GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown, NSW 2148, Australia
PO Box 1543, Macquarie Centre. North Ryde, NSW 2113
ABN 62 084 294 762
Tel : (02) 9679 8733
Fax : (02) 9679 8744

31st May 2011

JC09077A-r3

Angus Bristow Village
C/- McFadyen Architects Pty Ltd
Suite F8, 1-15 Barr Street
BALMAIN NSW 2041

Attention: Mr Peter McFadyen

Dear Sir

Re Dam Embankment Assessment
Lot 200 DP 1022680 and Lot 13 DP 242250, Lodges Road, Elderslie

1.0 Introduction

Further to our Preliminary Dam Embankment Assessment report referenced JC09077A-r2 dated 10th January 2011, a geotechnical investigation was carried out on the existing dam embankment as shown on the attached Drawing No 1.

We understand that the existing dam is proposed to be retained as part of the proposed residential subdivision and aged care facility development and this dam will be used as a detention basin to store an additional 380m^3 of stormwater. The design permanent water level of the dam will be similar to current.

The purpose of the investigation was to assess the nature of the earthfill material which forms the existing embankment and foundation material. Based upon the information obtained, the following information is provided;

- Assessment of the stability of the existing embankments.
- Recommendations on remedial works to improve stability of the embankments.

2.0 Dam Embankment Description

Refer to the attached Drawing No 1 for dam features. The following is a summary of our site observations;

- The dam appeared to have been formed by excavation into the natural ground on the eastern side and construction of an embankment on the western side.
- The upstream cut embankment has gentle slopes of between 3 to 4 Horizontal to 1 Vertical.
- The fill embankment was estimated to have a maximum height of 2m reducing to nothing to the north and south. Crest width was estimated to be roughly 3m.
- The upstream fill embankment has steeper slopes of between 0.5 to 2.5 Horizontal to 1 Vertical.

- The downstream fill embankment generally has gentle slopes of between 4 to 5 Horizontal to 1 Vertical. Relatively steep slope of 1 Horizontal to 1 Vertical exists on the northern side.
- The spillway is approximately in the middle of the fill embankment with water level roughly 1m below the crest of the fill embankment.
- A concrete footpath was constructed along the crest of the embankment with the other areas covered with grass.
- Some minor sloughing of the upstream fill embankment was noted immediately above the water line. Elsewhere, the embankments appear even with no obvious signs of slump or slip failure.
- There were no visible signs of tension cracking along the crest of the fill embankment.
- There were no visible signs of rills, erosion and tunnelling noted on the embankments.
- There were no visible signs of animal burrows.

3.0 Investigation Methodology

3.1 Fieldwork

Fieldwork for the investigation consisted of drilling 3 boreholes through the dam embankment using spiral auger attached to a pendulum drill rig as shown on the attached Drawing No 1. The boreholes were drilled through the earthfill embankment and into natural clay and terminated on shale at depths varying from 2.7m to 2.8m below existing ground surface. The field investigation was monitored on a full time basis by an engineer from GeoEnviro Consultancy Pty Ltd.

To assess the relative densities of the earth fill and consistency of the natural clay, Dynamic Cone Penetrometer (DCP) testes were carried out immediately adjacent to the boreholes. The DCP tests involved driving a steel probe into the ground using a standard weight sliding hammer and recording the number of blow counts per 100mm depth intervals.

The boreholes were observed for groundwater seepage, during and upon completion of the site investigation.

The field test results, together with details of the subsurface profile encountered are presented on the Borehole Reports attached. Explanatory notes and Graphic Symbols for Soil and Rock are also attached defining the terms and symbols used in this report and its limitation.

3.2 Laboratory Testing

Disturbed soil samples were taken from the boreholes to our NATA accredited laboratory for Atterberg Limits, Emerson Dispersion, PinHole Dispersion and Particle Size Distribution tests to aid assessment of the quality of the earthfill material

4. Results of the Investigation

4.1 Subsurface Soil Profile

Reference should be made to the Borehole Reports for details of the subsurface profile encountered. A summary of the interpreted subsurface profile is as follows:

Embankment

The embankment material was found to consist mainly of medium to high plasticity Silty Clay. In BH 1 and BH 3, the lower fill material was found to consist of Silty Clay with some Clayey Silt mixture.

Based on the results of the DCP, the earthfill was assessed to be generally moderately to well compacted with the exception of the upper 0.7m of the fill in BH 2 which was found to be loose. The earthfill was assessed to be dry to moist.

Foundation

The underlying foundation material beneath the embankment was found to consist predominantly of medium to high plasticity Silty Clay. The Silty Clay was assessed to be very stiff to hard with moisture content less than the plastic limit.

Shale was encountered beneath the natural clay in all boreholes at depths ranging from 2.5m to 2.6m.

Groundwater

All boreholes were found to be dry

4.2 Laboratory Test Results

The Atterberg Limits and Particle Size Distribution test results confirmed our visual soil assessment. The fill embankment material was assessed to be of medium to high plasticity with a Liquid Limit of 43%.

The Emerson Dispersion tests indicate the embankment material and natural clay to be generally highly dispersive (ie Emerson Class Nos 1 and 2).

The Pin Hole Dispersion tests indicate the embankment material to be non-erodible (ie ND 1).

5.0 Assessment and Recommendations

Based on the results of the investigation, our assessment and recommendations are follows;

- The upper 0.7m of the fill in BH 2 was assessed to be loose and some marginal quality fill containing some Clayey Silt (ie with some topsoil properties) was encountered in BH 1 and BH 3 at below 0.7m and 1.2m below surface. We therefore recommend remedial works to include excavation of the upper 0.7m of the embankment, inspection of the underlying fill material for presence of unsuitable fill (eg topsoil, organic or soft fill) and recompaction of the earthfill. We recommend earthfill be placed in layers not exceeding 250mm loose thickness and compacted to achieve a minimum 98% to 102% Standard Maximum Dry Density (SMDD) at –1% to +3% Optimum Moisture Content.
- The slopes of the upstream fill embankment and northern part of the downstream fill embankment should be reduced to not steeper than 3 Horizontal to 1 Vertical. To achieve this, the upstream fill embankment may be trimmed back and additional fill or berm be placed on the downstream fill embankment. Good quality fill should be used and this may include Silty Clay or Sandy Silty Clay of low to medium plasticity having a Liquid Limit of less than 45%.
- The fill was found to be high dispersive therefore dispersive soil may be treated by stabilising with 5% by weight of lime or placement of a stable layer of fill (ie 0.5m thick) such as a well graded ripped sandstone/shale.

- A minimum crest width of 2.5m should be maintained. The permanent water level of 1.0m below crest level is recommended. A minimum 0.5m freeboard is recommended during peak storms.
- Spillway should discharge water away from the fill embankment and not along the toe of the embankment. Spillway should be appropriately sized to prevent overtopping of dam embankment.
- Appropriate erosion protection measures should be in placed on the upstream embankment (particularly on the fill embankment) to reduce rapid drawdown effects. Riprap consisting of durable crushed rock or synthetic liners may be used.
- The remedial works should be controlled by a NATA accredited laboratory.

6.0 Limitations

The interpretation and recommendations submitted in this report are based in part upon data from a limited site information obtained from the test pits and boreholes. The nature and extent of variations between test locations may not become evident until construction.

Groundwater conditions are only briefly examined in this investigation. The groundwater conditions may vary seasonally or as a consequence of construction activities on or adjacent to the site.

In view of the above, the subsurface soil and rock conditions between the test locations may be found to be different or interpreted to be different from those expected. If such differences appear to exist, we recommend that this office be contacted without delay. Your attention is drawn to the attached "Explanatory Notes". This document should be read in conjunction with our report.

The statements presented in this document are intended to advise you of what should be your realistic expectations of this report and to present you with recommendations on how to minimise the risk associated with groundworks for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro Consultancy Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in to doing

Should you have any queries regarding the above, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd

Solern Liew CPEng
Director

Attachment: Drawing No 1: Dam Features and Borehole Location Plan
Borehole Reports
DCP Test Reports
Laboratory Test Reports
Explanatory Notes

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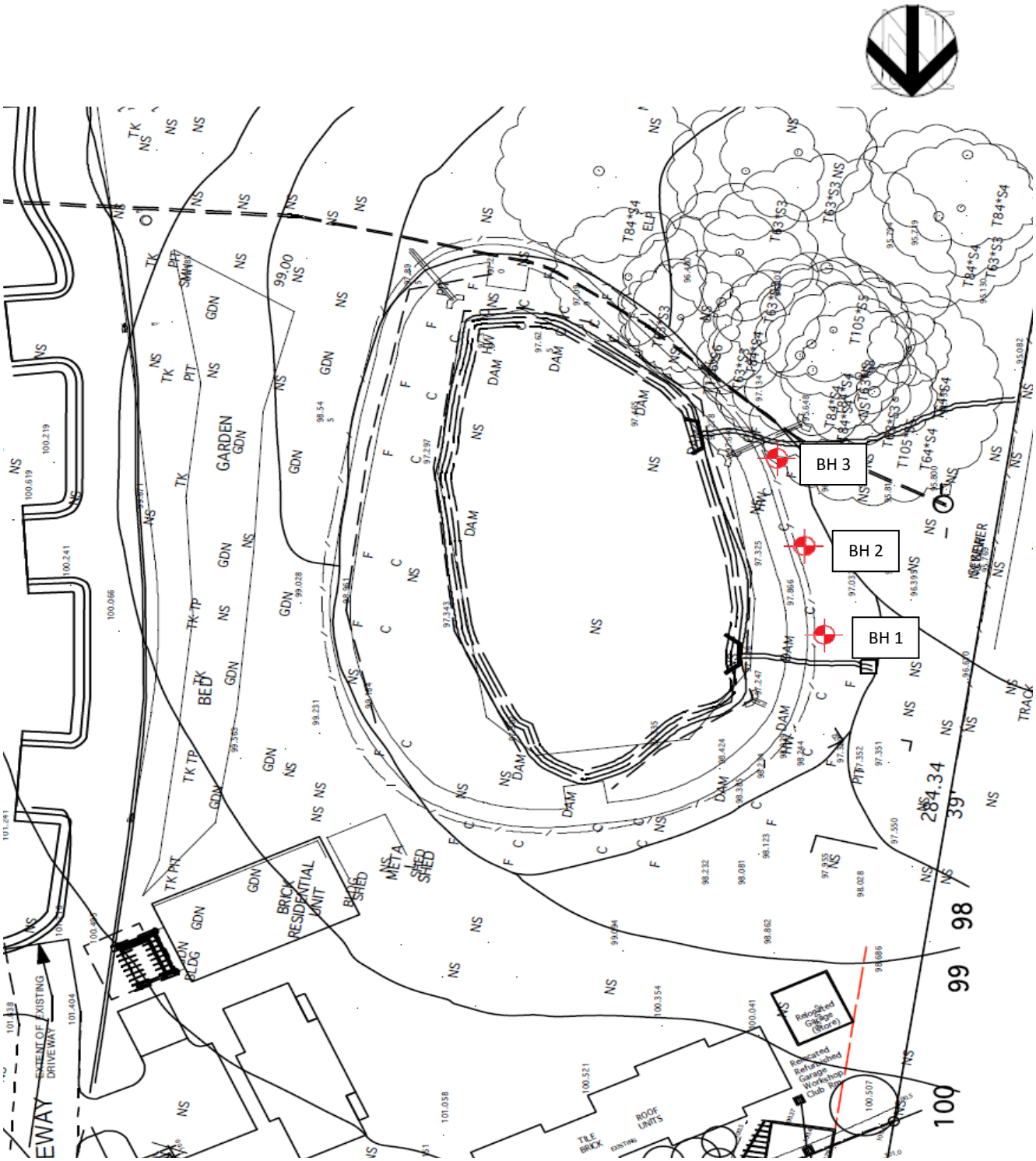

Legend

Borehole

GeoEnviro Consultancy Pty Ltd Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 96798733 Fax: (02) 96798744	Drawn By: SG	Date: 17/05/2011	McFadyn Architects Pty Ltd	
	Checked By: SL	Date: 17/05/2011	Angus Bristow Village, Lodges Road, Elderslie	
	Revision:	Date:	Borehole Location Plan	
	Scale: Proportional	A4	Project No: JC09077A-r3	Drawing No: 1

GeoEnviro Consultancy Pty Ltd
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Borehole Report

Borehole no: 1

Client: McFadyen Architects Pty Ltd

Job no: JC09077A-r3

Project: Dam Embankment Assessment

Date: 07/05/2011

Location: Angus Bristow Village, Lotges Road, Elderslie

Logged by: SG

Drill Model and Mounting: Pendulum Rig | Slope: | R.L. Surface:

Hole Diameter: 150 mm | Bearing: | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description (Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component)	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
Continuous Flight Auger	NIL	DRY					Topsoil: Clayey Silt: Low liquid limit, dark brown	D		8	Start of DCP 1
							Fill: Silty Clay: Medium to high plasticity, brown grey	D		5	
										3	
										8	
				0.5						5	
			DS							6	
										6	
							Fill: Silty Clay: Medium plasticity, brown and grey, trace of fine grained gravel and clayey silt	D-M		3	
										4	
				1.0						4	Moderately compacted
			DS							3	
										4	
										5	
						CI-CH	Silty Clay: Medium to high plasticity, brown and red	MC< PL	Vst -H	5	
				1.5						4	
			DS							3	
										4	
										5	
				2.0						6	
										7	
										7	
										8	
										16	
			DS							28	End of DCP Test
				2.5							
							Shale: Extremely to distinctly weathered, grey brown to dark grey, low to medium strength				
							End BH 1 at 2.70m				Near Refusal
				3.0							
				3.5							
				4.0							

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Borehole Report

Borehole no: 2

Client: McFadyen Architects Pty Ltd
Job no: JC09077A-r3

Project: Dam Embankment Assessment
Date: 07/05/2011

Location: Angus Bristow Village, Lotges Road, Elderslie
Logged by: SG

Drill Model and Mounting: Pendulum Rig
Slope:
R.L. Surface:

Hole Diameter: 150 mm
Bearing:
Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description (Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component)	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	T	Structure and Additional Observations
Continuous Flight Auger	NIL	DRY					Fill/Topsoil: Clayey Silt: Low liquid limit, dark brown	D		-		Start of DCP 2
							Fill: Silty Clay: Medium to high plasticity, brown grey, trace of fine grained gravel	D	L-MD	3		
										4		
										3		
				0.5						2		Loose
			DS							3		
										3		
										4		
				1.0						4		Compacted
			DS							4		
										5		
						CH	Silty Clay: High plasticity, red brown, trace of fine grained gravel	MC< PL	Vst	5		
										7		
										7		
				1.5						7		
			DS							7		
										5		
										7		
										8		
				2.0						10		
			DS			CI	Silty Clay: Medium plastictiy, brown	MC< PL	H	11		
										12		
										14		
										16		End of DCP test
				2.5								
							Shale: Extremely to distinctly weathered, grey brown, trace of siltstone, low to medium strength					
							End BH 2 at 2.80m					
				3.0								
				3.5								
				4.0								

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Borehole Report

Borehole no: 3

Client: McFadyen Architects Pty Ltd
Job no: JC09077A-r3

Project: Dam Embankment Assessment
Date: 07/05/2011

Location: Angus Bristow Village, Lotges Road, Elderslie
Logged by: SG

Drill Model and Mounting: Pendulum Rig Slope: R.L. Surface:

Hole Diameter: 150 mm Bearing: Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
Continuous Flight Auger	NIL	DRY					Topsoil/FIll: Clayey Silt: Low liquid limit, dark brown	D		1	Start of DCP 3
							Fill: Silty Clay: Medium plasticity,brown	D		5	
										6	
										9	
				0.5						5	Compacted
			DS							6	
										8	
				1.0						8	
			DS							8	
										8	
										8	
										7	
										8	
							Fill: Silty Clay: Medium plasticity, brown and grey, trace of fine grained gravel and clayey silt			6	
										5	
				1.5						6	
			DS							2	
						CH	Silty Clay: High plasticity, brown red	MC< PL	H	3	
										6	
										7	
				2.0						15	
										13	
										15	End of DCP
			DS								
				2.5							
							Shale: Extremely to distinctly weathered, grey to dark grey, low to medium strength				
							End BH 2 at 2.80m				Near Refusal
				3.0							
				3.5							
				4.0							

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Tel: (02) 96798733 Fax: (02) 96798744

Dynamic Cone Penetration Test Report

Client / Address: McFadyn Architects Pty Ltd — Job No. JC09077A-r3

Project: Dam Embankment Investigation — Date: 17/05/2011

Location: Angus Bristow Village, Lodges Road, Elderslie — Report No. R01A

Test Procedure: AS 1289 1.1, 1.2.1, 6.3.2

Test Data

Test No: 1		Test No: 2		Test No: 3		Test No:	
Test Location: Borehole 1		Test Location: Borehole 2		Test Location: Borehole 3		Test Location:	
RL: 97.70		RL: 97.50		RL: 97.40		RL:	
Soil Classification: Refer to Borehole Logs		Soil Classification: Refer to Borehole Logs		Soil Classification: Refer to Borehole Logs		Soil Classification:	
Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows
0.0-0.1	8	0.0-0.1	-	0.0-0.1	1	0.0-0.1	
0.1-0.2	5	0.1-0.2	3	0.1-0.2	5	0.1-0.2	
0.2-0.3	3	0.2-0.3	4	0.2-0.3	6	0.2-0.3	
0.3-0.4	8	0.3-0.4	3	0.3-0.4	9	0.3-0.4	
0.4-0.5	5	0.4-0.5	2	0.4-0.5	5	0.4-0.5	
0.5-0.6	6	0.5-0.6	3	0.5-0.6	6	0.5-0.6	
0.6-0.7	6	0.6-0.7	3	0.6-0.7	8	0.6-0.7	
0.7-0.8	3	0.7-0.8	4	0.7-0.8	8	0.7-0.8	
0.8-0.9	4	0.8-0.9	4	0.8-0.9	8	0.8-0.9	
0.9-1.0	4	0.9-1.0	4	0.9-1.0	8	0.9-1.0	
1.0-1.1	3	1.0-1.1	5	1.0-1.1	7	1.0-1.1	
1.1-1.2	4	1.1-1.2	5	1.1-1.2	8	1.1-1.2	
1.2-1.3	5	1.2-1.3	7	1.2-1.3	6	1.2-1.3	
1.3-1.4	5	1.3-1.4	7	1.3-1.4	5	1.3-1.4	
1.4-1.5	4	1.4-1.5	7	1.4-1.5	6	1.4-1.5	
1.5-1.6	3	1.5-1.6	7	1.5-1.6	2	1.5-1.6	
1.6-1.7	4	1.6-1.7	5	1.6-1.7	3	1.6-1.7	
1.7-1.8	5	1.7-1.8	7	1.7-1.8	6	1.7-1.8	
1.8-1.9	6	1.8-1.9	8	1.8-1.9	7	1.8-1.9	
1.9-2.0	7	1.9-2.0	10	1.9-2.0	15	1.9-2.0	
2.0-2.1	7	2.0-2.1	11	2.0-2.1	13	2.0-2.1	
2.1-2.2	8	2.1-2.2	12	2.1-2.2	15	2.1-2.2	
2.2-2.3	16	2.2-2.3	14	2.2-2.3	DCP Terminated	2.2-2.3	
2.3-2.4	28	2.3-2.4	16	2.3-2.4	at 2.20m	2.3-2.4	
2.4-2.5	DCP Bouncing	2.4-2.5	DCP Terminated	2.4-2.5		2.4-2.5	
2.5-2.6	at 2.40m	2.5-2.6	at 2.40m	2.5-2.6		2.5-2.6	
2.6-2.7		2.6-2.7		2.6-2.7		2.6-2.7	
2.7-2.8		2.7-2.8		2.7-2.8		2.7-2.8	
2.8-2.9		2.8-2.9		2.8-2.9		2.8-2.9	
2.9-3.0		2.9-3.0		2.9-3.0		2.9-3.0	

Remarks:

Weight: 9kg
Drop: 510mm
Rod Diameter: 16mm

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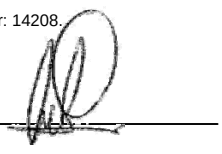
NATA ACCREDITED FOR TECHNICAL COMPETENCE

This document is issued in accordance with NATA's accreditation requirements
Accredited for compliance with ISO/IEC 17025
NATA Accredited Laboratory Number: 14208.

Approved Signatory  Solern Liew Date 17/05/2011

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R02A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6665
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 1 (0.5-0.7m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:57
Time dispersion starts:
13:58

REMOULDED SOIL

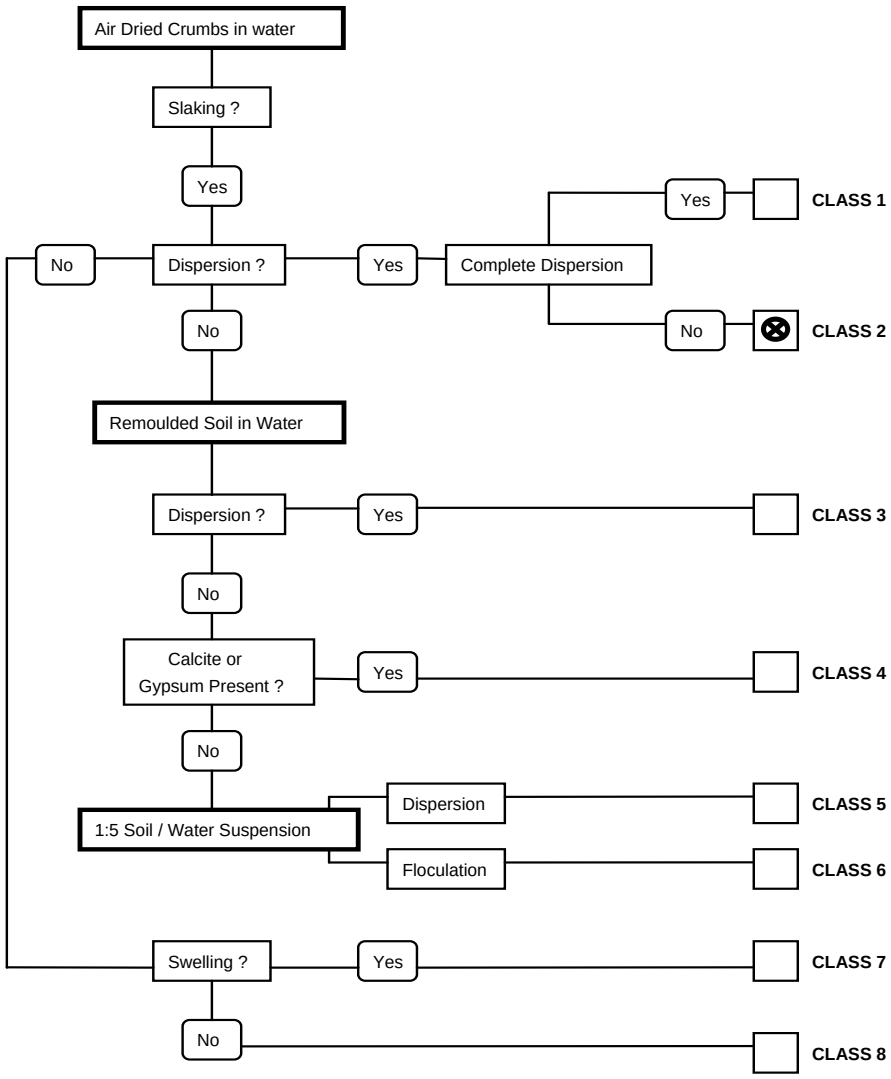
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



Remarks

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Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R03A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6666
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 1 (1.0-1.2m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown, with gravel	

Details of Test

AIR DRIED CRUMBS

Time in water:
14:00
Time dispersion starts:
14:04

REMOULDED SOIL

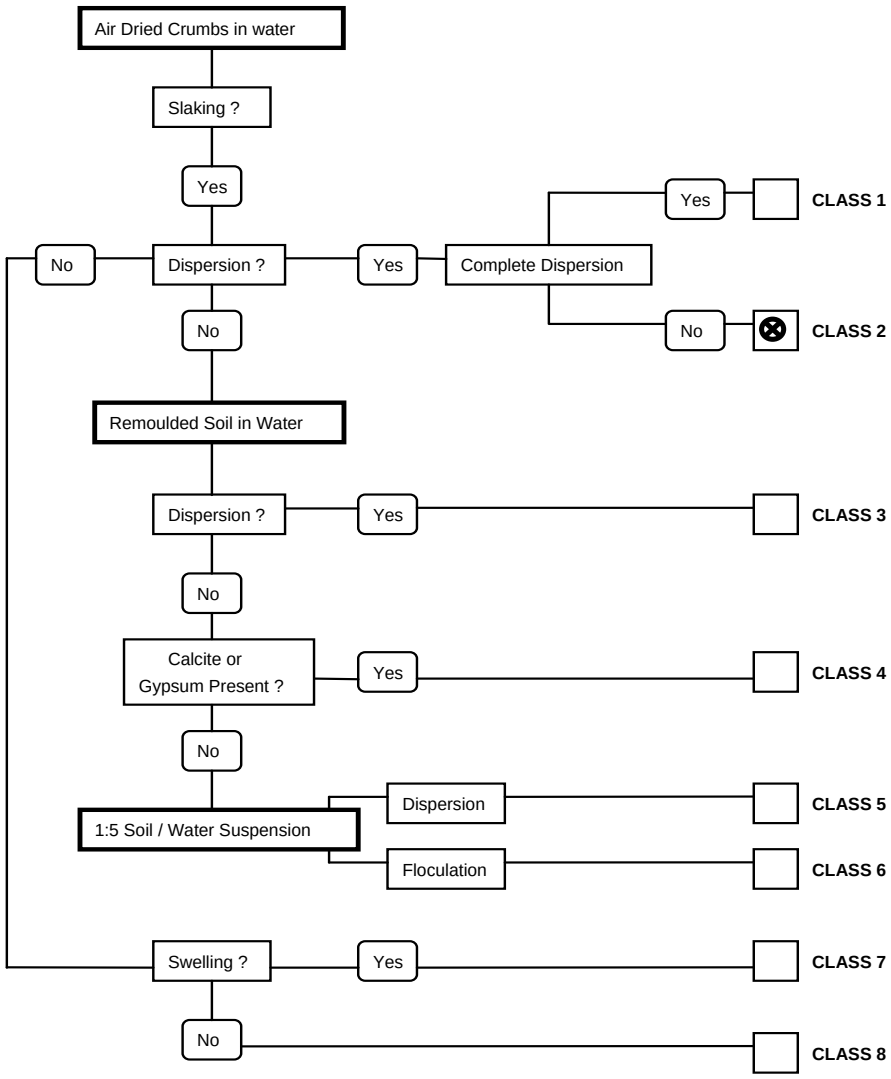
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



Remarks

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Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R04A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6667
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 1 (1.5-1.7m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium to high plasticity, brown red	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:27
Time dispersion starts:
13:28

REMOULDED SOIL

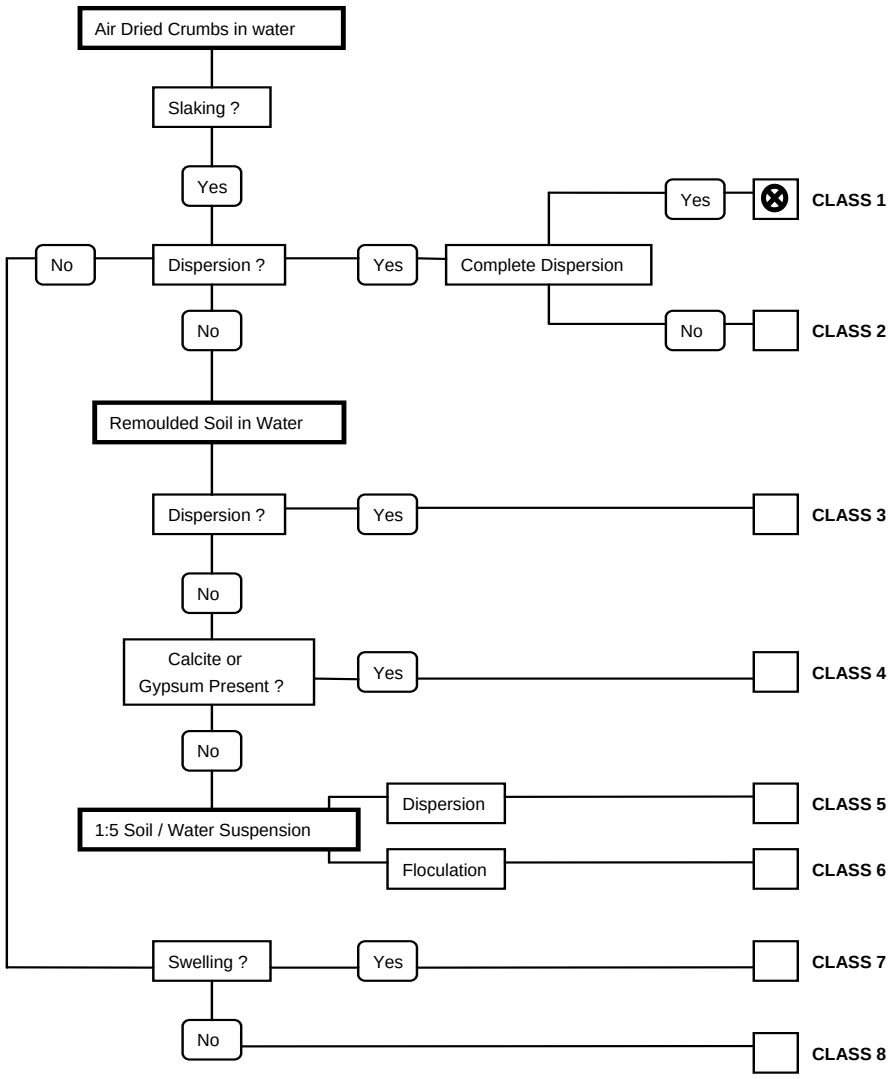
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



Remarks

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Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R05A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6668
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 1 (2.3-2.5m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown red	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:26
Time dispersion starts:
13:27

REMOULDED SOIL

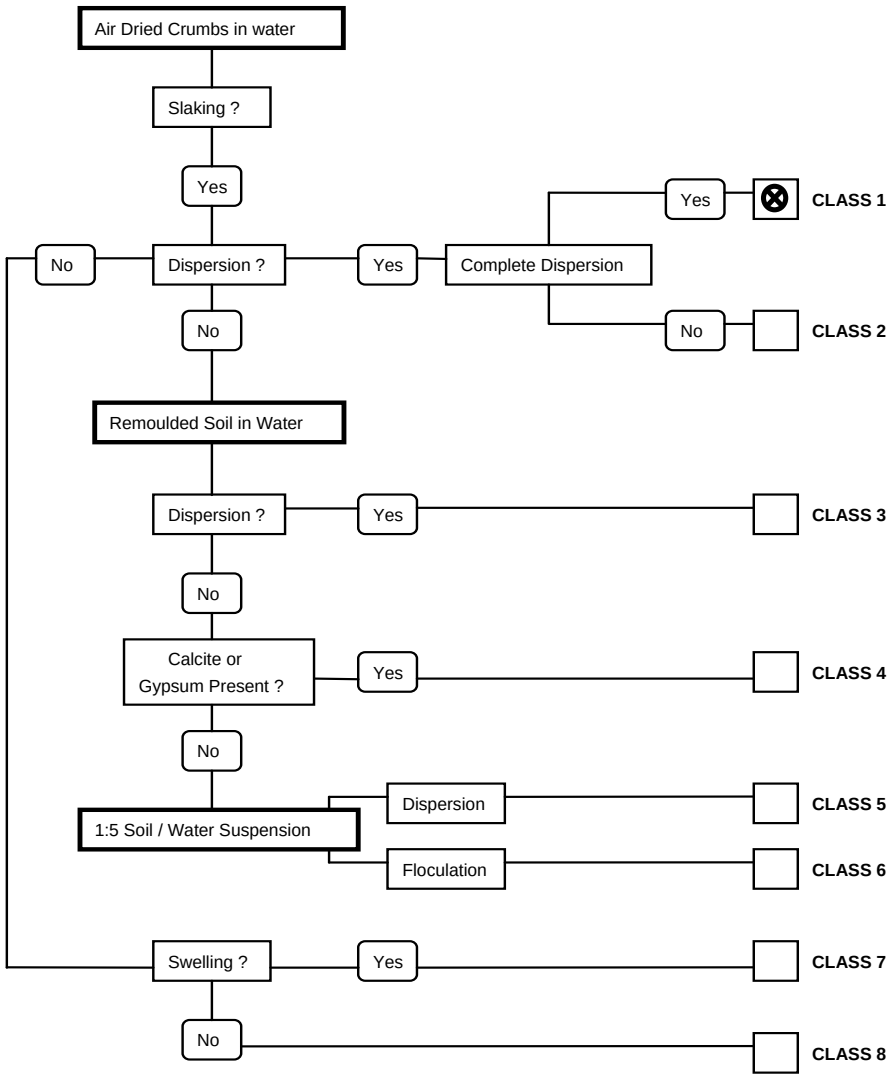
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



Remarks

Approved Signatory _____ Solern Liew Date 17/05/2011

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R06A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6669
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 2 (0.5-0.7m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown, with gravel	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:27
Time dispersion starts:
13:37

REMOULDED SOIL

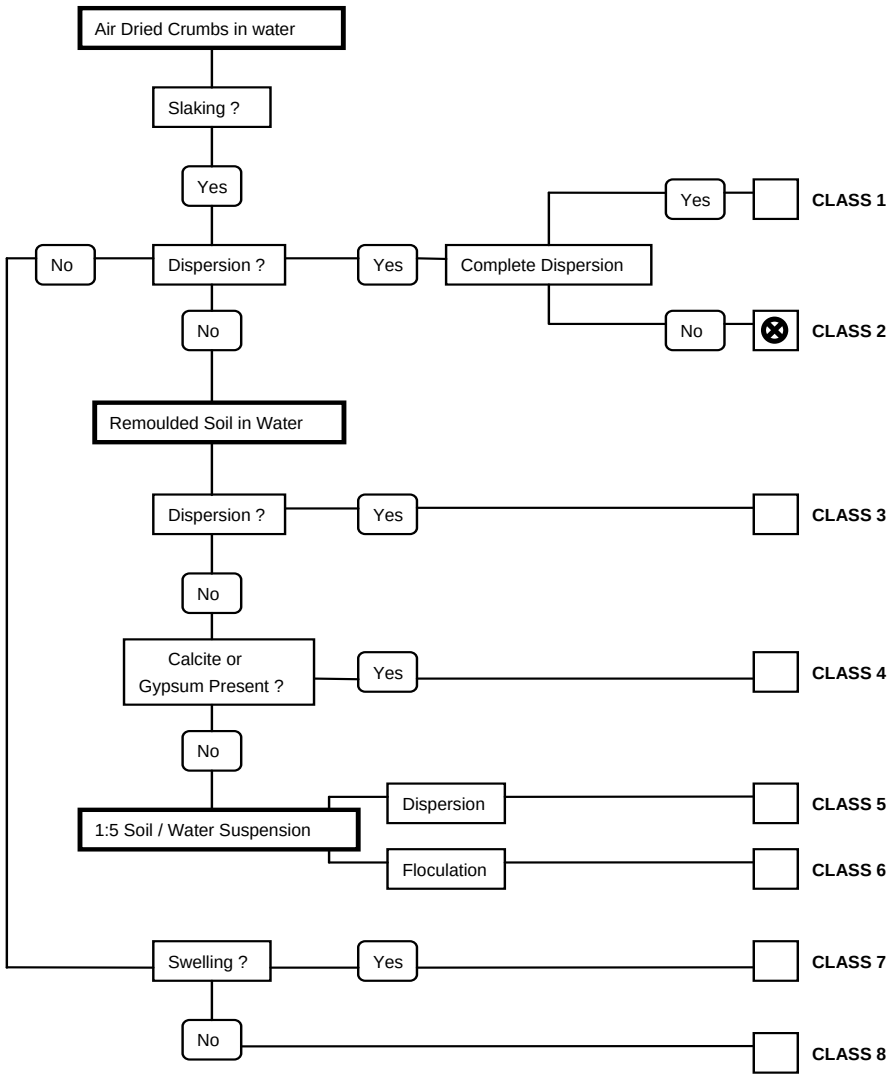
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



Remarks

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Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R07A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6670
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 2 (1.0-1.2m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown red	

Details of Test

AIR DRIED CRUMBS

Time in water:
14:03
Time dispersion starts:
-

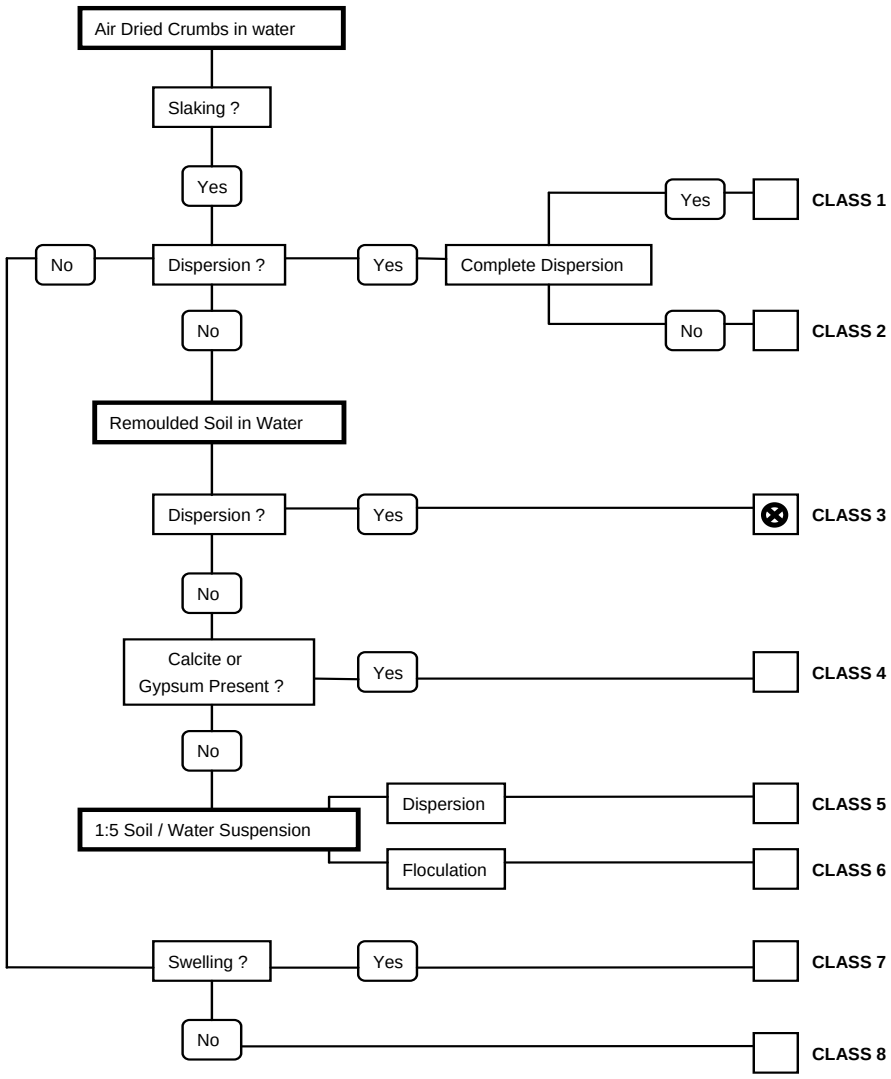
REMOULDED SOIL

Time in water:
14:14
Time dispersion starts:
14:19

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



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Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R08A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6671
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 2 (1.5-1.7m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium to high plasticity, brown red	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:26
Time dispersion starts:
13:42

REMOULDED SOIL

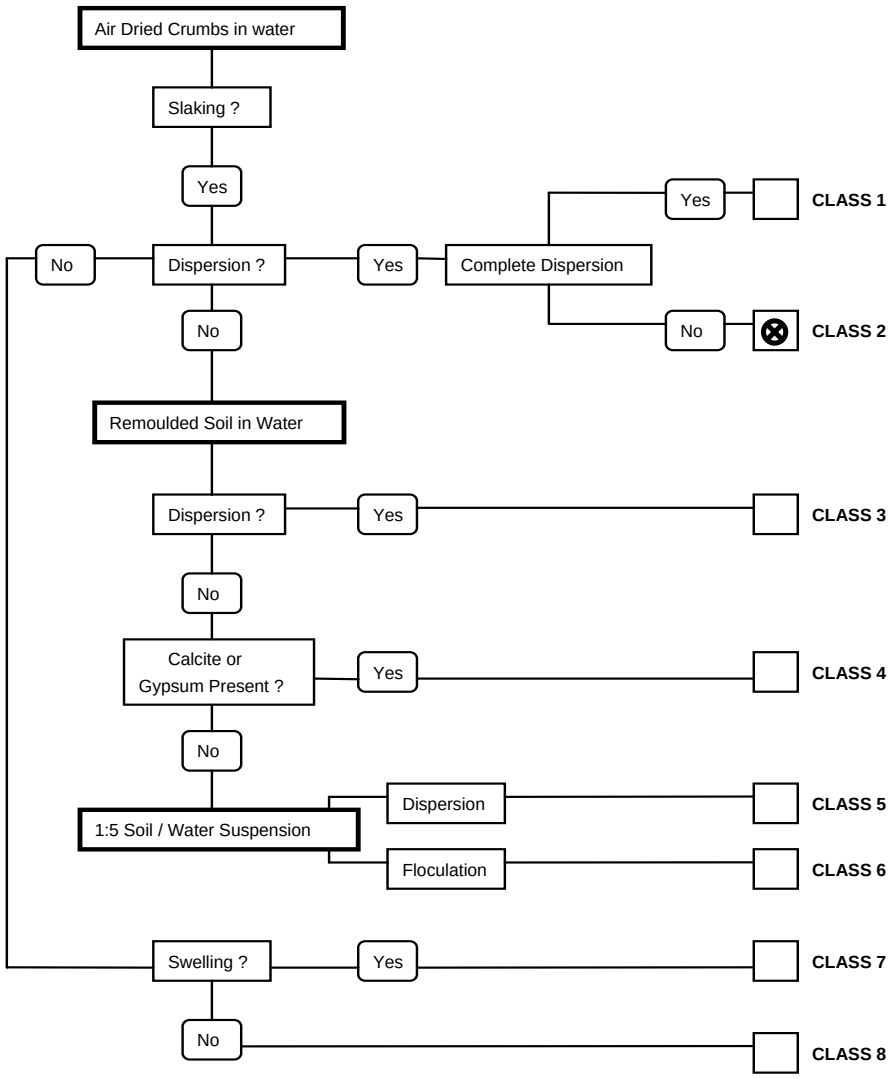
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



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Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R09A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6672
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 2 (2.0-2.2m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity. Brown,trace of gravel	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:53
Time dispersion starts:
13:54

REMOULDED SOIL

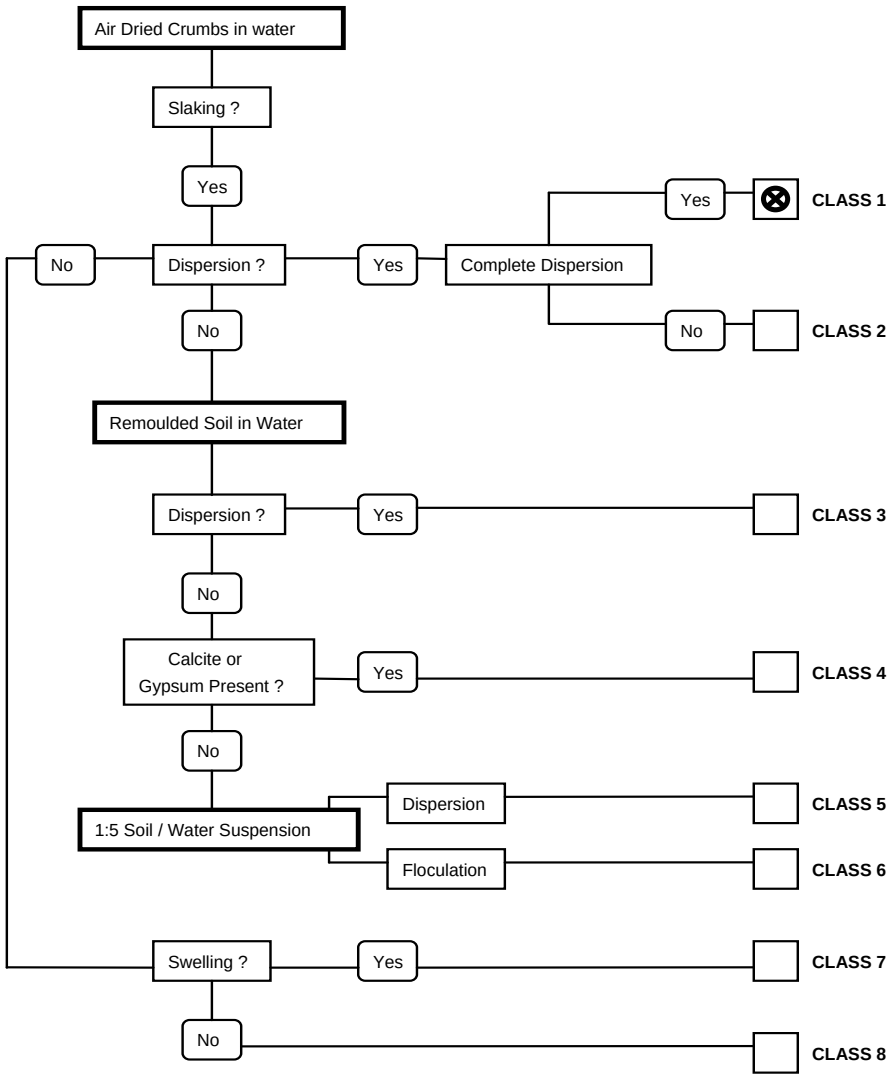
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



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Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R10A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6673
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 3 (1.0-1.2m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown, with gravel	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:55
Time dispersion starts:
-

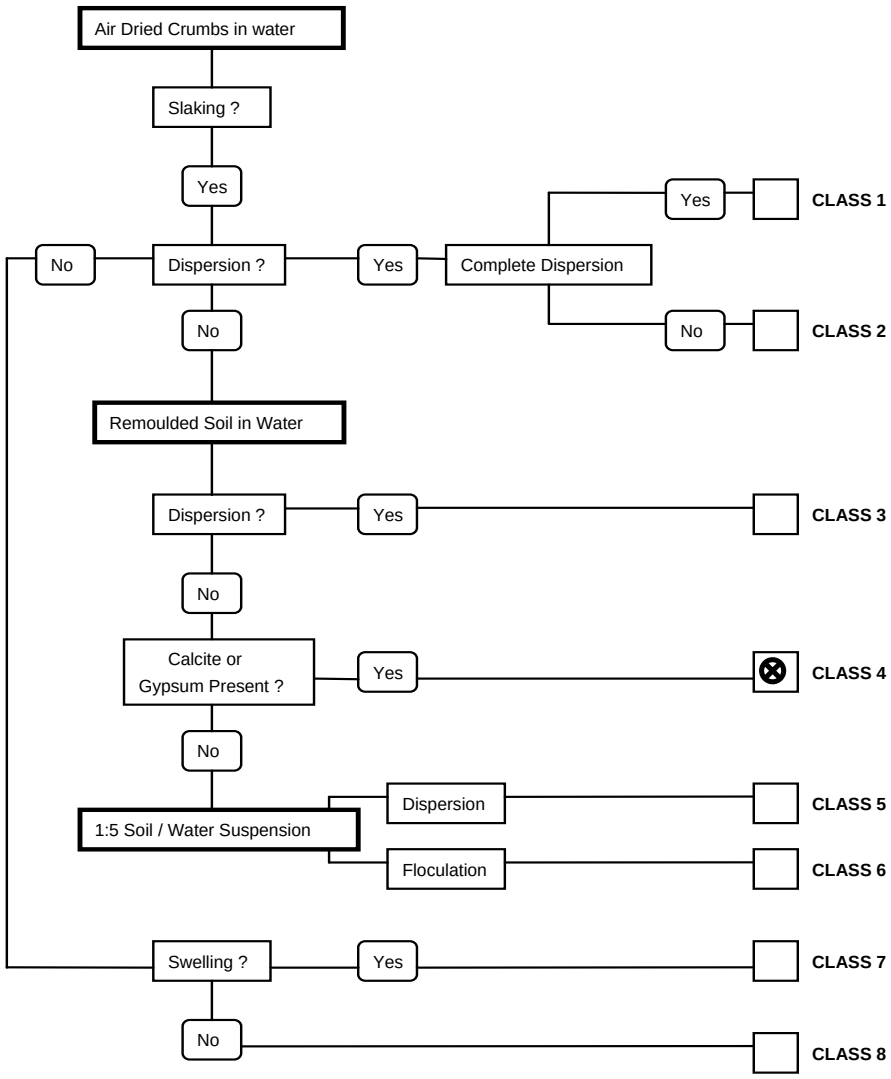
REMOULDED SOIL

Time in water:
14:00
Time dispersion starts:
-

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



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Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R11A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6674
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 3 (1.5-1.7m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium plasticity, brown red	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:27
Time dispersion starts:
13:33

REMOULDED SOIL

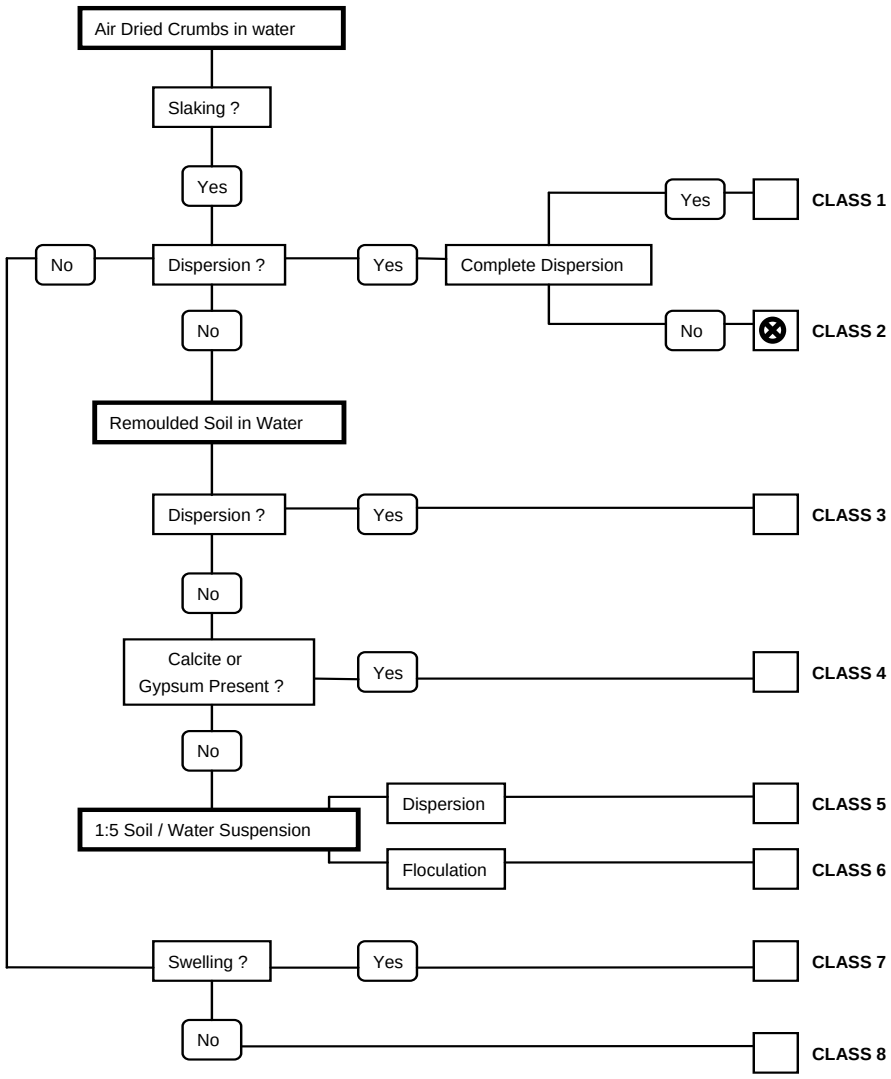
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



Remarks

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Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Emerson Class Number of a Soil

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No. R12A
Test Procedure: AS 1289 1.1, 1.2.1, 3.8.1	Lab Reference No. SR 6675
Sample Procedure: AS 1289 1.1, 1.2.1 (6.5.3)	Sample Identification: BH 3 (2.3-2.5m)
Sample Date: 21/04/2011	Test Date: 02/05/2011
Sample Description: Silty Clay: Medium to high plasticity, brown red	

Details of Test

AIR DRIED CRUMBS

Time in water:
13:52
Time dispersion starts:
13:59

REMOULDED SOIL

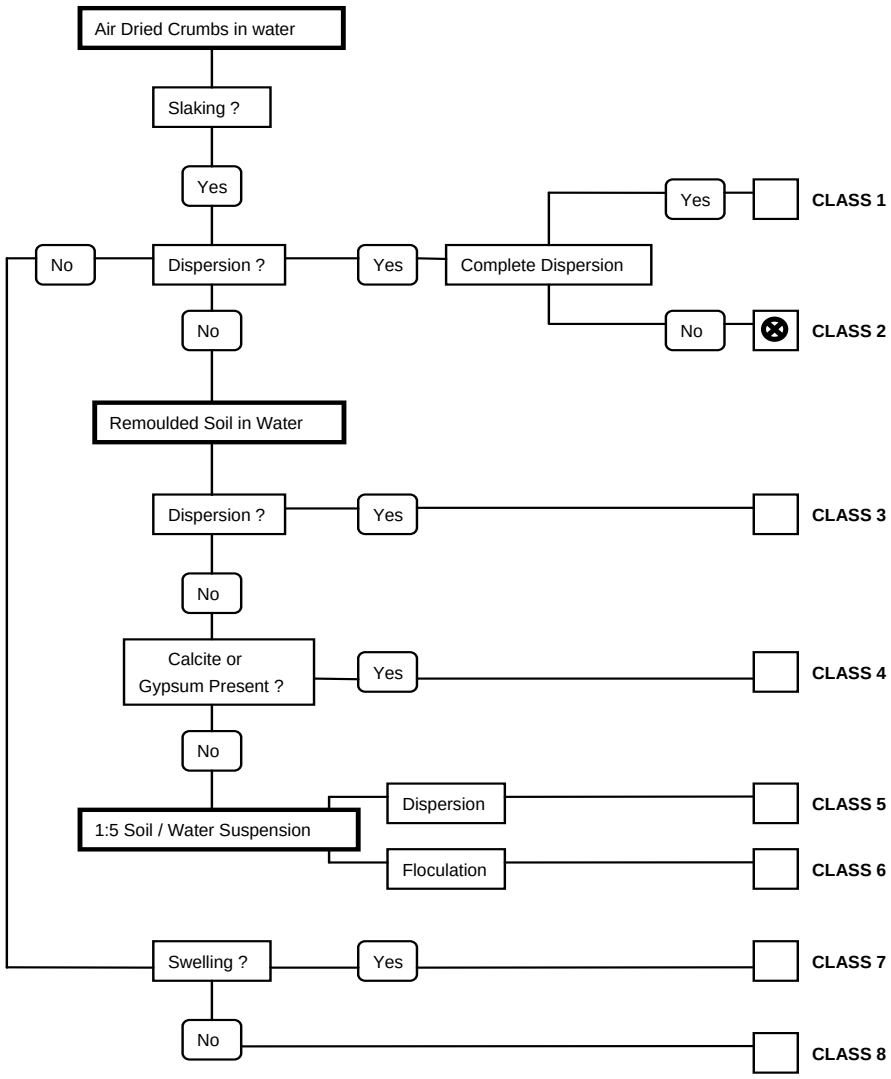
Time in water:

Time dispersion starts:

TYPE OF WATER
Distilled
Temp. of water
20°

OTHER OBSERVATIONS:

Dispersion Flow Chart



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Tel: (02) 96798733 Fax: (02) 96798744

Test Results - Atterberg Limits

Client / Address: McFadyn Architects Pty Ltd — Job No. JC09077A-r3

Project: Dam Embankment Investigation — Date: 17/05/2011

Location: Angus Bristow Village, Lodges Road, Elderslie — Report No: R13A

Sample Identification	BH 1 (1.0-1.2m)	BH 3 (1.0-1.2m)		
Sample Register No	SR 6666	SR 6673		
Sample Date	21-Apr-11	21-Apr-11		
Test Date	4-May-11	4-May-11		
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.3)	AS 1289 1.1, 1.2.1 (6.5.3)		
Test Results				
Test Procedure:	AS 1289 3.1.2	AS 1289 3.1.2		
Liquid Limit (%)	43	43		
Test Procedure:	AS 1289 3.2.1	AS 1289 3.2.1		
Plasitc Limit (%)	20	20		
Test Procedure:	AS 1289 3.3.1	AS 1289 3.3.1		
Plasticity Index (%)	23	23		
Test Procedure:	AS 1289 3.4.1	AS 1289 3.4.1		
Linear Shrinkage (%)	6.0	12.5		
Test Procedure:	AS 1289 2.1.1	AS 1289 2.1.1		
Natural Moisture Content %	17.1	12.7		
Material Description	Silty Clay: Medium plasticity, brown, with gravel	Silty Clay: Medium plasticity, brown, with gravel		

Remarks

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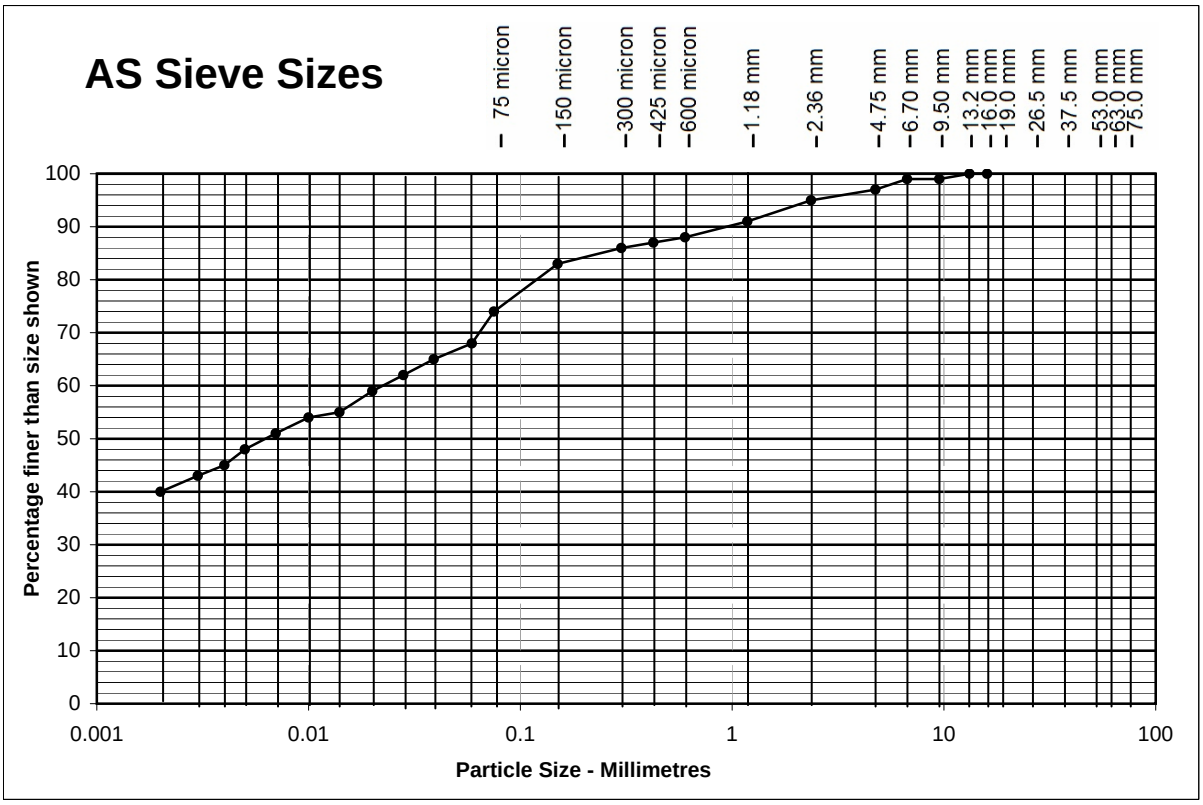
GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Particle Size Distribution

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No: R14A
Lab Reference No: SR 6666	Sample Identification: BH 1 (1.0-1.2m)
Laboratory Specimen Description: Silty Clay: Medium plasticity, brown, with gravel	
Test Procedure AS1289 3.5.1, 3.6.1, 3.6.3	Sample Procedure AS 1289 1.1, 1.2.1 (6.5.3)

Sieve Size	% Passing	Specification	Sieve Size	% Passing	Specification
150 mm			425 um	87	
75 mm			300 um	86	
63 mm			150 um	83	
53 mm			75 um	74	
37.5 mm			59 um	68	
26.5 mm			39 um	65	
19 mm			28 um	62	
16 mm	100		20 um	59	
13.2 mm	100		14 um	55	
9.5 mm	99		10 um	54	
6.7 mm	99		7 um	51	
4.75 mm	97		5 um	48	
2.36 mm	95		4 um	45	
1.18 mm	91		3 um	43	
600 um	88		2 um	40	



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	

Remarks: Particle Density: 2.65 Assumed (Particle Density test reported are outside the scope fo the facilities accreditation)

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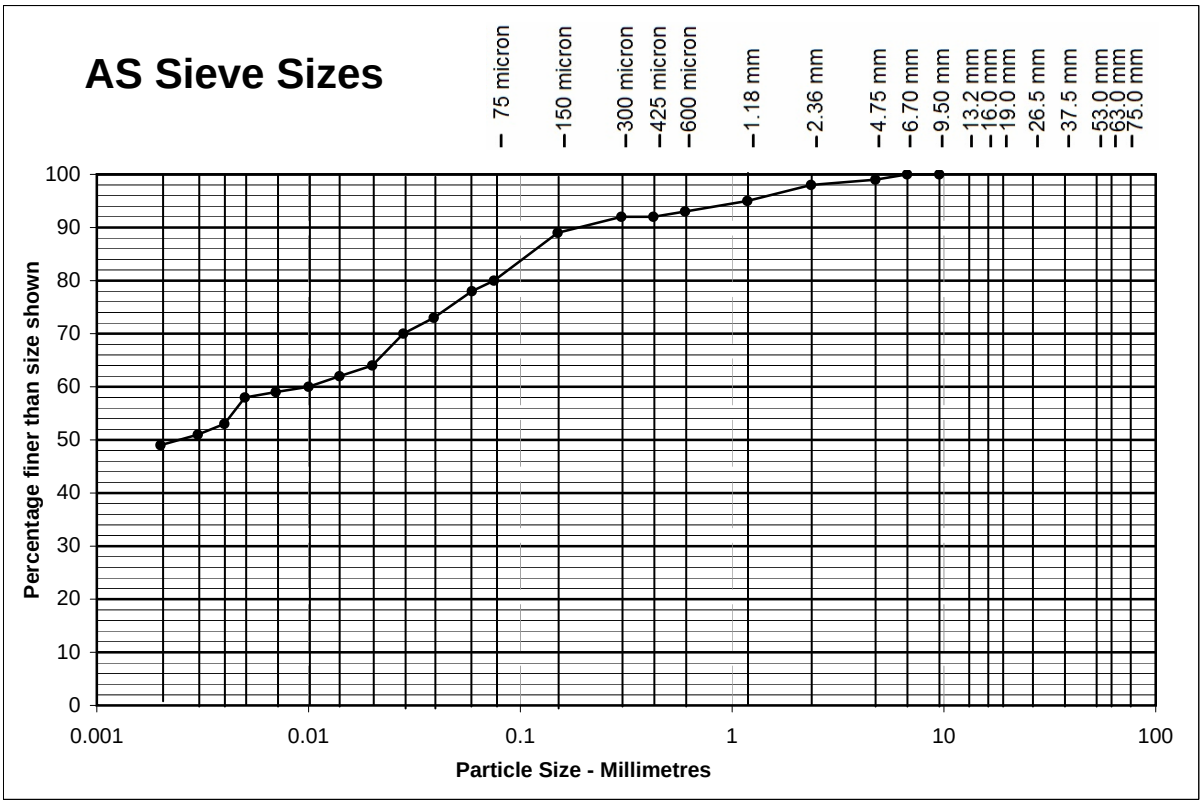
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Particle Size Distribution

Client / Address: McFadyn Architects Pty Ltd	Job No. JC09077A-r3
Project: Dam Embankment Investigation	Date: 17/05/2011
Location: Angus Bristow Village, Lodges Road, Elderslie	Report No: R15A
Lab Reference No: SR 6673	Sample Identification: BH 3 (1.0-1.2m)
Laboratory Specimen Description: Silty Clay: Medium plasticity, brown, with gravel	
Test Procedure AS1289 3.5.1, 3.6.1, 3.6.3	Sample Procedure AS 1289 1.1, 1.2.1 (6.5.3)

Sieve Size	% Passing	Specification	Sieve Size	% Passing	Specification
150 mm			425 um	92	
75 mm			300 um	92	
63 mm			150 um	89	
53 mm			75 um	80	
37.5 mm			59 um	78	
26.5 mm			39 um	73	
19 mm			28 um	70	
16 mm			20 um	64	
13.2 mm			14 um	62	
9.5 mm	100		10 um	60	
6.7 mm	100		7 um	59	
4.75 mm	99		5 um	58	
2.36 mm	98		4 um	53	
1.18 mm	95		3 um	51	
600 um	93		2 um	49	



clay	silt			sand			gravel			cobbles
	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	

Remarks: Particle Density: 2.65 Assumed (Particle Density test reported are outside the scope fo the facilities accreditation)

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GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Test Results - Pinhole Dispersion Classification

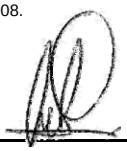
Client / Address: McFadyn Architects Pty Ltd — Job No. JC09077A-r3

Project: Dam Embankment Investigation — Date: 17/05/2011

Location: Angus Bristow Village, Lodges Road, Elderslie — Report No: R16A

Sample Identification	BH 1 (1.0-1.2m)	BH 3 (1.0-1.2m)		
Sample Register No	SR 6666	SR 6673		
Sample Date	21-Apr-11	21-Apr-11		
Test Date	5-May-11	5-May-11		
Sample Procedure	AS 1289 1.1, 1.2.1 (6.5.3)	AS 1289 1.1, 1.2.1 (6.5.3)		
Test Procedure:	AS 1289 2.1.1, 3.8.3	AS 1289 2.1.1, 3.8.3		
Test Results				
Pin Hole Classification	ND1	ND1		
Test Sample Before Testing:	-	-		
Moisture Content %	20	20		
Density of Test Sample	N/A	N/A		
Natural Moisture Content %	17.1	18.5		
Curing Time (Hours)	24	24		
Source of Water	Distilled	Distilled		
Material Description	Silty Clay: Medium plasticity, brown, with gravel	Silty Clay: Medium plasticity, brown, with gravel		

Remarks

Approved Signatory  Solern Liew Date 17/05/2011

EXPLANATORY NOTES

Introduction

These notes have been provided to amplify the geotechnical report with regard to investigation procedures, classification methods and certain matters relating to the Discussion and Comments sections. Not all notes are necessarily relevant to all reports.

Geotechnical reports are based on information gained from finite sub-surface probing, excavation, boring, sampling or other means of investigation, supplemented by experience and knowledge of local geology. For this reason they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods
The methods the description and classification of soils and rocks used in this report are based on Australian standard 1726, the SSA Site investigation Code, in general descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions. Identification and classification of soil and rock involves to a large extent, judgement within the acceptable level commonly adopted by current geotechnical practices.

Soil types are described according to the predominating particle size, qualified by the grading or other particles present (eg sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	Less than 0.002mm
Silt	0.002 to 0.6mm
Sand	0.6 to 2.00mm
Gravel	2.00m to 60.00mm

Soil Classification	Particle size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2.00mm
Gravel	2.00mm to 60.00mm

Cohesive soils are classified on the basis of strength, either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very Soft	Less than 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very Stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer test (CPT), as below:

Relative Dense	SPT 'N' Value (blows/300mm)	CPT Cone Value (q_c-Mpa)
Very Loose	Less than 5	Less than 2
Loose	5 - 10	2 - 5
Medium Dense	10 - 30	5 - 15
Dense	30 - 50	15 - 25
Very Dense	> 50	> 25

Rock types are classified by their geological names, together with descriptive terms on degrees of weathering strength, defects and other minor components. Where relevant, further information regarding rock classification, is given on the following sheet.

Sampling
Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provided information on plasticity, grained size, colour, type, moisture content, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin walled sample tube (normally know as U_{50}) into the soil and withdrawing a sample of the soil in a relatively undisturbed state. Such Samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Details of the type and method of sampling are given in the report.

Field Investigation Methods
The following is a brief summary of investigation methods currently carried out by this company and comments on their use and application.

Hand Auger Drilling
The borehole is advanced by manually operated equipment. The diameter of the borehole ranges from 50mm to 100mm. Penetration depth of hand augered boreholes may be limited by premature refusal on a variety of materials, such as hard clay, gravels or ironstone.

Test Pits
These are excavated with a tractor-mounted backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3.0m for a backhoe and up to 6.0m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Care must be taken if construction is to be carried out near, or within the test pit locations, to either adequately recompact the backfill during construction, or to design the structure or accommodate the poorly compacted backfill.

Large Diameter Auger (eg Pengo)
The hole is advanced by a rotating plate or short spiral auger generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 05m) and are disturbed, but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers and is usually supplemented by occasional undisturbed tube sampling.

Continuous Spiral Flight Augers
The hole is advanced by using 90mm - 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the augers flights, but they are very disturbed and may be highly mixed with soil of other stratum.

Information from the drilling (as distinct from specific sampling by SPT or undisturbed samples) is of relatively low reliability due to remoulding, mixing or softening of samples by ground water, resulting in uncertainties of the original sample depth.

Continuous Spiral Flight Augers (continued)
The spiral augers are usually advanced by using a V - bit through the soil profile refusal, followed by Tungsten Carbide (TC) bit, to penetrate into bedrock. The quality and continuity of the bedrock may be assessed by examination of the recovered rock fragments and through observation of the drilling penetration resistance.

Non - core Rotary Drilling (Wash Boring)
The hole is advanced by a rotary bit, with water being pumped down the drill rod and returned up the annulus, carrying the cuttings, together with some information from the "feel" and rate of penetration.

Rotary Mud Stabilised Drilling
This is similar to rotary drilling, but uses drilling mud as a circulating fluid, which may consist of a range of products, from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg SPT and U_{50} samples).

Continuous Core Drilling
A continuous core sample is obtained using a diamond tipped core barrel. Providing full core recovery is achieved (which is not always possible in very weak rock and granular soils) this technique provides a very reliable (but relatively expensive) method of investigation. In rocks an NMLC triple tube core barrel which gives a core of about 50mm diameter, is usually used with water flush.

Portable Proline Drilling
This is manually operated equipment and is only used in sites which require bedrock core sampling and there is restricted site access to truck mounted drill rigs. The boreholes are usually advanced initially using a tricone roller bit and water circulation to penetrate the upper soil profile. In some instances a hand auger may be used to penetrate the soil profile. Subsequent drilling into bedrock involves the use of NMLC triple tube equipment, using water as a lubricant.

Standard Penetration Tests
Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils, as a means of determining density or strength and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289 "Methods of testing Soils for Engineering Purpose"- Test F31.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63Kg hammer with a free fall of 769mm. It is normal for the tube to be driven in three successive 150mm increments and the "N" value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rocks, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In a case where full penetration is obtained with successive blows counts for each 150mm of, say 4, 6, and 7 blows.

  as 4, 6, 7
  N = 13

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm.

  as 15,30/40mm

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally the test methods is used to obtain samples in 50mm diameter thin walled samples tubes in clays. In these circumstances, the best results are shown on the bore logs in brackets.

Dynamic Cone Penetration Test
A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The cone can be continuously driven into the borehole and is normally used in areas with thick layers of soft clays or loose sand. The results of this test are shown as 'N_c' on the bore logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing and Interpretation
Cone penetrometer testing (sometimes referred to as Dutch Cone-CPT) described in this report, has been carried out using an electrical friction cone penetrometer and the test is described in Australian Standard 1289 test F5.1.

In the test, a 35mm diameter rod with cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig, which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130mm long sleeve, immediately behind the cone. Transducer in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart recorders. The plotted results in this report have been traced from the original records. The information provided on the charts comprises:

- Cone resistance - the actual end bearing force divided by the cross sectional area of the cone, expressed in Mpa.
- Sleeve friction - the frictional force on the sleeve divided by the surface area, expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percentage.

There are two scales available for measurement of cone resistance. The lower "A" scale (0-5Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main "B" scale (0-50Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative frictions in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and very soft clays, rising to 4% to 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (Mpa)} = (0.4 \text{ to } 0.6)\ N \text{ (blows per 300mm)}$$

In clays the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to} 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimate of modulus or compressibility values to allow calculation of foundation settlements. Inferred stratification, as shown on the attached report, is assessed from the cone and friction traces, from experience and information from nearby boreholes etc.

Cone Penetrometer Testing and Interpretation continued
This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties and where precise information or soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometer (AS1289)
Portable dynamic cone penetrometer tests are carried out by driving a rod in to the ground with a falling weight hammer and measuring the blows per successive 100mm increments of penetration.

There are two similar tests, Cone Penetrometer (commonly known as Scala Penetrometer) and the Perth Sand Penetrometer. Scala Penetrometer is commonly adopted by this company and consists of a 16mm rod with a 20mm diameter cone end, driven with a 9kg hammer, dropping 510mm (AS 1289 Test F3.2).

Laboratory Testing
Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedures are given on the individual report forms.

Engineering Logs
The engineering logs presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, however, this is not always practicable or possible to justify economically. As it is, the boreholes represent only a small sample of the total sub-surface profile. Interpretation of the information and its application to design and construction should take into account the spacing of boreholes, frequency of sampling and the possibility of other than "straight line" variations between the boreholes.

Ground water
Where ground water levels are measured in boreholes, there are several potential problems:
- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all, during the investigation period.
- A localised perched water table may lead to a erroneous indication of the true water table.
- Water table levels will vary from time to time, due to the seasons or recent weather changes. They may not be the same at the time of construction as indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole if any water observations are to be made.

More reliable measurements can be made by installing stand pipes, which are read at intervals over several days, or weeks for low permeability soils. Piezometers sealed in a particular stratum may be interference from a perched water table or surface water.

Engineering Reports
Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal is changed, say to a twenty storey building. If this occurs, the company will be pleased to review the report and sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussions of geotechnical aspects and recommendations or suggestions for design and construction. However, the company cannot always anticipate or assume responsibility for:
- Unexpected variations in ground conditions. The potential for this will depend partly on bore spacing and sampling frequency.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the company request immediate notification. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes
Attention is drawn to the document “Guidelines for the Provision of Geotechnical Information trader Documents”, published by the Institute of Engineers Australia. Where information obtained for this investigation is provided for tender purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or make additional copies of the report available for contract purpose, at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspect of work to which this report is related. This could range from a site visit to confirm that the conditions exposed are as expected, to full time engineering presence on site

Review of Design
Where major civil or structural developments are proposed, or where only a limited investigation has been completed, or where the geotechnical conditions are complex, it is prudent to have the design reviewed by a Senior Geotechnical Engineer.

Graphic Symbols For Soil and Rock

SOIL


Fill


Topsoil


Gravel (GW , GP)


Sand (SP, SW)


Silt (ML, MH)


Clay (CL, CH)


Clayey Gravel (GC)


Silty Sand (SM)


Clayey Sand (SC)


Sandy Silt (ML)


Gravelly Clay (CL, CH)


Silty Clay (CL, CH)


Sandy Clay (CL, CH)


Peat or Organic Soil

ROCK


Shale


Sandstone


Siltstone,Mudstone,Claystone


Granite, Gabbro


Dolerite, Diorite


Basalt, Andesite

Other Materials


Concrete


Bitumen, Asphaltic Concrete, Coal


Ironstone Gravel


Organic Material