

GEOTECHNICAL INVESTIGATION

FOR

NSW LAND & HOUSING CORPORATION

289-291 Beauchamp Road, Matraville, New South Wales

Report No: 21/0520

Project No: 21021/4822D-G

March 2021

Table of Contents

1. INTRODUCTION	2
2. NATURE OF THE INVESTIGATION	2
2.1. Fieldwork	2
2.2. Laboratory Testing.....	3
3. GEOLOGY AND SITE CONDITIONS.....	3
4. SUBSURFACE CONDITIONS	3
5. GEOTECHNICAL DISCUSSION	4
5.1. Site Classification to AS2870	4
5.2. Foundation Design.....	4
5.3. Soil Aggressiveness	4
6. FINAL COMMENTS	5

DRAWING NO. 21/0520 – BOREHOLE AND PENETROMETER LOCATIONS

NOTES RELATING TO GEOTECHNICAL REPORTS

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

APPENDIX B – LABORATORY TEST RESULTS

1. INTRODUCTION

This report presents the results of a Geotechnical Investigation carried out by STS Geotechnics Pty Limited (STS) for a proposed new residential development to be constructed at 289-291 Beauchamp Road, Matraville. At the time of writing this report STS were not provided with architectural drawings for the project, however we understand the development will typically comprise the demolition of existing dwellings and construction of one to two level residential unit type buildings. The development will not include basement levels.

The purpose of the investigation was to:

- assess the subsurface conditions over the site,
- provide a Site Classification to AS2870,
- provide recommendations regarding the appropriate foundation system for the site including design parameters, and
- comment on soil aggressiveness to buried steel and concrete.

The investigation was undertaken at the request of NSW Land and Housing Corporation.

Our scope of work did not include a contamination assessment.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of drilling four (4) boreholes numbered BH1 to BH4 inclusive, at the locations shown on Drawing No. 21/0520. The boreholes were drilled using a track mounted Christie mini drilling rig owned and operated by STS. Soils were drilled using rotary solid flight augers. Soil strengths were determined by undertaking Perth Sand Penetrometer (PSP) tests at each borehole location.

Drilling operations were undertaken by one of STS's senior geologists who also logged the subsurface conditions encountered.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

2.2. Laboratory Testing

In order to assess the soils for their aggressiveness, two representative soil samples were tested to determine the following:

- pH,
- Sulphate content (SO₄),
- Chloride content (CL), and
- Electrical Conductivity (EC)

Detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Sydney geological series sheet at a scale of 1:100,000 shows the site is underlain by Permian Age deposits that comprise marine sands. These were deposited as transgressive dunes.

The site is rectangular in shape with an area of approximately 1,320 m². At the time of the fieldwork, the site was occupied by single level brick residential dwellings with tiled roof.

Site vegetation comprised grass, trees and shrubs.

The ground surface falls less than 0.3 metres to the north.

4. SUBSURFACE CONDITIONS

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies, particularly, on a site such as this where there has been previous development.

The subsurface conditions generally consist of topsoil, fill and sands overlying weathered sandstone. Topsoil and fill were present to depths of 0.3 to 0.6 metres. In general, loose to medium dense becoming medium dense sands are present to depths of 3.0 and in excess of 6.0 metres. In BH2, loose sands are present to a depth of 3.0 metres. In BH2 weathered sandstone underlies the sands to the depth of auger refusal, 3.5 metres.

No groundwater was observed in the boreholes during the drilling.

5. GEOTECHNICAL DISCUSSION

5.1. Site Classification to AS2870

The classification has been prepared in accordance with the guidelines set out in the “Residential Slabs and Footings” Code, AS2870 – 2011.

Because of the loose sands present, the site is classified *a problem site (P)*.

5.2. Foundation Design

Pad and/or strip footings should not be founded in the loose sands. Any footings that bear in these materials will likely experience unacceptable total and differential settlement. The extent of the loose sands on the site is unclear.

Piles, 300 mm diameter or greater, founded in medium dense sand below a depth of 2 metres may be proportioned using an allowable end bearing pressure of 350 KPa. Piles founded in weathered sandstone, may be proportioned using an allowable bearing pressure of 800 kPa. The onsite soils are sandy, therefore, steel screw piers are best suited to the site conditions. Conventional augered cast in place piers are not suited to the site conditions. When the slab is suspended on piles a stable (A) classification may be used to proportion the slab.

5.3. Soil Aggressiveness

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulphates and chlorides. In order to determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling – Design and Installation and Tables 5.1 and 5.2 of AS2870-2011. Regarding the electrical conductivity, the laboratory test results have been multiplied by the appropriate factor to convert the results to EC_e. The test results are summarised in Table 5.1 below.

Table 5.1 – Soil Aggressiveness Summary Table

Sample No.	Location	Depth (m)	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Electrical Conductivity (dS/m)	
						EC _{1:5}	EC _e
S1	BH1	0.4	6.8	<10	<10	0.016	0.3
S2	BH4	0.5	6.2	<10	<10	0.007	0.1

The report results range between:

- pH - minimum 6.2
- soluble SO₄ - maximum <10 mg/kg (ppm)
- soluble Cl - maximum <20 mg/kg (ppm)
- EC_e - maximum value of 0.3 dS/m

The soils on the site consist of sands above the water table. Therefore, the soil conditions B are considered appropriate.

In accordance with AS2159-2009, the exposure classification for the onsite soils is non-aggressive to both steel and concrete. The soils are classified as A1 in accordance with AS2870-2011.

Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that EC_e values of 0.1 dS/m and 0.3 dS/m are consistent with the presence of non-saline soils.

6. FINAL COMMENTS

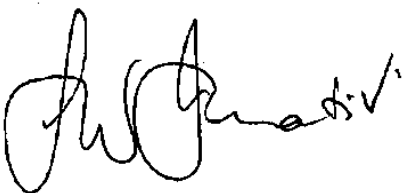
Attention is drawn to Appendix B of AS2870 - 2011 regarding the need to properly maintain the foundations. Surface drainage should be provided to avoid the possibility of water ponding near the building and the finished ground surface should fall at least 50 mm over a distance of one metre away from the building.

The above classification has been made assuming that all footings will bear in either natural ground or in controlled filling. Prior to the placement of any filling the existing surface should be stripped of all vegetation and topsoil.

This report has been prepared assuming the site development will be limited to one or two storey residential buildings. The information and interpretation may not be relevant if the design proposal changes (e.g. to a five-storey building involving major cuts during the site preparation). If changes occur, we would be pleased to review the report and advise on the adequacy of the investigation.

During construction, should the subsurface conditions vary from those inferred above, we would be contacted to determine if any changes should be made to our recommendations.

The exposed bearing surfaces for footings should be inspected by a geotechnical engineer to ensure the allowable pressure given has been achieved.



Laurie Ihnativ
Senior Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.

Scale: Unknown

Date: February 2021

Client: NSW LAND & HOUSING CORPORATION

**GEOTECHNICAL INVESTIGATION
289-291 BEAUCHAMP ROAD, MATRAVILLE
BOREHOLE AND PENETROMETER LOCATIONS**

Project No.
31021/4822D-G

Drawing No: 21/0520

NOTES RELATING TO GEOTECHNICAL REPORTS

Introduction

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report.

When copies of reports are made, they should be reproduced in full.

Geotechnical Reports

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS

Geotechnics Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

Subsurface Information

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

Supply of Geotechnical Information or Tendering Purposes

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

Client: NSW Land & Housing Corporation		Project / STS No. 31021/4822D-G		BOREHOLE NO.: BH 1		
Project: 289-291 Beauchamp Road, Matraville		Date: February 17, 2021				
Location: Refer to Drawing No. 21/0580		Logged: JK Checked By: SS		Sheet 1 of 1		
W A T E R L E V E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
	S1 @ 0.4 m		FILL: CLAYEY SILTY SAND: dark brown, fine to medium grained, trace of gravel, metal	SC	FIRM	M
			SAND: light brown, fine to medium grained	SP	LOOSE TO MEDIUM DENSE	M
		1.0				
		2.0				
		3.0				
			BOREHOLE DIUSCONTINUED AT 3.0 M			
		4.0				
		5.0				
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Mini Christie Hole Diameter (mm): 100		
NOTES:				Angle from Vertical (°): 0 Drill Bit: Spiral		

[illegible]

Client: NSW Land & Housing Corporation		Project / STS No. 31021/4822D-G		BOREHOLE NO.: BH 3		
Project: 289-291 Beauchamp Road, Matraville		Date: February 17, 2021				
Location: Refer to Drawing No. 21/0580		Logged: JK Checked By: SS		Sheet 1 of 1		
W A T E R L E V E L	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			TOPSOIL: SILTY SAND: dark grey with light grey, fine to medium grained	SM	LOOSE	M
			CLAYEY SILTY SAND: orange brown with dark brown, fine to medium grained, trace of weathered rock	SC	LOOSE BECOMING LOOSE TO MEDIUM DENSE	M
		1.0	SAND: light brown, fine to medium grained	SP	MEDIUM DENSE	M
		2.0				
		3.0				
		4.0				
		5.0				
			BOREHOLE DISCONTINUED AT 6.0 M			
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Mini Christie Hole Diameter (mm): 100		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols				Angle from Vertical (°): 0 Drill Bit: Spiral		

Client: NSW Land & Housing Corporation			Project / STS No. 31021/4822D-G		BOREHOLE NO.: BH 4		
Project: 289-291 Beauchamp Road, Matraville			Date: February 17, 2021				
Location: Refer to Drawing No. 21/0580			Logged: JK Checked By: SS		Sheet 1 of 1		
W A T T A B E R L E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)		S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
	S2 @ 0.5 m		FILL: SILTY SANDY CLAY: dark grey, fine to medium grained sand, trace of gravel		SM	LOOSE TO MEDIUM DENSE	D-M
			SAND: light brown, fine to medium grained		SP	MEDIUM DENSE	D-M
		1.0					
		2.0					
		3.0	BOREHOLE DISCONTINUED AT 3.0 M				
		4.0					
		5.0					
D - disturbed sample WT - level of water table or free water S - jar sample					Contractor: STS Equipment: Mini Christie Hole Diameter (mm): 100		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols					Angle from Vertical (°): 0 Drill Bit: Spiral		

Perth Sand Penetrometer Test Report

Project: 289-291 BEAUCHAMP ROAD, MATRAVILLE

Project No.: 31021/4822D

Client: NSW LAND & HOUSING CORPORATION

Report No.: 21/0520

Address: 12 Darcy Street, Parramatta

Report Date: 22/2/2021

Test Method: AS 1289.6.3.3

Page: 1 of 1



Accredited for compliance with ISO/IEC

17025 - Testing

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards
NATA Accreditation Number 2750

Site No.	P1	P2	P3	P4		
Location	Refer to Drawing No. 21/0520	Refer to Drawing No. 21/0520	Refer to Drawing No. 21/0520	Refer to Drawing No. 21/0520		
Date Tested	17/2/2021	17/2/2021	17/2/2021	17/2/2021		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	1	1	1	1		
0.15 - 0.30	1	1	1	3		
0.30 - 0.45	2	1	1	2		
0.45 - 0.60	2	1	1	2		
0.60 - 0.75	1	2	5	2		
0.75 - 0.90	1	1	4	3		
0.90 - 1.05	2	1	4	3		
1.05 - 1.20	4	1	4	4		
1.20 - 1.35	4	1	6	5		
1.35 - 1.50	4	1	6	6		
1.50 - 1.65	6	1	6	6		
1.65 - 1.80	6	2	8	5		
1.80 - 1.95	6	2	7	6		
1.95 - 2.10	7	1	13	6		
2.10 - 2.25	7	2	11	6		
2.25 - 2.40	5	1	10	7		
2.40 - 2.55	5	2	12	7		
2.55 - 2.70	6	1	17	8		
2.70 - 2.85	6	1	22	7		
2.85 - 3.00	5	2	Refusal	7		
3.00 - 3.15	6	5		Discontinued		
3.15 - 3.30	5	13				
3.30 - 3.45	5	22				
3.45 - 3.60	5	Refusal				
3.60 - 3.75	6					
3.75 - 3.90	7/D					

Remarks: * Pre drilled prior to testing

Approved Signatory.....



Technician: JK

Orlando Mendoza - Laboratory Manager

Tree Heights and Type

Project No. / STS No.: 31021/4822D-G

Technician: JK

[illegible]

E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by STS Geotechnics Pty Ltd (STS) in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-1981, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour)

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

- (a) Soil Name and Classification Symbol

The USC system is summarised in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).
- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms "some" and "trace" as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - medium to high plasticity	H

(b) Grading

“Well graded”	Good representation of all particle sizes from the largest to the smallest.
“Poorly graded”	One or more intermediate sizes poorly represented
“Gap graded”	One or more intermediate sizes absent
“Uniformly graded”	Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as “rounded”, “sub-rounded”, “sub-angular” or “angular”.

Particle **form** can be “equidimensional”, “flat” or “elongate”.

Surface texture can be “glassy”, “smooth”, “rough”, “pitted” or “striated”.

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by “light” or “dark”. Borderline colours may be described as a combination of two colours, eg red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

E1.3 Soil Condition

(a) Moisture

Soil moisture condition is described as “dry”, “moist” or “wet”.

The moisture categories are defined as:

Dry (D) - Little or no moisture evident. Soils are running. Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 - 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 - 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 - 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 - 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2 c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q _c (MPa)	DENSITY INDEX (%)
Very Loose	0 - 3	0 - 2	0 - 15
Loose	3 - 8	2 - 5	15 - 35
Medium Dense	8 - 25	5 - 15	35 - 65
Dense	25 - 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample

Lens - discontinuous with lenticular shape

Pocket - irregular inclusion

Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

“Residual Soil” - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

“Colluvium” - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

“Landslide Debris” - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

“Alluvium” - Material which has been transported essentially by water. usually associated with former stream activity.

“Fill” - Material which has been transported and placed by man. This can range from natural soils which have been

placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicated by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes “O” or “H” depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an “organic material” by classification.

Coal and lignite should be described as such and not simply as organic matter.

APPENDIX B – LABORATORY TEST RESULTS

CERTIFICATE OF ANALYSIS

Work Order	: ES2105846	Page	: 1 of 5
Client	: STS Geotechnics	Laboratory	: Environmental Division Sydney
Contact	: ENQUIRES STS	Contact	: Customer Services ES
Address	: Unit 14/1 Cowpasture Place Wetherill Park 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 30055/30060/31021	Date Samples Received	: 18-Feb-2021 15:00
Order number	: E-2021-0063	Date Analysis Commenced	: 19-Feb-2021
C-O-C number	: ----	Issue Date	: 23-Feb-2021 12:02
Sampler	: MB/JK		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 12		
No. of samples analysed	: 12		



Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW



General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	30055/7348	30055/7351	30055/7359	30055/7360	30055/7361
Sampling date / time					17-Feb-2021 00:00	17-Feb-2021 00:00	17-Feb-2021 00:00	17-Feb-2021 00:00	17-Feb-2021 00:00
Compound	CAS Number	LOR	Unit		ES2105846-001	ES2105846-002	ES2105846-003	ES2105846-004	ES2105846-005
Result					Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		5.1	6.2	7.0	6.2	6.7
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		57	15	81	14	23
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		15.0	18.9	19.3	8.7	12.7
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		30	20	20	<10	10



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	30055/7364	30055/7365	30055/7366	390060/1368	30060/1382
Sampling date / time					17-Feb-2021 00:00	17-Feb-2021 00:00	17-Feb-2021 00:00	17-Feb-2021 00:00	17-Feb-2021 00:00
Compound	CAS Number	LOR	Unit		ES2105846-006	ES2105846-007	ES2105846-008	ES2105846-009	ES2105846-010
				Result	Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		7.5	6.7	5.3	4.9	4.5
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		143	23	111	40	62
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		17.0	13.6	7.4	22.8	17.8
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		50	<10	<10	30	40



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	31021/4822D-R/S1	31021/4822D-R/S2	----	----	----
Sampling date / time					17-Feb-2021 00:00	17-Feb-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2105846-011	ES2105846-012	-----	-----	-----
Result					Result	Result	----	----	----
EA002: pH 1:5 (Soils)									
pH Value	----	0.1	pH Unit		6.8	6.2	----	----	----
EA010: Conductivity (1:5)									
Electrical Conductivity @ 25°C	----	1	µS/cm		16	7	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		4.5	3.4	----	----	----
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		<10	<10	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	10	mg/kg		<10	<10	----	----	----

November 8, 2021
Project No. 31021/5663D-G
Report No. 21/3125
IW/ms

NSW Land & Housing Corporation
LAHC Parramatta
12 Darcy Street
PARRAMATTA NSW 2124

SUBJECT: INFILTRATION TESTING
289-293 BEAUCHAMP ROAD, MATRAVILLE (BGXPQ)

At your request, STS Geotechnics Pty Limited has determined the infiltration rate of the onsite soils. The purpose of obtaining this infiltration rate is to determine the required size of the proposed onsite storm water absorption pit.

The Sydney geological series sheet at a scale of 1:100,000 shows the site is underlain by Quaternary age medium to fine grained marine sand.

The subsurface conditions were determined by drilling one borehole, numbered BH5, at the location shown on Drawing No. 21/3125. The subsurface conditions consist of topsoil overlying sand.

No groundwater was observed in the borehole during the fieldwork.

The infiltration rate of the onsite soils was determined using the falling head test method. The test was carried out using a PVC pipe installed into a preformed borehole that had been previously drilled. In order to create a saturated bulb in the testing zone, the casing was repeatedly filled with water and the drop in water level measured relative to time. This process was carried out until successive tests gave different readings by less than 5%. The last run has been used to determine the soil infiltration rate.

Results of the testing are as follows:

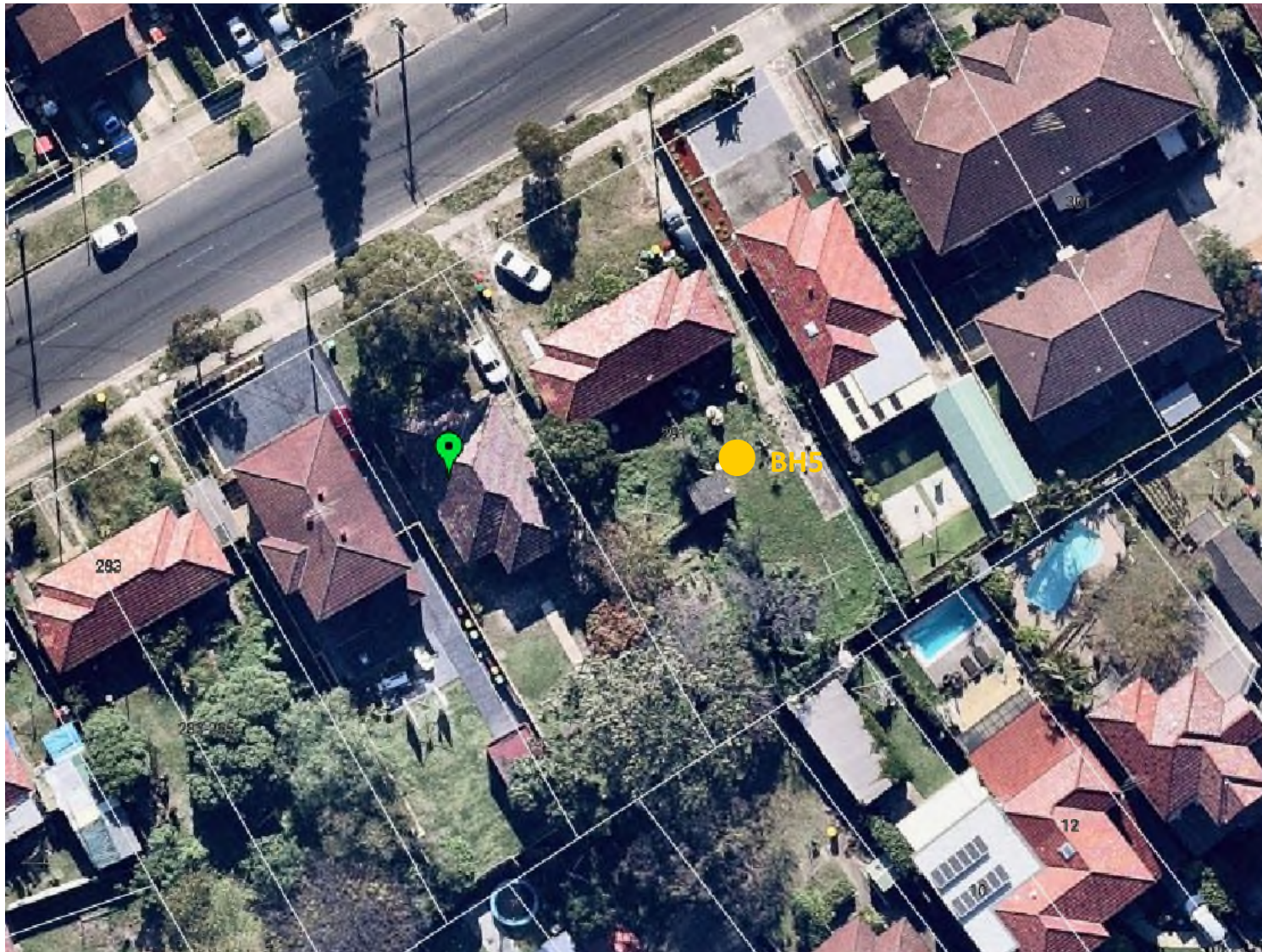
Location	Depth of Test (m)	Design Infiltration Rate (litres/m ² /sec)
BH3	1.0	0.7
BH3	2.0	0.4

We trust the above meets with your requirements. Should you have any questions, please contact us.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'Ian Watts', with a long horizontal stroke extending to the right.

Ian Watts
Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: November 2021
Client: NSW LAND & HOUSING CORPORATION		
INFILTRATION TESTING 289-293 EAUCHAMP ROAD, MATRAVILLE BOREHOLE LOCATIONS		Project No. 31021/5663D-G
		Drawing No: 21/3125

NOTES RELATING TO GEOTECHNICAL REPORTS

Introduction

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report.

When copies of reports are made, they should be reproduced in full.

Geotechnical Reports

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

Unforeseen Conditions

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS

Geotechnics Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

Subsurface Information

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

Supply of Geotechnical Information or Tendering Purposes

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

Client: NSW Land & Housing Corporation		Project / STS No. 31021/5663D-G		BOREHOLE NO.: BH 5		
Project: 289-293 Beauchamp Road, Matraville		Date: November 1, 2021				
Location: Refer to Drawing No. 21/3125		Logged: TS Checked By: IW		Sheet 1 of 1		
W A T E R L E V E	S A M P L E S	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT (Soil type, colour, grain size, plasticity, minor components, observations)	S Y M B O L	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	M O I S T U R E
			TOPSOIL: SAND: dark grey, medium grained	SM		M
		0.5	SAND: yellow/brown, medium grained	SM		M
		1.0				
		1.5				
		2.0	BOREHOLE DISCONTINUED AT 2.0 M			
		2.5				
D - disturbed sample U - undisturbed tube sample B - bulk sample WT - level of water table or free water N - Standard Penetration Test (SPT) S - jar sample				Contractor: STS Equipment: Mini Christie Hole Diameter (mm): 100 Angle from Vertical (°): 0 Drill Bit: Spiral		
NOTES: See explanation sheets for meaning of all descriptive terms and symbols						

E1. CLASSIFICATION OF SOILS

E1.1 Soil Classification and the Unified System

An assessment of the site conditions usually includes an appraisal of the data available by combining values of engineering properties obtained by the site investigation with descriptions, from visual observation of the materials present on site.

The system used by STS Geotechnics Pty Ltd (STS) in the identification of soil is the Unified Soil Classification system (USC) which was developed by the US Army Corps of Engineers during World War II and has since gained international acceptance and has been adopted in its metricated form by the Standards Association of Australia.

The Australian Site Investigation Code (AS1726-1981, Appendix D) recommends that the description of a soil includes the USC group symbols which are an integral component of the system.

The soil description should contain the following information in order:

Soil composition

- SOIL NAME and USC classification symbol (IN BLOCK LETTERS)
- plasticity or particle characteristics
- colour
- secondary and minor constituents (name estimated proportion, plasticity or particle characteristics, colour)

Soil condition

- moisture condition
- consistency or density index

Soil structure

- structure (zoning, defects, cementing)

Soil origin

interpretation based on observation eg FILL, TOPSOIL, RESIDUAL, ALLUVIUM.

E1.2 Soil Composition

- (a) Soil Name and Classification Symbol

The USC system is summarised in Figure E1.2.1. The primary division separates soil types on the basis of particle size into:

- Coarse grained soils - more than 50% of the material less than 60 mm is larger than 0.06 mm (60 µm).
- Fine grained soils - more than 50% of the material less than 60 mm is smaller than 0.06 mm (60 µm).

Initial classification is by particle size as shown in Table E1.2.1. Further classification of fine grained soils is based on plasticity.

TABLE E1.2.1 - CLASSIFICATION BY PARTICLE SIZE

NAME	SUB-DIVISION	SIZE
Clay (1)		< 2 µm
Silt (2)		2 µm to 60 µm
Sand	Fine Medium Coarse	60 µm to 200 µm 200 µm to 600 µm 600 µm to 2 mm
Gravel (3)	Fine Medium Coarse	2 mm to 6 mm 6 mm to 20 mm 20 mm to 60 mm
Cobbles (3)		60 mm to 200 mm
Boulders (3)		> 200 mm

Where a soil contains an appropriate amount of secondary material, the name includes each of the secondary components (greater than 12%) in increasing order of significance, eg sandy silty clay.

Minor components of a soil are included in the description by means of the terms "some" and "trace" as defined in Table E1.2.2.

TABLE E1.2.2 - MINOR SOIL COMPONENTS

TERM	DESCRIPTION	APPROXIMATE PROPORTION (%)
Trace	presence just detectable, little or no influence on soil properties	0-5
Some	presence easily detectable, little influence on soil properties	5-12

The USC group symbols should be included with each soil description as shown in Table E1.2.3

TABLE E1.2.3 - SOIL GROUP SYMBOLS

SOIL TYPE	PREFIX
Gravel	G
Sand	S
Silt	M
Clay	C
Organic	O
Peat	Pt

The group symbols are combined with qualifiers which indicate grading, plasticity or secondary components as shown on Table E1.2.4

TABLE E1.2.4 - SOIL GROUP QUALIFIERS

SUBGROUP	SUFFIX
Well graded	W
Poorly Graded	P
Silty	M
Clayey	C
Liquid Limit <50% - low to medium plasticity	L
Liquid Limit >50% - medium to high plasticity	H

(b) Grading

“Well graded”	Good representation of all particle sizes from the largest to the smallest.
“Poorly graded”	One or more intermediate sizes poorly represented
“Gap graded”	One or more intermediate sizes absent
“Uniformly graded”	Essentially single size material.

(c) Particle shape and texture

The shape and surface texture of the coarse grained particles should be described.

Angularity may be expressed as “rounded”, “sub-rounded”, “sub-angular” or “angular”.

Particle **form** can be “equidimensional”, “flat” or “elongate”.

Surface texture can be “glassy”, “smooth”, “rough”, “pitted” or “striated”.

(d) Colour

The colour of the soil should be described in the moist condition using simple terms such as:

Black	White	Grey	Red
Brown	Orange	Yellow	Green
Blue			

These may be modified as necessary by “light” or “dark”. Borderline colours may be described as a combination of two colours, eg red-brown.

For soils that contain more than one colour terms such as:

- Speckled Very small (<10 mm dia) patches
- Mottled Irregular
- Blotched Large irregular (>75 mm dia)
- Streaked Randomly oriented streaks

(e) Minor Components

Secondary and minor components should be individually described in a similar manner to the dominant component.

E1.3 Soil Condition

(a) Moisture

Soil moisture condition is described as “dry”, “moist” or “wet”.

The moisture categories are defined as:

Dry (D) - Little or no moisture evident. Soils are running. Moist (M) - Darkened in colour with cool feel. Granular soil particles tend to adhere. No free water evident upon remoulding of cohesive soils.

In addition the moisture content of cohesive soils can be estimated in relation to their liquid or plastic limit.

(b) Consistency

Estimates of the consistency of a clay or silt soil may be made from manual examination, hand penetrometer test, SPT results or from laboratory tests to determine undrained shear or unconfined compressive strengths. The classification of consistency is defined in Table E1.3.1.

TABLE E1.3.1 - CONSISTENCY OF FINE-GRAINED SOILS

TERM	UNCONFINED STRENGTH (kPa)	FIELD IDENTIFICATION
Very Soft	<25	Easily penetrated by fist. Sample exudes between fingers when squeezed in the fist.
Soft	25 - 50	Easily moulded in fingers. Easily penetrated 50 mm by thumb.
Firm	50 - 100	Can be moulded by strong pressure in the fingers. Penetrated only with great effort.
Stiff	100 - 200	Cannot be moulded in fingers. Indented by thumb but penetrated only with great effort.
Very Stiff	200 - 400	Very tough. Difficult to cut with knife. Readily indented with thumb nail.
Hard	>400	Brittle, can just be scratched with thumb nail. Tends to break into fragments.

Unconfined compressive strength as derived by a hand penetrometer can be taken as approximately double the undrained shear strength ($q_u = 2 c_u$).

(c) Density Index

The insitu density index of granular soils can be assessed from the results of SPT or cone penetrometer tests. Density index should not be estimated visually.

TABLE E1.3.2 - DENSITY OF GRANULAR SOILS

TERM	SPT N VALUE	STATIC CONE VALUE q _c (MPa)	DENSITY INDEX (%)
Very Loose	0 - 3	0 - 2	0 - 15
Loose	3 - 8	2 - 5	15 - 35
Medium Dense	8 - 25	5 - 15	35 - 65
Dense	25 - 42	15 - 20	65 - 85
Very Dense	>42	>20	>85

E1.4 Soil Structure

(a) Zoning

A sample may consist of several zones differing in colour, grain size or other properties. Terms to classify these zones are:

Layer - continuous across exposure or sample

Lens - discontinuous with lenticular shape

Pocket - irregular inclusion

Each zone should be described, their distinguishing features, and the nature of the interzone boundaries.

(b) Defects

Defects which are present in the sample can include:

- fissures
- roots (containing organic matter)
- tubes (hollow)
- casts (infilled)

Defects should be described giving details of dimensions and frequency. Fissure orientation, planarity, surface condition and infilling should be noted. If there is a tendency to break into blocks, block dimensions should be recorded

E1.5 Soil Origin

Information which may be interpretative but which may contribute to the usefulness of the material description should be included. The most common interpreted feature is the origin of the soil. The assessment of the probable origin is based on the soil material description, soil structure and its relationship to other soil and rock materials.

Common terms used are:

“Residual Soil” - Material which appears to have been derived by weathering from the underlying rock. There is no evidence of transport.

“Colluvium” - Material which appears to have been transported from its original location. The method of movement is usually the combination of gravity and erosion.

“Landslide Debris” - An extreme form of colluvium where the soil has been transported by mass movement. The material is obviously distributed and contains distinct defects related to the slope failure.

“Alluvium” - Material which has been transported essentially by water. usually associated with former stream activity.

“Fill” - Material which has been transported and placed by man. This can range from natural soils which have been

placed in a controlled manner in engineering construction to dumped waste material. A description of the constituents should include an assessment of the method of placement.

E1.6 Fine Grained Soils

The physical properties of fine grained soils are dominated by silts and clays.

The definition of clay and silt soils is governed by their Atterberg Limits. Clay soils are characterised by the properties of cohesion and plasticity with cohesion defines as the ability to deform without rupture. Silts exhibit cohesion but have low plasticity or are non-plastic.

The field characteristics of clay soils include:

- dry lumps have appreciable dry strength and cannot be powdered
- volume changes occur with moisture content variation
- feels smooth when moist with a greasy appearance when cut.

The field characteristics of silt soils include:

- dry lumps have negligible dry strength and can be powdered easily
- dilatancy - an increase in volume due to shearing - is indicated by the presence of a shiny film of water after a hand sample is shaken. The water disappears upon remoulding. Very fine grained sands may also exhibit dilatancy.
- low plasticity index
- feels gritty to the teeth

E1.7 Organic Soils

Organic soils are distinguished from other soils by their appreciable content of vegetable matter, usually derived from plant remains.

The soil usually has a distinctive smell and low bulk density.

The USC system uses the symbol Pt for partly decomposed organic material. The O symbol is combined with suffixes “O” or “H” depending on plasticity.

Where roots or root fibres are present their frequency and the depth to which they are encountered should be recorded. The presence of roots or root fibres does not necessarily mean the material is an “organic material” by classification.

Coal and lignite should be described as such and not simply as organic matter.