

Kilnwood Vale – Waste Recovery Environmental Permit: Operating Techniques (EPR/FB3704GH/A001)



Kilnwood Vale – Waste Recovery Environmental Permit: Operating Techniques (EPR/FB3704GH/A001)

Prepared for

Dunton Environmental Ltd
Unit 1, Tamebridge Industrial Estate
Aldridge Road
Perry Barr
West Midlands
B42 2TX

Report reference:
66354R5, February 18

Report status:
Final

CONFIDENTIAL
Prepared by ESI Limited

t. 01743 276 100

e. info@esi-consulting.co.uk | www.esi-consulting.co.uk
@ESI_consulting

ESI Ltd., New Zealand House, 160-162 Abbey Foregate, Shrewsbury, Shropshire SY2 6FD

Shrewsbury
01743 276 100

Reading
01189 572 915

Cardiff
02920 660 144

ESI Limited is registered in England and Wales with Company No. 3212832 at New Zealand House, 160 Abbey Foregate, Shrewsbury, SY2 6FD






Kilnwood Vale – Waste Recovery Environmental Permit: Operating Techniques (EPR/FB3704GH/A001)

This report has been prepared by ESI Ltd. (ESI) in its professional capacity as environmental specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by ESI solely for the internal use of its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to ESI at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, ESI may, by prior written agreement, agree to such release, provided that it is acknowledged that ESI accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. ESI accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against ESI except as expressly agreed with ESI in writing.

	Name	Signature
Author	Kate Brady	
Checked by	Francis Crozier	
Reviewed by	Francis Crozier	

Revision record:

Issue	Date	Status	Comment	Author	Checker	Reviewer
D1	12 February 2018	Draft	Draft for client review	KLB	FKC	FKC
1	21 February 2018	Final		KLB	FKC	FKC

Contents

1	INTRODUCTION	1
1.1	Site Location	1
1.2	Supporting Documents	2
1.3	Planning Status	2
1.4	Proposed Waste Recovery Operation	3
2	GENERAL MAINTENANCE	4
2.1	Site Infrastructure	4
2.2	Plant and Equipment	4
2.3	Site Security	4
2.4	Cameras and Lighting	5
3	STAFFING AND OPERATIONS	6
3.1	Hours of Operation	6
3.2	Roles and Responsibilities	6
4	MANAGEMENT	7
4.1	Relevant Offences	7
4.2	Technical Ability	7
4.3	Environmental Management System	7
4.4	Finance	7
4.5	Information and Record Keeping	7
4.5.1	Site diary	8
4.6	Accidents, Incidents and Non-Conformances	8
4.7	Spills and Leaks	9
4.8	Fire	9
5	WASTE ACCEPTANCE PROCEDURE	10
5.1	Materials Handling	10

TABLES

Table 1.1	Site setting	1
Table 1.2	Supporting documents and figures	2
Table 1.3	Planning permission summary	3

APPENDICES

Appendix A	Technical competence management registration
Appendix B	Summary environmental management system
Appendix C	ISO 14001 accreditation for environmental management system
Appendix D	Waste acceptance procedure
Appendix E	Earthworks specification
Appendix F	Method statements: CKD treatment, Placement and compaction of material

1 Introduction

ESI Ltd (ESI) has been instructed by Dunton Environmental Ltd (Dunton Environmental), the Operator, to act as its Agent in the preparation of a bespoke Environmental Permit application seeking appropriate consent from the Environment Agency (the EA) to allow the treatment of in-situ soil with waste as a waste recovery activity at Phases 2 and 3 of Kilnwood Vale, west of Crawley, West Sussex (the Site). The Kilnwood Vale development extends over a total of 3 Phases (the Development) with Phase 1 already under construction.

The waste to be used will be Cement Kiln Dust (CKD), which will replace the use of lime in moisture conditioning of the in-situ soils, in order to achieve the engineering properties necessary for the Development platform on behalf of the Developer (Crest Strategic Projects).

This Operating Techniques document has been prepared by ESI on behalf of Dunton Environmental to support the Environmental Permit application.

1.1 Site Location

The Site is situated off the A264 (Crawley Road), approximately 2 km west of Crawley, West Sussex. The Development area covers approximately 140 ha. The areas which are the subject of this WRP comprise Phase 2.4 to Phase 2.6 (the Site), covering approximately 32 ha, see Drawing Number 66444D3 Permit Boundary.

Table 1.1 Site setting

Site address	Kilnwood Vale, Crawley, West Sussex	
NGR	TQ 23654 35321	
Area	Approximately 32 ha	
Topography	Site topography gently rises from approximately 78 mAOD in the west and east to 85 mAOD in the centre of the Site. In the southern-most section of the Site, levels rise from approximately 82 mAOD in the west and east rising to 90 mAOD in the centre.	
Surrounding land use	North	The Horsham-Crawley Arun Valley rail link, Future development (Phases 4 and 5 currently agricultural fields), woodland and residential estates.
	South	Kilnwood Vale Phases completed to formation level, A264 Crawley Road, Burns Way industrial estate, woodland.
	West	Phase 1 residential development, Hopper's Brook (flowing south to north), then agricultural fields
	East	Residential estates, Spruce Hill Brook (flowing south to north), recreational playing field, Bewbush School.

1.2 Supporting Documents

As well as the documents included as appendices to this report, the Environmental Permit application is also supported by a number of associated documents and figures required in response to Environmental Permit application forms, Parts A, B2, B4 and F1. All supporting documents and drawings are summarised in Table 1.2.

Table 1.2 Supporting documents and figures

Reference	Title	Description
Documents		
66444R1	Hydrogeological Risk Assessment	Appended to Environmental Risk Assessment. Considers the risks to controlled waters.
66444R2	Waste Recovery Plan	Document, approved by the EA, outlines the proposed deposit of waste for recovery operation
66444R3	Non-Technical Summary	A summary of the proposed activities using non-technical language.
66444R4	Environmental Setting and Site Design (ESSD) Report	Sets out the Site, Site history, proposed development, environmental setting.
66444R5	Environmental Risk Assessment	Considers the source, pathway, receptor linkages associated with the Site.
66444R7	Waste Acceptance procedure	Appended to Operating Techniques report Details the procedure to be followed to accept the CKD to Site.
Figures		
66444D1	Site Location	
66444D2	Sensitive Receptors	
66444D3	Permit boundary	
11950-SK07 SK Rev.06	Cut/fill levels	

1.3 Planning Status

The Development is a major strategic development in the south-east of England including c.2,500 dwellings, schools, transport infrastructure, amenity facilities, and employment development. The Development has been the subject of three separate planning permissions issued by Horsham District Council. Table 1.3 provides a summary of the planning permission history. Copies of the planning consents are presented in Appendices A to C of the Approved WRP (ESI report reference 66444R2).

It should be noted that planning permissions DC/15/2813 is a variation of DC/10/1612 with variations to Conditions 3, 4, 7, 8, 9 and 10 in DC/15/2813.

Table 1.3 Planning permission summary

Reference no.	Date	Comment
DC/10/1612	17 October 2011	Part A: Outline approval for development of approximately 2,500 dwellings, new access from A426, secondary access to A246, neighbourhood centre, pumping station, land for primary school and nursery, land for employment, new rail station, energy centre and amenity space. Part B: Engineering operational associated with landfill remediation and associated infrastructure including pumping station.
DC/13/1437	14 February 2014	Engineering operations associated with landfill remediation and associated infrastructure including pumping station.
DC/15/2813	28 April 2016	Variation of Conditions 3,4,7,8,9,10 of DC/10/1612. This permission supersedes DC/10/1612 Part B and appears to also supersede DC/13/1437

1.4 Proposed Waste Recovery Operation

Dunton Environmental proposes to import, store and use CKD, to reduce the moisture content of the receiving, in-situ soil material, in order to construct the Development platform to pre-approved Formation Levels, as shown on Drawing Number 11950-SK07 SK Rev.S6.

The Formation Layer is to be constructed in strict accordance with the Earthworks Specification (CampbellReith, 2017b), which sets out the engineering parameters and testing, required by the Developer. A copy of the Earthworks Specification is provided as Appendix E.

2 General maintenance

2.1 Site Infrastructure

Infrastructure associated with the Site will include:

- 4 x CKD storage silos (1 x 50 t, 3 x 30 t);
- Office compound(s) (including associated temporary utilities which are already currently operational and parking facilities); and
- Internal access roads (which will form part of the development).

Fuel and oil will be stored on Site for use in Site-based plant only and will be provided with adequate secondary containment.

2.2 Plant and Equipment

Plant and equipment associated with the waste recovery operation will include:

- Excavator (Mixer);
- Dozer (Mixer);
- Dumper;
- CKD mixer/ rotor (one of the following);
 - BomagMPH122;
 - Stehr SFB 24/6;
 - Self-propelled Wirigen WR2500SK;
 - Tractor and spreader;
- Tractor and Water Bowser;
- Jet wash;
- Roadsweeper;
- Compacting roller;
- Fuel Bowser; and
- CAT Scanner.

All Site-based mobile and static plant and equipment will be serviced and maintained in accordance with the manufacturers' recommended maintenance schedules.

Staff will only be permitted to operate machinery and undertake activities for which they have received appropriate training.

Additional information to mitigate against possible plant failures are contained in the ERA submitted with this application (ESI report reference 66444R5).

2.3 Site Security

Access to the Site will be via a gated access from the A264 Horsham Road.

All gates will remain locked when the Site is not operational. All Site boundaries feature existing fencing which will ensure Site security.

Site staff will be briefed that in the event of evidence suggesting unauthorised access or vandalism being found, the matter must be reported to site management who in turn will inform the police, if appropriate. If the incident involved unauthorised tipping or spillage of any waste, the EA will be informed.

Site gates and fencing will be inspected on a daily basis. Any identified damage to the fence or gates which could prejudice the Site security, will be recorded and temporarily repaired as necessary, by the end of the working day. Permanent repair or replacement to gates or fencing will be undertaken as soon as practicable.

2.4 Cameras and Lighting

The Site is within the urban edge of Crawley. The Site will be fully fenced with lockable gates and gates will be kept locked at all times when the Site is not operational. The Site will be manned between the hours of 08:00 to 18:00 from Monday to Friday and between the hours of 08:00 – 13:00 on a Saturday.

Out of hours, the Site will be manned by Crest Strategic Projects Ltd (the Developer). In addition, the Site is subject to 24/7 CCTV surveillance.

3 Staffing and operations

3.1 Hours of Operation

The standard operating hours of the Site will be:

- 0800 – 1800 Monday to Friday; and
- 0800 – 1300 Saturday.

The Site will not undertake operations on Sundays, Public or Bank Holidays unless otherwise agreed with the EA in writing.

3.2 Roles and Responsibilities

Staff will have clearly defined roles and responsibilities. Appropriate training will be undertaken and appropriate written instructions will be given, where necessary. Copies of any such written instructions will be retained and used to investigate any incidents. Any Contractors present on Site will be provided with necessary information and training before commencing work.

Details of the Technical Competent Management (TCM) for the Site is provided in Section 4.2.

4 Management

This section has been prepared in response to Question 3 of Environmental Permit application form Part B2 (Version 10, January 2017) and accompanying Guidance Notes which ask for a demonstration of the ability of the Operator.

In order to demonstrate Operator competence, information is requested concerning:

- Relevant offences;
- Technical ability;
- Finances; and
- Management systems.

This document provides the information required. Due regard has been paid to EA guidance (EA, 2016a).

4.1 Relevant Offences

It can be confirmed that none of the individuals listed on the application form have been convicted of any relevant offence. Dunton Environmental has not been convicted of any relevant offences.

4.2 Technical Ability

The proposed waste recovery activity will be undertaken by Dunton Environmental, which is a market leader in the design and implementation of ground and water remediation solutions for land restoration.

Dunton Environmental maintain staff who will be managing the waste recovery operation and are deemed to be technically competent for the management of waste under the WAMITAB Operator Competence Scheme. Copies of up-to-date technical competence certificates for relevant staff are provided in Appendix A.

Continued professional development is undertaken as part of Dunton Environmental's Environmental Management System (EMS). It is considered that the Operator has an effective management system in place that ensures a high level of environmental protection.

4.3 Environmental Management System

Dunton Environmental operates an EMS which meets the requirements of ISO 14001. An EMS summary is provided in Appendix B and the current ISO certification is provided in Appendix C.

4.4 Finance

Neither Dunton Environmental nor the relevant persons have been subject to insolvency or bankruptcy.

4.5 Information and Record Keeping

A notice board will be displayed near the Site entrance. Displayed information will include:

- the company name;
- emergency contact details;
- the site Environmental Permit number; and
- the EA's contact details.

Dunton Environmental's EMS includes procedures and check sheets for the recording of accidents and incidents, maintenance of the site and any plant and equipment, as well as staff training, technical competence and health and safety.

In accordance with EA guidance (2016a), records of the Site's operating hours and when the TCM arrives and leaves, will be maintained. This is to demonstrate compliance with the minimum attendance for the Site.

Records relating to waste pre-acceptance and acceptance will be kept for a minimum of six years. Records relating to waste characterisation and any compliance sampling and testing or on-site verification will be maintained at the Site's head office.

A copy of the Site's Environmental Permit will be maintained in a convenient location on Site, allowing suitable access for all persons working on, or visiting the Site.

4.5.1 Site diary

A Site Diary will be kept in the site office and updated on a daily basis. This diary will be used to record all incidents on Site. This will provide an ongoing record and allow for investigative and corrective action to take place in line with the requirements of the EMS.

The Site Diary will include the following:

- The name of the TCM holder and dates and times of attendance and departure;
- Details of all visitors, including status, dates and times of attendance and departure;
- Details of maintenance, modification, repair, replacement, delivery and return, and breakdown of any plant and machinery in line with the principles of planned preventative maintenance;
- Weather conditions;
- Non-conforming wastes and actions taken; and
- Damage to vehicles, fences, gates, etc. and incidents of trespass.

In addition to this, a daily environmental monitoring checklist will be completed.

4.6 Accidents, Incidents and Non-Conformances

Accidents and incidents related to the waste recovery operation have been considered in the ERA for the Site (ESI report reference 66444R5).

All necessary measures will be taken to prevent accidents, which may have environmental consequences, and to have procedures in place to limit those consequences should they occur. To achieve this it will be necessary to:

- Identify hazards;
- Identify the likelihood of occurrence;
- Identify the consequence of occurrence; and
- Identify appropriate mitigation measures.

The risk of accidents will be minimised by appropriate staff training together with staff awareness of the safety and environmental risks.

All operatives involved in the waste recovery operation shall wear appropriate PPE, such as hard hats, high visibility jackets, safety spectacles, ear defenders (where applicable) and gloves at all times. Dust masks shall be available at all times at the Site.

Incidents and non-conformances may include:

- The rejection of waste;
- Complaints made relating to odour, noise, air quality; and
- The breach of conditions of the Environmental Permit.

All non-conformances will be recorded on a Non-Compliance Report (NCR).

The NCR will describe the non-conformance and action taken. All non-conformances will be discussed at Senior Management meetings in order to prevent a recurrence.

If a complaint is received, the incident will be investigated as soon as practicable. The appropriate corrective action will be taken, the incident recorded and any recommendations for improvements to procedures made. The complainant will be kept informed of the progress.

4.7 Spills and Leaks

Good operational and management practices will ensure spills and leaks are unlikely to occur. Should one occur, the procedures in the EMS will be followed.

4.8 Fire

The Site will not accept any combustible waste. Site security measure will ensure that risk of fire due to vandalism remains low.

In the unlikely event that a fire occurs, emergency services will be contacted immediately. The area will be evacuated immediately. The fire may be fought with appropriate extinguisher if it is safe to do so. The EA will be notified as soon as practicable.

5 Waste acceptance procedure

A waste acceptance procedure (WAP) is presented in Appendix D and relates to the acceptance criteria which will be applied to the acceptance of CKD.

It has been prepared in accordance with EA guidance (2016b) and will form part of Dunton Environmental's EMS.

In the absence of detailed guidance on waste acceptance for recovery operations, EA guidance (2010) and (2013) have also been referenced.

5.1 Materials Handling

All soil handling will follow prevailing Environment Agency guidance as well as relevant industry guidance, including but not limited to MAFF (Ministry of Agriculture Food and Fishery) (2000) and DEFRA (Department for Environment, Fisheries and Rural Affairs) (2009).

Procedures for the treatment of in-situ soils with CKD and placement and compaction of the resulting material are provided in Appendix F.

REFERENCES

- EA, (2010).** Waste acceptance at landfills – guidance on waste acceptance procedures and criteria. Environment Agency, V1, November 2010.
- EA, (2013).** Guidance for the recovery and disposal of hazardous and non-hazardous waste, Sector guidance note, Environment Agency, v5, May 2013.
- EA, (2014).** Regulatory Guidance Series, No RGN 5: Operator Competence. Version 4.0, Environment Agency, March 2014.
- EA, (2016a).** Legal operator and competence requirements: environmental permits, [online] available at: <https://www.gov.uk/guidance/legal-operator-and-competence-requirements-environmental-permits> , accessed 01 February 2018.
- EA, (2016b).** Waste acceptance procedures for waste recovery on land [online], available at: <https://www.gov.uk/guidance/waste-acceptance-procedures-for-waste-recovery-on-land>, 18 October 2016, accessed 01 February 2018.
- Defra, (2009).** Construction code of practice for the sustainable use of soils on construction sites. September 2009.
- MAFF, (2000).** Good practice guide for handling soils. April 2000.

APPENDICES

Appendix A

Technical competence management registration



REF: FORMC5/AUG16/QSP/SF/EQ

18th November 2016

Adrian Jefimiuk
10 Abney Close
Bilston
WV14 0AN

Dear Adrian

WAMITAB Award Registration MROC1

Thank you for registering with QSP Training for your WAMITAB award as listed above. You will receive notification of your WAMITAB registration number directly from the Awarding Body in due course. Keep this information safe as you will need to include the letter in your portfolio.

Your assessor is **Nigel Brown**; he will contact you to arrange an assessment visit to get you started on your award. Your internal verifier is **Steve Pearce**; he will check over your work on completion. Your assessor is currently on Holiday until the end of November, but he will contact you on his return.

Your portfolios are being prepared and will be despatched shortly and will be delivered to you by our courier service.

After each visit with your Assessor you will be asked to sign a time sheet for their time with you along with their travel element which will be charged to you / your company where appropriate.

If you have any queries please contact me on the number above.

Yours sincerely

Emma Quince
Statutory Administrator

Appendix B

Summary environmental management system

Appendix C

ISO 14001 accreditation for environmental management system

Registration Certificate

*This document certifies that the
Environmental Management Systems of*

DUNTON ENVIRONMENTAL LIMITED

*Have been assessed and approved by
CQS (Certified Quality Systems) Limited
to the following Environmental Management
Systems, standards and guidelines*

BS EN ISO 14001:2004

*The scope of this certification applies to the approved
Environmental Management Systems relating to the following activities*

**THE DESIGN AND IMPLEMENTATION OF
GROUND AND WATER REMEDIATION SOLUTIONS
FOR LAND RESTORATION**



Certificate Issued: 23rd March 2015

Certificate No: EM2000829

Expiry Date: 22nd March 2018

*Should verification of the validity of this certificate
be required please contact:*

*CQS (Certified Quality Systems) Ltd
United Kingdom Head Office: +44(0)1684 571350
email: verification@cqsltd.com*



A handwritten signature in black ink, appearing to be 'A. Brown', is written over a horizontal line.

On behalf of CQS (Certified Quality Systems) Limited

EAC 35

SIC 39000

Appendix D

Waste acceptance procedure

1 Waste acceptance procedure

This waste acceptance procedure (WAP) outlines the acceptance criteria to be applied to the incoming Cement Kiln Dust (CKD) to be accepted to Kilnwood Vale, west of Crawley, West Sussex (the Site).

This WAP has been prepared in accordance with EA guidance (2016)¹, and will form part of Dunton Environmental's Environmental Management System (EMS). As the imported waste will ultimately be used in a deposit for recovery operation and in the absence of detailed guidance on waste acceptance for waste recovery operations, EA guidance (2010)² and (2013)³ have also been referenced.

CKD will be used to treat in-situ soils to achieve the target moisture content to allow construction of the required development platform. The resulting mix of CKD and in-situ soils will comprise a deposit of waste for recovery operation.

1.1 Waste types

The waste to be accepted for the waste treatment operation is presented in Table 1.1 and will comprise CKD only.

Table 1.1 Waste codes for waste treatment operation

EWC	Description
10	Wastes from thermal processes
10 13	wastes from manufacture of cement, lime and plaster and articles and products made from them
10 13 06	particulates and dust (except 10 13 12 and 10 13 13)
10 13 13	solid wastes from gas treatment other than those mentioned in 10 13 12

The waste for the waste recovery operation (**Error! Not a valid bookmark self-reference.**) will comprise the mixing of in-situ soils and the imported CKD. As such, the waste will be created on-site, and acceptance criteria does not apply.

Table 1.2 Waste codes for waste recovery operation

EWC	Description
19	Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use
19 02	Wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)
19 02 03	premixed wastes composed only of non-hazardous wastes

¹ EA, (2016). Control and monitor emissions for your environmental permit, www.gov.uk, 1 February 2016

² EA, (2010). Waste acceptance at landfills – guidance on waste acceptance procedures and criteria. Environment Agency, V1, November 2010.

³ EA, (2013). Guidance for the recovery and disposal of hazardous and non-hazardous waste, Sector guidance note, Environment Agency, v5, May 2013.

1.2 Pre-acceptance Procedure

In order to prevent the acceptance of unsuitable wastes, which may lead to adverse reactions or uncontrolled emissions, systems and procedures must be in place to ensure that wastes are subject to appropriate technical appraisal. This ensures their suitability for the proposed waste treatment and storage operation. These checks must be carried out before any decision is made to accept a waste.

The Operator will obtain the following information:

- the producer of the waste, including the variability of this process;
- the composition of the waste (chemicals present and individual concentrations) and;
- the classification of the waste (hazardous or non-hazardous)*.

**NOTE: It is determined that the source of CKD will be single source from CEMEX UK Materials Ltd. (CEMEX). This source has been determined to be non-hazardous due to it being classed as non-corrosive to skin (by In-vitro EPIDERM™ Skin Corrosion test, ENVIGO, Oct 2017).*

Following a change in the process producing CKD at CEMEX or for additional sources of CKD, the waste stream will be subject to a separate in-vitro test.

The Operator will ensure that:

- a representative sample(s) of the waste should be taken from the production process and analysed; and
- for each new waste enquiry, a comprehensive characterisation of the waste and identification of a suitable treatment method is undertaken.

1.3 Acceptance Procedure

The WAP is followed to ensure that the waste imported to the Site conforms to the information provided at the pre-acceptance stage.

Waste arriving to Site will be pre-booked (minimum 24 hrs notice) so that the waste is compliant with the conditions of the Permit.

Waste will only be delivered to the Site by accepted licensed waste carriers.

The documentation is checked on arrival and if it is incorrect or the waste does not match the written description then the waste will be rejected.

The Operator will ensure that waste delivered to the Site is accompanied by a written description of the waste, describing:

- physical and chemical composition;
- characteristics and handling precautions;
- compatibility issues; and
- information specifying/confirming the original waste producer and process.

1.3.1 Basic characterisation

The waste producer will be asked to provide a basic characterisation of the waste by means of a Waste Information Form (WIF), which will include the following information:

- the process producing the waste;
- the quantity of the waste;

- chemical analysis of the waste;
- the form the waste takes (i.e. loose powder);
- any hazards associated with the waste;
- any specific handling/storage requirements; and
- an EWC (European Waste Catalogue) code.

The WIF will be reviewed by qualified members of staff to ensure that the waste is suitable for the proposed waste operation and compliant with the conditions of the permit.

1.3.1.1 Regularly generated wastes

Regularly generated wastes are individual and consistent wastes regularly generated in the same process, where the process is well known, and the inputs are well defined. They can be from different sources if they are a single stream with common characteristics within known boundaries.

The basic characterisation for these wastes should focus on:

- Compositional range of the wastes;
- Range and variability of characteristic properties;
- If required, leachability of the wastes; and
- Key variables to be tested on a regular basis.

When the waste has been fully characterised it only needs to be subject to compliance testing if there are significant changes in the generation process. The waste producer shall inform the Operator of any changes to the process.

For regularly generated waste sources, a WIF form may be completed at the beginning of the project and used throughout.

1.3.2 Compliance testing

For regularly generated wastes, periodic compliance testing will be carried out to confirm consistency to the Basic Characterisation (i.e. non-hazardous nature).

Imported waste will be sampled at a rate of one sample per 1000 m³. Any job with a volume of less than 1000 m³ will be sampled. Results will be reviewed to ensure it is non-hazardous. Corrosivity testing will not be re-tested per source unless there has been a change in the process.

1.3.3 On-Site verification

1.3.3.1 Documentation check

If the waste is the same as that which has been shown to be acceptable by basic characterisation and compliance testing and is the waste described in the accompanying documents, it may be accepted to the Site.

If this is not the case, the waste will be rejected.

1.3.3.2 Visual inspection

Wastes will not be visually inspected on Site as delivery vehicles do not allow. Instead, the operator will satisfy themselves that they are receiving the correct CKD from the pre-approved waste producer.

Waste will be delivered in sealed tankers, suitable for the delivery of loose-powdered wastes. Delivery of the waste will be by pneumatic transfer (hose) to the Site's receiving sealed silos.

A sample of the waste may be taken for verification testing of the waste.

The following details will be recorded by the member of staff receiving the waste:

- the date and time of delivery of the load;
- the origin of the waste;
- the quantity and characteristics of the waste;
- the producer; and
- details and description of the vehicle delivering the waste (including waste carrier's licence), the driver's signature and the operator of the vehicle.

1.3.4 Unauthorised waste

No unauthorised waste will be accepted at the Site.

Wastes having any of the following characteristics shall not be accepted:

- Hazardous wastes; and
- Wastes in liquid form.

A note will be made in the site diary of any incidents involving unauthorised waste, and a record of any rejected waste, maintained.

In the event that unpermitted wastes are inadvertently delivered to the Site, the unauthorised waste will be transferred back into the vehicle that discharged it, if possible, and safe to do so. If it is not possible, then the unpermitted waste will remain in the secure, sealed silo until removal from Site is possible, as soon as possible within 48 hours.

Appendix E

Earthworks specification

Kilnwood Vale Phase 2.4 – 2.6

Earthworks Specification

For

Crest Strategic Projects

Project Number: 11950

June 2017

Campbell Reith Hill LLP
Friars Bridge Court
41-45 Blackfriars Road
London
SE1 8NZ

T:+44 (0)20 7340 1700

F:+44 (0)20 7340 1777

E:london@campbellreith.com

W:www.campbellreith.com

Kilnwood Vale Phase 2.4-2.6

EARTHWORKS SPECIFICATION

Project Specification Revision Record

Date	Revision	Clause Revisions	Prepared By	Checked By
25/05/17	A		AED/SMB	AED

APPENDIX 0/3: LIST OF NUMBERED APPENDICES REFERRED TO IN THE SPECIFICATION AND INCLUDED IN THE CONTRACT

APPENDIX 0/3: LIST OF NUMBERED APPENDICES REFERRED TO IN THE SPECIFICATION AND INCLUDED IN THE CONTRACT

APPENDIX 0/3: LIST OF NUMBERED APPENDICES REFERRED TO IN THE SPECIFICATION AND INCLUDED IN THE CONTRACT

SERIES 600: EARTHWORKS SPECIFICATION REVISION

The Specification shall be the 'Manual Contract Documents For Highway Works Specification of Highway Works', February 2017 (SHW), produced by the Highways Agency, as amended and added to by the Appendices contained within this document.

Appendix No.	Title.
0/3	List of numbered appendices referred to in this specification and included in the Contract
0/4	List of drawings included in the Contract
	PRELIMINARIES
1/5	Earthworks Testing
	EARTHWORKS
6/1	Requirements for Acceptability & Testing of Earthworks Materials
6/2	Requirements for Dealing with Class U1B and U2 Unacceptable Materials
6/3	Requirements for Excavation, Deposition, Compaction (Other than Dynamic Compaction)
6/8	Topsoil
6/12	Instrumentation and Monitoring
6/13	Ground Improvement
6/14	Limiting Values for Harm to Human Health and Environment

APPENDIX 0/4: LIST OF DRAWINGS INCLUDED IN THE CONTRACT

APPENDIX 0/4: LIST OF DRAWINGS INCLUDED IN THE CONTRACT

A list of Drawings is included below:

PHASE 2.4

Contractor to refer to current issue sheet as drawings likely to be updated iteratively.

Drawing No.	Drawing Title
11950-CE420	PHASE 2.4B: EARTHWORKS FINISHED LEVELS AND CONTOURS
11950-2.4A-CE420	PHASE 2.4A: EARTHWORKS FINISHED LEVELS AND CONTOURS
11950-2.4C-CE420	PHASE 2.4C: EARTHWORKS FINISHED LEVELS AND CONTOURS
11950-2.4D-CE420	PHASE 2.4D: EARTHWORKS FINISHED LEVELS AND CONTOURS
11950-2.4E/F/G/H-CE420	PHASE 2.4E/F/G/H: EARTHWORKS FINISHED LEVELS AND CONTOURS
11950-CE421	PHASE 2.4B: EARTHWORKS EXCAVATION FORMATION LEVELS
11950-2.4E/F/G/H-CE421	PHASE 2.4E/F/G/H: EARTHWORKS EXCAVATION FORMATION LEVELS
11950-2.4E/F/G/H-CE422	PHASE 2.4E/F/G/H: EARTHWORKS TOP OF SURCHARGE LEVELS
11950-2.4A-CE423	PHASE 2.4A: EARTHWORKS INSTRUMENTATION AND MONITORING
11950-2.4B-CE423	PHASE 2.4B: EARTHWORKS INSTRUMENTATION AND MONITORING
11950-2.4C-CE423	PHASE 2.4C: EARTHWORKS INSTRUMENTATION AND MONITORING
11950-2.4D-CE423	PHASE 2.4D: EARTHWORKS INSTRUMENTATION AND MONITORING
11950-2.4E/F/G/H-CE423	PHASE 2.4E/F/G/H: EARTHWORKS INSTRUMENTATION AND MONITORING
11950-CE424	PHASE 2.4-2.6 INDICATIVE SURCHARGE DESIGN
11950-SK107	PHASE 2 AND 3 PARCEL DELIVERY PROGRAMME
11950-SK53	FILL IN AREAS OF STEEPENED MADE GROUND BATTER
11950-SK135	PHASE 2.4B EARTHWORKS SECTION A
11950-SK151	ENGINEERED FILL TIE IN DETAIL
11950-CE202	BEWBUSH BROOK DIVERSION PROPOSED LAYOUT AND EXISTING GROUND
11950-CE203	BEWBUSH BROOK DIVERSION PROPOSED/EXISTING GROUND
11950-SK147	BEWBUSH BROOK DIVERSION OPTION 1 1:2.8 BANKS WITH RETAINING WALLS

PHASE 2.5

To be confirmed

PHASE 2.6

To be confirmed

APPENDIX 1/5: EARTHWORKS TESTING

TABLE 1/5A: FOR USE WHEN SOILS ARE PROCESSED AT THE POINT OF FINAL PLACEMENT

CLAUSE	WORK, GOODS OR MATERIAL		TEST	SOURCE APPROVAL	ROUTINE FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600 Earthworks							
601, 631 to 637, 640	Acceptable Limits						
	Class	General Description					
	1	General Granular Fill	Grading (U) and UC	Included with Routine Testing	1 per 1000m ³ ⁽ⁱ⁾	Required for all tests	Refer to Table 6/1 of Appendix 6/1 for method of determining the OMC and MDD.
			MC (U)	Included with Routine Testing	1 per 250m ³ ⁽ⁱ⁾		
			OMC/MDD (U) and Particle Density (U)	Included with Routine Testing	At each insitu density test ⁽ⁱⁱ⁾		
			pH (U), Total SO ₄ (U), W/S SO ₄ (U), and Total S (U)	Included with Routine Testing	1 per 3000m ³		
			Forensic TOC tests in accordance with CLAIRE RB17	Included with Routine Testing	1 per 500m ³		
			Drum Test	Included with Routine Testing	1 per 2500m ³		
			Chemical Analysis (U)	Included with Routine Testing	1 per 2500m ³		
	2	General Cohesive Fill	Grading (U)	Included with Routine Testing	1 per 500m ³ ⁽ⁱ⁾	Refer to Appendix 6/12 for method of Drum Tests.	
			Sedimentation Analysis by Pipette (U)	Included with Routine Testing	1 per 5 Gradings		
			PL/LL (U)	Included with Routine Testing	1 per 1000m ³ ⁽ⁱ⁾		
			MC(U) or MCV(U)	Included with Routine Testing	1 per 250m ³ ⁽ⁱ⁾		
					Refer to Notes beneath this Table for additional clarifications including those for F.TOC tests.		

CLAUSE	WORK, GOODS OR MATERIAL	TEST	SOURCE APPROVAL	ROUTINE FREQUENCY	TEST CERTIFICATE	COMMENTS	
Series 600 Earthworks							
601, 631 to 637, 640	Acceptable Limits						
	Class	General Description					
			Undrained Shear Strength using HSV	Included with Routine Testing	As required in relation to 'Compaction of Fills' below.	Required for all tests	
			OMC/MDD (U) and Particle Density (U)	Included with Routine Testing	At each insitu density test ⁽ⁱⁱ⁾		
			pH (U), Total SO ₄ (U), W/S SO ₄ (U), and Total S (U)	Included with Routine Testing	1 per 3000m ³		
			Drum Test	Included with Routine Testing	1 per 2500m ³		
			Chemical Analysis (U)	Included with Routine Testing	1 per 2500m ³		
			Forensic TOC tests in accordance with CLAIRE RB17	Included with Routine Testing	1 per 500m ³		
			Permeability (U)	As per compaction Trial	N/A		

CLAUSE	WORK, GOODS OR MATERIAL		TEST	SOURCE APPROVAL	ROUTINE FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600 Earthworks							
601, 631 to 637, 640	Acceptable Limits						
	Class	General Description					
612	Compaction of Fills					Required for all tests.	More tests may be required pending monitored performance.
			Field Dry Density (including air voids) (U) HSV(U)		1 per 35m x 35m grid per layer on placed and compacted materials. 1 per 70x70m grid per layer on placed and compacted materials.		
			Infiltration Rate via Soakaway Test		Upon completion of filling. 1 per 100x100m, with a minimum of 3 No per individual phase.		
			Insitu CBR using plunger (U)		1 per 35m x 35m grid per layer on placed and compacted materials. Top two layers only.		
			Insitu CBR using Plate Load Test(U)		1 per 70m x 70m on final layer.		

Test Frequency Notes:

- (i) Or, per layer, or per day of earthworks (whichever gives the highest number of results). This may be modified by the Engineer where only small volumes of fill are placed and treated, for example where <math> < 300\text{m}^3 </math>.
- (ii) The need for such testing is to be reviewed based on the Engineer's judgement of the Contractor's processing operation, visual assessment of how homogenous the processed material has become and on laboratory test results. The Engineer shall review how much consistency is being achieved in the processed material from the laboratory compaction tests, particle density and moisture content results and potentially reduce the need for the laboratory testing based on findings.

TABLE 1/5B: FOR USE WITH PROCESSED STOCKPILED SOILS THAT HAVE BEEN SEGREGATED BY SHW MATERIAL CLASS, OR NATURAL SOILS WHICH DO NOT REQUIRE FURTHER PROCESSING AT THE POINT OF FINAL PLACEMENT.

CLAUSE	WORK, GOODS OR MATERIAL	TEST	SOURCE APPROVAL	ROUTINE FREQUENCY	TEST CERTIFICATE	COMMENTS	
Series 600 Earthworks							
601, 631 to 637, 640	Acceptable Limits						
	Class	General Description					
	1	General Granular Fill	Grading (U) and UC	3 per source	1 per 1000m ³	Required for all tests	Refer to Table 6/1 of Appendix 6/1 for method of determining the OMC and MDD. Refer to Appendix 6/12 for method of Drum Tests. Refer to Notes beneath this Table for additional clarifications including those relating to F.TOC.
			MC (U)	3 per source	1 per 250m ³		
			OMC/MDD (U) and Particle Density (U)	3 per source	1 per 2000m ³		
			pH (U), Total SO ₄ (U), W/S SO ₄ (U), and Total S (U)	3 per source	1 per 3000m ³		
			Forensic TOC tests in accordance with CLAIRE RB17	3 per source (on same materials used in drum tests)	1 per 500m ³		
			Drum Test	3 per source	1 per 2500m ³		
			Chemical Analysis (U)	3 per source	1 per 2500m ³		
	2	General Cohesive Fill	Grading (U)	3 per source	1 per 500m ³		
			Sedimentation Analysis by Pipette (U)	3 per source	1 per 5 Gradings		
			PL/LL (U)	3 per source	1 per 1000m ³		
MC(U) or MCV(U)			3 per source	1 per 250m ³			
Undrained Shear Strength using HSV			3 per source	As required in relation to 'Compaction of			

CLAUSE	WORK, GOODS OR MATERIAL	TEST	SOURCE APPROVAL	ROUTINE FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600 Earthworks						
601, 631 to 637, 640	Acceptable Limits					
	Class	General Description				
					Fills' below.	Required for all tests
			OMC/MDD (U) and Particle Density (U)	3 per source ⁽ⁱⁱⁱ⁾	1 per 2000m ³	
			pH (U), Total SO ₄ (U), W/S SO ₄ (U), and Total S (U)	3 per source	1 per 3000m ³	
			Drum Test	3 per source	1 per 2500m ³	
			Chemical Analysis (U)	3 per source	1 per 2500m ³	
			Forensic TOC tests in accordance with CLAIRE RB17	3 per source	1 per 500m ³	
		Permeability (U)	As per compaction Trial	N/A		

CLAUSE	WORK, GOODS OR MATERIAL		TEST	SOURCE APPROVAL	ROUTINE FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600 Earthworks							
601, 631 to 637, 640	Acceptable Limits						
	Class	General Description					
612	Compaction of Fills					Required for all tests.	More tests may be required pending monitored performance.
			Field Dry Density (including air voids) (U)		1 per 35m x 35m grid per layer on placed and compacted materials.		
			HSV(U)		1 per 70x70m grid per layer on placed and compacted materials.		
			Infiltration Rate via Soakaway Test		Upon completion of filling. 1 per 100x100m, with a minimum of 3 No per individual phase		
			Insitu CBR using plunger (U)		1 per 35m x 35m grid per layer on placed and compacted materials. Top two layers only.		
		Insitu CBR using Plate Load Test(U)		1 per 70m x 70m on final layer			

General Notes:

- 1** These general notes relate to both Tables 1/5A and Table 1/5B unless otherwise indicated.
- 2** With respect to Table 1/5B, the column entitled 'Source Approval' relates to testing of the Contractor's proposed source material, prior to placement and compaction in the works, to provide confidence that it will be acceptable. Where source approval is specified, source testing shall be carried out at each source or stockpile used.
- 3** The columns entitled 'Routine Frequency', relate to testing materials on an on-going basis during placement and compaction in the works.

- 4** The columns entitled 'Clause' in Table 1/5A and Table 1/5B are split into 2 sections: a section dealing with tests required in relation to CI 601, 631 to 637, 640 of the Specification for Highways Works and a section dealing with testing required in relation to CI 612 of the Specification Highway Works. The testing in relation to CI 601, 631, 637 and 640 is to ensure that materials are physically and chemically acceptable, and they are applicable to all soils to be used in the works. Testing in relation to CI 612 deals with testing required to ensure that End Product requirements are met. Soils for which the compaction requirement is End Product are detailed in Appendix 6/1.
- 5** Where End Product is required, a compaction trial as detailed in Appendix 6/3 CI 13.3 is to be undertaken to demonstrate that the End Products are achievable for each source of material and to give confidence that the contractor's compaction method is appropriate. The compaction trial is to be completed in accordance with App 6/3 and be witnessed by the Engineer.
- 6** Should the nature of any given test result be sufficiently unusual as to call the reliability of that test result in to doubt this to be brought the attention of the Engineer within 48hrs of its receipt by the contractor. The sample is to be examined by the testing laboratory and an engineering description provided, a test restriction issued or other formal correspondence issued by the testing laboratory and additional testing undertaken so as to confirm the behaviour of the material.
- 7** All tests are to be undertaken by a reputable independent UKAS accredited testing laboratory. So as to be consistent with the current version of the 600 series of the SHW (February 2016) all geotechnical tests are undertaken in accordance with BS1377 unless otherwise stated. It should be noted however, that parts of BS1377 have been or are in the process of being superseded by BS EN ISO 17892. As when the SHW is up dated to reflect such changes to the testing standards the Engineer is to be contacted to confirm instructions.
- 8** (U) indicates that a UKAS test report or certificate is required.
- 9** Frequency of testing applies to each separate earthworks source within each of the earthworks material classes. The testing shall be distributed evenly throughout the materials placed.
- 10** In relation to all materials placed to form the permanent works, the co-ordinates of all sample and insitu test locations are to be surveyed and recorded based on the established grid to an accuracy of 1m in plan. A unique layer number is to be recorded for all such samples/tests such that this can be correlated to survey data for each layer. Each layer of placed material is to be surveyed using topographical surveying techniques to an vertical accuracy not worse than 25mm.
- 11** Definitions of abbreviations:

 - § UC: Uniformity Coefficient
 - § MC: natural moisture content;
 - § OMC: Optimum Moisture Content;
 - § MDD: Maximum Dry Density;
 - § PL: Plastic Limit;
 - § LL: Liquid Limit;
 - § MCV: Moisture Condition Value;
 - § HSV: Hand Shear Vane;
 - § CBR: California Bearing Ratio
 - § W/S SO₄: Water Soluble Sulphate;
 - § Total SO₄: Total Sulphate;

- § Total S: Total Sulphur;
- § Forensic TOC: Forensic Total Organic Carbon

- 12** Control of moisture is to be either via the use of Moisture Content determinations or by the use of
- 12** Moisture Condition Vale (MCV) apparatus. Such sampling/testing is to be undertaken just prior to compaction. Should results be outside the required range (refer to Appendix 6/1 for details) the material is to be further conditioned and retested until they are within this range just prior to compaction just prior to compaction. Moisture Condition Vale (MCV) apparatus is to calibrated against MC and undrained shear strength (Cu) at a rate of 1 set of calibrations per day of compaction.
- 13** The method of compaction test is given in Appendix 6/1 for each material type.
- 14** Particle densities shall be determined using a pycnometer or a gas jar, whichever is determined by the independent geotechnical testing laboratory as being most appropriate to the material type.
- 15** Laboratory permeability tests are to be undertaken on remoulded samples, compacted using a compaction apparatus appropriate to the material type as given in Appendix 6/1 and to be compacted to 95% maximum dry density. Testing is to be undertaken using triaxial equipment in accordance with BS1377 Part 6: 6. It is noted that this testing is related to the method trials rather than routine works.
- 16** pH, W/S SO₄, Total SO₄ and Total S tests are to be undertaken in accordance with methods prescribed in TRL Report 447.
- 17** The Contractor may propose the use of a additives to treat soil to so as ensure that the engineering characteristics of the soils used will meet with the requirements of Appendix 6/1. Treatment includes moisture conditioning, modification and stabilisation. Where treated soils are used this must be reflected in the laboratory tests undertaken. For example the samples taken to facilitate the testing must relate to materials in their treated state or mixed in the lab with same additives, to the same proportion and with same degree of mixing. If modification or stabilisation are proposed trials and suchlike are required to understand the treatment process they shall be fully agreed in advance with the Engineer. Proposals are to be submitted two weeks in advance of any such trial and the trial and associated reporting completed two week prior to use in main works.
- 18** Where treatment using lime or cement kiln dust is utilised additional allowance is required for the implementation of heave testing at the instruction of the Engineer. Heave testing to be in accordance with the procedures indicated in HA70/07 'Treatment of Fill and Capping Materials using either Lime or Cement or Both'.
- 19** For chemical analysis requirements refer to Appendix 6/14.
- 20** The chemical analysis suite will be dictated by the proposed depth of the soils tested: for the upper 2.00m of from Finished Earthworks Level the suite will comprise those determinants listed in the Upper 2.00m Engineered Fill column of Table 6/14 (11/04), Appendix 6/14. For fill placed greater than 2.00m below Finished Earthworks Level the suite will be restricted to asbestos quantification, as defined in Table 6/14 (11/04) but with 1 sample in every ten also analysed for the full suite (as listed the Upper 2.00m Engineered Fill column of Table 6/14 (11/04).
- 21** Forensic TOC analysis is to be undertaken on site won materials after they have been processed and in accordance with Cl:aire Research Bulletin 17 (November 2012), Appendix C, whereby all constituents of the Made Ground are assessed and proportioned together with a TOC percentage for the fine soil fraction. It is noted that due to the nature of the test, each sample must weigh a minimum of 10kg and the exact weight shall be confirmed by the laboratory. The selected laboratory must be agreed 2 weeks in advance of any testing with the Engineer.
- 22** Drum Tests are a bespoke form of analysis which are intended to simulate soil conditions to inform the potential for ground gas production. They are also to be undertaken on site won materials after processing and are to be used to further assess and finesse the requirement for gas protection measures. Full details are provided in Appendix 6/12.

- 23** Where HSV testing is to be undertaken to determine undrained shear strength, such tests are to be undertaken in accordance with the manufacturers user manual. The HSV is to be calibrated against the unconsolidated undrained shear strength laboratory triaxial test to BS 1377:Part 7, clause 8 on 100mm nominal diameter samples. Otherwise, shear strength testing requirements are to be as set out in Clause 633 of the Specification for Highway Works.
- 24** Field Dry Density determinations are to be either via Sand Replacement Density tests or Nuclear Density Gauges. The test must be taken to sufficient depth to ensure that the layer tested is fully penetrated. For End Product compaction testing, nuclear surface density gauges shall be permitted so long as the calibrations are deemed by the Engineer to be acceptable. Each instrument in use on the Contract shall be calibrated in accordance with BS 1377: Part 9, as augmented by HA70/94. With respect of both bulk density and moisture density, this is to include the manufacturer's calibrations, initial site calibrations (compliance tests for compacted material), soil calibrations and gauge standardisation procedures. If nuclear density testing used every twentieth determination shall be checked with a sand replacement test (BS1377: PART 9: 1990, Section 2). Nuclear density gauge determinations are not to be undertaken in soils rich in carbonaceous substances or rich in chalk. In such soils Sand Replacement Density tests are to be used.
- 25** With respect to Table 5.1A: Each insitu density test is to be accompanied by a compaction test to determine MDD and OMC and a particle density determination undertaken. Such data, along with the moisture content associated with the insitu density test will be used to determine the dry density, the %compaction and the Air Voids Ratio. All such data is to be presented on the test sheet and in a manner that enables supporting certificates to be traced. The these requirements are to be reviewed based on the Engineer's judgement of the Contractor's processing operation, visual assessment of how homogenous the processed material has become and on initial laboratory test results. The Engineer shall review how much consistency is being achieved in the processed material from the laboratory compaction tests, particle density and moisture content results and potentially reduce the need for the laboratory testing based on findings.
- 26** With respect to Table 5.1B: 2 weeks. 2 weeks prior to placement of the materials, for each stockpile/source , a suitable MDD and PD values are to be proposed by the Contractor based on source approval testing results and available routine testing results. The agreed values, along with the bulk density and moisture content associated with the insitu density tests, will be used to determine the dry density, the %compaction and the Air Voids Ratio. All such data is to be presented on the test sheet and in a manner that enables supporting data to be traced. The agreed MDD and PD values will be routinely reviewed against on any additional routine testing as the works progress and revised values agreed with the Engineer as required.
- 27** CBR tests by plunger and by plate load tests are to demonstrate a minimum CBR value of 3% at the as constructed soil moisture content. Plate load tests (min 300mm dia. plate) are to be carried out in accordance with Chapter 7 of IAN 73/06.
- 28** Infiltration rates are to be determined using soakaway tests. The tests are not be performed during periods of rainfall or when there is ponded water on the ground. These are to be undertaken in accordance with BRE Digest 365. They shall be undertaken by an AGS accredited ground investigation specialist contractor with their Method Statement agreed prior to works. The pit dimensions shall be a minimum of 1m wide 1m long and 1m deep (but shall not exceed 1.25m deep). It shall be assumed that the associated pit will need support during the test by backfilling with 10mm clean pea shingle, however, this can be omitted if the contractor can assure that the soakaway pit would otherwise remain stable throughout the test. A data logger is to be used to measure the water during test. Water must be added rapidly. The specialist ground investigation contractor is to provide full time supervision of such tests and is to provide a real time interpretation of the results.
- The duration of the tests shall be such that it can be confirmed in the field the by the specialist subcontractor that the infiltration rate is less than 1×10^{-7} m/s. The Engineer shall be informed of the findings. The test can only be terminated once the Engineer has given his approval to do so. The earthworks contactor and specialist shall work together so as to prevent water (other than that added

to perform the test) from entering the excavation. Upon completion of the test any pea shingle and the water is to be fully removed and the excavation re-instated with materials placed and compacted in accordance with this specification so as to form Engineered Fill. The contractor shall provide a report on the soakaway testing, including details of the testing undertaken, the data from the test, the specialist contractor's interpretation and tests associated with the backfilling of the excavation

- 29** The Contractor will follow all the Specification Appendices for the form of all deliverables, storage of test records and storage of records of materials imported to and exported from site.
- 30** Should for any reason materials be imported into the site for use as fill, unless specifically instructed to the contrary, all samples used for testing materials to be incorporated into the works shall be taken from materials after they have been delivered to the site, (where imported) and in such case with 7 days notice to the Engineer so as to review requirements.
- 31** Unless otherwise shown in this Appendix, tests and test certificates for works, goods or materials as scheduled under any one clause are required for all such work, goods or materials in the works.

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF
EARTHWORKS MATERIALS

1.0 Acceptable Limits for Fill Materials

1.1 Earthworks materials shall comply with the 600 series of the Highways Agency 'The Manual of Contract Documents for Highway Works, Volume 1: Specification for Highway Works' (SHW) and with the particular requirements of this Appendix. Permitted classes of construction materials are defined in Appendix 6/1, Table 6/1: Acceptable Earthworks Materials: Classification and Compaction Requirements.

1.2 All earthworks materials are to meet the acceptability limits as set out in Appendix 6/1, Table 6/1 and SHW Table 6/2.

1.3 Unacceptable Material Class U1A shall be:

- § material which does not comply with the permitted constituents and material properties of Table 6/1 and Appendix 6/1 for acceptable material;
- § peat, materials from swamps, marshes and bogs;
- § logs, stumps and perishable material;
- § potentially deleterious materials;
- § potentially degradable material that presents a future source of gas;
- § material that exceeds the Forensic TOC content limit of 4%;
- § materials in a frozen condition;
- § clay having a liquid limit determined in accordance with BS1377 : Part 2, exceeding 90% or plasticity index determined in accordance with BS1377 : Part 2, exceeding 65%;
- § material susceptible to spontaneous combustion; and
- § material contaminated with vegetative matter including invasive plant species.

1.4 Unacceptable material Class U1B shall be:

- as defined in SHW;
- contaminated, noxious or deleterious materials;
- asbestos containing material.

1.5 Fill materials will generally comprise:

- Class 2 to provide: Engineered Fill. Placed and compacted to meet the End Product requirements.
- Class 6 material: used for starter layers, sub-formations and working platform fill below water.

- 1.6 Material designated as Class U1A due to physical properties that fall outside those permitted in Appendix 6/1, Table 6/1, Table 6/2 may be physically processed and conditioned to obtain the appropriate classification.
- 1.7 Where possible U1A oversized materials are to be processed to meet the 'recycled aggregate' requirements of Clause 601.12 of SHW and the target acceptability limits as set out in Table 6/1, SHW Table 6/2 and site specific requirements.
- 1.8 When rendering Class U1A material acceptable by lime (quicklime) or another alternative agreed (e.g. ckd) the Contractor shall demonstrate that any swell/heave does not cause damage to overlying materials and that the finished surface remains within the specified tolerances. The method of spreading lime is to provide for a controllable rate of application, even spreading, and for the percentage lime added to be either directly measured or readily calculable. The Contractor is to be responsible for obtaining and keeping full and detailed records of where lime modified material has been incorporated within the works.
- 2.0 Special Requirements for Determining Acceptability, and Whether Sampling and Testing is Required
- 2.1 The Contractor shall carry out Acceptability and End Product Compaction Testing in accordance with Specification Appendix 6/1, Table 6/1 and at the frequencies given in Appendix 1/5 in an independent UKAS accredited testing laboratory. Each sample and in-situ test shall be identified by a unique identification number directly referenced to both the sample type, location and position.
- 2.2 Testing shall be the responsibility of the Contractor and be carried out in accordance with Specification Appendices 1/5, 6/1 and 6/3. The Contractor shall maintain full records on each sub-unit of materials, including but not limited to, the location of the sources, the suppliers details, the acceptability testing and the location it has been incorporated within the works. This also applies to Client sourced materials.
- 2.3 Should any material be placed which has not been given prior approval from the Engineer, the Contractor will have done this at its own risk and shall be responsible for any remedial works required to rectify the situation. In this regard, it is noted that the Engineer shall not be assumed to be present on site on Saturdays and works shall accommodate this. All costs associated with any remedial works or actions shall be borne solely by the Contractor.
- 2.4 The Contractor shall undertake testing of fill materials to determine their acceptability with respect to meet the compaction requirements given in this specification. A copy of the results of such testing shall be provided to the Engineer in paper hard copy and digital format (pdf, excel and AGS 3.1). With respect to provision of AGS data, all laboratory test results shall be submitted in full accordance with The Association of Geotechnical and Geo-environmental Specialists (AGS) version 3.1 standard (available on the AGS website: <http://www.ags.org.uk> under 'datatransfer'). Each AGS data file must be checked for errors (i.e. must not contain warnings, structural or integrity errors) before it is submitted and it must be accompanied by an error log file to verify
- 2.5 Results of source approval tests are to be provided within 10 days of testing being completed and prior to the materials being placed, with the exception of drum test as detailed elsewhere in this specification. Results of routine tests are to be provided with 10 working days of sampling with the exception of:
- MC tests; to be provided within 24hrs of sampling

- MCV tests; to be provided within 24hrs of testing
- Compaction tests: to be provided within 5 working days of sampling
- Particle Density tests: to be provided within 5 working days of sampling
- Drum Tests: As detailed elsewhere in this specification

- 2.6 Hand shear vane tests, insitu density and CBR related tests are to be undertaken on the day of compaction and the results provided within 24hrs of testing. Dates for soakaway testing are to be agreed with the engineer.
- 3.0 Permitted Use of Rapid Assessment Procedure for Material Acceptability
- 3.1 Where moisture content is undertaken as the method of material classification and control, the Contractor may use a 'rapid' method (e.g. microwave oven) as an alternative to the BS1377: Part 2 method provided that such 'rapid' methods are calibrated weekly against conventional BS methods using drying ovens. The 'rapid' procedure will need to be UKAS accredited or a documented in house procedure.
- 4.0 Requirements for the Assessment of the Effects of Water Soluble (WS) Sulphate, Oxidisable Sulphides and Total Potential Sulphate in Accordance with TRL 447, Test Nos. 1 to 5
- 4.1 Water soluble (WS) sulphate, oxidisable sulphides and total potential sulphate contents are to be determined in accordance with Clause 644 of SHW.

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

TABLE 6/1: ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612	Class				
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:			Lower	Upper	2	A	-
GENERAL COHESIVE FILL	2	A	-	Wet cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) Grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	MDD determined using 2.5kg Rammer. Except for materials with liquid limit greater than 50, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used. End Product Compaction to achieve: • an undrained shear strength of 50 kN/m ² or more • at least 95% Maximum Dry Density • not more than 5% air voids in top 2m. (Air voids can be relaxed to not more than 10% where used at a depth of >2m below the top of the Engineered Fill surface). • A permeability of not more than 1x10 ⁻⁷ m/s • CBR 3% at as placed moisture content where used in top 2 layers of Engineered Fill. Where Hydraulic Binders are used maximum TPS is 1%.	2	A	-		
							(ii) D10	BS1377-2	-	0.003mm						
							(iii) Plasticity Index (PI)	BS 1377-2	6	40						
							(iv) mc	BS 1377-2	That associated with end product requirements as determined by testing							
							(v) MCV	Clause 632								
							(vi) Permeability of remoulded material	Appendix 1/5 note 15	-	10 ⁻⁷ m/s						
							(vii) Forensic TOC	Cl:aire RB17 (Nov 2012)	-	Total combined Forensic TOC 4%						
							(viii) Chemical analysis	App 6/14	App 6/14							
							(ix) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14							
							(x) Undrained shear strength of remoulded material.	Hand shear vane	50 kN/m ²	-						

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class				General Material Description	Typical Use	Permitted Consituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612		Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:						
									Lower	Upper					
GENERAL COHESIVE FILL	2	B	-	Dry cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) Grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	MDD determined using 2.5kg Rammer. Except for materials with liquid limit greater than 50, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used. End Product Compaction to achieve: As per Class 2A above Where Hydraulic Binders are used maximum TPS is 1%.	2	B	-	
							(ii) D10	BS1377-2	-	0.003mm					
							(iii) Plasticity Index (PI)	BS 1377-2	6	40					
							(iv) mc	BS 1377-2	That associated with end product requirements as determined by testing						
							(v) MCV	Clause 632							
							(vi) Permeability of remoulded material	Appendix 1/5 note 15	-	10 ⁻⁷ m/s					
							(vii) Forensic TOC	Cl:aire RB17 (Nov 2012)	-	Total combined Forensic TOC 4%					
							(viii) Chemical analysis	App 6/14	App 6/14						
							(ix) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14						
							(x) Undrained shear strength	Hand shear vane	50 kN/m ²	-					

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class	General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612	Class					
				Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:			2	C	-			
						Lower	Upper							
GENERAL COHESIVE FILL	2	C	-	Stony cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) Grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	MDD determined using 2.5kg Rammer. Except for materials with liquid limit greater than 50, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used. End Product Compaction to achieve: As per Class 2A above Where Hydraulic Binders are used maximum TPS is 1%.	2	C	-
							(ii) D10	BS1377-2	-	0.003mm				
							(iii) Plasticity Index (PI)	BS 1377-2	6	40				
							(iv) mc	BS 1377-2	That associated with end product requirements as determined by testing					
							(v) MCV [where not possible to determine, acceptability shall be by civils	Clause 632						
							(vi) Permeability of remoulded material	Appendix 1/5 note 15	-	10 ⁻⁷ m/s				
							(vii) Forensic TOC	Cl:aire RB17 (Nov 2012)	-	Total combined Forensic TOC 4%				
							(viii) Chemical analysis	App 6/14	App 6/14					
							(ix) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14					
(ix) Undrained shear strength	Hand shear vane	50 kN/m ²	-											

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612		Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:						
									Lower	Upper					
GENERAL COHESIVE FILL	2	D	-	Silty cohesive material	General fill	Any material, or combination of materials (excluding those listed in SHW Clause 6.1.2 (i) (b)) other than material designated as Class 3 in the contract	(i) Grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	MDD determined using 2.5kg Rammer. Except for materials with liquid limit greater than 50, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used. End Product Compaction to achieve: As per Class 2A above Where Hydraulic Binders are used maximum TPS is 1%.	2	D	-	
							(ii) Plasticity Index (PI)	BS 1377-2	6	40					
							(iii) D10	BS1377-2	-	0.003mm					
							(iv) mc	BS 1377-2	That associated with end product requirements as determined by testing						
							(v) MCV [where not possible to determine, acceptability shall be by (iii)]	Clause 632							
							(vi) Permeability of remoulded material	Appendix 1/5 note 15		10 ⁻⁷ m/s(v)					
							(vii) Forensic TOC	Cl:aire RB17 (Nov 2012)	-	Total combined Forensic TOC 4%					
							(viii) Chemical analysis	App 6/14	App 6/14						
							(ix) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14						
							(x) Undrained shear strength of remoulded material	Hand shear vane	50 kN/m ²	-					

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612		Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:						
									Lower	Upper					
TOPSOIL	5	A	-	Topsoil, or turf, existing on site	Top soiling	Topsoil or turf designated as Class 5A in the Contract	(i) Grading	SHW Clause 618	-	SHW Clause 618	-	5	A	-	
								ii) Properties as required by BS 3882	BS 3882	To meet with requirements given in BS 3882					
								iii) Chemical analysis	App 6/14	App 6/14					
								(iv) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14					

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:			6	A	-
									Lower	Upper				
SELECTED GRANULAR FILL	6	A	-	Selected well graded granular material	Below water	Natural gravel, natural sand, crushed gravel, crushed rock (other than argillaceous rock, chalk or colliery spoil), blast furnace slag, crushed concrete, or any combination thereof. Recycled aggregate	(i) Grading	BS 1377-2 (on-site)	SHW Table 6/2	SHW Table 6/2	No compaction	6	A	-
							(ii) Uniformity coefficient	See note 5	10	-				
							(iii) Plasticity Index (PI)	BS 1377-2	Non-plastic					
							(iv) Chemical analysis	App 6/14	App 6/14					
							(v) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14					

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612	Class		
6	B	-	Property (See Exceptions in Previous Column)				Defined and Tested in Accordance with:	Acceptable limits Within:		6		B	-	
								Lower	Upper					
	6	B	-	Selected coarse granular material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock (other than argillaceous rock, chalk or colliery spoil), blast furnace slag, crushed concrete, or any combination thereof. Recycled aggregate	(i) Grading	BS 1377-2 (on-site)	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 5	6	B	-
							(ii) Plasticity Index (PI)	See note 5	10					
							(iii) Chemical analysis	App 6/14	App 6/14 Threshold Concentration is dependent on depth – refer to Table 6/14					
							(iv) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964						
				(v) Los Angeles coefficient		SHW Clause 635	-	50						

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:			6	C	-
Lower	Upper													
6	C	-	Selected uniformly graded granular material	Starter layer	Natural gravel, natural sand, crushed gravel, crushed rock (other than argillaceous rock, chalk or colliery spoil), blast furnace slag, crushed concrete, or any combination thereof. Recycled aggregate	(i) Grading	BS 1377-2 (on-site)	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 3 OMC to be determined using Vibrating Hammer	6	C	-	
						(ii) Uniformity coefficient	See note 5	-	10					
						(iii) Plasticity Index (PI)	BS 1377-2	Non-plastic						
						(iv) Chemical analysis	App 6/14	App 6/14						
						(v) Asbestos screen and ID	UKAS Gravimetric Quantification of Bulk Asbestos Products and Fibre Bundles in soils by PLM/PCOM HSG 248/HSG 264/HSE Report NO. 83/19964	Threshold Concentration is dependent on depth – refer to Table 6/14						
						(vi) Los Angeles coefficient	SHW Clause 635	-	50					
						(vii) mc & OMC/MDD	BS 1377-2 & 4	OMC -2%	OMC +2%					

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING OF EARTHWORKS MATERIALS

Footnotes to Table 6/1:

1. App = Appendix
2. Tab = Table
3. Where BS 1377:Part 2 is specified for MC, this shall mean BS 1377:Part 2 or BS EN 1097-5 as appropriate.
4. Uniformity coefficient is defined as the ratio of the particle diameters D60 to D10 on the particle-size distribution curve, where: D60 = particle diameter at which 60% of the soil by weight is finer and D10 = particle diameter at which 10% of the soil by weight is finer.
5. The Limiting Values for Class U1B material are given in Appendix 6/14. The contents of this table may be revised following periodic Engineering assessments and design by the Engineer.
6. Where supplementary clauses and tables are referenced in Table 6/1, they shall refer to the equivalent clause or table from the Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1: (SHW).
7. Definitions of abbreviations: Refer to Appendix 1/5

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS

- 1 Requirements for Removal Off Site of Excavated Acceptable Material or Unacceptable Material Requiring Processing or Retention of Surplus Material On Site
- 1.1 Any surplus soils from form the site shall be retained on the wider Phase 2&3 site in accordance with a: location plan; CEMP; MMP; and Environmental Permit approved by the Engineer to which the contractor shall fully accord. Where material cannot maintained in accordance with the above it shall be removed from site by the Contractor in accordance with current regulations.
- 1.2 If any Class U1B or U2 Material is identified at excavation formation level the Engineer shall be notified and the Contractor shall prepare appropriate risk assessments to permit the completion of works. Thereafter the requirements detailed in 1.3 below shall apply and all materials shall be handled by the Contractor in accordance with Environment Agency Pollution Prevention guidance.
- 1.3 If visual or olfactory evidence of soil contamination is identified during the reduced level excavation works, the following actions shall be undertaken:
- work shall cease in the area of visual or olfactory contamination;
 - the area of concern shall be approximately delineated and clearly marked in order that personnel or equipment shall not be permitted to enter into the area of concern;
 - the soils of concern shall be inspected by the Engineer with suitable investigation equipment or operated mechanical excavator provided by the Contractor;
 - suitable samples of the soils of concern shall be recovered and submitted for laboratory testing;
 - suspected contaminated soils shall be excavated and suitably stockpiled in a clearly defined and segregated area whilst the results of laboratory testing are awaited, if required by the Engineer;
 - following receipt of the results of laboratory testing (between three to ten days thereafter, depending upon scope of testing required) the soils may be confirmed to be contaminated or of an unacceptable nature;
 - if soils are deemed contaminated or otherwise unacceptable, they shall be excavated under supervision of the Engineer and placed in a clearly demarked stockpile area pending either onsite treatment or offsite disposal;
 - validation samples of the soils that remain in the vicinity of the soils of concern shall be taken by the contractor under the direction of the Engineer;
 - following receipt of the results of the laboratory testing carried out on the soils that remain (between three to ten days thereafter, depending upon scope of testing required) excavation in this area can then proceed;
 - the results of site inspections, laboratory testing and actions taken shall be recorded by the Contractor as a record of the works carried out;
 - these records shall be compiled within the validation report for the Earthworks to provide a permanent record.

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNACCEPTABLE MATERIALS

- 1.4 For the principle approach to stockpiling and materials movement refer to Section 8.0 and 9.0 of Appendix 6/3, noting that any particular provisions of the SHW shall notwithstanding apply. The requirements for environmental monitoring and protection shall be in accordance with the CEMP.
- 1.5 There is no requirement for the remediation of Unacceptable U1B material. However such material may potentially be re-classified by the Engineer. Any U1B material that fails the prerequisite Limiting Values (Appendix 6/14) shall be referred to the Engineer for review and associated temporary stockpiles of material maintained. Unless specific approval for these materials is received from the Engineer these shall be considered U1B classification and removed. Any material that fails the Limiting Values shall not be imported to site without prior agreement of the Engineer.
- 1.6 All waste soils shall be removed and disposed of in accordance with the Waste (England and Wales) Regulations 2011 (as amended). All waste soils shall be tested and classified to permit Hazardous Properties Assessment and WAC testing in accordance with Environment Agency Guidance (WM3).

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION,
COMPACTION (OTHER THAN DYNAMIC COMPACTION)

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

1.0 Earthworks General

1.1 Two weeks prior to work the contractor shall provide method statements for the works required to address this specification to the Engineer.

1.2 No ground disturbing activities, including any earthmoving activities, are to commence prior to the Contractor obtaining any necessary permits or licences including those relating to protected species or habitats. If a licence or permit for such works is granted, those works shall only be undertaken during the periods as stated on the licence or permit under the direction of the licence or permit holder. A copy of the licence and/or permit shall be provided to the Engineer prior to commencement of the relevant activities.

1.3 Setting out shall be carried out from established grid lines and maintained for the duration of the construction of the ground improvement. A minimum 10 x 10m inspection grid is required.

1.4 The following sequence of works is anticipated:

- Agree works Method Statements.
- Set up permanent datum and other survey control stations.
- Undertake compaction and treatment trials.
- Excavate to Excavation Formation Level (refer to associated drawings)
- Identify the engineered fill placed as part of previous works.
- Proof roll and inspect excavation formation.
- Complete surface monitoring and flux chamber tests (S3.0 and 4.0 of Appendix 6/12).
- Complete Validation Trial Pits (S5.0 Appendix 6/12).
- Remove any gaseous, soft or highly degradable materials.
- Construct piezometers (Appendix 6/13).
- Allow piezo readings to settle/become consistent and grout to cure.
- Commence Drum Tests (S2.0 of Appendix 6/12).
- Construct of Rod Settlement Gauges* (Appendix 6/13).
- Commence monitoring in accordance with Appendix 6/13 Table 1.
- Place/compact Engineered Fill, ensuring that the Engineered Fill placed as part of these works tie into those placed as part of the previous phases of works.
- Place surcharge: as shown on drawings. The basal 250mm of the surcharge is to be constructed as Engineered Fill (Appendix 6/13).
- Place gas monitoring installations (S1.0 of Appendix 6/12) and confirm with the Engineer whether any supplemental surface monitoring or flux chamber tests are required.
- Remove surcharge after Engineer approval including continued monitoring and reporting in accordance with Appendix 6/13.
- Grub out and decommission instruments: Place/compact Engineered Fill accordance with the Specification in areas of associated excavation.
- Place/compact Engineered Fill to make up to Finished Earthworks Level.
- Test Finished Earthworks Level (note other tests required as works progress).

* Rod Settlement Gauges are to be constructed at the Excavation Formation Level

1.5 If during excavation undisturbed competent natural ground is encountered then the excavation is to cease and the Engineer consulted for additional instructions. The Contractor shall provide a full level survey of the associated area.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 1.6 At the excavation formation level, trial pits will be excavated, to inform the gas assessment and to inspect areas where the ground investigations have identified the presence of the 'poorest' material from a geotechnical point of view. The requirements are detailed in Appendix 6/12, section 5.0.
- 1.7 If unforeseen ground conditions or unforeseen responses to the treatment are encountered then the Engineer shall be verbally notified immediately (and within 48 hours in writing).
- 1.8 If Unacceptable Materials (class U1B/U2) are observed at the excavation formation then provision shall be made for these to be removed following instruction from the Engineer. Any associated 'hotspot' excavations shall be validated by the Contractor via the application of Forensic TOC tests comprising on composite sample per face and one composite sample from the base. Each spot will be surveyed to include base levels and lateral extents such that volumes can be calculated.
- 1.9 Surcharging operations and associated monitoring are detailed in Appendix 6/13.
- 1.10 Earthworks materials derived from processed Class U1B material are to be used in the works only when agreed with the Engineer. This shall be recorded in the As-Built Drawings.
- 1.11 The Contractor is responsible for the works covered by the Specification. The Contractor shall however require the inspection and approval of works from the Engineer subject to the notice periods presented in the Contract (and a minimum of 7 days) and in particular inspection of:
- a. Excavation formations
 - b. Classified stockpiles
 - c. Material placement and compaction (of permanent fills)
 - d. Unforeseen contamination (Class U1B / U2 Materials)
 - e. Validation trial pits
 - f. Completed works following removal of surcharge
 - g. Instrumentation and monitoring
- 1.12 A tracking system shall be established to the satisfaction of the Engineer to document material movements from excavation to segregation, stockpiling and eventual reuse. A reference grid shall be established to aid the control of material movements and shall be agreed with the Engineer prior to commencement. The proposed system shall be submitted to the Engineer 2 weeks in advance of its required use.
- 1.13 The tracking system shall enable location and extent of materials placed in any one day to be determined in three dimensional space and shall locate in-situ and ex-situ test locations the location of samples taken for laboratory tests and associated levels. This will enable excavation and removal as necessary in the event that pre and/or post placement testing indicates that the soils are unacceptable and/or placement has not achieved the required state of compaction. The tracking system should also incorporate the requirements of the MMP which includes those soils moved off the site due to surplus requirements and/or unacceptability.
- 2.0 Control of Water
- 2.1 All works and associated costs relating to the control and management of water on site, from existing, proposed or redundant watercourses or from any other sources including groundwater, rainfall and surface water is the responsibility of and all costs are to be borne by the Contractor.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

Any uncertainty over the issues associated with water or groundwater control shall be submitted to the Engineer for clarification, as soon as any such issue is noted or identified by any party.

- 2.2 The Contractor shall provide for such measures as may be necessary to ensure that water, whether groundwater, from precipitation or any other source does not accumulate in excavations or on sub-grades, subject to licensing and permitting requirements. In addition, the Contractor shall ensure any adjacent areas, used to source material (subject to agreement) are graded so as to shed water away from the treated area.
- 2.3 The Contractor shall provide, where necessary, temporary watercourses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provision shall include carrying out the work of forming the earthworks in such a manner that their surfaces have at all times a sufficient minimum cross-fall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding. This shall include the provision of temporary measures to remove water expelled from the ground due to the application of load from the Engineered Fill and surcharge material.
- 2.4 Will respect to the re-alignment of Bewbush Brook and the ponds the contractor will be responsible for both temporary and permanent works, including temporary diversion of the existing brook and temporary and permanent drainage. In relation to such features the contractor is to note the construction sequence shown on drawings.
- 3.0 Requirements for Groundwater Lowering or Other Treatment (where required)
- 3.1 The Contractor is responsible for all groundwater lowering where this is required for the purposes of the works. This is particularly relevant, but is not limited to, dewatering of deep excavations and trenches.
- 3.2 The Contractor is responsible for obtaining all permits and/or licences required to undertake groundwater lowering and for treatment and/or disposal of said groundwater or other encountered liquids.
- 3.3 Where earthworks operations or ground improvement measures result in the expelling of groundwater into drainage layers or onto earthworks surfaces the discharged water shall be collected, treated if necessary and disposed.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 4.0 Blasting for Excavation
- 4.1 Blasting for excavation is not a permitted alternative to normal excavation methods.
- 5.0 Stability of Excavation
- 5.1 Where the area to be filled comprises an existing excavation, the excavation shall be inspected and subsequently monitored by the Contractor, to ensure that there is no danger of its collapse during the works with consequences for safety, for existing buildings or for other construction adjoining. Shoring or propping shall be used where appropriate.
- 5.2 The Contractor shall provide appropriate barriers or other preventative measures around open excavations to minimise the health and safety risk to site users of these areas.
- 5.3 The Contractor shall ensure all temporary excavations are formed with suitable, safe batters or other suitable methods of support. The Contractor shall give notice without delay if any newly excavated faces are too unstable to allow work and take immediate action if instability is likely to affect structures, roadways, offsite land or the safety of the site operations.
- 6.0 Obstructions
- 6.1 An obstruction is deemed to be any material which is comprised principally of concrete, brick or stone, whether loose material or in a homogeneous form $>0.2\text{m}^3$. Where obstructions are encountered the Engineer shall be notified immediately. In ground conditions where breaking out is deemed necessary this shall be carried out by a method and to a sequence agreed with the Engineer. All breaking out methods shall be carried out to the relevant professional standards.
- 6.2 Where encountered during the works, obstructions shall be removed to a minimum depth of 1m below the underside of the proposed excavation formation level. Where obstructions encountered in the works extend below this depth, they shall either be removed in their entirety, or cut down, surveyed and recorded if confirmed to be deep obstructions (e.g. piles). The preferred option shall be confirmed by the Engineer.
- 6.3 Where the obstruction extends beyond the boundary of any zone or area to be excavated, remediated and/or treated, the obstruction shall be removed 1m beyond the boundary except where this extends beyond the demise of the client's ownership or interferes with a permanent structure (such as adjacent building or footpath).
- 6.4 Where any obstruction to be removed extends beyond the demise of the client's ownership or interferes with a permanent structure, the obstruction shall be carefully removed up to the site demise in a way that causes no damage.
- 6.5 All obstructions discovered shall be marked on a set of the construction drawings indicating the position, extent and a description of the materials evident together with details of any residual obstructions left in. These details shall be made available to the Engineer. Prior to any filling, the Engineer shall be given the opportunity to decide if further works should be carried out beyond that specified. In the event of a residual obstruction being left insitu its location, extent and level are to be recorded by topographical surveying.
- 6.6 Where obstructions are broken out, filling or infilling of voids shall be deemed to be included with approved materials arising from the general works. Voids, pits, vents and the like shall be reported to the Engineer and shall be filled or capped with approved materials arising from the Works.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 6.7 The Contractor shall contact the Engineer before the disconnection and removal of any services comprising pipes, cables and general service installations discovered where they are above the Excavation Formation Level. These shall each be marked on a drawing and handed to the Engineer. The extent of any removal shall be within the plane of the works plus 1m where such service installations are discovered and are to be removed. The ends of any remnant pipework at the edge of any such excavation shall be cut and sealed.
- 7.0 Cutting Faces
- 7.1 No specific limitations or restrictions on undercutting are included, but the Contractor shall comply with his appointed Temporary Works Designer's requirements when excavating trenches at or within the vicinity of the toe of any slopes.
- 7.2 Clearing loose material from cutting slopes by airline hose is not permitted.
- 7.3 The Contractor shall provide additional drainage measures to intercept and discharge seepages from cutting or embankment slopes. The Contractor is responsible for all drainage required to carry out the works and to protect them upon completion, which will include, where necessary, temporary drainage measures.
- 8.0 Segregation of Excavated Materials
- 8.1 During excavation, materials arising are to be inspected and segregated to Classes U1A, U1B, U2, 5A, General Fill Classes (and further segregation as may be required to ensure adequate control of compaction behaviour). Classes U1A, U1B, U2, 5A materials must be separated.
- 9.0 Stockpile Management
- 9.1 When materials are to be stockpiled, clearly defined segregated stockpiles are to be formed for different sub-classes of processed material. The maximum permitted height of stockpiles, excluding topsoil Class 5, shall be 5.00m unless otherwise agreed with the Engineer. Stockpiles of different materials shall be clearly separated by a gap of not less than 5.00m.
- 9.2 Stockpiles of topsoil shall be formed in accordance with guidance provided by DEFRA '*Construction code of Practice for the Sustainable Use of Soils on Construction Sites (2009)*' and research carried out by non-statutory bodies, which suggests that optimum stockpiles of topsoil shall not exceed 1.3 m in height and that topsoil shall not be stockpiled for more than 1 year.
- 9.3 On completion of a stockpile the slopes shall be trimmed to falls to shed rain water and the surface sealed via compaction to limit infiltration. Temporary drainage shall be provided at the base of the stockpile to collect runoff from the stockpile and to carry any surface water away from the base of the stockpile.
- 9.4 The Contractor shall provide and maintain such measures as necessary to eliminate the production of dust from the stockpile during the its life.
- Existing Stockpiles*
- 9.5 The earthworks carried out for previous phases of the Kilnwood Vale development has resulted in the formation of various stockpiles of potentially acceptable fill materials. The existing stockpiled materials may also be reused provided they are or can be demonstrated as having been subject to the testing as defined in Appendix 1/5 and meet the criteria given in Appendix 6/1.
- 9.6 The Contractor shall include details of the movement of these soils in the Materials Tracking documentation as detailed in Section 1.0 of Appendix 6/3.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 10.0 Geotechnical Methods for Soil Treatment
- 10.1 The Contractor shall provide moisture conditioning, modification and solidification/ stabilisation and physical treatment to render soils suitable under in accordance with Appendix 6/1, Table 6/1 and Table 6/2.
- 10.2 Moisture conditioning is defined as works that may be required to ensure that stockpiled or as dug materials comply with the requirements of this specification and the Specification for Highways Works. These are processes where, either through the addition of chemicals such as lime, or through physical processes such as spreading out and air drying, the moisture content of the soils may be rendered acceptable for earthworks.
- 10.3 The physical treatment of unacceptable materials is defined as physical screening/crushing of stockpiled or as-dug soils to remove timber, wood, potentially deleterious materials and oversized fragments of bricks, concrete and the like.
- 10.4 Rendering SHW Class U1A material acceptable by lime (quicklime) modification (or other additives) is permitted provided the modified material is able to meet the performance requirements given and that it or its method of placement do not result in a risk to the environment. The design of any such treatment shall be based on HA70/07 'Treatment of Fill and Capping Materials using either Lime or Cement or Both'. The Contractor shall demonstrate, to the satisfaction of the Engineer, that the treated materials do not have any significant potential to swell/heave. The method of spreading the additives is to provide a controllable rate of application and even spreading. It shall also enable the percentage of additives added to be either directly measured or readily calculable.
- 10.5 The Contractor shall be responsible for obtaining and keeping full and detailed records of where treated/modified material has been incorporated within the works.
- 10.6 Prior to undertaking any such soil treatment the Contractor shall submit full details to all relevant statutory authorities and the Engineer and obtain their approval to his proposals. The Contractor's attention is brought to the environmental sensitivity of the site and any such works must be undertaken in full compliance with the relevant statutory authority requirements and the requirements of the agreed Construction and Environmental Management Plan.
- 11.0 Water Courses
- 11.1 Details regarding existing water courses, construction of new water courses and earthworks drainage ditches are shown on the Drawings provided by the Engineer.
- 11.2 Redundant watercourses shall be drained and cleaned. Excavated arisings are to be treated as described in Appendix 6/2.
- 12.0 Construction of Fill
- 12.1 Engineered Fill: This is to comprise Class 1 and 2 material and must be compacted to achieve End Product requirements given in Appendix 6/1, Table 6/1 and as detailed below. Class 1 materials are not to be used within 2m of final earthworks level.
- 12.2 Surcharge Fill: This is a temporary fill and can be Class 1 or Class 2 material. This is discussed in more detailed in Appendix 6/13.
- 12.3 Treated Fill: Site won fill that is treated using additives. The approved method of treatment, placement, mixing and compaction shall be informed by a trial. On-going testing types and frequency beyond those already required in Appendix 1/5 shall be agreed with the Engineer after review of trials to establish an appropriate methodology.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 12.4 Any material placed by the Contractor prior to the provision of full testing shall be at their risk. If fill material is to be screened, processed or treated after excavation, laboratory testing shall be required after the material has been processed in order to determine its acceptability. Material will only be considered suitable, based on the results of the testing, if it is placed and compacted during a period of time in which the moisture content could not have varied outside of the appropriate range to meet the compaction requirements.
- 12.5 After materials have been brought up to Finished Earthworks Levels where required, ground improvement via the use of a surcharge to preload the ground will then be undertaken as shown on the drawings. Full details of the surcharge operation are given in Appendix 6/13. Subsequent to the removal of the surcharge, site levels are then to be brought back up by Engineered Fill materials which will be placed and compacted to meet End Product requirements. It is noted that the surcharge material does not generally have an End Product requirement, apart from the basal 250mm. The basal 250mm shall be placed and compacted as Engineered Fill to allow for settlement and the residual of this removed following surcharge completion.
- 12.6 Embankment slopes shall not be constructed steeper than that considered safe by the contractor's temporary works engineer. Temporary over-widening or steepening to achieve adequate compaction of the shoulders of the embankment are permitted.
- 12.7 Any sub-formation areas requiring protection against weather should be protected in accordance with SHW.
- 12.8 Formations for earthworks construction and cutting formations shall be proof-rolled using as a minimum, the compactive effort detailed in SHW. This compactive effort shall be increased for cutting formations where different compactive efforts, dependent on the type of follow-on earthworks operations, are required by the Specification. Observations shall be made by the contractor to identify soft spots. The identification of a 'soft spot' is qualitative and depends on the response of the ground to the compactive effort during proof-rolling. As a minimum excessive matting, bow-waving or ground heave shall be indicative of a 'soft spot'. The Contractor shall agree with the Engineer the extent and nature of 'soft spot' treatment. The extent of the soft spot and associated treatment are to be recorded.
- 12.9 As part of the requisite compaction trials, consideration for dealing with soft spots shall be addressed by the contractor and agreed with the Engineer.
- 12.10 The earthworks construction formations and cutting formations shall be inspected by the Engineer for the possible presence of any soils that have visual or olfactory evidence of contamination and/or the presence of any significant concentrations of organic or decayable material. The contractor shall agree with the Engineer on the course of action to be taken where such 'hot spots' are encountered.
- 12.11 Fill shall be placed and compacted in near-horizontal layers of the thickness required to achieve the required end product and shall, as far as practicable, be brought up at a uniform rate so that all parts of the site reach Finished Earthworks Levels at the same time.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 12.12 Where different thicknesses of fill material are to be employed, the thickness shall be benched to ensure that differential settlements are minimised.
- 12.13 No fill shall be placed and left uncompacted at the end of a working day. Compacted fill shall be sealed and graded to falls to ensure free runoff of rainwater without ponding.
- 12.14 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls, monitoring installations or other structures and all work shall be performed in such a way as to ensure that their existing stability is not impaired.
- 12.15 After removal of surcharge (Appendix 6/13) material exposed is to be proof rolled as per the compaction method used for the Engineered Fill.
- 13.0 Compaction
- 13.1 General
- 13.1.1 All materials shall be placed and compacted to achieve the associated End Product requirements as given in Appendix 6/1 of this specification. The compaction techniques to be adopted for materials are to be informed by compaction trials as outlined below.
- 13.2 Use of Nuclear Density Gauges
- 13.2.1 Refer to Appendix 1/5 Note 24.
- 13.3 Compaction Trial For Engineered Fill

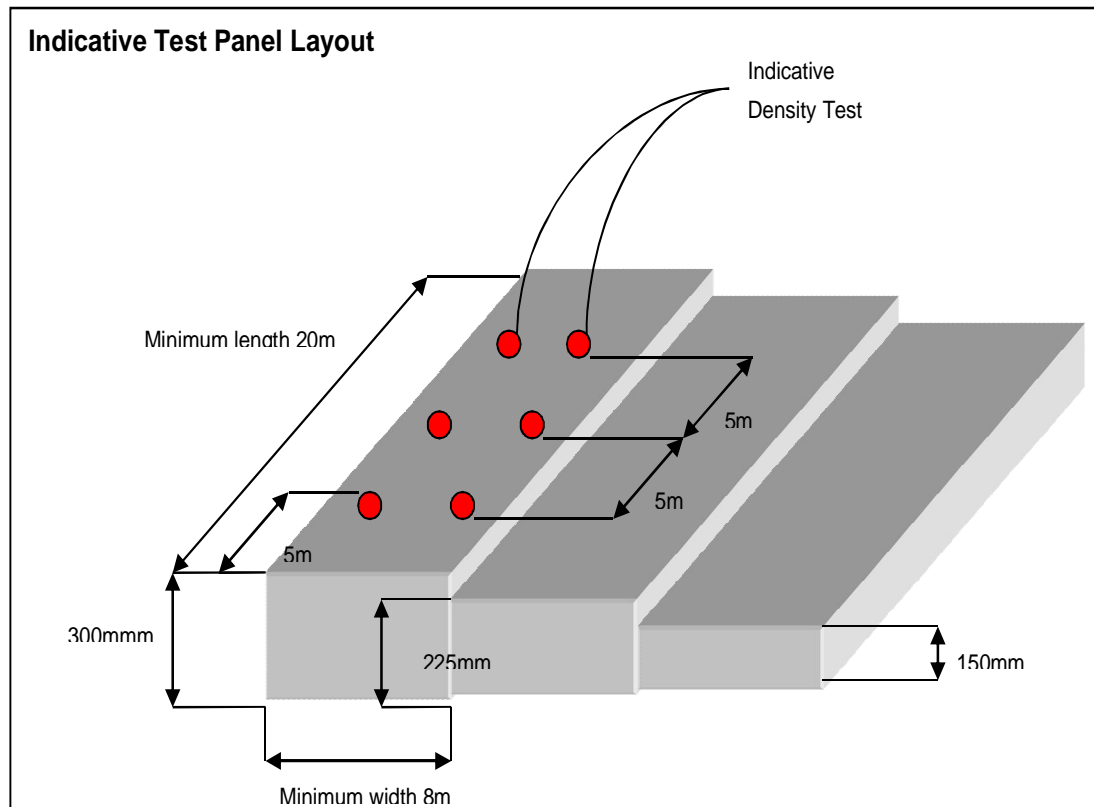
Initial Considerations

- 13.3.1 Compaction trials are required for each material source to be used in the main works and, in relation to such materials, for each compaction method to be used. Compaction trials shall be undertaken with the Engineer in attendance. Two week notice is to be provided and two weeks prior to the trial the Contractor shall provide the Engineer with the geotechnical and chemical results relating to the source material suitability testing. The contractor shall plan his works so as to ensure that compaction trial and associated testing and appraisal is complete in good time in advance of the main works. Failure to do so will result in materials being placed at the contractor's risk. The site of the trials shall be clearly marked and levels taken to determine the thickness of each layer before and after compaction.
- 13.3.2 The exception to the above is where the same materials have been placed and compacted in previous phases of work and where it is has been possible to demonstrate that the End Product requirements considered herein have been met for the method of compaction that the contractor proposes to use. Approval of the omission of a compaction trial would be required in writing from the Engineer, however, subject to confirmation of proposed plant and method as described in CI 13.3.5. This must be sought at least 2 weeks prior the scheduled commencement of the compaction trial. The scheduled commencement of the compaction trial must be in good time in advance of the placement of permanent fill as outlined above.
- 13.3.3 For each material type, a number of test panels will be required in order that a full assessment of the material and compaction method can be completed, which would then constitute the Compaction Trial. Although the size of each panel will reflect the size of the compaction plant and methodology of work proposed, a minimum width of 10m by 20m in length is recommended, with a number of different layer thicknesses trialled as indicated in the Figure

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

below. Any existing topsoil shall be removed from the area of the compaction trial and the formation proof rolled and inspected for soft spots as described in Cls 12.8 and Cl12.9.

- 13.3.4 The depth of each layer forming the test panel shall reflect the likely range of depths of compacted material to be adopted in the main works, but is not to exceed a compacted layer thickness of 250mm (i.e. an uncompacted layer thickness of not more than 300mm, assuming a 20% reduction in thickness upon compaction, which is to be confirmed by the compaction trial). Each panel shall be made up using the layer thickness being trialled until the total thickness for each trial panel is not less than 1m



- 13.3.5 Each test panel shall be laid out and clearly identified and defined separately from any other test panel to avoid accidental influence from adjacent works. At least 2 weeks prior to undertaking the trial, the Contractor shall confirm to the Engineer the following:
- What compaction plant is to be used, including but not limited to the type of equipment, manufacturer, mass per meter width and any other relevant information which can be used to assess its suitability for the material to be compacted.
 - What method of compaction is to be used in the trial and whether or not it has been based upon the guidance from SHW Table 6/4.
 - Confirmation of the source of material to be used.
 - Confirmation that they understand the minimum specification requirements for end-performance of the fill which are to be assessed and demonstrated during the trial.
 - The methodology for assessing fill, including test type and frequency and who will be undertaking the testing both on site and for the subsequent laboratory analysis.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- Confirmation that all parties who are to attend the trial have been informed of when and where the trial will be undertaken.

13.3.6 For each proposed compaction method, a number of test panels shall be constructed in order to allow a full assessment to be completed. Key criteria to identify during the compaction trial will be:

- Change in density and air voids against number of passes.
- Change in density and air voids against thickness of layer.
- Change in engineering performance against compactive effort.
- Identification of point of over-compaction/softening of fill.
- Comparative analysis between different plant.
- Suitability of material for use on site for the proposed end-use.
- Confirmation of classification and engineering performance of material, including sampling, laboratory testing and classification of the material.
- Comparison of actual performance of material against End Product requirements.
- Initial calibration of testing equipment, in particular where the use of a Nuclear Density Gauge [NDG] is proposed for the monitoring of earthworks operation.

Compaction of Test Panels

13.3.7 Earthmoving plant shall not be accepted as compaction equipment, nor the use of lighter compaction plant to provide any preliminary compaction prior to the use of heavier equipment.

13.3.8 Although the guidance from Table 6/4 of the SHW may indicate the optimum number of passes of the appropriate plant, it is important that the progression of improvement of the material is monitored throughout the compaction process. As such, after every two passes of the appropriate roller, in-situ assessment of the density of the material shall be undertaken. One pass of the roller is defined as a single movement of the compaction plant, in one direction, over a given strip of the test panel.

13.3.9 Where the width of the test panel or roller requires a number of passes in order to ensure the full width of the surface is compacted, it is acceptable for the roller to overlap the previous strip by a small margin [no more than 25% of the maximum roller width]. However the Contractor shall ensure that no in-situ testing is undertaken in this zone to prevent the effect of over-compaction influencing the assessment of the performance of the plant and material.

13.3.10 Compaction of the test panel shall continue incrementally until a clear indication has been obtained to show that the soil has either achieved a maximum density, i.e. where after a number of repeat passes is completed no change is identified or has been over compacted and the performance of the material begins to deteriorate.

13.3.11 The exception to this will be where the final performance of the test panel is required to be confirmed using plate load testing, and in this instance it is recommended that a separate panel is constructed, to the same specification as has been identified during the compaction trial, in order that the assessment of the performance can be completed without the detrimental

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

influence of over-compacted material. Guidance on the point of over compaction may be readily identifiable on site from a number of key parameters:

- Reduction in bulk density/dry density with increasing compaction.
- Increase in moisture content, where the over-compaction of the material drives moisture up through the material to the surface [mobilisation of excess pore pressure]. This may also be observed during the passage of the roller, with material adhering to the roller, and/or the surface of the compacted layer beginning to tear.
- Reduction in engineering performance of the material with increasing compaction.
- Visible movement of the surface of the material during the passage of the compaction plant, typically exhibited as a 'bow wave' in front of the roller.

13.3.12 Identifying the point at which the materials become over-compacted is very important for a number of reasons. Should the material not be competent to undergo additional compaction and/or trafficking, then an engineering decision will be required by the Contractor prior to the commencement of the main earthworks program.

Assessment of Test Panels

13.3.13 The compaction trials shall be undertaken in such a way as to demonstrate what works are able to achieve the End Product criteria given in Appendix 6/1.

13.3.14 Initial characterisation of the material shall comprise: sets of testing (one from each layer) each comprising grading, Atterberg Limits laboratory compaction curves [OMC/MDD using the test appropriate to the material type as given in Appendix 6/1], particle density, field moisture content and laboratory permeability testing.

13.3.15 In-situ density (bulk and dry) measurement of the compacted material and moisture content shall comprise: on each layer and at each increment of two passes: six nuclear density gauge readings, evenly spaced in two rows at distances of 5m, 10m and 15m along the test layer. Refer to Appendix 1/5 with respect to the use of NDG equipment. Undrained Shear Strength using hand shear vane shall comprise: on each completed panel: one test per density test location. Refer to Appendix 1/5 regarding the use of Hand Shear Vane equipment.

13.3.16 A CBR value using conventional CBR testing apparatus shall be determined on each completed test panel to determine the materials suitability for use in the upper 2 layers of Engineered Fill. Tests shall be evenly spaced in a central row at distances of 5m, 10m and 15m along the test panel.

13.3.17 CBR using Plate Load Tests shall be completed after CBR testing outlined in 13.3.16 has indicated that a value of 3% has been achieved for a given number of passes. 1 Plate Load Test shall be undertaken per trial panel. The test is to be undertaken in the centre of the panel and in multiple cycles as defined in IAN 73/06.12.3.18. Table 6/3-1 summarises the minimum testing requirements to be undertaken for each trial panel.

13.3.18 Upon completion of the above a soakaway test shall be performed in the test panel materials so as to determine the infiltration rate. The base of the associated excavation shall such that not less than 500mm of trialled material is present below the test. Refer to Appendix 1/5 for further details for the test method.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

13.3.19 The Contractor shall provide a report describing the findings of the test panel. The proposed report format shall be presented to the Engineer 2 weeks in advance of any test panel tests for approval. The report shall include:

- Date and weather conditions, personnel recording the test panel findings.
- Description of the plant and method used (make, weight, model, roller size etc.).
- Description of material used in the test panel (source, tests result certificates, Class type).
- Photographic records of material used, plant used and examples of the as compacted condition.
- Certificates for insitu and laboratory tests undertaken on the compacted layers.
- Appraisal of test results, conclusions and description of the method proposed for the mainworks.

Table 6/3-1 Compaction Trial Testing Requirements

Test Property	Recommended Frequency of Testing
Bulk Samples before compaction	Per layer for MC, PI, PSD, OMC/MDD, particle density and laboratory permeability testing.
Bulk, Dry Density and Air Voids	6 tests per compaction increment per layer using NDG ¹ All such tests to include particle density and moisture content determinations hence derivation of air voids. % relative compaction to be determined relative to the MDD established for the layer.
Undrained shear strength ²	1 per NDG test using HSV
NDG Calibration ¹	As part of each compaction trial initial calibration of NDG equipment shall be undertaken for each instrument used. The calibration shall be undertaken in accordance with methods prescribed in BS1377 Part 9: 2.5 and to the satisfaction of the Engineer.
CBR (BS1377 Part 9 Section 4.3)	3 test per panel at the specified locations.
Plate Load Test to IAN 73/06	1 per completed trial panel, multiple cycles as defined in IAN 73/06
Soakaway Test (BRE 365)	1 set of tests per completed trial panel

1. subject to revision depending on soil type – refer to note 24 in Appendix 1/5.

2. Where fill is cohesive

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 13.4 Placing and Compacting Fill
- 13.4.1 Cobbles, boulders, rocks or fragments whose largest dimension is greater than two-thirds of the compacted layer thickness shall not be incorporated into the Earthworks Material. Any softened cohesive materials encountered in stockpiles shall be removed and not incorporated into the fill. Potentially deleterious materials shall not be incorporated into the fill.
- 13.4.2 The contractor shall take all necessary steps to ensure that fills are placed at the moisture content/condition necessary to achieve the compaction specification and shall, where necessary, add water to or dry the fill, in order to obtain this value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.
- 13.4.3 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all work shall be performed in such a way as to ensure that their stability is not impaired.
- 13.4.4 If the results of control tests indicate that the fill is being placed and compacted in such a way that the desired End Product is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.
- 14.0 End Product Testing
- 14.1 The compliance of the compacted materials meeting the compaction specification shall be demonstrated by undertaking End Product testing as detailed in Appendix 1/5 and with reference to End Product requirements given in Table 6/1 of Appendix 6/1. Test locations shall be evenly distributed throughout the fill area at the frequency defined in Appendix 1/5. The Contractor shall agree test locations with the Engineer.
- 14.2 The Engineer shall be at liberty to request additional tests considered necessary to confirm that the End Product requirements are being met.
- 14.3 In the event of a test failure the Contractor shall provide a full comprehensive interpretation of the nature of the failure based on the test results and propose suitable remedial action. In the event of a test failure the Engineer shall be informed verbally immediately and (no later than 48 hours in writing), all work should cease in the associated area until a full comprehensive interpretation and solution has been found to rectify any such failure.
- 14.4 The relative dry density requirement shall be deemed to have been obtained provided that at least 90% MDD of tests attain the specified dry density, provided that no value falls below 93% MDD.
- 14.5 The air voids required shall be deemed to have been achieved if at least 90% of tests attain the specified air voids, provided that no remit value exceeds 10% air voids.
- 14.6 Placed and compacted cohesive soils are to be have an undrained shear strength of 50kN/m² using the testing methods described in Appendix 1/5.
- 14.7 With respect to permeability the end product requirements can be consider to be met provided all of the following requirements are satisfied (i) laboratory permeability tests undertaken in the compaction trial record permeability values of not more than 1x10⁻⁷ m/s and (ii) the

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

requirements for relative density and air voids given above are met and (iii) the soakaway tests determine an infiltration rate of not more than 10^{-7} m/s.

- 14.8 CBR tests are to be undertaken on placed and compacted materials in the upper 2 layers of Engineered Fill. CBR tests shall be undertaken at the as placed moisture content at a rate of 1 per 35m x 35m grid per layer and are to demonstrate a CBR of 3%.
- 14.9 Plate load tests (min 300mm dia. plate) shall be carried out in accordance with IAN 73/06 on the completed Earthworks Formation Level to demonstrate a minimum CBR value of 3% at the as placed moisture content. Such testing is to be undertaken on a 70x70m grid, subject to modification to ensure that any marginal pass CBR determinations (arising from testing based Appendix 1/5 and Appendix 6/1) are tested.
- 14.10 The requirement for flux chamber tests and a surface emission mapping survey for ground gas assessment purposes is detailed in Appendix 6/12.
- 15.0 Additional Limitations of Deposition of Materials Referred to in 601.13, 601.14 and 601.17
- 15.1 Cobbles having an equivalent diameter of more than 150mm shall not be deposited within 2m of the finished surface at any location.
- 16.0 Permissible Deviation
- 16.1 Permissible deviation from formation levels +/- 50mm.
Permissible deviation from linear dimensions +/- 75mm.
- 16.2 In addition the requirements of Appendix 6/13 should be noted. In the event of conflict Appendix 6/13 takes precedence.
- 17.0 Restrictions on Battering of Excavations for Foundations and Trenches and Requirements for Benching
- 17.1 No specific limitations or restrictions are included for the battering of excavations for foundations and , but the contractor shall be responsible for ensuring safe working practices. Battered excavations are to be benched prior to backfilling. Contractor to also note the specific requirements for batter where existing Made Ground is to receive fill as indicated on SK53
- Benching or shaping of earthworks slope faces to receive fill
- 17.2 Where existing embankments are to be extended and where fill is to be constructed on ground with a slope steeper than one in eight, benching of the existing slope shall be formed as per the SHW. Bench heights are to be a multiple of the relevant compaction layer thickness, with the maximum vertical height of each bench not exceeding 500mm.
- 17.3 Where, during the progress of the work, the difference in level between adjacent areas of filling exceeds 600mm, the Contractor shall cut into the edge of higher filling to form benches having a minimum width of 600mm and a height equivalent to the depth of a layer of compacted filling. The Contractor shall spread and compact new filling to ensure maximum continuity with the previous filling.
- 17.4 Where the Engineered Fill is to be placed against a batter comprising existing Made Ground (which is to be treated by preload/surcharge loading) the tie in will be based on a suitable benching arrangement which is described thus: the material is to be placed and compacted in a

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

prepared benched excavation formed in the natural undisturbed clay. The height of the benches shall be as per the layer thickness required by the compaction method used but the height shall not exceed 250mm. The width of each bench shall be the greater (i) 3 x bench height, (ii) 1.0m or (iii) the width required to ensure adequate compaction by the plant used. Refer to 11950-SK53 for detail.

- 17.5 Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the upright steps of the benching.
- 17.6 Placement and compaction of the fill material shall continue to the level of an adjacent bench before material is placed upon that bench.
- 17.7 Four additional passes of the roller shall be made on the area within two metres each side of the upright face immediately following the compaction of the first layer of fill material on each bench.
- 18.0 Excavation Supports to be Left in Place
- 18.1 No excavation supports are to be left in place.
- 19.0 Mixing of Excavated Materials
- 19.1 Mixing of acceptable and unacceptable excavated material is not permitted.
- 20.0 Fill to Excavated Voids.
- 20.1 Areas of inadequate strength shall be removed and backfilled and replaced with materials placed and compacted in accordance with this Specification.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

21.0 Deterioration of Fill Materials

21.1 If an authorised formation or material deposited as fill subsequently deteriorates due to inclement weather or water ingress (or for any other reason) such that, in the opinion of the Engineer, it would be reclassified as unacceptable and cannot be compacted in accordance with the Contract, the Contractor shall:

- i. Cease work on the material until its condition is such that it can again be classified as acceptable.
- ii. Make good by removing and disposing of the unacceptable material and replacing it with acceptable material.

21.2 Where, in the opinion of the Engineer, earthworks have been adversely affected by the ingress of water during the earthworks contract so as to render the material unacceptable, these works shall be removed and made good at the Contractor's expense subject to test results proving the material to be unacceptable

22.0 Reporting

22.1 For each phase of works, the contractor shall prepare and present to the Engineer on weekly basis a report which provides the following

- § Volume of Fill Placed
- § Per Test: quantity of test required by the specification based on this volume
- § Per Test: quantity scheduled to date
- § Per Test: quantity of results received to date
- § Confirmation that all MCV or MC results are within the required range
- § Per Test: quantity of results that do not comply with the specification
- § An outline of corrective action in relation to any non-compliant results
- § An indication if the corrective action has been completed or is pending (with dates).
- § Confirmation that the corrective action has resolved the issue
- § A spreadsheet based detailing the above and the test results, which is to be traceable between the test/sample location, layer, grid coordinate, a unique sample/ testing ID and the related test certificates.

22.2 On completion of earthworks in each development sub-phase (refer to 11950-SK107 for sub-phase areas), the Contractor will prepare a collated factual Validation Report and submit this to the Engineer. In addition to the items list below it shall also include information needed for completion of the geotechnical feedback report as defined in Design Manual for Roads and Bridges (BMRB) HD22/08 Managing Geotechnical Risk.

The validation report is to include, but is noted limited to, the following:

- a) general description of the earthworks, excavations, placement and compaction methodology and plant used;
- b) quantities of excavated, imported, re-used, treated and disposed materials;
- c) details of remediation and treatment, including quantities, licence arrangements;
- d) the extent of the excavation formation;
- e) details and quantities of any grouting, sealing or similar of historical structures;
- f) surveyed location of all remnant obstructions and week by week progress drawings;
- g) detailed weather conditions;
- h) formation treatment including ground improvement, drainage measures and treatment of soft areas or contamination;
- i) data relating to the relevant compaction trial reports.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- j) application of acceptability criteria and summary of the end product test results for each specific earthworks material placed during the earthworks operations;
- k) a copy of all test results including grid location and level;
- l) actions taken in relation to any test failures and the results of any testing associated with this;
- m) drawings showing the location of each specific earthworks material placed during the earthworks operations on a layer by layer basis, any feature or operation relevant to the earthworks including instrumentation and the location of the trial areas and control tests;
- n) drawings showing the location, extent and contours of all stockpiles formed from surplus site won soils;
- o) an electronic copy of all the test results and monitoring associated with the earthworks operations, including chemical validation results and including those associated with surplus soil stockpiles;
- p) environmental and groundwater monitoring results;
- q) additional requirements of the Local Authority and Environment Agency;
- r) Contamination relevant records including:
 - Description of U1B / U2 material actions
 - Description of residual contamination
 - Volumes of Materials Treated, Disposed of, Imported and Stockpiled (Soil and Water)
 - Description of Waste Management: Quantities, Classification, Licensing and Documentation
 - Formation Inspection
 - Remnant Obstructions
 - QP Declaration for MMP
 - All records required for the MMP validation report
 - Details of Regulatory Liaison and Discussions
 - Waste Records (including classification and Duty of Care)
 - Laboratory analytical results.
 - Photographs

22.2 The Contractor shall make provision for the production of three such validation reports to enable phased delivery of the site.

23.0 Other survey Requirements

23.1 Before starting work the Contractor shall complete a visual survey and update the topographical survey of the site and submit the survey report to the Engineer.

23.2 During works the Contractor shall survey the extents of excavation, retained features (such as obstructions) and underground services (if encountered) prior to backfilling.

23.3a For each development sub-phase the Contractor shall provide a survey of: the full extent of the Excavation Formation Level including any side batters; location of former subterranean structures removed; drainage routes; extent and level of each layer of compacted earthworks layer placed (see below); the Finished Earthworks Level and extent of Engineered Fill; and the extent of surcharge load. All retained exploratory locations and supplementary investigation points shall also be surveyed and included.

23.3b Subject to the prior written agreement of the Engineer and the presentation of an agreed Method Statement, the contractor shall be permitted to omit the survey of each Engineered Fill layer placed on the provision that all the associated earthworks plant is demonstrated to have a working GPS layer control in addition to other earthworks controls on level thickness. The

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

contractor shall still maintain a layer control system such that each layer can be individually identified and sample locations still surveyed (along with other survey requirements noted above/elsewhere). If in the opinion of the Engineer layer control is not being achieved the Contractor shall be required to implement the survey of each layer.

- 23.4 For each development sub-phase on completion of the bulk earthworks and the surcharge loading treatment (as discussed in Appendix 6/13 and including any making good of levels and re-making up to final site level), an as built survey, including level data of the completed works shall be undertaken by the Contractor. All level survey information and an assessment of volumes of excavated, remediated and surplus soil shall be provided to the Engineer. The final 'as built' topographic survey shall include details of the earthworks placement areas, reduced level areas and remaining stockpiles.
- 23.5 Upon request by the Engineer the contractor shall provide cross sections through the works so as to demonstrate (i) the excavation formation level (ii) layer thicknesses and (iii) extent of engineered fill (so as to facilitate construction of any tie in arrangements) and (iv) any side batters. The cross sections are to be geo-referenced, provide level information to Ordnance Datum Newlyn, provided with chainage and produced to scale. The vertical scale may be exaggerated to as to illustrate key features. Any such section are to accompanied with plan showing the extent and orientation of the cross-section along with the chainage. The such plans are to be to scale and to be related to the National Grid coordinate system.
- 23.6 Survey works shall ensure that the reporting requirements given above can be met along with any other survey requirements given in this specification.
- 23.7 All levels shall be related to Ordnance Datum Newlyn and surveys shall be based on the national grid coordinate system and shall be considered with the updated topographical survey.
- 23.8 The maximum error between permanent survey control stations shall not exceed 1:20,000.
- 23.9 A drawing shall indicate each permanent survey control station showing its general location with dimensions to at least three easily recognisable and durable points.
- 23.10 The maximum distance between adjacent spot levels shall not exceed 15 metres. Ground survey spot levels on hard surfaces shall be correct to +/- 10mm r.m.s.e. and elsewhere to +/- 25mm r.m.s.e. Accuracy for linear dimensions is to be +/- 25mm. The drawing shall be supplied in 3D AUTOCAD.DWG format, at a scale of 1:200 on CD ROM. It shall be kept up to date on at least a weekly basis with respect to ground excavations and be made available to the Engineer on request.
- 24.0 Tie in Of Engineered Fill with Surrounding Ground
- 24.1 As part of the excavation works for each development phase as built plans for the surrounding phases area (as provided by the relevant contractor) will be referred to by contractor who will locate any Engineered Fill placed as part of the previous work. The placement and compaction of Engineered Fill as of the current Phase works shall be undertaken by the contractor so as to tie into the any previously placed Engineered Fill. The nature of this tie in detail will be in accordance with Drawing SK 151. Likewise Engineered Fill is to tie in to the Weald Clay
- 24.2 Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the upright steps of the benching.
- 24.3 Placement and compaction of the fill material shall continue to the level of the adjacent bench before material is placed upon that bench.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

- 24.4 Four additional passes of the roller shall be made on the area within two metres each side of the upright face immediately following the compaction of the first layer of fill material on each bench.

APPENDIX 6/8: TOPSOIL

APPENDIX 6/8: TOPSOIL

APPENDIX 6/8: TOPSOIL

Strip topsoil and stockpile. Stockpiles of topsoil and pseudo-topsoil shall be formed in accordance with guidance provided by DEFRA '*Construction code of Practice for the Sustainable Use of Soils on Construction Sites (2009)*'.

APPENDIX 6/12: INSTRUMENTATION AND MONTORING

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

Refer to Appendix 6/13 for instrumentation and monitoring associated with the ground treatment works.

Refer to the CEMP for environmental monitoring requirements

1.0 Post Earthworks Gas Monitoring

1.1 In order to inform the requirement for gas protection measures in the proposed development gas monitoring will be required. Locations are shown on the Instrumentation and Monitoring drawings.

1.2 Installations will be carried out via Dynamic Continuous Sampler (DCS) at the locations indicated on drawings. Two holes will be required at those locations where different depths and/or strata require monitoring (as detailed below). The response zones shall be isolated into one material only and single locations with dual installations shall not be carried out. The following criteria shall be followed:

a) Locations in the Surcharge Area - two installations required. The shallow well shall be progressed through the surcharge, where present, and extend 1m into the underlying Engineered Fill with a 0.5m response zone at the base. The holes shall be sealed with bentonite above the response zone to the surface. The deeper well shall be sealed with bentonite all the way through the clay cap and the response zone shall be 3m long in the underlying fill material (not to extend into the Weald Clay, if encountered).

b) Locations outside the Surcharge Area and over Engineered Fill which is deeper than 2.5m - two installations required at those locations where Engineered Fill exceeds 2.5m depth. The shallow well shall be 1m deep overall with a 0.5m response zone at the base. The deeper wells, where installed, shall be sealed with bentonite to 2m below ground level. The response zone will extend to the base of the Engineered Fill or be 3m in length, whichever is the shallower.

c) Locations outside the Surcharge Area and over Engineered Fill which is less than 2.5m depth, or over natural clay (i.e. no fill materials present) - the well shall be 1m deep overall with a 0.5m response zone at the base.

1.3 The works shall be progressively carried out as phases are completed across the site.

1.4 The works shall be carried out in accordance with BS 8576: 2013 and the UK Specification for Ground Investigation, 2nd Edition, published by Thomas Telford Ltd 2012 with the following amendment to Clause 12.4.1:

1. The following parameters shall be monitored and recorded on each visit to the site. Items iv to viii shall proceed in the order stated and the gas tap shall be closed between the flow and gas concentration stages.

i) Weather conditions on the day of and 24 hours prior to the visit.

ii) Air temperature.

iii) Barometric Pressure on day of visit and preceding 3 days.

iv) Downhole temperature.

v) Downhole pressure and the flow rate should be recorded every minute over a 10 minute period.

vi) Concentrations (% vol) of CH₄, CO₂ and O₂ (ppm) over a 10 minute period with concentrations recorded every minute.

vii) Water level

If water is encountered the Engineer may instruct removal.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

Engineer approval shall be obtained prior to commencement of any laboratory analysis.

The Engineer may instruct that prolonged pumping gas monitoring is undertaken over a period of up to 2 hours on selected wells.

2. Monitoring on-site shall generally be undertaken using portable handheld equipment. The performance specification and accuracy of the equipment employed shall meet the requirements of Table 2 in BS8576: 2013 and be stated in the final report.

3. Any damage to the monitoring installation or incidents of open gas taps upon arrival shall be recorded.

4. The name of the person monitoring shall be stated and wherever possible the same person shall be used on each monitoring visit to maximise consistency. Monitoring visits shall be coordinated so as to include 'worst case' events comprising periods of rapidly falling barometric pressure.

- 1.5 Before construction of each ground gas standpipe the Engineer shall be contacted to agree installation details.
- 1.6 Bulk bag soil samples shall be taken in order to accommodate Forensic TOC analysis that may be scheduled. For the shallow installations one representative samples shall be taken of the Engineered Fill (all sampled soils will be placed into a large bulk bag throughout the full depth of the fill); and for the deeper installations one representative samples shall be taken of the unclassified fill (all sampled soils will be placed into a large bulk bag throughout the full depth of the fill).
- 1.7 The temperature of the soil shall be recorded every 1m on removal of the borehole tool.
- 1.8 Soil descriptions and logs are required in accordance with BS 5930:2015.
- 1.9 Raised covers will be provided and these will be protected via concrete drainage rings or similar (e.g. 0.5m depth, 2m diameter)
- 1.10 Monitoring for flammable gases via Flame Ionisation Detector (FID) is required at 1m intervals during formation of each borehole. Results to be provided on the respective logs.
- 1.11 Provision shall be made for 3 months monitoring at *weekly intervals* on the surcharged areas of the site. Monitoring may be curtailed in areas where initial monitoring results are within acceptable parameters but this will require agreement with the Regulator. Three monitoring visits should be required in total in the single installation DCS 1102 in the non surcharge area which has been subject to a cut and fill treatment.
- 1.12 Groundwater samples shall be obtained for each installation on the first 2 sequential visits and the samples tested for pH, conductivity, ammonia, dissolved oxygen, dissolved carbon dioxide and SO₄. Samples shall be obtained using low flow sampling methods.
- 1.13 Data shall be provided in excel, pdf and AGS 3.1 in full incorporating both the main phase of fieldwork and all subsequent gas and water monitoring visits and iterative phases of chemical analysis. The data shall be checked by the Contractor prior to issue and be accompanied by the error log.
- 1.14 In order to prevent the creation of gas migration pathways and to prevent water ingress all installations will be decommissioned upon completion of the monitoring (as agreed with the

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

regulatory authorities) in accordance with EA guidance (Decommissioning Redundant Boreholes and Wells).

2.0 Large Scale Gas Generation Field Tests (Drum Tests)

2.1 Drum Tests shall be undertaken as per the frequency provided in Appendix 1/5 on the following classes of soils: 1A – 1C and 2A – 2D.

2.2 Scope

2.2.1 This document specifies test methods for assessing the gas generation potential of fill materials used below developments.

2.2.2 This is intended as a test from which the risk associated with ground gas generation from fill materials below developments can be assessed following guidance in documents such as the Local Authority Guide to Ground Gas (CIEH, 2007).

2.2.3 This test provides a measure of the potential amount of biogas (methane and carbon dioxide) that might be released if it is placed in the ground. It is a large scale test that is intended to replicate the actual ground conditions in a site. As such it is not artificially seeded with an inoculum of methanogenic bacteria and any gas generated is the result of bacteria present in the fill already.

2.3 Terms and definitions

2.3.1 For the purposes of this document the following terms and definitions apply.

Biogas – methane and carbon dioxide.

Aerobic – Soil atmosphere that is rich in oxygen.

Anaerobic – Soil atmosphere that does not contain oxygen.

Biodegradation - chemical dissolution of materials by bacteria, fungi or other biological means.

2.4 Principle

2.4.1 When fill material is placed in the ground it will initially be in an aerobic environment as oxygen is trapped in the material. Aerobic degradation of any degradable organic matter occurs and uses up the oxygen. Once anaerobic conditions are established methanogenic bacteria continue to degrade the organic material that is available for degradation until it is used up and gas production ceases.

2.4.2 A representative sample of fill material and groundwater from a site is placed in a sealed steel drum. A sealable gas tap is fitted to the top of the drum to allow gas monitoring from the headspace above the sample. The concentration of methane and carbon dioxide in the headspace of the drum is recorded at set intervals over a period from 20 days to 100+ days.

The temperature during the test is recorded (but is not maintained at a set value). The ambient temperature during the tests must not drop below 10°C (in winter the tests will need to be housed indoors and appropriate safety precautions taken).

2.4.3 The results are reported as litres of biogas per kg of fill material.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

2.5 Equipment

Biodegradation test vessels – a series of steel drums of height 0.85m and diameter 0.57m. This gives 0.22m³ internal volume with an air tight lid and a sealable gas tap. (other dimensions to be agreed with the Engineer)

Balance – capable of weighing mass of sample to +/- 1%

Thermometer – capable of measuring air temperature to +/- 0.5°C

Gas monitor – Meeting the requirements of BS8576: 2013, Guidance on investigations for ground gas – permanent gases and volatile organic compounds (VOCs). Clause 9.3 and Table 2. The sample pump rate should be stated.

2.6 Sample Size

2.6.1 The sample should be sufficient to fill a 0.22m³ drum and leave a 100mm deep headspace at the top of the drum when loosely compacted down in the drum. The weight of the sample should be recorded.

2.7 Procedure

Filling

2.7.1 A steel drum is filled with the material to be tested.

2.7.2 The materials shall be loosely compacted into the steel drum to remove all large voids and leaving a 0.1m depth of headspace (this equates to 0.025 m³ headspace volume). The mass of each material used to fill the barrels should be measured using a balance to determine the approximate wet bulk density of the material within each barrel. The moisture content of the materials placed into the barrels will be measured using either a theta probe or by sending samples to a laboratory.

2.7.3 Groundwater from the site should be used to fill the barrels with at least 20 litres of water (to the top of the soil).

2.7.4 Following emplacement of the materials into the barrels and filling with water, the barrel lids should be secured and sealed using a volatile organic compound (VOC) free sealant. A small hole (0.5mm diameter) should be drilled into the top of the barrel lid for insertion of a gas tap. The gas tap should be sealed into the barrel lid using a VOC free sealant. Filling of the drum and sealing and securing of the gas tap should be carried out on the same day.

2.7.5 Filled barrels should be located in a safe location agreed with site staff where there is no need for disturbance of the barrels during the test period. The ambient temperature during the tests should not fall below 10°C for any significant period of time and therefore a heated container shall be provided, if required, to ensure temperature does not fall below 10°C.

Biogas measurement

2.7.6 Following filling of the barrels on day zero, measurements of ground gas concentrations should be made twice per week at three day intervals (e.g. Monday and Thursday) over a period of 100 days. Each measurement event shall last for exactly 5 minutes (if this is amended then the time shall be recorded but amendments must be avoided where at all possible). Concentrations of ground gases will be recorded each minute over the 5 minute period. The tests may be extended up to a total period beyond 100 days if required. The date of the first test should be recorded as T1 and dated, the second as T2 and dated, and so on.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

2.7.7 Concentrations of ground gases will be measured using the gas monitor. Gases measured should be methane (CH₄), carbon dioxide (CO₂), oxygen (O₂), carbon monoxide (CO) and hydrogen sulphide (H₂S). Flow measurements are not required but the differential (may be referred to as borehole pressure on some gas monitors) is required. The temperature of the barrels should be recorded during each measurement event.

2.7.8 To measure the temperature of the soils within the drum one thermometer/thermocouple should be attached to the side of each of the drums and protected as necessary. The bulb/thermocouple wire leg junction should be thermally protected from the elements using insulation spay foam or similar.

Reporting for Drum Tests and Gas Monitoring

2.7.9 The test report should provide the following:

1. Date of test
2. Description of material tested and source
3. Cumulative record of biogas concentration and number of sampling events.
4. Temperature record over period of test

2.7.10 The test results shall be provided in an excel spreadsheet that is updated each time measurements are taken. The results should be provided in tabular form in the spreadsheet in a layout that is agreed with the Engineer.

2.7.11 The results of each weekly monitoring round will be forwarded to the Engineer on completion.

2.7.12 The Drum Test is for information and assessment purposes and the results will be used to inform remedial and re-use decisions.

3.0 Flux Chamber Tests

Flux chamber tests shall be undertaken to measure methane emissions, as shown on Instrumentation and Monitoring drawings. For the Surcharged Area the tests will be carried out over the surface of the excavated formation layer, including over dig, and prior to installation of Engineered Fill. If the results indicate a potential gas risk then the monitoring shall be repeated on completion of the installation of the engineered fill and prior to the installation of the surcharge. For non surcharged areas they shall be carried out across the finished formation layer. The flux chamber tests shall be undertaken in accordance with the guidance in the Environment Agency LFGTN 07, Guidance on monitoring landfill gas surface emissions. The location of the tests shall be agreed with the Engineer in advance. A method statement for the works shall be agreed with the Engineer for prior approval. If the Contractor is not able to carry out the works then the work shall be sub contracted, at no additional cost to the client, to a suitable specialist who must be approved by the Engineer prior to appointment.

4.0 Surface Emission Tests

4.1 A surface emission mapping survey shall be carried out to measure methane emissions.

4.2 For Surcharged Areas the survey shall be carried out over a 5m grid (i.e. on a series of traverse lines spaced at 5.0m centres). The survey will be carried out over the surface of the excavated formation layer, including over dig, and prior to installation of Engineered Fill. If the results indicate a potential gas risk then the monitoring shall be repeated on completion of the installation of the engineered fill and prior to the installation of the surcharge.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

- 4.3 For non surcharged areas the survey shall be conducted on a 25m grid across the finished formation layer
- 4.4 All measurements shall be taken at 10mm above ground level with a laser diode methane detector calibrated to detect methane and with a detection threshold of 1 ppm. The instrument shall have a response time less than 5 seconds. Readings shall be taken every 3 seconds and shall be time stamped with the time and GPS location.
- 4.5 The survey work shall be carried out by an experienced and competent technician who has undertaken similar work for compliance testing on licensed landfill sites. A method statement for the works will be submitted to the Engineer for prior approval. If the Contractor is not able to carry out the works then the work shall be sub contracted to a suitable specialist who must be approved by The Engineer prior to appointment. The results shall be reported as a table of results alongside a contour plot of the emissions recorded. The wind speed/direction, temperature, atmospheric pressure and rainfall on the site at the time of the survey shall be recorded.
- 5.0 Validation Trial Pits in Surcharged Area
- 5.1 At the excavation formation level and prior to construction of the Engineered Fill, trial pits shall be excavated to 4m below excavation formation level across landfilled areas on an approximate 50m grid and/or where elevated TOC concentrations and/or elevated methane concentrations were detected. The locations are shown on the Instrumentation and Monitoring drawings. The purpose of these is to inspect for both gaseous material and soft / organic material that could present an ground settlement issue. The trial pits will require inspection by the Engineer and therefore the Contractor will provide 5 days' notice of the works. All trial pits shall be surveyed in accordance with this specification (one survey point per trial pit location is sufficient).

Gas Related Pits

- 5.2 Composite samples of representative soils from the excavated soils shall be taken for one Forensic TOC and one Drum Test per trial pit.
- 5.3 If Forensic TOC analysis and/or assessments associated with the Drum Tests indicate Unacceptable Material then these may require excavation as part of a hot spot exercise and the soil will be stockpiled for further assessment. The Contractor shall therefore allow time in the programme for results to be returned and assessed to accommodate this potential outcome.

Geotechnical Trial Pits

- 5.4 Where shown on drawings, trial pits shall be excavated to 4m below excavation formation level in areas where the ground investigation identified potentially compressible material beneath the excavation formation level. The pits are required to determine whether the zones represent significant soft spots that require excavation and replacement with Engineered Fill.
- 5.6 Subject to the Engineers instruction the Contractor shall excavate any soft or highly degradable materials and replace with Engineered Fill.

APPENDIX 6/13: GROUND IMPROVEMENT

APPENDIX 6/13: GROUND IMPROVEMENT

APPENDIX 6/13: GROUND IMPROVEMENT

- 1.0 Geotechnical Improvement by Placement of Engineered Fill and Preloading by Surcharge
- 1.1 General
- 1.1.1 Geotechnical improvement will not be required where the excavation formation reveals the presence of undisturbed natural strata comprising firm clay or medium dense sand or better. Geotechnical improvement will be required in areas where Made Ground is encountered at Excavation Formation Level. The purpose of the ground treatment is to ensure that the resultant works meet with the 'Performance Criteria' agreed with the Client (the performance criteria agreed with the client comprise total post construction settlements of not more than 75mm a differential movement of not more than 1/100, a permeability of not more than 10^{-7} m/s and a CBR value of 3% as the final and penultimate layers.
- 1.1.2 To ensure that the post treatment load-settlement characteristics of the treated materials are within the performance criteria mentioned above, geotechnical improvement is to be undertaken by forming: (i) pre-loading and surcharge loading of the pre-existing Made Ground; (2) the placement and compaction of fill materials to End Product criteria, as outlined below, totalling a 2m minimum thickness.
- 1.1.3 This fill is to be placed and compacted so as to form an Engineered Fill. The Engineered Fill is to have the following properties: (i) a permeability of less than 10^{-7} m/sec (ii) an air voids content of not more than 5% (increasing to not more than 10% where below 2m below proposed Finished Earthworks Level); (iii) relative density of not less than 95% Maximum Dry Density based on the appropriate compaction test for the material type (see Appendix 6/1); and (iv) a CBR value of not less than 3% at as placed moisture content in the upper 2 layers.
- 1.1.4 The earthworks operations undertaken to form the Engineered Fill outlined above shall be informed by compaction trials as detailed in Appendix 6/3. The compaction trials shall be witnessed by the Engineer. The Engineer will also witness the construction of installations and monitoring devices associated with the geotechnical improvement works.
- 1.1.5 The works shall be undertaken in the sequence stated in Appendix 6/3.
- 1.1.6 All earthworks and associated compliance testing shall be carried out in accordance with Appendix 6/3. The placement and compaction of the Engineered Fill will be monitored full time by the Engineer.
- 1.1.7 If unforeseen ground conditions or unforeseen responses to the treatment are encountered then the Engineer shall be notified immediately.
- 1.1.8 In the event of a test failure the Contractor shall provide a full comprehensive interpretation of the nature of the failure based on the test results and propose suitable remedial action. In the event of a test failure the Engineer shall be verbally informed immediately (and no later than 48 hours in writing), all work should cease in the associated area until a full comprehensive interpretation and solution has been found to rectify any such failure.
- 1.1.9 Prior to the commencement of the construction of the surcharge embankment the Contractor shall confirm their proposed sequence and phasing of embankment construction: this shall indicate the location and phasing of each discrete embankment location. Where not otherwise detailed the Contractor shall construct each sequential surcharge embankment with a full height 5m overlap with the previous embankment when these are sequentially constructed.

APPENDIX 6/13: GROUND IMPROVEMENT

- 1.2 Formation of Engineered Fill
- 1.2.1 The formation of the fills is detailed in Appendix 6/3.
- 1.3 Surcharge Construction
- 1.3.1 The lower 250mm of surcharge material shall be constructed from compacted Engineered Fill placed and compacted in accordance with the Appendix 6/3. Upon placement and compaction this upper surface of this 250mm Engineered Fill shall be surveyed. Other materials are then to be placed as discussed below.
- 1.3.2 The surcharge fills are to be placed to levels and over areas indicated on the Drawings and Sections provided by the Engineer.
- 1.3.3 No surcharge materials shall be placed closer than 10m to any existing structures, services or road pavements that are to be retained or that are off site.
- 1.3.4 Above the basal 250mm of Engineered Fill outlined above, the surcharge material is to comprise either Class 1 or Class 2 materials, as defined in the Specification for Highway Works (SHW) or, subject to the approval of the Engineer, (iii) Class 5 material as defined in the SHW. A minimum of 2 weeks shall be allowed for the Engineer to approve Class 5 material after the Contractor has presented supporting information. The surcharge materials shall be placed and compacted in layers not more than 500mm thick and, to confirm the bulk density of such surcharge materials, insitu density tests are to be undertaken at a frequency of 2 per 2000m³ for each 1m of lift, the test depth for these shall be 300mm below the then current surface of the works. Compaction shall be undertaken using the same plant and number of passes as used for compaction of each material type used in forming the Engineered Fill (i.e. same compactive effort as used for each layer of the Engineered Fill but layer thickness will be greater for the surcharge fill). Alternatively, the surcharge can be constructed from Engineered Fill as detailed in Appendix 6/3. In either case, the bulk density information is to be provided to the Engineer who may instruct alterations to the surcharge height so as to ensure an adequate surcharge pressure.
- 1.3.5 The edges of the surcharge are to be formed at slopes of 1 in 3 unless otherwise agreed by the Engineer.
- 1.3.6 The contractor is responsible for controlling the rate of construction so as to prevent temporary slope failure due to the temporary increase in pore pressure arising from the earthworks. The contractor is to use the piezometers proposed on drawings and is to install any additional piezometers as he may require so as to ensure adequate control of the works. Considering his governing criteria for the control the works vs. piezometric level along with associated calculations. The contractor shall employ a suitably qualified temporary works designer to provide this based on established soil mechanics theory and to be referenced accordingly.
- 1.3.7 The surcharge shall be trimmed to falls to shed rain water and the surface sealed to limit infiltration. The Contractor shall provide temporary drainage at the base of the surcharge to collect run off and to carry any surface water away from the base of the surcharge.
- 1.3.8 The full extent of the surcharge and its side slopes shall be surveyed upon completion.
- 1.3.9 Each surcharge treatment zone is to be left insitu for the minimum duration shown on plans after completion of construction to enable the amount and rate of settlement to be monitored and hence establish that 90% of primary consolidation has been achieved and any residual

APPENDIX 6/13: GROUND IMPROVEMENT

settlement is approximately linear when plotted against log time. The duration can be altered by the Engineer depending on the findings of the monitoring data.

- 1.3.10 If 90% consolidation and/or linear settlement vs. log time has not been established at the end of the period shown on drawings, the Engineer will instruct: (i) additional time for surcharging; (ii) increased surcharge loading; or (iii) acceptance of the anticipated further settlement. Conversely if these criteria are achieved sooner this period may be shortened by the Engineer and it should be recognised therefore the early provision of specified data could provide the Engineer the option to reduce the surcharge programme.
- 1.3.11 If the surcharge is constructed as a number discrete panels there is to be a 5m overlap of each individual panel constructed i.e. surcharge panels shall be constructed such that the embankment (at its full height) extends 5m beyond the shoulder of any previously placed surcharge embankment.
- 1.3.12 Following completion of treatment work, panel load tests may be required by the Engineer. Test panels will comprise earth mounds 13m x 13m x 2m high with additional side slopes constructed at 1:3. A settlement plate will be installed centrally beneath the base of the panel to the Engineer's requirements.
- 1.4 Permanent Datum
- 1.4.1 Two permanent datum's are required to provide a reference for the measurement of ground levels and instrumentation and to provide crosschecks with one another. The datum's are to be fixed into deeper, competent ground and isolated from any soft or compressible strata or strata subject to shrink-swell movements. These datum's are to be as per Fig 6 of BRE Digest 386 'Monitoring Building and Ground Movement by Precise Levelling', are to be at least 25m from existing or recently removed trees and to be secured at a minimum depth of 6m. The datum's shall be fenced off with a fence comprising at least three wooden stakes, 75mm square, preserved in accordance with BS8417, firmly bedded in the ground and stoutly cross-braced and projecting at least 1m above ground level. The woodwork is to be brightly painted.
- 1.4.2 The Contractor shall agree the locations of the permanent datum's with the Engineer 2 weeks ahead of their installation. It may be permissible to utilise datums from previous phases of work, subject to discussion with the Engineer, in which case agreement must be sought two weeks prior to commencement of earthworks or the installation of instruments, whichever is the earliest. The datums are to be located so as to minimise risk of damage from the proposed works, with due regard to any constraints as advised by the client and in areas where the contractor can be sure of security throughout the duration of the monitoring period. The installation of permanent datum's shall be completed prior to the installation of instruments and the commencement of earthworks
- 1.4.3 The level of the permanent datum's shall be established by the levelling techniques with reference to agreed benchmarks or survey stations in the vicinity. Levelling shall be closed back to the benchmarks to check accuracy.
- 1.4.4 The level value and co-ordinate position shall be measured three times soon after installation of the datum's and shall be checked at intervals to be established by the Engineer.
- 1.4.5 The following data shall be recorded for the permanent datum's:
- § Reduced level of datum (m OD)
 - § Plan position (National Grid Co-ordinates)

APPENDIX 6/13: GROUND IMPROVEMENT

1.5 Treatment Monitoring

- 1.5.1 Installation of instruments will be required prior to and after surcharge construction in order to monitor key parameters during the placement of the fill and the subsequent monitoring period. Rod settlement gauges shall be constructed at an approximate grid spacing of 40m. The RSGs and piezometers are to be installed at positions and levels indicated on drawings.
- 1.5.2 The Contractor shall be responsible for following the manufacturers' instructions and the requirements of this specification in the installation, calibration and testing of all measuring instruments and equipment, which shall be carried out in the presence of the Engineer.
- 1.5.3 The Contractor shall inform the Engineer at least 10 working days prior to undertaking the installation of the equipment. The Contractor shall make due allowances in his construction programme for delays which may arise on account of the installation of the instruments and of their maintenance.
- 1.5.4 The Contractor shall provide a geotechnical engineer or engineering geologist, as approved by the Engineer, experienced in the installation of geotechnical instrumentation for full time supervision of the drilling of boreholes and installation of the instrumentation equipment. The Contractor shall instruct a member of his engineering staff in the use of the equipment.
- 1.5.5 Boreholes for instruments are to be formed by an AGS accredited ground investigation sub-contractor in accordance with the UK Specification for Ground Investigation (Second Edition). They may be drilled by any method provided that it results in a clean and stable hole of the required diameter to the correct depth. Boreholes shall be cased to their full depth unless strata are sufficiently competent for the hole to stay open. Drilling mud or polymer additives shall only be used with the prior approval of the Engineer. The Engineer is to be given 2 weeks notice if mud or polymers are proposed. In the case of piezometer installation, drilling mud or polymer additives shall not be permitted.
- 1.5.6 During drilling, care shall be taken to ensure that the minimum material is lost from outside the casing. Surging casing shall not be allowed and flushing of drilling water up the outside of the casing shall be minimised.
- 1.5.7 The method of borehole formation, including the procedure for advancing casing, shall be submitted to the Engineer for approval 2 weeks before the commencement of the works. The works shall not commence until such time as the Engineer has approved the proposals.
- 1.5.8 A small disturbed sample and a bulk disturbed sample shall be taken during drilling of the boreholes at 1.0m centres and at every change in stratum. SPTs are to be performed at 1m intervals. If an SPT test is undertaken at the base of a borehole, it shall be ensured that the borehole extends at least 200mm beyond the base of the SPT test and cleaned out. A geotechnical log shall be produced in accordance with BS5930:2015 from the samples and borehole records submitted to the Engineer one working day after drilling has been completed at that location.
- 1.5.9 For all instruments placed in boreholes, grouting is required for part or all of the borehole during installation. The grout shall be a bentonite: cement mixture with sufficient water to achieve a pumpable mix. For piezometers it shall be ensured that grout placement does not affect the response zone.
- 1.5.10 Grout shall be poured or pumped into boreholes using a tremie pipe.

APPENDIX 6/13: GROUND IMPROVEMENT

- 1.5.11 All instruments shall be labelled with their reference number at the location where readings or measurements are to be taken. The labelling shall be permanent using a method or material to be agreed with the Engineer.
- 1.5.12 The Contractor shall provide suitably qualified and competent staff to take readings of instruments during construction and provide measurements/data at the time the instruments are read. The Contractor shall submit names and evidence of competence of personnel to carry out the instrumentation installation and commissioning for the approval of the Engineer before the commencement of the Works.
- 1.5.13 All records produced for the instrumentation must include the following data:
- § Project name
 - § Contract name and number
 - § Instrument reference number and type
 - § Dates of installation, reading or summary
 - § Times of installation or reading
 - § National Grid co-ordinates
 - § Personnel responsible for undertaking the monitoring
 - § Any relevant comments or remarks
- 1.5.14 The Contractor shall prepare an installation record sheet for each instrument installed. The format of the sheet shall be prepared by the Contractor and submitted to the Engineer for approval at least one week before installation commences. The record sheet shall include the following information in addition to the general information required:
- § Existing ground level at the time of installation
 - § Location in plan and elevation – Planned and 'As Built'
 - § Orientation – Planned and 'As Built'
 - § Lengths, widths, diameters, depth and volumes of backfill – Planned and 'As Built'
 - § Equipment used, including diameter and depth of any drill casing used
 - § Spaces for necessary measurements or readings required during installation to ensure that all previous steps have been followed correctly, including acceptance tests
 - § A simplified log of ground conditions (obtained during each boring)
 - § Type of backfill used
 - § Weather conditions
 - Space for notes, including problems encountered, delays, unusual features of the installation and any events that may have a bearing on instrument behaviour
 - § record of commissioning information and readings
 - § Any colour coding used
- 1.5.15 The Contractor shall submit to the Engineer a copy of each installation report sheet within one working day of completion of the installation, including taking of base readings.
- 1.5.16 The Contractor shall maintain the instrumentation in working order throughout the Contract or until the Engineer informs him that monitoring is no longer required. The Contractor shall ensure that the frequency of monitoring is adequate and in compliance with all requirements for control of construction and associated monitoring of constructions, as detailed on the Drawings.
- Settlement Gauges
- 1.5.17 Steel plate settlement gauges (300mm square) shall be placed at excavation formation level. Monitoring of these and analysis of the data obtained should enable determination as to when the rate of settlement has suitably reduced and therefore when the surcharge can be removed.

APPENDIX 6/13: GROUND IMPROVEMENT

- 1.5.18 The plates shall have a welded $\frac{3}{4}$ " BSPF socket and are to be connected to reference rods which will extend through the surcharge materials. The steel rods are to be in 1m lengths and to have a 25mm OD with a $\frac{3}{4}$ " BSPF thread and external socket. The settlement gauge base plate and first length of rod shall be placed as early as possible during the earthworks, i.e. before any filling has taken place in the vicinity of the settlement gauge location. Extension lengths shall be installed when the level of the surrounding materials has been brought up to 250mm below the top of the preceding length. Levels shall be taken of the top of the rod and the surcharge fill adjacent to the gauge (i.e. outside the manhole ring) on each occasion. When rods are extended, levels (including the level of the base plate upon addition of the 1st rod) shall be measured immediately before and immediately after adding the extension. Good levelling practice should be observed.
- 1.5.19 Protective tubes will be placed around the reference rods as the surcharge are placed. These are to have an internal diameter of 52mm. In addition manhole rings shall be placed around the settlement gauges and associated rods, which are to be brought up progressively with the formation of the surcharge. Between the manhole ring and the protective tube, Class 6L (sand) shall be evenly placed. This is also to be brought up at the same rate as the construction of the surcharge. Care will be taken so as to prevent the sand from entering the protective tube.
- 1.5.20 Any fill placed around a settlement gauge should be placed in a 5m x 5m area using small manoeuvrable suitably sized compaction plant to avoid the risk of disturbance to the monitoring rod. The fill should be placed in layers of a thickness appropriate to the materials and compaction plant used. A method statement shall be provided by the contractor for approval by Engineer 2 weeks prior to the works.
- 1.5.21 The following data shall be recorded for the settlement gauges and similar settlement monitoring equipment:
- § Original ground level at the gauge location (m OD)
 - § Reduced level of the top of the rod (m OD) and length of rod(s) from this level to base plate (m)
 - § The reduced level of the base plate (mOD)
 - § Reduced level of the ground adjacent to the gauge (m OD)
 - § A record of the height of fill placed and the start/finish dates of filling
 - § The total thickness of the fill (m)
 - § A record of extensions to the gauge, including before/after reduced levels of the gauge
 - § The settlement of the plate relative to base readings and previous readings (m)

Piezometers

- 1.5.22 Prior to placing Engineered Fill vibrating wire piezometers (VWP) shall be installed from the base of the excavation. Piezometers will be installed in the underlying pre-existing Made Ground materials. The piezometer locations and response zones are shown on drawings.

APPENDIX 6/13: GROUND IMPROVEMENT

- 1.5.23 The piezometers shall be of the VWP-3000 type and are to be installed by a specialist ground investigation subcontractor who is a member firm of the AGS. Piezometers are to be installed in accordance with the UK Specification for Ground Investigation (2nd Edition). The equipment shall be installed strictly in accordance with the manufacturer's instructions.
- 1.5.24 Prior to installation of piezometers, the piezometer tips shall be thoroughly saturated by boiling them in previously de-aired water. The piezometer shall be assembled and connected to the tubing while still underwater and the entire arrangement kept saturated and filled with de-aired water for at least 24 hours and until it is installed.
- 1.5.25 The following data shall be provided from the VWP readings:
- § Water pressure reading (m water)
 - § File name of data stored on the data logger
 - § Reduced level of piezometer tip as installed (m OD)
 - § Reduced level of ground adjacent to piezometer (m OD)
 - § Estimated or measured settlement of piezometer tip (m)
 - § Water head (m OD)
 - § Water level (m OD)
 - § Change in water head relative to base reading (m)
- 1.5.26 Initial readings shall be taken to demonstrate when conditions have stabilised following installation. Further readings shall be taken as given in Table 1. Monitoring and analysis by the contractor of this data should enable the rate of land raising to be controlled by preventing a build-up of destabilising excess porewater pressures (which could otherwise result in an increased risk of shear failure) and will aid the Engineer in identifying when the rate of settlement has been suitably reduced. The piezometers shall be remotely monitored using data loggers and associated equipment (Contractor to submit proposals 2 weeks ahead of installation).
- 1.5.27 Available ground investigation data suggests that the groundwater level at the site can vary considerably with location and with time. This may limit the usefulness of the piezometer data. This matter is to be kept under review by the Engineer.

APPENDIX 6/13: GROUND IMPROVEMENT

General Monitoring Requirements

- 1.5.28 All level monitoring and surveying should be accurate to within ± 1 mm in the vertical plane and ± 2.5 mm in the horizontal plane.
- 1.5.29 Monitoring of settlement gauges and piezometers is to commence at least 5 days before earthworks materials are placed. The frequency of monitoring observations is given in Table 1 below. In all cases the frequency of readings may be altered at any time by the Engineer if circumstances so dictate.

APPENDIX 6/13: GROUND IMPROVEMENT

Table 1: Instrument Reading Frequency Summary

Instrument	Initial Reading(s)	Commence Sequential Readings	Initial Sequential Frequency ¹	Subsequent Frequency ¹	Surcharge Removal ^{1,2}
Settlement Gauges	Survey position and level immediately following installation	5 days prior to placement of earthworks in the surrounding area	Daily (Monday to Friday) until 15 days have elapsed past completion of surcharge earthworks. Then twice weekly until one month has elapsed.	Weekly for the three subsequent months and then monthly	Daily until 2 weeks after the surcharge is fully removed, then as advised by the Engineer subject to results from the 2 week period .
Piezometers	Daily following installation until stable reading obtained. Readings can then be suspended until commencement of sequential readings	5 days prior to placement of earthworks in the surrounding area	Daily (Monday to Friday) until 15 days have elapsed past completion of surcharge construction. Then twice weekly until one month has elapsed	Weekly for the three subsequent months and then monthly	Daily until 2 weeks after the surcharge is fully removed, then as advised by the Engineer subject to results from the 2 week period.

Note: 1. This period may be extended by the Engineer if monitoring suggests insufficient diminution of settlement rate or pore pressures.
2. The surcharge removal and heave monitoring is a two phase operation as outlined below.

- 1.5.30 For each 40x40m area of treatment the twice weekly, weekly and monthly observations are to be made on the same day. To achieve this when different installations are completed at different times in one location, an initial interval shall be reduced to achieve synchronisation, rather than extended.
- 1.5.31 During the monitoring programme, the Contractor shall report on results twice a week from initial reading through to 15 days after completion of the surcharge placement, and then at weekly intervals.
- 1.5.32 The Contractor shall be responsible for preparing a final factual report (paper and pdf copy) of the instrumentation, installation and monitoring, and including graphical plots of the monitoring results. The draft reports shall be forwarded to the Engineer for comment within 2 weeks following physical completion of the works. The Contractor shall forward 2 bound copies of the final report to the Engineer the within 2 weeks of receipt of any comments from the Engineer.

Calibration Requirements

- 1.5.33 The Contractor shall test the whole instrumentation installation by taking three sets of base readings at suitable intervals and shall provide two copies of the results to the Engineer and shall satisfy him that all instruments are functioning correctly and readings are repeatable before the associated earthworks are commenced.
- 1.5.34 After installation, the functioning and monitoring of each instrument shall be demonstrated to the Engineer, including the recording of measured values using the appropriate readout device.

APPENDIX 6/13: GROUND IMPROVEMENT

As part of the commissioning, three sets of readings shall be taken and compared. If there are significant differences or anomalies, then further readings shall be taken. For instruments installed prior to the earthworks commencing this process is to be repeated at the start of the earthworks. Once two sets of comparable data have been obtained, these shall be averaged to form the base reading, representing the conditions before the start of earthworks.

- 1.5.35 In cases where instruments are installed during earthworks, three sets of readings shall be taken in quick succession and the results compared. These results shall be used to provide base readings in a manner to be agreed with the Engineer.

Protection of Instruments

- 1.5.36 The Contractor shall take all necessary precautions to protect the instruments and maintain the instruments in good working order after commissioning. For all instruments which project through and above the fill, special precautions shall be taken to provide protection from vehicles and plant, including substantial and readily visible barriers at a distance of no less than 750mm around each instrument

- 1.5.37 Heavy compaction equipment shall not approach within 5m of projecting instruments. Compaction around any cabling to be by hand held tools and to be in accordance with the manufacturer's requirements.

- 1.5.38 Cables and connections are to be of a form that can withstand the subsequent placement of materials settlement and weathering they are to have appropriately welded joints and protection as needed to ensure they do not malfunction under loading of soils and traffic. Adequate cable slack shall be provided during installation to prevent failure as a result of stretching. If the specialist installer wishes to propose an alternative design to ensure the protection of cables this shall be submitted to the Engineer with an associated method and design 14 days prior to works and subject to the Engineer's approval. The cabling shall not be placed within the Engineered Fill as this could present a potential hydraulic pathway.

- 1.5.39 Adequate protection measures shall be provided for all new and existing instrumentation to protect it from vandalism or damage during construction.

- 1.5.40 Any damage to instruments or cabling shall be reported immediately to the Engineer. Damaged instruments and cabling shall be replaced or repaired by the Contractor at his own expense within seven days of its reported damage.

- 1.5.41 Should any settlement monitoring location be damaged or moved, a new level should be taken on the damaged rod immediately and the incident reported to the Engineer. Earthworks must be suspended in that area until the problem has been resolved. Replacement of the damaged rods and plates may be required.

1.6 Surcharge Removal

- 1.6.1 The surcharge is only to be removed when instructed by the Engineer based on 1.3.9 and 1.3.10. As noted above the basal 250mm of the surcharge materials will comprise Engineered Fill. Based on a survey of the upper surface of this Engineered Fill (at the time of placement as discussed in Appendix 6/13 C1.3.1) and monitoring results the contractor shall confirm that the upper surface this Engineered Fill is above finished earthworks level. The contractor shall provide this confirmation a least 1 week before excavation of the surcharge commences.

- 1.6.2 The surcharge removal is to be done in two stages comprising (i) lowering the surcharge mound by 2m and (ii) then removal of the remaining surcharge materials down to finished earthworks level. During and after each stage of soil removal the settlement gauges are to be

APPENDIX 6/13: GROUND IMPROVEMENT

monitored. For each stage this monitoring is to continue until, to the satisfaction of the Engineer, any heave has effectively ceased.

- 1.6.3 During and after surcharge removal operations great care shall be taken by the contractor so as to prevent damage to the RSGs or other effects that could influence the results (e.g. vibrations from plant, including haulage plant) and temporary haul roads are to be constructed no closer than 10m from the RSGs. Such requirements apply to the RSGs until the Engineer instructs their removal. The process for maintaining the settlement gauges during the excavation of the surcharge mound shall be proposed by the Contractor and agreed with the Engineer not less than 2 weeks prior to the removal of surcharge.
- 1.6.4 At the start of the surcharge removal operation all the RSGs are to be resurveyed. As the surcharge is removed the RSGs are to be sequentially dismantled in such a manner that they can still be used to determine movements of their respective base plates. This is to be a closely controlled operation undertaken by the contractor. Levels shall be taken of the top of the rod and the fill adjacent to the gauge on each occasion. When rods are removed, levels (including the level of the base plate upon removal of the final rod) shall be measured immediately before (on the rod to be removed and that left insitu) and immediately after removal (on the rod length left insitu). Good levelling practice shall be observed.
- 1.6.5 Removal of the surcharge shall be a controlled operation so as to prevent damage of the underlying Engineered Fill. Once the surcharge has been removed and once instructed by the Engineer based on 1.6.2 above, the Rod Settlement Gauges are to be grubbed out and reinstated with Engineered Fill so as to ensure that the Engineered Fill is as specified and its integrity as a low permeability layer maintained. Once the surcharge is removed down to final formation the formation is to be inspected for any soft spots or relict surcharge materials, which are to be removed and placed with Engineered Fill placed and compacted in accordance with this specification. The whole surface is to be recompacted using the same compaction technique used in its initial construction, the surface surveyed and, if required, brought up with the same materials placed and compacted in accordance with the specification.
- 1.6.6 During surcharge removal, the Contractor shall report on monitoring results (see Table 1 above for monitoring frequency) daily from commencement of surcharge removal in the vicinity of the RSG through to 2 weeks after complete removal. The need for and frequency of any continued monitoring and reporting shall be reviewed by the Engineer after the initial 2 week period.
- 1.7 Survey of Completed Works
- 1.7.1 On completion a full 3D topographic survey referenced to ordinance datum is to be undertaken to enable a cross check against design formations to be undertaken.
- 1.8 Reporting of the Surcharged Area
- 1.8.1 See CI 1.5.31, CI 1.5.32 and 1.6.6 for frequency of reporting associated with monitoring.
- 1.8.2 On completion of the works a detailed Ground Treatment Completion Report will be provided by the Contractor for each sub-phase (refer to 11950-SK107 for sub-phases) subject to surcharge treatment. The reports will describe the procedures undertaken at the site and include all relevant factual data for the ground treatment works. They shall also include information needed for completion of the geotechnical feedback report as defined in Design Manual for Roads and Bridges (BMRB) HD22/08 Managing Geotechnical Risk.
- 1.8.3 This reports shall include all relevant site records and illustrate that the remedial and ground preparation works have been carried out in accordance with the design. The report are to be provided at the conclusion of the works (including the surcharge/monitoring period).

APPENDIX 6/13: GROUND IMPROVEMENT

1.8.4 The reports shall include but not be restricted to:

- As required by Appendix 6/3 S22
- any supplementary ground investigation undertaken;
- the design information and design revisions or additional design work that arise during the works;
- all records referred to elsewhere in this specification;
- full details of all instrumentation and associated ground conditions;
- all monitoring data associated with the works.

1.8.5 The reports shall also include:

- daily record sheets to include a summary of the day's activities in relation to the ground improvement operations;
- progress photographs;
- general description of the works completed, including any earthworks, excavations (including excavations of hard obstructions or foundations), placement and compaction methodology and plant used;
- information on weather conditions;
- application of acceptability criteria and a summary of control test results sufficient to allow interpretation by the Engineer for each specific earthworks material placed during the ground improvement operations;
- geotechnical test certificates and monitoring data including location and level, with associated drawings;
- as built surveys (to include drawings);
- drawings showing the location and level of each specific earthworks material placed during the ground treatment operations, any feature or operation relevant to the works including instrumentation and the location of trial areas and control tests;
- Full as-built details of all monitoring instruments installed and associated exploratory hole records;
- All monitoring data relating to surcharge monitoring or as otherwise required by this Specification.

APPENDIX 6/13: GROUND IMPROVEMENT

APPENDIX A

EARTHWORKS – SUPPLEMENTARY INFORMATION FOR SITE SURVEYOR

- Set out and establish the level and coordinates of a stable datum monitoring point remote from the influence of the works to which subsequent monitoring will be related.
- Set out monitoring station plate positions, using suitable co-ordinates and record the existing ground level.
- When the monitoring station plate is positioned record precisely the level of the base plate, plus the top of the first rod fitted.
- During the earthwork and surcharge operations, monitor on a daily basis the precise level of the top of rod on each monitoring station plate together with the surface level of the adjacent Engineered Fill.
- When monitoring station rods are raised during earthworks, level the top of the existing rod, top of the new rod placed and the then existing adjacent ground level.
- Survey the positions extent and levels of completed surcharge mounds for checking against design.
- Survey the finished level of the engineered material using a 25m grid and check that the design tolerances have been achieved.
- Survey the finished level of the base of the treated material using the 25m grid and check that the design tolerances have been achieved.
- Survey compliance test locations and levels within the Engineered Fill.
- Provide the foregoing services for any trial loading panels specified.
- All monitoring station levels should be recorded to an accuracy within + or – 1mm using an automatic barcode reading level.

APPENDIX 6/14: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND ENVIRONMENT

APPENDIX 6/14: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

TABLE 6/14: (11/04) LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

	Units	Upper 2.00m Engineered Fill*	General Fill Beneath 2.00m final earthworks level **
GENERAL REQUIREMENTS			
Asbestos ^c	% weight	<0.001	<0.1
Arsenic ^a	mg/kg	37	n/a
Cadmium ^a	mg/kg	26	n/a
Chromium (total)	mg/kg	910	n/a
Lead ^a	mg/kg	200	n/a
Mercury (total)	mg/kg	40	n/a
Selenium	mg/kg	250	n/a
Nickel	mg/kg	180	n/a
Copper	mg/kg	2400	n/a
Zinc	mg/kg	3700	n/a
Benzo(a)pyrene ^a (use as surrogate for PAH)	mg/kg	5.0	n/a
TPH Total ^b	mg/kg	260	n/a
Aliphatic >C5 – C6	mg/kg	42	n/a
Aliphatic >C6 – C8	mg/kg	100	n/a
Aliphatic >C8 – C10	mg/kg	27	n/a
Aliphatic >C10 – C12	mg/kg	130	n/a
Aliphatic >C12 – C16	mg/kg	1100	n/a
Aliphatic >C16 – C21	mg/kg	1100	n/a
Aliphatic >C21 – C35	mg/kg	1100	n/a
Aromatic C5 – C7	mg/kg	70	n/a
Aromatic >C7 – C8	mg/kg	130	n/a
Aromatic >C8 – C10	mg/kg	34	n/a
Aromatic >C10 – C12	mg/kg	74	n/a

APPENDIX 6/14: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

	Units	Upper 2m of Engineered Fill *	General Fill Beneath 2m below final earthworks level
GENERAL REQUIREMENTS			
Aromatic >C12 – C16	mg/kg	140	n/a
Aromatic >C16 – C21	mg/kg	260	n/a
Aromatic >C21 – C35	mg/kg	1100	n/a
Phenols	mg/kg	120	n/a
Cyanide (total) ^c	mg/kg	18	n/a
pH	Units	5 – 10	n/a
<p>* based on a residential with plant uptake end use ** 1 sample every ten will also be analysed for the full suite (i.e. as per the samples for the upper 2m engineered fill) S4ULs used unless otherwise stated (Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL 3036. All rights reserved) ^a – C4SL used ^b – Based on the S4UL for Aromatic C16 – C21 but assumes no petroleum hydrocarbon contamination is present ^c – S4UL and C4SL not generated, use in-house GAC/value</p>			

1.0 LABORATORY AND SAMPLING REQUIREMENTS ARE PROVIDED BELOW

1.1 Purpose

1.1.1 The works specified herein are required to ensure a minimum standard for the preparation and receipt of analytical data from the works for comparison to the Limiting Values set for the works. The Contractor shall also satisfy the requirements of BS 5930 and 10175, as subsidiary standards in the completion of all fieldworks and sampling and any supplementary investigations required. In addition works shall be undertaken in accordance with the ICE Specification for Ground Investigation (2nd Ed). This document shall be read in conjunction with other related Specifications and where any ambiguity arises this shall be clarified with the Engineer.

1.2 Protocol

1.2.1 The Contractor shall supply suitably qualified specialist environmental staff to carry out the monitoring works. All sub-contractors should have in place appropriate written quality control and quality assurance procedures. Evidence of UKAS and MCERTS accreditation for the specified chemical analytical testing and testing laboratory shall be provided to the Engineer. All testing shall be UKAS and MCERTS accredited where this is currently available. All sampling, monitoring and subsequent analysis shall be documented and managed using a Chain of Custody system to track the fate of all samples. All field and laboratory analytical results shall be reported to the Engineer for review and subsequent inclusion within the Contractor's Validation Reports.

1.3 Laboratory Testing

1.3.1 All preparation, testing and reporting shall be where applicable in accordance with the relevant British Standards. Where tests are not covered by British Standards they shall be performed in accordance with the procedures in the references or as described in the Schedules. Analysis of

APPENDIX 6/14: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

samples will also be required for waste classification purposes. The scope of such testing shall be determined by the Contractor in accordance with the technical requirements of Environment Agency guidance for Waste Classification (EA Document WM2 as revised (assumed to be WM3 circa 2015)).

1.4 Personnel

- 1.4.1 The Contractor shall nominate an individual Technical Advisor to control all processes associated with site investigation, analysis and data management. The person should be suitably qualified. Details of the required qualifications for each of these proposed designations are given in SITE INVESTIGATION STEERING GROUP, *Site investigation on construction. Part 2: Planning procurement and quality management of site investigation*. London: Thomas Telford, 1993. This person shall be Qualified as Section 2.2e (or greater) e.g. a Chartered Engineer/Geologist/Environmental Scientist with at least 5 years of relevant experience.

1.5 Further Investigation

- 1.5.1 Where any additional site investigation, including groundwater monitoring or associated boreholes, are required, the Contractor shall submit proposals for the scope and detail of works proposed for the approval of the Engineer. This shall accord with the requirements of the technical standards noted above.

2.0 SAMPLING PROTOCOL

- 2.1 Samples of suspected contaminated ground, groundwater and leachate for chemical analysis shall be taken in accordance with BS10175 and the companion publication (UK Specification for Ground Investigation, 2nd edition (Site Investigation Steering Group, 2011) under the supervision of an appropriately qualified environmental scientist (SISG 2.2d or more).
- 2.2 The size and type of sample and container, method of sampling and time limitations for carrying out specific analyses shall be commensurate with current guidance.
- 2.3 As a minimum: soil samples shall comprise as a minimum a 1kg plastic tub and 500ml glass bottle; and, water samples shall comprise a 1l plastic and 1l glass bottle.
- 2.4 Sampling shall be undertaken such that cross contamination between samples and sampling locations does not occur. Sampling utensils shall be stainless steel and shall be cleaned prior to the commencement of the excavation works as a minimum and between holes. Where visual or olfactory evidence of contamination is noted equipment shall be cleaned between each sample retrieval.
- 2.5 All samples shall be examined and described by a suitably qualified geotechnical engineer meeting the requirements of BS EN ISO 14688-1:2002. Samples of suspected contaminated ground and leachate shall be described by a qualified environmental or geotechnical person meeting the requirements of SISG Clause 2.2 item d). Descriptions shall include colour and smell with reference to specific inclusions.
- 2.6 All samples shall be labelled with sample location, depth, sample ID (job number, client reference, AGS sample type), time and date of collection. All samples for contamination analysis shall be stored and transported in cool boxes with pre-frozen ice packs and submitted directly to the laboratory from the site within 24hrs of sampling. Samples shall be protected to ensure that their temperature does not fall below 2°C or rise above 45°C. They shall also be protected from direct heat and sunlight.

APPENDIX 6/14: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

- 2.7 A 'Chain of Custody' form shall accompany each batch of samples with a copy retained on-site during works and submitted to the Engineer with the exploratory hole logs. The Chain of Custody shall include the sample details in full combined with any special instructions indicated by the Engineer.
- 3.0 LABORATORY & ANALYTICAL METHODOLOGY ACCREDITATION
- 3.1 Accreditation
- 3.1 The Contractor shall select laboratories which are compliant to ISO 17025 and MCERTs. Where necessary, the Contractor may need to use a range of laboratories to ensure that all reported results meet these accreditations. In particular, it is noted that all asbestos testing must be undertaken by a laboratory who are ISO 17025 accredited for the test. With respect to asbestos in soils analysis the laboratory proposed must have undergone an inspection in accord with UKAS ABS001 note during 2011.
- 4.0 DATA MANAGEMENT
- 4.1 All chemical data shall be provided in Adobe PDF, 'CrossTab' collated Microsoft Excel, and validated AGS 4.0 format. AGS data shall be complete with wider site data such as stratigraphy and sample coordinates. AGS data shall be compiled into a single file by the Contractor and forwarded to the Engineer on a weekly basis.
- 4.2 All laboratory test results must be submitted in full accordance with The Association of Geotechnical and Geoenvironmental Specialists (AGS) version 4 standard (available on the AGS website: <http://www.ags.org.uk/site/datatransfer/intro.cfm>). Each AGS data file must be checked for errors (i.e. must not contain warnings, structural or integrity errors) before it is submitted and it must be accompanied by an error log file to verify.
- 4.3 On receipt of the AGS file, the Engineer will check for errors before loading it into its central database. If any errors are found, the data shall be returned to the Contractor (accompanied with an error log file detailing all errors) for corrections and editing.
- 4.4 The Engineer will not accept and will return to the Contractor any data that does not meet the AGS standards or has not been checked (i.e. is not accompanied by an error-free log file).
- 4.5 In addition to the above requirements, chemical analysis spread sheets shall be provided in:
- Excel spread sheet format that shall follow a consistent order and format for rows and columns to allow direct referencing across a given row/column for either a single determinant across all exploratory samples or vice versa all results for a single exploratory sample;
 - Separate sheets shall be provided for the analysis results for soil, water, leachate and gas;
 - Each of the spread sheet fields shall be populated free of hidden data, spaces, or other insertions (other than explained symbols) that inhibit interpretation of data;
 - The detection limit applicable to each chemical analysis, agreed at appointment, shall remain consistent throughout the works; and,
 - The units of expression shall be consistent (e.g. micrograms or milligrams) and shall remain consistent throughout the works for a given medium and parameter.

APPENDIX 6/14: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

5.0 DATA QUALITY

5.1 Provision shall be made for a suitable quantity of blanks and duplicate sampling to be collected and analysed in order to express the sampling and analytical error.

6.0 DATA MANAGEMENT SYSTEM

6.1 The Contractor shall maintain a data management system in order to coordinate all validation testing, appraisals and reporting. This shall be kept current with works with a delay of no more than 2 weeks from the point of a given sample.

6.2 The Contractor shall provide the Engineer with results upon request and present a summary of results at the Progress Meetings of works.

Appendix F

Method statements: CKD treatment, Placement and compaction
of material

METHOD STATEMENT

Company name	Dunton Environmental Ltd		
Project Title	Kilnwood vale Phase 2.2		
Project number	DTR 16525		
Location	Crest Nicholson Site Crawley Road Kilnwood Vale Faygate, West Sussex RH12 4SE		
Duration of Project & Proposed Start Date	Start Date: March 2017	Finish Date: October 2021	
Job Description	Compaction of fill		
Method Statement Reference number	DE - MS – 06/2017		
Revision	Rev 1	DATE: 23/02/17	
Author	VA	Reviewer	JH

Briefing Record (*Information to be communicated to the workforce*)

Date	Briefed by (name/signature)	Briefed to (name/signature)

1	PRELIMANARIES – Before Work Starts
<p>Preparatory Works: -</p> <ul style="list-style-type: none"> • Provide full briefing to staff involved in works. • Indicate key risks and technical requirements of works. • Locate / demarcate services. • Demarcate and sign working area. • Establish traffic routes, pedestrian access routes and storage areas. • Ensure the proposed areas of work present a safe, level surface, without unstable slopes or deep excavations that are, free of standing water and appropriately lit and signed prior to the commencement of work. • All personnel shall refer to the Construction Phase Health and Safety plan and DEL Risk Assessments listed at the rear of this method statement. • Compaction requirements to be determined on the basis of a compaction trial prior to works. • Routine frequency sampling regime to be established and tracked by Materials Quality Supervisor. 	

Note this method statement must be read in conjunction with CRH Specification 2.2 Rev C and the nominated works undertaken by named individuals referred to on the organogram.

2 Scope of work (Method Statement)

Outline of the Job:

1. Areas of processed fill material prior to Compaction will be set out and demarcated as necessary, generally being in accordance with the agreed / planned sequence of works detailed in Dunton's "Contract Programme" and or "Phasing Plans".
2. Each week the areas of compaction shall be agreed with the ER and marked on the site grid. The principle areas of compaction shall be in accordance with those agreed in advance such that the works are completed in an orderly fashion.
3. Materials excavated from cut areas, shall be spread over the demarcated fill area using tracked 25t excavators to form layers of no more **than 300mm thick (compacted 250mm)**. Care shall be taken such that a single layer is placed across whole of the demarcated area agreed prior to commencement of works.
4. Care shall be taken to ensure the area to be compacted is not so small as to limit the ability of the plant to compact the materials effectively, or so large that moisture control cannot be controlled across the entire layer, either through drying out or wetting as a result of the weather.
5. The un-compacted layer thickness will be measured using GPS dozers to ensure that thickness of the layers is no more than 300 mm thick, also additional measure of rods with 0.3m marks may be implemented as a spot check. Spot checks shall be enforced by Materials Movement Supervisor and the ER.
6. Method of compaction performance will be met using:
 - a. Smooth drum vibratory roller CAT CS74B of mass/ m width roll of 4976kg/m; category 9 of SHW. Plant specification appended to this Method Statement.
 - b. Pad foot (tamping) vibratory roller CAT CP74B of mass/ m width of roll 5023kg/m; category 8 of SHW. Plant specification Appended to this Method Statement.
 - c. As demonstrated and in accordance with the compaction trial detailed in method statement DE-MS-2017/01, in compliance with the Earthworks Specification and the Specification for Highways Works (SHW, Series 600).
7. Compaction shall only be undertaken by plant described above and in a manner determined by a compaction trial performed in accordance with the Earthworks Specification.
8. Additional plant shall require an additional compaction trial unless otherwise agreed by the Engineer.
9. The layer thickness and number of passes shall be determined by a compaction trial described in DE-MS-2017/01. The compaction trial shall demonstrate that the end product specification criteria were met.
10. This shall be validated though post compaction in-situ testing and sampling for laboratory tests. In-situ tests and samples shall be undertaken at the following frequency:
 - a. Field Dry Density by Nuclear Density Gauge (NDG) and Undrained Shear Strength (Cu) by Hand Shear Vane (HSV) 1 per 35m x 35m grid.
 - b. At each NDG test location described above, samples shall also be taken for laboratory compaction, particle density (PD), and Moisture Content (MC) to determine AVR, MDD and % Compaction as per the Earthworks Specification.
 - c. Infiltration Rate via soakaway test 1 per 100x100m³.
 - d. In-situ CBR in to two layers of Engineered Fill 1 per 35x35m grid.
 - e. CBR determination using Plate Load Testing min plate diameter of 300mm in final formation layer 1 per 70x70m grid.
 - f. Testing and sampling frequency may be reviewed by the Engineer dependant on an assessment of the works and initial field and laboratory test results.
11. Where the placed layer is required to key into an existing compacted profile it will be benched into the existing profile. GPS dozer will cut into the edge of higher filling, to form benches of minimum width 600mm and height equivalent to the depth of a single layer of compacted fill (refer to Appendix 6/3 Cl

17.2 and 17.3).

12. Each compacted layer shall be surveyed using the GPS equipment attached to the Roller and via conventional surveying prior to the commencement of the next layer. For clarity, the top surface of every compacted layer shall be checked using traditional surveying methods by the land surveyor, with the maximum distance between adjacent spot levels not exceeding 15 metres. In-situ tests will be undertaken, and samples taken for laboratory testing shall have their location surveyed and recorded on the grid basis.
13. The completed layer shall then be inspected for the presence of bow waves, matting / deep rutting.
14. Each compacted layer shall be inspected by the Materials Movement Supervisor, ITP paperwork completed and then presented to the ER for inspection.
15. Completed layers shall be protected from damage via inclement weather, water ingress, trafficking and for any other reason.
16. Plant shall stick to agreed haul routes.
17. Subject to the opinion of the General Foreman, Materials Movement Supervisor, Materials Quality Supervisor or the Engineer's Representative, if a layer would be reclassified as unacceptable, work shall cease on the material until it's condition can be improved to become acceptable or made good by removing unacceptable material and replacing with acceptable material and in either case subject to test results to confirm.

Sequence and Programme of Works: As per the program submitted please see appendix 1 scope of works

Plant and Equipment to be used:

1. Smooth drum vibratory roller CAT CS74B of mass/ m width roll of 4976 kg/m. (*)
 2. Pad foot (tamping) vibratory roller CAT CP74B of mass/ m width of roll 5023 kg/m (*)
- (*) Subject to results of compaction trial (ref. MS 16).

Evidence of maintenance: Weekly Plant inspection records, 12 months examination certificate will be maintained.

Materials to be Used: Materials as per specific phases.

3 SIGNIFICANT RISK/IMPACT ASSESSMENT

Access to Project: The access and egress to and from the site will be via the main entrance. The sign in and out records will be maintained on the main entrance.

Location of Project: Crest Nicholson Site Crawley Road Kilnwood Vale Faygate, West Sussex RH12 4SE

Risk Assessments Associated with the Works:

- RA-DE-01 -001 **Traffic Management systems for plant movements**
- RA-DE-01- 002 **Dumper Operation**
- RA-DE- 01-003 **180-360 Excavator Operation**
- RA-DE- 01-004 **Work on contaminated sites**
- RA-DE- 01-005 **Work on active construction sites**
- RA- DE- 01-007 **Noise**
- RA- DE- 01-011 **Working on vibrating roller**
- RA- DE- 01-013 **Working at height**
- RA- DE- 01-015 **Handling and Carrying**
- RA- DE- 01-019 **Vibration**

RA- DE- 01-020 **Leptospirosis**
 RA- DE- 01-021 **Working in the sun**
 RA- DE- 01-023 **Excavation work**

Environmental Impacts: Potential for dust, odours, noise and residues on road.

4 ADDITIONAL CONTROL MEASURES

Site induction: All Operatives will undergo the full induction covering all the site safety measures and ensuring validation of training certificates including Method Statement / Risk assessment briefing by Dunton Environmental for the works to be carried out.

Permits to penetrate the ground: Before penetrating the ground a permit to penetrate must be approved

Specialist Training: Supervisors will hold CITB SSSTS and Valid CSCS cards
 Project Site management will hold CITB SMSTS and Valid CSCS Card
 Plant Operatives to hold Valid CPCS cards.
 General Operatives to hold valid CSCS cards.

Waste Management and Housekeeping: A full waste management system will be implemented, and all site works kept tidy and housekeeping duties recorded.

Fire: An emergency fire contingency plan will be provided, and all operatives fully informed including the provision of fire extinguishers for site accommodation and pertinent plant and also air horn alarm will be on site.

First Aider: First aider will be present on site at all times.

Incidents and Accidents: All the near miss reports will be recorded and maintained on site. The Toolbox talk will be done twice in a week and as per site requirement.

6 PPE/RPE

Mandatory Requirements: Safety helmet, Safety Goggles, Safety footwear, Minimum Cut 3 Gloves, Hi viz vests.

P.P.E. TASK RELATED	Note: Site rules may require some PPE to be worn at all times						
	✓ Must be worn R Use is recommended						
Hard Hat BSEN397:1995	✓	FFP3 Half Mask BSEN405	✓	Standard Eye Protection BSEN166:2002	✓	Gloves EN388-CL3	✓
Safety Boots BSEN345	✓	FFP3 Dust Mask BSEN149:2001	✓	Impact Resistant Eye BSEN166-B:2002		Waterproofs BSEN473-3	
High-vis BSEN 471	✓	Ear Defenders BSEN352-1:2002	✓	Type 5/6 coveralls asbestos		Other as specified by control measures	R

7 COMMUNICATION – contact numbers

Site Contact

Contracts Manager	Sean Deloughery	07876 860 637
Project Manager	John Harrison	07393 462 370
Works Manager	David Thompson	07387 108665

Emergency Contact

Operations Director	Steve England	07393 462 368
---------------------	---------------	---------------

Off Site Contact

Managing Director	Neil Roe	07814 979 368
-------------------	----------	---------------

In case of emergency the nearest hospital available is:

East Surrey Hospital

Tel: 01737 768511

Address: Canada Avenue, Redhill, Surrey, RH1 5RH

Website: <http://www.surreyandsussex.nhs.uk>

Email: pals@sash.nhs.uk



METHOD STATEMENT

Company name	Dunton Environmental Ltd		
Project Title	Kilnwood vale Phase 2.4 – 2.6		
Project number	DTR16525		
Location	Crest Nicholson Site Crawley Road Kilnwood Vale Faygate, West Sussex RH12 4SE		
Duration of Project & Proposed Start Date	Start Date: March 2017	Finish Date: October 2021	
Job Description	<i>Cement Kiln Dust (CKD) Modification</i>		
Method Statement Reference number	DE – MS – 01/2018 - CKD Modification		
Revision	Rev 0	DATE: 31/01/18	
Author	VA	Reviewer	DL

Briefing Record (*Information to be communicated to the workforce*)

Date	Briefed by (name/signature)	Briefed to (name/signature)

1 PRELIMANARIES – Before Work Starts

Preparatory Works: - Approved layout with all the details showing location, Traffic routes, Pedestrian access routes, Storage areas and filling areas.

- Receive and store Cement Kiln Dust (CKD) in horizontal trailer silo(s)
- Load & spread Lime using towed or self propelled spreader
- In calm conditions, CKD will be incorporated using Tractor towed Stehr SFB 24/6;
- In windy conditions, the following will be used: Self-propelled Wirigen WR2500SK ; Self-propelled BomagMPH122.
- Tray Test to check CKD percentage dosing rates
- Incorporate CKD into soil
- Level & compact CKD modified materials
- Clear site
- All personnel shall refer to the Construction Phase Health and Safety Plan and DEL Risk Assessments.

2 SCOPE OF WORK (Method Statement)

Outline of the Activity:

- Plant and equipment will be transported to the site and unloaded at an agreed location adjacent to the area of works. All vehicles must have an amber-flashing beacon.
- CKD, delivered to site in a road tanker, will be pneumatically transferred to secure storage silo in a safe place, as agreed in advance with site management.
- All personnel involved in the import and use of material imported to site shall abide by the Construction Phase Health and Safety Plan, DEL Risk Assessments and appropriate COSHH requirements obtainable from the Project Manager or site supervisor.
- Tanker driver to unload CKD into the static silo by pneumatic transfer. Tanker driver to be wearing full PPE (gloves, face mask, goggles, helmet, high-viz vest) throughout operation and in conjunction with the COSHH requirements. If the spreader machine operator is required to assist the tanker driver he also must wear full PPE and subject to the same requirements. In any case, displaced air will be back-vented to the delivery tanker and there is an amber light alarm to prevent overfilling.
- Before CKD spreading can commence, the area must be trimmed and cleared of boulders / oversize materials that may not break down during processing, possibly causing damage to plant.
- Tray test shall be undertaken to calibrate the amount of CKD being added. This shall be recorded by the Materials Quality Supervisor.
- CKD is transferred into site spreader by pneumatic transfer, operator to be wearing full PPE (gloves, face mask, goggles, helmet, high-viz vest) throughout operation.
- Having checked prevailing and expected wind conditions, both in terms of direction and force (conditions to be recorded in daily diary) ensuring any dust does not travel outside the site boundary, CKD is spread over a designated treatment area, ensuring no more than 4000 m² is spread out at any one time, in advance of the mixing to facilitate subsequent testing.
- While this operation is in progress, any person in the immediate vicinity or inside the working area must wear full PPE. Only operators with air-conditioned cabs with windows closed are not required not to wear PPE.
- CKD is incorporated into the identified materials by mixing through either by machine, disks or rotavator dependent upon the quantity and materials being modified, and to the depth of the placed layer prior to compaction.
- CKD is added during the modification process at the discretion of the Materials Quality Supervisor or Materials Movement Supervisor. Generally, between 1.0 – 6.0% of CKD would be added to reduce higher than optimum moisture contents.
- The required **reaction is generally immediate**, with CKD burning off the excess moisture, additional mixing may assist the evaporation process with very wet materials, thereby limiting the need for adding more product.

- Final compaction is applied as soon as the Materials Quality Supervisor is satisfied that the modified material is likely to meet the requirements of the end product specification criteria. The earthworks layer is compacted, trimmed and tested as per Method statements DE-MS-06/2017 or DE-MS-22a.
- The “Design Manual for Roads & Bridges Volume 4 – Section 1 – Part 6 HA 74/07 – General Fill”, the reference document for this process, is not prescriptive in the use of CKD as a moisture modifier during soil modification, as it is the end product that determines final acceptance. It does note that sulphate suitability checks on the natural material should be checked and monitored; DEL carry these out as a matter of course when undertaking any Modification and or Stabilisation process.
- Samples shall be taken for pH, SO₄, W/S SO₄ and Total S testing at a frequency of 1/1000m³ where modification or stabilisation due to lime or cement has taken place, as per the Earthworks Specification.

Sequence and Programme of Works: As per the Contract Program submitted.

Plant and Equipment - utilised as necessary / required:

1. Excavator (Mixer)
2. Dozer (Mixer)
3. Dumper
4. Tractor + Integrator Rotor (Mixer)
5. Tractor + Rotor (Mixer)
6. Tractor + Disks (Mixer)
7. Tractor + Spreader
8. Tractor + Water Bowser
9. Fuel Bowser
10. CAT Scanner

Plant may be varied & or selected by the site manager, to suit the immediate activities being undertaken and productivity required, all above equipment is suitable for undertaking Modification.

Evidence of maintenance: Weekly Plant inspection records, 12 months examination certificate will be maintained.

Materials to be Used:

Suitable earthworks materials that subject to their moisture content being modified, will allow them to be fully compacted in accordance with the controlling specification and incorporated in the final works.

3 SIGNIFICANT RISK/IMPACT ASSESSMENT

Access to Project: The access and egress to and from the site will be via the main entrance. The sign in and out records will be maintained on the main entrance.

Location of Project: Crest Nicholson Site Crawley Road Kilnwood Vale Faygate, West Sussex RH12 4SE

Risk Assessments Associated with the Works:

RA-DE-01 -001 **Traffic Management systems for plant movements**

RA-DE-01- 002 **Dumper Operation**

RA-DE- 01-003 **180-360 Excavator Operation**

RA-DE- 01-004 **Work on contaminated sites**

RA-DE- 01-005 **Work on active construction sites**

RA- DE- 01-007 **Noise**

RA- DE- 01-011 **Working on vibrating roller**
 RA- DE- 01-013 **Working at height**
 RA- DE- 01-015 **Handling and Carrying**
 RA- DE- 01-019 **Vibration**
 RA- DE- 01-020 **Leptospirosis**
 RA- DE- 01-021 **Working in the sun**
 RA- DE- 01-023 **Excavation work**

Environmental Impacts: Potential for dust, odours, noise and residues on road.

4 ADDITIONAL CONTROL MEASURES

Site induction: All Operatives will undergo the full induction covering all the site safety measures and ensuring validation of training certificates including Method Statement / Risk assessment briefing by Dunton Environmental for the works to be carried out.

Permits to penetrate the ground: Before penetrating the ground a permit to penetrate must be approved

Specialist Training: Supervisors will hold CITB SSSTS and Valid CSCS cards
 Project Site management will hold CITB SMSTS and Valid CSCS Card
 Plant Operatives to hold Valid CPCS cards.
 General Operatives to hold valid CSCS cards.

Waste Management and Housekeeping: A full waste management system will be implemented, and all site works kept tidy and housekeeping duties recorded.

Fire: An emergency fire contingency plan will be provided, and all operatives fully informed including the provision of fire extinguishers for site accommodation and pertinent plant and also air horn alarm will be on site.

First Aider: First aider will be present on site at all times.

Incidents and Accidents: All the near miss reports will be recorded and maintained on site. The Toolbox talk will be done twice in a week and as per site requirement.

6 PPE/RPE

Mandatory Requirements: Safety helmet, Safety Goggles, Safety footwear, Minimum Cut 3 Gloves, Hi viz vests.

P.P.E. TASK RELATED	Note: Site rules may require some PPE to be worn at all times						
	✓		✓		✓		✓
Hard Hat BSEN397:1995	✓	FFP3 Half Mask BSEN405	✓	Standard Eye Protection BSEN166:2002	✓	Gloves EN388-CL3	✓
Safety Boots BSEN345	✓	FFP3 Dust Mask BSEN149:2001	✓	Impact Resistant Eye BSEN166-B:2002		Waterproofs BSEN473-3	
High-vis BSEN 471	✓	Ear Defenders BSEN352-1:2002	✓	Type 5/6 coveralls asbestos		Other as specified by control measures	R

7 COMMUNICATION – contact numbers

Site Contact

Contracts Manager	Sean Deloughery	07876 860 637
Project Manager	John Harrison	07393 462 370
Works Manager	David Thompson	07387 108665

Emergency Contact

Operations Director	Steve England	07393 462 368
---------------------	---------------	---------------

Off Site Contact

Managing Director	Neil Roe	07814 979 368
-------------------	----------	---------------

In case of emergency the nearest hospital available is:

East Surrey Hospital

Tel: 01737 768511

Address: Canada Avenue, Redhill, Surrey, RH1 5RH

Website: <http://www.surreyandsussex.nhs.uk>

Email: pals@sash.nhs.uk

