DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M05-086

DIST. 4 REGION Central

W.P. No. 131-65-01

CONT. No. 73-47

W. O. No. 70-11030

STR. SITE No.

HWY. No. 25N

LOCATION Sta 120+00 to Sta 124+00

(Hwy 25 South to Q.E.W.)

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS: DOCUMENTS TO BE UNFOLDED

BEFORE MICROFILM

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO
FOUNDATIONS OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 74-11006 SITE QEW & HWY 25 BOREHOLE No. 1 GROUND ELEVATION ______

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	GRAIN SIZE DISTRIBUTION: SHAPE	PERCENTAGE: GRAVEL	PERCENTAGE: SAND	PERCENTAGE: SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
1	3 4.5	3/4"	ANGUL	40	50	10						BROWN			GRAVELLY SAND TRACES OF SILT	
2	6 7.5	3/4"	"	30	50	20						"			GRAVELLY SAND SOME SILT & CLAY	
3	9 10.5	"	"	"	"	"						"			"	
4	15 16.5	"	"	"	"	"						"			"	
5	26.5 28	"	"	"	"	"						"			"	

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

Feb 1st — 19th 11109

Feb. 20 21 & 25 11110

FORM OD-MT-28
REVISED JULY 1971

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO
MATERIALS AND TESTING

P.K. April 17/74

FOUNDATION TEST RESULTS

PROJECT 74-11006 SITE ______ BOREHOLE No. 1 GROUND ELEVATION 401.5

SAMPLE No.	DEPTH	LAB. No.	SAMPLE TYPE	LIQUID LIMIT %	PLASTIC LIMIT %	MOISTURE CONTENT %	DENSITY LBS/CU. FT.	FIELD VANE SHEAR STRENGTH LBS/SQ.FT.	LAB. VANE SHEAR STRENGTH LBS/SQ.FT. & REMOLDED	UNCONFINED SHEAR STRENGTH LBS/SQ.FT. & REMOLDED	TRIAXIAL SHEAR STRENGTH LBS/SQ.FT. & REMOLDED	C' LBS/SQ. FT.	Φ DEGREES	SPECIFIC GRAVITY	ORGANIC CONTENT %	CONSOLIDATION	STANDARD PENETRATION BLOWS PER FOOT	GRAIN SIZE DISTRIBUTION Gr Sa Si Cl
1		30650	SS			55												43 47 10
2		30651	"															
3		30652	"			85												27 56 17
4		30653	"															
5		30654	SS			76												34 50 16

REMARKS :—

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO
FOUNDATIONS OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 74 - 11006 SITE QEW HWY 25 BOREHOLE No. 2 GROUND ELEVATION

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	SHAPE	PERCENTAGE: GRAVEL	SAND	SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
1	10 11.5	3/4"	ANGULAR	10	50	40						BROWN			SAND WITH SILT & CLAY TRACES OF GRAVEL	
2	15 16.5	"	"	"	"	"						DARK BROWN			SAND WITH SILT TRACES OF GRAVEL & CLAY	
3	20 21.5	"	"	"	"	"						"			"	
4	25 26			30		70						REDDISH BROWN			WEATHERED SHALE	

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE BRONTE RD BOREHOLE No. 1 GROUND ELEVATION 411.1

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
2	3.0–4.5	3/4"	SUB ROUND	25	20	55	HIGH	NIL	NIL	HIGH	EARTHY	BROWN	STRONG	HARD	CLAYEY SILT WITH GRAVEL, SOME SAND	CL
3	6.0–7.5	"	"	20	20	60	"	"	"	"	"			"	"	
4	10.0 11.5			30	20	50	"	"	"					"	"	
5	15.0–16.5	1/2"		40	20	40				—				"	CLAYEY SILT AND GRAVEL WITH SAND	[illegible]
6	18.0–19.5	"		50	20	30	"		SLOW	—	"			"	GRAVEL WITH SAND WITH [illegible]	[illegible]

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE BRONTE RD BOREHOLE No. 2 GROUND ELEVATION 378.5

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	GRAIN SIZE DISTRIBUTION: SHAPE	PERCENTAGE: GRAVEL	PERCENTAGE: SAND	PERCENTAGE: SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
3	3.5-5.0	2"		40	20	40	HIGH	NIL	NIL	—	EARTHY	REDDISH BROWN	NIL	HARD	GRAVEL AND CLAYEY SILT, SOME SAND, SHALE & TRACES OF [illegible]	GF
4	6.0-7.5	2		40	20	40	"	"		—				VERY STIFF	" (GLACIAL TILL)	GF
5	9.0-10.5	1/2		35	25	40				—		BROWN		HARD	CLAYEY SILT, SAND AND GRAVEL (GLACIAL TILL)	GF
6	12.0-13.5			[illegible]	20	45	"	"	"	MED	"	BROWN	STRONG	"	"	GF
7	15.0-16.5			50	20	30	"	"	SLOW	—	"	REDDISH BROWN		"		GF
8	20.0-21.5			60	25	15	MED	"		—	"				Same mostly gravel	GF

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE BRONTE RD BOREHOLE No. 3 GROUND ELEVATION 312.9

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	GRAIN SIZE DISTRIBUTION: SHAPE	PERCENTAGE: GRAVEL	PERCENTAGE: SAND	PERCENTAGE: SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
3	6.5–8.0	2"		65	15	20	MED	N–	QUICK	—	EARTHY	GREYISH BROWN	STRONG	VERY STIFF	SHALE, DECOMPOSED SHALE WITH CLAYEY SILT, SAND & GRAVEL	GT
4	10.0–11.5												"	HARD	SHALE & TRACES OF DECOMPOSED SHALE	
5	14.5–15.0												"	"	DECOMPOSED SHALE & SHALE	
6	19.5–20.0															

NOTES:– VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:–

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE BRONTE RD BOREHOLE No. 4 GROUND ELEVATION 317.6

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	SHAPE	PERCENTAGE: GRAVEL	SAND	SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
3	6.0–7.5			5	10	85	MED	NIL	NIL	MED	ORGANIC	BROWN [illegible]	STRONG	LOOSE	ORGANIC SILT OF MEDIUM PLASTICITY	OL
4	9.0–10.5			15	15	70	HIGH	"	"	[illegible]	"	BROWN	STRONG	FIRM	CLAYEY SILT [illegible] SAND & GRAVEL TRACES OF ORGANICS	CL
5	11.5–13.0											[illegible]	"	HARD	DECOMPOSED SHALE & SHALE, TRACES OF CLAYEY SILT SAND & GRAVEL	

NOTES:— VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:—

FF 22

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE Bronte Rd BOREHOLE No. 5 GROUND ELEVATION 310.8

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	SHAPE	PERCENTAGE: GRAVEL	SAND	SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
3A	4.0-5.0	1/2"										Reddish Brown	Strong	Hard	Clayey Silt, Sand & Gravel And Weathered Shale	CL
3B	5.0-5.5										"	Red	"	"	Shale, Traces Of Decomposed Shale	
4	6.0-6.3										"	"	"	"	Decomposed Shale & Shale	

NOTES:– VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:–

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE BRONTE RD BOREHOLE No. 6 GROUND ELEVATION 379.0

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	SHAPE	PERCENTAGE: GRAVEL	SAND	SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
1	0.5-1.5	1/2"		50	20	30	MED	NIL	SLOW	—	EARTHY	BROWN	STRONG	V. DENSE	GRAVEL WITH CLAYEY SILT AND SAND (FILL)	GF
2	3.0-4.5	2"		50	20	30	"	"	"	—	"	"	"	V. DENSE	CLAYEY SILT, SAND & GRAVEL WITH LIMESTONE BOULDERS	GF
3	6.0-6.5													HARD	SHALE & DECOMPOSED SHALE	

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE Bronte Rd BOREHOLE No. 7 GROUND ELEVATION 377.2

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
3	6.0-7.5	2"		50	20	30	High	Nil	Quick	—	Earthy	Brown	Strong	Hard	Clayey Silt, Sand & Gravel	GF
4	9.0-10.5	"		50	35	15	Med	"	Quick	"	"	"	"	Very Dense	Gravel & Sand, Some Clayey Silt	GF
5	12.0-13.5			50	30	20	"	"	Quick	"				"	"	GF
6	15.0-16.5			60	10	30	High	"	Slow	—	"	"	"	Hard	Gravel & Clayey Silt, Trace of Sand	GF
7	20.0-21.5													"	Decomposed Shale	

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE Bronte Rd BOREHOLE No. 8 GROUND ELEVATION 414.5

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	SHAPE	PERCENTAGE: GRAVEL	SAND	SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
3	6.0-7.5				90	10	Nil	Nil	Quick	Nil	Earthy	Reddish Brown	Strong	Compact	Sand Trace Silt	SF
4	9.0-10.5				50	50	"	"	"	"	"	"	"	"	Sandy Silt Or Silty Sand	SF/ML
5A	12.0-13.0			15	15	70	Med	"	Nil	Med	"	Brown		Very Stiff	Silt, Clayey Silt, Sand & Gravel	ML
5B	13.0-13.5			50	20	30		"					"	Hard	Clayey Silt Sand & Gravel / Decomposed Shale	
6	15.0-16.5			40	20	40	Med	Nil	Nil	Med	"	Brown	Strong	"	Clayey Silt, Sand & Gravel	CL
7	20.0-21.5			[illegible]	20	60	"			—		"	"	"	"	GF
8	25.0-25.5			[illegible]	[illegible]	[illegible]								"		CL
9	30.0-30.5			30	15	55	"	"			"	Reddish Brown	"	"	Clayey Silt, Sand & Gravel / [illegible]	[illegible]

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

DEPARTMENT OF HIGHWAYS — ONTARIO

MATERIALS AND TESTING OFFICE

VISUAL CLASSIFICATION SHEET

PROJECT 70-11030 SITE Bronte Rd BOREHOLE No. 9 GROUND ELEVATION 409.8

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION: LARGEST GRAIN SIZE	SHAPE	PERCENTAGE: GRAVEL	SAND	SILT & CLAY	DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
2	3.0–4.5			30	20	50	High	No	No	Med	Earthy	Brown	Strong	Firm	Clayey Silt Sand & Gravel (Glacial Till)	CL
3	6.0–7.5			30	20	50	[illegible]							[illegible]		CL

NOTES:— VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:—

K. Selby 70-11030

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

Telephone: 248-3415

To: FILE

From: M.W. Booth, Toronto Regional Road Design.

Attention:

Date: October 19, 1970.

Our File Ref.

In reply to

Subject: Re: W.P. 131-65-1, Hwy. 25 N. from Queen Elizabeth Way Interchange Northerly to Palermo - Grading, Drainage & Paving. District 4, Hamilton.

This memo will record a meeting held at McCormick, Rankin & Associates Ltd. office October 16/70 at 2:00 p.m. in connection with the above-mentioned work project. The following were in attendance:-

Mr. R.C. McCormick - McCormick, Rankin & Associates Ltd.
Mr. J. Cousins - "

Mr. M.A. MacKrell - Philips Planning & Engineering

Mr. Ken Selby - Foundations Section - D.H.O.
Mr. I. Nethercot - Regional Road Design - D.H.O.
Mr. M.W. Booth - "

Mr. MacKrell was in attendance to represent the Halton Region Conservation Authority which is planning the construction of a 12-foot tunnel to cross Highway 25 approximately one-half mile north of the Bronte Interchange. The fact that the proposed tunnel would be in rock at a depth of approximately forty feet below our proposed retaining wall was established and would therefore be no problem to the Highways when the Conservation Authority proceeds with the construction. A drop inlet would be constructed immediately east of our proposed right-of-way for this project. (See attached plan).

Continued .... /2

Memo to File - Re: W.P. 131-65-01.

After some discussion it was resolved that the Conservation Authority's proposal would not affect the present construction proposed for this project, however, as the alignment for Highway 25 in this area has not been definitely established those in attendance were unable to comment as to whether the inlet to the tunnel or the open channel would conflict with the final plans for Highway 25 when it is widened to four lanes.

In the event that the future alignment along the 4°30' curve be adopted then it would seem that the drop inlet for the tunnel should be kept approximately 10' further east to allow for our four-lane construction in the future.

May we suggest that our Planning Office review the proposed future alignment at this location.

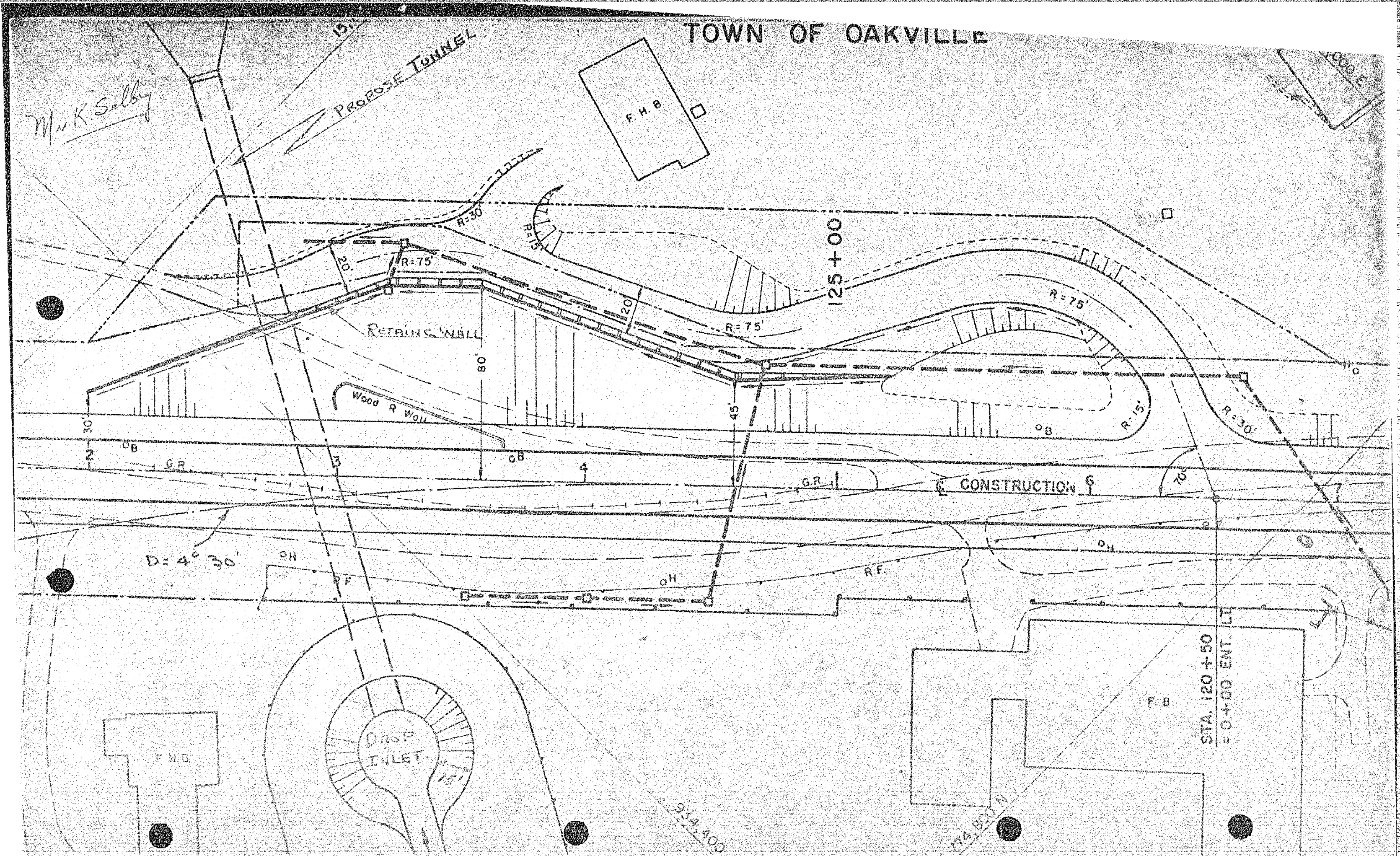
The meeting adjourned at 4:00 p.m.

M.W. Booth

M.W. Booth
For:
G.K. Hunter
Regional Road Design Engineer

MWB/GB
Attach.

c.c. R. Burnfield - Attn: R. Oddson
K. Selby
McCormick, Rankin & Associates Ltd. (no plan)
A.M. MacKrell - Philips Planning & Engineering
C.R. Robertson


TOWN OF OAKVILLE
Mr K Selby
PROPOSE TUNNEL
F.H.B
R=30
R=15
R=75'
20'
125+00
R=75'
R=75'
Retaining Wall
80'
Wood R Wall
30'
45'
R-15'
R=30'
B
G.R.
2
3
4
G.R.
℄ CONSTRUCTION
6
70'
D=4° 30'
H
R.F.
F.B
STA. 120+50
= 0+00 ENT. LT
Drop Inlet
F.H.B
934,400
714,800 N

A. G. STERN[illegible]

Telephone: 248-3415.

Mr. T.J. Kovich,
Reg. Materials Engineer,
Lab Building.

I. Nethercot,
Toronto Regional Road Design.

November 2, 1970.

RE: W.P. 131-65-01, Highway 25,
Palermo to Q.E.W., Dist. 4, Hamilton.

We are enclosing prints of plans and cross-sections showing the layout and installation details of the proposed retaining wall at the south end of this project.

If you have any comments concerning these proposals, please contact this office.

I. Nethercot
Project Design Engineer
For:
G.K. Hunter
Regional Road Design Engineer

IN/mj
Encl.
c.c. D. Barr.
A. Walker
T. Sterman
Burkhardt

445

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

Telephone: 248-3415

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

From: I. Nethercot,
Toronto Regional Road Design.

Attention: Mr. K.G. Selby

Date: November 2, 1970.

Our File Ref.

In reply to

Subject: Re: W.P. 131-65-01, Highway 25,
Palermo to Queen Elizabeth Way,
District 4, Hamilton.

70-11030

As requested at our recent meeting on this project, we are enclosing prints showing the layout and installation details of the retaining wall at the south end of this project.

If you have any comments concerning these proposals, please contact this office.

I. Nethercot

I. Nethercot
Project Design Engineer
For:
G.K. Hunter
Regional Road Design Engineer

IN/GB
Encl.

c.c. D. Barr

PRINCIPALS
E. D. McCORMICK, P. ENG.
G. A. RANKIN, P. ENG.
R. C. McCORMICK, P. ENG.
R. D. NAIRN, P. ENG.
J. F. BEATSON
ASSOCIATES
J. L. MALCOLM, P. ENG.
C. P. KORZENIOWSKI, P. ENG.
D. R. BLAY, P. ENG.

McCORMICK, RANKIN & ASSOCIATES
LIMITED
CONSULTING ENGINEERS
PORT CREDIT OTTAWA

MEMBER ASSOCIATION OF CONSULTING ENGINEERS OF CANADA
8 STAVEBANK ROAD
PORT CREDIT, ONTARIO
TELEPHONE 274-3477

70-11030

April 29, 1971

Mr. A. Stermac, P. Eng.,
Principal Foundations Engineer,
Materials & Testing Section,
DEPARTMENT OF HIGHWAYS,
DOWNSVIEW, Ontario.

Attention: Mr. K.G. Selby, P. Eng.

RE: W.P. 131-65-01 - Highway 25
From Highway 5 Southerly to Q.E.W.
District 4 - Hamilton
Our File: W.O. 518-69

Dear Sir:

Please find enclosed drawings from the above project, which pertain to the retaining wall and to the Fourteen Mile Creek structure. We are forwarding these drawings to assist you in updating the foundation drawings which will form part of this Contract.

We have also enclosed prints of the foundation drawings with some suggested revisions marked on them. If you require further information, please do not hesitate to contact us.

Yours very truly,

McCORMICK, RANKIN & ASSOCIATES LIMITED

R. C. McCormick, P. Eng.

RCM:lc
Encl.

cc: Mr. G.K. Hunter, P. Eng.

AGS

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To:	Mr. A. Stermac Foundation Section Lab. Bldg.	From:	M.W. Booth Regional Road Design
Attention:	Mr. K. Selby	Date:	May 17, 1971
Our File Ref.		In reply to	

Subject: W.P. 131-65-01 -- Hwy. 25, Bronte Rd. 70-11-030
Reconstruction from QEW Northerly to Palermo

This memo will confirm that we have received from you today the following original drawings for the above mentioned project.

Drawing No. 70-11030A - Bore Hole Locations & Soil Strata
Drawing No. 70-11030B - Sections and soil Strata

These drawings are in connection with the retaining wall construction. It is our intention to forward them to our Consultant, McCormick & Rankin Ltd. to be included in the originals for the project.

Drawing No. 70-F-5A prepared in connection with foundation report No. WJ 70-F-5 for the 14 mile creek structure we understand is in the Bridge Office and will be retained there with the balance of the original Bridge Drawings for this project.

M W Booth

M.W. Booth
For: G.K. Hunter
Regional Road Design Engineer

MW/bk

c.c. R.C. McCormick (McCormick & Rankin)
S. McCombie (Bridge Office)

83-73-44

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

TO: Mr. G. K. Hunter,
Regional Road Design Engr.,
Central Region - Central Bldg.
TORONTO, Ont.

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

ATTENTION: Mr. A. G. Kelly,
Sr. Project Design Engr.

DATE:

OUR FILE REF.

IN REPLY TO

JUN 19 1970

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Realignment of Hwy. #25 (New)
Fill Stability
Station 120+00 to Station 124+00
Hwy. #5 Southerly to Q.E.W.
District No. 4 (Hamilton)
W.O. 70-11030 -- W.P. 131-65-01

Enclosed please find our complete foundation report for the above mentioned project.

We believe that factual information pertaining to subsoil conditions at the site, and recommendations regarding the design and construction of the proposed fills, contained within the report, should be sufficient for your purposes.

If additional information is required, or should the report require further clarification, please contact this Office.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/McF
Attach.
cc: Messrs. G. K. Hunter (2)
B. R. Davis
H. A. Tregaskes
D. W. Farren
C. R. Robertson (2)
W. Friedmann
T. J. Kovich
W. S. Melinyshyn
McCormick & Rankin, Consulting Engineers
B. A. Singh
Foundations Files
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
Proposed Realignment of Hwy. #25 (New)
Fill Stability
Station 120+00 to Station 124+00
Hwy. #5 Southerly to Q.E.W.
District No. 4 (Hamilton)
W.O. 70-11030 -- W.P. 131-65-01

1. INTRODUCTION:

During discussions between Mr. T. Kovich, Regional Materials Engineer, and Mr. A. G. Stermac, Principal Foundation Engineer, on March 13th, 1970, it was decided that a foundation investigation should be carried out at the above-mentioned site in order to determine the stability of proposed 110 ft. high side-hill fills. Accordingly an investigation has been carried out by the Foundation Section, the results of which are presented in the following pages of this report.

2. DESCRIPTION OF THE SITE:

Existing Bronte Road at the investigated site runs in a South East - North West direction. Immediately west of the road the ground slopes steeply down to Bronte Creek forming a steep ravine. The slopes are tree and bush covered, the difference in elevation between the road surface and the creek being about 110 ft. The east side of the existing road is generally flat, occupied by farmlands.

Geologically the area belongs to the Iroquois Plain physiographic region. These, some 190 mi. long lowlands bordering Lake Ontario, were inundated in late Pleistocene times by a body of water known as Lake Iroquois. At and near Bronte are some sandy deposits of old deltas, brought into the lake by streams. Bronte Creek cuts deep into the soft red Queenston shale, which due to exposure to the atmosphere is badly disintegrated and decomposed at the surface.

3. FIELD AND LABORATORY INVESTIGATION:

Some 9 boreholes were placed near the road, also on the valley slopes and floor. The locations and elevations of boreholes are marked on the accompanying drawing #70-11030A. A conventional diamond rig, adapted for soil sampling purposes was used for the borings. "Undisturbed" Shelby tube samples were taken from the upper portion of the boreholes. In the lower elevations split spoon samples were carried out by performing standard penetration tests. A limited number of field vane tests were implemented within the stiff layers.

Upon arrival in the laboratory all the samples were subjected to detailed visual examinations and description. Representative samples were further tested in the laboratory in order to determine natural moisture contents, Atterberg limits, grain size distributions and a few undrained shear strength parameters. Field and laboratory tests are plotted on the Borelogs, appended to the report.

4. SUBSOIL CONDITIONS:

4.1) General:

Soil deposits within the area investigated were identified to be a surficial organic material, underlain by heterogenous layers of clayey silt with some sand and gravel (Glacial till) which in turn were followed by weathered and sound shale bedrock.

A brief description of each layer is as follows.

4.2) Surficial Deposit:

Within the uppermost few feet the overburden was found to be clayey silt with a high degree of organic contamination. The depth of the organic material varies between 2 and 4 ft., the deeper deposits being on the valley floor; however, in a few locations along the steep slope, the organics appeared to be completely eroded. The soft to stiff consistency of this stratum together with the constituent organic substances render the layer unacceptable from an engineering point of view.

4.3) Clayey silt with Sand and Gravel:

This is the main body of the overburden and its very heterogenous nature suggests glacial origin. A large portion of the material appears to be badly remoulded and disturbed by erosion so that in the upper zones it shows characteristics similar to a talus. The consistency and relative density increases with depth, penetration 'N' values being around 20 - 30 blows per ft. within the upper half and much above 100 blows per ft. within the lower half of the stratum. The reddish brown colour of the soils would indicate that they have derived from the parent rock of Queenston shale. In its entirety the layer may be considered to be cohesive with slight to medium plasticity; seams of granular gravelly sands and silts were however also observed.

4.4) Bedrock:

The transition from overburden to bedrock was noticed to be gradual, consequently the exact borderline between the glacial till and weathered rock is difficult to determine. In boreholes

3, 4 and 5 placed near the ravine floor the upper bedrock zone was so extensively weathered and decomposed, that it could be penetrated without diamond drilling equipment. The tops of the sound bedrock was found at el. 379.5 ft. in Bh. #8, near the existing road.

Bedrock was identified to be shale of the Queenston formation typically red in colour with grey intrusions.

4.5) Groundwater Conditions:

The groundwater levels were established at each Bh. location and the elevations are marked on the borelogs. The depth of groundwater varied between 1 ft. and 15 ft. below ground elevations, having a steep gradient, roughly paralleling the ground surface. The gradient naturally indicates a seepage flow towards the creek.

5. DISCUSSION AND RECOMMENDATIONS:

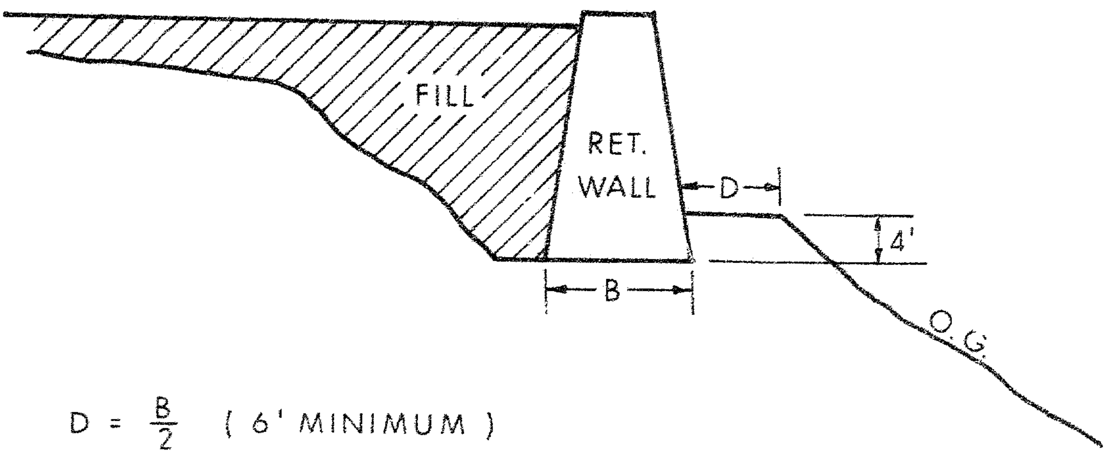
5.1) General:

It is proposed to improve Bronte Road to highway standards as part of Hwy. #25. At the investigated locations the road is proposed to be widened and shifted south-west so that it will partially or entirely be above the steep slope of the ravine. According to information from Mr. R. McCormick of McCormick & Rankin, received by Mr. K. G. Selby of the Foundation Section, two alternative proposals are being considered for the rebuilding of this road section. The first proposal calls for constructing the new fill with unsupported slopes of 2 horizontal to 1 vertical, incorporating two 10 ft. wide berms at el. 390 ft. and el. 360 ft. The second proposal utilizes a retaining wall for the lateral support of the fill. The wall might be only a short one along the steepest section, or it might be designed with a length of approximately 350 ft., as shown on the plan.

5.2) Comments and Recommendations:

In view of the high shear strength of the overburden, no stability problems are foreseen for the proposed unsupported fills, when constructed according to the appropriate highway standards. However, all organic soil should be removed prior to placing fill material within the construction area and the full extent of the organic deposits should be determined by the Regional Soils Section during their routine soil investigation.

The proposed retaining walls may be founded on spread footing constructed within the shale bedrock or the overlying hard till deposits assuming a safe pressure of 5 t.s.f. A minimum of 4 ft. cover should be provided for frost protection. A horizontal bench in original ground of minimum width 6 ft. or half the footing width, whichever is greater, must be constructed in front of the wall as per the sketch below.



$D = \frac{B}{2}$ (6' MINIMUM)

Backfilling of the walls should comply with D.H.O. Standard No. SD-4-58. The stability of the walls should be checked against sliding along the base of the wall caused by lateral earth pressure. In computing the resistance to lateral pressure an adhesion value of 3500 PSF may be assumed to apply along the footing bottoms.

Some surface erosion, sloughing and local (shallow) failures were noticed along the natural slopes, indicating inadequate drainage. In order to avoid further water pressure build-up due to the new fill, adequate drainage should be designed. It is pointed out also that sand deposits of 10 ft. or more were observed at the top of the slope. These deposits must be drained fully to the bottom otherwise water will accumulate and cause stability problems in the new fill. The full extent of these deposits should be determined by the Regional Soils Section.

The new fills should be benched to the natural slopes according to D.H.O. Standard No. DD-414.

6. MISCELLANEOUS:

The fieldwork was performed by Mr. R. A. Hendry during the period April 12 - 28, 1970. Equipment used was owned and operated by Master Soil Inv., Ltd. This report was written by Mr. A. K. Barsvary, Senior Foundation Engineer, and reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

May, 1970.

APPENDIX I

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70-11030 LOCATION Co-ords. 774,662 N; 934,215 E. ORIGINATED BY RAH

W.P. 131-65-01 BORING DATE April 13 - 14, 1970 COMPILED BY RAH

DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100); SHEAR STRENGTH P.S.F. (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE; 1000, 2000)	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % (10, 20, 30)	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
	Ground Level									
409.1 / 2.0	Clayey silt with some sand, traces of orgs. Soft. Black & Brown		1	TW	PM	410			129	
	Clayey silt, sand and gravel (Glacial Till) Hard		2	SS	32					
			3	SS	43					
			4	SS	70/4"	400				▽ 399.8
			5	SS	157/6"					
391.6			6	SS	156/6"					
19.5	End of Borehole					390				

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 70-11030

W.P. 131-65-01

DATUM Geodetic

LOCATION Co-ords. 774,558 N; 934,145 E.

BORING DATE April 14 - 15, 1970

BOREHOLE TYPE Washboring, NX Casing

ORIGINATED BY RAH

COMPILED BY RAH

CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	REMARKS GR. SA. SI. CL.
378.5	Ground Level						
0.0	Clayey silt to silt with traces of sand & organics	1	TW	PM			
						+ (field vane)	
375.0	(Topsoil)	2	TW	PM			3 63 26 8
3.5	Clayey silt, sand and gravel, traces of shale	3	SS	31			
		4	SS	27			
	(Glacial Till)				370		
	Very stiff to hard	5	SS	35			
		6	SS	87			
		7	SS	125/5"			▼363. 37 52 (11)
					360		
357.5		8	SS	115/6"			
21.0	End of Borehole						

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE (scale 1000, 2000)

LIQUID LIMIT — w_L; PLASTIC LIMIT — w_P; WATER CONTENT — w

WATER CONTENT % (10, 20, 30)

BULK DENSITY γ P.C.F.

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 70-11030 LOCATION Co-ords. 774,350 N; 933,999 E. ORIGINATED BY RAH

W.P. 131-65-01 BORING DATE April 16, 1970 COMPILED BY RAH

DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
312.9	Ground Level								
0.0	Black Organic Material								▼ 311.6
0.5	Clayey silt with traces of sand and organics	1	TW	PM		+ (field vane)	W_p= 51%, W_L=63%, W%=99		
					310				
308.9		2	TW	PM		o (unconfined)		124	
4.0	Silty sand with layers of sand and organics.					+ (field vane)			
306.4									
6.5	Clayey silt, sand and grav. Some shale. V. stiff	3	SS	27					
304.9									
8.0	Bedrock Weathe~ed Shale								
		4	SS	44					
					300				
		5	SS	130/3"					
292.9		6	SS	100/3"					
20.0	End of Borehole								
					290				

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE (scale 1000, 2000)

LIQUID LIMIT — w_L; PLASTIC LIMIT — w_p; WATER CONTENT — w (scale 10, 20, 30)

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 70-11030 LOCATION Co-ords. 774,328 N; 934,323 E. ORIGINATED BY RAH

W.P. 131-65-01 BORING DATE April 17, 1970 COMPILED BY RAH

DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F. (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE) 1000 2000	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
317.6	Ground Level									
0.0	Clayey silt, traces of sand & organics		1	TW	PM					▼ 314.8
							+			
	Stiff		2	TW	PM		o		130	
311.6 / 6.0	Organic Silt									
310.1	Firm		3	SS	6				o	
7.5	Clayey silt, sand and gravel, traces of organics.					310				
			4	SS	5					
306.1	Firm									
11.5	Bedrock									
304.6	Weathered Shale		5	SS	103					
13.0	End of Borehole									
						300				

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 70-11030 LOCATION Co-ords. 774,265 N; 934,436 E. ORIGINATED BY RAH
W.P. 131-65-01 BORING DATE April 20, 1970 COMPILED BY RAH.
DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE)	WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
310.8	Ground Level								
0.0	Clayey silt, traces of organics.	1	TW	PM	310	O		124	▼ 309.5
						+> 2240			
307.3 / 3.5	Clayey silt, sand & gr (Glac. Till). V. stiff to Hard	2	TW	PM					
305.8 / 5.0	Bedrock	3	SS	100/3"					
304.5	Weathered Shale	4	SS	100/3"					
6.3	End of Borehole				300				

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 70-11030

W.P. 131-65-01

DATUM Geodetic

LOCATION Co-ords. 774,435 N; 934,382 E.

BORING DATE April 21, 1970

BOREHOLE TYPE Washboring, NX Casing

ORIGINATED BY RAH

COMPILED BY RAH

CHECKED BY [signature]

SOIL PROFILE: ELEV. DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT; SHEAR STRENGTH P.S.F. (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE)	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
379.0	Ground Level									
0.0	Clayey silt, sand and gravel.		1	SS	50/2"					25 62 (13)
	Very dense or hard		2	SS	119			o ⊢—⊣		▼ 374.8
373.0										
372.5	Bedrock-weathered shale		3	SS	110/5"					
	Sound Shale		4	AXT	40%	370				
			5	AXT	93%					
364.5										
14.5	End of Borehole					360				

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 70-11030 LOCATION Co-ords. 774,444 N; 934,313 E. ORIGINATED BY RAH
W.P. 131-65-01 BORING DATE April 22-23, 1970 COMPILED BY RAH
DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY [signature]

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT; SHEAR STRENGTH P.S.F. (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE) 1000 2000	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
377.2	Ground Level									
0.0	Clayey silt, sand and gravel, traces of organics. Stiff		1	TW	PM					
373.2			2	TW	PM					
4.0	Clayey silt, sand and gravel. Very dense or hard (glacial Till)		3	SS	58	370				
			4	SS	50					
			5	SS	140					▼ 364.4
			6	SS	100/5"	360		np		
357.2			7	SS	100/2"					
20.0	Bedrock Weathered Shale		8	AXT	38%					
351.7										
25.5	End of Borehole									

FORM OB-MT-126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 70-11030
W.P. 131-65-01
DATUM Geodetic

LOCATION Co-ords 774,315 N; 934,557 E.
BORING DATE April 23-28, 1970
BOREHOLE TYPE Washboring, NX & BX Casing

ORIGINATED BY RAH
COMPILED BY RAH
CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT	REMARKS GR.SA.SI.CL.
414.5	Ground Level				
0.0	Black Organic Material				2 66 (32)
0.5	Silty sand, traces of gravel and organics.	1	TW	PM	
		2	TW	PM	0 67 (33)
410.5 / 4.0	Sand to silty sand. Compact	3	SS	22	
		4	SS	27	
404.0 / 10.5	Silt to clayey silt, sand and gravel Hard (Glacial Till)	5	SS	82	
		6	SS	100/4"	
		7	SS	164/10"	
		8	SS	100/4"	
		9	SS	100/3"	
384.0 / 30.5	Bedrock Weathered Shale				
379.5 / 35.0	Sound Shale	10	AXT	100%	
		11	AXT	87%	
369.5 / 45.0	End of Borehole				

ELEV. SCALE: 410, 400, 390, 380, 370

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
1000 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w

WATER CONTENT % 10 20 30

BULK γ DENSITY P.C.F.

20
15 -○- 5 % STRAIN AT FAILURE
10

FORM OB-MT-126 (REV. 1969) OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 70-11030 LOCATION Co-ords. 774,649 N; 934,360 E. ORIGINATED BY RAH

W.P. 131-65-01 BORING DATE April 23, 1970 COMPILED BY RAH

DATUM Geodetic BOREHOLE TYPE Washboring, NX Casing CHECKED BY [signature]

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLE NUMBER	SAMPLE TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE) 1000 2000	WATER CONTENT % (wp, w, wL) 10 20 30	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
409.8	Ground Level									
0.0	Black Organic Materia									
0.5	Clayey silt, traces of sand, gravel & organics Stiff		1	TW	PM				125	
406.8										
3.0	Clayey silt, sand & gravel (Glacial Till) Firm to Hard		2	SS	7					▼ 406.3
402.3			3	SS	96					
7.5	End of Borehole					400				

ABBREVIATIONS USED IN THIS REPORT

PENETRATIO 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 :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
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 UNDRAINED 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 $= \frac{c_v t}{d}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION — IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

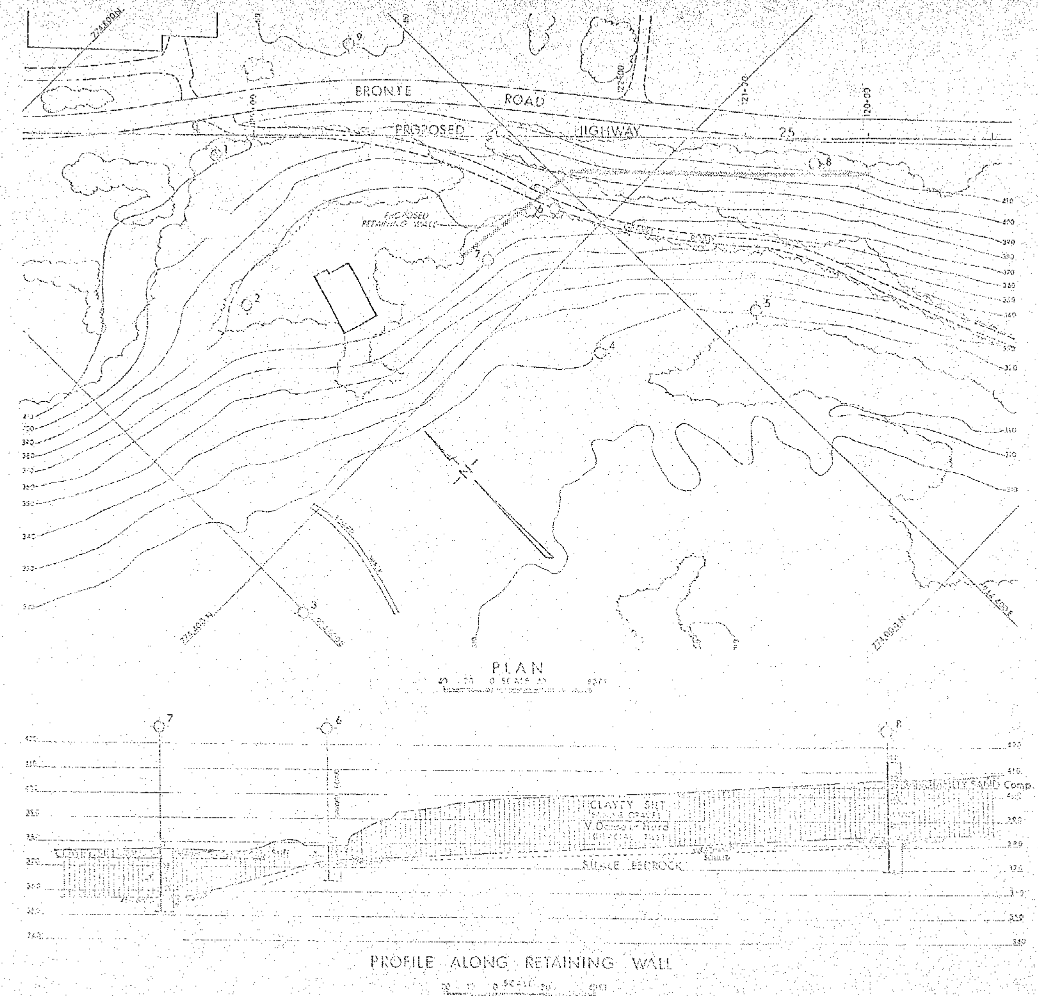
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

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

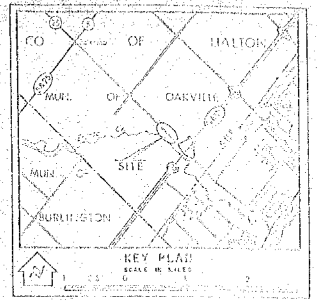
SLOPES

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



PLAN

PROFILE ALONG RETAINING WALL



KEY PLAN

SCALE IN MILES

LEGEND

Bore Hole

Cone Penetration Hole

Bore & Cone Penetration Hole

NO	ELEVATION	CO-ORDINATES	
			EAST
1	411.1	774,5[illegible]7	934,215
2	378.5	774,558	934,145
3	3[illegible]2.9	774,350	932,[illegible]99
4	317.6	774,372	934,323
5	310.6	774,285	[illegible]
6	379.0	774,[illegible]	934,[illegible]
7	377.2	774,[illegible]	[illegible]
8	414.5	774,3[illegible]	[illegible]
9	409.8	774,[illegible]	[illegible]

– 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.

DEPARTMENT OF HIGHWAYS – ONTARIO

BRONTE ROAD

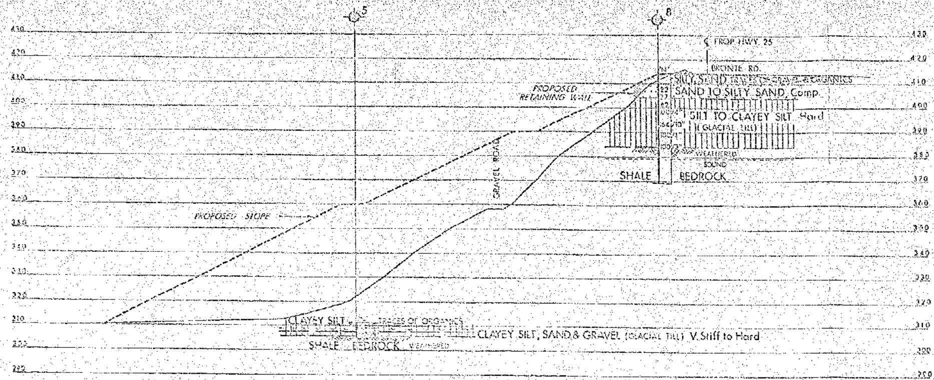
KING'S HIGHWAY No. 25 PROPOSED DIST. No. 4

CO. HALTON MUN. OF OAKVILLE

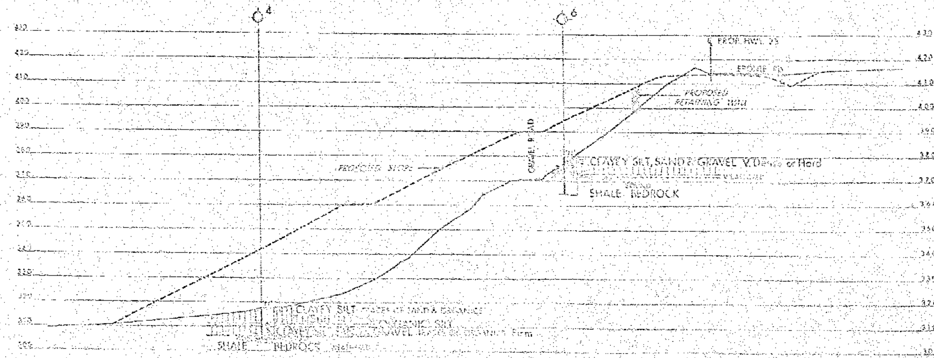
TWP. LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

70-11030 A



SECTION ALONG STATION 121+00



SECTION ALONG STATION 122+00

SCALE

SEE DRAWING Nº 70-11030A

KEY PLAN

SCALE IN MILES

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. APRIL 1970

NOTE - Water Level in Bore Hole ... at time of field investigation.

NO.	ELEVATION	STATION	CO-ORD.

– 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.

DEPARTMENT OF HIGHWAYS – ONTARIO

MATERIALS & TESTING OFFICE – FOUNDATION SECTION

BRONTE ROAD

KING'S HIGHWAY NO. 25 PROPOSED DIST. NO. 4

CO. HALTON MUN. OF OAKVILLE

TWP. LOT CON.

SECTIONS & SOIL STRATA

SUBMITTED	CHECKED	W.P. NO. 121-65-01	DRAWING NO. 70-11030B
DRAWN S.O.	CHECKED	JOB NO. 70-11030	
DATE JUNE 1970		SITE NO.	
APPROVED		CONT. NO.	

cc: R. McConnell

MIKE KAISER

Mr. D.A. Waller,
Construction Engineer,
District #4, Hamilton.

Soil Mechanics Section,
Geotechnical Office,
West Building, Downsview.

May 23rd, 1974.

RE: Bin Retaining Wall on Hwy. 25 (New),
Stas. 120 - 124, Contract #73-47,
W.O. 70-11030, W.P. 131-65-01,
District #4, Hamilton.

As discussed at our meeting at the abovementioned location on May 22nd, 1974, our initial recommendations relating to remedial measures necessary to stabilize the wall are as follows:

1. The present overall objective is to investigate possibilities of (a) consolidating material within the bins, and other means of stabilizing the existing wall structure, and
   (b) increasing the resisting moment, and
   (c) decreasing the overturning moment.

2. X-Sections should be taken every 10 ft. from ℄ of Hwy. to at least 50 ft. in front of the wall. It will then be possible to determine how much fill can be placed in front of the wall to achieve 1.(b) and what changes can be effected behind the wall to achieve 1.(c).

3. Enquiries should be made from specialist grouting contractors to determine whether anything can be done about 1.(a).

4. Provided 1.(a), (b) and (c) are found to be feasible construction procedures, should be in the following sequence:

   (a) Remove earth fill from behind wall.
   (b) Place new fill in front (properly compacted).
   (c) Grout bin interior.
   (d) Bench slopes behind wall and place new fill, monitoring bin wall as the height of backfill increases.

Provided that all goes well, it would be adviseable to install a slope indicator behind the wall to provide advance warning of any possible future movements.

Mr. D.A. Waller - RE: W.O. 70-11030.

The foregoing is believed to be the best approach at the present time since it promises the most economical solution to the problem.

It is understood that the original wall designers will be retained to carry out the design of the above remedial measures. In determining the overturning moment it should be assumed that the safety factor at the time of the original movement was 1.0. This Office will advise and assist the designers where necessary.

K.G. Selby,
Supervising Engineer.

KGS/mj
c.c. R. Pillen
A. McKim
S. Cant
W. McFarlane
G. Burkhardt

Ontario

Ministry of
Transportation
and
Communications

Box 5020, Burlington L7R 3Z9
May 28, 1974

MINUTES OF FIELD MEETING - CONTRACT 73-47
HIGHWAY #25 FROM Q.E.W. TO HIGHWAY #5
DISTRICT #4, HAMILTON - HELD ON MAY 22, 1974 AT 10:00 A.M.

ATTENDING:

G. Turvey	Armco Canada
J. Madsen	Armco Canada
R. McCormick	McCormick, Rankin & Assoc. Ltd.
S. Cant	Construction Branch, M.T.C. Downsview
A. McKim	Construction Branch, M.T.C. Downsview
G. Burkhardt	Regional Structural Planning, M.T.C.
W. Killin	Regional Structural Planning, M.T.C.
W. McFarlane	Structural Design Office, M.T.C.
K. Selby ✓	Soil Mechanics Section, M.T.C.
D. Waller	District Construction Engineer, M.T.C. District #4-Hamilton
J. Regan	Construction Supervisor, M.T.C. District #4-Hamilton
M. Keizars	Project Supervisor, M.T.C. District #4-Hamilton

SUBJECT:

To determine cause and propose counter measures for bin type retaining wall's movement on the west side of Highway 25 some 1500 feet north of Q.E.W. (Station 122+00± to Station 123+50± left of centre line Highway 25). Following at the site discussions, the meeting was moved to Bronte field office on South Service Road.

IT WAS EXPLAINED THAT:

1) In this location bin type retaining wall was selected for earth slope support because it was appraised to be the most economical means of embankment treatment.

2) Design safety factor of 2 was planned and, in effect, over 2 was input in several bins. Design is usually for 1.5 safety factor.

3) General soil study indicated that material on slope is basically stable.

4) Placing material behind wall is very important to the eventual strength in the structure.

5) Records indicate that Granular "A" material in bins was placed and compacted to the satisfaction of M.T.C. inspector. However, presently, rodding and bore hole samples denote a definite lack of compaction of granular material in bins.

......./2

6) Bin panels #'s 0, 1, 2 and 3 were constructed 7 feet deeper and raised to meet designed elevation.

7) Most base plates are sitting on and/or in shale rock.

IT WAS NOTED THAT:

1) Bin type retaining wall at top has moved in the vicinity of bin panels #'s 4, 5 and 6 at maximum to 4'± westerly and 'nil' at bin panel #0 from designed alignment.

2) Although not as pronounced, movement of bin panels has taken place at existing ground level.

3) A cushioned pad was not designed under base plates which is normally included with this type of structure.

4) Earth fill on top is sliding and settling into bins.

5) Movement of bin type retaining wall was not noted in the month of May.

6) Present safety factor of bin type retaining wall is about 1 (K. Selby).

IN REGARDS TO BIN TYPE RETAINING WALL, THE FOLLOWING POINTS WERE MADE:

1) Grouting - To increase density of Granular "A" and stability of bin type retaining wall. Although this proposal has a lot of merit it was not determined what effect such an operation will have on bin columns and stringers. Furthermore, consideration must be given to overturning factor of the present wall. It was concluded to contact expertise on this matter.

2) Replacing existing wall with concrete retaining wall. Cost of this proposal must be evaluated.

3) Installing tie backs to stabilize present wall. Basically two methods were considered.

   (a) Drilling through the front and back stringers of bins and anchoring into shale rock, or

   (b) In front of wall installing a beam with braces to top which are connected to drilled anchors behind the wall. Again, cost of this proposal must be evaluated.

4) Removing part of earth fill at top of bin wall and replacing with rubble and cover with asphalt at a better than 2:1 slope in conjunction with tie backs.

5) Replacing present wall with earth embankment. This proposal would completely eliminate access road to historical cottage and may change appearance of present slope.

......../3

6) Rebuilding some or all bin panels.

7) The presence of historical oak tree, Ontario Hydro transmission pole, new sanitary sewer and watermain, storm sewer, benching of slope, perched water were also noted and considered.

IT WAS PROPOSED TO TREAT SECTION OF BIN TYPE RETAINING WALL FROM PANEL #2 to #8 INCLUSIVE AS FOLLOWS:

1) Take cross-sections present and original about 40 feet down slope and at right angles to highway from base of each column.

2) Design earth fill in front of bin type retaining wall.

3) Remove earth fill behind bin wall.

4) Review 2:1 fill slope to see what effect a steeper slope would have (contact M.G.S. re access road). If a steeper slope is designed, consideration should be given for a paved runoff ditch at toe of slope.

5) Place earth fill in front of bin type retaining wall. This may necessitate a low concrete retaining wall at brow of slope.

6) Investigate low pressure grouting of material in bin and go ahead if okay.

7) Place earth fill behind retaining wall ... slowly ... benching ... and monitor retaining wall. See attached sketch.

IT WAS CONCLUDED THAT:

1) McCormick, Rankin & Assoc. will design under the proposed guidelines.

2) M.T.C. field office will supply cross-sections and other data presently available.

Presently, members of this meeting were not able to determine the cause of movement in the bin type retaining wall.

Meeting adjourned at 1:30 p.m.

Please advise this writer if any omissions or errors are noted in these minutes at 827-4461.

M. Keizars
Project Supervisor

MK:lo

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. K. Selby
Foundations Office
West Building
Downsview, Ontario

ATTENTION:

OUR FILE REF.

FROM: Mr. M. Keizars
Project Supervisor
District #4, Hamilton

DATE: June 4, 1974

IN REPLY TO

SUBJECT:

Bin Type Retaining Wall on the West Side of Highway 25
Station 122+00 to Station 123+50 - Contract 73-47

With reference to our meeting on May 22, 1974 enclosed you will find cross-sections from centre line of Highway 20 westerly for approximately 240 feet at each base column. I have taken the liberty of mailing original roll to McCormick, Rankin and Associates. If further information is needed with regards to the above, please feel free to contact this writer.

M. Keizars

M. Keizars
Project Supervisor

MK:lo
Encl.

c.c. R. McCormick

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

To: Mr. C. Mirza,
Soil Mechanics Office,
West Building.

From: A. G. Kelly,
Systems Design Branch,
East Building.

Attention: Mr. K. Selby.

Date: June 18, 1974.

Our File Ref.

In Reply To

Subject: W.P. 131-65-01 - Highway #25,
From QEW to Highway #5 (Palermo)

This Branch is in receipt of an addendum to the Ministry's agreement with McCormick, Rankin & Associates Ltd. instructing the consultant to carry out the engineering investigation and to advise of the remedial measures to be taken at the Armco type bin retaining wall constructed between Sta. 122+00 and Sta. 124+75 left, Contract #73-47. The estimated consultant's fee for this work is $5,000.00.

Before we process this addendum we solicit your opinion as to whether the failure was a design deficiency, a foundations problem or a construction problem.

AGK/DWF/dp

for A. G. Kelly,
Manager,
Special Designs & Analysis Office.

RECEIVED
GEOTECHNICAL OFFICE
JUN 21 1974
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

Ken:
I thought we had done the necessary investigation and had proposed remedial measures (your memo of May 24/74). What gives?
Lu

Mr. A.G. Kelly,
Manager,
Special Designs & Analysis,
West Building, Downsview.

Soil Mechanics Section,
Geotechnical Office,
West Building, Downsview.

June 27th, 1974.

RE: W.P. 131-65-01, Contract #73-47,
Highway 25 from Q.E.W. to
Highway 5 (Palermo),
District #4, Hamilton.

Further to your memo dated June 18th, regarding the bin wall failure on the abovementioned contract, the probable main causes of failure, in our opinion are as follows:

(1) Lack of adequate benching and stripping of topsoil on the existing 1.4:1 slopes behind the bin wall.

(2) Heavy rain which orrurred during or after placing of cohesive fill material on the 1.4:1 slopes referred to in (1).

(3) Lack of compaction of the granular material placed inside the bins and behind the bins.

(4) Seepage of water from zones within the existing slopes.

Benching was a necessary requirement in order to achieve conditions assumed for the design. The fact that proper benching was not done is confirmed by M.T.C. records in the Field Office. Borings carried out by this Section on April 3rd, 1974 show the material in the bins to be in a loose, poorly compacted state, however, M.T.C. records do not confirm that compaction by the contractor was unsatisfactory.

The net result of points (1) - (4) would be to increase the overturning moment on the wall and decrease the resisting moment. A tilting of the wall would, however, result in a slightly more favourable geometry since the material behind the wall depressed as the wall moved forward. The present safety factor is estimated to be slightly in excess of 1.0 at the worst location.

..... /2

Mr. A.G. Kelly - RE: W.P. 131-65-01.

The present assignment of McCormick-Rankin is to determine whether or not the safety factor can be increased to an acceptable value as outlined in our memo of May 23rd, 1974. The alternative is of course a new design which might cost upwards of $150,000.

K.G. Selby,
Supervising Engineer.

KGS/mj
c.c. D. Waller
Files
Documents

ENGINEERING REPORT

OUTLINING REMEDIAL MEASURES

FOR

BIN TYPE RETAINING WALL

HIGHWAY 25 Cont 73-47

September 1974

McCORMICK, RANKIN AND ASSOCIATES LIMITED
Consulting Engineers
MISSISSAUGA ST. CATHARINES OTTAWA

TABLE OF CONTENTS

1. INTRODUCTION

In June 1974, the Ministry of Transportation and Communications retained McCormick, Rankin and Associates Limited to carry out an investigation and advise on the remedial measures to be taken at the Armco-type bin retaining wall constructed on Highway 25.

This report contains the results of this investigation and contains recommendations on the temporary and permanent remedial measures required as well as the estimated costs of these measures.

2. EXISTING CONDITIONS

The construction of the bin type retaining wall was undertaken in 1973, and was backfilled in October 1973. Almost immediately it was noticed that movement of the bins was taking place. Field measurements indicated that some of the bins moved as much as four feet at the top and one and a half feet at the bottom (as measured at the ground surface). These measurements have been taken continually since last fall and it has been found that no measurable movement has taken place since April 1974.

3. FIELD INVESTIGATIONS

3.1 Ministry of Transportation and Communications

As mentioned previously, immediately upon completion of the wall and prior to completion of the backfill behind the wall, it was evident that the wall had moved and this movement was monitored by M. T. C. personnel. This information revealed that the top of the wall had moved up to four feet at the top and up to one and a half feet at the ground surface in front of the wall. These readings also indicated that the majority of the movement took place in late 1973 and that the movements have now ceased.

In addition, the M. T. C. took borings within the bins to determine the type of backfill material utilized and it was determined that the material contained up to 35% silt and was in a very loose state of compaction.

3.2 Golder Associates

Golder Associates dug test pits both in front of the wall, within the bins and behind the wall and in addition, falling head permeability tests were carried out to establish the ability to grout the backfill material within the bins. The results of this investigation are included in their report (Appendix 10.1) and are summarized below:

... density of backfill 80 - 87%

... permeability of backfill 2×10^{-1} cm/sec.

... silt content of backfill 10 - 35%

4. STABILITY OF WALL

The original design calculations carried out by McCormick, Rankin and Associates Limited provided minimum factors of safety against sliding and overturning of 1.7 and 1.8 respectively. These values were obtained using a conventional analysis and utilizing the recommended values contained in the Foundation Investigation report recommendations.

Golder Associates have subsequently recalculated the factors of safety for the wall and have obtained factors of 1.1 and 1.8 for sliding and overturning respectively. The significant difference between these values is in the factor of safety against sliding and Golder Associates feel that a cohesion of 1,000 psf. as opposed to 3,500 psf. should be used for the calculation of the sliding resistance.

The conclusion reached has been that the movement of the wall is a sliding movement as opposed to an overturning movement and the fact that the wall has moved so much further at the top than the bottom is due to the fact that the material within the bins is not compacted enough to give the bins the required strength to maintain their shape.

5. STRUCTURAL STRENGTH OF BINS

As mentioned, the backfill material within the bins is very loose and it has been determined that the Proctor density of this material is approximately 80 - 87% of optimum. In addition, it is evident that the members of the bins have been subjected to severe stresses as there is evidence of significant distortion of the bin members. The bins are intended to provide a "skin" to the material within the bins to ensure that this material within the bins acts as a homogeneous mass. If the material within the bins is not fully compacted, the bins are subjected to distortion from the backfill pressures as well as significant stresses due to the settlement of the material within the bins.

Meetings with representatives of the manufacturer of the bin wall, Armco, have indicated that unless further settlement of the material within the bins is prevented, the structural integrity of the bins cannot be guaranteed. The only positive means to prevent further settlement of the material would be to grout the bins.

Therefore any remedial scheme involving retaining the bin wall will require the grouting of the material within the bins. Golder Associates have determined by means of permeability tests that the backfill can be grouted.

6. GROUTING MATERIAL WITHIN BINS

Cementation Company (Canada) Limited were asked to submit a proposal including estimated costs for the grouting and their report is included in Appendix 10. 2. The estimated cost of this work, including access, is approximately $50, 000. 00; however, it should be pointed out that this operation is particularly sensitive to costly overruns because of the inability to be able to accurately estimate the quantities involved.

7. REMEDIAL SCHEMES

As recommended by Golder Associates, two of the remedial schemes involve the following:

... stabilizing the material within the bins

... increasing the factor of safety against sliding

... ensuring adequate drainage is maintained.

The third remedial scheme involves constructing a new concrete retaining wall in front of the bin wall. Therefore, the three remedial schemes are as follows:

Scheme 1	Tieing Back Existing Bin Wall
Scheme 2	Replacing Bins
Scheme 3	Concrete Retaining Wall

The total estimated cost of each of these schemes is as follows:

Scheme 1	$150,000.00
Scheme 2	$170,000.00
Scheme 3	$170,000.00

A breakdown of each of these costs is given in Appendix 10.3 of this report.

In addition to the above, a scheme of filling in front of the bins was considered but an adequate factor of safety against sliding could not be obtained.

7.1 Tieing Back Existing Bin Wall

This scheme involves grouting the bins to prevent settlement of the material within the bins, installing a tie-back system utilizing a grillage on the front of the wall, installing additional drainage, and providing a clay blanket on the slope behind the wall. The total estimated cost of this scheme is $150,000.00. The advantage of this scheme is that it maintains the provision for access into the valley in front of the wall as envisaged in the original contract.

7.2 Replacing Bins

This scheme would involve removing and replacing bins 3 to 10 inclusive, installing additional drainage, and providing a clay blanket on the slope behind the wall. The total estimated cost of this scheme is $170, 000. 00.

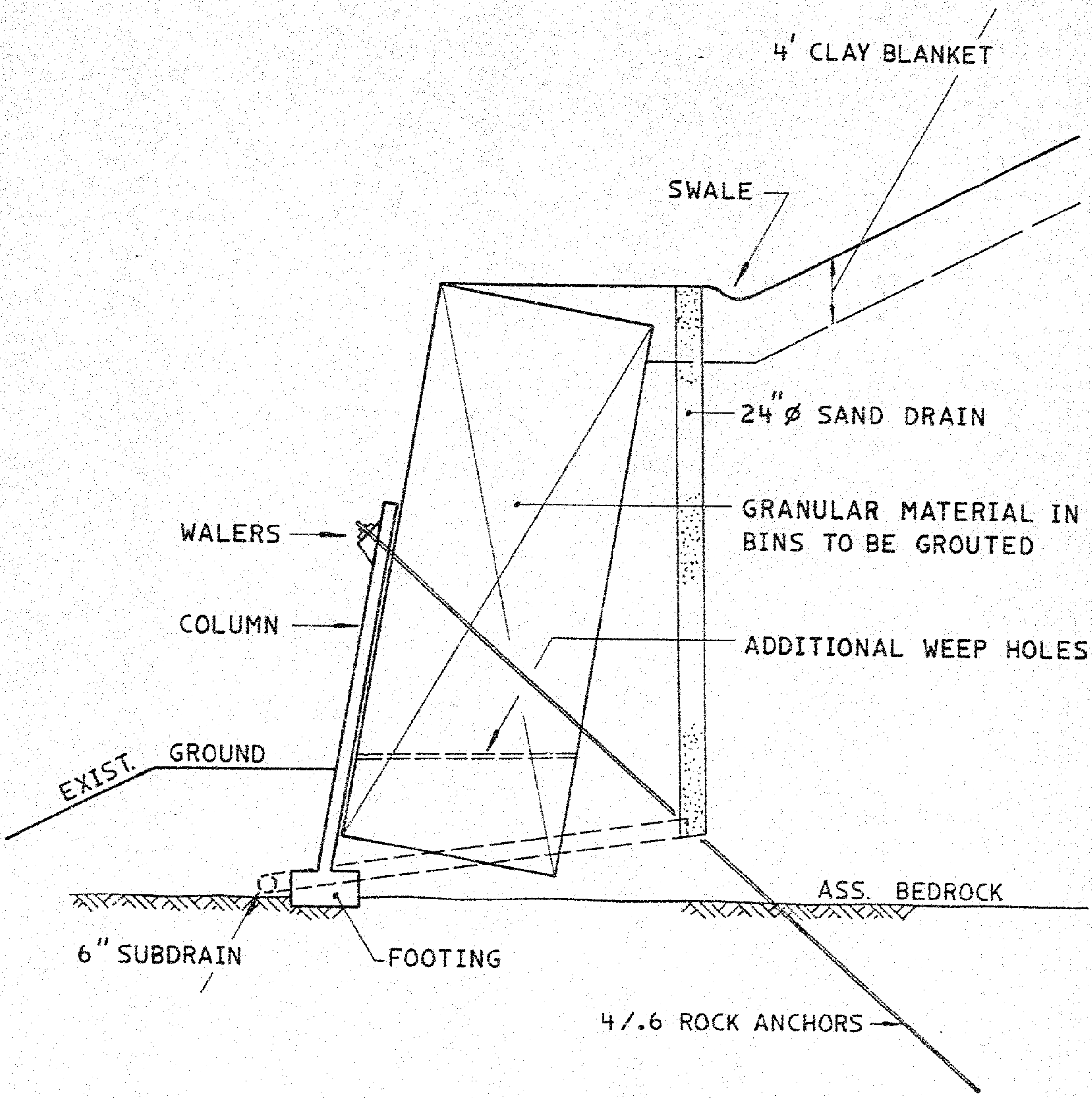
7.3 Concrete Retaining Wall

This scheme involves abandoning the existing bin wall and constructing a new concrete retaining wall in front of the existing wall. The total estimated cost of this scheme is $170, 000. 00.

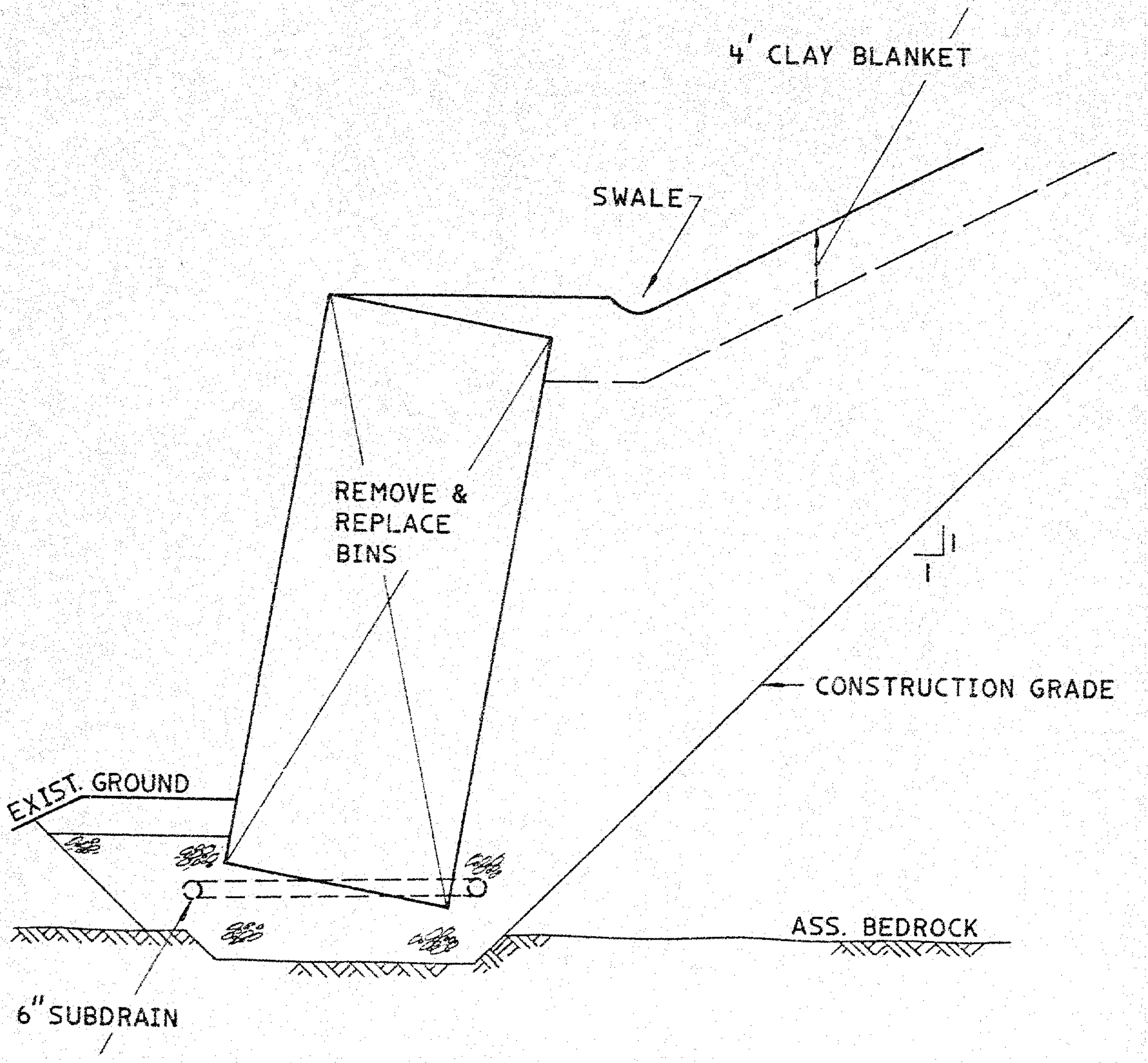
8. TEMPORARY REMEDIAL MEASURES

It appears likely that this report cannot be considered, pre-engineering carried out, tendering carried out and still provide adequate construction time for the remedial measures to be carried out prior to 1975. Therefore, it is mandatory that some remedial work be carried out this fall as there is more than sufficient evidence that the wall will not be stable with any build-up of hydrostatic pressure.

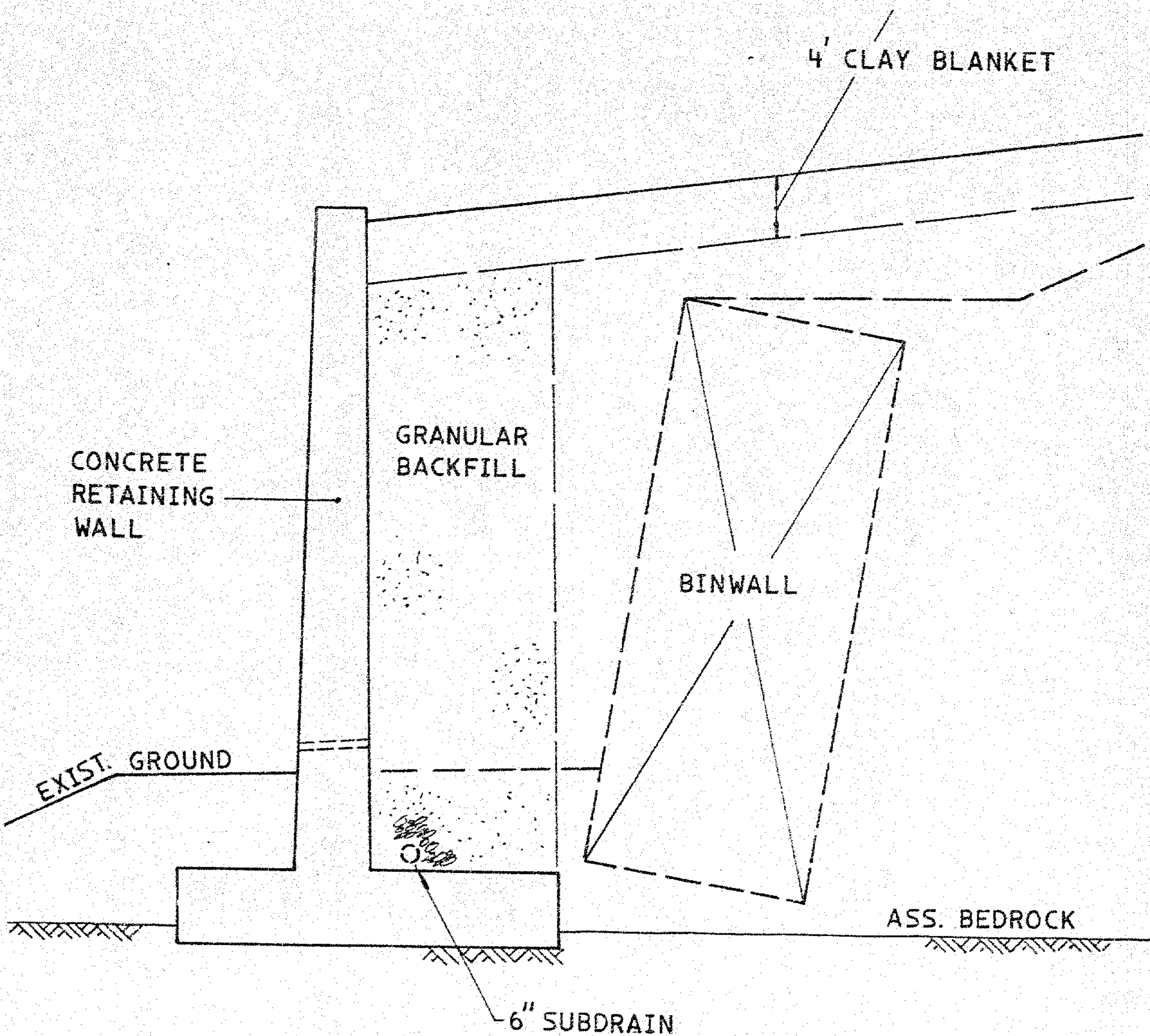
Therefore, it is recommended that the fill be placed in front of the wall immediately and the remainder of the remedial work can be carried out next year. Also, because of the low factor of safety of sliding of the wall in this condition, piezometers and slope indicators should be installed in the slopes.


4' CLAY BLANKET
SWALE
24" ø SAND DRAIN
GRANULAR MATERIAL IN
BINS TO BE GROUTED
WALERS
COLUMN
ADDITIONAL WEEP HOLES
EXIST. GROUND
ASS. BEDROCK
6" SUBDRAIN
FOOTING
4/.6 ROCK ANCHORS

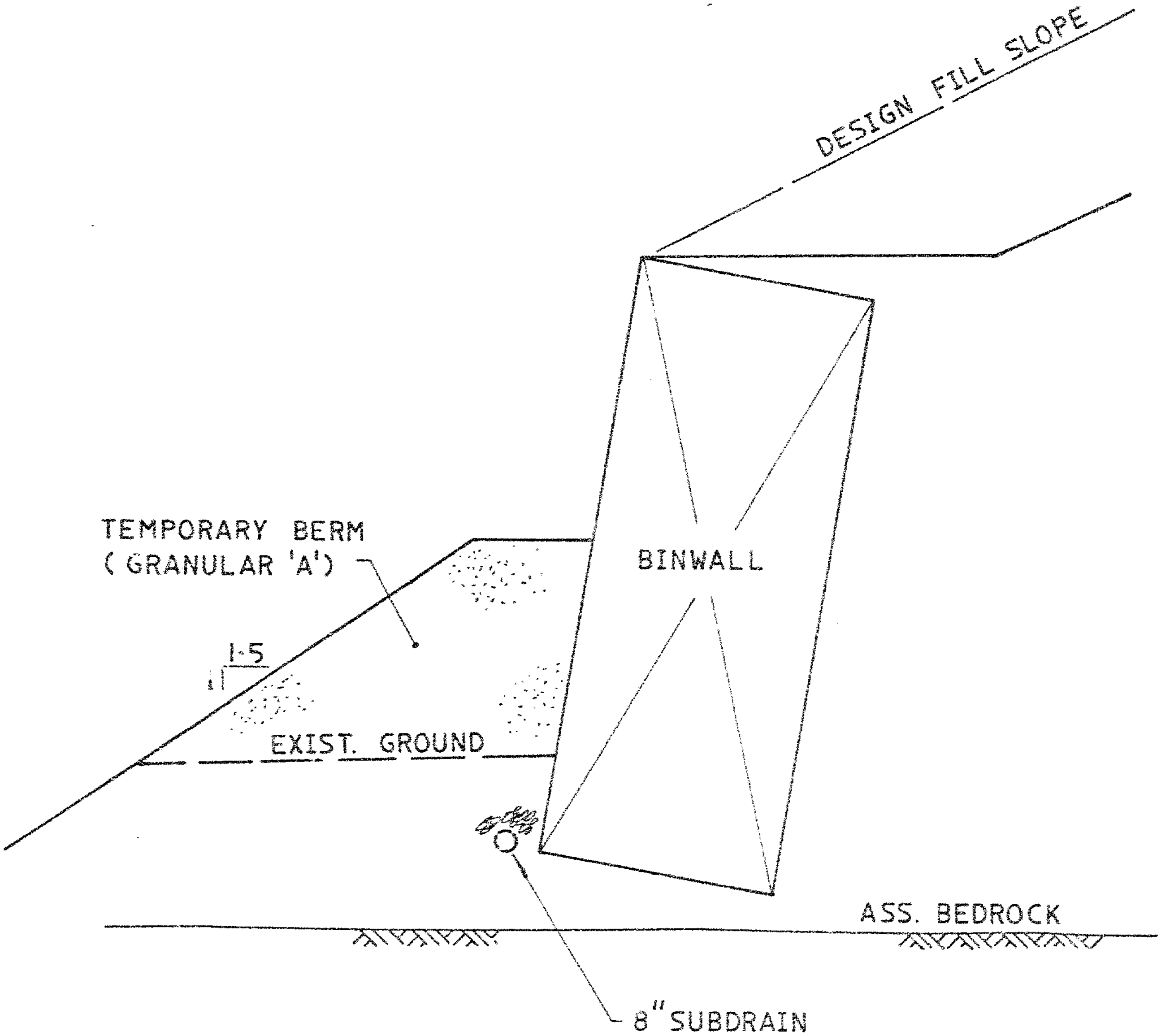
SCHEME I


4' CLAY BLANKET
SWALE
REMOVE &
REPLACE
BINS
1
1
CONSTRUCTION GRADE
EXIST. GROUND
ASS. BEDROCK
6" SUBDRAIN

SCHEME 2


4' CLAY BLANKET
CONCRETE
RETAINING
WALL
GRANULAR
BACKFILL
BINWALL
EXIST. GROUND
ASS. BEDROCK
6" SUBDRAIN

SCHEME 3



TEMPORARY REMEDIAL MEASURES

9. CONCLUSIONS

Although the estimated cost of Scheme 1 is somewhat less than the estimated cost of Schemes 2 and 3, it is recognized that the grouting cost included in Scheme 1 could quite easily be low because of the difficulty in estimating the quantity of grout involved. Therefore, it is felt that the final costs of the three schemes are equivalent. Consideration should be given by the M. T. C. to all three schemes before a decision is made on the implementation of one of them.

It is recommended that the following temporary remedial measures be carried out if the above measures cannot be carried out in 1974.

... place fill in front of wall

... install slope indicators and piezometers.

10. APPENDIX

10.1 GOLDER REPORT

Golder Associates
CONSULTING GEOTECHNICAL ENGINEERS

REPORT

TO

McCORMICK, RANKIN & ASSOCIATES LIMITED

INVESTIGATION OF RETAINING WALL MOVEMENTS

HIGHWAY 25

OAKVILLE ONTARIO

Distribution:

12 copies - McCormick, Rankin & Associates Limited, Port Credit, Ontario.

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

September 1974

741119

FIGURES (continued)

ABSTRACT

The results of an investigation carried out to determine the probable cause(s) of movement of an approximately 25 ft. high bin type retaining wall on Hwy 25 about 1/4 mile north of the Queen Elizabeth Way in Oakville, Ontario are reported and recommendations are provided for stabilizing the existing wall or replacing the wall with a new structure.

Based on the results of this investigation, it appears that the observed movements of the wall are due primarily to:

i) Sliding along the base of the wall, probably during periods of high groundwater levels behind the wall, and

ii) Structural distress of the bins themselves due to consolidation of the poorly compacted backfill within the bins

To prevent further movement of the wall, it is recommended that either the existing wall be tied-back by means of tendons grouted into the rock and the bins grouted (this will, as a precaution, necessitate installation of a new drainage system behind the wall) or alternatively that the wall be replaced with a new bin wall constructed on a granular pad keyed into the bedrock. As a temporary remedial measure, a stabilizing berm could be constructed along the face of the wall. In this case, it is essential that the wall be instrumented as discussed in the report.

1.0 INTRODUCTION

H. Q. Golder & Associates Ltd. have been retained by McCormick, Rankin & Associates Limited, Consulting Engineers to the Ministry of Transportation and Communications to carry out an investigation regarding the movement of a bin type retaining wall on Highway 25, about 1/4 mile north of the Queen Elizabeth Way in Oakville, Ontario. The purposes of this investigation were as follows:

1) to analyze the stability of the existing slope and retaining wall,

2) to assess the structural integrity of the bin type retaining wall proper,

3) to provide geotechnical recommendations for the design and construction of alternative schemes for stabilization of the bin wall.

2.0 HISTORY OF PROJECT

Grade improvements and re-alignment of Highway 25 were carried out for the 2.5 mile section of roadway between the intersection of Highway 5 and 25 south to the Q.E.W. under the Ministry of Transportation and Communications project W.P.131-65-01. In order to avoid a wide embankment fill slope, a bin type retaining wall as manufactured by Armco Canada Ltd. was built during the period August to October, 1973 to retain the section of roadway fill on the east bank of Bronte Creek between about Station 122+00 and Station 123+50.

The installation and backfilling of the bin type retaining wall was completed by the end of October 1973.

Within one month, however, severe structural distress was apparent in the column members and stringers of several bin sections. From field measurements, it was established that the top of the bin wall had moved forward significantly from the "as built" location (average maximum movement of 3.7 feet at columns 3 to 8 inclusive). Based on the results of field monitoring of the bin columns from November 26, 1973 to August 19, 1974, the movement of the top of the columns continued at a reduced rate during the period December 1973 to March 1974 and has virtually ceased from April 1, 1974 to date (maximum total lateral movement of 4.2 feet at column 5).

A control line at the toe of the bin wall was established in April 1974 and it was therefore not possible to determine the rate of movement at groundline at the front face of each bin. However, the results of the field survey indicate that measurable lateral movement occurred at the groundline level from the "as-built" location (2.2 feet maximum movement at column 5).

3.0 PREVIOUS INVESTIGATIONS BY OTHERS

A soil investigation was carried out at the site of the proposed bin type retaining wall by the Ministry of Transportation and Communications (formerly Department of Highways, Ontario) during April 1970; the results of their investigation are presented in a report No. W.O.70-11030, dated June 19, 1970. This report indicates that the soil conditions at the site consist generally of a surficial organic material underlain by heterogeneous layers of clayey silt with some sand and gravel (glacial till) which in turn were followed by weathered and sound shale bedrock. The report further indicates that the groundwater level varied between 1 and 15 feet below ground elevation with a naturally steep gradient towards the Bronte Creek.

In April 1974, the M.T.C. put down two boreholes and one cone penetration test within the bin sections proper, (M.T.C. Project No. 74-11006). Copies of the field log sheets and results of laboratory testing on the backfill samples obtained during drilling were provided to us by the Ministry of Transportation and Communications. Based on the results of this investigation (pertinent information given on Figures 2 and 8) it was apparent that the backfill at the borehole locations consisted of a dirty sand and gravel material (10 to 35 per cent by weight passing the No. 200 mesh sieve). The results of standard penetration tests carried out during sampling operations in the granular backfill range from 3 to 10 blows per foot indicating that the material is in a generally very loose to loose state of packing.

4.0 PRESENT INVESTIGATION

The field work for the present investigation was carried out during the period July 8 to August 15, 1974, and consisted of six (6) hand dug test pits at locations shown on Figure 1. The pertinent information regarding details of the test pit locations and purpose of the excavations are given below.

TEST PIT No.	LOCATION	DEPTH (FT.)	PURPOSE OF EXCAVATION
	WITHIN BIN SECTION		
1	Bin 5	6.0	In situ testing of granular backfill
2	Bin 7	6.6	

TEST PIT NO.	LOCATION	DEPTH (FT.)	PURPOSE OF EXCAVATION
	FRONT TOE OF BIN WALL		
3	At Col. 7	5.1	Location and examination of column base plates
4	At Col. 6	6.0	
	REAR OF BIN WALL		
5	At Col. 5	1.5	Location and examination of top of rear bin columns
6	At Col. 7	3.5	

At Test Pits 1 and 2 in situ density testing of the granular backfill was carried out at regular 1 foot intervals of depth. Two bulk samples of the backfill material were obtained from Test Pit 1 and were brought to our laboratory for gradation analysis and standard Proctor compaction testing. In addition, falling head permeability tests were carried out in the granular fill from the bottom of the test pits at various levels during excavation to establish the permeability characteristics of the bin fill material.

The soil stratigraphy encountered in each test pit, together with the results of the field and laboratory testing are given on the Record of Test Pit sheets and on Figures 7 and 9, following the text of this report.

In addition to the test pit work at the site, the batter of 14 bin columns (columns 0 to 13 inclusive) was measured on July 24, 1974, and this information is presented in Table III.

The locations and ground surface elevations at the test pits were established in the field by Golder Associates personnel. The ground elevations are referenced to known elevation points at the site established by M.T.C. field staff and are referred to Geodetic datum.

Several sources of information regarding various aspects of the bin wall have been used in the preparation of this report and are given in Appendix A.

During the investigation, Mr. B. Gray of Golder Associates met with Mr. M. Kaiser, M.T.C. Project Supervisor, on several occasions at the M.T.C. site office (Hwy. 25, 1 mile north of Hwy. 5) to discuss various construction details of the bin type retaining wall and to obtain the results of the monitoring programme (by M.T.C. site staff) at the bin columns.

5.0 RESULTS OF FIELD INVESTIGATION

5.1 Bin Backfill Material

Test Pits 1 and 2, dug within Bins 5 and 7, encountered surficial fill material consisting of brown clayey silt, sand and rubble to depths of 1.5 and 3.7 feet respectively. This surficial fill is underlain by granular backfill to the maximum depth of exploration (6.6 feet). The results of grain size analysis on bulk samples of the granular material obtained from Test Pit 1, are given on Figure 9 and indicate that the material does not meet M.T.C. grading specifications for Granular Class 'A' backfill (excessive fines on No. 200 mesh sieve).

Grain size distribution curves for granular samples obtained during sampling operations in Boreholes 1 and 2, within Bins 5 and 6, (M.T.C. Project W.O.74-11006, April 1974) showed similar grading discrepancies from Granular 'A' backfill specifications.

The results of a laboratory standard Proctor compaction test carried out on a bulk sample of the granular backfill (sand and gravel with some silt) are given on Figure 7, and indicate a maximum dry density of 130.1 pounds per cubic foot at an optimum water content of 8.1 per cent.

Reference to Figure 7 indicates that the in situ dry density of the upper 3 to 4.5 feet of the granular backfill in Bins 5 and 7 is typically only about 80 to 87 per cent standard Proctor density and it is therefore considered that the material is in only a loose state of packing. The results of standard penetration tests (M.T.C. Boreholes 1 and 2) in the granular backfill in Bins 5 and 6, gave 'N' values ranging from 3 to 6 blows per foot. There is an indication that the loose state of packing of the granular backfill could extend to the bottom of bin (maximum test depth of about 21 feet below ground level).

The results of falling head permeability tests carried out in the granular backfill from the bottom of the test pit at various levels during excavation are given on the Record of Test Pit sheets. The average permeability coefficient K, of the granular backfill based on 19 tests is about 2×10^{-1} centimetres per second. It would appear that there is a discrepancy in the coefficient of permeability K for the granular backfill based on field test results and the K value which would be estimated from results of grain size analyses for dirty granular backfill (per cent passing No. 200 mesh sieve ranging between 10 and 35 per cent). However, it is believed that the K value from field results is realistic because of the loose state of packing of the backfill material, based on density test results in the test pits and from N valuesrecorded in the boreholes.

5.2 Condition of Bin Wall

The bin type retaining wall constructed at the site during the period August to October 1973, consisted of 17 bin sections (numbered Bin 0 to 16 inclusive). All standard bin sections manufactured by Armco Canada Limited, have a single panel width of 10 feet (front and rear "stringer" members 9.5 feet in length). The base width of Bins 0 to 10 inclusive is 14.3 feet (transverse side members - "spacers" are 14.0 feet in length). Bins 11 to 16 were constructed using a smaller spacer length of 11.8 feet.

The thickness of the stringers vary from 10 to 16 gauge (0.138 to 0.064 inch) depending on the height of the bin wall which varies from about 15 to 30 feet. The thickness of the spacers is typically 12 gauge (0.109 inch). The bin wall was installed with a batter or inclination of 1 to 6 (2 inch per foot of height).

In addition, a 6 inch diameter perforated pipe sub-drain was specified behind the back of the bin wall and discharging through Bin 14, into the existing storm sewer system.

Based on discussions with M.T.C. site personnel and available photographs taken during the erection of the bin wall, it is believed that the bin columns were installed at a batter of about 1 to 6 and that the stringer and the spacer members were in satisfactory condition (dimensions of the members generally within manufacturing tolerances). At the time of the field work for this investigation, some 9 months after erection of the bin wall (October 1973), several visual signs of the distress in the bin wall could be observed.

(a) The front face of the bin wall (Bins 0 to 12 inclusive) which was originally straight (per contract specifications) had obviously moved and formed a curve. Particularly large differential movement of the front face of the bins had occurred at column 2 (between Bins 2 and 3).

(b) The batter of the bins had visibly increased (the original 1 to 6 batter was now approaching vertical at Bins 4 to 8).

(c) The stringer members were badly distorted and bent, particularly in Bins 3 to 7 inclusive.

(d) Several stringer to stringer bolted connections had failed or showed signs of distress (rotation of bolt and tearing of stringer member).

(e) Loss of bin backfill was occurring along the front face because of distortion of the stringer members.

(f) Loss of bin backfill had also probably occurred through the 6 inch diameter pipe sub-drain as evidenced by soil deposited in the manhole in front of Bin 14 (single discharge point for sub-drain behind bin wall).

Test Pits 3 and 4 were dug at the toe of columns 7 and 6 to expose the lower section of the bin columns and examine the condition of the column plates. The base plates for columns 6 and 7 were encountered at elevation 373.5 and 373.9, about 5.3 and 4.6 feet below ground level respectively, which is close to the design level for the base plates under consideration, elevation 373.6.

The base plates at both locations were badly bent and the bin columns were not centred on the plates. The maximum movement of the base plate relative to the bin column (or vice versa) had occurred at Bin 6 where the bin column was at the extreme edge of the base plate (about 6 inches relative movement had occurred). In addition, the lower section of the column appeared to have buckled slightly and the bottom of the column was not perpendicular to the base plate.

The soil stratigraphy in the test pits is given on the Record of Test Pit sheets and consisted of reddish brown clayey silt to silty clay fill with cobbles, boulders, shale fragments and rubble, to about 5.0 feet, underlain by silty clay with shale fragments becoming sound shale bedrock. The base plates were founded on reddish brown silty clay with shale fragments (a piece of 2 x 10 lumber was encountered beneath column 7). Sound shale bedrock was within about one foot of the underside of the base plates.

At Test Pits 5 and 6, dug at the rear of Bins 5 and 7, all accessible 5/8 inch diameter bolts connecting the spacers and rear bin columns were in place and tight during our inspection. The horizontal distance between front and rear sections of the bin wall was about 14 feet.

Figure 2 presents topographic sections through Bins 5, 6 and 7 and our estimate of the approximate existing configuration of the bins. It would appear that the corners of the bins are not square and have deflected and moved forward. The top of the rear bin at columns 5 and 7 has moved laterally and downward slightly from the "as-built" location.

5.3 Movement of Bin Wall

A monitoring programme of the bin wall movement was carried out during the period November 1973 to August 1974, by the Ministry of Transportation and Communications. The maximum lateral movement of the front top of the bin wall and the groundline at the base of the bins has been presented diagrammatically on Figure 1. Tables I and II present field measurements of the lateral movement and elevation changes of the top of the bin columns at various time intervals during the monitoring programme. Table III gives batter measurements of the bin columns carried out by members of our engineering staff on July 24, 1974.

Based on the results of the field monitoring as given in Table I, it is apparent that 60 to 70 per cent (some 2.4 feet) of the total lateral movement at the top of the bin columns 3 to 8 inclusive, occurred by November 26, 1973, within 1 month following completion of backfilling of the bins at the site. The movement of the top of the bin columns continued from November 26, 1973 to April 1, 1974, at a significantly reduced rate and it is understood that the wall movement has virtually ceased from April 1, 1974 to date. The maximum total movement of 4.2 feet has occurred at column 5 with an average movement of 3.7 feet along the length of the wall from Bins 3 to 8 inclusive.

The existing position of the top of the bin wall is indicated on Figure 1, which illustrates the approximate curved shape of the bin wall when compared to the "as-built" location for the structure. The elevation of the top of the bin columns as measured periodically from November, 1973 to August, 1974, is given in Table II and indicates a downward movement of generally less than 0.2 feet (average vertical movement of bin columns since completion of bin wall is typically less than 0.5 feet).

Table III gives the results of batter measurements of the bin columns and indicates that the batter of bin columns 3 to 8 which have showed the largest movement has increased from the design value of 1 to 6, to about an average batter of 1 to 11.

The control reference line at the base of the bin wall was established in April 1974, and no movement of the bin wall at the groundline has been measured to date. However, the groundline at the toe of the bin type retaining wall from bin columns 3 to 8 inclusive, has moved forward an average 1.7 feet from the "as-built" location (maximum deviation from construction position measured at bin column 5 - some 2.2 feet). The present location of the groundline at the base of the retaining wall is given on Figure 1.

6.0 DISCUSSION

6.1 Principle of Bin Type Retaining Wall

The bin wall is a gravity retaining wall consisting of continuously connected steel bins which are filled with earth. In essence, the earth mass acts as the gravity wall with the steel members serving to hold the earth mass intact. Because the bin walls are constructed of lightweight, deep corrugated steel members, the sides of the bin can deflect, thus permitting stress relief from soil pressures and any superimposed loads.

Since the confined earth mass serves as a gravity wall, it is important that adequate foundation support be provided under the earth mass as opposed to beneath the steel members. If the bin wall is to be constructed on a rigid foundation, it is normal practice to provide a compressible cushion under the base plates to allow for slight settlement of the bin columns. In this regard, the column base plates are provided to aid erection and are not a functional part of the bin.

The bin type retaining wall must be proportioned (bin dimensions and batter of wall) to resist overturning and sliding forces imposed by soil pressures and from surcharge loadings. When the bins are erected and backfilled, the structural analysis and interrelation of the soil/steel system is quite complex. However, the bin type retaining wall becomes a statically indeterminate structure when excessive deflection of the bin members takes place, or when the backfill within the bins is no longer a confined earth mass (loss of ground through front face of bins or into perforated pipe sub-drain system).

6.2 Stability Analysis of Bin Wall

The bin type retaining wall must be stable when subjected to lateral earth pressures and superimposed surcharge loads. Figure 3 presents a force diagram of the bin wall retaining structure, equations for determination of factor of safety against overturning and against sliding, and soil parameters assumed for calculation purposes.

The stability analysis has been carried out on a 28 foot high bin section with a batter of 1 to 6, assuming two different surcharge configurations. Case A represents the condition of the above dimensioned bin section supporting the design fill slope, 2 horizontal to 1 vertical. Case B represents the 28 foot bin section with an intermediate surcharge slope corresponding to about existing ground surface conditions.

The stability of the bin section (Case A) was computed for various assumed unit weights of bin backfill. The results are given in Figure 4, and for convenience, are summarized below:

Unit Weight of Bin Backfill	Computed Safety Factor Against Sliding	Against Overturning
γ = 110 lb/cu.ft.	1.0	1.7
γ = 120 lb/cu.ft.	1.1	1.8

The above unit weight values for the bin backfill were selected for illustrative purposes and represent the typical ranges of in situ density test results measured in the test pits. The lateral pressure acting against the bin section due to soil pressure and superimposed surcharge loads was taken as an equivalent fluid pressure of 50 pounds per square foot (corresponds to an approximate active earth pressure coefficient Ka = 0.4).

The sliding resistance mobilized along the base of the bin section was computed using the friction component of the bin section and a friction angle δ of 25 degrees between the granular backfill and underlying clayey till/shale bedrock. This δ value may be considered relatively high for design purposes (δ = 20 degrees a more typical value). It is believed however, that the friction angle mobilized along the bin base is about 25 degrees because of the recorded movement of the bin wall under known conditions of surcharge loading and the like.

For comparative purposes, the sliding resistance of the bin sections assuming a constant adhesion force C_a acting along the base of the bin has been computed for various C_a values and is summarized below:

Assumed Adhesion C_a At Base of Bin Wall (lb/sq.ft/ft. width of bin)	Safety Factor Against Sliding
2000	1.2
3000	1.6
4000	2.0

The effect of the unit weight for the bin backfill on the toe and heel pressures is given on Figure 5 and shows that the maximum toe pressures at the base of the bin wall could be as high as 6 tons per square foot.

All stability analyses for the bin sections previously discussed in this report have assumed that there is NO hydrostatic pressure build-up behind the bin wall (sub-drains sufficient to maintain fully drained conditions at back of bins). The effect of hydrostatic build-up behind the bins on the stability is illustrated on Figure 6 (for Case B - intermediate slope corresponding to existing ground profile) and in the following table:

FACTOR OF SAFETY	HYDROSTATIC HEAD ABOVE BASE OF BIN WALL (ft.)	(ft.)	(ft.)	(ft.)
	0	5	10	15
Against sliding	1.1	1.0	<1.0	<1.0
Against overturning	1.8	1.7	1.6	1.4

In summary, computations for the 28 foot high bin wall with 1 to 6 batter and surcharge loading (see Figure 3), indicate that the safety factor against overturning about the toe of the bin wall is slightly less than 2.0 and it is therefore considered adequate. However, the sliding resistance of the bin wall (assuming a high friction angle δ = 25 degrees and full drainage behind the bin section) is only marginal at about 1.1. This value could approach unity if there is a small build-up of hydrostatic pressure (about 5 feet of head) above the base of the bins.

6.3 Mechanism of Failure

The bin type retaining wall was constructed on the west side of Highway 25, about 1/4 mile north of the Q.E.W. during the period August to October, 1973. Within 1 month of completion of backfilling of the bins, severe distress was evident in several of the bin sections. The top of the bin wall (bin columns 3 to 8 inclusive) had moved forward an average of 2.4 feet.

The bins continued to move, but at a reduced rate over the 1973/1974 winter period. No movement of the bins has been recorded from April 1, 1974, to date.

Based on the details of the known movement of the bin wall, together with the results of the present investigation, it is considered that two main factors have attributed to the lateral movement of the bin wall, and subsequent distortion of the bin members:

a) Insufficient compaction of the granular backfill in the bins

b) Marginal sliding stability of the bins

It is believed that significant settlement of the loose granular backfill occurred almost immediately after completion of the backfilling operations due to weight of the bin fill itself, weight of surcharge fill material, and by downward seepage of surface rain water during a wet fall season.

The densification of the bin material resulted in substantial drag-down forces (similar to negative skin frictin) on the stringers and bin columns, which deflected and distorted. The lateral movement of the front face of the bin wall could result in a slight loosening of the granular backfill because of the increase in volume of the earth mass within the bins, and loss of material through the distorted stringer members.

The factor of safety against sliding for the bin sections at the site is only marginal assuming full drainage conditions behind the bins, and could approach unity with hydrostatic pressure build up of only about 5 feet above the base of the bins. It is believed that a portion of the observed movement of the bin wall can be attributed to sliding at the base of the bins. The build up of a hydrostatic pressure behind the bin wall is possible due to several factors regarding site conditions:

a) presence of dirty backfill within bins
b) blockage/silting up of perforated pipe sub-drain
c) seasonal freeze and thaw of front face of bin wall and drain outlet(s)
d) peculiar site groundwater conditions consisting of local springs flowing in direction of Bronte Creek
e) surface water run-off entering bin backfill

Because of the depressed groundwater conditions during the summer period, the sliding stability of the bin is not as critical as the fall and spring periods when there is movement of large quantities of groundwater and surface water run-off.

7.0 RECOMMENDATIONS

As previously discussed in this report, the factor of safety against sliding at the base of the bin wall under full drainage conditions of the backfill is marginal. Therefore, should the water level raise only about 5 feet (for any reason), it is possible that lateral movement of the bin wall could occur since the safety factor would approach unity. The following alternative schemes are recommended to increase the factor of safety against sliding along the base of bin type retaining wall.

7.1 Tied-Back Anchorage System

Consideration should be given to resisting the lateral earth pressures behind the wall (increasing safety factor against sliding) by means of tie-backs grouted into the sound shale bedrock (scheme shown diagrammatically on Figure 10).

7.1.1 Tied-Back System

It is anticipated that one tie-back (conventional tendon) will be required per bin section along a select portion of the bin type retaining wall. It is suggested for estimating purposes that tie-backs be provided for 10 bin sections.

We recommend that the following parameters be used for the design of the tie-backs (details shown on Figure 10).

a) The tie-backs should be inclined downwards not less than 30 degrees and not more than 45 degrees from the horizontal.

b) The anchorage should begin not closer to the back of the bin wall than a line inclined upwards from the heel of the bin wall at an angle of 45 degrees to the horizontal plus 0.15 times the total height of the fill (see Figure 10) and the anchorage should be not less than 5 feet below the surface of the sound shale.

c) The maximum design allowable stress between the grout and the shale should be taken as 100 pounds per square inch.

d) The total bonded length of the tendon should be not less than 10 feet.

During construction, each anchorage should be tested to at least twice its design capacity by jacking. Further, we recommend that the anchor rods be heavily greased above the bonded portion and that the entire drill hole be carefully grouted following load testing of the anchor. Based on preliminary design information, it is recommended that each tendons be capable of developing a design working load of 50 tons.

To prevent damage to the portion of the anchor rods outside of the drill holes and possible distortion of the rods due to settlement of the backfill in the bin wall proper we recommend that each anchor be encased in a sleeve extending the full depth of the bin section. These sleeves should consist of rigid steel pipe having an inside diameter at least 2 to 3 inches larger than the diameter of the anchor rod. The annular space within the sleeves should be packed with grease to prevent corrosion of the rods.

To ensure load transfer from the tie-back to bin type retaining wall we recommend a steel grillage be provided at the front face of the bin wall. In this regard, the vertical steel members of the grillage should be supported on concrete footings dowelled into sound shale bedrock.

7.1.2 Grouting of Bin Backfill

It is understood that Armco Canada Limited have recommended that the bin wall be grouted to ensure the structural integrity of the bins themselves. Although this matter is outside our field of expertise, we can comment on the geotechnical aspects of grouting the bin wall.

The purpose of the grouting operations would be to fill the voids within the bins to prevent or minimize further settlement of the backfill and thus prevent further structural distress to the bin columns, stringers and spacers. Because of the high silt content of the backfill material, it is anticipated that the actual grout take (using water/cement mixture) within the bin fill (exclusive of voids) will be relatively small.

Although grouting of the voids within the bin type retaining wall would increase the unit weight of the backfill, grouting "take" within the bins will probably be quite variable and it is considered that the overall factor of safety against sliding (due to an increased weight of backfill) would not be substantiately increased by grouting of the bins alone.

It should be noted that during grouting operations, the existing drainage system (6 inch diameter perforated pipe sub-drain installed along the heel of the wall and surrounded by granular filter material) could inadvertently be grouted. Any resultant build up of hydrostatic pressure behind the wall could drastically reduce the factor of safety against sliding and could result in failure of the wall. To minimize the possibility of accidentally grouting the drainage system, we suggest that, prior to consolidation grouting of the bin fill material, a cut-off be provided at the rear of the bins by controlled grouting using a thick cement/bentonite mixture and injecting measured volumes of grout at low pressures through closely spaced injection pipes along the back of the retaining wall. However, because of the location and condition of the back face of the bin wall and of the drainage system are not known, provision of the cut-off at the rear of the bins (although desirable) may not be practically successful and it is not possible to state with certainty that the existing drain pipe and surrounding granular filter material would remain effective after grouting of the bin fill was completed.

It is therefore recommended that additional drainage facilities as shown on Figure 10 be provided to ensure full draining conditions behind the bin wall.

This drainage scheme includes twenty-four inch diameter augerholes drilled at the back of each bin at about 5 foot centres along the length of the retaining wall. The holes should be backfilled with crushed stone/ peagravel and concrete sand with provision of a clay seal as noted on Figure 10. It is recommended that lateral drain pipes be provided through each bin section and installed such as to intercept the vertically augered drainholes at the back of the bin wall. The horizontal drains should discharge into the existing storm sewer system or a frost free outlet.

7.2 New Bin Retaining Wall

As an alternative to the tie-back anchorage system, consideration should be given to replacing several of the more severely damaged bins (Bins 3 to 10 inclusive) by the construction of new bin retaining wall. The new bin type retaining wall would involve use of the same size of bin (14.3 foot width) and provision of a key trench extending into the sound shale bedrock and back-filled with angular (crushed) material as illustrated on

Figure 11. Based on the stability calculations for this structure (assuming a bin backfill unit weight of 130 pounds per cubic foot, friction angle along base of bin wall δ = 30 degrees and a 2 horizontal to 1 vertical fill slope), the factor of safety against sliding with passive toe pressure ignored is about 1.5. The factor of safety against overturning about the toe of the bin wall is greater than 2.0 and is therefore considered adequate.

Because of the relatively high assumed unit weight of bin fill and friction angle at base of bin wall it is imperative that continuous construction inspection be provided during placement and compaction of the backfill in the key trench beneath the bin sections and within the bins. It is recommended that the backfill consist of a crushed clean free draining granular material meeting M.T.C. granular 'A' specification (frequent grain size analysis should be carried out to ensure proper gradation of backfill). The granular fill should be placed in horizontal lifts not exceeding 6 in. loose thickness and each lift should be compacted to a minimum dry density equal to 100 per cent of standard Proctor dry density. Proper care and attention should be given to the manufacturers recommendations for installation of the retaining wall. Details of the recommended lateral drains through the bins are given on Figure 11. This drainage system should discharge into a frost free outlet to prevent build up of water pressure behind bin wall.

The removal of several of the existing bins will probably involve a major detour of Highway 25 in order that construction side slopes behind the wall are stable.

To this end, it may be desirable to relocate the new bin wall a few feet west of the existing location to ensure an overall construction slope of about 1 horizontal to 1 vertical.

7.3 Temporary Remedial Measure

Because of the short time remaining in the 1974 construction season, it may not be possible to carry out permanent repair work to the bin wall as recommended in Section 7.1 and 7.2. Consequently, to increase the stability of the wall against sliding during the 1974-75 fall and winter period, we suggest that consideration be given to constructing a temporary stabilizing berm along the face of the wall. Figure 12a presents details of a suggested berm at the base of the bin wall. The main features of the berm construction are given below:

a) The provision of granular berm with the fill material meeting M.T.C. grading specifications for Granular A, Granular B or equivalent placed in horizontal lifts not exceeding 12 inches loose thickness and compacted to a minimum dry density of 95 per cent standard Proctor maximum dry density.

b) The geometry of the earth berm includes a 10 to 15 foot wide crest width (depending on available space at the base of the bin wall) and side slopes inclined at 1-1/2 horizontal to 1 vertical. All organic, compressible and other unsuitable materials should be stripped from the area at the base of the bin wall prior to placement of the berm fill material.

c) The crest level of the earth berm varies along the length of the bin wall in order that the maximum unsupported height of the bin wall is about 14 feet as shown on Figure 12B.

d) Drainage facilities at the base of the bin wall will include provision of an 8 inch diameter perforated drain pipe, nominally 5/8 inch crushed stone filter and weeping holes through the bins.

e) The granular berm should be keyed into the existing ground at the toe of bin wall as shown on Figure 12A and this work should be carried out in sections not exceeding 10 feet in length.

Figure 12C presents the results of an analyses of the stability of the bin retaining wall with provision of the granular berm at the base of the wall. For the existing slope (Case 1), the construction of the granular berm following the recommendations given in this report will increase the factor of safety against sliding along the base of the bins to about 1.4 for an unsupported bin height of 14.5 feet (assuming full drainage conditions behind the bin wall). The lateral earth pressure developed in the granular berm in front of the bin wall has been computed using a value of 1.0 for the earth pressure coeffic[illegible] This value is considered to be realistic based on [illegible]obable movement of the bin wall for mobilization of the computed lateral pressure and the actual geometry of the granular berm as dictated by the available space at the base of the bin wall.

As shown on Figure 12C, the safety factor against sliding for the bins with the design fill slope 2 horizontal to 1 vertical, in place, (Case 2 denoted by dashed line of this figure) is about 1.2 for the recommended maximum berm height and assuming full drainage from behind the wall.

The effect of hydrostatic pressure build-up behind the bin wall on the factor of safety against sliding has also been computed and is presented on Figure 12C for various assumed water levels (Hw = 0 feet, 5 feet, 10 feet, etc.). Because of the severe reduction in safety factor for hydrostatic build-up of only about 10 feet it is imperative that particular attention be given to preventing hydrostatic build-up behind the bin wall. In this regard, a possible system for groundwater control behind the bins is shown on Figure 12A and would involve a provision of a perforated drain pipe, filter material and weeping holes through the bins (system to be connected to frost free outlet).

It is understood that the design fill slope (2 horizontal to 1 vertical) may be completed after the construction of the temporary granular berm at the base of the bin wall. Because of the relatively low safety factor against sliding of the existing bins with the design fill slope in place (see Figure 12C - Case 2), it is recommended that the conditions of the bins and earth slope be monitored in the field during construction and during the coming winter. To this end, it is suggested that at least 2 slope indicator casings be attached directly to the front face of the bin columns (between Bins 4 and 5 and between Bins 6 and 7). The slope indicator casings should extend at minimum of 10 feet into the sound shale bedrock.

In addition, it is suggested that a slope indicator be located behind the bin wall on the existing shoulder of Highway 25 and installed at a sufficient depth (say 40 feet) to record possible movement of the subsoil which could indicate deep-seated instability of the slope.

Further, it is recommended that a minimum of three (3) piezometers be installed behind the bin wall to permit monitoring of any groundwater build-up behind the wall. The slope indicators and piezometers should be read at frequent intervals during and after placement of the slope fill material. The results of the instrumentation should be plotted and reviewed by an experienced geotechnical engineer in order that appropriate remedial action may be taken, if warranted.

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SOURCES OF INFORMATION
USED IN PREPARATION OF REPORT
BIN WALL HWY 25 ONTARIO

(i) Chronological sequence and details of construction of the bin wall based on information in M.T.C. field inspectors' diaries. (Appendix B to this report)

(ii) Drawing showing details of M.T.C. topographic survey on May 27, 1974, (section profiles along length of bin wall at each bin column location).

(iii) M.T.C. field survey information - the elevation of the front bin columns (see Table I)

(iv) M.T.C. field survey information - details of the movement of the bin wall with time (see Table II)

(v) Record of Borehole Sheets and results of laboratory testing. (Boreholes 1 and 2, M.T.C. Project W.O. 74-11006, April 1974)

(vi) Foundation Investigation Report prepared by former Department of Highways Ontario, titled "Proposed Realignment of Hwy. 25 (New) Fill Stability, Station 120+00 to Station 124+00, Hwy. No. 5 Southerly to Q.E.W., District No. 4 (Hamilton) W.O. 70-11030, W.P. 131-65-01" dated June 19, 1970.

CHRONOLOGICAL SEQUENCE OF BIN WALL CONSTRUCTION DETAILS HWY. 25 ONTARIO

Date (1973)	Remarks
August 15	Start Excavation of Bin Wall.
August 21	Excavation of Bin 0 and Bin 1 completed.
August 22	Excavation of Bin 2 and Bin 3 completed.
August 23	Excavation of Bin 4 completed.
August 24	Backfilling commenced in Bin 0 and Bin 1.
August 27	Backfilling at Bin 2 in progress.
August 28	Backfilling stopped - granular material from Sherman pit too dirty.
September 6	Excavation completed Bin 12 and Bin 13.
September 24 to 27	Field Inspector's report mentions back-filling and compacting of fill (bin numbers not recorded) - batter of bins checked - 1 to 6.
October 26	All bins assembled and backfilled.
on about Novemer 23	Visual distress noted in stringers of bin wall.
November 26	Monitoring programme of bin column commenced.

NOTE: The above information was obtained from field inspectors' diaries during a July 3, 1974 meeting between Mr. B. Gray (Golder Associates and Mr. M. Kaiser (M.T.C.), at the field office on Hwy. 25, about 1 mile north of Highway 5.

FIELD MEASUREMENTS OF HORIZONTAL MOVEMENTS OF BIN WALL HWY. 25 ONTARIO

HORIZONTAL MOVEMENT

COLUMN NO.	TOP FRONT COLUMN OF BIN WALL (Ft.) Nov.26/73	Mar.6/74	Apr.1/74	FRONT FACE OF BIN WALL AT GROUND LINE (Ft.) Apr.8/74
2	N/A	N/A	1.5	0.8
3	1.8	3.2	3.7	1.8
4	2.2	3.5	4.0	1.7
5	2.6	3.8	4.2	2.2
6	2.8	3.3	3.6	1.5
7	2.8	3.2	3.5	1.5
8	2.2	2.7	3.1	1.3
9	N/A	2.2	2.5	0.9
10	N/A	1.8	2.1	0.6
11	N/A	1.1	1.4	0.6
12	N/A	0.8	1.2	0.6
13	N/A	1.1	1.5	0.7

NOTES.

1) Horizontal movement of bin wall established in the field by M.T.C. during the period Nov/73 to May/74 with respect to control base lines.

2) Reference line at base of bin wall established in April, 1974.

3) Horizontal movement measurements reflect changes in the horizontal distance from the base line to top of the bin wall and are based on an assumed "as-built" location for the bin wall.

4) N/A - information not available at the time of the preparation of this report.

FIELD MEASUREMENTS OF ELEVATIONS OF COLUMN CAPS OF BIN WALL

HWY. 25 ONTARIO

COLUMN NO.	STATION	NOV.26/73	MAR.6/73	MAY 7/74	AUG.19/74
0	121+98	409.45	409.40	409.35	409.40
1	122+08	409.40	409.32	409.29	409.36
2	122+17	409.18	409.08	409.06	409.07
3	122+26	407.44	407.32	407.31	407.29
4	122+35	405.68	405.63	405.63	405.65
5	122+44	404.26	404.16	404.13	404.12
6	122+55	403.23	403.07	403.05	403.04
7	122+64	402.24	402.07	402.04	402.04
8	122+73	400.98	400.83	400.83	400.81
9	122+83	398.41	398.30	398.29	398.12
10	122+92	397.16	397.06	397.06	396.87
11	123+01	395.77	395.68	395.67	395.71
12	123+10	394.40	394.35	394.33	394.36
13	123+20	391.73	391.69	391.68	391.68

NOTE: Elevation of column caps established in the field by M.T.C. site staff.

FIELD RESULTS OF BATTER MEASUREMENTS
ON COLUMNS OF BIN WALL
HWY. 25 ONTARIO

COLUMN NO.	WALL HEIGHT TO GROUNDLINE (ft.)	DEVIATION FROM VERTICAL (ft.)	APPROXIMATE BATTER OF COLUMN
0	5.4	0.7	1:8
1	11.6	1.8	1:6.5
2	17.5	2.7	1:6.5
3	20.5	2.3	1:9
4	23.9	1.9	1:12.5
5	23.7	2.3	1:10.5
6	23.4	2.1	1:11
7	22.9	2.0	1:11.5
8	22.6	2.0	1:11.5
9	20.5	2.0	1:10.5
10	19.5	1.8	1:11
11	18.9	2.3	1:8
12	17.0	2.2	1:7.5
13	14.3	1.7	1:8.5
14	15.0	1.9	1:8

NOTE: The field survey work was carried out by members of Golder Associates engineering staff on July 24, 1974.

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 $\bar{R}$.

LIST OF SYMBOLS

I. GENERAL

$\pi = 3.1416$
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

II. STRESS AND STRAIN

- u pore pressure
- σ normal stress
- σ' normal effective stress ($\bar{\sigma}$ is also used)
- τ shear stress
- ϵ linear strain
- ϵ_{xy} 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

III. SOIL PROPERTIES

(a) *Unit weight*

- 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_s specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
- e void ratio
- n porosity
- w water content
- S_r degree of saturation

(b) *Consistency*

- w_L liquid limit
- w_P plastic limit
- I_P plasticity index
- w_S shrinkage limit
- I_L liquidity index $= (w - w_P)/I_P$
- I_C consistency index $= (w_L - w)/I_P$
- e_{max} void ratio in loosest state
- e_{min} void ratio in densest state
- D_r relative density $= (e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

- 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

(d) *Consolidation (one-dimensional)*

- m_v coefficient of volume change $= -\Delta e/(1+e)\Delta\sigma'$
- C_c compression index $= -\Delta e/\Delta \log_{10} \sigma'$
- c_v coefficient of consolidation
- T_v time factor $= c_v t/d^2$ (d, drainage path)
- U degree of consolidation

(e) *Shear strength*

- τ_f shear strength
- c' effective cohesion intercept
- ϕ' effective angle of shearing resistance, or friction
  - (c', ϕ':) in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
- c_u apparent cohesion*
- ϕ_u apparent angle of shearing resistance, or friction
  - (c_u, ϕ_u:) in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
- μ coefficient of friction
- S_t sensitivity

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

RECORD OF TEST PIT 1

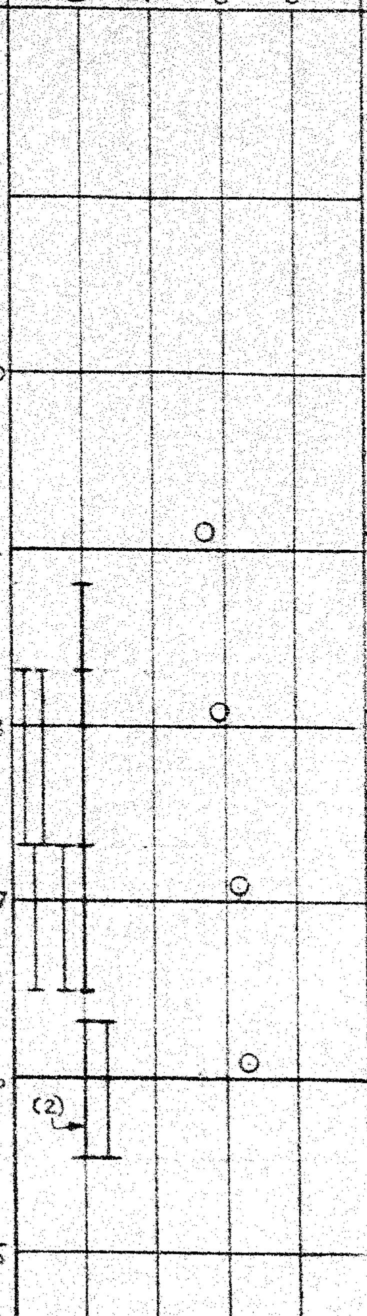
LOCATION See Figure 1 EXCAVATION DATE JULY 8, 1974 DATUM GEODETIC

TEST PIT TYPE HAND DUG TEST PIT SIZE 2.5' X 6'

ELEVN. / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	ELEVATION SCALE	ADDITIONAL LAB TESTING (BULK DENSITY γ P.C.F.)	GROUNDWATER CONDITIONS
401.3	GROUND SURFACE					
0.0	BROWN CLAYEY SILT, SAND AND RUBBLE (FILL)			401		
399.8 / 1.5	LOOSE SAND AND GRAVEL SOME SILT (GRANULAR 'A' BACKFILL)			400		
		1	C.S.	399	γ=109	TEST PIT DRY DURING EXCAVATION
		2	"	398	γ=111	
		3	"	397	γ=119	
		4	"	396		
395.3 / 6.0	END OF TEST PIT			395		

COEFFICIENT OF PERMEABILITY K, CM./SEC. — 1X10^{-1} 1X10^{-2} 1X10^{-3} 1X10^{-4}

WATER CONTENT, PERCENT — W_P W W_L — 2 4 6 8



VERTICAL SCALE 1 IN. TO 1 FT.

Golder Associates

DRAWN [signature]
CHECKED BRG

RECORD OF TEST PIT 2

LOCATION See Figure 1 EXCAVATION DATE JULY 9, 1974 DATUM GEODETIC

TEST PIT TYPE HAND DUG TEST PIT SIZE 2.5' X 6'

SOIL PROFILE

ELEVN. / DEPTH	DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	COEFFICIENT OF PERMEABILITY K, CM./SEC. / WATER CONTENT, PERCENT	ADDITIONAL LAB. TESTING (BULK DENSITY γ P.C.F.)	GROUNDWATER CONDITIONS
399.4	GROUND SURFACE					
0.0	BROWN CLAYEY SILT, SAND AND RUBBLE (FILL)					TEST PIT DRY DURING EXCAVATION
395.7 / 3.7	LOOSE SAND AND GRAVEL SOME SILT (GRANULAR 'A' BACKFILL)	1	C.S	(2)	γ=120	
		2	"	(2)	γ=125	
		3	"	(2)	γ=118	
393.8 / 6.5	END OF TEST PIT					

Elevation scale: 400, 399, 398, 397, 396, 395, 394, 393

Coefficient of permeability scale: 1X10⁻¹ 1X10⁻² 1X10⁻³ 1X10⁻⁴

Water content scale: W_P — W — W_L; 2 4 6 8

VERTICAL SCALE 1 IN. TO 1 FT.

Golder Associates

DRAWN

CHECKED BRG

RECORD OF TEST PIT 3

LOCATION See Figure 1 EXCAVATION DATE JULY 8&9, 1974 DATUM GEODETIC

TEST PIT TYPE HAND DUG TEST PIT SIZE 2.5'x6'

SOIL PROFILE						WATER CONTENT, PERCENT (W_P — W — W_L)	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
ELEVN. / DEPTH	DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	ELEVATION SCALE			
					379			
378.5 / 0.0	GROUND SURFACE							
					378			
	REDDISH BROWN CLAYEY SILT TO SILTY CLAY COBBLES, BOULDERS, SHALE FRAGMENTS, RUBBLE (FILL)				377			TEST PIT DRY DURING EXCAVATION
					376			
					375			NOTE: WEST EDGE BASE PLATE FOR COL. NO.7 AT ELEV. 373.9 ON JULY 9,1974
					374			
373.4 / 5.1	END OF TEST PIT SOUND SHALE BEDROCK							
					373			

VERTICAL SCALE 1 IN. TO 1 FT.

Golder Associates

DRAWN [signature] CHECKED BRG

RECORD OF TEST PIT 4

LOCATION See Figure 1 EXCAVATION DATE JULY 8 – 12, 1974 DATUM GEODETIC

TEST PIT TYPE HAND DUG TEST PIT SIZE 2.5' X 6'

SOIL PROFILE: ELEVN. / DEPTH	SOIL PROFILE: DESCRIPTION	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	ELEVATION SCALE	WATER CONTENT, PERCENT (W_P — W — W_L)	ADDITIONAL LAB TESTING	GROUNDWATER CONDITIONS
378.8	GROUND SURFACE				379			
0.0	BROWN CLAYEY SILT, SAND AND RUBBLE (FILL)				378 377 376 375 374			TEST PIT DRY DURING EXCAVATION NOTE: WEST EDGE BASE PLATE FOR COL. NO. 6 AT ELEV. 373.2 TO ELEV. 373.5 (VARIES) ON JULY 12, 1974
373.8 5.0	REDDISH BROWN SILTY CLAY AND SHALE FRAGMENTS				373			
372.8 6.0	END OF TEST PIT REFUSAL FOR PENETRATION OF 2" DIA. IRON BAR PROBABLY SHALE BEDROCK							

VERTICAL SCALE 1 IN. TO 1 FT.

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CHECKED BKG

RECORD OF TEST PIT 5 & 6

LOCATION See Figure 1 EXCAVATION DATE AUG 15, 1974 DATUM GEODETIC

TEST PIT TYPE HAND DUG TEST PIT SIZE 2'X2'

ELEVN. / DEPTH	DESCRIPTION (SOIL PROFILE)	STRATIGRAPHY PLOT	SAMPLE NUMBER	SAMPLE TYPE	ELEVATION SCALE	WATER CONTENT, PERCENT (W_P — W — W_L)	ADDITIONAL LAB. TESTING	GROUNDWATER CONDITIONS
						TP 5		
402.8	GROUND SURFACE				403			TEST PIT DRY DURING EXCAVATION
0.0	BROWN CLAYEY SILT SAND, RUBBLE (FILL)				402			NOTE: TOP OF COL. 5 (BACK OF BIN WALL) AT ELEV. 401.3 ON AUG. 15, 1974
401.3 / 1.5	END OF TEST PIT				401			
						TP 6		
402.9	GROUND SURFACE				403			
0.0	BROWN CLAYEY SILT SAND, RUBBLE (FILL)				402			TEST PIT DRY DURING EXCAVATION
					401			NOTE: TOP OF COL. 7 (BACK OF BIN WALL) AT ELEV. 399.4 ON AUG. 15, 1974
					400			
399.4 / 3.5	END OF TEST PIT				399			

VERTICAL SCALE 1 IN. TO 1 FT.

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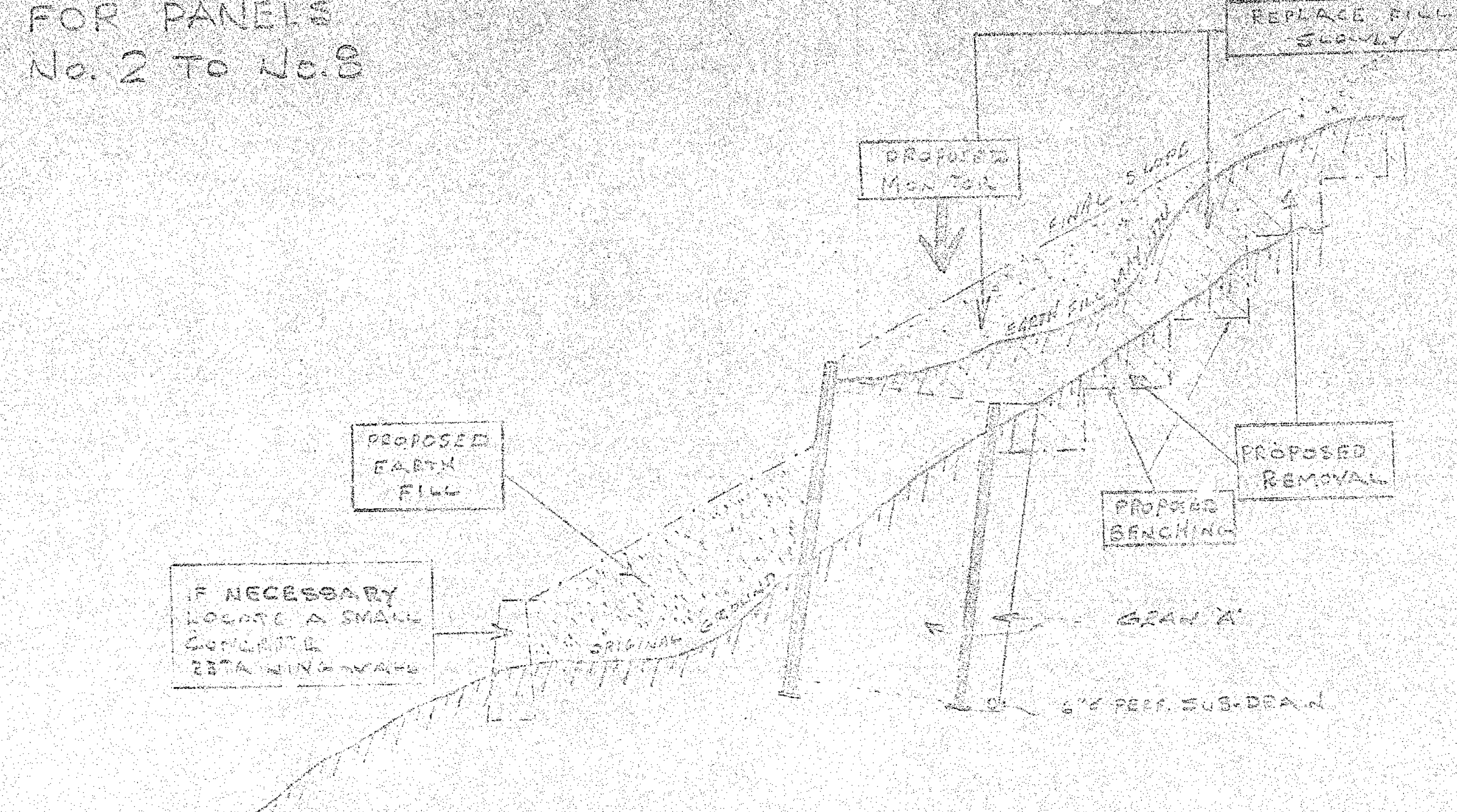
CHECKED BRG

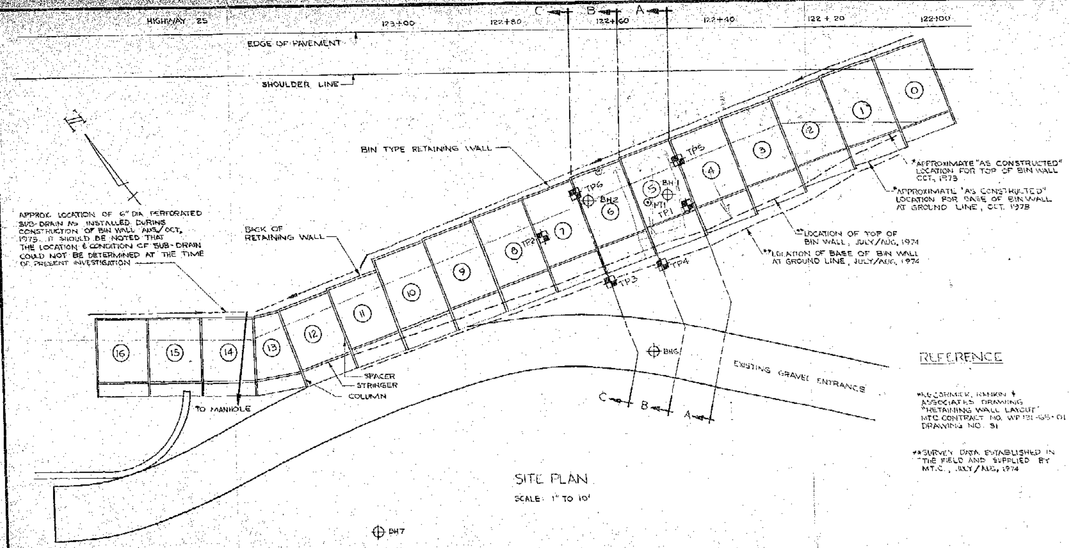
FOR PANELS
No. 2 TO No. 8



TYPICAL
CROSS SECTION

NOT TO SCALE

SITE PLAN & KEY PLAN | FIGURE 1



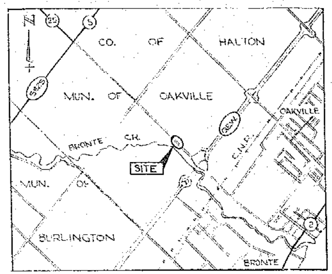
SITE PLAN

SCALE: 1" TO 10'

REFERENCE

*McCORMICK, RANKIN & ASSOCIATES DRAWING "RETAINING WALL LAYOUT" MTC CONTRACT NO. WP 131-65-01 DRAWING NO. 31

**SURVEY DATA ESTABLISHED IN THE FIELD AND SUPPLIED BY M.T.C., JULY/AUG. 1974



KEY PLAN

SCALE: 1" TO 0.8 MI.

LEGEND

TEST PIT IN PLAN, PRESENT INVESTIGATION

BOREHOLE IN PLAN { DHO REPORT NO. W.O. 70-11030 DATED JUNE, 1970; M.T.C. UNPUBLISHED REPORT NO. W.O. 74-11006, DATED APRIL, 1974 }

PENETRATION TEST IN PLAN { M.T.C. UNPUBLISHED REPORT NO. W.O. 74-11006, DATED APRIL, 1974 }

SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.

NOTE:

FOR SECTIONS A-A, B-B, & C-C, REFER TO FIGURE 2

Date AUG. 20, 1974

Golder Associates

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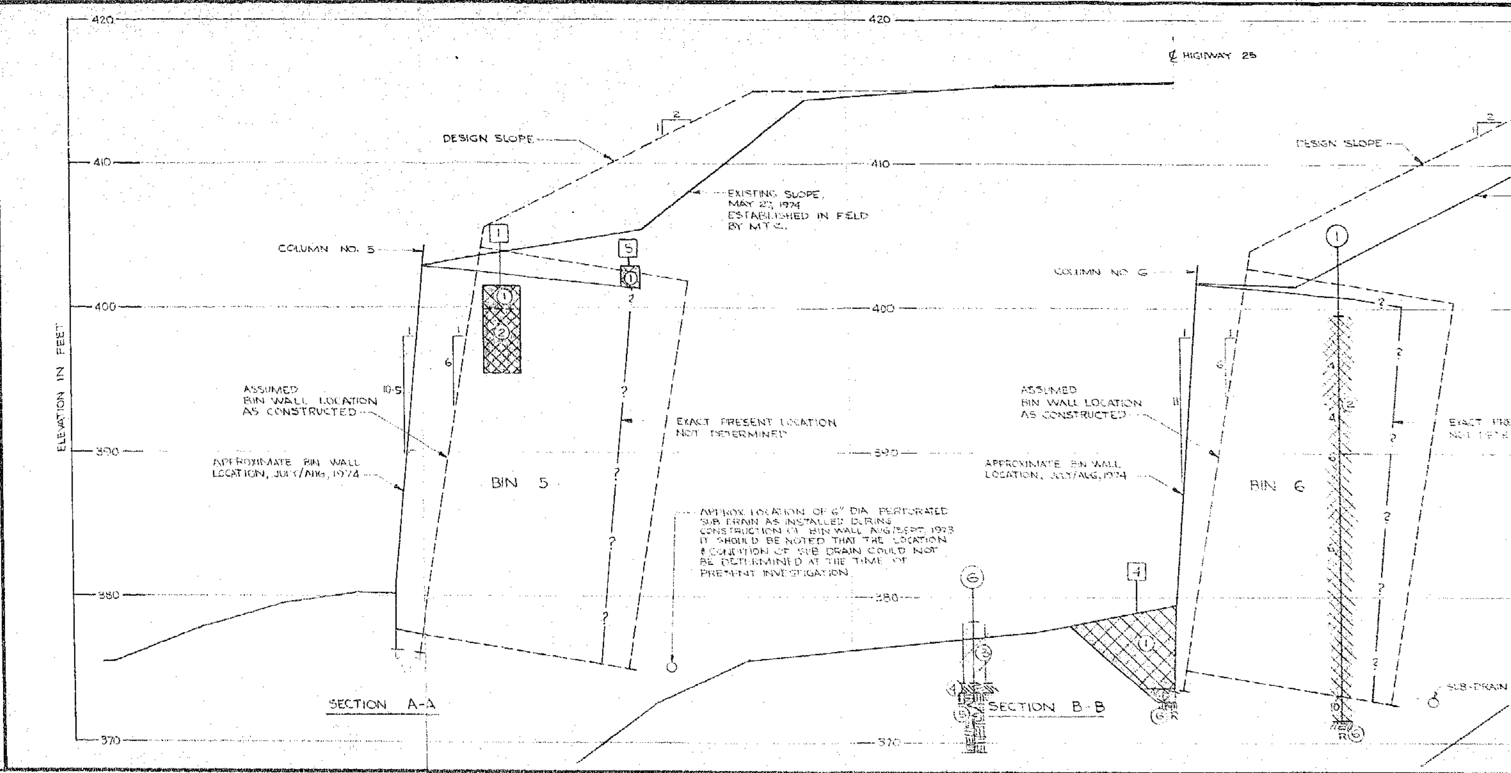
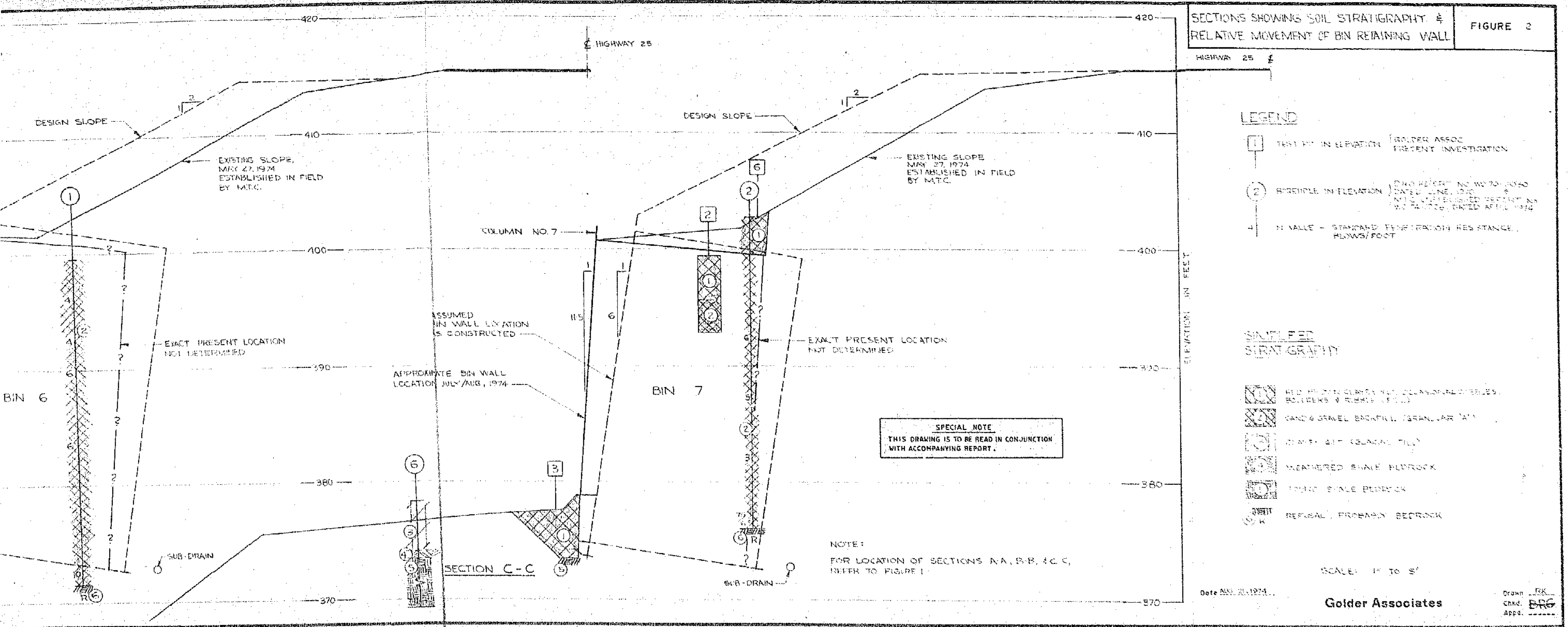
Chkd. PRG
Appd.

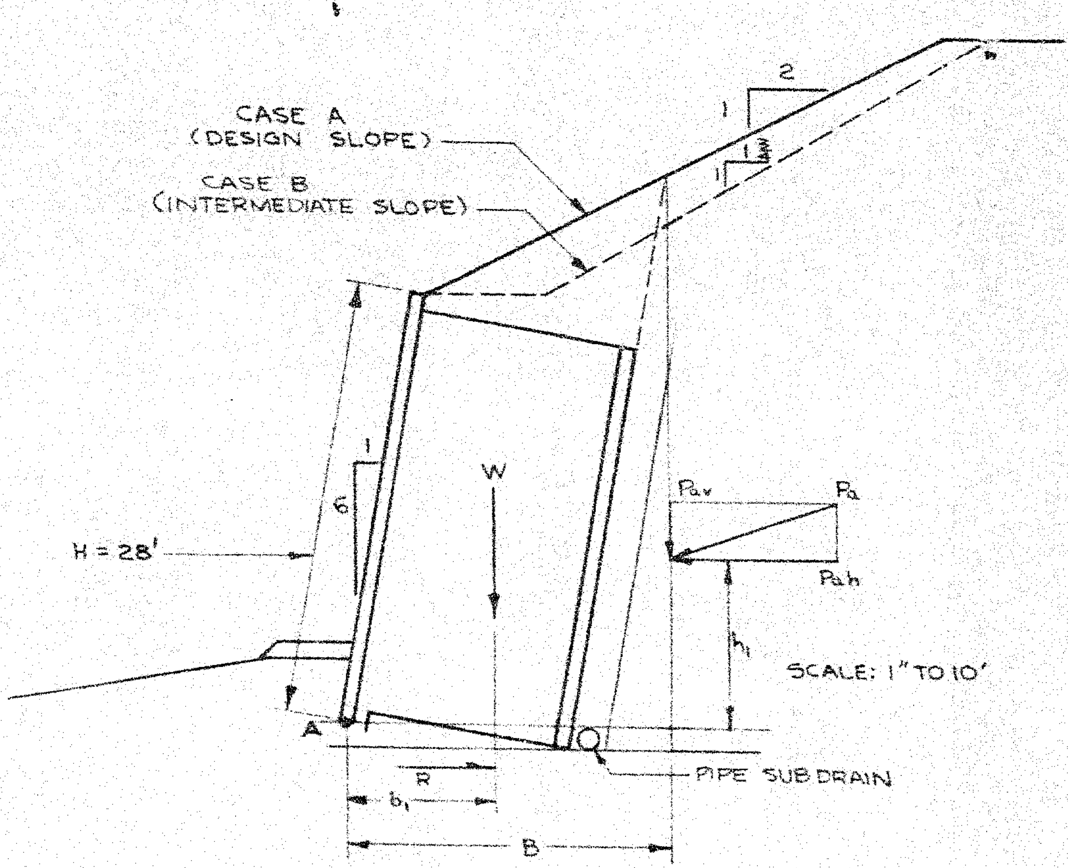


℄ HIGHWAY 25
DESIGN SLOPE
EXISTING SLOPE, MAY 23, 1974 ESTABLISHED IN FIELD BY MTC.
COLUMN NO. 5
ASSUMED BIN WALL LOCATION AS CONSTRUCTED
APPROXIMATE BIN WALL LOCATION, JULY/AUG, 1974
ELEVATION IN FEET
BIN 5
EXACT PRESENT LOCATION NOT DETERMINED
APPROX. LOCATION OF 6" DIA. PERFORATED SUB DRAIN AS INSTALLED DURING CONSTRUCTION OF BIN WALL AUG/SEPT. 1973 IT SHOULD BE NOTED THAT THE LOCATION & CONDITION OF SUB DRAIN COULD NOT BE DETERMINED AT THE TIME OF PRESENT INVESTIGATION.
SECTION A-A
COLUMN NO. 6
BIN 6
SUB-DRAIN
SECTION B-B
420
410
400
390
380
370


SECTIONS SHOWING SOIL STRATIGRAPHY &
RELATIVE MOVEMENT OF BIN RETAINING WALL
FIGURE 2
HIGHWAY 25
℄ HIGHWAY 25
DESIGN SLOPE
EXISTING SLOPE, MAY 27, 1974 ESTABLISHED IN FIELD BY M.T.C.
COLUMN NO. 7
ASSUMED BIN WALL LOCATION AS CONSTRUCTED
APPROXIMATE BIN WALL LOCATION JULY/AUG, 1974
EXACT PRESENT LOCATION NOT DETERMINED
BIN 6
BIN 7
SUB-DRAIN
SECTION C-C
SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.
NOTE:
FOR LOCATION OF SECTIONS A-A, B-B, & C-C, REFER TO FIGURE 1.
ELEVATION IN FEET
420
410
400
390
380
370
LEGEND
GOLDER ASSOC PRESENT INVESTIGATION
BLOWS/FOOT
SIMPLIFIED STRATIGRAPHY
SAND & GRAVEL BACKFILL (GRANULAR 'A')
WEATHERED SHALE BEDROCK
REFUSAL, PROBABLY BEDROCK
SCALE: 1" TO 8'
Golder Associates

FORCE DIAGRAM OF BIN WALL RETAINING STRUCTURE

FIGURE 3



NOTE

STABILITY AGAINST OVERTURNING ABOUT TOE (PT. A)

$$F.S. = \frac{\text{STABILIZING MOMENT}}{\text{OVERTURNING MOMENT}} = \frac{W b_1}{P_{ah} h_1 - P_{av} B}$$

STABILITY AGAINST SLIDING

$$F.S. = \frac{\text{HORIZONTAL RESISTANCE}}{\text{HORIZONTAL FORCE}} = \frac{R}{P_{ah}}$$

LEGEND

W = UNIT WEIGHT OF BIN BACKFILL , γ = 120 LB/CU. FT.
R = SLIDING RESISTANCE ALONG BASE OF BINWALL ; R = W tan δ
δ = FRICTION ANGLE ACTING ALONG BASE OF BIN WALL ; δ = 25°
P_a = LATERAL EARTH PRESSURE AGAINST BACK OF BIN WALL
P_{ah}, P_{av} = HORIZONTAL & VERTICAL COMPONENTS OF LATERAL PRESSURE P_a, RESPECTIVELY.

THE PIPE SUB DRAIN HAS BEEN ASSUMED FULLY EFFECTIVE IN PREVENTING HYDROSTATIC BUILD - UP BEHIND THE BINS

Date AUG 20, 1974

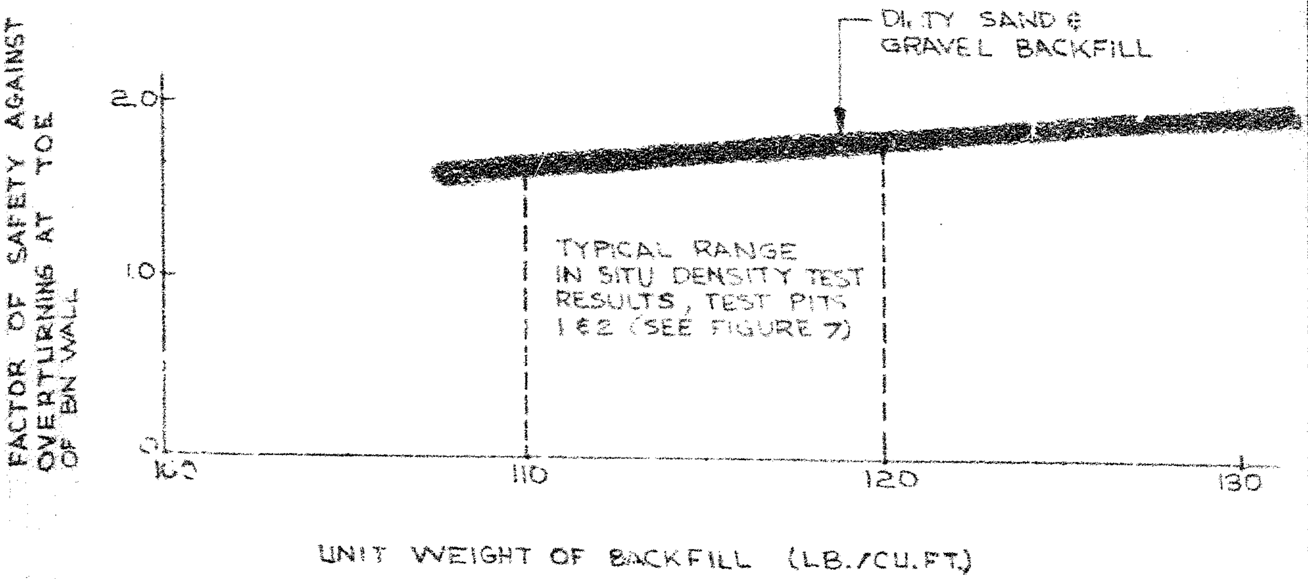
Golder Associates

Drawn RK
Chkd BRG
Appd

EFFECT OF UNIT WEIGHT OF BACKFILL ON STABILITY OF BIN WALL (CASE A)

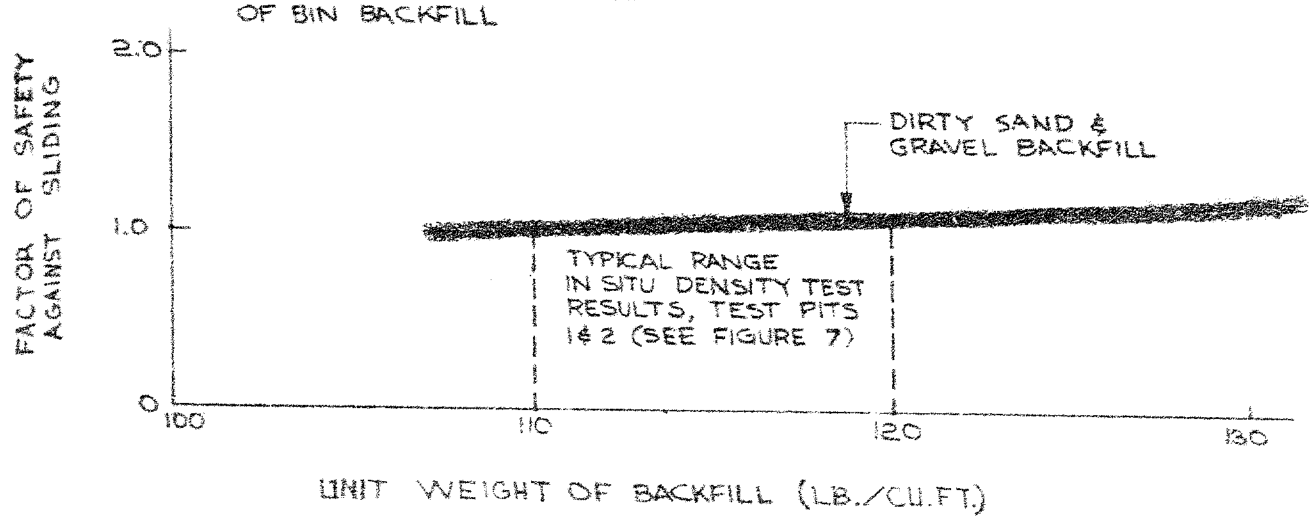
FIGURE 4

FACTOR OF SAFETY AGAINST OVERTURNING VERSUS UNIT WEIGHT OF BIN BACKFILL



NOTE:
REFER TO FIGURE 3, CASE 'A' FOR SLOPE GEOMETRY & SOIL PARAMETERS
FULL DRAINAGE CONDITIONS ASSUMED BEHIND BIN WALL

FACTOR OF SAFETY AGAINST SLIDING VERSUS UNIT WEIGHT OF BIN BACKFILL



Date AUG. 16, 1974.

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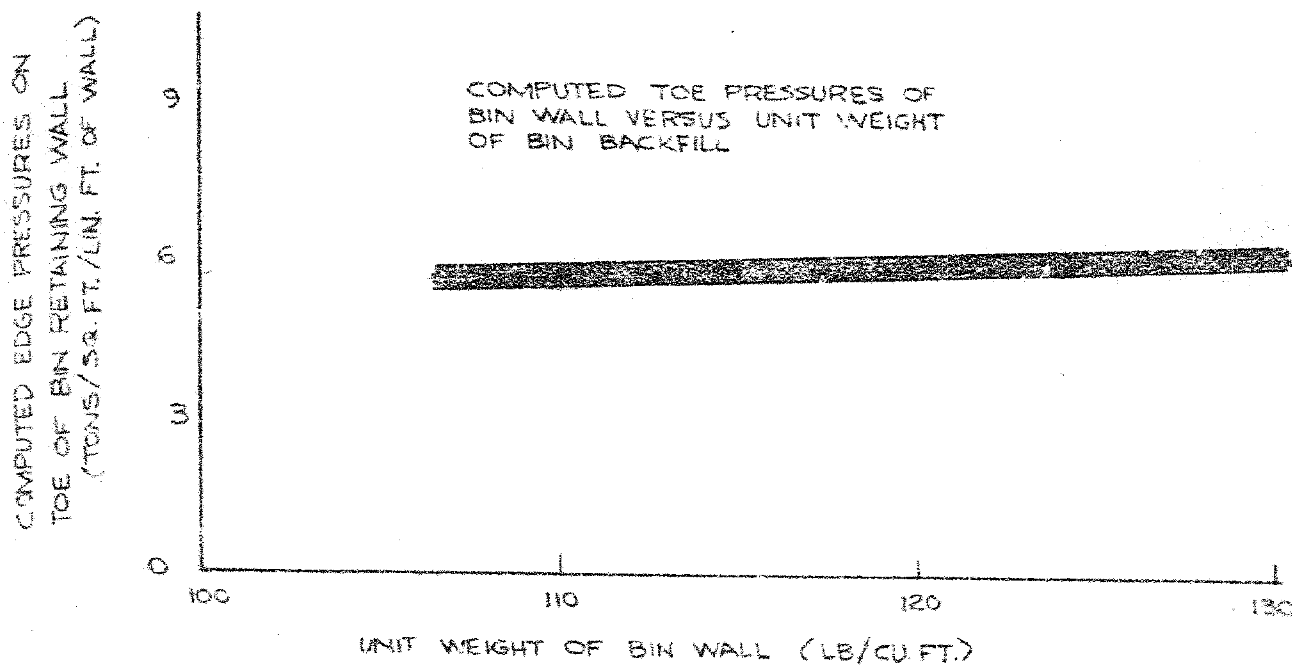
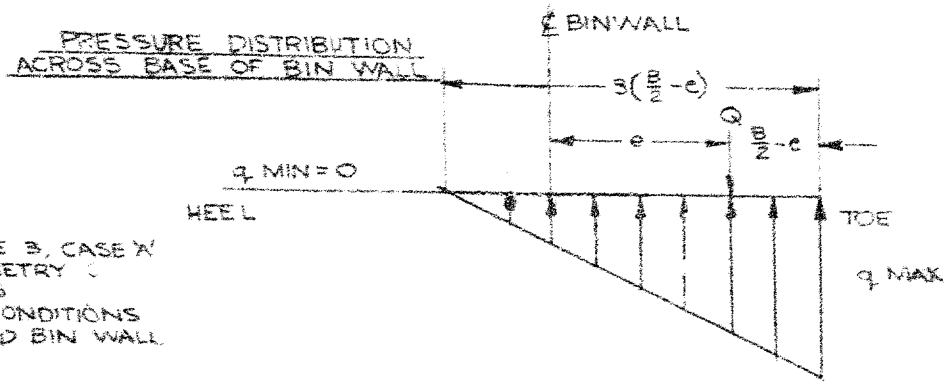
Chkd. RRG
Appd

EFFECT OF UNIT WEIGHT OF BACKFILL ON TOE AND HEEL PRESSURES OF BIN WALL (CASE A)

FIGURE 5





NOTE:
REFER TO FIGURE 3, CASE 'A' FOR SLOPE GEOMETRY & SOIL PARAMETERS
FULL DRAINAGE CONDITIONS ASSUMED BEHIND BIN WALL

LEGEND

B - WIDTH OF BIN WALL ; B = 14 FEET

e ECCENTRICITY (FT) DISTANCE FROM BIN ℄ TO FORCE Q TO GIVE EQUIVALENT OUT OF BALANCE MOMENT AT TOE OF BIN WALL. (FROM LATERAL EARTH PRESSURE AND WEIGHT OF BIN FILL)

Q - TOTAL VERTICAL LOAD (TONS) (WEIGHT OF BIN BACKFILL & VERTICAL COMPONENT OF LATERAL EARTH PRESSURE)

q MAX - MAXIMUM STRESS AT TOE OF BIN WALL (TONS/SQ.FT. /LIN FT. OF WALL)

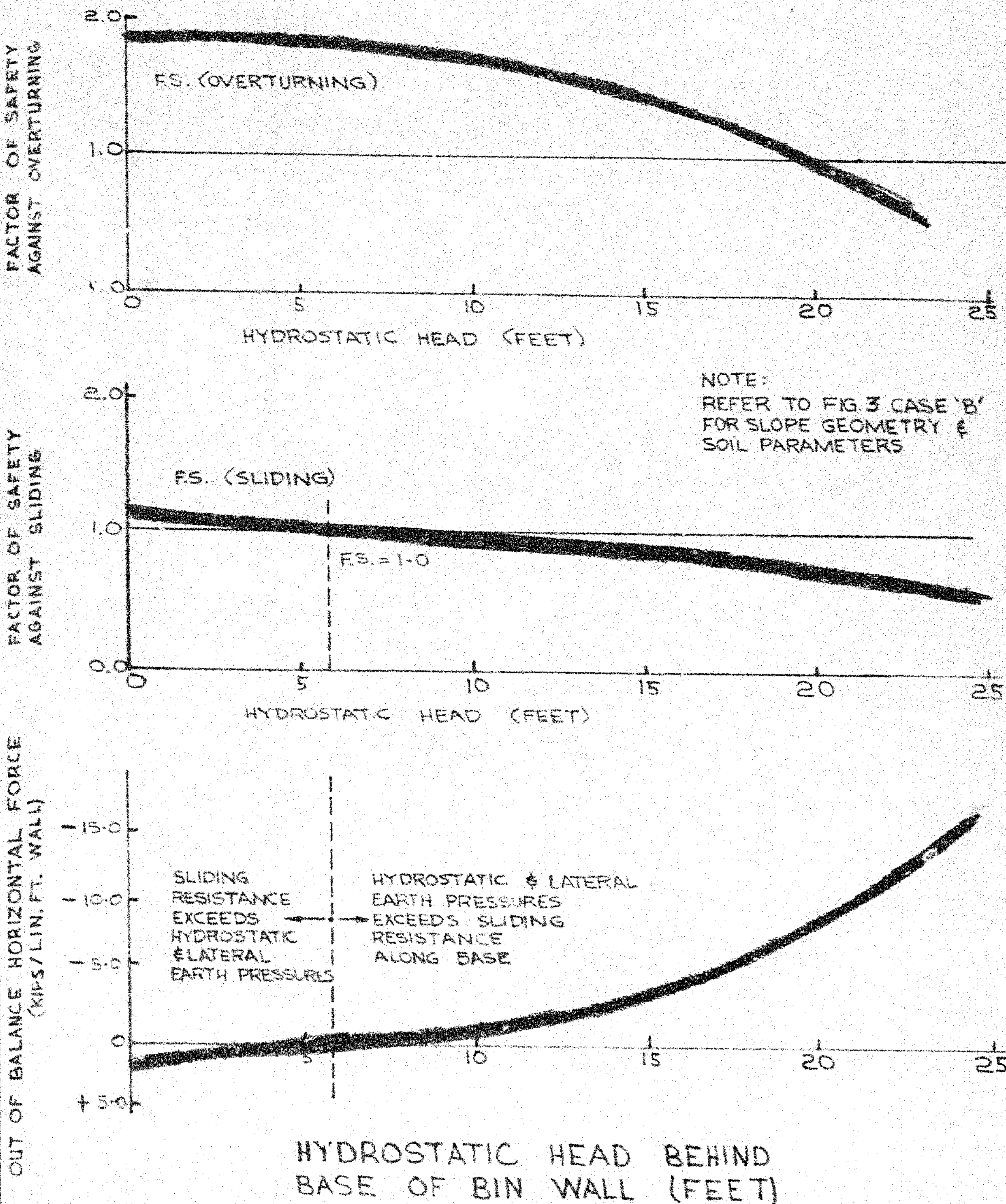
Date AUG 27, 1979

Golder Associates

Drawn RK
Chkd. BRG
Appd. ____

EFFECT OF HYDROSTATIC PRESSURES ON STABILITY OF BIN WALL (CASE B)

FIGURE 6



Date JULY 31, 1974

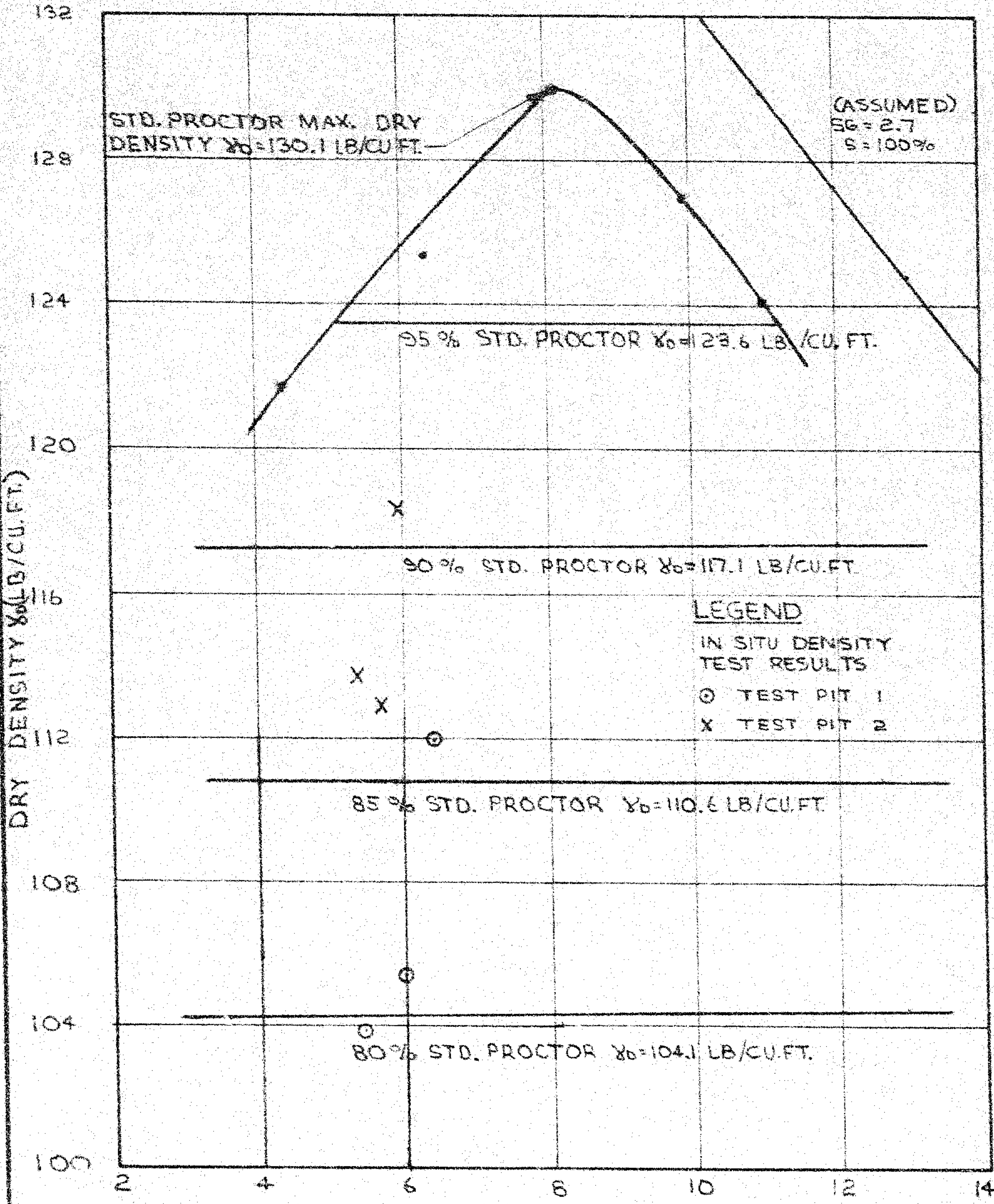
Golder Associates

Drawn S.A.
Chkd. BRG
Appd. ______

STANDARD PROCTOR COMPACTION CURVE
SHOWING RESULTS OF INSITU DENSITY MEASUREMENTS

FIGURE 7

BIN WALL BACKFILL – GRANULAR 'A'
HIGHWAY 25, ONTARIO



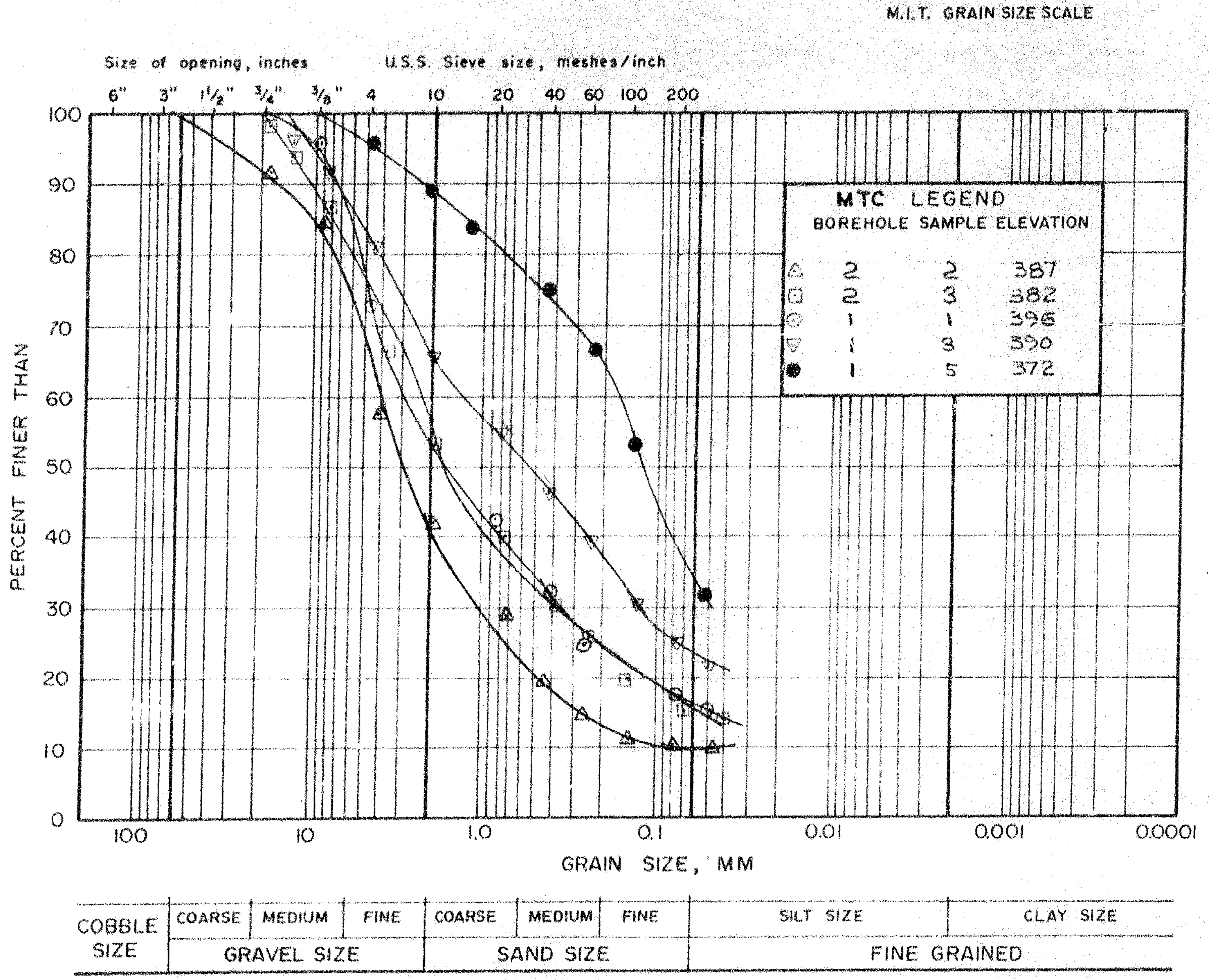
Date AUG 19 1974

Golder Associates

Drawn RK
Chkd. BRG
Appd.

PRO[redacted] No. [redacted]

Golder Associates



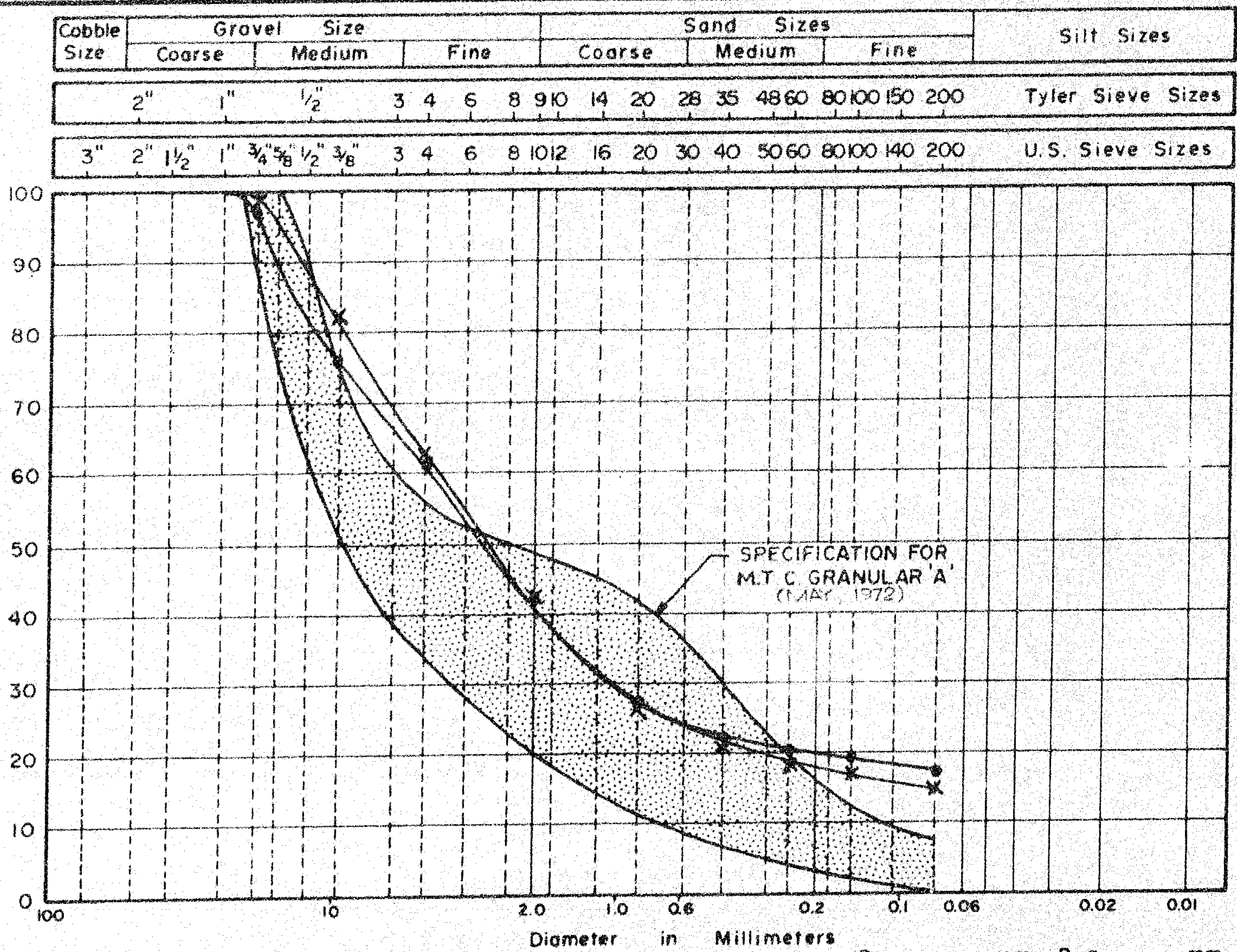
GRAIN SIZE DISTRIBUTION
MECHANICAL SIEVE ANALYSIS BY M.T.C. APRIL, 1974
GRANULAR 'A' BACKFILL

FIGURE 8

[redacted] Form G.A. - D - 15a [redacted] ROJ [redacted] No. 741119

GRAIN SIZE DISTRIBUTION

Golder Associates



Remarks: ● TEST PIT No. 1, SAMPLE No. 1, ELEV. 399.0
X TEST PIT No. 1, SAMPLE No. 2, ELEV. 398.0

D_{50} = ______ mm. D_{10} = ______ mm.

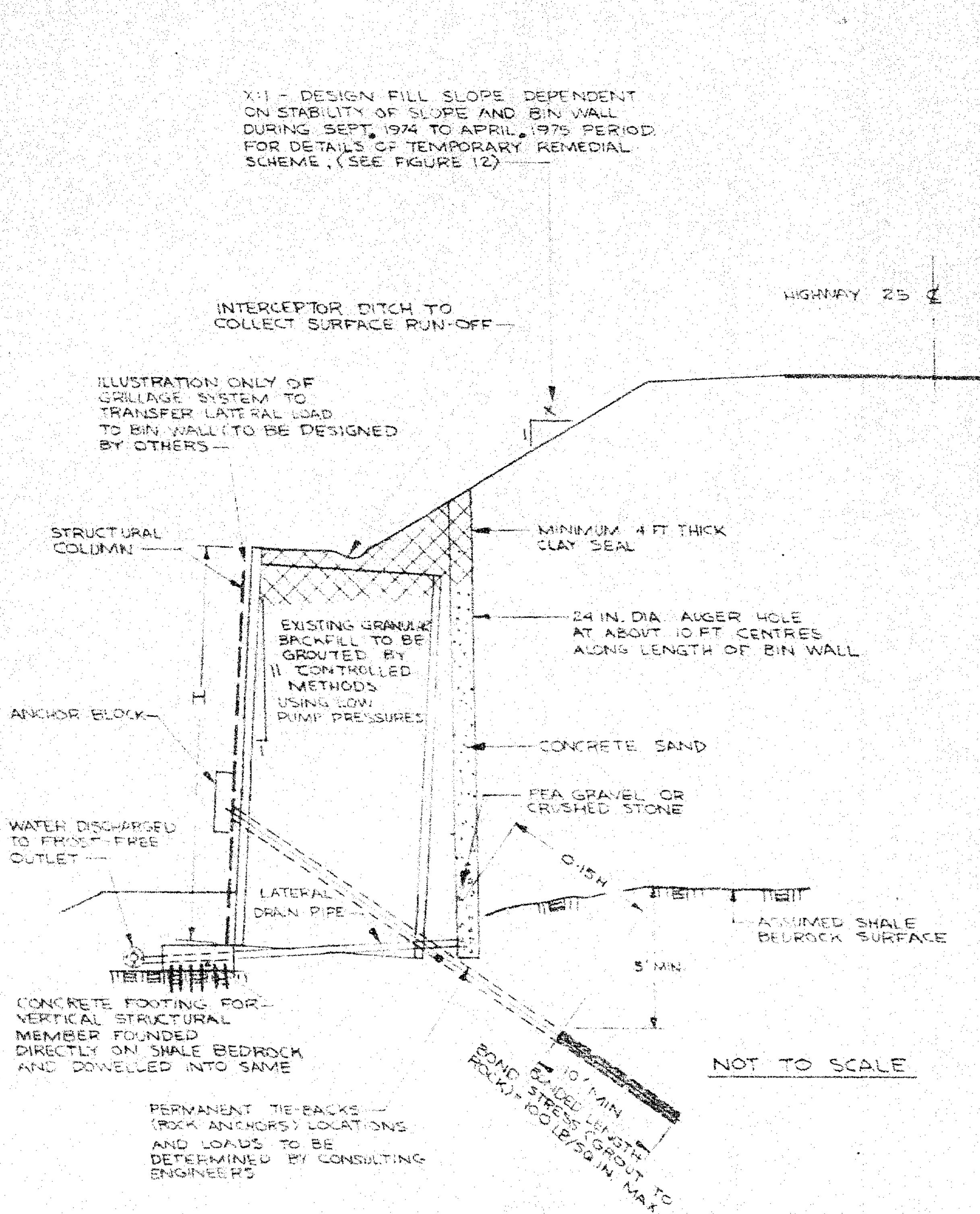
D_{60} = ______ mm. C_u = ______

FIGURE 9

[redacted] PRO [redacted] No [redacted]

ILLUSTRATION OF TIE-BACK SYSTEM FOR STABILIZATION OF BIN WALL

FIGURE 10



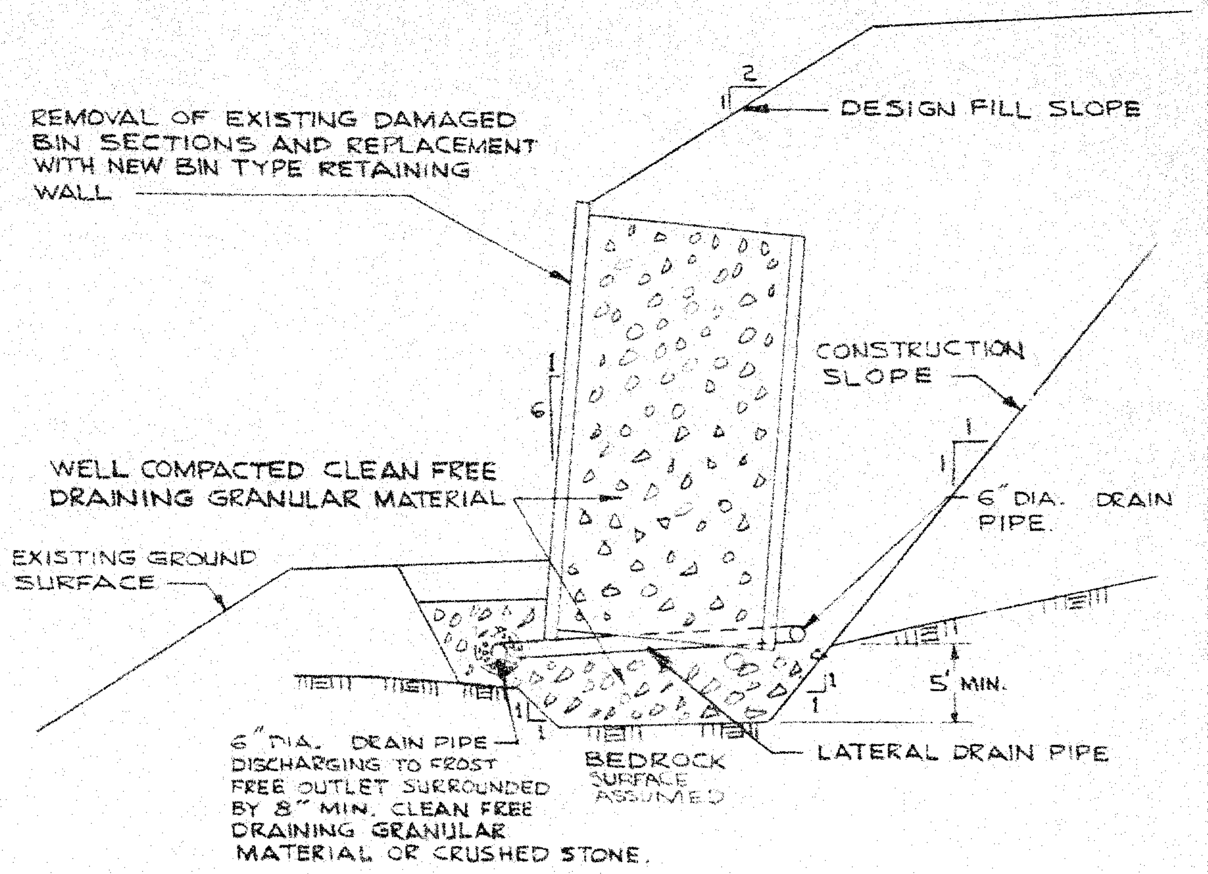
Date SEPT. 5, 1974

Golder Associates

Drawn RK
Chkd. BRG
Appd.

ILLUSTRATION OF NEW BIN TYPE RETAINING WALL

FIGURE 11

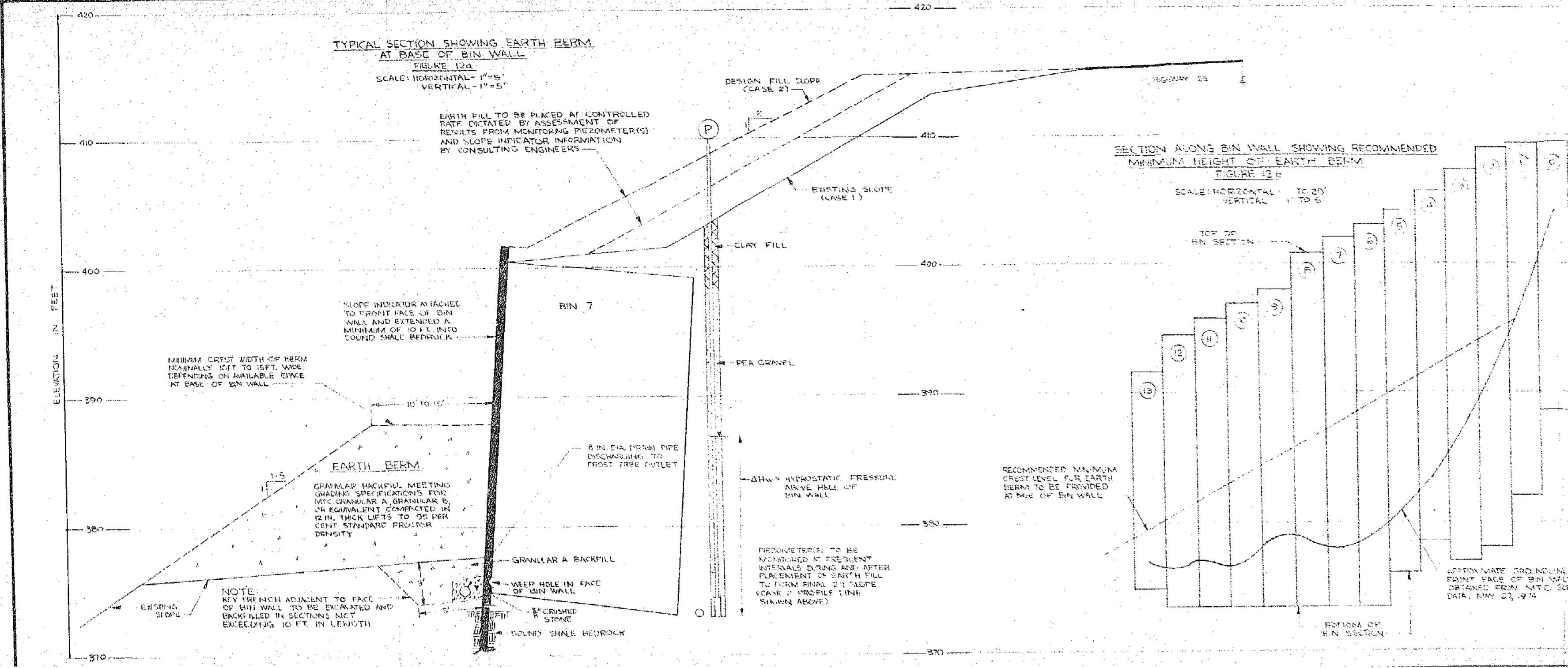


NOT TO SCALE

Date SEPT. 5, 1974

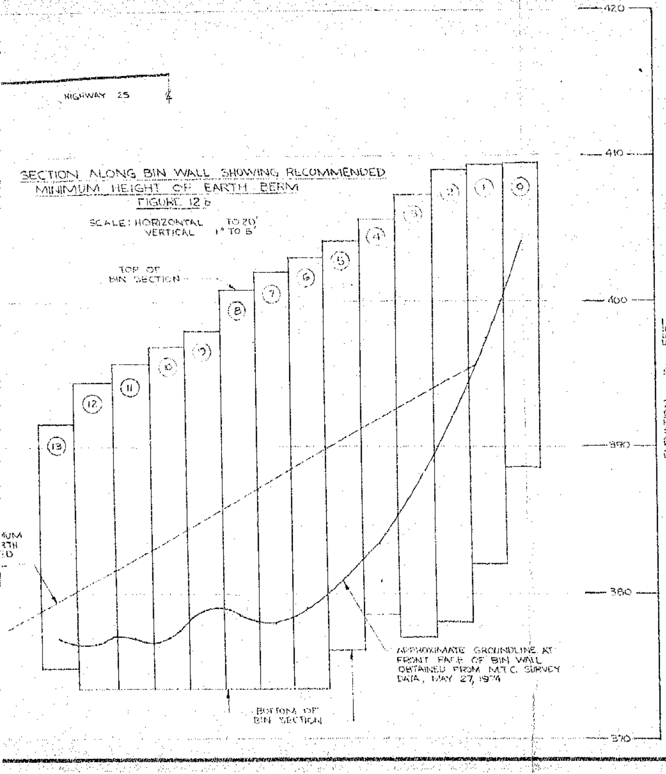
Golder Associates

Drawn
Chkd BRG
Appd



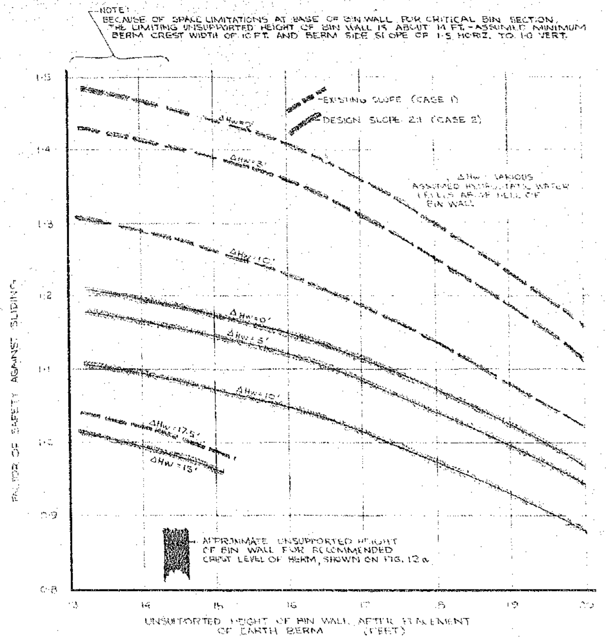
TYPICAL SECTION SHOWING EARTH BERM AT BASE OF BIN WALL
FIGURE 12a
SCALE: HORIZONTAL - 1"=5'
VERTICAL - 1"=5'
ELEVATION IN FEET
420
410
400
390
380
370
EARTH FILL TO BE PLACED AT CONTROLLED RATE DICTATED BY ASSESSMENT OF RESULTS FROM MONITORING PIEZOMETER(S) AND SLOPE INDICATOR INFORMATION BY CONSULTING ENGINEERS
DESIGN FILL SLOPE (CASE 2)
EXISTING SLOPE (CASE 1)
CLAY FILL
PEA GRAVEL
BIN 7
SLOPE INDICATOR ATTACHED TO FRONT FACE OF BIN WALL AND EXTENDED A MINIMUM OF 10 FT. INTO SOUND SHALE BEDROCK
MINIMUM CREST WIDTH OF BERM NOMINALLY 10FT TO 15FT. WIDE DEPENDING ON AVAILABLE SPACE AT BASE OF BIN WALL
10' TO 15'
EARTH BERM
GRANULAR BACKFILL MEETING GRADING SPECIFICATIONS FOR MTC GRANULAR A, GRANULAR B, OR EQUIVALENT COMPACTED IN 12 IN. THICK LIFTS TO 95 PER CENT STANDARD PROCTOR DENSITY
8 IN. DIA. DRAIN PIPE DISCHARGING TO FROST FREE OUTLET
ΔHw = HYDROSTATIC PRESSURE ABOVE HEEL OF BIN WALL
GRANULAR A BACKFILL
WEEP HOLE IN FACE OF BIN WALL
3/4" CRUSHED STONE
SOUND SHALE BEDROCK
EXISTING SLOPE
NOTE:
KEY TRENCH ADJACENT TO FACE OF BIN WALL TO BE EXCAVATED AND BACKFILLED IN SECTIONS NOT EXCEEDING 10 FT. IN LENGTH
PIEZOMETER(S) TO BE MONITORED AT FREQUENT INTERVALS DURING AND AFTER PLACEMENT OF EARTH FILL TO FORM FINAL 2:1 SLOPE (CASE 2 PROFILE LINE SHOWN ABOVE)
HIGHWAY 25
SECTION ALONG BIN WALL SHOWING RECOMMENDED MINIMUM HEIGHT OF EARTH BERM
FIGURE 12b
SCALE: HORIZONTAL 1" TO 20'
VERTICAL 1" TO 5'
TOP OF BIN SECTION
RECOMMENDED MINIMUM CREST LEVEL FOR EARTH BERM TO BE PROVIDED AT BASE OF BIN WALL
BOTTOM OF BIN SECTION
APPROXIMATE GROUNDLINE FRONT FACE OF BIN WALL OBTAINED FROM MTC SURVEY DATA, MAY 23, 1974

TEMPORARY REMEDIAL SCHEME FOR STABILIZATION OF BIN WALL & PROVISION OF EARTH BERM AT BASE OF STRUCTURE	FIGURE 12



SECTION ALONG BIN WALL SHOWING RECOMMENDED MINIMUM HEIGHT OF EARTH BERM

FIGURE 12 b



EFFECT OF HYDROSTATIC PRESSURES AND UNSUPPORTED HEIGHT OF BIN WALL ON FACTOR OF SAFETY AGAINST SLIDING

FIGURE 12 c

LEGEND

(P) PROPOSED PIEZOMETER INSTALLATION

WATER LEVEL

PIEZOMETER

SPECIAL NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.

NOTE:

SURVEY DATA ESTABLISHED IN FIELD BY M.T.C., MAY 27, 1974

Date SEPT. 5, 1974

Golder Associates

Drawn RK
Chkd. PRG
Appd.

10.2 CEMENTATION REPORT

Mining Contractors and Water Sealing Specialists

Cementation

THE CEMENTATION COMPANY (CANADA) LIMITED

P.O. Box 9
120 Railroad Street
Brampton, Ontario L6V 2K7
Telephones: Brampton 451-1033
Toronto 677-4120
Telex 069-7526

W0518.010

August 8, 1974.

H. Q. Golder & Associates Ltd.,
3151 Wharton Way,
Mississauga, Ontario.
L4X 2B6

RECEIVED AUG 12 1974

Attention: Mr. Brian Gray

Dear Sirs: Subject: Grouting of Voids within Bin Type Retaining Wall on Highway 25, Oakville, Ontario.

We refer to the meeting between our Mr. Jones, Mr. Brian Gray and Mr. Elmer Kolsi of McCormick, Rankin & Associates on 7th August at the above site.

We understand that the bin type retaining wall erected on the west side of Highway 25 just north of the Queen Elizabeth Way is approximately 167 feet long by 14 feet deep. The average height of the bin is approximately 24 feet varying between 15 feet and 33 feet approximately. Movement has occurred on the centre section of the wall and has been estimated at three feet at the worst place. The grading of the granular 'A' backfill used in the construction of the wall varies considerably with silt contents from 10% to 38% being found. Insitu Standard Proctor Compaction tests taken from test pits on the site indicate values of between 80 and 90%.

It is felt that pressure grouting of the voids within this material may consolidate the structure to prevent further movement. Because of the varying silt content in the material, grouting using cement will be selective and theoretically only the gravel sizes of the backfill can accept this type of grout. It is felt however that if actual voids exist within the bin due to arching and leaching out of fine material that grouting will considerably enhance the overall strength of the backfill.

Because of the presence of a 6" perforated pipe sub-drain behind the bins, it will be necessary to drill and grout with a thick grout at the rear of the bin to produce a cut off which it is hoped

.......2

H. Q. Golder & Associates Ltd.,
Mississauga, Ontario.

August 8, 1974.

will prevent leakage of grout into this area. As shown on the accompanying drawing, this would be carried out through 1-1/2" diameter perforated injection pipes driven at 2'-6" centres along the back of the retaining wall. The grout would be a Cement/Bentonite material with as low a water cement ratio as possible. The grout would be injected at low pressures and in measured volumes.

It may be necessary to carry out the same procedure on the face of the wall as leakage of grout could occur at the connections to the columns. An alternative would be to caulk each of the potential areas of leakage from a scaffold erected in front of the retaining wall.

Finally, grouting of the main part of the bins would be carried out using the split spacing method of primary and secondary holes as outlined on the accompanying drawing.

It is suggested that an experimental section of perhaps two bins should be grouted initially to test out the procedures outlined above and the effectiveness of the grouting.

We attach our proposal and conditions for carrying out this work and an estimate of the cost of the operation. You will see that we have shown an estimate of the cost of scaffolding and caulking of the face of the retaining wall as an additional item which may be necessary. It should be noted that an alternative method of drilling and grouting the bins would be from this scaffold by drilling holes at 5 foot centres horizontally into the bins. Should large boulders or slabs of concrete be encountered in the fill, this might well be a better method than that outlined above. Finally, should drainage holes be required after grouting has been carried out, these could easily be carried out by redrilling the horizontal grout holes and inserting a perforated casing.

We hope this letter and the attached proposal and estimate are of assistance to you in solving your problem. Should you have any further queries, please do not hesitate to contact the writer.

Yours sincerely,

M. C. Jones, P. Eng.
Manager, Ground Engineering

MCJ/mb
Att.

E S T I M A T E

We give below an estimate of the cost of the drilling and grouting operations as outlined in the accompanying letter.

Transportation and preparation of labour and plant to and from our yard at Brampton.		$ 2,000.00
Provision of labour and plant to carry out drilling and grouting operations outlined in the accompanying letter. 20 days of 10 hours each @ $1,000.00/day		20,000.00
Materials		
5,000 bags of Cement @ $2.25/bag	$ 11,250.	
500 bags of Bentonite @ $6.00/bag	3,000.	
80 tons of brick sand @ $6.00/ton	480.	
	14,730.	
Injection pipes, bits, drive heads, etc. allow	1,500.	
	16,230	
10% Overhead	1,623	
	17,853	
10% Profit	1,785	19,638.00
		$41,638.00

Additional Item

Provision, erection and dismantling of scaffold (if required).	3,000.

THE CEMENTATION COMPANY (CANADA) LIMITED

PROPOSAL

For preparation and transportation of labour and plant to and from our yard at Brampton, we would require a Lump Sum of $2,000.00.

For provision of 1 working foreman, 1 track driller, 1 pumpman and 1 mixerman, drilling and grouting equipment to carry out the work outlined in the accompanying letter, we would require a Daily Rate of $800.00. A minimum day would be 8 hours - should overtime be required, this would be charged at a pro rata rate.

For provision, erection and dismantling of scaffold on face of retaining wall, we would require a Lump Sum of

Materials

Grouting materials would be charged at cost plus ten percent overhead and ten percent profit. This would include cement, sand and bentonite and also injection pipes and fittings used during the operation.

Services

The following services would be provided free of all cost to the Cementation Company.

1. An adequate supply of water close to the grouting operations. (Storage tanks could be supplied by Cementation.)
2. Access to the base of the retaining wall for erection and dismantling of scaffold if required.
3. An area at the top of the embankment to set up our compressor and grouting equipment.
4. Clearing of a pathway from this area to facilitate access to the top of the retaining wall for our track drill.
5. Clearing of the area over the bins to allow access for drilling. (Removal of cement blocks would be required.)
6. Provision for tenting and heating if required (or compensation for provision of same).

for THE CEMENTATION COMPANY (CANADA) LIMITED

____

The foregoing Proposal and the attached Conditions are acceptable to us.

for H. Q. GOLDER & ASSOCIATES LTD.

______________ ____________________________

Date

Standard Conditions with Regard to Damage and Insurance

We can accept no responsibility for damage to or interference with underground cables, mains, or other services or structures in carrying out the work unless their precise location has been indicated to us before commencement of work.

No allowance has been made in our rates and we shall not be responsible for meeting any claims made by owners or tenants of land or property resulting from our carrying out the specified work, other than for damage caused through negligence on our part. Every care of course will be taken to avoid damage and to leave the site in a clean and tidy condition on completion of operations.

In respect of claims, losses or other expenses arising out of death of or bodily injury to persons or loss of or damage to property, including the property of the Client above and below ground, the Contractor's liability shall be restricted to:-

(i) occurrences solely due and arising from the Contractor's negligence, and

(ii) during the progress of the work, one million dollars ($1,000,000) in respect of any one occurrence or series of occurrences originating from a single event, exclusive of interest or legal or other costs incurred for which the Contractor may be legally liable, or

(iii) after completion or abandonment of the work, a total of one million dollars ($1,000,000) in respect of any number of occurrences.

10.3 COST ESTIMATES

10.3 COST ESTIMATES

	Scheme 1	Scheme 2	Scheme 3
Grouting Bins	50,000	-	-
Supply & Install Tie Back System	50,000	-	-
Detour	-	30,000	-
Remove Existing Bins	-	20,000	-
Rock Key	-	20,000	-
Replace Bins	-	50,000	-
Place Concrete in Retaining Walls	-	-	125,000
Granular Backfill	-	-	5,000
Additional Drainage	10,000	10,000	-
Clay Blanket & Complete Slope	10,000	10,000	10,000
Miscellaneous	5,000	5,000	5,000
Total Cost	125,000	145,000	145,000
Engineering & Contingencies	25,000	25,000	25,000
Total Cost	$150,000	$170,000	$170,000

MEMBER ASSOCIATION OF CONSULTING ENGINEERS OF CANADA

McCORMICK, RANKIN & ASSOCIATES
LIMITED
CONSULTING ENGINEERS

8 STAVEBANK ROAD
MISSISSAUGA, ONTARIO
L5G 2T4
TELEPHONE 274-3477

September 4, 1974

Mr. A. Sulavella
Senior Project Design Engineer
Ministry of Transportation & Communications
3501 Dufferin Street
DOWNSVIEW, Ontario

RE: W.P. 131-65-1
Highway 25 Bin-Wall
Our File: W.O. 518.010

Dear Sir:

A meeting was held on August 28, 1974, at 9:00 A.M. in the M.T.C. offices to review the Consultant's progress on the above-noted project. The following were in attendance:

Mr. A. Sulavella	Ministry of Transportation & Communications
Mr. K. Selby ✓	Ministry of Transportation & Communications
Mr. J. Regan	Ministry of Transportation & Communications
Mr. Miro Almer	Ministry of Transportation & Communications
Mr. J. Davis	Golder & Associates
Mr. B. Gray	Golder & Associates
Mr. R. McCormick	McCormick, Rankin & Associates Limited
Mr. J. Tuck	McCormick, Rankin & Associates Limited

The following matters were discussed:

1) Mr. Sulavella explained that a meeting had been held on June 24, 1974, and that since that time the Consultant had retained foundation consultants to provide geotechnical assistance.

2) Mr. McCormick stated that Golder had been retained and that additional field information had been obtained.

RGS have [illegible]

3) Mr. Davis explained that Golder's investigation had determined that the factor of safety of sliding of the wall is slightly greater than 1.0 assuming no hydrostatic build-up, and that if the hydrostatic head builds up to about 5 feet, this factor of safety reduces to less than 1.0. The factor of safety against overturning appears to be adequate. Golder have found that the material within the bins contains approximately 30% silt and is compacted to 80-90% Proctor densities.

4) Mr. Davis also explained that a meeting has been held with Armco and than Armco have stated that further settlement of the material in the bins must be prevented in order to ensure the structural integrity of the bins. In order to ensure that no further consolidation takes place within the bins it is felt that grouting must be carried out and in this regard Cementation were asked to review the project on the site and provide an estimate of the cost of grouting the bins. Golder feel that the material can be grouted because of the presence of voids within the material. The estimate for grouting the bins is approximately $50,000.00.

5) In order to increase the factor of safety against sliding it is also necessary to tie back the wall and the estimated cost of tieing back the wall is $50,000.00.

6) Also, additional drainage will have to be provided to ensure that the grouting of the bins has not destroyed the drainage system and a clay blanket will have to be installed on the slope to ensure that the hydrostatic build-up is not excessive.

7) The total cost of the remedial measures is therefore in the order of $125,000.00.

. . . .

8) A lengthy discussion took place on the cost of the remedial measure and it was felt that it was important that the Consultant's report be submitted as soon as possible. It was agreed that this report would be submitted by September 15, 1974. Also, the report should include temporary measures that should be taken in the event that the remedial measures cannot be undertaken prior to next spring.

9) It was agreed that the completion of the slope behind the wall could not be carried out until some remedial measures were undertaken.

10) A discussion took place as to the possibility of replacing and reconstructing some of the bins. The Consultant is to investigate this as one possible remedial scheme.

The meeting adjourned at 11:30A. M.

Yours very truly,

McCORMICK, RANKIN & ASSOCIATES LIMITED

R. C. McCormick, P. Eng.

RCM/slf
cc to all present.

Mr. A. Sulavella,
Project Design Engineer,
Systems Design Office,
Central Region, Toronto.

Soil Mechanics Section,
Geotechnical Office,
West Building, Downsview.

October 1st, 1974.

RE: Retaining Wall at Hwy. 25,
Contract 73-47, Q.E.W. to
Highway #5, District 4, Hamilton.

We have reviewed the engineering report prepared by McCormick, Rankin & Assoc. Ltd. outlining remedial measures for the Bin Type Retaining Wall on the above-mentioned contract. Based on the information in the report and on our own knowledge of the situation, our recommendations are as follows:-

1. The temporary berm referred to in the report should be constructed as soon as possible.

2. No additional fill should be placed on top of the wall for the time being.

3. This Section will install slope indicators and piezometers and will observe these over the winter and spring periods. We should be able in this way to determine any failure planes which exist in the soil behind the wall.

4. The District should continue to monitor the wall.

5. After observing the performance of the wall over the critical periods we will be in a better position to make a decision for a permanent solution.

K.G. Selby,
Supervising Engineer.

KGS/mj

c.c. D. Waller,
W. McFarlane,
G. Metcalfe,
S. Kant,
G. Burkhardt.

Files
Documents

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. D.A. Waller
Construction Engineer
District 4, Hamilton

FROM: A. Sulavella
Regional Systems Design Office

ATTENTION:

DATE: October 11, 1974

OUR FILE REF.

IN REPLY TO

SUBJECT: RE: RETAINING WALL - HIGHWAY 25
SHEET 6 OF CONTRACT 73-47

I have been advised by Mr. G. Minor and Mr. H. Forsyth of the Regional Property Office, that the Ministry now has acquired the property owned by Maurice S. Flint and shown as Part 1 and 2 on Reference Plan, P-1738-92.

The title was obtained by registration of a Deed on September 4, 1974.

For your information, we are sending you copies of the following:-

1) Copy of P-1738-92

2) Copy of memo from the Title Processor to G.J. Minor dated September 11, 1974, re Agreement T-16965.

3) Copy of Soil Mechanics Section memorandum to myself dated October 1, 1974.

Mr. J. Regan was in contact with me recently and advised that he had received information from McCormick, Rankin and Associates Limited on the size of the berm needed and is now obtaining an estimate for the remedial work from the Contractor.

The unfortunate part is that the above permits remedial work to be carried out only on the northerly half of the wall in question. However, I was advised today that the southerly portion is owned by a Provincial Governmental Agency, and Mr. N. Reid is making immediate arrangement for a Property Office representative to visit and discuss the matter.

It is hoped the latter requirement can be obtained within a matter of a few days.

A. Sulavella

for: J.P. Cullen
Sr. Project Design Engineer

cc: H. Aron
K. Selby
G.C. Burkhardt
D. Gunter McCormick Ranki

JPC/AS/..

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: J. P. Cullen
Project Design Engineer
Regional Systems Design
Central Region
Downsview

ATTENTION: Mr. A. Sulavella

OUR FILE REF.

FROM: J. J. Regan
Construction Supervisor
District 4, Hamilton

DATE: November 21, 1974

IN REPLY TO:

SUBJECT: Retaining Wall, Highway 25, Contract 73-47

Temporary remedial repairs have been completed as of November 19, 1974. The monitoring of movement of the wall will proceed on a weekly basis.

J. J. Regan
Construction Supervisor

JJR/mt

RECEIVED GEOTECHNICAL OFFICE DEC 16 1974 SOIL MECHANICS MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Ken:
Please advise me as to how you propose to utilize the results of the monitoring that J Regan will do. What are the objectives? When will the monitoring end? Who will end it? What commitments do we have to fulfil? Where are these written down? Will you personally follow through?

Carn

ary of
ansportation and
Communications

Memorandum

To: Mr. E. Balint
Regional Systems Design Office

From: J.P. Cullen
Regional Systems Design Office

Attention:

Date: January 14, 1975

Our File Ref.:

In Reply to

Subject:

Addendum #11 - Bin Wall Investigation
McCormick, Rankin & Associates Limited
W.P. 131-65-01, Highway 25

Golder Associates in its report of September 1974 notes that the design calculations carried out by McCormick, Rankin & Associates Limited provided minimum factors of safety against sliding and overturning of 1.7 and 1.8 respectively. These values were obtained using a conventional analysis and using the recommended values contained in the Foundation Report. Golder Associates recalculated the factors of safety and obtained factors of 1.1 and 1.8 for sliding and overturning respectively. The significant difference between these values is in the factor of safety against sliding and the consultant feels that a cohesion of 1000 p.s.f. as opposed to 3500 p.s.f. should be used for the calculation of sliding resistance.

It was concluded that the movement of the wall is a sliding movement as opposed to overturning movement. Material within the bins is not compacted sufficiently to give the bins the required strength to maintain their shape. It has been determined that the proctor density of this material is approximately 80%-87% of optimum.

It is my conclusion that conditions beyond the control of McCormick, Rankin & Associates Limited led to the failure of the bin type retaining wall.

J.P. Cullen
Sr. Project Design Engineer

JPC/phw

cc: G. Burkhardt
D. Waller
K. Selby

Cont. 73-47

Mr. J.P. Cullen,
Sr. Project Design Engineer,
Central Region, Toronto.

Soil Mechanics Section,
Geotechnical Office,
West Bldg., Downsview.

January 27th, 1975.

Addendum #11 - Bin Wall Investigation,
Highway #25, District #4, Hamilton,
W.P. 131-65-01.

We have noted your memo dated January 14th, 1975, and would like to correct what we feel is an erroneous impression that the Foundation Report for the abovementioned project contained recommendations for computing sliding resistance between foundation soil and the base of a sand filled bin type retaining wall. This is not the case, and recommendations given applied only to concrete footings (i.e. 'an adhesion value of 3500 psf may be assumed to apply along the footing bottoms').

In computing safety factors against sliding, a wall designer would have to consider the following possible failure planes:

1. A plane along the contact of wall and soil
2. A plane below the contact of wall and soil within the foundation soil and
3. A plane above the contact of wall and soil within the wall itself.

The actual safety factor would be the lowest obtained from the three cases. For a concrete wall it is obvious that cases 1. and 2. only need be considered but for a bin wall filled with sand, it is also obvious that case 3. must definitely be considered since this is likely to produce the lowest safety factor. Had this been done for the wall in question, a safety factor against sliding (neglecting passive resistance) of less than 1.0 would have been obtained.

The writer is not completely in agreement with the conclusions of Golder & Associates that the movement of the wall was mainly a sliding movement as opposed to an overturning movement. The base of the wall in fact, moved very little, if at all, at the founding level probably because of the passive resistance of the earth in front of the wall. As is well known by all concerned the top of the wall moved forward by as much as 4 ft. This is exactly what happens if the safety factor against overturning is less than 1.0.

K.G. Selby,
Supervising Engineer.

KGS/ma
c.c. E. Balint
G. Burkhardt
D. Waller
Files
Record Services

Ministry of Transportation and Communications

Ontario

Memorandum

To: Mr. K.G. Selby
Supervising Engineer
Soil Mechanics Section
Geotechnical Office, West Bldg.

From: J.P. Cullen
Regional Systems Design Office
Central Region

Attention:

Date: February 5, 1975

Our File Ref.

In Reply to

Subject: <u>W.P. 131-65-01, Addendum #11 - Bin Wall Investigation, Highway 25</u>

Please refer to your letter of January 27, 1975 on the above subject.

The information contained in my letter of January 14, 1975 was taken solely from the Golder & Associates Report. I note that you disagree with the report on several points. These should be discussed and clarified with both McCormick, Rankin & Associates and Golder & Associates.

I concluded in my January 14, 1975 memo that the bin wall design developed by McCormick, Rankin & Associates was not the source of the failure of the wall. I used the Golder Report in support of this position. Based on the data available now, do you believe that there was an error in the bin wall design which was a factor in the failure of the wall.

J.P. Cullen
Sr. Project Design Engineer

JPC/phw

cc: E. Balint
G. Burkhardt
D.A. Waller

RECEIVED GEOTECHNICAL OFFICE
FEB - 6 1975
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

Ken,
I suggest face to face mtgs & recording of decisions in minutes than the creation of ...

Soil Mechanics Section
Geotechnical Office
West Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Tel: (416) 248-3282

February 12, 1975

Atcost Soil Drilling Inc.,
2160 Highway 7,
Concord, Ontario.

Dear Sirs:

This letter confirms our request by telephone of February 11, 1975 for the supply of a 1.1(A) Diamond Drill as per your Tender for Supply Contract S-74-2110 for our Project Cont. 73-47 at Q.E.W. & Hwy. 25, Ontario, starting on or about February 18, 1975, at which time we were advised by Mr. T. Archer that you were not able to comply with our request.

Yours truly,

K. G. SELBY
Supervising Engineer.

c.c. Files
Record Services

Soil Mechanics Section
Geotechnical Office
West Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Tel: (416) 248-3282

February 17, 1975

P.V.K. & Sons Drilling Ltd.,
R.R. #4,
Brantford, Ontario.
N3T 5L7

Dear Sirs:

This letter confirms our request by telephone of February 11, 1975 for the supply of a Diamond Drill - skid mounted (Item No. 1.1(A)), together with all necessary equipment, as per your Tender for Supply Contract S-74-2110, at Junction of Q.E.W. & Hwy. No.25 on February 18, 1975.

Mobilization will be from Burford - Downsview - Job Site (Q.E.W. & Hwy. No.25) - Burford.

Our Project Number is Contract 73-47.

Yours truly,

K. G. SELBY
Supervising Engineer.

c.c. W. W. Fry
(Attn: Mrs. M. Porter)

Files (2)
Record Services

Ministry of
Transportation and
Communications
Ontario

Memorandum

To:	K. G. Selby Soils Mechanics Section Downsview	From:	M. Keizars Project Supervisor District 4, Hamilton
Attention:		Date:	February 18, 1975
Our File Ref.		In Reply to	

Subject: Contract 73-47, Highway 25 from Q.E.W. to Palermo (Highway 5) - Bin Type Retaining Wall west side of Highway 25

As noted during our telephone conversation on February 10, 1974 our survey indicates that during the last two months significant movement to the bin type retaining wall was not noticed. For your reference and use you will find our readings on the bin type wall.

If you require further information with regards to the enclosed please feel free to contact this writer.

M. Keizars
Project Supervisor

MK/mt

Encl.

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GEOTECHNICAL OFFICE
FEB 19 1975
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

KGS. Hope Ramlow is plotting these up.

Ministry of Transportation and Communications

Ontario

Memorandum

To: Mr. A. K. Barsvary
Head
P.P.I. Section

From: Soil Mechanics Section
Geotechnical Office

Attention:

Date: March 21, 1975

Our File Ref. W.P. 131-65-1

In Reply to

Subject: W.P. 131-65-1 - BIN-WALL ON HWY. 25
Contract 73-47

This is to formally request the aid of your Section with regard to the Bin-Wall failure which occurred in November 1973 on the above-mentioned Project. Slope indicators and a piezometer have already been installed by your staff at our request and, what is required now and in the next few weeks is as follows:-

(1) Plotting up in a concise and comprehensible manner all movements as recorded by District staff.

(2) Field readings of slope indicators and piezometer and plotting of data.

(3) A short report stating results of (1) & (2) in about 8 weeks time.

I suggest that to familiarize yourself with the Project, you examine the entire correspondence file. Details of action to be taken will be established from discussions between yourself and the writer.

When you have completed this assignment we should be in a much better position to make recommendations relating to remedial measures.

Thanking you,

K. G. Selby

K. G. SELBY
Supervising Engineer.

Report 75-3-06

c.c. A. Rutka
Files
Record Services

Golder Associates
CONSULTING GEOTECHNICAL ENGINEERS

RECEIVED
GEOTECHNICAL OFFICE
APR 28 1975
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

April 23, 1975

Ministry of Transportation & Communications
1201 Wilson Avenue
West Building
DOWNSVIEW, Ontario
M3M 1J8

ATTENTION: Mr. K.G. Selby, P. Eng.

RE: BIN-TYPE RETAINING WALL
HIGHWAY 25
OAKVILLE, ONTARIO

Dear Sirs:

Further to recent discussions with your Mr. K.G. Selby we herewith amplify our report No. 741119 to McCormick, Rankin & Associates Limited entitled "Investigation of Retaining Wall Movements, Highway 25, Oakville, Ontario dated September, 1974, regarding the mechanism of failure of the bin wall at the above site.

The analysis of a conventional rigid, gravity retaining wall using traditional terminology involves the determination of the stability of the structure with respect to:

(a) stability against overturning
(b) stability against sliding.

The above discrete mechanisms of failure are not directly applicable to a flexible "bin type" retaining wall. Lateral distortion more appropriately describes the behaviour of a flexible bin wall in distress, since this is differential movement within the bins proper in addition to basal sliding and overall rotation. Therefore, the term "sliding" used in our report should be read in the context of lateral distortion instead of simply "basal instability".

It is believed that the mechanism of failure of the bin wall at the site is essentially as previously described in section 6.3 of our report. The loss of integrity of the structure was due to the significant settlement of loose granular backfill which caused substantial drag-down forces on the stringers and bin columns. The resultant "lateral distortion" of the bins and backfill material precipitated further movements which in essence led to the "failure" of the bin structures.

Yours truly,

H.Q. GOLDER & ASSOCIATES LTD.

B.R. Gray

B.R. Gray, P. Eng.

BRG:hs
741119

cc: Mr. John Tuck
McCormick, Rankin & Associates Limited

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr C. Mirza
Head, Soil Mechanics Section

FROM: A. K. Barsvary

ATTENTION: Mr K. Selby

DATE: June 13th, 1975

OUR FILE REF. 5901-1-4

IN REPLY TO

SUBJECT:

BIN WALL MOVEMENT ON HWY. # 25
W.P. 131-65-1 CONT. # 73-47

In complying with your request dated March 21st, 1975, the following is a report on our observations of the movements of the above bin wall, together with a brief list of events at this site.

1) HISTORY & INSTRUMENTATION

Construction of the bin wall was carried out in 1973, the backfilling operation being undertaken in October the same year.

Within one month after completion of the backfill, severe structural distress was noted in the columns and stringers of several bins. The distress was accompanied by a forward movement of the wall, the maximum of which, was measured to be approximately four feet (*1.2 m*) at the top of the wall and some two feet (*0.6 m*) at the ground line.

Movements of the wall were closely observed and monitored by District personnel, and as a result of this, it became evident that between December 1973 and March 1974 the movement of the top of the wall continued at a much reduced rate. From April 1974 up to the present time practically no further movement has taken place.

In a report dated September 1974, the consultants McCormick and Rankin, discussed the deteriorations and presented various possible remedial measures. In their recommendations McCormick and Rankin were aided by the report of H. Q. Golder and Associates, retained by the Consultant. As an immediate temporary measure, it was suggested that a granular "A" fill be placed in front of the wall. It was further suggested that slope indicators and piezometers be installed in the slopes.

The recommended berm in front of the wall was constructed in November 1974, a typical cross section of this is shown on Fig. # 1. The top of the granular fill is about 14 ft. *(4.3 m)* from the top of the bin wall, the width of the berm being some 10 ft. *(3 m)* with 1-1/2 to 1 slope. Granular "B" material was used for the berm. Before the berm construction, a trench, some 5 ft. *(1.5 m)* wide and 3 ft. *(0.9 m)* deep was excavated in front of the bins and an 8 inch *(203 mm)* perforated drainage pipe was placed at the bottom of the trench.

Two slope indicators and one Geonor type brass piezometer were installed in February 1975 by the Geotechnical Office. The locations of the instruments are shown on Fig. # 2. Slope indicator casing # 1 has been attached to the face of bin # 6, the bottom of the casing being some five feet *(1.5 m)* below the top of the berm. Indicator casing # 2 rests on bedrock, and the top of the casing is about 2 ft. *(0.61 m)* outside the back of the bin. The length of the casing was supposed to be embedded in the granular backfill material, however, it was noticed during installation that the upper portion of the casing was in earth fill and only at the lower part of the casing was granular material encountered.

The piezometer is about 25 ft. *(7.6 m)* below ground level and it is embedded in granular backfill.

......3

2) OBSERVATIONS

Fig. # 3 shows the movements of the wall monitored by direct measurement at the top and at the base by District personnel. The movement versus time plot clearly indicates that from April 1974 onward, no further movement has occurred. By examining the present location and distorted shape of the bin (Fig. # 1) and taking into account the fact that the top of the wall has moved more than twice the distance than the base, an early rotational type of failure cannot be ruled out.

On Fig. # 4 the total cumulative displacements are shown, measured by the slope indicators during the period March - June 1975. For practical purposes it can be stated that no instability or lateral deformation was observed by the slope indicators, the maximum cumulative movement measured on slope behind bin # 6 being 0.2 inches (5 mm).

In spite of the clearly visible wet and soft areas along the slope above the wall and the likely seepage directed towards the bins, the piezometer has remained dry. This would indicate that at least at the piezometer location the granular backfill behind the bins is effectively acting as a drainage medium.

Interpretation of the observations and recommendations for possible remedial measures are outside the scope of our terms of reference.

The instrumentation will be further observed and readings taken until the time you suggest to terminate these. In view of the present stable conditions, however, I suggest that bi-weekly or monthly readings would suffice in the

.....4

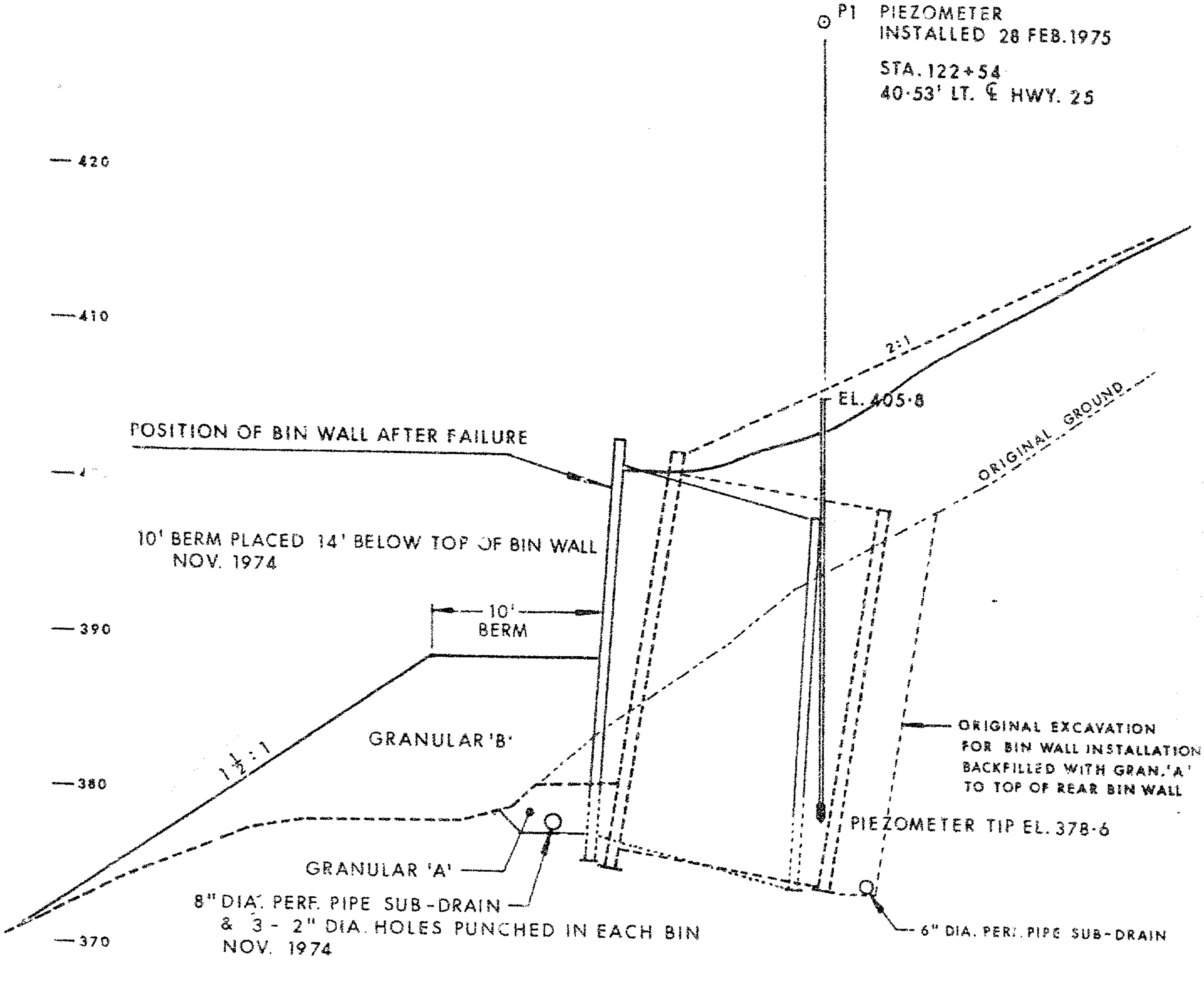
future instead of the present weekly measurements.

If we can be of any further assistance to you, we would be happy to do so.

A. K. Barsvary
Head, P.P.I. Section

AKB/jw

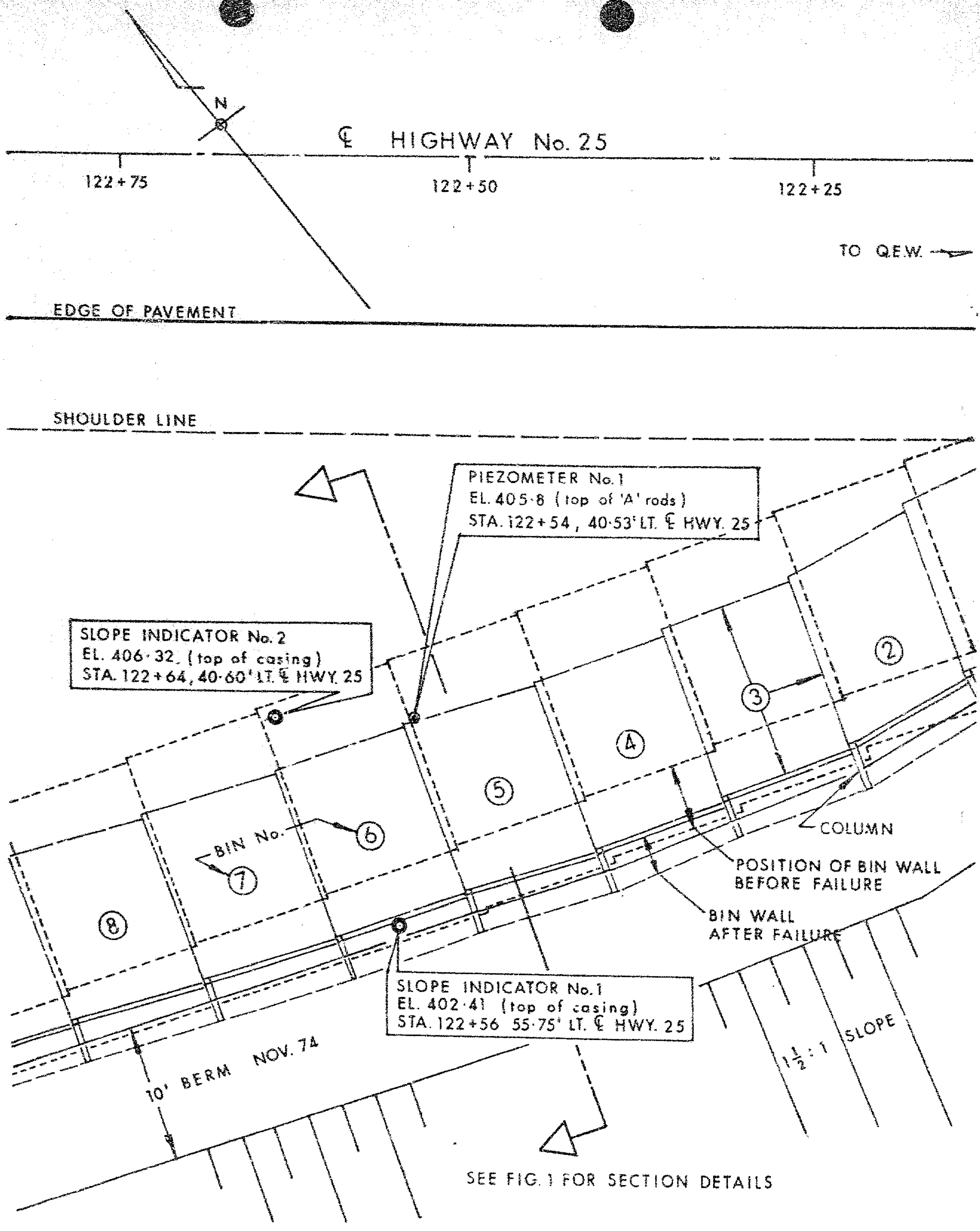
Att'd.



SECTION AT BIN No. 5

FIG. 1

SHOWING POSITION OF BIN BEFORE (BROKEN LINES) AND AFTER FAILURE



PLAN

SCALE 1" = 10'

FIG. 2

SHOWING POSITION OF SLOPE INDICATORS AND PIEZOMETER

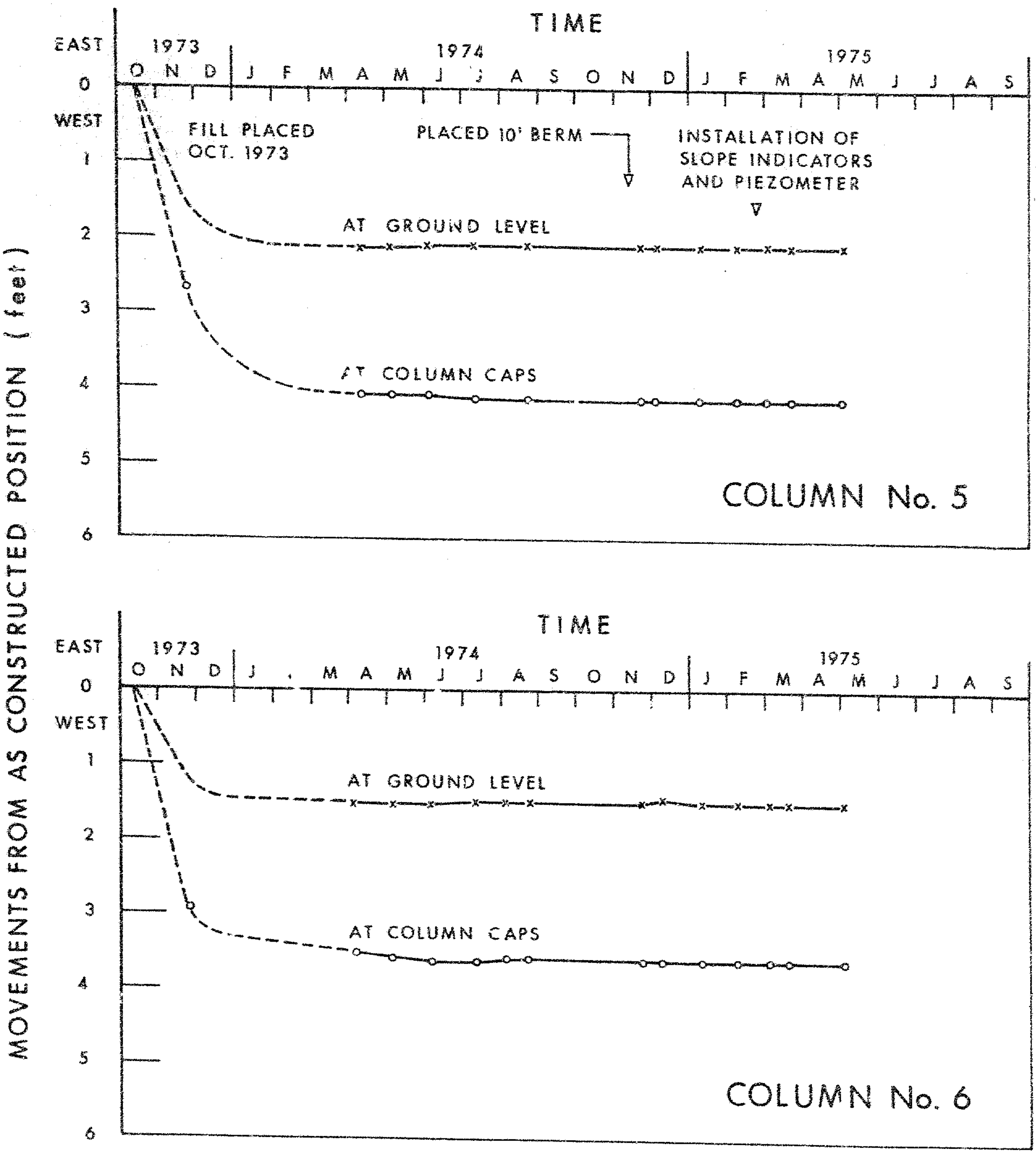
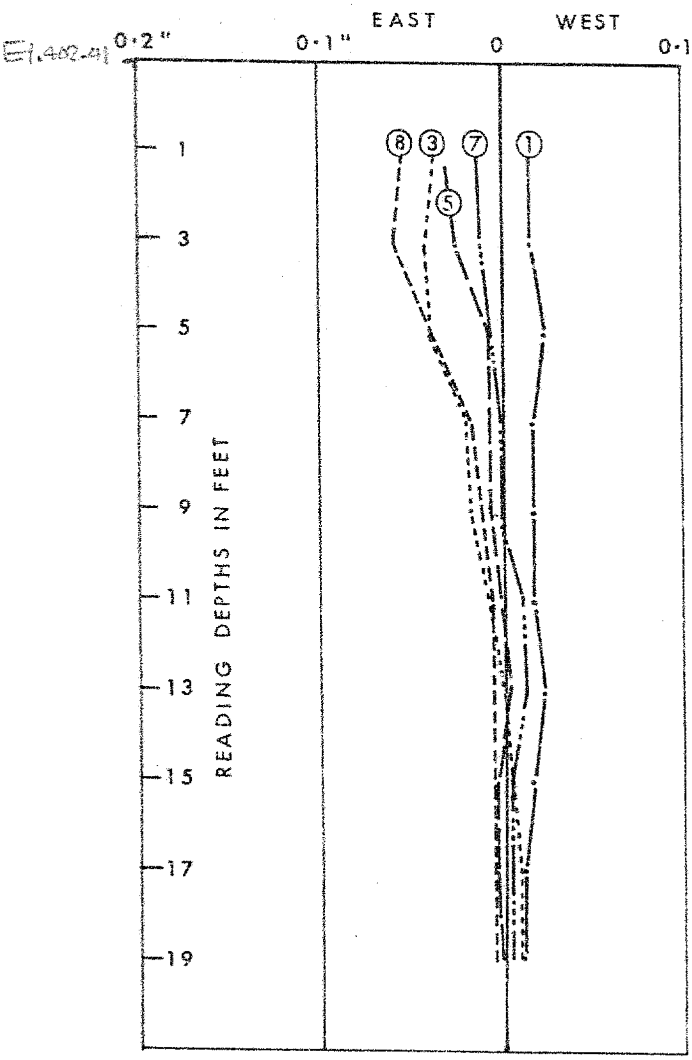


FIG. 3

SHOWING MOVEMENTS RECORDED BY THE DISTRICT

RELATIVE DEFLECTION



SLOPE INDICATOR No. 1

CASING STRAPPED TO FACE OF BIN #6

READINGS

INITIAL 14 MARCH 1975

① 21 MARCH

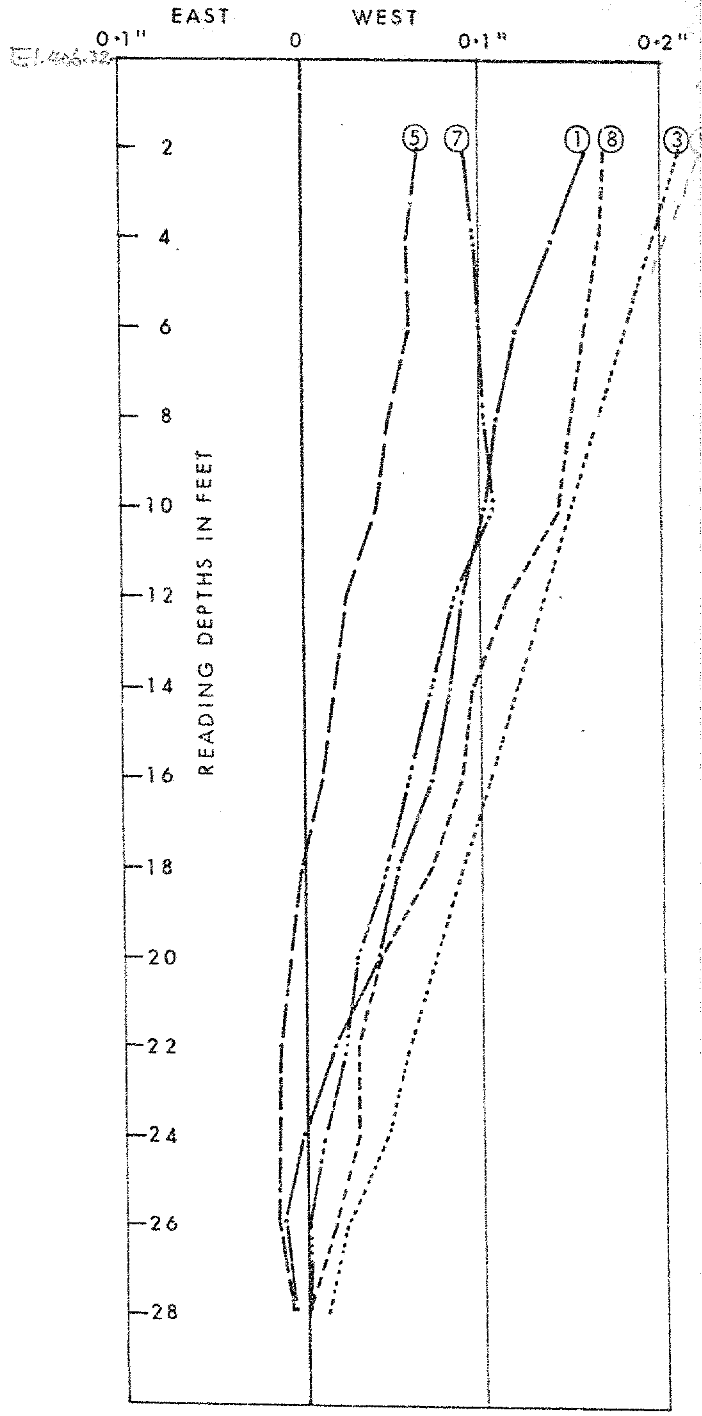
③ 7 APRIL

⑤ 18 APRIL

⑦ 9 MAY

⑧ 6 JUNE

ACTUAL DEFLECTION



SLOPE INDICATOR No. 2

CASING FIXED TO BEDROCK

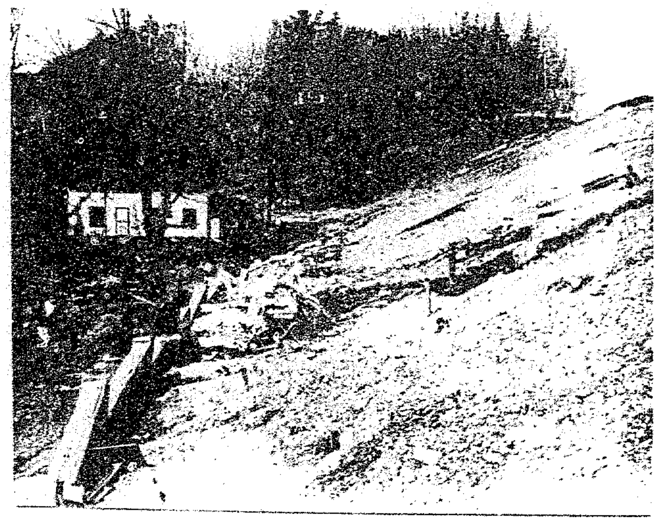
LOCATED BEHIND BIN #6

FIG. 4

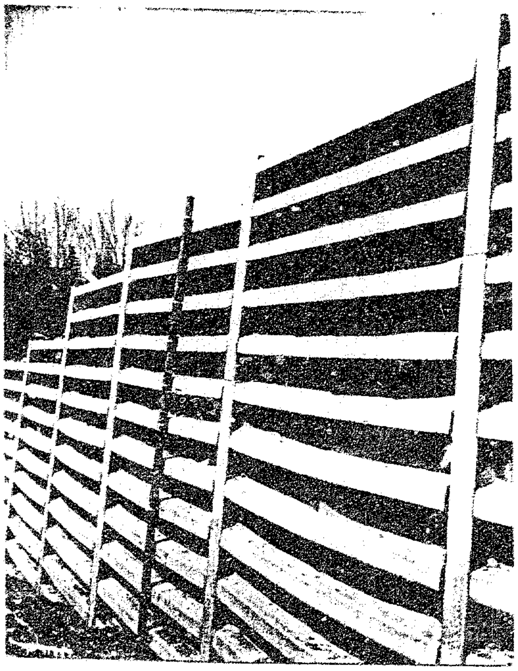
SHOWING PLOTS OF SLOPE INDICATOR READINGS

PHOTO'S

Contract 73-47
April 11th, 1975



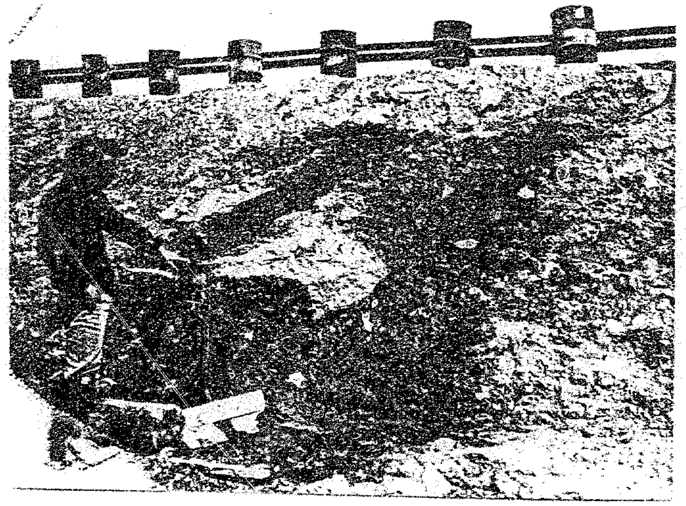
View to north, showing piezometer and slope indicator pipes, as well as wet areas on side slope



Slope indicator No 1 strapped to face of Bin No. 6

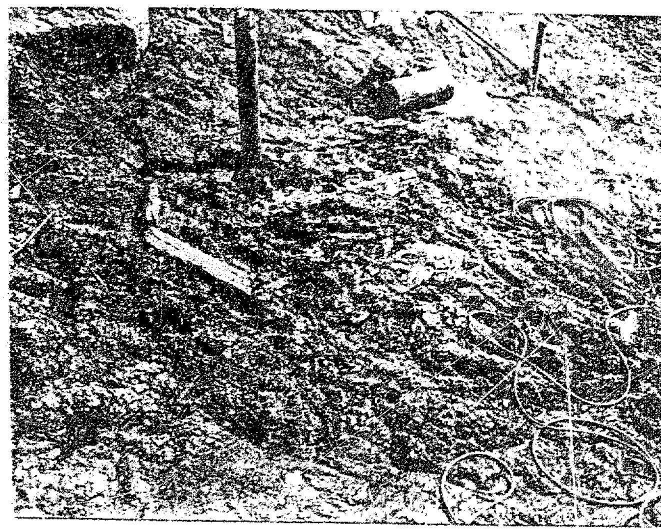
PHOTO'S

Contract 73-47
April 11th, 1975



Wet area on slope above slope indicator No. 2

Slope indicator No. 2 in wet area and piezometer in dry area



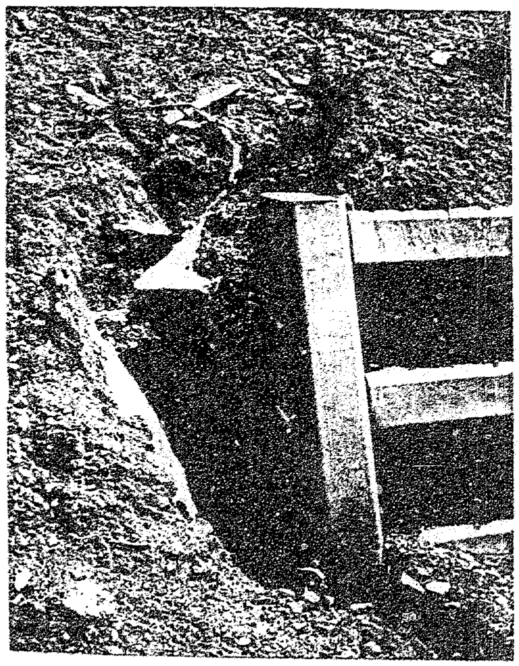
Wet area on side slope above Bin No. 16 approximately 15' wide & 13' below pavement grade

PHOTO'S

Contract 75-47
June 6th, 1975

Erosion of slope above Bin No. 16

Wash out of soil around column No. 17 of last Bin



Ministry of Transportation and Communications

Ontario

Memorandum

To: Mr. C.R. Robertson
District Engineer
District #4, Hamilton

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Attention: Mr. D. Waller
Construction Engineer

Date: July 15, 1975

Our File Ref.

In Reply to

Subject: RETAINING WALL AT HWY. #25
Contract 73-47 Q.E.W. to Hwy. #5
District #4 (Hamilton)

This memo confirms recommendations given verbally to you on June 26th, 1975 and to Mr. M. Kaiser on July 11th, 1975 regarding remedial measures to be taken in an attempt to achieve a permanent solution to the problems at the above mentioned project:-

(1) Place additional Granular 'B' fill in front of the bin wall so as to form a 1.5:1 slope from top of the wall downwards.

(2) Trim the existing slope behind the wall so as to remove high spots and low areas where water can pond.

(3) Construct french drains 2 ft. wide and average 4 ft. deep on the existing slope behind the wall spaced 15 ft. apart. These drains should discharge into a 3 ft. wide ditch located at the back of the bin wall which should discharge into a 4' X 4' soakaway located near the north end of the wall. Drains ditches and soakaways should be backfilled with Granular 'A'.

(4) Complete the backfill above the wall to the section as designed originally. Material to be used should be Granular 'B' with the upper 12 inches Granular 'A'.

(5) Slope indicators and piezometers already installed must be protected as the work proceeds. Monitoring of these will be carried out during construction by this Office.

Details of our requirements were plotted on X sections at your office on July 10th, 1975 by the writer and Mr. Kaiser.

We cannot be certain at this stage that the above measures will actually achieve a permanent solution to this problem, however, we believe that there is a reasonable chance of success. The expenditure required will be quite small when compared to the Consultant's estimate of $150,000 for a permanent solution.

Please keep us advised as to your intentions in this matter.

K.G. Selby

K.G. Selby
Supervising Engineer

c.c. J. Callaghan
J. Cullen
W. McFarlane
S. Cant
G. Burkhardt
Files
[illegible]

Mr. J.P. Cullen
Sr. Project Design Eng.
Systems Design Office
3501 Dufferin St.

Soil Mechanics Section
Geotechnical Office
West Building, Downsview

July 23, 1975

BIN WALL INVESTIGATION, HWY. 25
Addendum #11
W.P. 131-65-01

This is in answer to your memo dated Feb. 5, 1975. As previously discussed we have delayed our reply until information resulting from our slope indicator and piezometer installation could be obtained and reviewed.

Attached for your information is a copy of a report compiled by this Office dealing with the slope indicator and piezometer installation. Also attached is a copy of a letter from Golder Associates dated April 23, 1975 in which they modify certain conclusions reached in their original report relating to the mechanism of failure.

As a result of our review of all of the data available at the present time we have reached the following conclusions:-

(1) The original movement of the wall was a rotational or overturning type of failure which caused severe distortion of the bin wall and loosening of its contents because of its non-rigid character.

(2) The mass of earth which moved was the clayey fill material placed on the original slope behind the wall and the plane of failure was probably parallel to and slightly above the average plane surface of the original slope. Seepage zones on the original slope surface contributed to the failure by softening the clayey soil.

(3) There is a reasonable chance that the wall can be stabilized permanently by placing additional material in front of the bins and providing drainage for the seepage zones mentioned in (2) before constructing the remainder of the fill behind the wall. Details of this have already been given to Mr. D. Waller in our memo of July 15, 1975.

With regard to the last paragraph in your memo we are of the opinion that most probably a combination of several factors caused the original failure.

c.c. D. Waller
W. McFarlane
G. Burkhardt
Files
Record Services

K.G. Selby
Supervising Engineer

Ontario
Ministry of Transportation and Communications

Memorandum

To: Mr. G. A. Metcalfe
Asst. Construction Engineer
Construction Branch
Central Bldg.
Downsview, Ontario

Attention:

Our File Ref.

From: Mr. D. A. Waller
District Construction Engineer
District #4-Hamilton

Date: July 28, 1975

In Reply to

Subject: Contract 73-87
Retaining Wall

I think your office has been kept in the picture by Ken Selby of the problems which the District has had with this retaining wall.

Mr. Selby's recommendations were forwarded to your office and we have roughly estimated the cost of undertaking the recommended repairs as being in the neighbourhood of $17,000. tender type work and approximately $2,000. of engineering.

The prime Contractor on the 73-47 contract was Bot Holdings Limited and our acceptance dated July 30th, 1974 stated that, as one of the conditions, that all roadwork remaining to be completed within the bin wall area of the contract, between Stations 122 and 125, will be negotiated for at the time the remedial work is done. I would suggest that we do follow this procedure rather than calling a separate contract or District Inquiry.

May we please have your approval.

D. A. Waller
District Construction Engineer

DAW:cdk

c.c. K. Selby
J. J. Regan

TCN061 08051358

DMA953

HAM

AUGUST 5, 1975   1:52 PM Y-37

C R ROBERTSON DISTRICT ENGINEER

ATTN: MR D A WALLER

RE: CONTRACT NUMBER 73-37 RETAINING WALL, YOUR MEMO OF JULY 28, 1975.

PLEASE PROCEED AS YOU HAVE DETAILED IN YOUR MEMO OF JULY 28, 1975, AND HAVE THE QUOTATION VARIFIED BY ESTIMATING. IF THE PRICES ARE OUT OF LINE THEN WE SHOULD REVERT TO A DISTRICT INQUIRY PROCEEDURE.

G A METCALFE FOR J E CALLAHAN DIRECTOR CONSTRUCTION BR.

MD

Ministry of Transportation and Communications

Ontario

1253

Memorandum

To: J. J. Regan
Construction Supervisor
District #4-Hamilton

From: D. A. Waller
District Construction Engineer
District #4-Hamilton

Attention:

Date: August 6, 1975

Our File Ref.

In Reply to

Subject: Contract 73-47

Attached please find a copy of a teletype approval from G. A. Metcalfe to obtain prices from Bot to carry out this remedial work.

Would you proceed along these lines and at the same time keep the Estimating Section in the picture so that when we obtain the prices from Bot, we can get a ready answer from the Estimating Section as to whether the prices are reasonable.

D. A. Waller
District Construction Engineer

Attach.
DAW:cdk

c.c. K. Selby

Ministry of Transportation and Communications

Ontario

128

Memorandum

To: Mr. K. G. Selby
Supervising Engineer
Geotechnical Office
West Bldg.
Downsview, Ontario

Attention:

From: Mr. E. R. Dufresne
Engineering Office Supervisor
District #4-Hamilton

Date: July 13, 1976

Our File Ref.

In Reply to

Subject: Retaining Wall at Hwy. 25
Contract 73-47, Q.E.W. to Hwy. 5
District #4-Hamilton

Your recommendation dated June 15, 1976 was reviewed by various district staff and we offer the following.

Since the eroded zone you make reference to is isolated somewhat, in that it is quite a distance down the steep slope and it is one pocket rather than throughout, we feel that the area should be kept under observation this summer rather than attempt a costly backfill operation. You can well appreciate it would be quite difficult to correct due to the steep slope. The Crown Vetch or other will not grow on the granular slope surface, therefore we will not seed.

In the event the intent of your recommendation is not understood, please advise.

E. R. Dufresne
Engineering Office Supervisor

ERD/mw

c.c. Mr. M. Scrimshaw

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GEOTECHNICAL OFFICE
JUL 1 5 1976
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

Mr. C. R. Robertson
Dist. Engineer
District 4, Hamilton

D. A. Waller, Constr. Engineer

Soil Mechanics Section
Geotechnical Office
West Building, Downsview

June 15, 1976

Retaining Wall at Hwy. 25
Contract 73 - 47, Q.E.W. to Hwy. 5
District 4, Hamilton

Further to our memo of November 21, 1975, we have taken slope indicator readings at the above mentioned site on the following dates:

Nov. 26, 1975
Dec. 17, 1975
Jan. 28, 1976
Feb. 24, 1976
Apr. 2, 1976
Jun. 4, 1976

No significant movements were recorded hence indications are that the slope to the rear of the binwall is essentially stable. The Granular'B' material in front of thewall has flattened somewhat and a drainage channel has formed through it. This was anticipated however and is not serious. We would suggest that the eroded zone be backfilled with coarse material (more than 2 inches) and that some vegetation such as Crown Vetch be planted on the complete slope surface in front of the wall.

We do not intend to carry out any further inspections of this project until the spring of 1977 unless specifically requested by the District.

K.G. Selby, P. Eng.
Supervising Engineer

cc: J. Cullen
H.B. Potts
J. Crannie
G. Metcalfe
Files
Record Services

Mr. C.R. Robertson,
District Engineer,
District #4, Hamilton.

Mr. D.A. Waller,
Construction Engineer.

Soil Mechanics Section,
Geotechnical Office,
West Building, Downsview.

November 21, 1975.

Retaining Wall at Hwy. 25
Contract 73-47. QEW to Hwy. 5
District #4, Hamilton

WP 131-65-01-02
114-72-01

The above mentioned site was visited by the writer on October 31, 1975, at which time the construction of french drains and regrading of the slope behind the retaining wall was underway. Advice was given to Mr. M. Kaiser, Project Supervisor, that certain material excavated from the drainage ditches and some to the rear of the bins, was of very poor quality and should be disposed of by dumping it on the surface of the fill material previously placed in front of the wall. Additional Granular 'B' would therefore be required to replace this material.

We have taken slope inclination readings on the following dates:-

September 17th - Prior to construction
October 30th - Fill completed in front of wall
November 5th - Fill completed behind wall
November 14th - Construction completed

No significant movements were recorded. We will continue to monitor at least until after the spring of 1976 since we anticipate that some material from in front of the wall may be lost due to erosion and due to steepness. The final angle of repose of this material will probably be some few degrees less than that of the present slope. This should not affect the slope above the wall.

K.G. Selby,
Supervising Engineer.

cc: J. Crannie,
G. Metcalfe,
Files, ✓
Record Services.