

DIST. 8 REGION

W.P. No. 160-92-00

CONT. No. _____

W. O. No. _____

STR. SITE No. _____

HWY. No. 33

LOCATION Hwy 33 - Ferry Dock
Replacement at Adolphus town

No. of PAGES - 1

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____



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A&E SERVICES
MARINE DIVISION

**Geotechnical Investigation
Proposed Adolphustown Ferry Dock Improvement
Project No. 686941
Bay of Quinte, Ontario**

Prepared For:

**Public Works Canada
4900 Yonge Street
Willowdale, Ontario
M2N 6A6**

Trow Consulting Engineers Ltd.

**428 Millen Road
Stoney Creek, Ontario
L8E 3N9**

**H03435-G
September 22, 1994**

**Telephone: (905) 560-3001
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Reference: H03435-G

September 22, 1994

Mr. I. Schenkman
Public Works Canada
4900 Yonge Street
Willowdale, Ontario
M2N 6A6

Dear Sirs:

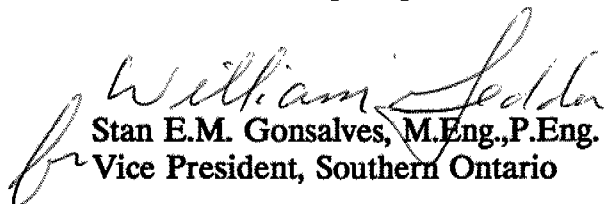
**Geotechnical Investigation
Proposed Adolphustown Ferry Dock Improvement
Project No. 686941
Bay of Quinte, Ontario**

We are pleased to enclose our geotechnical report for the above noted project.

We will retain the soil samples obtained during the investigation for three (3) months. At that time if we have not heard from you, we will discard the soil samples. If you wish the samples to be stored, this can be arranged for a small service charge.

Trow appreciates the opportunity to undertake this assignment on your behalf and we look forward to working with you again.

Yours very truly,
Trow Consulting Engineers Ltd.


Stan E.M. Gonsalves, M.Eng., P.Eng.
Vice President, Southern Ontario

SEG/ct
Encl.



Summary

- The stratigraphy encountered at the proposed new ferry dock, as revealed in the boreholes, comprised water ranging from 1.52 m depth near the shore to 9.75 m out towards the Bay, shallow deposits of sand and gravel, sand and silt, and silt, underlain by limestone bedrock. Borehole 6, closest to the shore, encountered a deposit of silt and sand below 1.52 m depth of water to about 5.5 m below water surface. The silt and sand contains numerous organic inclusions and is very loose.

Probable bedrock was encountered in all boreholes at depths of about 6.8 to 10.2 m below water surface (approximately Elevation 68.04 to 64.30 m). Coring of the bedrock carried out in two locations retrieved sound limestone with minor shaley layers. Based on the RQD, the bedrock is generally in fair condition in the upper 1.5 m and fair to excellent condition below this level.

- Based on the results of the investigation, it is our opinion that the proposed structures can be supported on end bearing piles. A combination of steel H piles and steel sheet piles may be required should backfilling to create a platform is contemplated. In view of the shallow depth of typically very loose overburden, piles socketed into the bedrock may be required to provide toe or lateral support. Since final concepts are preliminary at this point, the information provided is essentially generic. Further reporting might be required when final design plans are available. At that time specific comments can be made to check whether the geotechnical recommendations are compatible and sufficient.



Geotechnical Investigation
Proposed Adolphustown Ferry Dock Improvement
Project No. 686941
Bay of Quinte, Ontario

Introduction

Trow Consulting Engineers Ltd. was retained by Public Works Canada to carry out a geotechnical investigation for the proposed Adolphustown Ferry Dock Improvement in the Bay of Quinte, Ontario (Drawing No. 1).

The project will involve the construction of a new ferry dock to be located to the east of the existing structure. Specifics of the proposed dock structure and loading conditions had not been established at the time of the investigation.

The purpose of the geotechnical investigation was to examine the subsurface soils and rock conditions at the proposed dock location and, based on this information, to provide an engineering report with geotechnical recommendations pertinent to the design and construction of the proposed structure. Since final concepts are preliminary at this point, the information provided is essentially generic. Further reporting might be required when final design plans are available. At that time specific comments can be made to check whether the geotechnical recommendations are compatible and sufficient.

Accordingly, the comments and recommendations given in this report are based on these assumptions. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required.



Part A

Investigation Procedures, Laboratory Testing & Subsurface Conditions

Investigation Procedures

The fieldwork of the investigation was carried out on September 6, 7 and 8, 1994 and consisted of eight (8) boreholes as requested in the Terms of Reference. The site location and borehole locations are shown on Drawings Nos. 1 and 2, respectively. Six (6) of the boreholes were advanced to refusal at depths ranging from 6.78 to 10.52 m below bay water level. Dynamic cone tests were performed in these boreholes to provide an indication of probable bedrock level. Coring of 3 m into the bedrock was carried out in the remaining two boreholes to confirm bedrock.

The boreholes were advanced using a CME-75 track mounted drill rig equipped with continuous flight hollow stem auger and rock coring equipment operated by a specialist drilling contractor under the direction and supervision of Trow personnel. The drilling operations was carried out on the barge.

In the boreholes, representative samples of the subsoils were recovered at regular intervals using a split spoon sampler driven in accordance with the standard penetration test procedure. Continuous samples of the bedrock were obtained by diamond drilling techniques using NX coring equipment in the boreholes. Samples were preserved in moisture tight containers and returned to Trow's laboratory for visual, textural and olfactory classification.

The fieldwork was supervised throughout by a member of the Trow engineering staff who located the boreholes in the bay, directed the drilling and sampling operations, documented the stratigraphy encountered at the boreholes, and cared for the recovered samples.

The locations of the boreholes were established by the client and laid out in the field by Trow staff. The bay water level elevation was determined by Trow Consulting Engineers Ltd. and referred to the following temporary benchmark.

T.B.M. Top of nail located at the northwest corner of the timber pier
Elevation: 75.84 m (IGLD), supplied by client



Laboratory Testing Procedures

The following laboratory testing program was carried out:

- natural moisture content tests on all recovered samples, with results presented on the Log of Borehole sheets;
- grain size analysis on two samples, with results presented on Drawings 11 and 12, and;
- point load tests on upper 1.5 m of bedrock with results presented in Table 1.

Site and Subsurface Conditions

Site Description

The existing ferry dock is located at the south terminus of Highway 33, in the Bay of Quinte, Ontario. The ferry service links southwest to Glenora on the Prince Edward Peninsula where the highway continues. The south arm of the dock, about 60 m in length is in fairly good repair based on visual assessment. A rock berm is placed against the south side of the arm from the shore to about half the length of the dock. The north arm of the dock appears to be in poor condition. Part of the dock face is reinforced and tied back from reaction piles. It could be seen from the exposed areas that the dock is built on soldier piles and lagging structure. The prevalent wind during the time of the fieldwork was from the east.

Geological Setting

The general area of the site is known to be covered with only a veneer of overburden. Based on the Palaeozoic Geology of the Belleville - Wellington area, (Ontario Geological Survey, Preliminary Map P2412), the bedrock in the area is Limestone of the Verulam Formation (middle Ordovician).

Subsurface Conditions

Refer to the Log of Borehole sheets for details of the fieldwork including depth of water, soil and rock descriptions, inferred stratigraphy, standard penetration 'N' values and details of the coring.



It must be noted that the boundaries of soil and rock indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The "Notes on Sample Descriptions" preceding the borehole logs form an integral part of this report should be read in conjunction with this report.

A general summary of the engineering properties and description of the various stratigraphic units encountered in the boreholes is presented below. In general, the stratigraphy at the site, as revealed in the boreholes, comprised sediment, sand/sand and gravel, silt, silt and sand, clayey gravel underlain by bedrock.

Bay Water

The depth of water at the borehole locations ranged from 1.52 m near the shore (Borehole 6) to 9.75 m (Borehole 8).

Silt (Sediment)

A very loose sediment was encountered at the bottom of the bay in Boreholes 4 and 5 to about 1.0 to 1.9 m depth below bay bottom. This is manifested by the substantial drop of the sampler below the taped depths of water. These boreholes are located just to the east of the existing timber pier where the velocity of the water is somewhat slower.

Sand/Sand and Gravel

A shallow deposit, about 0.3 to 1.2 m thick, of sand/sand and gravel was found in Boreholes 1 to 4 below the bay water and sediment. The material typically contains trace silt, shells and organic inclusions. The sand/sand and gravel is loose to compact.

Silt

A layer of silt was encountered below the sediment in Borehole 5 and bay water in Borehole 7. The silt is dark grey and contains numerous organic inclusions. The silt is very loose.



Silt and Sand

A deposit of silt and sand was found below about 1.6 m of water in Borehole 6. The silt and sand contains numerous organic inclusions with decayed wood pieces and scattered plant fibre. The silt and sand is very loose.

Clayey Gravel (Fractured Rock)

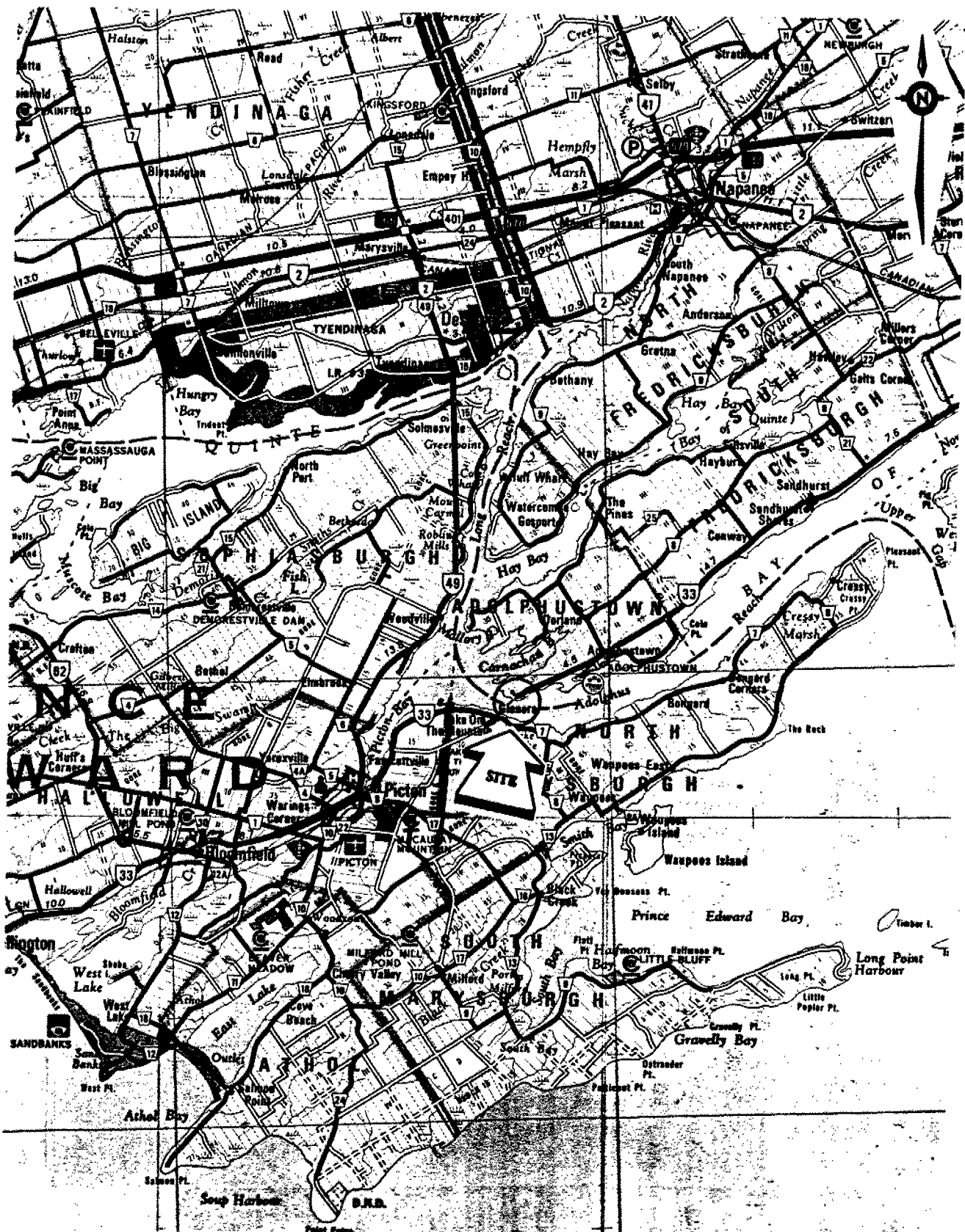
A layer of clayey gravel, about 100 to 150 mm thick was found above the bedrock surface. The material is highly weathered or fractured rock. The clayey gravel is very dense.

Bedrock

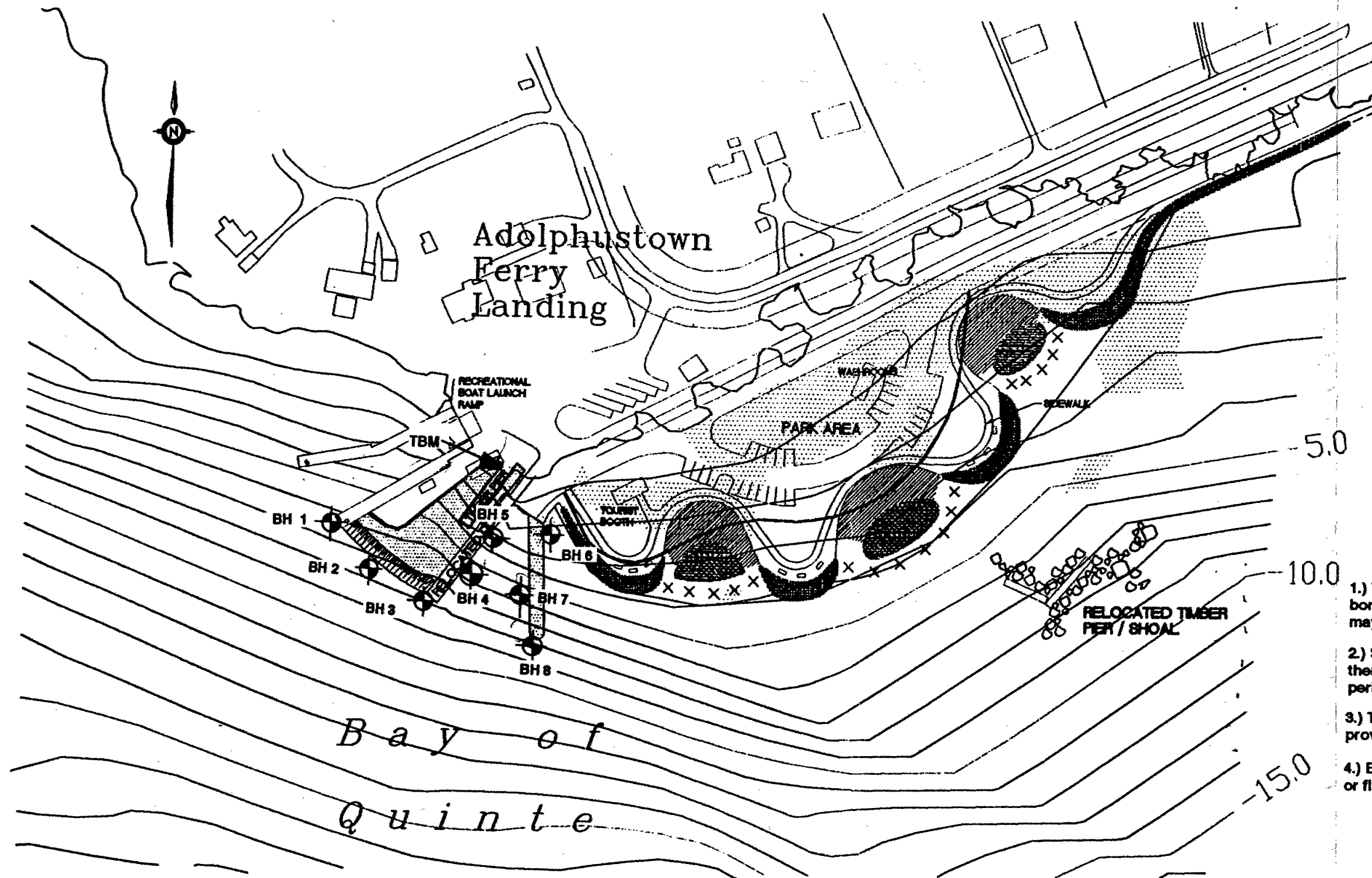
Probable bedrock was encountered in all the boreholes at about 6.8 to 10.5 m below the bay water level (approximately Elevation 68.04 to 64.30 m). Coring of the bedrock was carried out in Boreholes 3 and 6. In general, the bedrock is limestone with shaley limestone and scattered shale seams (Verulam Formation). The limestone is medium grey, unweathered and of medium to high strength. The shaley limestone is dark grey, unweathered and medium strength. The RQD for the upper 1.5 m of the bedrock ranged from 35 to 60%, signifying poor to fair quality. RQD values of 68 to 92% were obtained for the lower 1.5 m representing fair to excellent quality. Results of point load tests carried out on selected specimens are presented in Table 1.

Table 1
Point Load Test Results
Borehole 6

Depth (m)	Loading Orientation	Is_{50}	Approximate Uniaxial Compressive Strength (MPa)
7.01	Parallel to bedding	3.3	76
7.01	Perpendicular to bedding	6.5	105
7.16	Parallel to bedding	3.2	74
7.26	Parallel to bedding (shaley)	1.7	39
7.42	Parallel to bedding	3.3	76
7.57	Parallel to bedding (shaley)	3.1	71
7.57	Perpendicular to bedding	6.9	159
7.82	Parallel to bedding (shaley)	0.9	21
7.87	Parallel to bedding	4.2	97
8.08	Parallel to bedding	3.1	71



DRAWING NO. 1 - LOCATION MAP



LEGEND


 BOREHOLE LOCATIONS (APPROX.)

This drawing is to be read in conjunction with
 Trow Consulting Engineers Ltd., reference no: H03435-G.
 Base information presented on this drawing was obtained
 from the client.

Benchmark Description: TBM - Top of nail. Elevation:
 75.84 m I. G. L. D.

- 1.) The boundaries and soil types have been established only at borehole locations. Between boreholes they are assumed and may be subject to considerable error.
- 2.) Soils samples will be retained in storage for 3 months and then destroyed unless the client advises that an extended time period is required.
- 3.) Topsoil quantities should be established from the information provided at the borehole locations.
- 4.) Borehole elevations should not be used to design building(s) or floor slab(s) or parking lot(s) grades.

SCALE m 

	Trow Consulting Engineers Ltd.
GEOTECHNICAL INVESTIGATION PROPOSED GLENORA / ADOLPHUSTOWN FERRY DOCK IMPROVEMENT SITE PLAN AND BOREHOLE LOCATIONS BAY OF QUINTE, ONTARIO	
Ref. No. H03435-G	Scale: As Shown Date: 12/09/94 Dwg. No. 2

LOG OF BOREHOLE 1



Auger Sample ☒
 SPT (N) Value ☐ ☐ ☒
 Dynamic Cone Test ☐
 Shelby Tube ☐ ☐ ☒
 Field Vane Test ☐ + s
 Natural Moisture ☐ X
 Plastic and Liquid Limit ☐ ☐
 Penetrometer ☐ ▲

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 3
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale m (ft)	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			sample	Natural Unit Weight kN/m ³
			m	ft		20	40	60	80	% Dry Weight				
	Shear Strength				MPa		0.1	0.2	10	20	30			
	74.85	Bay Water												
				4										
				2										
				8										
				12										
			4											
				16										
	69.67	SAND and Gravel: blueish grey, numerous shell, very loose, becoming silty with organic inclusions below 6.5 m depth	6											
			20	4	o									
				WOH										
		becoming compact silty sand	24											
	67.23	CLAYEY GRAVEL (Fractured Rock): dark grey, very dense (50 blows for last 25 mm of penetration)	8		44			o				X		
		Refusal (Probable Bedrock)	28											
				32										
			10											

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

(1) Borehole advanced by hollow stem augers to refusal at 7.92 m depth, on September 6, 1994, by Malone's Soil Sample Co. Ltd.

(2) WOH - Weight of hammer.

LOG OF BOREHOLE 2



Auger Sample
 SPT (N) Value
 Dynamic Cone Test
 Shelby Tube
 Field Vane Test
 Natural Moisture
 Plastic and Liquid Limit
 Penetrometer

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 4
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale m (ft)	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content % Dry Weight			Sample	Natural Unit Weight kN/m ³	
			m	ft		20	40	60	80	Shear Strength	MPa	10			20
	74.87	Bay Water													
				4											
				2											
				8											
				12											
				16											
				20											
				24											
	66.95	SAND: dark grey, some silt, trace shell and organic, compact over:		28											
		very dense fractured rock (last 150 mm)		32											
	65.73	Cone Refusal (Probable Bedrock)		36											
				40											

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

(1) Borehole advanced by hollow stem augers to refusal at 9.14 m depth, on September 7, 1994, by Malone's Soil Sample Co. Ltd.

(2) Dynamic cone started bouncing below 9.10 m depth.

LOG OF BOREHOLE 3



Auger Sample ☒
 SPT (N) Value ☒
 Dynamic Cone Test ☐
 Shelby Tube ☒
 Field Vane Test ☒
 Natural Moisture ☒
 Plastic and Liquid Limit ☒
 Penetrometer ☒

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 5
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			Sample	Natural Unit Weight
	m		ft	20		40	60	80	% Dry Weight					
	(ft)			Shear Strength			MPa	10	20	30	kN/m ³			
	74.87	Bay Water	m	ft										
				4										
				2										
				8										
				12										
				4										
				16										
				20										
				24										
				8										
				28										
	65.73	Continued on next page		32										
				10										

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

LOG OF BOREHOLE 3 con't





Auger Sample ☒
 SPT (N) Value ☐ ☐ ☒
 Dynamic Cone Test ☐
 Shelby Tube ☐ ☐ ☒
 Field Vane Test ☐ + s
 Natural Moisture ☐ X
 Plastic and Liquid Limit ☐ ☐
 Penetrometer ☐ ▲

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 5A
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale m (ft)	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			Sample	Natural Unit Weight kN/m ³
			m	ft		20	40	60	80	% Dry Weight				
	Shear	Strength			MPa		10	20	30					
		Continued from previous page					0.1	0.2						
		Bay Water												
	65.73	SAND and GRAVEL: dark grey, trace silt, shell and organics, compact, over:		30										
	64.76	very dense fractured rock	10		20						X			
		Continued on next page	34		50/50 mm									
				38										
			12											
				42										
			14	46										
				50										
			16											
				54										
				58										
			18											

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

LOG OF BOREHOLE 3 con't



Auger Sample ☒
 SPT (N) Value ☐ ☐ ☒
 Dynamic Cone Test ☐
 Shelby Tube ☐ ☐ ☒
 Field Vane Test ☐ + s
 Natural Moisture ☐ X
 Plastic and Liquid Limit ☐ ☐
 Penetrometer ☐ ▲

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 5B
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale	Soil Description	Depth Scale		N Value	Rock Quality Designation	Natural Moisture Content % Dry Weight			Sample	Natural Unit Weight kN/m ³
	m (ft)		Continued from previous page				10	20	30		
	64.76	BEDROCK: Limestone and shaley limestone with occasional shale seams (Verulam Formation) a) Limestone (> 80%) medium grey, unweathered, medium to high strength. b) Shaley Limestone, dark grey, unweathered medium strength. c) Shale, dark grey, unweathered. d) Discontinuities, rough underlating to rough planar, close to very close. Terminated	m	ft		10.05					
						1450	100	35	100		
						11.5					
						1600	100	68	100		
	61.76					13.1					
						Depth (m)	Run (mm)	Recovery (%)	R.Q.D. (%)	Drilled Water return (%)	

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

(1) Borehole advanced cased with NX coring equipment to termination at 13.10 m depth, on September 7, 1994, by Malone's Soil Sample Co. Ltd.

LOG OF BOREHOLE 4



Auger Sample
 SPT (N) Value
 Dynamic Cone Test
 Shelby Tube
 Field Vane Test
 Natural Moisture
 Plastic and Liquid Limit
 Penetrometer

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 6
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale m (ft)	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content % Dry Weight			Sample	Natural Unit Weight kN/m ³
			m	ft		20	40	60	80	10	20	30		
	74.87	Bay Water												
				4										
				2										
				8										
				12										
				4										
				16										
	68.77			20										
	67.86	SILT: dark grey, some organics, very loose, (sediment)		24										
	67.55	spoon sampler sunk to 7.0 m		24	100									
		SAND: grey, some silt, trace shells and organics, compact over:		24										
		very dense fractured rock		24										
		Cone Refusal (Probable Bedrock)		24										
				28										
				32										
				10										

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

(1) Borehole advanced by hollow stem augers to refusal at 7.32 m depth, on September 7, 1994, by Malone's Soil Sample Co. Ltd.

LOG OF BOREHOLE 5





Auger Sample ☒
 SPT (N) Value 0 0 ☒
 Dynamic Cone Test ☐
 Shelby Tube ☒
 Field Vane Test + s
 Natural Moisture X
 Plastic and Liquid Limit ☐
 Penetrometer ☒

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 7
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale m (ft)	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content % Dry Weight			Sample	Natural Unit Weight kN/m ³	
			m	ft		20	40	60	80	Shear Strength 0.1	MPa	0.2			10
	74.87	Bay Water													
			4												
			2												
			8												
	71.52	SILT (Sediment): very loose		12											
			4												
			16												
	69.38	spoon sampler sunk to 5.2 m depth			WOH								X		
		SILT: dark grey, numerous organic inclusions, very loose	6	20											
68.01	0.3 m layer of peat at 6.6 m			WOH											
67.76	CLAYEY GRAVEL: (Fractured Rock)		24	60											
	Refusal (Probable Bedrock)		24	100 mm											
			8												
			28												
			32												
			10												

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1.) Borehole advanced by hollow stem augers to refusal at 7.11 m depth, on September 7, 1994, by Malone's Soil Sample Co. Ltd.

LOG OF BOREHOLE 6









Auger Sample
 SPT (N) Value
 Dynamic Cone Test
 Shelby Tube
 Field Vane Test
 Natural Moisture
 Plastic and Liquid Limit
 Penetrometer

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 8
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			Sample	Natural Unit Weight
	m		(ft)	20		40	60	80	% Dry Weight					
				Shear Strength			MPa	10	20	30				
			m	ft		0.1	0.2							
	74.82	Bay Water												
	73.30	SILT and SAND: dark grey, numerous organic inclusions, very loose decayed wood pieces at 2.3 m	2		WOH							66.4%		
			8		100									
			12		WOH							41.5%		
		scattered plant fibre	16		WOH							X		
		becoming silty sand, some organic inclusions	20		WOH							X		
	68.42	100 mm layer of peat	24		94/175 mm									
	68.04	CLAYEY GRAVEL: (Fractured Rock) very dense	28											
		Continued on next page	32											
			10											

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

LOG OF BOREHOLE 6 con't



Auger Sample ☒
 SPT (N) Value ☐ ☐ ☒
 Dynamic Cone Test ☐
 Shelby Tube ☐ ☐ ☒
 Field Vane Test ☐ + s
 Natural Moisture ☐ X
 Plastic and Liquid Limit ☐ ☐
 Penetrometer ☐ ▲

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 8A
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale m (ft)	Soil Description Continued from previous page	Depth Scale		N Value	Rock Quality Designation					Natural Moisture Content % Dry Weight			Sample	Natural Unit Weight kN/m ³
			m	ft							10	20	30		
	68.04	BEDROCK: Limestone and shaley limestone with occasional shale seams (Verulam Formation) a) Limestone (85 %) medium grey, unweathered medium to high strength b) Shaley Limestone (15 %) dark grey, unweathered medium strength. c) Shale (1 %) dark grey, moderately weathered to unweathered. d) Discontinuities: bedding joints are rough underlating to rough planar and usually correspond with shale seams, close to very close spacing, moderate spacing below 7.8 m depth. Terminated				6.78									
				24			1600								
			8				100	60	100						
				28		8.38									
							1530								
				32			100	92	100						
	64.91		10			9.91									
				36											
			12	40											
				44											
			14												
				48											
				52											
			16												

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

(1) Borehole advanced cased with NX coring equipment to termination at 9.91 m depth, on September 8, 1994, by Malone's Soil Sample Co. Ltd.

LOG OF BOREHOLE 7



Auger Sample ☒
 SPT (N) Value ☒
 Dynamic Cone Test ☐
 Shelby Tube ☒
 Field Vane Test ☒
 Natural Moisture ☒
 Plastic and Liquid Limit ☒
 Penetrometer ☒

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 9
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			Sample	Natural Unit Weight
	m		(ft)	20		40	60	80	% Dry Weight					
	m		ft	Shear Strength		MPa		10	20	30	kN/m ³			
	74.82	Bay Water												
			4											
			2											
			8											
			12											
			4											
			16											
	68.72		6											
		SILT: numerous organic inclusions over: Gravel with wood fragments over:	20											
		Fractured rock	24		65			o						
	67.66	Cone Refusal (Probable Bedrock)	8											
			28											
			32											
			10											

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

(1) Borehole advanced by hollow stem augers to refusal at 7.16 m depth, on September 8, 1994, by Malone's Soil Sample Co. Ltd.

LOG OF BOREHOLE 8



Auger Sample ☒
 SPT (N) Value ☐ ☐ ☒
 Dynamic Cone Test ☐
 Shelby Tube ☐
 Field Vane Test ☐
 Natural Moisture ☒
 Plastic and Liquid Limit ☐
 Penetrometer ☐

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 10
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			Sample	Natural Unit Weight
	m		(ft)	20		40	60	80	% Dry Weight					
				Shear Strength		MPa								
			m	ft		0.1	0.2		10	20	30		kN/m ³	
	74.82	Bay Water												
				4										
			2											
				8										
				12										
			4											
				16										
			6											
				20										
				24										
			8											
				28										
				32										
	65.07	Continued on next page		10										

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

LOG OF BOREHOLE 8 con't



Auger Sample ☒
 SPT (N) Value 00 ☒
 Dynamic Cone Test —
 Shelby Tube ••■
 Field Vane Test + s
 Natural Moisture X
 Plastic and Liquid Limit —○—
 Penetrometer ▲

Project: Geotechnical Investigation
 Proposed Glenora / Adolphustown
 Ferry Dock Improvement
 Bay of Quinte, Ontario

Dwg. No: 10A
 Project No: H03435-G

Borehole location and datum see drawing no. 2.

Water Level	Elev. Scale	Soil Description	Depth Scale		N Value	N Value				Natural Moisture Content			Sample	Natural Unit Weight
	m		(ft)	Shear		Strength		MPa	% Dry Weight					
						0.1	0.2		10	20	30			
		Continued from previous page	m	ft										
		Bay Water												
	65.07		10											
		0.6 m sand and silt, very loose												
	64.30	Fractured rock												
		Cone Refusal (Probable Bedrock)												
			12											
			14											
			16											
			18											
			20											
			22											
			24											
			26											
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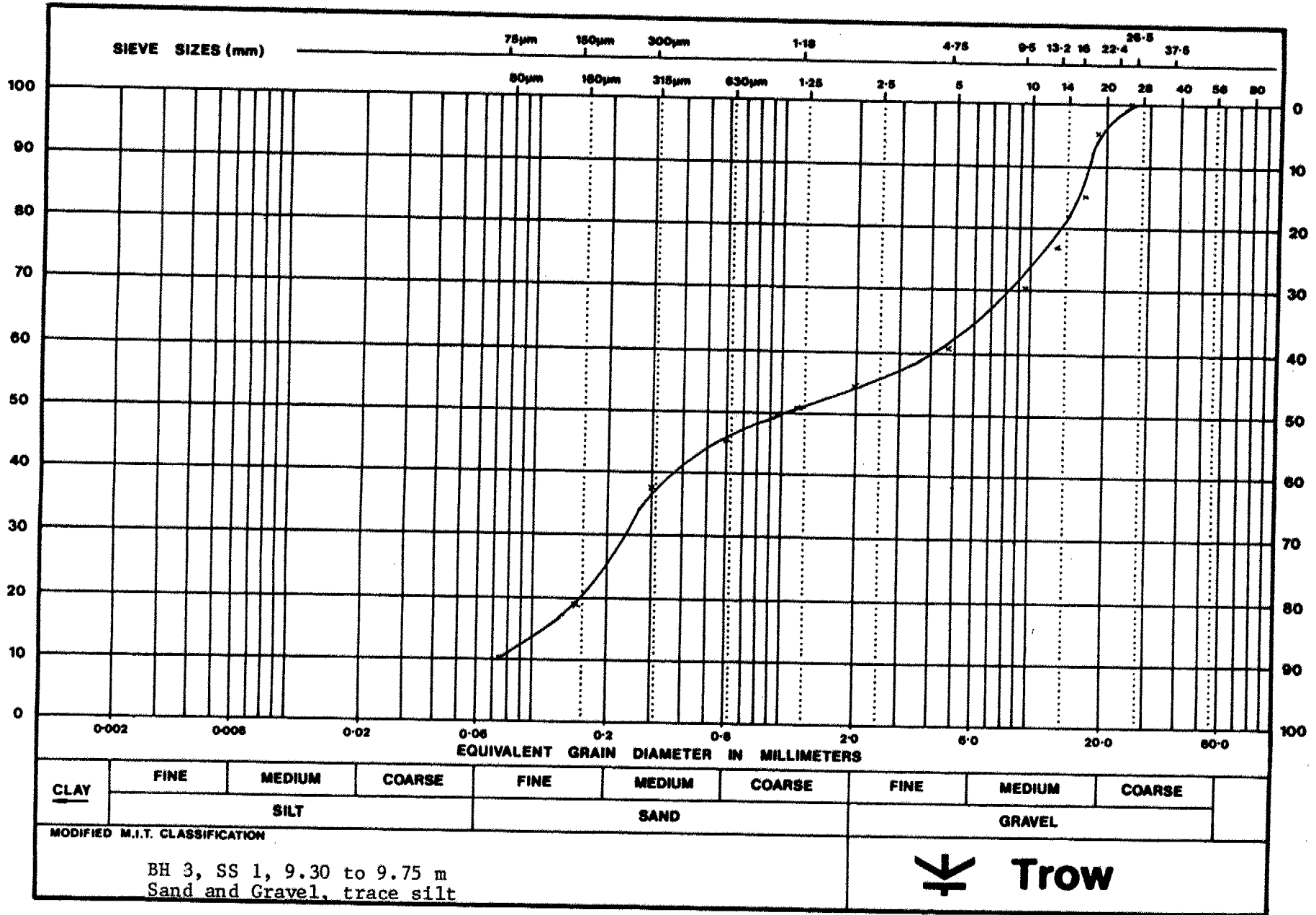
GRAIN SIZE ANALYSIS - ASTM D 422

PROJECT: H03435-G

PERCENTAGE RETAINED

DRAWING 11.

PERCENTAGE PASSING



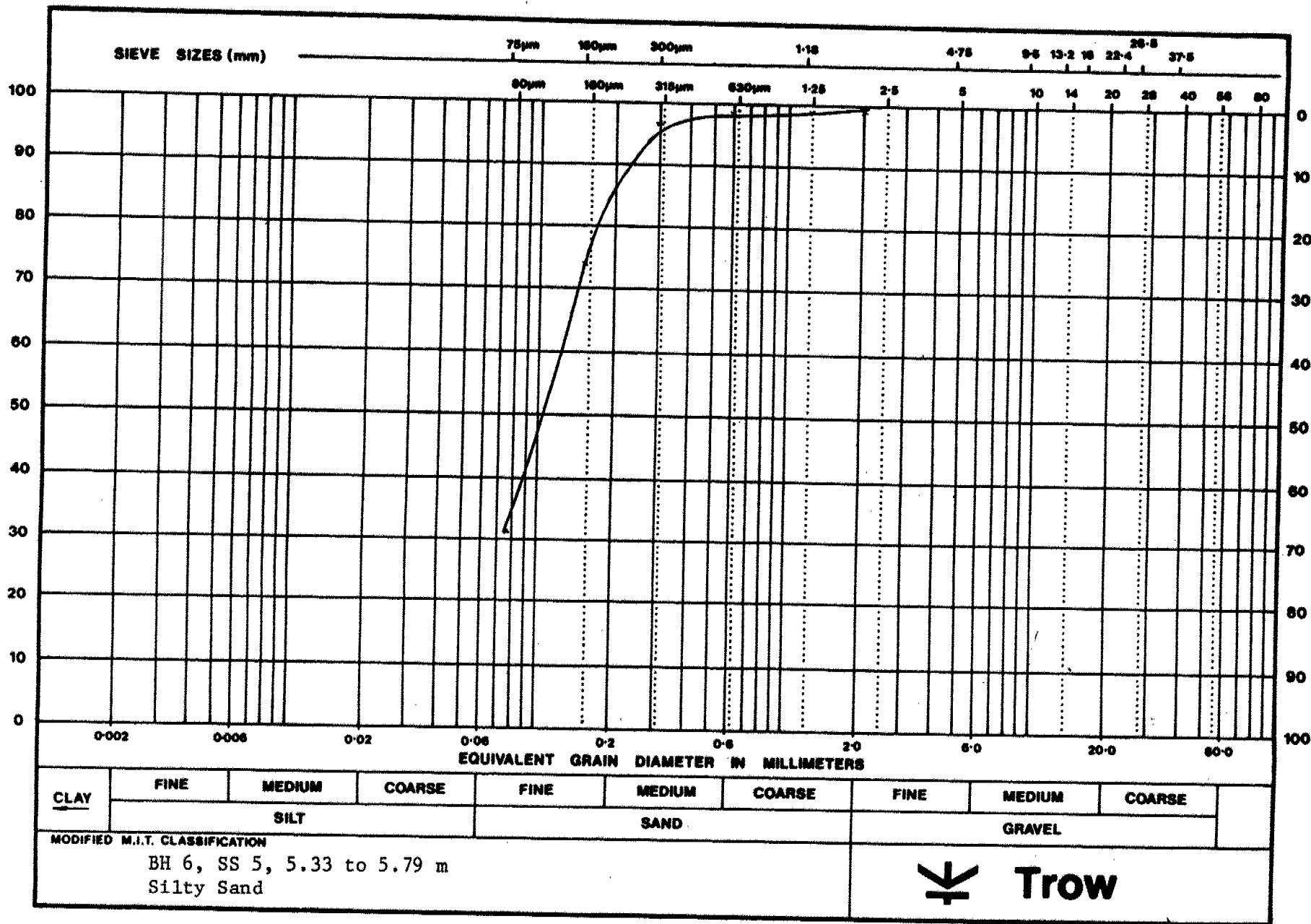
GRAIN SIZE ANALYSIS - ASTM D 422

PROJECT: H03425-G

PERCENTAGE RETAINED

DRAWING 12.

PERCENTAGE PASSING





Part B
Engineering Discussions



Part B

Engineering Discussions

General

The project will involve the design and construction of a new ferry dock to be located to the east of the existing dock structure. Details of the proposed structure and loading conditions had not been established at the time of the investigation. General comments regarding dock construction pertaining to the site conditions are given in this section. Since final concepts are preliminary at this point, the information provided is essentially generic. Further reporting might be required when final design plans are available. At that time specific comments can be made to check whether the geotechnical recommendations are compatible and sufficient.

The investigation indicated typically about 1 m of very loose deposits of sand, sand and gravel or silt overlying the limestone bedrock at depths of about 6.8 to 9.8 m below the bay water level. Near the shore at one borehole location, about 5 m of very loose silt was found above the bedrock.

Dock Construction

Based on the results of the investigation, it is our opinion that the proposed structure can be supported on end bearing piles. It is considered that steel H piles driven into the underlying limestone bedrock will be suitable to support the proposed structure.

The suggested working loads for various piles are given below:

<u>Pile Type</u>	<u>Suggested Working Load (tons)</u>
Steel H Section, 310 x 110	110
Steel H Section, 310 x 79	85

The piles should be driven to adequate set cognizant of the pile driving equipment chosen for the particular piles. The design capacity will depend on the chosen pile dimensions and driving techniques. Accordingly, a pile hammer will be required that can develop sufficient energy to efficiently drive the piles to practical refusal compatible with the design loads, yet



limit the input energy so as not to overstress the pile during driving. The hammer must develop sufficient energy to achieve the necessary working load per pile. For preliminary guidance, a suitable hammer such as a Delmag D-22 or equivalent should be used to drive the pile (eg. HP310 x 79) to practical refusal to achieve the 85 ton capacity. The final set will likely be about 5 blows per 8 mm or less for three consecutive sets, depending on actual (not rated) hammer efficiency, hammer capblock system, etc.

The complete driving system, ie. the hammer-cushion pile combination, should be reviewed by this office. Prior to the pile driving, a Wave Equation Analysis should be carried out in order to determine the penetration resistance required to develop the capacity of the piles. In the field, a number of piles should be monitored with the Pile Driving Analyser for the end of initial driving and restrike conditions to check for soil freeze and/or relaxation conditions as well as to confirm the ultimate bearing capacity of the piles. The installation operations should be inspected on a full-time basis by geotechnical personnel from Trow Consulting Engineers Ltd. to confirm uniformity of set, founding elevation, alignment and plumbness.

Nonsense!

The minimal depth of very loose overburden available at the proposed location is not expected to provide significant lateral support to the structure. In this regard, the piles may be socketed into the bedrock to provide toe support and resist lateral loading. At the top end of the structure, tie backs attached to 'dead-man' may be employed to generate lateral support provided that a land mass is to be created out into the bay area as conceptualized in Drawing 1. Details of such design from a geotechnical point of view can be provided if such a route is chosen. In the case where backfilling to create a platform is contemplated, a combination of H piles and sheet piles may be required. In all cases, socketing into the bedrock, may be required to resist sliding of the entire structure due to impact from the ferry. The hardness of the rock is reflected by the uniaxial compressive strength. These information is contained in Table 1.

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Rechnings



General Comments

We trust this information is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Yours very truly,

Trow Consulting Engineers Ltd.

Peter Chan, P. Eng.
Head, Geotechnical Services Group

Stan E.M. Gonsalves, M.Eng., P.Eng.
Vice President, Southern Ontario

KRT/ct

Encl.

Distribution: Public Works Canada
Attention: Mr. I. Schenkman

(3)

Disk: GEO.526/H03435G

MEMORANDUM



To: H. Kleywegt, P. Eng.
Area Structural Engineer
Eastern Region

Date: 1995 02 03

From: Foundation Design Section
Room 315, Central Bldg.

Tel: 235-3731
Fax: 235-5240

Re: Adolphustown Ferry Dock Replacement
WP 160-92-00

The preliminary drawings of the Adolphustown Ferry Dock replacement have been reviewed by our office. As indicated in our memorandum dated February 15, 1995, , the lateral resistance of the steel sheeting piling is an important design consideration. The drawings reveal that deadman anchors supported by granular 'A' material encapsulated within quarry run fill in combination with rock anchor toe pins will be used to provide the lateral resistance of the steel sheet piling.

The design of deadman anchors under the conditions given must be examined critically. The passive resistance of the deadman anchor is a function of the material type and the method of placement of this material. The proposed material and method of construction has inherent uncertainties and consequently further discussion regarding the deadman anchor design including concept, method, parameters and corrosion protection is recommended. Further discussion regarding the toe pin design and construction is also recommended.

A proposed detailed construction sequence and procedure should also be submitted for review to clarify unknowns regarding the method of construction of the construction activities. It is not understood, for instance, how the rock anchors are to be installed in the dry prior to fill placement.

We trust that our input can assist in finalizing the design and construction scheme for this interesting project.

A handwritten signature in black ink, appearing to read "T. Sangiuliano".

T. Sangiuliano, P. Eng.
Foundation Engineer

for

D. Dundas, P. Eng.
Sr. Foundation Engineer

MEMORANDUM



To: H. Kleywegt, P. Eng.
Area Structural Engineer
Structural Section
Eastern Region

February 15, 1995

From: Pavements and Foundations Section
Room 315, Central Bldg.

Tel: 235-3731
Fax: 235-5240

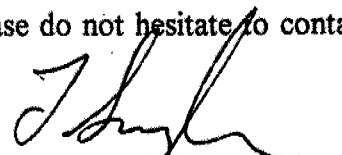
Re: Adolphustown Ferry Dock Replacement
WP 160-92-00
Highway 33, Bay of Quinte

The Foundation Investigation Report produced by Trow Consulting Engineers for the proposed ferry dock replacement at Adolphustown has been reviewed by our office. This report recommends that the dock structure be supported on end bearing piles or a combination of steel H piles and steel sheet piles founded on the bedrock. These piles will definitely encounter refusal at the bedrock surface and therefore any piles driven need only have this tip elevation specified. The elaborate guidelines given to control the pile installation that includes a final set and the application of the Pile Driving Analyser are hence not required.

It is indicated in your memorandum that preliminary drawings for the docks have been produced. It is suggested that in order to provide a complete review that these drawings be submitted. Specific details including the steel sheet piling, steel dowels socketted into the rock, tie backs and backfilling can then be reviewed. The lateral resistance of the steel sheeting piling is an important design consideration. Therefore the system lateral resistance, in particular, will require careful review.

It is understood that the vertical loading on the sheet piles is not significant. For this particular application, it is expected that the axial load carrying capacity of the piles driven to bedrock will be governed by the structural resistance of the pile as opposed to the geotechnical resistance provided by the unyielding bedrock.

If you have any questions regarding the above comments, please do not hesitate to contact this office.


T. Sangiuliano, P. Eng.
Foundation Engineer

for

D. Dundas, P. Eng.
Senior Foundation Engineer