#67-F-275 M

ATKIN CULVERT

ELMA - MORNINGTON

TWP. LINE, CON. 14

ELMA TWP.

DOMINION SOIL INVESTIGATION LIMITED
77 CROCKFORD BOULEVARD - SCARBOROUGH ONTARIO CANADA - TELEPHONE 421-2567

BRANCH
[illegible] QUEENS AVENUE
[illegible]NDON, ONTARIO
TELEPHONE GE. 3-3881

FOUNDATION ENGINEERS

ASSOCIATED COMPANY
SOIL TESTING AND ENGINEERING LTD.
34 BRENTFORD ROAD,
KINGSTON 5, JAMAICA, WEST INDIES
TELEPHONE: 63989

London
January 31, 1967

Report
6-11-L23

Mr. R. M. Dawson, P. Eng.,
Consulting Engineer,
258 William Street,
STRATFORD, Ontario.

Dear Sir:

Soil Investigation for Atkin Culvert, Elma-Mornington Township Line, Conc. 14 Elma Township.

I INTRODUCTION

In accordance with a letter of authorization from Mr. R. M. Dawson, P.Eng., Consulting Engineer, a soil investigation has been carried out on the Elma-Mornington Township line, where it is proposed to replace an existing road bridge with a new structure.

The existing structure is located on Concession 14 of Elma Township and is named Atkin Culvert. It is understood that the proposed structure will have the same centre line as the existing bridge.

The purpose of this investigation was to reveal the subsurface conditions at the site and to determine the relevant soil properties for the design and construction of the new foundations.

II FIELD WORK

The field work, consisting of 2 boreholes, was carried out on January 4 and 13, 1967, at the locations shown on

Enclosure 2. The holes were advanced to the sampling depths by washboring methods and were lined with Bx size casing.

Standard penetration tests were carried out at frequent intervals of depth, as detailed on Appendix A, and the results are recorded on the Geotechnical Data Sheet as 'N' values.

Dynamic cone penetration tests were performed adjacent to each borehole location to obtain an indication of soil density changes with depth. The same source of energy was used to drive the cone as was used for the standard penetration test.

Elevations were referred to the centre of the existing bridge deck, which was given the arbitrary value, El. 100 feet.

III SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the Geotechnical Data Sheet, comprising Enclosure 3, and a general picture of the soil stratigraphy, in relation to the existing bridge, is given in the form of a Subsurface Profile on Enclosure 2.

The boreholes revealed the following general ground succession:-

		Thickness	
		Borehole 1	Borehole 2
(a)	Road ballast	1'- 0"	2'- 0"
(b)	Topsoil and soft black peat.	10'- 6"	4'- 1"
(c)	Soft grey organic silt.	4'- 6"	Nil
(d)	Grey clayey silt with layers of sand and gravel. Atterberg limit and moisture content tests carried out on a disturbed sample of this stratum gave a value of Liquid Limit of 20%; Plastic Limit of 10% and Plasticity Index of 10. The Liquidity Index which relates the natural moisture content to the Atterberg Limits was 1.1 confirming the 'soft' consistency indicated by visual and tactile examination.	5'- 0"	"
(e)	Compact grey silty fine sand, with a little gravel and a trace of clay.	Nil	4'-11"
(f)	Grey silty clay containing a little gravel and a trace of sand (Glacial Till). The consistency of this stratum is described as 'stiff' to 'hard' as indicated by standard penetration test results ranging from 21 to 108 blows per foot. Atterberg Limit and moisture content tests carried out on disturbed samples of this stratum gave a value of Liquid	Penetrated 5'- 6"	10'- 6"

Limit of 23%; Plastic Limit of 11% and Plasticity Index of 12, indicating that the soil is a clay of low plasticity and compressibility. The Liquidity Index which relates the natural moisture content of the soil to the Atterberg Limits was -0.1 confirming the 'very stiff' consistency obtained from visual and tactile examination.

IV GROUNDWATER CONDITIONS

From observations of water levels and cave-ins in the boreholes, it may be assumed that the groundwater table is closely related to the water level in the creek at any particular time. At the time the field work was carried out the creek was frozen over and the ice level was at El. 92.8.

V DISCUSSION AND RECOMMENDATIONS

The natural soil profile consists of soft highly compressible peat and organic silt deposits overlying hard silty clay till. The till was encountered at El. 77.5 in borehole 1 and at El. 88.3 in borehole 2, from which it may be assumed that the surface of the till stratum varies considerably across the site.

To avoid large settlements which may be detrimentalto the structure, loads from the footings must be supported in the clay till stratum. This may be accomplished by constructing deep spread footings, or alternatively, the footings may be supported on timber piles which are driven into the clay till stratum. Because of the depth of excavation involved it appears that the piled type of foundation will be the most practical and economical.

Timber Piles

From the borehole results and interpolation of the subsurface profile, timber piles would be expected to achieve a suitable set at about El. 70.

The ultimate bearing capacity of a pile is estimated from the sum of the end-bearing and skin-friction components. Assuming that the piles are driven 10 feet into the silty clay till stratum, the end-bearing value for a nominal 12-inch diameter pile will be 15 tons, and the skin-friction component will be 2.5 tons per foot of penetration of the pile into the clay stratum. This results in a 40 ton ultimate capacity for the pile.

A factor of safety of 2 is usually applied in the design of piles, therefore the allowable working load for such a pile would be 20 tons. This is normally the maximum load which may be carried by timber piles.

The foregoing estimate of bearing capacity is only a theoretical prediction, therefore in practice the piles should be driven to a satisfactory set in accordance with an accepted pile driving formula such as the Hiley formula.

It is estimated that settlement due to consolidation of the clay till stratum will be less than 1/2 inch.

Construction

Following excavation for the footings, it will probably be necessary to place a layer of sand or gravel on the exposed grade to facilitate movement of construction personnel.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

C.J.W. Atkinson, M.Sc., P.Eng.,
Branch Manager

C.J.W. ATKINSON
PROVINCE OF ONTARIO

CJWA:jms

APPENDIX A

STANDARD PENETRATION TESTS

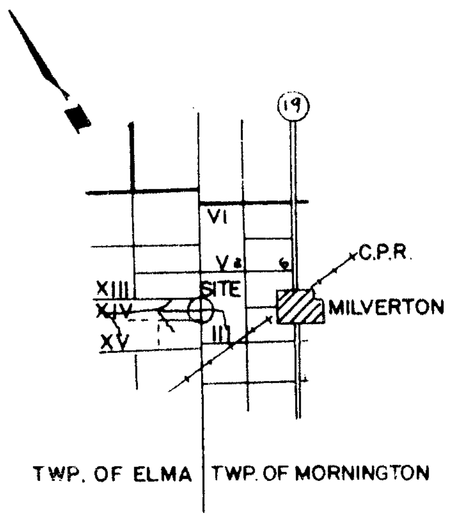
In order to determine the relative density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted. The test also gives an indication of the consistency of cohesive soils.

A two-inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30 in. The tube is first driven an initial 6 in. to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12 in. is recorded. The sample tube used is one originally developed by the Raymond Concrete Pile Company in the United States, where a sufficient number of tests have been made in conjunction with field investigations to show that the results, although essentially empirical, may be applied to foundation design.

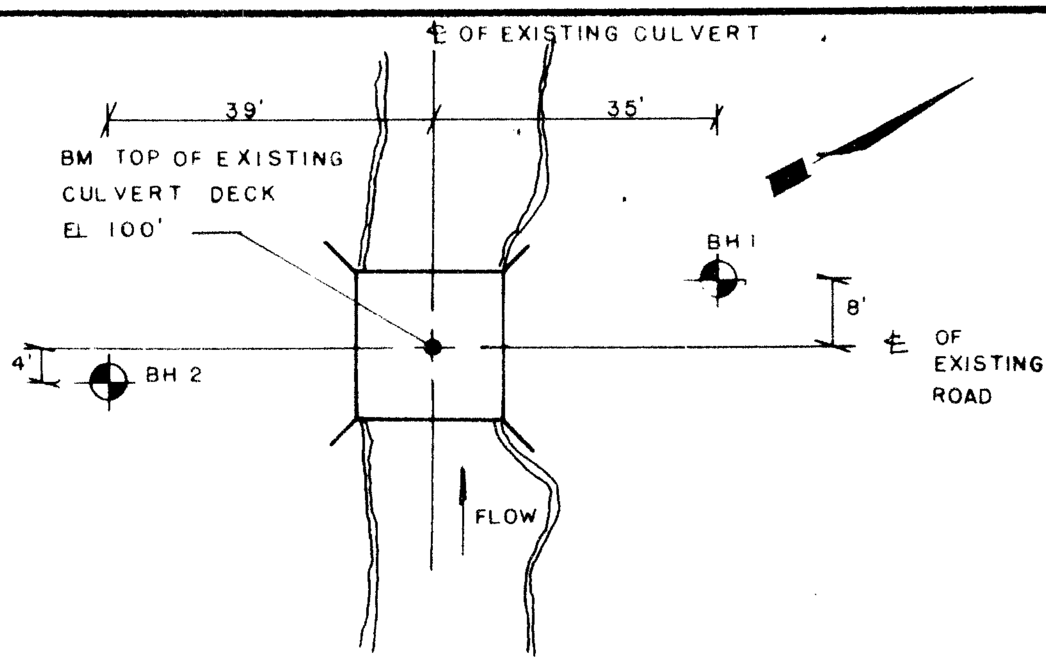
For sands:

Values of N	Density
Less than 10	Loose
Between 10 and 30	Compact
Between 30 and 50	Dense
Greater than 50	Very dense

Enclosures

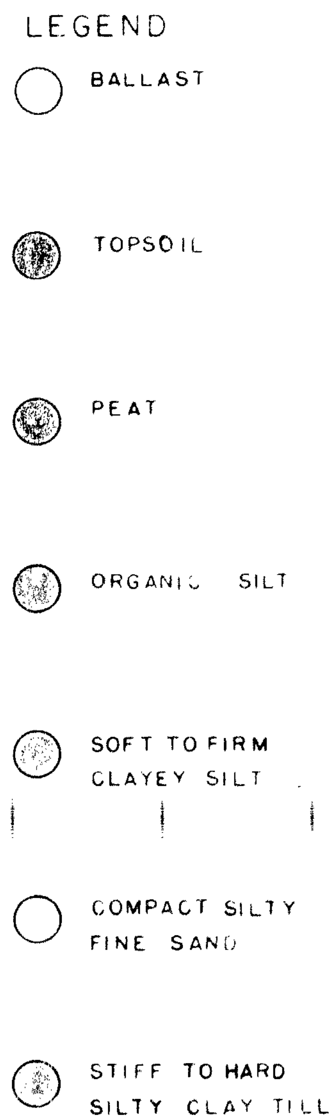


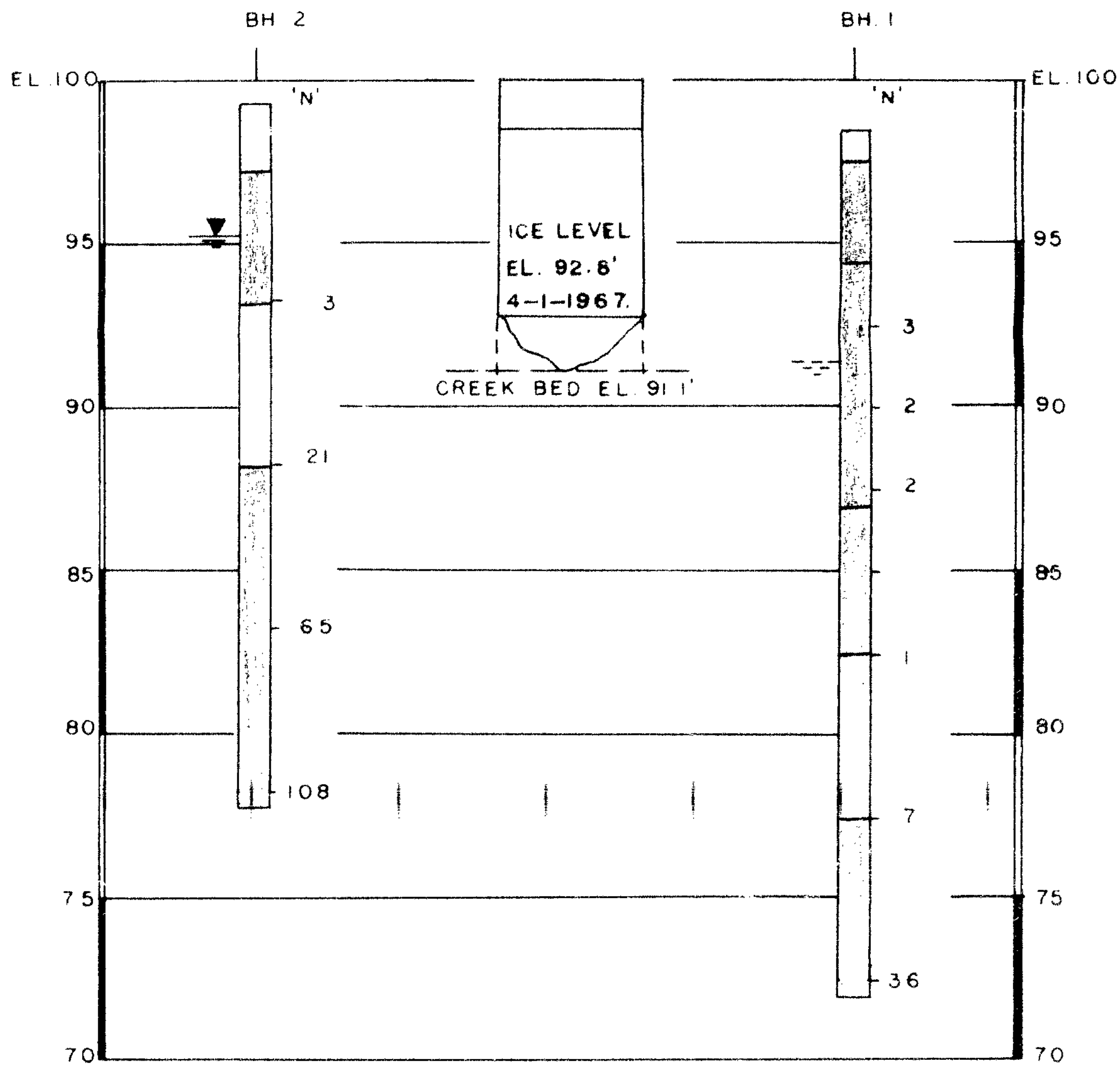
KEY PLAN



LOCATION OF BOREHOLES

SCALE 1" – 20'





SUBSURFACE PROFILE

VERT. SCALE 1" – 5'

GEOTECHNICAL DATA SHEET FOR BOREHOLE 1 and 2

OUR REFERENCE NO. 6-11-L23

CLIENT: R. M. Dawson
PROJECT: Atkin Culvert
LOCATION: Elma - Mornington Townline. Conc 14 Elma.
DATUM ELEVATION: 100 feet (See enclosure 2)

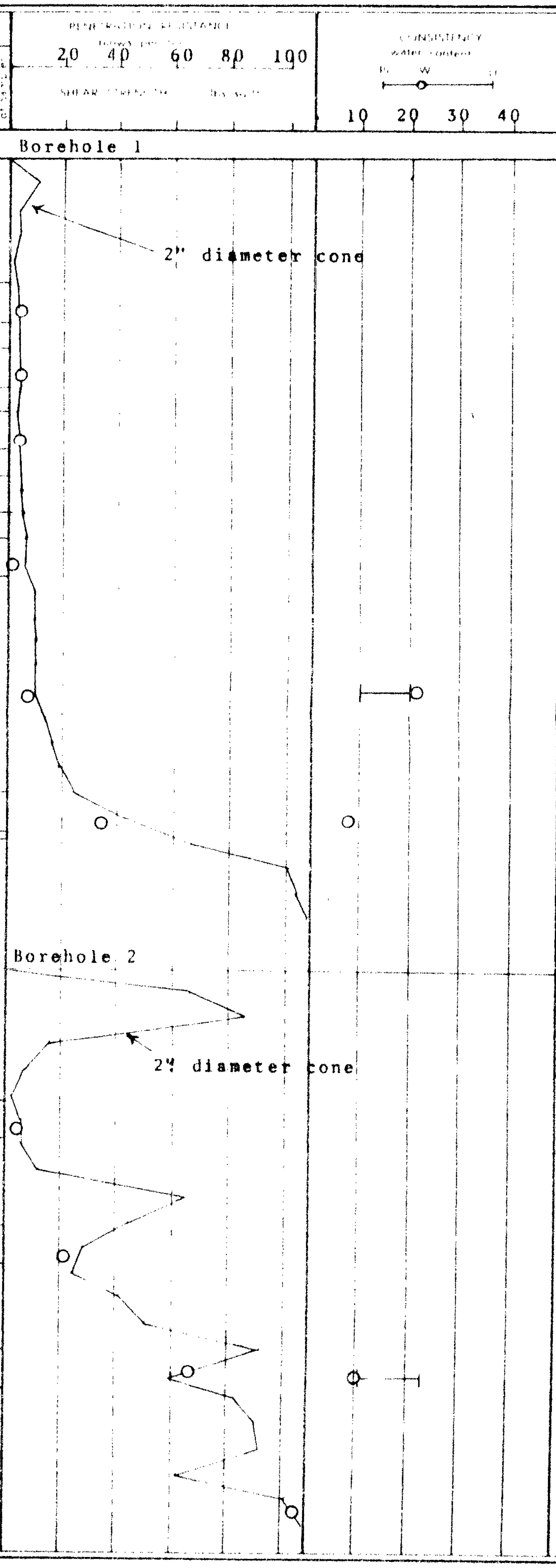
METHOD OF BORING: Auger & washboring
DIAMETER OF BOREHOLE: 4-inch & Bx (3-inch)
DATE: January 4 & 13, 1967
FIGURE NO. 3

Borehole 1

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	SAMPLE NUMBER	TYPE	N	REMARKS
98.5	0.0	Ground Surface				
	1.0	Road Ballast				
95	4.0	Topsoil				
		Soft Black Peat	1	SS	3	Cave-in El. 91.5 Jan 5, '67
90			2	SS	2	
	11.5		3	SS	2	
85		Soft Grey Organic silt	4	W		
	16.0		5	SS	1	
80	21.0	Soft to firm grey clayey silt and layers of sand & gravel	6	SS	7	
75	26.5	Stiff to hard grey silty clay, traces of sand, little gravel. (Glacial Till)	7	SS	36	
		End of Borehole				

Borehole 2

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	SAMPLE NUMBER	TYPE	N	REMARKS
99.3	0.0	Ground Surface				
	2.0	Road Ballast				
95	6.1	Soft Black Peat	1	SS	3	W. L. El. 95.3 Jan 13, '67
90	11.0	Compact grey silty fine sand little gravel & traces of clay				
85		Hard grey silty clay, traces of sand little gravel. (Glacial Till)	2	SS	21	
80			3	SS	65	
	21.5		4	SS	108	
		End of Borehole				



VERTICAL SCALE 1 IN. TO 5 ft

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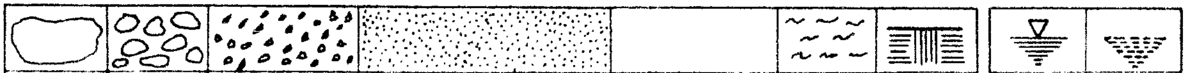
MADE CHD

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.



BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø > 8"	3"	3/4"	4.76mm	2.0	0.42	0.074	0.002 >		NO SIZE LIMIT			

U.S. Standard Sieve Size: No.4 No.10 No.40 No.200

SAMPLE TYPES.

AS	Auger sample	RC	Rock core	TP	Piston, thin walled tube sample
CS	Sample from casing	%	Recovery	TW	Open, thin walled tube sample
ChS	Chunk sample	SS	Split spoon sample	WS	Wash sample

SAMPLER ADVANCED BY static weight : w
" pressure : p
" tapping : t

OBSERVATIONS MADE WHILE CORING: Steady pressure; No pressure; Intermittent pressure

Washwater returns

Washwater lost

PENETRATION RESISTANCES.

SYMBOL:

DYNAMIC PENETRATION RESISTANCE : to drive a 2"ϕ, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

EXTRAPOLATED -N- VALUE — 322

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SOIL PROPERTIES.

W %	Water content	γ	Natural bulk density (unit weight)	k	Coeff of permeability
LL %	Liquid limit	e	Void ratio	C	Shear strength — in terms of total stress
PL %	Plastic limit	RD	Relative density	ϕ	Angle of int. friction — in terms of total stress
PI %	Plasticity index	C_v	Coeff. of consolidation	c'	Cohesion — in terms of effective stress
LI	Liquidity index	m_v	Coeff. of volume compressibility	ϕ'	Angle of int. friction — in terms of effective stress

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL / UNCONFINED COMPRESSION TEST: ◉ (triaxial), ● St (unconfined)

LABORATORY / FIELD VANE TEST: X St (laboratory), + St (field)

POCKET PENETROMETER TEST: ▼ St

Strain at failure is represented by direction of stem: 20% (up), 5% (right), 10% (down), 15% (left)

$$St : \text{sensitivity} = \frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$$

SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq ft
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000