

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 41P-18

DIST. 14 REGION

W.P. No. 194-88-02

CONT. No. 90-450

W. O. No.

STR. SITE No. 46-22

HWY. No. 560

LOCATION Jessie James Creek

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

PLATE No  
**CONT No 90-450**  
**WP No 194-88-02**



**JESSE JAMES CREEK**  
**BOX CULVERT**  
**GENERAL ARRANGEMENT**

**SHEET**  
**5054**

**Marshall Mackin Monaghan**  
Limited  
San Jose  
Consulting Engineers - Surveyors - Planners

**NOTES**

**Loading**

1. OHSR Code 62 Class 'A' Highway.

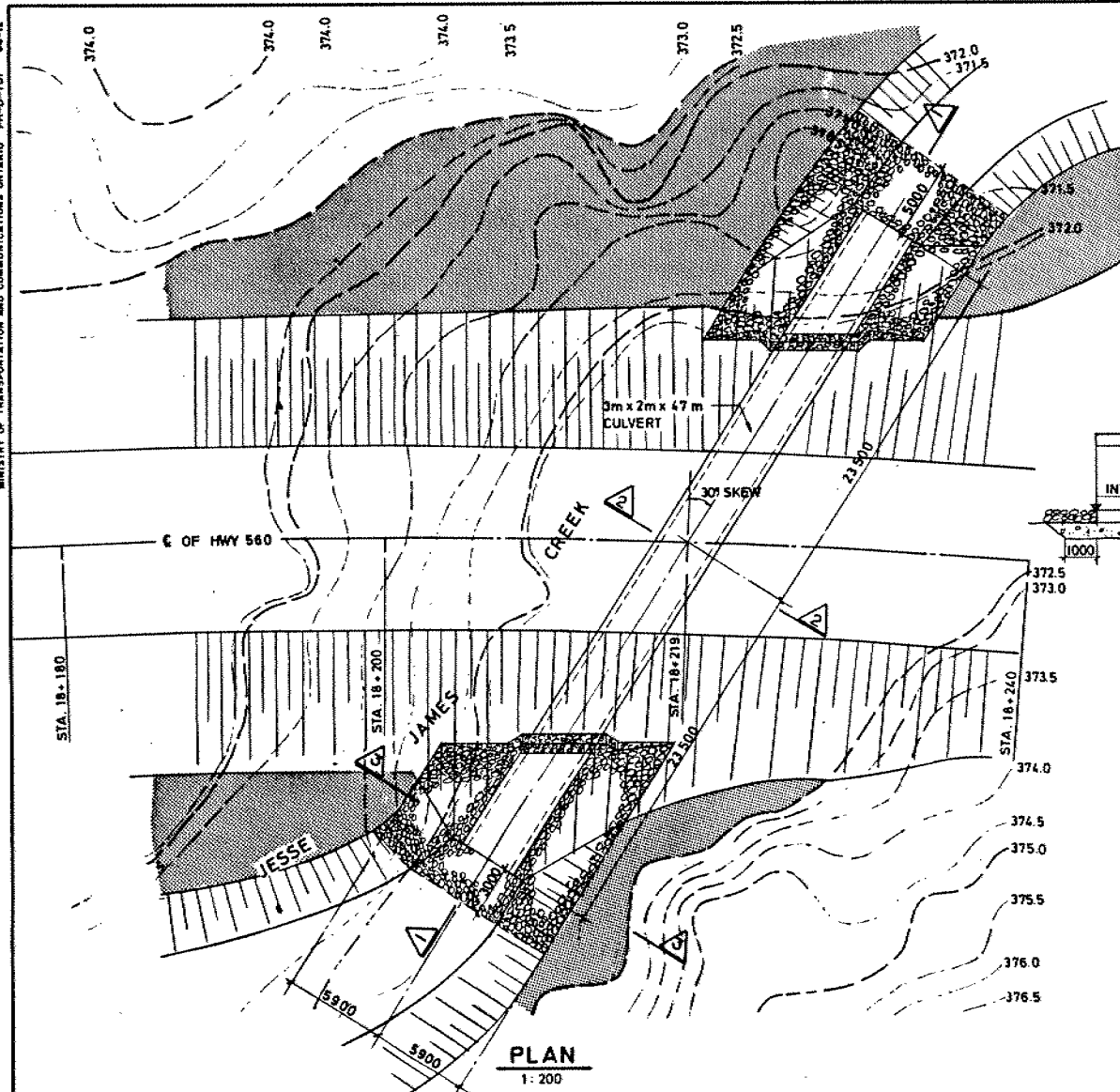
**Materials**

1. Class of Concrete  
All concrete ..... 30 MPa
2. Reinforcing Steel  
Reinforcing Steel - Grade 400 MPa
3. Clear Cover to Reinforcing Steel

Cast Against Ground ..... 100 ± 25  
Bottom of Top Slab ..... 40 ± 10  
Remainder ..... 75 ± 20  
Unless Noted on Drawings

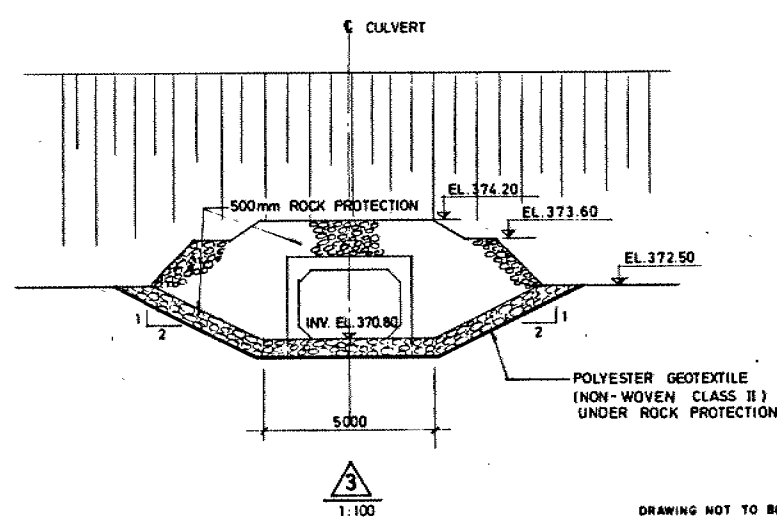
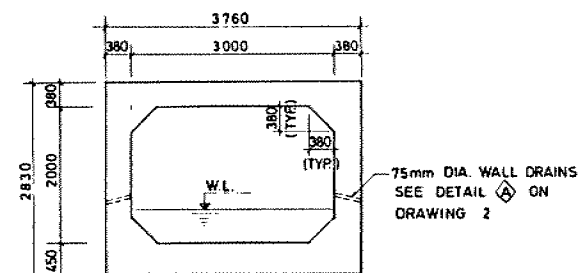
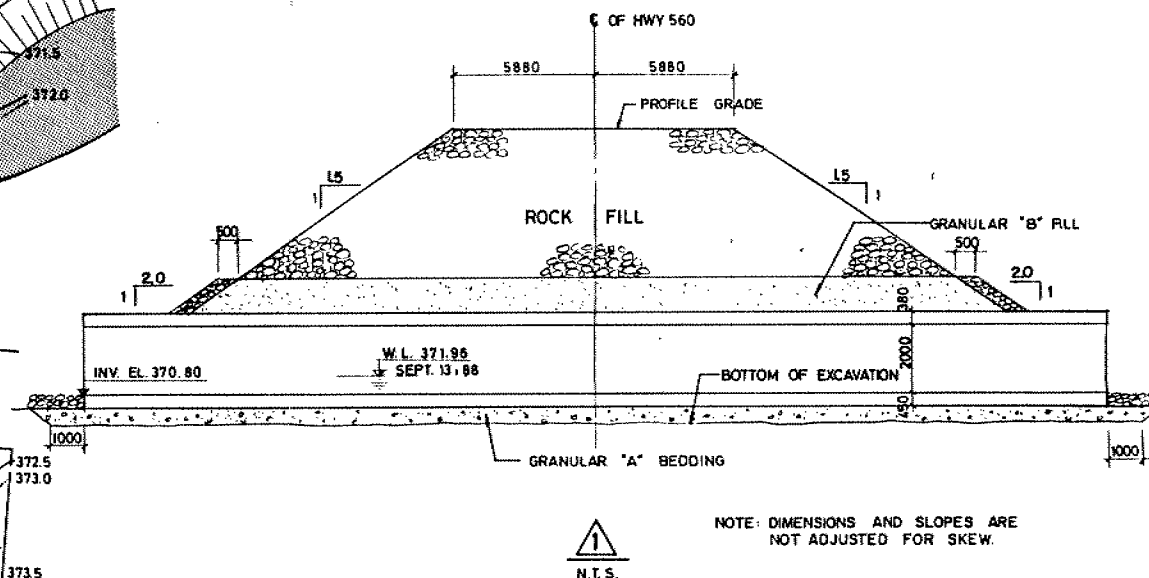
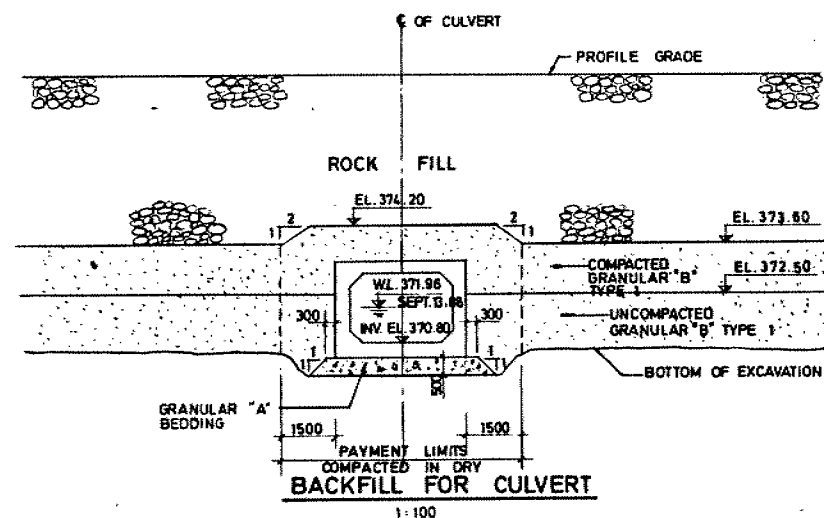
**Construction**

1. No concrete shall be placed until the depth of the excavation and character of the foundation approved by the engineer.
2. Wall drain openings shall be formed of non-metallic material. The vertical location of wall drains shall be verified in the field by the engineer.
3. Backfill shall be placed at both sides of the culvert simultaneously with a maximum height difference of 500 mm.



**LEGEND:**

FILL TO EL. 372.50 (MIN.)



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN K.K. CHK S.K. CODE	10/04	DATE NOV 1998	
DRAWN R.S. CHK S.K. SITE 46-22	1/2000	IS/STRUCT	SCHEME
			CHG 1

# METRIC

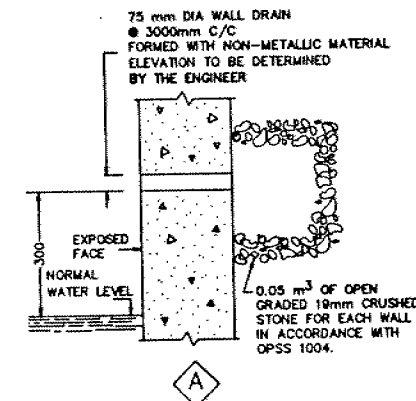
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No 90-450  
WP No 194-88-02

JESSE JAMES CREEK  
BOX CULVERT  
REINFORCING DETAILS

SHEET  
55

Marshall Macklin Monaghan  
Limited  
Consulting Engineers - Surveyors - Planners



## GENERAL NOTES

CLASS OF CONCRETE  
30 MPa

CLEAR COVER TO REINFORCING STEEL  
BOTTOM OF TOP SLAB 40 ± 10  
BOTTOM OF BOTTOM SLAB 100 ± 25  
REMAINDER 70 ± 20 UNLESS OTHERWISE NOTED  
REINFORCING STEEL SHALL BE GRADE 400 UNLESS  
OTHERWISE SPECIFIED. BARS MARKED WITH SUFFIX C  
DENOTE COATED BARS.

ALT DENOTES ALTERNATE  
IF DENOTES INSIDE FACE  
OF DENOTES OUTSIDE FACE  
EF DENOTES EACH FACE

## CONSTRUCTION NOTES

- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
- NO CONCRETE SHALL BE PLACED UNTIL THE DEPTH OF THE EXCAVATION AND THE CHARACTER OF THE FOUNDATION HAVE BEEN APPROVED BY THE ENGINEER.

MARK	NO. REQ'D	C/C	LENGTH	DETAILS	REMARKS
H15001	158	600	1810	STRAIGHT	TOP OF TOP SLAB BOTTOM OF BOTTOM SLAB
J20001	158	600	6610	1820 [RADIUS = 300] 1820 2040 ±	J BARS ALTERNATE WITH K BARS
K20001	158	600	5000	1010 [RADIUS = 300] 1010 2040 ±	K BARS ALTERNATE WITH J BARS
P15001	314	150	3380	STRAIGHT	BOTTOM OF TOP SLAB
Q15001	314	150	3380	STRAIGHT	TOP OF BOTTOM SLAB
R15001	532	300	7100	STRAIGHT 76 SETS • 7 PER SET	LONGITUDINAL IN WALLS AND SLABS
S15001	314	300	1690	45° 1330 45° 180°	HAUNCH
T15001	314	300	2000	STRAIGHT	INSIDE FACE OF WALLS
U15001	314	300	1630	45° 1270 45° 180°	HAUNCH

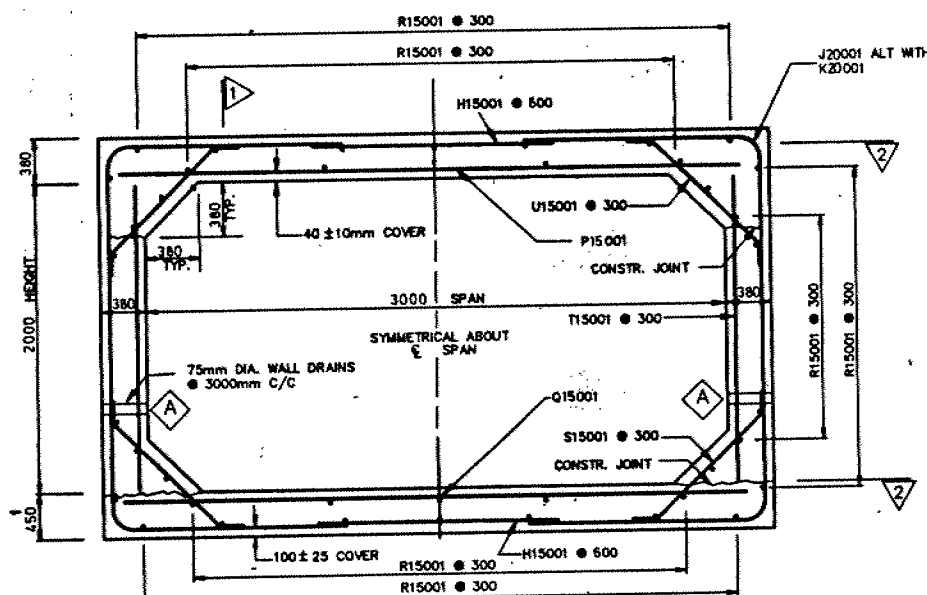
QUANTITIES			
ITEM	WALLS & SLABS	RETAINING WALL	TOTAL
MASS OF REINF. STL tonnes	16.7		16.7
VOL. OF CONCRETE cubic metres	232		232

NOTE: - All dimensions shown to centre line of bar.  
- \* represents vertical or horizontal dimension.

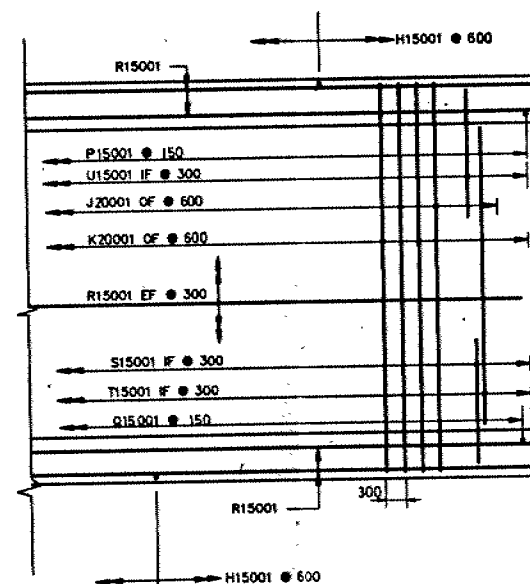
STANDARD DRAWING  
MARCH 1988  
SS114 - 2  
RIGID FRAME BOX CULVERT HEIGHT ≤ 3m

DATE	BY	DESCRIPTION	DATE
DESIGN K.K. CHK S.K.	CODE	LOAD	NOV 1989
DRAWN R.S. CHK S.K.	SITE 46-22	STRUCT	SCHEME
		DWG 2	

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING



TYPICAL CULVERT SECTION  
(APRON DETAILS SHOWN IN A)



**Dominion Soil Investigation Inc.**  
Consulting Engineers

FOUNDATION INVESTIGATION  
PROPOSED STRUCTURE OVER JESSE JAMES CREEK  
SITE 46 - 22 W.P. 194-88-02  
HWY. 560 - DISTRICT 14 - NEW LISKEARD

REF. NO. 88-12-7

APRIL 1989

*CONT 90-450*

PREPARED FOR:

MINISTRY OF TRANSPORTATION  
FOUNDATION DESIGN SECTION  
CENTRAL BUILDING  
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DOWNSVIEW, ONTARIO  
M3M 1J8

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## APPENDICES

PROCEDURES  
LIMITATIONS OF REPORT

## ENCLOSURES

BOREHOLE LOG SHEETS  
DYNAMIC CONE PENETRATION TESTS  
GRAIN SIZE DISTRIBUTION CURVES  
BOREHOLE LOCATION & SOIL STRATA

ENCL. 1-11 INCL.  
ENCL. 12-18 INCL.  
FIGURE 1-7 INCL.  
DWG. NO. 1948802-A

*GEO NO 418-18*

## 1.0 INTRODUCTION

Dominion Soil Investigation Inc., Consulting Geotechnical Engineers, was retained by the Ontario Ministry of Transportation to carry out a foundation investigation at the site of a new structure over Jesse James Creek (Site 46-22) on the proposed new alignment of Highway 560, about 2 km west of Shining Tree in District 14-New Liskeard. The preferred structure is a 30 m long and 4 m wide concrete box culvert, although a structural plate pipe and a single span bridge structure are also under consideration.

The purpose of the investigation has been to determine the subsurface conditions at the proposed structure site; to establish the engineering properties of the substrata; and to make recommendations for the geotechnical aspects of the design and construction of the proposed structures.

The field work was carried out during the period of January 14-17, 1989 and consisted of drilling eleven sampled boreholes and conducting seven dynamic cone penetration tests at the site. The locations of the boreholes and cone penetration tests along with stratigraphic sections are shown on Drawing No. 1948802-A.

.../...

## 2.0 SITE & GEOLOGY

The site is located about 2 km west of Shining Tree and approximately 100 m downstream from the existing timber crib structure at Highway 560. Jesse James Creek flows in a northerly direction, and at the proposed new structure site it has very gentle, peat covered banks and probably a shallow channel. A thick cover of evergreen trees exists on both sides of the structure. Several rock outcrops about 1 to 3 m high were observed in the vicinity. Two steeply inclined outcrops, several metres high, were noted; one is just east of the proposed site location and one north west of the existing bridge.

Published geological data shows that Asquith Township is underlain by Early and Middle Precambrian rocks which are generally covered by a mantle of Pleistocene and recent deposits. In the general area, the Early Precambrian rocks generally comprise mafic metavolcanics and diabase dikes. In many cases, these rocks have been converted to amphibolites. It is also of interest to note that in the general area of the site, the Creek follows a major fault known as the 'Jesse James Creek Fault'.

.../...

There is also evidence that in the geological past there has been some relative movement to the north of the bridge site. Schist zones which are believed to represent shear zones commonly occur within the Township and are characteristic features.

### 3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at eleven borehole locations and were inferred at the locations of dynamic cone penetration tests (C1 through C7). The locations of the boreholes and cone penetration tests are shown on the Plan and Profile Dwg. No.1948802-A. Details of the stratigraphy encountered in the boreholes are given on the individual Record of Borehole Sheets. Briefly the subsurface conditions can be summarized as follows:

The site is generally underlain by an approximately 2 m thick peat layer which is in turn underlain by a silt deposit extending to depths ranging between 2.3 and 5.2 m below the ground surface. Underlying the silt the majority of the boreholes contacted a sand and/or gravelly sand deposit to the surface of the bedrock, at depths generally ranging between 3.1 and 7.7 m below the ground surface.

.../...

The strata are briefly described in the following paragraphs.

- a) Peat: The Boreholes contacted a peat deposit ranging in thickness from 1.7 m (B.H.2) to 2.4 m (B.H.3) with an average thickness of 2.0 m at the proposed structure locations. At Boreholes 8, 9 and 10 which were drilled outside the proposed structure locations, the thickness of the peat cover ranges from only 0.3 m to 1.7 m. It would appear that the thickness of peat generally decreases with increasing distance from the creek shores.

The recovered samples show that the peat is well humified and has a fine fibrous to amorphous granular structure. The moisture contents of samples as determined in the laboratory range from 398 to 676% with an average value of 550%.

- b) Silt: Beneath the peat the majority of the boreholes contacted silt deposits ranging from 0.6 (B.H.2) to 3.4 m (B.H.5) in thickness. The grain-size distribution of samples from the silt is shown on Figures 1 and 2. The silt is frequently layered and contains small pockets or thin seams of clay, especially within the upper zones.

The grain size distribution of samples from these upper zones is given on Fig. No. 3. The silt is basically non-

.../...

plastic and the relatively high clay contents (i.e. generally 10 to 15%) indicated on the grain size distribution curves are believed to be largely due to the presence of the interbedded clay seams and pockets. Atterberg Limit tests were carried out in the laboratory on three typical samples from the silt and two of these tests indicated non-plastic soil. The third test gave Liquid and Plastic Limit values of 23% and 16% respectively with a corresponding Plasticity Index of 7. The measured moisture contents of samples from the silt range from 19 to 27% with an average value of 24%. The silt is also interbedded with sandy layers and in general attains with increasing depth a somewhat coarser texture. The grain-size distribution of samples from these somewhat coarser zones is shown in Figure No. 4.

From the grain size curves the silt is considered to be highly frost susceptible and erodible. Standard Penetration tests carried out in the silt deposit gave 'N'-values generally ranging between 10 and 14 blows/0.3 m, indicating a loose to generally compact condition. However 'N'-values as low as 3 and as high as 34 blows/0.3 m were also recorded, indicating the presence of very loose and dense zones within the deposit.

.../...

- c) Sand: Beneath the silt and overlying the bedrock, the overburden generally consists of granular materials ranging from fine grained silty fine sand (e.g. Boreholes 6 and 11) to gravelly sand (e.g. Boreholes 3, 4, 5, 6, 7 and 11). The grain size distribution of soil samples from these sand deposits is presented on Figures 5, 6 and 7. In several of the boreholes, the presence of cobbles was inferred during the drilling and in one borehole (B.H.7) this necessitated diamond drilling within the overburden.

'N'-values recorded in this material show a large variation ranging from 2 to 39 blows/0.3 m, indicating a very loose to dense condition. At some locations (e.g. Borehole 11), the entire depth of the deposit is loose.

- d) Bedrock: Bedrock was proven by diamond drilling and rock coring in Boreholes 1, 2, 4, 7 and 11 and was inferred from refusal to augering and dynamic cone penetration tests at the remaining exploration locations.

At the location of the west abutment of the proposed bridge, covered by Boreholes 1, 2, 11 and Cone Tests 1, 2 and 6, the surface of the rock throughout much of the area is relatively level, ranging from 3.1 to 4.3 m below the ground

.../...

surface. At the south east corner of this abutment location, however, the surface of the rock dips sharply to 6.6 m below grade. This indicates a 3.4 m drop in elevation within a horizontal distance of 4.0 m from the location of Borehole 1 to Cone Test 2.

On the opposite (east) side of the creek the depth to the surface of the rock ranges from 5.3 to 7.7 m giving a maximum elevation difference of 2.6 m at the exploration locations. It appears that along this side of the river bank the surface of the rock has a small ridge at the location of Borehole 3 and Cone Test 4 and then drops relatively more steeply towards Borehole 5, and less steeply in other directions.

The bedrock was penetrated and cored in five of the boreholes, to depths ranging between 1.1 and 2.9 m. A visual examination of the recovered cores indicated that the bedrock consists of a darkish grey amphibolite with some schist zones and is moderately fractured.

.../...

The percentage of recovery of the rock cores ranged from 97 to generally 100%. The R.Q.D. values ranged from 25 to 83% (generally 60 to 80%). The high percentage of core recoveries indicate that the rock is generally sound while the R.Q.D. values indicate a poor to good but generally fair rock quality. Unconfined compression tests performed on two samples from the rock cores gave unconfined compressive strength values of 46 and 53 mPa.

#### **4.0 GROUNDWATER CONDITIONS**

The site is located within the flood plain of the creek. The groundwater level at the site would therefore be controlled by the water level in the creek. At the time of the investigation the water (or ice) level was recorded generally at the ground surface level; but it could be higher during flooding conditions, especially since the creek has very shallow banks.

.../...

## **5.0 DISCUSSION & RECOMMENDATIONS**

A winding section of Highway 560 will be re-aligned necessitating the construction of a new structure over the Jesse James Creek to replace the existing bridge. The new structure will be located a short distance downstream from the existing bridge and it will be either a 10-metre wide single span bridge having a clear span of approximately 18 m, or a concrete box or structural plate pipe culvert.

The boreholes have shown that the site is underlain by an approximately 2 m thick peat deposit. Beneath the peat, the overburden consists of a generally loose to compact silt followed by sand and gravelly sand to the surface of the bedrock which was contacted, at the locations explored, at depths ranging from 3.1 to 7.7 m below grade. The groundwater level at the time of the investigation was at the ground surface level.

### **5.1 Foundations**

#### **5.1.1 Spread Footings**

Because of its organic nature the peat, which extends 1.7 to 2.4 m below grade, is weak and highly compressible. This deposit is therefore unsuitable to support foundations. The underlying loose to compact silt would be suitable to support foundations using relatively low soil bearing pressures. However, due to the

.../...

highly sensitive nature of the silt to disturbance and the prevailing high water table, this alternative would necessitate extensive dewatering measures not only to dewater the site to facilitate construction but also to prevent the disturbance of the silt to preserve its load carrying capacity, as further discussed in Section 5.4.

If by means of careful dewatering measures the disturbance of the founding soil can be prevented, for footings bearing on the undisturbed silt below the depth of minimum frost cover (i.e. 2.2 m), the Factored Bearing Capacity at Ultimate Limit States ( $q_F$ ) is 300 kPa, provided that the footing is at least 1.2 m wide. The Bearing Capacity at Serviceability Limit States Type II is 120 kPa. Under inclined loading conditions the Bearing Capacity at Ultimate Limit State should be reduced in accordance with Clause 6-7.3.3.5 of the Ontario Highway Bridge Design Code, 1983 (OHBDC). Provided that the founding soil is undisturbed during the construction, the total and differential settlements can be expected to be less than 25 mm and 20 mm respectively. These values are within tolerable limits for most types of structures.

.../...

It is recommended that footing excavations be inspected and approved at the time of construction by a Geotechnical Engineer to ensure that the footings rest on undisturbed inorganic soil capable of sustaining the design bearing pressure.

The silt and fine sand overburden is highly susceptible to scour and frost and therefore adequate protection against scour and frost should be provided for footings placed in the overburden.

For the evaluation of the sliding resistance of the foundations, the ultimate angle of friction between the underside of the foundations and the undisturbed silt can be taken as 21 degrees.

#### 5.1.2 Spread Footing Foundations on Engineered Fill

The structure could also be supported on shallow spread footings established on compacted granular fill.

In this case after proper control of groundwater as discussed in the preceding section and in Section 5.4, all the organic and unsuitable soils should be removed to the surface of competent, inorganic soils. The grade should then be raised using a well-graded, granular earth fill (Granular 'B' or preferably Granular 'A' quality). The peat is expected to provide very little horizontal support for granular backfill placed below the ground

.../...

surface level. To prevent a lateral yield therefore, soil replacement should take place at least 4 m beyond the perimeter of the fill at the ground surface level (i.e. approximately twice the depth of organic soil below ground surface level).

The engineered granular fill should be at least two footing widths wide at the footing level, and should increase at an angle of at least 2 horizontal in 1 vertical below this level. The fill should be placed in shallow lifts and each lift should be uniformly compacted to at least 100% of its Standard Proctor Maximum dry density. The horizontal distance measured from the edge of the footing to the face of the embankment slope, should not be less than 2 times the width of the footing, and the footing should also have a minimum earth cover of 2.2 m. It should be ensured that during the compaction of the fill, the underlying silt subgrade would not be disturbed or exposed to freezing temperatures.

For footings meeting the above requirements, the Factored Bearing Capacity at Ultimate Limit States ( $q_f$ ) is 330 kPa. The Bearing Capacity at Serviceability Limit States Type II is 150 kPa. With this value the maximum total settlement should be limited to 25 mm.

.../...

Assuming that all the peat will be removed and replaced with compacted granular fill for road construction, a structural plate type culvert can be installed with bedding as indicated by OPSD-802.02 and extending to the surface of the inorganic soil or at least 1.2 m below the bottom of the pipe. In this instance too dewatering measures would be required as discussed in Section 5.4 and the magnitude of settlements would depend on the construction techniques used to install the pipe culvert. It should be pointed out that unless the disturbance and dilation of the silt subgrade are prevented by means of proper dewatering and stabilization methods and proper compaction of the granular backfill beneath and around the pipe can be achieved, excessive settlements could occur.

#### 5.1.3 Pile Foundations

In view of the anticipated construction problems due to the high water table and the sensitive structure of the silt soils underlying the peat cover, the use of end bearing steel H piles driven to refusal on the surface of the bedrock in conjunction with a bridge or concrete box culvert structure would be a better alternative.

.../...

For the west abutment site, the depth to the (inferred or proven) bedrock surface ranges from 3.1 to 4.3 m but drops sharply to 6.6 m at the south east corner. At the east shore the surface of the rock would appear to have a ridge along B.H. 3, C 4 and B.H. 6 where the depth to surface of the rock ranges between 4.6 and 5.3 m. To the south the depth to the surface of the rock increases to 7.7 m at the location B.H.5. In addition to the undulating and in some instances steeply sloping rock surface, the boreholes also showed the presence of cobbles and boulders within the overburden especially near the rock surface. For these reasons, to reduce the risk of a pile (or piles) being "hung-up" on a cobble or boulder, to avoid damage during driving and to get a good seating on the sloping rock surface, the piles should be fitted with hardened rock points. Driving procedures which will provide good contact between the rock point on the pile and the bedrock must be adopted during pile installation. Furthermore care should be taken that the fill material should not contain larger grain sizes than 75 mm at locations where piles have to be driven.

.../...

The estimated pile capacities for some common sizes of steel H-piles driven to practical refusal on the surface of the bedrock (e.g. to a final set of about 1 blow/1 mm penetration with a hammer capable of delivering an energy of 40 to 70 kilo joules/blow) are tabulated below:

ESTIMATED PILE CAPACITY (kN)

<u>Pile Type</u>	<u>Size</u>	Factored Capacity at Ultimate Limit States (Q <sub>f</sub> )	Capacity at Serviceability Limit States Type II (Q <sub>s</sub> )
		<u>                    </u>	<u>                    </u>
Steel H	HP 310x110	1400	980
	HP 310x79	1000	690

The above capacities have to be reduced for very short piles (e.g. less than 4 m long). In this instance a reduction of 30% in the pile capacity would be appropriate.

It is recommended that the driving of the piles in the field be controlled by a recognized pile driving formula such as the Hiley formula. Unbalanced horizontal forces should be resisted by battered piles and for frost protection, the underside of the pile caps should have at least 2.2 m of frost cover.

.../...

## 5.2 Lateral Earth Pressures

For retaining walls, the lateral earth pressure can be calculated using the active earth pressure and the following equivalent fluid pressures as per OHBDC 6-6.1.2.2:

At Ultimate Limit States:                      8.0 kPa/m

At Serviceability Limit States:                6.5 kPa/m

The rigid abutment walls should, however, be designed to withstand the at-rest earth pressures, provided that the backfill is not heavily compacted (in which case much higher earth pressures could occur). For the at-rest earth pressure condition, the following equivalent fluid pressures can be used:

At Ultimate Limit States:                      10.0 kPa/m

At Serviceability Limit States:                8.5 kPa/m

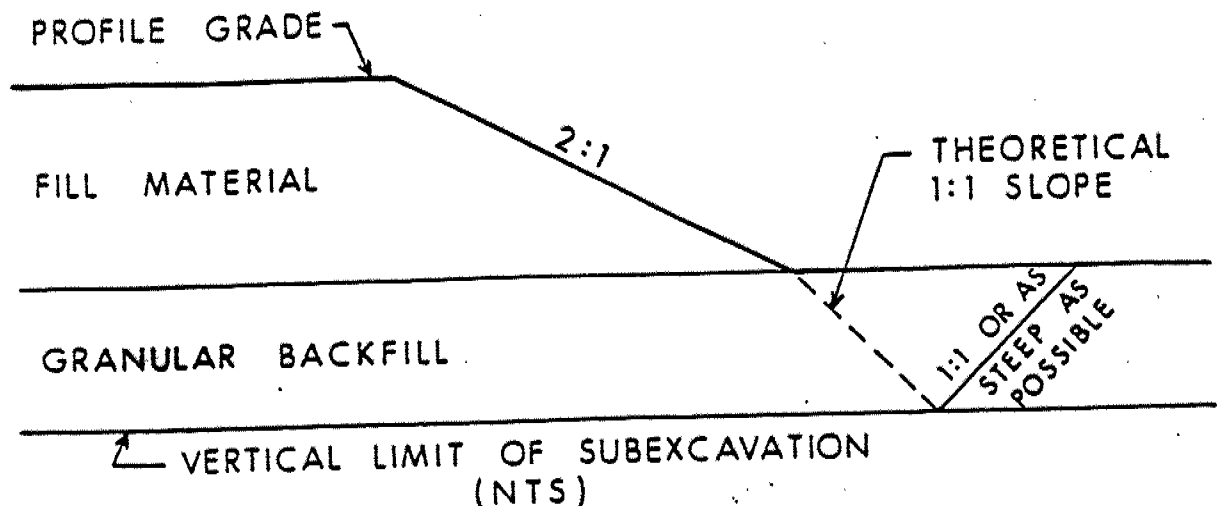
When using these values, it is assumed that the slope of the backfill behind the retaining structure is approximately level and free-draining granular material (i.e. Granular 'B') and adequate drainage have been provided. Water accumulation in the backfill behind the retaining structures should be prevented by means of perforated pipes or weep holes.

.../...

The over-compaction of the backfill could lead to the development of large horizontal pressures behind the retaining walls and the abutments. Vibratory compaction equipment for use behind the abutment walls and the retaining walls must therefore be restricted in size as per current M.T.O. Specifications.

### 5.3 Approach Fills

Provided that organic soils are removed as shown in the sketch below, there are no stability problems foreseen and therefore the design of the approach fills should not be limited by the strength of the foundation materials underlying the site.



.../...

The boreholes indicate that the thickness of peat decreases with increasing distance from the creek (ie. 0.3 and 1.1 m deep at Boreholes 8 and 9, respectively).

Provided that the organic soils (peat and topsoil) are removed, the design of the safe side slopes for the approach embankments, which can be expected to be up to 6 m high, will be governed by the material used for construction (e.g. 2 horizontal in 1 vertical for properly compacted earth fills and 1.5 horizontal in 1 vertical for rock fill). The portion of backfill material which will be placed below the groundwater level (i.e. approximately the existing ground surface level) should consist of granular materials (such as Granular 'A' or 'B' type). In the case of pile supported perched abutments, rock fill should not be used in that part of the embankment through which piles will be driven. Provided that the silt subgrade is prevented from infiltrating into the fill soils placed below the ground surface level (i.e. loss of ground is prevented either by the use of a graded backfill or by providing a geotextile separator) settlements should be within tolerable limits. It would be good construction practice to provide a period of at least two months between the time that the embankment reaches its full height and the paving of the highway, within about 20 m of the structures.

.../...

The faces of the embankments should be adequately protected against surface erosion and suitably designed riprap should be provided for the approaches as per hydrological considerations, etc.

#### 5.4 Construction

The groundwater table at the site is regulated by the water level in the creek and can generally be expected to be high (i.e. at the ground surface level or even above during flooding conditions). The peat deposit which covers the proposed structure site and the underlying silt are expected to have medium permeabilities and thus seepage can be expected into excavations both from the sides and bottom of the excavation. In addition, the silt has a sensitive structure which can easily be disturbed and dilate, especially in the presence of water, a condition which can be recognized by the liverish, jelly-like appearance of the soil. When re-loaded the dilated soil could undergo excessive post-construction settlements. Furthermore, the presence of a relatively less permeable layer (silt) overlying a more permeable layer (gravelly sand) could lead to basal uplift as a result of hydrostatic pressures unless the lower stratum is depressurised. It will therefore be necessary to stabilize these soils (i.e. silt and sand) in foundation excavations by careful dewatering techniques. This will probably

.../...

require the use of well points, after the construction of a temporary cofferdam to divert the creek, where necessary. After excavation, it may be necessary to pour a skim coat of lean concrete (i.e. mud slab) to prevent the disturbance of the silt subgrade.

Below the groundwater table the sides of temporary excavations will be stable only at flat slopes, unless properly supported. After dewatering they would be temporarily stable at relatively steep side slopes, but excavations more than 1.2 m deep must be sloped at 45 degrees or properly supported to comply with the Safety Regulations.

The availability of impervious soils to form temporary cofferdams could present problems. If a tight interlocking sheet pile cofferdam is considered for this purpose, the presence of cobbles and possible boulders within the granular overburden below the silt and above the bedrock, as well as the undulating surface of the bedrock, could present problems. These factors should also be anticipated for pile foundations.

.../...

In case of piled foundations where engineered fill is not required, a dredging and filling technique may be practical where the open trench is backfilled immediately after the excavation and removal of the peat soil.

The acidic environment (i.e. low pH) created by the presence of peat should be taken into account in material selection and protection.

#### 6.0 CLOSURE

The Limitations of Report, as quoted in the Appendix, are an integral part of this report.

DOMINION SOIL INVESTIGATION INC.



Z.S. Ozden, P.Eng.

ZSO/ma



.../...

## APPENDICES

## PROCEDURES

The field work was carried out during the period of January 14-17, 1989. During this period, a total of 11 boreholes was drilled and seven dynamic cone penetration tests were performed at the positions shown on the Borehole Location Plan, Drawing 1.

The boreholes were advanced to depths ranging between 1.1 and 8.9 m using a power auger drill rig equipped for soil sampling. Within the overburden, the boreholes were advanced by means of hollow-stem augers and where necessary, washboring and coring methods were employed through cobbles and boulders. Sampling was effected by the Standard Penetration test method and the test results, recorded as 'N'-values or Penetration Resistances were used to infer the consistency or the compactness condition of the soil strata. The bedrock was cored by diamond drilling methods using BXT size core barrel.

The drilling equipment was owned and operated by Dominion Soil Investigation Inc. (Thunder Bay Branch), and the field work was carried out under the supervision of a Professional Engineer from Dominion Soil Investigation Inc. Head (Scarborough) Office. Upon completion of the field work, the soil and rock samples were shipped to our laboratory where they were further examined by the Engineering staff and laboratory testing consisting of moisture content and Atterberg Limit tests and sieve and hydrometer analyses was carried out on selected soil samples. The

percentage of recovery and R.Q.D. values of the rock cores were established and on two representative core samples of the rock unconfined compressive strength tests were performed.

The ground surface elevations at the borehole and cone test locations were determined with respect to a local benchmark, as follows:

Nail in Cedar Tree

Station 18 + 210; 32 m Right of Centre Line

Elevation 372.784 m.

## DOMINION SOIL INVESTIGATION INC.

### LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

ENCLOSURES



## RECORD OF BOREHOLE No 1

METRIC

W P 194-88-02 LOCATION Sta. 18 + 191: o/s 5.0 m RT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger, BXT Rock Core COMPILED BY ZSO  
DATUM Geodetic DATE 89 01 14 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
372.3	Ground Level																GR SA SI CL
0.0							372										
	PEAT very soft		1	SS	1		371										
370.2			2	SS	1												
2.1	SANDY SILT with Sand seams compact, grey, wet traces of clay		3	SS	13		370										0 18 69 13
369.2			4	SS	80												
3.1	Amphibolite BEDROCK grey, sound		5	RC BXT	Rec. 100%	10cm	369										R.Q.D. = 73%
367.6							368										
4.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

3, x5: Numbers refer to  
Sensitivity20  
15  
10  
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2										METRIC	
W P 194-88-02		LOCATION Sta. 18 + 195; o/s 5.0m LT				ORIGINATED BY AAK					
DIST 14 HWY 560		BOREHOLE TYPE Hollow Stem Auger, BXT Rock Core				COMPILED BY ZSQ					
DATUM Geodetic		DATE 89 01 14 & 15				CHECKED BY CA					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
372.3	Ground Level										
0.0											
	PEAT very soft		1	AS	-					398%	
370.6											
1.7	SANDY SILT loose, grey, wet traces of clay		2	SS	8						0 20 72 8
370.0											
2.3											
	SAND with gravelly & silty layers, occasional cobbles, compact to v. dense, grey, wet		3	SS	34						8 70 (22)
			4	SS	50						Sample 4: No recovery
368.0											
4.3											
	Amphibolite BEDROCK grey, sound		5	SS	22						
			6	SS	50						
			7	RC BXT	Rec. 100%						R.Q.D.=59%
			8	RC BXT	Rec. 97%						R.Q.D.=80%
365.1											
7.2	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity20  
15 5 (%) STRAIN AT FAILURE  
10



## RECORD OF BOREHOLE No 3

METRIC

W P 194-88-02 LOCATION Sta 18 + 210; o/s 5.0 m LT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZSD  
DATUM Gendetic DATE 89 01 16 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	PLASTIC LIMIT W <sub>p</sub>	W	LIQUID LIMIT W <sub>L</sub>		
372.4 0.0	Ground Level																
	PEAT very soft		1	AS	-		372									523 %	*Sampler sank under static weight of hammer no recovery
			2	SS	WH*		371										
370.0 2.4	SILT compact, grey, wet traces of root fibres & clay		3	SS	14		370							d *			0 4 81 15 non plastic
368.8 3.6			4	SS	13		369							o *			0 7 84 9 non plastic
	GRAVELLY SAND some cobbles dense, grey, wet		5	SS	38		368										28 64 (8)
367.7 4.7	End of borehole. Probable bedrock		6	SS	63/10cm												Sampler bouncing @ 4.7m probably on bedrock * Atterberg Limits attempted. Sample non- plastic.

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 4										METRIC						
W P 194-88-02		LOCATION Sta 18 + 214; o/s 5.0 m RT					ORIGINATED BY AAK									
DIST 14 HWY 560		BOREHOLE TYPE Hollow Stem Auger, BXT Rock Core					COMPILED BY ZSO									
DATUM Geodetic		DATE 89 01 15 & 16					CHECKED BY CA									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80
372.5	Ground Level															
0.0																
	PEAT very soft		1	AS	-											
370.7			2	SS	3											
1.8	loose compact SILT traces of sand & clay grey, wet v. loose		3	SS	11											
			4	SS	12											
368.1			5	SS	3											
4.4			6	SS	37											
	GRAVELLY SAND dense, grey, wet		7	SS	39											
366.5			8	RC BXT	Rec. 100%											
6.0	Amphibolite BEDROCK grey, sound		9	RC BXT	Rec. 100%											
			10	RC BXT	Rec. 100%											
363.6																
8.9	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

3, x 5: Numbers refer to  
Sensitivity20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 5

METRIC

W P 194-88-02 LOCATION Sta. 18 + 214; o/s 14.0m RT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZSO  
DATUM Geodetic DATE 89.01.16 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
372.4	Ground Level																
0.0																	
	PEAT very soft		1	SS	1		372										652%
							371										
370.6			2	SS	5												
1.8							370										0 3 79 18
	SILT some clay lenses loose to compact grey, wet traces of clay		3	SS	10												0 0 80 20
			4	SS	13		369										0 40 49 11
368.8																	
3.6			5	SS	28		368										
	SANDY SILT compact, grey, wet dense		6	SS	34												
367.2							367										
5.2			7	SS	22												
	GRAVELLY SAND some silt compact, grey, wet		8	SS	19		366										35 55 (10)
364.7			9	SS	70/6cm		365										
7.7	End of Borehole Probable Bedrock																Sampler bouncing probably on bedrock

+3, x3: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 6

METRIC

W P 194-88-02 LOCATION Sta. 18 + 220 @ E ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZSD  
DATUM Geodetic DATE 89 01 17 CHECKED BY CA

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
372.5	Ground Level																GR SA SI CL
0.0	PEAT very soft						372										
							371									87.5%	* Samplers sank under static weight of hammer
370.4			1	SS	W.H. +												
2.1	SILT some clay seams compact, grey, wet traces of clay		2	SS	13		370										0 0 86 14
			3	SS	14		369										0 1 86 13
368.9																	
3.6	SILTY FINE SAND v. loose, grey, wet		4	SS	2												0 65 22 13
368.1	occ. thin clay seams						368										
4.4	GRAVELLY SAND compact, grey, wet		5	SS	23												
367.2			6	SS	75/10cm												
5.3	End of Borehole Probable Bedrock																Sampler bouncing @ 5.3m, probably on bedrock

3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 7

METRIC

W P 194-88-02 LOCATION Sta. 18 + 226; o/s 14.0m LT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger, BXT Rock Core & washboring COMPILED BY ZSD  
DATUM Geodetic DATE 89 01 15 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
372.3	Ground Level																GR SA SI CL
0.0							372										
	PEAT very soft		1	SS	1		371									479%	
			2	SS	1												
370.2							370										
2.1	SILT compact, grey, wet traces of clay & sand		3	SS	11												
			4	SS	10		369										0 8 81 11
368.5			5	SS	14/	2cm											
3.7	GRAVELLY SAND with frequent COBBLES & BOULDERS	boulder	6	SS	50/	0cm	368										
			7	WS	=		367										Sample 8: no recovery
366.5			8	SS	55/	3cm											R.Q.D.=25%
5.7	Amphibolite BEDROCK grey, sound		9	RC BXT	Rec. 100%		366										
			10	RC BXT	Rec. 100%		365										R.Q.D.=83%
364.2																	
8.1	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 8

METRIC

W P 194-88-02 LOCATION Sta. 18 + 243 @ E ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZSD  
DATUM Geodetic DATE 89 01 17 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
372.5	Ground Level																
372.2	PEAT																
0.3	Sandy Gravel & cobbles		1	SS	50/	0cm	372										Sample No.1: no recovery
371.4	End of Borehole Probable Bedrock																Sampler bouncing @ 1.1m, probably on bedrock
1.1																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 9										METRIC					
W P 194-88-02		LOCATION Sta 18 + 172 @ E						ORIGINATED BY AAK							
DIST 14 HWY 560		BOREHOLE TYPE Hollow Stem Auger						COMPILED BY ZSO							
DATUM Geodetic		DATE 89 01 15						CHECKED BY CA							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
372.3	Ground Level														
0.0	PEAT very soft	1					372								
371.2		2													
1.1	SILT with Silty Sand & Peat Seams compact, grey, wet	1	SS	12			371								
370.1	embedded gravel	2	SS	23											
2.2	End of Borehole Probable Bedrock														Refusal to further augering @ 2.2 m probably on bedrock

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity20  
15  $\div$  5 (%) STRAIN AT FAILURE  
10



## RECORD OF BOREHOLE No 10

METRIC

W P 194-88-02 LOCATION Sta. 18 + 206; o/s 23.0 m RT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger COMPILED BY ZSJ  
DATUM Geodetic DATE 89 01 16 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH kPa						

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity20  
15  
10  
5 (%) STRAIN AT FAILURE



## RECORD OF BOREHOLE No 11

METRIC

W P 194-88-02 LOCATION Sta. 18 + 195: o/s 6.2 m RT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Hollow Stem Auger, BXT Rock Core COMPILED BY ZSO  
DATUM Gendetic DATE 89 01 17 CHECKED BY CA

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
372.4	Ground Level													
0.0	PEAT very soft		1	SS	1									
370.1														
2.3	SILT compact, grey, wet traces of clay & sand		2	SS	14									
369.4														
3.0	SILTY FINE SAND v. loose, grey, wet		3	SS	2									
368.6														
3.8	GRAVELLY SAND with some cobbles loose, grey, wet		4	SS	5									
366.2			5	SS	60/3cm									
6.2	Amphibolite BEDROCK grey, sound		6	RC BXT	Rec. 100%									R.Q.D. = 71%
365.1														
7.3	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C1										METRIC			
W P 194-88-02		LOCATION Sta. 18 + 191: o/s 5.0m LT					ORIGINATED BY AAK						
DIST 14 HWY 560		BOREHOLE TYPE Dynamic Cone Penetration Test					COMPILED BY ZSO						
DATUM Geodetic		DATE 89 01 14					CHECKED BY CA						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
372.3 0.0	Ground Level												
368.8 3.5	End of Cone Test (Probable Bedrock)												

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE No C2

METRIC

W P 194-88-02 LOCATION Sta 18 + 195; o/s 5.0m 2" ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY ZSO  
DATUM Geodetic DATE 89 01 14 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	GR SA SI CL		
372.4	Ground Level													
0.0							372							
							371	1 blow						
							370							
							369							
							368							
							367							
							366							
365.8														
6.6	End of Cone Test (Probable Bedrock)							Cone Refusal						

+3, x5: Numbers refer to Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



Encl. 14

## METRIC

W P 194-88-02 LOCATION Sta 18 + 210; o/s 5.0m RT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY ZSO  
DATUM Geodetic DATE 89 01 17 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	Type	'N' VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			WATER CONTENT (%)					
372.5 0.0	Ground Level												
366.1 6.4	End of Cone Test (Probable Bedrock)						Cone refusal						

+3, x5; Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE No C4

METRIC

W P 194-88-02 LOCATION Sta. 18 + 214; o/s 5.0m LT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY ZSO  
DATUM 14 DATE 89 01 17 CHECKED BY CA

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%)				
372.8 0.0	Ground Level												
							372						
							371	1 blow					
							370						
							369						
							368						
367.8 4.8	End of Cone Test (Probable Bedrock)							Cone refusal					

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

15  $\pm$  5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No C5

METRIC

W.P. 194-88-02 LOCATION Sta. 18 + 223; o/s 7.5m LT ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY ZSO  
DATUM Geodetic DATE 89 01 17 CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH $kPa$ ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT $W_p$	NATURAL MOISTURE CONTENT $W$	LIQUID LIMIT $W_L$	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES								
372.5 0.0	Ground Level												
							372						
							371	1 blow					
							370						
							369						
							368						
							367						
366.2													
6.3	End of Cone Test (Probable Bedrock)							Cone Refusal					

OFFICE REPORT ON SOIL EXPLORATION



## RECORD OF BOREHOLE No C6

METRIC

W P 194-88-02 LOCATION Sta. 18 + 193; E  
DIST 14 HWY 560 BOREHOLE TYPE Dynamic Cone Penetration Test  
DATUM Geodetic DATE 89 01 15

ORIGINATED BY AAK  
COMPILED BY ZSO  
CHECKED BY CA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH $kPa$ ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT $W_p$ NATURAL MOISTURE CONTENT $W$ LIQUID LIMIT $W_L$ WATER CONTENT (%)	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
372.3 0.0	Ground Level										
368.7 3.6	End of Cone Test (Probable Bedrock)										

Weight of hammer

Cone refusal

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

## RECORD OF BOREHOLE No C7

METRIC

W P 194-88-02 LOCATION Sta. 18 + 231; E ORIGINATED BY AAK  
DIST 14 HWY 560 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY ZSO  
DATUM Geodetic DATE 89 01 17 CHECKED BY CA

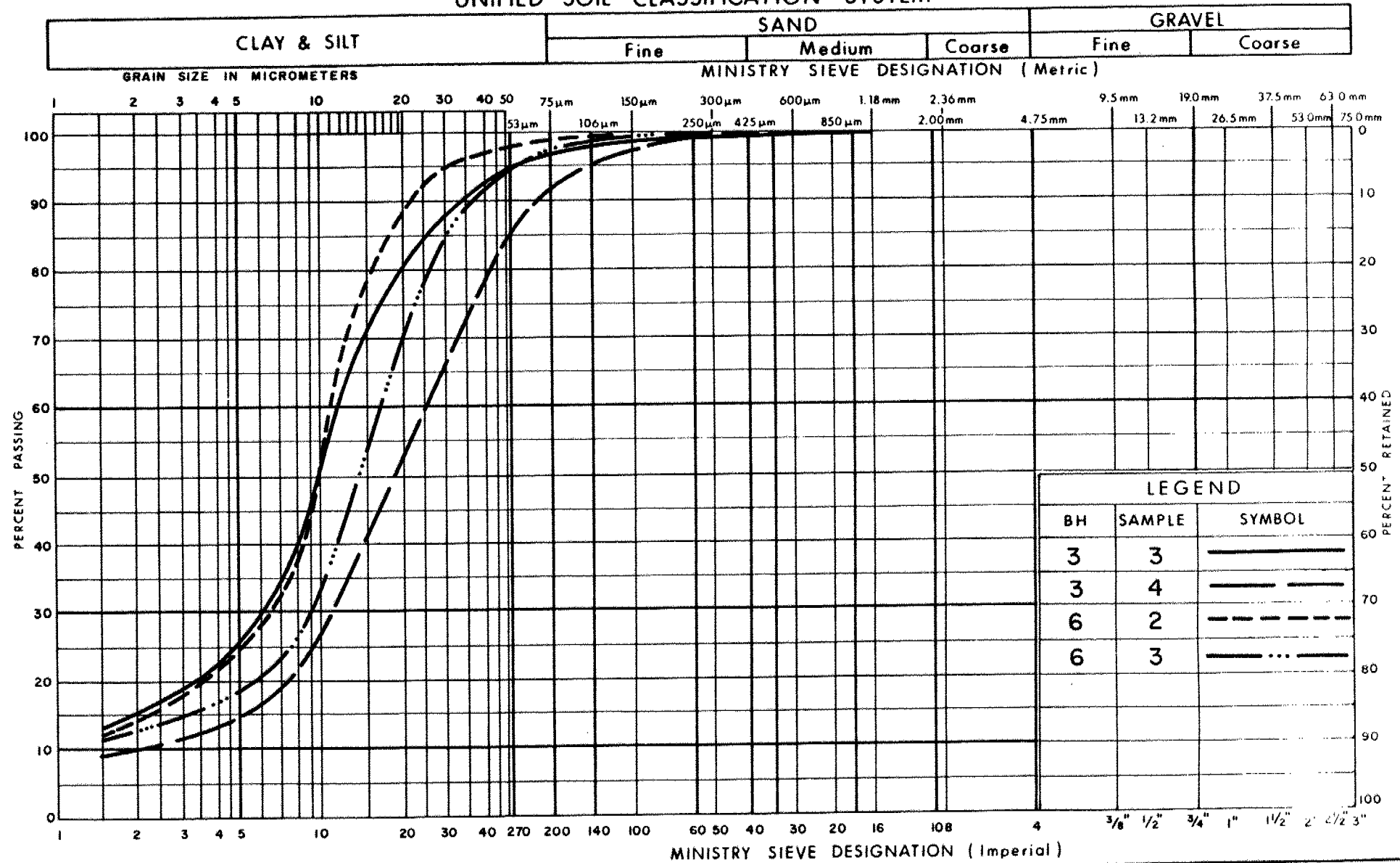
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%)			
372.6 0.0	Ground Level											
							1 blow					
366.6 6.0	End of Cone Test (Probable Bedrock)						Cone refusal					

OFFICE REPORT ON SOIL EXPLORATION

+3, x5; Numbers refer to Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

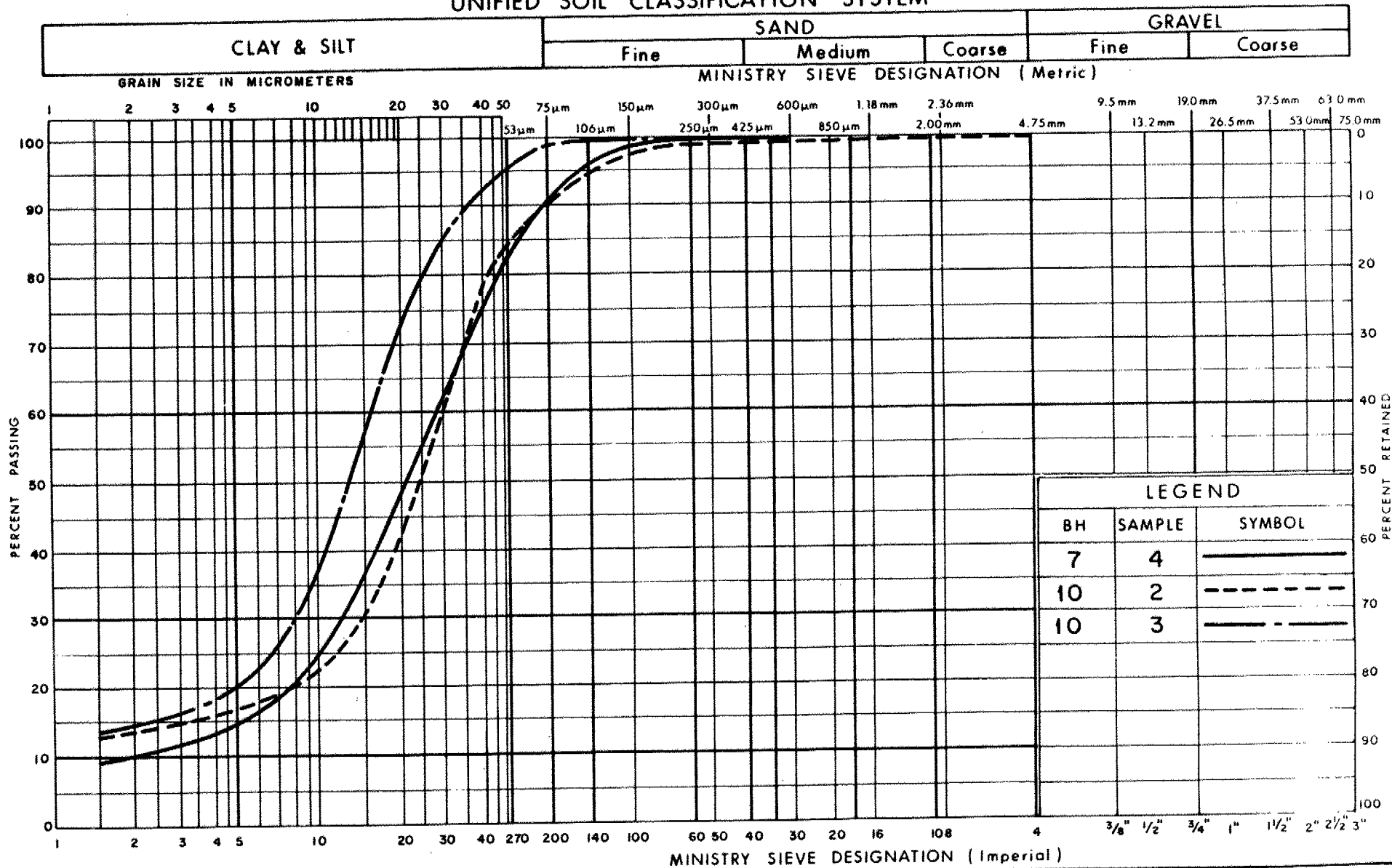
# GRAIN SIZE DISTRIBUTION

## SILT

FIG No 1

W P 194-88-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



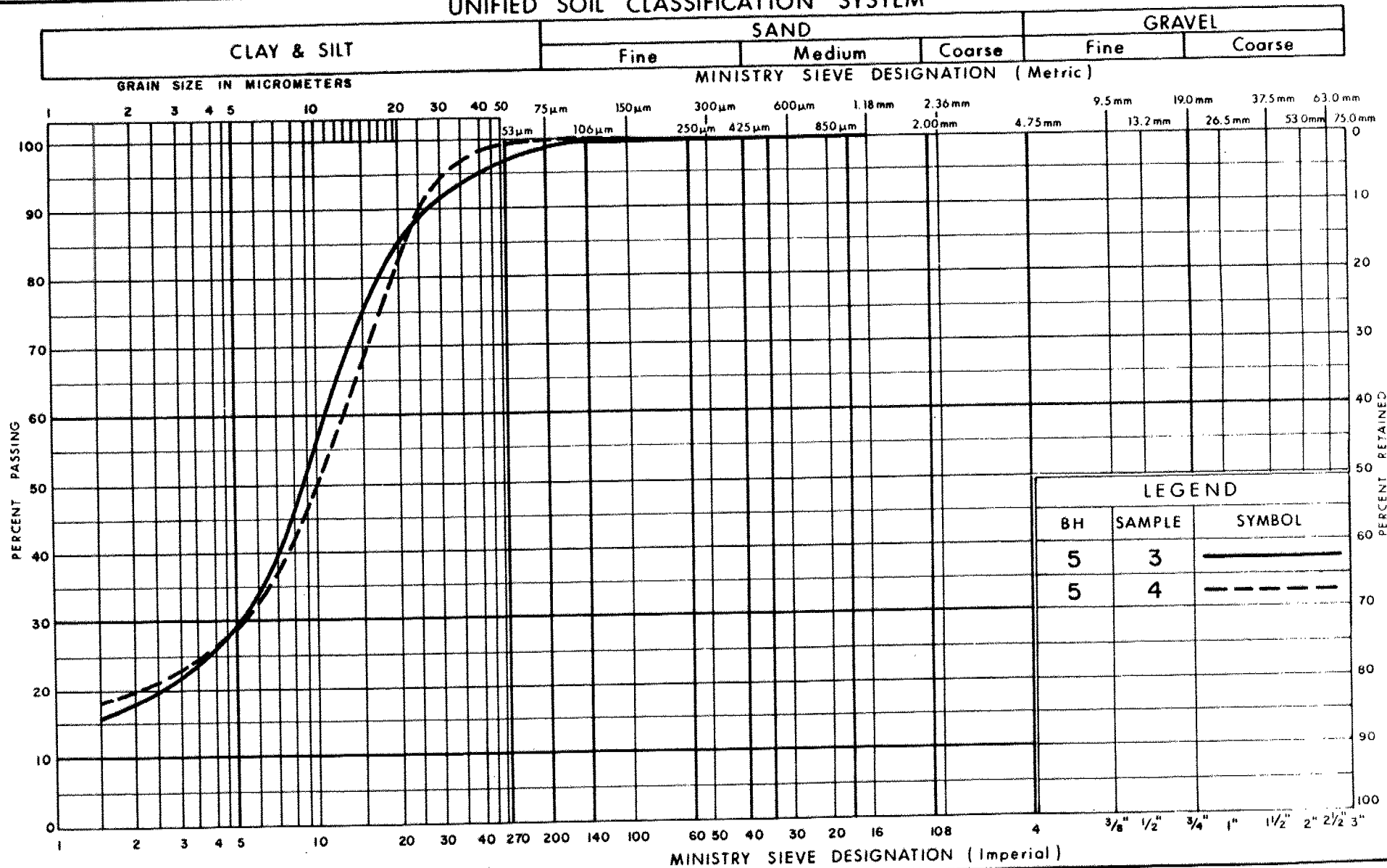
Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION SILT

FIG No 2

W P 194-88-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

Ontario

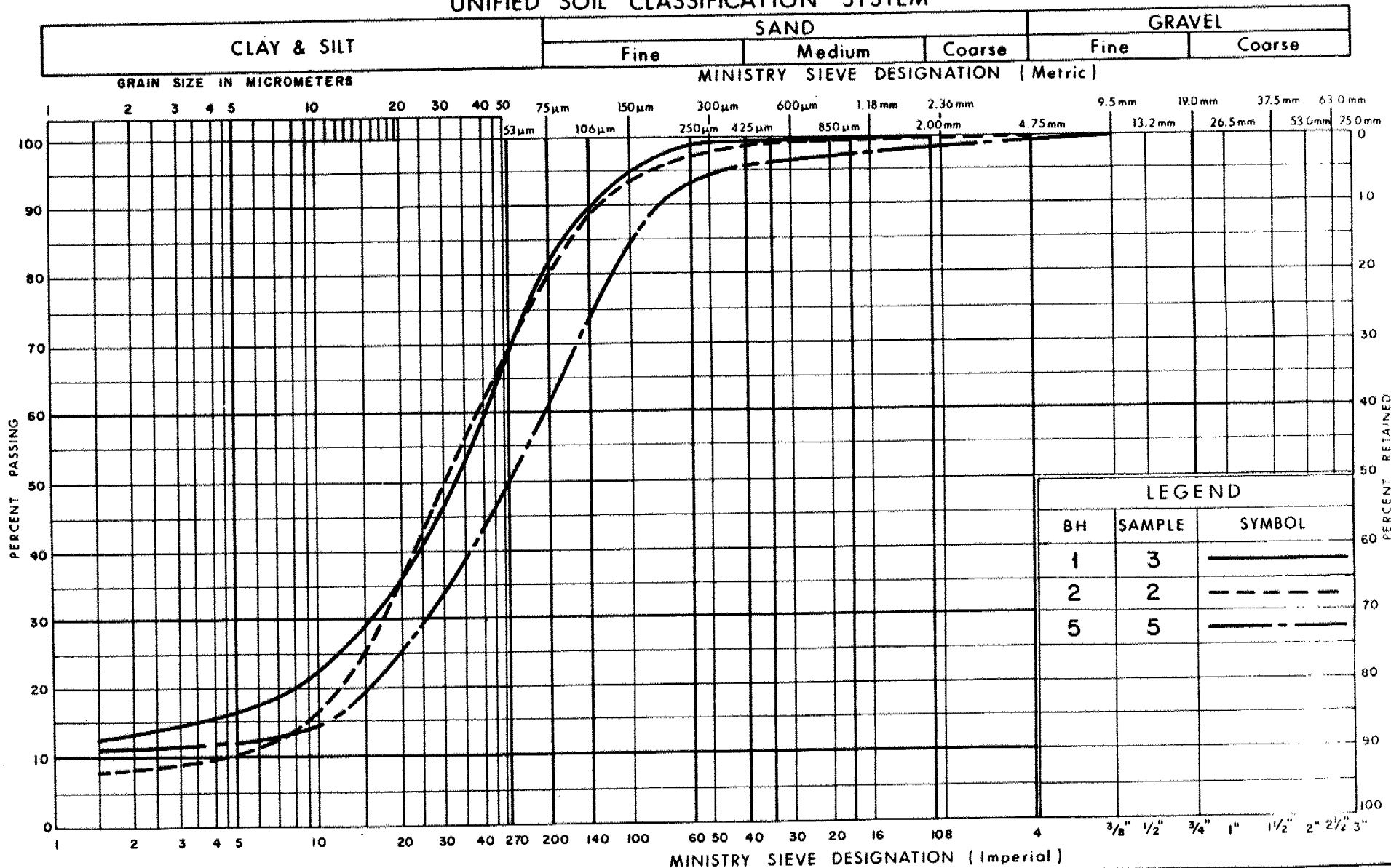
## GRAIN SIZE DISTRIBUTION

SILT, with some Clay

FIG No 3

W P 194-88-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



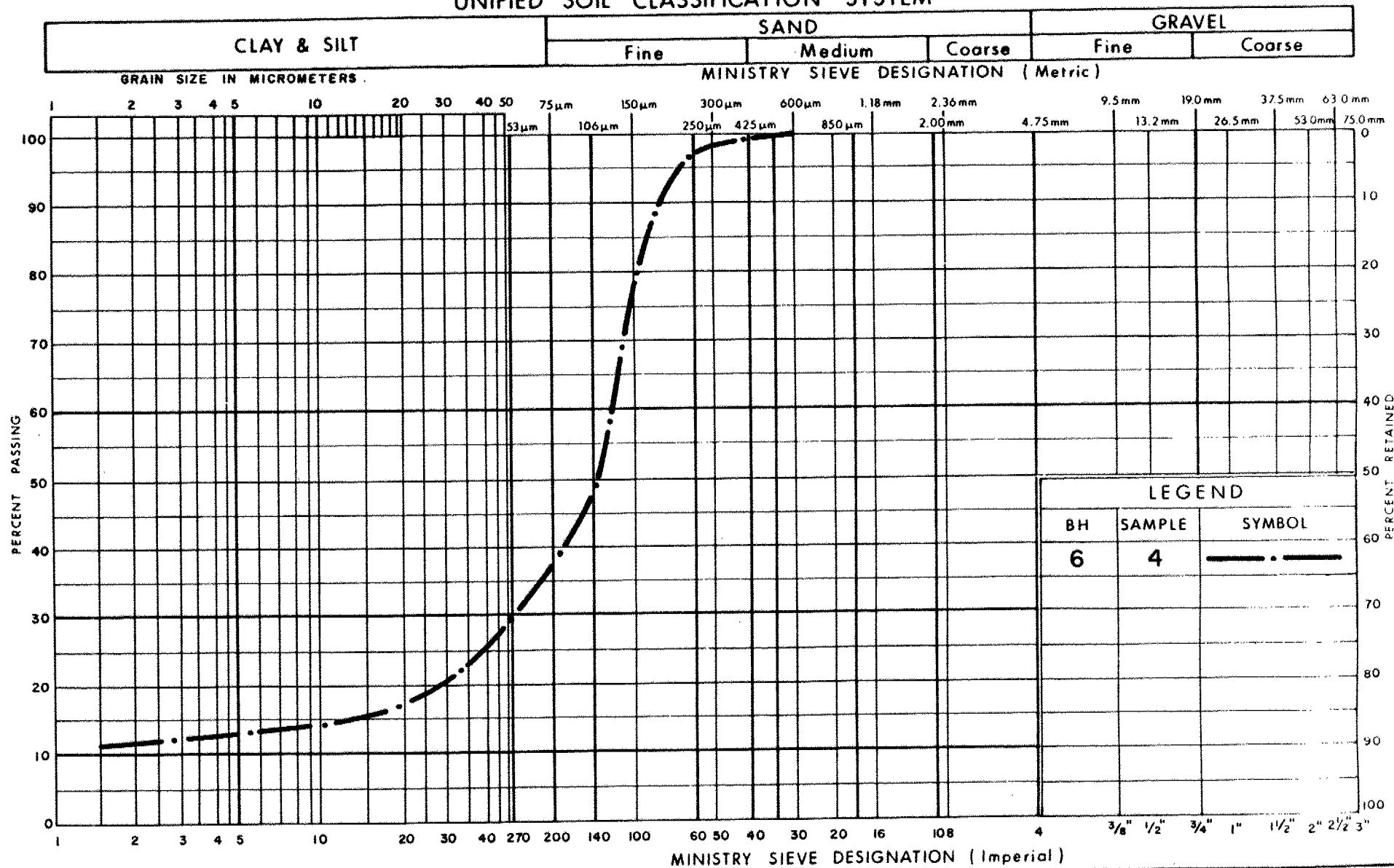
Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION SANDY SILT

FIG No 4

W P 194-88-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



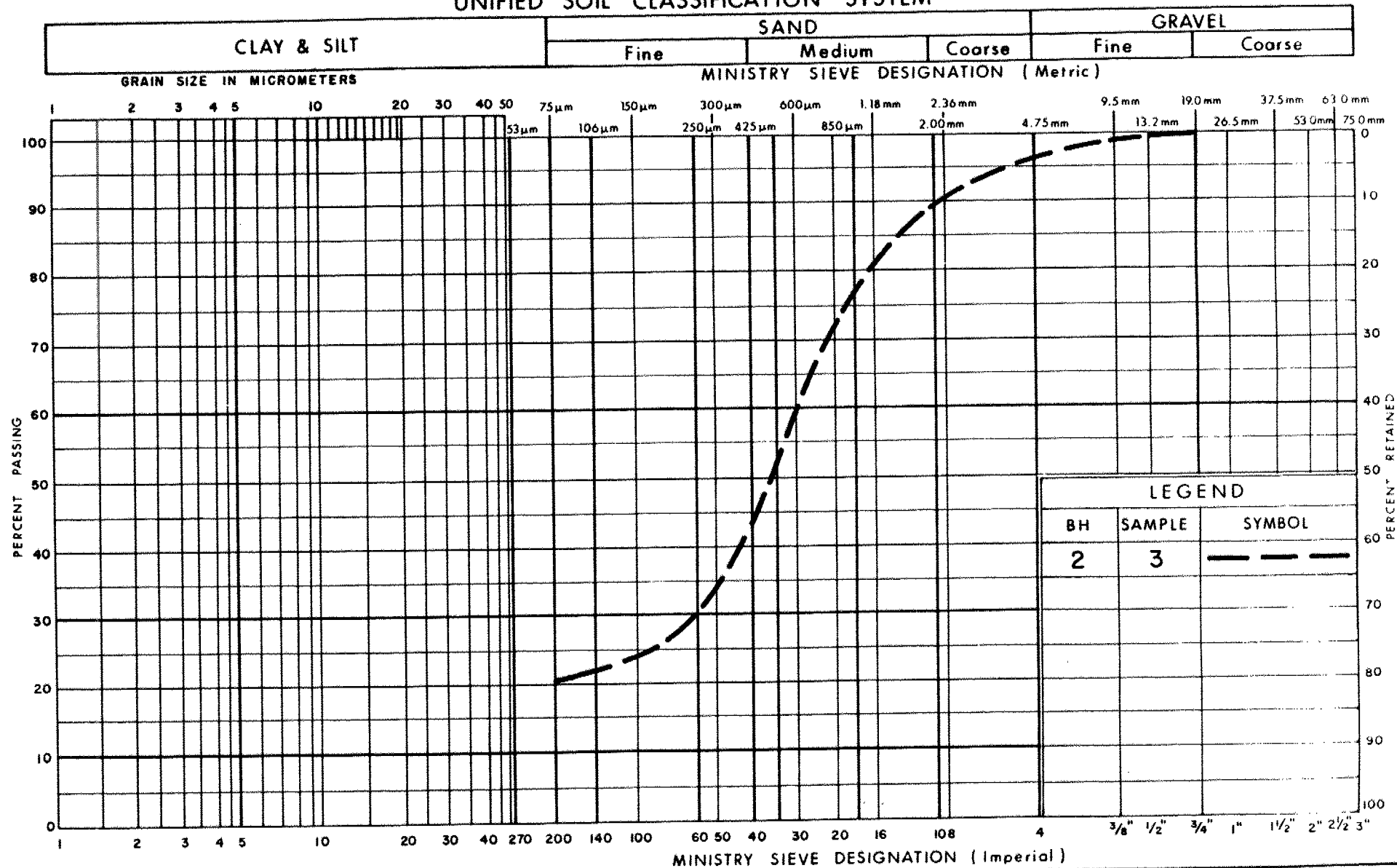
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SILTY FINE SAND

FIG No 5

W P 194-88-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



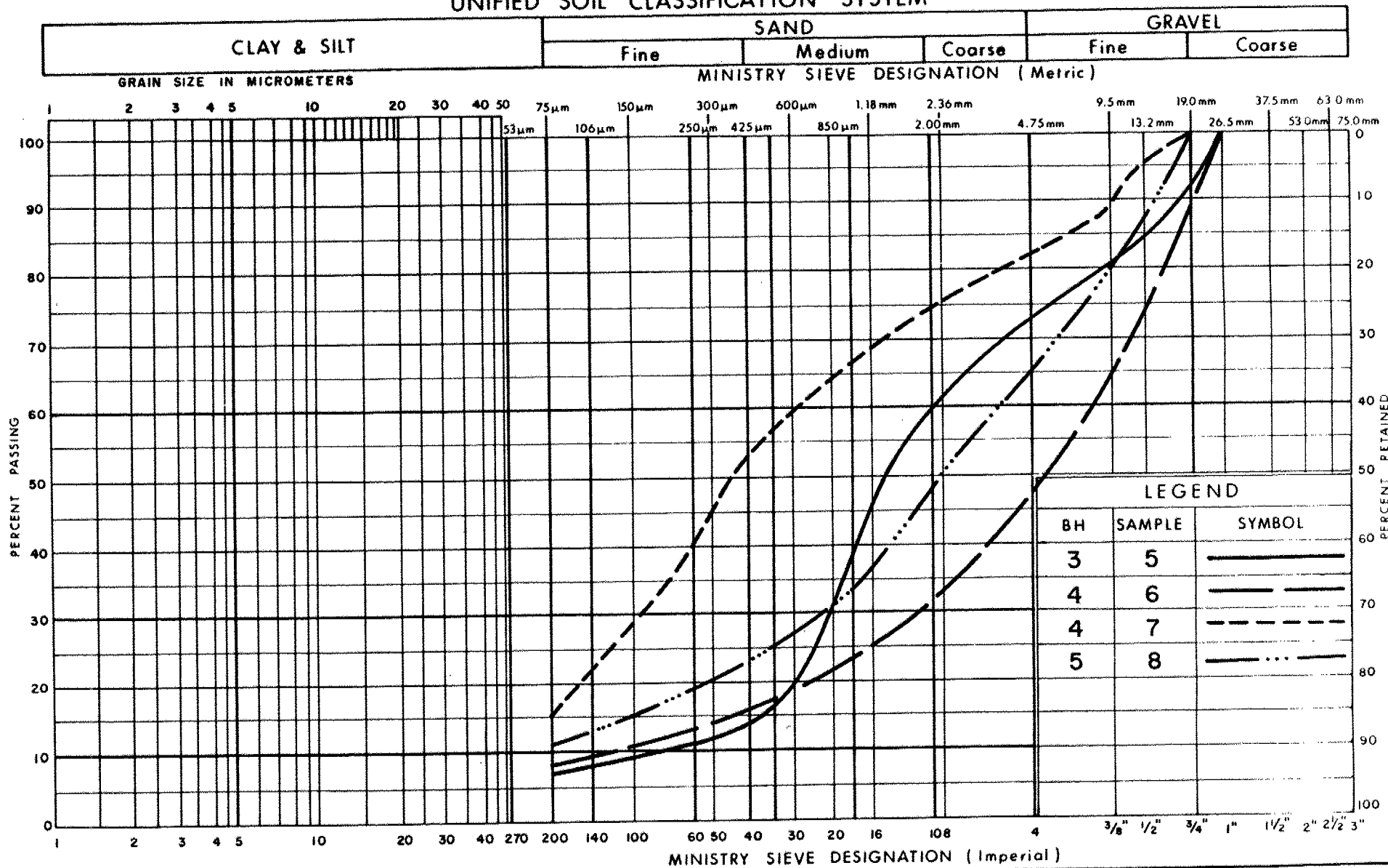
Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SAND

FIG No 6

W P 194-88-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



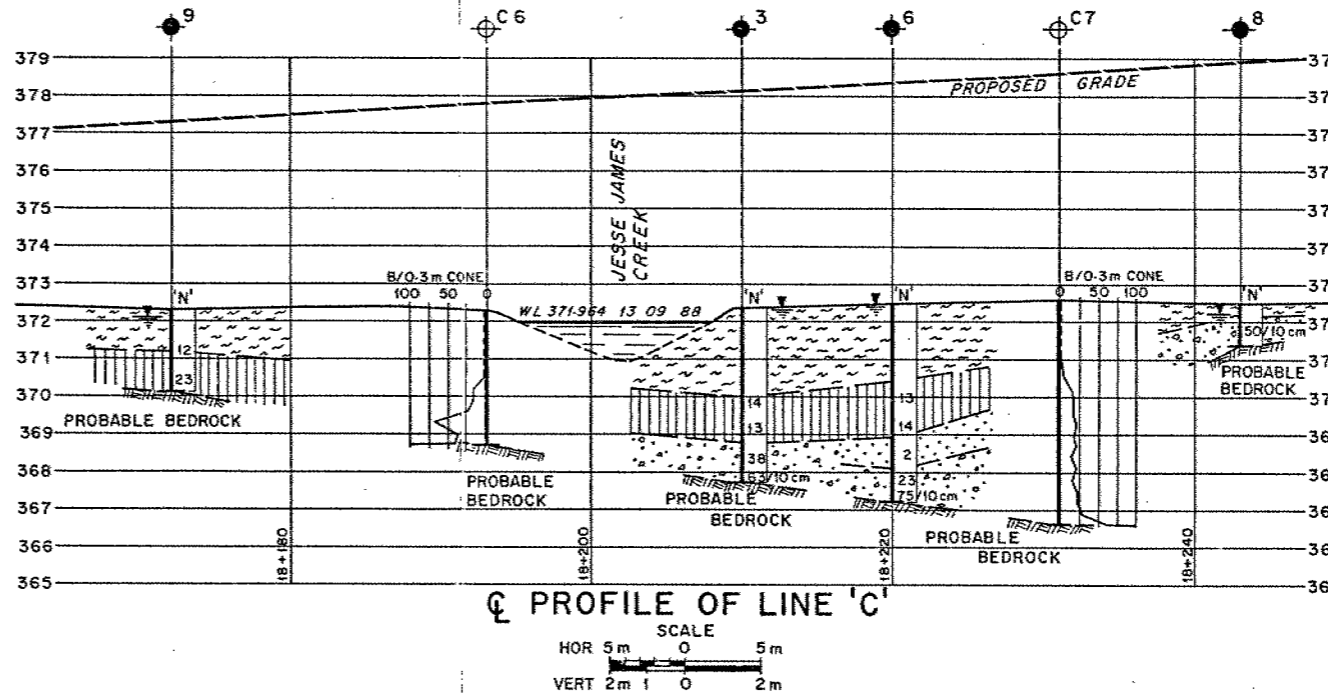
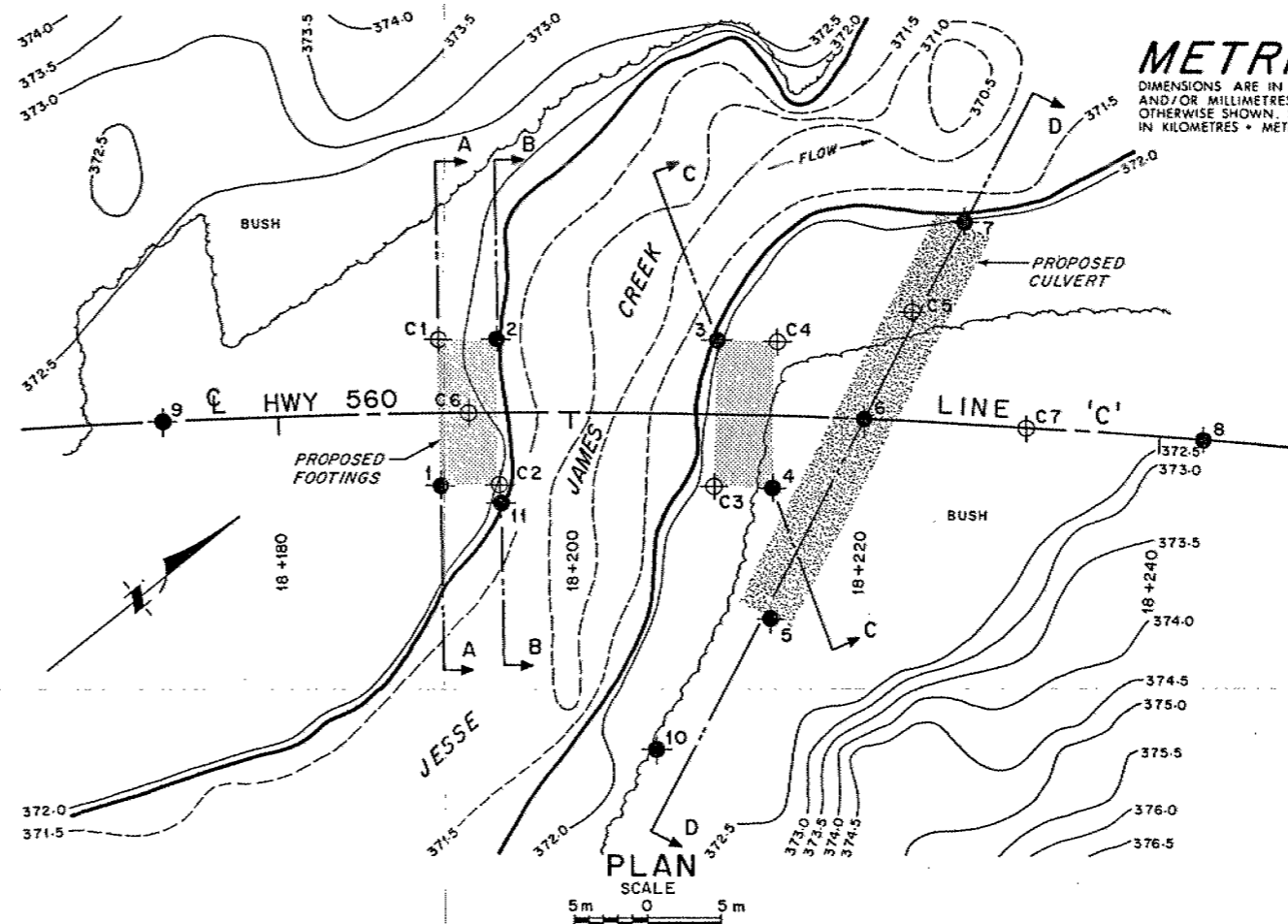
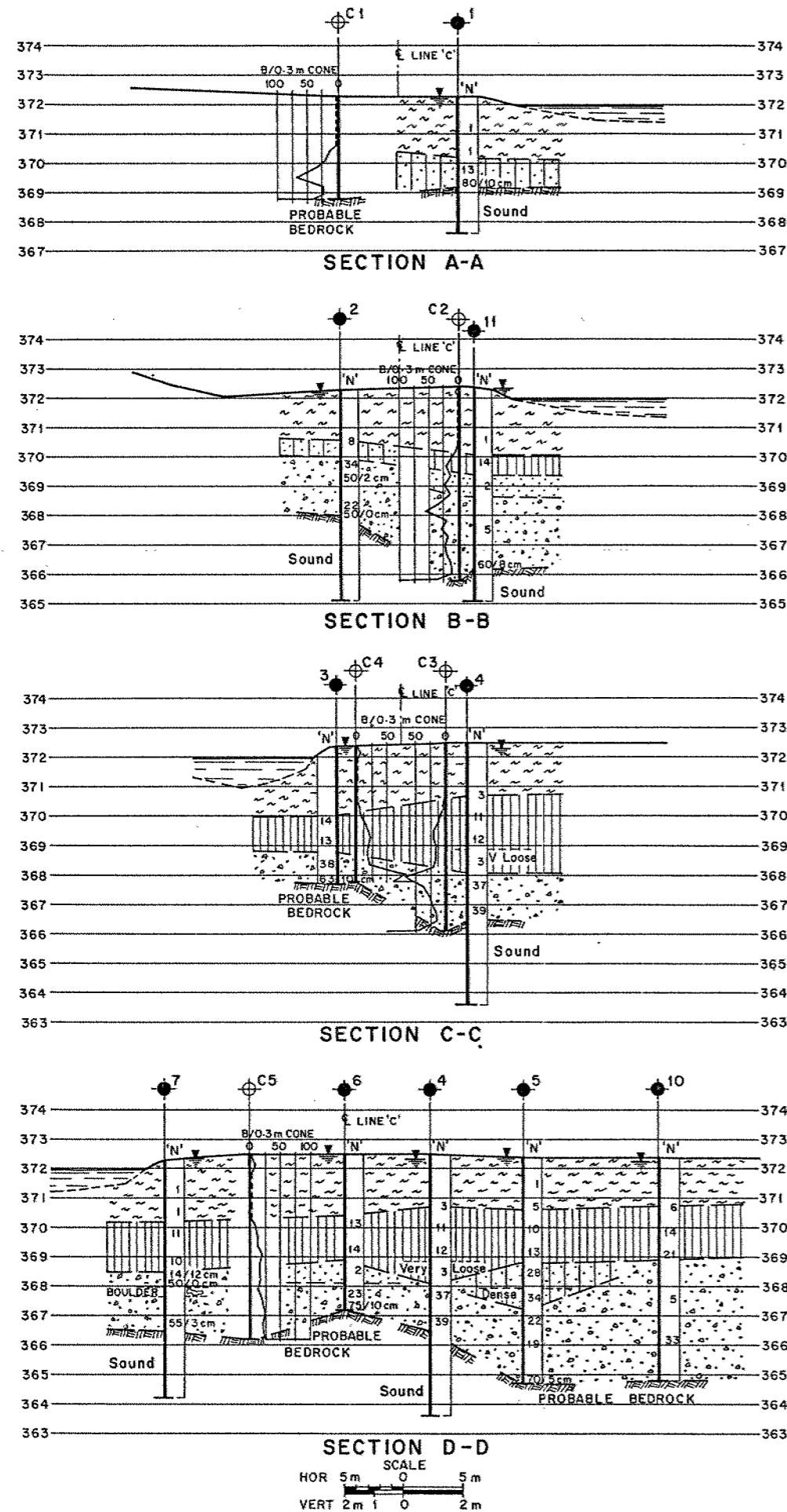
Ministry of  
Transportation

# GRAIN SIZE DISTRIBUTION

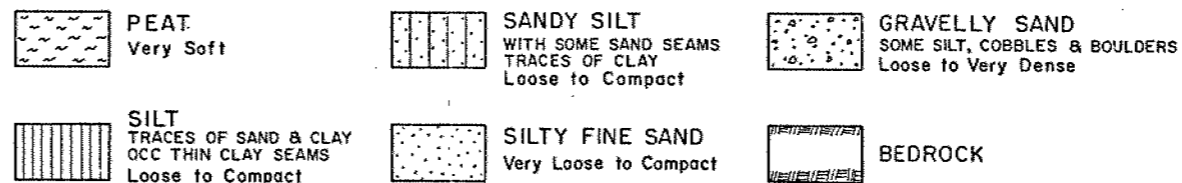
## GRAVELLY SAND

FIG No 7

W P 194-88-02



**SOIL STRATIGRAPHY LEGEND**

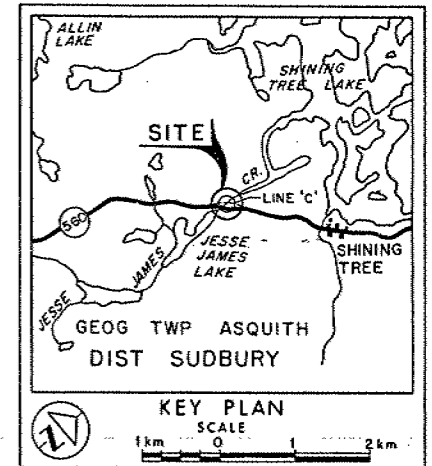


CONT No  
WP No 194-88-02

JESSE JAMES CREEK

BORE HOLE LOCATIONS & SOIL STRATA

DOMINION SOIL INVESTIGATION INC.



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Jan 89

No	ELEVATION	STATION	OFFSET
1	372.3	18+191	5.0m Rt
2	372.3	18+195	5.0m Lt
3	372.4	18+210	5.0m Lt
4	372.5	18+214	5.0m Rt
5	372.4	18+214	14.0m Rt
6	372.5	18+220	0
7	372.3	18+226	14.0m Lt
8	372.5	18+243	0
9	372.3	18+172	0
10	372.4	18+206	23.0m Rt
11	372.4	18+195	6.2m Rt
C1	372.3	18+191	5.0m Lt
C2	372.4	18+195	5.0m Rt
C3	372.5	18+210	5.0m Rt
C4	372.4	18+214	5.0m Lt
C5	372.5	18+223	7.5m Lt
C6	372.3	18+193	0
C7	372.6	18+231	0

**NOTE**

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No

HWY No 560 LINE 'C'	DIST 14
SUBM'D/SO/CHECKED	DATE Mar 22, 89 SITE 46-22
DRAWN RM/CHECKED	APPROVED DWG 1948802-A