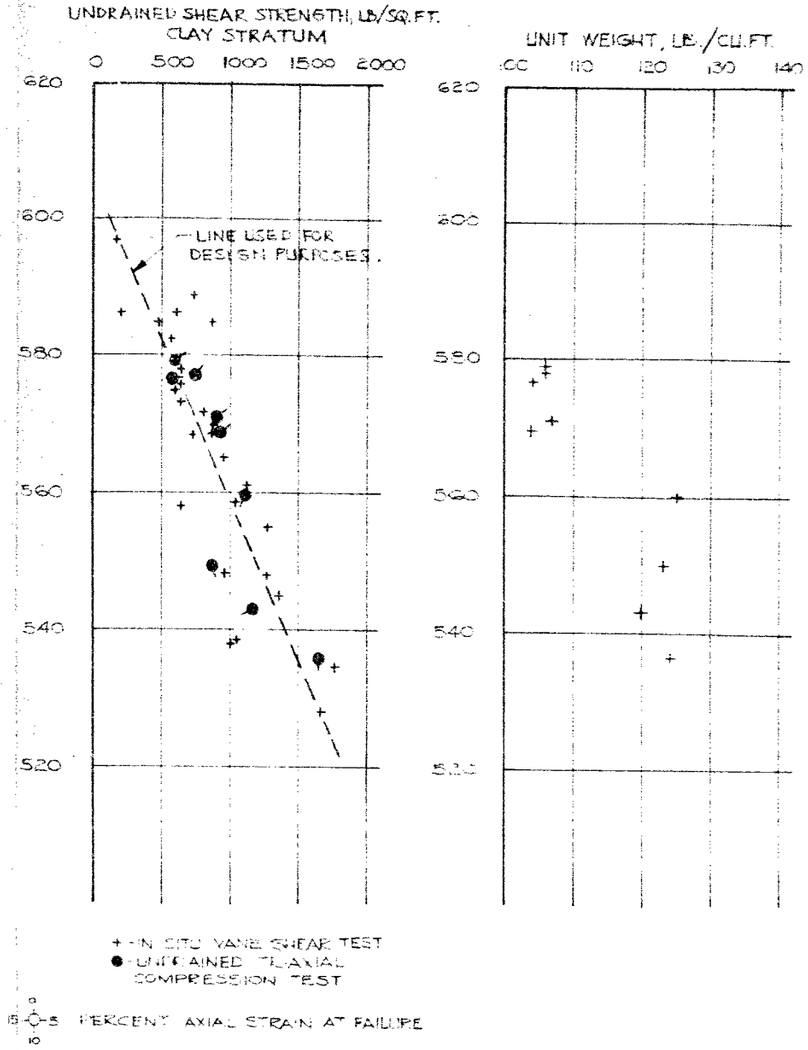
SIMPLIFIED SOIL STRATIGRAPHY







ELEVATION IN FEET



Drawn MARCH 22, 1966

GOLDER & ASSOCIATES

Made
Chkd.
Appd.

file ags.
RM-115

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN
L. G. SODERMAN
J. L. SEYCHUK

2444 BLOOR STREET WEST
TORONTO 9, ONTARIO
763-4103
767-9201

April 5, 1966.

Department of Highways, Ontario,
Materials and Testing Division,
Hwy. 401 & Keele Street,
DOWNSVIEW, Ontario.

Attention: Mr. A. G. Stermac, P.Eng.,
Principal Foundations Engineer.

RE: W.P. 919-64,
SOIL INVESTIGATION,
PROPOSED McINTYRE RIVER BRIDGE,
BALMORAL STREET EXTENSION - LINE D,
FORT WILLIAM, ONTARIO.

Dear Sirs:

Eleven copies of our report for the above project, together with a Cronaflex copy of Figure 1, were delivered to you yesterday by messenger.

As discussed on the telephone today, the allowable load for a 12BP74 steel "H" pile driven to practical refusal is given as 50 tons on page 8 of our report. This is a typographical error and the allowable load per pile should be taken as at least 70 tons.

If you have any further questions regarding our report, please call us.

Yours truly,

H. Q. GOLDER & ASSOCIATES LTD.

J. L. Seychuk, P.Eng.

JLS:NG
66002

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

TO: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie.

FROM: Foundation Section,
Materials & Testing Division,
Room 107, Lab. Bldg.

DATE: April 5, 1966.

OUR FILE REF.

IN REPLY TO

APR - 6 1966

SUBJECT: FOUNDATION INVESTIGATION REPORT BY H. G. Golder and Associates Limited - W.P. 919-64, Proposed McIntyre River Bridge Balmoral Street Extension -- Line 'D' -- District #19 (Fort William).

Attached, we are forwarding to you the above-mentioned report prepared and submitted by the Consultant, H. G. Golder and Associates, Ltd.

We have reviewed the report and have found the factual information adequate and well presented.

The recommendations pertaining to the foundations of the structure are clear and self-explanatory. In connection with the piled foundation we would like to make the following comments:

Any type of pile which would be driven as specified on page 3 of the report could be considered, for all practical purposes, as being driven to refusal and would therefore be an end-bearing pile. It is our opinion that a steel H pile 12 BP 74 could support a safe load of between 80 and 100 tons.

Yet another type of pile to be considered is the prestressed concrete pile. We understand that due to the fact that this type of pile is being manufactured at the Lakehead the use of prestressed concrete piles may be more economical.

We believe that the information contained in the report should be adequate for you to proceed with the design. Should there, however, be any additional problems you would like to discuss please feel free to call on our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

Attach.
AGS/tt
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
F. Hurrell (2)
A. De Visser
Foundations Office -
Gen. Files
P. Norman
A. K. Watt

cc: Mr. H. Szymanski

Rey. 401 & Eagle St.,
Newmarket, Ontario.

December 17, 1965

Materials and Testing Division

M. . Dolsen and Associates Ltd.,
Fifth Floor Street East,
Toronto, Ontario.

Attention: Mr. D. L. Dolsen

re: McIntyre River crossing at proposed diamond St. extension,
District 19 (Port William) -- P.I. 919-64; Site 401-103.

Dear Sir:

Please consider this your authority to carry out a foundation investigation at the above-mentioned site.

Attached, you will find two prints of Plan C-1533-1. On one copy, the proposed footing layout is indicated and the boreholes should be located accordingly.

It is assumed that this investigation will be carried out by the same crew which will investigate the Chukuni River crossing. Unless some important and valid reasons arise, you are requested to start this investigation immediately upon completion of the field work at the Chukuni River. Any changes in scheduling should be discussed with Mr. P. Pavlasek, Regional Bridge Location Engineer, and our Office should also be advised.

Eleven (11) copies of the completed report should be submitted as soon as possible, but not later than three weeks after completion of the field work. Previous requirements as to preliminary borehole information and laboratory testing reports, should be followed.

Because the drawing accompanying the foundation report, showing the location of borings, the inferred subsoil conditions, etc., is to become a contract drawing, you are required to prepare it in accordance with the O.H.D. standards. To enable you to do this, we are supplying you with a bristle drawing with all the necessary explanations, together with a linen sheet for your drawing. You are also requested to provide us with a Cronaflex copy of the drawing.

cont'd. to ....

[illegible] Associates Ltd.
Attn: Mr. [illegible]

- 2 -

[illegible]ember 17, 1965

Charges for the work performed will be in accordance with your Schedule of Rates, dated October 1, 1965, and invoice to be addressed to the attention of the undersigned.

We are attaching Purchase Order # 31800, covering the purchase of any new material required for this work, in order that you may use this as a basis for exemption from the Federal Tax for such purchases. The Exemption Certificate is printed thereon.

Yours very truly,

A. Rutka,
[illegible]

[illegible]
Attach.

cc: Messrs. D. McCombie, F. Norman, N. Szymanski (2), H. Murrell, A. Crowley, Foundations, V. A. Snell, Mrs. I. Steinberg, Gen. Files (2), F. Devisser

P.S. — [illegible] sent under separate cover.

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Building

From: Bridge Division,
Downsview, Ontario

Attention:

Date: September 5, 1968

Our File Ref:

In reply to

Subject: McIntyre River Bridge
On Balmoral Street Extension
W.P. 919-64, Site 48C-103
L.H.E., District No. 19

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.

C.S. Grebski,
Bridge Design Engineer

CSG:rd

Attach.

c.c. Foundation Section

Re Comments.
M. Devata
Sept 8/68

Department of Highways Ontario

Copy for the information of
Mr. A. Stermac, Principal Foundation Engineer,
Room 107, Lab. Building

Mr. F. DeVizser,
Reg. Bridge Location Engineer,
P.O. Box 1170,
Port Arthur, Ontario

Bridge Division,
Downsview, Ontario

May 8, 1967

McIntyre River Bridge
on Balmoral St. Extension
W.P. 919-64, Site No. 48C-103
Lakehead Expressway, District 19

Attached herewith are prints of the Preliminary Bridge Plan Drawing D-5925-P1 for the above-mentioned structure.

The estimated cost of the proposed structure is $55,000. This cost includes tender, materials, engineering and sundry construction.

Any comments or revisions you may have should be submitted within three weeks.

C.S. Grebski,
Bridge Design Engineer

CSG:rd

Attach.

c.c. S. McCombie
A. Stermac
R. Forrest
E. Cross

cc: Foundations Files (Rm. 110)

Mr. C. S. Grebski,
Bridge Design Engineer,
Bridge Division,
Admin. Bldg.

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

May 18, 1967

McIntyre River Bridge on Balmoral Street
Extension - W.P. 919-64, Site 48C-103,
Lakehead Expressway, District #19 (Ft. William).

The Preliminary Bridge Plan Drawing D-5925-P1 for the above mentioned structure, has been reviewed.

We have no comments pertaining to the structure foundations.

MD/MdeF

M. Devata,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. S. McCombie
F. DeVisser

Foundations Files
Gen. Files

Department of Highways Ontario

Copy for the information of

Mr. A. Stermac

Mr. S.B. Davidson,
Reg. Bridge Planning Engineer,
Thunder Bay Regional Office

Bridge Office,
Downsview

May 1, 1970

McIntyre River Bridge
on Balmoral St. Extension
W.P. 919-64, Site 480-103
Lakehead Expressway, District 19

Attached herewith are prints of the Preliminary Bridge Plan Drawing D-6836-P1 for the redesign of the above-mentioned structure.

The estimated cost of the proposed structure is $110,000. This cost includes tender, materials, engineering and sundry construction.

Any comments or revisions you may have should be submitted within three weeks.

C.S. Grebski,
Bridge Design Engineer

CSG:rd

Attach.

c.c. S. McCombie
A. Stermac (2)
J. Anderson

Please refer Page 2 of the Foundation Report in regard to the removal of soft materials at the south approach ~~[illegible]~~ embankment location

[illegible]
4th May 1970

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Building

From: C.S. Grebski,
Bridge Office

Attention:

Date: June 12, 1970

Our File Ref.

In reply to

Subject: McIntyre River Bridge
on Balmoral St. Extension
W.P. 919-64, Site 48C-103
L.H.E., District 19

Golden/66

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.

C.S. Grebski,
Bridge Design Engineer

CSG:rd
Attach.
c.c. Foundation Office

Advised G. Rodkasky
No Comments.
M. Stermac

FILE P W

1970 MAY 11 AM 9:31

Golder/66

D.H.O. TORONTO RECEIVED MAY 11 1970 BRIDGE OFFICE

D

TBAR DOWN 2 MAY 11/70 921A VR

S B DAVIDSON RGN BRIDGE PLAN ENGR

RE MCINTYRE RIVER BRIDGE ON BALMORAL STREET WP919-64 SITE 48C-103

THE FOUNDATION OFFICE , AFTER REVIEWING THE PRELIMINARY PLAN D6836-1 HAVE DRAWN OUR ATTENTION TO THE RECOMMENDATION ON PAGE 12 OF THE FOUNDATION REPORT WITH REGARDS TO SUB EXCAVATION OF ALL TOPSOIL, LOOSE FILL MATERIAL AND SOFT SILTY CLAY CONTAINING ORGANIC MATERIAL AT THE SOUTH APPROACH. THIS MATERIAL SHOULD BE REMOVED UP TO 50 FEET BEHIND THE SOUTH ABUTTMENT. WOULD YOU PLEASE ADVISE REGIONAL ROAD DESIGN ABOUT THIS RECOMMENDATION.

K G BASSI BRIDGE OFF

c.c. M Devata