



**CHERRY COBB SANDS WET GRASSLAND  
KEYINGHAM DRAIN SALINITY STUDIES**

**OCT 2013**

Able UK Ltd  
Able House,  
Billingham Reach Industrial Estate,  
Teesside  
TS23 1PX  
Tel: 01642 806080 Fax: 01642 655655

	<b>CHERRY COBB SANDS WET GRASSLAND KEYINGHAM DRAIN SALINITY STUDIES</b>	<b>OCT 2013</b>
---	---	-----------------

**APPROVAL & REVISION REGISTER**

	<b>NAME</b>	<b>SIGNATURE</b>	<b>DATE</b>
<b>Originator:</b>	J Monk		08/10/2013
<b>Checked by:</b>	R Cram		08/10/2013
<b>Approved by:</b>	R Cram		08/10/2013

<b>REVISION</b>	<b>COMMENTS</b>	<b>DATE</b>
<b>A</b>	Approved for issue	14/10/2013

**CONTENTS**

<b>1</b>	<b>INTRODUCTION .....</b>	<b>3</b>
1.1	General .....	3
1.2	Potential Sources of Saline Contamination .....	3
1.3	Studies Undertaken.....	4
<b>2</b>	<b>CONDUCTIVITY MONITORING .....</b>	<b>5</b>
<b>3</b>	<b>CHEMICAL SAMPLING AND ANALYSIS .....</b>	<b>6</b>
<b>4</b>	<b>BOTANICAL AND ZOOLOGICAL ANALYSIS.....</b>	<b>7</b>
<b>5</b>	<b>SITE INVESTIGATIONS .....</b>	<b>8</b>
<b>6</b>	<b>CONCLUSIONS .....</b>	<b>9</b>
<b>APPENDIX 1 –CONTINUOUS CONDUCTIVITY MONITORING RESULTS (THOMSON ECOLOGY, INTERP. ABLE UK) .....</b>		
		<b>10</b>
<b>APPENDIX 2 – CHEMICAL SAMPLING AND ANALYSIS RESULTS (DELTA SIMONS) .....</b>		
		<b>11</b>
<b>APPENDIX 3 – WATER QUALITY STATUS OF KEYINGHAM DRAIN, EAST YORKSHIRE, WITH SPECIFIC REFERENCE TO FRESHWATER CONDITIONS (INSTITUTE OF ESTUARINE AND COASTAL STUDIES).....</b>		
		<b>12</b>
<b>APPENDIX 4 – CHERRY COBB SANDS WET GRASSLAND SITE INVESTIGATION REPORT (DELTA SIMONS).....</b>		
		<b>13</b>

## **1 INTRODUCTION**

### **1.1 GENERAL**

1.1.1 As part of its compensation scheme for the effects of the AMEP project, Able Humber Ports Ltd (the Applicant) proposed to develop a 38ha site to provide optimally-managed wet grassland at Cherry Cobb Sands in the East Riding of Yorkshire, and incorporate a 5ha wet roost. These two habitats together comprise the Cherry Cobb Sands Wet Grassland proposal (CCSWG), and are targeted to provide a new roost and supplementary feeding resource for black-tailed godwit displaced from their current habitat by AMEP.

1.1.2 One of the key objectives of the scheme is that it should remain sufficiently damp for the birds to probe-feed during the period August-October each year; the reduced rainfall in the summer time requires the use of water from the wet roost site to irrigate to the grassland during this period. However, in drier years, it may not always be possible both to maintain the roost islands and to irrigate the wetland without sourcing additional water. To address this potential shortfall, the Applicant has proposed to abstract water from the Keyingham Drain, a large land drain with an extensive catchment which borders the CCSWG site. This Drain is classified as an Environment Agency Main River, and is maintained by the Environment Agency (EA).

1.1.3 In order for water from the Drain to be used for irrigation purposes, it must be demonstrated to be of low salinity, in order to avoid causing chemical stress to the grassland flora. The Keyingham Drain, however, was suspected to be subject to saline contamination. The Applicant has undertaken a series of studies to determine the nature and extent of saline contamination in the Drain, and to pinpoint its source. These studies are appended to, and summarised in, this report.

### **1.2 POTENTIAL SOURCES OF SALINE CONTAMINATION**

1.2.1 There are three possible sources of saline contamination in the Keyingham Drain. The first possibility is that saline water is migrating horizontally from the Humber Estuary through the local perched water table, i.e. under the CCSWG site, and entering the Drain. The sands underlying the site are known to be laterally permeable, and there is close proximity between the Drain and the Estuary.

1.2.2 The second potential source is leakage through the clough (or tidal gate) structure which separates the Drain from the Estuary. This structure comprises a pair of tidally-operated, vertically-hung swinging doors and a penstock, which is kept in the open position and used for holding back the Drain water when the EA wishes to sluice out Stone Creek (an operation which it carries out approximately monthly). It had long been suspected that the clough structure is allowing water to enter the Drain from the Estuary.

1.2.3 The third potential source is contamination by agricultural fertilisers and other chemicals, which, while not representing true saline intrusion, can have similar effects and can mirror the effects of saline intrusion when electrical conductivity is used as a proxy for chemical salinity. It is also possible that these three sources could be acting in combination, to give a mixed source for the contamination.

### **1.3 STUDIES UNDERTAKEN**

1.3.1 The Applicant's researches into the presence of salinity in the Keyingham Drain have comprised four strands:

- Conductivity monitoring: continuous water quality monitoring using a probe and datalogger which was conducted by Thomson Ecology during July 2013. This recorded electrical conductivity as a proxy for relative salinity.
- Direct chemical sampling: Delta Simons sampled water from the Drain for direct chemical analysis, measuring concentrations of sodium and chloride ions in the water, in order to exclude some potential explanations for the conductivity results.
- Botanical and zoological analysis: the Institute of Estuarine and Coastal Studies (IECS) undertook a programme of sampling and analysis of zooplankton, infaunal invertebrates, vegetation and water quality parameters during September 2013. These provide an understanding of longer-term average conditions than the continuous monitoring, and also provide an insight into direct ecological effects of saline contamination. This study also gathered evidence on the source of the contamination.
- Site investigation: Delta Simons had previously undertaken site investigation works at CCSWG. These had not been targeted towards identifying saline contamination or its sources; however, reference to the findings and observations of this study has enabled the exclusion of potential sources of saline ingress.

## **2            CONDUCTIVITY MONITORING**

- 2.1.1 Thomson Ecology undertook continuous conductivity monitoring in the Keyingham Drain during the period 21<sup>st</sup> June 2013 to 23<sup>rd</sup> July 2013. A Solinst LevelLogger was placed in the Drain at three different locations as shown on the plan included in Appendix 1. The datalogger measured temperature, water level, barometric pressure, pH and electrical conductivity, which was the parameter used as a proxy to calculate salinity in Practical Salinity Units using software provided by the datalogger supplier.
- 2.1.2 The data collected by the datalogger is expressed on the three charts presented in Appendix 1. These display salinity against water level for the time series measured. The charts are arranged in increasing distance from the clough.
- 2.1.3 It can clearly be seen from the calculated salinity levels that they correlate closely with the water level, i.e. the tidal level; this effect is most pronounced closest to the clough, but is detectable clearly along the whole of the site's drain frontage. This is strong evidence that the waters of the drain are heavily tidally influenced.
- 2.1.4 However, because the salinity data here is calculated from a proxy, rather than being drawn from direct measurements, there is a risk that other chemical influences which influence conductivity could be affecting the salinity data. In particular, agricultural fertilisers entering the water could be a source of electrolytes which would increase the electrical conductivity of the drain, and the apparent salinity. To exclude the possibility of this, it was necessary to collect samples for direct sodium and chloride analysis, to provide a check on the conductivity data. This was undertaken, and is reported in Section 3 of this report.

	<b>CHERRY COBB SANDS WET GRASSLAND KEYINGHAM DRAIN SALINITY STUDIES</b>	<b>OCT 2013</b>
---	---	-----------------

### 3 CHEMICAL SAMPLING AND ANALYSIS

3.1.1 Delta Simons were commissioned to collect and analyse samples of water from the Keyingham Drain from four separate points, as shown on the plan included in Appendix 2 of this report. Each point was sampled at both low tide and high tide (except Point 4, which was high tide only), and on each of these occasions, four replicate samples were collected. The analytical certificates are set out in Appendix 2 and summarised below.

**Table 3.1 – Keyingham Drain chemical analyses (High Tide)**

Point	Sample	Calcium (mg/l)	Manganese (µg/l)	Potassium (mg/l)	High Tide Sodium (mg/l)	High Tide Chloride (mg/l)	Sulphate (mg/l)
Point 1	Sample 1	295.36	30.7	201.30	5302.8	11205	1231
	Sample 2	292.57	66.1	198.56	5263.4	10435	1433
	Sample 3	292.62	74.5	200.12	5202.0	10367	1263
	Sample 4	291.61	40.6	197.59	5159.2	10100	1237
Point 2	Sample 1	297.32	67.9	204.28	5247.4	10427	1307
	Sample 2	297.70	18.5	202.76	5222.0	10348	1308
	Sample 3	299.25	99.7	205.30	5217.5	11109	1315
	Sample 4	298.70	69.7	204.55	5157.6	10244	1356
Point 3	Sample 1	352.75	92.1	265.42	6863.0	12978	1755
	Sample 2	357.97	124.0	269.50	6839.6	14185	1789
	Sample 3	357.89	95.2	268.37	7071.9	13565	1877
	Sample 4	361.55	113.6	270.95	6948.2	14503	1814
Point 4	Sample 1	422.73	124.8	331.55	8330.5	1917	2388
	Sample 2	432.87	27.6	343.53	8538.7	16703	2676
	Sample 3	427.70	39.9	339.91	8349.9	16914	2273
	Sample 4	424.58	29.0	338.51	8273.7	15762	2328

**Table 3.2 – Keyingham Drain chemical analyses (Low Tide)**

Point	Sample	Calcium (mg/l)	Manganese (µg/l)	Potassium (mg/l)	Low Tide Sodium (mg/l)	Low Tide Chloride (mg/l)	Sulphate (mg/l)
Point 1	Sample 1	295.37	84.4	119.06	4713.5	9939	1358
	Sample 2	291.46	86.0	195.50	4668.5	11704	1304
	Sample 3	298.28	92.2	201.32	4768.7	10002	1233
	Sample 4	295.89	112.2	198.24	4723.9	9721	1244
Point 2	Sample 1	295.84	58.2	200.41	4738.0	9826	1402
	Sample 2	297.86	79.8	199.59	4766.7	9987	1234
	Sample 3	295.01	79.4	198.24	4756.5	9824	1274
	Sample 4	297.99	67.7	199.89	4775.4	10133	1329
Point 3	Sample 1	343.84	55.6	249.58	638.7	12039	1642
	Sample 2	338.28	47.3	244.34	5932.8	12283	1636
	Sample 3	340.22	46.4	244.92	5924.9	12582	1574
	Sample 4	342.24	52.3	245.92	5987.4	12482	1686

3.1.2 The results of the chemical analysis entirely support the electrical conductivity results, demonstrating that sodium chloride is the overwhelmingly dominant electrolyte, making saline intrusion by estuarine waters by far the principal factor in the salinity of the Drain.

#### **4 BOTANICAL AND ZOOLOGICAL ANALYSIS**

- 4.1.1 IECS were commissioned to investigate the infaunal invertebrates, zooplankton, vegetation and water quality of the Keyingham Drain to ascertain to what extent the trends detectable in the chemical and conductivity data were also discernible in the ecology of the Drain. This has the dual purpose of determining whether the saline intrusion is a temporary, transient phase or a more permanent one, and also of giving an indication of the effects of salinity on the ecosystem.
- 4.1.2 IECS' study is fully reported in Appendix 3 of this report. In summary, all the parameters investigated reflected significant saline intrusion, which potentially diminished upstream north-west of the site (towards Marsh Bridge). This is in accordance with the findings of the other studies, and similarly indicates an estuarine source for the saline contamination.
- 4.1.3 A further conclusion of the IECS report is the positive identification that the clough is leaking significant volumes of water into the Drain even at comparatively high tides (the head of water on the Drain even at high tide is very small, and outflow is not powerful). Observational and photographic evidence is presented to demonstrate that water is passing inward through the clough. This further increases the likelihood that leakage through the clough is the principal source of saline contamination, as suggested by the other studies.


## **5 SITE INVESTIGATIONS**

- 5.1.1 Although the site investigation works conducted by Delta Simons as part of the AMEP application were not specifically targeted to answering the question of the source of saline contamination in the Keyingham Drain, they produced useful data which helps to answer this question.
- 5.1.2 Appendix 4 of this report contains the Factual Report of this site investigation. It included a series of boreholes drilled along the margin of the Keyingham Drain to a depth of 5.45m below ground level – considerable in excess of the maximum depth of the Drain. At no point in any of these boreholes, or in any of the associated trial pits, was groundwater encountered. No hydraulic connectivity exists between the Keyingham Drain and the Humber Estuary, except via the clough. This conclusively discounts the possibility of saline migration through a perched water table.

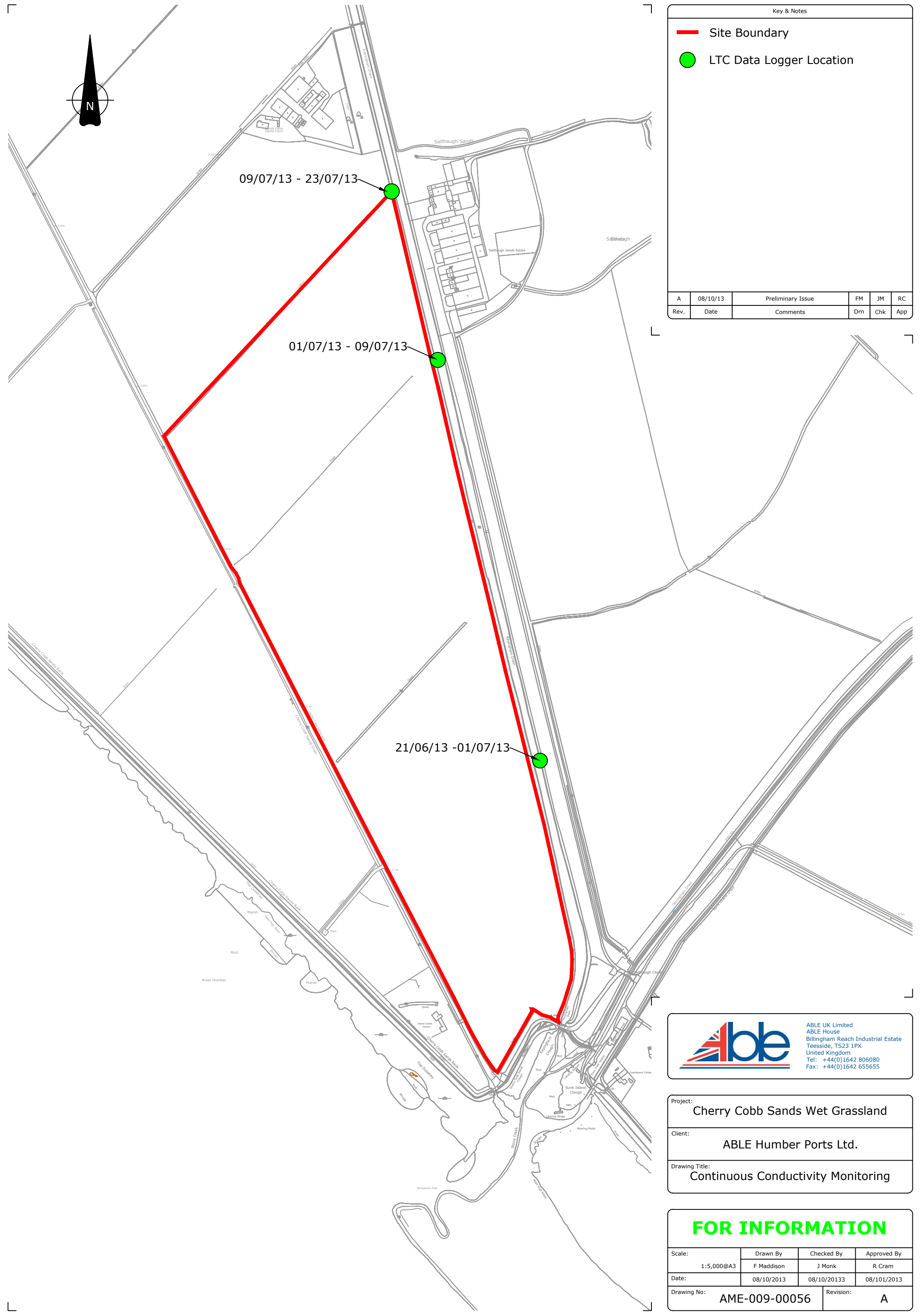
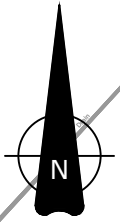


## **6**      **CONCLUSIONS**

- 6.1.1      Taken collectively, the studies reported above allow the existence, magnitude and source of the saline contamination present in the Keyingham Drain to be determined with certainty. Of the possible sources identified in section 1, migration through the water table has been demonstrated to be impossible and contamination by other chemicals electrolytes has been shown to be *de minimis* in comparison to the contamination by sodium chloride, for which the only credible local source is the Humber Estuary.
- 6.1.2      This leaves the only feasible pathway for the contamination to be ingress through the clough. Positive evidence that this is the case is presented in the IECS report (Appendix 3).
- 6.1.3      The corollary of this is that if ingress through the clough can be prevented, the Drain will, relatively rapidly, return to freshwater conditions as the drainage from its catchment pushes the contaminated water by stages back out into the estuary.
- 6.1.4      Discussions with the EA have identified that the clough is known to be in need of substantial refurbishment. Repair and refurbishment of this structure will lead to a dramatic increase in its efficiency, and although perfect efficiency may not be achieved, saline ingress will be reduced very significantly. Repair works to the clough will thus effectively resolve any uncertainty in the functioning of CCSWG which may arise from its water supply.

 <p>amep able marine energy park</p>	<p><b>CHERRY COBB SANDS WET GRASSLAND KEYINGHAM DRAIN SALINITY STUDIES</b></p>	<p><b>OCT 2013</b></p>
---	--	------------------------

**APPENDIX 1 -CONTINUOUS CONDUCTIVITY MONITORING RESULTS  
(THOMSON ECOLOGY, INTERP. ABLE UK)**



Key & Notes

- Site Boundary
- LTC Data Logger Location

A	08/10/13	Preliminary Issue	FM	JM	RC
Rev.	Date	Comments	Drn	Chk	App



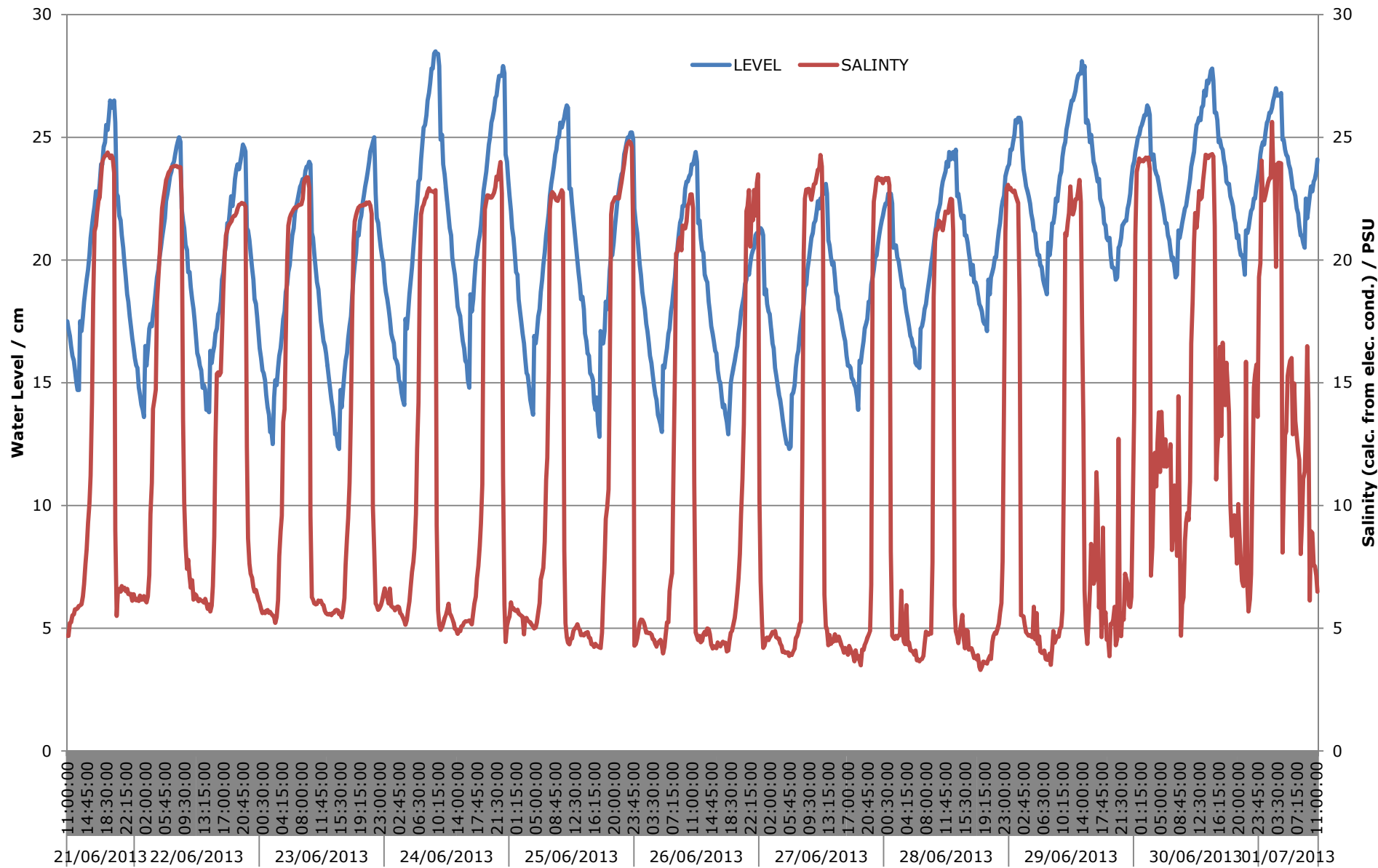
ABLE UK Limited  
 ABLE House  
 Billingham Reach Industrial Estate  
 Teesside, TS23 1PX  
 United Kingdom  
 Tel: +44(0)1642 806080  
 Fax: +44(0)1642 655655

Project:	Cherry Cobb Sands Wet Grassland
Client:	ABLE Humber Ports Ltd.
Drawing Title:	Continuous Conductivity Monitoring

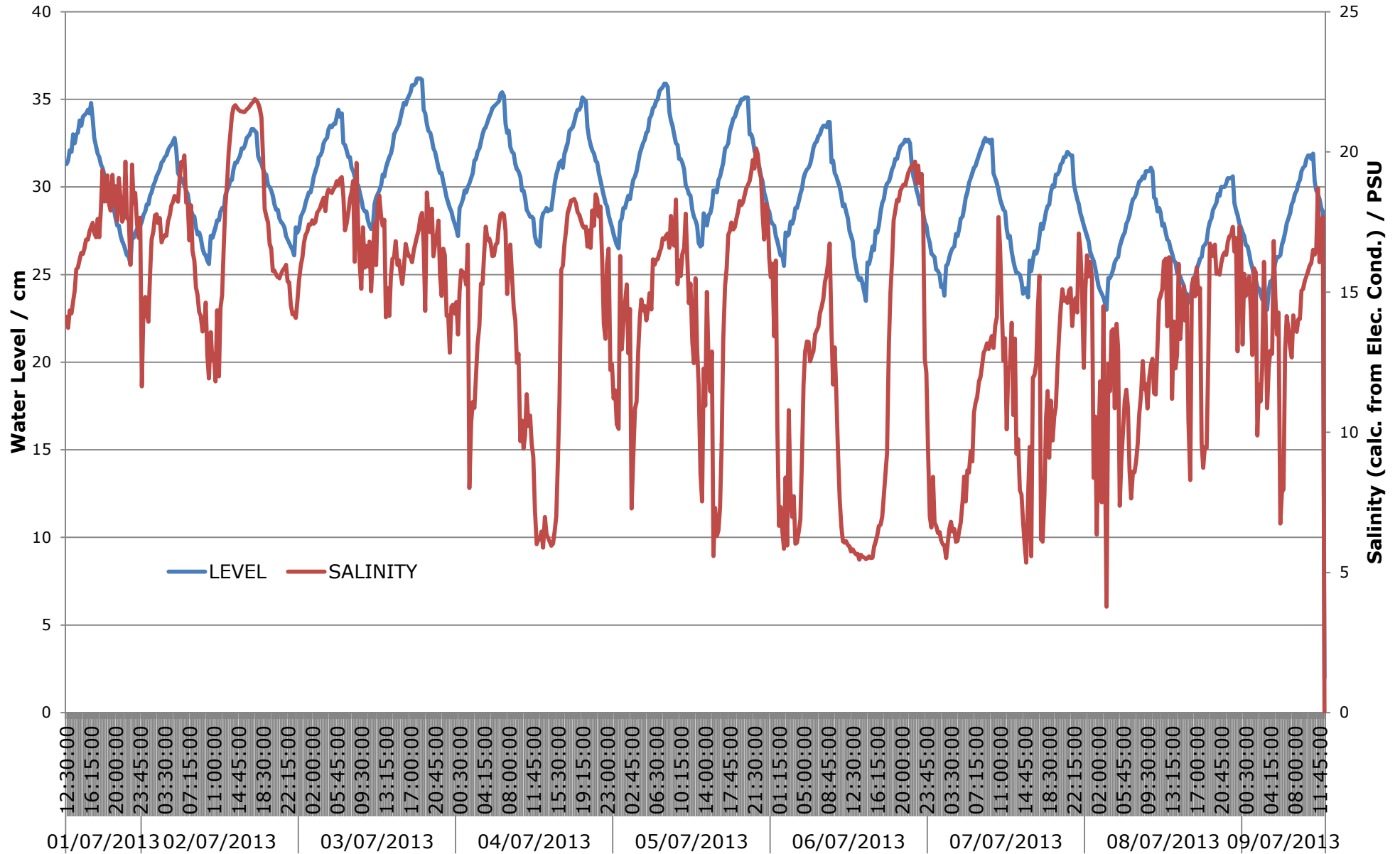
FOR INFORMATION

Scale:	1:5,000@A3	Drawn By:	F Maddison	Checked By:	J Monk	Approved By:	R Cram
Date:	08/10/2013	08/10/2013	08/10/2013	08/10/2013	08/10/2013	08/10/2013	08/10/2013
Drawing No:	AME-009-00056		Revision:	A			

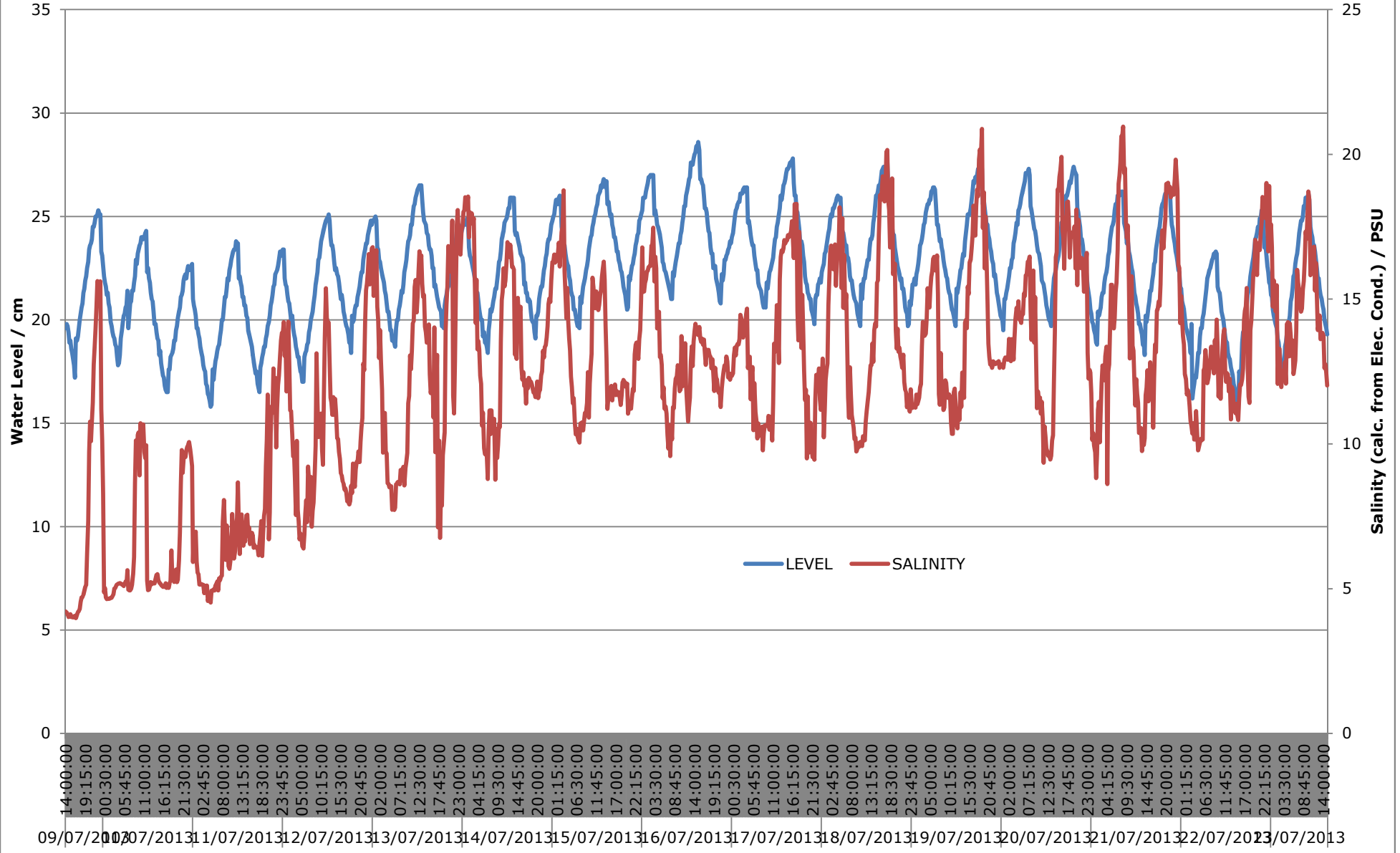
### Keyingham Drain Continuous Salinity Monitoring 21/06/2013 - 01/07/2013




# Keyingham Drain Continuous Salinity Monitoring 01/07/2013 - 09/07/2013

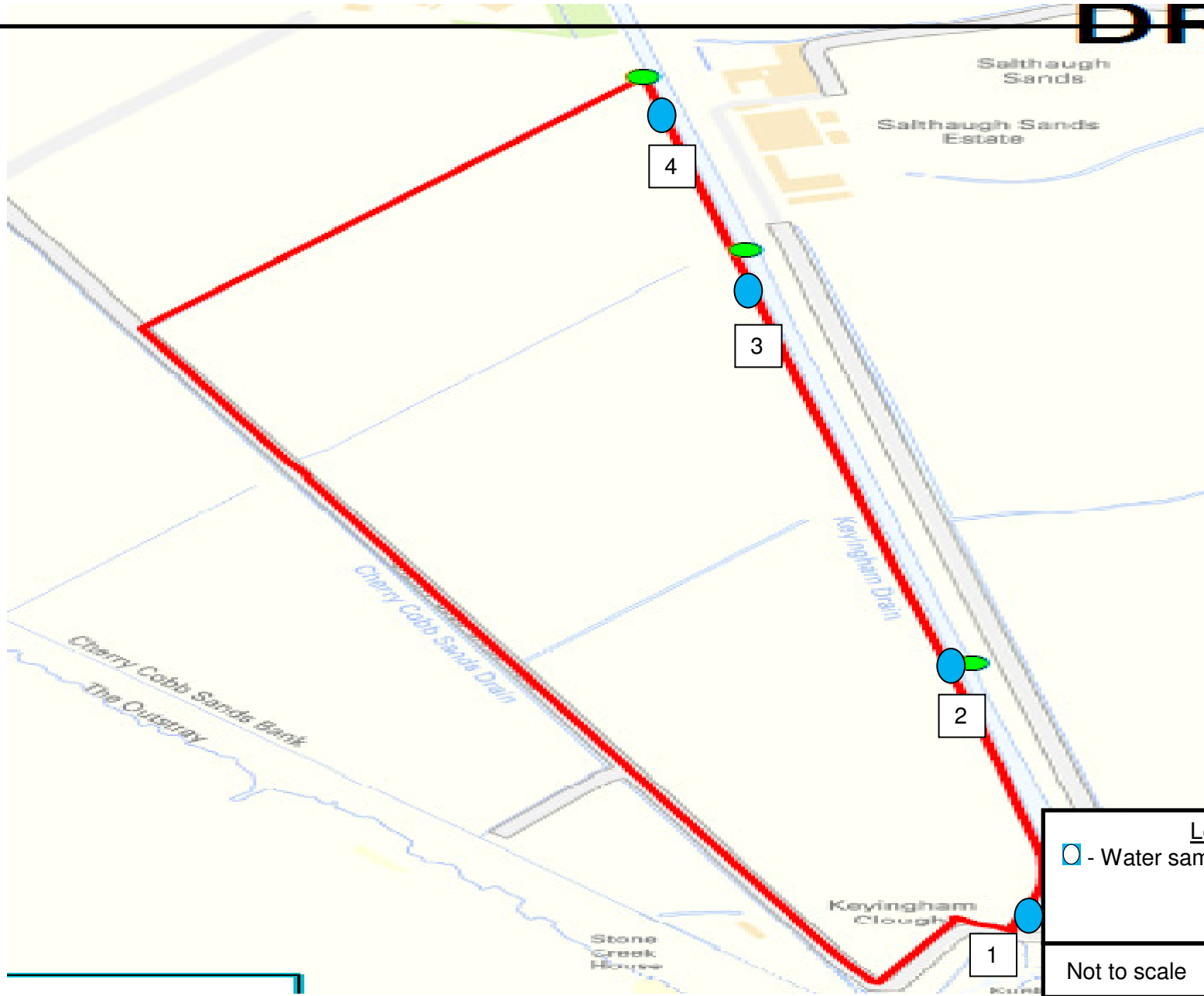


### Keyingham Drain Continuous Salinity Monitoring 09/07/2013 - 23/07/2013



	<b>CHERRY COBB SANDS WET GRASSLAND KEYINGHAM DRAIN SALINITY STUDIES</b>	<b>OCT 2013</b>
---	---	-----------------

**APPENDIX 2 – CHEMICAL SAMPLING AND ANALYSIS RESULTS (DELTA SIMONS)**



<u>Legend</u>	
○ - Water samples taken	
Not to scale	↑ North
DWN: KB	PROJECT NO.: 12-0592.01
DATE: SEP 2013	FIGURE NO.: 3





2531

## ANALYTICAL TEST REPORT

**Contract no:** 48981  
**Contract name:** Keyingham Drain  
**Client reference:** -  
**Clients name:** Delta Simons  
**Clients address:** The Lawn  
Union Road  
Lincoln  
LN1 3BL

**Samples received:** 09 September 2013  
**Analysis started:** 10 September 2013  
**Analysis completed** 17 September 2013  
**Report issued:** 17 September 2013

**Notes:** Opinions and interpretations expressed herein are outside the UKAS accreditation scope. Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling. Methods, procedures and performance data are available on request. Results reported herein relate only to the material supplied to the laboratory. This report shall not be reproduced except in full, without prior written approval. Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

**Key:** U UKAS accredited test  
M MCERTS & UKAS accredited test  
\$ Test carried out by an approved subcontractor  
I/S Insufficient sample to carry out test  
N/S Sample not suitable for testing

**Approved by:**

Karan Campbell  
Director

John Campbell  
Director

# Chemtech Environmental Limited

## WATERS

Lab number			48981-1	48981-2	48981-3	48981-4	48981-5	48981-6
Sample id			P1 HT S1	P1 HT S2	P1 HT S3	P1 HT S4	P2 HT S1	P2 HT S2
Depth (m)			-	-	-	-	-	-
Date sampled			06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013
Time sampled			-	-	-	-	-	-
Test	Method	Units						
Calcium (dissolved)	CE128	mg/l Ca	295.36	292.57	292.62	291.61	297.32	297.70
Manganese (dissolved)	CE128	µg/l Mn	30.7	66.1	74.5	40.6	67.9	18.5
Potassium (dissolved)	CE128	mg/l K	201.30	198.56	200.12	197.59	204.28	202.76
Sodium (dissolved)	CE128	mg/l Na	5302.8	5263.4	5202.0	5159.2	5247.4	5222.0
Chloride	CE049 <sup>U</sup>	mg/l Cl	11205	10435	10367	10100	10427	10348
Sulphate	CE049 <sup>U</sup>	mg/l SO <sub>4</sub>	1231	1433	1263	1237	1307	1308

# Chemtech Environmental Limited

## WATERS

Lab number			48981-7	48981-8	48981-9	48981-10	48981-11	48981-12
Sample id			P2 HT S3	P2 HT S4	P3 HT S1	P3 HT S2	P3 HT S3	P3 HT S4
Depth (m)			-	-	-	-	-	-
Date sampled			06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013
Time sampled			-	-	-	-	-	-
Test	Method	Units						
Calcium (dissolved)	CE128	mg/l Ca	299.25	298.70	352.75	357.97	357.89	361.55
Manganese (dissolved)	CE128	µg/l Mn	99.7	69.7	92.1	124.0	95.2	113.6
Potassium (dissolved)	CE128	mg/l K	205.30	204.55	265.42	269.50	268.37	270.95
Sodium (dissolved)	CE128	mg/l Na	5217.5	5157.6	6863.0	6839.6	7071.9	6948.2
Chloride	CE049 <sup>U</sup>	mg/l Cl	11109	10244	12978	14185	13565	14503
Sulphate	CE049 <sup>U</sup>	mg/l SO <sub>4</sub>	1315	1356	1755	1789	1877	1814

# Chemtech Environmental Limited

## WATERS

Lab number			48981-13	48981-14	48981-15	48981-16	48981-17	48981-18
Sample id			P4 HT S1	P4 HT S2	P4 HT S3	P4 HT S4	P1 LT S1	P1 LT S2
Depth (m)			-	-	-	-	-	-
Date sampled			06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013
Time sampled			-	-	-	-	-	-
Test	Method	Units						
Calcium (dissolved)	CE128	mg/l Ca	422.73	432.87	427.70	424.58	295.37	291.46
Manganese (dissolved)	CE128	µg/l Mn	124.8	27.6	39.9	29.0	84.4	86.0
Potassium (dissolved)	CE128	mg/l K	331.55	343.53	339.91	338.51	119.06	195.50
Sodium (dissolved)	CE128	mg/l Na	8330.5	8538.7	8349.9	8273.7	4713.5	4668.5
Chloride	CE049 <sup>U</sup>	mg/l Cl	1917	16703	16914	15762	9939	11704
Sulphate	CE049 <sup>U</sup>	mg/l SO <sub>4</sub>	2388	2676	2273	2328	1358	1304

# Chemtech Environmental Limited

## WATERS

Lab number			48981-19	48981-20	48981-21	48981-22	48981-23	48981-24
Sample id			P1 LT S3	P1 LT S4	P2 LT S1	P2 LT S2	P2 LT S3	P2 LT S4
Depth (m)			-	-	-	-	-	-
Date sampled			06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013	06/09/2013
Time sampled			-	-	-	-	-	-
Test	Method	Units						
Calcium (dissolved)	CE128	mg/l Ca	298.28	295.89	295.84	297.86	295.01	297.99
Manganese (dissolved)	CE128	µg/l Mn	92.2	112.2	58.2	79.8	79.4	67.7
Potassium (dissolved)	CE128	mg/l K	201.32	198.24	200.41	199.59	198.24	199.89
Sodium (dissolved)	CE128	mg/l Na	4768.7	4723.9	4738.0	4766.7	4756.5	4775.4
Chloride	CE049 <sup>u</sup>	mg/l Cl	10002	9721	9826	9987	9824	10133
Sulphate	CE049 <sup>u</sup>	mg/l SO <sub>4</sub>	1233	1244	1402	1234	1274	1329

# Chemtech Environmental Limited

## WATERS

Lab number			48981-25	48981-26	48981-27	48981-28
Sample id			P3 LT S1	P3 LT S2	P3 LT S3	P3 LT S4
Depth (m)			-	-	-	-
Date sampled			06/09/2013	06/09/2013	06/09/2013	06/09/2013
Time sampled			-	-	-	-
Test	Method	Units				
Calcium (dissolved)	CE128	mg/l Ca	343.84	338.28	340.22	342.24
Manganese (dissolved)	CE128	µg/l Mn	55.6	47.3	46.4	52.3
Potassium (dissolved)	CE128	mg/l K	249.58	244.34	244.92	245.92
Sodium (dissolved)	CE128	mg/l Na	6038.7	5932.8	5924.9	5987.4
Chloride	CE049 <sup>u</sup>	mg/l Cl	12039	12283	12582	12482
Sulphate	CE049 <sup>u</sup>	mg/l SO <sub>4</sub>	1642	1636	1574	1686

# Chemtech Environmental Limited

## METHOD DETAILS

<b>METHOD</b>	<b>WATERS</b>	<b>METHOD SUMMARY</b>	<b>STATUS</b>	<b>LOD</b>	<b>UNITS</b>
CE128	Calcium (dissolved)	ICP-MS		0.04	mg/l Ca
CE128	Manganese (dissolved)	ICP-MS		0.4	µg/l Mn
CE128	Potassium (dissolved)	ICP-MS		0.03	mg/l K
CE128	Sodium (dissolved)	ICP-MS		0.6	mg/l Na
CE049	Chloride	Ion Chromatography	U	1	mg/l Cl
CE049	Sulphate	Ion Chromatography	U	10	mg/l SO <sub>4</sub>

# Chemtech Environmental Limited

## DEVIATING SAMPLE INFORMATION

### Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

### Key

- N No (not deviating sample)
- Y Yes (deviating sample)
- A Sampling date not provided
- B Sampling time not provided (waters only)
- C Sample exceeded holding time(s)
- D Sample not received in appropriate containers
- E Headspace present in sample container
- F Sample not chemically fixed (where appropriate)
- G Sample not cooled
- H Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
48981-1	P1 HT S1	-	Y	Metals (C/F)
48981-2	P1 HT S2	-	Y	Metals (C/F)
48981-3	P1 HT S3	-	Y	Metals (C/F)
48981-4	P1 HT S4	-	Y	Metals (C/F)
48981-5	P2 HT S1	-	Y	Metals (C/F)
48981-6	P2 HT S2	-	Y	Metals (C/F)
48981-7	P2 HT S3	-	Y	Metals (C/F)
48981-8	P2 HT S4	-	Y	Metals (C/F)
48981-9	P3 HT S1	-	Y	Metals (C/F)
48981-10	P3 HT S2	-	Y	Metals (C/F)
48981-11	P3 HT S3	-	Y	Metals (C/F)
48981-12	P3 HT S4	-	Y	Metals (C/F)
48981-13	P4 HT S1	-	Y	Metals (C/F)
48981-14	P4 HT S2	-	Y	Metals (C/F)
48981-15	P4 HT S3	-	Y	Metals (C/F)
48981-16	P4 HT S4	-	Y	Metals (C/F)
48981-17	P1 LT S1	-	Y	Metals (C/F)
48981-18	P1 LT S2	-	Y	Metals (C/F)
48981-19	P1 LT S3	-	Y	Metals (C/F)
48981-20	P1 LT S4	-	Y	Metals (C/F)
48981-21	P2 LT S1	-	Y	Metals (C/F)
48981-22	P2 LT S2	-	Y	Metals (C/F)
48981-23	P2 LT S3	-	Y	Metals (C/F)
48981-24	P2 LT S4	-	Y	Metals (C/F)
48981-25	P3 LT S1	-	Y	Metals (C/F)
48981-26	P3 LT S2	-	Y	Metals (C/F)
48981-27	P3 LT S3	-	Y	Metals (C/F)
48981-28	P3 LT S4	-	Y	Metals (C/F)





2531

## ANALYTICAL TEST REPORT

**Contract no:** 48982  
**Contract name:** Marsh Road Bridge  
**Client reference:** -  
**Clients name:** Delta Simons  
**Clients address:** The Lawn  
Union Road  
Lincoln  
LN1 3BL

**Samples received:** 09 September 2013  
**Analysis started:** 10 September 2013  
**Analysis completed** 17 September 2013  
**Report issued:** 17 September 2013

**Notes:** Opinions and interpretations expressed herein are outside the UKAS accreditation scope. Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling. Methods, procedures and performance data are available on request. Results reported herein relate only to the material supplied to the laboratory. This report shall not be reproduced except in full, without prior written approval. Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

**Key:** U UKAS accredited test  
M MCERTS & UKAS accredited test  
\$ Test carried out by an approved subcontractor  
I/S Insufficient sample to carry out test  
N/S Sample not suitable for testing

**Approved by:**

Karan Campbell  
Director

John Campbell  
Director

# Chemtech Environmental Limited

## WATERS

Lab number			48982-1	48982-2	48982-3	48982-4
Sample id			S1 HT	S2 HT	S3 HT	S4 HT
Depth (m)			-	-	-	-
Date sampled			06/09/2013	06/09/2013	06/09/2013	06/09/2013
Time sampled			-	-	-	-
Test	Method	Units				
Calcium (dissolved)	CE128	mg/l Ca	283.06	279.24	278.59	276.19
Manganese (dissolved)	CE128	µg/l Mn	359.9	575.2	489.8	1004.0
Potassium (dissolved)	CE128	mg/l K	185.31	182.43	180.60	182.57
Sodium (dissolved)	CE128	mg/l Na	4391.9	4349.6	4310.5	4303.4
Chloride	CE049 <sup>u</sup>	mg/l Cl	8526	8085	8050	8268
Sulphate	CE049 <sup>u</sup>	mg/l SO <sub>4</sub>	1145	1100	1120	1147

# Chemtech Environmental Limited

## METHOD DETAILS

METHOD	WATERS	METHOD SUMMARY	STATUS	LOD	UNITS
CE128	Calcium (dissolved)	ICP-MS		0.04	mg/l Ca
CE128	Manganese (dissolved)	ICP-MS		0.4	µg/l Mn
CE128	Potassium (dissolved)	ICP-MS		0.03	mg/l K
CE128	Sodium (dissolved)	ICP-MS		0.6	mg/l Na
CE049	Chloride	Ion Chromatography	U	1	mg/l Cl
CE049	Sulphate	Ion Chromatography	U	10	mg/l SO <sub>4</sub>

# Chemtech Environmental Limited

## DEVIATING SAMPLE INFORMATION

### Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

### Key

- N No (not deviating sample)
- Y Yes (deviating sample)
- A Sampling date not provided
- B Sampling time not provided (waters only)
- C Sample exceeded holding time(s)
- D Sample not received in appropriate containers
- E Headspace present in sample container
- F Sample not chemically fixed (where appropriate)
- G Sample not cooled
- H Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
48982-1	S1 HT	-	Y	Metals (C/F)
48982-2	S2 HT	-	Y	Metals (C/F)
48982-3	S3 HT	-	Y	Metals (C/F)
48982-4	S4 HT		Y	Metals (C/F)

	<b>CHERRY COBB SANDS WET GRASSLAND KEYINGHAM DRAIN SALINITY STUDIES</b>	<b>OCT 2013</b>
---	---	-----------------

**APPENDIX 3 - WATER QUALITY STATUS OF KEYINGHAM DRAIN, EAST YORKSHIRE, WITH SPECIFIC REFERENCE TO FRESHWATER CONDITIONS (INSTITUTE OF ESTUARINE AND COASTAL STUDIES)**

the  
**INSTITUTE**  
of  
**ESTUARINE**  
and  
**COASTAL**  
**STUDIES**



**Water Quality Status of Keyingham Drain,  
East Yorkshire, with Specific Reference to  
Freshwater Conditions**

**Final Report**

Report to Able UK Ltd

Institute of Estuarine and Coastal Studies  
University of Hull

8<sup>th</sup> October 2013

**Author(s): A. Leighton, M.J. Bailey,  
O. Dawes, W.A. Musk & S. Brown**

**Report: SBB700-F1-2013**

**Institute of Estuarine & Coastal Studies  
(IECS)**

The University of Hull  
Cottingham Road  
Hull  
HU6 7RX  
UK

  
**UNIVERSITY OF Hull**  
Institute of Estuarine and Coastal Studies

Tel: +44 (0)1482 464120  
E-mail: [iecs@hull.ac.uk](mailto:iecs@hull.ac.uk)  
Web site: <http://www.hull.ac.uk/iecs>



## Document Control

Title: Water Quality Status of Keyingham Drain, East Yorkshire, with Specific Reference to Freshwater Conditions

Report No.: SBB700-F1-2013

Version: F1

Status: Final

Issue date: 8<sup>th</sup> October 2013

Client name: Able

Client contact: Jonathan Monk

## Current Report

Report QA	Name	Position	Signature	Date
Written by	A. Leighton	Benthic Survey Manager	<i>A. Leighton</i>	08/10/13

## Report History (version and approval)

Report date	Version	Status	Name	Organisation	Review Date	Approval Date
20/09/2013	D1	Draft Report	A Leighton	IECS	20/09/13	20/09/13
02/10/2013	D2	Draft Report	A Leighton	IECS	02/10/13	02/10/13
08/10/2013	F1	Final Report	A Leighton	IECS	08/10/13	08/10/13

## Disclaimer

This report has been prepared by the Institute of Estuarine and Coastal Studies, with all reasonable care, skill and attention to detail as set within the terms of the Contract with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This is a confidential report to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such parties rely on the report at their own risk.



This page is intentionally blank

## TABLE OF CONTENTS

TABLE OF CONTENTS .....	i
1. INTRODUCTION.....	1
1.1 Context .....	1
1.2 Survey requirement.....	1
2. METHODOLOGY.....	2
2.1 Field methodology.....	2
2.2 Infaunal invertebrates.....	2
2.3 Zooplankton .....	2
2.4 Vegetation.....	2
2.5 Water quality .....	4
2.6 Laboratory analysis.....	4
3. RESULTS .....	5
3.1 Water quality .....	5
3.2 Benthic infaunal communities.....	6
3.3 Zooplankton .....	7
3.4 Aquatic vegetation .....	8
4. CONCLUSIONS AND DISCUSSION .....	11
4.1 Conclusions .....	11
4.2 Discussion .....	11

This page is intentionally blank.

## **1. INTRODUCTION**

### **1.1 Context**

Able UK Ltd wish to seek a source of freshwater from which abstraction maybe permitted in order to maintain a freshwater grassland and scrape habitat adjacent to Keyingham Drain. This habitat will be used as part of a suite of tools to provide compensation for habitat losses within the Humber Estuary European Marine Site relating to the proposed AMEP development on the south bank at North Killingholme Marsh.

In particular, the freshwater grassland component of the compensation package is required to provide over-compensation for loss of foraging function for Black-tailed Godwit, and meet any time-lag in the provision of such function from the development of the main Cherry Cobb regulated tidal exchange and managed realignment site.

### **1.2 Survey requirement**

As part of the design stage for the wet grassland site, a review of the water quality within Keyingham Drain was undertaken on behalf of Able UK Ltd, in order to establish the suitability of the drain water for use in irrigation of the site. This was undertaken by Thomson Ecology, and identified a potential 'salinity' content within the waters that would potentially preclude its use for the irrigation of grassland.

As such, a follow-up survey was required to determine whether this 'salinity' was a result of saline intrusion from the estuary, or was an artefact of agricultural activity and the method of measurement. The details of this programme are provided in Section 2, the programme therefore aimed at the characterisation of the water quality conditions along the drain, and in particular, the salinity of the waters in the drain.

## **2. METHODOLOGY**

### **2.1 Field methodology**

The survey programme was aimed at the characterisation of the water quality conditions along the drain, and in particular, the salinity of the waters in the drain.

Field sampling along Keyingham drain and also in the Humber Estuary was undertaken on Wednesday 11<sup>th</sup> September 2013, during a Spring tidal cycle. The main sampling stations were at the location of the existing water quality monitoring, in order to provide a clear water parameter: biological component association (3 locations), but with additional samples within the creek on the estuarine side of the sluice facility and along the drain as far as Marsh Bridge (Figure 1). These additional stations were established to provide an indication both of the 'normal' estuarine community present as well as any modification to community on the landward side where continuum of effect might occur.

A small boat was used to access the stations located along the drain, where as the station located in the creek (station 7) was accessed on foot from the intertidal area. At each station samples were taken of the drain bed for invertebrate community analysis, within the water column for zooplankton, and within the water column for salinity. In addition, vegetative samples were taken both from within the drain and from adjacent banks. The following provides detail of the methods employed.

### **2.2 Infaunal invertebrates**

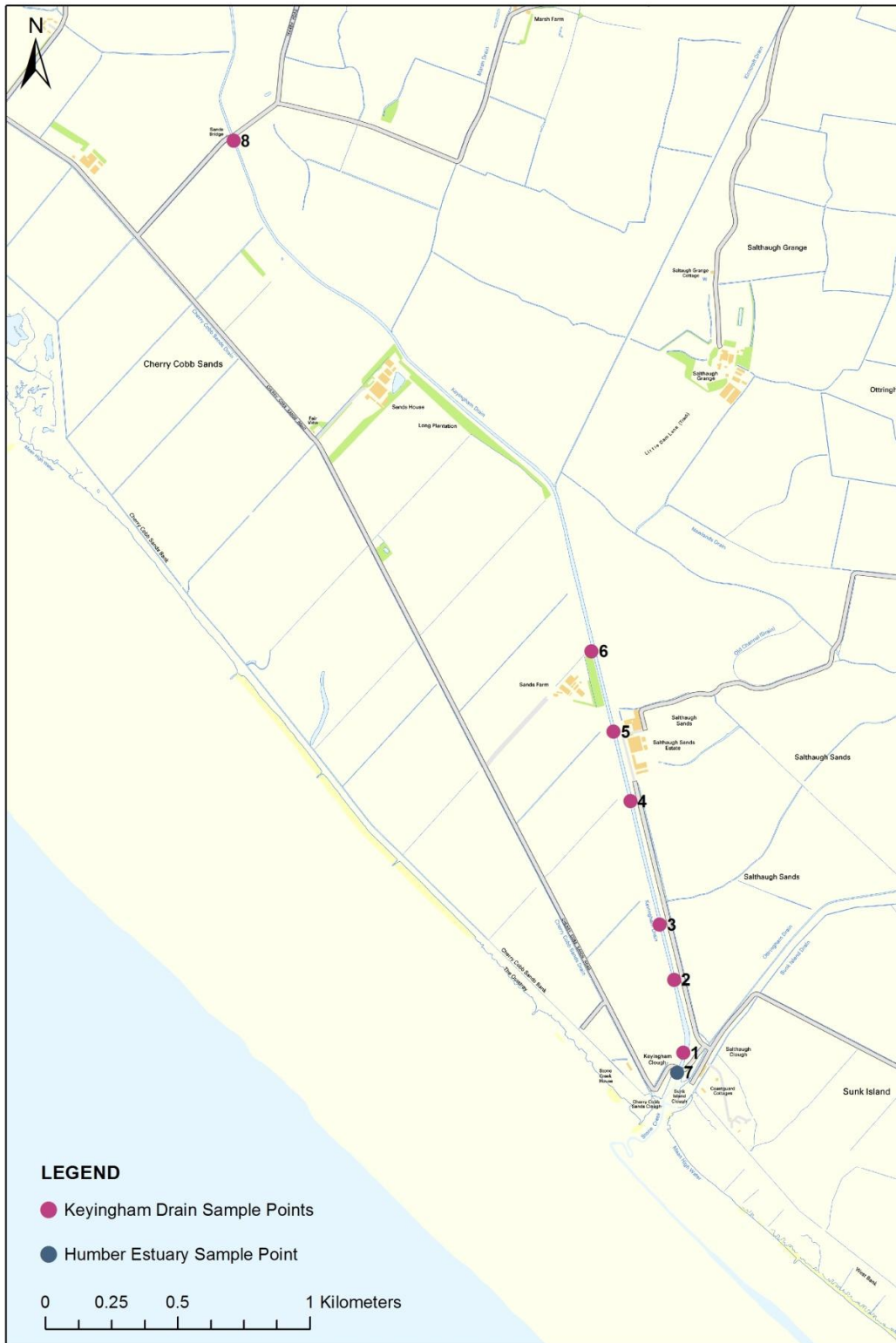
A 0.022m<sup>2</sup> handheld Ekman grab was used to gain a suitable single replicate sample volume and quality from the bed of the drain. Material was then sieved and sorted in the laboratory and any retained organisms identified to species level where possible. Information from these samples provides an indication of the assemblage characterised to tolerate long-term inundation.

### **2.3 Zooplankton**

A standard hand-held plankton net was deployed at each station and was passed through the water column for a set duration across differing depths within the column. The sinusoidal approach was employed to negate any stratification effect which may occur in the water column of the drain. Total tow length was approximately 10m. Any retained material was decanted to a sample bottle, fixed using 4% formaldehyde and subsequent identification of any fauna present was undertaken at the IECS laboratory.

### **2.4 Vegetation**

In addition, vegetation was sampled, both from within the water (subsurface or emergent), as well as from any tidally influenced vertical/semi vertical drain edge. Key species were then subsequently identified.



Contains Ordnance Survey data © Crown copyright and database right 2013 Institute of Estuarine & Coastal Studies

**Figure 1. Sample stations located along Keyingham drain and within the creek (Humber Estuary).**

## **2.5 Water quality**

A Hydrolab Quanta Water Quality Monitoring System (Salinity accuracy +/- 1% of reading +/- 1 count, Resolution 0.01 PSS) was deployed at each station in order to measure salinity levels (a conductivity:temperature calculation) as well as other standard parameters.

## **2.6 Laboratory analysis**

Following the survey work, the invertebrate, zooplankton and botanical samples were analysed with the aim of the identification of any likely association with fresh water conditions. In particular, species/communities that are clearly intolerant of brackish/variable salinity conditions were the focus of identification as these would indicate conditions suitable for the drain water to be utilised on the wet grassland site.

### 3. RESULTS

#### 3.1 Water quality

Salinity values in an estuary can range from 0.5 to 35 and as such are described as brackish waters, where as freshwater is classed as <0.5 and seawater >35. Due to the relatively recent adoption of the Practical Salinity Scale, salinity measurements, like pH, do not have units. Table 1 provides a summary of the water quality parameters measured along the drain including salinity measurements.

**Table 1. Water Quality Parameters**

Parameter	Sampling station							
	7	1	2	3	4	5	6	8
Time (hh:mm)	14:36	10:00	10:42	10:59	11:36	12:25	12:56	15:13
Temperature (°C)	14.57	14.79	14.11	13.77	14.14	14.81	14.48	16.17
Specific conductivity (mS/cm)	37.8	44.5	35.1	33.8	37.2	38.7	35.4	36.1
Dissolved oxygen (mg/l)	8.96	7.54	8.82	7.17	6.29	6.24	4.99	13.39
pH	9.32	9.16	9.36	9.32	9.17	9.07	8.97	9.41
Salinity	23.52	28.41	21.10	20.35	23.23	24.42	22.01	22.96
Dissolved oxygen (% saturation)	100.7	90.2	94.7	77.2	65.3	69.9	55.2	53.4
Turbidity (ntu)	72.8	21.1	49.4	55.9	29.7	22.3	17.3	29.1

A slight potential reduction in salinity was observed between the creek, the immediate landwards side of the sluice and the Marsh Bridge, however there was no uniform continuum of decline as might be expected, with a notable increase at stations 4 and 5. Certainly salinity was present at all locations at a level which would be commonly encountered in estuarine conditions. This may be a result of sluice operation on the day, although other factors would indicate that saline conditions are prevalent in this area of the drain. The lower salinity recorded on the estuary side of the sluice compared to the landward side is considered to be an artefact of timing, with the estuary-side measurement taken during the ebb phase, and thus with some freshwater mixing.



A reduction in dissolved oxygen was observed along the drain with percentage saturation decreasing to 53.4% at Marsh Bridge, therefore suggesting the potential for anoxia further up the drain. The reduction in turbidity with distance up the drain would be expected, with the gradual settling out of sediment from the highly loaded estuarine waters with movement up the drain. The increase in water temperature at Marsh Bridge (c. 1.5°C above the other stations) is of some note, as this might indicate a gradual influence of warmer freshwater at this location.

### 3.2 Benthic infaunal communities

The benthic invertebrate community recorded outside of the sluice, within the Humber Estuary was dominated by *Heterochaeta costata* and contained species typical of the middle estuary (Table 2). The benthic invertebrate community recorded along the drain at stations 1 to 4 was also characteristic of an estuarine assemblage including *Hediste diversicolor*, *Heterochaeta costata* and *Tubificoides pseudogaster* (Table 3). The abundance and diversity values were lower at stations 5 and 6, and no invertebrates were recorded at station 8.

**Table 2. Benthic invertebrate community data.**

MCS Code	Species	Qualifier	Sampling station								
			7	1	2	3	4	5	6	8	
P462	<i>Hediste diversicolor</i>			21	6	6			1		
P799	<i>Streblospio shrubsolii</i>			15							
P1479	<i>Heterochaeta costata</i>		87	72	5	3					
P1498	<i>Tubificoides pseudogaster</i>	aggregate	3	77	8	34	3				
P1501	Enchytraeidae	spp	3								
R2511	<i>Cyprideis torosa</i>						2			5	
S76	<i>Neomysis integer</i>			1							
S1385	<i>Crangon crangon</i>		1								
S1594	<i>Carcinus maenas</i>		1								
W385	<i>Hydrobia ulvae</i>		4	7			4				
	Aphidoidea		2								
	Chalcidoidea		3								

**Table 3. Benthic invertebrate habitat description and salinity tolerances**

MCS Code	Species	Habitat description / salinity tolerances
P462	<i>Hediste diversicolor</i>	Inhabits estuaries tolerating low and fluctuating salinities down to <5.
P799	<i>Streblospio shrubsolii</i>	A brackish water species tolerating salinities as low as 4 in estuaries and lagoons.

P1479	<i>Heterochaeta costata</i>	A brackish water species common on estuarine mudflats and is tolerant of mid range salinities.
P1498	<i>Tubificoides pseudogaster</i>	A brackish water species common on estuarine mudflats and is tolerant of low salinities.
P1501	Enchytraeidae	Enchytraeidae are earthworm like, but have not been identified to species. They can occur in marine, brackish and freshwater environments.
R2511	<i>Cyprideis torosa</i>	A species that can tolerate a wide range of salinities from almost freshwater to fully marine environments.
S76	<i>Neomysis integer</i>	Predominantly a brackish water species usually found in rarely found in estuaries in areas of salinity between 0.5 and 20.
S1385	<i>Crangon crangon</i>	A marine and brackish water species that can be found in salinities as low as 6 in Baltic areas but is associated with higher salinities in Northwest European estuaries.
S1594	<i>Carcinus maenas</i>	A marine and brackish water species with adults tolerating salinities as low as 4.
W385	<i>Hydrobia ulvae</i>	A marine and brackish water species which often occurs in large numbers and can tolerant of a wide salinity range from 5 to 40.
	Aphidoidea	Terrestrial in origin.
	Chalcidoidea	Fairy flies which can swim under water, however they are not a benthic species.

### 3.3 Zooplankton

No zooplankton was recorded at stations 1 and 4, however all species recorded at stations along the drain were tolerant of saline conditions (Tables 4 & 5). In particular, Chaetognatha, a predatory marine arrow worm, is intolerant of freshwater. Gobidae (gobies) and *Gasterosteus aculeatus* (three-spined stickleback) were both recorded in the zooplankton samples however they are highly mobile and tolerant of saline conditions. No zooplankton samples were collected from station 7.

**Table 4. Zooplankton Data**

MCS Code	Species	Qualifier	Sampling station							
			1	2	3	4	5	6	8	
L1	Chaetognatha								X	
P1479	<i>Heterochaeta costata</i>									X

R142	Copepoda							X	X
R2511	<i>Cyprideis tornosa</i>								X
S76	<i>Neomysis integer</i>			X			X		X
	Aphids								X
P1501	Enchytraidae							X	
ZG455	Gobiidae ( <i>P. microps</i> )			X	X		X		
ZG226	<i>Gasterosteus aculeatus</i>			X					

**Table 5. Zooplankton habitat description and salinity tolerances**

MCS Code	Species	Habitat description / salinity tolerances
L1	Chaetognatha	Primarily planktonic mobile predatory worms which are only found in salt water.
P1479	<i>Heterochaeta costata</i>	Detritivore found within a variety of sediments in mid range brackish salinities. Low mobility.
R142	Copepoda	Species unknown. Subclass Copepoda found in fresh to fully marine conditions.
R2511	<i>Cyprideis tornosa</i>	Found on muddy or sandy mud sediment in a range of salinities from almost freshwater to 60. Low mobility.
S76	<i>Neomysis integer</i>	Opossum shrimp found in the upper reaches of estuaries, reported to be able to withstand freshwater for long periods of time. Mobile.
	Aphids	Terrestrial in origin.
P1501	Enchytraidae	Species unknown. Family Enchytraidae found in fresh to fully marine conditions.
ZG455	Gobiidae ( <i>P. microps</i> )	Probably <i>Pomatoschistus microps</i> , found in fully marine to low salinity conditions. Mobile.
ZG226	<i>Gasterosteus aculeatus</i>	Found in fully marine to fully freshwater conditions. Mobile.

### 3.4 Aquatic vegetation

The aquatic vegetation was relatively constant along the length of Keyingham drain between stations 1 and 6, with the bank side vegetation dominated by *Phragmites australis* and

*Atriplex prostrata* fringing the water (Plates 1 - 4). Patches of *Scirpus maritimus* were also common along the drain with occasional *Aster tripolium* and *Aster tripolium var discoides*. All these species are tolerant of saline and brackish water, and are common on saltmarshes. The vegetation observed at station 7 (along the estuarine creek) was a typical mixture of salt marsh plants (Table 4).

Along the length of the drain dense patches of *Crateagus monogyna* (Hawthorn) were present at the top of the banks, with mature *Fraxinus excelsior* (Ash trees) from stations 4 to 6 creating areas of dense shading and restricting the growth of ground vegetation.



**Plate 1. Station 1 (direction south along drain)**



**Plate 2. Station 2 (direction north along drain)**



**Plate 3. Station 4 (direction north along drain)**



**Plate 4. Station 5 (direction north along drain)**



**Plate 5. Station 8 (direction south along drain)    Plate 6. Station 8 (direction north along drain)**

The only submerged aquatic vegetation observed along the drain was recorded at station 8, where small quantities of *Potamogeton pectinatus* and *Agrostis stolonifera* were present.

**Table 4. Vegetation recorded along Keyingham Drain.**

Species	Common name	Station							
		7	1	2	3	4	5	6	8
<i>Phragmites australis</i>	Common Reed		X	X	X	X	X	X	X
<i>Scirpus maritimus</i>	Sea Club-rush			X	X				
<i>Atriplex portulacoides</i>	Sea purslane	X							
<i>Atriplex prostrata</i>	Spear-leaved Orache	X	X	X					X
<i>Aster tripolium</i>	Sea Aster (rayed)	X	X						
<i>Aster tripolium var discoideus</i>	Sea Aster (rayless)	X		X					
<i>Elytrigia atherica</i>	Sea Couch	X							
<i>Salicornia europea agg.</i>	Glasswort	X							
<i>Puccinellia maritima</i>	Common saltmarsh grass	X							
<i>Plantago maritima</i>	Sea Plantain	X							
<i>Suaeda maritima</i>	Annual Seablite	X							
<i>Spergularia media</i>	Greater Sea-spurrey	X							
<i>Cochlearia officinalis</i>	Common Scurvy grass	X							
Epilobium	Willowherb					X			
<i>Petasites fragrans</i>	Winter Heliotrope							X	
<i>Potamogeton pectinatus</i>	Fennel-leaved pondweed								X
<i>Agrostis stolonifera</i>	Creeping Bent								X

## 4. CONCLUSIONS AND DISCUSSION

### 4.1 Conclusions

The analysis of the samples taken from the stations within the drain failed to identify any species intolerant of saline conditions (e.g. freshwater indicators). In fact at least one species was recorded that would be considered intolerant of freshwater conditions (albeit this was a mobile zooplankton species).

Most faunal species recorded are those commonly observed in estuaries, including the Humber, and even several estuarine fish were recorded in the drain (e.g. Goby and Stickleback). Such findings are consistent with the salinity measurements that were made on the day of the survey which indicated a salinity of between 20 and 28 within the drain, only a slight reduction with distance from the estuary (e.g. by Marsh Bridge), where a salinity of 23 was recorded.

However, invertebrate and botanical community information suggest that whilst there is the likelihood of saline intrusion as far as station 8 (Marsh Bridge), this station, and maybe station 6 may feature a degree of freshwater (or almost freshwater) exposure for at least some part of the tidal cycle.

### 4.2 Discussion

The first faunal and floral samples were collected from station 1 along Keyingham drain in close proximity to the sluice. The survey time coincided with high water and on initial assessment of the water could be seen entering the drain from the estuary via an opening in the sluice (Plate 7).

There was clear indication of substantial 'estuarine' water penetration into the drain through the sluice, and this is borne out by the water quality parameters taken, as well as the other findings.

Clearly, based on the salinity data, this slug of estuarine water moves some distance up the drain, and is present over a protracted period of time, given the presence of at least one freshwater intolerant species.

The water quality parameters are somewhat anomalous in terms of an expected continuum of salinity reduction with distance from the sluice. In particular, whilst the highest salinity value was recorded at the sluice (landward side), there was then a reduction of 8 units to site 3 (salinity of 20), before a further increase of several units to Marsh Bridge. It is likely this is an artefact of sampling depth, or perhaps some field drain input.

Other water quality parameters however did indicate that station 8 at Marsh Bridge was somewhat different to the other downstream locations, with an increase in water temperature as well as a reduction in dissolved oxygen. It might therefore be of value to carry out additional 'upstream' measurements to identify whether this trend is continued.

The presence of *Potamogeton* at station 8 could indicate freshwater conditions although it is also tolerant of brackish water. Vegetation along the banks was either often recorded in estuaries, or was common to both estuarine and freshwater conditions (e.g. *Phragmites*).



**Plate 7. Sluice at Keyingham drain with visible surface ripples from estuarine water entering the drain at high tide.**

The invertebrate community information does also suggest a gradual reduction in 'saline' conditions with distance up the drain, in that species that are often recorded within the Humber are present in very low numbers by station 4 and absent at station 8. The Ostracod *Cypræis torosa* is present at stations 4 and 6, but whilst this is a largely marine species, it can tolerate almost freshwater conditions. The absence of any infauna at station 8 may be an artefact of the single replicate sampling method, but may also reflect both an indication that conditions are unsuitable for estuarine species, as well as a possible anoxic component restricting all macrofaunal colonisation.

As such, whilst the invertebrate community analysis does not allow the absence of saline water to be confirmed from any location, it does suggest that there is a reduction in the conditions suitable for estuarine infaunal development with distance upstream, with this largely curtailed by station 5 (albeit a single *H. diversicolor* being present, which is somewhat anomalous). The zooplankton data do however perhaps contradict this finding, with the presence of a freshwater intolerant species at station 6. However it should be borne in mind that this would be a mobile (water-column) species, and as such may have moved up the drain with the saline slug of water. As such, the presence of this species does not necessarily indicate that this location features saline waters at all stages of the tide.

This potential reduction in the presence of 'estuarine' infauna with distance up the drain is interesting, as the water parameter data indicate similar salinity levels along the entire drain length surveyed. Potentially, although there is no observation to support this, the

differentiation in invertebrate community between stations 1, 2, 3, 4 and stations 5, 6 and 8 may then be due to diurnal variability in salinity level, with freshwater conditions penetrating down to around station 5 during the ebb and early flood phase, but then with a saline slug moving back up the drain from mid tide onwards (and thus measured during the IECS monitoring programme at these locations). This could also explain the presence of *Potamogeton* at station 8, as although it is generally associated with freshwater, it is tolerant of brackish influence (as well as polluted waters).

Continuous salinity monitoring across the tidal cycle may therefore be of value to identify any shift in the brackish:fresh interface along the drain, as if freshwater is present over a period of the tidal cycle there may be the potential for abstraction to occur over a reduced period. However it should be noted that other factors including flow rate, tide state etc may alter this.

In summary, the combination of differing data types clearly indicate that for much of the drain surveyed, there is a considerable saline influence. There is a possibility however that this influence is somewhat reduced by around Marsh Bridge, possibly with a more variable 'salinity' at this location, and even perhaps a freshwater flow at some stages of the tide.

If data are not already available, it is suggested that additional salinity data are collected across the tidal cycle and perhaps immediately (say 250m) further up the drain in order to establish whether there is a freshwater presence at least for part of the tidal cycle.



 <p>amep able marine energy park</p>	<p><b>CHERRY COBB SANDS WET GRASSLAND KEYINGHAM DRAIN SALINITY STUDIES</b></p>	<p><b>OCT 2013</b></p>
---	--	------------------------

**APPENDIX 4 – CHERRY COBB SANDS WET GRASSLAND SITE INVESTIGATION  
REPORT (DELTA SIMONS)**



**delta-simons**  
environmental consultants



A different perspective

**FACTUAL REPORT ON GEO-ENVIRONMENTAL  
GROUND INVESTIGATION  
CHERRY COBB SANDS WET GRASSLAND**

**FOR  
ABLE (UK) LTD**

**DELTA-SIMONS PROJECT NO. 13-0054.01**



**delta-simons**  
environmental consultants

**FACTUAL REPORT ON GEO-ENVIRONMENTAL  
GROUND INVESTIGATION  
CHERRY COBB SANDS WET GRASSLAND**

**FOR  
ABLE (UK) LTD**

**DELTA-SIMONS PROJECT NO. 13-0054.01**



When you have finished with  
this Report please recycle it

This Report was issued in July 2013 and prepared by:  
Delta-Simons Environmental Consultants, The Lawn, Union Road, Lincoln, LN1 3BL  
Tel: 0870 0400 012 Fax: 01522 882567 [www.deltasimons.com](http://www.deltasimons.com)

A member of



# TABLE OF CONTENTS

---

1.0 INTRODUCTION.....	1
1.1 Introduction and Purpose.....	1
1.2 Scope of Works .....	1
2.0 BACKGROUND .....	2
2.1 Site Location and Description .....	2
3.0 SITE INVESTIGATION .....	3
3.1 Boreholes.....	3
3.2 Trial Pits.....	3
3.3 Soil Sampling.....	3
3.4 Laboratory Analysis .....	3
3.4 In-situ Testing .....	4
4.0 OBSERVED GROUND CONDITIONS.....	5
4.1 Ground Conditions.....	5
5.0 LIMITATIONS TO GEOTECHNICAL INVESTIGATIONS .....	6

## Tables

Table 1	Summary of Ground Conditions Encountered
---------	--

## Figures

Figure 1	Site Location Map & Layout Plan
Figure 2	Approximate Intrusive Location Plan

## Appendices

Appendix I	Cable Percussion Borehole and Trial Pit Logs
Appendix II	Geotechnical Analytical Results
Appendix III	Environmental Analytical Results
Appendix IV	In-situ Testing Results

**FACTUAL REPORT ON GEO-ENVIRONMENTAL GROUND INVESTIGATION  
CHERRY COBBSANDS WET GRASSLAND  
DELTA-SIMONS PROJECT NO. 13-0054.01**

**1.0 INTRODUCTION**

**1.1 Introduction and Purpose**

Delta-Simons Environmental Consultants Ltd (Delta-Simons) was instructed by Able (UK) Ltd to conduct an intrusive Geo-Environmental Site Investigation on a parcel of arable farmland located at Cherry Cobb Sands, East Yorkshire (hereafter referred to as the "Site"). The purpose of the Geo-Environmental Ground Investigation is to determine the ground and groundwater conditions at the Site to assist Able (UK) Ltd in the geo-environmental appraisal of the Site in the context of the proposed redevelopment of the Site as a compensatory nature reserve.

**1.2 Scope of Works**

The scope of works undertaken as part of the Geo-Environmental Site Investigation was as follows:

- △ Undertake the advancement of 8no. boreholes to a maximum depth of 5.45 metres below ground level (m bgl);
- △ Undertake the advancement of 15no machine-excavated trial pits to a maximum depth of 3.10 m bgl;
- △ Undertake both constant head and failing head permeability testing in the exploratory holes as scheduled by the Client;
- △ Undertake geotechnical and environmental laboratory analysis as scheduled by the Client; and
- △ Present the factual findings of the investigation in a Factual Geo-Environmental Report.

## **2.0 BACKGROUND**

### **2.1 Site Location and Description**

The Site is located approximately 5 km east of the village of Thorngumbald in the East Riding of Yorkshire, and approximately 250 m north of the River Humber as shown on Figure 1. The Site is part of a wider proposed wildlife compensation scheme. The Site is currently in use as arable farmland. It is understood that Able (UK) Ltd wish to assess the viability of the Site as wetland habitat for birds.

### **3.0 SITE INVESTIGATION**

Exploratory hole locations were determined by the Client, to provide representative coverage of the Site.

#### **3.1 Boreholes**

Eight boreholes (BH 101 to BH 108), were advanced using a Commachio track mounted rotary-percussive drilling rig to a maximum depth of 5.45 m bgl, between the 19<sup>th</sup> and 21<sup>st</sup> March 2013 under the supervision of Delta-Simons. Standard penetration tests were carried out at intervals of approximately 1.00 m in all materials encountered, while bulk and undisturbed samples were recovered from throughout the boreholes at regular intervals.

The locations of the boreholes are shown on Figure 2 and logs are provided as Appendix I.

#### **3.2 Trial Pits**

Fifteen trial pits (TP 1 to TP 2), were advanced using a track mounted excavator to a maximum depth of 3.10 m bgl on the 11<sup>th</sup> April 2013 under the supervision of Delta-Simons with bulk and undisturbed samples were recovered from throughout the boreholes at regular intervals.

The locations of the trial-pits are shown on Figure 2 and logs are provided as Appendix I.

#### **3.3 Soil Sampling**

Soil samples were recovered from the boreholes at selected intervals for geotechnical, geo-chemical and environmental analysis. Samples were stored and transported in appropriate containers to maintain suitable temperatures and moisture contents, and to avoid cross-contamination or other degradation of sample quality.

#### **3.4 Laboratory Analysis**

The location, depth and suite of analysis selected for each soil sample and location is detailed on the laboratory analysis certificates. The geotechnical analytical results are included in Appendix II and the environmental analytical results are included in Appendix III.

### **3.4 In-situ Testing**

In-situ constant head tests in the boreholes and falling head tests (soakaways) in the trial pits were undertaken in accordance with the Client's requirements. The results are included in Appendix IV.



#### **4.0 OBSERVED GROUND CONDITIONS**

Full details of the ground conditions encountered during the investigation are shown on the borehole logs in Appendix I.

#### **4.1 Ground Conditions**

A summary of the identified ground conditions at the Site is provided in Table 1 below:

**Table 1 – Summary of Ground Conditions Encountered**

<b>Typical Description</b>	<b>Identified Thickness (m bgl)</b>
MADE GROUND Topsoil	0.20 – 1.20
MADE GROUND comprising brown silty sandy clay (possible reworked natural materials).	1.20 – 2.10
Clayey SAND and silty sandy CLAY	1.20 – 5.00 (base unproven)


## **5.0 LIMITATIONS TO GEOTECHNICAL INVESTIGATIONS**

Delta-Simons obtained, reviewed and evaluated information from Able (UK) Ltd, Chemtech Environmental Limited, Professional Soils Limited and others. Delta-Simons' conclusions, opinions and recommendations are based on this information, on observations made during the Site reconnaissance, on ground conditions encountered during the site work, and on the results of laboratory and field tests performed during the investigation. However, there may be conditions at the Site that have not been taken into account, such as unpredictable soil strata and water conditions between or below intrusive locations. It should also be noted that groundwater levels vary due to seasonal and or tidal, or other effects and may at times differ to those measured during the investigation.

The observations contained in this Report represent our findings within the limitations of agreed scope of works. These observations were arrived at in accordance with currently accepted industry best practices, and, as such, are not a guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

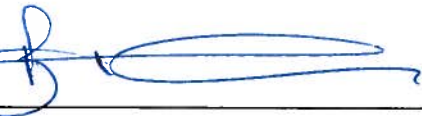
Delta-Simons Environmental Consultants Limited prepared this Report for our Client. Any third parties using this Report do so entirely at their own risk. Delta-Simons makes no warranty or representation whatsoever, express or implied, with respect to the use by a third party of any information contained in this Report or its suitability for any purpose. Delta-Simons assumes no responsibility for any costs, claims, damages or expenses (including any consequential damages) resulting from the use of this Report or any information contained in this Report by a third party.

This Report was prepared by:

PP   
\_\_\_\_\_  
Kathryne Bradley  
**Environmental Scientist**

15/07/2013  
\_\_\_\_\_  
Date

This Report was reviewed by:

PP   
\_\_\_\_\_  
Kevin McGee  
**Geo-Environmental Consultant**

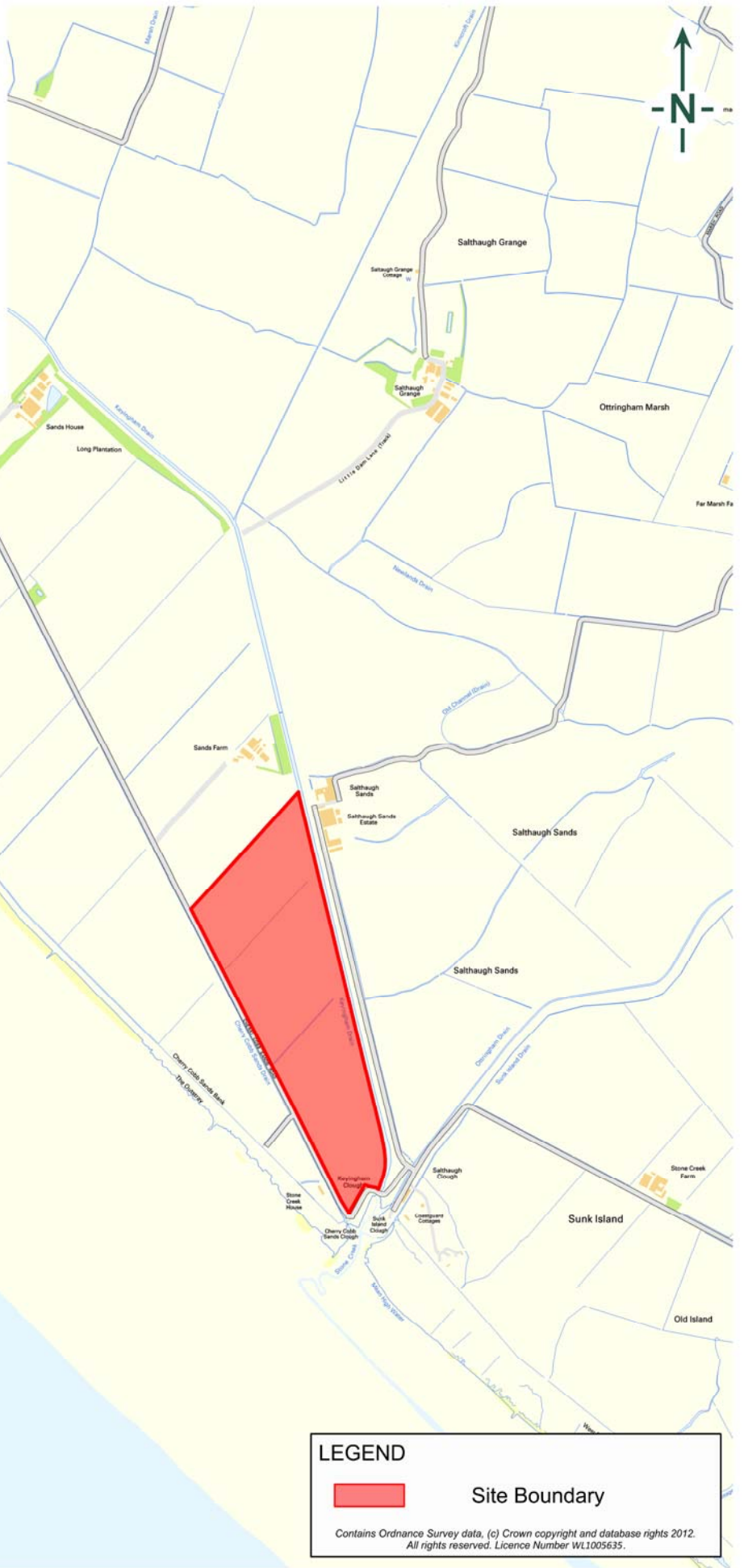
15/07/2013  
\_\_\_\_\_  
Date

This Report was authorised by:

  
\_\_\_\_\_  
Paul Bennett  
**Unit Manager - Regions**

15/7/13  
\_\_\_\_\_  
Date

# Figures



**LEGEND**

Site Boundary

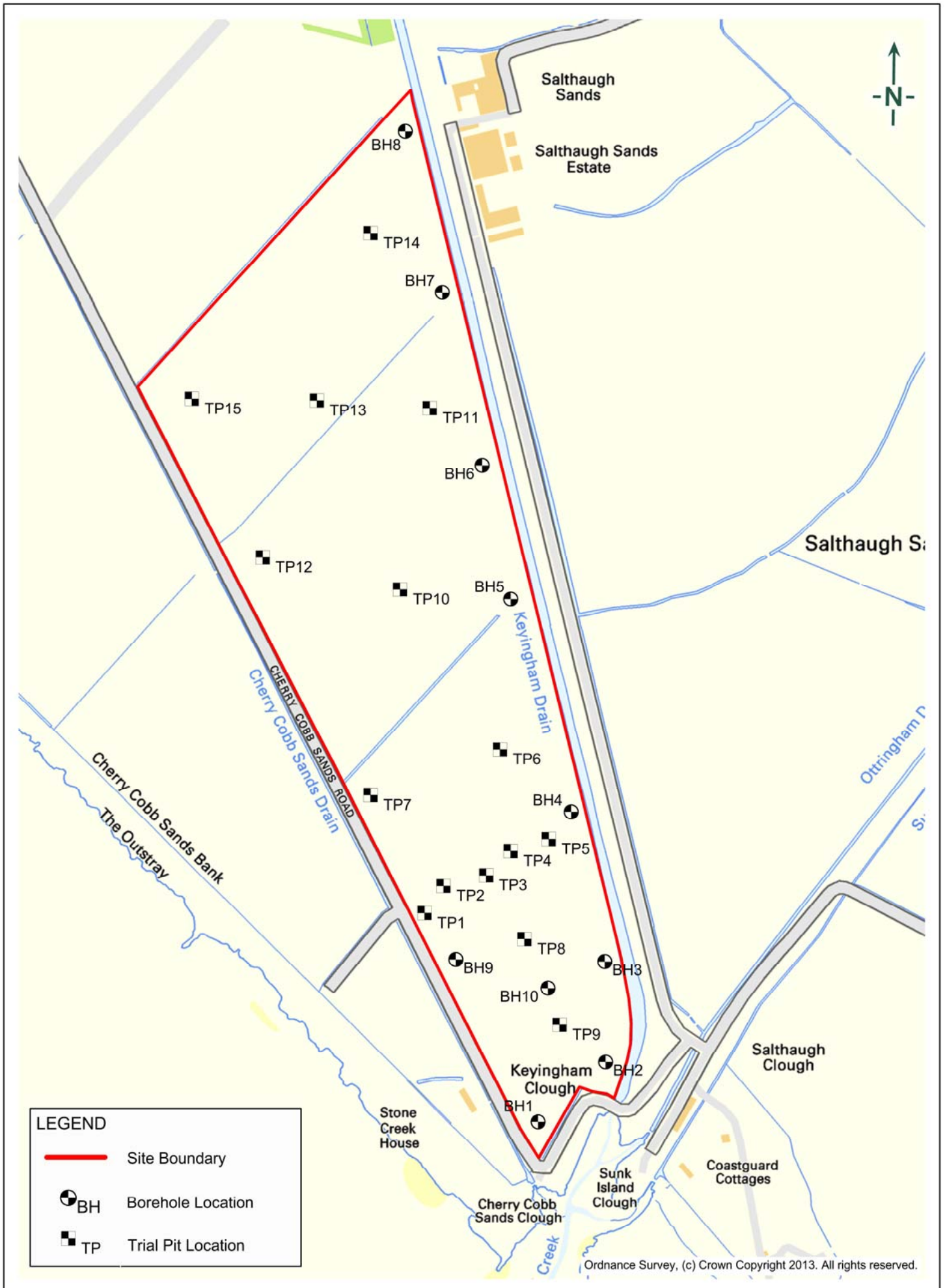
Contains Ordnance Survey data, (c) Crown copyright and database rights 2012. All rights reserved. Licence Number W11005635.

Scale: 1 / 20,000 @ A4



TITLE:  
Site Location Plan  
Cherry Cobb Sands  
Hull

DWN: DE	SCA: To Scale@A4	PROJECT NO.: 10-2041.02
CHK: KDM	REV: 1	FIGURE NO.: 1
DATE: 14 April 2013		



**LEGEND**

- Site Boundary
- BH Borehole Location
- TP Trial Pit Location

Ordnance Survey, (c) Crown Copyright 2013. All rights reserved.



TITLE:  
**Approximate Intrusive Location Plan**  
**Cherry Cobb Sands**  
**Hull**

DWN: DE	SCA: Not To Scale
CHK: KB	APP: -
DATE: 14 April 2013	REV: 1

PROJECT NO: <b>10-2041.02</b>
FIGURE NO.: <b>2</b>

# Appendix I

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project: <b>Cherry Cobb Sands Wet Grassland</b>	Project No: <b>13-0054.01</b>	Hole ID: <b>BH101</b>
	Date: 19/03/2013	Client: <b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details				
					TYPE	REF	Depth	SPT N Value/Drive mm					
Brown sandy silty CLAY.				(1.40)	BES	1	0.00 - 1.00	SPT N=0 1,1/0,0,0,0					
					ES	2	0.10 0.30						
					ES	3	0.50						
					B SPTLS D	4	1.00 - 2.00 1.00 - 1.45 1.00 1.00 - 1.45						
Very soft black/brown sandy silty CLAY.													
					B D	5	2.00 - 3.00 2.00 2.00 - 2.45			SPT N=0 0,0/0,0,0,0			
					B SPTLS D	6	3.00 - 4.00 3.00 - 3.45 3.00 3.00 - 3.45			SPT N=3 1,1/1,1,1,0			
					SPTLS D	7	4.00 - 4.45 4.00 4.00 - 4.45			SPT N=11 1,1/1,2,4,4			
Brown slightly clayey SAND.													
				5.00	SPTLS D	8	5.00 - 5.45 5.00 5.00 - 5.45	SPT N=10 2,2/2,4,4,0					
Borehole complete at 5.45m bgl.				5.45									

**REMARKS :**

1. Logs are drillers records.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523367.427 N: 419202.637	Logged By: SW	Checked By:	Approved By:



**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wet Grassland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>BH102</b>
		Date:	19/03/2013	Client:	<b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy silty CLAY.					BES	1	0.00	SPT N=6 1,1/1,2,1,2	
					ES	2	0.10		
					ES	3	0.30		
					SPTLS D	4	1.00 - 1.45 1.00		
Very soft black/brown silty CLAY.				(3.00)	SPTLS D	5	2.00 - 2.45 2.00	SPT N=4 1,1/1,1,1,1	
					SPTLS D	6	3.00 - 3.45 3.00	SPT N=0 0,0/0,0,0,0	
					SPTLS D	7	4.00 - 4.45 4.00	SPT N=17 0,0/1,4,6,6	
Light brown SAND.				(0.85)	SPTLS D	8	5.00 - 5.45 5.00	SPT N=22 1,2/4,6,6,6	
Borehole complete at 5.45m bgl.									

**REMARKS :**

1. Logs are drillers records.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523526.085 N: 419147.452	Logged By: SW	Checked By:	Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project: <b>Cherry Cobb Sands Wet Grassland</b>	Project No: <b>13-0054.01</b>	Hole ID: <b>BH103</b>
	Date: 19/03/2013	Client: <b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy CLAY.					BES	1	0.00 - 1.00	SPT N=13 1,2/2,3,4,4	
					ES	2	0.10 0.30		
					ES	3	0.50		
					B SPTLS D	4	1.00 - 2.00 1.00 - 1.45 1.00 1.00 - 1.45		
Very soft black/brown silty CLAY.				2.80	B SPTLS D	5	2.00 - 3.00 2.00 - 2.45 2.00 2.00 - 2.45	SPT N=11 2,2/3,3,3,2	
					SPTLS D	6	3.00 - 3.45 3.00 3.00 - 3.45		
					SPTLS D	7	4.00 - 4.45 4.00 4.00 - 4.45		
					SPTLS D	8	5.00 - 5.45 5.00 5.00 - 5.45		
Borehole complete at 5.45m bgl.				5.45					

**REMARKS :**

1. Logs are drillers records.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523611.12 N: 419188.462	Logged By: SW	Checked By:	Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project: <b>Cherry Cobb Sands Wet Grassland</b>	Project No: <b>13-0054.01</b>	Hole ID: <b>BH104</b>
	Date: 19/03/2013	Client: <b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy silty CLAY.					ES	1	0.10		
					ES	2	0.30		
					ES	3	0.50		
					SPTLS D	4	1.00 - 1.45 1.00 1.00 - 1.45		
Brown wet SAND.					SPTLS D	5	2.00 - 2.45 2.00 2.00 - 2.45	SPT N=11 2,2/3,3,3,2	
					D	6	3.00 3.00 - 3.45	SPT N=0 0,0/0,0,0,0	
Soft black/brown silty CLAY.					D	7	4.00 4.00 - 4.45	SPT N=4 1,1/1,1,1,1	
Light brown SAND.					SPTLS D	8	5.00 - 5.45 5.00 5.00 - 5.45	SPT N=13 1,1/2,3,4,4	
Borehole complete at 5.45m bgl.									

**REMARKS :**

1. Logs are drillers records.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523524.54 N: 418904.98	Logged By: SW	Checked By:	Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project: <b>Cherry Cobb Sands Wet Grassland</b>	Project No: <b>13-0054.01</b>	Hole ID: <b>BH105</b>
	Date: 20/03/2013	Client: <b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy CLAY with occasional bands of sand.				(1.20)	B ES ES ES	1 2 3	0.00 - 1.00 0.10 0.30 0.50	SPT N=7 1,2/2,1,2,2	
Brown slightly clayey SAND.				(0.70)	B SPTLS D	4	1.00 - 2.00 1.00 - 1.45 1.00 1.00 - 1.45		
Brown damp SAND.				(1.90)	B SPTLS D	5	2.00 - 3.00 2.00 - 2.45 2.00 2.00 - 2.45	SPT N=11 1,1/2,3,3,3	
Black/brown silty SAND.				(1.90)	B SPTLS D	6	3.00 - 4.00 3.00 - 3.45 3.00 3.00 - 3.45	SPT N=0 0,0/0,0,0,0	
Borehole complete at 5.45m bgl.				(1.65)	D	7	4.00 4.00 - 4.45  5.00 - 5.45	SPT N=4 1,1/1,1,1,1  SPT N=10 3,3/3,2,3,2	

**REMARKS :**

1. Logs are drillers records.
  2. Borehole remained dry on completion.
  3. Backfilled with arisings.
- No recovery  
No recovery

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available	Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523624.919 N: 419016.397	Logged By: SW	Checked By: Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wet Grassland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>BH106</b>
		Date:	20/03/2013	Client:	<b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy CLAY.					B ES	1	0.00 - 1.00	SPT N=13 1,1/2,3,3,5	
					ES	2	0.10 0.30		
					ES	3	0.50		
				(2.10)	B SPTLS D	4	1.00 - 2.00 1.00 - 1.45 1.00 1.00 - 1.45		
Brown SAND.					B SPTLS D	5	2.00 - 3.00 2.00 - 2.45 2.00 2.00 - 2.45	SPT N=14 1,2/3,4,4,3	
				(1.70)	B SPTLS D	6	3.00 - 4.00 3.00 - 3.45 3.00 3.00 - 3.45	SPT N=11 2,2/2,3,3,3	
				3.80					
Dark brown/black silty SAND.					B D	7	4.00 - 5.00 4.00 4.00 - 4.45	SPT N=7 0,1/1,2,2,2	
				(1.65)					
					SPTLS D	8	5.00 - 5.45 5.00 5.00 - 5.45	SPT N=13 1,1/2,3,3,5	
				5.45					
Borehole complete at 5.45m bgl.									

**REMARKS :**

1. Logs are drillers records.
  2. Borehole remained dry on completion.
  3. Backfilled with arisings.
- No recovery

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523560.138 N: 419412.94	Logged By: SW	Checked By:	Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project: <b>Cherry Cobb Sands Wet Grassland</b>	Project No: <b>13-0054.01</b>	Hole ID: <b>BH107</b>
	Date: 20/03/2013	Client: <b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy CLAY.				(2.60)	BES	1	0.00 - 1.00	SPT N=8 1,2/2,2,2,2	
					ES	2	0.10 0.30		
					ES	3	0.50		
					B SPTLS D	4	1.00 - 2.00 1.00 - 1.45 1.00 1.00 - 1.45		
					B SPTLS D	5	2.00 - 3.00 2.00 - 2.45 2.00 2.00 - 2.45		
Light brown damp SAND.				(1.30)	B SPTLS D	6	3.00 - 4.00 3.00 - 3.45 3.00 3.00 - 3.45	SPT N=13 1,2/3,4,3,3	
Grey silty SAND.				(1.55)	B SPTLS D	7	4.00 - 5.00 4.00 - 4.45 4.00 4.00 - 4.45	SPT N=15 2,3/3,3,4,5	
					B SPTLS D	8	5.00 - 5.45 5.00 5.00 - 5.45		
Borehole complete at 5.45m bgl.									

**REMARKS :**

1. Logs are drillers records.
  2. Borehole remained dry on completion.
  3. Backfilled with arisings..
- Hole collapsed, driven 50mm before test

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523505.684 N: 419617.558	Logged By: SW	Checked By:	Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wet Grassland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>BH108</b>
		Date:	20/03/2013	Client:	<b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth		
Brown sandy CLAY.				(0.30)	B ES	1	0.00 - 1.00	SPT N=9 1,1/2,2,2,3	
Fine brown SAND.				0.30	ES	2	0.10 0.30		
Brown sandy CLAY.				(0.40)	ES	3	0.50		
Light brown SAND.				0.70					
				(0.30)	B SPTLS D	4	1.00 - 2.00 1.00 - 1.45 1.00 1.00 - 1.45		
				1.00	B SPTLS D	5	2.00 - 3.00 2.00 - 2.45 2.00 2.00 - 2.45		
				(2.90)	B SPTLS D	6	3.00 - 4.00 3.00 - 3.45 3.00 3.00 - 3.45		
				3.90	B D	7	4.00 - 5.00 4.00 4.00 - 4.45		
Grey/brown silty SAND.				(1.55)	B D	8	5.00 - 5.45 5.00 5.00 - 5.45	SPT N=21 2,3/5,5,5,6	
Borehole complete at 5.45m bgl.				5.45					

**REMARKS :**

1. Logs are drillers records.
  2. Borehole remained dry on completion.
  3. Backfilled with arisings.
- No recovery

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523462.139 N: 419795.287	Logged By: SW	Checked By:	Approved By:

**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wet Grassland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>BH109</b>
		Date:	21/03/2013	Client:	<b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy CLAY.					ES	1	0.10		
					ES	2	0.30		
					ES	3	0.50		
			(1.90)	SPTLS D	4	1.00 - 1.45 1.00	1.00 - 1.45	SPT N=4 1,1/1,1,1,1	
			1.90	SPTLS D	5	2.00 - 2.45 2.00	2.00 - 2.45	SPT N=0 0,0/0,0,0,0	
Very soft grey/black silty CLAY.			(1.10)	SPTLS D	6	3.00 - 3.45 3.00	3.00 - 3.45	SPT N=0 1,0/0,0,0,0	
Grey/brown sandy CLAY.			(2.45)	SPTLS D	7	4.00 - 4.45 4.00	4.00 - 4.45	SPT N=0 0,0/0,0,0,0	
			5.45	SPTLS D	8	5.00 - 5.45 5.00	5.00 - 5.45	SPT N=2 1,0/0,1,1,0	
Borehole complete at 5.45m bgl.									

**REMARKS :**

1. Logs are drillers records.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:37.47	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523408.588 N: 420008.061	Logged By: SW	Checked By:	Approved By:



**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project: <b>Cherry Cobb Sands Wet Grassland</b>	Project No: <b>13-0054.01</b>	Hole ID: <b>BH110</b>
	Date: 21/03/2013	Client: <b>Able UK</b>

DESCRIPTION OF STRATA	LEGEND	WATER	CASING DEPTH / (Diam. mm)	DEPTH (Thickness)	Sample Details			Test Results	Backfill Details
					TYPE	REF	Depth	SPT N Value/Drive mm	
Brown sandy CLAY.				(1.60)	B ES ES ES	1 23 3	0.00 - 1.00 0.10 0.30 0.50	SPT N=5 1,1/1,2,1,1	
Very soft wet grey/black silty CLAY.				1.60	B D	4	1.00 - 2.00 1.00 1.00 - 1.45		
Grey/brown SAND.				(1.20)	B D	5	2.00 - 3.00 2.00		
				2.80	B D	6	3.00 - 4.00 3.00		
				(2.20)	B D	7	4.00 - 5.00 4.00		
Borehole complete at 5m bgl.				5.00	D	8	5.00		

**REMARKS :**

1. Logs are drillers records.
  2. Borehole remained dry on completion.
  3. Backfilled with arisings.
- No recovery

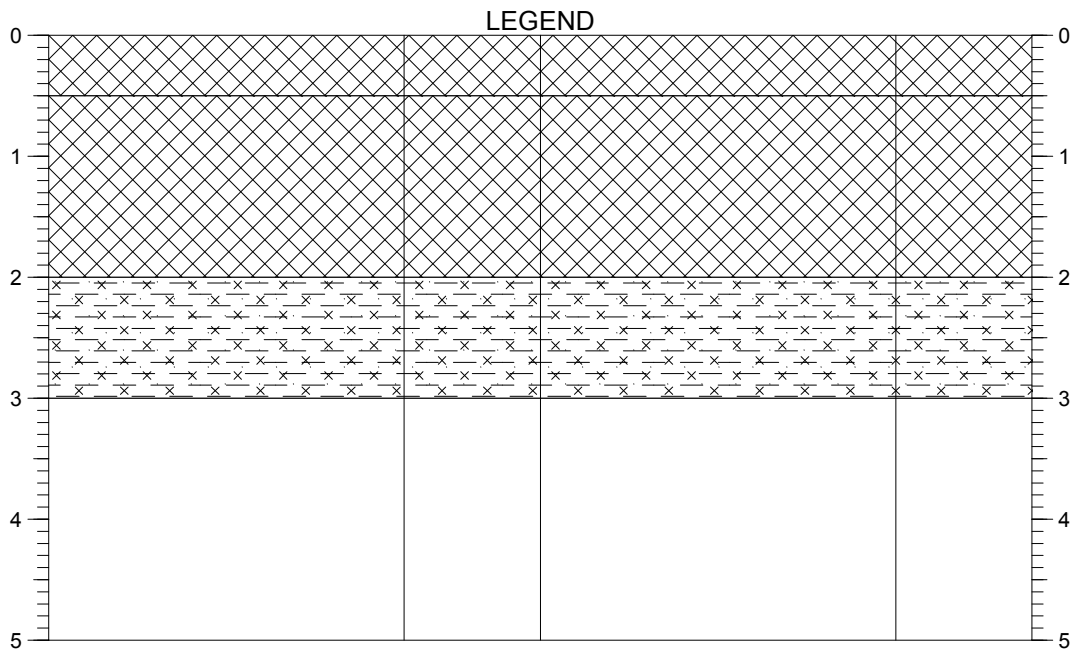
CHISELLING			WATER LEVEL OBSERVATIONS				
Depth From	Depth To	Time Taken	Date	Time	Water Strike	Standing Level	Casing Depth
NO CHISELLING UNDERTAKEN:			NO WATER ENCOUNTERED:				
BOREHOLE DIAMETER			CASING DIAMETER		DEPTH SEALED		

All measurements in metres unless otherwise stated	10m/page Scale: 1:34.38	Coordinates to National Grid No Datum Information Available		Page 1 of 1
Plant Used: Commachio205	Coordinates / Level (mAOD): E: 523351.084 N: 420254.885	Logged By: SW	Checked By:	Approved By:

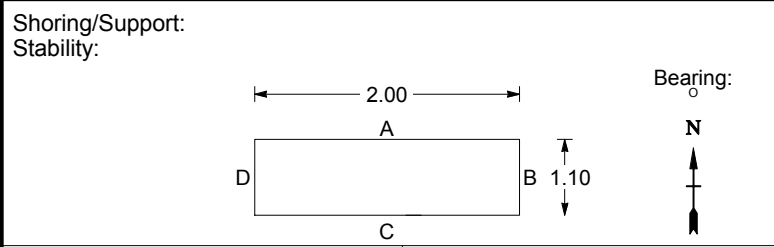
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP1</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
(0.50)	0.50	MADE GROUND: Brown gravelly sandy clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	D		
			0.20	j		
(1.50)		MADE GROUND: Brown/yellow clayey sand.	0.50-2.00	B		
			1.00	j		
(1.00)		Black, clayey, silty SAND.	2.00-3.00	B		
			2.50	j		
		Borehole complete at 3.00m bgl.				



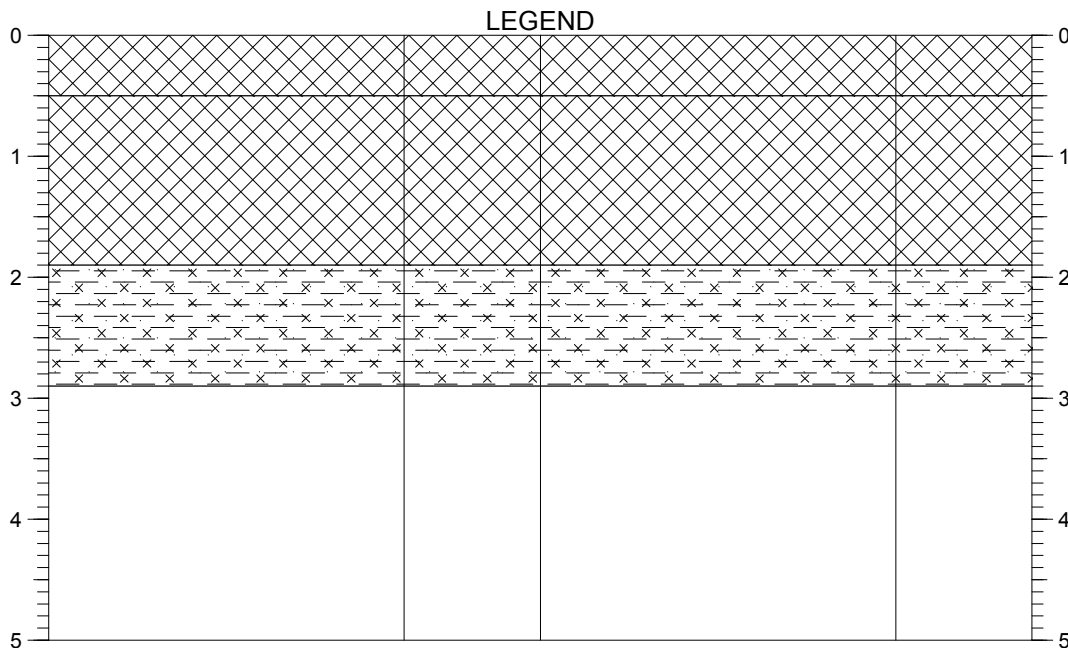
**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523360.672 N: 419221.348	Logged By: KB	Checked By: KDM	Approved By:	

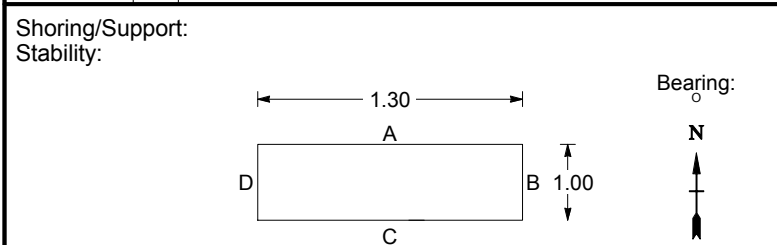
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP10</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
(0.50)	0.50	MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.40)	1.90	MADE GROUND: Brown/yellow clayey sand.	0.50-1.90	B D		
(1.00)	2.90	Black clayey, silty SAND.	1.90-2.90	B D		
Borehole complete at 2.90m bgl.						



**REMARKS :**

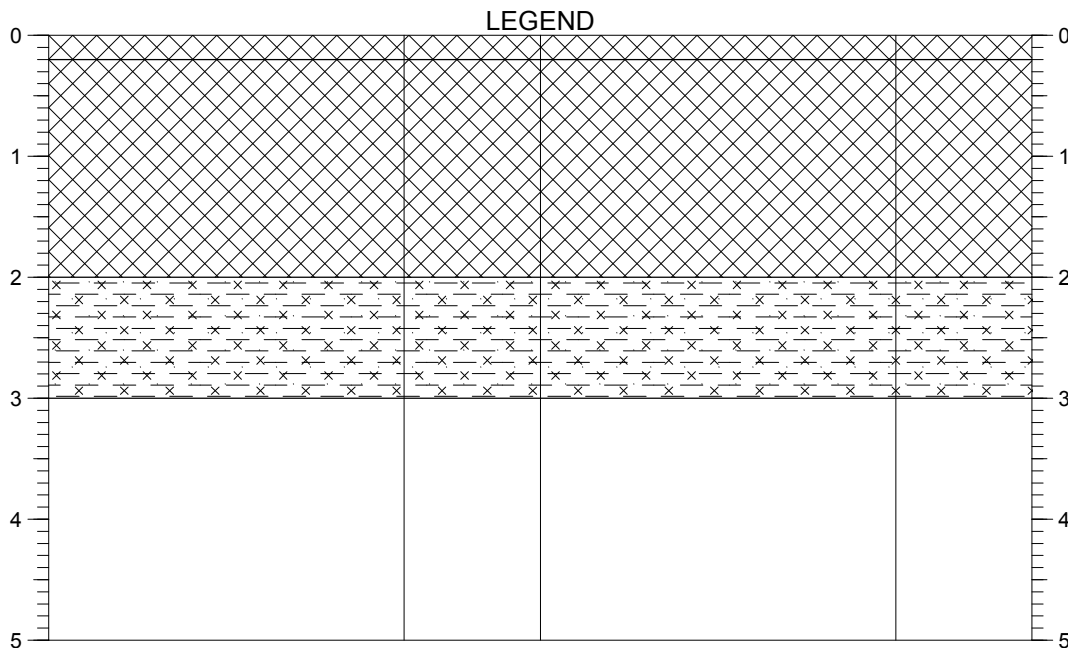
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523364.535 N: 419521.329	Logged By: KB	Checked By: KDM	Approved By:	

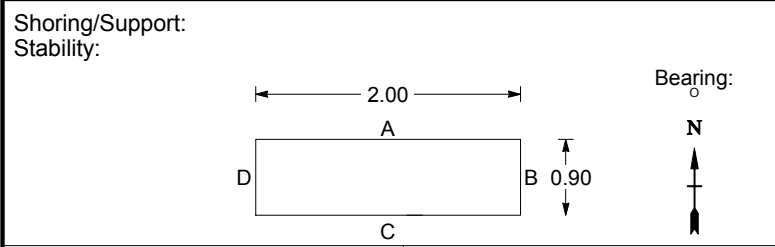
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP11</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.20		MADE GROUND: Brown gravelly, sandy, clayey topsoil. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.80)		MADE GROUND: Brown clayey sand.	0.20-2.00	B		
2.00			0.20	D		
(1.00)		Black clayey, silty SAND.	2.00-3.00	B		
3.00		Borehole complete at 3.00m bgl.	2.00	D		



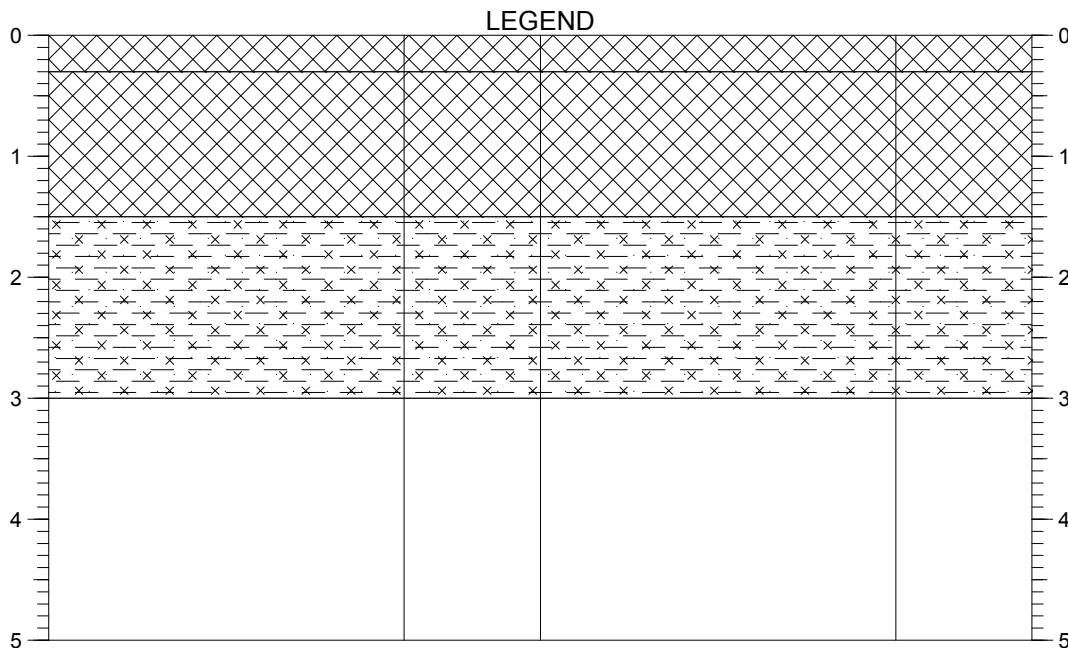
**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523337.177 N: 419775.546	Logged By: KB	Checked By: KDM	Approved By:	

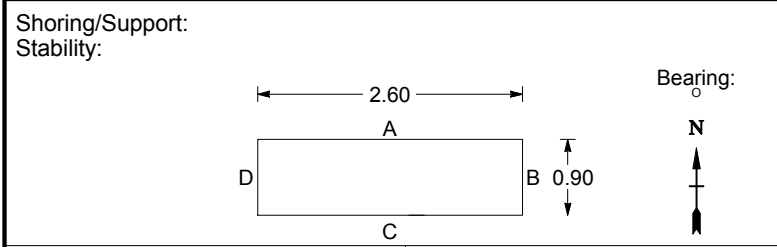
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP12</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.30		MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.20)		MADE GROUND: Brown clayey sand.	0.30-1.50	B		
1.50			0.30	D		
(1.50)		Black clayey, silty SAND.	1.50-3.00	B		
3.00			1.50	D		
		Borehole complete at 3.00m bgl.				



**REMARKS :**

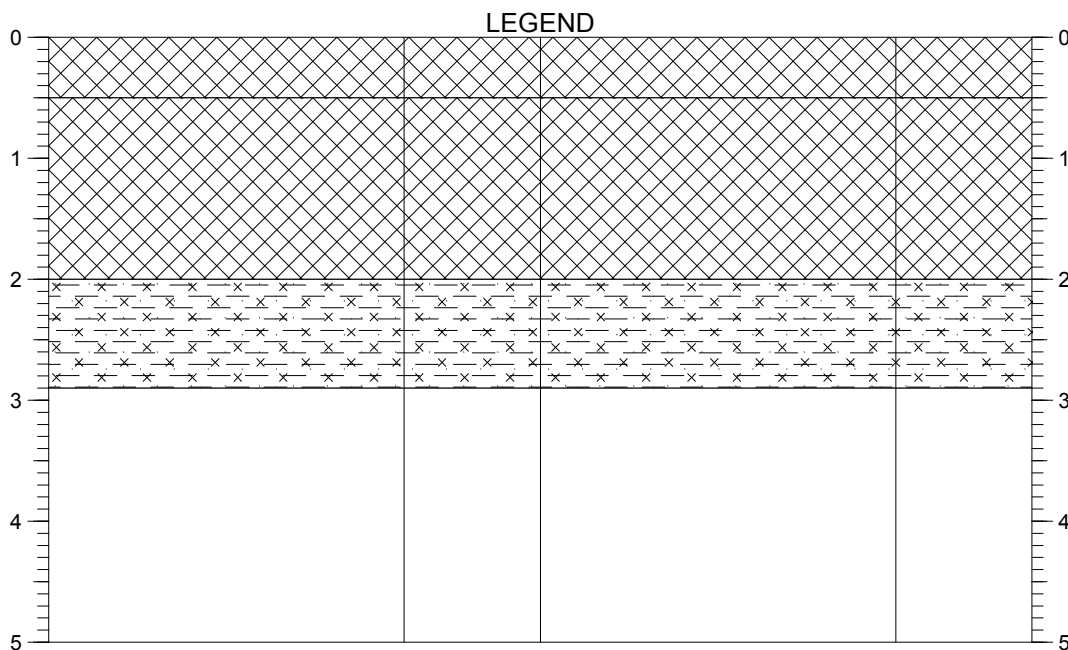
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523210.989 N: 419637.947	Logged By: KB	Checked By: KDM	Approved By:	

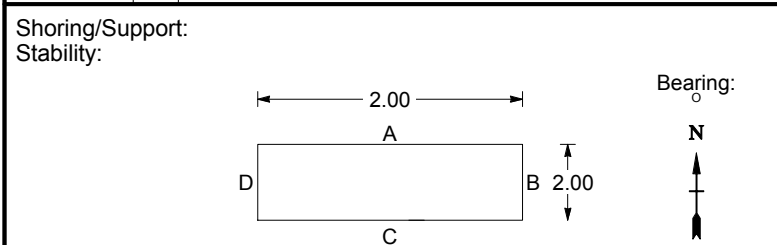
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP13</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
(0.50)	0.50	MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	j		
(1.50)	2.00	MADE GROUND: Brown clayey sand.	0.50-2.00	B D		
(0.90)	2.90	Grey clayey, silty SAND.	2.00-2.90	B D		
Borehole complete at 2.90m bgl.						



**REMARKS :**

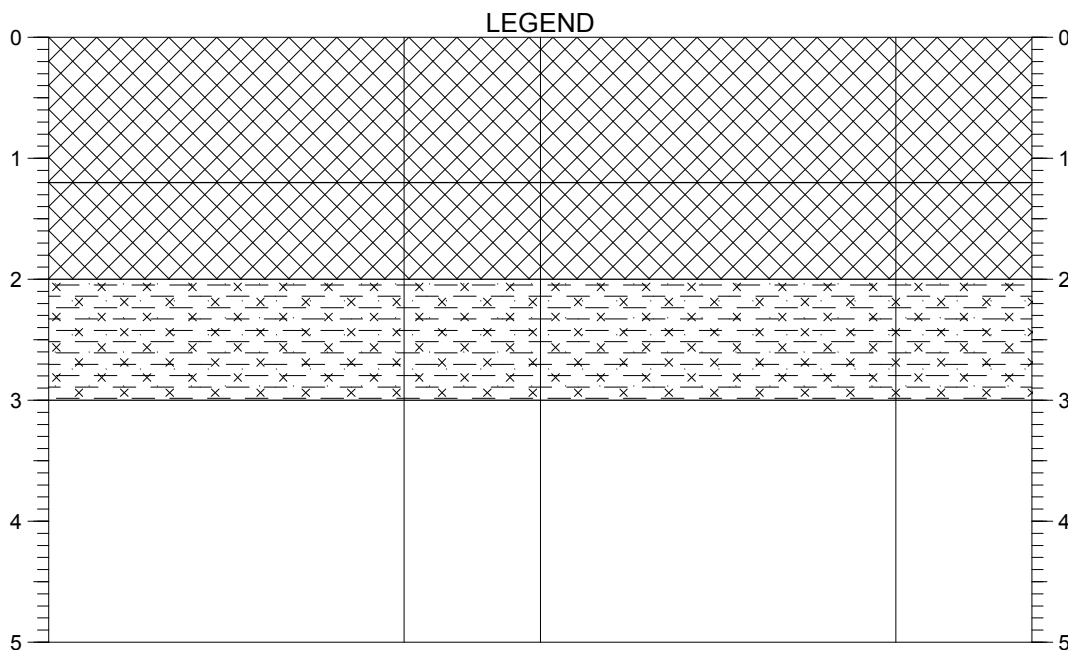
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523240.344 N: 419869.216	Logged By: KB	Checked By: KDM	Approved By:	

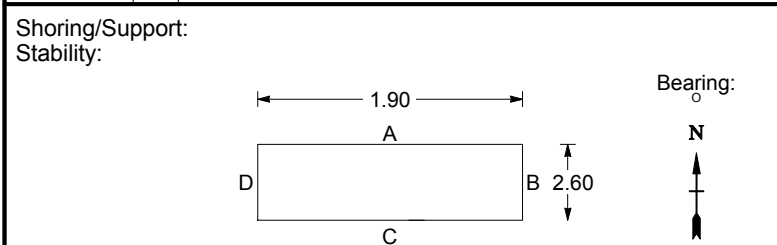
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP14</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
(1.20)		MADE GROUND: Brown gravelly, sandy, clayey topsoil. Gravel is fine to coarse. Sand is fine.	0.00	j		
1.20						
(0.80)		MADE GROUND: Brown/orange clayey sand.	1.20-2.00	B		
2.00			1.20	D		
(1.00)		Black clayey, silty SAND.	2.00-3.00	B		
3.00			2.00	D		
		Borehole complete at 3.00m bgl.				



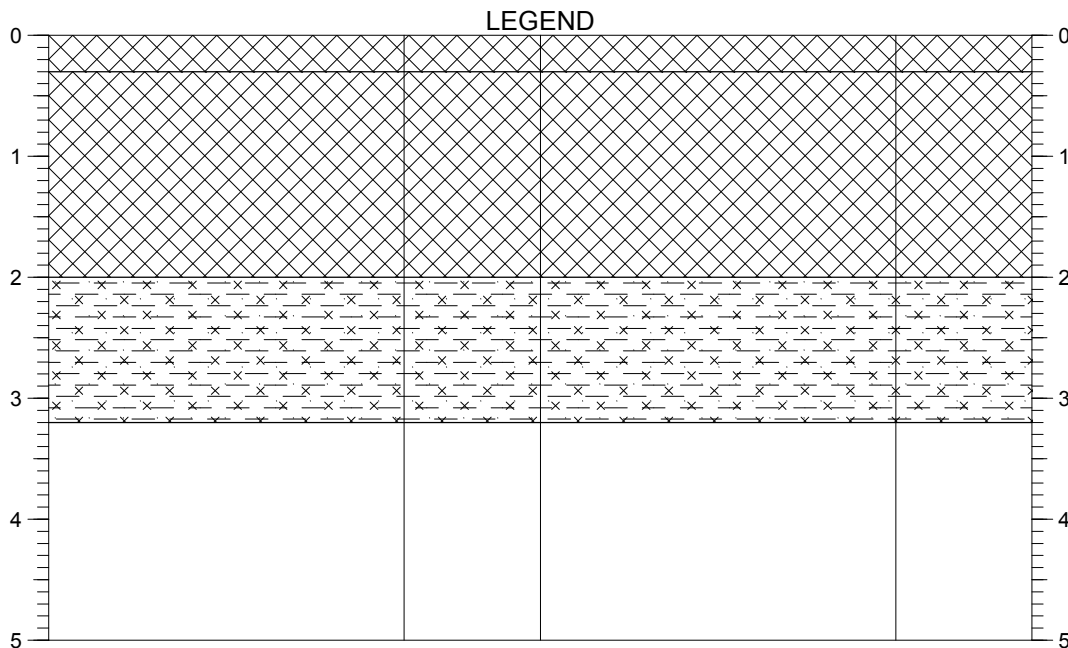
**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523276.424 N: 420085.27	Logged By: KB	Checked By: KDM	Approved By:	

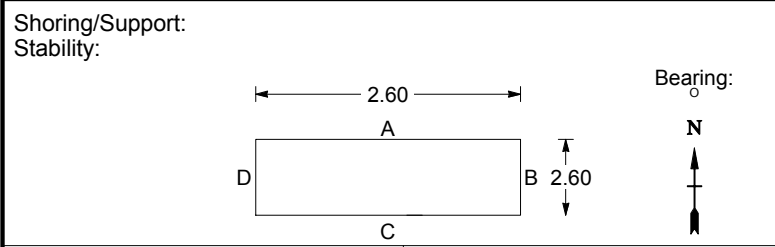
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP15</b>	
<b>TRIAL PIT LOG</b>			Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.30		MAD GROUND: Brown gravelly, sandy, clayey topsoil. Gravel is fine to coarse. Sand is fine.	0.00	j		
(1.70)		MADE GROUND: Brown/orange clayey sand.	0.30-2.00	B		
2.00			0.30	D		
(1.20)		Black/grey clayey, silty SAND.	2.00-3.20	B		
3.20		Borehole complete at 3.20m bgl.	2.00	D		



**REMARKS :**

1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

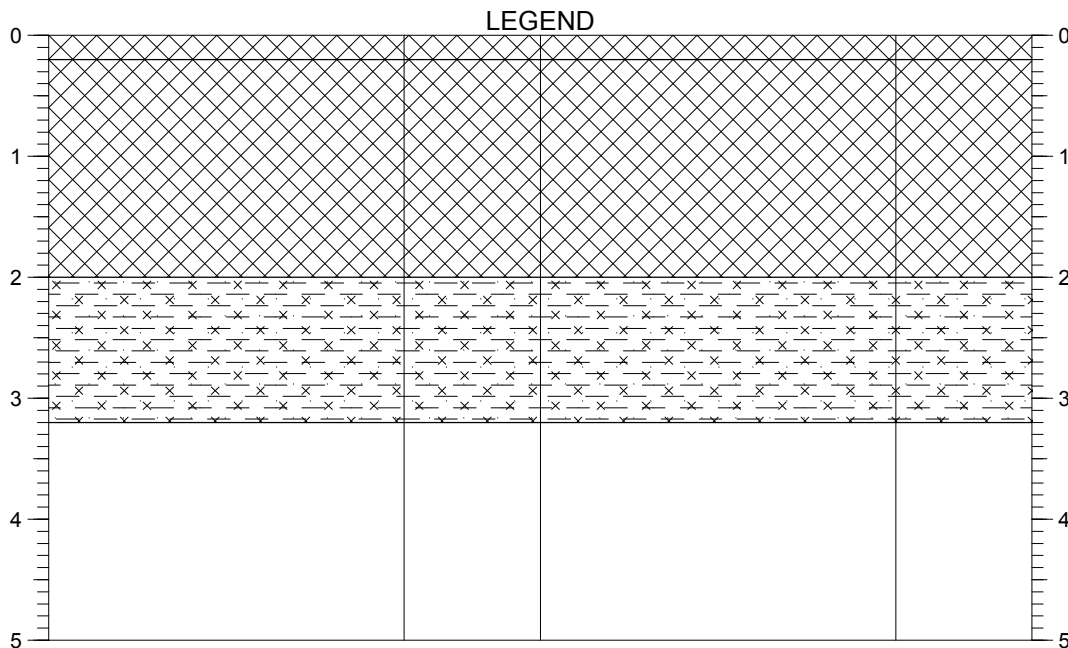
All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523108.129 N: 419903.072	Logged By: KB	Checked By: KDM	Approved By:	



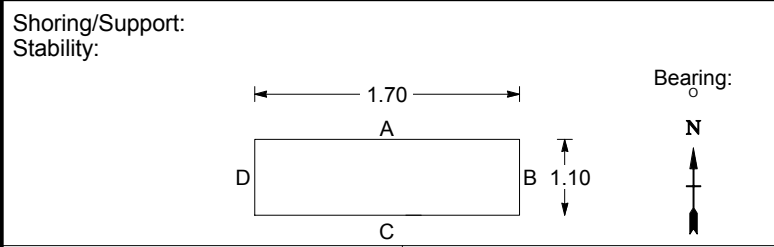
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP2</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.20		MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.20-2.00	B		
(1.80)		MADE GROUND: Brown/yellow clayey SAND.	0.20	D		
			0.20	j		
			1.00	j		
2.00		Black clayey silty SAND.	2.00-3.20	B		
(1.20)			2.00	j		
3.20		Borehole complete at 3.20m bgl.				



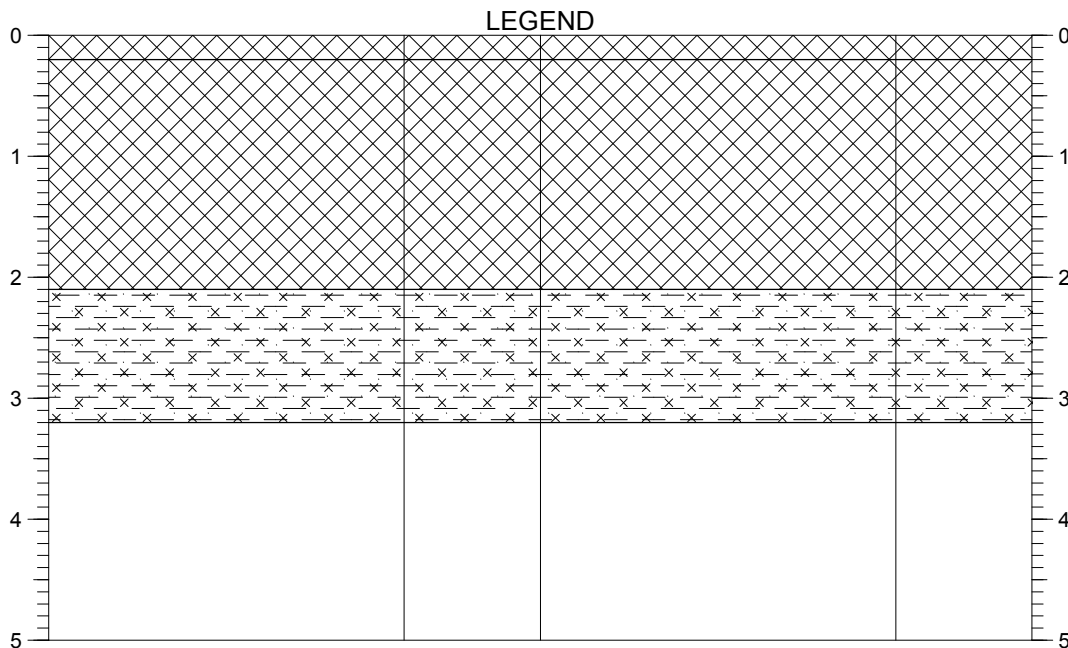
**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523397.447 N: 419254.592	Logged By: KB	Checked By: KDM	Approved By:	

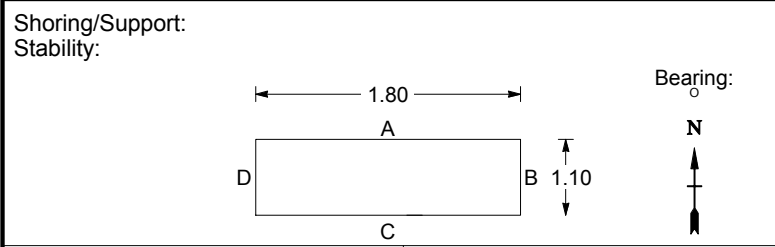
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP3</b>	
<b>TRIAL PIT LOG</b>			Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.20		MADE GROUND: Brown gravelly, sandy, clayey topsoil. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.90)		MADE GROUND: Brown/yellow clayey sand.	0.20-2.00	B		
			0.20	D		
2.10		Black clayey, silty SAND.	2.10-3.20	B		
(1.10)			2.10	D		
3.20		Borehole complete at 3.20m bgl.				



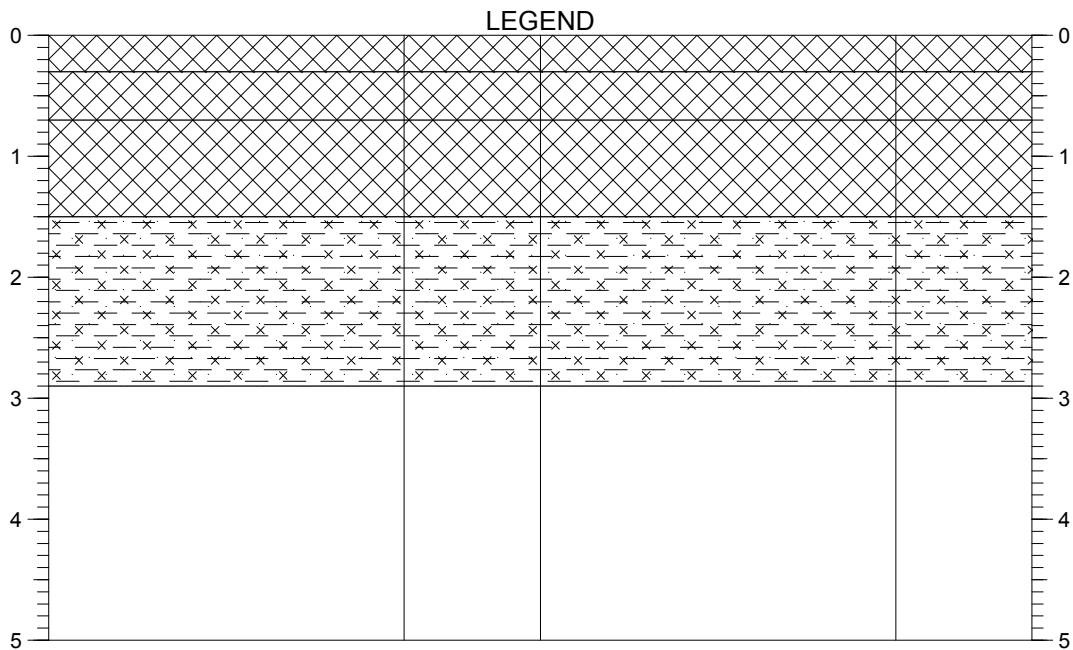
**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523441.472 N: 419300.107	Logged By: KB	Checked By: KDM	Approved By:	

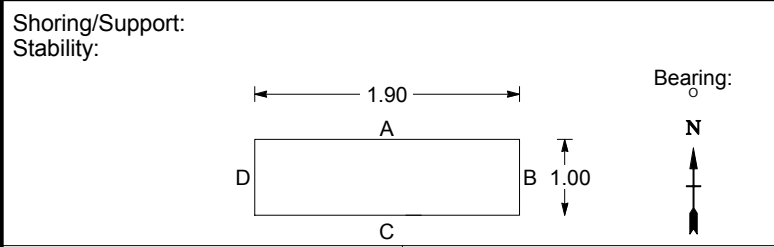
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP4</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.30		MADE GROUND: Brown gravelly, sandy, clayey topsoil. Gravel is fine to coarse. Sand is fine.	0.00	D		
0.70		MADE GROUND: Brown/yellow clayey sand.	0.30-0.70	B		
(0.80)		MADE GROUND: Brown clayey sand.	0.30	D		
1.50			0.70-1.50	B		
			0.70	D		
(1.40)		Black clayey, silty SAND.	1.50-2.90	B		
2.90			1.50	D		
		Borehole complete at 2.90m bgl.				



**REMARKS :**

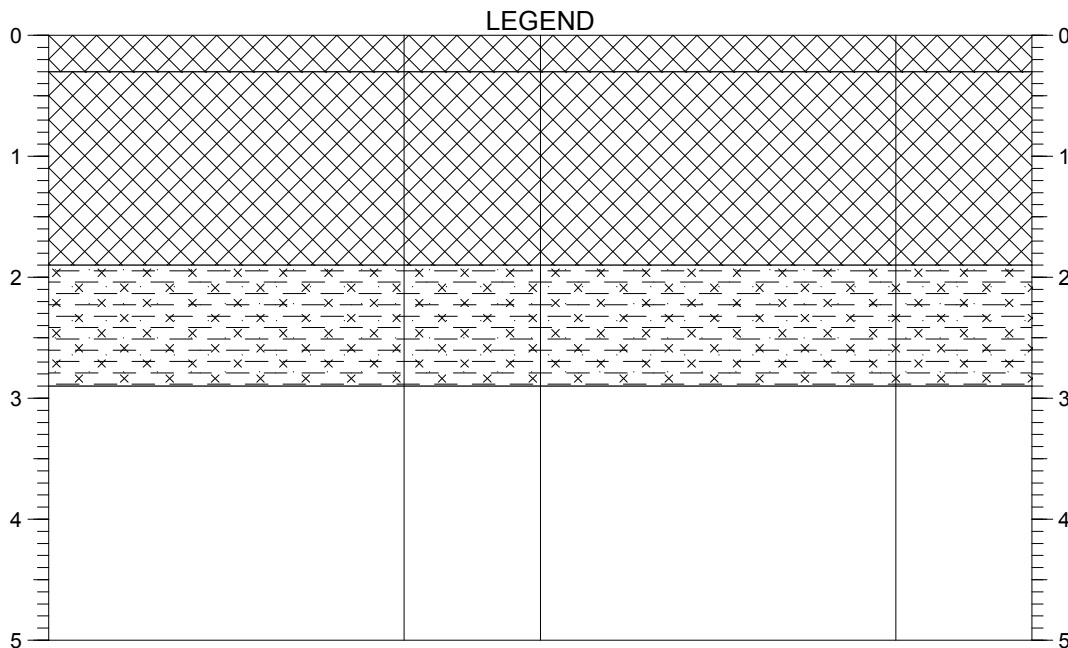
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523474.673 N: 419333.732	Logged By: KB	Checked By: KDM	Approved By:	

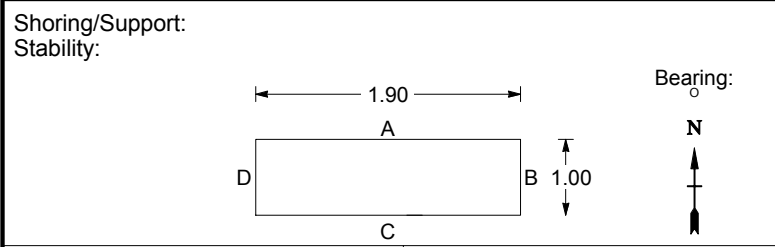
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP5</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.30		MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.20	j		
(1.60)		MADE GROUND: Brown clayey sand.	0.30-1.90	B		
1.90			1.00	j		
(1.00)		Black clayey, silty SAND.	1.90-2.90	B		
2.90			2.50	j		
Borehole complete at 2.90m bgl.						



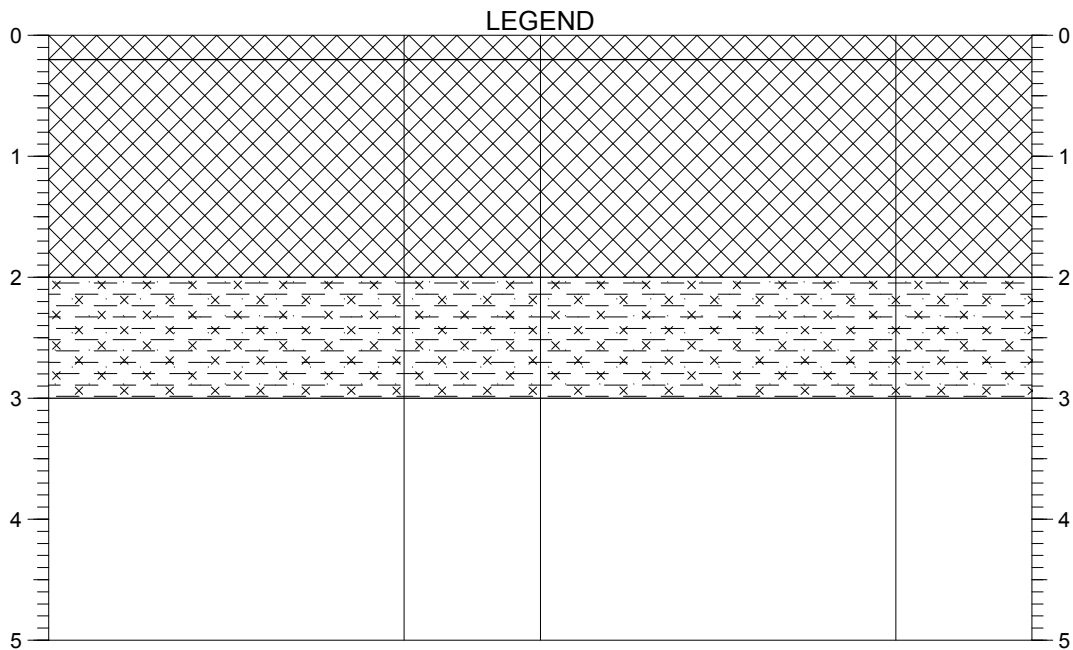
**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Backfilled with arisings.

All measurements in metres unless otherwise stated		5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available	
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523517.098 N: 419381.739	Logged By: KB	Checked By: KDM	Approved By:	

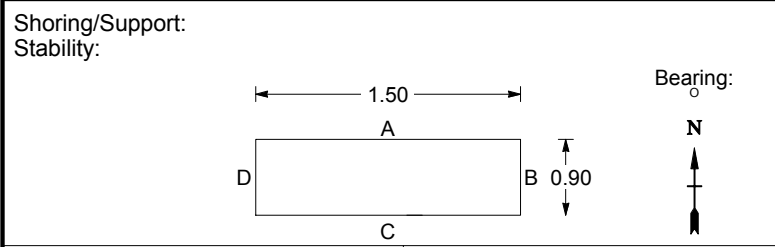
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP6</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.20		MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.80)		MADE GROUND: Brown/yellow clayey sand.	0.20-2.00	B		
			0.20	D		
2.00		Black clayey, silty SAND.	2.00	D		
(1.00)						
3.00		Borehole complete at 3.00m bgl.				



**REMARKS :**

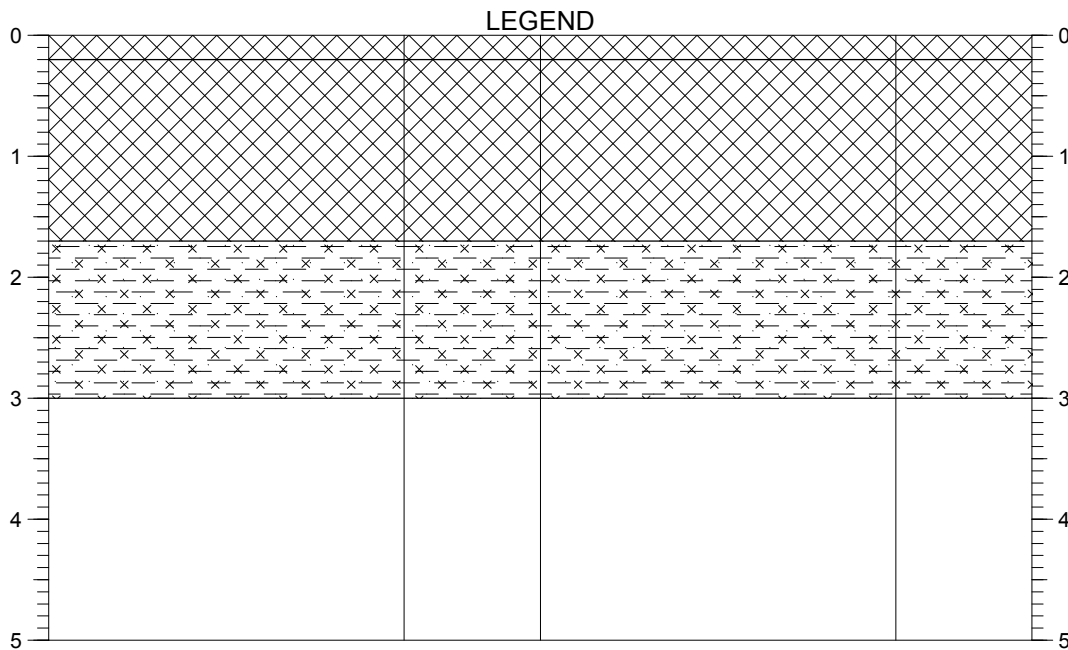
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

All measurements in metres unless otherwise stated		5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available	
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523472.361 N: 419443.344	Logged By: KB	Checked By: KDM	Approved By:	

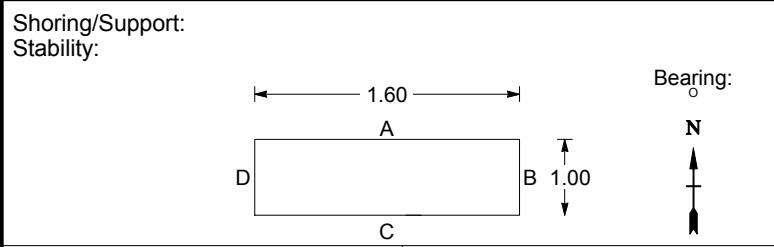
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP7</b>	
<b>TRIAL PIT LOG</b>			Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.20		MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.50)		MADE GROUND: Brown/yellow clayey sand.	0.20-1.70	B		
1.70			0.20	D		
(1.30)		Black clayey, silty SAND.	1.70-3.00	B		
3.00			1.70	D		
		Borehole complete at 3.00m bgl.				



**REMARKS :**

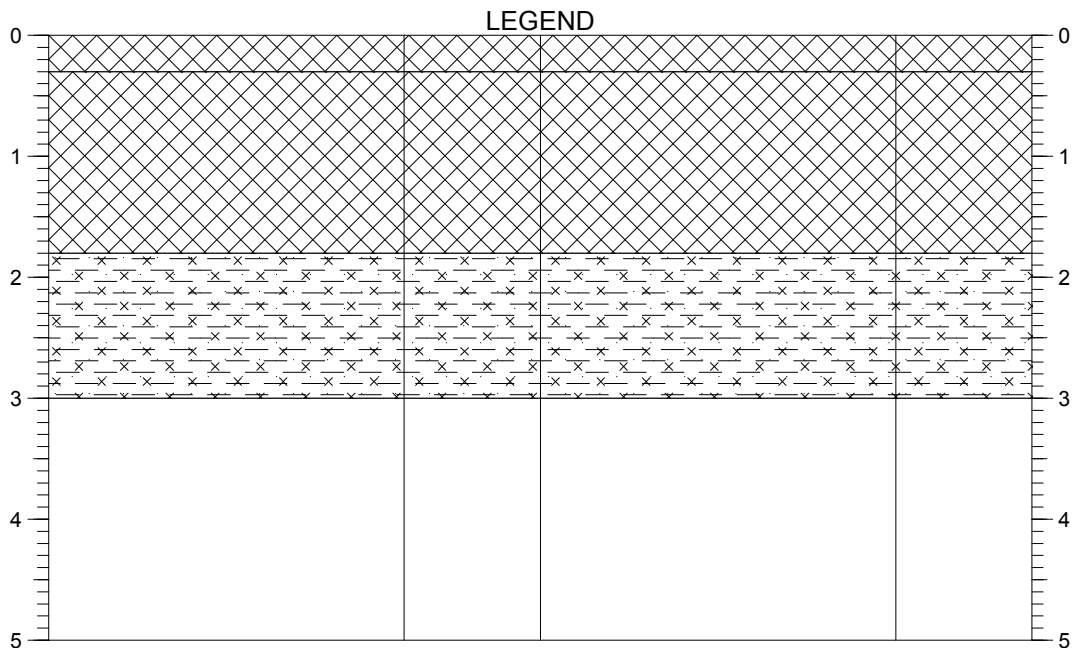
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Backfilled with arisings.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523316.307 N: 419378.173	Logged By: KB	Checked By: KDM	Approved By:	

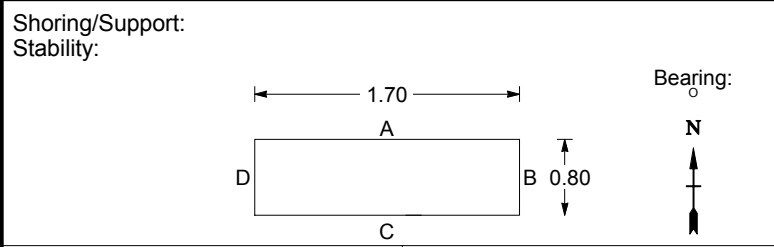
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP8</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.30		MADE GROUND: Brown gravelly, sandy, clayey topsoil with grass. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.50)		MADE GROUND: Brown clayey sand.	0.20-1.80	B		
1.80			0.30	D		
(1.20)		Black clayey, silty SAND.	1.80-3.00	B		
3.00		Borehole complete at 3.00m bgl.	1.80	j		



**REMARKS :**

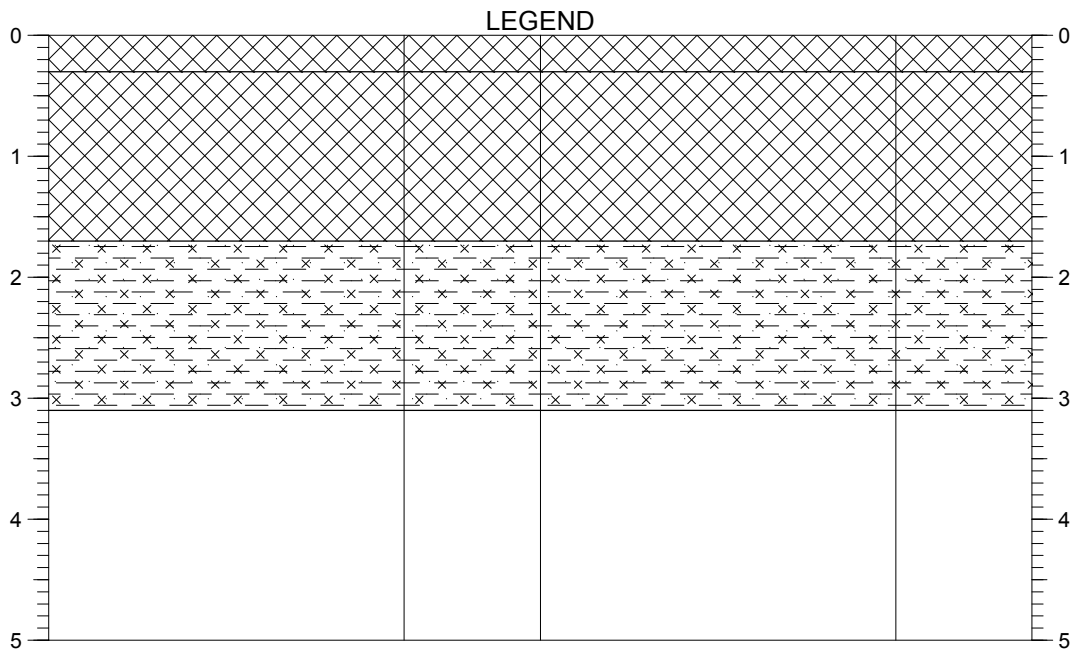
1. Engineer verified logged in general accordance to BS 5930:2010.
2. Borehole remained dry on completion.
3. Installed with a 63 mm HDPE standpipe to 3.00 m bgl.

All measurements in metres unless otherwise stated	5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available		
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523465.398 N: 419146.501	Logged By: KB	Checked By: KDM	Approved By:	

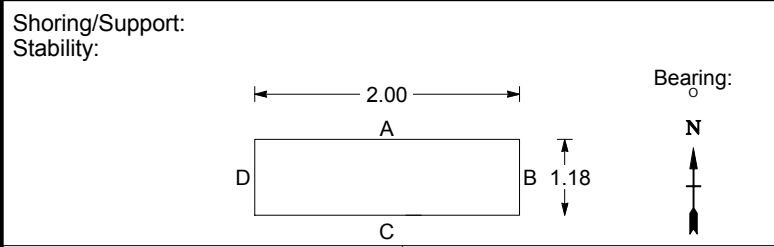
**Delta-Simons Environmental Consultants Ltd**  
 The Lawn, Union Road,  
 Lincoln LN1 3BL  
 Tel: 08700 400 012  
 Fax: 01522 882 567  
 Email: info@deltasimons.com



Project:	<b>Cherry Cobb Sands Wetland</b>	Project No:	<b>13-0054.01</b>	Hole ID:	<b>TP9</b>
<b>TRIAL PIT LOG</b>		Date:	11/04/2013	Client:	<b>Able UK</b>



STRATA			SAMPLES		TESTS	
Depth	No	DESCRIPTION	Depth	No	Depth	Results
0.30		MADE GROUND: Brown gravelly, sandy, clayey topsoil. Gravel is fine to coarse. Sand is fine.	0.00	D		
(1.40)		MADE GROUND: Brown clayey sand.	0.30-1.70	B		
			0.30	D		
1.70		Black clayey, silty SAND.	1.70-3.10	B		
(1.40)			1.70	D		
3.10		Borehole complete at 3.10m bgl.				



**REMARKS :**  
 1. Engineer verified logged in general accordance to BS 5930:2010.  
 2. Borehole remained dry on completion.  
 3. Installed with a 63 mm HDPE standpipe to 3.10 m bgl.

All measurements in metres unless otherwise stated		5m/page	Scale: 1:62.5	Coordinates to National Grid No Datum Information Available	
Plant Used: 360 Excavator	Coordinates / Level (mAOD): E: 523527.262 N: 419062.514	Logged By: KB	Checked By: KDM	Approved By:	



# Appendix II



# LABORATORY REPORT



4043

**Contract Number: PSL13/1511**

Client's Reference:

Report Date: 14 June 2013

Client Name: Delta Simons  
The Lawn  
Union Road  
Lincoln

LN1 3BL

**For the attention of: Kathryn Bradley**

Contract Title: Cherry Cobb Sands

Date Received: 2/5/2013

Date Commenced: 2/5/2013

Date Completed: 4/6/2013

**Notes: Observations and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson  
(Director)

A Watkins  
(Director)

M Beastall  
(Laboratory Manager)

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		BH10
Sample Ref.		-
Sample Depth	m	2.00
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly sandy CLAY

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.95
Dry Density	Mg/m <sup>3</sup>	1.57
Moisture Content	%	24
Void Ratio		0.689
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	26
Bulk Density	Mg/m <sup>3</sup>	1.99
Dry Density	Mg/m <sup>3</sup>	1.57

### Test Setup

Date Started		21/05/2013
Date Finished		03/06/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

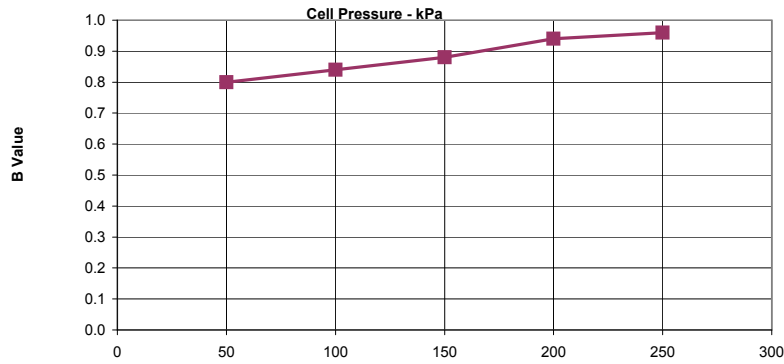
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		BH10
Sample No.		-
Depth:	m	2.00

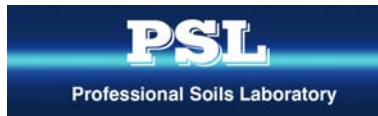
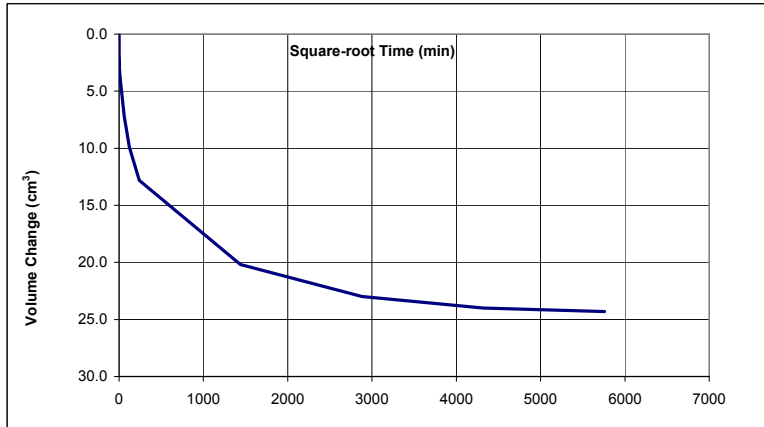
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	303.00
% PWP dissipation		98.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

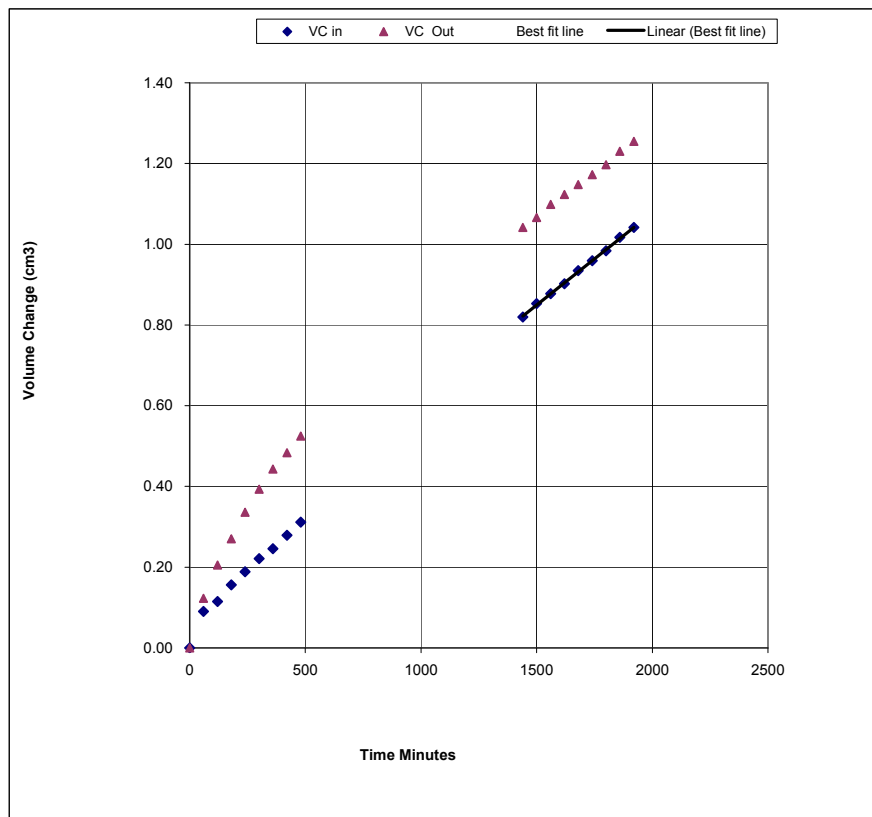
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		BH10
Sample No.		-
Depth	m	2.00

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.0005
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$4.8 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		BH10
Sample Ref.		-
Sample Depth	m	3.00
Sample Type		B
Date		31/05/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly sandy CLAY

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.94
Dry Density	Mg/m <sup>3</sup>	1.54
Moisture Content	%	26
Voids Ratio		0.726
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	29
Bulk Density	Mg/m <sup>3</sup>	1.97
Dry Density	Mg/m <sup>3</sup>	1.53

### Test Setup

Date Started		21/05/2013
Date Finished		30/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	3
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

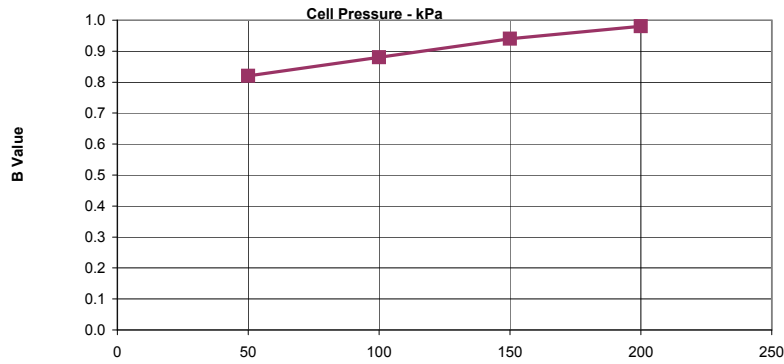
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		BH10
Sample No.		-
Depth:	m	3.00

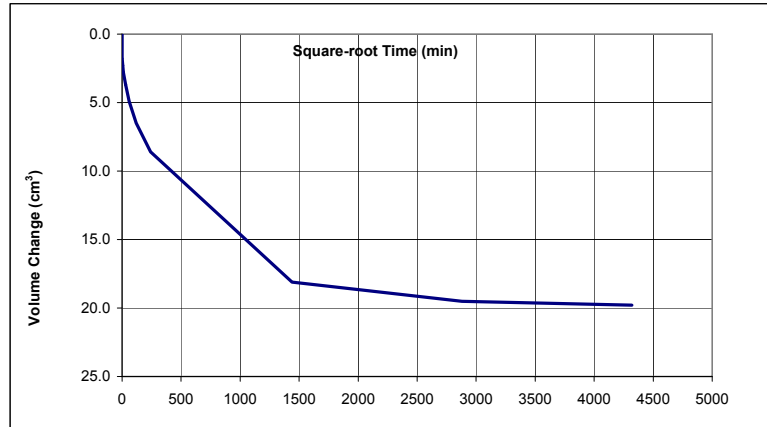
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	200
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	302.00
% PWP dissipation		99.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

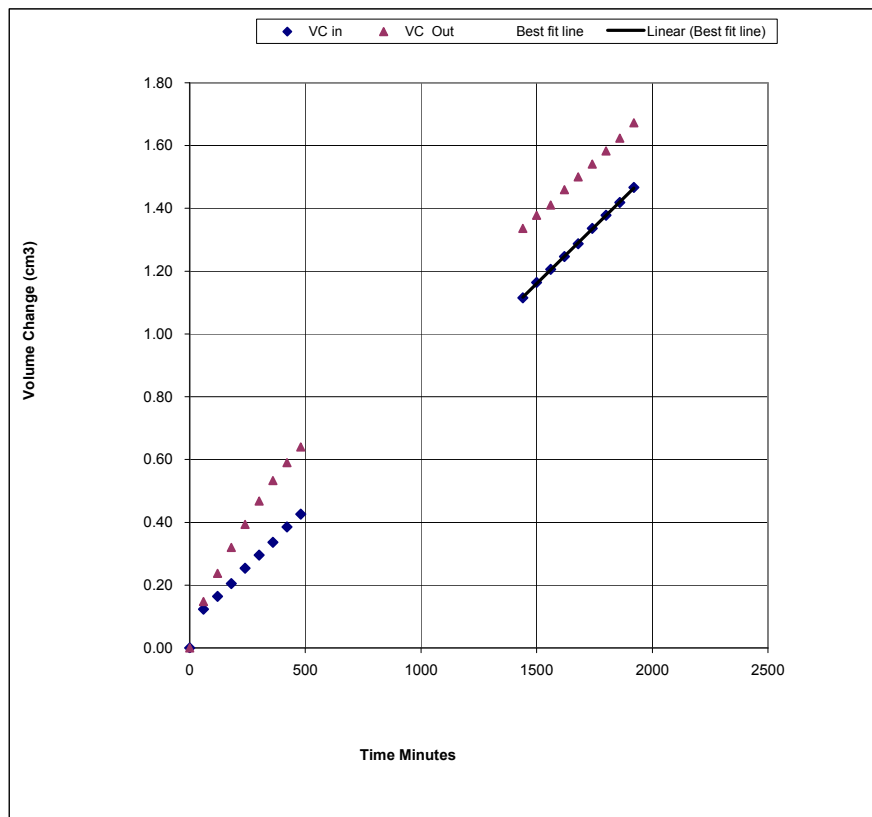
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		BH10
Sample No.		-
Depth	m	3.00

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.0007
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$7.6 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511



## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP01
Sample Ref.		-
Sample Depth	m	0.50
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.91
Dry Density	Mg/m <sup>3</sup>	1.52
Moisture Content	%	25
Voids Ratio		0.738
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	26
Bulk Density	Mg/m <sup>3</sup>	1.95
Dry Density	Mg/m <sup>3</sup>	1.55

### Test Setup

Date Started		06/05/2013
Date Finished		17/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

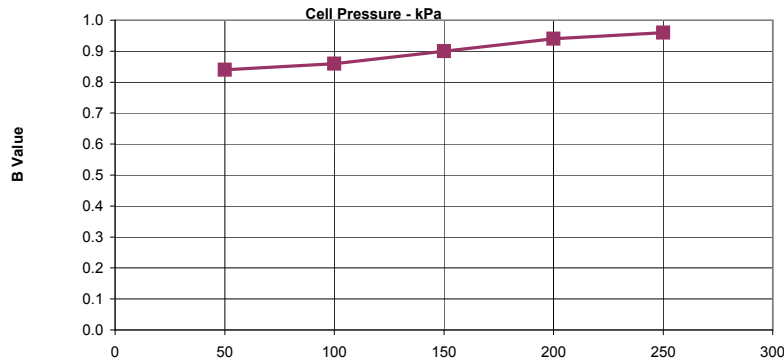
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP01
Sample No.		-
Depth:	m	0.5

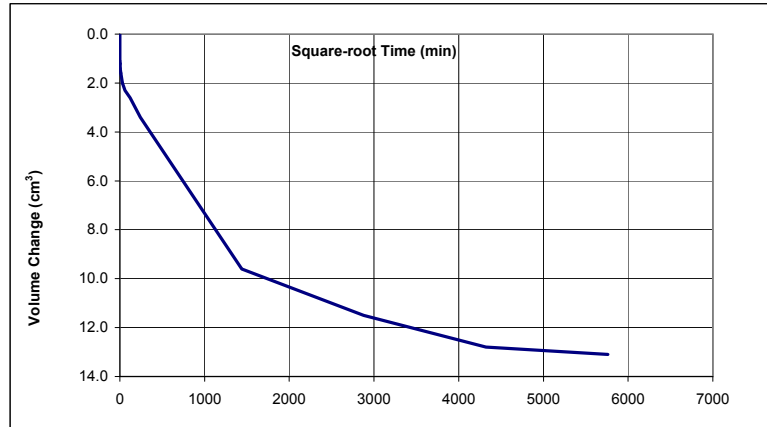
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	302.00
% PWP dissipation		99.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

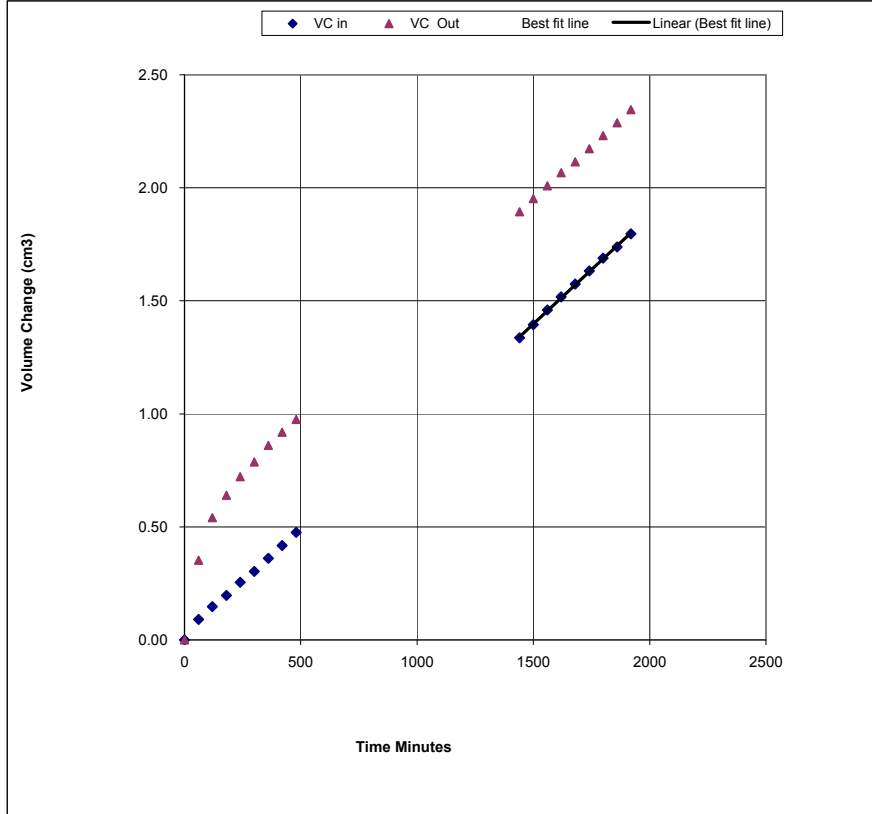
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP01
Sample No.		-
Depth	m	0.5

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$9.9 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP01
Sample Ref.		-
Sample Depth	m	2.10
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY

### Initial Specimen Conditions

Height	mm	100.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	801.18
Bulk Density	Mg/m <sup>3</sup>	1.90
Dry Density	Mg/m <sup>3</sup>	1.52
Moisture Content	%	24
Voids Ratio		0.739
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	27
Bulk Density	Mg/m <sup>3</sup>	1.93
Dry Density	Mg/m <sup>3</sup>	1.52

### Test Setup

Date Started		06/05/2013
Date Finished		17/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

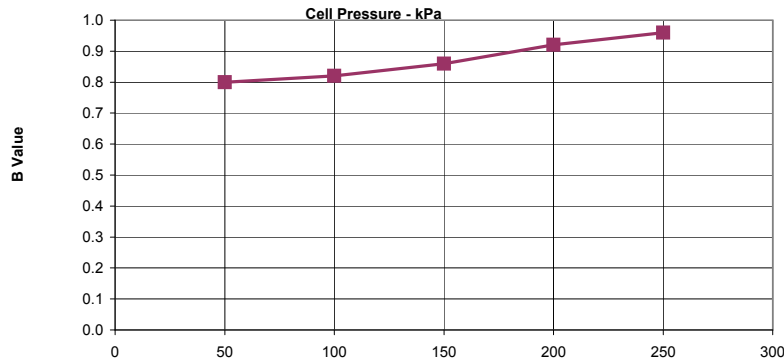
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP01
Sample No.		-
Depth:	m	2.1

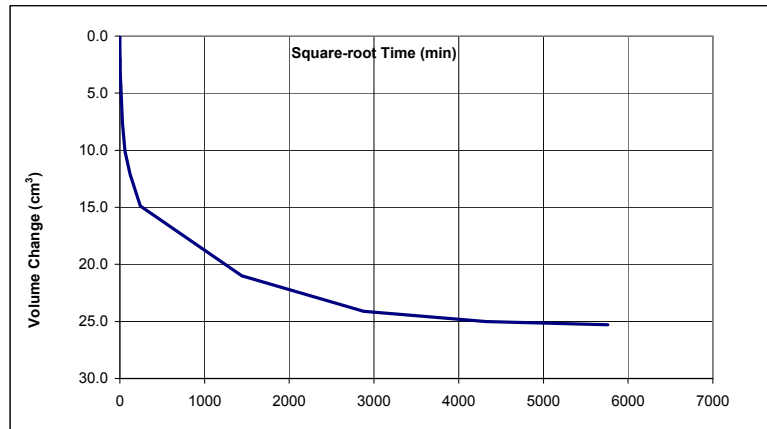
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	305.00
% PWP dissipation		96.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

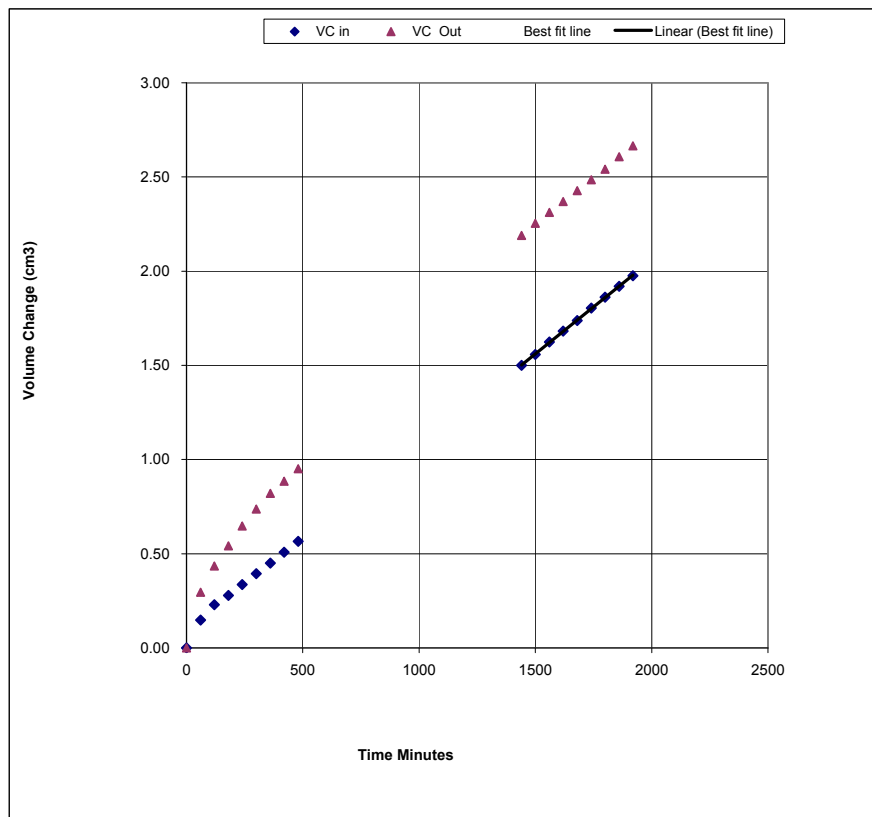
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP01
Sample No.		-
Depth	m	2.1

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.0 \times 10^{-10}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP02
Sample Ref.		-
Sample Depth	m	2.00
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown gravelly sandy CLAY

### Initial Specimen Conditions

Height	mm	85.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	681.01
Bulk Density	Mg/m <sup>3</sup>	1.97
Dry Density	Mg/m <sup>3</sup>	1.66
Moisture Content	%	19
Voids Ratio		0.593
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	21
Bulk Density	Mg/m <sup>3</sup>	2.01
Dry Density	Mg/m <sup>3</sup>	1.66

### Test Setup

Date Started		06/05/2013
Date Finished		15/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	3
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

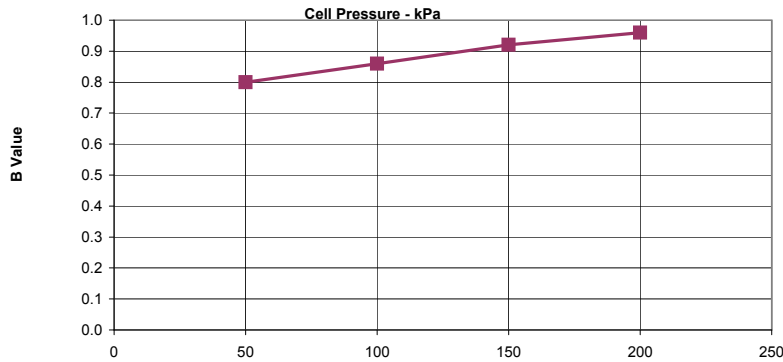
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP02
Sample No.		-
Depth:	m	2.00

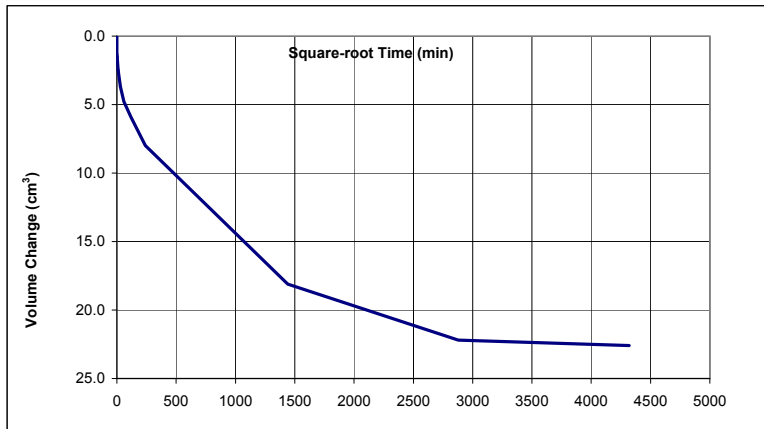
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	200
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	303.00
% PWP dissipation		97.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511



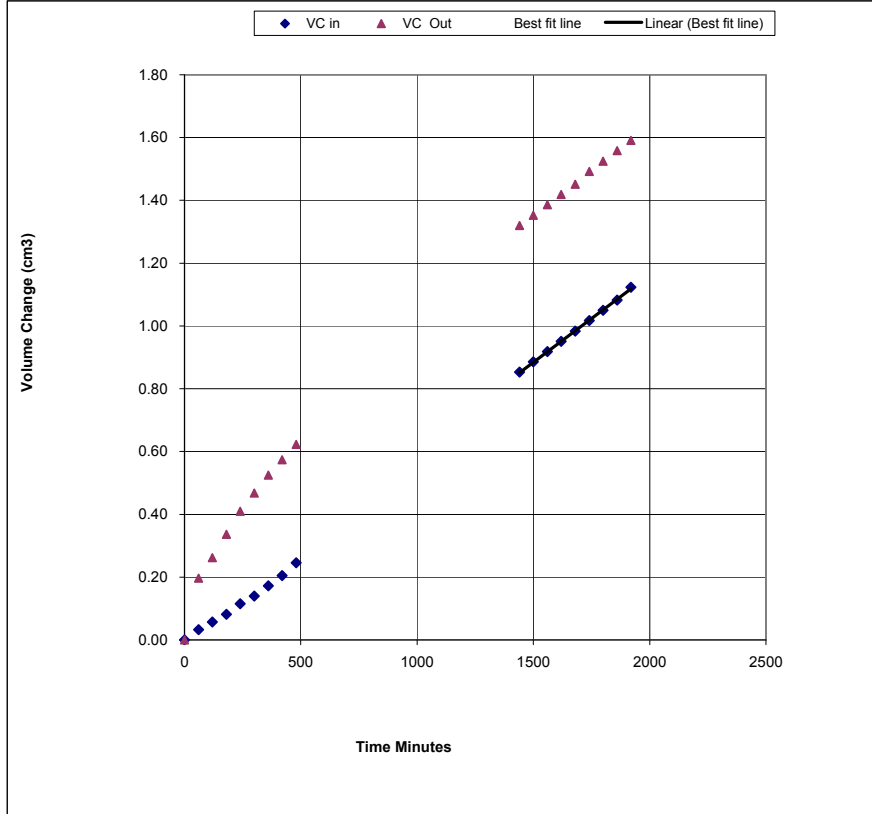
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP02
Sample No.		-
Depth	m	2.00

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$4.9 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP03
Sample Ref.		-
Sample Depth	m	2.10
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly sandy CLAY
------------------------------------

### Initial Specimen Conditions

Height	mm	82.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	656.97
Bulk Density	Mg/m <sup>3</sup>	2.03
Dry Density	Mg/m <sup>3</sup>	1.69
Moisture Content	%	20
Voids Ratio		0.565
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	21
Bulk Density	Mg/m <sup>3</sup>	2.06
Dry Density	Mg/m <sup>3</sup>	1.69

### Test Setup

Date Started		06/05/2013
Date Finished		17/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

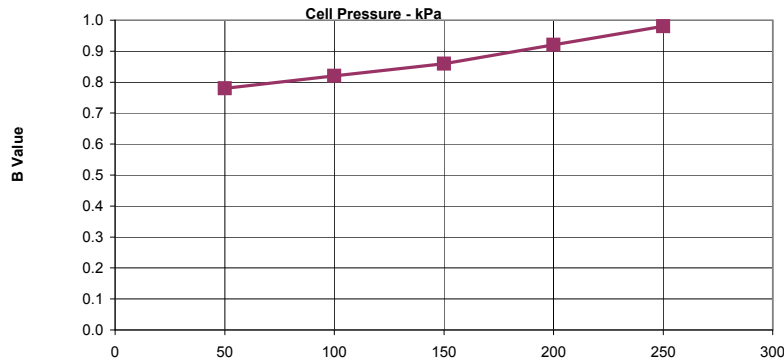
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP03
Sample No.		-
Depth:	m	2.10

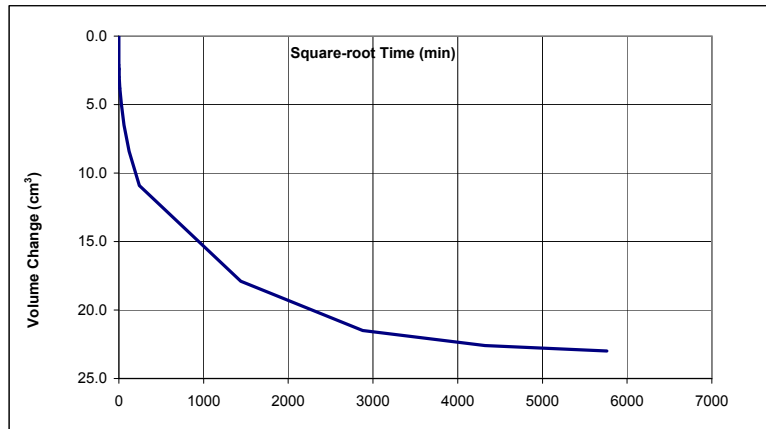
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	304.00
% PWP dissipation		95.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

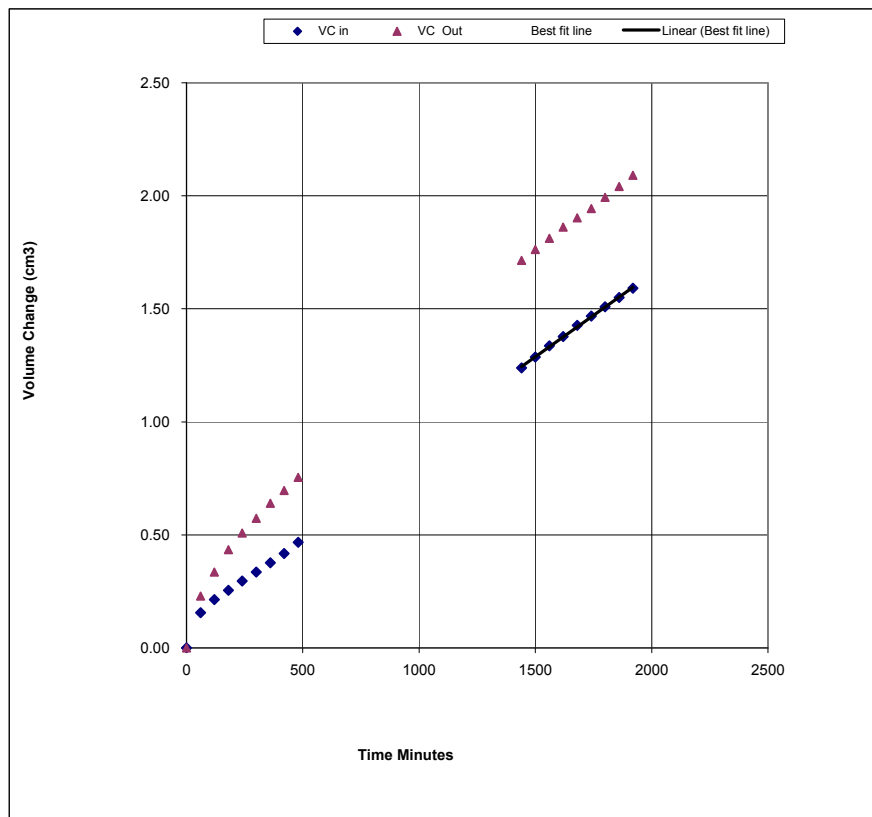
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole	TP03
Sample No.	-
Depth	m 2.10

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$6.1 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP04
Sample Ref.		-
Sample Depth	m	0.70
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	100.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	801.18
Bulk Density	Mg/m <sup>3</sup>	1.89
Dry Density	Mg/m <sup>3</sup>	1.50
Moisture Content	%	26
Voids Ratio		0.762
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	28
Bulk Density	Mg/m <sup>3</sup>	1.92
Dry Density	Mg/m <sup>3</sup>	1.50

### Test Setup

Date Started		06/05/2013
Date Finished		17/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294

Contract No  
PSL/1511

## Permeability in a Triaxial Cell

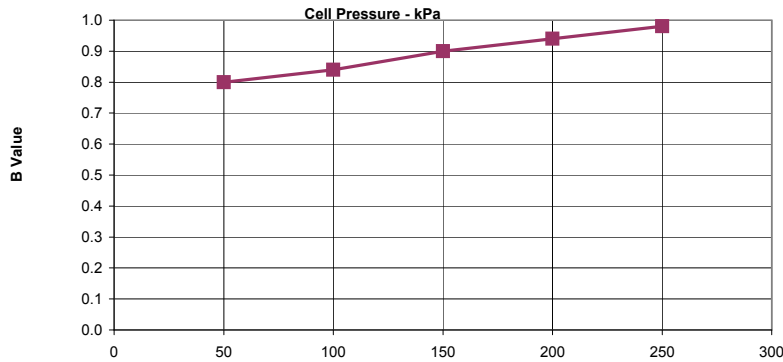
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP04
Sample No.		-
Depth:	m	0.70

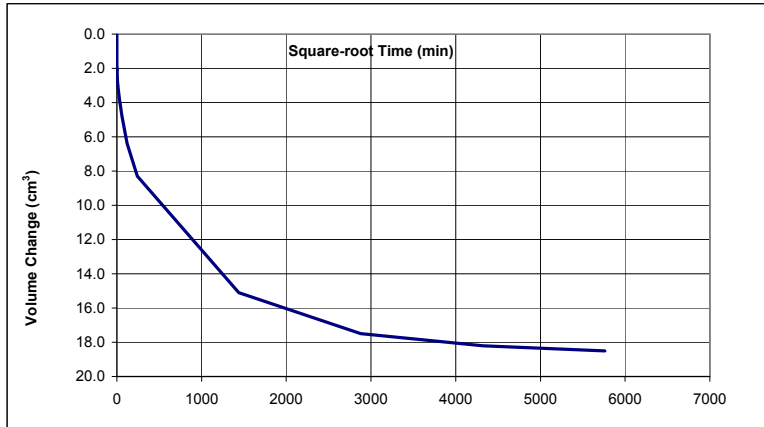
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	303.00
% PWP dissipation		98.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

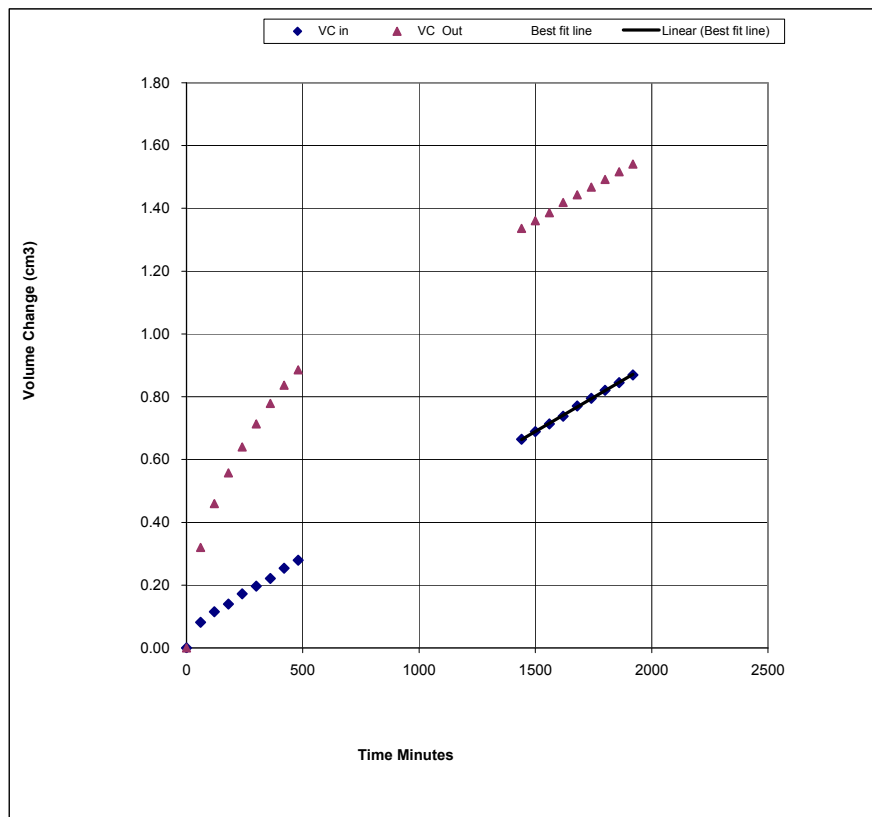
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole	TP04
Sample No.	-
Depth	0.70 m

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.0004
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$4.5 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP04
Sample Ref.		-
Sample Depth	m	1.50
Sample Type		B
Date		00/01/1900
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	82.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	656.97
Bulk Density	Mg/m <sup>3</sup>	2.01
Dry Density	Mg/m <sup>3</sup>	1.65
Moisture Content	%	22
Voids Ratio		0.605
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	26
Bulk Density	Mg/m <sup>3</sup>	2.08
Dry Density	Mg/m <sup>3</sup>	1.65

### Test Setup

Date Started		06/05/2013
Date Finished		00/01/1900
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511



## Permeability in a Triaxial Cell

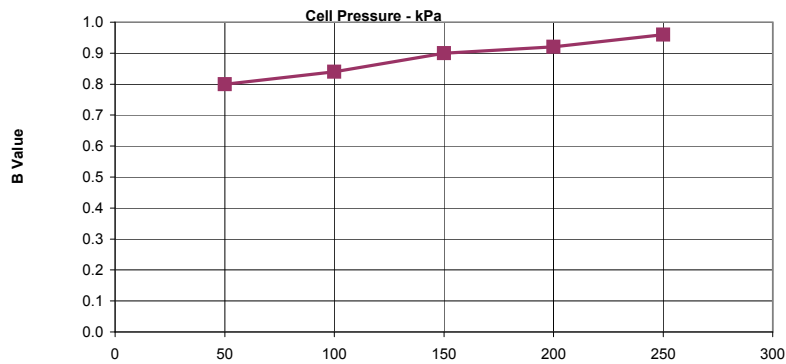
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP04
Sample No.		-
Depth:	m	1.50

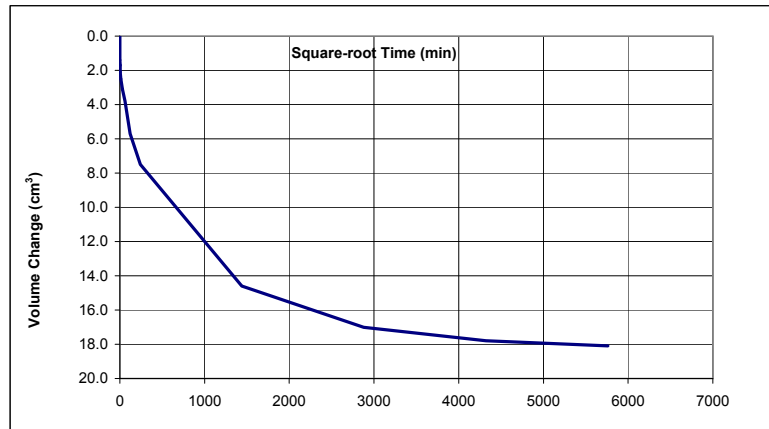
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	302.00
% PWP dissipation		99.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

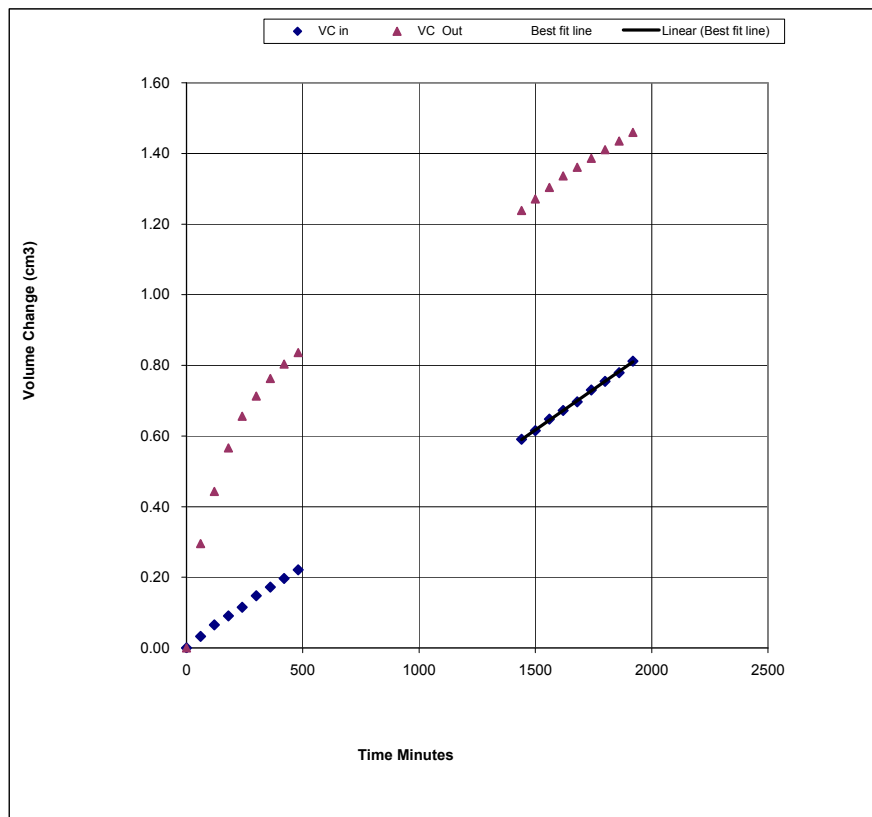
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP04
Sample No.		-
Depth	m	1.50

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.0005
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$3.8 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP05
Sample Ref.		-
Sample Depth	m	0.30
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.85
Dry Density	Mg/m <sup>3</sup>	1.52
Moisture Content	%	22
Voids Ratio		0.744
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	24
Bulk Density	Mg/m <sup>3</sup>	1.88
Dry Density	Mg/m <sup>3</sup>	1.52

### Test Setup

Date Started		06/05/2013
Date Finished		16/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294

Contract No  
PSL/1511

## Permeability in a Triaxial Cell

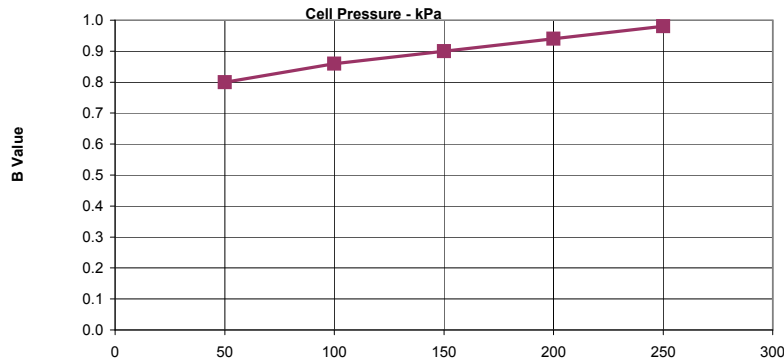
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP05
Sample No.		-
Depth:	m	0.30

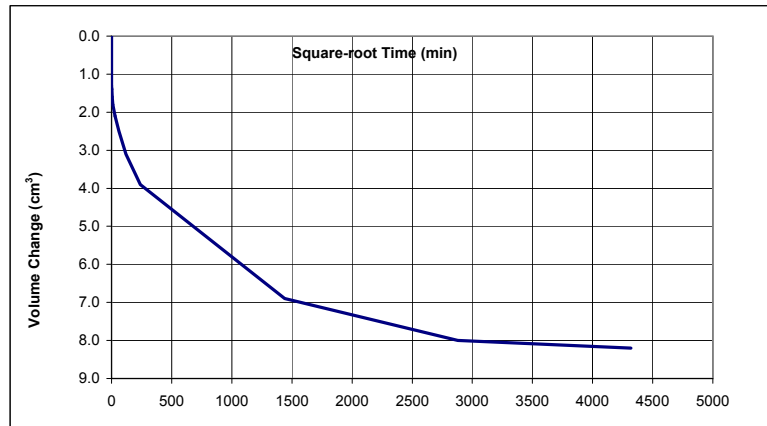
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	304.00
% PWP dissipation		96.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

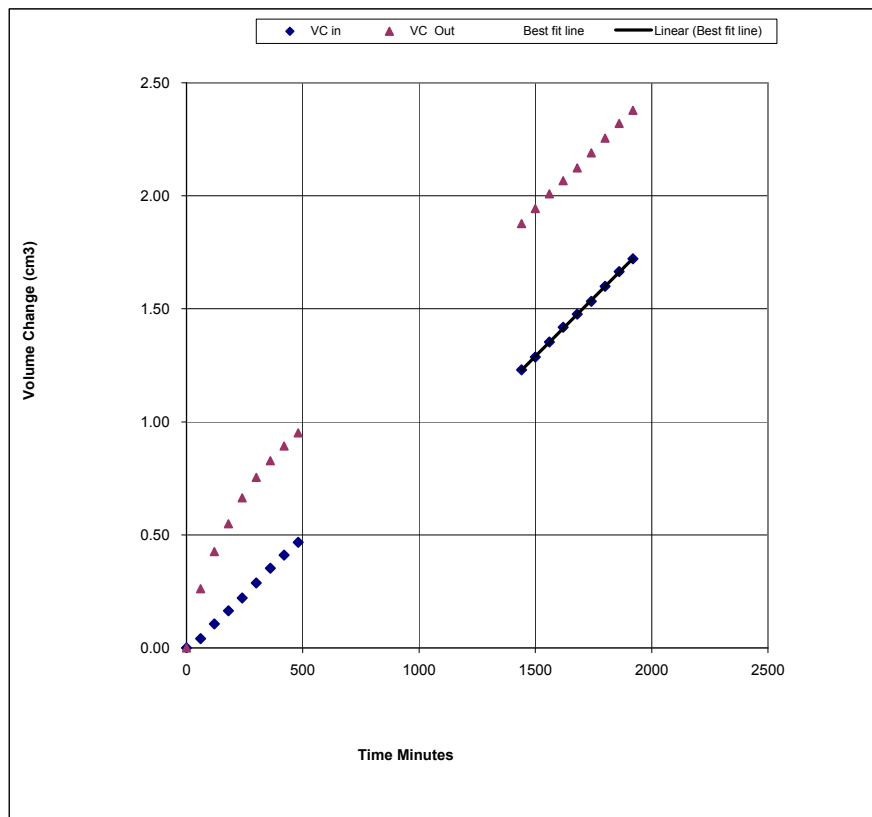
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP05
Sample No.		-
Depth	m	0.30

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.1 \times 10^{-10}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP05
Sample Ref.		-
Sample Depth	m	1.90
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.91
Dry Density	Mg/m <sup>3</sup>	1.63
Moisture Content	%	17
Voids Ratio		0.627
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	20
Bulk Density	Mg/m <sup>3</sup>	1.95
Dry Density	Mg/m <sup>3</sup>	1.63

### Test Setup

Date Started		06/05/2013
Date Finished		17/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294

Contract No  
PSL/1511

## Permeability in a Triaxial Cell

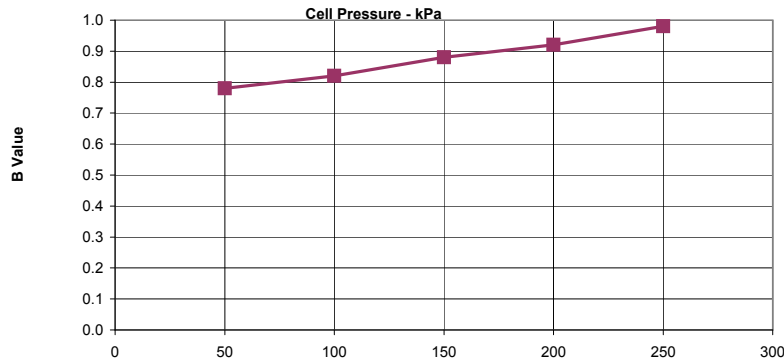
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP05
Sample No.		-
Depth:	m	1.90

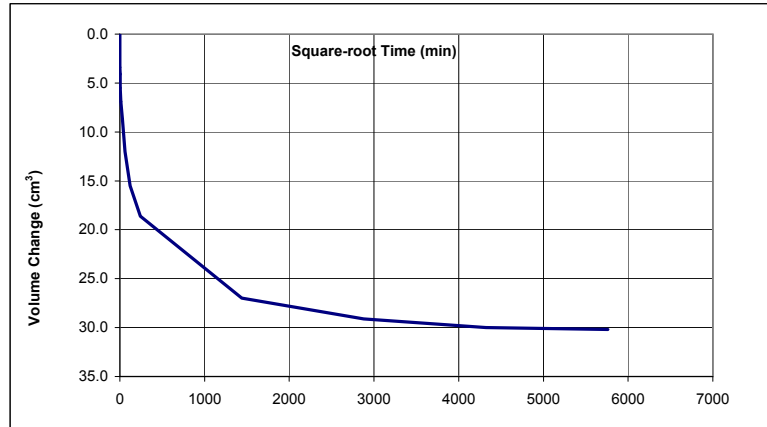
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	303.00
% PWP dissipation		98.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

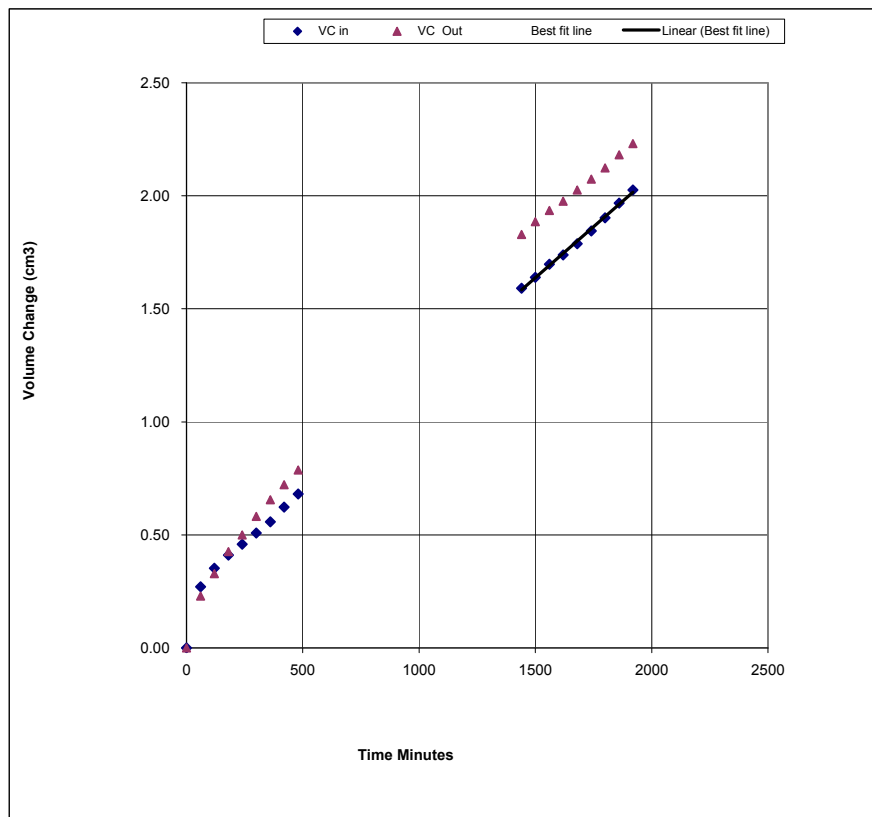
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP05
Sample No.		-
Depth	m	1.90

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$9.5 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511



## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample Ref.		-
Sample Depth	m	0.20
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.95
Dry Density	Mg/m <sup>3</sup>	1.56
Moisture Content	%	25
Voids Ratio		0.696
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	28
Bulk Density	Mg/m <sup>3</sup>	2.00
Dry Density	Mg/m <sup>3</sup>	1.56

### Test Setup

Date Started		06/05/2013
Date Finished		16/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

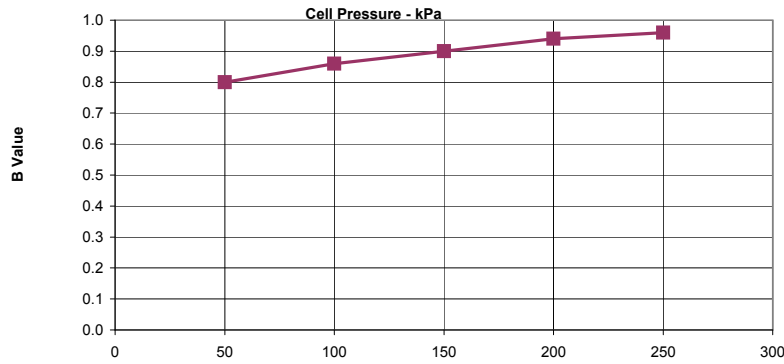
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample No.		-
Depth:	m	0.20

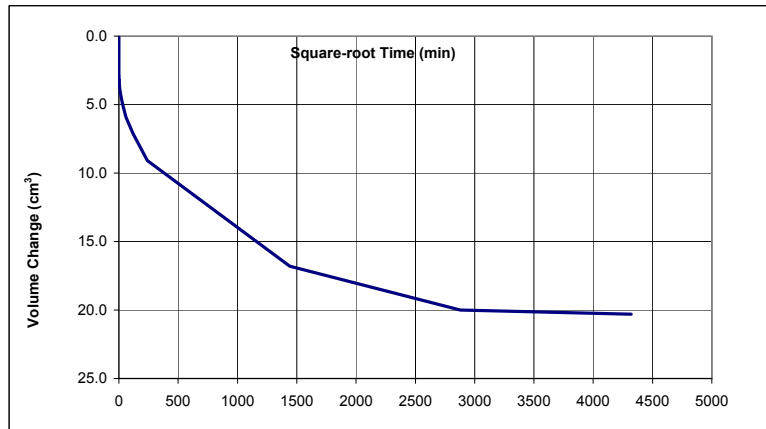
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	304.00
% PWP dissipation		97.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

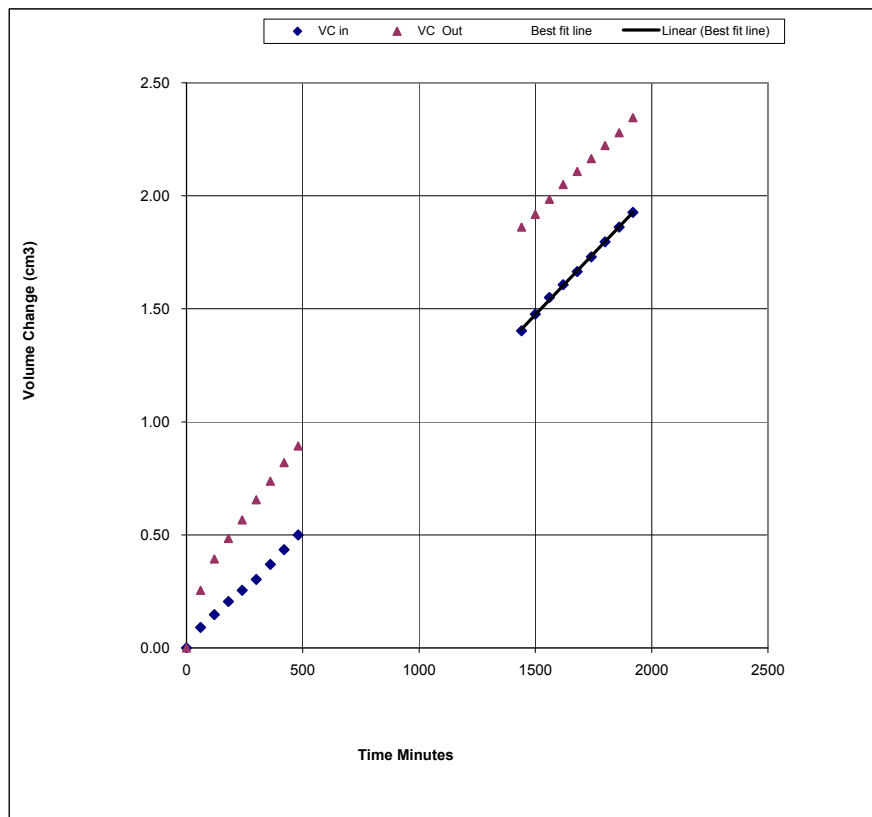
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample No.		-
Depth	m	0.20

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.0 \times 10^{-10}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample Ref.		-
Sample Depth	m	1.00
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.90
Dry Density	Mg/m <sup>3</sup>	1.51
Moisture Content	%	26
Voids Ratio		0.759
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	30
Bulk Density	Mg/m <sup>3</sup>	1.96
Dry Density	Mg/m <sup>3</sup>	1.51

### Test Setup

Date Started		06/05/2013
Date Finished		17/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

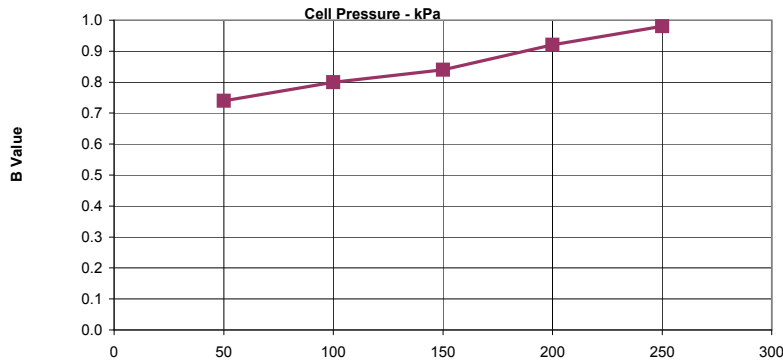
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample No.		-
Depth:	m	1.00

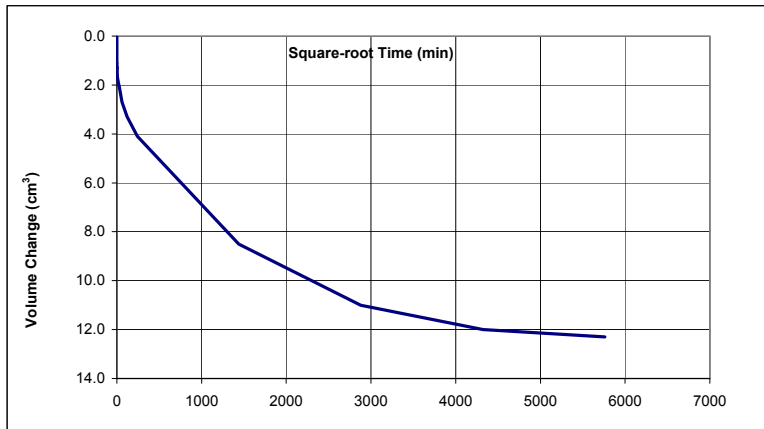
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	302.00
% PWP dissipation		98.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

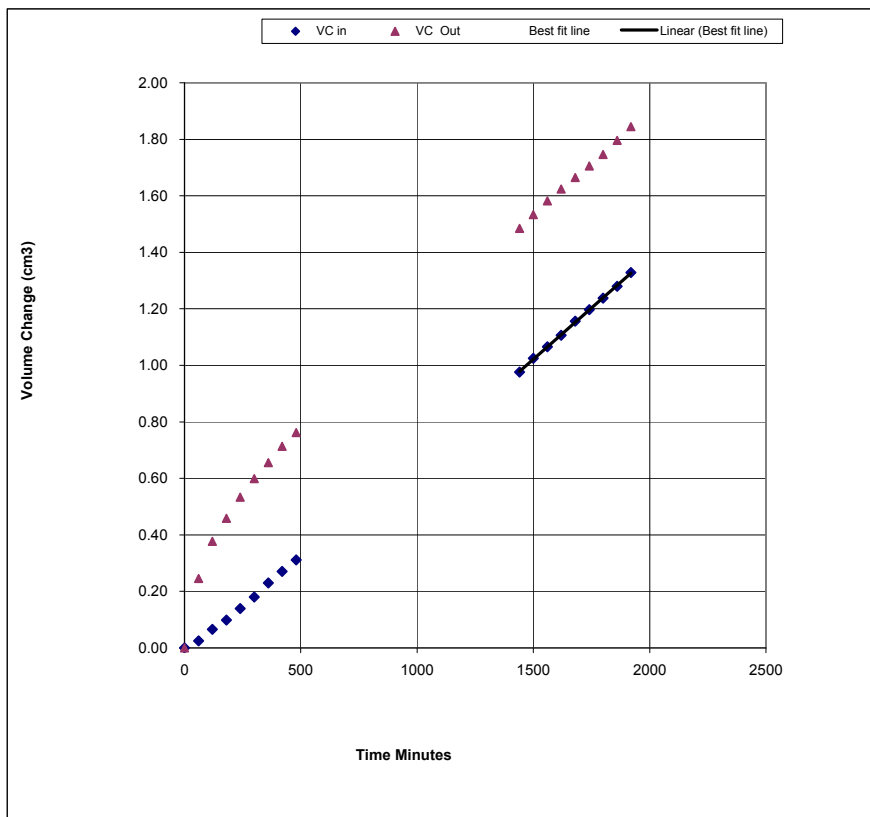
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample No.		-
Depth	m	1.00

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$7.6 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample Ref.		-
Sample Depth	m	1.80
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly CLAY

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.88
Dry Density	Mg/m <sup>3</sup>	1.46
Moisture Content	%	28
Voids Ratio		0.812
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	31
Bulk Density	Mg/m <sup>3</sup>	1.91
Dry Density	Mg/m <sup>3</sup>	1.46

### Test Setup

Date Started		06/05/2013
Date Finished		16/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

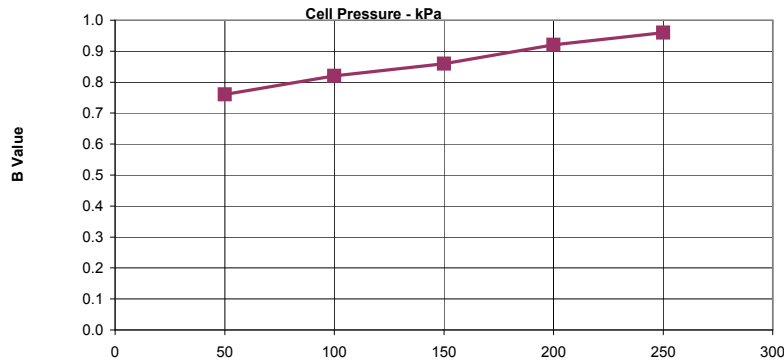
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample No.		-
Depth:	m	1.80

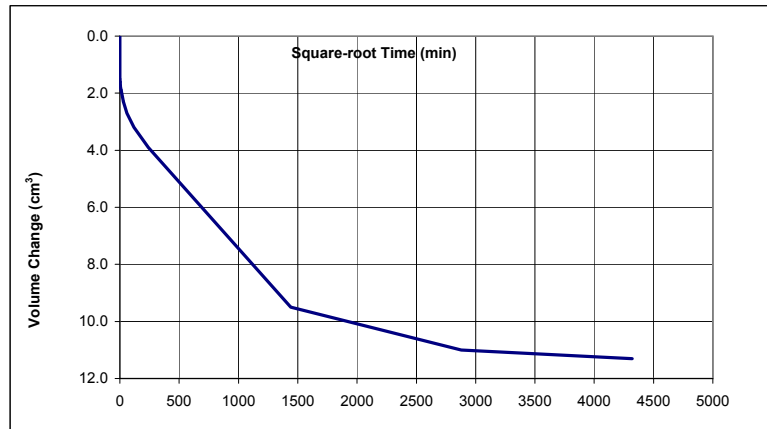
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	304.00
% PWP dissipation		95.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511



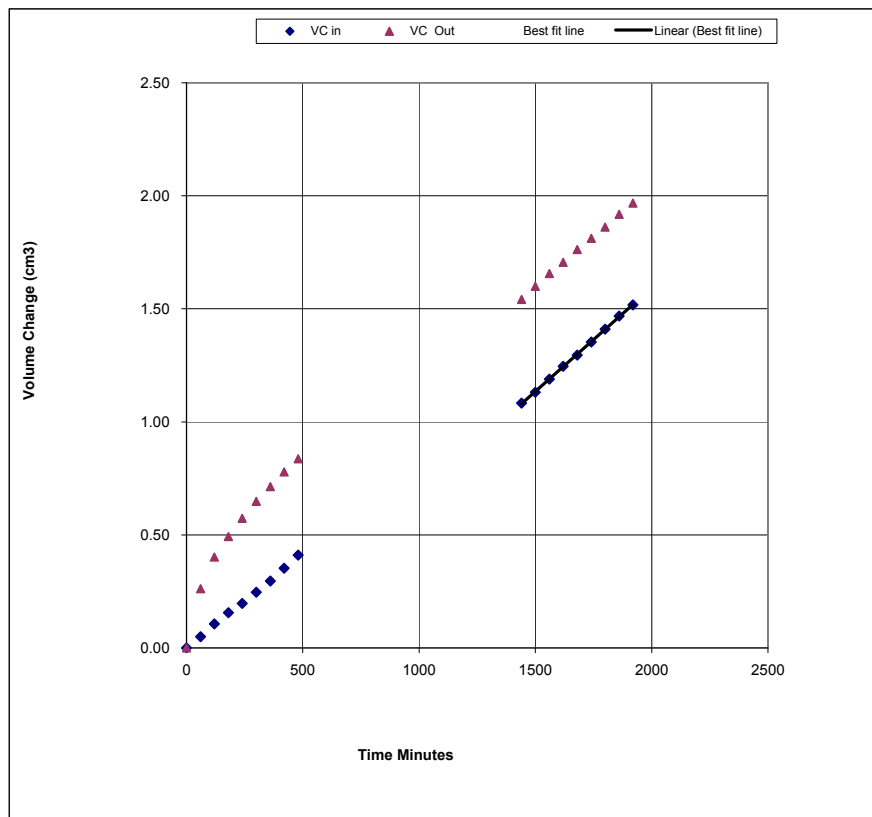
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP08
Sample No.		-
Depth	m	1.80

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$9.5 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP09
Sample Ref.		-
Sample Depth	m	0.30
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.89
Dry Density	Mg/m <sup>3</sup>	1.51
Moisture Content	%	25
Voids Ratio		0.757
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	26
Bulk Density	Mg/m <sup>3</sup>	1.90
Dry Density	Mg/m <sup>3</sup>	1.51

### Test Setup

Date Started		06/05/2013
Date Finished		15/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	3
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

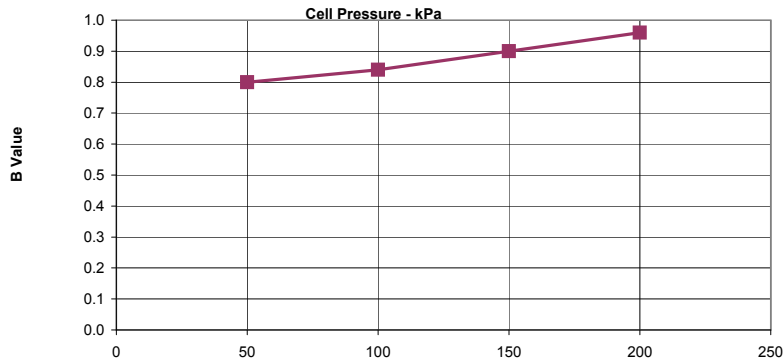
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP09
Sample No.		-
Depth:	m	0.30

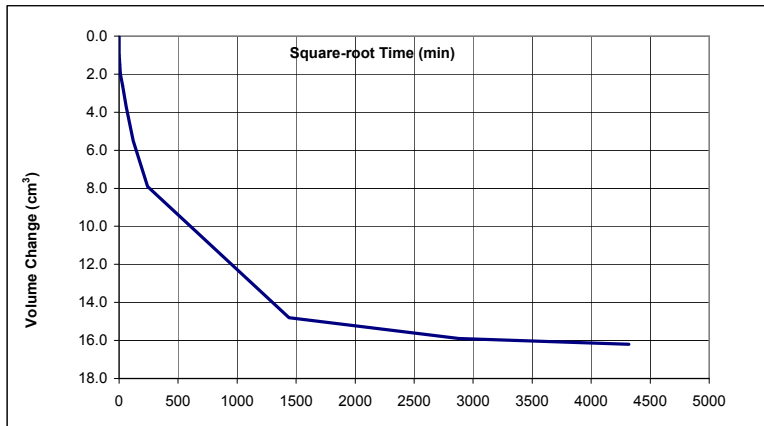
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	200
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	303.00
% PWP dissipation		97.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

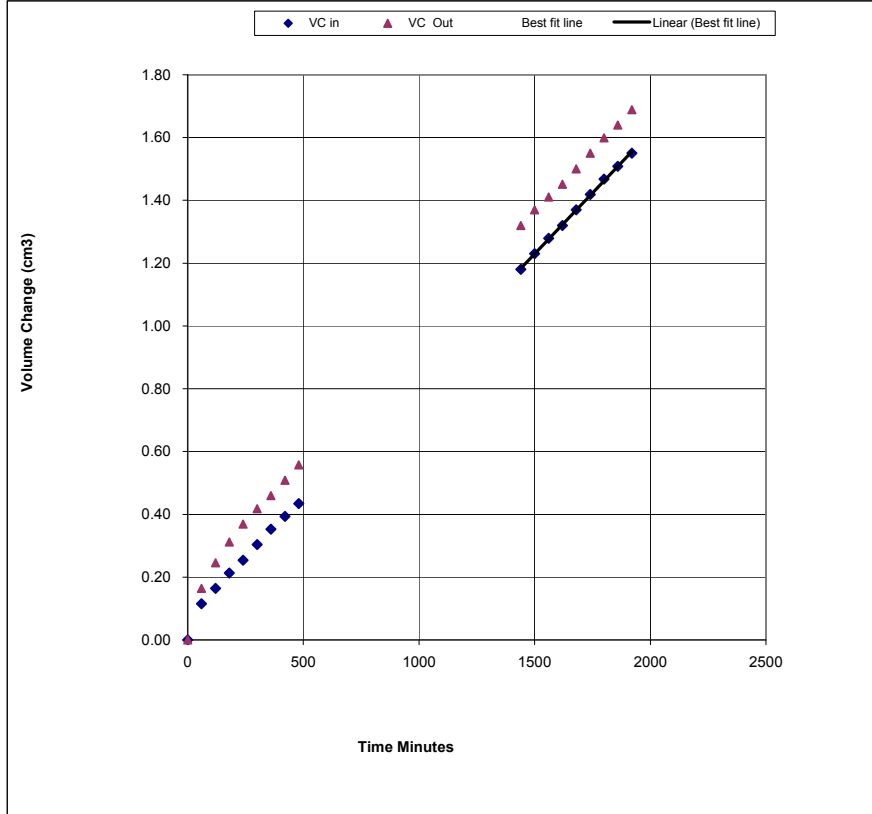
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP09
Sample No.		-
Depth	m	0.30

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$8.0 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP09
Sample Ref.		-
Sample Depth	m	1.70
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.88
Dry Density	Mg/m <sup>3</sup>	1.60
Moisture Content	%	18
Void Ratio		0.659
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	18
Bulk Density	Mg/m <sup>3</sup>	1.89
Dry Density	Mg/m <sup>3</sup>	1.60

### Test Setup

Date Started		21/05/2013
Date Finished		31/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

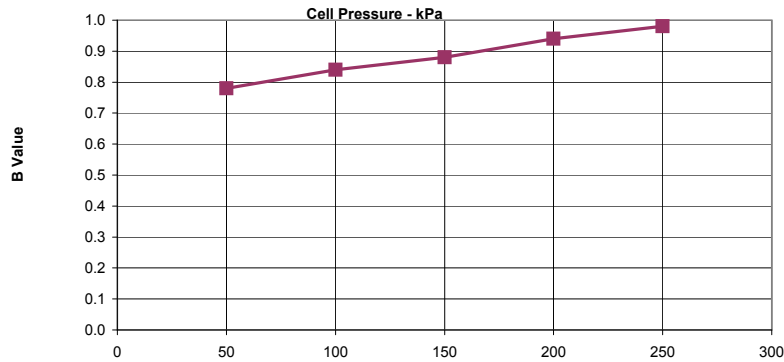
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP09
Sample No.		-
Depth:	m	1.70

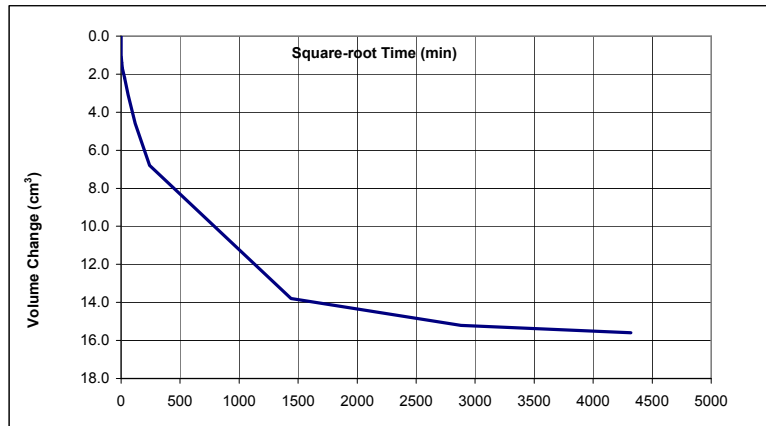
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	302.00
% PWP dissipation		99.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

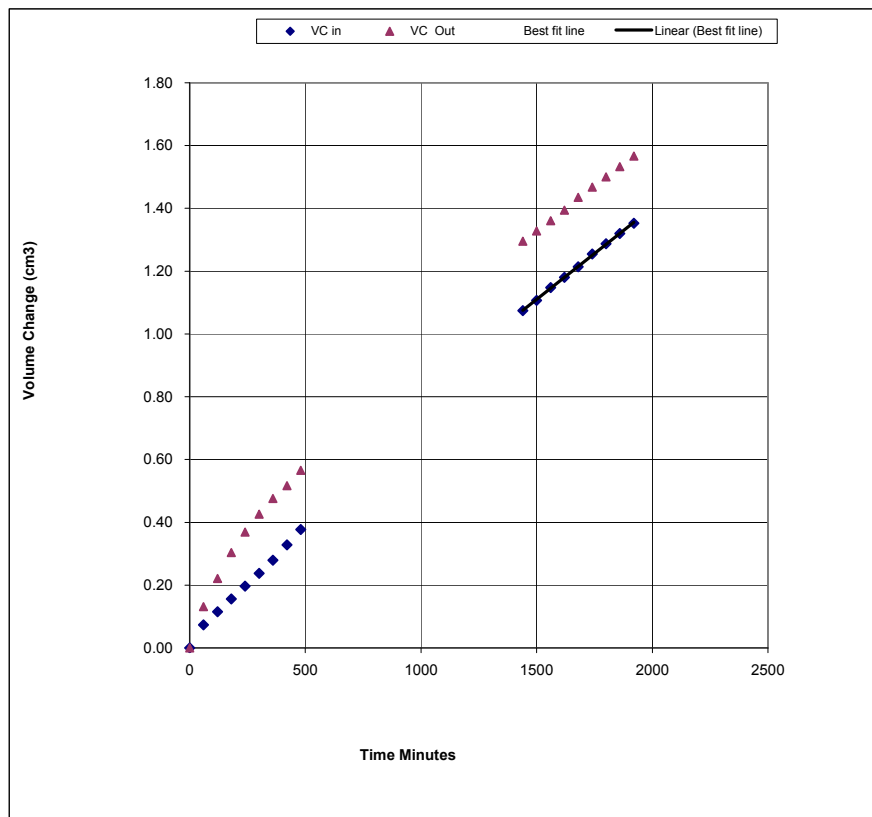
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP09
Sample No.		-
Depth	m	1.70

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$6.1 \times 10^{-11}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP10
Sample Ref.		-
Sample Depth	m	0.50
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.89
Dry Density	Mg/m <sup>3</sup>	1.56
Moisture Content	%	21
Voids Ratio		0.694
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	22
Bulk Density	Mg/m <sup>3</sup>	1.91
Dry Density	Mg/m <sup>3</sup>	1.56

### Test Setup

Date Started		21/05/2013
Date Finished		03/06/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	5
Consolidation Time	Days	4
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511



## Permeability in a Triaxial Cell

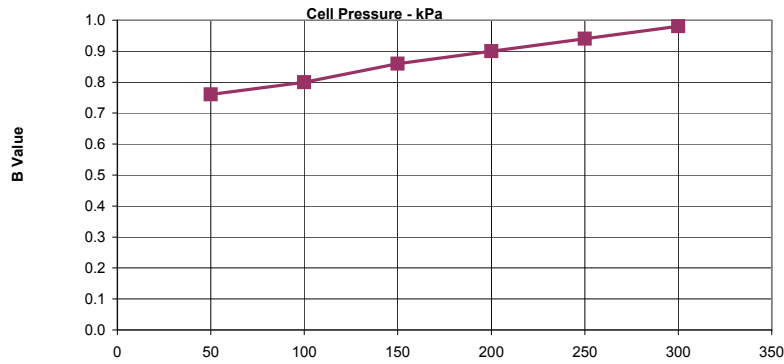
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP10
Sample No.		-
Depth:	m	0.50

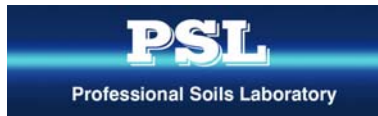
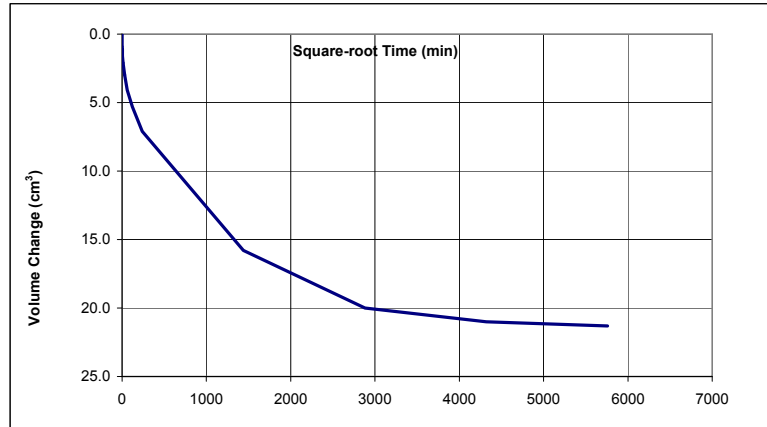
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	300
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	301.00
% PWP dissipation		99.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

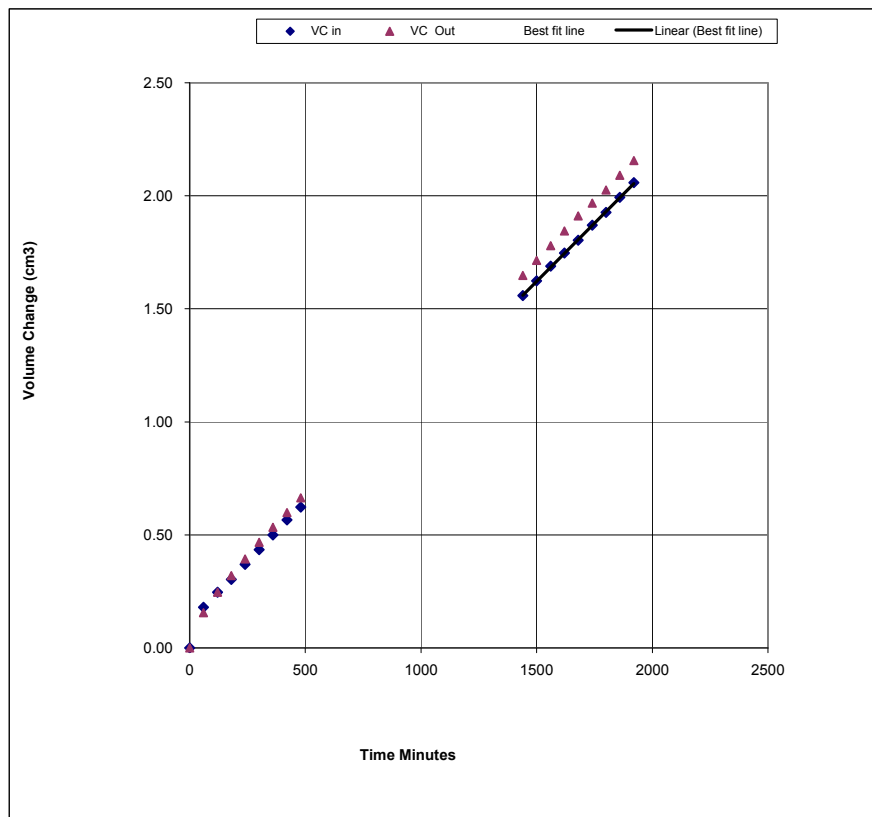
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP10
Sample No.		-
Depth	m	0.50

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.1 \times 10^{-10}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP10
Sample Ref.		-
Sample Depth	m	1.90
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.93
Dry Density	Mg/m <sup>3</sup>	1.57
Moisture Content	%	23
Voids Ratio		0.692
Specific Gravity	Mg/m <sup>3</sup>	2.65
	(assumed/measured)	assumed

### Final Specimen Conditions

Moisture Content	%	25
Bulk Density	Mg/m <sup>3</sup>	1.96
Dry Density	Mg/m <sup>3</sup>	1.57

### Test Setup

Date Started		21/05/2013
Date Finished		31/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	3
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

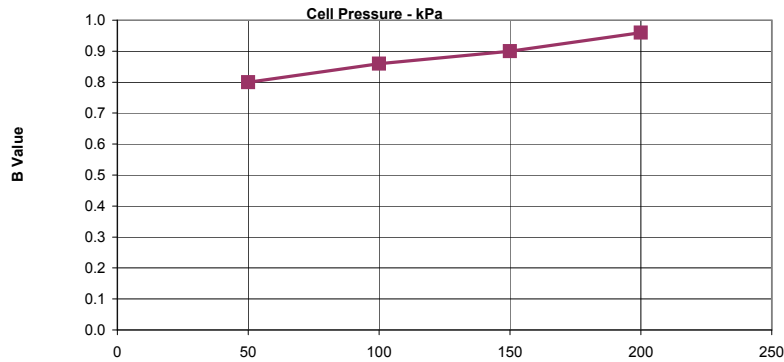
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP10
Sample No.		-
Depth:	m	1.90

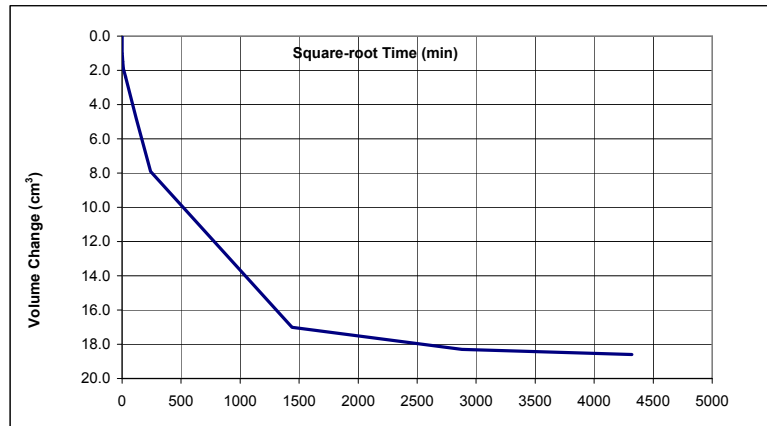
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	200
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	303.00
% PWP dissipation		98.00



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

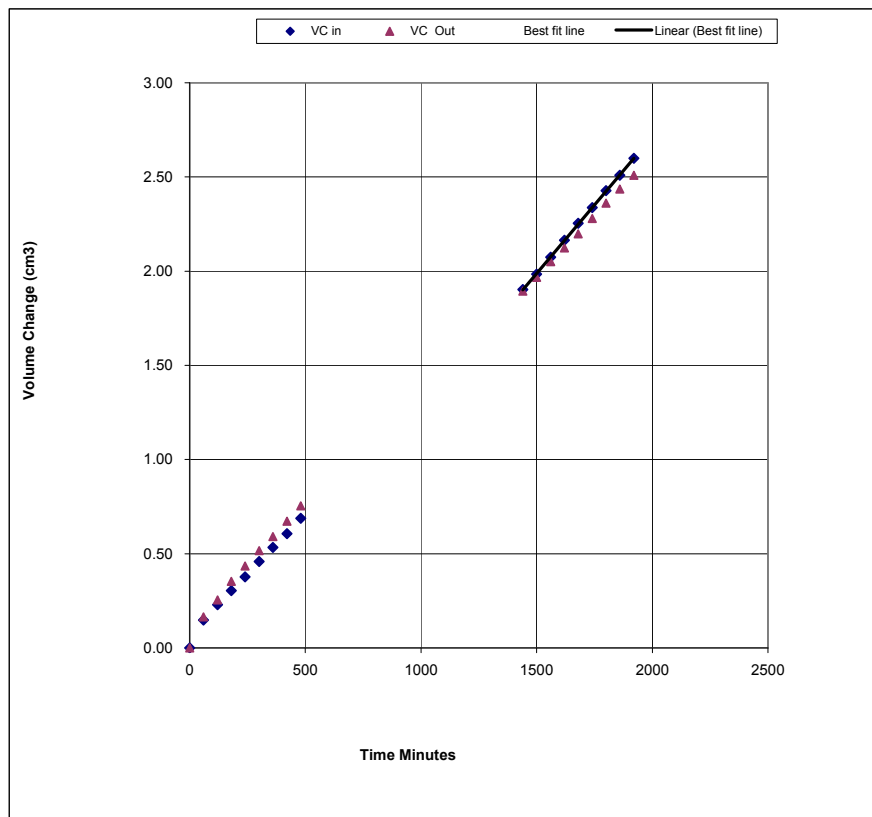
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP10
Sample No.		-
Depth	m	1.90

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.5 \times 10^{-10}$



CHERRY COBB SANDS

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP11
Sample Ref.		-
Sample Depth	m	2.00
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY
---

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.93
Dry Density	Mg/m <sup>3</sup>	1.54
Moisture Content	%	25
Voids Ratio		0.720
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	27
Bulk Density	Mg/m <sup>3</sup>	1.96
Dry Density	Mg/m <sup>3</sup>	1.54

### Test Setup

Date Started		21/05/2013
Date Finished		31/05/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	4
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COB SANDS.

Client Ref  
KM294  
Contract No  
PSL/1511

## Permeability in a Triaxial Cell

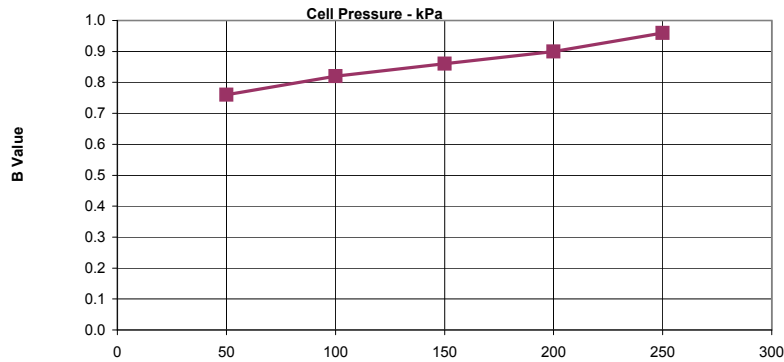
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP11
Sample No.		-
Depth:	m	2.00

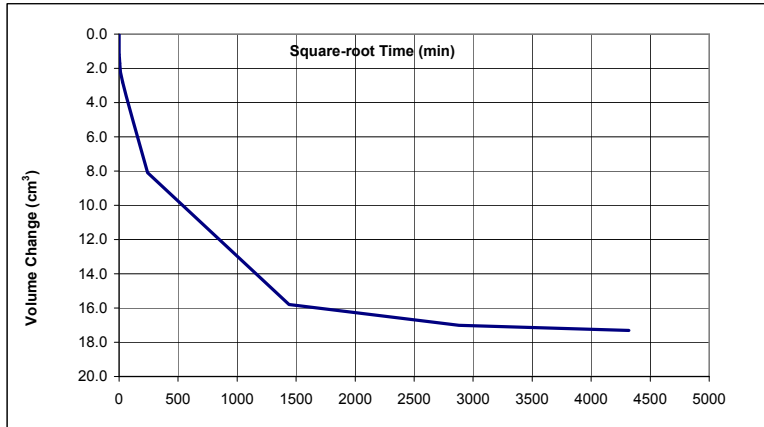
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	250
Final B Value		0.96



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	304.00
% PWP dissipation		97.00



CHERRY COB SANDS.

Client Ref  
KM294  
Contract No  
PSL/1511

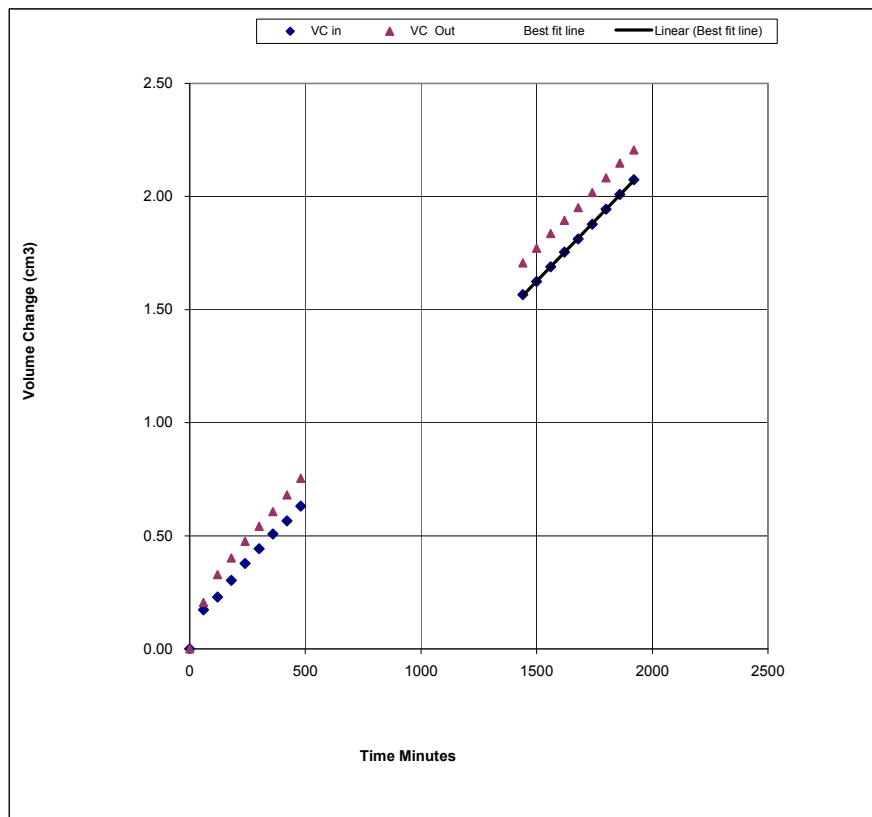
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP11
Sample No.		-
Depth	m	2.00

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.1 \times 10^{-10}$



CHERRY COB SANDS.

Client Ref  
KM294  
Contract No  
PSL/1511



## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP13
Sample Ref.		-
Sample Depth	m	0.50-2.00
Sample Type		B
Date		06/06/2013
Disturbed / Undisturbed		Remoulded Disturbed

### Description of Specimen

Brown slightly gravelly slightly sandy CLAY

### Initial Specimen Conditions

Height	mm	102.00
Diameter	mm	101.00
Area	mm <sup>2</sup>	8011.85
Volume	cm <sup>3</sup>	817.21
Bulk Density	Mg/m <sup>3</sup>	1.93
Dry Density	Mg/m <sup>3</sup>	1.59
Moisture Content	%	21
Voids Ratio		0.671
Specific Gravity	Mg/m <sup>3</sup>	2.65
(assumed/measured)		assumed

### Final Specimen Conditions

Moisture Content	%	23
Bulk Density	Mg/m <sup>3</sup>	1.96
Dry Density	Mg/m <sup>3</sup>	1.59

### Test Setup

Date Started		21/05/2013
Date Finished		03/06/2013
Top Drain Used		Y
Base Drain Used		Y
Method of Saturation		By back pressure
Direction Of Flow		Vertically Downwards
Saturation Time	Days	5
Consolidation Time	Days	3
Permeability Time	Days	2

Checked and Approved By



Date 06/06/13



CHERRY COB SANDS.

Client Ref  
KM294

Contract No  
PSL/1511

## Permeability in a Triaxial Cell

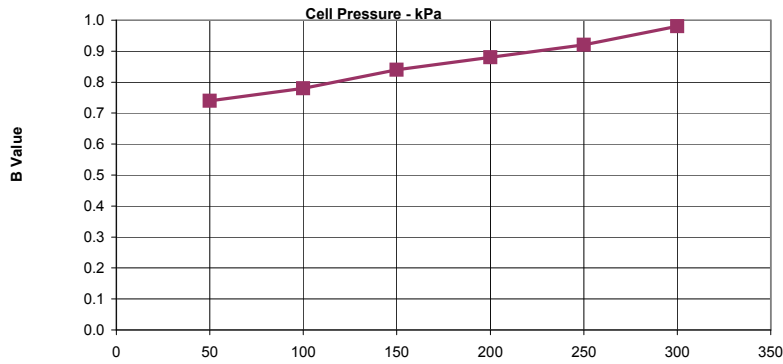
BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP13
Sample No.		-
Depth:	m	0.50-2.00

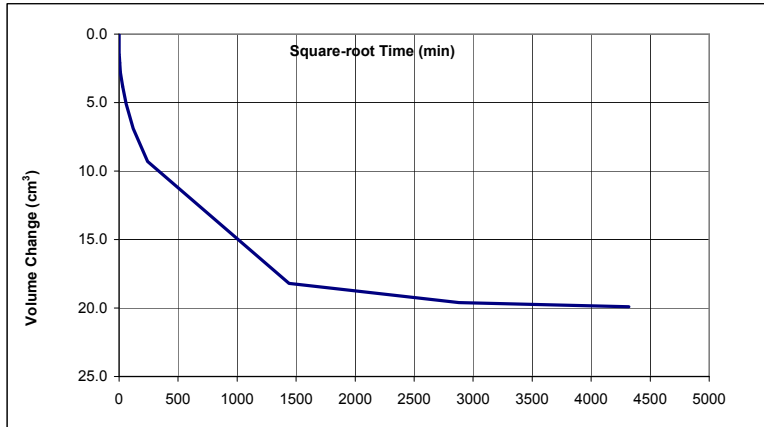
### Saturation

Cell Pressure Incr.	kPa	50
Back Pressure Incr.	kPa	50
Differential Pressure	kPa	10
Final Cell Pressure	kPa	300
Final B Value		0.98



### Consolidation

Effective Pressure	kPa	100.00
Cell Pressure	kPa	400.00
Back Pressure	kPa	300.00
Final PWP	kPa	302.00
% PWP dissipation		99.00



CHERRY COB SANDS.

Client Ref  
KM294  
Contract No  
PSL/1511

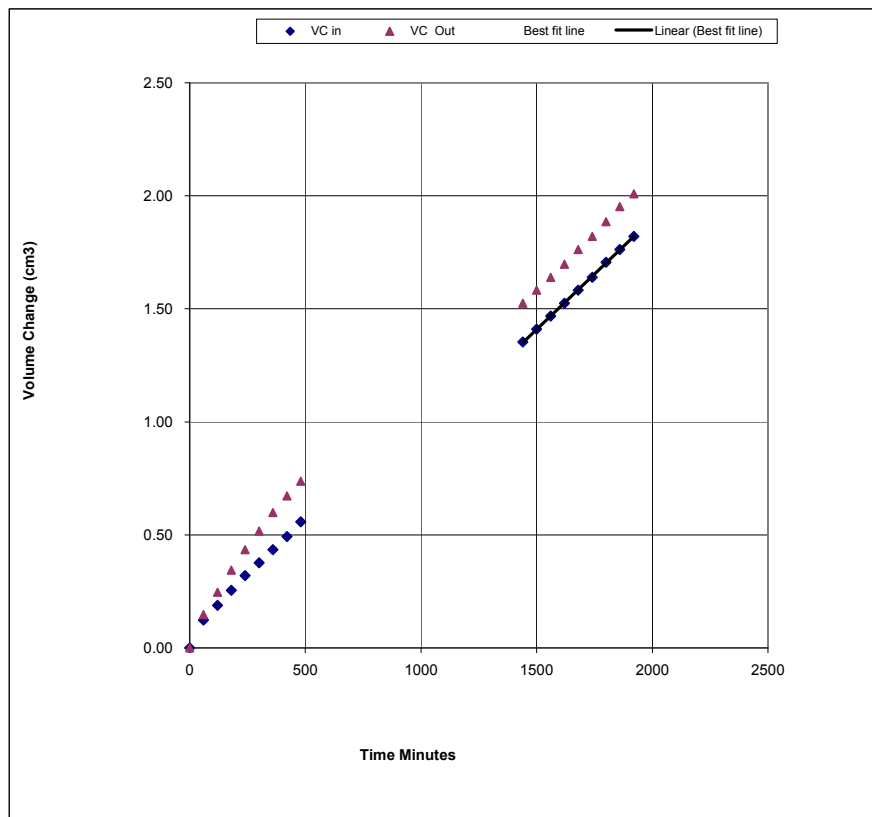
## Permeability in a Triaxial Cell

BS 1377 : Part 6 : 1990 Clause 6

### Specimen Details

Borehole		TP13
Sample No.		-
Depth	m	0.50-2.00

### Permeability Stage



Cell Pressure	kPa	400.00
Mean Effective Stress	kPa	100.00
Back Pressure Diff.	kPa	20.00
Mean Rate of Flow	ml/min	0.001
Average Temperature	'C	20
Vertical Permeability Kv	m/s	$1.0 \times 10^{-10}$



CHERRY COB SANDS.

Client Ref  
KM294  
Contract No  
PSL/1511



2139

## Certificate of Analysis

Date: 04/06/2013

Certificate Number: 13-82048

Client: Professional Soils Laboratory Ltd  
5/7 Hexthorpe Road  
Hexthorpe  
DN4 0AR

Our Reference: 13-82048

Client Reference: PSL13/1511

Contract Title: Cherry Cobb Sands

Description: 15 soil samples


Date Received: 29 May 2013

Date Started: 29 May 2013

Date Completed: 04 June 2013

Test Procedures: Identified by prefix DETSn, details available upon request.

Notes: Observations and interpretations are outside the scope of UKAS accreditation

Approved By:   
Rob Brown, Business Manager

This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

# Information in Support of the Analytical Results

## **Analysis**

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425um sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28oC +/-2oC.

### ***Key***

- \* Denotes test not included in laboratory scope of accreditation
- # Denotes test that holds MCERTS accreditation, however, MCERTS accreditation is only implied if the report carries the MCERTS logo
- \$ Denotes tests completed by an approved subcontractor
- I/S Denotes insufficient sample to carry out test
- U/S Denotes that the sample is not suitable for testing

## **Disposal**

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month

Liquids - 2 weeks

Asbestos (test portion) - 6 months

# Summary of Chemical Analysis

## Soil Samples

Our Ref: 13-82048

Client Ref: PSL13/1511

Contract Title: Cherry Cobb Sands

				Lab No.	518326	518327	518328	518329	518330
				Sample ID	BH1	BH1	BH2	BH3	BH3
				Depth	1.00	2.00	1.00	2.00	3.00
				Sample Ref					
				Sample Type					
				Sampling Date	//	//	//	//	//
				Sampling Time					
Test	Units	DETSxx	LOD						
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	79	360	340	1000	650	
pH		DETSC 2008#		8.2	9.6	8.0	7.3	8.1	

# Summary of Chemical Analysis

## Soil Samples

Our Ref: 13-82048

Client Ref: PSL13/1511

Contract Title: Cherry Cobb Sands

				Lab No.	518331	518332	518333	518334	518335
				Sample ID	BH4	BH5	BH5	BH6	BH7
				Depth	1.00	1.00	2.00	1.00	1.00
				Sample Ref					
				Sample Type					
				Sampling Date	//	//	//	//	//
				Sampling Time					
Test	Units	DETSxx	LOD						
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	130	100	100	250	150	
pH		DETSC 2008#		8.1	8.2	8.2	7.9	7.9	

# Summary of Chemical Analysis

## Soil Samples

Our Ref: 13-82048

Client Ref: PSL13/1511

Contract Title: Cherry Cobb Sands

				Lab No.	518336	518337	518338	518339	518340
				Sample ID	BH7	BH8	BH8	BH9	BH10
				Depth	2.00	1.00	2.00	1.00	1.00
				Sample Ref					
				Sample Type					
				Sampling Date	//	//	//	//	//
				Sampling Time					
Test	Units	DETSxx	LOD						
Sulphate Aqueous Extract as SO4	mg/l	DETSC 2076#	10	52	110	94	170	39	
pH		DETSC 2008#		8.2	8.1	8.2	8.1	8.3	



## Sample Comments

DETS cannot be held responsible for the integrity of sample(s) received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating.

Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note "Guidance on Deviating Samples".

All samples received are listed below. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations.

If no sampled date (soils) or date/time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters), this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Lab No.	Sample ID	Date Sampled	Containers Received	Deviating due to holding time being exceeded for test(s)	Deviating due to inappropriate container for test(s)	Deviating due to headspace presence in container for test(s)
518326	BH1 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518327	BH1 2.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518328	BH2 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518329	BH3 2.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518330	BH3 3.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518331	BH4 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518332	BH5 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518333	BH5 2.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518334	BH6 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518335	BH7 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518336	BH7 2.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		
518337	BH8 1.00 SOIL		Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)		

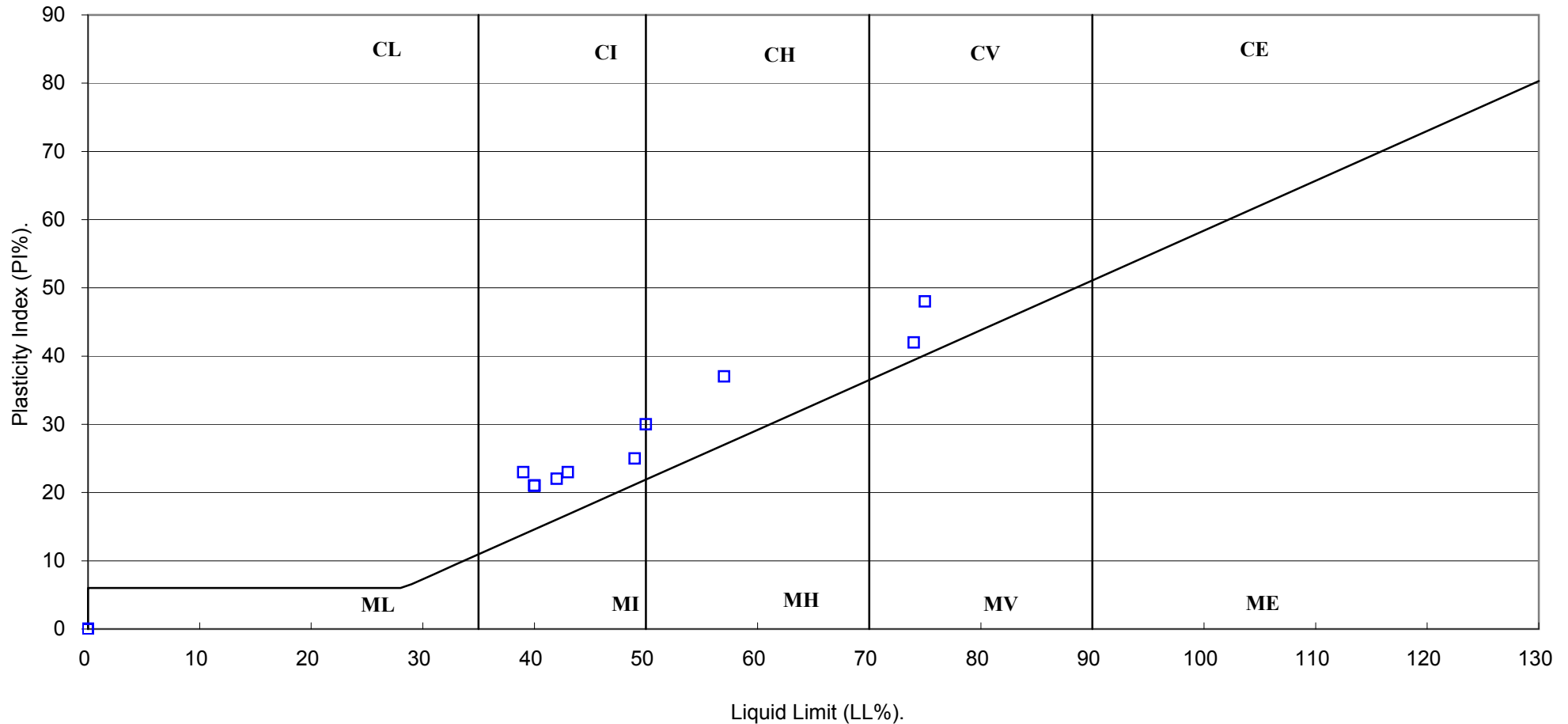


518338	BH8 2.00 SOIL	Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)
518339	BH9 1.00 SOIL	Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)
518340	BH10 1.00 SOIL	Plastic Tub 1 litre (1kg)	Sample is deviating (no sampled date supplied)



# PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)



Compiled by	Date	Checked by	Date	Approved by	Date
<i>[Signature]</i>	04/06/13	<i>[Signature]</i>	04/06/13	<i>[Signature]</i>	04/06/13
<b>CHERRY COBB SANDS.</b>				Contract No:	PSL13/1511
				Client Ref:	KM294

















# Appendix III





## ANALYTICAL TEST REPORT

**Contract no:** 48055  
**Contract name:** Cherry Cobb Sands  
**Client reference:** -  
**Clients name:** Delta Simons  
**Clients address:** The Lawn  
Union Road  
Lincoln  
LN1 3BL

**Samples received:** 03 May 2013

**Analysis started:** 03 May 2013

**Analysis completed:** 13 May 2013

**Report issued:** 13 May 2013

**Notes:** Opinions and interpretations expressed herein are outside the UKAS accreditation scope. Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling. Methods, procedures and performance data are available on request. Results reported herein relate only to the material supplied to the laboratory. This report shall not be reproduced except in full, without prior written approval. Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

**Key:** U UKAS accredited test  
M MCERTS & UKAS accredited test  
\$ Test carried out by an approved subcontractor  
I/S Insufficient sample to carry out test  
N/S Sample not suitable for testing  
NAD No Asbestos Detected

**Approved by:**

*K Campbell*

Karan Campbell  
Director

John Campbell  
Director

# Chemtech Environmental Limited

## SAMPLE INFORMATION

### MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

All results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.

Analytical results are exclusive of stones.

Lab ref	Sample id	Depth (m)	Soil description passing 2mm sieve	Description of material retained on 2mm sieve	% Retained on 2mm sieve	Moisture (%)
48055-1	TP 1	0.00	Clay	N/A	<1	20.4
48055-2	TP 2	0.20	Loamy Clay	N/A	<1	23.8
48055-3	TP 3	0.20	Sandy Clay	N/A	<1	21.8
48055-4	TP 4	0.70	Clayey Sand	N/A	<1	22.3
48055-5	TP 5	0.20	Clay	N/A	<1	20.5
48055-6	TP 6	2.00	Clay	N/A	<1	28.7
48055-7	TP 7	1.70	Sand	N/A	<1	23.8
48055-8	TP 8	0.00	Clayey Loam	N/A	<1	23.8
48055-9	TP 8	0.30	Sandt Clay	N/A	<1	22.9
48055-10	TP 8	1.80	Sand	N/A	<1	23.1
48055-11	TP 9	0.00	Clay	N/A	<1	22.8
48055-12	TP 9	0.30	Clayey Sand	N/A	<1	22.7
48055-13	TP 9	1.70	Clay	N/A	<1	25.1
48055-14	TP 10	0.50	Clay	N/A	<1	23.8
48055-15	TP 10	0.00-0.50	Sandy Clay	N/A	<1	22.8
48055-16	TP 11	0.20	Sandy Clay	N/A	<1	22.5
48055-17	TP 12	0.30	Clayey Sand	N/A	<1	22.2
48055-18	TP 13	0.00	Clay	N/A	<1	17.8
48055-19	TP 14	1.20	Sandy Clay	N/A	<1	21.5
48055-20	TP 15	0.00	Clay	N/A	<1	19.2

# Chemtech Environmental Limited

## SOILS

Lab number			48055-1	48055-2	48055-3	48055-4	48055-5	48055-6
Sample id			TP 1	TP 2	TP 3	TP 4	TP 5	TP 6
Depth (m)			0.00	0.20	0.20	0.70	0.20	2.00
Date sampled			-	-	-	-	-	-
Test	Method	Units						
Arsenic (total)	CE054 <sup>M</sup>	mg/kg As	12	12	6.1	7.7	13	7.5
Boron (water soluble)	CE063 <sup>M</sup>	mg/kg B	1.6	2.3	0.6	1.0	1.3	4.9
Cadmium (total)	CE054 <sup>M</sup>	mg/kg Cd	1.1	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (total)	CE054 <sup>M</sup>	mg/kg Cr	37	36	15	23	35	25
Copper (total)	CE054 <sup>M</sup>	mg/kg Cu	32	15	4.1	7.9	12	7.2
Lead (total)	CE054 <sup>M</sup>	mg/kg Pb	50	49	15	24	38	20
Mercury (total)	CE054	mg/kg Hg	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Nickel (total)	CE054 <sup>M</sup>	mg/kg Ni	33	34	14	22	33	24
Selenium (total)	CE054 <sup>M</sup>	mg/kg Se	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Zinc (total)	CE054 <sup>M</sup>	mg/kg Zn	106	79	29	44	66	45
pH	CE004 <sup>M</sup>	units	8.3	8.2	8.6	8.3	8.2	8.5
<b>PAH</b>								
Naphthalene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Acenaphthylene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Acenaphthene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Fluorene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Phenanthrene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Anthracene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Fluoranthene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Pyrene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Benzo(a)anthracene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Chrysene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Benzo(b)fluoranthene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Benzo(k)fluoranthene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Benzo(a)pyrene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Indeno(123cd)pyrene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Dibenz(ah)anthracene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
Benzo(ghi)perylene	CE087	mg/kg	<0.1	-	-	-	<0.1	-
PAH (total)	CE087	mg/kg	<5	-	-	-	<5	-
<b>TPH</b>								
TPH (C10-C40)	CE033 <sup>U</sup>	mg/kg	30	-	-	-	32	-
<b>Subcontracted analysis</b>								
Asbestos	\$	-	NAD	-	-	-	NAD	-

# Chemtech Environmental Limited

## SOILS

Lab number			48055-7	48055-8	48055-9	48055-10	48055-11	48055-12
Sample id			TP 7	TP 8	TP 8	TP 8	TP 9	TP 9
Depth (m)			1.70	0.00	0.30	1.80	0.00	0.30
Date sampled			-	-	-	-	-	-
Test	Method	Units						
Arsenic (total)	CE054 <sup>M</sup>	mg/kg As	6.7	11	6.2	5.0	12	5.2
Boron (water soluble)	CE063 <sup>M</sup>	mg/kg B	0.8	1.6	0.6	0.8	1.6	0.6
Cadmium (total)	CE054 <sup>M</sup>	mg/kg Cd	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (total)	CE054 <sup>M</sup>	mg/kg Cr	10	32	16	10	35	16
Copper (total)	CE054 <sup>M</sup>	mg/kg Cu	3.6	12	4.7	3.3	14	4.6
Lead (total)	CE054 <sup>M</sup>	mg/kg Pb	12	44	18	7.8	49	17
Mercury (total)	CE054	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel (total)	CE054 <sup>M</sup>	mg/kg Ni	11	31	16	10	33	15
Selenium (total)	CE054 <sup>M</sup>	mg/kg Se	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Zinc (total)	CE054 <sup>M</sup>	mg/kg Zn	21	69	32	20	76	31
pH	CE004 <sup>M</sup>	units	7.9	8.1	8.6	8.4	8.2	8.5
<b>PAH</b>								
Naphthalene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Acenaphthene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Fluorene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Phenanthrene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Anthracene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Fluoranthene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Pyrene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Chrysene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Indeno(123cd)pyrene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Dibenz(ah)anthracene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	CE087	mg/kg	-	-	<0.1	<0.1	<0.1	<0.1
PAH (total)	CE087	mg/kg	-	-	<5	<5	<5	<5
<b>TPH</b>								
TPH (C10-C40)	CE033 <sup>U</sup>	mg/kg	-	-	125	21	32	21
<b>Subcontracted analysis</b>								
Asbestos	\$	-	-	-	-	-	-	NAD



# Chemtech Environmental Limited

## SOILS

Lab number			48055-13	48055-14	48055-15	48055-16	48055-17	48055-18
Sample id			TP 9	TP 10	TP 10	TP 11	TP 12	TP 13
Depth (m)			1.70	0.50	0.00-0.50	0.20	0.30	0.00
Date sampled			-	-	-	-	-	-
Test	Method	Units						
Arsenic (total)	CE054 <sup>M</sup>	mg/kg As	6.7	13	5.7	5.4	5.4	11
Boron (water soluble)	CE063 <sup>M</sup>	mg/kg B	1.5	1.5	0.3	0.3	0.4	0.8
Cadmium (total)	CE054 <sup>M</sup>	mg/kg Cd	<0.2	<0.2	<0.2	<0.2	0.2	<0.2
Chromium (total)	CE054 <sup>M</sup>	mg/kg Cr	20	36	11	14	17	29
Copper (total)	CE054 <sup>M</sup>	mg/kg Cu	6.6	15	3.4	4.5	5.6	9.4
Lead (total)	CE054 <sup>M</sup>	mg/kg Pb	21	49	12	19	18	35
Mercury (total)	CE054	mg/kg Hg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel (total)	CE054 <sup>M</sup>	mg/kg Ni	19	35	12	14	18	29
Selenium (total)	CE054 <sup>M</sup>	mg/kg Se	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Zinc (total)	CE054 <sup>M</sup>	mg/kg Zn	38	78	23	28	34	56
pH	CE004 <sup>M</sup>	units	8.0	8.2	8.6	8.6	8.6	8.6
<b>PAH</b>								
Naphthalene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Acenaphthylene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Acenaphthene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Fluorene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Phenanthrene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Anthracene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Fluoranthene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Pyrene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Benzo(a)anthracene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Chrysene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Benzo(b)fluoranthene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Benzo(k)fluoranthene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Benzo(a)pyrene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Indeno(123cd)pyrene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Dibenz(ah)anthracene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
Benzo(ghi)perylene	CE087	mg/kg	<0.1	<0.1	-	-	-	<0.1
PAH (total)	CE087	mg/kg	<5	<5	-	-	-	<5
<b>TPH</b>								
TPH (C10-C40)	CE033 <sup>U</sup>	mg/kg	48	76	-	-	-	33
<b>Subcontracted analysis</b>								
Asbestos	\$	-	-	-	-	-	-	NAD

# Chemtech Environmental Limited

## SOILS

Lab number			48055-19	48055-20
Sample id			TP 14	TP 15
Depth (m)			1.20	0.00
Date sampled			-	-
Test	Method	Units		
Arsenic (total)	CE054 <sup>M</sup>	mg/kg As	5.7	8.6
Boron (water soluble)	CE063 <sup>M</sup>	mg/kg B	0.4	0.8
Cadmium (total)	CE054 <sup>M</sup>	mg/kg Cd	<0.2	<0.2
Chromium (total)	CE054 <sup>M</sup>	mg/kg Cr	12	27
Copper (total)	CE054 <sup>M</sup>	mg/kg Cu	4.1	9.2
Lead (total)	CE054 <sup>M</sup>	mg/kg Pb	15	24
Mercury (total)	CE054	mg/kg Hg	<05	<0.5
Nickel (total)	CE054 <sup>M</sup>	mg/kg Ni	13	22
Selenium (total)	CE054 <sup>M</sup>	mg/kg Se	<0.3	<0.3
Zinc (total)	CE054 <sup>M</sup>	mg/kg Zn	26	53
pH	CE004 <sup>M</sup>	units	8.6	8.5
<b>PAH</b>				
Naphthalene	CE087	mg/kg	-	<0.1
Acenaphthylene	CE087	mg/kg	-	<0.1
Acenaphthene	CE087	mg/kg	-	<0.1
Fluorene	CE087	mg/kg	-	<0.1
Phenanthrene	CE087	mg/kg	-	<0.1
Anthracene	CE087	mg/kg	-	<0.1
Fluoranthene	CE087	mg/kg	-	<0.1
Pyrene	CE087	mg/kg	-	<0.1
Benzo(a)anthracene	CE087	mg/kg	-	<0.1
Chrysene	CE087	mg/kg	-	<0.1
Benzo(b)fluoranthene	CE087	mg/kg	-	<0.1
Benzo(k)fluoranthene	CE087	mg/kg	-	<0.1
Benzo(a)pyrene	CE087	mg/kg	-	<0.1
Indeno(123cd)pyrene	CE087	mg/kg	-	<0.1
Dibenz(ah)anthracene	CE087	mg/kg	-	<0.1
Benzo(ghi)perylene	CE087	mg/kg	-	<0.1
PAH (total)	CE087	mg/kg	-	<5
<b>TPH</b>				
TPH (C10-C40)	CE033 <sup>U</sup>	mg/kg	-	26
<b>Subcontracted analysis</b>				
Asbestos	\$	-	-	NAD

# Chemtech Environmental Limited

## METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE054	Arsenic (total)	Aqua regia digest, ICP-OES	Dry	M	1	mg/kg As
CE063	Boron (water soluble)	Hot water extract, ICP-OES	Dry	M	0.3	mg/kg B
CE054	Cadmium (total)	Aqua regia digest, ICP-OES	Dry	M	0.2	mg/kg Cd
CE054	Chromium (total)	Aqua regia digest, ICP-OES	Dry	M	1	mg/kg Cr
CE054	Copper (total)	Aqua regia digest, ICP-OES	Dry	M	1	mg/kg Cu
CE054	Lead (total)	Aqua regia digest, ICP-OES	Dry	M	1	mg/kg Pb
CE054	Mercury (total)	Aqua regia digest, ICP-OES	Dry		0.5	mg/kg Hg
CE054	Nickel (total)	Aqua regia digest, ICP-OES	Dry	M	1	mg/kg Ni
CE054	Selenium (total)	Aqua regia digest, ICP-OES	Dry	M	0.3	mg/kg Se
CE054	Zinc (total)	Aqua regia digest, ICP-OES	Dry	M	3	mg/kg Zn
CE004	pH	Based on BS 1377, pH Meter	Wet	M	-	units
CE087	PAH (speciated)	Solvent extraction, GC-MS	Wet		0.1	mg/kg
CE087	PAH (total)	Solvent extraction, GC-MS	Wet		5	mg/kg
CE033	TPH (C10-C40)	Solvent extraction, GC-FID	Wet	U	10	mg/kg
\$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

# Chemtech Environmental Limited

## DEVIATING SAMPLE INFORMATION

### Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

### Key

- N No (not deviating sample)
- Y Yes (deviating sample)
- A Sampling date not provided
- B Sampling time not provided (waters only)
- C Sample exceeded holding time(s)
- D Sample not received in appropriate containers
- E Headspace present in sample container
- F Sample not chemically fixed (where appropriate)
- G Sample not cooled
- H Other (specify)

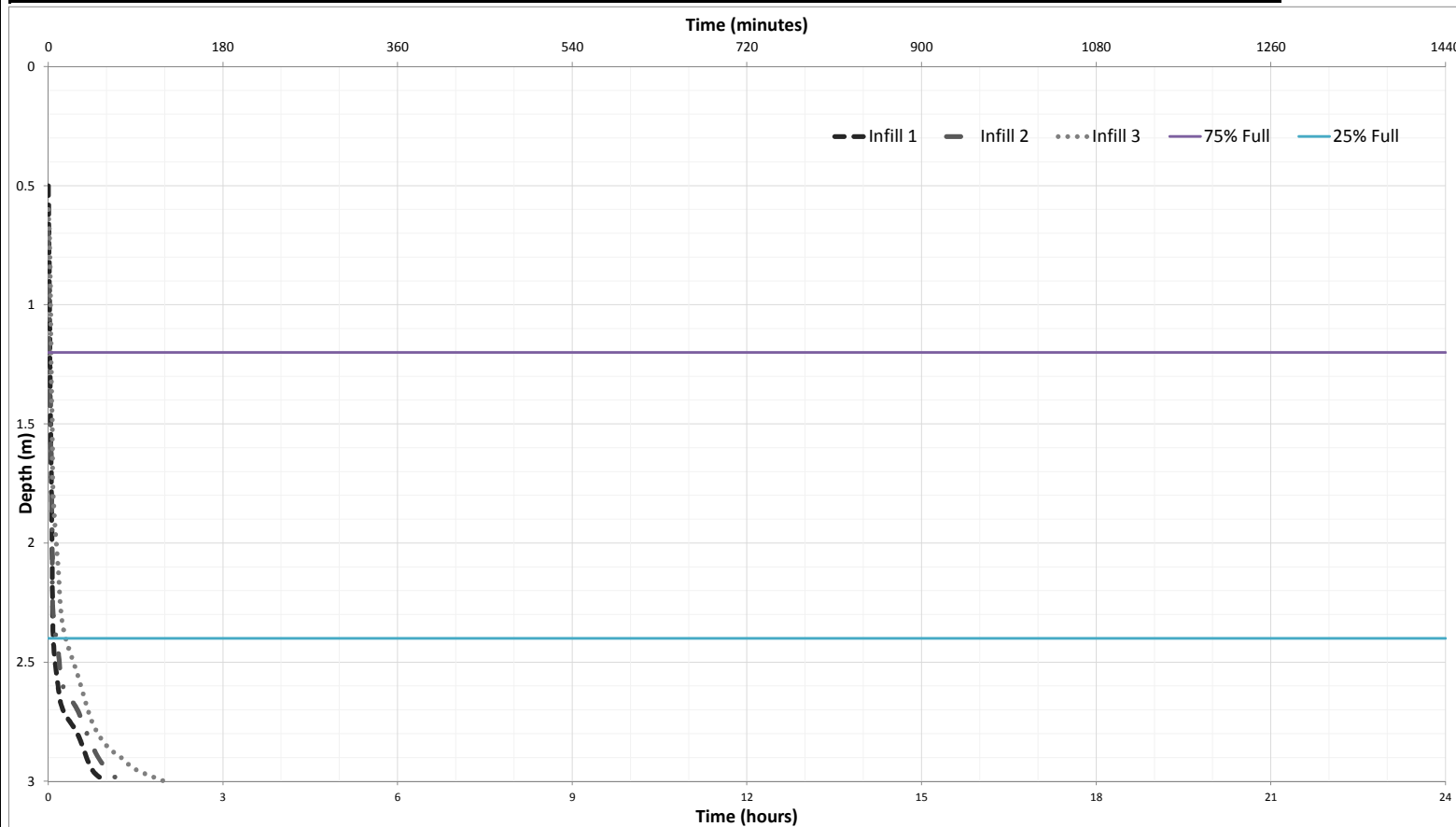
Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
48055-1	TP 1	0.00	Y	All (A), PAH / TPH C10-C40 (D)
48055-2	TP 2	0.20	Y	All (A)
48055-3	TP 3	0.20	Y	All (A)
48055-4	TP 4	0.70	Y	All (A)
48055-5	TP 5	0.20	Y	All (A)
48055-6	TP 6	2.00	Y	All (A)
48055-7	TP 7	1.70	Y	All (A)
48055-8	TP 8	0.00	Y	All (A)
48055-9	TP 8	0.30	Y	All (A), PAH / TPH C10-C40 (D)
48055-10	TP 8	1.80	Y	All (A)
48055-11	TP 9	0.00	Y	All (A), PAH / TPH C10-C40 (D)
48055-12	TP 9	0.30	Y	All (A), PAH / TPH C10-C40 (D)
48055-13	TP 9	1.70	Y	All (A), PAH / TPH C10-C40 (D)
48055-14	TP 10	0.50	Y	All (A), PAH / TPH C10-C40 (D)
48055-15	TP 10	0.00-0.50	Y	All (A)
48055-16	TP 11	0.20	Y	All (A)
48055-17	TP 12	0.30	Y	All (A)
48055-18	TP 13	0.00	Y	All (A)
48055-19	TP 14	1.20	Y	All (A)
48055-20	TP 15	0.00	Y	All (A)

# Appendix IV



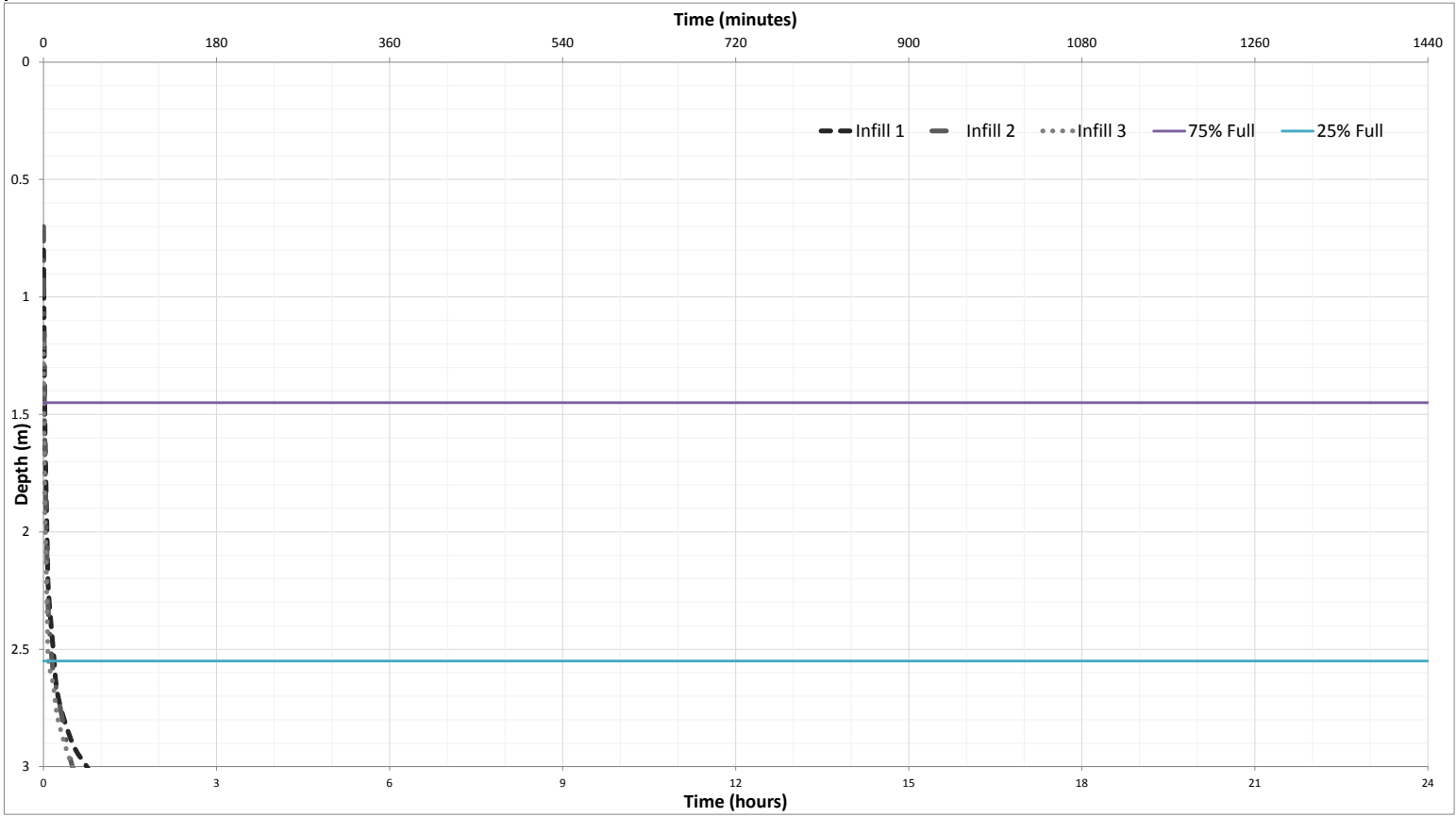
	units	Fill 1	Fill 2	Fill 3
Depth (final reading)	m	3.00	3.00	3.00
Pit depth	m	3.00		
Pit length	m	4.00		
Pit width	m	0.60		
Depth to first reading	m	0.50	0.70	0.60
Maximum effective depth	m	2.50	2.30	2.40
Depth at 75% full	m	1.13	1.28	1.20
Depth at 25% full	m	2.38	2.43	2.40
Time at 75% full	mins	1.45	0.96	2.75
Time at 25% full	mins	4.92	9.17	18.75
Vp75 - 25 (volume outflowing between 75% and 25% effective depth)	m <sup>3</sup>	1.050	0.966	1.008
Mean surface area for outflow (50% effective depth)	m <sup>2</sup>	13.90	12.98	13.44
Time for outflow	mins	3.47	8.21	16.00
Soil infiltration rate, f =		<b>0.0003631710</b>	<b>0.0001511110</b>	<b>0.0000781250</b>
or		<b>3.63E-04</b>	<b>1.51E-04</b>	<b>7.81E-05</b>

Recommended soil infiltration rate	
0.0000781250	m/s
or	
7.81E-05	m/s



	units	Fill 1	Fill 2	Fill 3
Depth (final reading)	m	3.10	3.10	3.10
Pit depth	m		3.10	
Pit length	m		4.00	
Pit width	m		0.60	
Depth to first reading	m	0.80	0.70	1.20
Maximum effective depth	m	2.30	2.40	1.90
Depth at 75% full	m	1.38	1.30	1.68
Depth at 25% full	m	2.53	2.50	2.63
Time at 75% full	mins	0.96	0.75	0.79
Time at 25% full	mins	10.63	8.00	8.75
Vp75 - 25 (volume outflowing between 75% and 25% effective depth)	m3	0.966	1.008	0.798
Mean surface area for outflow (50% effective depth)	m2	12.98	13.44	11.14
Time for outflow	mins	9.67	7.25	7.96
Soil infiltration rate, f =		<b>0.0001283141</b>	<b>0.0001724138</b>	<b>0.0001500183</b>
or		<b>1.28E-04</b>	<b>1.72E-04</b>	<b>1.50E-04</b>

Recommended soil infiltration rate	
0.0001283141	m/s
or	
1.28E-04	m/s



PROJECT NAME	Cherry Cobb Sands
CLIENT	Able UK

**SOAKAWAY TEST RESULTS**

*In accordance with BRE Digest 365 (1991 with amendments in 2003 and 2007)*

DATE	PROJECT NUMBER
Apr-13	13-0054.01
SOAKAWAY NUMBER	FILL NUMBER
<b>TP 9</b>	<b>1-3</b>