

PRELIMINARY ONLY

DIST 62

WP 272-90-00

**SOILS INVESTIGATION FOR
EROSION CONTROL ON
HIGHWAY 17 AT
STOKELY CREEK STATION 20+670
HAVILLAND TOWNSHIP**

GEORES No 41K-50

Client: Ministry of Transportation

Prepared By
M. R. Wright & Associates Co. Ltd.
Consulting Engineers
Sault Ste. Marie, Ontario

INDEX

1. PURPOSE OF SOILS INVESTIGATION
2. DESCRIPTION OF THE SITE
3. DESCRIPTION OF SOIL TESTING METHODS
4. SOIL CONDITIONS
5. CONSIDERATIONS FOR EMBANKMENT STABILIZATION
6. RECOMMENDATIONS
7. SUMMARY

ENCLOSURES

BOREHOLE LOG

BH1

SITE PLAN

Drawing No. 2

TYPICAL SECTION FOR EMBANKMENT PROTECTION
HIGHWAY 17 NORTH RECONSTRUCTION AT STOKELY
CREEK STATION 20+670, HAVILLAND TOWNSHIP

Drawing No. 3

SOIL TEST DATA SHEET - WATER CONTENT
FOR SAMPLES 1, 3, 5 and 7

Exhibit A

SAMPLE NO. 1 GRAIN SIZE DISTRIBUTION CHART
Lab Sample SA 2864

Exhibit B

SAMPLE NO. 3 GRAIN SIZE DISTRIBUTION CHART
Lab Sample SA 2865

Exhibit C

SAMPLE NO. 5 GRAIN SIZE DISTRIBUTION CHART
Lab Sample SA 2866

Exhibit D

SAMPLE NO. 7 GRAIN SIZE DISTRIBUTION CHART
Lab Sample SA 2867

Exhibit E

PICTURES NUMBERED 1 AND 2

Exhibit F

PICTURES NUMBERED 3 AND 4

Exhibit G

**SOILS INVESTIGATION FOR
EROSION CONTROL ON HIGHWAY 17
AT STOKELY CREEK
STATION 20+670 HAVILLAND TOWNSHIP**

1. PURPOSE OF REPORT

As part of WP 272-90-00 project of rebuilding a portion of Highway 17 from the Goulais River Bridge northerly, 17.8 kilometers, a soils investigation was required in the area of Stokely Creek in order to address erosion conditions on the existing Highway embankment which had taken place over the years where the Stokely Creek runs near the Highway at Station 20+670, Township of Havilland.

A number of options for bank stabilization were to be considered, along with inputs for the following:

- Control of silt contamination in the Creek during construction.
- Protection of the Environment to Ministry of the Environment Standards.
- Protection of the waters in Stokely Creek re fish wildlife, and fish spawning requirements as per requirements of the Ontario Ministry of Natural Resources and Department of Fisheries.
- Encroachment on private property if required for construction procedures.

2. DESCRIPTION OF THE SITE

The Stokely Creek curves into the west side of Highway 17 at Station 20+670. During October of 1997, when local site soil information was obtained, water in the Creek was quite shallow and the water velocity was about 0.5 meters per second. In essence, the Creek was quite controlled. The Creek is a part of the Goulais River system which is known in the spring to cause rampages, with spring run-offs causing the waters to rise some two to three meters above normal water levels, and for water velocities to increase greatly. Also, during periods of heavy rains, water in the Stokely Creek and Goulais River have been found in these parts to rise quickly, with related increases in water velocity. It is during these times of high water flooding, that erosion of banks takes place.

In the area of Station 20+270 on Highway 17, the Stokely Creek bends in a circular curve along the west side of the Highway, and the water's edge during low water comes within about nineteen meters of the Highway centreline. In this area the low water level is about six meters below the Highway centreline elevation. The road embankment in this area has been eroded over the years, caused by scour from the Stokely Creek during high periods of run-off, and also by ditches on both sides of the Highway which feed water into this area, and eventually to Stokely Creek. The ditch on the east side of the Highway drains into an existing culvert which extends under Highway 17 to effluent into the Stokely Creek at this location. The ditch on the west side of the Highway also effluents into this area from the north, and erosion has taken place where the ditch gradient becomes excessive as it approaches Stokely Creek.

The Stokely Creek flows north at this location and turns west to divert away from the Highway. To the north of the Stokely Creek in this area there is a very steep rise in the terrain for a length of some 50 meters in an east west direction. This hill has been badly eroded. The silty sand in this area has been scoured, and overburden and trees have been displaced due to erosion. This is evidenced by observing the enclosed pictures Numbered 1 and 3 which are enclosed. Our preliminary investigation indicates that this eroded hill is located on Crown Property. Toward the north of this hill a large swamp is located. Much of the water from this swamp seeps through the silty sand soil as groundwater, and intersects this high hill about one third of the way up from bottom of the hill, or the level of water in the Stokely Creek. When the groundwater meets the slope of this hill the silty sand soil erodes immediately, and as the soil below this groundwater table falls away, the soil on this slope above the groundwater level also erodes and falls down the hill, bringing with it the overburden and trees at the top of the hill as erosion progresses. Due to continuing erosion in this area there is no topsoil or overburden remaining with the silty sand, which leaves this soil very susceptible to continued erosion.

The culvert which currently extends under the Highway at this location, has erosion at both the inlet and outlet ends.

The Highway at this location slopes upward to the north for a distance of some 150 meters, and ditches on both sides of the Highway bring water to the area in question, and some erosion is evident on both sides of the Highway where these ditches outlet. The majority of these ditches are in relatively good condition, and require a minimal of repairs.

Water which runs off the shoulder of the asphalt on the road in this area has also caused erosion on the sides of the shoulders before the water reaches the ditches. This is evidenced near Station 20+670 where shoulders in the vicinity of guiderail posts have been eroded. (See Picture Number 2)

3. DESCRIPTION OF SOIL TESTING METHODS

One Test Borehole was extended at this site in order to determine soil conditions. Due to the fact that a nearby hill on the west side of the Highway at Stokely Creek was exposed, it was obvious that soil conditions at the site were quite uniform and this is the reason why only one Borehole was extended. The location of this Borehole Number 1 is shown on the enclosed Site Plan Drawing Number 2.

This Borehole was extended to approximate depth 18.3 meters below grade, which is far below the level of the adjacent Creek. The reason for extending the Borehole was to examine soil conditions at greater depth in order to assemble design data for a Sheet Pile Retaining Wall, if this type of Embankment Control should become a consideration.

The Test Hole was advanced with the use of hollow stem augers, with samples being taken at one and one half meter intervals as drilling progressed, or sooner when felt necessary. These samples were recovered with a 50 mm diameter hollow sampler which was driven through the soil with a hammer which delivered an energy of 475 Joules per blow. At intervals the number of blows required to advance the sampler 300 mm through the soil, was recorded, this being a measure of the strength of soils. These numbers are recorded as standard "N" Values and are shown on the Borehole log. All samples were recovered and identified at this site, and were also retained for further office and laboratory testing. From these samples, certain ones were selected for the following laboratory tests:

- Grain Size distribution
- Classification of soils
- Moisture content
- Atterberg limits

- Plasticity Index
- Hydrometer analysis of fine soils

The results of these laboratory tests are shown on the enclosed data sheets.

Standard split spoon samples were continued to depth 12 meters below grade, at which point it became impossible to continue testing because water in combination with the silty sand came into the casing and prevented further penetration. At this point the test hole was extended by driving a standard 50 mm cone through the soil to depth 18.5 meters, below grade, at which point the Test Hole was discontinued. At certain intervals the number of blows required to advance the penetration cone one foot through the soil from a hammer which delivered an energy of 475 Joules per blow was recorded which again gives an indication of the general strength of soils. These are recorded as "B" counts on the Borehole log.

The watertable was determined by measuring the depth of free standing water in the Test Hole.

4. SOIL CONDITIONS

Soils in the Borehole generally consisted of the following, from grade downward;

- 0 to 0.45 meters - Granular "A" and Granular "B" materials probably from the existing road base
- 0.45 to 2.05 meters - fine brown silty sand
- 2.05 to 6.0 meters - medium grained brown sand and silt, saturated below the groundwater level
- 6.0 to 7.6 meters - grey saturated silty sand
- 7.6 to 13.1 meters - grey brown, moist, silt
- 13.1 to 18.29 meters - reasonably firm soils, which could not be classified since a 50 mm penetration cone was driven through the soil and no samples were recovered.

The watertable was located at depth 4.5 meters below grade, or elevation 190.73, which is about 2.7 meters above the water level in the adjacent Stokely Creek. The elevation of water in Stokely Creek at this time of testing was 188.0 meters.

From all of the Samples which were retained for laboratory testing, four samples were further tested. Samples numbered 1, 3, 5 and 7 were tested for the following:

- Water content
- Grain size for classification purposes
- Atterberg Limits
- Plasticity Index
- Hydrometer Analysis for fine soils - Sample No. 7 only

These samples were all located on Borehole No. 1 and are further defined as follows;

Soil Sample No. 1 - at depth 1.5 meters

Lab Sample No. SA2864

- Water Content 20.4%
- Soil Classification - fine brown sand and silt
- Plasticity Index - 0
- Atterberg Limits - could not be performed due to the absence of clay

Soil Sample No. 3 - at depth 3.0 meters

Lab Sample No. SA2865

- Water Content 9.9%
- Soil Classification - fine sand with some silt

- Plasticity Index - 0
- Atterberg Limits - could not be performed due to the absence of clay

Soil Sample No. 5 - at depth 6.0 meters

Lab Sample No. SA2866

- Water Content 25.2%
- Soil Classification - moist sand and silt
- Plasticity Index - 0
- Atterberg Limits - could not be performed due to the absence of clay

Soil Sample No. 7 - at depth 9.1 meters

Lab Sample No. SA2867

- Water Content 34.0%
- Soil Classification - moist clayey silt with a trace of fine sand
- Plasticity Index - 0
- Atterberg Limits - could not be performed due to the absence of clay

Based on the results of visual examination of samples, and further laboratory tests, the soils at the site from grade to approximate depth 7.6 meters below grade generally can be identified as follows:

- soil classification - fine brown sand and silt
- water content - varies from 9.9 to 25.2%
- Plasticity Index - 0

- Atterberg Limits - could not be performed due to the absence of clay, and a plasticity index of zero.

5. CONSIDERATIONS FOR EMBANKMENT STABILIZATION

Soil at this site from grade to approximately depth 7.6 meters below grade consists generally of fine moist silty sand to sandy silt. These soils are quite unstable when water is present, especially when below the water table, as evidenced by current erosion at the site. Above the water table, embankments in these soils should have a slope of not less than 2 horizontal to one vertical. Below the water table the slopes of embankments would be expected to be almost non-existent.

Option 'A' Do Nothing

The decision to leave the bank in its present state and do nothing is not a consideration given the fact the on-going erosion is causing a major concern with the bank stabilization and remedial action will be required to preserve the highway embankment.

Option 'B' Creek Diversion

This portion of Stokely Creek is on a long curve and it could be possible to divert the Creek further west by excavating a new water course as follows:

- excavate new water course
- fill in existing portion of Creek
- stabilize all new slopes

Problems with this alternative would be as follows:

- High cost for excavation of fill.

- Disruption of the stream flow including coffer dams which would be required to divert flow while construction work was being completed.
- Problems and costs associated with stabilizing the new Creek banks due to the presence of fine silty sand in combination with water.
- Disruption to the wild life and fish cycles in the Creek which would require Ministry of Natural Resources approval.
- Problems with pollution associated with excavation, and control of sediment, which would require approval of the Ministry of the Environment.

Based on the above assessments this option for improvement and bank stabilization was not proceeded with any further, due to cost and many other associated problems.

Option 'C' Sheet Pile Retaining Wall

This consideration should be rejected because soils at greater depth were found to be rather unstable, and lateral support for Sheet Piles in a Retaining Wall system would be difficult to achieve in these soils. Also, since no solid soils were found above the bottom of the test hole, extending Sheet Piles to this depth or greater for lateral support would become prohibitive. Lateral bulkheads on circular coffer dam stabilizers would be required at intervals to support sheet pile walls laterally.

One advantage of this type of structure would be minimal damage to the stream and stream bed. Once the Sheet Pile wall is driven, most of the remaining slope stabilization work could be carried on behind the new wall.

Based on the conclusions of excessive construction cost and the high cost of providing lateral stabilization for a steel Sheet Pile Retaining Wall, this option was not considered further.

Option 'D' Rip Rap Slope Stabilization and Containment

Rip Rap protection of slopes adjacent to the Creek would be a viable consideration for the stabilization problems and would offer the following advantages:

- reasonable cost compared with other considerations
- Construction would be adaptable to the site and soil conditions
- Rip Rap materials are available from two nearby sites
- minimal interference with the water flow in the Creek, and also with local fish cycles
- damage to the existing Creek could be minimized with suitable silt and sediment curtains.

This alternative appears to provide the best solution to embankment containment problems for this portion of the Highway.

7. RECOMMENDATIONS

Based on our examination of the site, analysis of soils information from the Boreholes, laboratory tests and soil samples, it is hereby recommended that soil stabilization of slopes at this site be completed as follows, as outlined in Item C above.

- I Place Rip Rap containment on slopes which are to be protected, consisting of a 1000 mm thickness of rock averaging 100 to 600 mm in size, placed on a geotextile fabric. It is our opinion that the Rip Rap should be 1000 mm in thickness in order to provide stabilization when water velocities are high, and also

due to the fact that the Rip Rap will be placed on the outside of the Creek curve, where erosion would be more intense when water currents are high. The Rip Rap should extend one meter below the Creek bed and be placed to a height of 1.5 meters above the anticipated high water level, which would be about elevation 192.5 meters. Slopes of the Rip Rap stabilization could vary from 1.5:1 to 1:1 slopes. Rip Rap protection is to be extended between the Creek and Highway, and also along the bottom of the high hill which is currently eroded west of the Highway, to locations as shown on the enclosed Site Plan Drawing Number 2. Drawing No. 2 has also been enclosed to show proposed details for Rip Rap placement in relation to the Highway and Creek.

- II Slopes on embankments which extend above the Rip Rap are to be graded to a minimum 2:1 slope and seeded with mulch for stabilization. For correction of the hill slope to the west of the Highway on Private or Crown land, additional excavation of the soil above the new Rip Rap embankment is to be excavated to give a slope of not less than 2 horizontal to 1 vertical. For new fill which would be required above the new Rip Rap wall and between the Highway and the creek, granular fill is to be utilized for this purpose and the new grade levelled to a slope of not more than 2 horizontal to 1 vertical. Excavated soil when constructing the new embankment slopes on the hill would consist of fine sandy silt and would be unacceptable for re-use as fill in the area between the Creek and the Highway. Select granular materials are to be brought to the site for this purpose. For the current hill embankment, Rip Rap is to be added, the existing hill re-graded to a slope of not less than 2 horizontal to 1 vertical, all debris removed and seed mulch placed over the new slope areas.
- III Current erosion which has occurred on the east side of the Highway at the existing culvert entrance on the east side of the Highway is to be corrected with Rip Rap placed around the inlet with a maximum 200 mm rock to a thickness of 450 mm placed over geotextile fabric, to a height of 1 1/2 meters above the invert of the Culvert. This Rip Rap is to be extended into the bottom of the existing ditches along the Highway.

- IV The existing outlet of the Culvert which crosses the Highway must be protected with Rip Rap, and blended into the proposed new Rip Rap which is to be installed along the existing Creek bank.
- V A concrete or asphalt sluice-way is to be continued at the end of the existing Highway ditch which comes from the north along the west side of the Highway, and extended down through the new Rip Rap embankment along the Creek bed, to the level of the water in the Creek.
- VI In order to collect drainage water from the Highway asphalt surface in this area the shoulder of the road on the west side of the Highway is to be paved with a ditch depression inside the guiderails which would collect water rather than have the water drain over the edge of the road embankment. The paved depression should start about Station 20+600 north of this area and extend to about Station 20+700 to the south, where a Catchbasin and Catchbasin lead would be used to carry run-off water to the adjacent ground which is currently about two meters below Highway level. This is required in order to divert as much runoff water as possible away from the area in question since the fine silty sand at the site becomes unstable when subjected to water.
- VII All proposals for construction work with respect to the Stokely Creek must be approved by the Ministry of the Environment, the Department of Fisheries, and the Ministry of the Natural Resources prior to the start of any work at the site and must follow procedures as outlined in the MNR document entitled "Environmental Guidelines for Access Roads and Water Crossings".
- VIII For corrective work which is proposed for the high hill at the north-west corner of this project, the Owners of the land must be established before any work can be commenced. At this time our information suggests that this area belongs to the Crown, however this item must be clarified.
- IX Any site soil which is excavated would consist of fine silty sand, which is very unstable in the presence of water. For this reason any excavated material should be disposed of, and not used as fill material for any aspects of new construction.

8. SUMMARY

We trust you will find the enclosed complete and adequate for design considerations at this time.

Respectfully submitted,

MRW:lc

M. R. Wright, P. Eng.

M.R.WRIGHT AND ASSOCIATES CO. LTD.

SAULT STE. MARIE ONTARIO

SOILS INVESTIGATIONS

CONSULTING ENGINEERS

BORING LOG

STRUCTURE: STOKLEY CREEK
EROSION AREA

CONTRACT: 5444

SHEET: 1 of 4

LOCATION: STATION 20+655 TWP. OF HAVILAND
O/S 6.0M RIGHT

INSPECTOR: MPF/MM

DATE: OCT. 8/97

OWNER: MINISTRY OF TRANSPORTATION

BOREHOLE NO.: ONE

DATUM: SEE NOTE BELOW

MISCELLANEOUS DATA

LENGTH OF HOLE: 18.29 M

ROCK: NOT FOUND mm

WEIGHT OF HAMMER: 63.5 kg

AVG. FALL OF HAMMER: 0.76 M

ELEV. OF GROUND WATER: 190.73 EL.

SAMPLE LEGEND

D — DISTURBED

W — WASH

U — UNDISTURBED

C — ROCK

STRATIFICATION

ELEVATION M	LEGEND	DEPTH M	SAMPLE NO.	PENETRATION RESISTANCE	STANDARD PENETRATION BLOWS						DESCRIPTION
					0	20	40	60	80	100	
195.23		0.00									0.25M DEPTH OF GRANULAR 'A' OVER 0.20M DEPTH OF GRANULAR 'B'
194.78		0.45									FINE BROWN SAND AND SILT MOIST — WITH SEAMS OF MEDIUM/ COURSE GRAINED SAND
193.73		1.50	1	N=49							
193.18		2.05									
192.98		2.25	2	N=24							MEDIUM GRAINED BROWN SAND MOIST
192.23		3.00	3	N=19							MEDIUM GRAINED BROWN SAND WITH SOME SILT — MOIST
190.73	W.T. X	4.50	4	N=9							MEDIUM GRAINED BROWN SAND WITH SOME SILT — SATURATED

DATUM: M.T.O. BENCHMARK — ELEVATION 191.448 — N+W IN ROOT OF 0.60 MAPLE,
22.7M RT OF STATION 20+795.4

5444BH1A.DWG 1=1

M.R.WRIGHT AND ASSOCIATES CO. LTD.

SAULT STE. MARIE ONTARIO

SOILS INVESTIGATIONS

CONSULTING ENGINEERS

BORING LOG

STRUCTURE: STOKLEY CREEK
EROSION AREA

CONTRACT: 5444

SHEET: 2 of 4

LOCATION: STATION 20+655 TWP. OF HAVILAND
O/S 6.0M RIGHT

INSPECTOR: MPF/MM

DATE: OCT. 8/97

OWNER: MINISTRY OF TRANSPORTATION

BOREHOLE NO.: ONE

DATUM: SEE NOTE BELOW

MISCELLANEOUS DATA

LENGTH OF HOLE: 18.29 M

ROCK: NOT FOUND mm

WEIGHT OF HAMMER: 63.5 kg

AVG. FALL OF HAMMER: 0.76 M

ELEV. OF GROUND WATER: 190.73 EL.

SAMPLE LEGEND

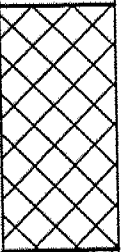
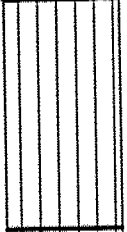
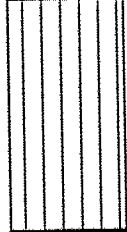
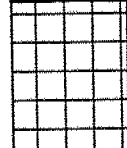
D — DISTURBED

W — WASH

U — UNDISTURBED

C — ROCK

STRATIFICATION

ELEVATION M	LEGEND	DEPTH M	SAMPLE NO.	PENETRATION RESISTANCE	STANDARD PENETRATION BLOWS						DESCRIPTION
					0	20	40	60	80	100	
189.23		6.0	5	N=4	○						DARK GREY SAND AND SILT SATURATED
187.61		7.62	6	N=0	○						GREY CLAYEY SILT MOIST
186.09		9.14	7	N=6	○						GREY/BROWN CLAYEY SILT MOIST
184.56		10.67	8	N=5	○						GREY/BROWN CLAY MOIST

DATUM: M.T.O. BENCHMARK - ELEVATION 191.448 - N+W IN ROOT OF 0.60 MAPLE,
22.7M RT OF STATION 20+795.4

1=1

5444BH1B.DWG

M.R.WRIGHT AND ASSOCIATES CO. LTD.

SAULT STE. MARIE ONTARIO

SOILS INVESTIGATIONS

CONSULTING ENGINEERS

BORING LOG

STRUCTURE: STOKLEY CREEK
EROSION AREA

CONTRACT: 5444

SHEET: 3 of 4

LOCATION: STATION 20+655 TWP. OF HAVILAND
O/S 6.0M RIGHT

INSPECTOR: MPF/MM

DATE: OCT. 8/97

OWNER: MINISTRY OF TRANSPORTATION

BOREHOLE NO.: ONE

DATUM: SEE NOTE BELOW

MISCELLANEOUS DATA

LENGTH OF HOLE: 18.29 M

ROCK: NOT FOUND mm

WEIGHT OF HAMMER: 63.5 kg

AVG. FALL OF HAMMER: 0.76 M

ELEV. OF GROUND WATER: 190.73 EL.

SAMPLE LEGEND


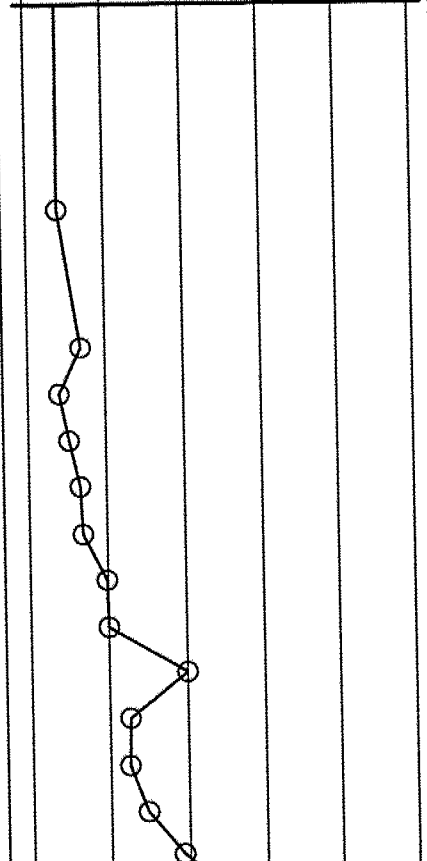
D — DISTURBED

W — WASH

U — UNDISTURBED

C — ROCK

STRATIFICATION

ELEVATION M	LEGEND	DEPTH M	SAMPLE NO.	PENETRATION RESISTANCE	STANDARD PENETRATION BLOWS						DESCRIPTION
					0	20	40	60	80	100	
183.04		12.19	9	N=7							SOFT WET GREY/RED CLAY AUGER HOLE HEAVED 600mm. NO LONGER ABLE TO USE AUGER BEGAN USING PENETRATION CONE @13.11M B= NUMBER OF BLOWS PER FOOT WHILE DRIVING A STANDARD 50mmØ PENETRATION CONE WITH 63.5 kg. HAMMER FALLING 760mm (ENERGY PER BLOW= 475 joules)
182.12		13.11		B=14							
181.82		13.41		B=7							
181.51		13.72		B=9							
181.21		14.02		B=13							
180.90		14.33		B=15							
180.60		14.63		B=19							
180.29		14.94		B=20							
179.99		15.24		B=40							
179.69		15.54		B=24							
179.38		15.85		B=23							
179.08		16.15		B=29							
178.77		16.46		N=38							

DATUM: M.T.O. BENCHMARK — ELEVATION 191.448 — N+W IN ROOT OF 0.60 MAPLE,
22.7M RT OF STATION 20+795.4

5444BH1C.DWG | 1=1

M.R.WRIGHT AND ASSOCIATES CO. LTD.

SAULT STE. MARIE ONTARIO

SOILS INVESTIGATIONS

CONSULTING ENGINEERS

BORING LOG

STRUCTURE: STOKLEY CREEK
EROSION AREA

CONTRACT: 5444

SHEET: 4 of 4

LOCATION: STATION 20+655 TWP. OF HAVILAND
O/S 6.0M RIGHT

INSPECTOR: MPF/MM

DATE: OCT. 8/97

OWNER: MINISTRY OF TRANSPORTATION

BOREHOLE NO.: ONE

DATUM: SEE NOTE BELOW

MISCELLANEOUS DATA

LENGTH OF HOLE: 18.29 M

ROCK: NOT FOUND mm

WEIGHT OF HAMMER: 63.5 kg

AVG. FALL OF HAMMER: 0.76 M

ELEV. OF GROUND WATER: 190.73 EL.

SAMPLE LEGEND

D — DISTURBED

W — WASH

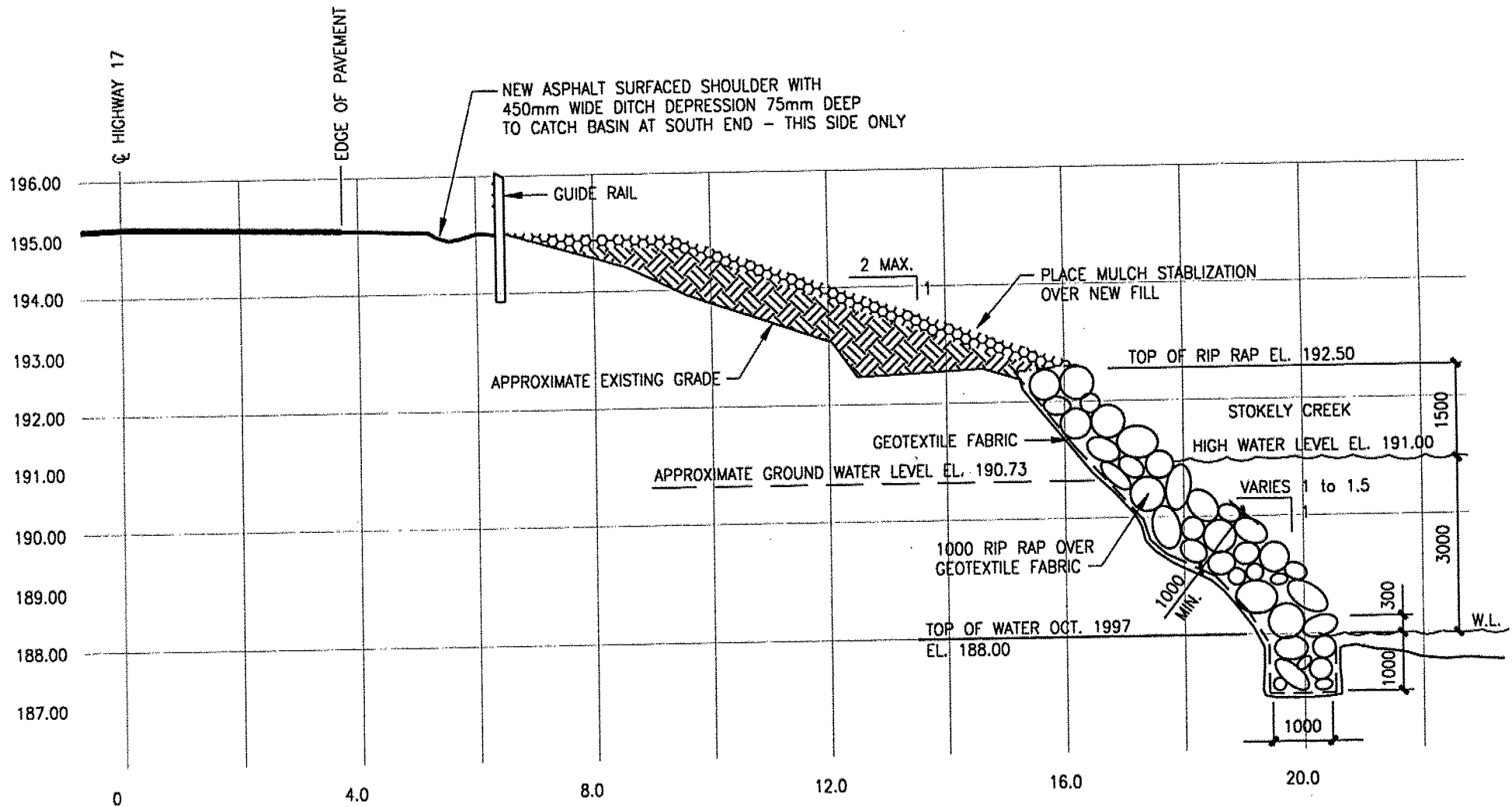
U — UNDISTURBED

C — ROCK

STRATIFICATION

ELEVATION M	LEGEND	DEPTH M	SAMPLE NO.	PENETRATION RESISTANCE	STANDARD PENETRATION BLOWS						DESCRIPTION
					0	20	40	60	80	100	
178.47		16.76		B=49							NO FURTHER PENETRATION HOLE DISCONTINUED
178.16		17.07		B=41							
177.86		17.37		B=26							
177.55		17.68		B=25							
177.25		17.98		B=19							
176.94		18.29									

DATUM: M.T.O. BENCHMARK — ELEVATION 191.448 — N+W IN ROOT OF 0.60 MAPLE,
22.7M RT OF STATION 20+795.4



TYPICAL SECTION FOR EMBANKMENT PROTECTION
HIGHWAY 17 NORTH - RE CONSTRUCTION AT STOKELY CREEK
STATION 20+670 - LOOKING SOUTH

M.R.WRIGHT AND ASSOCIATES CO. LTD.
CONSULTING ENGINEERS
SAULT STE. MARIE ONTARIO

SOIL TEST DATA SHEET

M.R. WRIGHT AND ASSOCIATES CO. LTD.
CONSULTING ENGINEERS
390 BAY STREET - 5TH FLOOR, SAULT STE. MARIE, ONTARIO
LABORATORY - 71 BLACK ROAD - UNIT 3

PROJECT - Hwy 17 N. - 17.5 kms North Of Goulais River

SAMPLE IDENTIFICATION - Stokely Creek Borehole - Samples No 1,3,5 & 7

SILT TEST

IN ACCORDANCE TO CSA 23.2-5A - M94

A ORIGINAL DRY WEIGHT =
B DRY WEIGHT AFTER WASHING =
% SILT = $(A - B) / A \times 100$ =

ORGANIC TEST

IN ACCORDANCE TO CSA A23.2-7A - M94

SODIUM HYDROXIDE ADDED

RESULTS

DATE	TIME	MATERIALS	DATE	TIME	READING

MOISTURE CONTENT

<u>MOISTURE CONTENT</u>		Sample #1	Sample #3	Sample #5	Sample #7	
	CONTAINER No.	1	2	3	4	5
A	TARE & WET SOIL (GRAMS)	1107.5	922.5	1148.8	1323.6	
B	TARE & DRY SOIL "	941.6	850.7	1046.4	1072.9	
C	WEIGHT OF WATER "	165.9	71.8	102.4	250.7	
D	TARE "	128.0	126.6	639.3	334.6	
E	WEIGHT OF DRY SOIL "	813.6	724.1	407.1	738.3	
F	WATER CONTENT, w %	20.4	9.9	25.2	34.0	

DATE - October 28 /1997

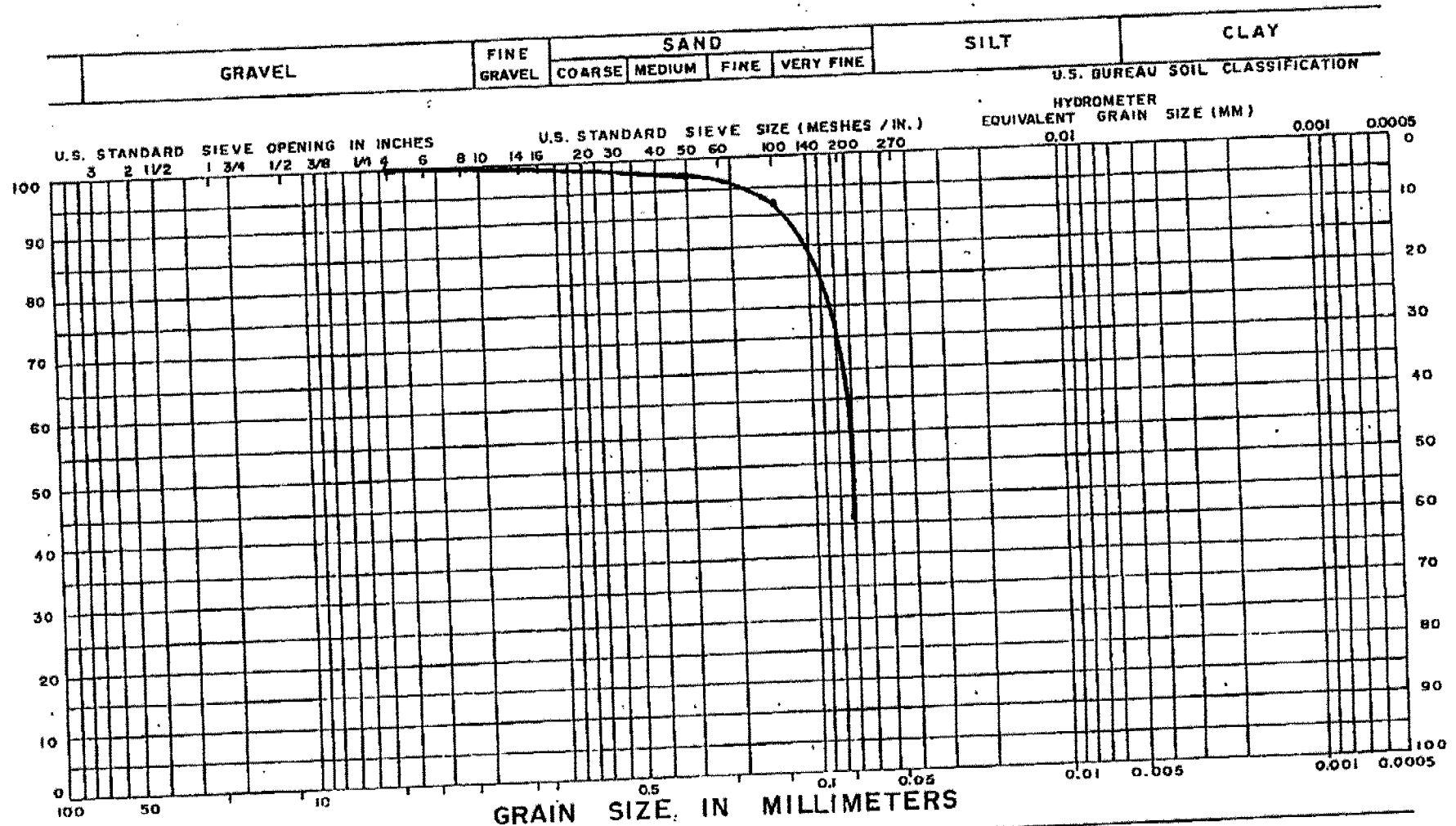
CONTRACT NO. - 5444

CLIENT -

COPIES TO -

Colin Liddiard

WE HEREBY CERTIFY TESTING PROCEDURES IN ACCORDANCE WITH CAN/CSA-A23.2-M94 FOR THAT PORTION OF TESTING PERFORMED BY THIS COMPANY.



GRAIN SIZE DISTRIBUTION

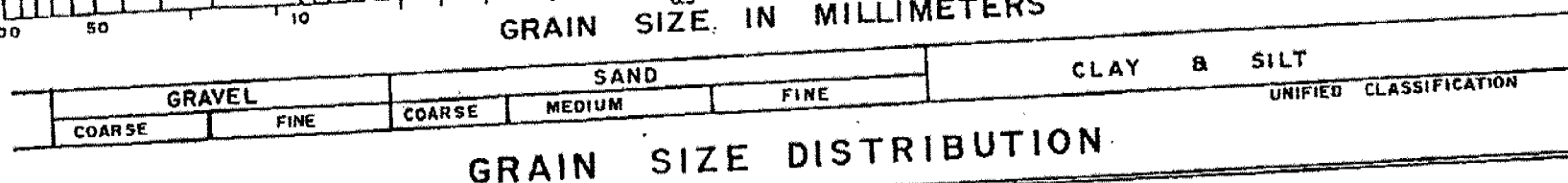
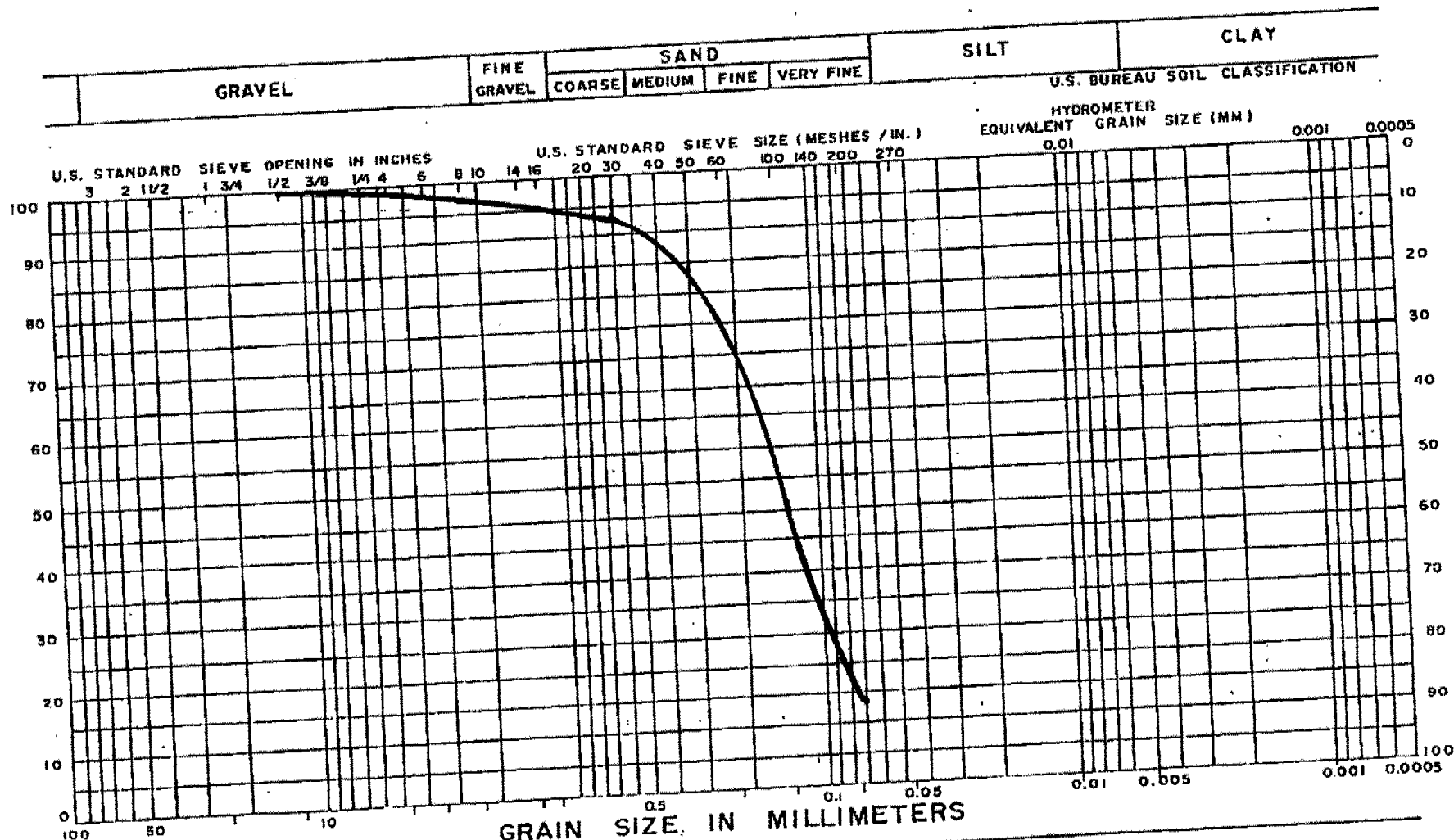


M.R. WRIGHT AND ASSOCIATES CO. LTD.
CONSULTING ENGINEERS

390 Bay Street, 6th Floor
Suite 606, St. Catharines, Ontario L9A 1X2
Phone: 1-705-946-6020
Fax: 1-705-949-3026

DESCRIPTION:	Hwy. 17 From Goulais River 17.5 kms North	GRAIN SIZE DISTRIBUTION NO.	SA 2864
	MTO Job No. 9660-7411-6102		
SAMPLED FROM:	Stokely Creek Borehole - Sample No. 1	SAMPLED BY:	Mike Figures
	Depth 1.5M	OF:	M.R. Wright & Associates
TESTED BY:	Colin Liddiard	DATE:	October 28 /1997
		CONT. NO.	5444

EXHIBIT B



M.R. WRIGHT AND ASSOCIATES CO. LTD.
CONSULTING ENGINEERS

390 Bay Street, 5th Floor
Sault Ste. Marie, Ontario P6A 1X2
Phone: 1-705-945-5090
Fax: 1-705-949-3026

DESCRIPTION: Hwy. 17 From Goulais River 17.5 kms North
MTO Job No. 9660-7411-6102

SAMPLED FROM: Stokely Creek Borehole - Sample No. 3
Depth 3.0M

TESTED BY: Colin Liddiard

DATE: October 28 /1997

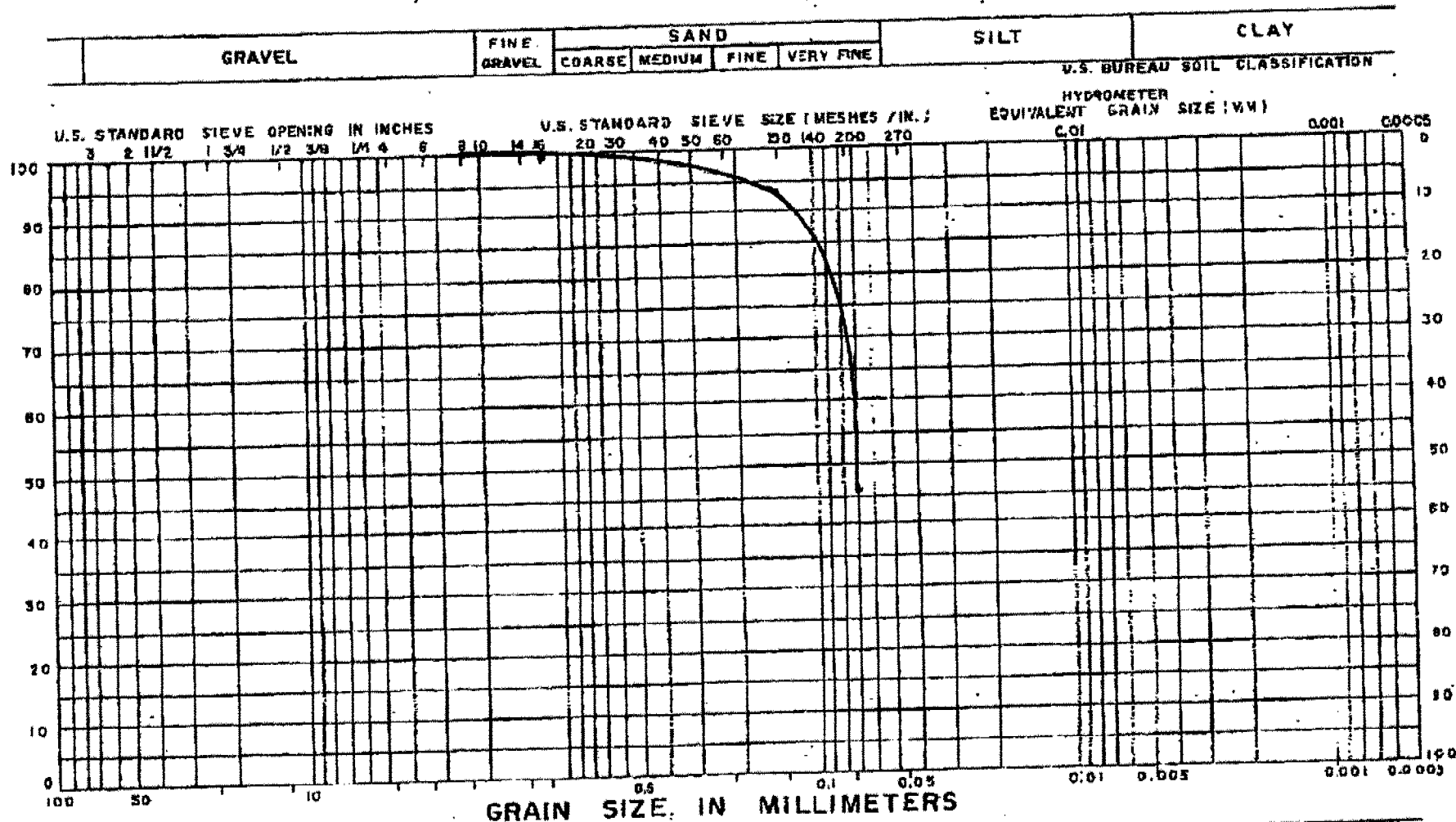
GRAIN SIZE DISTRIBUTION NO. SA 2865

SAMPLED BY: Mike Figures

OF: M.R. Wright & Associates

CONT. NO. 5444

EXHIBIT C-



GRAIN SIZE DISTRIBUTION



M.R. WRIGHT AND ASSOCIATES CO. LTD.
CONSULTING ENGINEERS

300 Bay Street, 5th Floor
St. Catharines, Ontario N6A 1X2
Phone: 1-705-945-5090
Fax: 1-705-945-3028

DESCRIPTION:

Hwy. 17 From Goulais River 17.5 kms North

GRAIN SIZE DISTRIBUTION NO.

SA 2866

SAMPLED FROM:

MTO Job No. 9660-7411-6102
Stokely Creek Borehole - Sample No. 5 DEPTH 6.0M

SAMPLED BY:

OF:
Mike Figures

M.R. Wright & Associates

TESTED BY:

Colin Liddiard

DATE:

October 28 /1997

CONT. NO.

5444

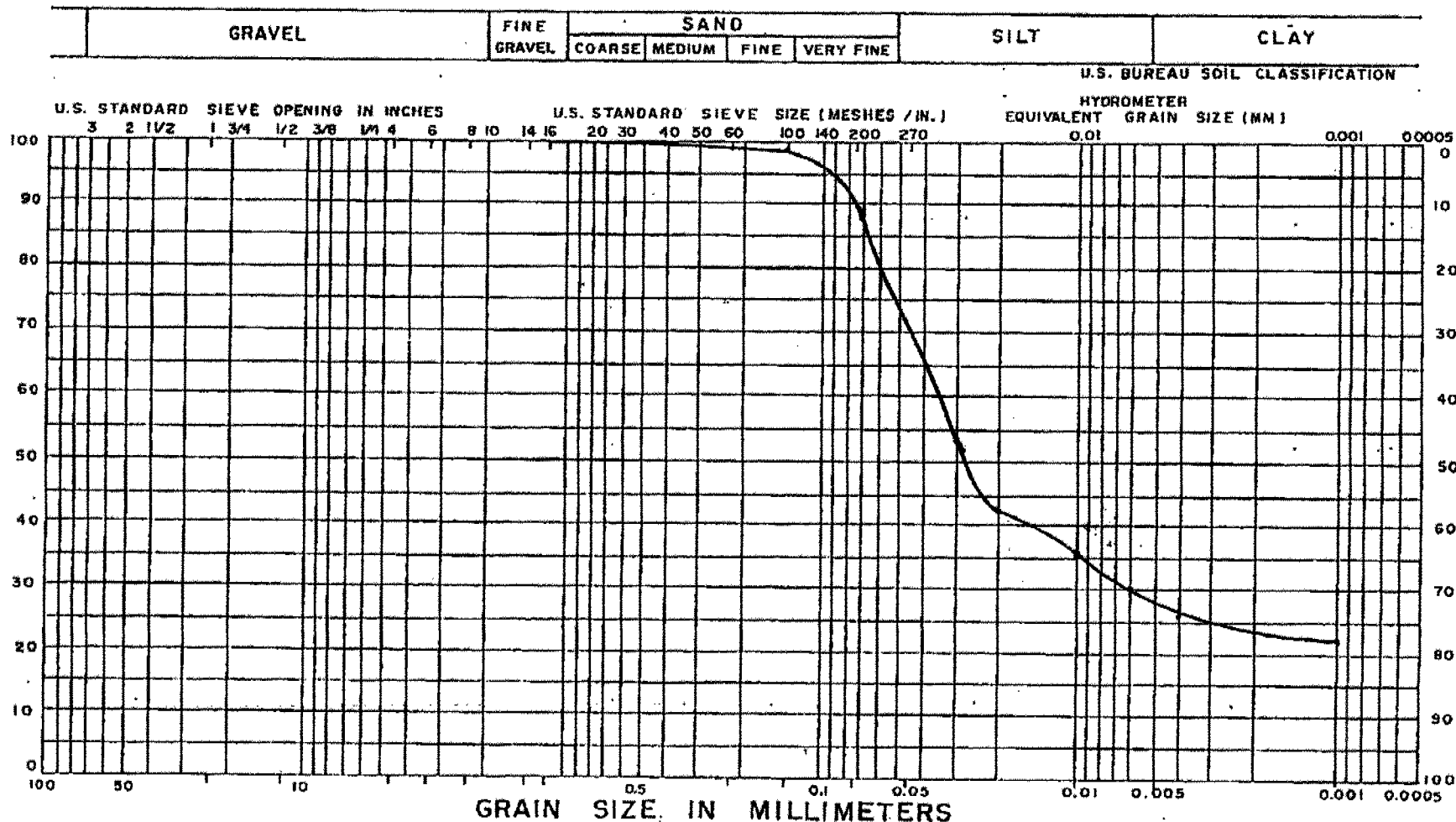
EXHIBIT D

10/29/97 10:33

0705 945 5092

M. R. WRIGHT LAB - OFFICE

003





PICTURE 1 Showing Erosion of Road Bank and adjacent hill - looking North-west.



PICTURE 2 Showing Erosion of bank at the north-west corner of site - looking North-west

Highway 17 North Reconstruction at Stokely Creek
Station 20+655

M. R. Wright and Associates Co. Ltd.
Consulting Engineers
Sault Ste. Marie, Ontario



PICTURE 3 Showing Erosion of bank at the north-west corner of the site - looking North-west



PICTURE 4 Showing Erosion at entrance to culvert on east side of highway - looking north

Highway 17 North Reconstruction at Stokely Creek
Station 20+670

M. R. Wright and Associates Co. Ltd.
Consulting Engineers
Sault Ste. Marie, Ontario