

Mr. C. Fraser,
District Engineer,
District #6, Toronto.

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

Attention: Mr. J. G. Tillcock,
Dist. Municipal Engr.

June 24, 1963

D.H.O. FOUNDATION INVESTIGATION REPORT --
Kleinburg Side Road Embankment Failure,
Twp. of Vaughan, Co. of York, Dist. #6.
W.J. 63-F-53

Attached, we are forwarding to you, the results of our detailed foundation investigation, carried out at your request, to determine the causes of embankment failure at the above-noted site.

As well as delineating existing conditions, this report contains recommendations pertaining to the remedial measures.

We believe you will find the contents self-explanatory; however, should further information be required, please do not hesitate to contact our Office.

AGE/MGeF
Attach.

cc: Messrs. J. F. Howard
T. J. Kovich

City Clerk, Twp. of Vaughan (2)
Duncan Hopper & Associates

Foundations Office
Gen. Files


A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

Materials and Research Division

September 3, 1963

Duncan Hopper & Associates,
1885 Wilson Avenue,
Downsview, Ontario.

Attention: Mr. Keith Hopper

Re: Kleinburg Side Road Embankment Failure,
W.J. 63-F-53, District 6, Toronto, Ont.

Dear Sir:

Listed below, are the levels of water as encountered
in the piezometers, at the site of failure on Kleinburg Side
Road:

<u>Piezometer No.</u>	<u>June 4, 1963</u>	<u>Aug. 29, 1963</u>
1	671.0	669.3
2	676.1	672.2
3	672.8	670.5
4	663.3	654.8
5	663.7	657.0
6	641.3	639.7
7	626.8	626.2

Yours very truly,

AGS/MdeF

cc: Foundations Office
Gen. Files

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

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TABLE OF CONTENTS

1. INTRODUCTION.
 2. PERTINENT INFORMATION AND DESCRIPTION OF
FIELD WORK.
 3. DISCUSSION.
 4. RECOMMENDATIONS.
 5. MISCELLANEOUS.
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FOUNDATION INVESTIGATION

At

Kleinburg Side Road
Embankment Failure,
Twp. of Vaughan, Co.
of York, District #6.
W.J. 63-F-53

1. INTRODUCTION:

The Township of Vaughan has, through the District Municipal Engineer, Mr. J. Tillicock, requested the Foundation Section of the Department of Highways, to carry out a subsoil investigation with the purpose of determining the causes that led to the failure of a part of the gravel road connecting the Village of Kleinburg and Maple, and to make the necessary recommendations regarding remedial measures.

2. PERTINENT INFORMATION AND DESCRIPTION OF FIELD WORK:

The road on which the failure occurred is known as Kleinburg Side Road, or Kleinburg Hill Road. The failure occurred on the section of the road which is still within Kleinburg, and is only a few hundred feet away from the Post Office. The road here, follows the side of the hill and descends into the valley where it crosses the Humber River.

From the available information, it was learned that at the site where the failure occurred, the centre line of the road had been moved away from the hillside in order to obtain a straight line. This necessitated the placement of substantial fill material

2. PERTINENT INFORMATION AND DESCRIPTION OF FIELD WORK: (cont'd.) ...
on the existing natural slope. The new embankment was built
with a $1\frac{1}{2}$: 1 slope.

The failure did not occur suddenly, but developed through a period of a few weeks, beginning in early April. During that time, because of the very appreciable subsidence of the outer half of the road surface, the Township forces placed sand on the road in order to bring it up to grade. This measure did not produce the desired result, because the settlements continued as would be expected when additional weight is placed on the top of a failing slope. Finally, the failure progressed to such a degree that the road had to be closed.

The field investigation consisted of 10 boreholes, six of them machine- and four hand-drilled, and 7 piezometers for the observation of the ground water conditions.

Nine boreholes were placed along cross section 'B' through the middle of the slide, while one borehole (No. 3), was placed on the downhill edge of the slide. Three piezometers were placed along the hillside road ditch, one adjacent to B.H. 3, and the rest along line 'B'. The locations of all the boreholes and piezometers are shown on the attached drawing. The borehole logs are given in the Appendix to the report.

cont'd. /3 ...

3. DISCUSSION:

Based on visual evidence during the first site inspection, the impression was formed that water may be one of the main causes of the slope instability. Therefore, in the subsequent investigation, special attention was paid to correctly and reliably establishing the ground water conditions.

The field investigation has shown that two distinctly different layers form the subsoil at the site of failure. These two layers do not differ appreciably as far as the type of the material is concerned, but there is a distinct difference in their properties. The upper layer is soft and loose, while the lower, is hard and dense. The subsoil stratigraphy as inferred from the borings along line 'B', is shown on the attached drawing. The upper layer of clayey silt, clay of low plasticity, is soft and contains traces of sand and gravel. It also contains a certain amount of organic matter.

The lower layer which, according to available information, could be the original ground, is basically of the same composition and plasticity as the upper one, except that no organics were found. The distinct difference is the dense to very dense or hard consistency of the material.

The ground water elevations at different locations, as established in the piezometers, show a very high ground water table.

At the location of piezometer No. 4, adjacent to B.H. 3, the water was actually above the ground surface. A probable phreatic line connecting all the established water elevations is shown on the attached drawing. It is believed that this line

3. DISCUSSION: (cont'd.) ...

must have been appreciably higher prior to the failure. Due to the subsidence of the road surface, new boundary conditions were created, resulting in a gradual lowering of the ground water table.

4. RECOMMENDATIONS:

The investigation has confirmed that one of the main causes for the slope failure was the very high ground water table and, therefore, the remedial measures will have to include provisions for lowering it permanently. It is recommended that a drainage system be constructed which will fulfill this purpose. Some details of the proposed system are shown on the attached drawing, while additional information is given below:

The drainage ditch along the hill side of the road should commence at the top of the hill - i.e., just around the corner of the road at the road junction, and should be taken down into the valley. The average depth of this trench should be around 8 ft., which is believed to be the depth of overburden overlying the dense till stratum as established by borehole No. 1 and the penetration resistance of piezometers No. 1, 2 and 3.

Two additional drainage trenches, parallel to the one described above, should be constructed through the failed zone at the respective locations shown on the drawing. The minimum depth of these trenches should be 10 feet, and they should be drained into a trench running down the slope at right angles to the road centre line. This trench should commence at the hill side of the road, thus connecting all three trenches and ending at the

cont'd. /5 ...

4. RECOMMENDATIONS: (cont'd.) ...

bottom of the slope where further provisions for water disposal have to be made. This trench should be constructed on the south side of the failed area - i.e., on the higher side, thus preventing any seepage into the reconstructed embankment from the side.

The above trenches should be backfilled with coarse, clean granular material - i.e., granular base course, type 'A', or better - i.e., coarser. The minimum width of the trenches is three feet. Because it is believed that the trench along the road will carry most of the water, it is suggested that a 4-inch perforated corrugated pipe be placed on its bottom. This, on condition that no shoring is necessary.

Apart from the drains, it is also recommended that the embankment be rebuilt with an average 2:1, instead of the original 1½:1 slope, and the material at the bottom of the slope be shaped as shown on the drawing.

It is realized that the recommended remedial measures will require the acquisition of some presently private property which, in this case, is unavoidable.

As a sequence of operations, we would suggest that, if possible, the drain at the hill side of the road be constructed first. After the completion of this drain, a period of ground water observation should be allowed for. During this period, it may become evident that some of the proposed additional measures could be dispensed with.

4. RECOMMENDATIONS: (cont'd.) ...

The above remedial measures are given mostly in general terms, with only the details that could be supplied at this time, and with the available geodetic data.

Attention is drawn to the necessity of immediate trench backfilling. If too long a stretch of the trench is left open for too long a time, an unstable condition could be created, resulting in further slope movements.

5. MISCELLANEOUS:

The field investigation was carried out during the month of May 1963, under the supervision of the Project Foundation Engineer, Mr. B. M. Ghadiali, who also prepared this report under the general guidance of Mr. A. G. Stermac, Principal Foundation Engineer.

June 1963

APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 63-F-53 LOCATION Kleinburg Side Road ORIGINATED BY B.M.G.
W.P. (Municipal) BORING DATE May 24, 1963. COMPILED BY B.M.G.
DATUM Geodetic BOREHOLE TYPE Washboring using BX casing CHECKED BY K.Y.L.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT			WD — W — WL				
						680								
677.4	Groundlevel													
	Road fill. V. dense													
1.0	Clayey silt - trace of sand, gravel and organics. Soft to firm. D. brown.		1	SS	4	675								
			2	SS	8	670								
8.0	Till. (Clayey silt with some sand and traces of fine gravel. Occasional layers of silt.) Hard and dense. Brown changing to grey at 15' depth.		3	SS	48	665								
			4	SS	44									
			5	SS	40	660								
			6	SS	30	655								
			7	SS	26	650								
647.4			8	SS	>100									
30.0	End of borehole.					645								

W.L.
at El.
670'

DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH DIVISION				RECORD OF BOREHOLE NO. 2				FOUNDATION SECTION					
JOB <u>63-F-53</u>		LOCATION <u>Kleinburg Side Road</u>		ORIGINATED BY <u>B.M.G.</u>									
W.P. <u>(Municipal)</u>		BORING DATE <u>May 25, 1963.</u>		COMPILED BY <u>B.M.G.</u>									
DATUM <u>Geodetic</u>		BOREHOLE TYPE <u>Washboring using BX casing</u>		CHECKED BY <u>K.Y.L.</u>									
SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WL WP W	WATER CONTENT % 15 30 45			
						665							
662.3	Groundlevel												
	Silty fine sand. (Original road fill). V. loose Brown.		1	SS	2	660							
			2	SS	2	655							
6.6	Clayey silt-trace of organics. Soft D. Brown.		3	SS	18								
652.3	Till. (Clayey silt-trace of sand). Hard Brown		4	SS	53	650							
10.0			5	SS	>100								
646.3													
16.0	End of borehole					645							

W.L. at El.
661.3

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 63-P-53 LOCATION Kleinburg Side Road ORIGINATED BY B.M.G.
W.P. (Municipal) BORING DATE May 27, 1963. COMPILED BY B.M.G.
DATUM Geodetic BOREHOLE TYPE Washboring using BX casing CHECKED BY K.Y.L.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.			wp — w — WL WATER CONTENT % 15 30 45				
663.8	Groundlevel					665								
	Sand fill													
0.9	Clayey silt with organics, some sand and trace of fine gravel. Soft to firm. D. Brown.		1	SS	5	660								
			2	SS	4									
						655								
			3	SS	8									
12.0	Till (Clayey silt and trace of fine sand) V. stiff to Hard Brown.		4	SS	21	650								
647.3			5	SS	45									
16.6	End of borehole.					645								

W.L. at El. 657.6'

▼
W.L. at El.
657.6'

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 63-F-53 LOCATION Kleinburg Side Road ORIGINATED BY B.M.G.
W.P. (Municipal) BORING DATE May 27, 1963. COMPILED BY B.M.G.
DATUM Geodetic BOREHOLE TYPE Washboring using BX Casing CHECKED BY K.Y.L.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — WL PLASTIC LIMIT — wp WATER CONTENT — w			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT			wp — w — WL				
							SHEAR STRENGTH P.S.F.			WATER CONTENT % 15 30 45				
650.2	Groundlevel					650								
	Topsoil													
1.0	Clayey silt occasionally mixed with some sand, trace of fine gravel and organics. Soft to stiff. D. brown to brown.		1	SS	2	645								
			2	SS	5									
			3	SS	9	640								
			4	SS	10									
			5	SS	11	635								
			6	SS	11	630								
22.0	Till. Clayey silt, trace of fine gravel and occasional layers of silt. Hard. Grey.		7	SS	47	625								
618.7			8	SS	95	620								
31.6	End of borehole.				42									

W.L. at El.
639.1

DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH DIVISION			RECORD OF BOREHOLE NO. 5										FOUNDATION SECTION							
JOB <u>63-F-53</u>			LOCATION <u>Kleinburg Side Road</u>										ORIGINATED BY <u>B.M.G.</u>							
W.P. <u>(Municipal)</u>			BORING DATE <u>May 27, 1963.</u>										COMPILED BY <u>B.M.G.</u>							
DATUM <u>Geodetic</u>			BOREHOLE TYPE <u>Washboring using NX casing</u>										CHECKED BY <u>K.Y.L.</u>							
SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT — WL			BULK DENSITY P.C.F.	REMARKS						
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	BLOWS / FOOT			PLASTIC LIMIT — WP					WATER CONTENT %					
							SHEAR STRENGTH P.S.F.			WATER CONTENT — W										
															WATER CONTENT % 15 30 45					
632.6	Groundlevel					635														
0.6	Topsoil																			
	Clayey silt with some sand, trace of gravel, and organics		1	SS	9		630													
	Firm to stiff																			
	D. brown.																			
			2	SS	15		625													
			3	SS	12		620													
12.0	Till (Clayey silt-trace of sand-fine gravel)																			
	V. stiff. Brown.																			
616.1			4	SS	22															
16.6	End of borehole.						615													

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

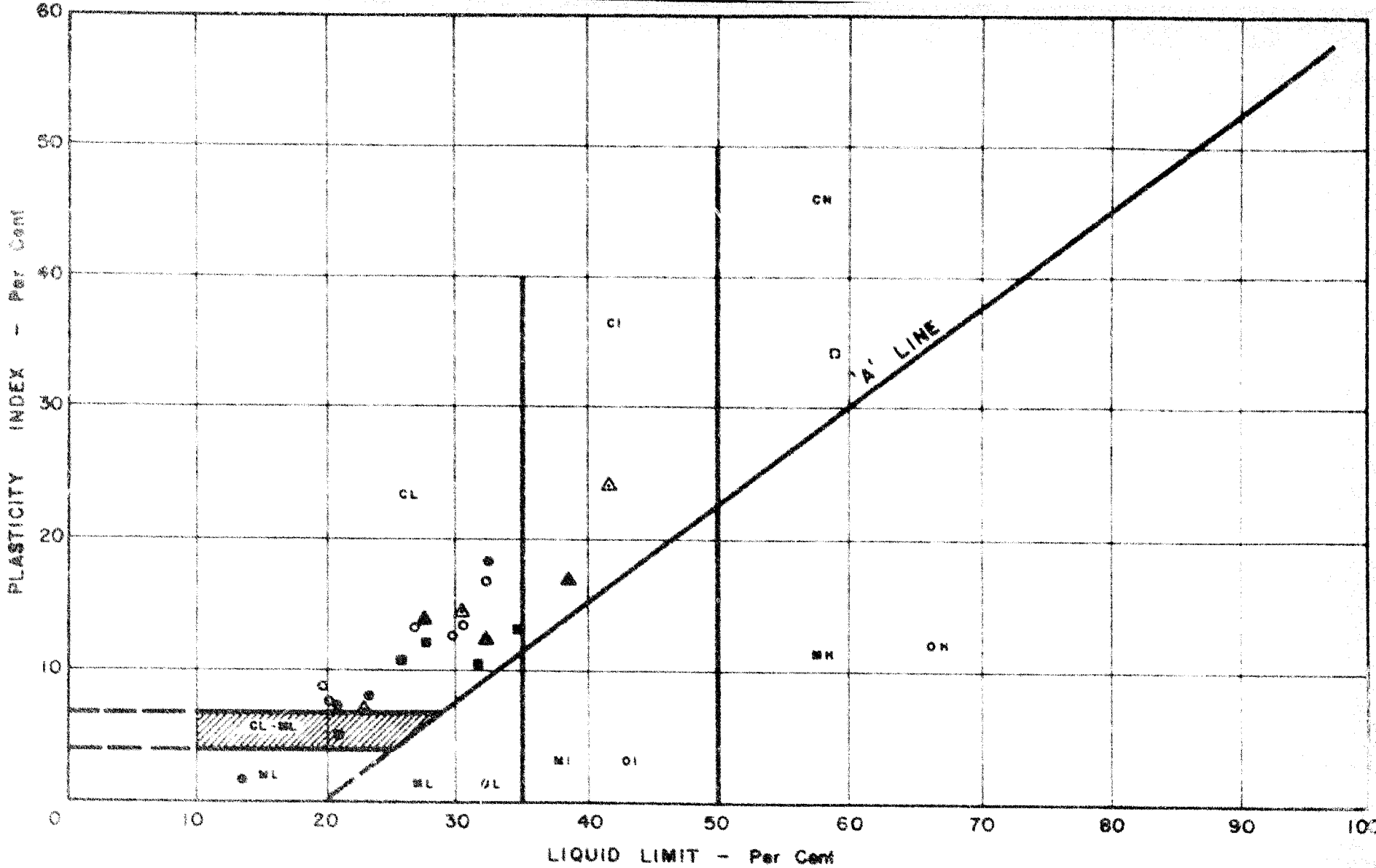
RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 63-F-53 LOCATION Kleinburg Side Road ORIGINATED BY B.H.G.
 W.P. (Municipal) BORING DATE May 29, 1963. COMPILED BY B.H.G.
 DATUM Geodetic BOREHOLE TYPE Washboring using BX casing. CHECKED BY K.Y.L.

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WP	W	WL		
611.8	Groundlevel														
0.0	Muck V. loose D. brown and black					610									
4.0	Till (sand-gravel with clayey silt binder) Dense Brown.		1	SS	33	605									
9.0	Clay (Trace of fine sand in this layer) V. stiff. Grey.		2	SS	15	600									
13.6	Silt V. dense. Grey		3	SS	59	595									
595.3															
16.6	End of borehole.														

W.L. at El.
610.5



NOTES BOREHOLE No. 1 - ● BOREHOLE No. 4 - ○
 " " " 2 - ▲ " " " 5 - △
 " " " 3 - ■ " " " 6 - □

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION
PLASTICITY CHART
 Job No. 63-F-53 W.P. No. MUNICIPAL
 Location KLEINBURG SIDE ROAD

#63-F-53

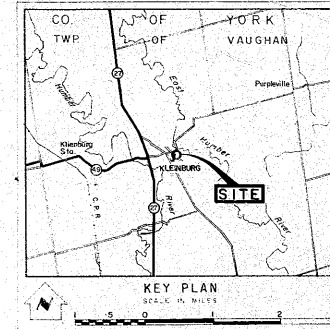
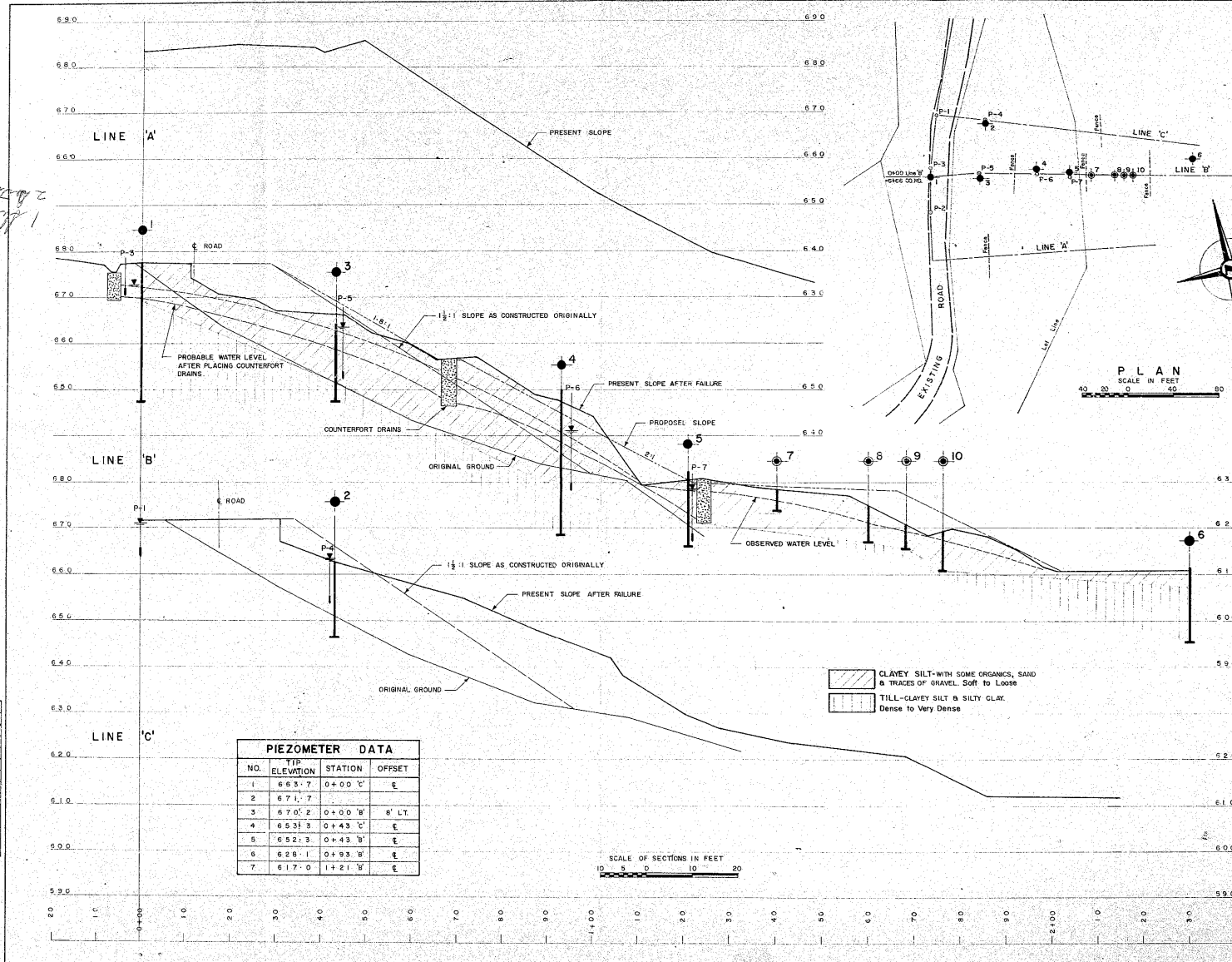
W.P. MUNIC.

EMBANKMENT

FAILURE

KLEINBURG

SIDE RD.



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation (June 11/63)
- Auger Hole
- Piezometer

NO.	ELEVATION	STATION	OFFSET
1	677.4	0+00 'W'	£
2	662.5	0+43 'C'	3' RT.
3	663.8	0+43 'B'	4' RT.
4	650.2	0+93 'B'	5' LT.
5	632.6	1+21 'B'	7' LT.
6	611.8	2+30 'W'	15' LT.
7	628.5	1+40 'B'	£
8	625.0	1+60 'B'	£
9	621.0	1+66 'B'	£
10	619.4	1+76 'B'	£

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.

SECTION	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

KLEINBURG SIDE ROAD EMBANKMENT FAILURE

KING'S HIGHWAY NO. COUNTY ROAD DIST NO. 6

CO. YORK

TWP. VAUGHAN LOT 24 CON. VIII

SECTIONS & PLAN

SUBMITTAL NO. CHECKED BY W.P.M. MURPHY K.S.B. DRAWING NO.

DRAWN BY D.M. CHECKED BY J.W.M. MURPHY K.S.B. F-53

DATE 20 JUNE 1963 DATE IN PROGRESS

APPROVED BY J.W.M. MURPHY K.S.B. COST NO.

63-F-53-A