

Coed Darcy
Capping of Crymlyn Tip -
Construction Quality Assurance Plan
St. Modwen Developments Ltd.

July 2013

ATKINS

Notice

This document and its contents have been prepared and are intended solely for St. Modwen Developments Limited's (SMD) use as a Construction Quality Assurance (CQA) Plan to Cyfoeth Naturiol Cymru/Natural Resources Wales (CNC/NRW) for the capping and restoration of the Crymlyn Tip, Llandarcy, Neath Port, Talbot, South Wales.

Atkins Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

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1. Introduction

Atkins Limited (Atkins) has been commissioned by St. Modwen Developments Limited's (SMD) to provide a Construction Quality Assurance (CQA) plan for the capping and restoration of the Crymlyn Tip, Llandarcy, Neath Port, Talbot, South Wales.

1.1. Background

The Crymlyn Tip as shown on Drawing 5041216-RAP-DWG--RAP-DWG-0001082 is a currently permitted waste tip facility with Cyfoeth Naturiol Cymru/Natural Resources Wales (CNC/NRW). The permitted area, which is also referred to as the "containment area", within the Permit Variation Notice (EPR/AP3990LR/V002 [Ref. 1]) is located next to the Crymlyn Bog on the former BP Llandarcy Refinery site, which is also known as the Coed Darcy site (Drawing 5041216-RAP-DWG-0001081).

The eastern part of the permitted area, where waste has been deposited since 1920s [Ref. 2], is referred to as the "landfilled area" as shown on the then Environment Agency Wales's (EAW's) Plan. All the rest of the permitted area, including the western part of the permitted area and that outside the landfilled area, is regarded as the "non-operational area" which has not been subject to permanent deposition of waste under the permit. It is understood that SMD intends to apply for partial permit surrender for the non-operational area. The Section 106 Agreement associated with the Outline Planning Consent [Ref. 3] for the Coed Darcy requires SMD to cap the landfilled area and surrender the permit as a whole. Under the Outline Consent the Tip will be non-public open space, i.e. will be kept securely fenced until surrender can be achieved. It is further understood that there are no specific restoration or landscape requirements associated with the Tip as a result of previous planning consents or the Outline Consent for the Coed Darcy.

It is understood that a Tip Closure and Completion Strategy report prepared by URS on behalf of the former site owner, BP, in 2006 [Ref.2] was previously communicated to and agreed in principle by the then EAW and partial restoration was commenced under the previous licence. The URS report stated that the Tip had not accepted waste since 1999 (Section 1.3 of Ref.2) and proposed it to be restored. On the basis that only the landfilled area was subject to deposition of waste, the proposed area for capping and restoration is limited to the landfilled area.

The restoration of the landfilled area is part of the remedial strategy for the Tip and the Crymlyn Bog Lagoon which has been undertaken since 2008 and is still ongoing [Ref. 9 and 10]. The licence surrender programme for the Tip will be covered in separate documents to be agreed with CNC/NRW.

1.2. Objectives of this CQA Plan

1.2.1. Construction proposal

The capping and restoration works are "construction of landfill infrastructure", and CNC/NRW's approval of the works will be required via a construction proposal in accordance with condition 2.5.2 of the permit [Ref. 1].

This CQA Plan serves as the construction proposal providing the design details of the proposed capping and restoration of the landfilled area of the Tip which is to be submitted to CNC/NRW for approval prior to the works commencing.

1.2.2. Definitions of specific CQA requirements

The design of the cap and the restoration is Landfill Directive compliant and the construction works will be carried out under construction quality assurance (CQA) procedures. Section 2 of this CQA Plan defines the scope of CQA works and the responsibilities of the parties involved. The proforma designed to record the necessary CQA information during the construction process are included in Appendix A.

1.2.3. Review of hydrogeological risks

As required by Condition 2.4.1 of the Environmental Permit, a review of the hydrogeological risk assessment [Ref 12] has been completed and submitted to CNC/NRW. The review demonstrates that the landfilled areas is not having a significant effect on groundwater quality and makes recommendations for further monitoring. As such, it supports the conclusions reached by URS [Ref. 2] with regard to acceptability of materials. Specifically, it is concluded that there is no requirement for a low permeability cap at the site to provide protection of the water environment.

The chemical acceptance concentrations for the capping material derived in the URS report [Ref. 2] were subsequently amended as advised by the then EAW and the final concentrations accepted by the EAW are tabulated in Appendix D, Tables D3 and D4.

A remedial action plan (RAP) was agreed with the the Environment Agency Wales and has been implemented at the Coed Darcy site following the decommissioning and demolition of the former Refinery in 2008/09. Some of the remedial actions (soil treatment, sludge removal, bioremediation, installation of oil containment/collection trenches) of the RAP have taken place within and in close proximity to the Tip. As a result of the RAP, the present contamination level of the waste in the landfilled area of the Tip is expected to be generally lower and posing less risk to controlled waters than those reported in the URS report in 2006 and hence it is considered that the conclusions reached within the URS report remain relevant and are probably more conservative than the present situation would determine.

1.2.4. Review of stability risks

This CQA Plan reviews parts of the URS report [Ref.2] which are relevant to the stability risks of the capping and restoration proposal of the landfilled area of the Tip, the restoration landform design in Sections 5.6 and 6 of Ref.2 in particular. The restoration landform design in the URS report recommended the final slopes in some of the Tip areas to be worked to 1v:10h and 1v:12h. However, following a review of the data a new landform design is proposed to minimize the disturbance of the existing waste including the asbestos graves and vanadium pits, to enable efficient surface water runoff and maximise the area of the containment area that can be relapsed (through the partial surrender process) for other uses within the development. The stability risk assessment (SRA) Review in Appendix C reviews the basis of the stability assessment in the URS report in the context of the current proposals and assesses the stability of the slopes of the new design by numerical analysis.

In 2006, a ground investigation within and in close proximity to the Tip was undertaken and was reported by URS in 2008 [Ref. 11]. The report confirmed the local geological profile as the following:

- Made Ground;
- Bog Sequence - Peat Deposits;
- Bog Sequence - Organic Clays, Sands and Gravels;
- Glacial Till; and
- Glacial Gravel.

The URS ground investigation report [Ref. 11] concludes that the finished landform should not have slopes in excess of angles of 32° (1 in 1.60), 30° (1 in 1.73) and 24° (1 in 2.25) for MCHW Class 1A granular and Class 1B granular and Class 2 cohesive materials respectively. Based upon the nature of the peat, the URS ground investigation report [Ref. 11] states the proposed timescale is 2 to 3 years from the restoration works to be sufficient for initial consolidation to have occurred, and the secondary compression is estimated to be likely to occur substantially in the 10 years following construction.

There is limited data on the existing waste as provided in the URS ground investigation report [Ref. 11] and the URS report [Ref. 2] states the landform design did not refer to any site-specific geotechnical data. Sampling and geotechnical testing of the waste and the proposed materials was undertaken under Atkins' control in November 2011 to support the design of the slopes in this CQA Plan. The sampling details and the test data are included in Appendix B, and the review of the stability risks in Appendix C.

Geostudio SLOPE/W modelling has been undertaken based on the geotechnical test data to assess the stability risks against slope failure for a 1v:3h slope. The modelling results indicate the stability risks are acceptable as the factor of safety (FoS) of the proposed slope is found to be greater than 1.3 (Appendix C).

The stability of the areas of the permitted area that have not been subject to permanent deposition of waste has been assessed via regular topographic surveys. This information was submitted to CNC/NRW by letter on 1st July 2013. A copy is included in Appendix E. The surveys confirmed that there has been no significant settlement in these areas over the last year.

1.2.5. Specification of materials

The proposed materials to be used for the capping and restoration works are materials recovered, i.e. won from within the Coed Darcy site as part of the RAP and development process. Materials will be imported for the works only if there is a deficiency of site won materials when work is about to start. Any imported materials used for the works will be subject to the same selection criteria, i.e. the specification in Appendix D, as those for the site won materials.

A selection of the proposed materials is currently stockpiled outside but near the Tip within the Coed Darcy (Drawing 5041216-RAP-DWG-0001081). These stockpiled materials are managed and tracked as part of the Coed Darcy Materials and Stockpile management system which forms part of the procedures for wider environmental management agreed as part of the planning requirements for the site. The system allows material provenance to be tracked and verified to ensure material placement complies with 'suitable for use' criteria, and, in the case of the landfilled area of the Coed Darcy tip, this CQA plan.

The acceptance criteria for the soil (and of the soil leachate) were previously agreed in the correspondence between URS and the then EAW in 2007 (Appendix E). A complete "Specification for Materials and Installation of the Cap and Restoration Layers" including the requirements for chemical quality, requirements for grading, conformance testing, sampling frequency, compaction and surveys is included in Appendix D of this CQA Plan.

1.2.6. Quantity of materials

This CQA Plan includes the design of the waste profile and post-restoration profiles of the landfilled area of the Tip, which demonstrates that the materials, and the estimated quantity, to be used for capping and restoration works will be truly "recovered", i.e. their use within the Tip is necessary and replacing the use of virgin materials that would otherwise have to be imported.

2. Definitions

2.1. General

In the context of this construction quality assurance (CQA) plan, “quality assurance” refers to the means and actions employed by the employer, and as delegated to the quality assurance consultant (QAC), to assure conformity of the materials, construction and installation with the specific project information, i.e. approved designs, specifications and regulatory requirements.

“Quality control” refers to the actions taken by the manufacturers, suppliers, contractors, installers, laboratories and surveyors to ensure the supplied materials, components, processes and workmanship meet the specific project information.

2.2. Site

The “Site” refers to the landfilled area of the Crymlyn Tip as shown on Drawing 5041216-RAP-DWG-0001082.

The Site is part of the permitted area of the Crymlyn Tip and is within the Coed Darcy (Drawing 5041216-RAP-DWG-0001081).

A site description is included in Appendix D as part of the information to the Contractor.

2.3. Scope

This CQA Plan relates to the following works:

- Selection and processing of materials;
- Site clearance including the removal of redundant boreholes prior to waste surface re-profiling;
- Re-profiling the surface of the waste;
- Installation of the cap on top of the waste;
- Installation of a restoration layer on top of the cap; and
- Surveys and laboratory analysis for conformity.

There will be further landscape works, including seeding, planting and addition of nutrient for vegetation over the restoration layer, which are outside the scope of this CQA Plan since they are considered to have no impact on the performance of the landfill.

2.4. Responsibilities

2.4.1. Employer

The Employer is St. Modwen Developments Limited (SMD).

2.4.2. Contractor

The Contractor will be appointed by the Employer. The Contractor is responsible for all the earthworks related to the proposed works and those undertaken by the Contractor’s sub-contractors, including material selection, material transportation, site clearance, disposal of material, waste surface re-profiling, and installation of capping and restoration layers.

2.4.3. Quality Assurance Consultant (QAC)

The Quality Assurance Consultant is Atkins Limited (Atkins). The QAC is the firm employed by the Employer to perform quality assurance and collect quality control documents from other parties.

The term **quality assurance engineer (QAE)** refers to the engineer, working for and designated by the QAC, who is in charge of the quality assurance.

The personnel of the QAC may also include **quality assurance monitors (QAM)** who will be located at the site to perform the following duties:

- Compiling site records to include the following:
 - Notes of observations and photographic records of the construction and changes to the site;
 - Weather conditions;
 - Personnel and contacts (e.g. mobile nos.) of all parties on site;
 - Types of machinery, equipment and plants used on site, and breakdowns;
 - Delivery, handling and storage of materials;
- compiling photographic photos of the construction;
- Assigning locations for CQA inspection and testing and maintaining records;
- Scheduling conformance testing;
- Reviewing conformance test results;
- Verifying calibration of in-situ testing equipments (if any);
- Identifying and resolving deviations from the CQA Plan;
- Liaison and correspondence with the CNC/NRW, the Employer, the Contractors and his sub-contractors, installers, manufacturers, suppliers, laboratories and surveyors; and
- Preparation of the CQA Report.

2.4.4. Topographical Surveyor

The topographical surveyor is the firm, professional body or academic institute which undertakes topographical surveys of the levels of various layers of the works. They will be employed by the Employer, the quality assurance consultant (QAC), or the Contractor or his sub-contractors.

2.4.5. Quality Assurance Laboratories (QAL)

The quality assurance laboratories (QAL) are the firm, professional body or academic institute which undertakes conformance testing as directed by the QAC.

The QAL are to be confirmed. The QAL will be employed by the Employer, the quality assurance consultant (QAC), or the Contractor or his sub-contractors.

Any QAL employed by the Contractor and his sub-contractors shall be pre-approved by the QAC in advance. All the conformance testing shall be UKAS accredited.

3. Design

3.1. Specification

3.1.1. Scope of works

The specification for the following works to be undertaken by the Contractor is included in Appendix D of this CQA Plan and includes:

- Selection and processing of materials;
- Site clearance including the removal of redundant boreholes prior to waster surface re-profiling;
- Re-profiling the surface of the waste;
- Installation of a cap on top of the waste;
- Installation of a restoration layer on top of the cap; and
- Surveys and laboratory analysis for conformity.

3.1.2. Criteria for selection of materials

The proposed materials for the works are existing stockpiles of suitable soil in the Coed Darcy which were soil won by remediation as part of the RAP and other development related activities. The Specification for selection and processing of materials includes chemical and grading requirements. Materials will be imported for the works only if there is a deficiency of site won materials when work is about to be commencing. Any imported materials used for the works will be subject to the same selection criteria, i.e. the specification in Appendix D, as those for the site won materials.

The contaminant acceptance criteria for soil (and of the soil leachate) specified in Appendix D, Table D3 and D4 are as previously agreed in the correspondence between URS and the then EAW in 2007 (Appendix E). These acceptance concentrations are derived from the risk assessments in the URS report [Ref. 2] and subsequently amended and accepted by the then EAW in the URS/EAW correspondence dated 23 August 2007 and 27 July 2007 (Correspondence letters included in Appendix F). As denoted in the URS/EAW correspondences, these values are for the protection of groundwater, protective of human health and groundwater, or previously agreed with Neath Port Talbot Borough Council Environmental Heath. The acceptance criteria are directly adopted to Appendix D, Tables D3 and D4.

The restoration materials require more well graded soil than the materials for waste surface re-profiling and capping materials so as to achieve a good quality final surface for future vegetation.

3.1.3. Thickness

The proposed thickness of the cap, on top of the waste, is a minimum of 500 mm, which is in line with the thickness previously agreed in the correspondence between URS and the then EAW in 2007 (Appendix E).

The proposed thickness of the restoration layer, on top of the cap, is also a minimum of 500 mm to allow rooting of future vegetation.

For the areas designed to be trafficked, i.e. access for machinery and vehicles, the thickness of the capping will be a minimum of 1000 mm, and restoration materials are not required in these areas (Appendix D).

3.1.4. Compaction

The specification (Appendix D) requires the materials to be compacted to form the cap and the restoration layer.

3.1.5. Surveys and laboratory analysis

The specification (Appendix D) requires that the conformance of the materials and the works are confirmed by UKAS accredited tests in QALs and topographical surveys. The sampling frequency and spatial interval for the surveys are also specified.

3.2. Design Drawings

The following Table 1 summarizes the design drawings:

Table 1

	Drawing Ref.	Drawing Title
EAW		Environment Agency Wales's Plan
URS	44382624-Figure 2	Topographical Survey
Atkins	5041216-RAP-DWG-000932	Topographical Survey
Atkins	5041216-RAP-DWG-0001081	Site Location and Access
Atkins	5041216-RAP-DWG-0001082	Site Boundary and Constraints
Atkins	5041216-RAP-DWG-0001083	Proposed Top of Waste Levels
Atkins	5041216-RAP-DWG-0001084	Proposed Top of Cap Levels
Atkins	5041216-RAP-DWG-0001085	Proposed Top of Restoration Levels
Atkins	5041216-RAP-DWG-0001086	CQA Testing Location Reference
Atkins	5041216-RAP-DWG-0001087	Cross Sections of Proposed Landform

3.3. Deviation from the CQA Plan

Following the approval of this CQA Plan, subsequent major amendments or deviation from it will be notified to the CNC/NRW for approval prior to the construction of the amended parts commencing.

4. CQA Monitoring and Reporting

4.1. CQA Monitoring

Site monitoring will be undertaken on a part-time basis by the quality assurance monitors (QAM) at a minimum frequency of 3 times a week for each week of 5 working days during the following works:

- The decommissioning, removal and backfilling of redundant boreholes prior to waster surface re-profiling;
- Re-profiling the surface of the waste;
- Installation of a cap on top of the waste; and
- Installation of a restoration layer on top of the cap.

Site monitoring is not proposed for the following works which will be validated by test results and survey data:

- Selection and processing of materials;
- Site clearance (apart from the decommissioning, removal and backfilling of redundant boreholes); and
- Surveys and laboratory analysis for conformity.

4.2. CQA Reporting

Following the construction outlined in the scope in Section 3.1, a CQA Report will be prepared by the quality assurance engineer (QAE) and submitted to the Environment Agency Wales in accordance with condition 2.5.3 of the permit [Ref. 1].

The CQA Report shall comprise the following:

- Inspection records of the re-profiled waste surface in the format of the proforma in Appendix A;
- Sampling records of materials in the format of the proforma in Appendix A;
- Sampling records of the compacted layers in the format of the proforma in Appendix A;
- Site inspection records, if other observations are noted, in the format of the proforma in Appendix A;
- Topographical surveys data and interpretation of thickness of capping and restoration layers;
- Laboratory analytical results of conformance tests of materials and compacted layers;
- Construction notes and as-built records supplied by contractors and installers (if any);
- Deviations from the approved design in this CQA Plan and non-conformance (if any); and
- Statements by the QAC which confirm that the works have been carried out in accordance with the CQA Plan and the CQA Report represents a true record of the works on the basis of CQA monitoring on site and the information supplied by various parties.

5. References

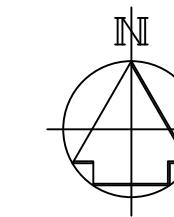
1. EAW, 2010, Environmental Permit, Variation Notice no. EPR/AP3990LR/V002, Environment Agency Wales.
2. URS, 2006, BP Llandarcy Remedial Action Plan, Tip Closure and Completion Strategy, Ref. 44382528, Issue No. 1c.
3. Outline Consent, Section 106, 2008, Deed OF Planning Obligations, pursuant to section 106 of the Town and Country Planning Act 1990, relating to land at Llandarcy, Neath Port Talbot, South Wales, Ref: GNP/NJR/13773-2.
4. EA, 2003, Hazardous waste: Interpretation of the Definition and Classification of Hazardous Waste, WM2, Environment Agency.
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7. BS 1377-2, 1990, Methods of test for soils for civil engineering purposes, Classification tests, British Standard.
8. HSE, L144, Construction (Design and Management) Regulations 2007, (CDM) Approved Code of Practice, Health and Safety Executive.
9. Celtic, 2010, Coed Darcy Urban Village Former BP Llandarcy Oil Refinery Neath/Port Talbot, Containment Area – Crymlyn Bog Lagoon Remediation Strategy, Ref. R1352/10/3907, Second Issue.
10. Celtic, 2009, Containment Area, Coed Darcy, Llandarcy, Free Product Recovery - Remedial Strategy, Ref. R1296/09/3619.
11. URS, 2008, Llandarcy Tip Restoration, Ground Investigation Report, Ref. 44382540/BDRP0011, Issue No. 1.
12. Atkins Limited, June 2013. Hydrogeological Risk Assessment. Crymlyn Tip.

CAPING OF CROMLYN CONSTRUCTION QUALITY ASSURANCE PLAN	–	MC	19.03.12
	Rev.	Authorised for issue	Date

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PROJECT
COED DARCÝ[illegible]

DRAWING NO	REV
5041216-RAP-DWG-0001081	-



NOTES

1. DO NOT SCALE
2. TOPOGRAPHICAL DATA TAKEN FROM 5041216-RAP-DWG-000932

LEGEND

- SITE BOUNDARY
 ACCESS TO SITE
 TIP, LANDFILLED AREA
 APPROXIMATE AREA OF HEAVY VEGETATION
 RESERVOIR

CRYMLYN BOG

OPEN SPACE



**OPEN
SPACE**

PLANT / MACHINERY ACCESS
HAUL ROAD

FLAT ASH BUND
HAUL ROAD

CRYMLYN B

3.5 TO 5m WIDE

OPEN SPACE

SOUTH BAY

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CAPPING OF CRYMLYN CONSTRUCTION QUALITY ASSURANCE PLAN	—	MC	19/03/20
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PROJECT

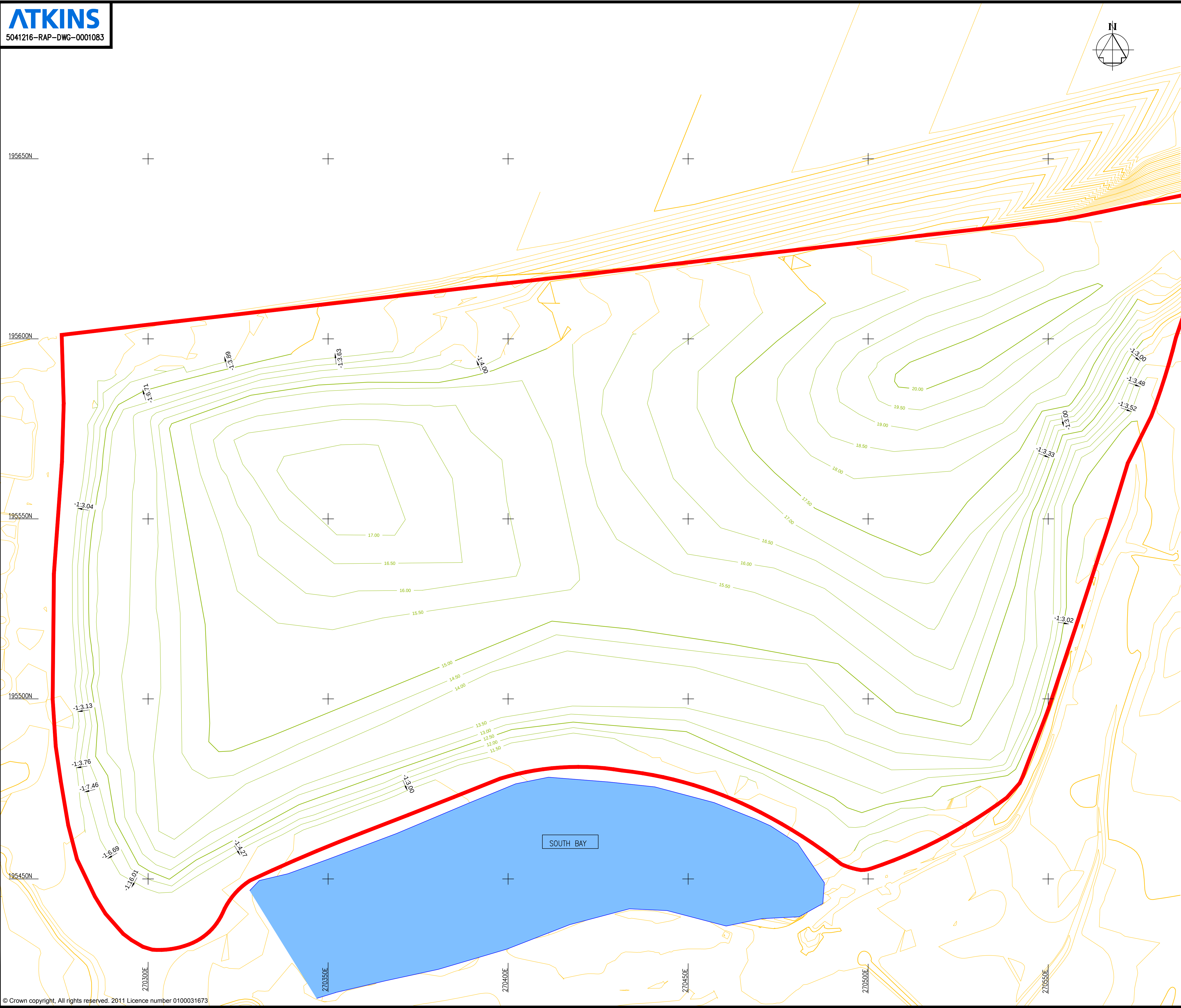
COED Darcy

DRAWING TITLE

SITE BOUNDARY AND CONSTRAINTS

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		SHEET A1	PLOT DATE 26/06/13
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- LEGEND
- SITE BOUNDARY (Area: 45713m²)
 - RESERVOIR

Base Surface	Comparison Surface	Cut (m3)	Fill (m3)	Net
Topo Survey	Top of Waste	3724.99	36735.37	-33010.38
Top of Waste	Top of Cap	0	18580.95	-18580.95
Top of Cap	Top of Restoration	0	19318.43	-19318.43

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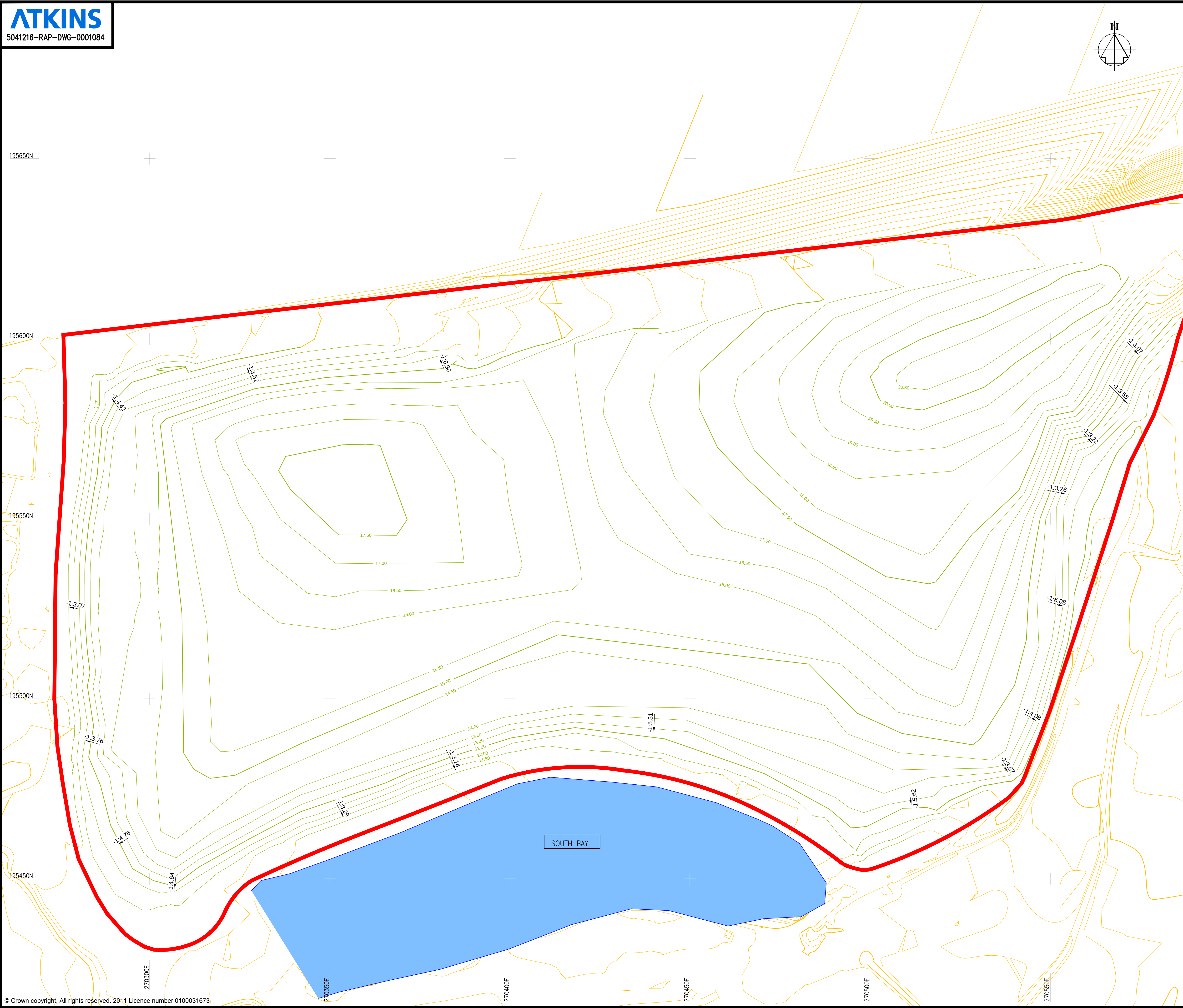
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PROJECT
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PROPOSED TOP OF WASTE LEVELS

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0		SHEET A1	PLOT DATE 26/06/13
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LEGEND

	SITE BOUNDARY (Area: 45713m ²)
	RESERVOIR

Base Surface	Comparison Surface	Cut (m3)	Fill (m3)	Net
Topo Survey	Top of Waste	3724.99	36735.37	-33010.38
Top of Waste	Top of Cap	0	18580.95	-18580.95
Top of Cap	Top of Restoration	0	19318.43	-19318.43

REVISIONS	Drawn By	Checked By	Date

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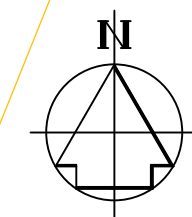
PROJECT

COED DARCY

DRAWING TITLE

PROPOSED TOP OF CAP LEVELS

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NOTES

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LEGEND

- SITE BOUNDARY (Area: 45713m²)
- RESERVOIR

Base Surface	Comparison Surface	Cut (m3)	Fill (m3)	Net
Topo Survey	Top of Waste	3724.99	36735.37	-33010.38
Top of Waste	Top of Cap	0	18580.95	-18580.95
Top of Cap	Top of Restoration	0	19318.43	-19318.43

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Consulting Engineers

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Birmingham West Midlands B1 1TF

Tel 0121 483 5000
Fax 0121 483 5252

©

THIS DRAWING IS NOT TO BE SCALED

CLIENT



PROJECT

COED Darcy

DRAWING TITLE
PROPOSED TOP OF RESTORATION LEVELS

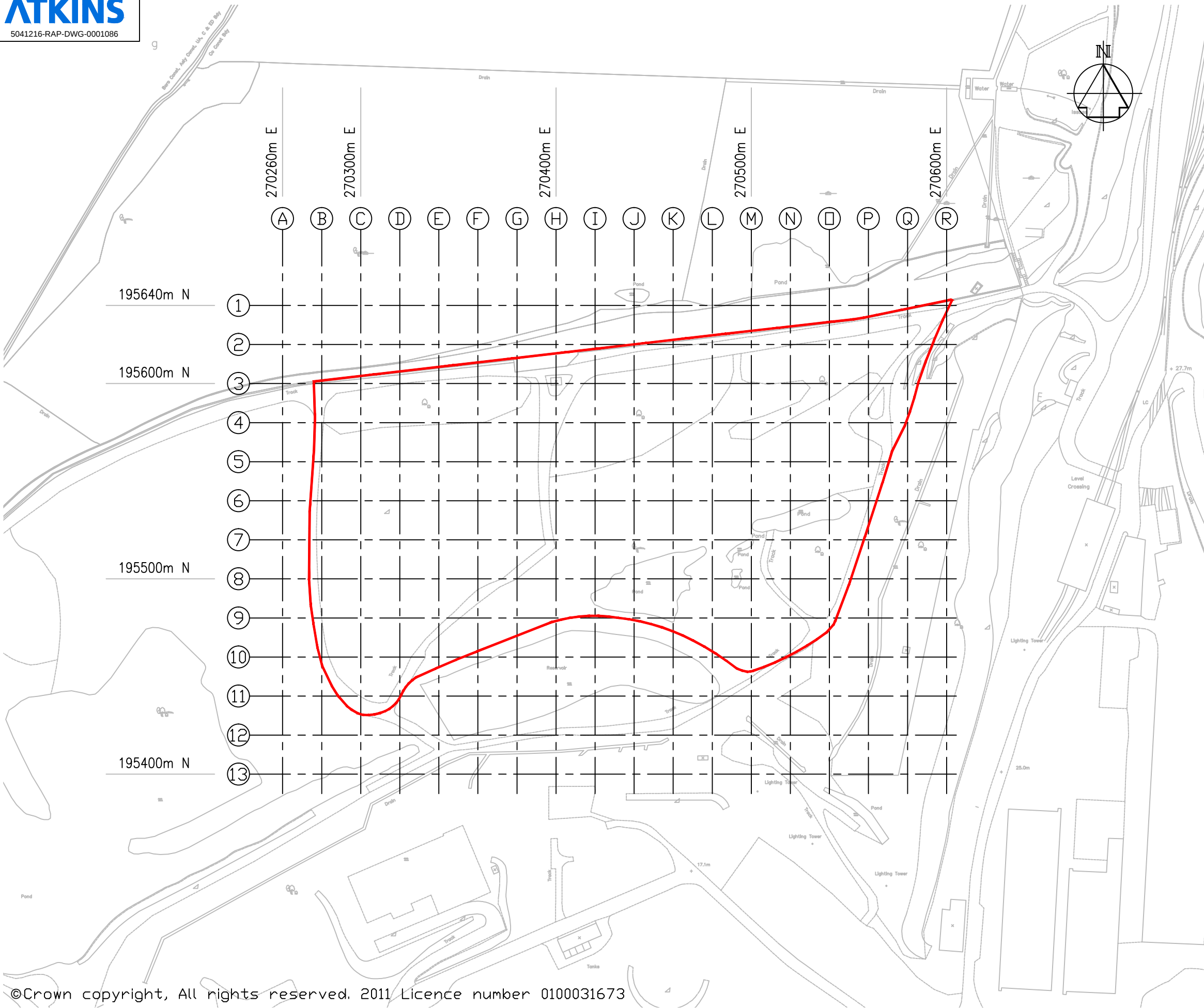
Scales 1 : 500	DRAWN AJ	CHECKED MC	CO-ORD. CHECK MIC/RM
	DATE 03.01.12	DATE 03.01.12	DATE 03.01.12

0		SHEET A1	PLOT DATE 26/06/13
---	--	-------------	-----------------------

DRAWING NO	REV
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5041216-RAP-DWG-0001085

—



NOTES

- DO NOT SCALE.
- THE ACTUAL CQA SAMPLING AND TESTING LOCATIONS ARE TO BE CONFIRMED BY THE QAE OR QAM.

LEGEND

— SITE BOUNDARY

REVISIONS	Drawn By	Checked By	Date

CAPPING OF CRYMLYN CONSTRUCTION QUALITY ASSURANCE PLAN	-	MC	19.03.12
---	---	----	----------

PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

Atkins Limited

Telford Office Cornerstone House Stafford Park 13 Telford TF3 3AZ	Birmingham Office The Axis, 10 Holliday Street Birmingham West Midlands B1 1TF
Tel 01952 201234 Fax 01952 200981	Tel 0121 483 5000 Fax 0121 483 5252

THIS DRAWING IS NOT TO BE SCALED

CLIENT **ST.MODWEN**

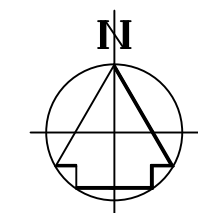
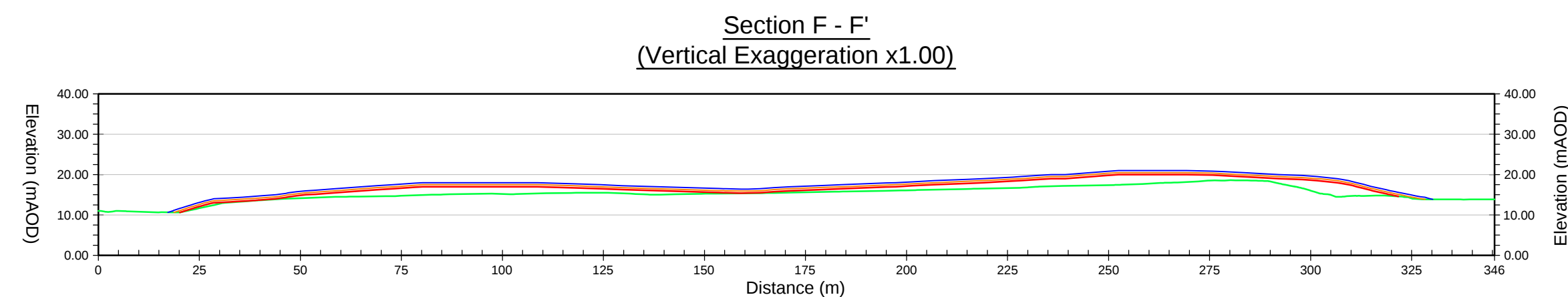
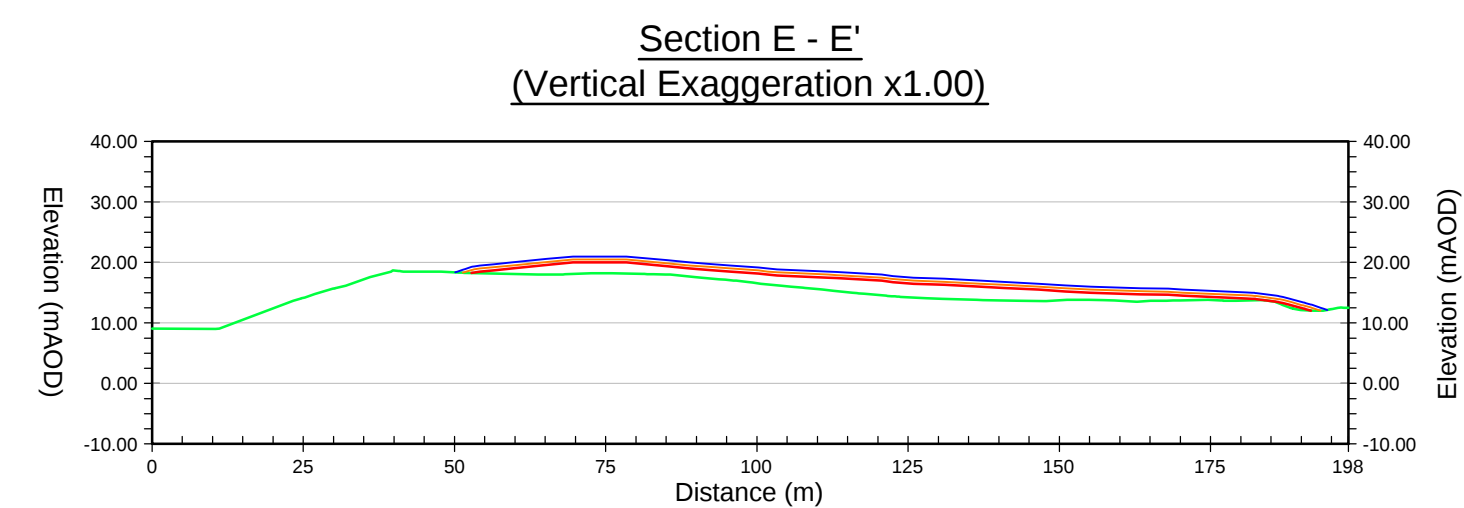
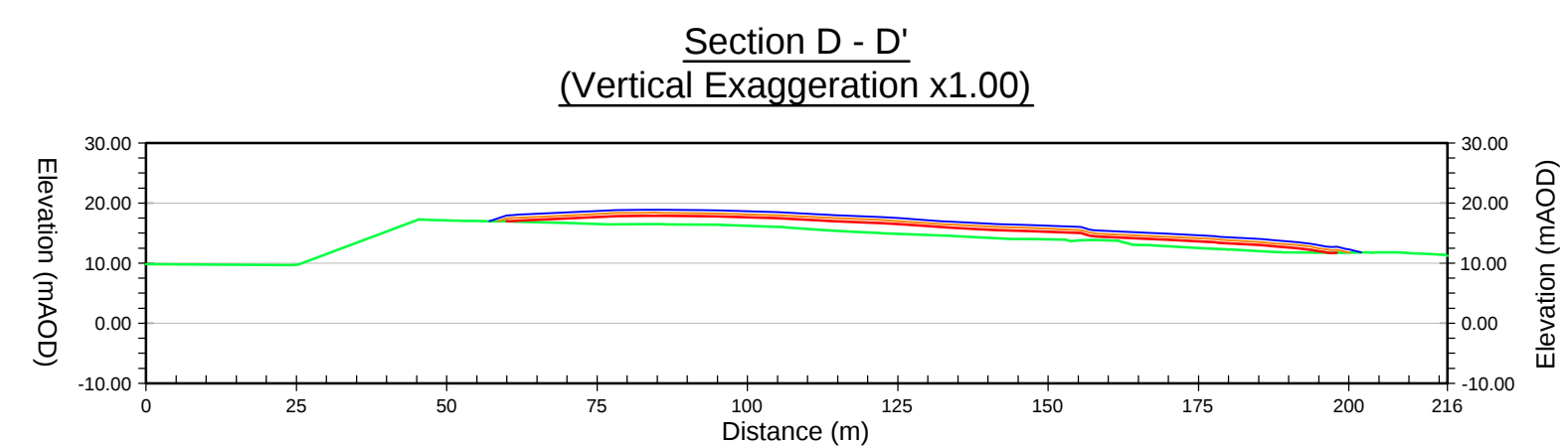
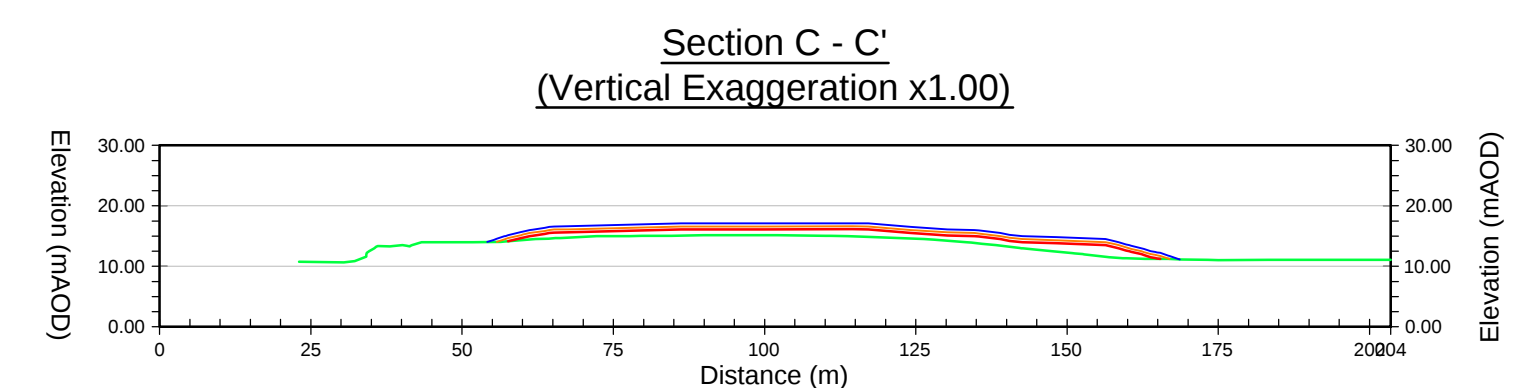
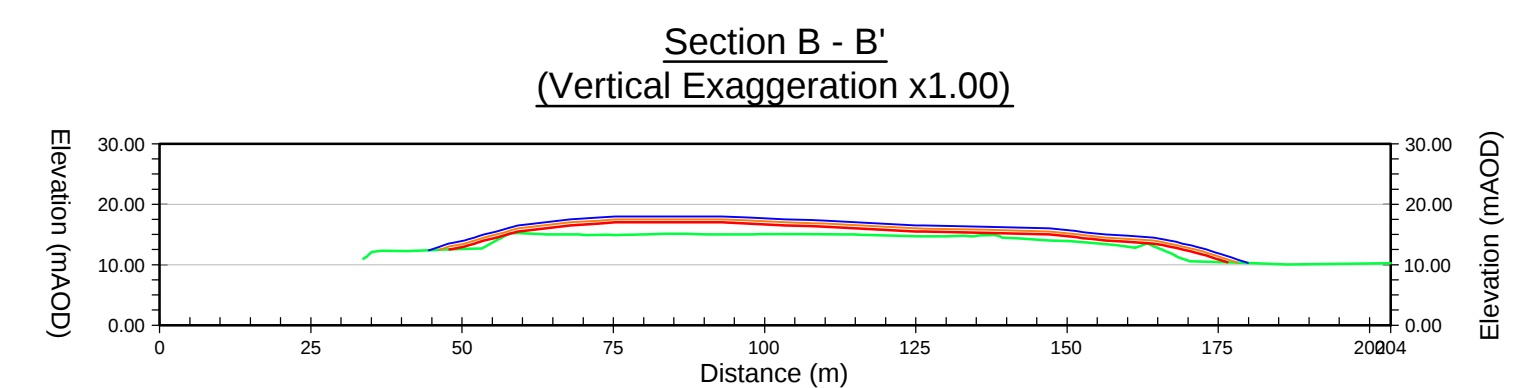
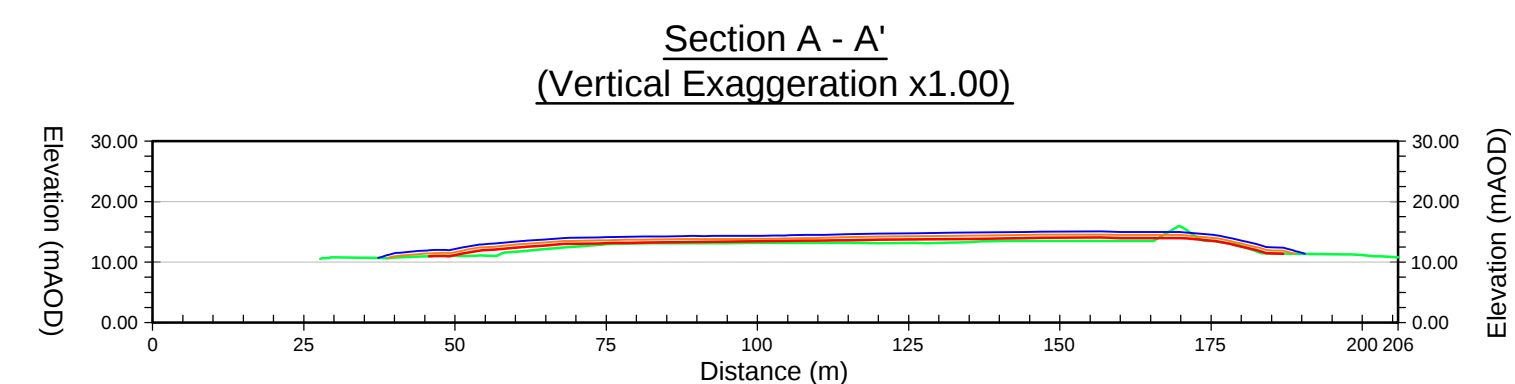
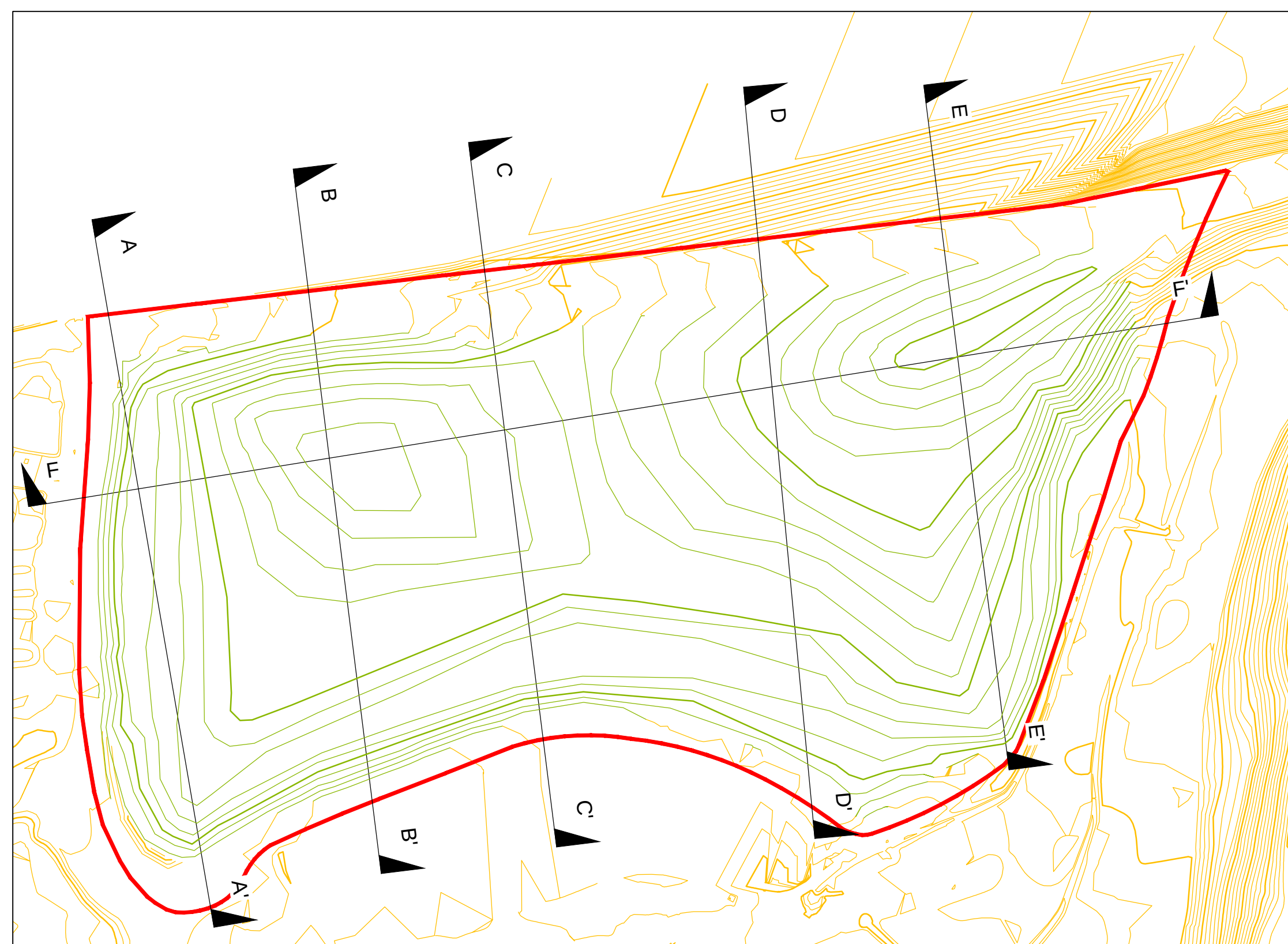
PROJECT **COED DARCY**

DRAWING TITLE
CQA TESTING LOCATION REFERENCE

SCALES	DRAWN	CHECKED	CO-ORD CHECK
1:2000	AJ	MC	MIC/RM
	DATE	DATE	DATE
	03.01.12	03.01.12	03.01.12

0	SHEET A3	PLOT DATE 26.06.13
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DRAWING NO 5041216-RAP-DWG-0001086	REV -
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NOTES

1. DO NOT SCALE
2. TOPOGRAPHICAL DATA TAKEN FROM 5041216-RAP-DWG-000932.
3. REFER TO DRAWINGS 5041216/ENG/1083 TO 1085 FOR CONTOURS OF THE PROPOSED LANDFORM.

KEY

- EXISTING GROUND
 TOP OF WASTE
 TOP OF CAP
 TOP OF RESTORATION

REVISIONS	Drawn By	Checked By	Date
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CAPPING OF CRYMLYN CONSTRUCTION QUALITY ASSURANCE PLAN	–	MC	19/03/
PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

Atkins Ltd
Consulting Engineers

The Axis, 10 Holliday Street
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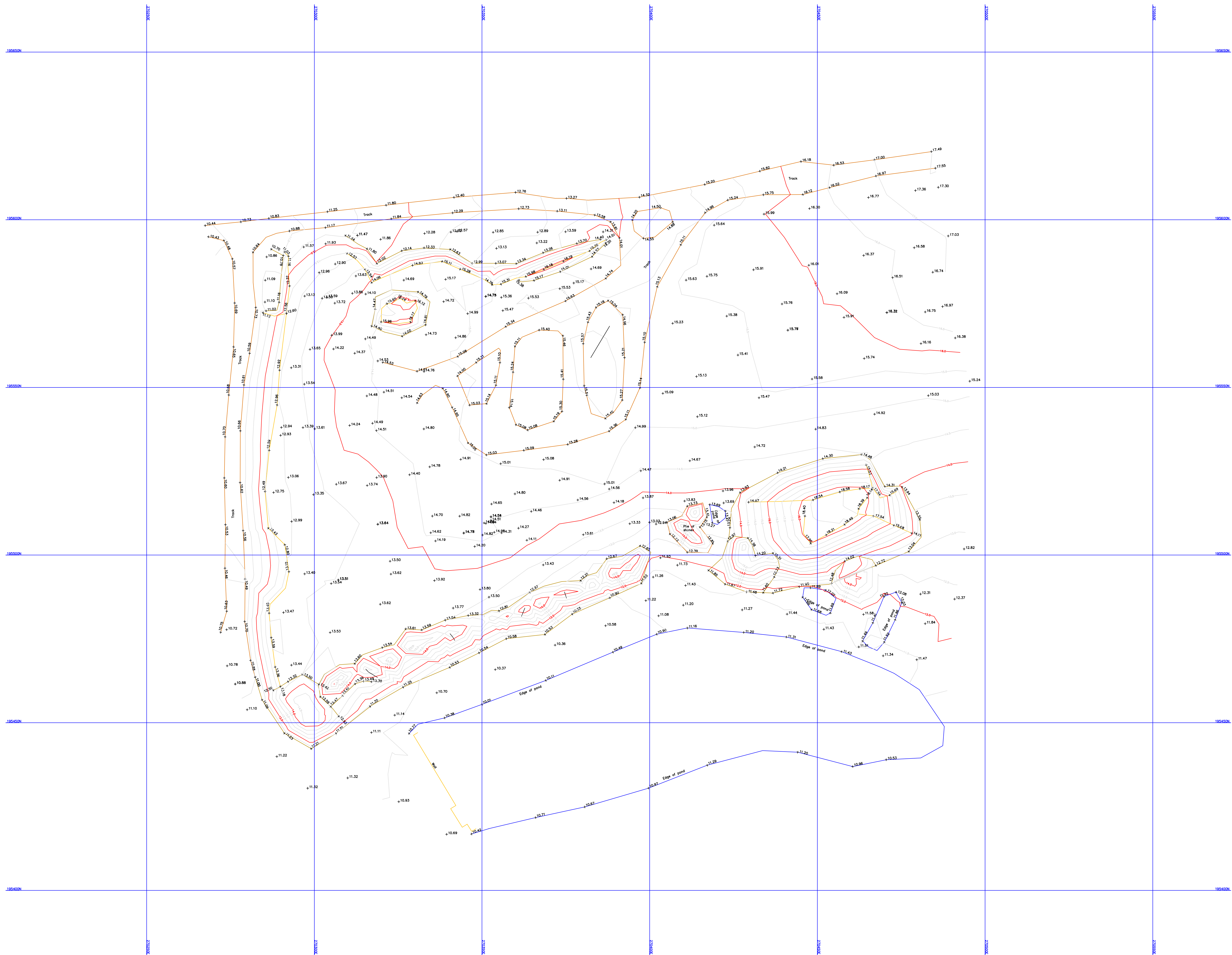
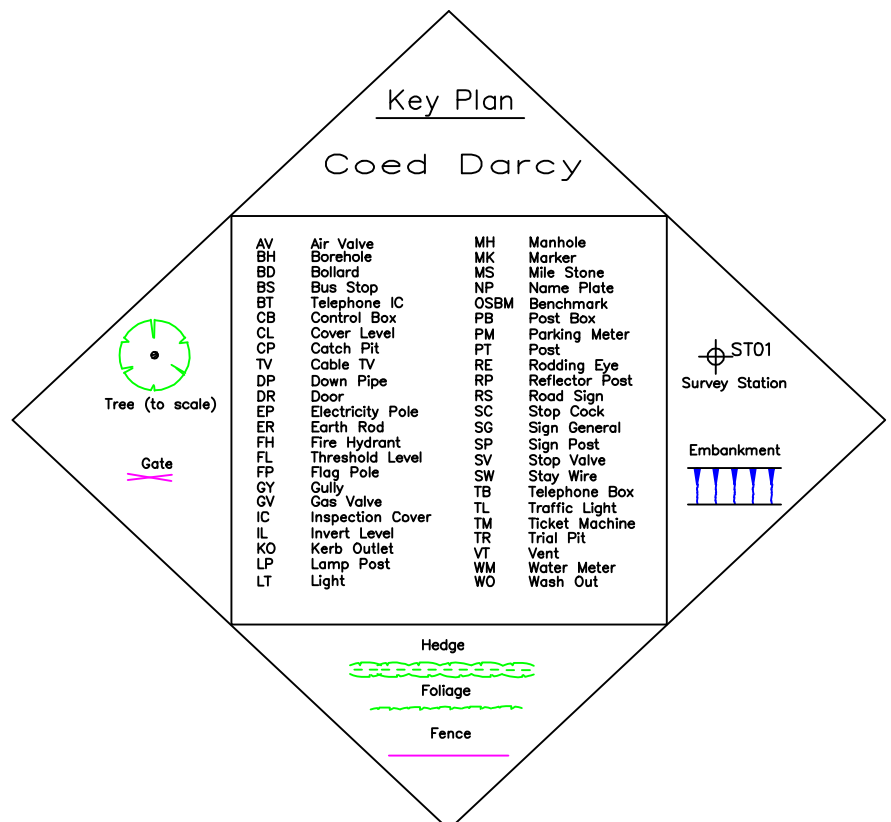
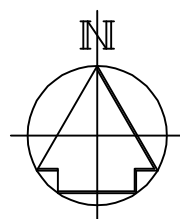
PROJECT

COED Darcy

DRAWING TITLE
CROSS SECTIONS OF PROPOSED LANDFORM

Scales	DRAWN A.J	CHECKED M.C	CO-ORD. CHECK M.C/R.M
1 : 1250	DATE 03.01.12	DATE 03.01.12	DATE 03.01.12
		SHEET A1	PLOT DATE 26/06/12
DRAWING NO 5041216-RAP-DWG-0001087			REV —

- 1) Grid Datum: OSGB36 National Grid derived from OS Active Network
- 2) Level Datum: Ordnance Datum Newlyn
- 3) Contour interval: 0.5m



REVISIONS	Drawn By	Checked By	Date
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Client Issue	Rev.	pl	01/04/1
PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

Atkins Ltd

Consulting Engineers
The Axis, 10 Holliday Street Tel 0121 483 5000
Birmingham West Midlands B1 1TF Fax 0121 483 5252

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CLIENT

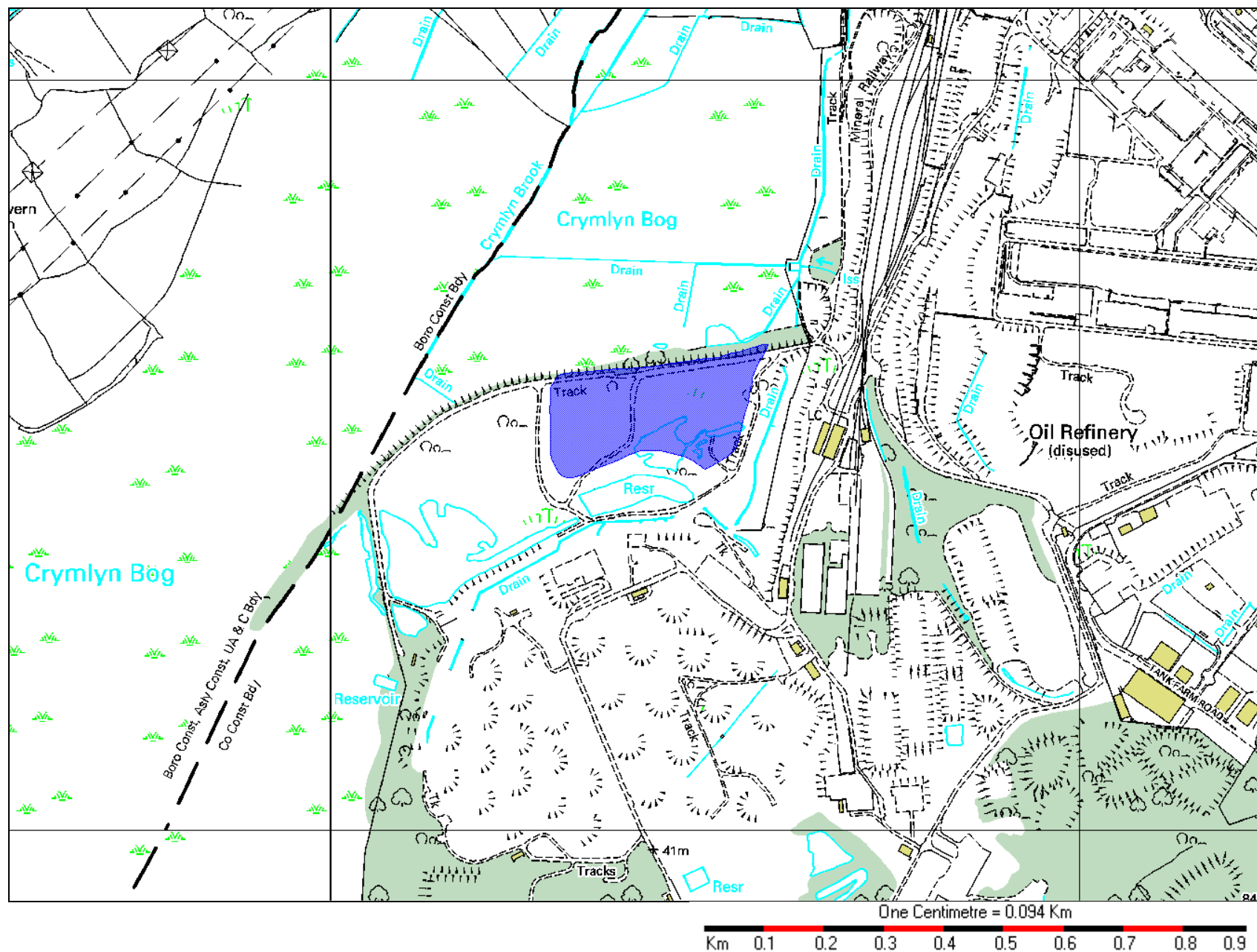
ST. MARY'S

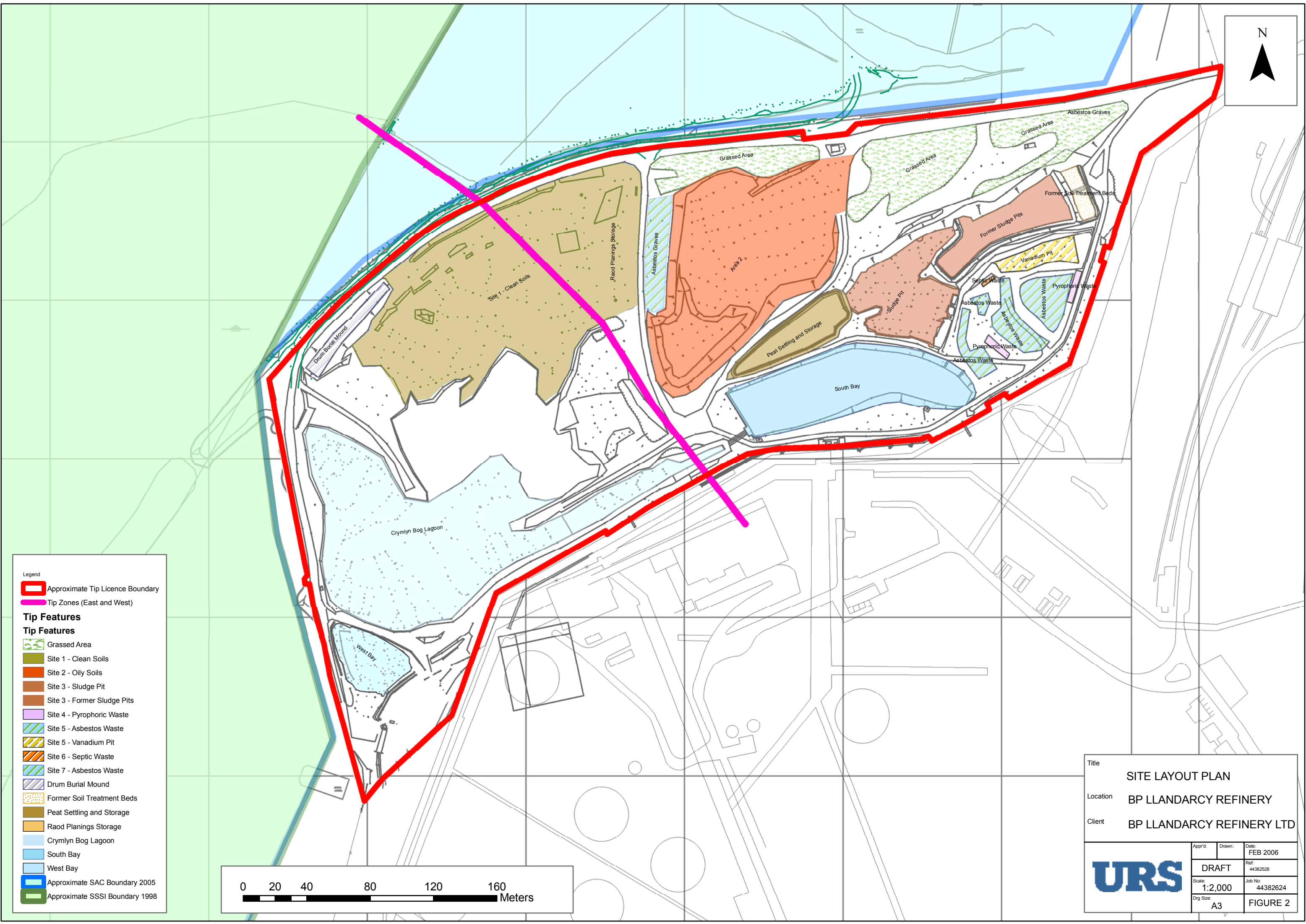
PROJECT
Pre Restoration Survey
of the Containment Area March 2011
Coed Darcy

DRAWING TITLE

Topographical Survey

SCALES	1:500	DRAWING mg	CHECKED pl	CO-ORD. CHECK
		DATE 24/03/2011	DATE	DATE
			SHEET A0	PLOT DATE 01/04/11
DRAWING NO				REV





- Legend
- Approximate Tip Licence Boundary
 - Tip Zones (East and West)
- Tip Features**
- Grassed Area
 - Site 1 - Clean Soils
 - Site 2 - Oily Soils
 - Site 3 - Sludge Pit
 - Site 3 - Former Sludge Pits
 - Site 4 - Pyrophoric Waste
 - Site 5 - Asbestos Waste
 - Site 5 - Vanadium Pit
 - Site 6 - Septic Waste
 - Site 7 - Asbestos Waste
 - Drum Burial Mound
 - Former Soil Treatment Beds
 - Peat Settling and Storage
 - Raod Planings Storage
 - Crymlyn Bog Lagoon
 - South Bay
 - West Bay
 - Approximate SAC Boundary 2005
 - Approximate SSSI Boundary 1998

Title				SITE LAYOUT PLAN			
Location				BP LLANDARCY REFINERY			
Client				BP LLANDARCY REFINERY LTD			
		Appr'd:	Drawn:	Date:	FEB 2006		
		DRAFT		Ref:	44382528		
		Scale:	1:2,000		Job No:	44382624	
		Org Size:	A3		FIGURE 2		

Appendices

Appendix A. CQA Proforma

Coed Darcy Capping of Crymlyn Tip

[illegible]

Coed Darcy Capping of Crymlyn Tip

ATKINS[illegible]

Coed Darcy Capping of Crymlyn Tip

[illegible]

Coed Darcy Capping of Crymlyn Tip

ATKINS

Daily Record Sheet	
Date:	
Weather (am):	
(pm):	
QA Engineer:	
Observations:	Lab:
Comments:	
	QA Engineer
Sign	
Date	

Appendix B. Recent Sampling and Geotechnical Testing

B.1. Sampling

Eight samples were taken from the Coed Darcy on 1st November 2011 for a range of geotechnical tests. Appendix Table B1 summarizes the samples of the tipped waste on Site and the two stockpiles, Batch 01 and Batch 02 at other parts of the Coed Darcy. The locations of the Site and the stockpiles are shown on Drawing 5041216-RAP-DWG-0001081.

It should be noted that as material is selected for placement these will be tested to ensure compliance with the requirements of this plan.

Three samples were taken from each of Batch 01, three from Batch 02 and two from tipped waste.

Appendix Table B1: Summary of Samples on 01 November 2011

Sample Ref.	Location	Depth of sampling
Batch 1 - 1	Material stockpile for capping and restoration from Batch 01	1.5m above ground
Batch 1 - 2		1.5m above ground
Batch 1 - 3		Ground level
Waste - 4	Tipped waste on Site	0 to 2m below ground
Waste - 5		0 to 2m below ground
Batch 2 - 6	Material stockpile for capping and restoration from Batch 02	0.5m above ground
Batch 2 - 7		Ground level
Batch 2 - 8		1.0m above ground

B.2. Geotechnical Test Results

The geotechnical test data from GEO Laboratory Testing Services Limited (GEO) are included in this Appendix. Appendix Table B2 summarizes the data.

Appendix Table B2: Data Summary

Parameter	Material	Minimum	Maximum	Average or value adopt in analysis
Moisture content	Tipped waste	16%	16%	16% (ave.)
	Stockpile Batch 01	86%	97%	90% (ave.)
	Stockpile Batch 02	63%	73%	68% (ave.)
Bulk density	Tipped waste	2.179 Mg/m ³	2.236 Mg/m ³	2.2 Mg/m ³ (ave.)
	Stockpile Batch 01	1.033 Mg/m ³	1.351 Mg/m ³	1.2 Mg/m ³ (ave.)
	Stockpile Batch 02	1.102 Mg/m ³	1.449 Mg/m ³	1.2 Mg/m ³ (ave.)
Dry density	Tipped waste	1.559 Mg/m ³	1.716 Mg/m ³	1.6 Mg/m ³ (ave.)
	Stockpile Batch 01	0.700 Mg/m ³	0.773 Mg/m ³	0.7 Mg/m ³ (ave.)
	Stockpile Batch 02	0.737 Mg/m ³	0.748 Mg/m ³	0.7 Mg/m ³ (ave.)
Effective shear strength parameter, Φ' (Peak)	Tipped waste	31.0°	31.5°	Conservative values applied in analysis. 31° for waste and 34° for capping soil and restoration soil.
	Stockpile Batch 01	37.0°	42.0°	
	Stockpile Batch 02	34.0°	36.0°	
Effective shear strength parameter, Φ' (Residual)	Tipped waste	24.0°	25.0°	Residual values are tested but not applicable.
	Stockpile Batch 01	31.5°	37.0°	
	Stockpile Batch 02	28.0°	29.0°	
Effective shear strength parameter, c' (Peak)	Tipped waste	12 kPa	13 kPa	Conservative values applied in analysis. 12 kPa for waste and 10 kPa for capping soil and restoration soil.
	Stockpile Batch 01	12 kPa	20 kPa	
	Stockpile Batch 02	10 kPa	15 kPa	
Effective shear strength parameter, c' (Residual)	Tipped waste	1 kPa	4 kPa	Residual values are tested but not applicable.
	Stockpile Batch 01	0 kPa	12 kPa	
	Stockpile Batch 02	0 kPa	10 kPa	
Hydraulic conductivity, k (test specimens prepared from re-compaction of samples to natural moisture content with a 2.5kg rammer)	Tipped waste	3.45x10 ⁻¹⁰ m/s	3.83x10 ⁻¹⁰ m/s	3.64 x 10 ⁻¹⁰ m/s (ave.)
	Stockpile Batch 01	5.0610 ⁻¹¹ m/s	1.39x10 ⁻¹⁰ m/s	9.82 x 10 ⁻¹¹ m/s (ave.)
	Stockpile Batch 02	6.8710 ⁻¹¹ m/s	1.77x10 ⁻¹⁰ m/s	1.23 x 10 ⁻¹⁰ m/s (ave.)

Tipped waste

The tipped waste samples are described as brown slightly clayey silty fine to coarse gravel with a wide range of particle sizes.

The waste has a moisture content of 16% and is reported as non-plastic. The average bulk density and dry density are 2.2 Mg/m^3 and 1.6 Mg/m^3 respectively. The average bulk density result, 2.2 Mg/m^3 (22 kN/m^3), is applied in the Geostudio SLOPE/W modelling.

Conservative values of the peak effective shear strength parameters, $\Phi' = 31^\circ$ and $c' = 12 \text{ kPa}$, of the waste are applied in the numerical analysis (Geostudio SLOPE/W modelling and veneer calculations) for the waste slope, the flat ash bund and the flat natural ground underneath. The numerical analysis results are included in Appendix C. The residual effective shear strength parameters have been determined but would only be applicable to analysis of material that had previously been subject to failure or gross deformation hence are not applicable to the failure scenarios considered in this CQA proposal.

The hydraulic conductivity (permeability) results of the waste are between $3.45 \times 10^{-10} \text{ m/s}$ and $3.83 \times 10^{-10} \text{ m/s}$.

Stockpiles

The samples from stockpile Batches 01 and 02 have similar geotechnical properties. They are described as brown slightly clayey silty soil with some organic materials. The particle size distribution results indicate the stockpiled materials fall into the Class 6F1, selected granular material (fine grading) for capping, of the Manual of Contract Documents for Highway Works (MCHW), Specification for Highway Works although the hydraulic conductivity results indicate a substantial fines fraction which was probably underrepresented in the soils sample selected for particle size analysis.

The stockpiled material had high moisture contents of 63% to 97% and are reported as non-plastic. The average bulk density and dry density are 1.2 Mg/m^3 and 0.7 Mg/m^3 respectively. The average bulk density result, 1.2 Mg/m^3 (12 kN/m^3), is applied in the Geostudio SLOPE/W modelling.

Conservative values of the peak effective shear strength parameters, $\Phi' = 34^\circ$ and $c' = 10 \text{ kPa}$, of the stockpile samples are applied in the numerical analysis (Geostudio SLOPE/W modelling and veneer calculations) for the capping soil and restoration soil. The numerical analysis results are included in Appendix C. The residual effective shear strength parameters have been determined but would only be applicable to analysis of material that had previously been subject to failure or gross deformation hence are not applicable to the failure scenarios considered in this CQA proposal.

The laboratory hydraulic conductivity (permeability) results of the stockpiles are between $5.06 \times 10^{-11} \text{ m/s}$ and $1.77 \times 10^{-10} \text{ m/s}$, which are similar (same order of magnitude) to those of the waste. The fact that the waste and the stockpile materials have similar permeabilities indicates the infiltration and run off should be similar before and after the landfilled area is capped.



Laboratory Report



Contract Number: 14183

Client's Reference: JOB Ref GEO011 PO 12145434

Report Date: 23-11-2011

Client Name: Atkins
10 Holiday Street
Birmingham
B1 1TF

Contract Title: Coed Darcy
For the attention of: Alex Mann

Date Received: 09-11-2011
Date Commenced: 09-11-2011
Date Completed: 10-01-2012

Test Description	Quantity	Checked	Approved
Moisture Content BS1377:1990 2/3.2 *	8		
4 Point Liquid & Plastic Limit BS1377:1990 2/4.3&5.3 *	8		
PSD Wet Sieve method BS1377:1990 2/9.2 *	8		
PSD: Sedimentation by pipette carried out with Wet Sieve BS1377:1990 2/9.4 *	8		
Bulk/Dry Density	8		
Procedure for the Determination of the Permeability of Clayey Soils in a Triaxial Cell Using the Accelerated Permeability Test R&D Technical Report PI-398/TR/2	8		
Consolidated Drained Peak and Residual Shear Strength - set of 3 60 x 60mm Shear Box Specimens (5 days) BS1377:1990 7/4	8		

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
 * - Denotes test included in laboratory scope of accreditation
 # - Denotes test carried out by approved contractor

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.

Approved Signatories:

D V Edwards (Managing Director), Paul Evans (Technical Manager), E Sharp (Technical Co-Ordinator).

Summary of Soil Classification Tests

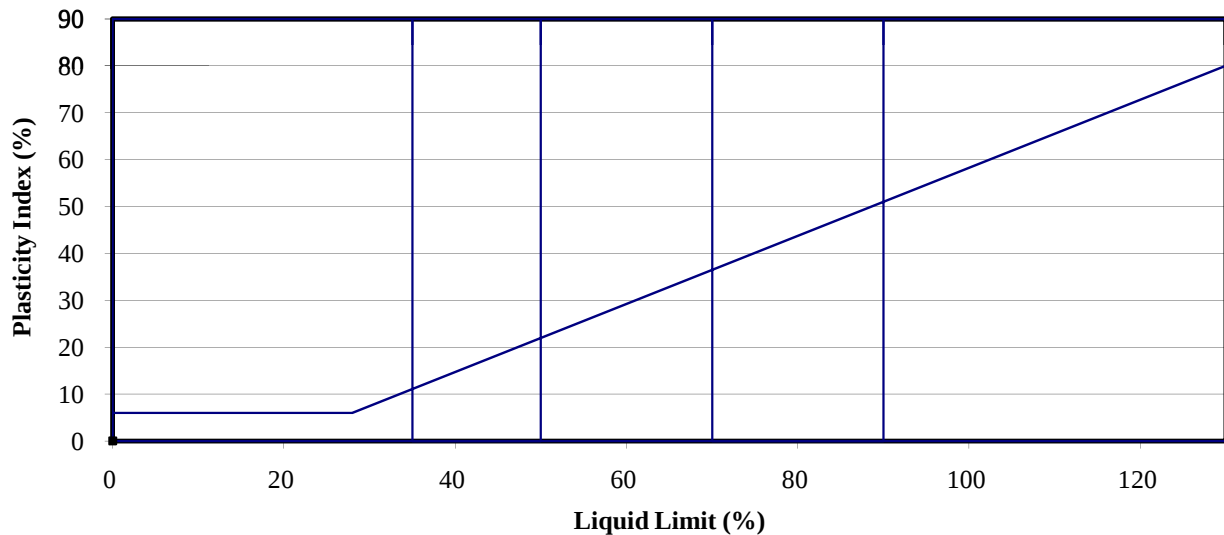
BS 1377:Part 2:1990

Hole/ Sample Number	Sample Type	Depth m	Moisture Content % Cl. 3.2	Liquid Limit % Cl. 4.3/4.4	Plastic Limit % Cl. 5.	Plasticity Index % Cl. 6.	% Passing .425mm	Remarks
BATCH 1 /1	B	1.50	88.0			NP	30	
BATCH 1 /2	B	1.50	97			NP	25	
BATCH1/3	B	GL	86			NP	20	
WASTE/4	B	- 2.00	16.0			NP	35	
WASTE/5	B	- 2.00	16			NP	35	
BATCH 2/6	B	0.50	69			NP	20	
BATCH 2/7	B	GL	73			NP	25	
BATCH 2/8	B	1.00	63			NP	25	

Symbols:

NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.
BS 5930:1999



[Signature] 22/11/11
Checked by Date

[Signature] 22/11/11
Approved by Date



Coed Darcy

Contract No.:

14183-091111

Client Ref No:

JOB Ref GEO0111



SUMMARY OF SOIL DENSITY TESTS.

(B.S. 1377 : PART 4 : 4.3/4.4 : 1990)

[illegible]


Checked By

10/01/12
Date


Approved By

10/01/12

Date



Coed Darcy

Contract No. 14183 - 091111

Client Ref No N/A

Page Of

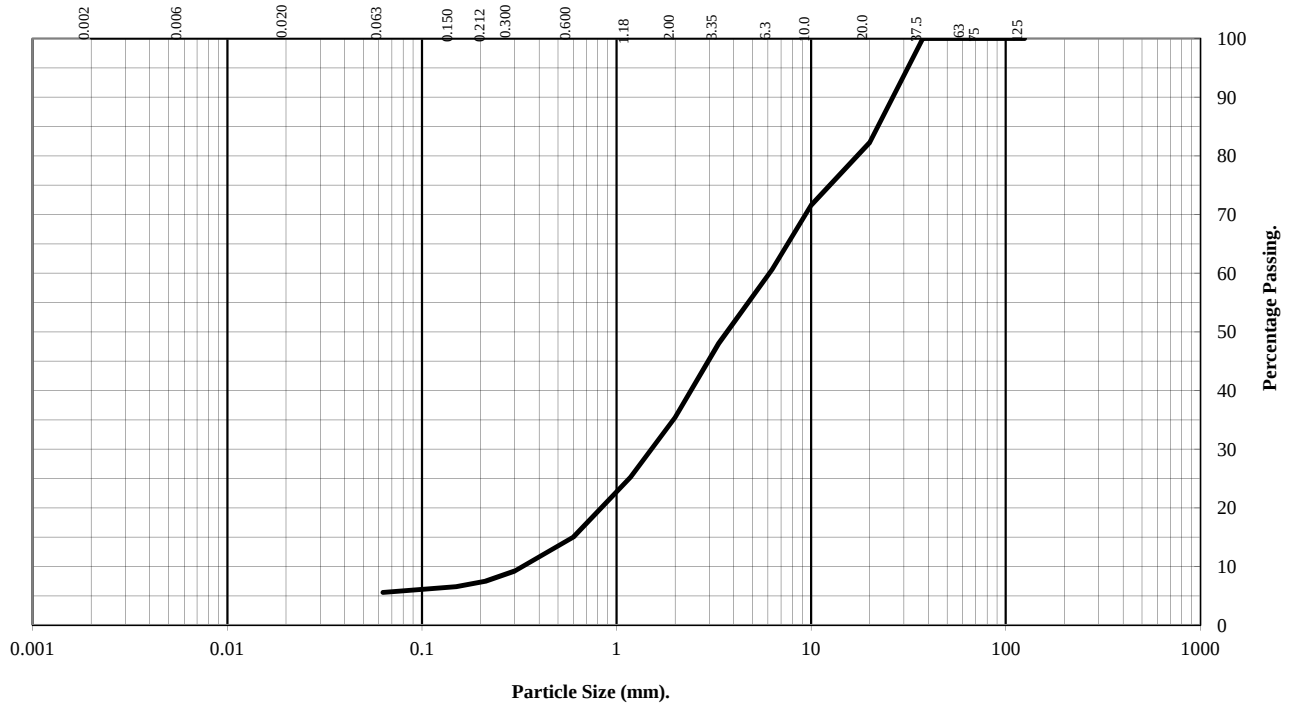
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: **Batch 1 - Sample 1**

Depth (m): **1.5 above ground**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	82
10	72
6.3	61
3.35	48
2.00	35
1.18	25
0.60	15
0.300	9
0.212	7
0.150	7
0.063	6

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	65
Sand	29
Silt and Clay	6

Remarks:

#- not determined

[Signature]

Checked by

12/12/2011

Date

[Signature]

Approved by

12/12/2011

Date



Coed Darcy

Contract No.:

14183-091111

Client Ref No:

B Ref GEO011 PO 121454



PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.



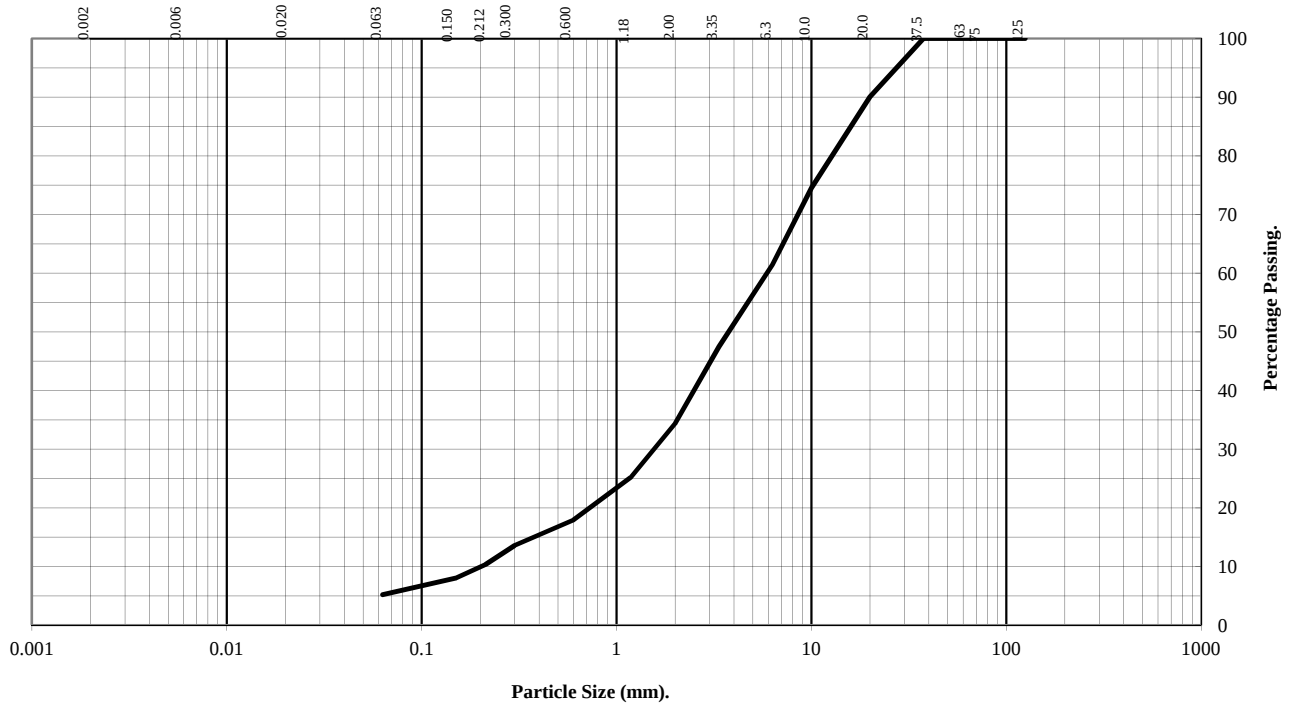
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: **Batch 1 - Sample 2**

Depth (m): **1.5 above ground**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	90
10	75
6.3	61
3.35	47
2.00	34
1.18	25
0.60	18
0.300	14
0.212	10
0.150	8
0.063	5

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	66
Sand	29
Silt and Clay	5

Remarks:

#- not determined

Checked by

12/12/2011

Date

Approved by

12/12/2011

Date



LABORATORY TESTING SERVICES LIMITED

Coed Darcy

Contract No.:

14183-091111

Client Ref No:

B Ref GEO011 PO 121454



2788

PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.



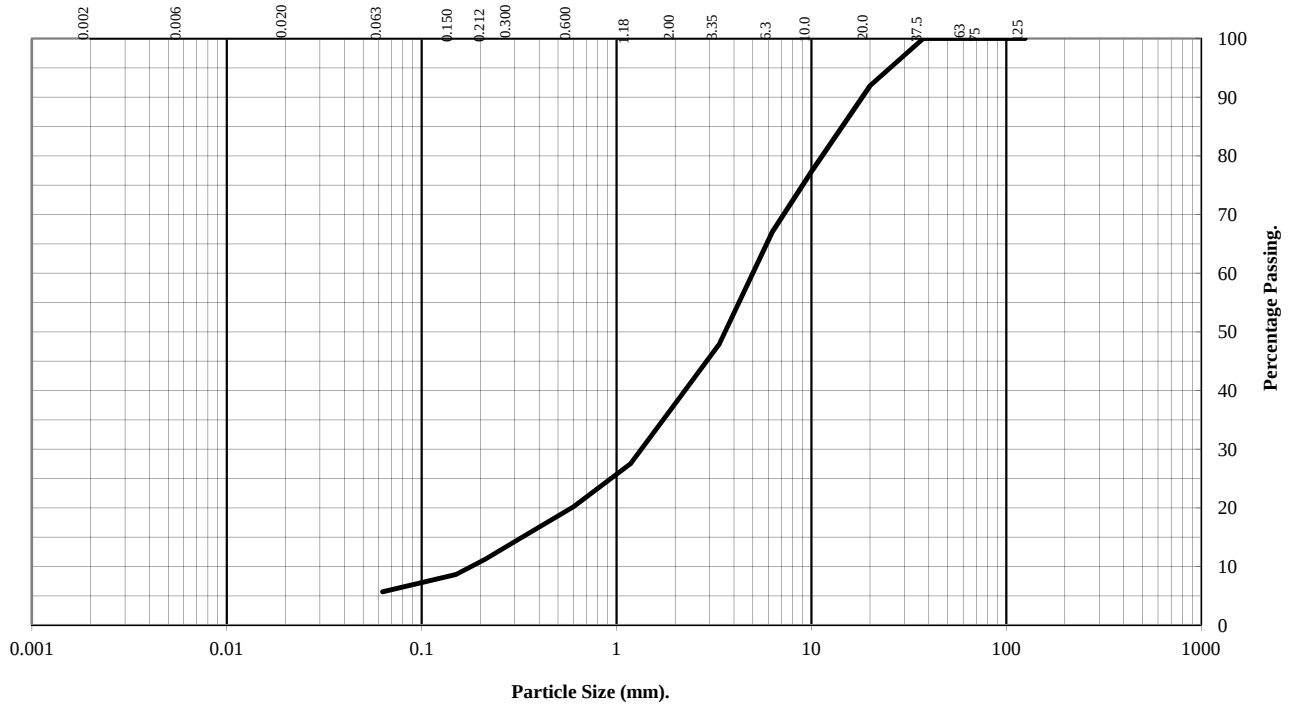
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: **Batch 1 - Sample 3**

Depth (m): **GL**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	92
10	77
6.3	67
3.35	48
2.00	38
1.18	28
0.60	20
0.300	14
0.212	11
0.150	9
0.063	6

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	62
Sand	32
Silt and Clay	6

Remarks:

#- not determined

Checked by

12/12/2011

Date

Approved by

12/12/2011

Date



Coed Darcy

Contract No.:

14183-091111

Client Ref No:

B Ref GEO011 PO 121454



PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.



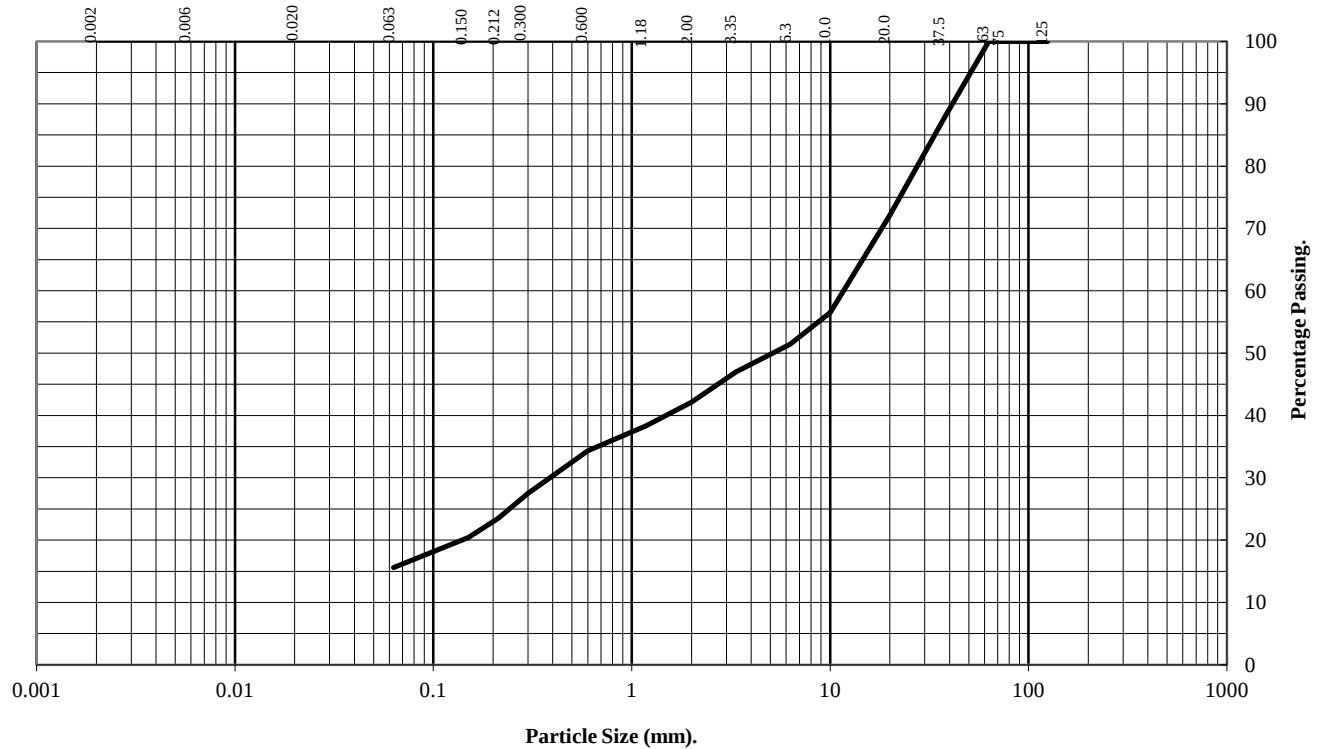
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: Waste - Sample 4

Depth (m): 0.00 to 2 Below ground



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	88
20	72
10	57
6.3	51
3.35	47
2.00	42
1.18	38
0.60	34
0.300	27
0.212	23
0.150	20
0.063	16

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	58
Sand	26
Silt and Clay	16

Remarks:

#- not determined

Checked by

10/01/2012

Date

Approved by

10/01/2012

Date

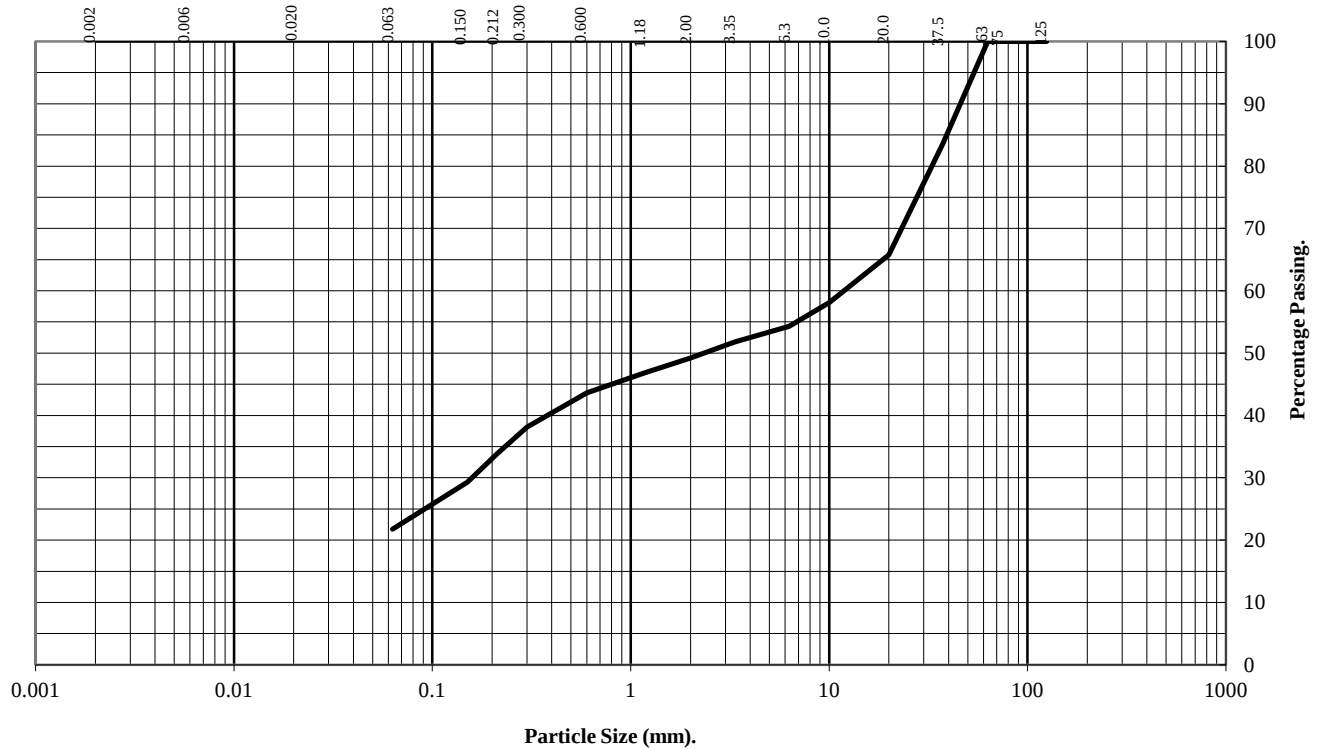
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: Waste - Sample 5

Depth (m): 0.00 to 2 Below ground



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	84
20	66
10	58
6.3	54
3.35	52
2.00	49
1.18	47
0.60	44
0.300	38
0.212	34
0.150	29
0.063	22

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	51
Sand	27
Silt and Clay	22

Remarks:

#- not determined

Checked by

10/01/2012

Date

Approved by

10/01/2012

Date

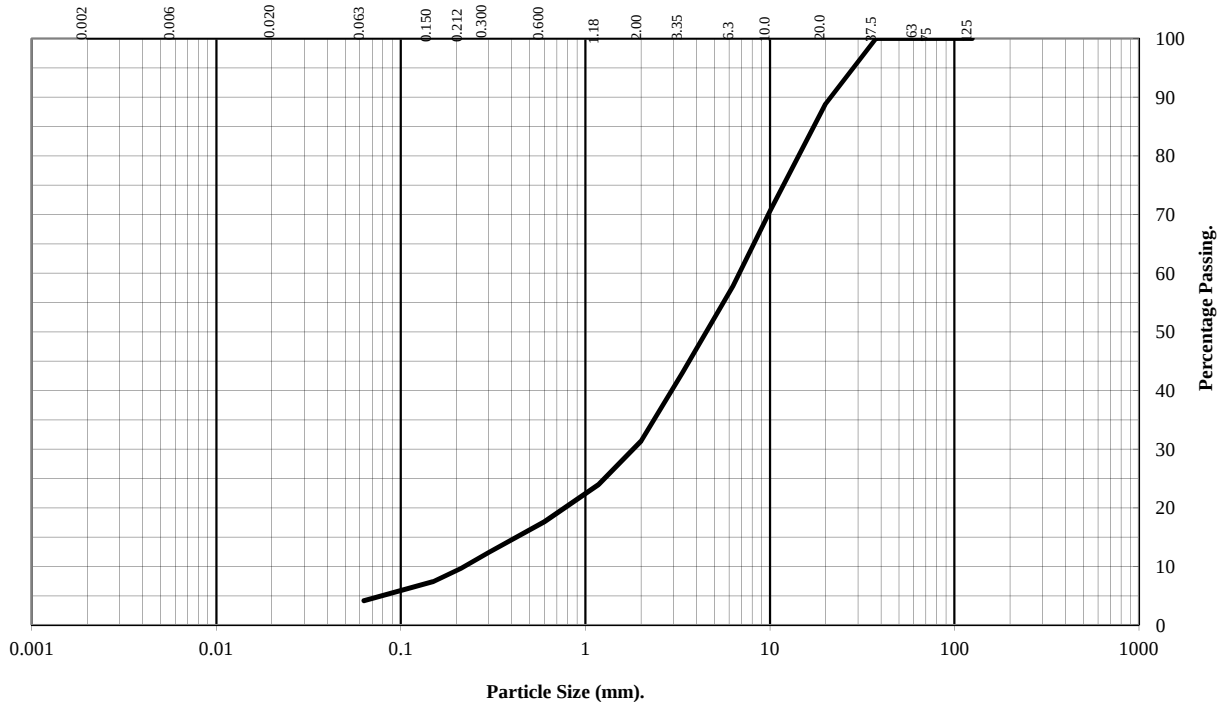
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: **Batch 2 - Sample 6**

Depth (m): **0.5 above ground**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	89
10	71
6.3	58
3.35	43
2.00	31
1.18	24
0.60	18
0.300	12
0.212	10
0.150	7
0.063	4

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	69
Sand	27
Silt and Clay	4

Remarks:

#- not determined


Checked by **Date** 12/2011


Approved by **Date** 12/12/2011



Coed Darcy

Contract No.:
14183-091111
Client Ref No:
B Ref GEO011 PO 12145



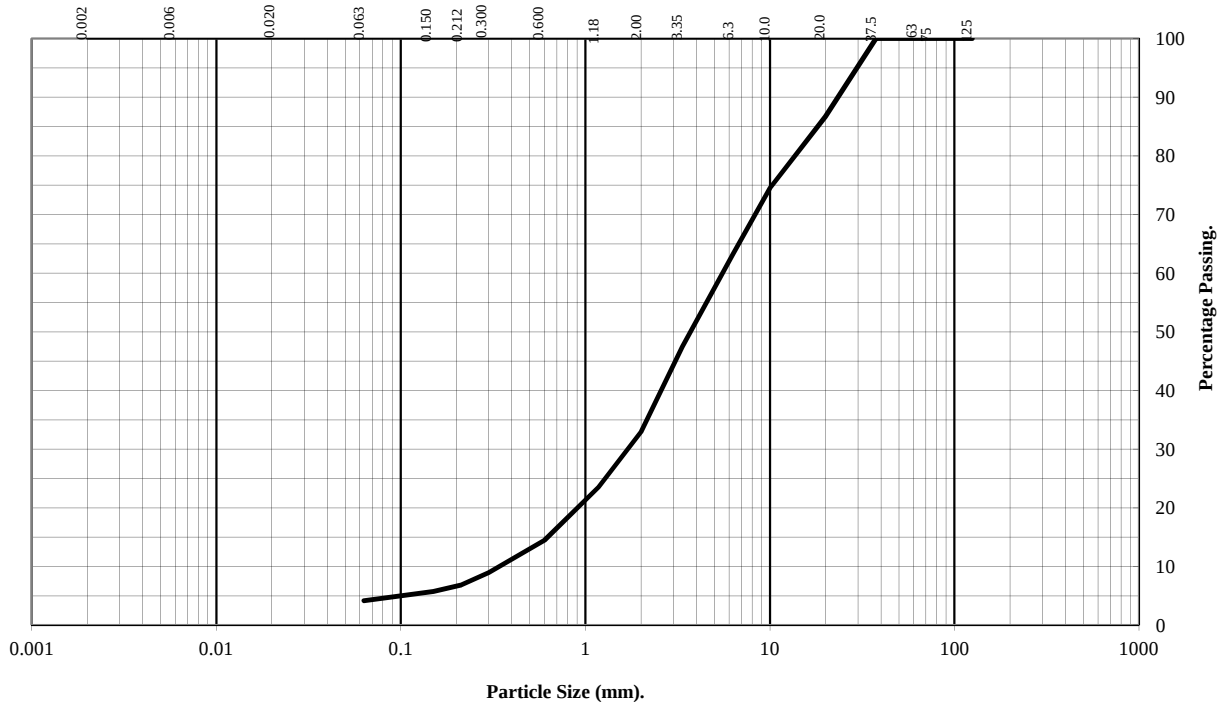
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: **Batch 2 - Sample 7**

Depth (m): **GL**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	87
10	75
6.3	63
3.35	47
2.00	33
1.18	23
0.60	14
0.300	9
0.212	7
0.150	6
0.063	4

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	67
Sand	29
Silt and Clay	4

Remarks:

#- not determined


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Contract No.:
14183-091111
Client Ref No:
B Ref GEO011 PO 12145



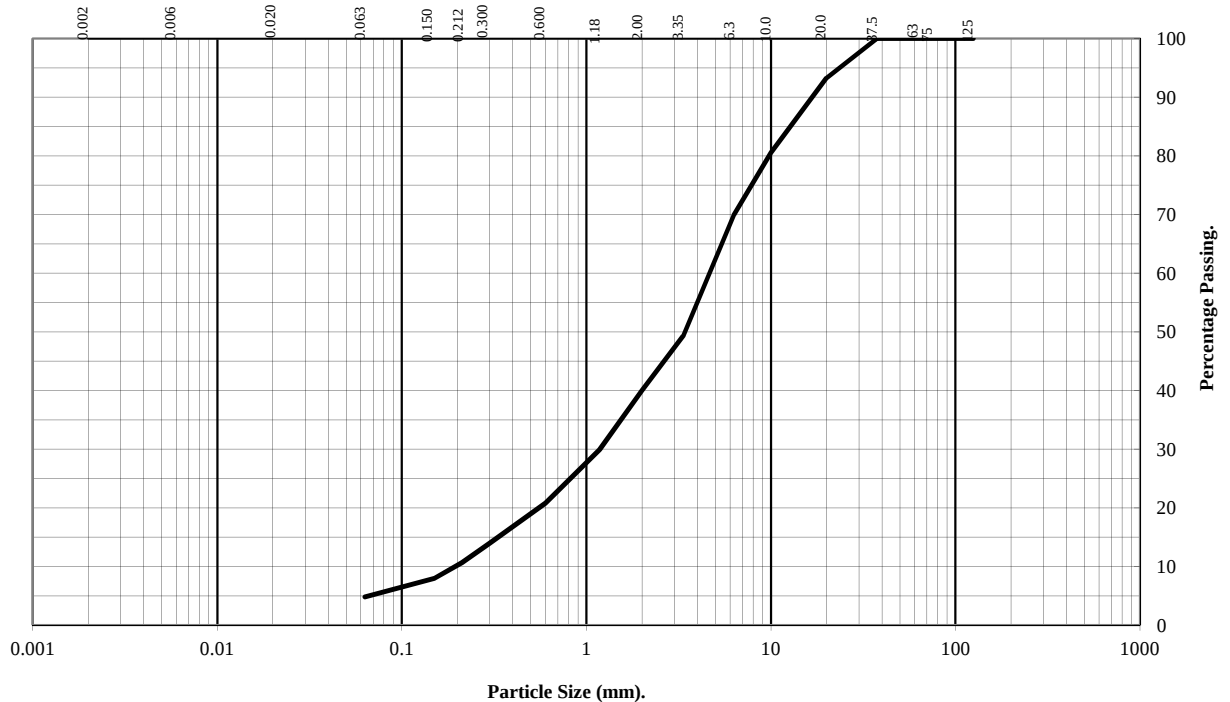
PARTICLE SIZE DISTRIBUTION TEST

BS 1377 Part 2:1990.

Wet Sieve, Clause 9.2

Hole Number: **Batch 2 - Sample 8**

Depth (m): **1.0 Above Ground**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	93
10	81
6.3	70
3.35	49
2.00	40
1.18	30
0.60	21
0.300	14
0.212	11
0.150	8
0.063	5

Particle Diameter	Percentage Passing
0.02	#
0.006	#
0.002	#

Soil Fraction	Total Percentage
Cobbles	0
Gravel	60
Sand	35
Silt and Clay	5

Remarks:

#- not determined


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Contract No.:
14183-091111
Client Ref No:
B Ref GEO011 PO 12145

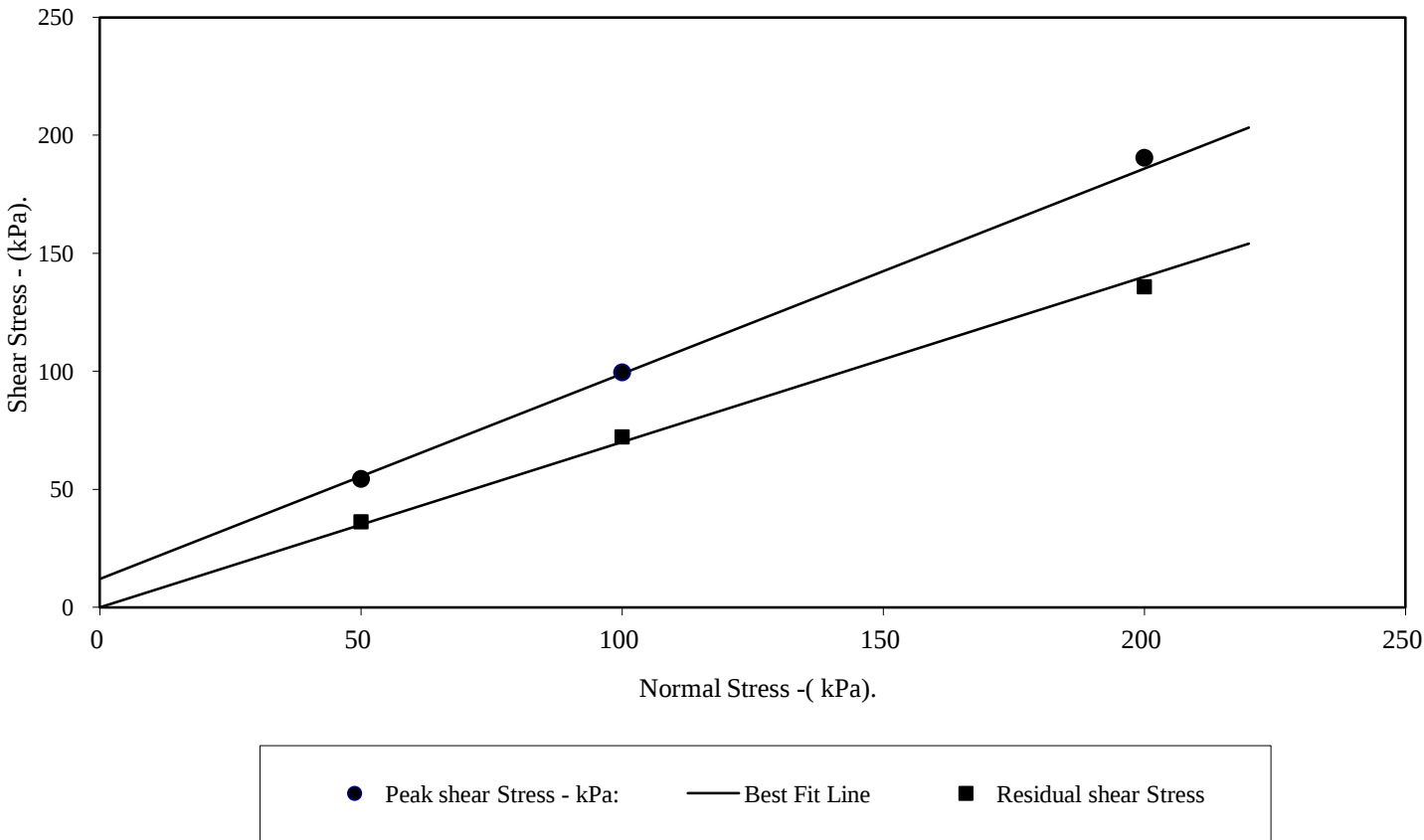


CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 1 Depth (m): GL

Sample Type:	Remoulded (2.5kg Rammer).		
Particle Density - Mg/m3:	2.65 (Assumed)		
Specimen Tested:	Submerged		
Sample Description: Dark brown silty sandy WOOD CHIPPINGS			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	83	83	83
Bulk Density - Mg/m3:	1.39	1.39	1.39
Dry Density - Mg/m3:	0.76	0.76	0.76
Voids Ratio:	2.4857	2.4977	2.4884
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	24.62	23.18	21.73
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (mm)	4.75	4.79	4.71
Peak shear Stress - kPa:	54	100	191
PEAK			
Angle of Shearing Resistance:(θ)			41.0
Effective Cohesion - kPa:			12
RESIDUAL			
Angle of Shearing Resistance:(θ)			35.0
Effective Cohesion - kPa:			0

FAILURE CONDITIONS

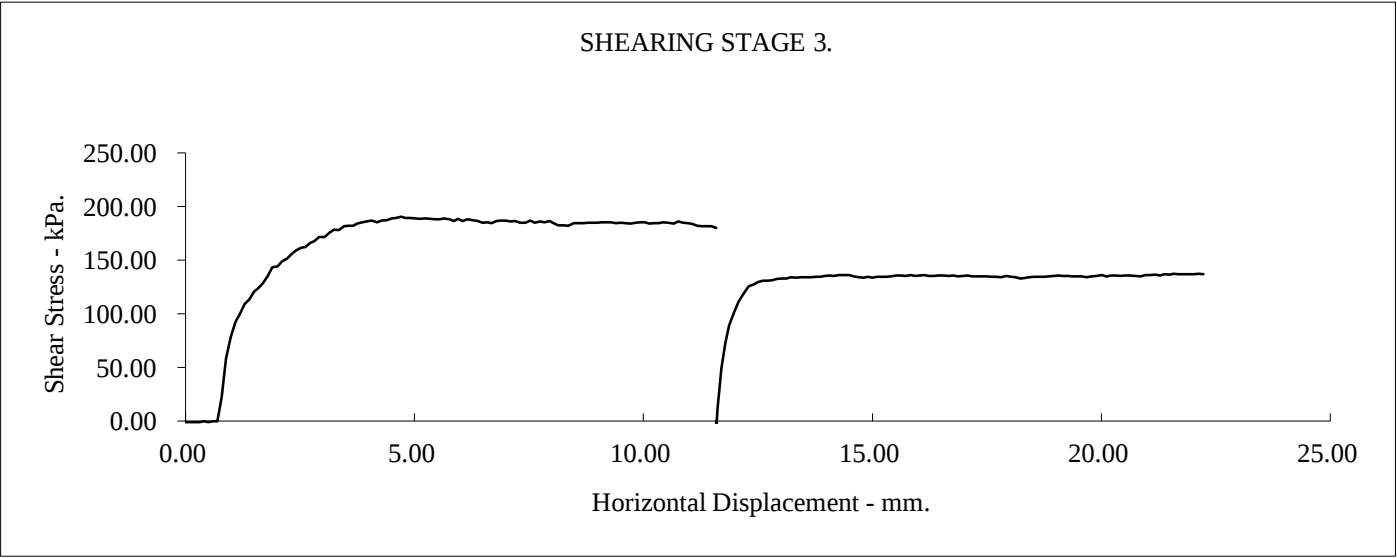
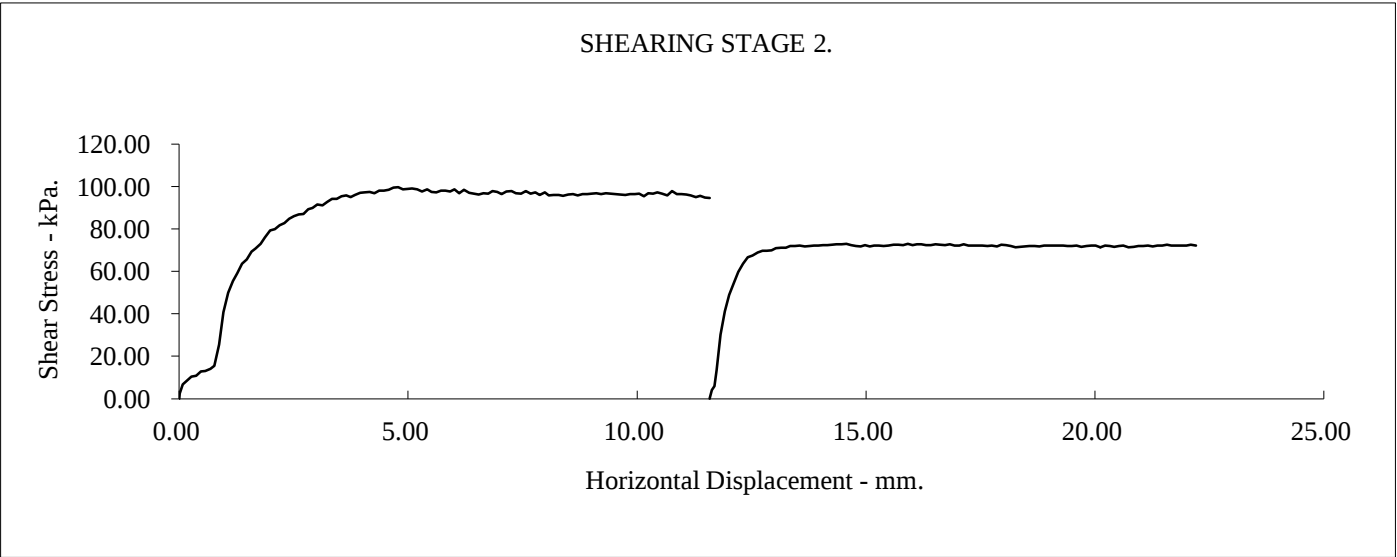
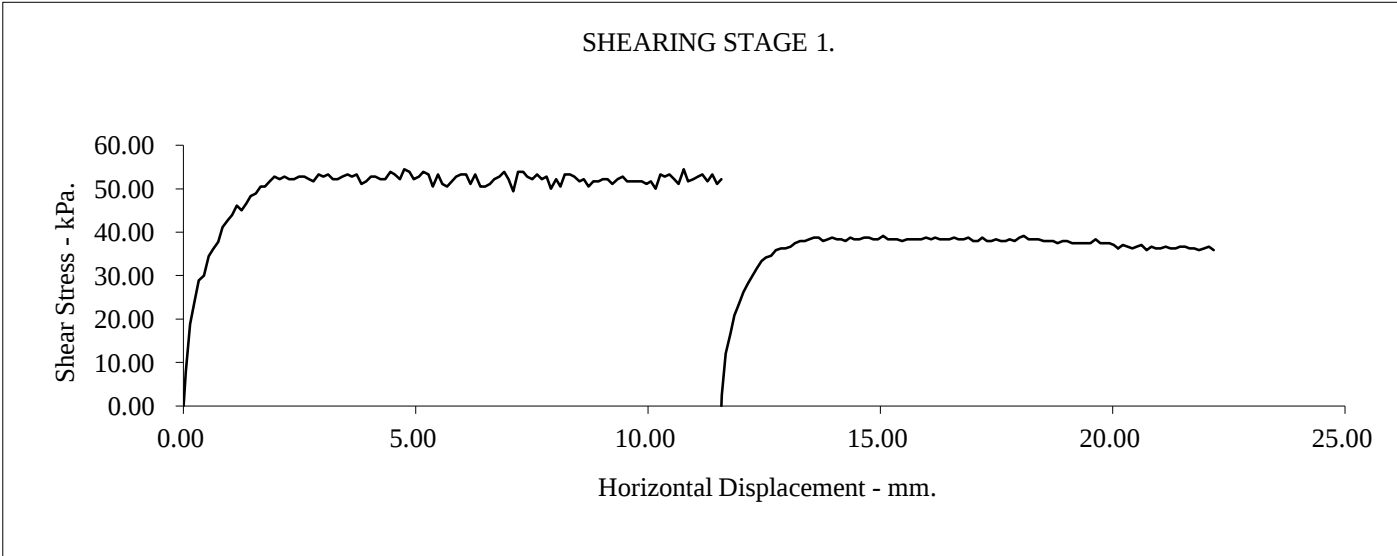


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 1 Depth (m): GL

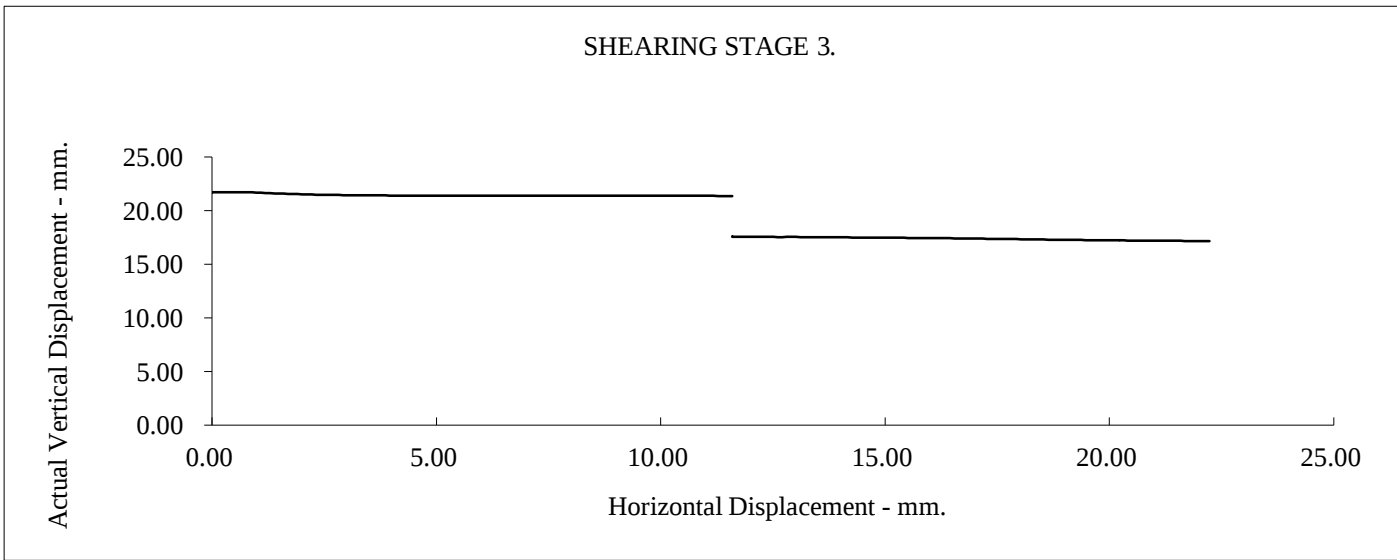
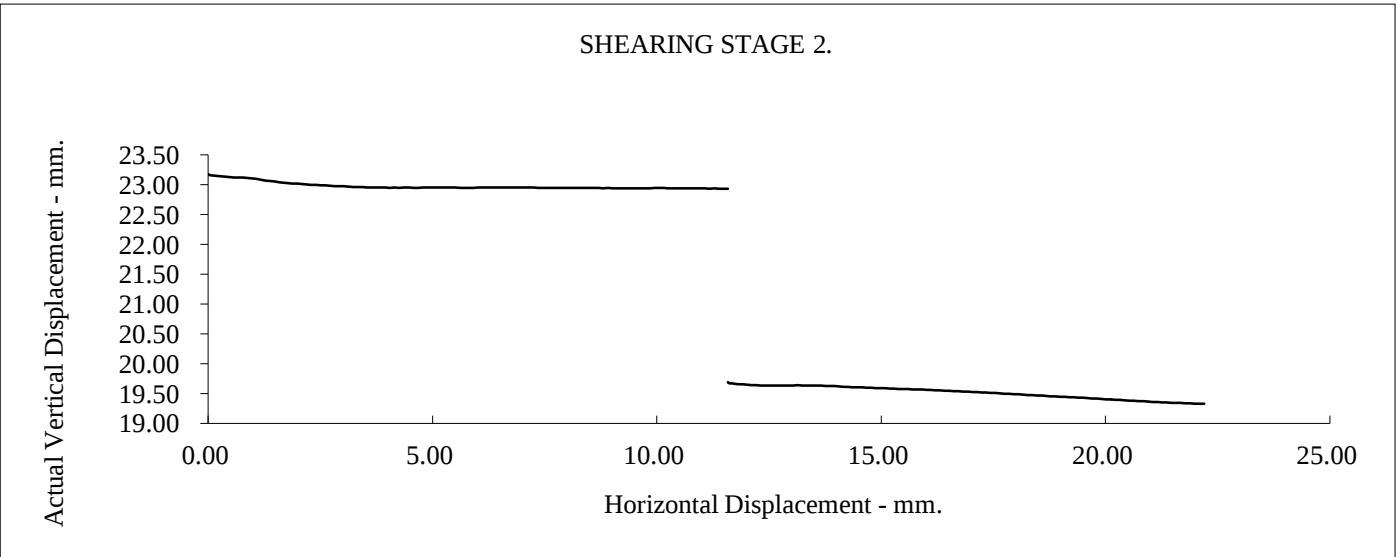
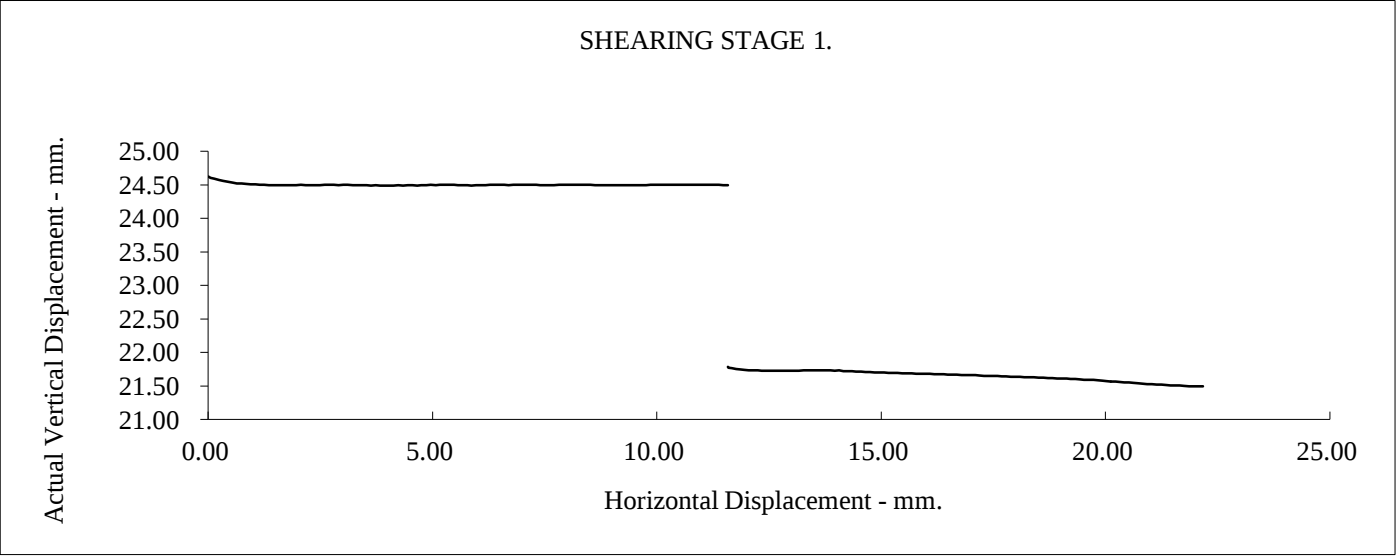


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 1 Depth (m): GL



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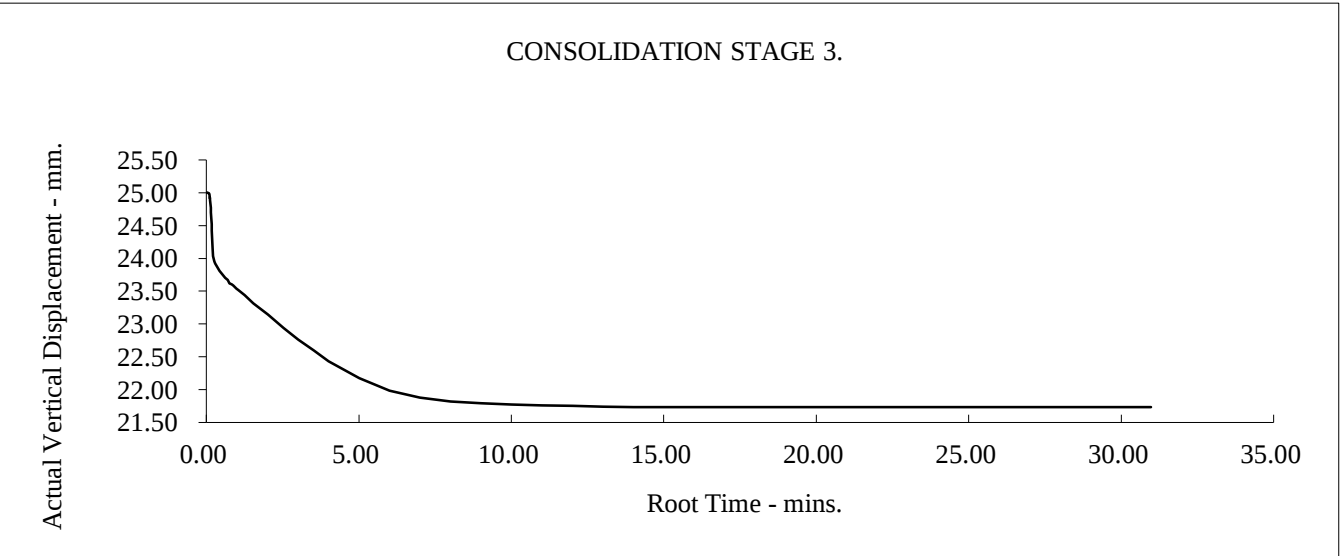
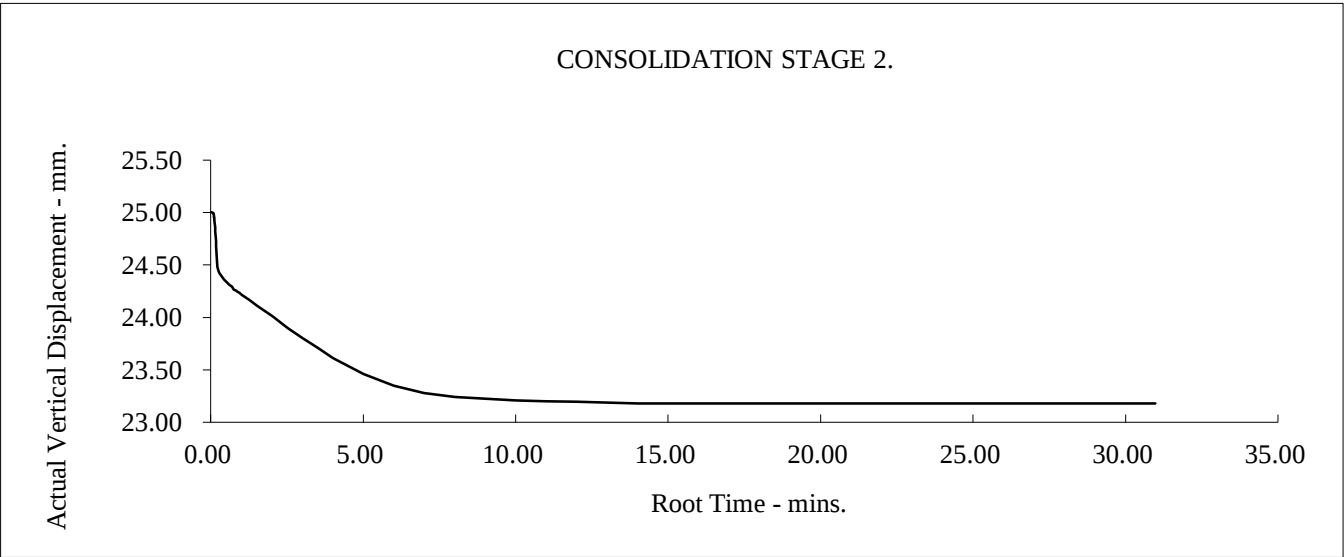
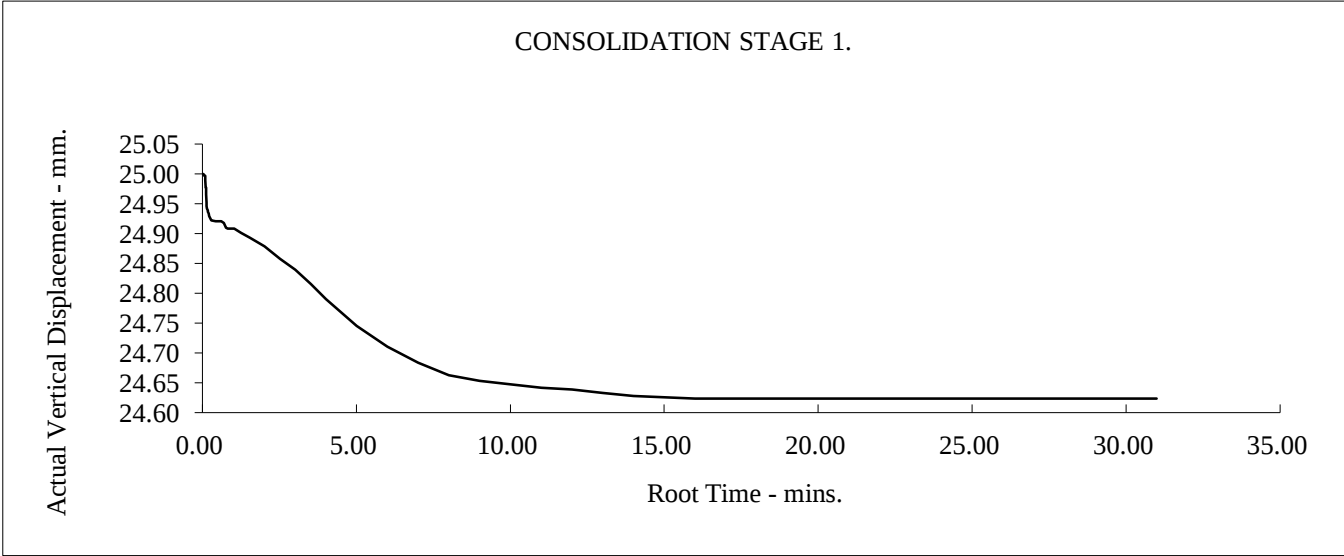


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Figure.
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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 1 Depth (m): GL



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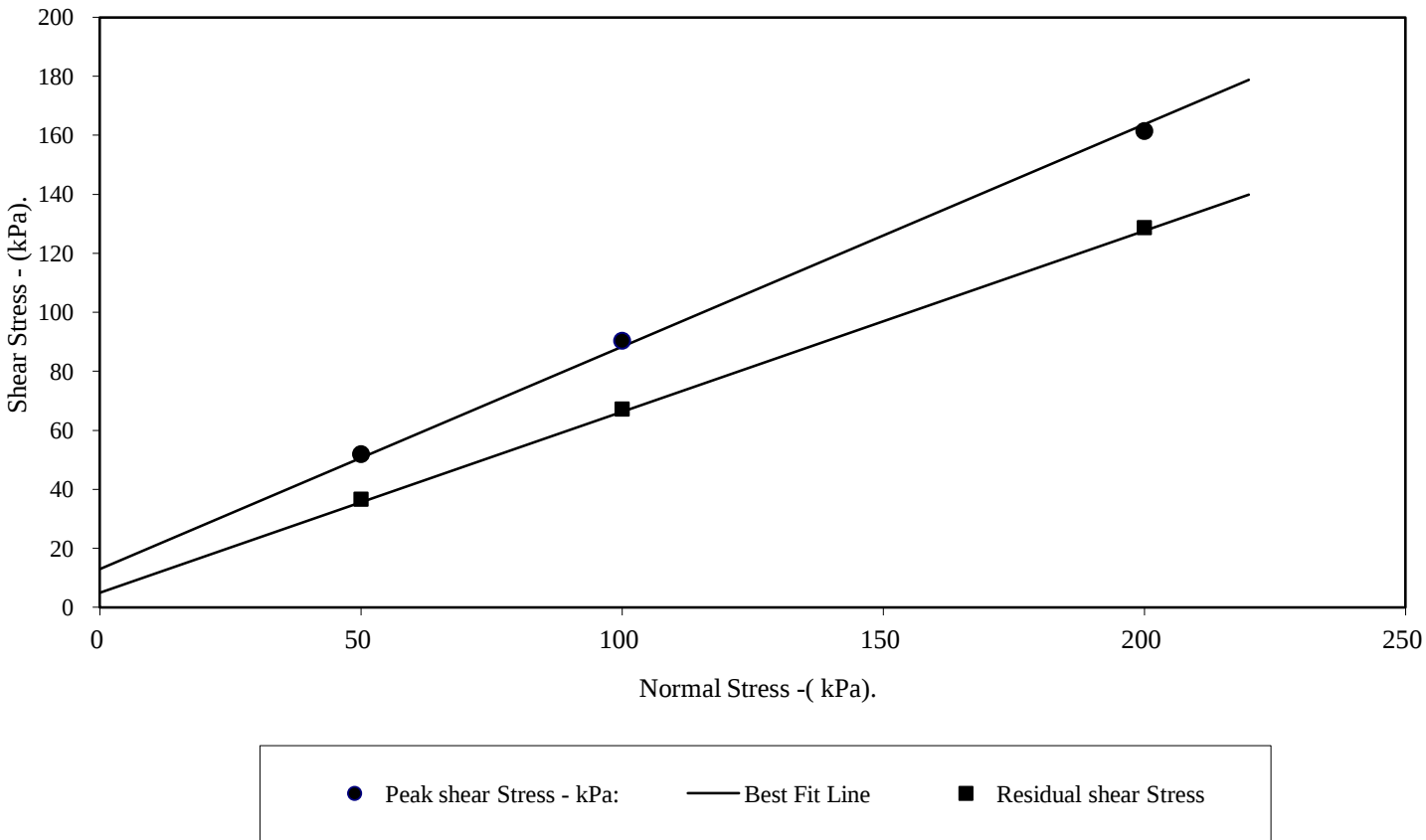
Client Ref Number:
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Figure.
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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 2 Depth (m): 1.50

Sample Type:	Remoulded (2.5kg Rammer).		
Particle Density - Mg/m3:	2.65 (Assumed)		
Specimen Tested:	Submerged		
Sample Description:			
Dark brown silty sandy WOOD CHIPPINGS			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	90	90	90
Bulk Density - Mg/m3:	1.43	1.44	1.44
Dry Density - Mg/m3:	0.76	0.76	0.76
Voids Ratio:	2.5053	2.4845	2.4942
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	24.41	22.48	20.55
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (mm)	2.70	4.79	4.80
Peak shear Stress - kPa:	52	90	161
PEAK			
Angle of Shearing Resistance:(θ)			37.0
Effective Cohesion - kPa:			13
RESIDUAL			
Angle of Shearing Resistance:(θ)			31.5
Effective Cohesion - kPa:			5

FAILURE CONDITIONS

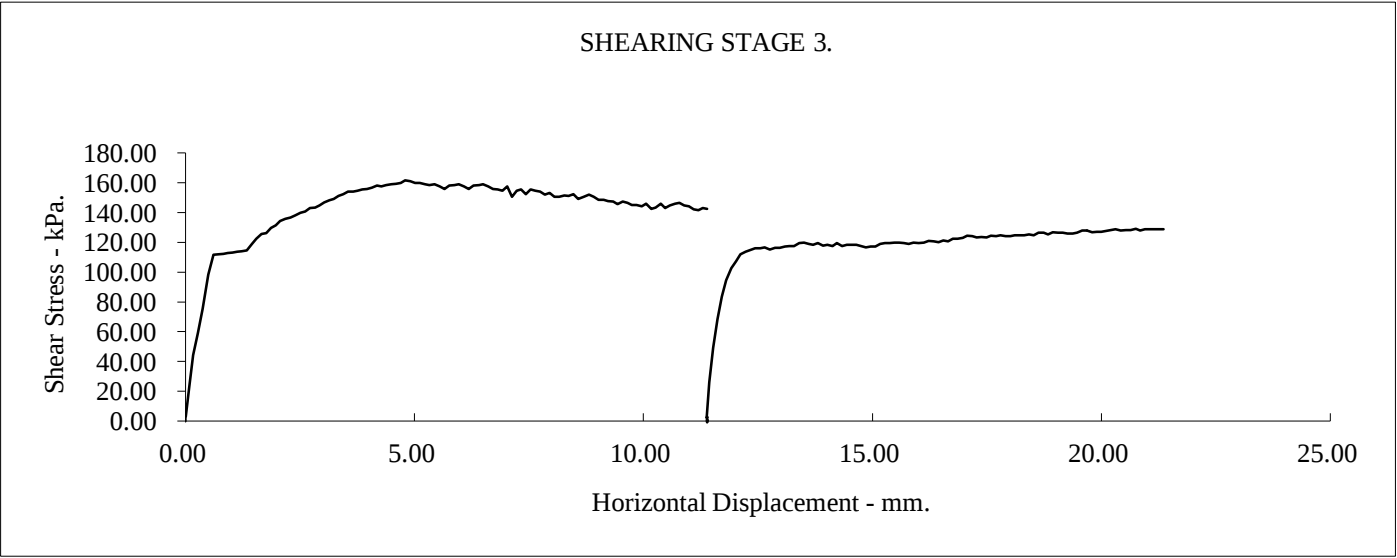
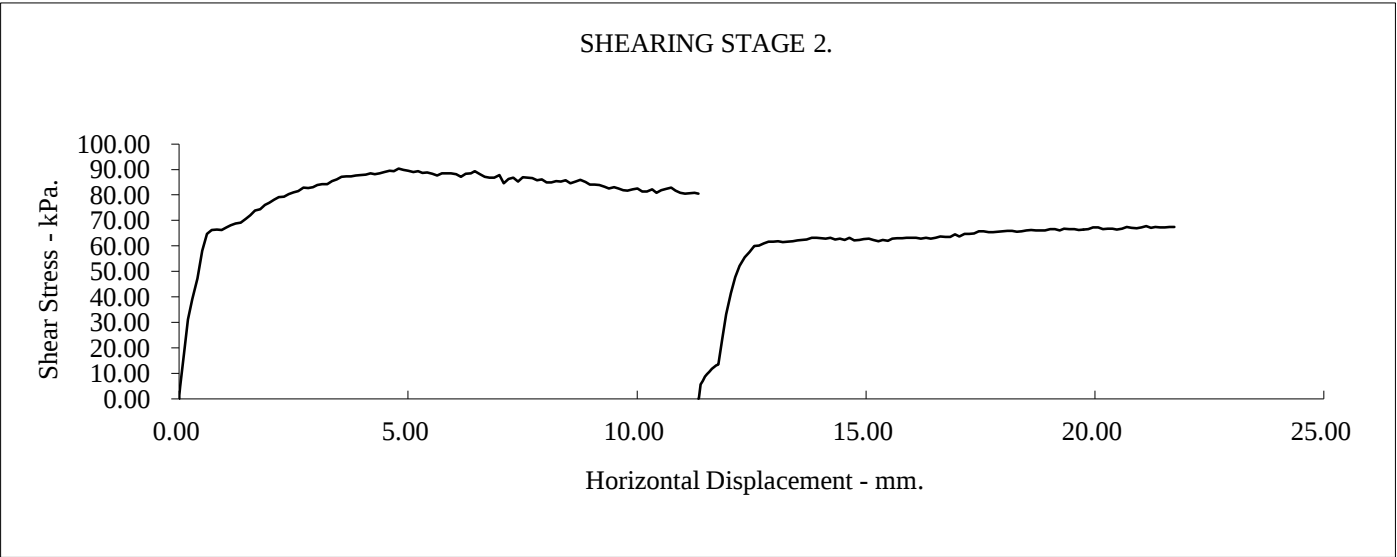
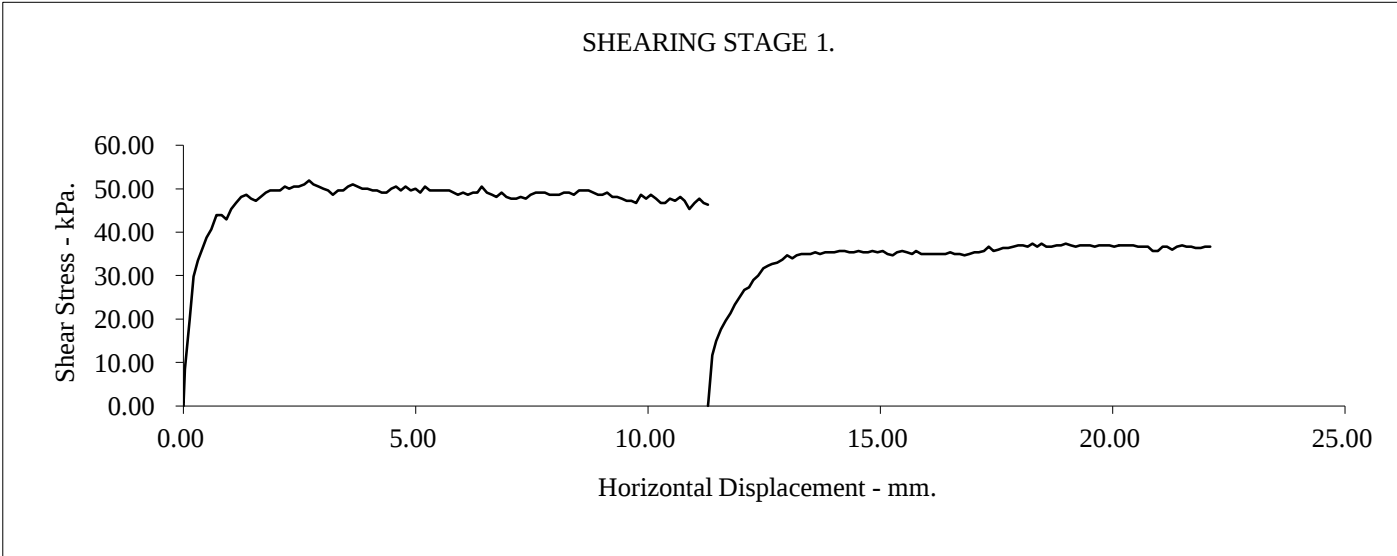


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 2 Depth (m): 1.50

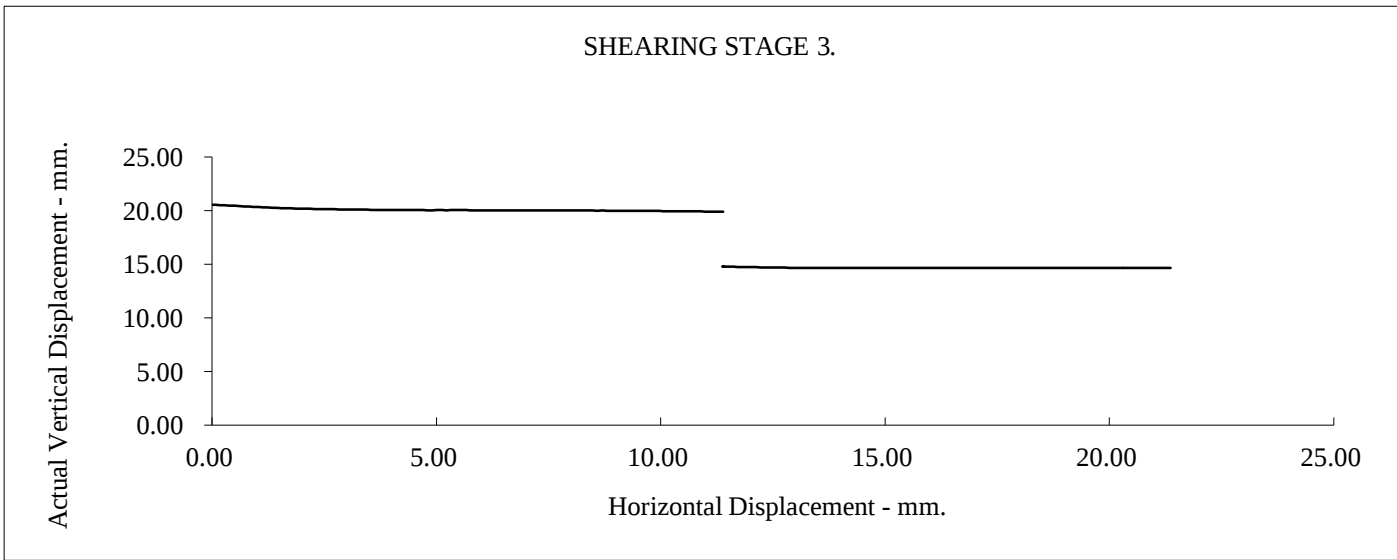
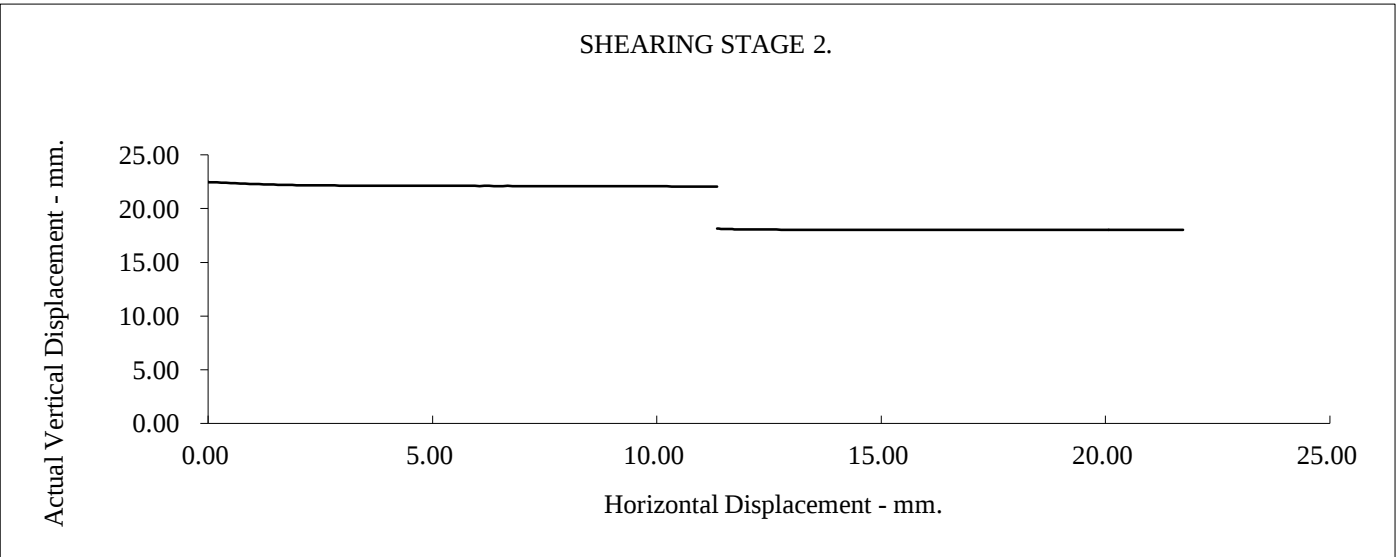
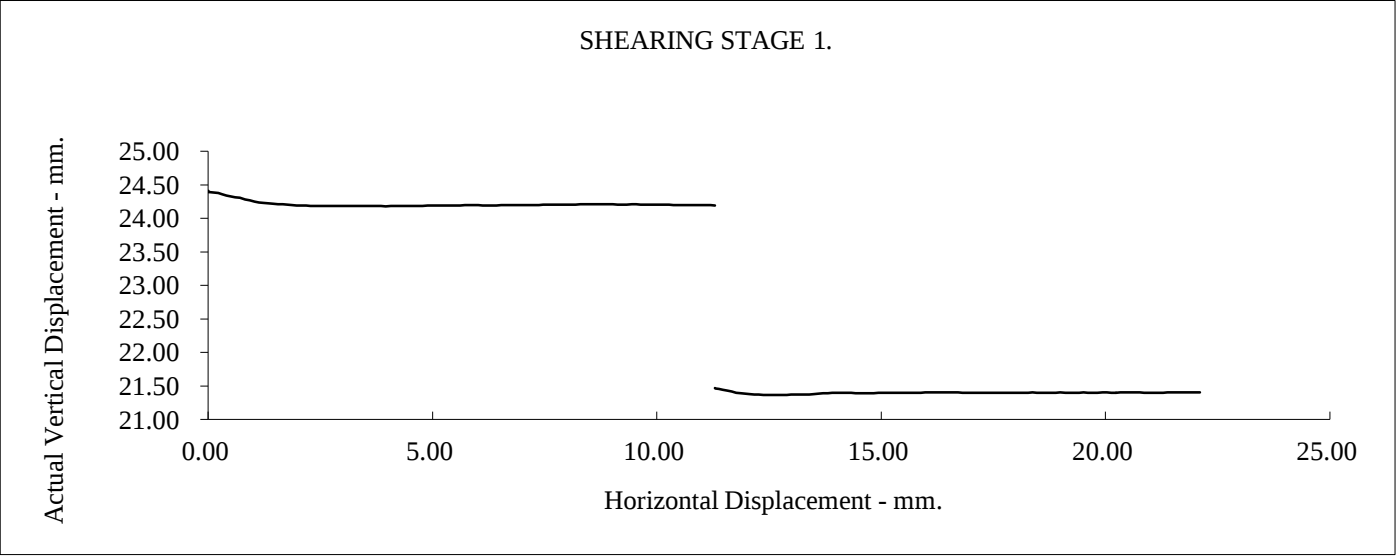


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 2 Depth (m): 1.50



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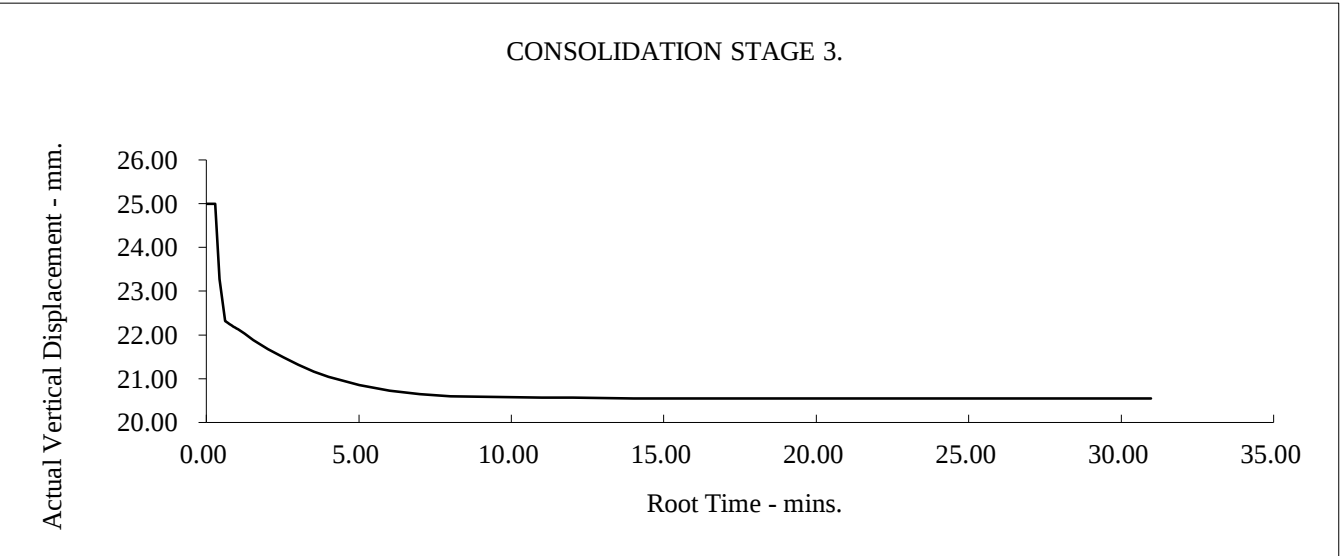
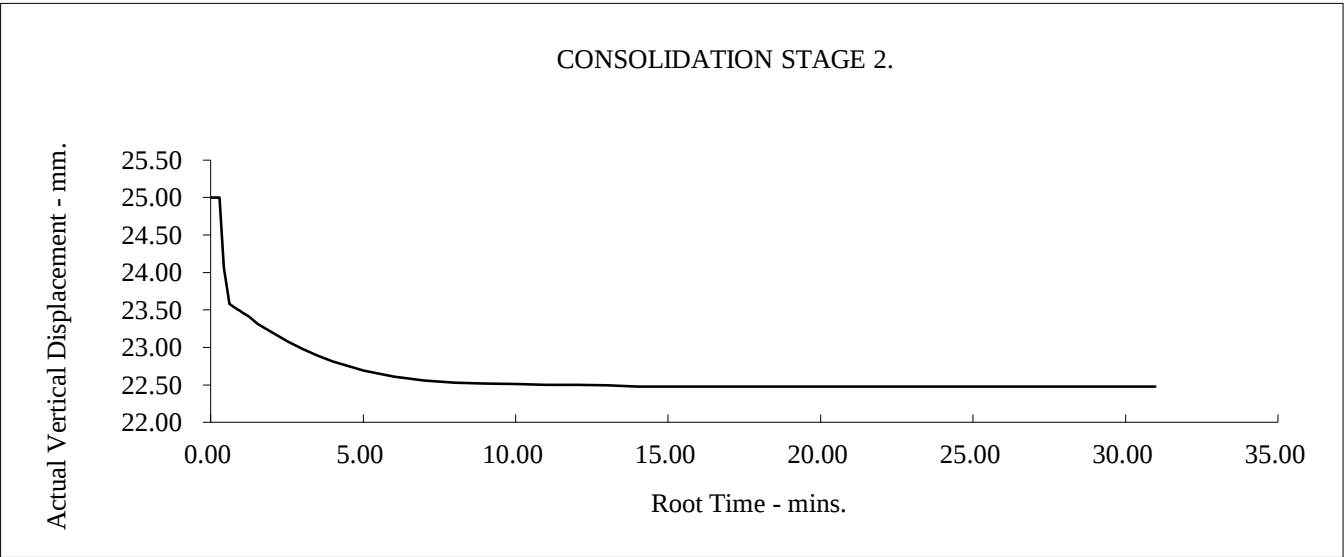
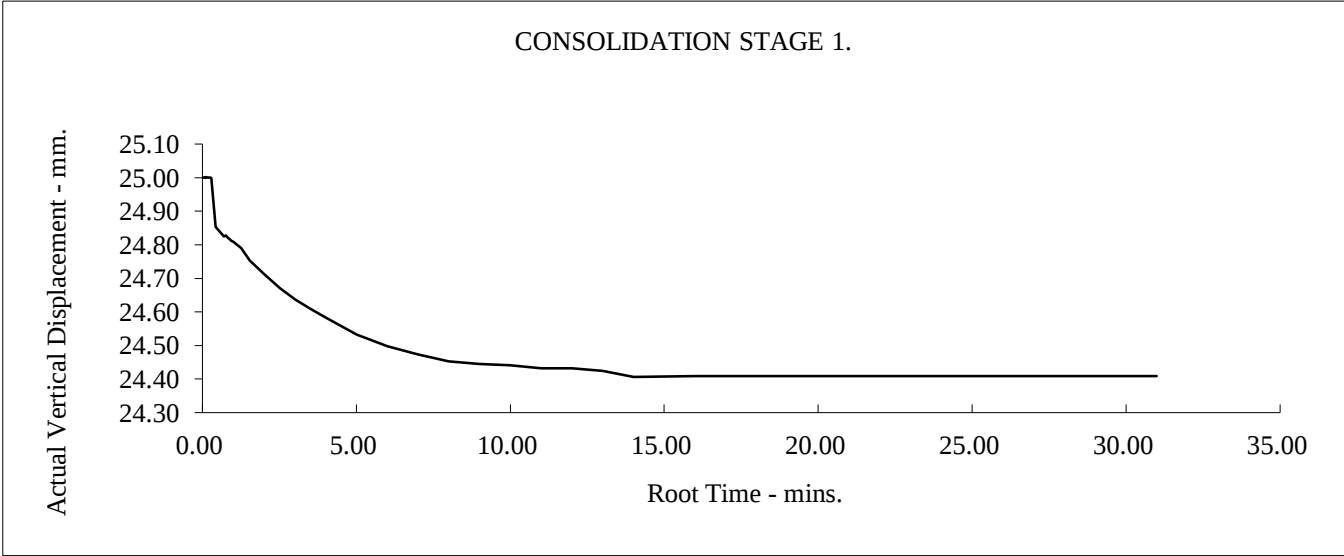


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 2 Depth (m): 1.50



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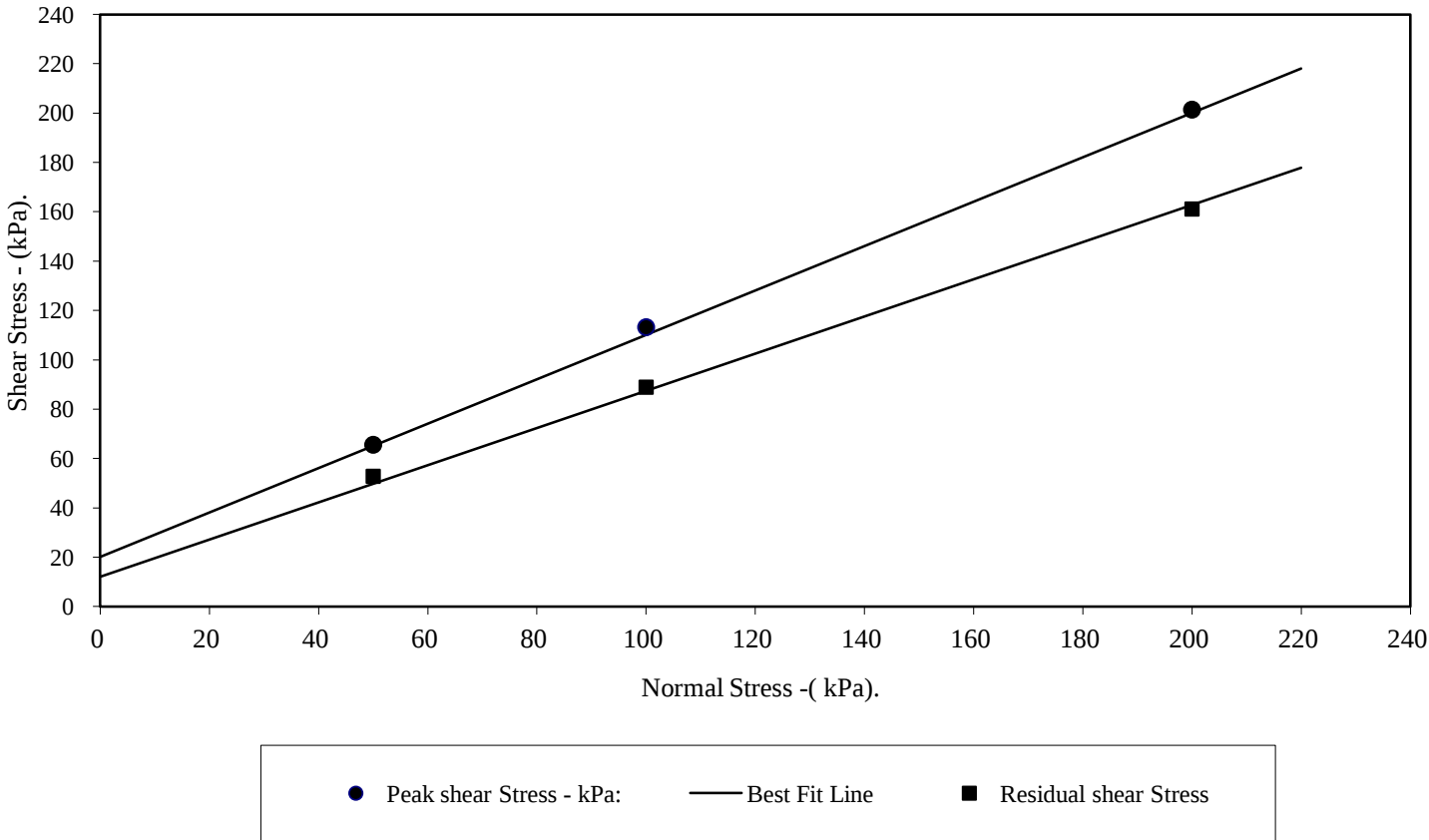
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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 3 Depth (m): GL

Sample Type:	Remoulded (2.5kg Rammer).		
Particle Density - Mg/m3:	2.65 (Assumed)		
Specimen Tested:	Submerged		
Sample Description:			
Dark brown silty sandy WOOD CHIPPINGS			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	80	80	80
Bulk Density - Mg/m3:	1.35	1.34	1.35
Dry Density - Mg/m3:	0.75	0.74	0.75
Voids Ratio:	2.5483	2.5757	2.5483
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	23.72	22.33	20.94
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (mm)	9.31	9.96	9.99
Peak shear Stress - kPa:	66	113	201
PEAK			
Angle of Shearing Resistance:(θ)			42.0
Effective Cohesion - kPa:			20
RESIDUAL			
Angle of Shearing Resistance:(θ)			37.0
Effective Cohesion - kPa:			12

FAILURE CONDITIONS

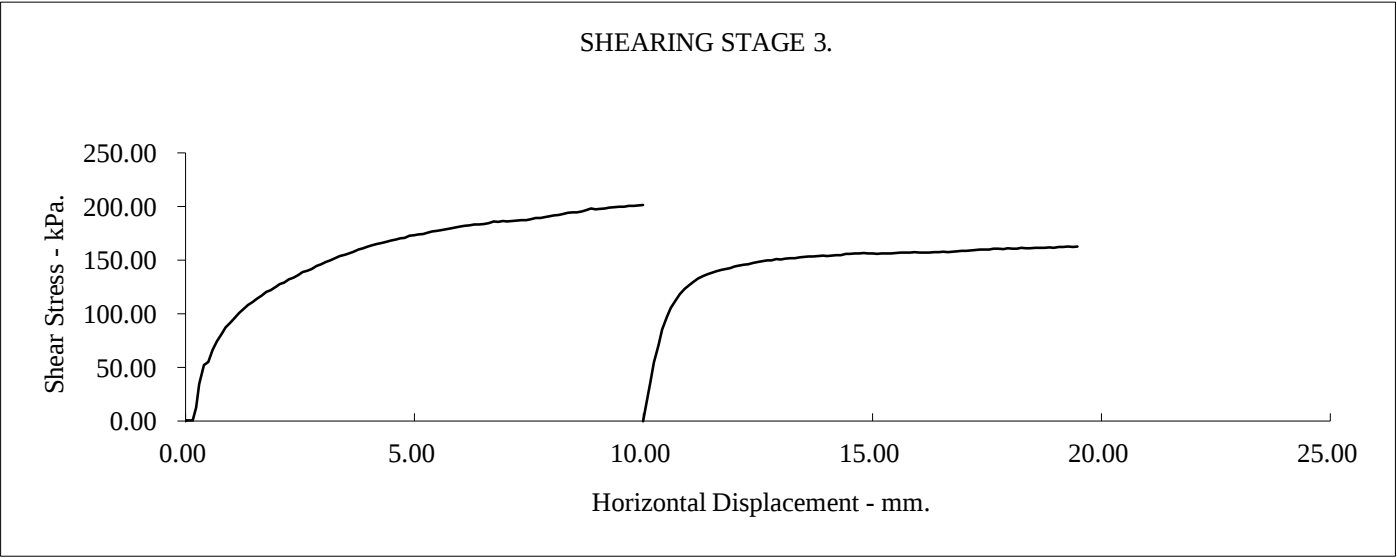
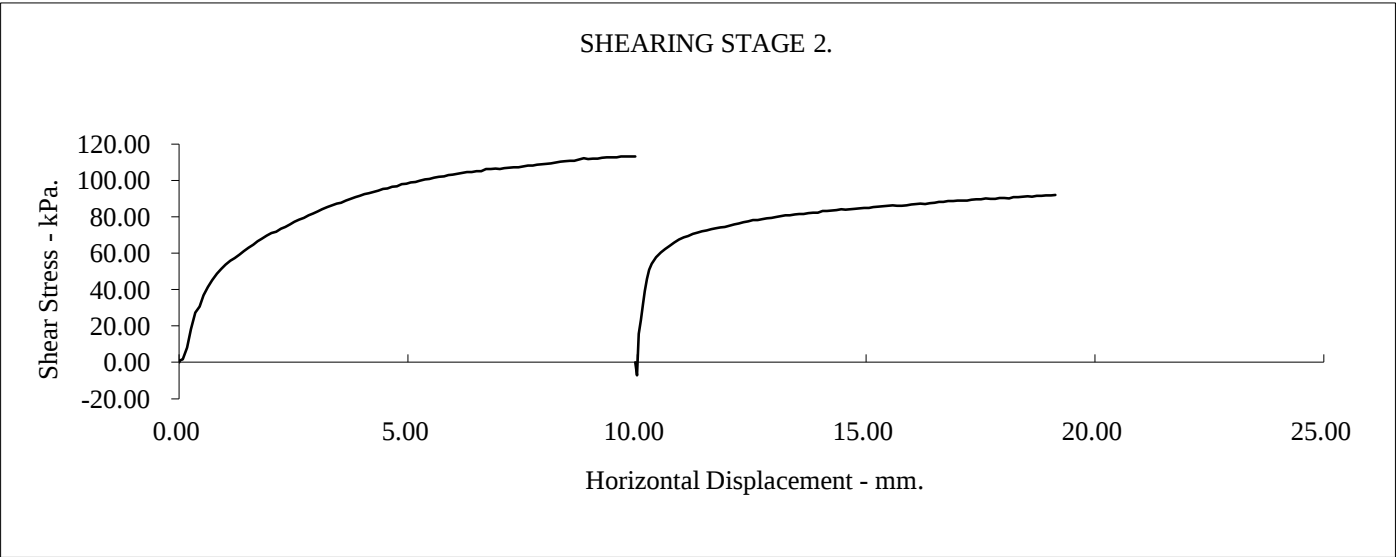
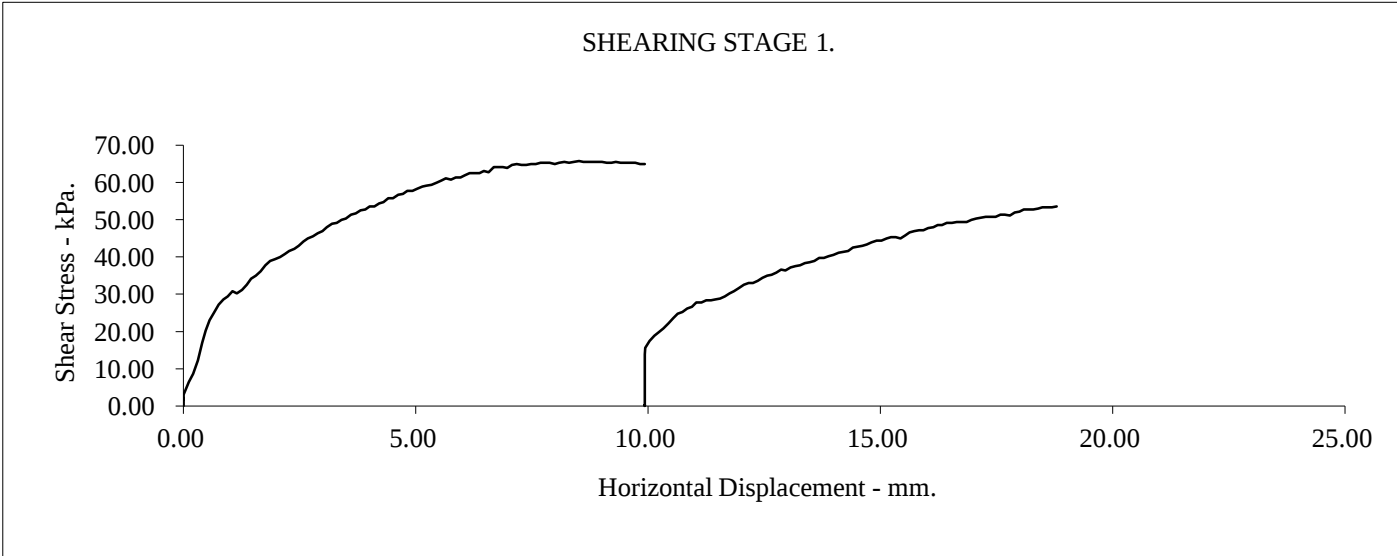


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 3 Depth (m): GL

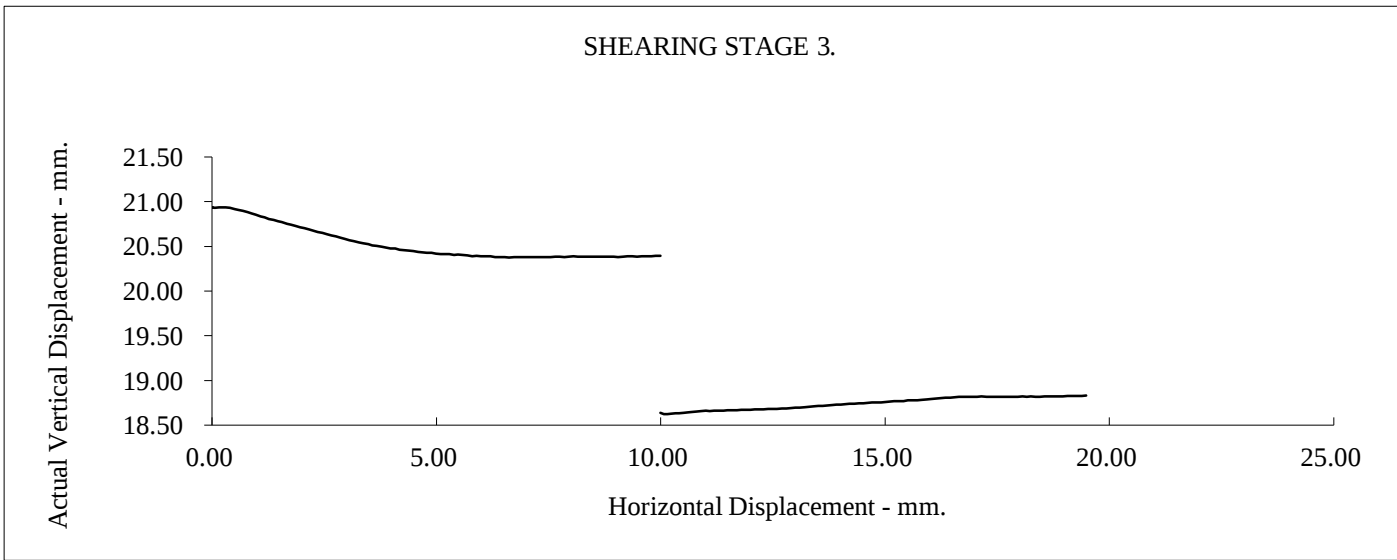
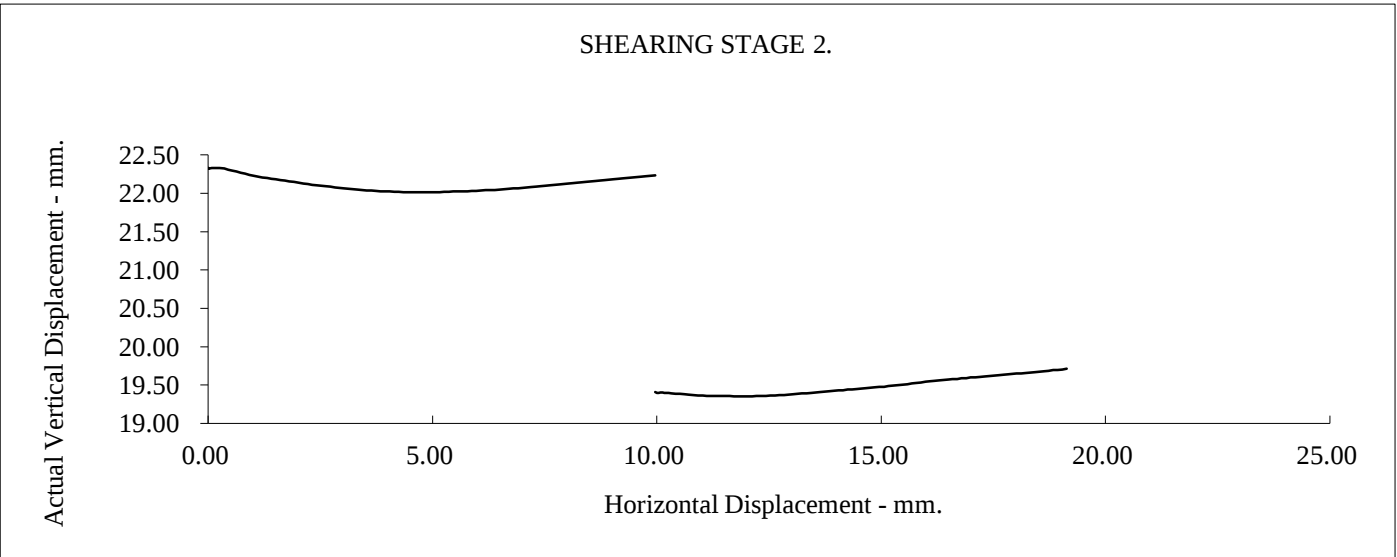
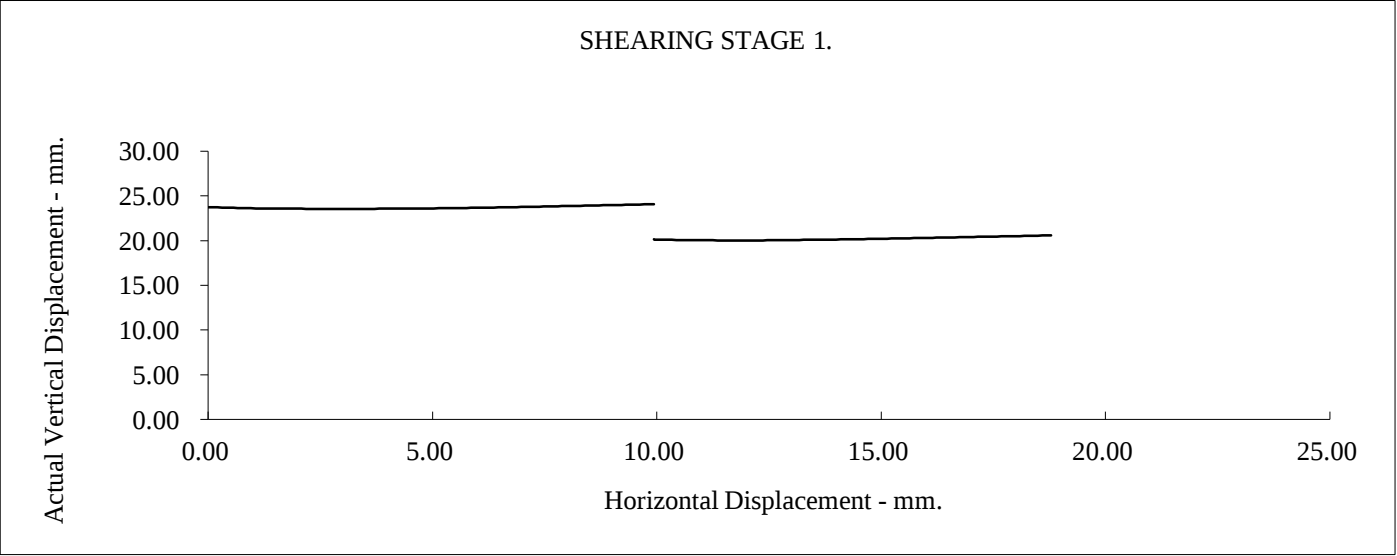


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 3 Depth (m): GL



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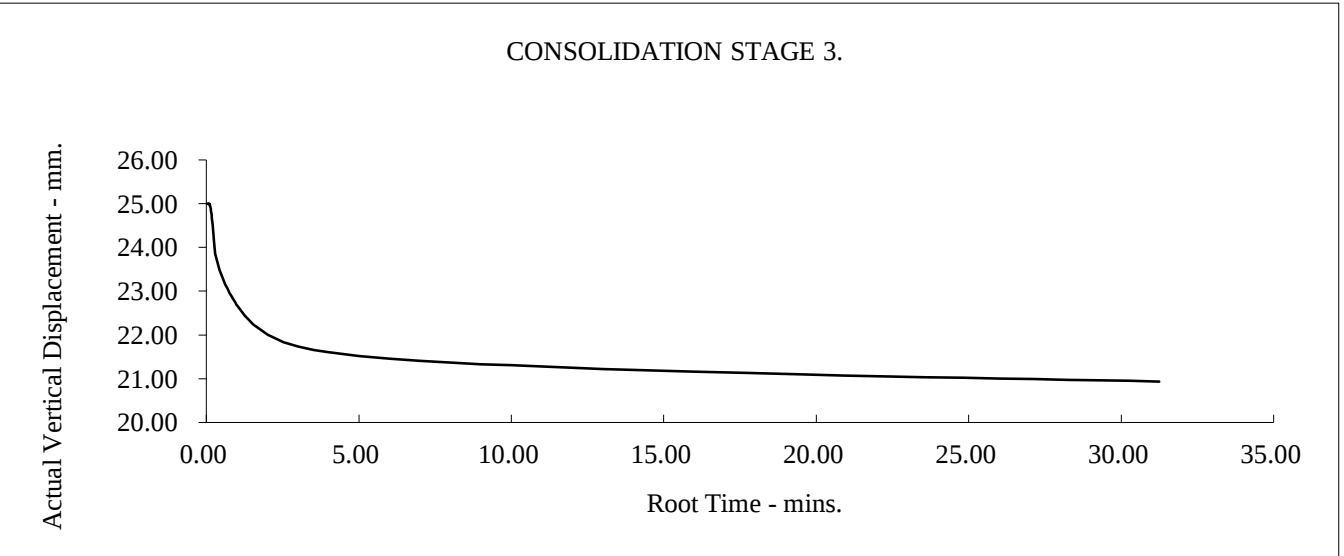
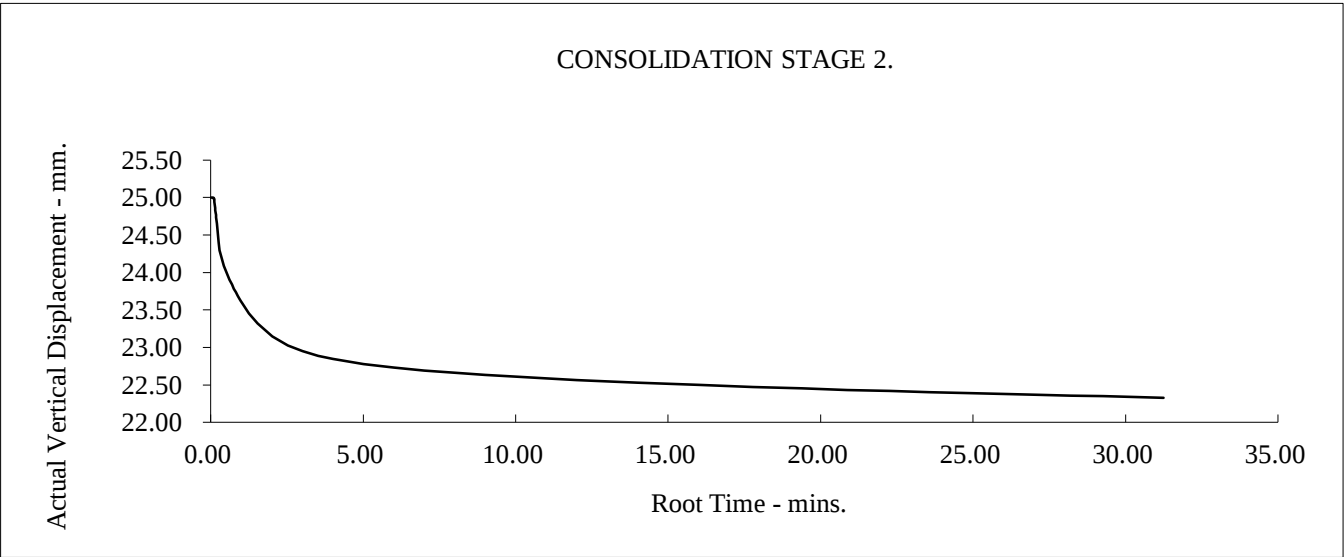
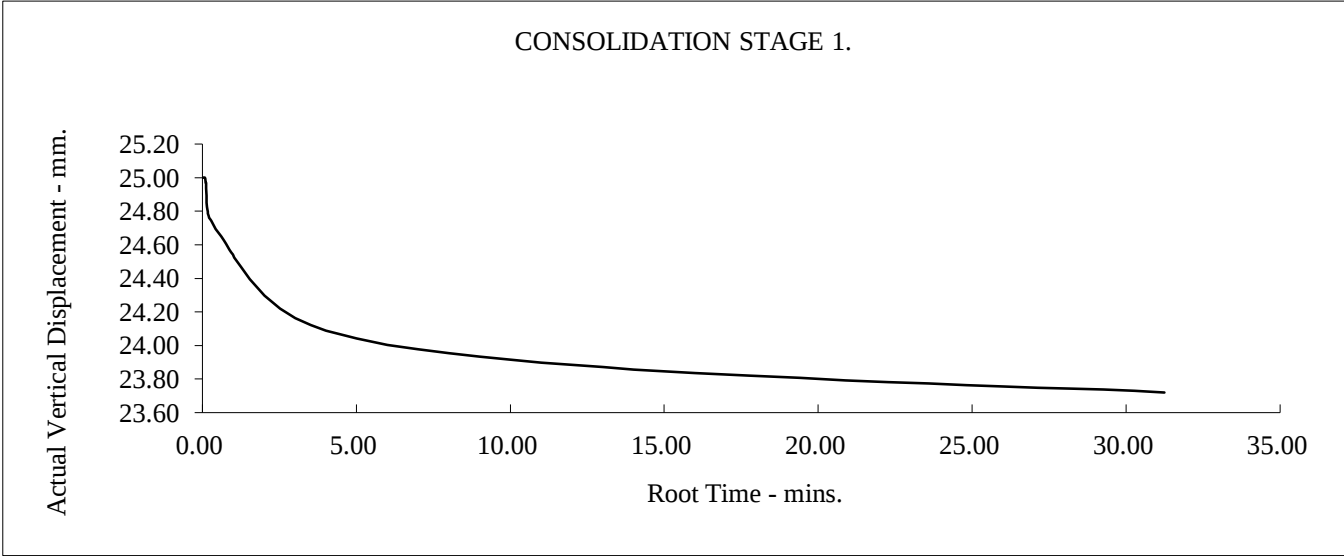
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Client Ref Number:
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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 1 Sample 3 Depth (m): GL



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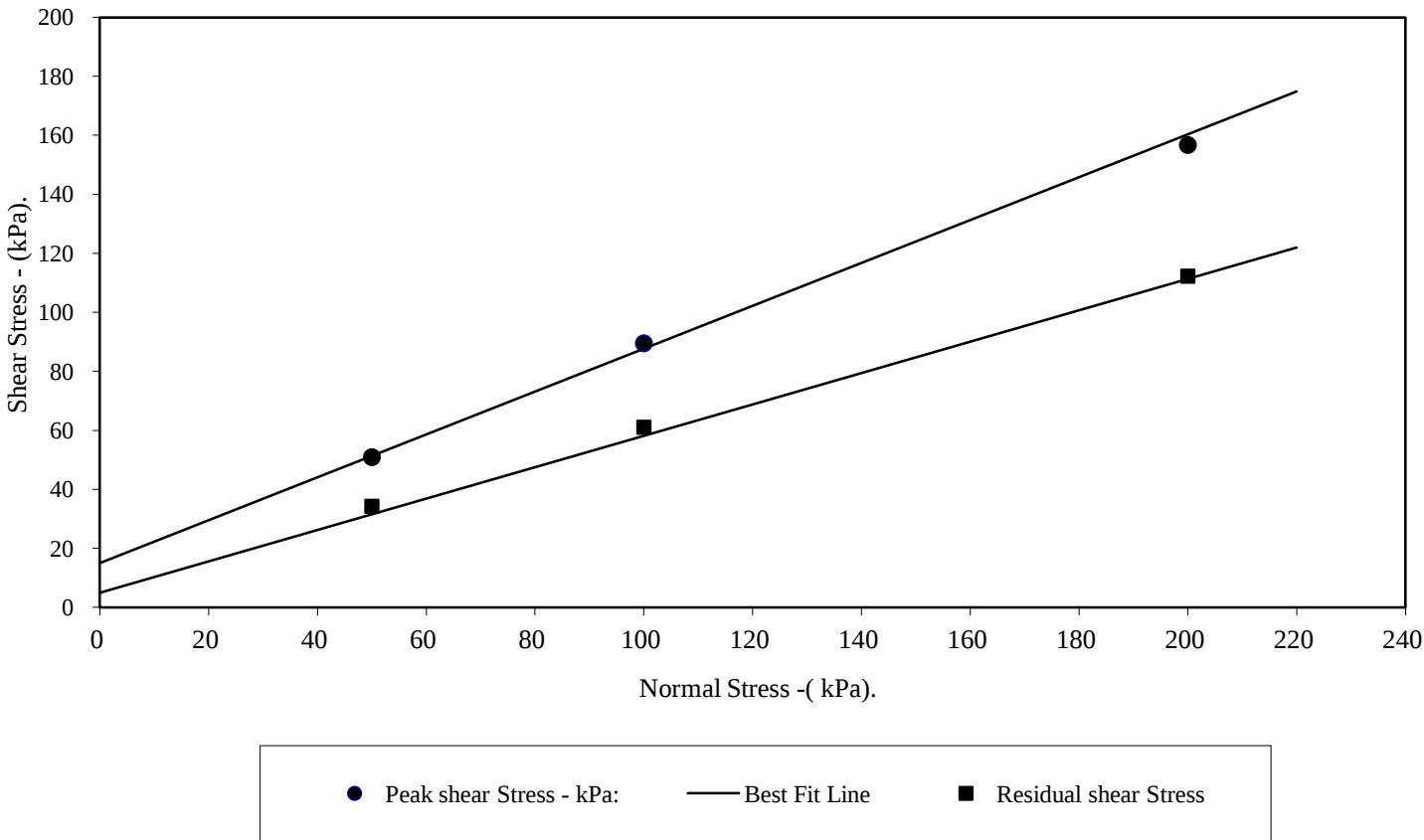
Client Ref Number:
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Figure.
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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 6 Depth (m): 0.50

Sample Type:	Remoulded (2.5kg Rammer).		
Particle Density - Mg/m3:	2.65 (Assumed)		
Specimen Tested:	Submerged		
Sample Description: Dark brown silty sandy WOOD CHIPPINGS			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	70	70	70
Bulk Density - Mg/m3:	1.46	1.47	1.47
Dry Density - Mg/m3:	0.86	0.86	0.86
Voids Ratio:	2.0781	2.0729	2.0764
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	23.81	22.12	20.43
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (mm)	9.98	7.77	7.85
Peak shear Stress - kPa:	51	90	157
PEAK			
Angle of Shearing Resistance:(θ)			36.0
Effective Cohesion - kPa:			15
RESIDUAL			
Angle of Shearing Resistance:(θ)			28.0
Effective Cohesion - kPa:			5

FAILURE CONDITIONS

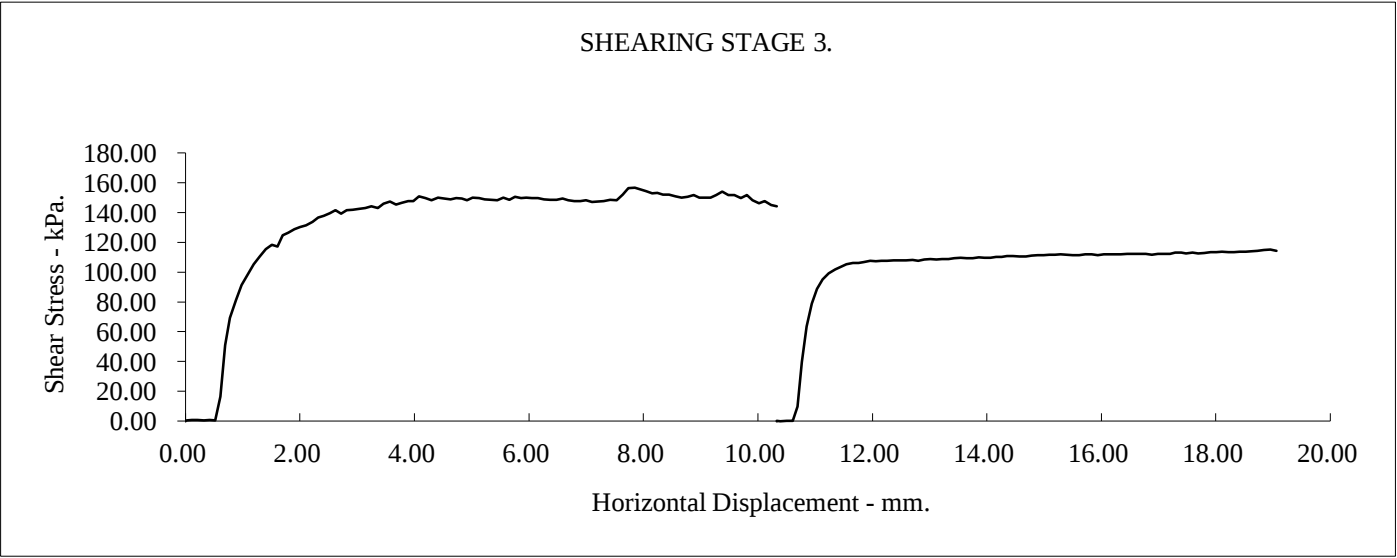
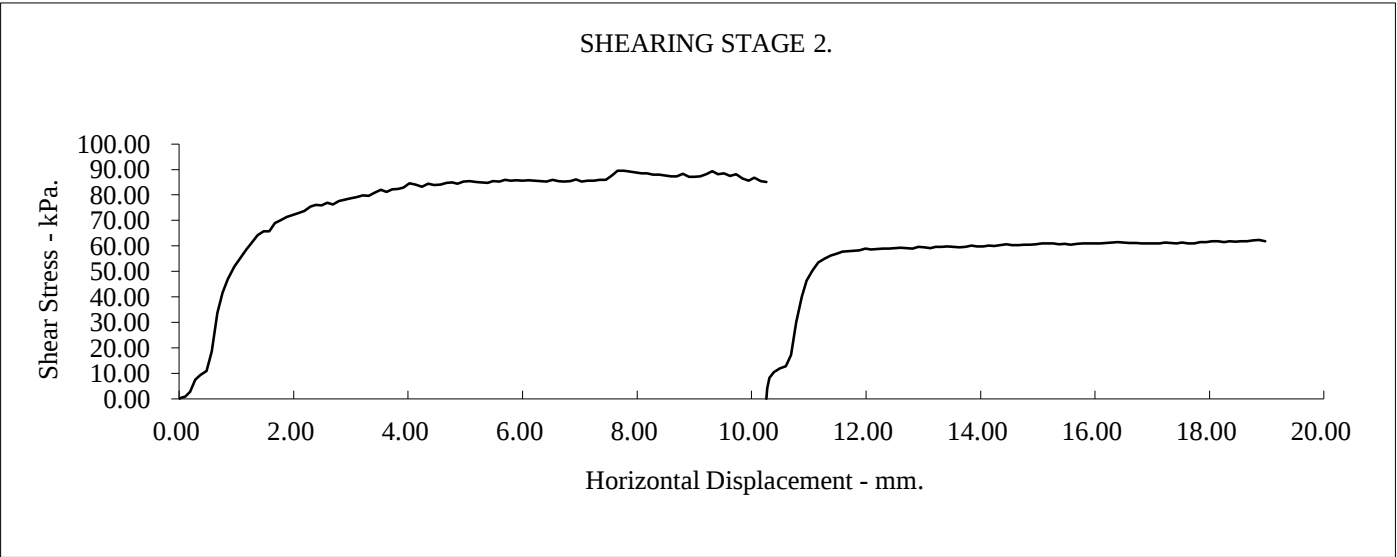
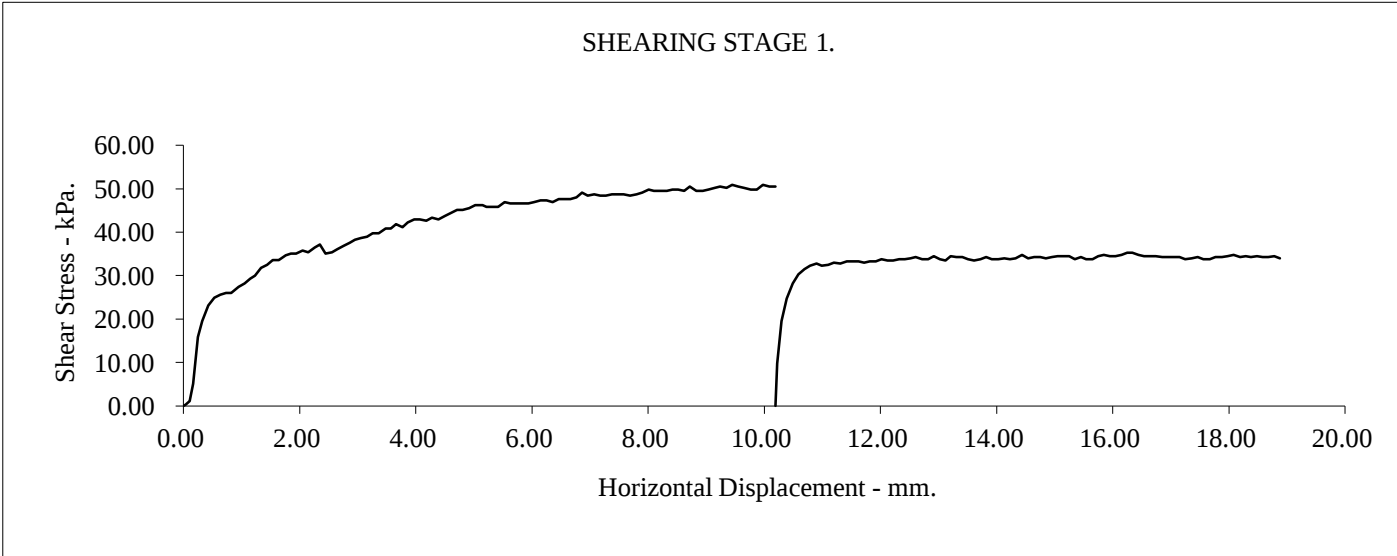


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 6 Depth (m): 0.50

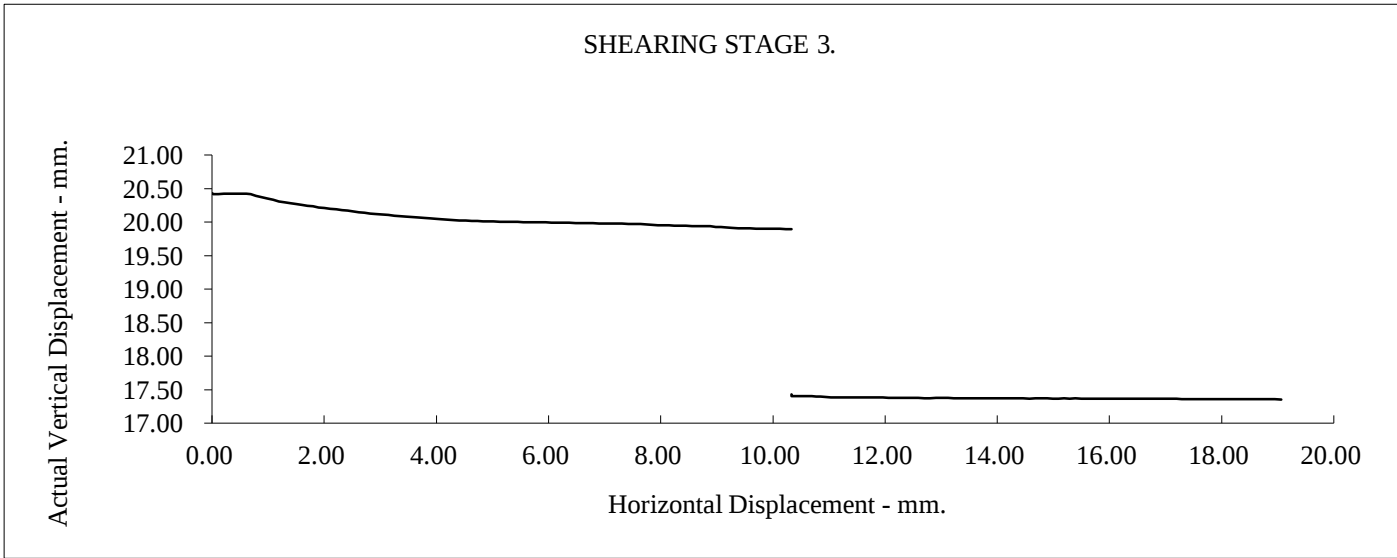
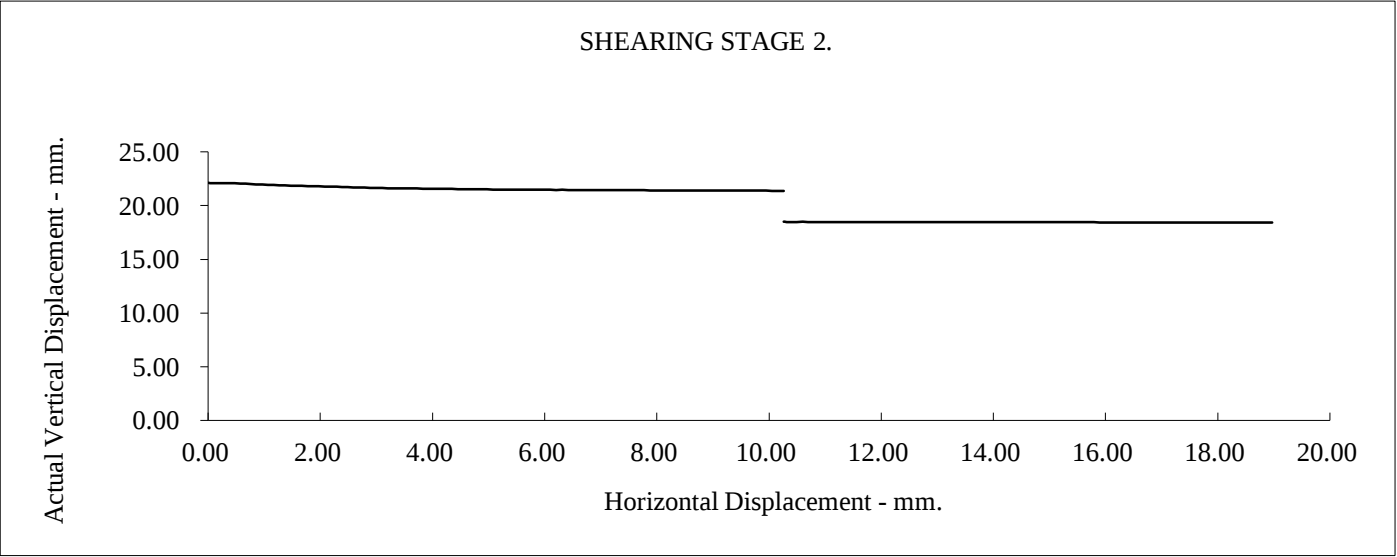
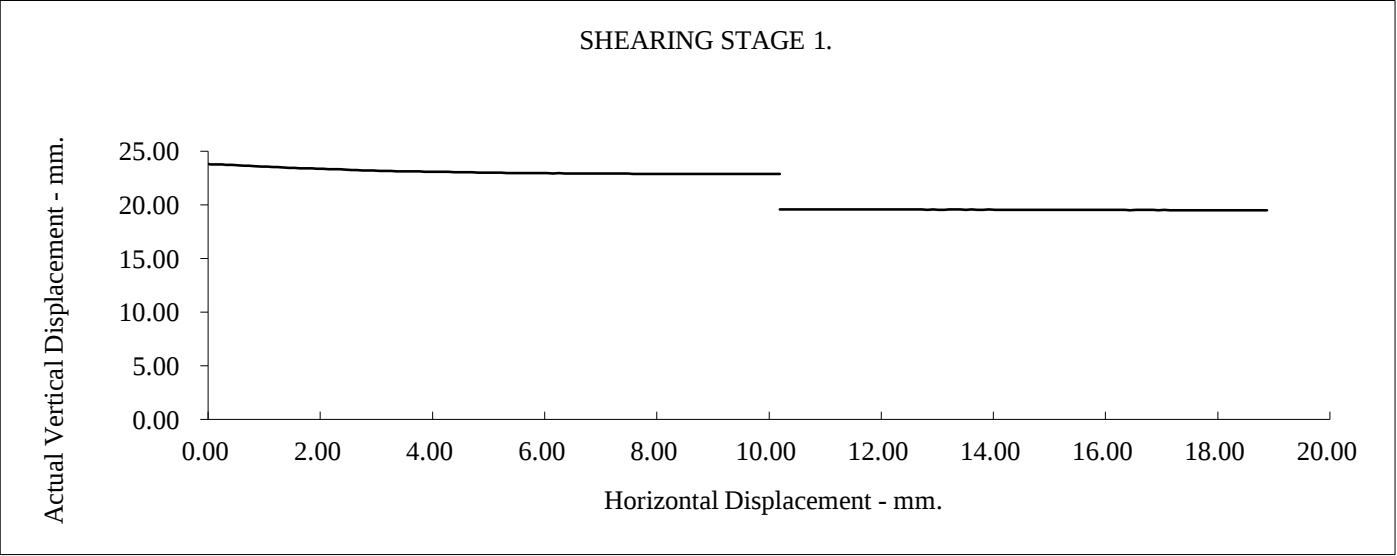


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 6 Depth (m): 0.50



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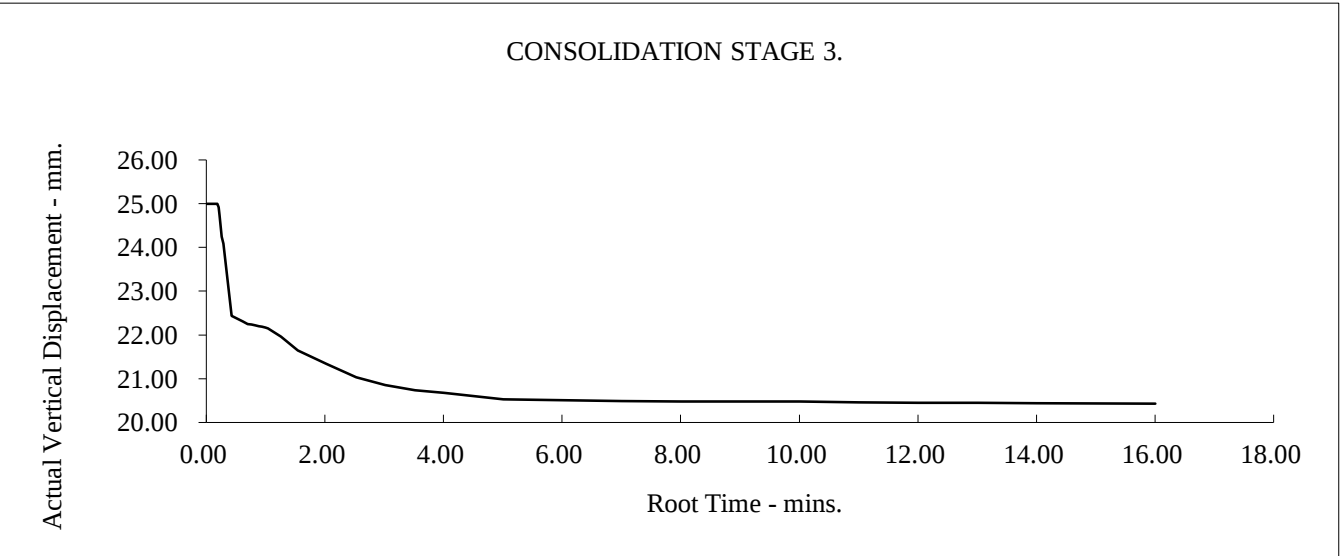
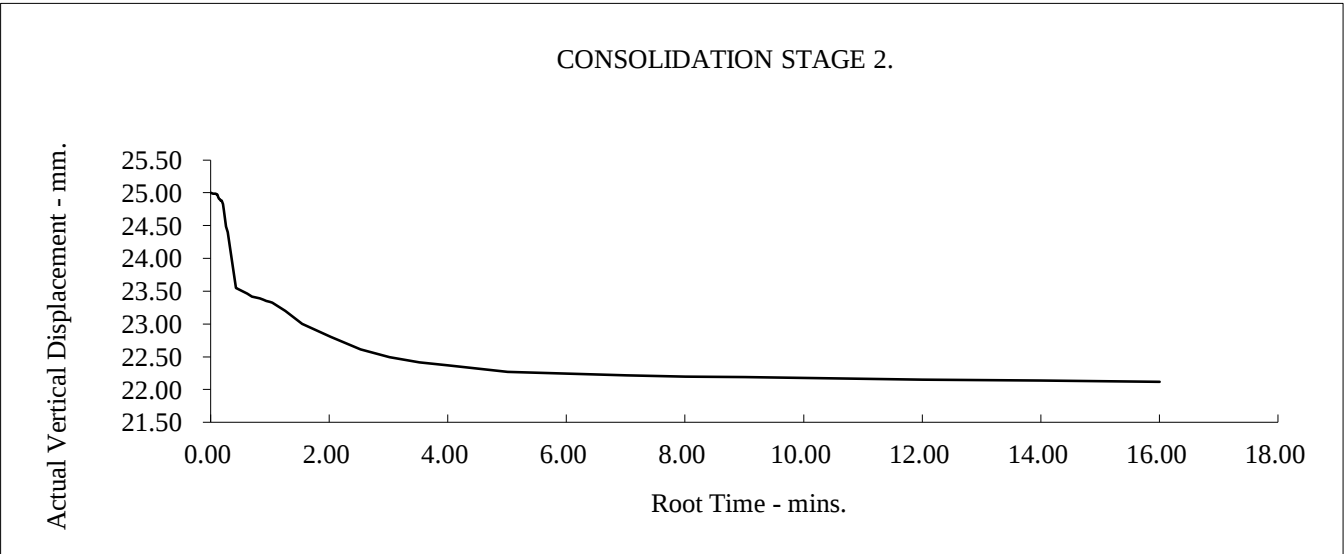
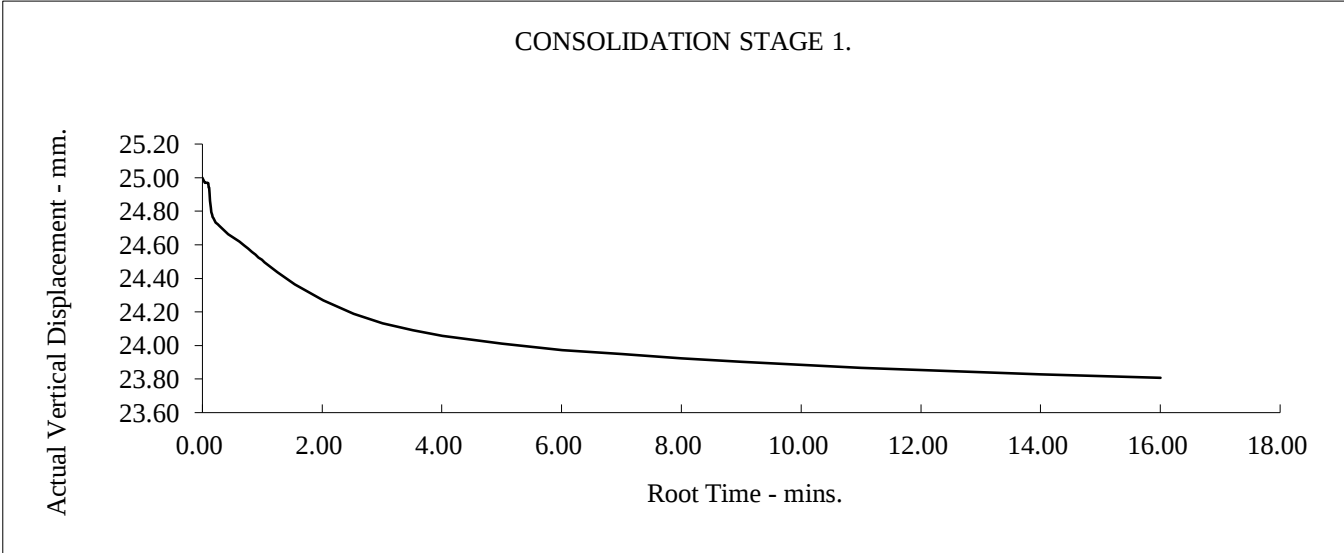


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Figure.
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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 6 Depth (m): 0.50



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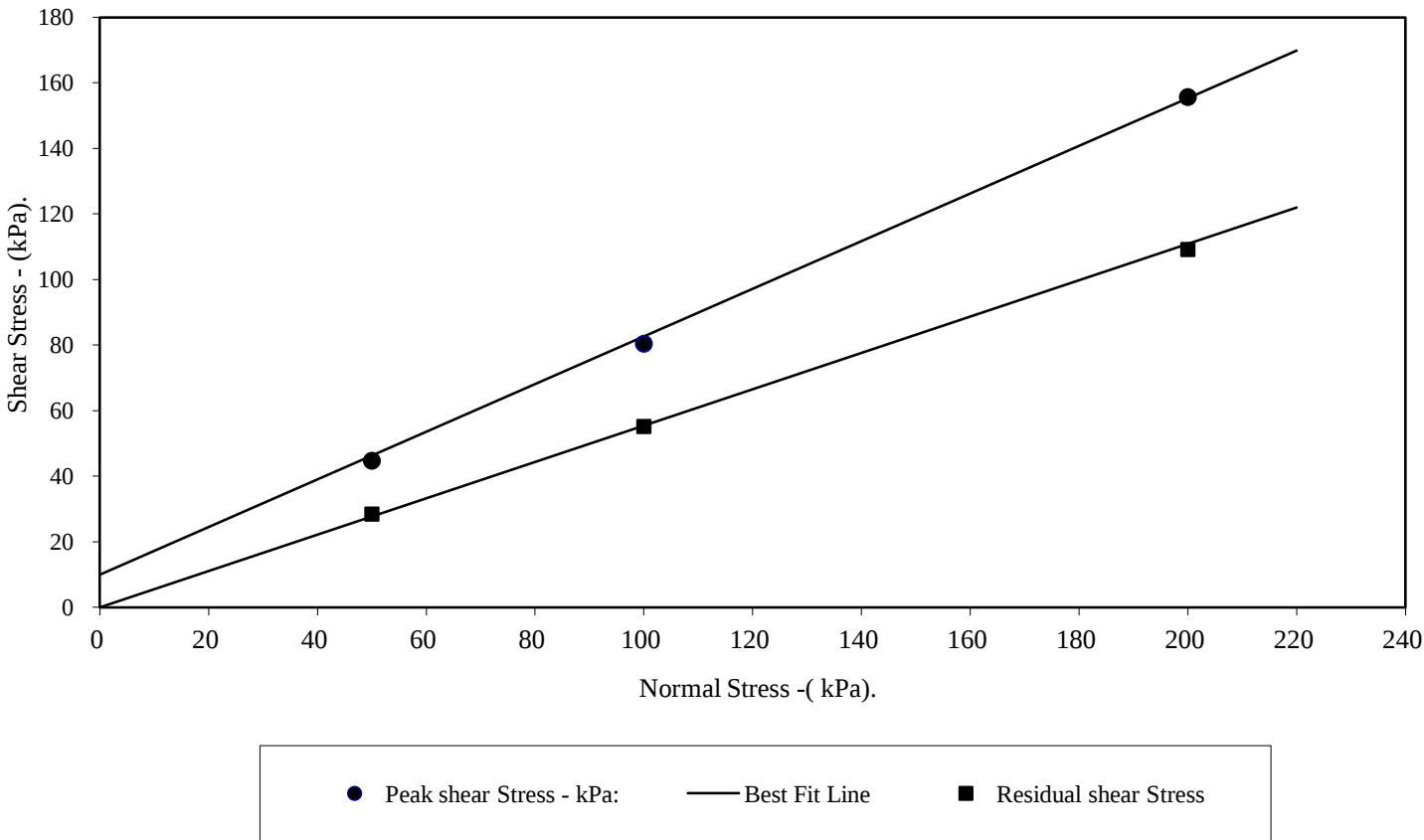
Client Ref Number:
12145434
Figure.
Bynea, Llanelli, SA14 9SU.

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 7 Depth (m): GL

Sample Type:	Remoulded (2.5kg Rammer).		
Particle Density - Mg/m3:	2.65 (Assumed)		
Specimen Tested:	Submerged		
Sample Description:			
Dark brown silty sandy WOOD CHIPPINGS			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	75	75	75
Bulk Density - Mg/m3:	1.40	1.41	1.42
Dry Density - Mg/m3:	0.80	0.81	0.81
Voids Ratio:	2.3090	2.2851	2.2779
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	24.39	23.31	22.22
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (mm)	10.70	10.58	9.41
Peak shear Stress - kPa:	45	80	156
PEAK			
Angle of Shearing Resistance:(θ)			36.0
Effective Cohesion - kPa:			10
RESIDUAL			
Angle of Shearing Resistance:(θ)			29.0
Effective Cohesion - kPa:			0

FAILURE CONDITIONS

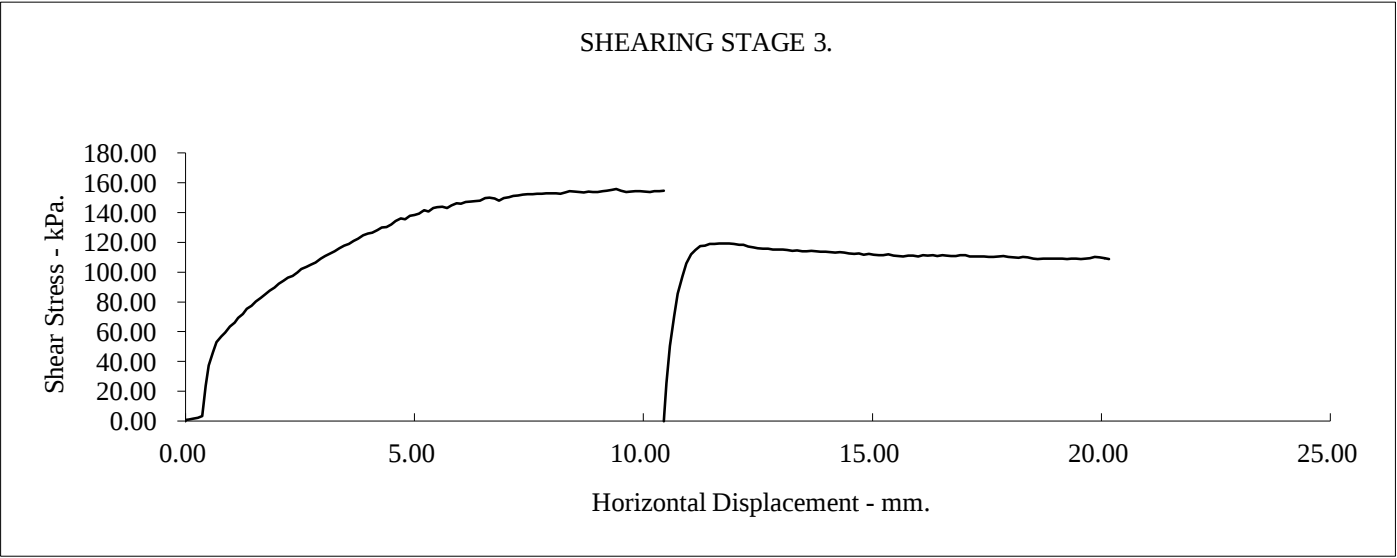
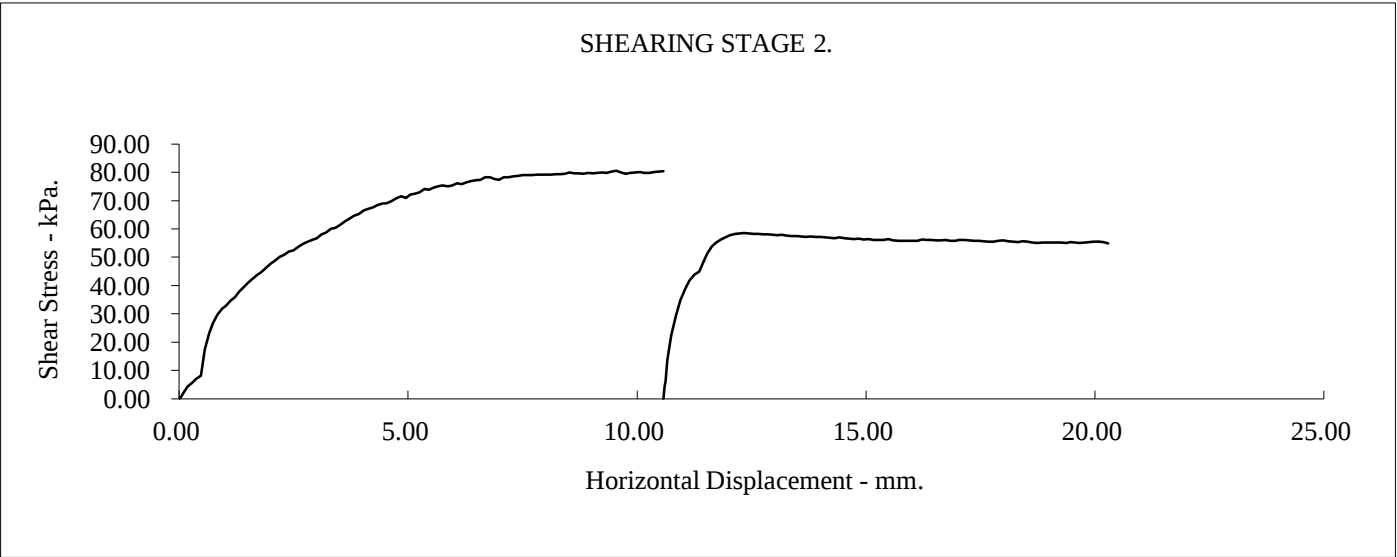
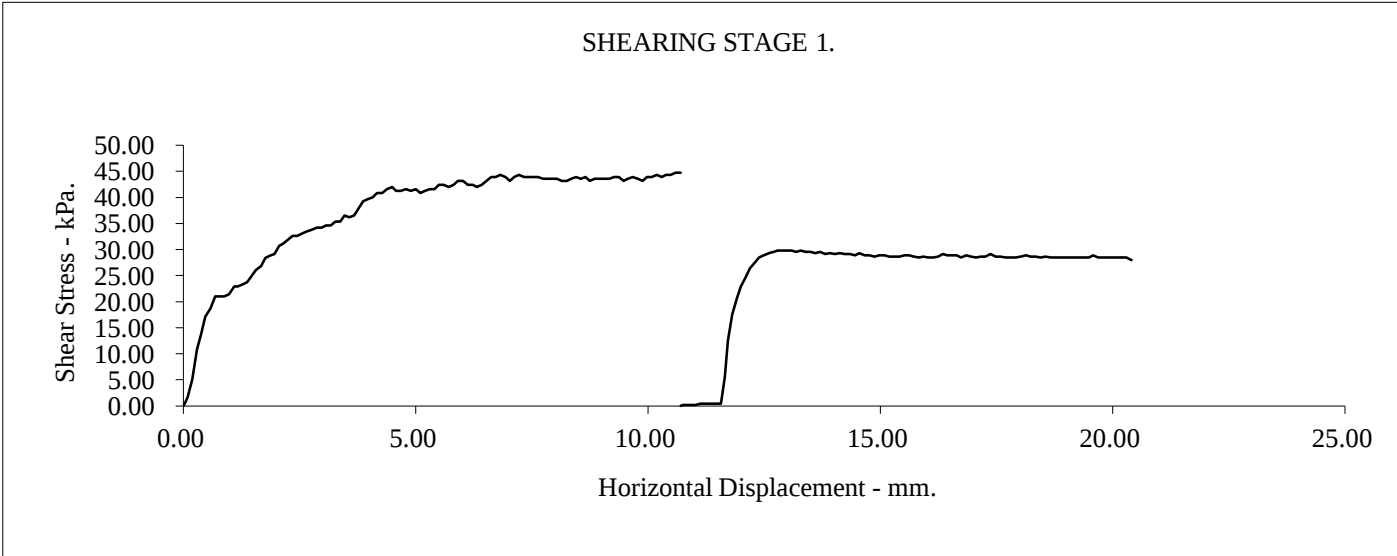


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 7 Depth (m): GL

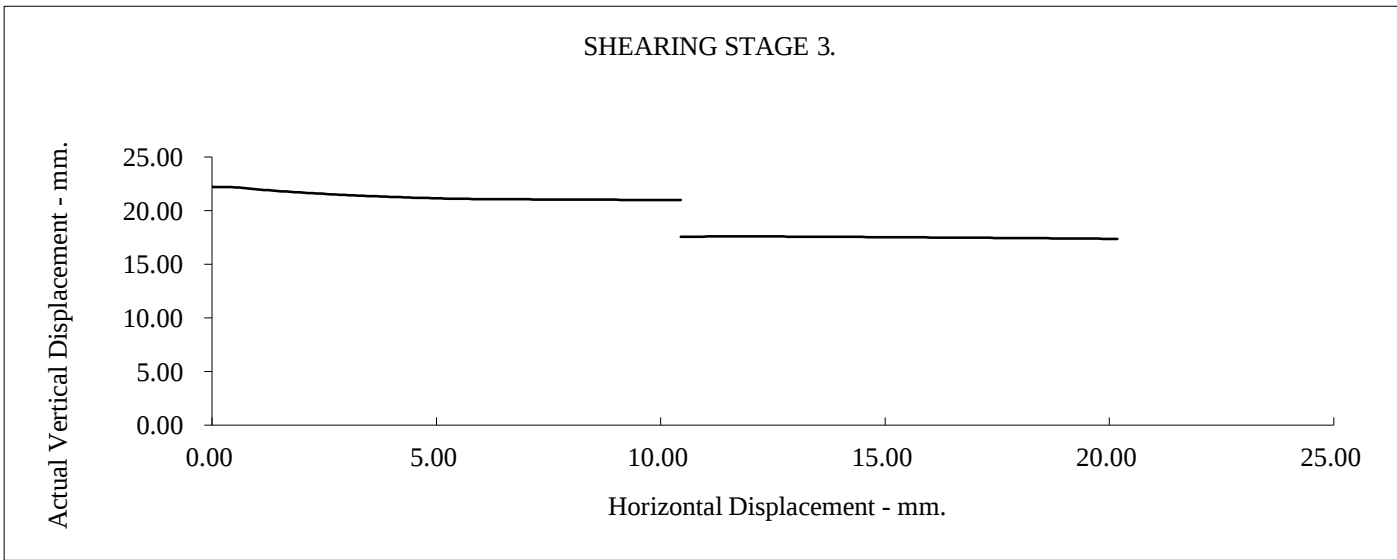
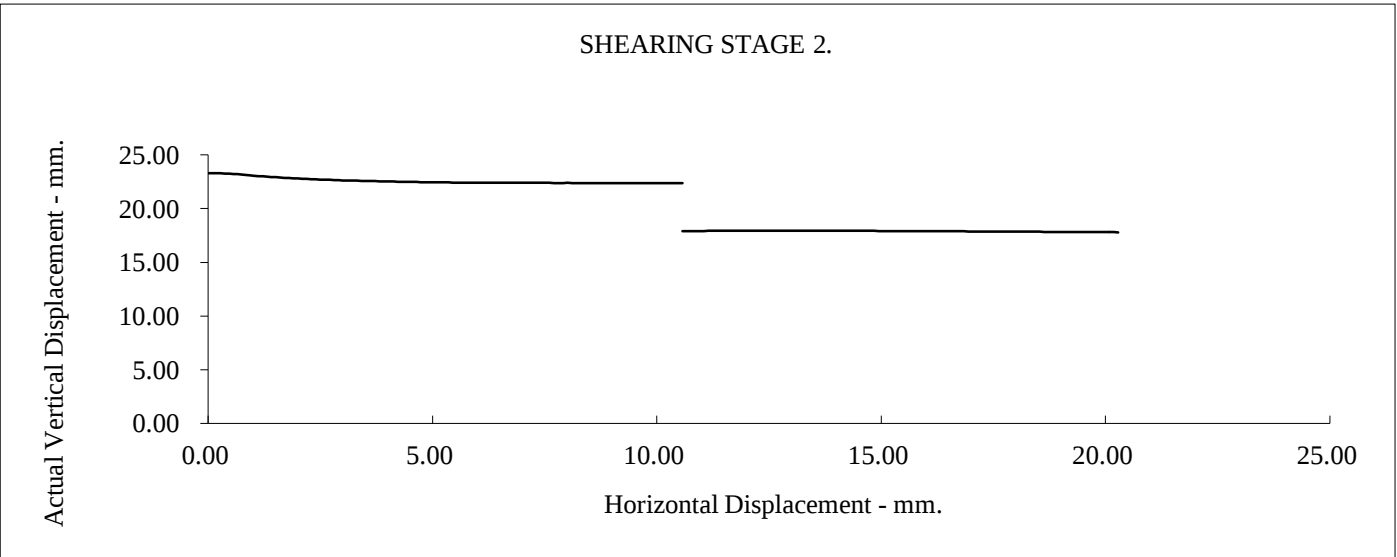
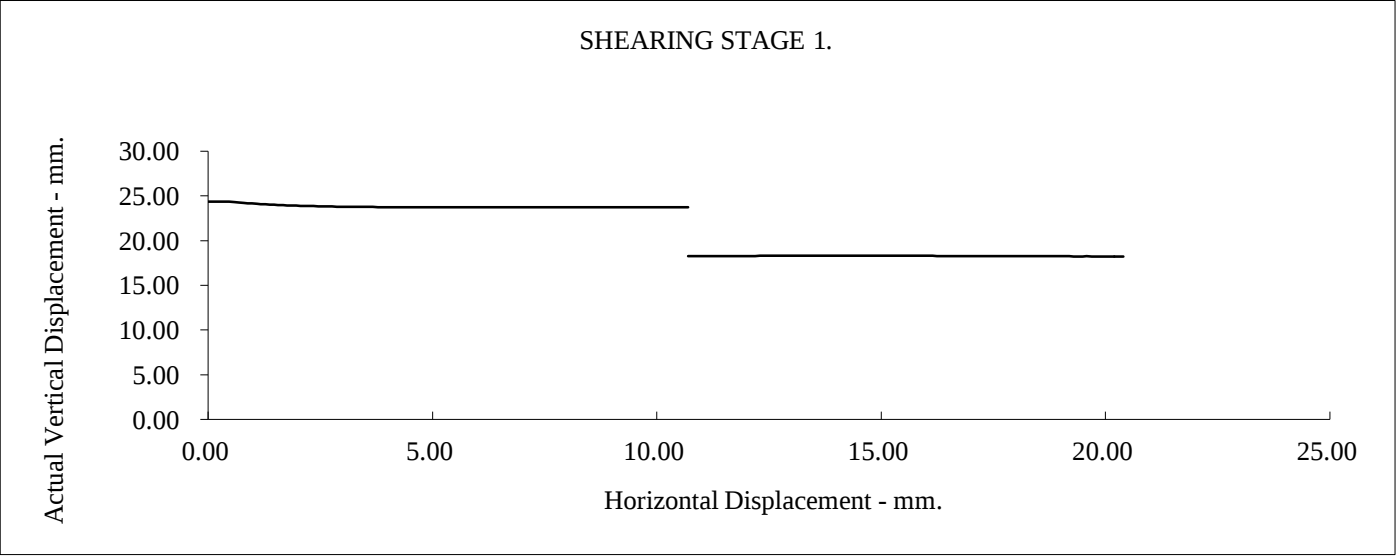


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 7 Depth (m): GL

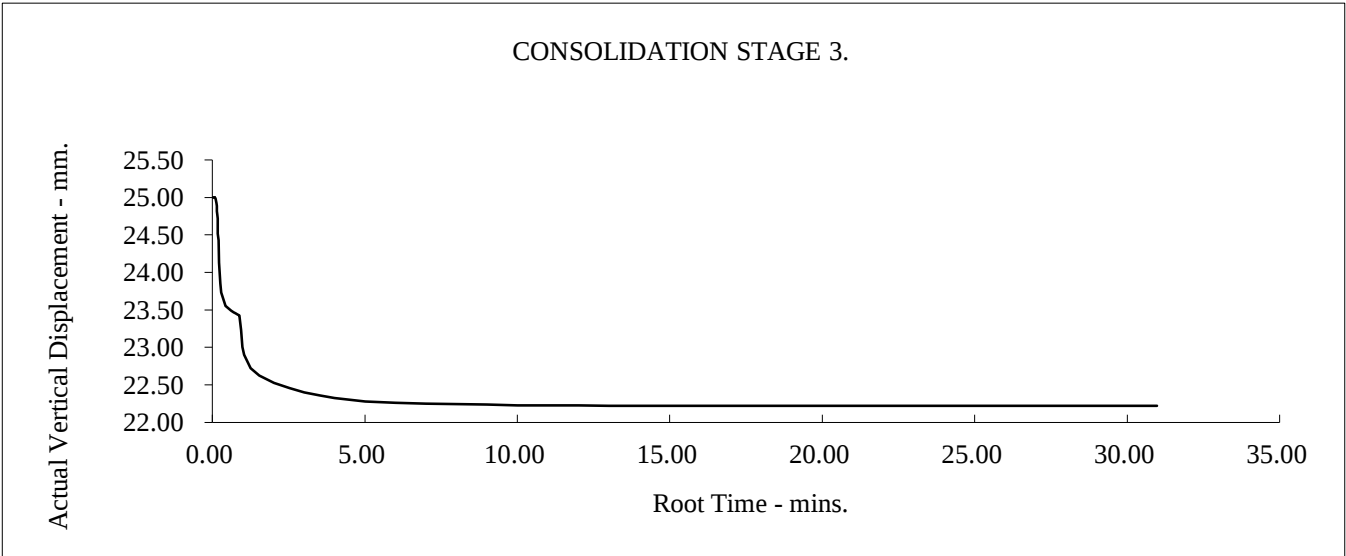
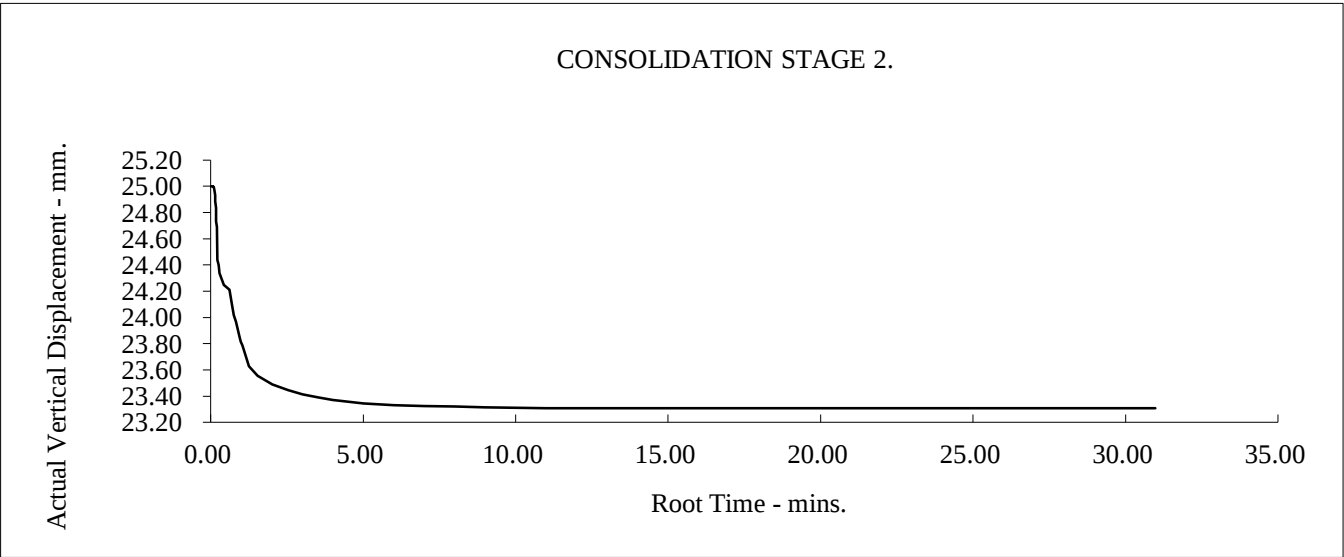
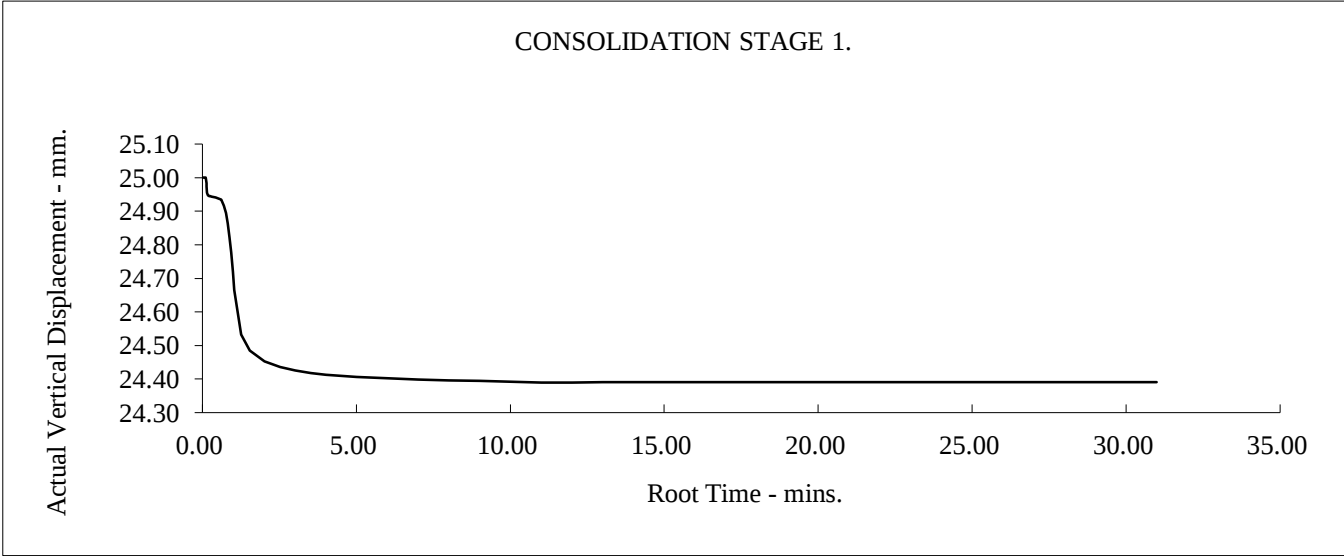


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 7 Depth (m): GL



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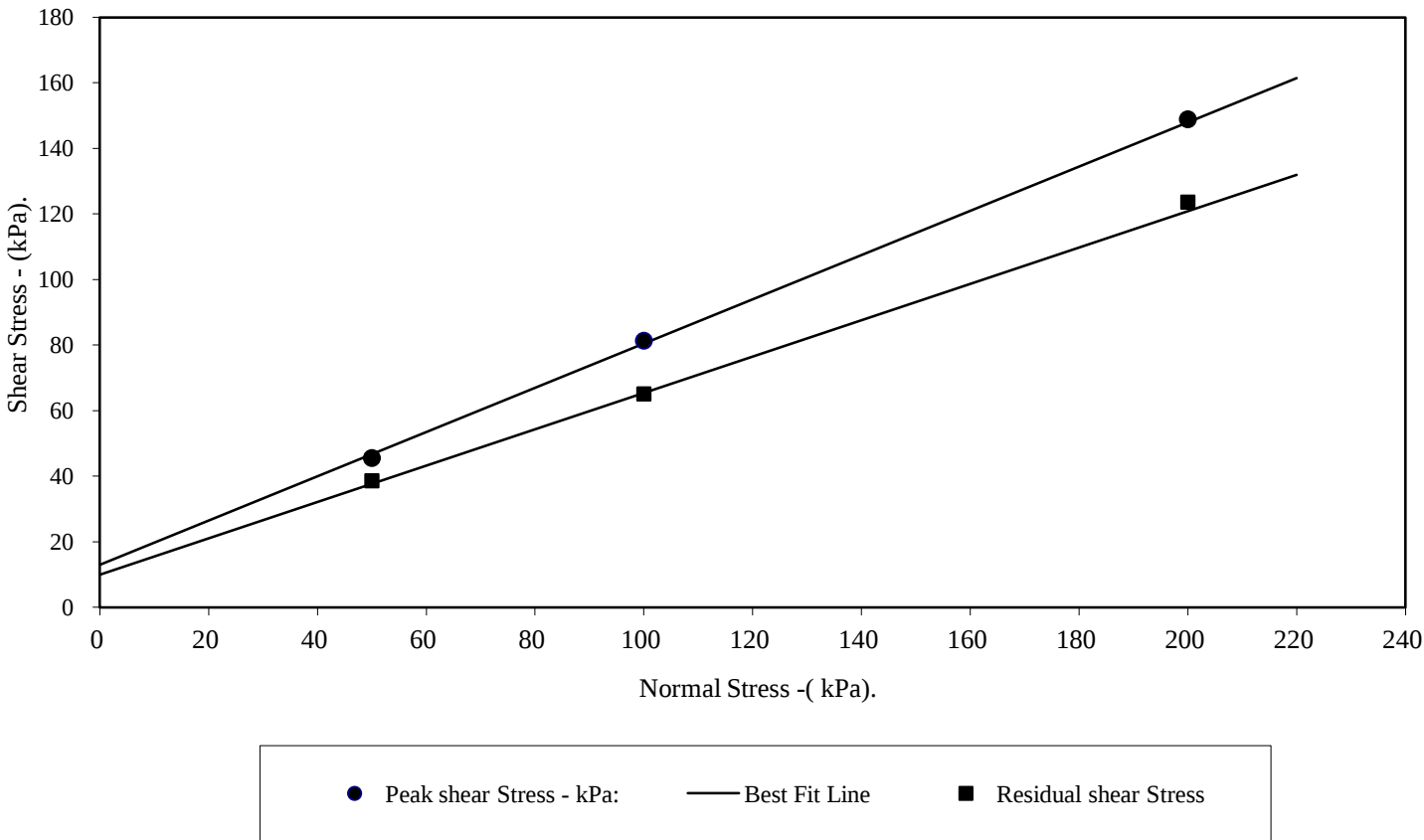
Client Ref Number:
12145434
Figure.
Bynea, Llanelli, SA14 9SU.

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 8 Depth (m): 1.00

Sample Type:	Remoulded (2.5kg Rammer).		
Particle Density - Mg/m3:	2.65 (Assumed)		
Specimen Tested:	Submerged		
Sample Description: Dark brown silty sandy WOOD CHIPPINGS			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	61	61	61
Bulk Density - Mg/m3:	1.48	1.48	1.48
Dry Density - Mg/m3:	0.92	0.92	0.92
Voids Ratio:	1.8904	1.8837	1.8824
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	23.98	23.10	22.23
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (mm)	3.49	5.45	5.57
Peak shear Stress - kPa:	46	81	149
PEAK			
Angle of Shearing Resistance:(θ)			34.0
Effective Cohesion - kPa:			13
RESIDUAL			
Angle of Shearing Resistance:(θ)			29.0
Effective Cohesion - kPa:			10

FAILURE CONDITIONS

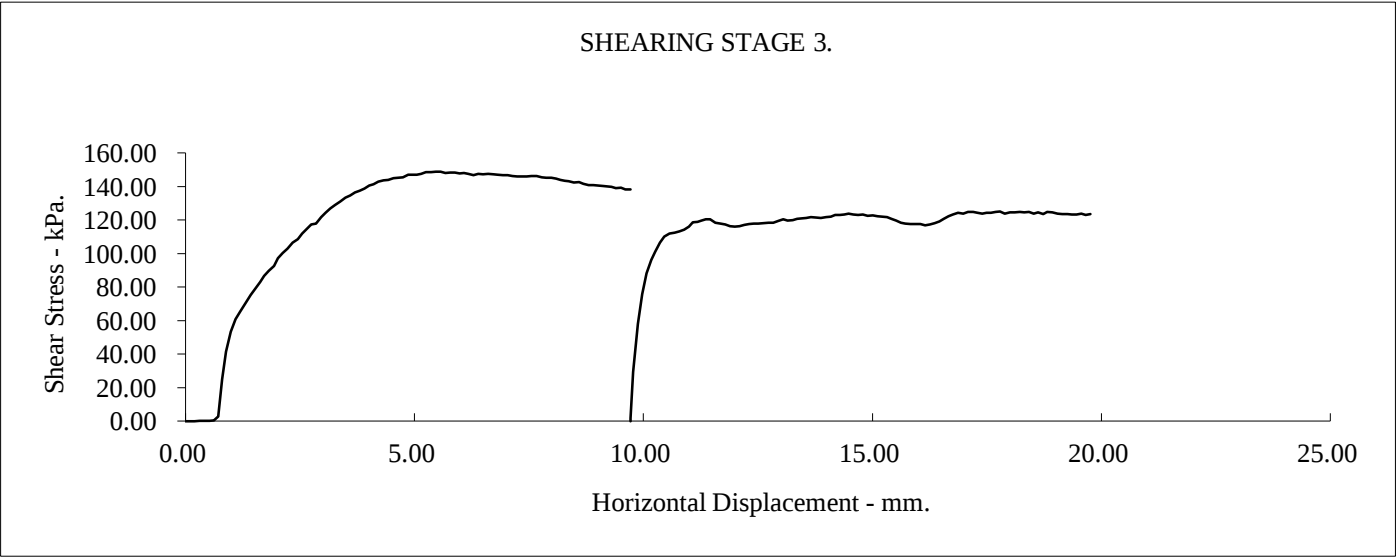
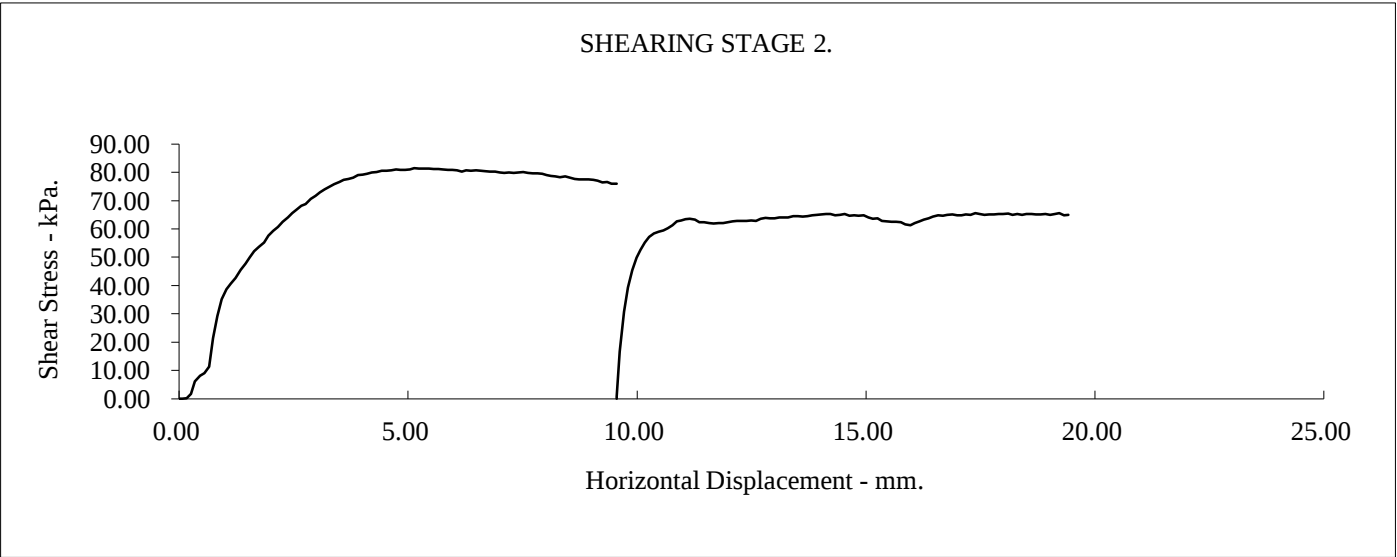
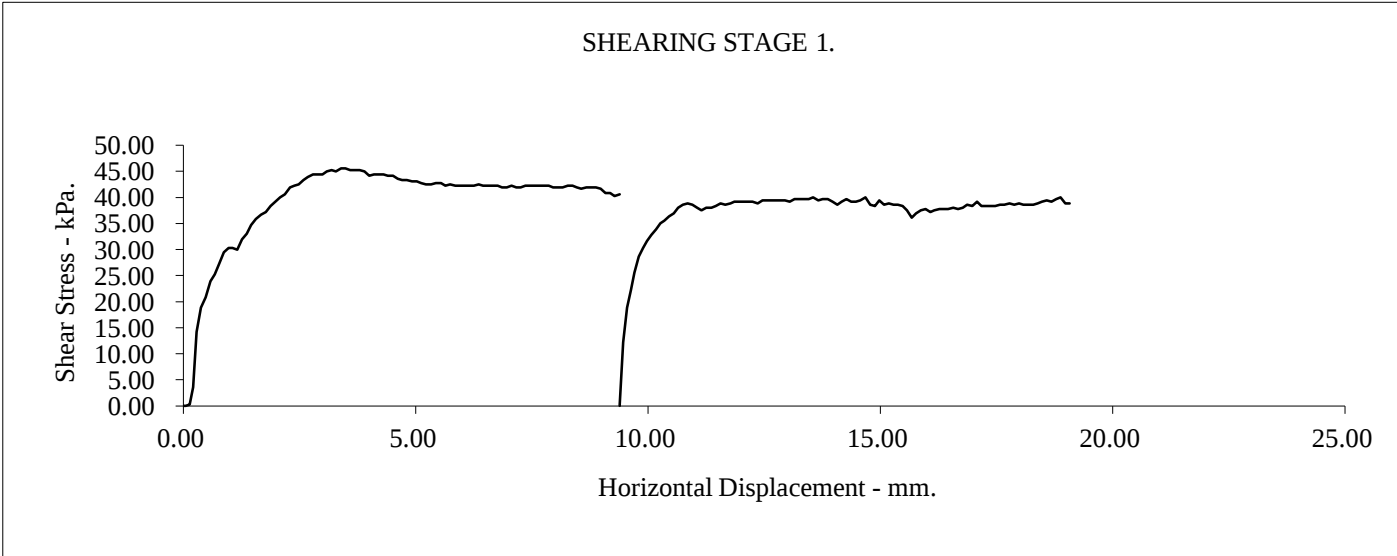


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 8 Depth (m): 1.00

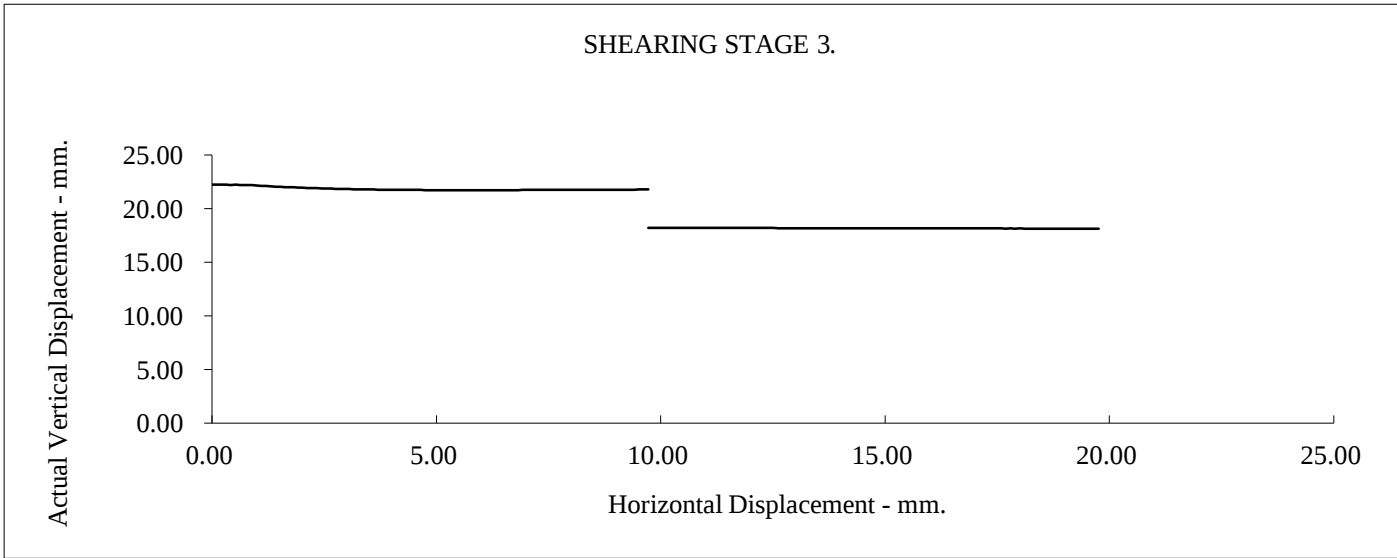
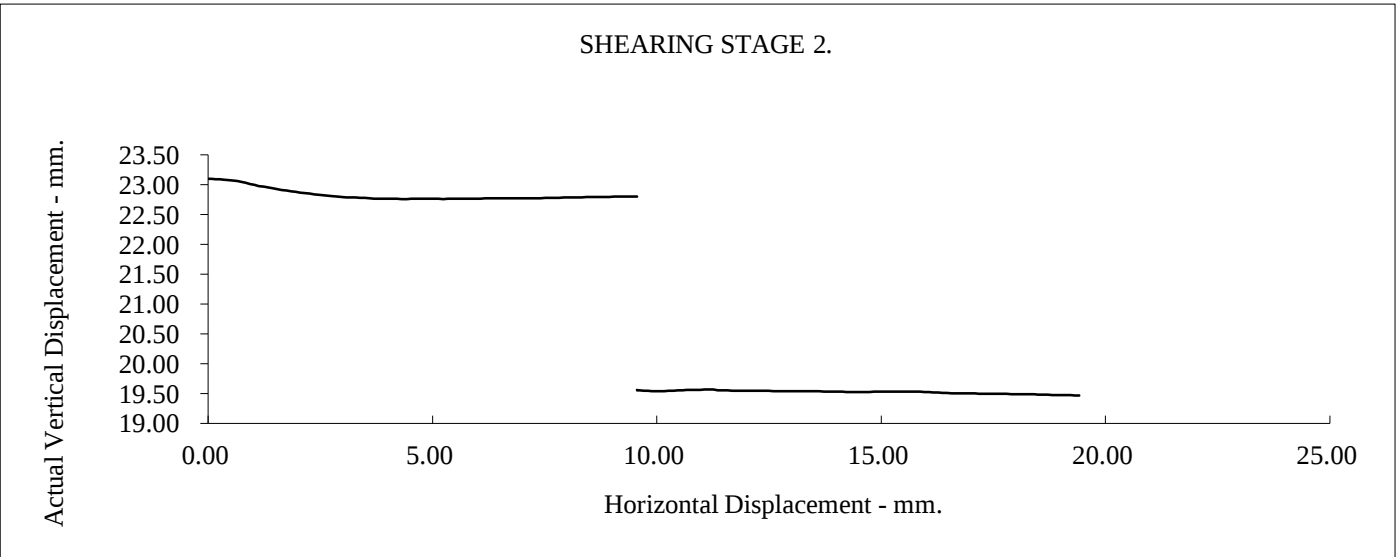
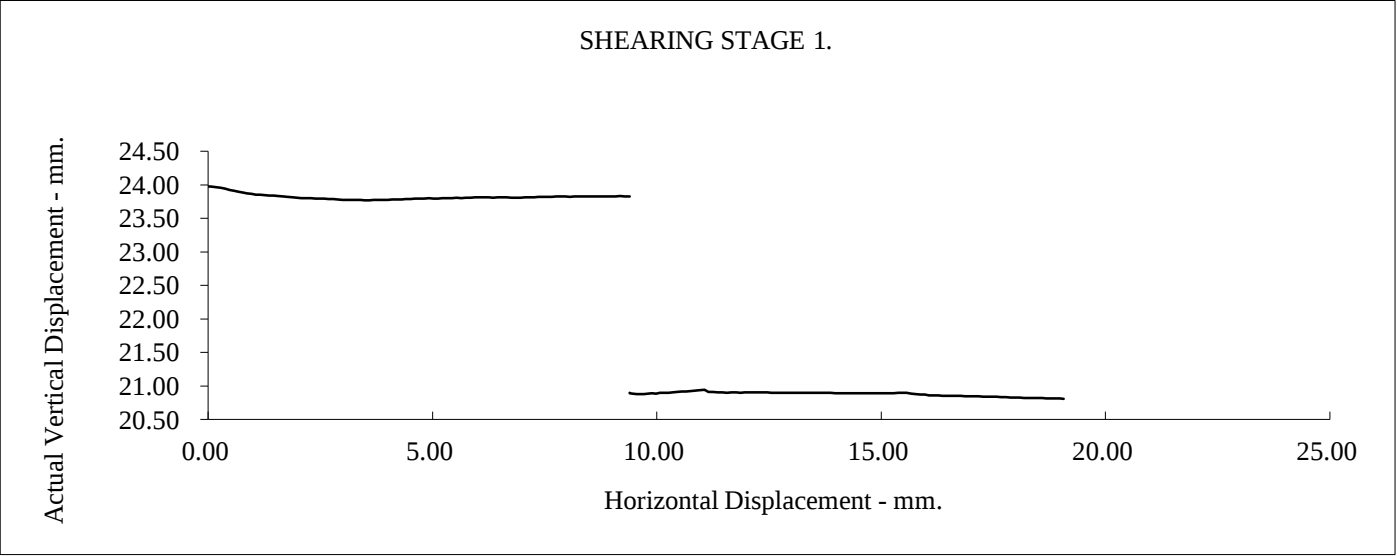


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Date

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Date

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 8 Depth (m): 1.00



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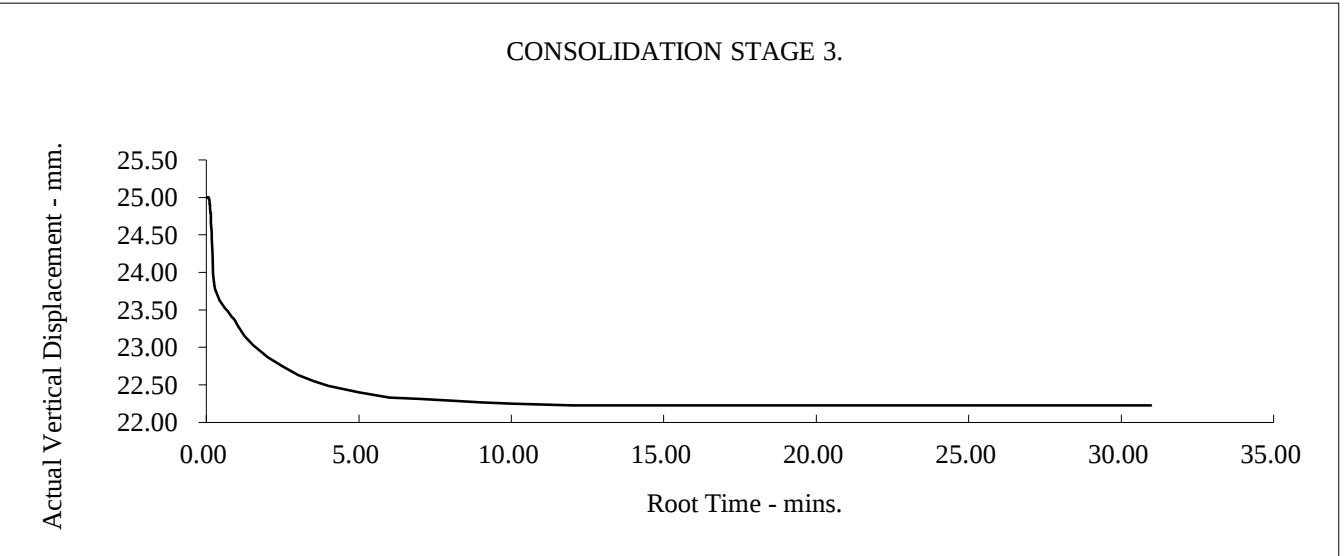
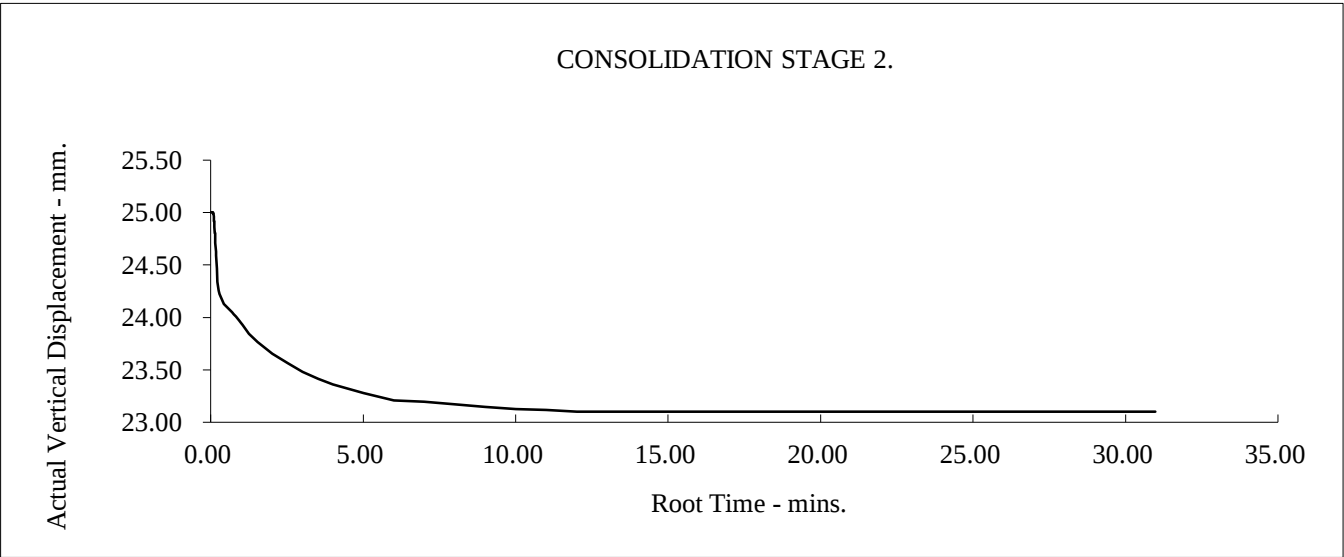
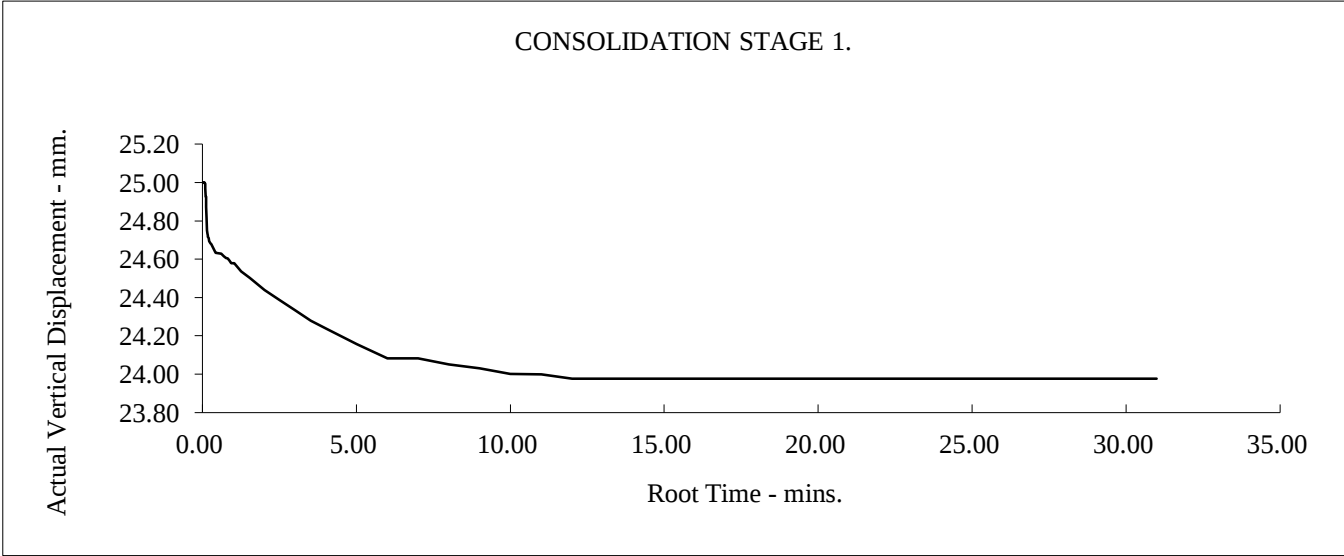
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GEO/064 17-May-05 Issue No. 1.1

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Contract No.:
14183
Client Ref Number:
12145434
Figure.
Bynea, Llanelli, SA14 9SU.

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Batch 2 Sample 8 Depth (m): 1.00



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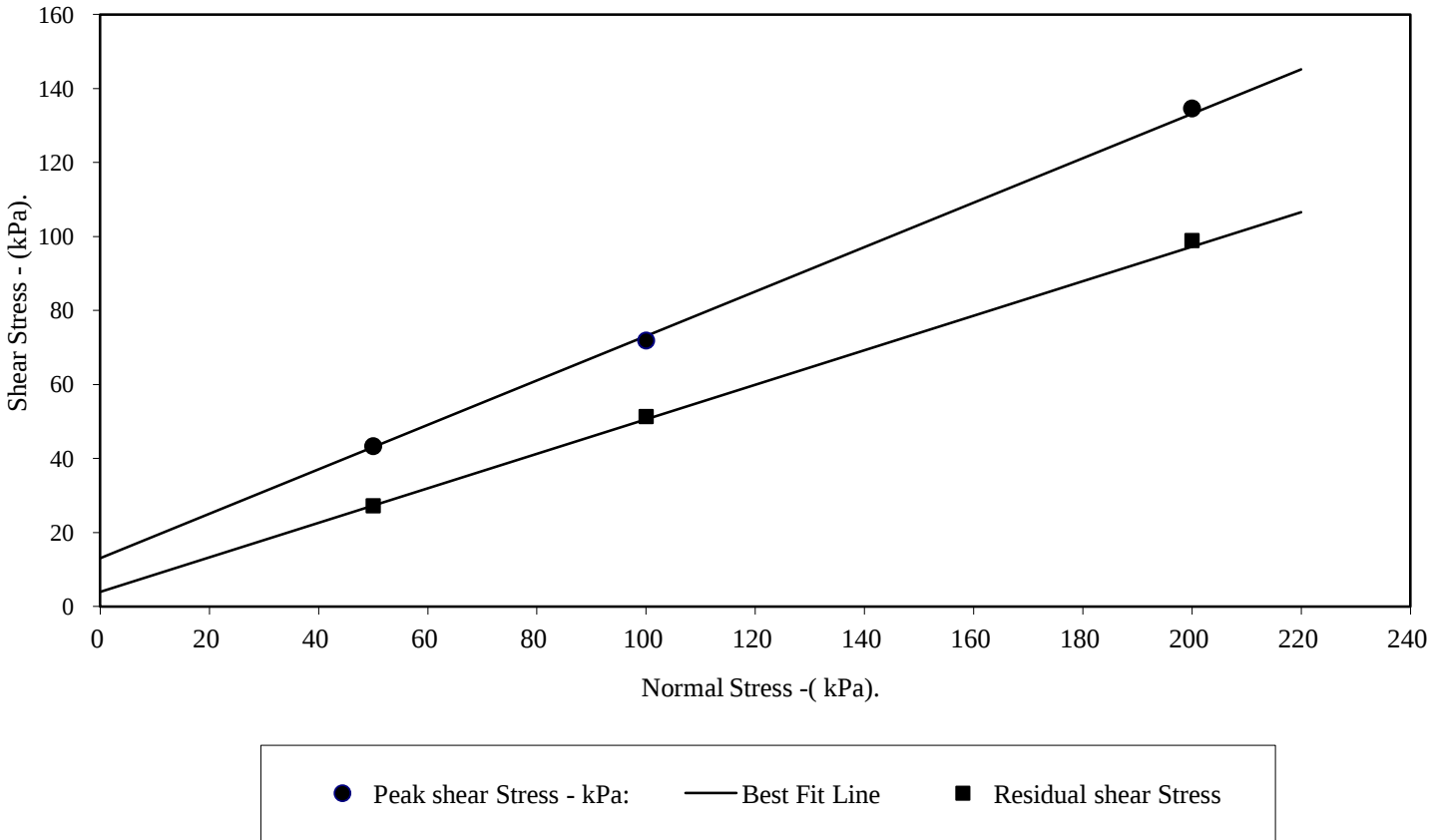
Client Ref Number:
12145434
Figure.
Bynea, Llanelli, SA14 9SU.

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Waste Sample 4 Depth (m): 0.0-2.0

Sample Type:	Remoulded (2.5kg Rammer) Material above 2mm removed.		
Particle Density - Mg/m3:	2.65		
Specimen Tested:	Submerged		
Sample Description: Brown silty sandy (fine-coarse) clayey GRAVEL (fine-medium/subangular)			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	17	17	17
Bulk Density - Mg/m3:	2.04	2.04	2.03
Dry Density - Mg/m3:	1.75	1.74	1.74
Voids Ratio:	0.5182	0.5203	0.5249
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	24.73	24.12	23.52
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (%)	3.93	4.07	4.90
Peak shear Stress - kPa:	43	72	135
PEAK			
Angle of Shearing Resistance:(θ)			31.0
Effective Cohesion - kPa:			13
RESIDUAL			
Angle of Shearing Resistance:(θ)			25.0
Effective Cohesion - kPa:			4

FAILURE CONDITIONS

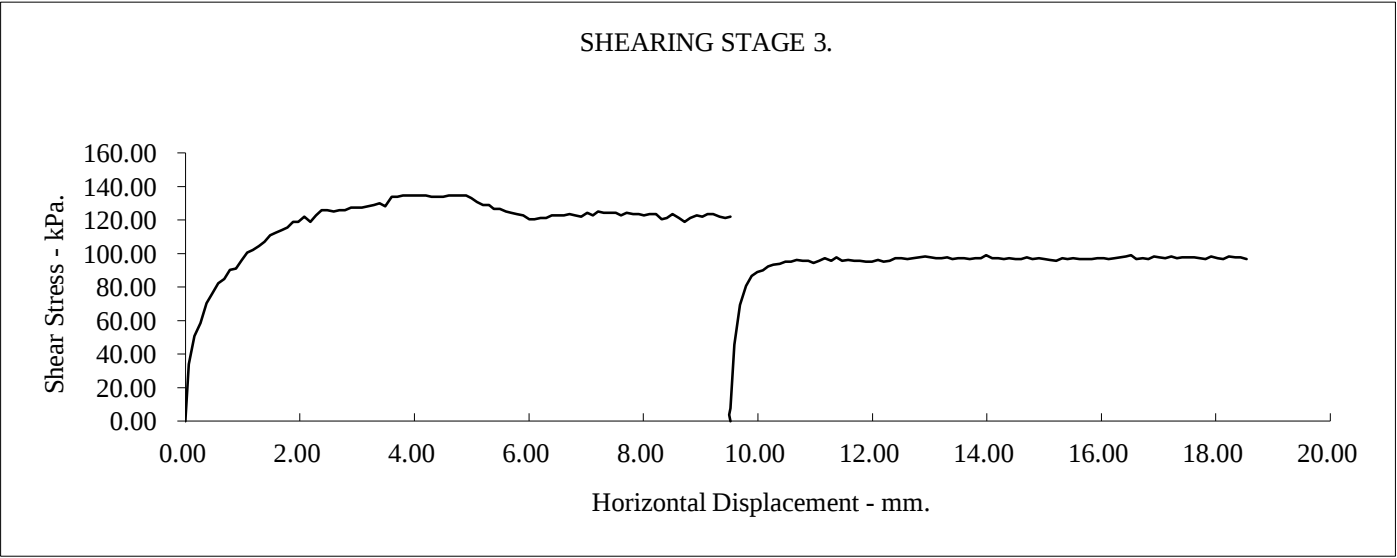
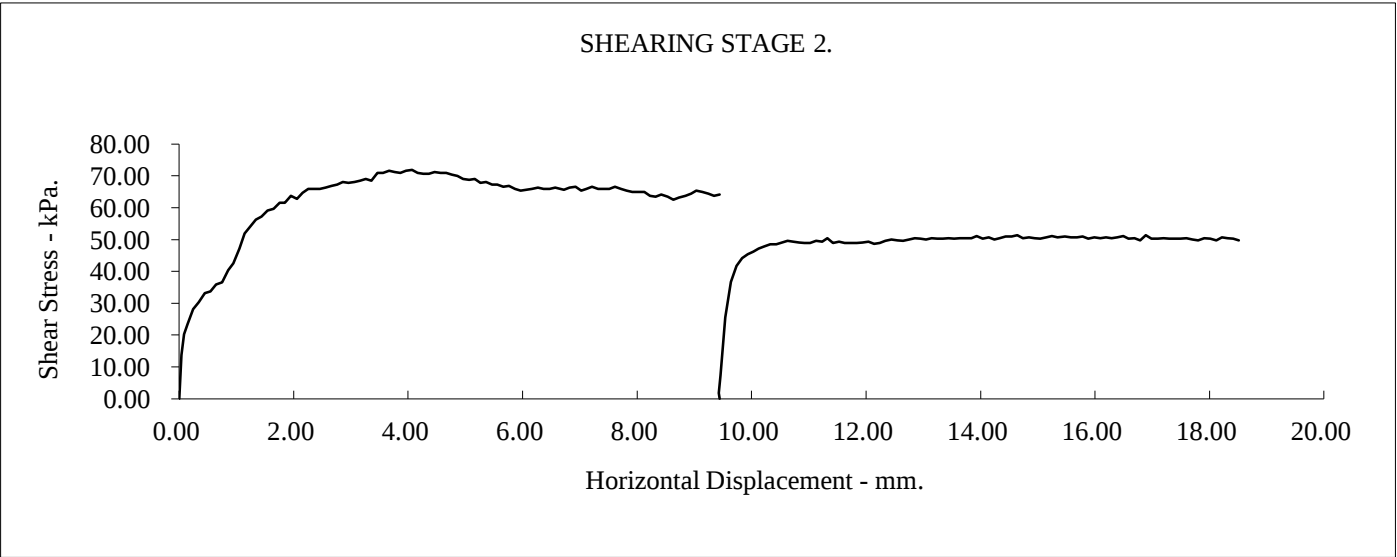
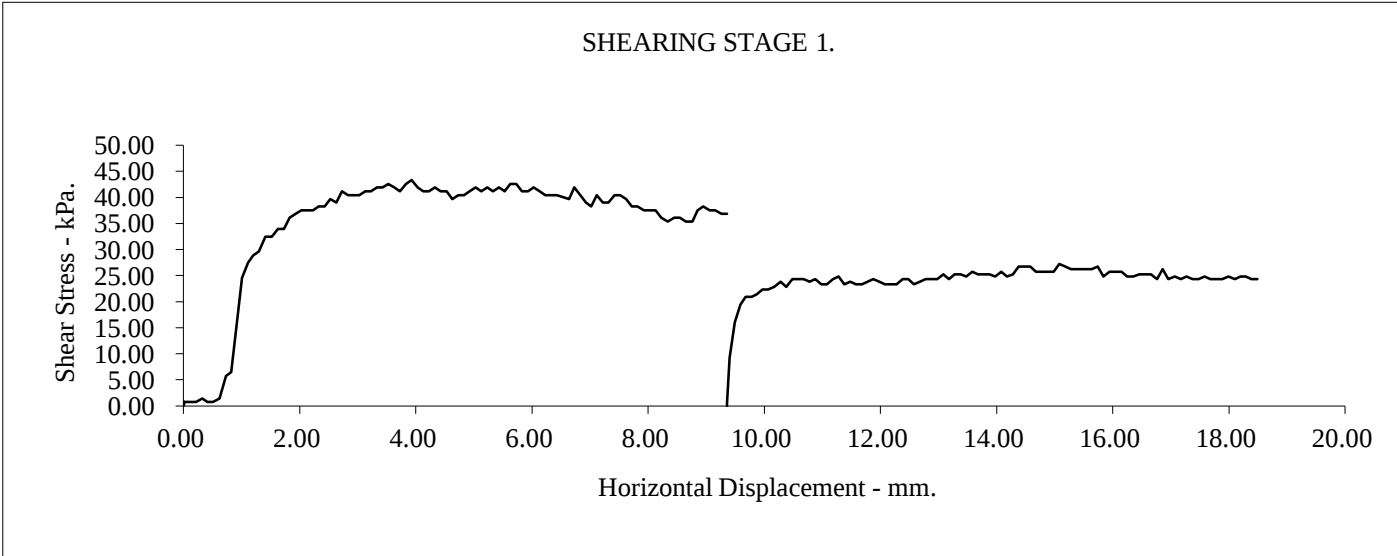


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Waste Sample 4 Depth (m): 0.0-2.0

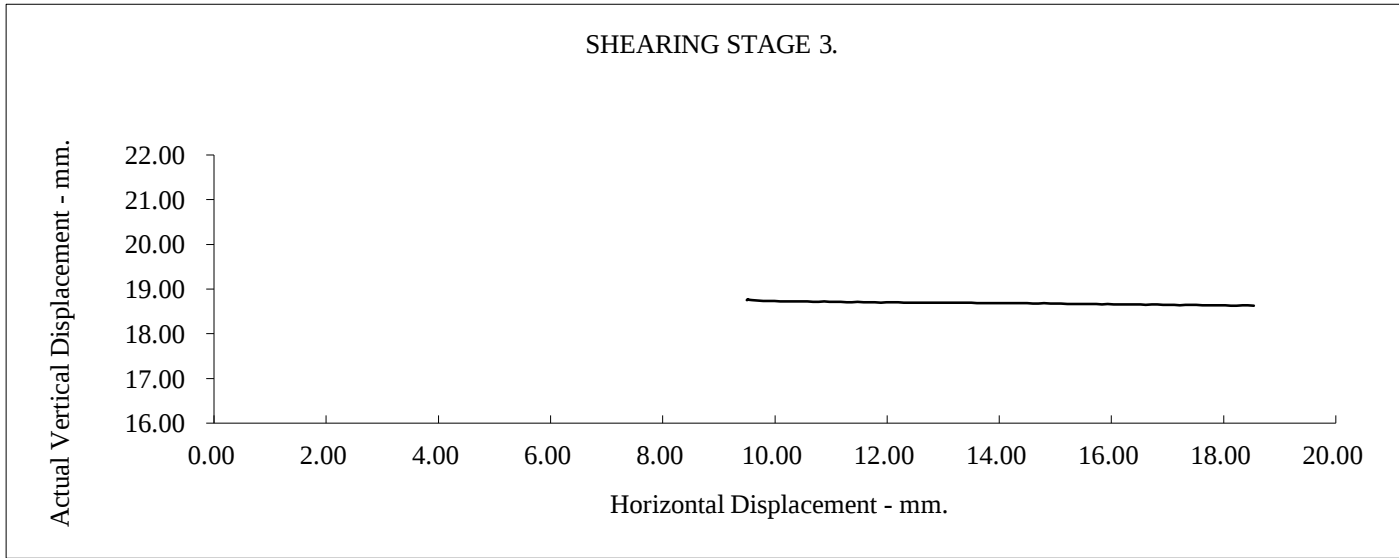
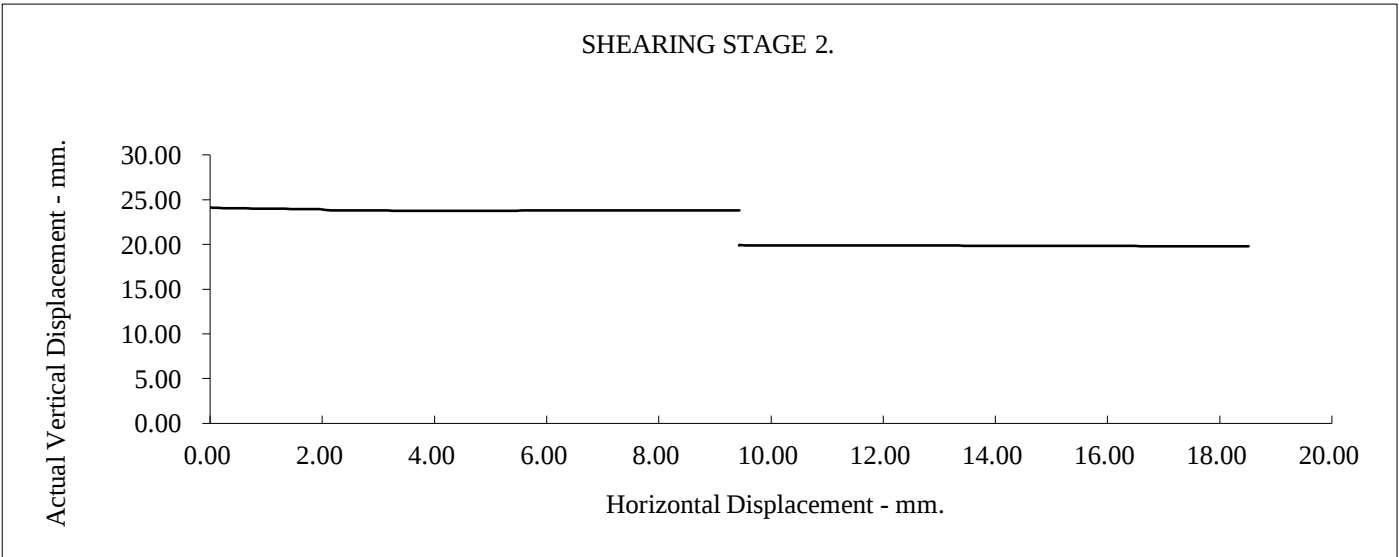
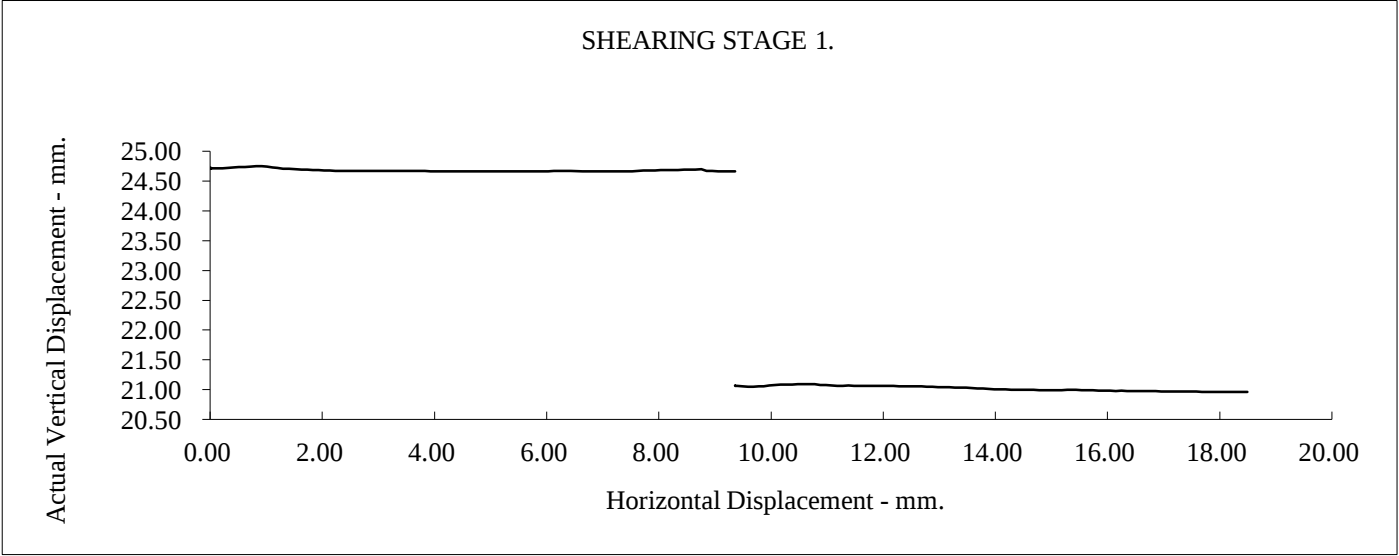


Checked by *[Signature]* Date 25/11/11

Approved by *[Signature]* Date 25/11/11

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Waste Sample 4 Depth (m): 0.0-2.0



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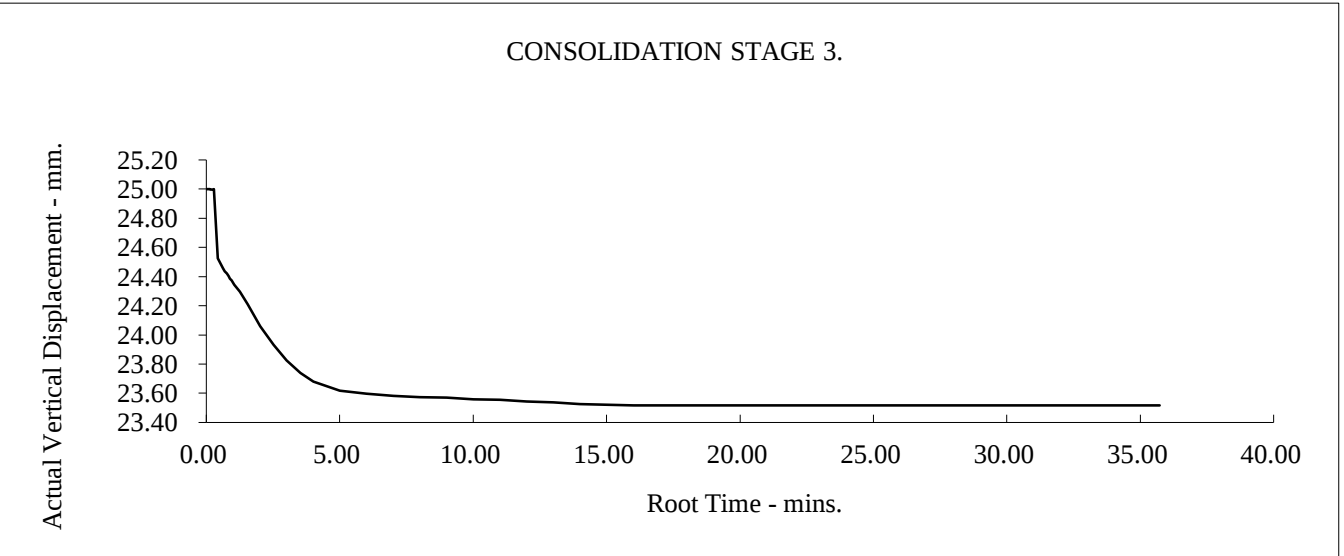
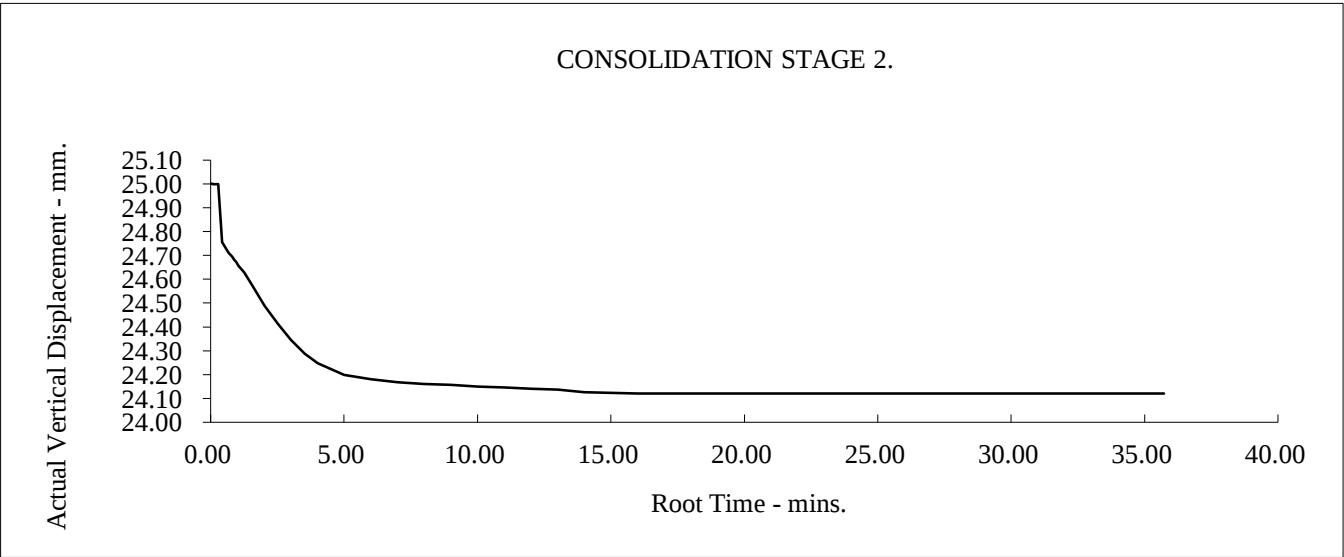
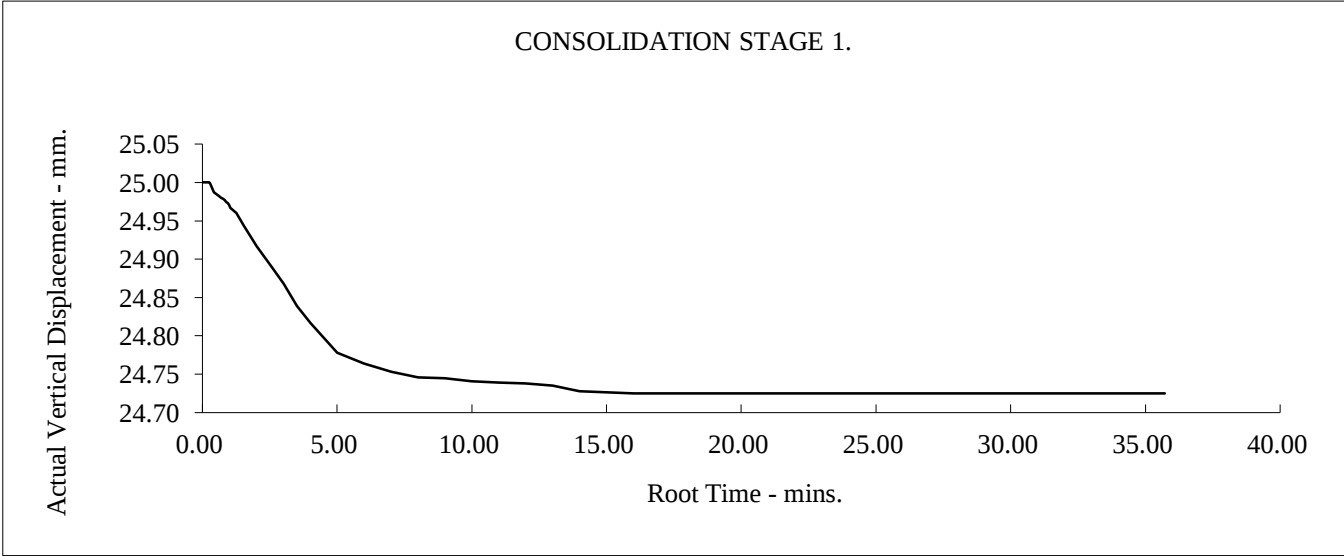
Contract No.:
14183

Client Ref Number:
12145434

Figure.
Bynea, Llanelli, SA14 9SU.

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Waste Sample 4 Depth (m): 0.0-2.0



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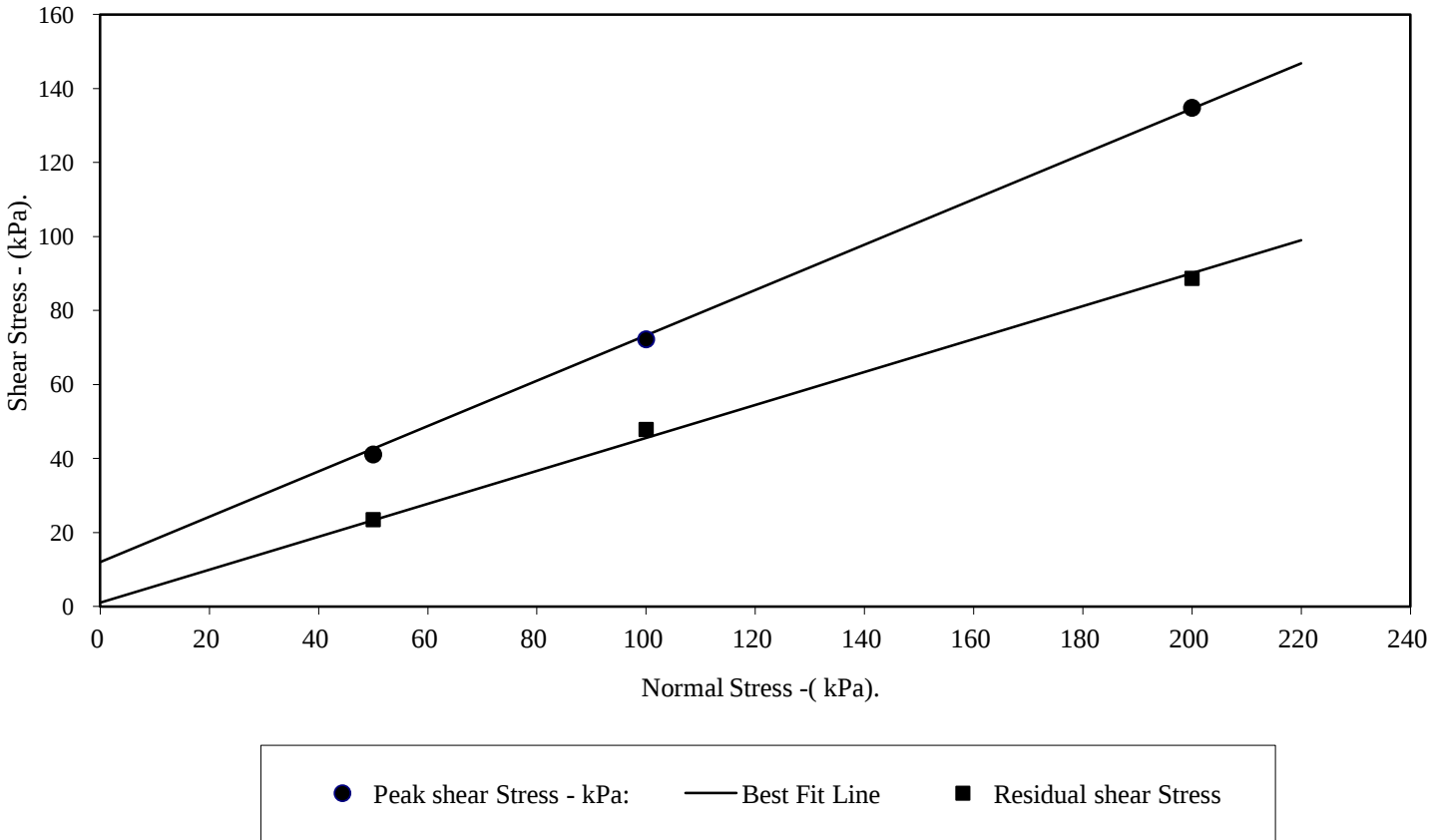
Figure.
Bynea, Llanelli, SA14 9SU.

CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Waste Sample 5 Depth (m): 0.0-2.0

Sample Type:	Remoulded (2.5kg Rammer) Material above 2mm removed.		
Particle Density - Mg/m3:	2.65		
Specimen Tested:	Submerged		
Sample Description: Brown silty sandy (fine-coarse) clayey GRAVEL (fine-medium/subangular)			
STAGE	1	2	3
Initial Conditions			
Height - mm:	25.00	25.00	25.00
Length - mm:	60.00	60.00	60.00
Moisture Content - %:	17	17	17
Bulk Density - Mg/m3:	2.02	2.02	2.02
Dry Density - Mg/m3:	1.73	1.73	1.73
Voids Ratio:	0.5293	0.5298	0.5283
Normal Pressure- kPa	50	100	200
Consolidation			
Consolidated Height - mm:	24.47	24.30	24.13
Shear			
Rate of Strain (mm/min)	0.010	0.010	0.010
Strain at peak shear stress (%)	9.47	9.39	8.79
Peak shear Stress - kPa:	41	72	135
PEAK			
Angle of Shearing Resistance:(θ)			31.5
Effective Cohesion - kPa:			12
RESIDUAL			
Angle of Shearing Resistance:(θ)			24.0
Effective Cohesion - kPa:			1

FAILURE CONDITIONS

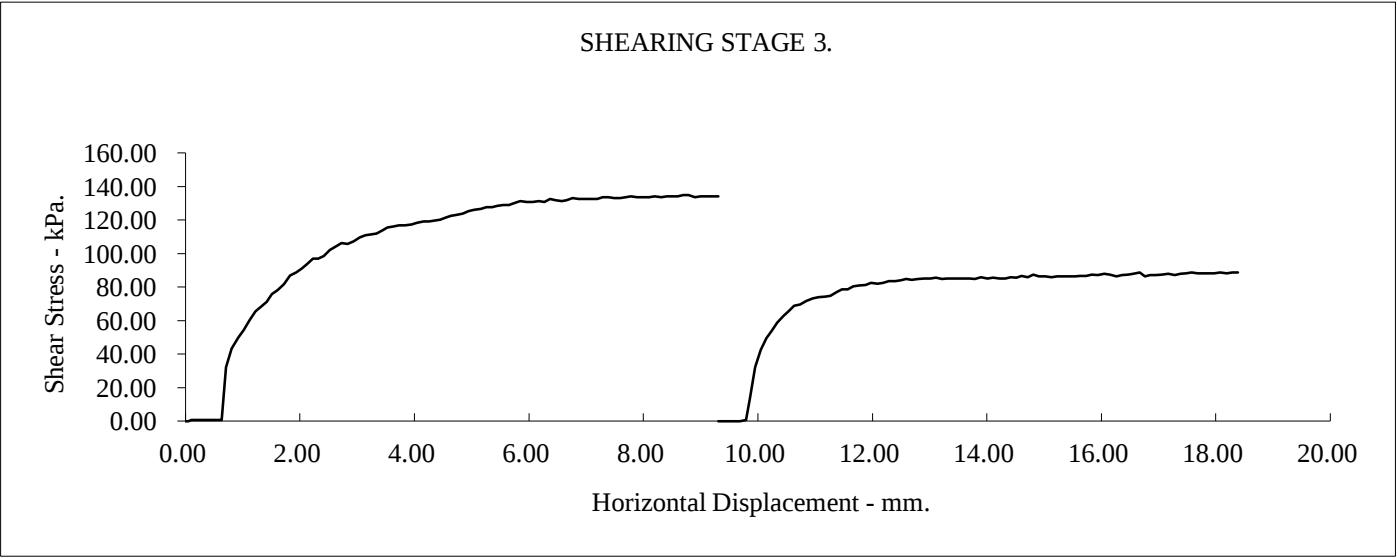
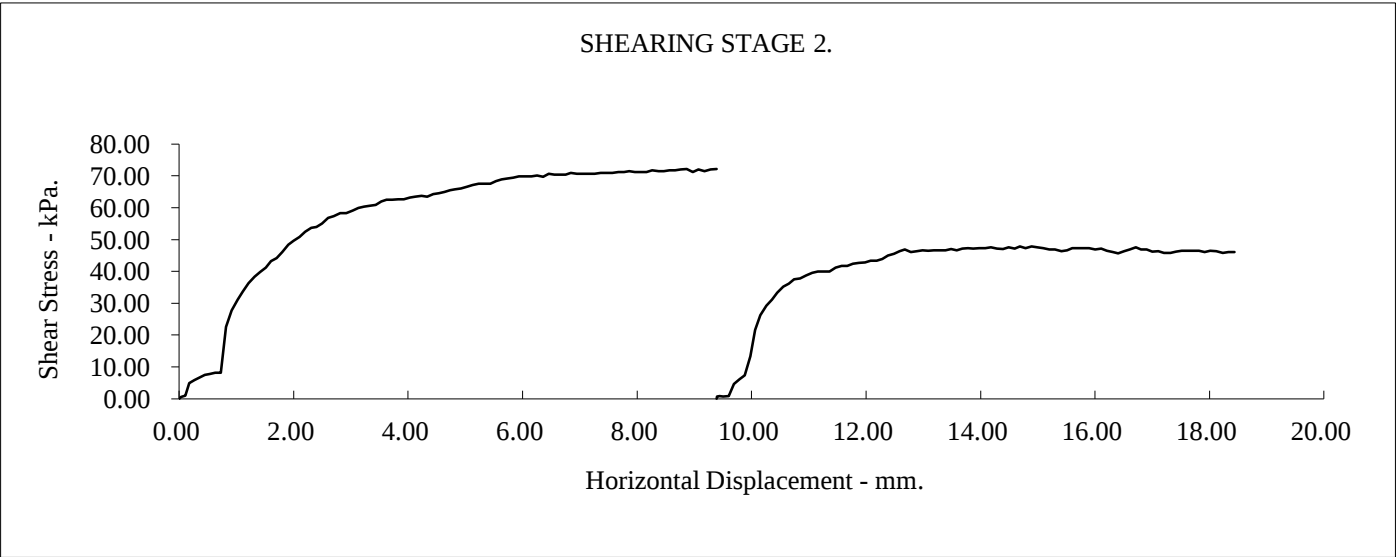
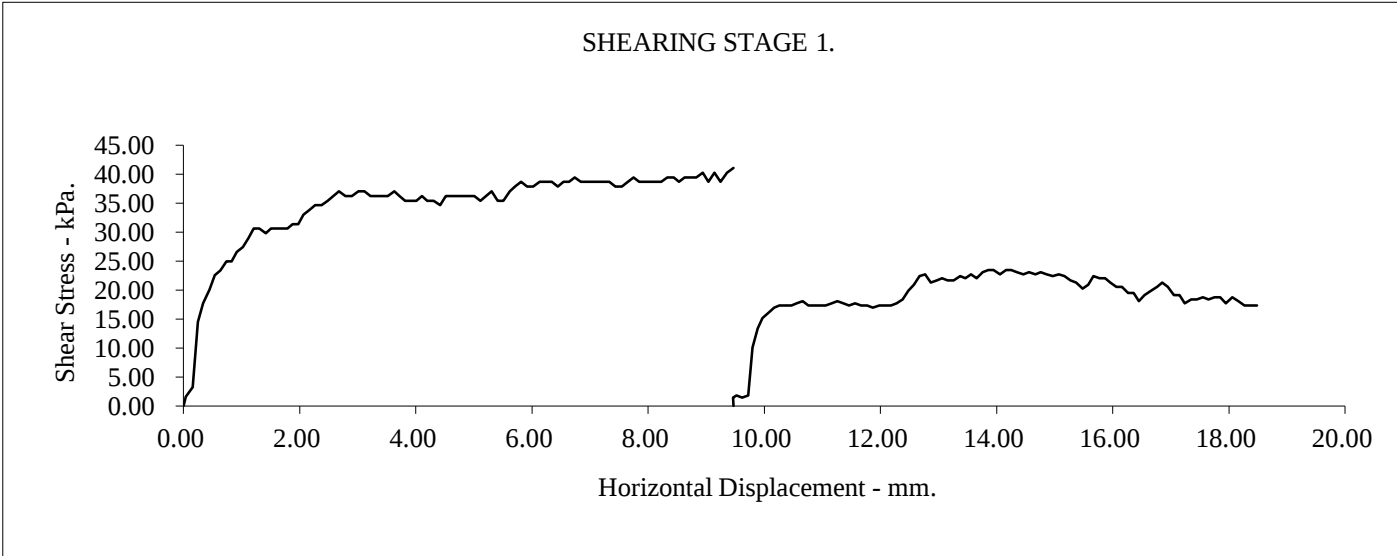


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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

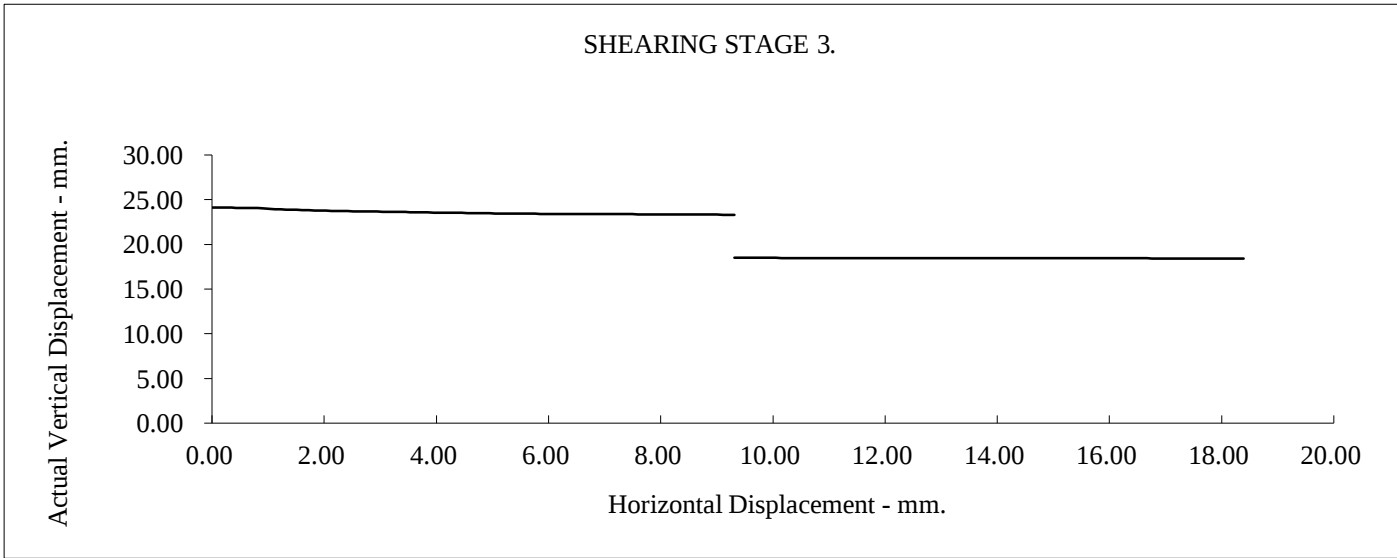
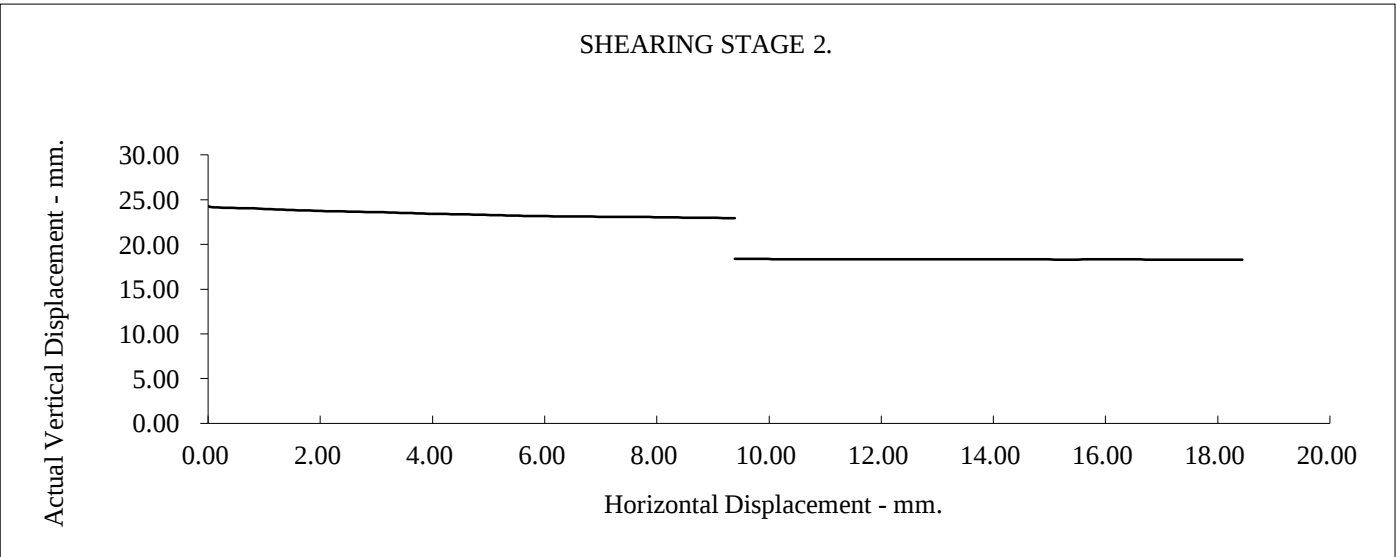
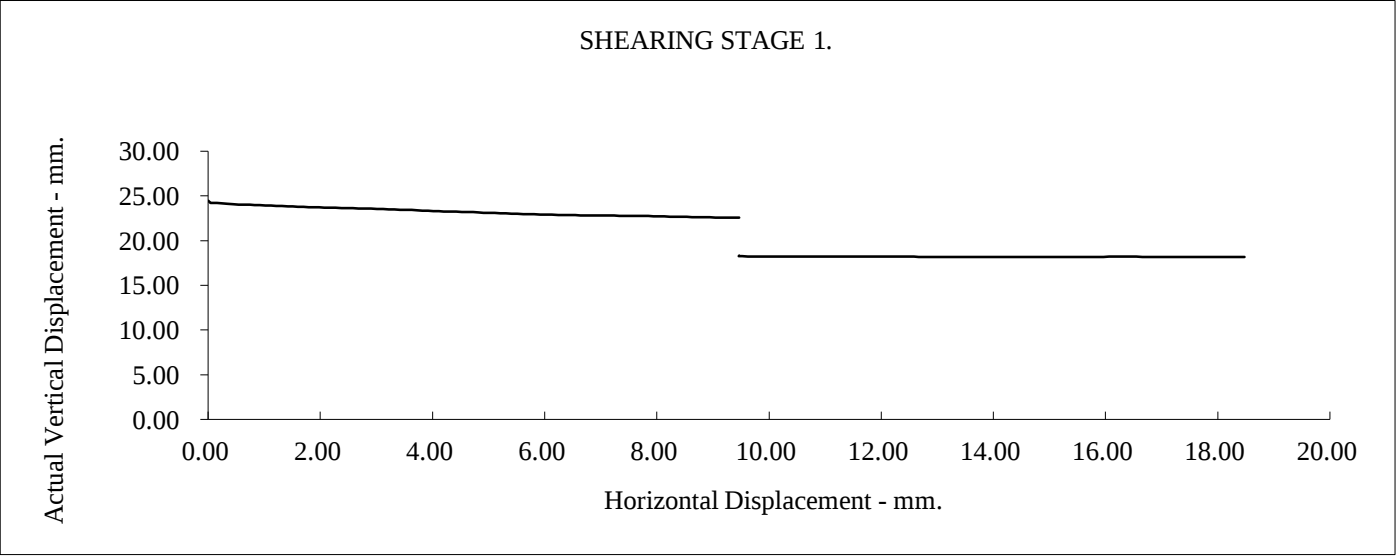
Borehole/Sample Number: Waste Sample 5 Depth (m): 0.0-2.0



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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

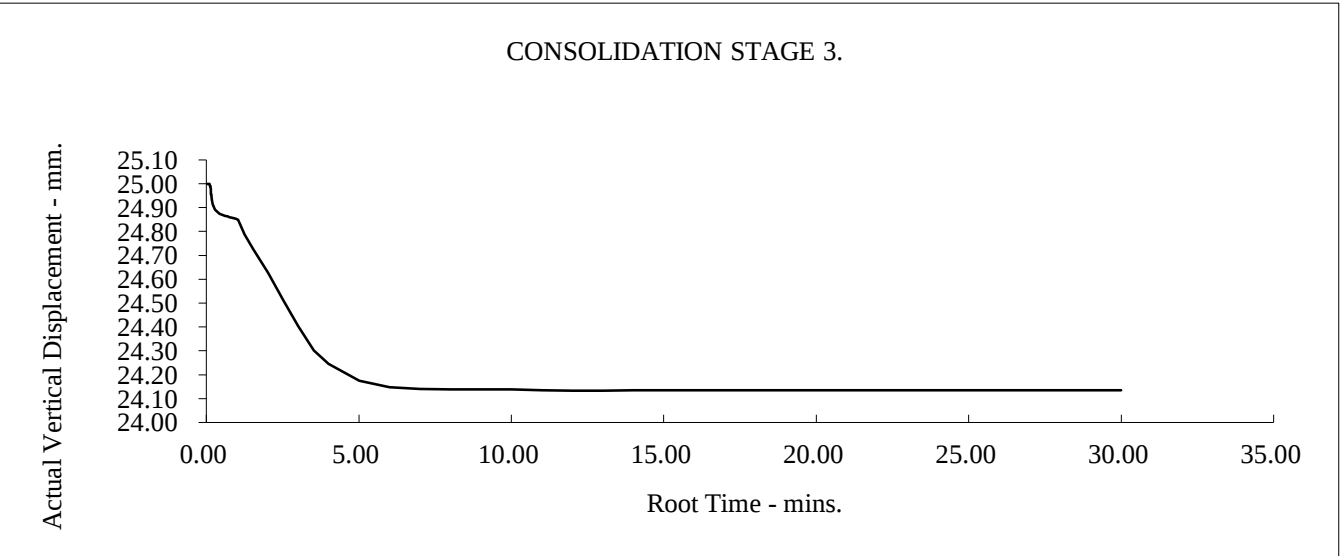
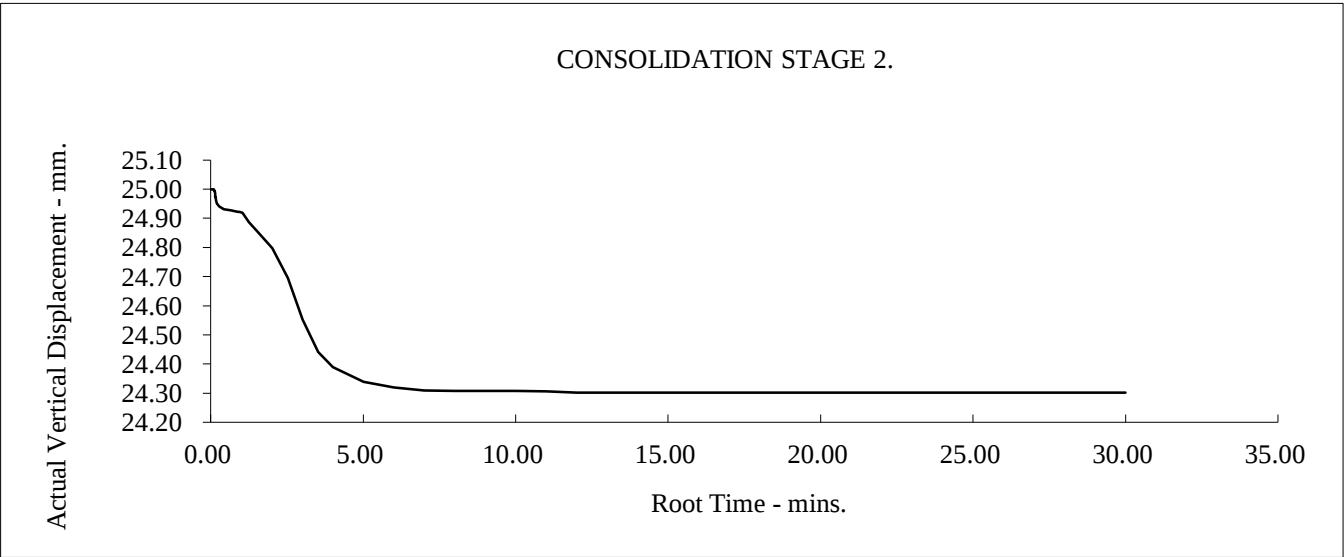
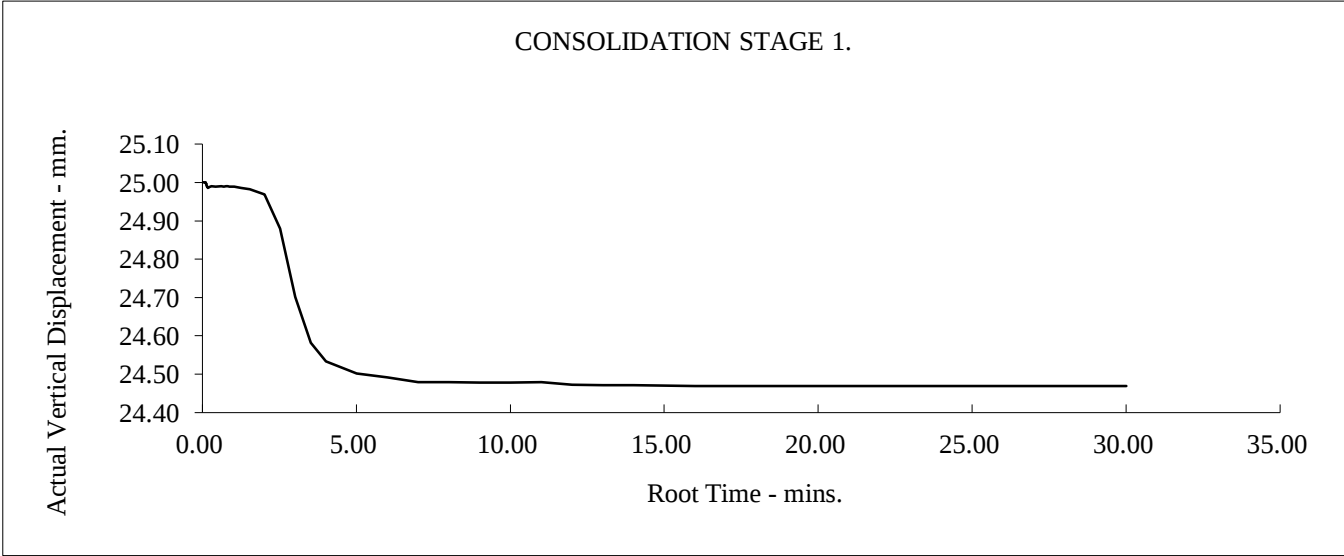
Borehole/Sample Number: Waste Sample 5 Depth (m): 0.0-2.0



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CONSOLIDATED DRAINED PEAK AND RESIDUAL SHEARBOX TEST.
BS1377:Part 7:4.5 :1990.

Borehole/Sample Number: Waste Sample 5 Depth (m): 0.0-2.0



Checked by Date Approved by Date

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Batch 1
Sample No.		Sample 1
Depth	m	1.5m above ground
Date		02/12/2011
Disturbed / Undisturbed		Disturbed

Description of Specimen

Black, loose, high in plant material (20-30%), slightly gravelly, organic soil

Initial Specimen Conditions

Height	mm	116.40
Diameter	mm	104.90
Area	mm ²	8642.53
Volume	cm ³	1005.99
Mass	g	1039.40
Dry Mass	g	704.60
Density	Mg/m ³	1.033
Dry Density	Mg/m ³	0.700
Moisture Content	%	47.5
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	91.20
Density	Mg/m ³	1.34
Dry Density	Mg/m ³	0.70

Test Setup

Date started	24/11/2011
Date Finished	28/11/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P1
Cell Number	C1

DP Gans

Checked and Approved By

02/12/11
Date

Client Ref



LABORATORY TESTING SERVICES LIMITED

Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

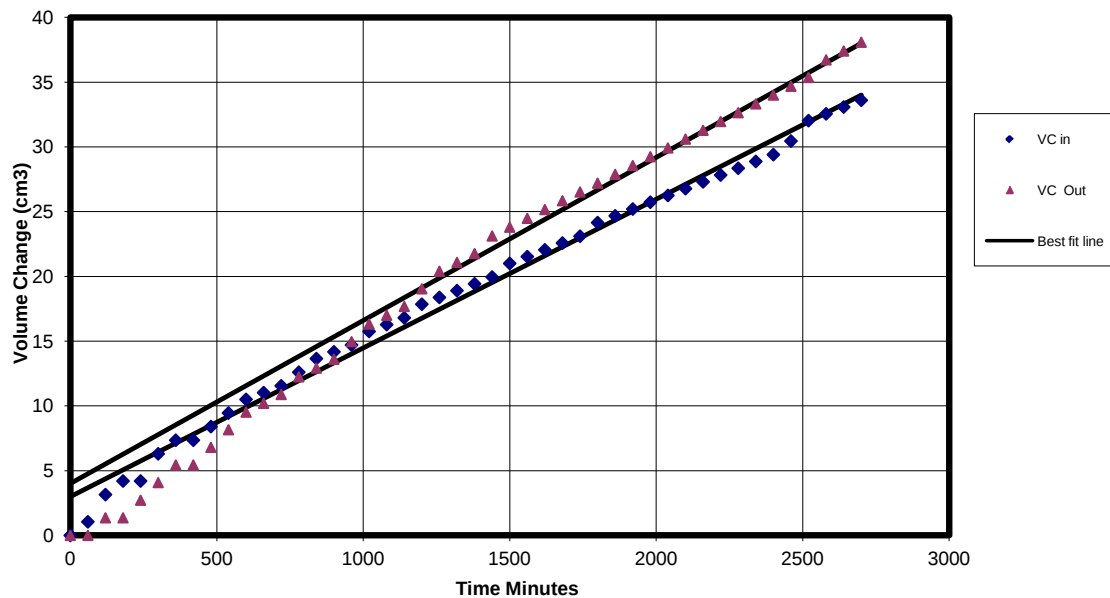
Borehole		Batch 1
Sample No.		Sample 1
Depth	m	1.5m above ground
Date		02/12/2011

Permeability

Cell Pressure	kPa	300.00
Inlet Pressure	kPa	270.00
Outlet Pressure	kPa	250.00
Mean Rate of Flow	ml/min	0.01204
Average Temperature	'C	22
Outlet Pressure	kPa	250.00

B Value

Post test	
Final B value	0.94



Corrected Vertical Permeability m/s	1.05×10^{-10}
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DP Gans

Checked and Approved By

02/12/11
Date

Client Ref



Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Batch 1
Sample No.		Sample 2
Depth	m	
Date		03/12/2011
Disturbed / Undisturbed		Disturbed

Description of Specimen

Black loose, high in plant material 30%, sub rounded, coarse gravel 5%, mainly organic soil

Initial Specimen Conditions

Height	mm	117.20
Diameter	mm	104.50
Area	mm ²	8576.74
Volume	cm ³	1005.19
Mass	g	1357.80
Dry Mass	g	712.90
Density	Mg/m ³	1.351
Dry Density	Mg/m ³	0.709
Moisture Content	%	90.5
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	91.64
Density	Mg/m ³	1.36
Dry Density	Mg/m ³	0.71

Test Setup

Date started	16/11/2011
Date Finished	02/12/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P2
Cell Number	C2



Checked and Approved By

03/12/11
Date

Client Ref



LABORATORY TESTING SERVICES LIMITED

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Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

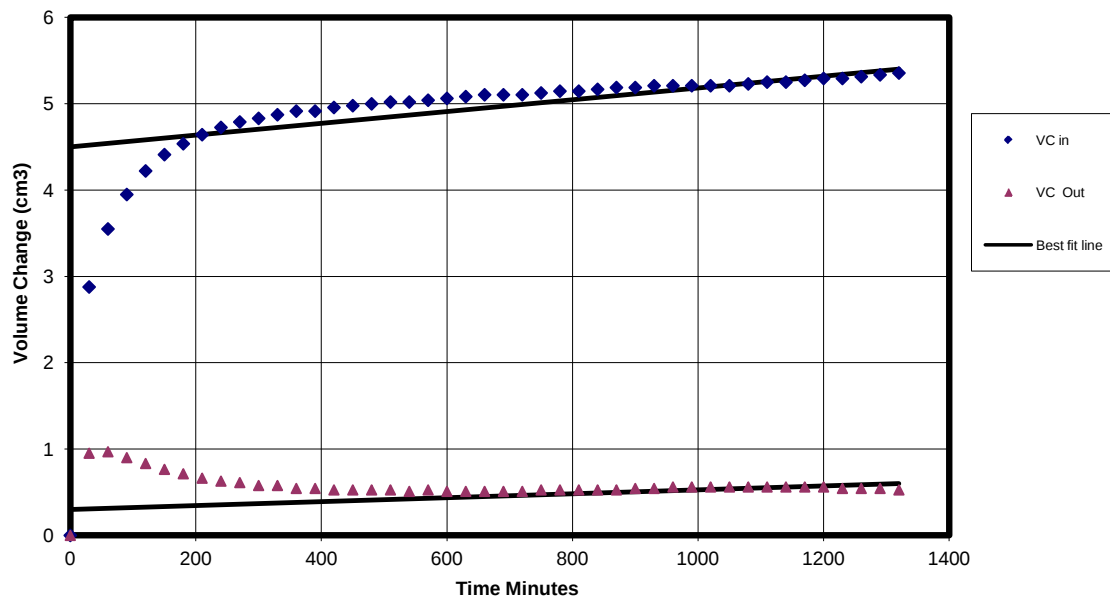
Borehole		Batch 1
Sample No.		Sample 2
Depth	m	
Date		03/12/2011

Permeability

Cell Pressure	kPa	300.00
Inlet Pressure	kPa	270.00
Outlet Pressure	kPa	250.00
Mean Rate of Flow	ml/min	0.00045
Average Temperature	'C	22
Outlet Pressure	kPa	250.00

B Value

Post test	
Final B value	0.92



Corrected Vertical Permeability l m / s	5.06 x 10 ⁻¹¹
--	--------------------------

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03/12/11
Date

Client Ref



Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Batch 1
Sample No.		Sample 3
Depth	m	GL
Date		12/12/2011
Disturbed / Undisturbed		Disturbed

Description of Specimen

Black , loose, 20-30% plant material, slightly gravelly, organic soil

Initial Specimen Conditions

Height	mm	117.20
Diameter	mm	100.40
Area	mm ²	7916.94
Volume	cm ³	927.87
Mass	g	1037.30
Dry Mass	g	717.70
Density	Mg/m ³	1.118
Dry Density	Mg/m ³	0.773
Moisture Content	%	44.5
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	86.69
Density	Mg/m ³	1.44
Dry Density	Mg/m ³	0.77

Test Setup

Date started	01/12/2011
Date Finished	10/12/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P3
Cell Number	C3

DP Gans

Checked and Approved By

12/12/11

Date

Client Ref



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Coed Darcy

Contract No

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Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

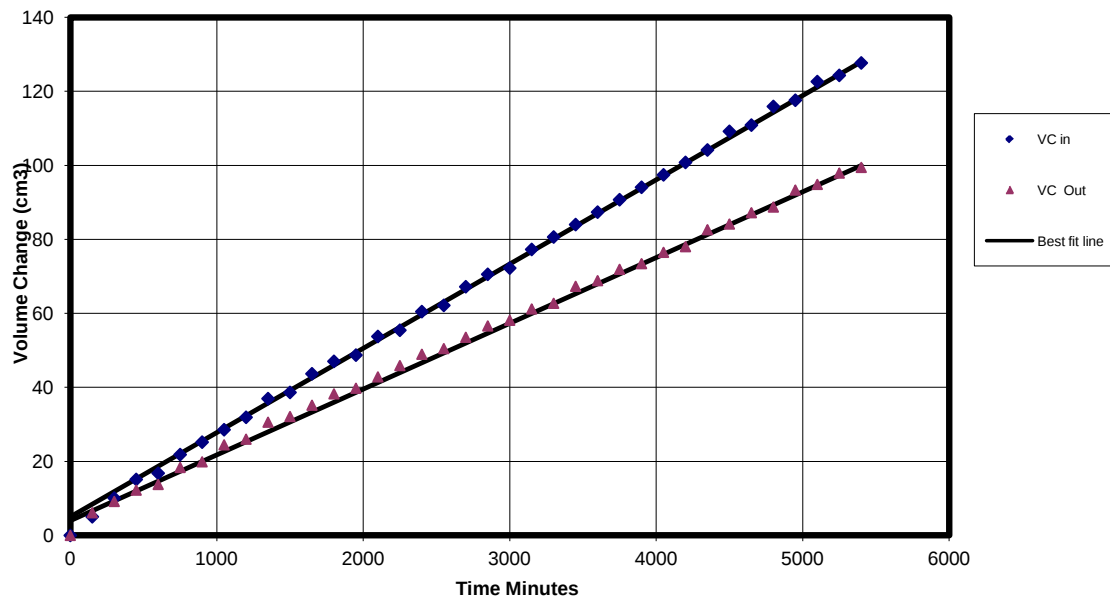
Borehole		Batch 1
Sample No.		Sample 3
Depth	m	GL
Date		12/12/2011

Permeability

Cell Pressure	kPa	400.00
Inlet Pressure	kPa	370.00
Outlet Pressure	kPa	350.00
Mean Rate of Flow	ml/min	0.02028
Average Temperature	'C	22
Outlet Pressure	kPa	350.00

B Value

Post test	
Final B value	0.94



Corrected Vertical Permeability m/s	1.39×10^{-10}
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DP Gans

Checked and Approved By

12/12/11
Date

Client Ref



Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Waste
Sample No.		Sample 4
Depth	m	0.00-2.00m above ground
Date		19/11/2011
Disturbed / Undisturbed		Disturbed

Description of Specimen

Angular cobbles and coarse gravel (20% approx) in a mottled brown silty CLAY

Initial Specimen Conditions

Height	mm	114.80
Diameter	mm	104.90
Area	mm ²	8642.53
Volume	cm ³	992.16
Mass	g	2161.50
Dry Mass	g	1702.10
Density	Mg/m ³	2.179
Dry Density	Mg/m ³	1.716
Moisture Content	%	27.0
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	15.12
Density	Mg/m ³	2.17
Dry Density	Mg/m ³	1.88

Test Setup

Date started	16/11/2011
Date Finished	12/12/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P3
Cell Number	C3



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19/11/11
Date

Client Ref



LABORATORY TESTING SERVICES LIMITED

Coed Darcy

Contract No

14185

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

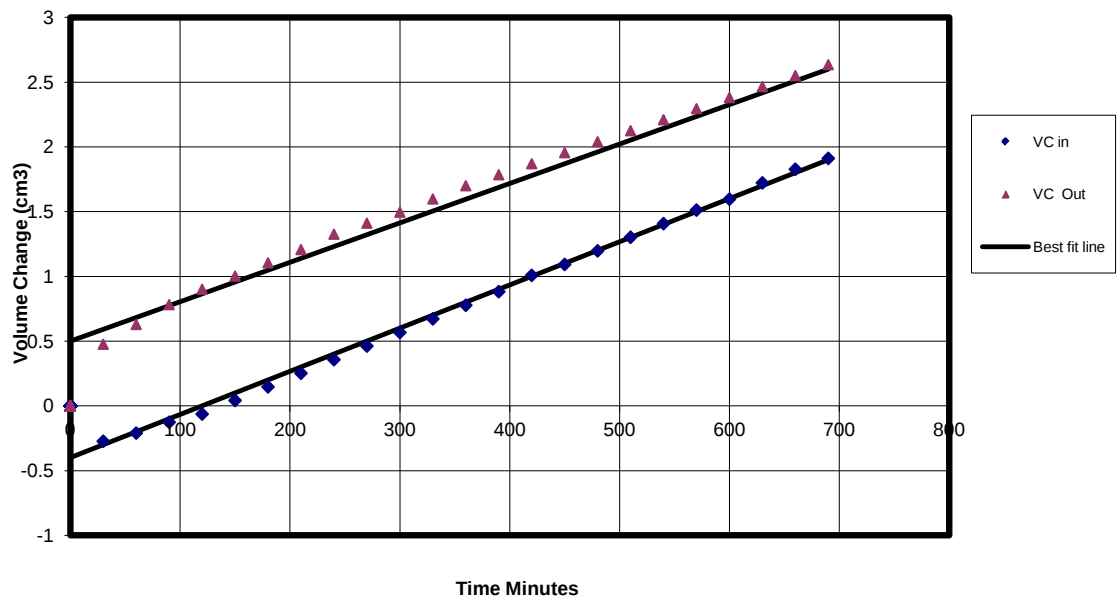
Borehole		Waste
Sample No.		Sample 4
Depth	m	0.00-2.00m above ground
Date		19/11/2011

Permeability

Cell Pressure	kPa	350.00
Inlet Pressure	kPa	320.00
Outlet Pressure	kPa	300.00
Mean Rate of Flow	ml/min	0.00319
Average Temperature	'C	22
Outlet Pressure	kPa	300.00

B Value

Post test	
Final B value	0.92



Corrected Vertical Permeability l m / s	3.45 x 10 ⁻¹⁰
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19/11/11
Date

Client Ref



Coed Darcy

Contract No

14185

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole	Waste
Sample No.	Sample 5
Depth m	0.00-2.00m above ground
Date	02/12/2011
Disturbed / Undisturbed	Disturbed

Description of Specimen

Angular, coarse gravel (approx 20%), maily mottled brown, firm, silty CLAY

Initial Specimen Conditions

Height	mm	115.00
Diameter	mm	102.30
Area	mm ²	8219.42
Volume	cm ³	945.23
Mass	g	2113.60
Dry Mass	g	1474.00
Density	Mg/m ³	2.236
Dry Density	Mg/m ³	1.559
Moisture Content	%	43.4
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	16.39
Density	Mg/m ³	2.30
Dry Density	Mg/m ³	1.97

Test Setup

Date started	22/11/2011
Date Finished	29/11/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P5
Cell Number	C5

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02/12/11
Date

Client Ref

Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

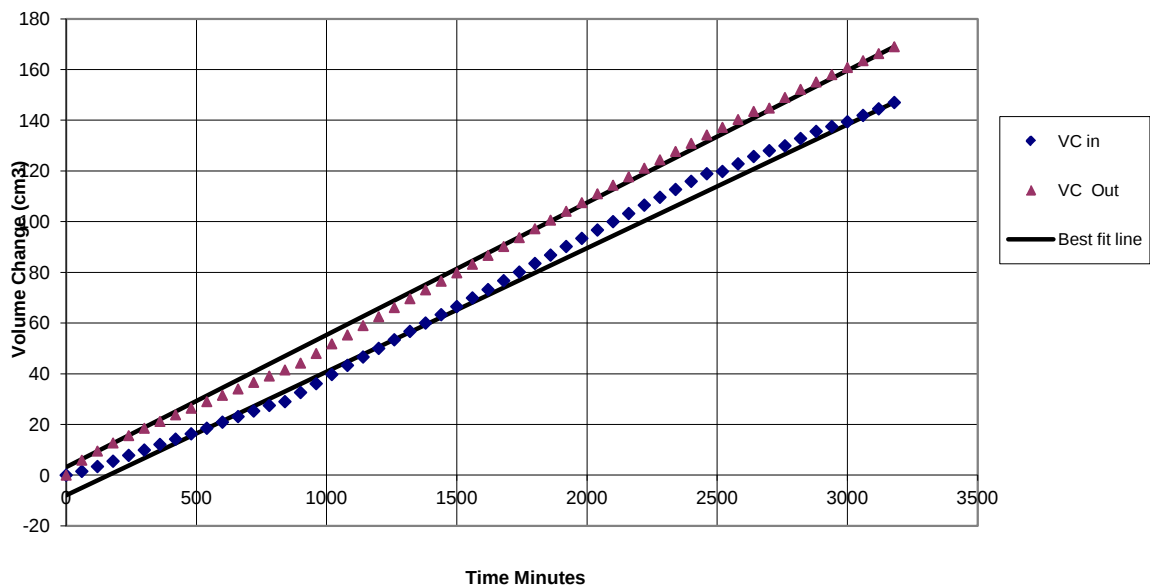
Borehole		Waste
Sample No.		Sample 5
Depth	m	0.00-2.00m above ground
Date		02/12/2011

Permeability

Cell Pressure	kPa	550.00
Inlet Pressure	kPa	425.00
Outlet Pressure	kPa	300.00
Mean Rate of Flow	ml/min	0.05044
Average Temperature	°C	22
Outlet Pressure	kPa	300.00

B Value

Post test	
Final B value	0.87



Corrected

Vertical Permeability K_v m/s	3.83×10^{-10}
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02/12/11

Date

Client Ref

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Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Batch 2
Sample No.		Sample 6
Depth	m	0.5m above ground
Date		07/12/2011
Disturbed / Undisturbed		Disturbed

Description of Specimen

Black, loose, approx 20% plant matter, slightly gravelly, organic soil.

Initial Specimen Conditions

Height	mm	115.80
Diameter	mm	102.40
Area	mm ²	8235.50
Volume	cm ³	953.67
Mass	g	1382.10
Dry Mass	g	713.40
Density	Mg/m ³	1.449
Dry Density	Mg/m ³	0.748
Moisture Content	%	93.7
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	90.51
Density	Mg/m ³	1.43
Dry Density	Mg/m ³	0.75

Test Setup

Date started	28/11/2011
Date Finished	05/12/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	PPerm6
Cell Number	CPerm6

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07/12/11
Date

Client Ref



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Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

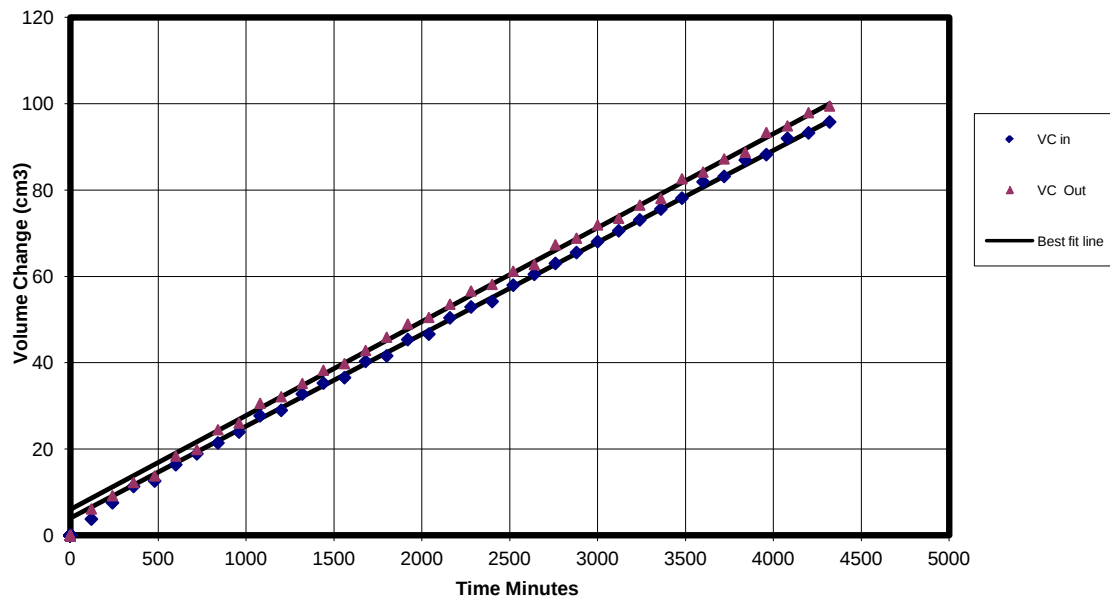
Borehole		Batch 2
Sample No.		Sample 6
Depth	m	0.5m above ground
Date		07/12/2011

Permeability

Cell Pressure	kPa	450.00
Inlet Pressure	kPa	420.00
Outlet Pressure	kPa	400.00
Mean Rate of Flow	ml/min	0.02153
Average Temperature	'C	22
Outlet Pressure	kPa	400.00

B Value

Post test	
Final B value	0.92



Corrected Vertical Permeability l m / s	1.23 x 10 ⁻¹⁰
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07/12/11
Date

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Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Batch 2
Sample No.		Sample 7
Depth	m	GL
Date		01/12/2011
Disturbed / Undisturbed		Undisturbed

Description of Specimen

Black, loose, 20-30% plant material, organic soil

Initial Specimen Conditions

Height	mm	116.60
Diameter	mm	101.70
Area	mm ²	8123.29
Volume	cm ³	947.18
Mass	g	1072.10
Dry Mass	g	699.10
Density	Mg/m ³	1.132
Dry Density	Mg/m ³	0.738
Moisture Content	%	53.4
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	92.06
Density	Mg/m ³	1.42
Dry Density	Mg/m ³	0.74

Test Setup

Date started	20/11/2011
Date Finished	29/11/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P5
Cell Number	C5

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01/12/11
Date

Client Ref



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Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

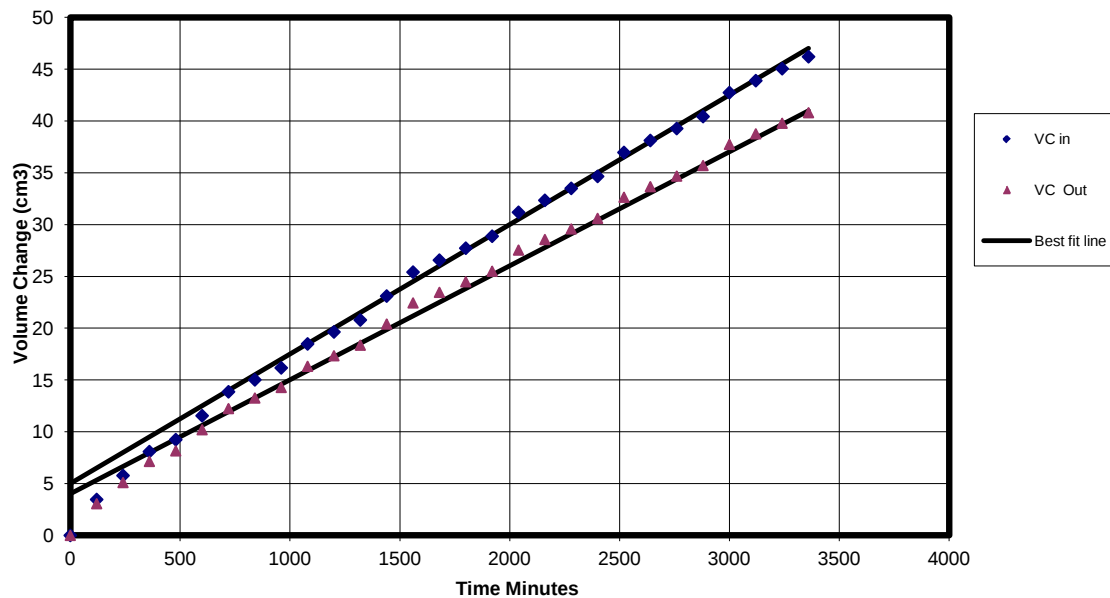
Borehole		Batch 2
Sample No.		Sample 7
Depth	m	GL
Date		01/12/2011

Permeability

Cell Pressure	kPa	450.00
Inlet Pressure	kPa	420.00
Outlet Pressure	kPa	400.00
Mean Rate of Flow	ml/min	0.01176
Average Temperature	'C	22
Outlet Pressure	kPa	400.00

B Value

Post test	
Final B value	0.96



Corrected Vertical Permeability l m / s	6.87×10^{-11}
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01/12/11
Date

Client Ref



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14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

Borehole		Batch 2
Sample No.		Sample 8
Depth	m	1.00m above ground
Date		09/12/2011
Disturbed / Undisturbed		Undisturbed

Description of Specimen

Black, loose, 20-30% plant material, slightly gravelly, organic soil

Initial Specimen Conditions

Height	mm	114.20
Diameter	mm	101.60
Area	mm ²	8107.32
Volume	cm ³	925.86
Mass	g	1020.00
Dry Mass	g	682.10
Density	Mg/m ³	1.102
Dry Density	Mg/m ³	0.737
Moisture Content	%	49.5
Voids Ratio		
Specific Gravity	kN/m ³	2.65
(assumed/measured)		assumed

Final Specimen Conditions

Moisture Content	%	95.34
Density	Mg/m ³	1.44
Dry Density	Mg/m ³	0.74

Test Setup

Date started	24/11/2011
Date Finished	08/12/2011
Top Drain Used	y
Base Drain Used	y
Pressure System Number	P7
Cell Number	C7

DP Gans

Checked and Approved By

09/12/11
Date

Client Ref



LABORATORY TESTING SERVICES LIMITED

Coed Darcy

Contract No

14183

Permeability in a Triaxial Cell

as per Accelerated test (Environment Agency Report P1-398/TR/2)

Specimen Details

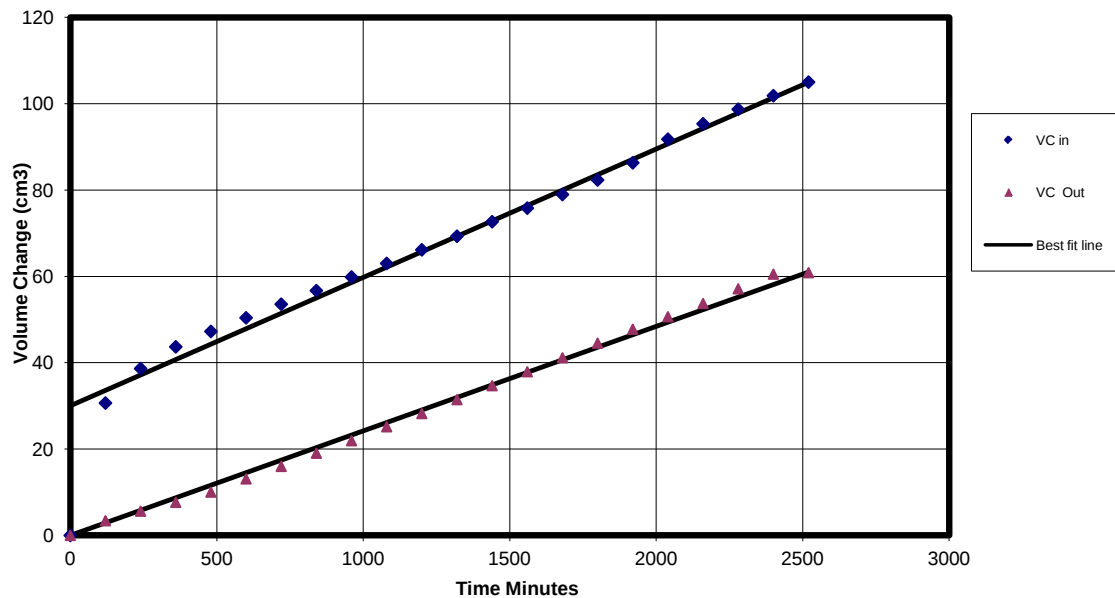
Borehole		Batch 2
Sample No.		Sample 8
Depth	m	1.00m above ground
Date		09/12/2011

Permeability

Cell Pressure	kPa	400.00
Inlet Pressure	kPa	370.00
Outlet Pressure	kPa	350.00
Mean Rate of Flow	ml/min	0.02698
Average Temperature	'C	22
Outlet Pressure	kPa	350.00

B Value

Post test	
Final B value	0.96



Corrected Vertical Permeability l m / s	1.77 x 10 ⁻¹⁰
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09/12/11
Date

Client Ref



Coed Darcy

Contract No

14183

Appendix C. Stability Risk Assessment Review

This appendix is divided into two parts. The first part reviews the previous URS reports [Ref. 2 and 11] which are relevant to the stability risks of the capping and restoration proposal of the landfilled area of the Tip, the restoration landform design in Sections 5 to 7 of the URS Tip Closure and Completion Strategy report [Ref.2], and Sections 8 and 11 of the URS Ground Investigation Report [Ref. 11] in particular,

The second part assesses the stability of the slopes of the proposed landform using Geostudio SLOPE/W modelling.

C.1. Stability Risk Assessment (SRA) Review

Appendix Table C1: Stability Risk Assessment (SRA) Review

Sections in the URS reports	Assumptions in the URS reports	Assumptions for the capping and restoration proposal	Comments
[Ref.2] Section 6	Lifecycle Phase The only life cycle phases considered are the waste only scenario prior to capping and the long-term post restoration scenario. All landform designs are permanent. No temporary slopes are anticipated.	All assumptions remain the same.	Assumptions remain applicable.
[Ref.2] Section 6	Conceptual Site Model (CSM) The CSM in the URS report considered the eastern and western areas as one area to be capped and restored. The cap is semi-permeable.	The area of concern for the capping and restoration proposal is only the eastern tip area. SMD intend to surrender the permit covering the western area, i.e. the “non-operational area” which has not been subject to permanent deposition of waste under the permit forthwith. The assumption that the cap is semi-permeable remains the same for the eastern tip area.	Change to URS model.

Sections in the URS reports	Assumptions in the URS reports	Assumptions for the capping and restoration proposal	Comments
[Ref.2] Sections 5.6 and 6	Risk Assessment There are only limited geotechnical data available on waste. No geotechnical data for proposed capping materials was available Generic and qualitative stability assessment. Stability risks were judged to be moderate within the Tip to low at the margin subject to further assessments. No building works were anticipated in the Tip area to be restored. Potential risks of settlement of peat.	Sampling and geotechnical testing on the waste and the proposed materials for capping and restoration have been undertaken in November 2011 (Appendix B). Geostudio SLOPE/W modelling has been undertaken based on the recent (November 2011) geotechnical test data to assess the stability risks against slope failure for a 1v:3h slope. There are still no proposals of building works on the eastern tip area to be restored. It is assumed that a new stability risk assessment will be required if the restored area is to be re-developed for other land uses. Given that the Tip had not accepted waste since 1999 (Section 1.3 of Ref.2), the clayey silty gravel nature of the waste as demonstrated by the recent sampling and testing on the waste, and the only proposed loading on the waste is the weight of the capping and restoration soils, further significant consolidation of the waste, i.e. settlement, is not anticipated.	Stability modelling required considering materials identified for capping. The Geostudio SLOPE/W modelling results indicate the stability risks are acceptable for slopes of steepness less than or equal to 1v:3h.
[Ref.2] Section 6.3 [Ref.11] Section 8 [Ref.2] Section 6.3	Landform Design The original design slopes in some of the Tip areas are recommended to be worked to 1v:10h and 1v:12h. The URS ground investigation concludes the finished landform should not have slope in excess of angles of 24° and 32° for cohesive (MCHW Class 2) and granular (MCHW Class 1A) materials respectively. The restored profile was designed to create a surface that naturally falls towards the South Bay and the Crymlyn Bog Lagoon.	The steepest slope of the proposed landform is 1v:3h (18°). The proposed landform is justified by the recent geotechnical test data (Appendix B) and this SRA review including the Geostudio SLOPE/W modelling results in this Appendix. The restored profile was designed to create a surface that naturally falls towards the existing interceptor trenches and surface water drains around the Tip whilst minimising the need to disturb by excavation and backfilling tipped materials which could lead to changes in the contaminant migration regime. It is also designed to maximise the land that can be released for other purposes. The profile is designed to ensure that settlement of underlying compressible materials will be accommodated and positive run-off gradients maintained.	The landform proposed in this CQA Plan is justified and supersedes the landform design in the URS report.

[illegible]

C.2. Numerical Analysis

This section presents the parts of the SRA requirements in the Environment Agency R&D Technical Report P1-385/TR2 [SRA-Ref. 3] which are relevant to the capping and restoration of the landfilled area of the Tip.

Risk Screening

Only the risks relevant to the CQA proposal are the following:

- Stability risks against slope failure for waste mass.
- Stability risks against slope failure for waste mass and capping & restoration soil.
- Stability risks against sliding at the interface between the waste and the capping & restoration soil.

The steepest slope of the proposed landform, i.e. the waste profile, the cap and the restoration layer, is 1v:3h at the edges around the landfilled area as shown on Drawings 5041216-RAP-DWG-0001083 to 1085. The maximum height of the edge slopes is approximately 5 m. The worst scenario geometry for slope stability analysis is a slope of 1v:3h and up to 8 m in height, which is considered to be sufficiently conservative.

The maximum thickness of the capping & restoration system is taken as 1m according to the design.

Lifecycle Phase

The two life cycle phases are:

- Prior to the construction of the cap – including the present state and re-profiling of the waste.
- Post restoration – after the capping and the restoration layer are constructed.

All landform designs are permanent. No temporary slopes are anticipated.

Justification of Geotechnical Parameters Selected for Analyses

The geotechnical parameters selected for analyses are based on the recent geotechnical test data (Appendix B) to assess the stability risks against slope failure for the worst scenario. A data summary is included in Appendix Table B2.

Factor of Safety

The stability analyses have been undertaken taking into account the guidance in Environment Agency R&D Report P1 – 385/TR2 (Ref SRA 3 below) and in Environment Agency Landfill Engineering guidance LFE04. The acceptable Factor of Safety (FoS) for the waste mass and for the capping & restoration system is taken as 1.3 or above for both SLOPE/W modelling and veneer calculations in which peak effective shear strength parameters are applied. The residual effective shear strength parameters have been determined but would only be applicable to analysis of material that had previously been subject to failure or gross deformation hence are not applicable to the failure scenarios considered in this CQA proposal.

C.2.1. SLOPE/W Modelling

Justification for Modelling Approach and Software

The risks against slope failure are to be analysed by SLOPE/W modelling. The assessment of slope stability has been undertaken using the SLOPE/W 2004 software using the “Bishop, Ordinary and Janbu” method of analysis. SLOPE/W 2004 is an ‘industry standard’ software of the GeoStudio 2004 series for undertaking two-dimensional modelling and analysis of the stability of earth slopes. The software allows modelling of perched water tables and specification of pore water conditions by Ru factor where necessary. The creation of comprehensive ground models is used with the ability to specify points on slip surfaces to analyse both

the deep seated and shallow potential slip surfaces. Circular potential failure surfaces are analysed to determine the lowest Factor of Safety (FoS) to be identified.

Water table

The configuration of the landfilled area is substantially higher than the surrounding natural ground, ash bunds, the South Bay and the Cymlyn Bog Lagoon. The groundwater table is assumed to be below the level of the slopes of the proposed landform for restoration.

A pore water pressure coefficient, $R_u = 0.1$, is assigned to the SLOPE/W analysis to account for the possibility of infiltrated water and leachate accumulated within the waste, and the capping and restoration soils.

Assessment Results

Based on the peak effective shear stress parameters (i.e. c' and Φ'), the modelling results indicate the stability risks against slope failure for a 1v:3h slope of up to 8m in height are acceptable in terms of the factor of safety (FoS) of the slope are found to be greater than 1.3 (Appendix C1) for the waste prior to the capping and following the construction of the capping & restoration system. The stability of the waste mass and the capping & restoration system against slope failure is satisfactory.

C.2.2. Veneer Calculations

Justification for Approach

The risks against sliding at the interface are to be analysed by veneer calculations. The analytical techniques used to assess the stability of the capping system are hand calculations assisted by spreadsheet in accordance with SRA-Ref. 1 and SRA-Ref. 2.

Water table

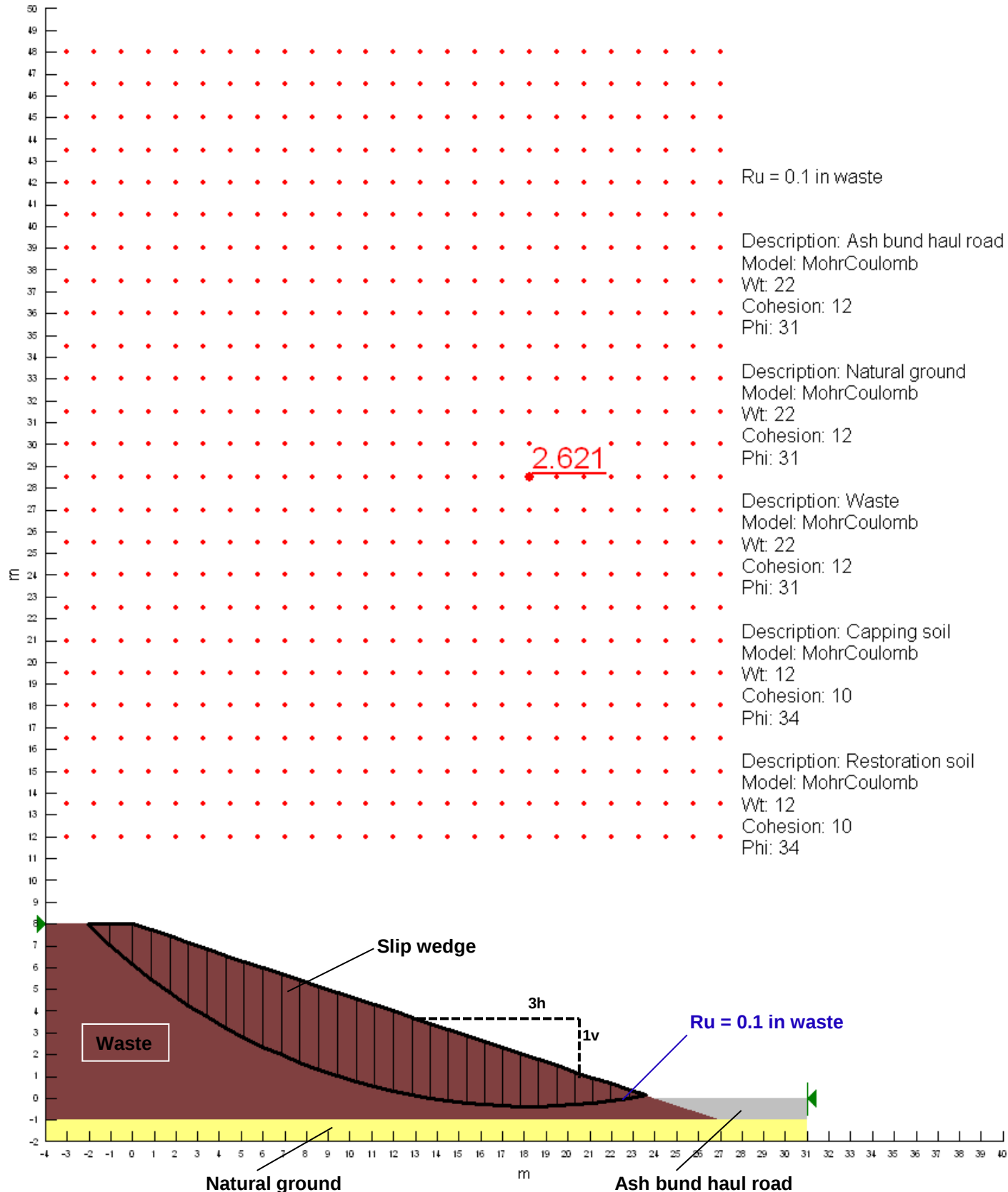
The Parallel Submergence Ratio (PSR) is defined in SRA-Ref. 1, Fig. 11. The PSR value is assigned as 0 to 0.5 in the spreadsheet for veneer calculations to assess the risks of sliding and to test the sensitivity of the FoS against the variation of PSR. The range of PSR values account for the various degrees of saturation of the infiltrated water and leachate within the capping & restoration soils.

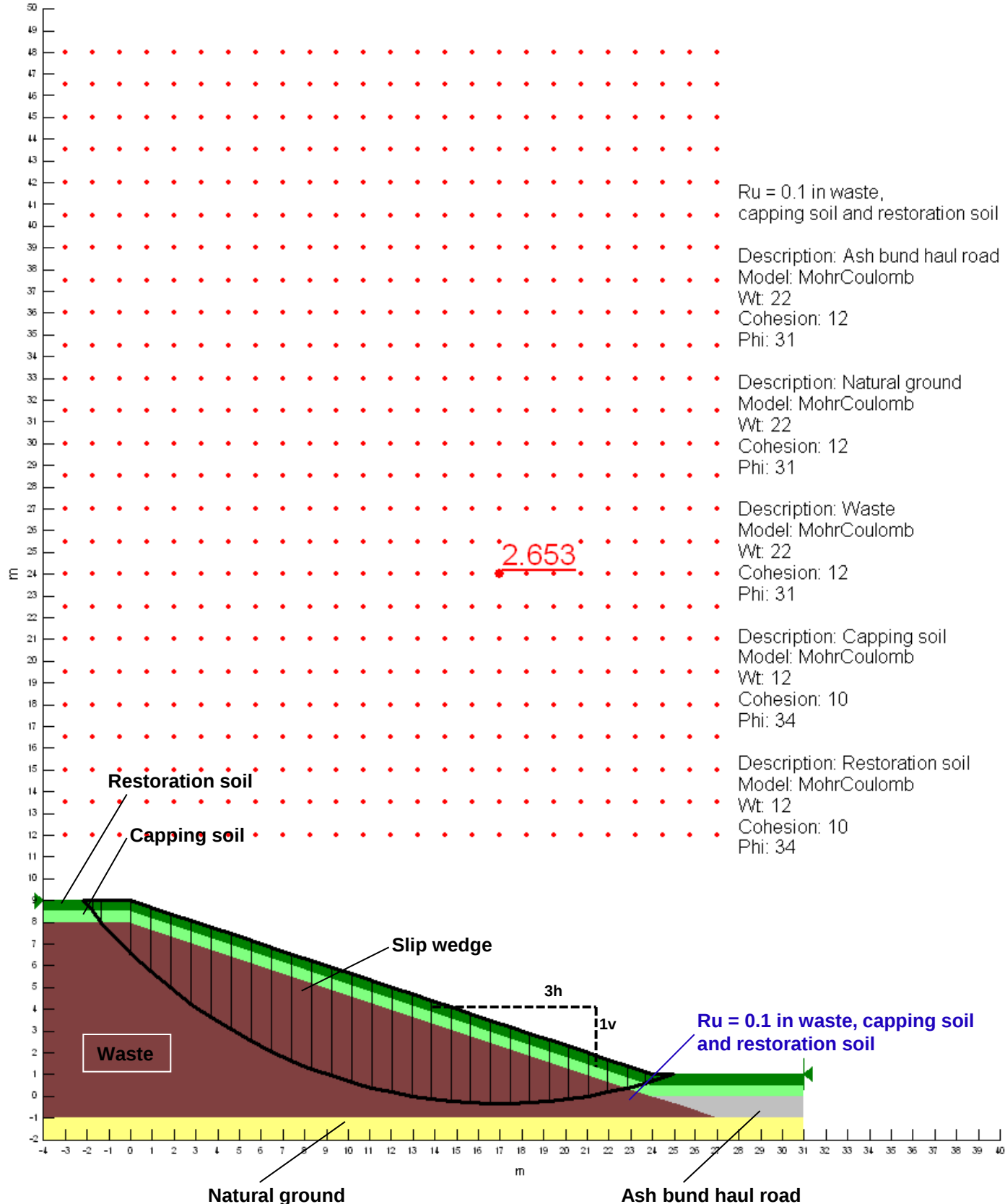
Assessment Results

Based on the peak effective shear stress parameters (i.e. c' and Φ'), the veneer calculations indicate the stability risks against sliding at the capping & restoration/waste interface for a 1v:3h slope of up to 8m in height and PSR between 0 and 0.5 are acceptable in terms of the factor of safety (FoS) of the slope are found to be greater than 1.3 (Appendix C2). The stability of the capping & restoration system against sliding is satisfactory.

References for SRA

- SRA-Ref. 1. Koerner, R.M and Soong, T.Y. (2005) Analysis and Design of Veneer Cover Soils Geosynthetics International, Vol. 12, No. 1, pp 28-49.
- SRA-Ref. 2. Jones, D.R.V and Dixon, N. (1998) The Stability of Geosynthetic Landfill Lining Systems, Proceedings Geotechnical Engineering of Landfills, Thomas Telford, pp 99-117.
- SRA-Ref. 3. Environment Agency, 2010, Environmental Permitting Application for a Landfill Permit, Stability Risk Assessment, Version 1, Ref. R&D Technical Report P1-385/TR2.





AUDIT SHEET

Created by	MC	22/02/2012	Stability calculations for cap of landfill cells. 1no. calculation sheet created for peak effective shear stress parameters.
Amended by	MC	24/02/2012	Extra 1no. calculation sheet created for residual effective shear stress parameters but this is NOT to be used or issued since residual parameters are not applicable to the proposal in which failure is not anticipated.
Checked and Reviewed by	MIC	20/03/2012	Checked and Reviewed the 1no. calculation sheet created for peak effective shear stress parameters.

Reference:

[SRA Ref. 1] Koerner, R.M and Soong, T.Y. (2005) Analysis and Design of Veneer Cover Soils, Geosynthetics International, Vol. 12, No. 1, pp 28-49.

[SRA Ref. 2] Jones, D.R.V and Dixon, N. (1998) The Stability of Geosynthetic Landfill Lining Systems, Proceedings Geotechnical Engineering of Landfills, Thomas Telford, pp 99-117.

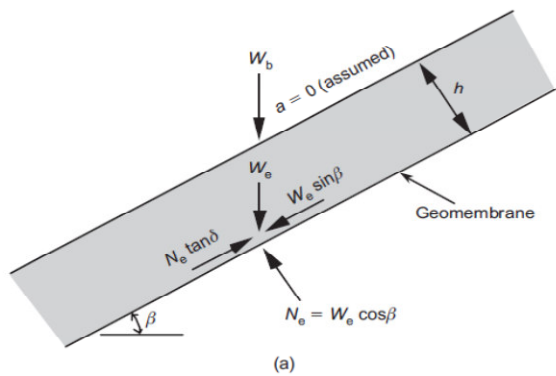


Figure 6(a) - plant moves uphill

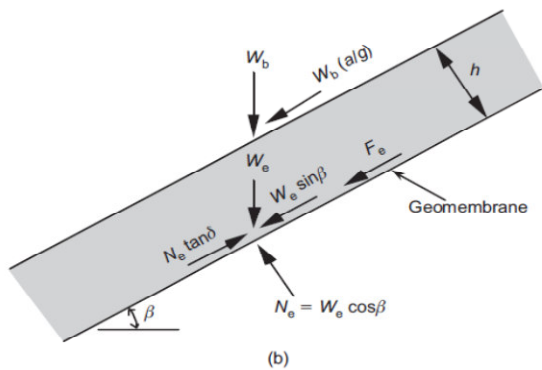


Figure 6(b) - plant moves downhill

Figure 6. Additional (to gravitational forces) limit equilibrium forces due to construction equipment moving on cover soil (see Figure 3 for the gravitational soil force to which the above forces are added): (a) equipment moving up slope (load with no acceleration); (b) equipment moving down slope (load plus acceleration)

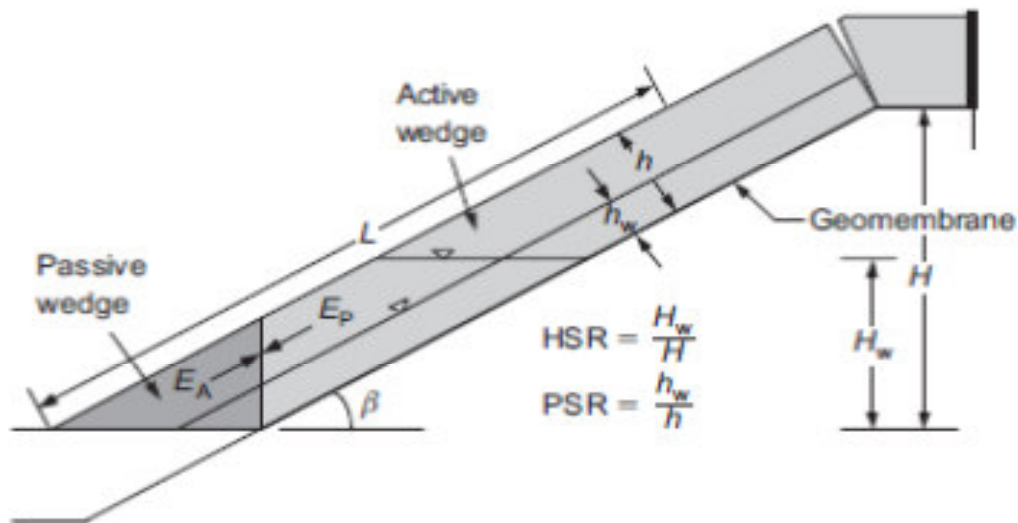


Figure 11. Cross-section of uniform thickness cover soil on geomembrane illustrating different submergence assumptions and related definitions (Soong and Koerner 1996)

Definition of Parallel Submergence Ratio (PSR).

Figure 11 of Koerner, R.M and Soong, T.Y. (2005) Analysis and Design of Veneer Cover Soils, Geosynthetics International, Vol. 12, No. 1, pp 28-49.

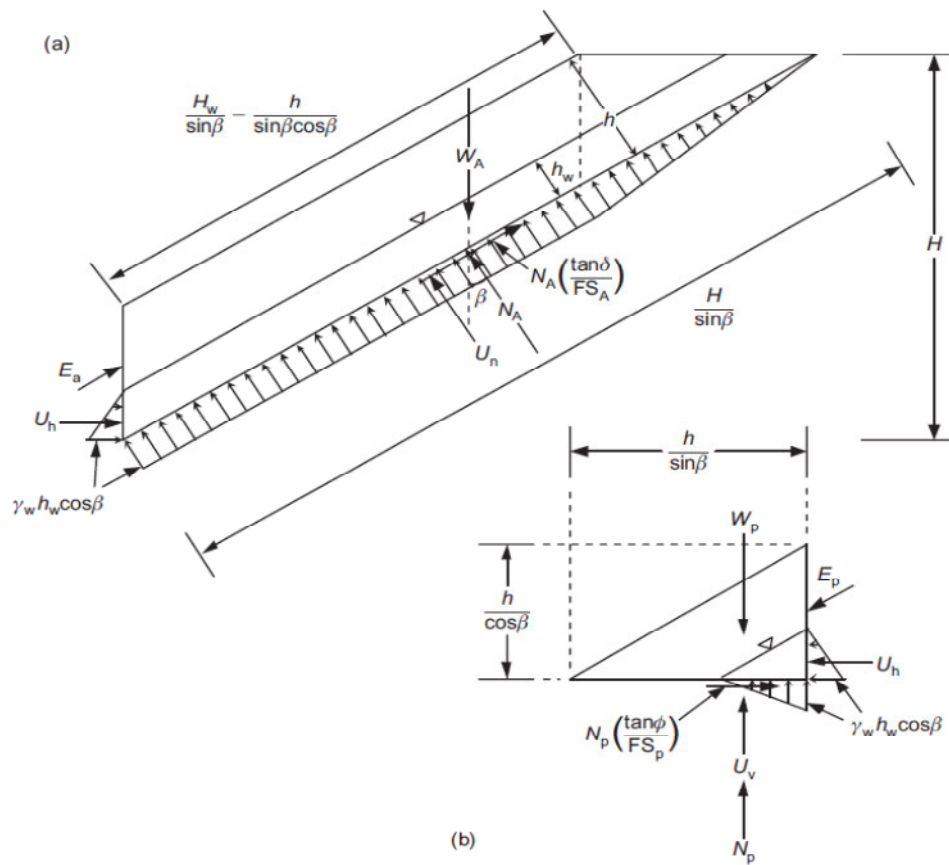


Figure 13. Limit equilibrium forces involved in finite-length slope of uniform cover soil with parallel-to-slope seepage build-up: (a) active wedge; (b) passive wedge

Figure 13 of Koerner, R.M and Soong, T.Y. (2005) Analysis and Design of Veneer Cover Soils, Geosynthetics International, Vol. 12, No. 1, pp 28-49.

Coed Darcy Urban Village - Capping of Crymlyn Tip



Stability Risk Assessment

Stability of capping against sliding - PSR - Peak shear stress parameters

References:

[SRA Ref. 1] Koerner, R.M and Soong, T.Y. (2005) Analysis and Design of Veneer Cover Soils, Geosynthetics International, Vol. 12, No. 1, pp 28-49.

[SRA Ref. 2] Jones, D.R.V and Dixon, N. (1998) The Stability of Geosynthetic Landfill Lining Sysytems, Proceedings Geotechnical Engineering of Landfills, Thomas Telford, pp 99-117.

Assumptions:

Finite slope analysis. Refer to Fig 13 of [SRA Ref. 1]

Incorporating cohesion of capping & restoration soil and cohesions between interface of capping & restoration soil/waste.

Various Parallel Submergence Ratio (PSR) for capping & restoration soil.

Assuming the laboratory test effective peak shear stress parameters are conservative and applicable to the CQA proposal in which stability failure is not anticipated..

Mode of failure - sliding.

conservative lab test results	waste cohesion	kPa	12.0						
conservative lab test results	waste friction angle	deg	31						
assumption	interface (capping & restoration soil/waste) α	kPa	12.0	12.0	12.0	12.0	12.0	12.0	12.0
	cohesion								
assumption	interface (capping & restoration soil/waste) δ	deg	31	31	31	31	31	31	31
	friction angle	rad	0.541	0.541	0.541	0.541	0.541	0.541	0.541
Conservative lab test results	capping & restoration soil cohesion	α_{soil}	10	10	10	10	10	10	10
Conservative lab test results	capping & restoration soil friction angle	Φ	34	34	34	34	34	34	34
		rad	0.593	0.593	0.593	0.593	0.593	0.593	0.593
			1:3 slope	1:3 slope	1:3 slope	1:3 slope	1:3 slope	1:3 slope	1:3 slope
steepest slope 1v:3h - design value	slope angle	β	18.43	18.43	18.43	18.43	18.43	18.43	18.43
		rad	0.322	0.322	0.322	0.322	0.322	0.322	0.322
Lab test results	dry unit weight of the restoration soil	γ_{dry}	7	7	7	7	7	7	7
assumption based on lab test bulk density results	saturated unit wt of the restoration soil	γ_{sat}	12	12	12	12	12	12	12
typical value	unit weight of water	γ_w	10	10	10	10	10	10	10
assumed largest height of slopes up to 8m	height of the slope	H	8	8	8	8	8	8	8
calculated	length of the slope	$L = H / \sin\beta$	25.30	25.30	25.30	25.30	25.30	25.30	25.30
assumption	variable - Parallel Submergence Ratio as PSR defined in Fig. 11 of Ref. 1.		0	0.1	0.2	0.3	0.4	0.5	
design value 1m	thickness of capping & restoration soil	h	1	1	1	1	1	1	1
calculated	thickness of saturated capping & restoration soil	$h_w = \text{PSR} \cdot h$	0	0.1	0.2	0.3	0.4	0.5	

Coed Darcy Urban Village - Capping of Crymlyn Tip



Stability Risk Assessment

Stability of capping against sliding - PSR - Peak shear stress parameters

calculated	adhesive force along failure plane of active wedge	$C_a = \alpha L$	kN	303.66	303.66	303.66	303.66	303.66	303.66
Eq. 10 of [Ref. 1]	cohesive force along failure plane of passive wedge	$C_{soil} = \alpha_{soil} h / \sin\beta$	kN	31.63	31.63	31.63	31.63	31.63	31.63
Eq. 32 of [Ref. 1]	total weight of the active wedge	$W_A = \{ \gamma_{dry} (h - h_w) [2H \cos\beta - (h + h_w)] + \gamma_{sat} h_w (2H \cos\beta - h_w) \} / \sin 2\beta$	kN	165.46	178.03	190.44	202.67	214.74	226.64
Eq. 35 of [Ref. 1]	total weight of the passive wedge	$W_p = [\gamma_{dry} (h^2 - h_w^2) + \gamma_{sat} h_w^2] / \sin 2\beta$	kN	11.67	11.75	12.00	12.42	13.00	13.75
Eq. 33 of [Ref. 1]	resultant of the pore pressures acting perpendicular to the slope	$U_n = [\gamma_w h_w \cos\beta (2H \cos\beta - h_w)] / \sin 2\beta$	kN	0.00	23.85	47.38	70.60	93.50	116.08
Eq. 34 of [Ref. 1]	resultant of the pore pressures acting on the interwedge surfaces	$U_h = (\gamma_w h_w^2) / 2$	kN	0.00	0.05	0.20	0.45	0.80	1.25
Eq. 26 of [Ref. 1]	resultant of the vertical pore pressures acting on the passive wedge	$N_A = W_A \cos\beta + U_h \sin\beta - U_n$	kN	156.98	145.07	133.35	121.82	110.48	99.33
Eq. 29 of [Ref. 1]	effective force normal to the failure plane of the active wedge	$U_v = U_h / \tan\beta$	kN	0.00	0.15	0.60	1.35	2.40	3.75
Eq. 31 of [Ref. 1]		$a = W_A \sin\beta \cos\beta - U_h \cos^2\beta + U_h$	kN	49.63	53.40	57.14	60.83	64.49	68.10
replace $(N_A \tan\delta)$ with $(N_A \tan\delta + C_a)$ and replace $(W_p \tan\Phi)$ with $(W_p \tan\Phi + C_{soil})$ in Eq. 31 of [Ref. 1] - also refer to Eq. 12 and Eq. 13 of [Ref. 2]		$b = -(W_A \sin^2\beta \tan\Phi) + (U_h \sin\beta \cos\beta \tan\Phi) - ((N_A \tan\delta + C_a) \cos\beta) - (W_p - U_v) \tan\Phi - C_{soil}$	kN	-428.22	-422.23	-416.22	-410.20	-404.16	-398.11
		$c = (N_A \tan\delta + C_a) \sin\beta \tan\Phi$	kN	84.87	83.34	81.84	80.36	78.91	77.48
Eq. 15 of [Ref. 1]	Factor of Safety	FoS = $[-b + \sqrt{(b^2 - 4ac)}] / (2a)$		<u>8.43</u>	<u>7.70</u>	<u>7.08</u>	<u>6.54</u>	<u>6.07</u>	<u>5.64</u>

Appendix D. Specification for Materials and Installation of the Capping and Restoration Layers

D.1. Introduction

D.1.1. Scope of works

The following works shall be undertaken by the Contractor:

- Selection and processing of materials;
- Site clearance including the removal of redundant boreholes prior to waster surface re-profiling;
- Re-profiling the surface of the waste;
- Installation of a cap on top of the waste;
- Installation of a restoration layer on top of the cap; and
- Surveys and laboratory analysis for conformity.

The works are subject to construction quality assurance (CQA) procedures as required by Cyfoeth Naturiol Cymru/Natural Resources Wales (CNC/NRW), i.e. formerly required by the Environment Agency Wales (EAW).

D.1.2. Definitions

The following parties are referred to in this specification. The Contractor shall liaise with these parties as required by the Employer prior to commencement, during and at completion of the works.

- Employer: St. Modwen Developments Limited (SMD).
- Employer's Project Manager: Prosurv Consult Limited.
- Engineer: Atkins Limited. The Engineer is also referred to as the quality assurance consultant (QAC) in the context of the CQA procedures.
- CDM-Coordinator: RFS Consultancy Limited.
- Contractor: Hawk Group. The Contractor shall take on the role and responsibilities of the Principal Contractor under the CDM Regulations 2007.

D.1.3. Site

D.1.3.1. Site location and access

The Site is situated within the Coed Darcy, off the M4 Motorway, Junction 43. A Security Lodge with security gates are present at main entrance to the development, Boiler House Road, which controls access to the Coed Darcy. Access to the Site is through the existing haul roads from the entrance to the Coed Darcy to the north and west edges of the Site as shown on Drawing 5041216-RAP-DWG-0001081. Haul roads are also present at the south edge of Site. The Contractor is responsible for confirming the existing routes are sufficient for the access of his machinery/equipment/plants required for the works. All accesses must be shared with the Employer and other parties who require access to the Site and the remainder of the Coed Darcy.

D.1.3.2. Site boundary

The "Site" refers to the landfilled area of the Crymlyn Tip as shown on Drawing 5041216-RAP-DWG-0001082. The Site is part of the permitted area of the Crymlyn Tip and is within the Coed Darcy.

D.1.3.3. Stockpiles of materials

The proposed materials to be used for the works are currently stockpiled within the Coed Darcy at two areas, Batches 01 and 02, as shown on Drawing 5041216-RAP-DWG-0001081. The recent geotechnical testing results of the samples from these stockpiles are included in Appendix B.

D.1.3.4. Geology and hydrogeology

The geological profile underneath the Tip is generally a shallow aquifer unit comprising made ground, peat and silty clay overlying a deeper aquifer unit which comprises sand and gravel, occasional alluvial clay and Carboniferous sandstone bedrock. The haul roads surrounding the Tip are essentially ash bunds above the natural geological profile.

D.1.3.5. Site layout and constraints

The existing waste levels on Site connect smoothly to the levels of the haul roads at the southern and western edges as shown on the topographical survey Drawing 5041216-RAP-DWG-000932. The middle part of the Site is generally flat but very steep slopes (steeper than 1v:2h) are present at the northern edge of the Site. The steep slopes shall be re-profiled to reduce their gradients to reach the design levels on Drawing 5041216-RAP-DWG-0001083.

Immediately to the north of the Site, as defined by the haul roads, is open space and the Crymlyn Bog, which is designated as a SSSI, SAC and Ramsar site, is located further to the north. The west of the Site, as defined by the haul roads and fencing, is the “non-operational area” of open space which has not been subject to permanent deposition of waste under the permit and further to the west is the Crymlyn Bog Lagoon. To the south of the Site, as defined by the haul roads, is the South Bay. The eastern side of the Site is hilly and vegetated open space where active recovery of hydrocarbon free product is being undertaken. There are existing interceptor trenches, which function as a gas/leachate extraction and monitoring system, and surface water drains around the Tip. The Contractor's works must not prevent the operations of the existing remedial facilities and drains.

D.1.3.6. Types of wastes

Available records show that the Site was a landfill and the types of wastes received by the Site include refinery wastes, demolition waste, refractory waste, asbestos, pyrophoric waste, vanadium waste and sludge, peat, soil and septic waste [Ref. 2 and 11]. The Site is currently uncapped with the exceptions that a number (the exact number is unknown) of small capped areas of vanadium pit and asbestos graves are present on Site. The URS ground investigation report [Ref. 11] has estimated the approximate footprints of the different types of waste within the Tip as shown on the URS Drawing (Ref. 44382624, Figure 2). The recent geotechnical testing results of the samples from the waste are included in Appendix B. **There are a number (the exact number is unknown) of redundant gas/groundwater monitoring boreholes on Site which are to be removed, or protected, as part of the scope of this Specification.**

D.1.4. Existing Information

The following reports are related to the contamination data and remedial strategy. The reports are available to the Contractor upon request to the Employer. These reports are provided for information only and the Contractor is responsible for satisfying himself with the information in the reports or proposing his own investigations/assessments/surveys and associated costs in his tender.

Appendix Table D1

	Reference Title
Ref. 2	URS, 2006, BP Llandarcy Remedial Action Plan, Tip Closure and Completion Strategy, Ref. 44382528, Issue No. 1c.
Ref. 9	Celtic, 2010, Coed Darcy Urban Village Former BP Llandarcy Oil Refinery Neath/Port Talbot, Containment Area – Crymlyn Bog Lagoon Remediation Strategy, Ref. R1352/10/3907, Second Issue.
Ref. 10	Celtic, 2009, Containment Area, Coed Darcy, Llandarcy, Free Product Recovery - Remedial Strategy, Ref. R1296/09/3619.
Ref. 11	URS, 2008, Llandarcy Tip Restoration, Ground Investigation Report, Ref. 44382540/BDRP0011, Issue No. 1.

D.1.5. Design Drawings

The following Appendix Table D2 summarizes the design drawings:

Appendix Table D2

	Drawing Ref.	Drawing Title
EAW		Environment Agency Wales's Plan
URS	44382624-Figure 2	Topographical Survey
Atkins	5041216-RAP-DWG-000932	Topographical Survey
Atkins	5041216-RAP-DWG-0001081	Site Location and Access
Atkins	5041216-RAP-DWG-0001082	Site Boundary and Constraints
Atkins	5041216-RAP-DWG-0001083	Proposed Top of Waste Levels
Atkins	5041216-RAP-DWG-0001084	Proposed Top of Cap Levels
Atkins	5041216-RAP-DWG-0001085	Proposed Top of Restoration Levels
Atkins	5041216-RAP-DWG-0001086	CQA Testing Location Reference
Atkins	5041216-RAP-DWG-0001087	Cross Sections of Proposed Landform

D.2. General Requirements

The following are the general requirements apply to all works unless otherwise specified:

- The hours of work on Site and within the Coed Darcy will be between 08.00 and 18.00, Monday to Friday, unless otherwise agreed in writing with the Employer.
- The Contractor shall submit a programme to the Employer and the quality assurance consultant (QAC) for approvals in advance to enable the QAC to deploy quality assurance monitors (QAM) to carry out site monitoring.
- The Contractor shall submit Risk Assessment, Method Statement and Health and Safety Plan to the QAC prior to mobilisation to the Site. The Method Statement must cover the measures of protection of the existing interceptor and surface water drains around the Tip.
- All quantities of materials stated on the design drawings are provided for information only. The Contractor shall confirm his own estimates of the required amounts of cut and fill of materials to achieve the design levels to the QAC in advance.
- Should the Contractor requires any areas outside the Site boundary for his works, including selection and temporary stockpiling of materials, he shall obtain the Employer's permission in advance.
- Prior to the transfer of materials, including the transfer of capping and restoration materials from the stockpiles to the Site, the materials must be slightly damped by clean water to minimise the generation of dust.
- Any debris and mud left on any accesses within the Coed Darcy as a result of the Contractor's works must be immediately cleared by the Contractor.
- The Contractor shall dispose all the wastes resulted from the works, including the waste resulting from Site clearance and unsuitable materials resulted from selection and processing, off the Coed Darcy to permitted facilities.
- The Contractor's works must not preclude the operations of the existing remedial facilities and surface water drains on the Coed Darcy.
- Any amendments to or deviation from this specification must be notified to the QAC for approvals prior to the works of the amended parts commencing.
- All the construction notes and as-built drawings shall be provided to the QAC within 3 days of the completion of the relevant part of the works. The information provided by the Contractor and his sub-contractors must represents a true record of the works.
- All the conformance testing must be UKAS accredited and shall be undertaken in a quality assurance laboratory (QAL). Any QAL employed by the Contractor and his sub-contractors shall be pre-approved by the QAC in advance.
- All topographical surveys shall be carried out on a *maximum* grid interval of 10 m x 10 m and at changes of slope. The survey data in dwg or dxf formats shall be submitted to the QAC within 3 days of the survey. The tolerance of the surveys must be reported to QAC.
- All slopes of the re-profiled waste, capping and restoration layers, either temporary or permanent, shall not be steeper than 1v:3h for stability and safety reasons.
- All slopes of the re-profiled waste, capping and restoration layers, either temporary or permanent, which are steeper than 1v:6h must not be trafficked by machinery and vehicles for stability and safety reasons.

D.3. Selection and Processing of Materials

The materials to be used for re-profiling the waste, capping and restoration shall be site won validated materials which are stockpiled within the Coed Darcy. **Materials shall be imported for the works only if there is a deficiency of site won materials when work is about to start.** Any imported materials used for the works shall be subject to the same selection criteria, i.e. the specification in Appendix D, as those for the site won materials.

The Contractor shall select and process materials to meet the requirements in this specification. Any materials which possess one or more of the following properties must not be used for the works:

- Any materials that have not been approved by CNC/NRW or previously approved by EAW for the purposes of capping and restoration of the Crymlyn Tip;
- Any materials containing any substances that would cause them to be classified as hazardous waste [Ref. 4 and 5];
- Any materials containing any dangerous substances or any contaminants at concentrations that would cause them to be classified as hazardous waste [Ref. 4 and 5]; and
- Any materials containing peat, litter or otherwise not meeting the material specification

D.3.1. Requirements for Contaminant Concentrations

The materials to be used for re-profiling the waste (i.e. infill to base of capping), and as capping and restoration shall not possess any concentrations of any contaminants which are above the maximum acceptable concentrations listed in Appendix Table D3. The contaminant concentrations in materials shall be determined from samples taken for analysis at a minimum rate of 1 sample per 5,000m³. All the analysis must be UKAS accredited and shall be undertaken in a QAL for all the determinands listed in Appendix Table D3. The minimum detection limit of a contaminant must be equal to or less than the acceptable concentration specified.

Appendix Table D3

Contaminant	Acceptance concentration Infill to base of capping ⁽¹⁾ Soil (mg/kg)	Acceptance concentration Capping and restoration material ⁽²⁾ Soil (mg/kg)
Arsenic	N/A	64*
Cadmium	N/A	2.6*
Copper	N/A	200*
Lead	N/A	1*
Mercury	N/A	75*
Nickel	N/A	3*
Selenium	N/A	337*
Vanadium	N/A	640*
Zinc	N/A	478*
Asbestos	200	200*
1,2-Dichloroethane	0.29	0.29*
Benzene	31	13*
Toluene	1,128	1,128*
Ethylbenzene	8,500	4,740*
Xylene (total)	3,067	3,067*
Total TPH	8,500	8,500*
Acceptance concentrations above are previously agreed with Environment Agency Wales (EAW). See Appendix D. (1) Protective of groundwater (2) Protective of human health and groundwater * Previously agreed with Neath Port Talbot Borough Council Environmental Health.		

The materials to be used for re-profiling the waste (i.e. infill to base of capping), and as capping and restoration shall not produce any leachate concentrations of any contaminants under leachability testing which are above the maximum acceptable concentrations listed in Appendix Table D4. The leachability of the materials shall be determined from samples taken for analysis in accordance with BS EN 12457-4 (at L/S 10 l/kg) at a minimum rate of 1 sample per 5,000m³. All the analysis must be UKAS accredited and shall be

undertaken in a QAL for all the determinands listed in Appendix Table D4. The minimum detection limit of a contaminant must be equal to or less than the acceptable concentration specified.

Appendix Table D4

Contaminant	Acceptance concentration Infill to base of capping ⁽¹⁾ Leachate (ug/l)	Acceptance concentration Capping and restoration material ⁽²⁾ Leachate (ug/l)
Arsenic	50	50
Cadmium	5	5
Copper	6	6
Lead	125	125
Mercury	1	1
Nickel	100	100
Selenium	10	10
Vanadium	20	20
Zinc	175	175
Asbestos	N/A	N/A
1,2-Dichloroethane	N/A	N/A
Benzene	N/A	N/A
Toluene	N/A	N/A
Ethylbenzene	N/A	N/A
Xylene (total)	N/A	N/A
Total TPH	N/A	N/A
Acceptance concentrations above are previously agreed with Environment Agency Wales (EAW). See Appendix E. (1) Protective of groundwater (2) Protective of human health and groundwater		

D.3.2. Requirements for grading – materials for capping

The materials to be placed above the existing waste to form the cap shall be site won suitable materials stockpiled within the Coed Darcy or imported materials. The materials shall be processed and tested prior to installation so that their grading meets the following requirement:

- The particle size distribution (PSD) specification of the Class 6F1, “selected granular material (fine grading) for capping”, of the Manual of Contract Documents for Highway Works (MCHW), Specification for Highway Works

The grading requirement is summarized in Appendix Table D5:

Appendix Table D5

Particle size	Percentage by mass passing the size
75 mm	100%
37.5 mm	75% to 100%
10 mm	40% to 95%
5 mm	30% to 85%
0.600 mm	10% to 50%
0.063 mm	<15%

The particle size distribution (PSD) of the materials shall be determined from samples taken for analysis in accordance with BS 1377-2, at a minimum rate of 1 sample per 2,500m³. All the analysis must be UKAS accredited and shall be undertaken in a QAL. The materials for re-profiling waste to reach the design waste levels are not subject to these grading requirements.

D.3.3. Requirements for grading – materials for restoration

The materials to be placed above the cap to form the restoration layer shall be site won materials which were remediated and stockpiled within the Coed Darcy or imported materials. The materials shall be processed and tested prior to installation so that their grading meets the following requirements:

- The particle size distribution (PSD) specification of the Class 6F1 of the Manual of Contract Documents for Highway Works (MCHW);
- The uniformity coefficient ($U_c = D_{60\%}/D_{10\%}$) must be equal to or greater than 15 to ensure the materials are well graded with a large range of particle sizes. The uniformity coefficient (U_c) is defined by the ratio of the diameter of the grain size that allows 60% ($D_{60\%}$) by mass of the material passing through the sieve, to the diameter of the grain size that allows 10% ($D_{10\%}$) by mass of the material passing through the sieve.

The particle size distribution (PSD), including the uniformity coefficient (U_c), of the materials shall be determined from samples taken for analysis in accordance with BS 1377-2, at a minimum rate of 1 sample per 2,500m³. All the analysis must be UKAS accredited and shall be undertaken in a QAL.

D.4. Installation Requirements

D.4.1. Site clearance

The following are the clearance requirements within the site, i.e. landfilled area of the Tip, prior to waste surface re-profiling:

- The Contractor shall submit a list and a location plan of redundant gas/groundwater monitoring boreholes on site to be removed and or protected, showing their locations on a drawing, to the QAC for approval prior to removal.
- Decommissioning, removal and disposal off of all agreed redundant boreholes. The voids resulted from the removal of boreholes shall be backfilled with bentonite. The boreholes including their installations shall be decommissioned to a minimum depth of 2m below the existing ground level and the entire void depth from the bottom of the borehole to the existing ground level shall be backfilled with bentonite.
- Removal and disposal off all the redundant borehole casing and installation, debris, vegetation and roots, re-bars, sharp objects and standing water off the Coed Darcy to permitted facilities.

D.4.2. Re-profiling of the waste surface

The following are the waste re-profiling requirements prior to the installation works:

- Re-profiling of the existing waste or placing extra materials to reach the design top of waste levels shown on Drawing 5041216-RAP-DWG-0001083 taking care to no disturb any areas of asbestos or other sensitive wastes.
- Where there is a deficiency of waste to reach the design top of waste levels, additional materials shall be brought from the areas of stockpiles to the Site to make up the levels. The additional materials for re-profiling must satisfy the conformance requirements for capping materials (excluding the chemical criteria).
- Compaction is only required on the surface of the additional materials and over-compaction shall be avoided. The compaction shall use the plant in accordance with the MCHW, Specification for Highway Works, Table 6/4 appropriate for Table 6/1, Class 6F1 material but only half of the number of passes by the plant as stated in the MCHW standard method for a layer of 250mm thickness shall be applied.
- All discontinuities and voids are to be filled and made safe for the capping and restoration works, and access for machinery/equipment/plants as appropriate.
- The surface of the waste shall be trimmed to provide a smooth surface which is free of debris, vegetation and roots, re-bars and sharp objects and standing water on which to place the capping materials.
- The top of the waste levels shall be determined and confirmed to be in accordance with Drawing 5041216-RAP-DWG-0001083 by a topographical survey prior to the placement of the capping materials.

D.4.3. Installation requirements for capping

The following are the installation requirements for the cap:

- The thickness of the cap shall be a minimum of 500 mm.
- For the areas designed to be trafficked, i.e. accesses of machinery and vehicles, the thickness of the capping shall be a minimum of 1000 mm.

- The capping materials shall be brought from the areas of stockpiles to the Site, placed and spread in layers not exceeding 500 mm (i.e. if the thickness is greater than 500 mm, it has to be spread and compacted in more than one layer).
- The placed materials shall be compacted in accordance with the MCHW, Specification for Highway Works, Table 6/4 appropriate for Table 6/1, Class 6F1 material but only half of the number of passes by the plant as stated in the MCHW standard method for a layer of 250mm thickness shall be applied and only apply to the finished surface of the capping. The compacted layer shall provide a smooth surface which is free must be free from large voids, cracks and discontinuities.
- The top of the capping levels shall be determined and confirmed to be in accordance with Drawing 5041216-RAP-DWG-0001084 by a topographical survey prior to the placement of the restoration materials.

D.4.4. Installation requirements for restoration soils

The following are the installation requirements for the restoration soils:

- The thickness of the restoration layer shall be a minimum of 500 mm.
- For the areas designed to be trafficked, where the thickness of the capping is a minimum of 1000 mm, a restoration layer is not required.
- The restoration materials shall be brought from the areas of stockpiles to the Site, placed and spread in layers not exceeding 500 mm (i.e. if the thickness is greater than 500 mm, it has to be spread and compacted in more than one layer).
- The placed materials shall be compacted in accordance with the MCHW, Specification for Highway Works, Table 6/4 appropriate for Table 6/1, Class 6F1 material but only half of the number of passes by the plant as stated in the MCHW standard method for a layer of 250mm thickness shall be applied and only apply to the finished surface of the restoration soil. The compacted layer shall provide a smooth surface which is free must be free from large voids, cracks and discontinuities.
- The surface of the restoration soil should be worked to a suitable tilth for landscaping following compaction.
- The restoration surface should have no abrupt changes with the exceptions of gentle slopes (no steeper than 1v:3h) connected to the surrounding ground levels of the Tip.
- The top of the restoration layer levels shall be determined and confirmed to be in accordance with Drawing 5041216-RAP-DWG-0001085 by a topographical survey.

Appendix E. EAW and CNC/NRW Correspondence

Your ref: EPR/AP3990LL/S003
Our ref: 5041216-RAP-OUT-000430

Tel: +44 (0)121 483 5000
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Gareth Davies
Cyfoeth Naturiol Cymru / Natural Resources Wales
Maes Newydd
Llandarcy
Neath Port Talbot
SA10 6JQ

info@atkinsglobal.com
www.atkinsglobal.com

01 July 2013

Dear Gareth,

Permit No. EPR/AP3990LR/S003
Topographical Surveys for Settlement of Crymlyn Tip

This letter presents the comparison of topographical surveys in order to assess whether settlements of materials have ceased at the permitted site, Crymlyn Tip [Ref. 1].

Drawing 5041216-RAP-DWG-1088 shows the most up to date topographical levels surveyed by St Modwen's surveyor, Planned Vision, in May and June 2013 with a survey level tolerance of 0.025 m. This survey in 2013 was compared to the survey completed in March 2011 (Drawing 5041216-RAP-DWG-932) and the differences in levels between the two surveys are shown on Drawing 5041216-RAP-DWG-1088.

The results show no obvious patterns of settlements across the footprints of historical tip features including peat, sludge pits, asbestos and the non-landfilled area. The differences in levels between the surveys in 2011 and 2013, which are less than twice the survey level tolerance (0.050 m), show no indication of significant settlements within the permit boundary including both the landfilled tip and the non-landfilled area to be surrendered.

Given the results above and the fact that the Tip had not accepted waste since 1999 [Ref.2, Section 1.3], further significant settlements are not anticipated. It is therefore concluded that the requirements of the permit with regards to stability are satisfied.

Should you have any queries regarding this letter, please do not hesitate to contact me.

Yours sincerely,
For and on behalf of Atkins Limited



May Chan
Senior Environmental Engineer

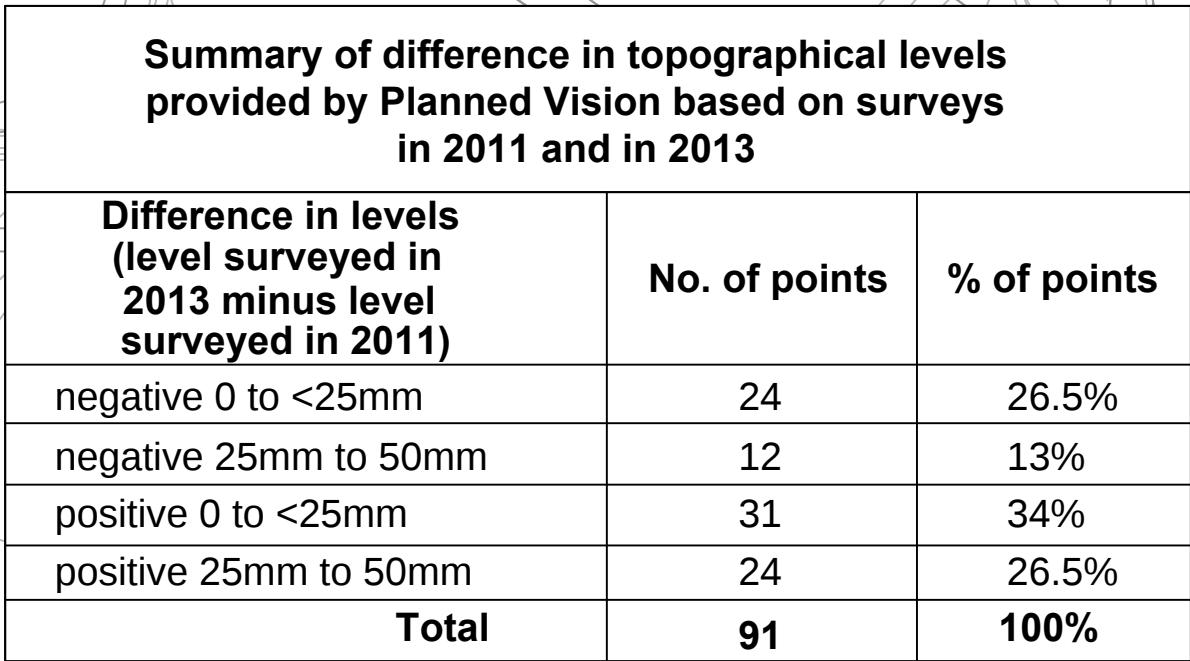
Enc. Drawings

[Ref. 1] EAW, 2010, Environmental Permit, Variation Notice no. EPR/AP3990LR/V002, Environment Agency Wales.

[Ref. 2] URS, 2006, BP Llandarcy Remedial Action Plan, Tip Closure and Completion Strategy, Ref. 44382528, Issue No. 1c.

Atkins Limited is a WS Atkins plc company

Registered office: Woodcote Grove Ashley Road Epsom Surrey KT18 5BW England Registered in England Number 688424



1. DO NOT SCALE.
2. TOPOGRAPHY DATA FOR MARCH 2011 TAKEN FROM 5041216-RAP-DWG--000932.
3. TOPOGRAPHY DATA FOR MAY 2013 TAKEN FROM SURVEY DATA PROVIDED BY PLANNED VISION ON DATE 21/05/2013 AND 22/05/2013 AND 10/06/2013
4. CONTOURS SHOWN ARE IN m\ad.
5. DIFFERENCE IN LEVELS DATA PROVIDED BY PLANNED VISION ON DATES 21/05/2013, 22/05/2013 AND 10/06/2013.
6. TIP FEATURES ARE TAKEN FROM URS DRAWING REF. 44382624-FIGURE 2, FEB 2006.

AREAS SHOWN UNOBTAINABLE DATA
DUE TO THE BUILD UP OF MATERIAL IN
PREPARATION FOR CONTAINERS AND
TEMPORARY OFFICE COMPOUND, AS WELL
AS THE NORTHERN MOST BATTER BEING
FILLED OUT FOR ACCESS.

THE FOLLOWING SOURCE DATA ARE PROVIDED BY PLANNED VISION
ON DATES 21/05/2013, 22/05/2013, 10/06/2013.

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ISSUE TO EAW	-	MC	12/06/13
PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

Birmingham Office
The Axis, 10 Holliday Street
Birmingham
West Midlands B1 1TF

THIS DRAWING IS NOT TO BE SCALED

COED DARCY

TOPOGRAPHICAL SURVEY 2013 AND COMPARISON WITH
TOPOGRAPHICAL SURVEY 2011

0	SHEET A1	PLOT DATE 26.06.13
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5041216-RAP-DWG-1088

creu lle gwell
creating a better place



Asiantaeth yr
Amgylchedd Cymru
Environment
Agency Wales

Mr Mark Briggs
Principal Engineer
URS Corporation Ltd
Company House
Tower Hill
Bristol
BS2 0EQ



Ein cyf/Our ref: F1.9.26.02 20070823

Eich cyf/Your ref:
44382540/BRLT0013MB

Dyddiad/Date: 23rd August 2007

Dear Mark

RE: LLANDARCY TIP RESTORATION EAWML/34003

Thank you for your letter dated 27th July 2007 and subsequent e-mails dated 17th and 23rd August 2007 regarding the restoration of the tip at BP Llandarcy.

The Environment Agency have considered the information supplied in relation to the interim deposit of treated granular material from Area 1 onto the tip as a restoration material, prior to the acceptance of the modified licence and working plan. Provided you work to the agreed methods supplied, the Environment Agency has no objection to you commencing these works. For reference I have attached copies of the previous correspondence which detail these agreed methods.

As confirmed in my e-mail of 2nd August 2007, the Environment Agency accept your tip restoration import criteria.

Please contact me at the address detailed below should you have any queries on the contents of this letter.

Yours sincerely

Michelle Walker
Environment Officer

Llinell uniongyrchol/Direct dial 01792 325648

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Michelle,

thank you for the quick reply. With regard to the three points that you require further information on, I would comment as follows.

1. During period of high winds there is an increased potential for generation of dust. Should conditions become such that damping down and other control measures are not sufficient to control dust then works would be suspended. This would be based on the observations of either the contractors site manager, or the URS supervisor. Ultimately it would be the contractors responsibility to ensure safe working conditions for both the work force and the wider environment. I understand that this is the process that is currently adopted in the Area 1 works.

2. Should the works stop for an extended period the placed material would initially be damped, rolled, and then covered with suitable material from Area 1. It is the intention that this would be sourced from the available suitable granular material from Area 1, ie the granular material not requiring treatment. Should sufficient granular material not be available, then either an alternative source of material or plastic sheeting would be used to provide cover and dust control.

3. The dust monitoring protocol adopted will be as used currently in Area 1. The 4 hour monitoring periods will comprise a morning and afternoon shift, essentially providing almost continuous coverage. The analysis period is currently two days, and we would seek to continue this fast turn around time.

As a general comment, it is likely that the existing contractor on Area 1 will move the material to the tip, and as such we would seek to use the same dust control protocols that are currently employed at Area 1.

I trust that this provides the additional information you require, and will enable the Environment Agency to grant permission for the placement of the initial phase of restoration material. As I mentioned before, as response before your upcoming leave would be much appreciated.

Regards

Mark Briggs
Principal Engineer
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Registered number: 118271
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"Michelle Walker" <michelle.walker@environment-agency.wales.gov.uk>

From: Michelle Walker
To: Mark_Briggs@URSCorp.com
Date: 21 August 2007 15:41:22
Subject: Re: Llandarcy tip restoration

Thanks Mark for the information supplied, I still have a few queries/ points to raise:

Points which need further clarification:

- Will you stop activities during periods of high winds, where the generation of dust is significant and could cause pollution of the environment / harm to human health? Who will make this decision?
- Your method statement says that *'upon completion of each layer, or at the end of each working day, the soil will be rolled to minimise future settlement, and to compact the surface to minimise generation of dust'*. At the end of placement of material, or if the placement of material needs to stop for a period of time, or high winds are experienced which are generating dust; what cover will be used to prevent the generation of dust - previously we have spoken about putting some granular fill (from area 1) as a barrier layer to prevent the generation of dust potentially containing asbestos.
- How frequently will you be doing the two 4 hour pumped monitor readings (which will provide a coverage for the working day)? How long will it take to get results back from this process? If unacceptable concentrations of asbestos fibres are found as a result of this monitoring, works should stop, and control measures be reviewed (and in necessary improved) before recommencing work.

Points not requiring an answer:

- When a contractor for the works is appointed, I would be grateful if you could send me copies of the specific method statements, (I note that they will be required to demonstrate compliance with the method statement you have supplied to the EA).
- I note that it is anticipated that URS will supervise the movement and placement of material during the works. When you have a contact name /telephone number could you provide me with the details.
- Please inform me 48 hours before commencing works on site.
- You will need to comply with the requirements of Duty of Care.
- Monitoring - Baseline conditions should be established by monitoring 5 days prior to any works.

Please get back in contact should you have any queries on the content of this e-mail.

Kind regards
Michelle

>>> <Mark_Briggs@URSCorp.com> 17 August 2007 15:57:59 >>>

Michelle,

please find attached a method statement and risk assessment which addresses the points raised in your last email, relating to material handling and the various environmental and human health risks that the interim placement phase may pose. I trust that this provides sufficient detail on these issues.

Method statement for the placement of treated material in to Llandarcy Tip

Objective

A proportion of the soil material generated during the regeneration of the Llandarcy site from within Area 1 has been subject to treatment to reduce its asbestos content. Post treatment the soil will have less than 200ppm asbestos, a residual concentration that Neath Port Talbot (NPT) Environmental Health have approved as suitable for use in a recreational land use setting.

It is proposed to use this material as part of the restoration of the Llandarcy Tip area. The intention is to place the material in the first phase of restoration, which will result in the material lying at depth once restoration is completed. While the risk posed by the treated soil is low, this is considered a prudent and beneficial use of the soil.

Due to the potential for residual asbestos content within the treated material a precautionary approach has been adopted during the planning of the material movement and placement. The following method statements address the following risks highlighted by risk assessment. Please note that the risk assessment is focussed on abnormal risk associated with this activity, and does not address the more usual construction related risks that a competent contractor will address as part of the normal working operation.

Hazard	Risk	Receptor	Mitigation
Release of residual asbestos fibres	Inhalation	All site personnel	- Appropriate PPE, comprising FFP3 grade mask, Tyvek suit, boots and gloves mandatory to all site workers. - Implementation of clean/dirty welfare facilities - Implementation of dust control measures, during loading, transportation and spreading of soils - Air monitoring to demonstrate effectiveness of control measures
		Visitors/ trespassers	- Strict control of access to site - Use of appropriate control measures as above
Creation of fugitive dust containing asbestos	Inhalation	All site personnel	- Implementation of dust control measures - Sheeting of soils during periods of inactivity - Control of vehicle movements (speed, route on hard surface where possible) - Wheelwash facilities to be used - Monitoring of operational areas of site
Contaminated site water	- Surface water contamination - Groundwater contamination	Surface water and groundwater	- Control of dust suppression to minimise excess water application - Control of surface water within loading/tipping areas - Sheeting of soils during periods of inactivity
Mud and debris	- Inhalation of dust - Surface water contamination - Groundwater contamination	- All site personnel - Surface water	- Control of vehicle movements (speed, route on hard surface where possible) - Wheelwash facilities to be used to minimise potential for road contamination

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Hazard	Risk	Receptor	Mitigation
Spillage of fuel during material handling.	• Surface water contamination • Groundwater contamination	• Surface water and groundwater	• Refuelling only in designated areas (hardstanding areas with spill kits present) • Spill kits to be available in loading and unloading areas

Summary Method Statements

The following method statements are intended to act as an overview for the procedures required. They address the key risk identified in the summary risk assessment above, and incorporate appropriate mitigation measures. At the time of writing a preferred contractor to undertake the works has not been selected. It is anticipated that contractor specific method statements will be prepared, incorporating details of specific plant and preferred methods of working. It is intended that the methods and working practices adopted will be as rigorous as those adopted during the current Area 1 asbestos works; the contractor will be required to demonstrate compliance with the following requirements.

Duration of work

The duration of the works will be dependent on the quantity and capacity of plant used during the earth-moving programme. However, it is anticipated that the works will take place over a 4 to 6 week period, assuming one excavator and three dumpers are deployed.

It is anticipated that URS will supervise the movement and placement of the material during the works, and will act as a point of contact for the Environment Agency and other interested parties.

Material Handling

- Treated material will be available for use from top terrace, where validated material from Area 1 is being stored. The area is currently remote from the Area 1 works, but not secured due to the perceived lower risk posed by the treated and validated material. The material is however, contained within the overall Llandarcy secure site, and public, or any other unauthorised access to the area is prohibited.
- Prior to movement the stockpile will be damped down to minimise dust generation.
- Material will be loaded using mechanical plant into a dump truck.
- Once loaded the dumper will exit the top terrace area, via a self-contained wheelwash. If required additional damping down of the loaded material will be undertaken prior to leaving the top terrace.
- On route to the tip the BP Llandarcy site wide speed limit of 20mph will be observed to minimise dust generation en-route.
- Traffic management procedures will be enforced. Transport routes will avoid operational areas, such as the bitumen plant, where possible.
- On arrival at the tip the dumper will proceed to the active area of the tip, and offload the soil. If required the material will be damped down on entry to the tip area.
- On exiting the tip the dumper will pass through a self-contained wheel wash.
- The soil will be damped down prior to spreading by a tracked dozer.
- The soil will be spread in layers not exceeding 500mm.
- Upon completion of each layer, or at the end of each working day, the soil will be rolled, to minimise future settlement, and to compact the surface to minimise generation of dust.

Personnel Protection

- All personnel will be fully briefed prior to commencement on site on the nature of the works to be undertaken, and the relevant control measures that are to be implemented.
- All staff will have received BP RM health and safety training, and will wear mandatory PPE comprising hard hat, boots, safety glasses. Additional PPE comprising hi-visibility

vest, Tyvek suit, gloves and asbestos rated mask will also be required. All operatives will be face fit tested to ensure appropriate masks are provided.

- Personnel will be provided with personal air monitoring equipment to monitor potential personal exposure to asbestos fibres, in line with current Area 1 practice.
- Access to and from the worksite will be strictly controlled, with secure fencing and appropriate clean/dirty area segregation.
- Welfare facilities will be provided in the clean area of the site. Eating/drinking outside of this area will be prohibited.

Monitoring

- Air quality monitoring will be undertaken in three areas of the site
 1. The material loading area
 2. The main operation area of the site, ie the bitumen plant
 3. The material spreading area.
- Monitoring in the loading area will comprise four monitoring points located on the periphery of the area.
- Baseline conditions will have been established as part of the treatment works. Should the baseline data not be considered adequate, monitoring for 5 days prior to any works will be undertaken.
- Monitoring will be based on the current Area 1 procedure, using two 4 hour pumped monitor readings, to provide coverage of the working day.
- Should results of monitoring indicate unacceptable concentrations of asbestos fibre dust control measures will be reviewed. Additional damping and use of sheeting will be implemented as appropriate.

Environmental Controls

Surface water

- Surface water run off will be initially controlled via careful application of water during damping down operations. Should however, excess water be generated this may be controlled using a system of water control ditches and bunding, with the intention of preventing potentially contaminated water exiting the worksite and entering the surface drainage system. It is noted that the top terrace surface water drainage network has been stopped up during the course of the current storage works, a condition that will be maintained.
- The nature of the made ground is such that generation of contaminated leachate is considered a low risk; the prime concern is the potential for entrained asbestos fibres to become liberated as any surface water evaporates.
- Care will be taken to use the minimum volume of water required to effect dust control, while also minimising the potential for ponding of surplus water. Water will be applied using a jet wash lance or sprinkler bar where required.
- Should excess water pond then settlement and screening prior to discharge may be required.

From: Michelle Walker
To: Mark_Briggs@URSCorp.com
Date: 02 August 2007 14:58:19
Subject: Re: Llandarcy Tip Restoration

Mark,
following on from our telephone conversation discussing your letter of 27th July 2007, I have the following points to make:

- Capping: with regards to the depth of cap I will need to pass your proposals to a colleague, I will get back to you on this issue.

- With regards to the interim agreement for the placement of treated material from Area 1: please provide additional information on the method of placement of material, including duration of works (estimated), what dust suppression will be in place, what monitoring will be done (I don't want a lengthy document, however a method of work would be a useful tool, with contact details for who to contact in an emergency or who to contact to visit the site).

- Again with regards to the interim agreement for the placement of treated material from Area 1: As there is a potential for the generation of asbestos contaminated dust from the placement of materials, you need to ensure that sufficient controls are in place to ensure that the handling of this material will not cause harm to human health, detriment to the amenities of the locality or pollution of the environment. No-doubt you will need to do a risk assessment of the job from a human health point of view anyway (H&S at Work). Tagged onto this assessment could you also consider environmental risk such as escape of dust, risk to surface water, risk to groundwater, you need to be able to demonstrate that you have considered these things, again I don't need a lengthy document, a table would do with expansion where controls are needed, this links in with your method of works as requested above). It may be worth your while looking at Churngold's Risk Assessment, this info is on the public register, so I should be able to dig you out a copy if you like?

- Revision of the Licence and Working Plan - as discussed I refer you to our letter 17th July 2007 which covers points we may consider need conditioning under a licence modification, when submitting your application you should consider these points and whether they need to be covered in your submission.

- With regards to the EU Birds and Habitats Directive, if the activities on the site (restoration works, not the restored site) have a significant effect on a European site, the EA is likely to carry out an appropriate assessment in consultation with CCW. It would be in your best interest to restore the site in a manner which would not have a significant effect on the Bog thus avoiding this protracted process. I understand that from the previous assessment done for the proposed bioremediation of soils on the tip the sticking point was the potential for an increase in nutrient loading to the bog. You need to ensure that your working plan has sufficient controls within it to prevent this being a problem, factors such as mixing in fertiliser to the restoration material and the nutrient leachability of the material which has already been bioremediated will need to be considered. We (the EA) have collected nutrient information on the discharges to the bog from the BP consented discharge points for over a year, I could send you a copy of this information if it would prove useful. The two EA Habitats Officers are on leave at the moment, as a result of a reorganisation I need clarification from them as to which area they cover before giving you a name.

- Tip restoration import criteria: based on the discussions during our recent meeting and the supporting information provided in your letter of 27th July, the EA accept your tip restoration import criteria.

So to summarise, I will need to consult internally on the capping thickness; for the interim placement of Area 1 material please could you supply a method of work and a risk assessment (they only need to be basic); when you submit your licence modification application it would be in your best interest to factor out any potential significant effects on the Bog to avoid having to go down the habitats assessment route. The EA accept your waste acceptance criteria.

Please get back to me if you need clarification on any of these points.

Kind regards
Michelle

>>> <Mark_Briggs@URSCorp.com> 27 July 2007 15:17:01 >>>

Michelle,

Please find attached a letter relating to the restoration of the Llandarcy tip, and proposals for progressing the project. A hard copy is in the post.

I will call next week to confirm receipt, discuss any queries, and the programme for submission of the application for licence modification.

In the interim, if you have any queries please call.

Regards

Mark Briggs
Principal Engineer
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URS Corporation Limited
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Registered office: 243 West George Street, Glasgow G2 4QE

(See attached file: BRLT0013 signed.PDF)

Our Ref: 44382540/BRLT0013/MB
Your Ref:

27 July 2007

Environment Agency Wales
South West Area Office
Maes Newydd
Llandarcy
Neath
Glamorgan SA10 6JQ



For the attention of Michelle Walker

Dear Michelle

Re: Llandarcy Tip Restoration

Subsequent to our meeting on the 19th July 2007, I write to both confirm the key points of the discussion, and provide the data requested on behalf of BP.

Restoration Context

The ultimate aim of BP is to enable the surrender of the landfill licence. In order to progress towards this aim it is proposed to begin the restoration of the tip as soon as practicable. Due to the current physical form of the landfill, re-profiling of the tip is required in order to render it stable in the long term. Given the long operational history of the tip, the detailed location of hazardous material placed is not complete and it is not desirable to disturb the existing infill. It is proposed to re-profile and restore the tip by sourcing the restoration material from within the Llandarcy regeneration site. Following our discussion it is hoped that sufficient suitable material may be available from the current Area 1 development.

The current landfill licence makes no provision for the restoration and closure of the landfill. To allow the restoration to take place, a modification of the existing licence is required. It is the intention of URS, on behalf of BP, to submit documentation to enable the modification to occur; it is anticipated that this will take the form of a new site specific working plan (SSWP) for the tip, which will address the restoration and closure phases.

As discussed, a modified licence with current working conditions is requested to be issued by the Environment Agency that will refer to the SSWP for specific details on the mechanics of restoration. The SSWP may evolve and require updating in the course of site works, so the SSWP will be developed to be flexible but robust to avoid repeated applications for licence revision should changes in operation be required over time.

While the final detailed design is yet to be completed, initial indications are that approximately 45,000-50,000 m³ of restoration material will be required to transform the current landform into one which meets that envisaged in the Llandarcy Remedial Action Plan (RAP) which was issued in 2000. The final design strategy for the tip is essentially a gently convex area with surface drainage mainly entering South Bay.

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Certificate No. FS21618

Granular material containing asbestos is currently being treated at Area 1 under a mobile treatment licence, the treated material remaining classified as a controlled waste. In order to avoid prolonging the treatment contract purely to facilitate temporary storage of the treated material, the option of using the of treated material sourced from Area 1 as an initial phase of infill (approximately 10,000m³) was discussed at our meeting.

It was understood that on the condition that a submission for a modification of the landfill licence was completed, supported by the detailed design, soil management and full SSWP are provided within approximately two months, the Area 1 treated material may be placed in advance of the full licence revision.

It is the intention of this letter to provide the required interim assurance on the working methods and placement details to facilitate the use of the Area 1 material in advance of the main works.

Restoration Materials

In our letter of 24th May 2007 a set of soil quality criteria were proposed for use in the restoration process. In the light of your subsequent reply, dated 17th July, and our meeting, I would make the following additional comments.

Impact of Acidity

The granular material from Area 1 is predominately power station ash, which has elevated metal concentrations. Leachate testing has been previously undertaken using the NRA test methodology. While this is a physically aggressive method it uses a neutral pH. The results of this have shown the granular material to have a negligible leachable component in neutral conditions. The EA have queried the potential for a change in pH that may mobilise the metal component within the tip area. It is the intention to place the Area 1 material approximately 1m above the current groundwater level, and it is therefore unlikely to be exposed to groundwater in the saturated zone.

The pH of the existing tip groundwater has been considered. Data gathered between March 2000 and September 2004; indicate that the water has a typical pH in the range of 6 to 7.5. Mobilisation of the metal component of the granular material is not considered to be a constraint to its use as infill.

Hydrocarbon Load

Further information on URS' proposed limit of permissible hydrocarbon was requested by the Environment Agency. The original assessment of the risk posed by hydrocarbons to the surrounding bog was initially undertaken as part of a site wide groundwater risk assessment, produced in 1999. This concluded that dissolved phase hydrocarbon migrating from the tip was likely to attenuate such that no significant risk would be posed to the bog within 50m. This was also summarised in the Tip Closure Strategy Report that was issued in March 2006, which proposed a >10,000mg/kg hydrocarbon concentration limit on infill material.

In response to comment by the Environment Agency at an effectively uncapped limit, it was proposed by URS that the acceptability criteria adopted for the bio-treatment of peat from the tip lagoon, namely 8,500mg/kg, be adopted for restoration materials. This concentration is considered to be protective of both groundwater and human health.

During the presentation to the Environment Agency in August 2006, the issue of the impact of the tip on the bog was discussed, with an emphasis on tip closure and licence surrender. Agreement was reached at this meeting that a reducing contaminant load can be demonstrated by monitoring the trends of reducing contamination in monitoring wells at the tip site perimeter, indicating a reducing contaminant load within the tip, which would be a key factor in permitting licence surrender.

This issue was raised at our recent meeting, where the previous history detailed above was discussed. It was recommended by URS that given the hydrocarbon content of the residues within the tip and the existing hydrocarbon impact of the surrounding bog, the placement of material with a hydrocarbon content of 8,500mg/kg would be unlikely to contribute significantly to the overall hydrocarbon load within the tip, or result in a detectable rise in contamination beyond the tip boundaries.

It is the intention to source infill material for the tip restoration works largely from Area 1. Chemical analysis has demonstrated the Area 1 free from significant hydrocarbon contamination. TPH analysis of 55 samples of the shallow soils (made ground and reworked natural) was undertaken prior to current phase of remediation. The analysis recorded hydrocarbon concentrations within 22 samples, at concentrations between 25mg/kg and 5580mg/kg, with an average of 1095mg/kg. The remaining 33 samples recorded no hydrocarbons. Subsequent detailed speciated hydrocarbon analysis on 44 of these samples provided aliphatic/aromatic splits for the samples detecting hydrocarbons in 7 of the 44 samples, varying between 128mg/kg and 3991mg/kg. This data has been presented previously, within the Area 1 Factual Site Investigation Report, issued in June 2006.

All material is being assessed as it is excavated for visual and olfactory evidence of hydrocarbon contamination during the remediation work. Where impact is suspected, samples are taken for laboratory analysis, and where concentrations in excess of the Risk Based Screening Level (1717mg/kg) are reported the material is stockpiled separately for treatment and disposal. These soils will not be included in the material proposed for use in tip restoration. To date only two locations have been identified in Area 1 exceeding RBSLs, comprising approximately 10m³.

It is considered unlikely that there will be a significant hydrocarbon content in the material sourced from Area 1 that will be used in the tip restoration.

A table of proposed acceptance criteria is attached to this letter and in the light of the additional information provided, URS request the Environment Agency acknowledge the acceptance of them for use in the restoration of the Tip

Thickness of Material over Treated Granular Material

BP has undertaken not to place treated granular material from Area 1 at the surface of the restored tip. It has been proposed that the treated granular material underlies a 0.5m layer of a suitable surface material.

The initial proposal for a cover thickness of 0.5m was developed in line with current accepted practice in the capping of soils in a residential re-development setting, typically 300mm in landscaped zones and 450mm-600mm in residential garden areas. This is considered adequate to minimise the likelihood of exposure to future users of the amenity area, and proportionate to the risk posed by the restoration materials to be placed.

The estimated volume of material to be generated by Area 1 indicates that the treated granular material will be less than initially anticipated, with corresponding increased volumes of cohesive soil and weathered rock. The final design of the Area 1 earthworks giving rise to these various materials is yet to be completed, however it is anticipated that three distinct types of material will be produced:

- treated granular material: predominately ash with a residual asbestos content (approx 10,000m³);
- soils: natural, and some previously reworked, predominately silty soils (approx 25,000m³); and
- weathered rock: crushed if required (approx 10,000m³).

The final design will incorporate an overall material balance calculation and therefore the estimate of material volumes may alter, however, based on the current estimates we expect that a covering in excess of 1m to the treated granular material will be provided.

The depth at which the ACM treated granular material from Area 1 is discussed in the following section.

Interim Placement of Treated Granular Material

During the meeting placement of treated granular material at the base of the tip in advance of submission of the final restoration details was proposed. Subject to your approval it is proposed to place treated granular material from Area 1 in areas of the tip that the current ground model indicates will be in excess of one metre below the final surface and greater than one metre above the water table. Three cross sections and an associated plan are attached to this letter. The cross sections detail the typical sections through the areas intended to receive the infill and the plan an indication of the corresponding plan area this will occupy. The proposed interim fill is shown as "Phase I" on the sections and plan.

It is proposed that the material will be transported to the tip in conventional civil operation, which will incorporate dust mitigation measures. The material will be tipped and spread by dozer in layers with a nominal thickness of 0.5m, and suitably compacted to minimise future settlement, while maintaining some inherent permeability within the material.

Upon completion of the material placement it will be covered with a nominal 150mm of natural material sourced from Area 1. This will mitigate the potential of generating asbestos containing dust in the interim consultation period of the licence revision and SSWP development.

We would request your approval for these interim proposals.

Document Submission Programme

It is intended that the submission of this letter will provide sufficient confidence in the proposed restoration programme and the proposal for the initial placement of material will be accepted by the Environment Agency on receipt of written approval. URS/BP will provide the supporting documentation to allow a full revision of the existing license as detailed below.

- Site specific working plan addressing site restoration.
 - To include:
 - Plan detailing areas for material placement
 - Plan and cross sections detailing final surface levels
 - Details of surface water drainage
 - Details of hydrocarbon recovery systems

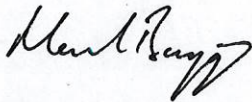
- Capping composition and thickness
 - Monitoring/Reporting of restoration process
- Post restoration monitoring plan.
To include:
 - Scope
 - Borehole monitoring locations
 - Sampling frequency
 - Reporting protocols

It is the intention to submit this documentation by the week ending 14 September.

Summary

I trust that the information above meets your expectations following the recent meeting, and look forward to receiving your approval to proceed with the initial placement of the granular material and acceptance of the proposed import criteria. Should you have any queries please do not hesitate to contact the undersigned.

Yours faithfully
URS Corporation Ltd



Mark Briggs
Principal Engineer

Enc Figure 1: Initial Phase Infilling Plan.

cc. BP (by email) : John Smith
 Craig Lines
 Steve Hiscock

Tip Restoration Import Criteria

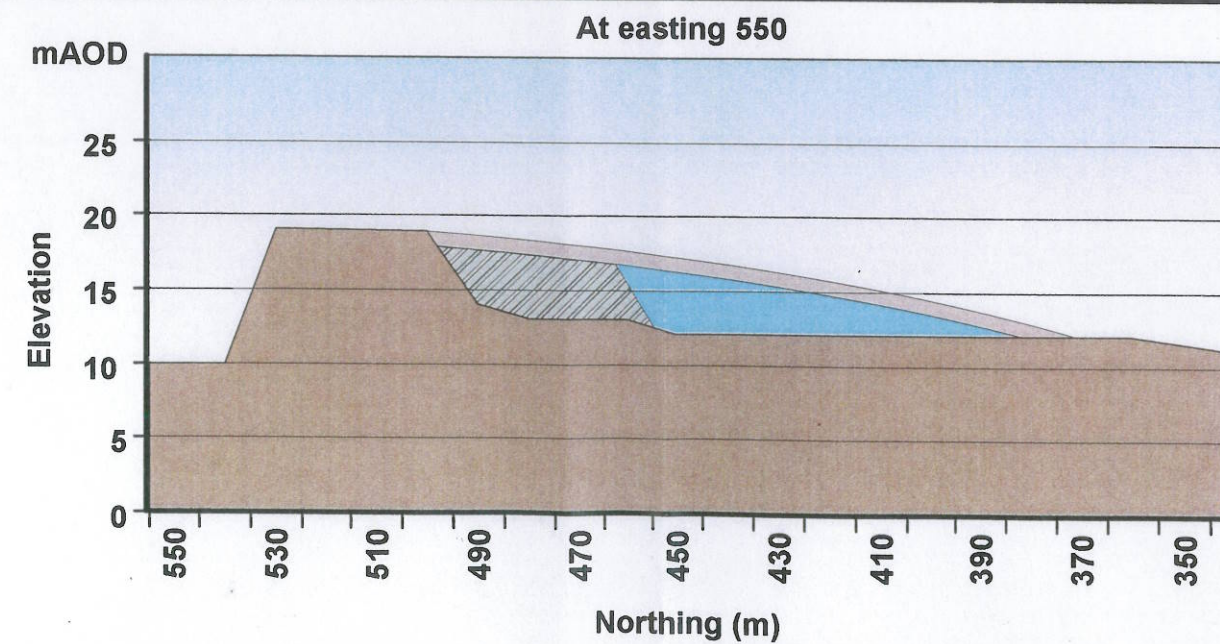
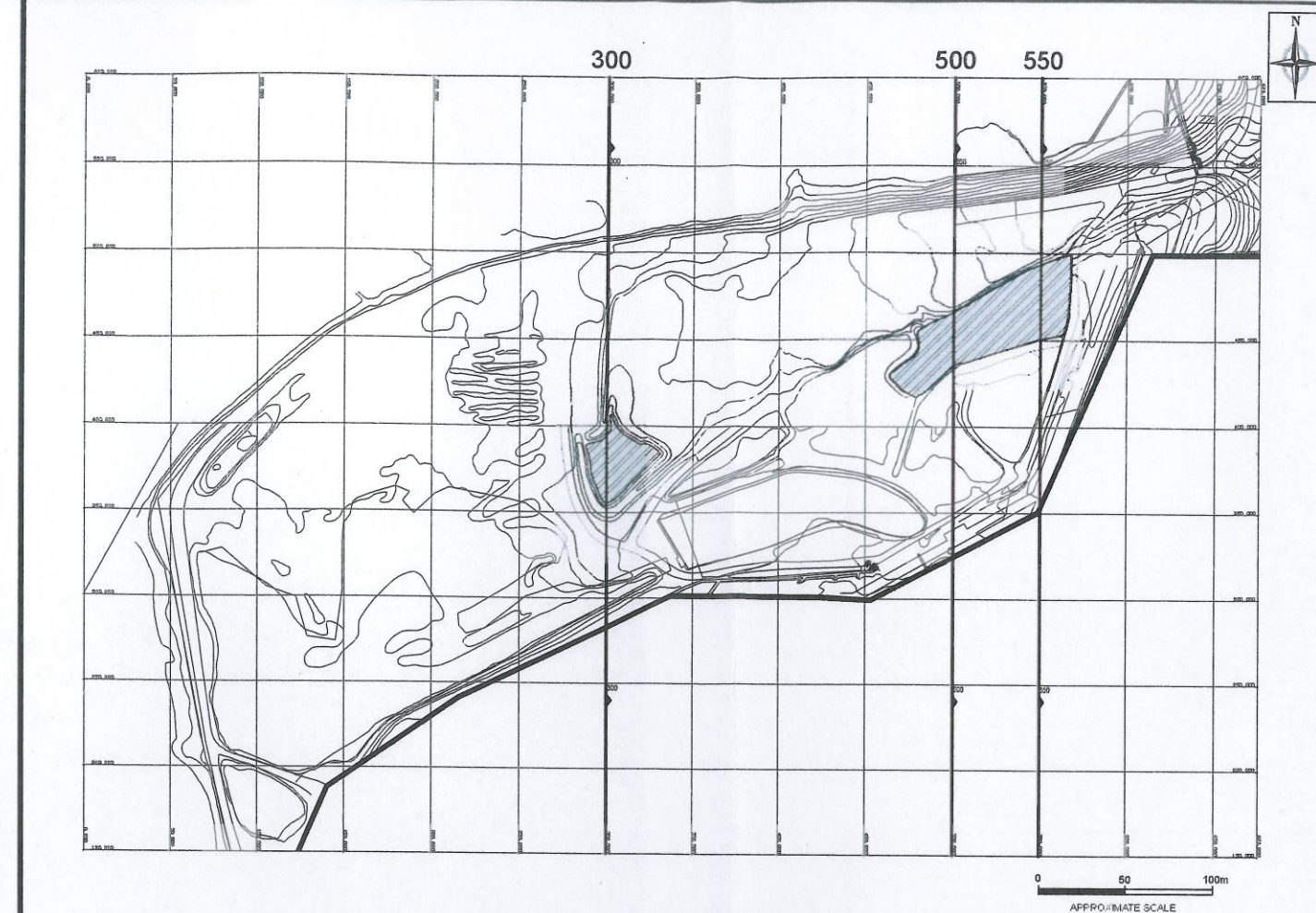
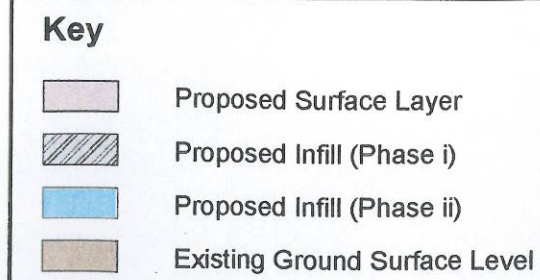
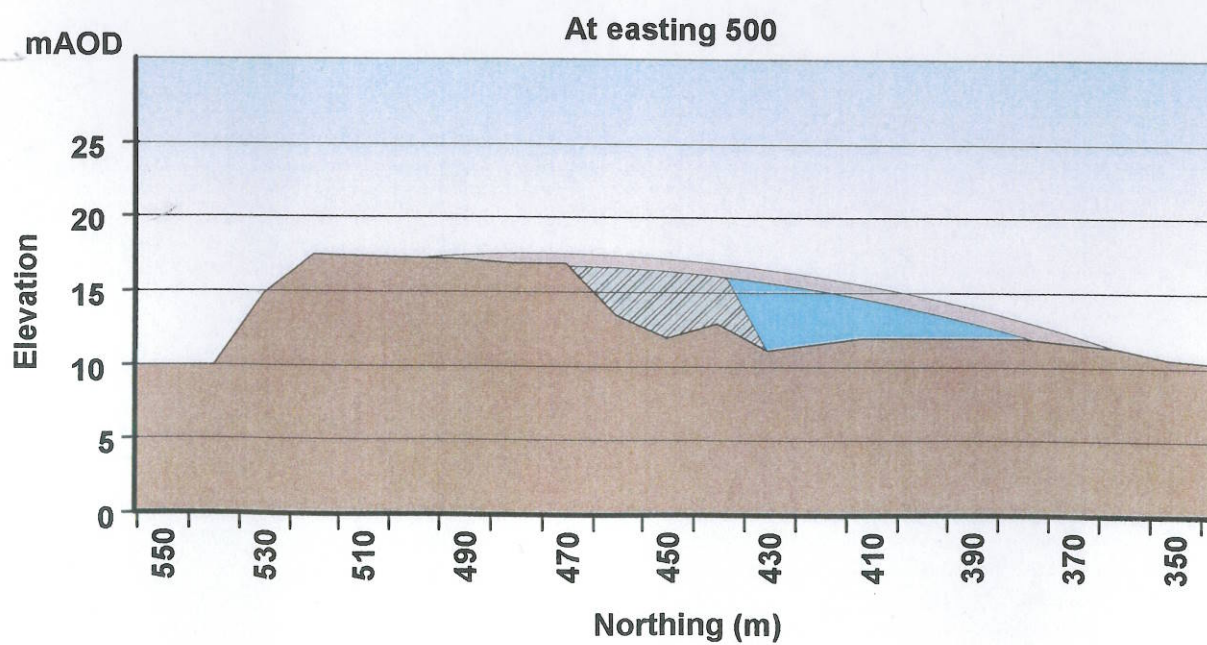
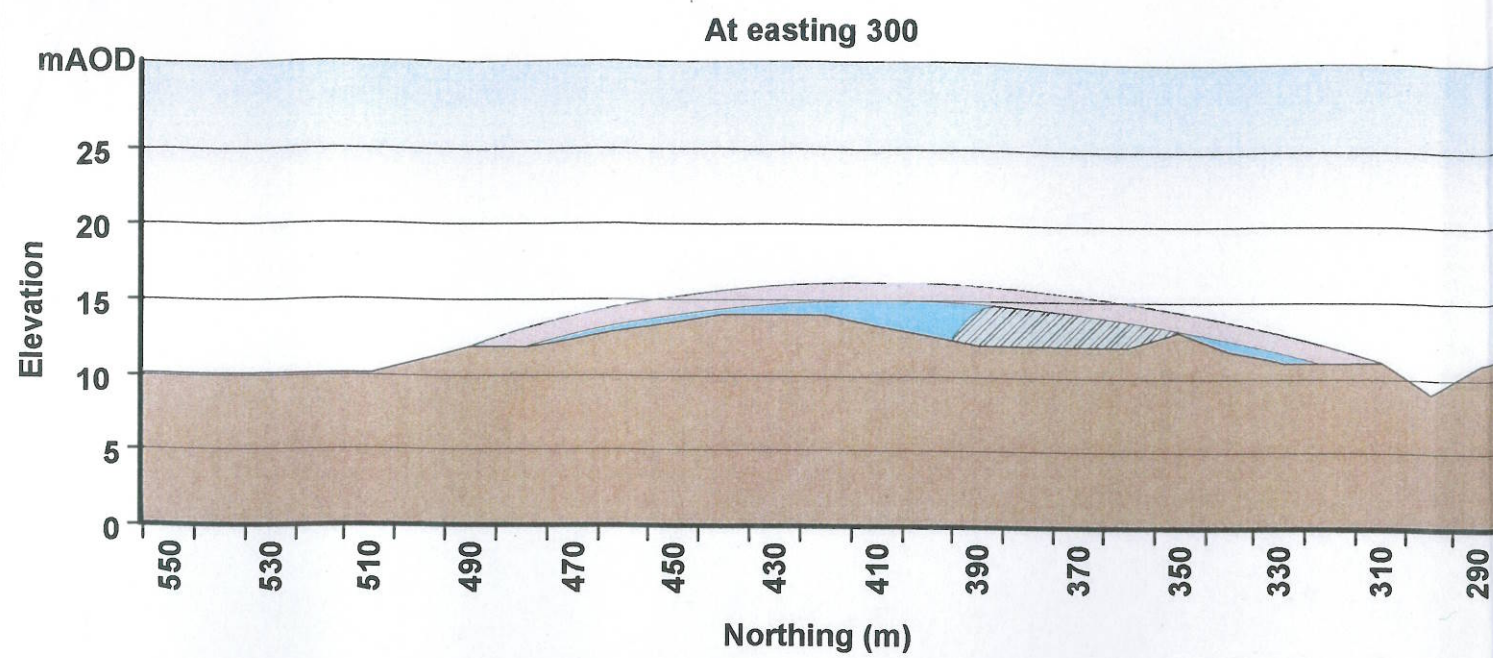
Contaminant	Infill to base of capping ¹		Capping material ²	
	leachate (µg/l)	Soil (mg/kg)	Leachate (µg/l)	Soil (mg/kg)
Metals				
Arsenic	50	N/A	50	64*
Cadmium	5	N/A	5	2.6*
Copper	6	N/A	6	200*
Lead	125	N/A	125	1*
Mercury	1	N/A	1	75*
Nickel	100	N/A	100	3*
Selenium	10	N/A	10	337*
Vanadium	20	N/A	20	640*
Zinc	175	N/A	175	478*
Asbestos	N/A	200	N/A	200*
Organic Compounds				
1,2-Dichloroethane	N/A	0.29	N/A	0.29*
Benzene	N/A	31	N/A	13*
Toluene	N/A	1,128	N/A	1,128*
Ethylbenzene	N/A	8,500	N/A	4,740*
Xylene (total)	N/A	3,067	N/A	3,067*
Total TPH	N/A	8,500	N/A	8,500*

Notes:

¹ Protective of groundwater

² Protective of human health and groundwater

* Previously agreed with Neath Port Talbot Borough Council Environmental Health.



Title	INITIAL PHASE INFILLING PLAN		
Location	BP LLANDARCY TIP		
Client	BP LLANDARCY LTD		
	App'd:	Drawn:	Date:
	MB	LCH	JULY 2007
	Status:	Ref:	
	FINAL	MB/BRIS/LCH/BRIS	
	Scale:	Job No:	
	AS SHOWN	44382540	
	Org. Size:		
	A3		FIGURE 1

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