

MEMORANDUM

TO: Mr. H. McArthur,
Regional Road Design Engr.,
Northern Region,
North Bay, Ont.

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

DATE: December 23, 1965
JAN 11 1965

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed New Alignment of Hwy. #63
between Sta. 84+50 and Sta. 86+50,
North Bay East City Limits Easterly
2.5 Miles.

W.J. 65-F-119 -- W.P. 270-62

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above site.

We believe that you will find the factual data and recommendations contained therein, will prove adequate for your design requirements. Should further information be required, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. H. McArthur (2)
D. W. Farren
G. Martens
E. R. Saint

Foundations Office
Gen. Files

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT

For

Proposed New Alignment of Hwy. #63
between Sta. 84+50 and Sta. 86+50,
North Bay East City Limits Easterly,
2.5 Miles.

W.J. 65-F-119 -- W.P. 270-62

1. INTRODUCTION:

A memo dated July 6, 1965, from Mr. E. R. Saint, Regional Materials Engineer, Northern Region, was received by this Section, requesting soils investigations at the above site.

Preliminary investigations at Sta. 90+00 indicated a soft silty clay layer between 10 and 19 feet below ground surface. The proposed new alignment calls for an embankment more than 10 ft. in height at this location, and it was felt that due to the soft layer, stability problems might arise. According to the request, this Section has carried out a detailed soils investigation, the results of which are presented in this report.

2. DESCRIPTION OF THE SITE:

The site is located some 2.5 miles East from the East City Limit of North Bay. At the area in question, Hwy. #63 closely follows the shoreline of Trout Lake. Immediately North of the highway, a hill rises rather steeply. This portion of the hill is a partially built-up resort type settlement. There is a large quantity of granite rock fill placed upon the hill near the site, which could probably be used for construction of the proposed fill. It is understood that the rock fill is the property of the Department of National Defense.

cont'd. /2

3. FIELD INVESTIGATION:

Five boreholes and 3 cone penetration tests were carried out with a conventional diamond core drill, adapted for soil sampling. Thin-walled and split-spoon samplings, together with field vane tests, were performed according to D.H.O. specifications. B.H. #2 was placed in the lake, utilizing a raft, while the rest of the boreholes were located on the ground. Locations and elevations of the holes are shown on Drawing #65-F-119A, accompanying this report. The soil stratigraphy revealed by the boreholes, field and laboratory results, is plotted on the borelog sheets under Appendix I, while the estimated soil profile, projected to the centre line of the proposed road, may be seen on the attached Drawing #65-F-119A.

4. SOIL CONDITIONS:

Generally, the subsoil consists of deposits of fine to coarse sand and a banded clayey silt to silty clay layer.

Moisture content determinations and a few grade size analyses were performed only on the granular deposits, since it was believed that these soils present no problem from the stability point of view. The relative densities of the sands are very loose to loose at the upper portion, becoming compact and very dense with depth. The thickness of the cohesive stratum increases towards the East direction, extending from 8 ft. to 12.5 ft. below ground at Sta. 84/56 (B.H. #1) and from 10 ft. to 19.5 ft. at Sta. 86/50 (B.H. #3A). Detailed sampling and testing was carried out on this material, including continuous Shelby tube sampling at B.H. #3A and continuous field vane testing immediately beside it in B.H. #3B. Relatively undisturbed samples indicated a stratum of a very complex and heterogeneous nature. At least 5 different seams were

cont'd. /3

4. SOIL CONDITIONS: (cont'd.)

observed, ranging from clays of high plasticity to fine sands. The stratification is generally horizontal, the thickness of the various seams being between 1/16" to 2". The predominant layers are clayey silts to silty clays, intercepted by thin seams of silt and clay. Sand seams also appear at random. Due to the sand and silt bands, most of the samples broke or cracked along these seams, upon removal from the tubes; hence, laboratory shear test results were considered to be unreliable. The shear strengths of the deposit measured by the field vane apparatus, were found to be 320 p.s.f. at B.H. #1, 480 p.s.f. at B.H. #5, and around 550 p.s.f. at the location of B.H. #3B, suggesting soft consistency at the West side of the area, becoming firm to stiff towards the East. It is believed that the sand and silt bands might have influenced the vane tests, resulting in somewhat higher values. The moisture contents were observed to be above the liquid limit, practically along the full depth of the deposit, which in turn confirms, indeed, emphasizes the softness and sensitivity of the stratum.

5. DISCUSSION AND RECOMMENDATIONS:

From the soil description, it may be seen that the proper evaluation of the shear strength characteristics of the clayey silt layer is rather difficult.

While the sand bands in the clayey silt might have resulted in an over-estimation of the shear strength, thus creating an impression of increased stability, they may have a truly beneficial influence on the stability of the slope by providing expedient paths for the dissipation of excess pore pressures created during construction.

A number of stability analyses were carried out by computer at Sta's 84+68, 85+42, and 86+50. Only the end-of-construction stability was investigated

cont'd. /4

5. DISCUSSION AND RECOMMENDATIONS: (cont'd.)

utilizing the $\phi = 0$ analysis, thus implying that the clayey silt and silty clay are purely cohesive materials. The analyses were carried out for rock fill embankments having steeper side slopes than the conventional earth fills. However, it is quite evident that even with flatter side slopes, unsatisfactory factors of safety would have been obtained. In addition to this, the placement of earth embankments under water is considered impractical, not only because of compaction difficulties, but also because a serious pollution problem could be created.

In spite of the results of the stability analyses, there is some likelihood that the proposed fill would be stable on account of the probable fast rate of consolidation under external loads, due to the horizontal bands of sand and silt, but constructing the fill under such critical circumstances would certainly imply a calculated risk.

Here, part of the memo by Mr. A. G. Stermac, Principal Foundation Engineer, written to Mr. E. R. Saint, Regional Materials Engineer, North Bay, on November 26, 1965, is quoted:

"If a calculated risk would be taken and the proposed design adopted, attention has to be given to the following question: What to do if it fails; how to remedy the situation?

The survey has shown that the shore of the lake dips quite rapidly at this location and the lake is therefore relatively deep. Because of this fact, it becomes most difficult to carry out any rational and effective corrective measures in case of an embankment failure."

cont'd. /5

5. DISCUSSION AND RECOMMENDATIONS: (cont'd.)

In view of the discussed problems, consideration should be given to:

a) the change of alignment. By shifting the centre line of the proposed road, some 80 - 90 ft. towards the hill, the construction of the fill could be entirely eliminated; or

b) lowering of the grade, thereby lessening the possibility of a slip failure. Further stability calculations would be necessary, using the new geometry of slope, if this alternative is to be investigated.

c) As a last resource, the excavation of the soft silt stratum and replacement with granular material may be mentioned. This, however, would mean an excavation of some 20 ft. in depth, which appears to be a rather expensive proposition. It is felt that the nature of the project would not warrant such an operation.

6. SUMMARY:

Soils investigations have confirmed the existence of a soft, silty clay layer beneath the proposed new alignment of Hwy. #63, between Sta's 84+50 and 86+50. A description of the site and subsoil conditions was given.

Stability analyses by means of the electronic computer, have shown that the proposed embankment is not stable. The unfavourable stratigraphy of the subsoil due to the sloping, rather thick (10 - 20 ft.) soft layer, and the propinquity of the lake, makes it difficult to employ remedial measures, applicable in such cases if failure would occur.

It is recommended, therefore, to give consideration to the change in alignment, or to the lowering of the grade.

7. MISCELLANEOUS:

The field work, performed during the last week of October 1965, was supervised by Mr. A. K. Barsvary, Project Foundation Engineer, together with the preparation of this report. General supervision was undertaken by Mr. A. G. Stermac, Principal Foundation Engineer.

December 1965

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 65-F-119

LOCATION Sta. 84+56 11' Rt. of E

ORIGINATED BY A.B.

W.P. 270-62

BORING DATE Oct. 26, 1965.

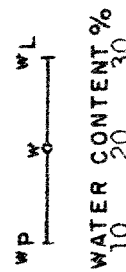
COMPILED BY A.B.

DATUM G.S.C.

BOREHOLE TYPE Washboring, NX Casing.

CHECKED BY A.G.S.

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT			P.C.F.	
665.0	Groundlevel										
0.0	Fine to medium sand with pieces of wood & organic matter. Very loose.		1	SS	4						
657.0											
8.0	Clayey silt with seams of clay and sand. Soft.		2	SS	1						
652.5			3	TM	P						
12.5	Fine to coarse sand. Compact.		4	SS	27						
646.0			5	SS	23						
17.0	End of borehole.										



WL 663.5

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 65-F-112

LOCATION Sta. 84+56 11' Rt. of E

ORIGINATED BY A.B.

W.P. 270-62

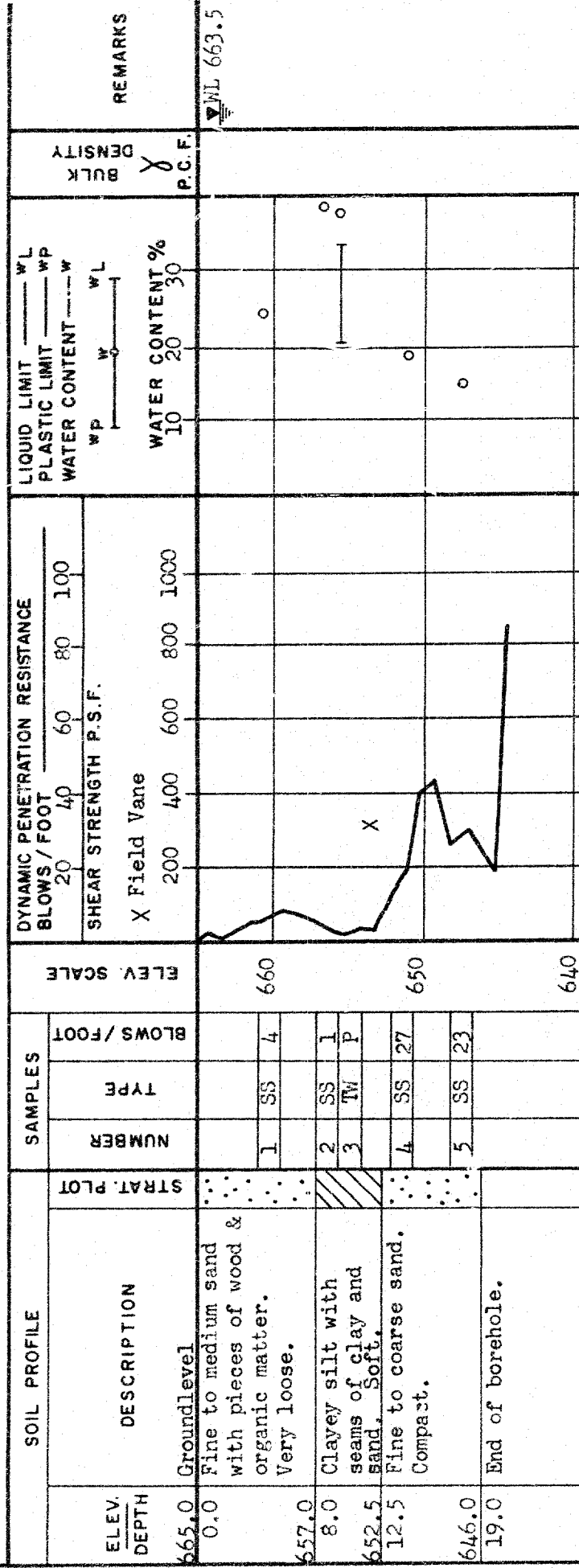
BORING DATE Oct. 26, 1965.

COMPILED BY A.B.

DATUM G.S.C.

BOREHOLE TYPE Washboring, NX Casing.

CHECKED BY A.G.S.



WL 663.5

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3 (A & B)

FOUNDATION SECTION

JOB 65-F-119 LOCATION Sta. 86+50 40' Rt. of E
W.P. 270-62 BORING DATE Oct. 28, 1965. ORIGINATED BY A.B.
DATUM G.S.C. BOREHOLE TYPE Washboring, NX Casing. COMPILED BY A.B.
CHECKED BY A.G.S. JR

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT	WATER CONTENT	
664.5	Groundlevel				20 40 60 80 100	X Field Vane	WP WL	WP WL	
0.0	Fine to medium sand.			660					
	Very loose.	1	SS						
		2	SS						
654.5		3	TW						
10.0	Silty clay to clayey silt with seams of sand and clay.	4	TW						
		5	TW						
		6	TW						
		7	TW						
645.0	Firm to stiff.	8	TW						
19.5	Fine sand.	9	SS						
642.5	Loose								
22.0	End of borehole.								

WATER CONTENT %

20 40 60

A B C D E

109 107 111 115

A=Sand Seams
B=Clayey silt seams
C=silty clay seams
D=Silt seams
E=Clay seams

BLK DENSITY X P.C.F.

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 2

MATERIALS & TESTING DIVISION

JOB 65-F-119 LOCATION Sta. 85+42, 70' Rt. of C

W.P. 270-62 BORING DATE Oct. 27, 1965.

DATUM G.S.C. BOREHOLE TYPE Washboring, NX Casing.

FOUNDATION SECTION

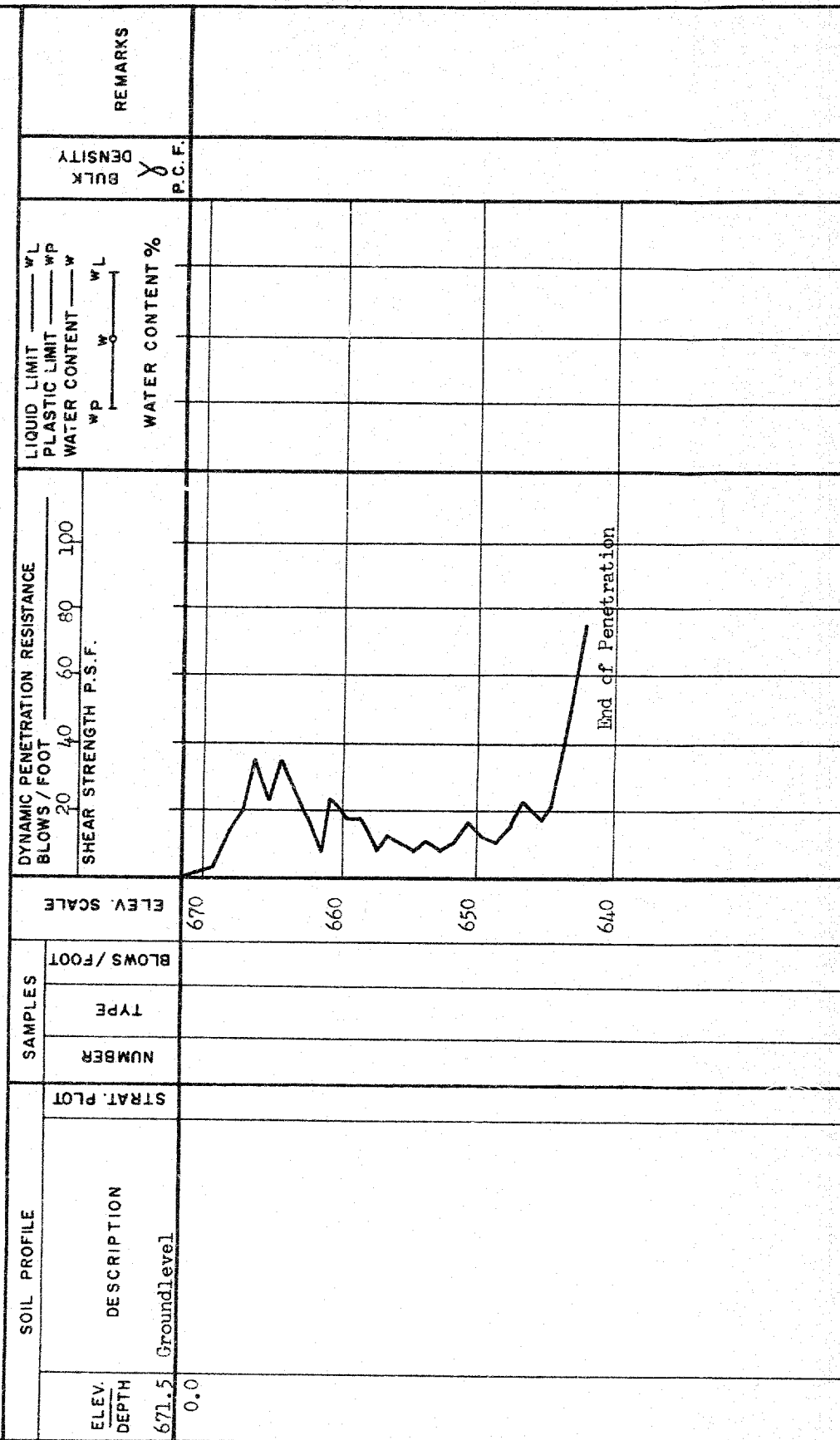
ORIGINATED BY A.B.

COMPILED BY A.B.

CHECKED BY A.G.S. *MR*

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		SHEAR STRENGTH S.F.	WATER CONTENT %				
663.7 0.0	Waterlevel (Trout Lake)				660						
	Lake				650						
	Water										
645.2	Fine sand.										
18.5	Very loose.		1	SS	640						
641.2	Silt										
22.5	Fine to medium sand.		2	SS							
23.5	Loose to very dense.		3	SS							
					630						
			4	SS							
624.2											
39.5	End of borehole.				620						

DEPARTMENT OF HIGHWAYS - ONTARIO		RECORD OF BOREHOLE NO. 4		FOUNDATION SECTION	
MATERIALS & TESTING DIVISION		LOCATION <u>Sta. 86+60, 20' Lt. of E</u>		ORIGINATED BY <u>A.B.</u>	
JOB <u>65-F-119</u>		BORING DATE <u>Oct. 29, 1965.</u>		COMPILED BY <u>A.B.</u>	
W.P. <u>270-62</u>		BOREHOLE TYPE <u>Cone Penetration.</u>		CHECKED BY <u>A.G.S. <i>AK</i></u>	
DATUM <u>G.S.C.</u>					



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 65-F-119 LOCATION Sta. 85450 E ORIGINATED BY A.B.
W.P. 270-62 BORING DATE Oct. 29, 1965. COMPILED BY A.B.
DATUM G.S.C. BOREHOLE TYPE Washboring, NX Casing. CHECKED BY A.G.S. *AK*

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. X Field Vane o Qu	WATER CONTENT %	W	WP	WL	
666.5	Groundlevel										
0.0	Fine to medium sand with pieces of wood & organic matter.										
656.0					660						
10.5	Silty clay with seams of sand, silt and clay.	1	TW	P							
648.0	Soft to firm.				650						
18.5	Fine to coarse sand.										
641.5											
25.0					640						

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ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma'}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

Mr. E. R. Saint,
Regional Materials Engr.,
North Bay, Ontario.

- 2 -

November 26, 1965

The above is a rough outline of our findings and conclusions. In view of all that, we would strongly recommend that serious and careful consideration be given to the change in alignment and to a possible lowering of the grade.

Attached, we are sending you two typical cross sections on which the subsoil stratigraphy is plotted. It is believed that these sections will contribute to a better and easier understanding of the problems in question.

At this stage, we are not submitting the full report containing all the details and calculations. However, this will be done shortly.

AGS/MdeF
Encl.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office ✓
Gen. Files

Mr. E. R. Saint,
Regional Materials Engr.,
North Bay, Ontario.

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

November 26, 1965

Proposed New Alignment of Hwy. #63,
Between Sta. 84+50 and Sta. 86+50,
North Bay East City Limits
W.P. 270-62 -- W.J. 65-F-119

In response to your request contained in the memo of July 6, 1965, and the subsequent discussions, this Section has carried out a foundation investigation at the above-mentioned site.

The investigation has disclosed the presence of a soft clayey silt to silty clay layer, having a relatively low shear strength. The fact that the boundaries of this layer are sloping in the direction of the lake, contributes to the possible instability of the proposed new embankment.

Based on the evaluated shear strength of the clay layer, the stability analysis of the proposed new road embankment indicates that it is not stable. However, it should be borne in mind that due to the stratified character of the clay deposit, the determination of the shear strength is very difficult and the chosen value may not be entirely representative. The presence of a sand layer above the clay contributes another difficulty to the stability analysis. It cannot be, therefore, emphatically stated that the proposed design is not feasible and that a failure is bound to occur. But it can be definitely stated that a failure is very likely to occur.

If a calculated risk would be taken and the proposed design adopted, attention has to be given to the following question: "What to do if it fails; how to remedy the situation".

The survey has shown that the shore of the lake dips quite rapidly at this location and the lake is therefore, relatively deep. Because of this fact, it becomes most difficult to carry out any rational and effective corrective measures in case of an embankment failure.

cont'd. /2 ...

NEW HWY.

EXISTING HWY

$\theta = 35^\circ$
 $\gamma = 130$

$\theta = 30^\circ$
 $\gamma = 115$

FINE TO MEDIUM
SAND

C = 1320 PSF
 $\gamma = 110$ PCF
 $M = 48$ PCF

CLAYEY SILT

$\theta = 30^\circ$
 $\gamma = 120$

FINE TO COARSE
SAND

84 + 68.51

NEW HWY

$\theta = 35^\circ$
 $\gamma = 130$

BLKMS/FT CONE
C = 1200 PSF
 $\gamma = 110$ PCF
 $M = 48$ PCF

$\theta = 30^\circ$
 $\gamma = 115$

FINE TO MEDIUM
SAND
Very Loose

C = 500 PSF
 $\gamma = 110$ PCF
 $M = 48$ PCF

SILTY CLAY TO CLAYEY SILT
WITH BEAMS OF CLAY & SAND
Firm to Stiff

$\theta = 30^\circ$
 $\gamma = 120$

FINE SAND
Loose

86 + 50

TROUT LAKE

W.L. 663.69

TROUT LAKE

W.L. 663.9

BLKMS/FT CONE
C = 1200 PSF
 $\gamma = 110$ PCF
 $M = 48$ PCF

Scale : 1 inch = 10 feet



ONTARIO
MATERIALS and
TESTING
DIVISION

PROPOSED NEW ALIGNMENT - HWY. NO. 63
BETWEEN STA 84+50 & STA 86+50
WP 270-62 DIST 13 JOB 65-F-119A

DATE 26 NOV 1965

APPROVED

DESIGNED BY 65-F-119A

MEMORANDUM

To: Mr. A. G. Stermac
Principal Foundation Engineer
Downsview, Ont.

FROM: Road Design Office
Box 855
North Bay, Ont.

DATE: May 12, 1966

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 270-62, Hwy. 63, North Bay City
Limits, Re: M. & T. Drawing No. 65-F-119B

As discussed by phone, I am forwarding the attached plan and cross-sections with the additional widening required shown in red.

Please check the proposed berm and forward your recommendations at your earliest convenience.

If you require additional information, please contact us.

Henry
H. R. Herbrand
Design Supervisor
For: W. S. Newman
Sr. Proj. Design Supervisor

HRR: les
Att.

Mr. H. McArthur,
Regional Road Design Engr.,
Northern Region,
North Bay, Ont.

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

April 21, 1966

Proposed New Alignment of Hwy. #63
Between Sta. 84+50 and Sta. 86+50,
2.5 Miles East of North Bay City Limits,
W.J. 65-F-119, W.P. 270-62, District #13.

A preliminary foundation investigation was carried out by this Section at the above mentioned site during October 1965, and the results were submitted in the report W.J. 65-F-119.

This investigation revealed, at a certain depth and over the entire area, the presence of a soft laminated clay layer. This finding indicated that it may not be possible to build the realigned highway without carrying out either certain alterations or undertaking some preventive measures.

During March 1966, a more detailed investigation consisting of 16 additional boreholes, was carried out in order to define more precisely and clearly the extent and properties of the soft clay layer.

Based on the findings of this investigation, a study of the stability of the highway embankment was carried out. The results of this study have confirmed that the embankment as designed, was not safe, and that a berm on the south side, between Sta. 84+50 and 86+00, is required for stability.

The details of the berm are shown on the attached Drawing 65-F-119B.

cont'd. /2

Mr. H. McArthur,
Regional Road Design Engr., - 2 -
Northern Region,
North Bay, Ont.

April 21, 1966

We trust that this information will suffice for your further design work. Should there be any details or problems that you would like to discuss, please feel free to contact this Office.

A detailed report containing all the field and laboratory findings as well as stability analyses, will be submitted at a later date.

AGS/MdeF
Attach.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Messrs. E. McArthur
D. W. Farren
G. Martens
E. R. Saint

Foundations Office ✓
Gen. Files

MEMORANDUM

To: Mr. A. Rutka
Materials & Testing Division
Downsview

FROM: Materials & Testing
Northern Region

Att: K.Y. Lo

DATE: July 6, 1965

65-F-119

Our File Ref.

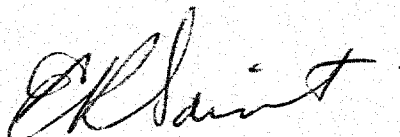
IN REPLY TO

SUBJECT:

Re: W.P. 270-62, Hwy. #63, North Bay East
City Limits Easterly 2.5 miles

Attached are the borehole logs and laboratory sample results from two preliminary holes placed at Stations 70 and 90. The Shelby sample No. 65 ML-2 was forwarded by private car June 30 (J. Gartner), for testing.

No problems are anticipated at Station 70. However, a soft silty clay layer was encountered between 10 and 19 feet at Station 90. There is a narrow beach with shallow water for 20-25 feet out, then a very steep drop-off. No sections are presently available of the lake bottom but can be obtained if necessary. Please check the area around Station 90 for stability and determine if a further investigation is required. G.A. Wrong has the plan and profile of this project previously forwarded to you.



E.R. Saint
Regional Materials Engineer

SRS/ef
c.c. G.A. Wrong
File (2)
Attach:

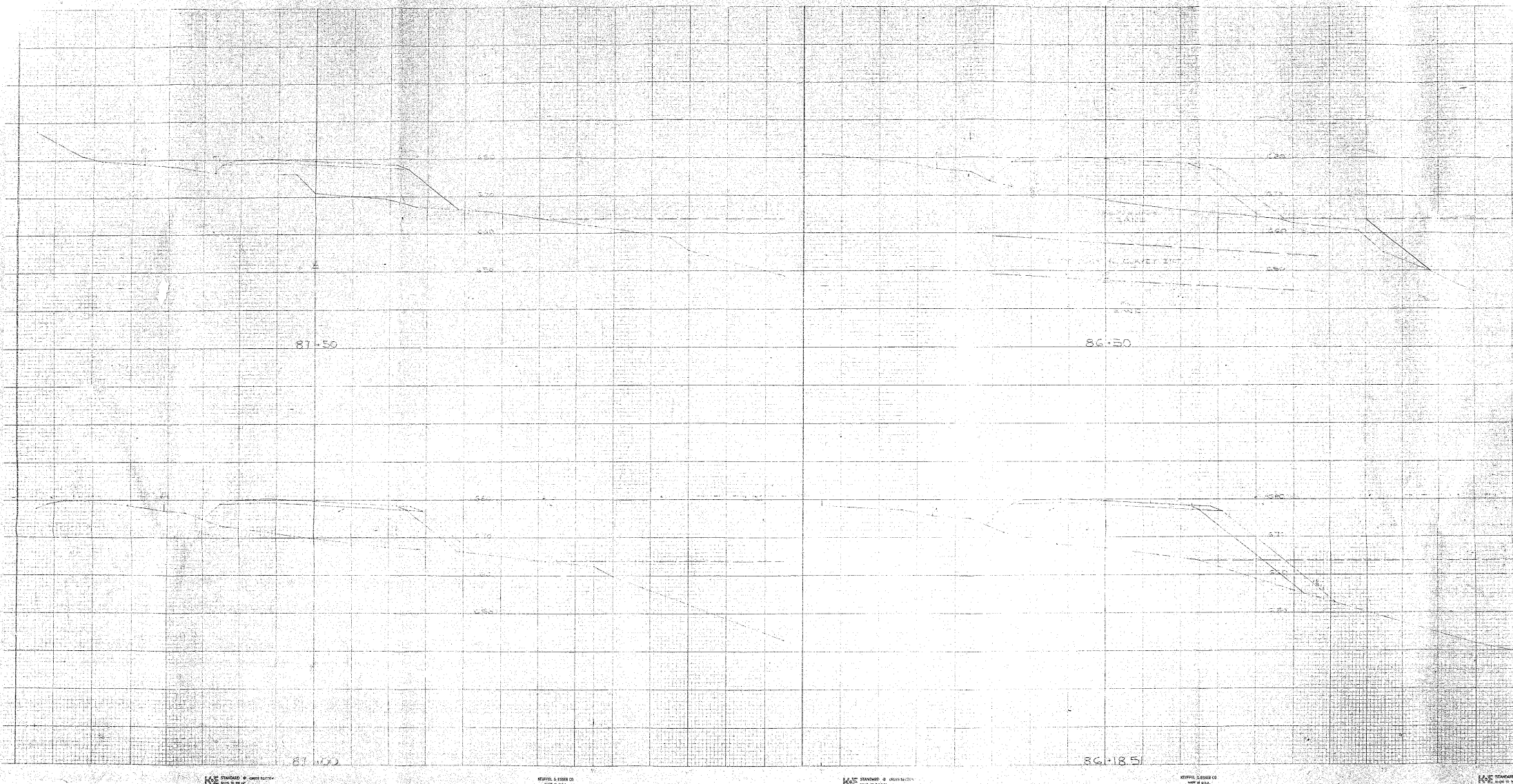
#65-F-119

W.P. #270-62

Hwy. #63

! TROUT LAKE

86-E-119



KEITH & SINGER CO.
MADE IN U.S.A.

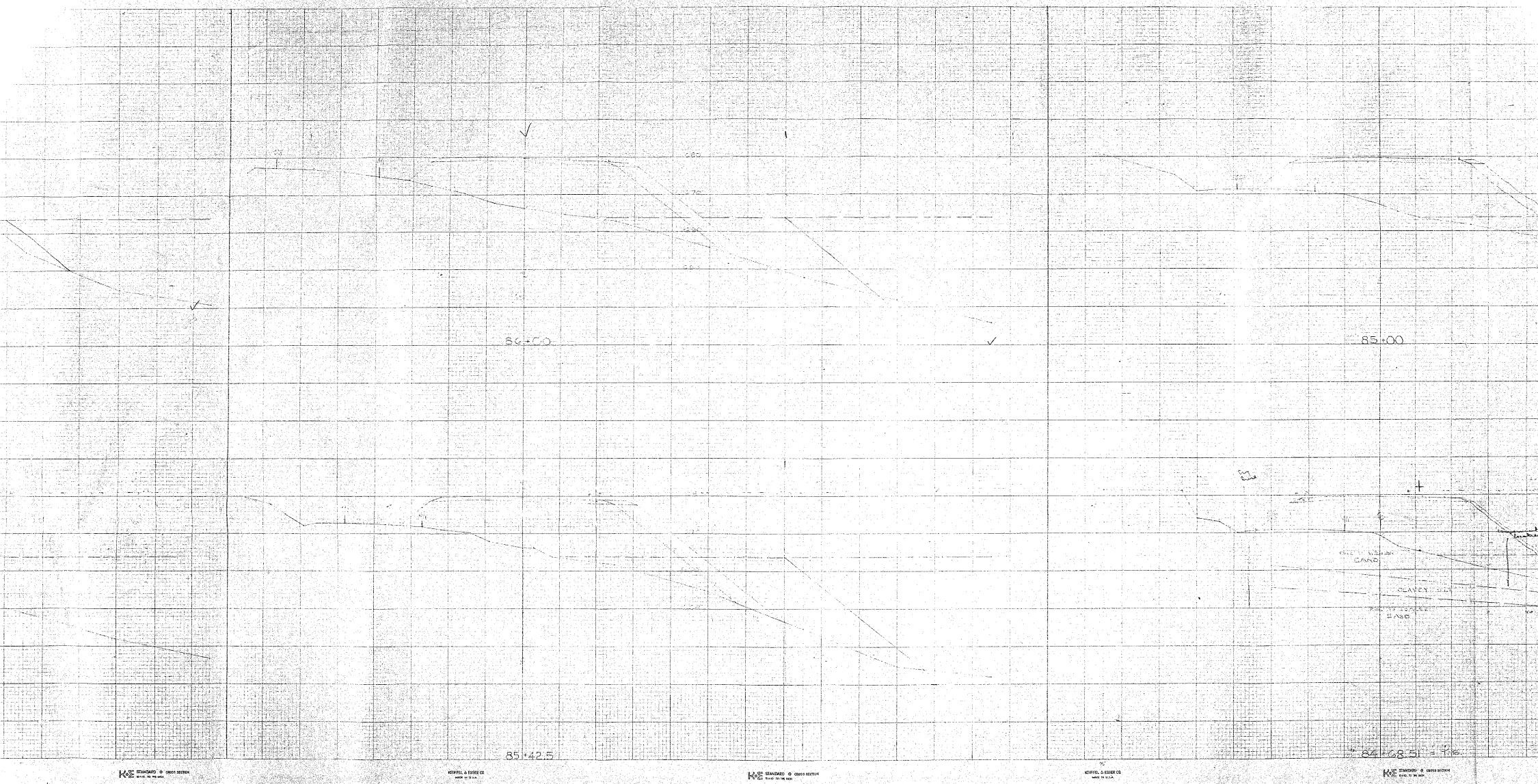
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MADE IN U.S.A.

KEITH & SINGER CO.
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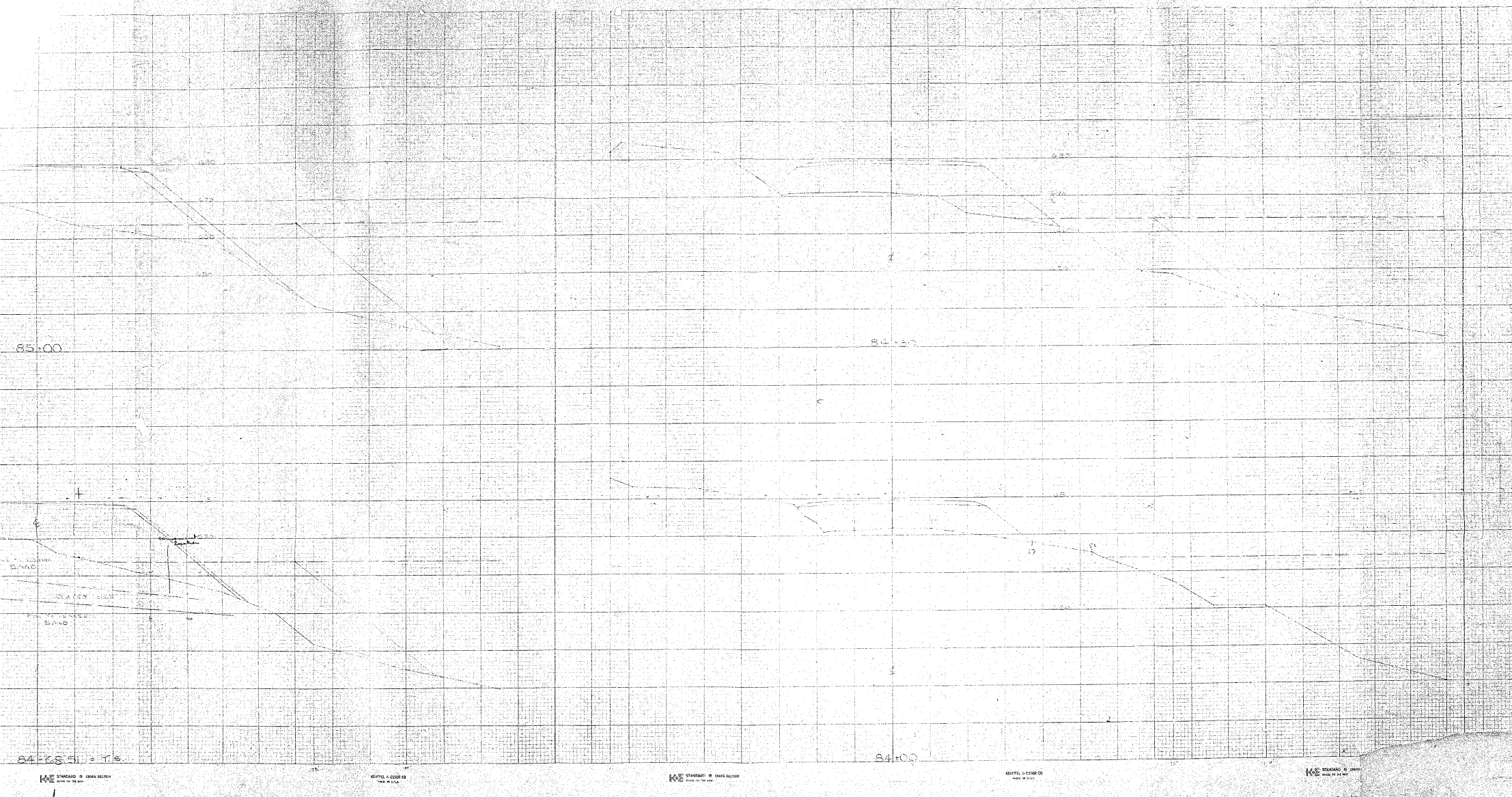
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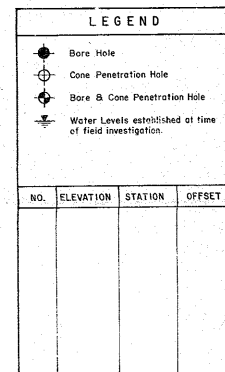
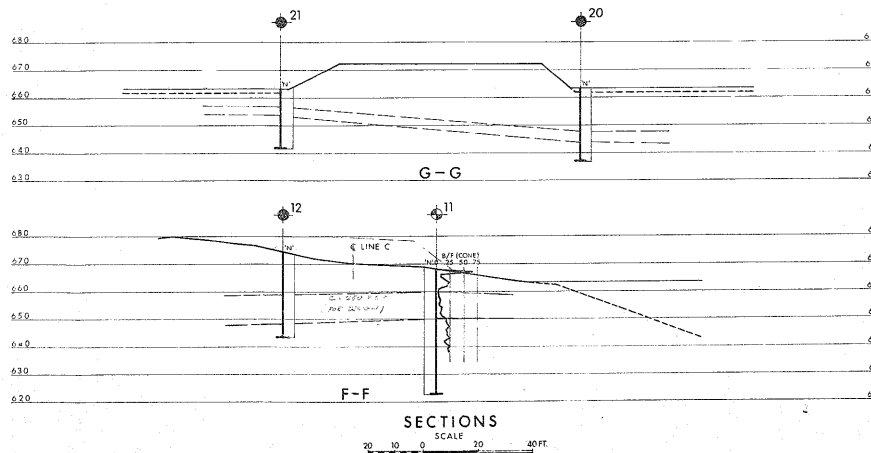
SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS



SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS



SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS



- 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.

TELEVISIONS				
DATE	BY	DESCRIPTION		

PRELIMINARY ONLY

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION - FOUNDATION SECTION

EMBANKMENT STABILITY

TROUT LAKE

KING'S HIGHWAY NO. 63 LINE 'C' _____ DIST. NO. 13

CD. NIPISSING

TWP. WIDFIELD LOT _____ CON. _____

BORE HOLE LOCATIONS & SOIL STRATA

SUBMB. R. M.	CHECKED	W. P. NO.	270 - 62	N. I. T. DRAWING NO.
DESIGN. S. O.	CHECKED	JOB. NO.	66-F-119	65-F-119 B
DATE	SITE NO.		BRIDGE SITE, KING NO.	

APPROVED *John Macdonald* (SIGNED) _____

ENGINEER IN CHARGE

MEMORANDUM

cc GEN. FILES
W.P. 270-62
23-66-29

TO: Mr. H. McArthur,
Regional Road Design Engr.,
Northern Region,
North Bay, Ont.

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

DATE: December 23, 1965

OUR FILE REF.

IN REPLY TO

JAN 11 1965

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed New Alignment of Hwy. #63
between Sta. 84+50 and Sta. 86+50,
North Bay East City Limits Easterly
2.5 Miles.

W.J. 65-F-119 -- W.P. 270-62

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above site.

We believe that you will find the factual data and recommendations contained therein, will prove adequate for your design requirements. Should further information be required, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. H. McArthur (2)
D. W. Farren
G. Martens
E. R. Saint

Foundations Office
Gen. Files

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

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1. INTRODUCTION.
 2. DESCRIPTION OF THE SITE.
 3. FIELD INVESTIGATION.
 4. SOIL CONDITIONS.
 5. DISCUSSION AND RECOMMENDATIONS.
 6. SUMMARY.
 7. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION REPORT

For

Proposed New Alignment of Hwy. #63
between Sta. 84+50 and Sta. 86+50,
North Bay East City Limits Easterly,
2.5 Miles.

W.J. 65-P-119 -- W.P. 270-62

1. INTRODUCTION:

A memo dated July 6, 1965, from Mr. E. R. Saint, Regional Materials Engineer, Northern Region, was received by this Section, requesting soils investigations at the above site.

Preliminary investigations at Sta. 90+00 indicated a soft silty clay layer between 10 and 19 feet below ground surface. The proposed new alignment calls for an embankment more than 10 ft. in height at this location, and it was felt that due to the soft layer, stability problems might arise. According to the request, this Section has carried out a detailed soils investigation, the results of which are presented in this report.

2. DESCRIPTION OF THE SITE:

The site is located some 2.5 miles East from the East City Limit of North Bay. At the area in question, Hwy. #63 closely follows the shoreline of Trout Lake. Immediately North of the highway, a hill rises rather steeply. This portion of the hill is a partially built-up resort type settlement. There is a large quantity of granite rock fill placed upon the hill near the site, which could probably be used for construction of the proposed fill. It is understood that the rock fill is the property of the Department of National Defense.

cont'd. /2

3. FIELD INVESTIGATION:

Five boreholes and 3 cone penetration tests were carried out with a conventional diamond core drill, adapted for soil sampling. Thin-walled and split-spoon samplings, together with field vane tests, were performed according to D.H.O. specifications. B.H. #2 was placed in the lake, utilizing a raft, while the rest of the boreholes were located on the ground. Locations and elevations of the holes are shown on Drawing #65-F-119A, accompanying this report. The soil stratigraphy revealed by the boreholes, field and laboratory results, is plotted on the borelog sheets under Appendix I, while the estimated soil profile, projected to the centre line of the proposed road, may be seen on the attached Drawing #65-F-119A.

4. SOIL CONDITIONS:

Generally, the subsoil consists of deposits of fine to coarse sand and a banded clayey silt to silty clay layer.

Moisture content determinations and a few grade size analyses were performed only on the granular deposits, since it was believed that these soils present no problem from the stability point of view. The relative densities of the sands are very loose to loose at the upper portion, becoming compact and very dense with depth. The thickness of the cohesive stratum increases towards the East direction, extending from 8 ft. to 12.5 ft. below ground at Sta. 84/56 (B.H. #1) and from 10 ft. to 19.5 ft. at Sta. 86/50 (B.H. #3A). Detailed sampling and testing was carried out on this material, including continuous Shelby tube sampling at B.H. #3A and continuous field vane testing immediately beside it in B.H. #3B. Relatively undisturbed samples indicated a stratum of a very complex and heterogeneous nature. At least 5 different seams were

cont'd. /3

4. SOIL CONDITIONS: (cont'd.)

observed, ranging from clays of high plasticity to fine sands. The stratification is generally horizontal, the thickness of the various seams being between 1/16" to 2". The predominant layers are clayey silts to silty clays, intercepted by thin seams of silt and clay. Sand seams also appear at random. Due to the sand and silt bands, most of the samples broke or cracked along these seams, upon removal from the tubes; hence, laboratory shear test results were considered to be unreliable. The shear strengths of the deposit measured by the field vane apparatus, were found to be 320 p.s.f. at B.H. #1, 480 p.s.f. at B.H. #5, and around 550 p.s.f. at the location of B.H. #3B, suggesting soft consistency at the West side of the area, becoming firm to stiff towards the East. It is believed that the sand and silt bands might have influenced the vane tests, resulting in somewhat higher values. The moisture contents were observed to be above the liquid limit, practically along the full depth of the deposit, which in turn confirms, indeed, emphasizes the softness and sensitivity of the stratum.

5. DISCUSSION AND RECOMMENDATIONS:

From the soil description, it may be seen that the proper evaluation of the shear strength characteristics of the clayey silt layer is rather difficult.

While the sand bands in the clayey silt might have resulted in an over-estimation of the shear strength, thus creating an impression of increased stability, they may have a truly beneficial influence on the stability of the slope by providing expedient paths for the dissipation of excess pore pressures created during construction.

A number of stability analyses were carried out by computer at Sta's 84+68, 85+42, and 86+50. Only the end-of-construction stability was investigated

cont'd. /4

5. DISCUSSION AND RECOMMENDATIONS: (cont'd.)

utilizing the $\phi = 0$ analysis, thus implying that the clayey silt and silty clay are purely cohesive materials. The analyses were carried out for rock fill embankments having steeper side slopes than the conventional earth fills. However, it is quite evident that even with flatter side slopes, unsatisfactory factors of safety would have been obtained. In addition to this, the placement of earth embankments under water is considered impractical, not only because of compaction difficulties, but also because a serious pollution problem could be created.

In spite of the results of the stability analyses, there is some likelihood that the proposed fill would be stable on account of the probable fast rate of consolidation under external loads, due to the horizontal bands of sand and silt, but constructing the fill under such critical circumstances would certainly imply a calculated risk.

Here, part of the memo by Mr. A. G. Stermac, Principal Foundation Engineer, written to Mr. E. R. Saint, Regional Materials Engineer, North Bay, on November 26, 1965, is quoted:

"If a calculated risk would be taken and the proposed design adopted, attention has to be given to the following question: What to do if it fails; how to remedy the situation?

The survey has shown that the shore of the lake dips quite rapidly at this location and the lake is therefore relatively deep. Because of this fact, it becomes most difficult to carry out any rational and effective corrective measures in case of an embankment failure."

cont'd. /5

5. DISCUSSION AND RECOMMENDATIONS: (cont'd.)

In view of the discussed problems, consideration should be given to:

a) the change of alignment. By shifting the centre line of the proposed road, some 80 - 90 ft. towards the hill, the construction of the fill could be entirely eliminated; or

b) lowering of the grade, thereby lessening the possibility of a slip failure. Further stability calculations would be necessary, using the new geometry of slope, if this alternative is to be investigated.

c) As a last resource, the excavation of the soft silt stratum and replacement with granular material may be mentioned. This, however, would mean an excavation of some 20 ft. in depth, which appears to be a rather expensive proposition. It is felt that the nature of the project would not warrant such an operation.

6. SUMMARY:

Soils investigations have confirmed the existence of a soft, silty clay layer beneath the proposed new alignment of Hwy. #63, between Sta's 84+50 and 86+50. A description of the site and subsoil conditions was given.

Stability analyses by means of the electronic computer, have shown that the proposed embankment is not stable. The unfavourable stratigraphy of the subsoil due to the sloping, rather thick (10 - 20 ft.) soft layer, and the propinquity of the lake, makes it difficult to employ remedial measures, applicable in such cases if failure would occur.

It is recommended, therefore, to give consideration to the change in alignment, or to the lowering of the grade.

7. MISCELLANECUS:

The field work, performed during the last week of October 1965, was supervised by Mr. A. K. Barsvary, Project Foundation Engineer, together with the preparation of this report. General supervision was undertaken by Mr. A. G. Stermac, Principal Foundation Engineer.

December 1965

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 65-F-119

LOCATION Sta. 84/56. 11' Rt. of C

ORIGINATED BY A.B.

W. P. 270-62

BORING DATE Oct. 26, 1965.

COMPILED BY A.B.

DATUM G.S.C.

BOREHOLE TYPE Washboring. NX Casing.

CHECKED BY _____ A.G.S.

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	Liquid Limit ——— w _L	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	PLASTIC LIMIT ——— w _p		
							20 40 60 80 100	WATER CONTENT ——— w		
							SHEAR STRENGTH P.S.F.				w_{p} ——— w ——— w_{L}
						X Field Vane	200 400 600 800 1000	WATER CONTENT % 10 20 30		
665.0	Groundlevel	.....							
0.0	Fine to medium sand with pieces of wood & organic matter. Very loose.	.....	1	SS	4	660				WL 663.
657.0		.....							
8.0	Clayey silt with seams of clay and sand. Soft.	|||||	2	SS	1					
652.5		|||||	3	Tw	P					
12.5	Fine to coarse sand. Compact.	.....	4	SS	27	650				
646.0		.....	5	SS	23					
19.0	End of borehole.					640				

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3 (A & B)

FOUNDATION SECTION

JOB 65-F-119 LOCATION Sta. 86+50 40' Rt. of C ORIGINATED BY A.B.
W.P. 270-62 BORING DATE Oct. 28, 1965. COMPILED BY A.B.
DATUM G.S.C. BOREHOLE TYPE Washboring, NX Casing. CHECKED BY A.G.S. JR

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w _L PLASTIC LIMIT — w _p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					w _p — w — w _L							
							SHEAR STRENGTH P.S.F.					WATER CONTENT %							
							X Field Vane												
							200	400	600	800	1000	20	40	60					
664.5	Groundlevel																		
0.0	Fine to medium sand. v loose.	•••				660										A=Sand Seams B=Clayey silt seams C=silty clay seams D=Silt seams E=Clay seams 109 107 111 115			
			1	SS	3														
654.5			2	SS	1														
10.0	Silty clay to clayey silt with seams of sand and clay.	▨	3	TW	P														
			4	TW	P														
			5	TW	P	650			X										
			6	TW	P				X	X									
			7	TW	P														
			8	TW	P							X							
645.0	Firm to stiff.		9	SS	7						X								
19.5	Fine sand.	•••																	
642.5	Loose	•••																	
22.0	End of borehole.					640													
						630													

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _P WATER CONTENT ——— w		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		WATER CONTENT % 10 20 30			
663.7 0.0	Waterlevel (Trout Lake)					660						
	Lake					650						
	Water											
645.2												
18.5	Fine sand.											
641.2	Very loose.		1	SS	1	640						
22.5	Silt											
23.5	Fine to medium sand.		2	SS	5							
	Loose to very dense.		3	SS	8							
						630						
			4	SS	90							
624.2												
39.5	End of borehole.					620						

CHECKED BY A.G.S.

[illegible]

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINEL TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	POPE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

Mr. E. R. Saint,
Regional Materials Engr.,
North Bay, Ontario.

- 2 -

November 26, 1965

The above is a rough outline of our findings and conclusions. In view of all that, we would strongly recommend that serious and careful consideration be given to the change in alignment and to a possible lowering of the grade.

Attached, we are sending you two typical cross sections on which the subsoil stratigraphy is plotted. It is believed that these sections will contribute to a better and easier understanding of the problems in question.

At this stage, we are not submitting the full report containing all the details and calculations. However, this will be done shortly.

AGS/MdeF
Encl.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office ✓
Gen. Files

Mr. E. R. Saint,
Regional Materials Engr.,
North Bay, Ontario.

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

November 26, 1965

Proposed New Alignment of Hwy. #63,
Between Sta. 84+50 and Sta. 86+50,
North Bay East City Limits
W.P. 270-62 -- W.J. 65-F-119

In response to your request contained in the memo of July 6, 1965, and the subsequent discussions, this Section has carried out a foundation investigation at the above-mentioned site.

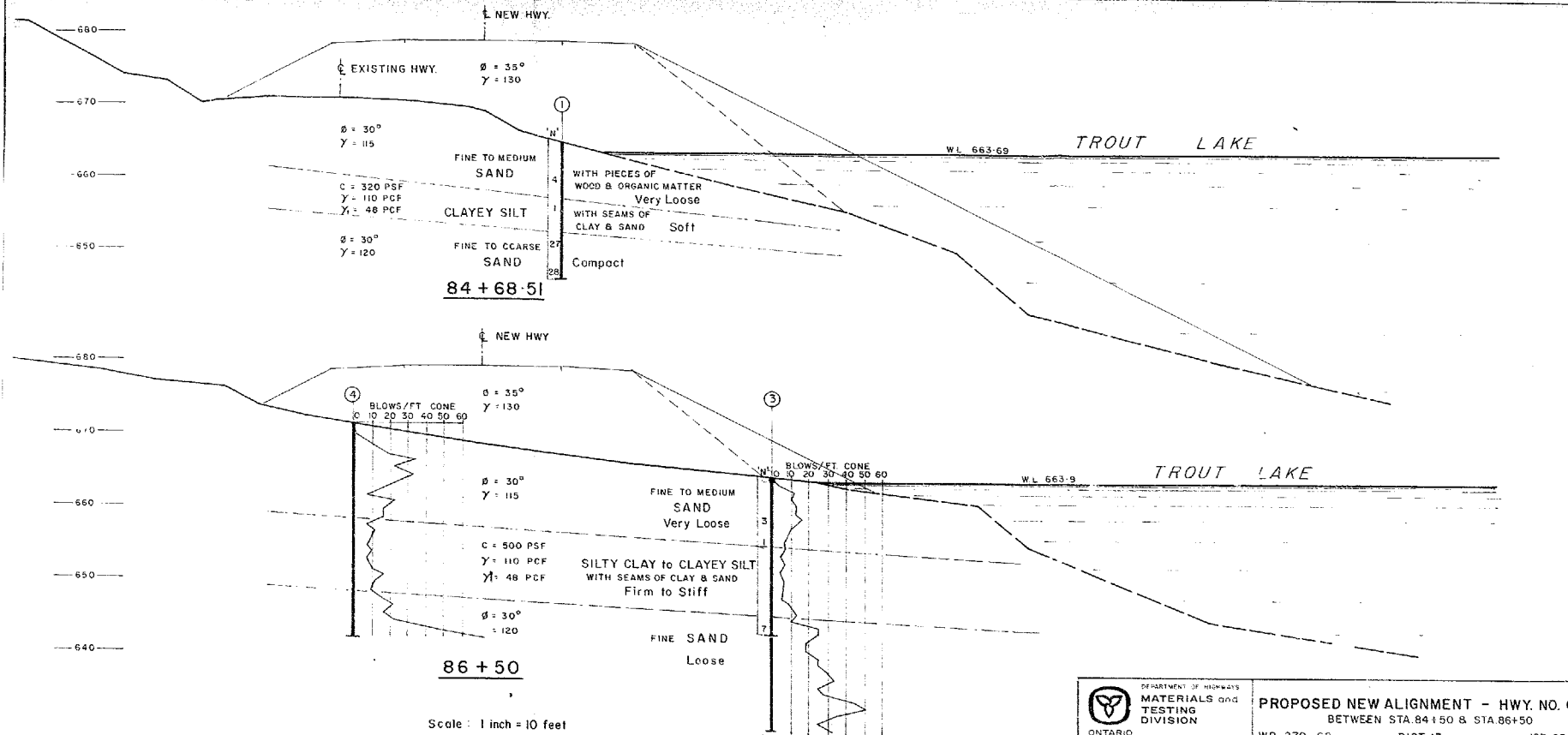
The investigation has disclosed the presence of a soft clayey silt to silty clay layer, having a relatively low shear strength. The fact that the boundaries of this layer are sloping in the direction of the lake, contributes to the possible instability of the proposed new embankment.

Based on the evaluated shear strength of the clay layer, the stability analysis of the proposed new road embankment indicates that it is not stable. However, it should be borne in mind that due to the stratified character of the clay deposit, the determination of the shear strength is very difficult and the chosen value may not be entirely representative. The presence of a sand layer above the clay contributes another difficulty to the stability analysis. It cannot be, therefore, emphatically stated that the proposed design is not feasible and that a failure is bound to occur. But it can be definitely stated that a failure is very likely to occur.

If a calculated risk would be taken and the proposed design adopted, attention has to be given to the following question: "What to do if it fails; how to remedy the situation".

The survey has shown that the shore of the lake dips quite rapidly at this location and the lake is therefore, relatively deep. Because of this fact, it becomes most difficult to carry out any rational and effective corrective measures in case of an embankment failure.

cont'd. /2 ...



DEPARTMENT OF HIGHWAYS
 MATERIALS and
 TESTING
 DIVISION
 ONTARIO

PROPOSED NEW ALIGNMENT - HWY. NO. 6
 BETWEEN STA. 84+50 & STA. 86+50

WP 270-62

DIST. 13

JOB 65-1

DATE 26 NOV. 1965

APPROVED

DRAWING NO. 65-F-119A

Sta 84+00 to Sta 87+50

First X Section \pm 84+50

B.H # 1 Completed by Alex
add two more borehole.

Second X Section \pm 85+42

B.H # 2

70 ft Rt

B.H # 5

Φ .

carry out at least two boreholes

- 1) one borehole 30 ft Rt of Φ .
- 2) " " 20 ft Lt of Φ .

Third Section 86+50

B.H # 3

40 ft Rt

carry out at least two boreholes.

- 1) one at Φ .
- 2) " at 25 ft Lt of Φ .

IV Section 87+00

- 1) one at 25 ft Lt of Φ
- 2) one at 25 ft Rt of Φ .

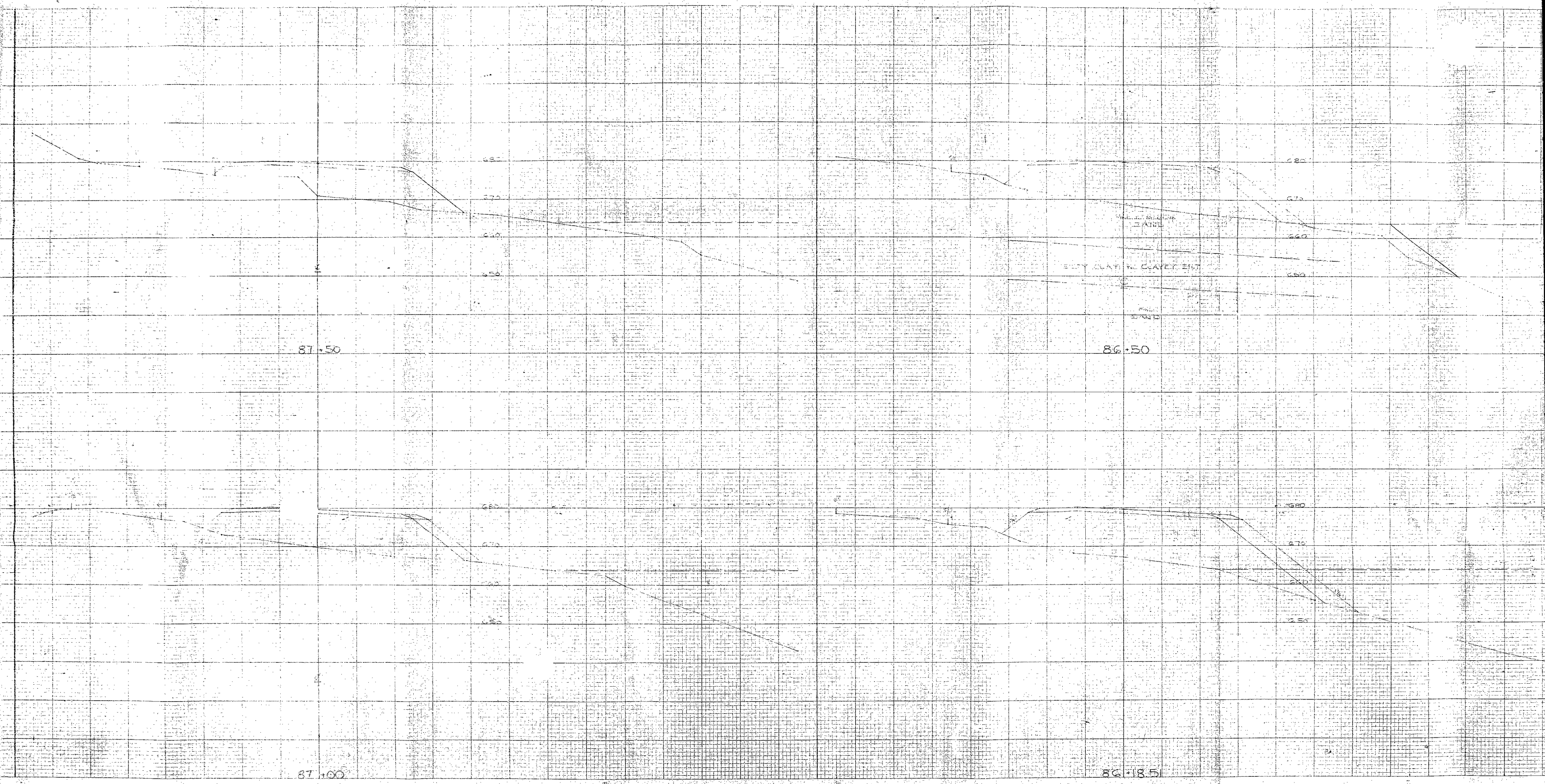
#65-F-119

W.P. #270-62

Hwy. #63

! TROUT LAKE

65-E-119



87.50

86.50

87.00

86.85

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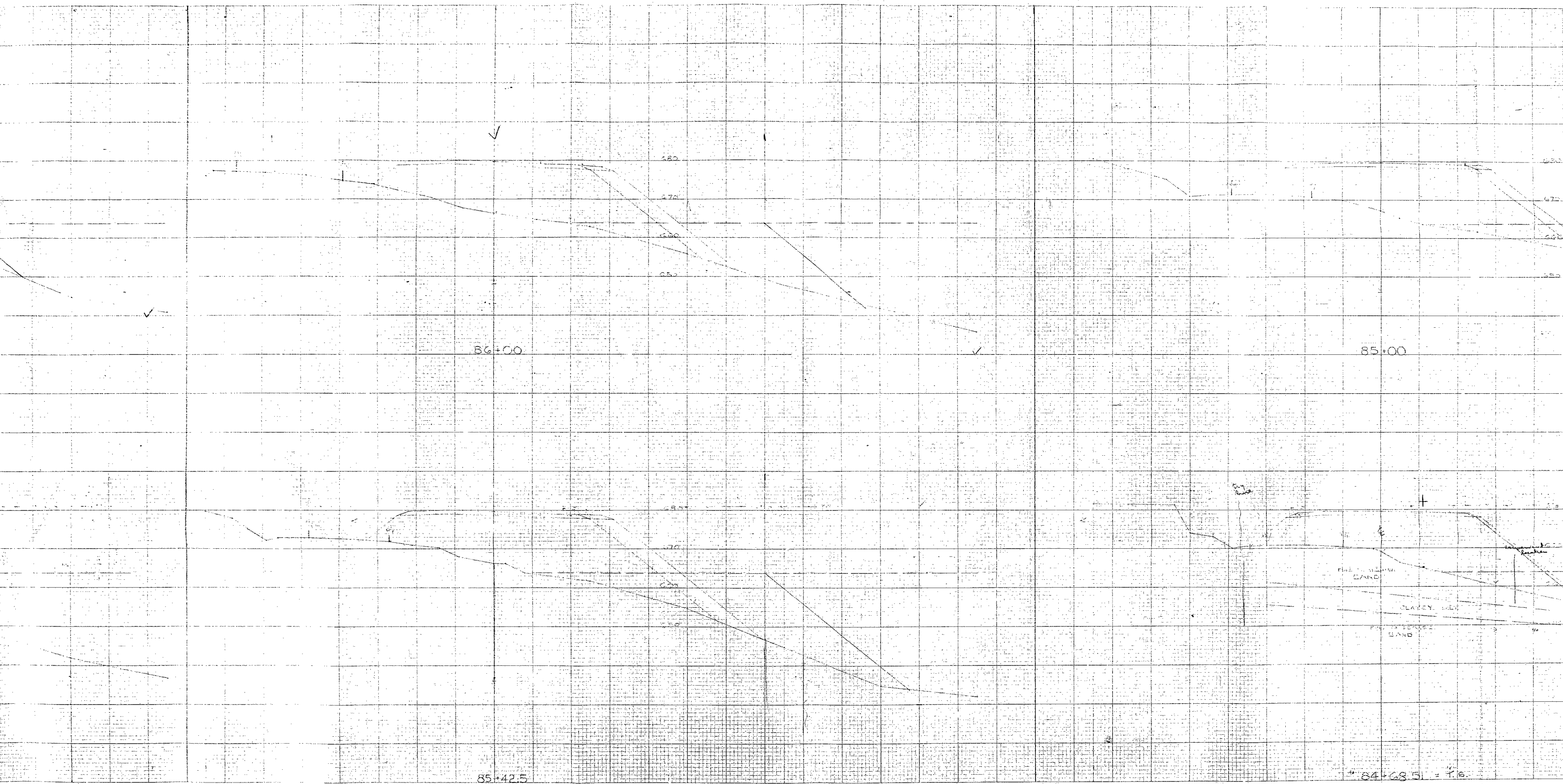
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SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS



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DRAWN TO THE 1/4"

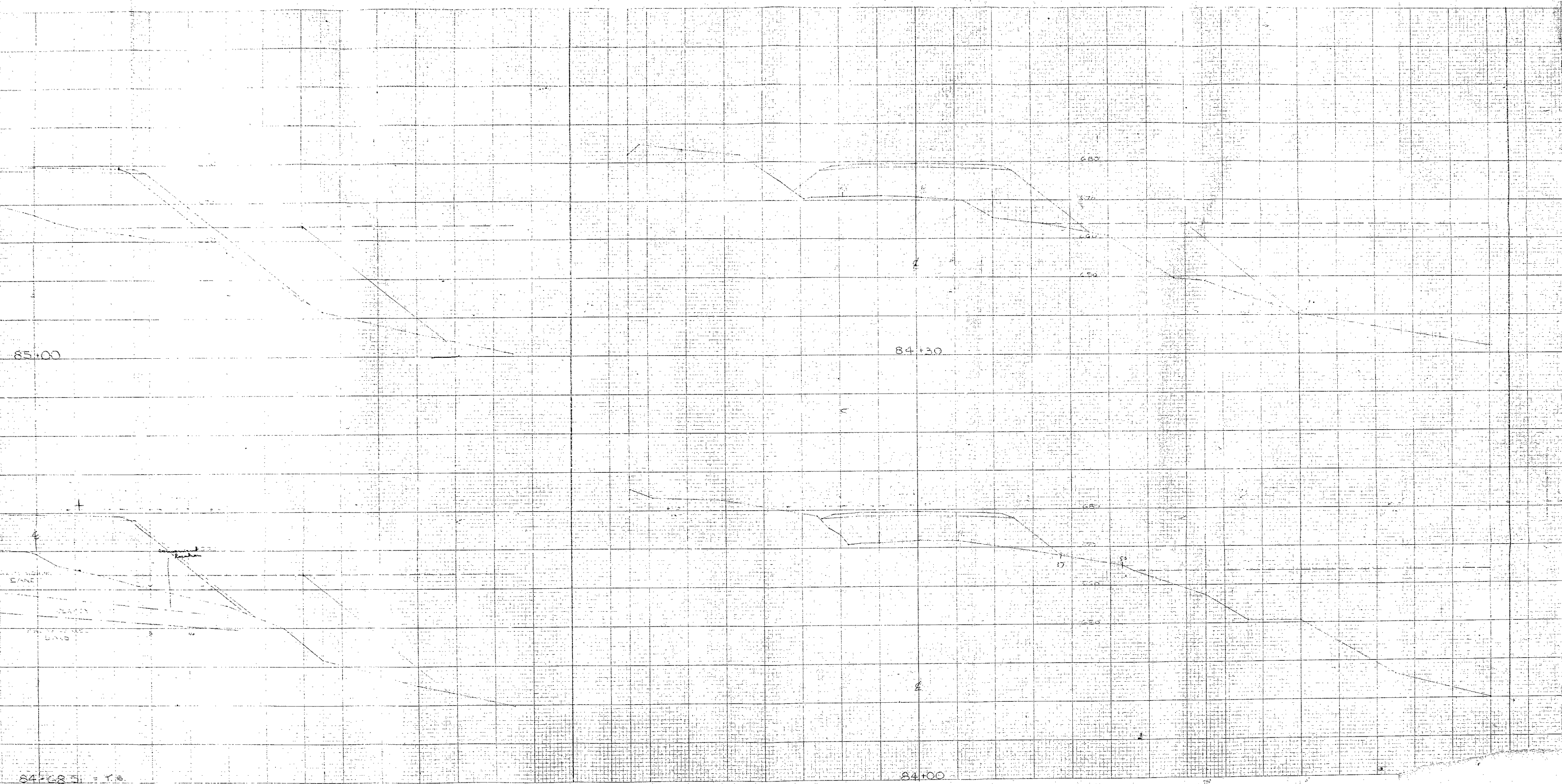
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DRAWN TO THE 1/4"

K&E STANDARD • CROSS SECTION
DRAWN TO THE 1/4"

K&E STANDARD • CROSS SECTION
DRAWN TO THE 1/4"

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DRAWN TO THE 1/4"

SOME DEFECTS IN INKATIVE DUE
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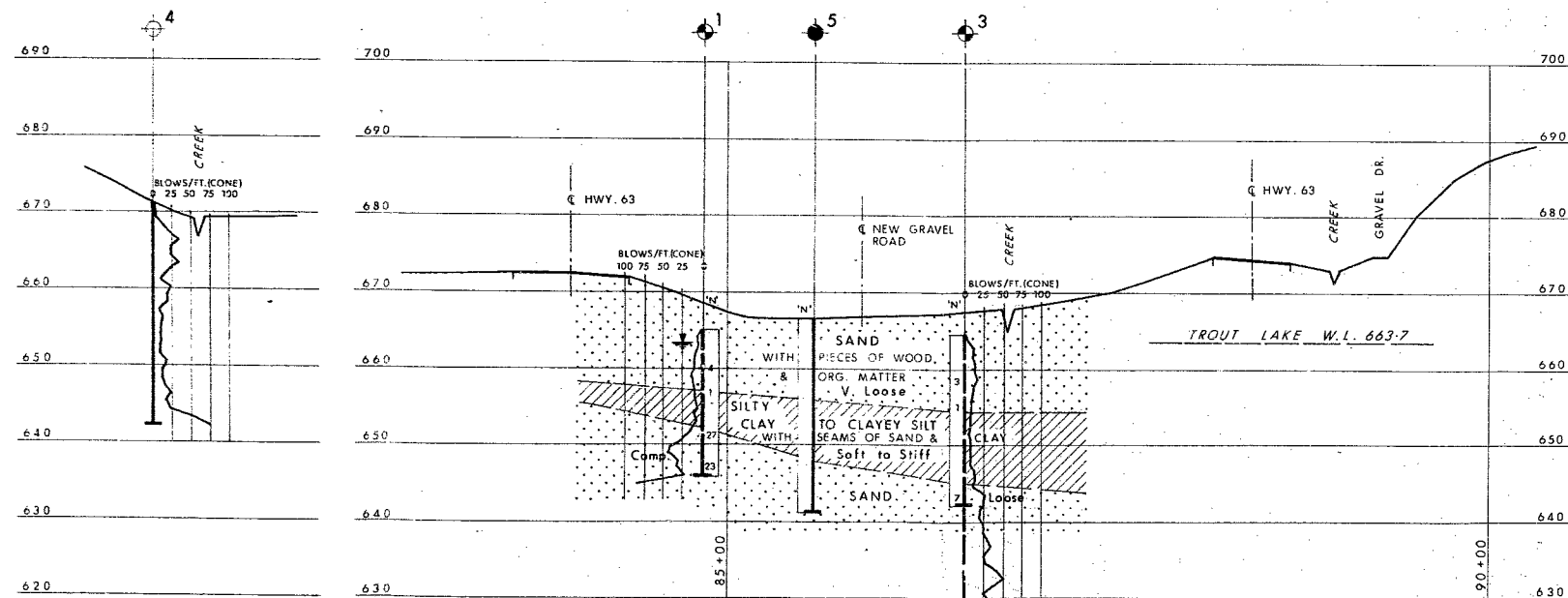
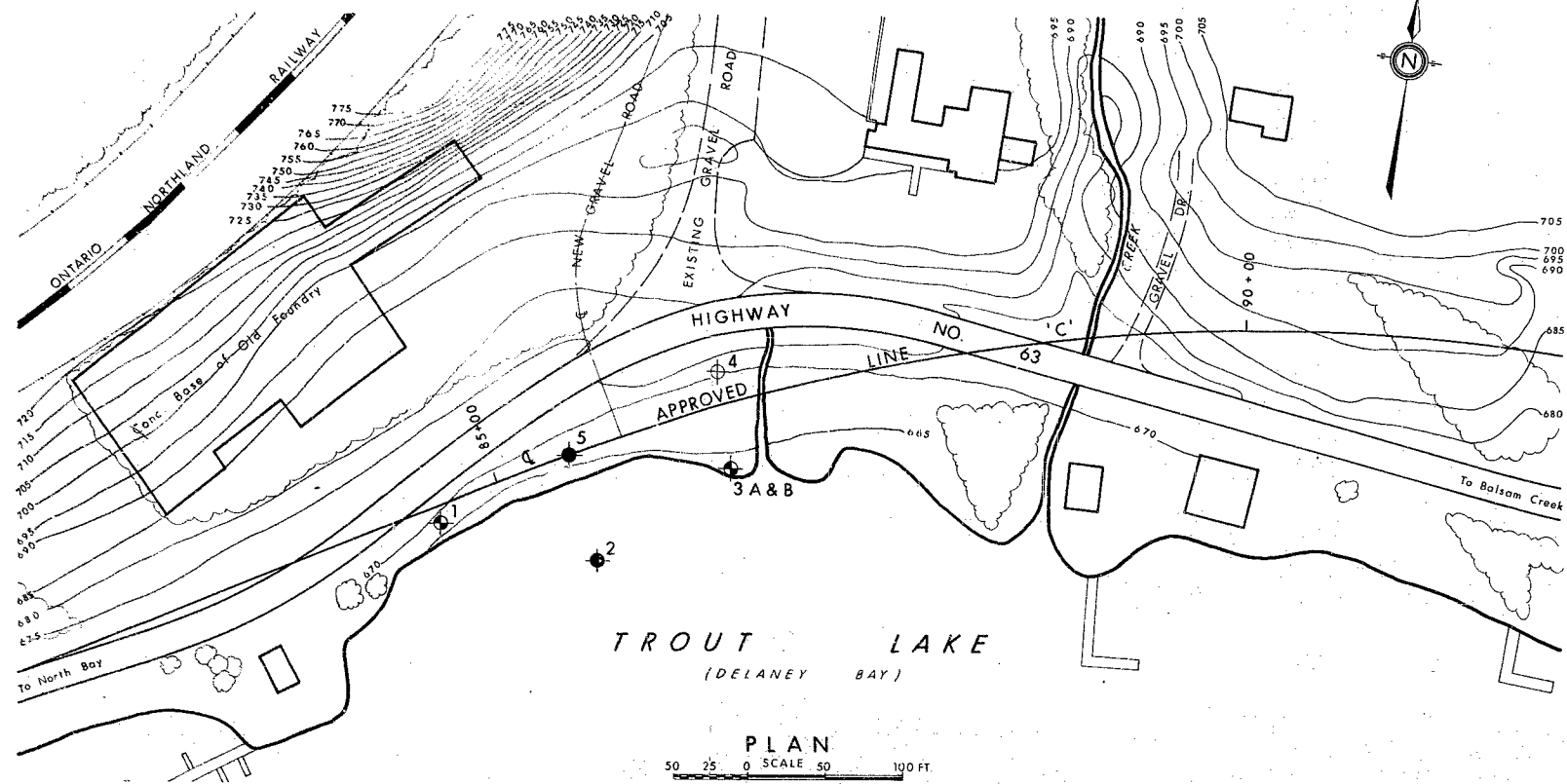
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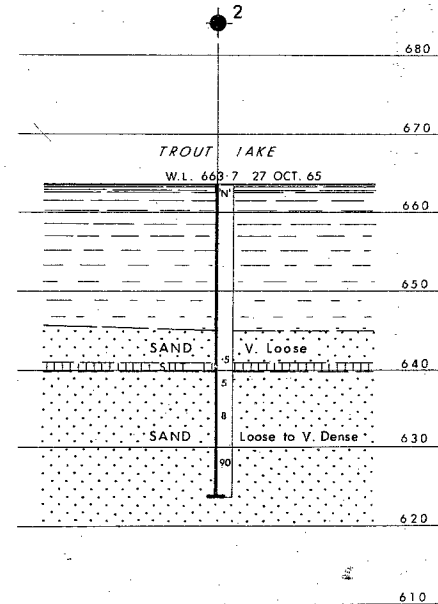
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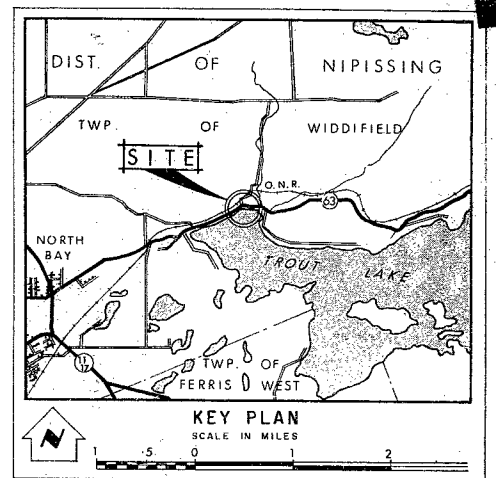
SOME DEFECTS IN NEGATIVE DUE
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CONE HOLE NO. 4



BORE HOLE NO. 2



LEGEND

- Bore Hole
- ⊕ Cone Penetration Hole
- ⊙ Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. 26 OCT. 1965

NO.	ELEVATION	STATION	OFFSET
1	665.0	84 + 56	11' RT.
2	663.7	85 + 42	70' RT.
3	664.5	86 + 50	40' RT.
4	671.5	86 + 60	20' LT.
5	666.5	85 + 50	□

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.

REVISIONS	DATE	BY	DESCRIPTION

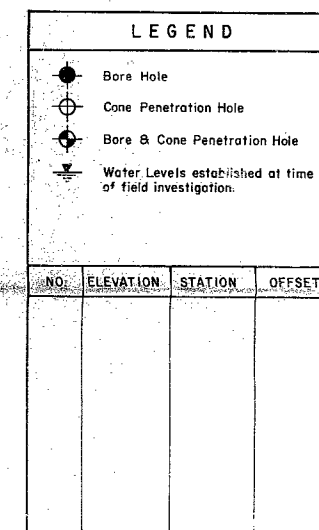
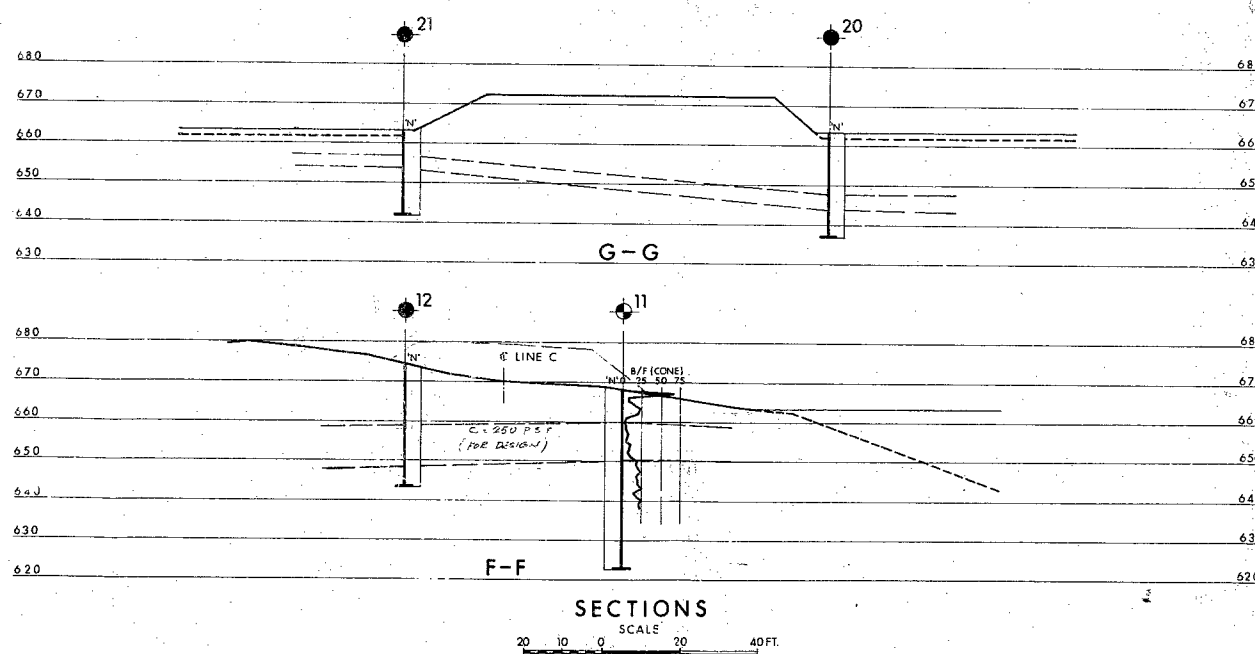
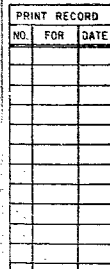
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

EMBANKMENT STABILITY
TROUT LAKE

KING'S HIGHWAY NO. 63 LINE 'C' DIST. NO. 13
CO. NIPISSING
TWP. WIDDIFIELD LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. A. B. CHECKED 27 W.P. NO. 270-62 M.B.T. DRAWING NO.
DRAWN S.O. CHECKED 27 JOB NO. 65-F-119 65-F-119-A
DATE 7 JAN. 1966 SITE NO. BRIDGE DRAWING NO.
APPROVED [Signature] CONT. NO.



- 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.

REVISIONS			
	DATE	BY	DESCRIPTION

PRELIMINARY ONLY

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

EMBANKMENT STABILITY
TROUT LAKE

KING'S HIGHWAY NO. 63 LINE 'C' DIST. NO. 1
CO. NIPISSING
TWP. WIDDIFIELD LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. R. M.	CHECKED	W.P. NO. 270-62	M.B.T. DRAWING NO.
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DRAWN S. O.	CHECKED	JOB NO. 65-F-119	65-F-119
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DATE	SITE NO.	BRIDGE DRAWING NO.
APPROVED <i>J. B. [Signature]</i>	CONT. NO.	

APPROVED *[Signature]* CONT. NO.
PRINCIPAL FOUNDATION ENGINEER

