

**PROPOSED RESIDENTIAL DEVELOPMENT,
WEST STREET, HAVANT**

Supplementary Geo-Environmental Site Assessment Report

PROJECT NO. SW-536

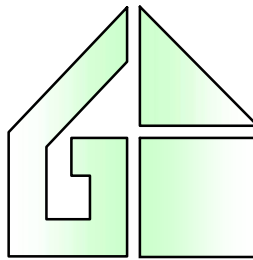
WORK CODE 1

REPORT NO. SW-536.1.1

REVISION 1

17th SEPTEMBER, 2014

PREPARED BY



Ground Investigation (South West) Ltd

UNIT 3
CUSTOM HOUSE COURT
KENN ROAD
CLEVEDON
BRISTOL
BS21 6EX

TEL: 01275 876903
FAX: 01275 879662

EMAIL: southwest@ground-investigation.com

ON BEHALF OF

Mansell Homes



Ground Investigation (South West) Ltd

DOCUMENT CONTROL

Project Title: Proposed Residential Development, West Street, Havant

Document Title: Supplementary Geo-Environmental Site Assessment Report

Rev	Date	Filename: report.sw.536.1.1		
1	17/09/2014	Description: Revision 1		
			Prepared by	Checked by
		Name	Richard Colwill BSc(Hons), MRes, CGeol, FGS	Tim Gillbanks BSc(Hons), CGeol, CSci, FGS
		Signature		

PROPOSED RESIDENTIAL DEVELOPMENT, WEST STREET, HAVANT

Supplementary Geo-Environmental Site Assessment Report

TABLE OF CONTENTS

1.	INTRODUCTION.....	1
1.1	Terms of Reference	1
1.2	Site Location	1
1.3	Proposed Development.....	1
1.4	Objectives	1
1.5	Scope of Work.....	2
1.6	Report Structure	2
2.	DESK STUDY & WALKOVER SURVEY	3
2.1	General	3
2.2	Sources of Information	3
2.3	Walkover Survey.....	3
2.4	Recent History.....	4
2.5	Geology	5
2.6	Hydrology, Hydrogeology and Environmental Setting.....	6
2.7	Regulatory Authority Information.....	7
2.8	Brief Summary of Previous Intrusive Investigation.....	7
3.	FIELDWORKS & LABORATORY TESTING	10
3.1	General	10
3.2	Intrusive Investigatory Works.....	10
3.2.1	Lined Dynamic Sampling Boreholes.....	11
3.2.2	Field Monitoring	11
3.3	Laboratory Testing	12
4.	PHYSICAL GROUND & GROUNDWATER CONDITIONS.....	13
4.1	General	13
4.2	Strata Descriptions.....	13
4.2.1	Made Ground	13
4.2.2	Probable Head Deposits.....	13
4.2.3	Probable River Terrace Deposits.....	14
4.2.4	Probable Lambeth Group.....	14
4.3	Groundwater	14
5.	GROUND AND GROUNDWATER CONTAMINATION	15
5.1	Introduction.....	15
5.2	Conceptual Site Model.....	15
5.2.1	Ground and Groundwater Conditions.....	15
5.2.2	Possible Sources of Contamination	15
5.2.3	Contaminants of Concern	16
5.2.4	Receptors and Pathways	16
5.2.4.1	Chronic Human Health Risks	16

PROPOSED RESIDENTIAL DEVELOPMENT, WEST STREET, HAVANT

Supplementary Geo-Environmental Site Assessment Report

	5.2.4.2	Acute Human Health Risks	17
	5.2.4.3	Controlled Waters	17
5.3		Assessment of Chronic Human Health Risks	17
	5.3.1	Methodology	17
	5.3.2	Sampling and Laboratory testing	18
	5.3.3	Risk Assessment	18
	5.3.4	Recommended Remedial Works (Human Health)	18
5.4		Assessment of Risk to Controlled Waters	19
	5.4.1	Context	19
	5.4.2	Receptors and Pollutant Linkage	20
	5.4.3	Methodology	20
	5.4.4	Environmental Sampling and Laboratory Analysis	20
	5.4.5	Level 2 Groundwater Risk Assessment	20
5.5		Gas Risk Assessment	21
	5.5.1	Methodology	21
	5.5.2	Possible Gas Sources	21
	5.5.3	Gas Monitoring	21
	5.5.4	Gas Screening Value and Characterisation	21
5.6		Aggressive Chemical Environment for Concrete	22
5.7		Waste Classification & Waste Assessment Criteria	22
6.		GROUND ENGINEERING	24
	6.1	Context	24
	6.2	Site Preparation	24
	6.3	Foundations	24
	6.4	Ground Floor Slabs	26

TABLES

- 1 Estimation of Chronic Human Health Risks for Standard Residential Land Use
- 2 Level 2 Assessment of Pollution Risks to Controlled Waters

FIGURES

- 1 Exploratory Hole Locations

APPENDICES

- A Engineering Records of Continuous Percussion Boreholes
- B Records of Field Monitoring
- C Results of Chemical Laboratory Tests - Soils
- D Results of Chemical Laboratory Tests - Waters
- E References

1. Introduction

1.1 Terms of Reference

Ground Investigation (South West) Limited has been commissioned by Mansell Homes, hereafter referred to as the Client, to carry out a supplementary Geo-Environmental Site Assessment for a proposed residential development site on West Street in Havant.

This report presents the findings of the supplementary investigation, together with generic quantitative assessments of chronic human health risks associated with the presence of potentially contaminated soils, potential risks to controlled waters and risks arising from potentially hazardous ground gas. A geotechnical interpretation is also included, presenting advice concerning foundation design and construction.

1.2 Site Location

The site is situated on the southern side of West Street, close to its junction with Brockhampton Lane in Havant. Its approximate National Grid reference is 471427,106291, and the postal address is 59-61 West Street, Havant, PO9 1LN.

Details of the site boundaries, together with a full description of the site interior, based on a walkover undertaken prior to commencement of the fieldworks, are provided within Section 2.3 of this report.

1.3 Proposed Development

We understand that the proposed development will comprise the conversion of an existing joinery workshop (the Henry Jones building) to form 8 No. one- and two-bedroom flats, together with the demolition of the remaining buildings and the construction of 16 No. 3 bedroom houses.

The proposed development will include private gardens, new vehicular access, car parking and communal landscaping.

1.4 Objectives

The primary objectives of this ground investigation are summarised as follows.

- (i) Provide further information concerning the physical ground and groundwater conditions at the site.
- (ii) Identify and investigate potentially significant geotechnical and geo-environmental hazards.
- (iii) Consider ground contamination in relation to threats posed to human health and controlled waters.
- (v) Advise on the need for remedial actions, or further investigation, to address potentially unacceptable human health or environmental risks associated with identified ground contamination hazards.

- (vi) Advise on geotechnical conditions, identify foundation options, and provide advice relating to ground engineering matters in the context of the proposed development.

1.5 Scope of Work

In order to achieve the objectives summarised in Section 1.4 above, the following general scope of work has been carried out.

- (i) A desk study involving the review of reports previously undertaken by others, together with a further walkover survey completed in conjunction with the supplementary fieldworks.
- (ii) Supplementary fieldworks involving the drilling of eleven dynamic percussive window sampler boreholes and the installation of gas/groundwater monitoring wells at eight positions.
- (iii) In-situ monitoring of groundwater levels, gas concentrations and flow rates, following completion of the initial fieldworks.
- (iv) Laboratory chemical analysis of soil samples recovered from the encountered strata and groundwater samples recovered from the installed monitoring wells.
- (v) Preparation of this Geo-Environmental Site Assessment Report addressing ground contamination and ground engineering issues relating to the proposed development.

1.6 Report Structure

This report is presented in six sections, the contents of which are summarised below.

- **Section 1** provides an introduction to the report. It identifies the site location, summarises the proposed development, and outlines the objectives of the study and the general scope of work.
- **Section 2** presents a summary of the findings of the desk-based research, together with a description of the site, based on information gathered during the walkover survey.
- **Section 3** describes the fieldworks and laboratory testing that have been carried out.
- **Section 4** provides a description of the physical ground and groundwater conditions revealed by the investigation.
- **Section 5** considers ground contamination hazards at the site in respect of chronic human health risks, risks to controlled waters and risks arising from potentially hazardous ground gas, and discusses the potential aggressive environment for concrete used below ground level.
- **Section 6** considers the ground conditions at the site in relation to ground engineering and geotechnical matters of likely significance in the context of the proposed development. Advice is given for the design of foundations and ground floor slabs.

2. Desk Study & Walkover Survey

2.1 General

The desk study has reviewed materials relating to the historical and present-day land uses in the vicinity of the site, together with geological, hydrogeological and environmental conditions from the information presented in the previous reports (Refs 3 & 4).

A walkover survey was carried out prior to commencement of the intrusive fieldworks and key observations made are presented.

2.2 Sources of Information

The principal sources of information consulted by the desk study are summarised below.

- | | | |
|-------|---|----------|
| (i) | Present-day Ordnance Survey Mapping | (Ref. 1) |
| (ii) | Geological Mapping | (Ref. 2) |
| (iii) | Contaminated Land Desk Study and Preliminary Risk Assessment, 2012. | (Ref. 3) |
| (iv) | Phase 1 & Phase 2 Geo-Environmental Site Investigation, 2014. | (Ref. 4) |

2.3 Walkover Survey

The desk study information has been supplemented by a site walkover survey conducted on 31st July, 2014. Significant observations made during the walkover are noted below and the existing site plan is presented as Figure 1.

The site comprises a former builder's yard extending to approximately 0.4 Hectares, with dimensions of some 70 m × 50 m. It is generally a level site comprising predominantly tarmac hardstanding, and existing buildings.

The northern boundary of the site is delineated by West Street, which provides vehicular access via a gated driveway. The southern boundary is formed by adjacent commercial premises that are part of a commercial estate called 'The Tanneries'. The eastern boundary of the site is delineated by a hard surfaced car parking area followed by a row of residential properties along Brockhampton Lane, and the west side of the site is bounded by the conservation area known as Brockhampton Springs, which comprises an area of open landscaping with lakes and water courses which are managed by Portsmouth Water, the offices and works of which are located further west. The western site boundary is immediately bordered by a narrow brick-lined watercourse, the channel of which appears to have been artificially straightened. This stream is culverted beneath West Street at the north-western corner of the site.

The main building at the site fronts onto West Street and is earmarked to be redeveloped/converted as the residential flats. This building is a two-storey brick structure that was most recently occupied by Henry Jones Joinery Limited. The building includes a large workshop area kitted out with timber workbenches, and still contains items of machinery including mechanical saws, planes and drills. The workshops are adjoined by offices and areas of open storage, together with a plant room/substation on the western elevation. A dilapidated lean-to structure of timber construction adjoins the eastern elevation of the building, which has been used to store tins of paint, coatings, oil and disinfectant.

A relatively recent, single storey, brick extension with a corrugated metal sheet roof, to the rear of the main building occupies the central area of the site. A single skinned steel fuel tank is located on the south-eastern corner of the extension, surrounded by a bund of concrete block construction, and a galvanised chimney is located at its southern end, behind a timber clad structure. A storage area was observed along the eastern side of the building, which had various materials in storage (including plastics, plywood and timber).

A single fuel pump labelled as “Unleaded Petrol” is located adjacent to the south-western corner of the extension, in the south-western area of the site. It is considered likely that the petrol pump was supplied by an on-site underground storage tank (UST). Some scarring to the surface was observed to run from the location of the fuel pump towards the south-western corner of the site. The extent of surface scarring does not appear to cover a sufficiently large area to be associated with the extraction of a buried fuel tank, however. There are a number of manhole covers in the vicinity which may be associated with filling points and/or associated drainage interceptors.

The remaining buildings on site are distributed along the southern and western boundaries, and were recently used as a solvent and petroleum store (southern building) and workshops/offices (western building).

Three further above ground fuel storage tanks of steel construction are associated with the southernmost building, two on the ground floor of the building and one on its roof. The tank on the roof is unbunded, and appears to be of single skin steel construction, with a capacity of some 4,500 litres. Of the two tanks on the ground floor, one also appears to be unbunded. The other ground floor tank is labelled to contain “eng oil” and has a surrounding low concrete block bund. A fuel line and pump nozzle are attached externally to the solvent store building, leading from the tank on its roof, which appears to have been historically used for fuelling vehicles. There is some oil staining around the base of the internal tanks, but no evidence of staining on the external surfaces near the filling point. An area of open-fronted covered storage racking occupies the eastern end of this building.

The westernmost building is divided into two storey offices with brick elevations in the north and single storey workshops/garages to the south. This building directly overlooks the adjacent brick lined watercourse to its rear. Signage is present just below roof level on the garage units warning of asbestos and a fragile roof. The roof of the garage units is constructed of corrugated cement sheeting which could contain asbestos.

The external areas are dominated by tarmacadam hardstanding with a large mature Yew tree near the north-east corner of the site surrounded by a small raised grassed area.

An area of rough unmade ground is located near the south-eastern corner of the site, this being the footprint of a previously demolished building.

2.4 Recent History

Previous land uses at the site, as inferred from the examination of historical Ordnance Survey maps presented in the previous reports (Refs 3 & 4) are summarised below.

- The earliest edition of the historical maps dated 1869 shows the eastern half of the site to comprise a row of terraced housing fronting onto West Street with some associated outbuildings. The western half of the site comprises a number of buildings concentrated along the southern and western boundaries, with a watercourse issuing from the south-western corner, possibly associated with an on-site Spring referred to by Portsmouth Water. It is possible that the buildings are associated with both residential and commercial usage.

Residential properties are located along West Street to the north and a Union Workhouse to the north-west. A large Reservoir is located to the west of the site with some associated Springs and Sluices. An Infant School and a Washing Factory are located some 100 m to the south-west. Further afield, a Parchment Factory and Brewery are located some 250 m to the south-east.

- The 1897 to 1909 edition of the maps show numerous buildings within the boundary of the site, which is by this time labelled as a Parchment Works. In this regard, we understand that due to the apparent purity of the water arising from the Springs in the area, the area has a long history of the manufacture of parchment. The manufacture of parchment requires the processing of animals and the treatment of their skins through a combination of mechanical separation of the skin layers and chemical processes including the use of alkalis, degreaser and boiling water. The by-product of unsuitable skins for parchment, was often industries such as Tanneries and Glove Making, which are known to have been present in the area. The Washing Factory to the south-west is by this time labelled as a Chamois Leather Works.
- The previous report (Ref 3) states that the site was known to have been occupied by the Stents Glove Making Factory from 1916.
- By 1932 a circular structure is shown just outside the south-eastern corner of the site, possibly associated with a nearby Spring reported to be located in the vicinity. The site is no longer labelled as a Parchment Works, although the layout remains essentially unchanged. A number of large buildings had been erected in the area of the former school to the south-west, associated with a Leather Works. The Leather Works subsequently increases markedly in size and encroaches up to the southern site boundary.
- The circular structure to the south-east is no longer shown on the 1953 edition of the maps. A Water Works is by this time shown to be located to the west, associated with the Reservoir. No significant changes are apparent within the boundaries of the site on this edition, however.
- By 1965, the site is labelled as a Builder's Yard and some of the earlier buildings had by this time been removed/replaced. Information contained in the previous reports suggests that the company operating the Builder's Yard (Henry Jones (Joiners) Limited) was issued with an improvement notice by the Health and Safety Executive (HSE) with regards to the Control of Substances Hazardous to Health (COSHH) relating to wood dust, glue, lacquers and finishing.
- No significant changes are shown on the next available map edition dated 1973, although an Engineering Works is shown directly adjacent to the southern boundary (occupying a building which was formerly part of the Leather Works). The Leather Works has by this time been divided into multiple commercial uses including a Tannery, Warehouse, Sheet Metal Works and Engineering Works.
- Subsequent changes to the general layout, including the construction and extension of the more recent buildings to the west, can be traced from an examination of more recent mapping. It is apparent from the mapping that a further building was relatively recently constructed close to the eastern site boundary, which has subsequently been demolished.

2.5 Geology

The geology of the site has been assessed on the basis of an examination of geological mapping and local knowledge, together with information included within the previous reports, as summarised below.

- Examination of the published British Geological Survey mapping (Ref. 2) indicates that the site should be underlain by superficial Head Deposits over Chalk bedrock of the White Chalk Subgroup. It should be noted, however, that the site is in an area of quite complex geology, such that in the immediate vicinity of the site, superficial River Terrace Deposits and bedrock of the Lambeth Group are also recorded. In this regard, the presence of such deposits beneath the site cannot entirely be discounted.
- Based on information published on the BGS website, the Chalk is likely to comprise 'chalk with flints. With discrete marl seams, nodular chalk, sponge-rich and flint seams throughout. Typology of flints and incidence of marl seams is important for correlation.' The Lambeth Group is described by the BGS as 'vertically and laterally variable sequences mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and lignites and occasional sandstone and conglomerate'. The Head Deposits are identified by the BGS as likely to comprise 'gravel, sand and clay depending on upslope source and distance from source. Poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hillwash and soil creep. Essentially comprises sand and gravel, locally with lenses of silt, clay or peat and organic material.' A generic description is provided for River Terrace Deposits as comprising 'sand and gravel, locally with lenses of silt, clay or peat'.
- The exploratory holes sunk as part of the previous intrusive works encountered to around 1.3 m of Made Ground over materials described as Head Deposits to the full depth of the investigation at 4.45 m. The Made Ground typically comprised fine-grained soils with some inclusions of brick, clinker, flint and chalk. The Head Deposits typically comprised fine-grained deposits with varying fractions of sand, gravel and cobbles of flint and chalk.
- According to information in the previous reports, the site is located in a radon affected area, and basic radon protection measures are required for new dwellings and extensions.
- The site is indicated to lie in an area of no hazard from compressible ground and running sand, very low hazards from collapsible ground, landslides and shrinking/swelling clay and low hazard from ground dissolution. However, it should be appreciated that the superficial deposits that underlie the site are predominantly coarse grained in nature, and when combined with a high water table as is the case on this site, could be prone to the development of running conditions. Chalk bedrock is also prone to dissolution such that the presence of solution features in the Chalk bedrock cannot entirely be discounted.
- The Chalk and/or Lambeth Group bedrock underlying the site is not listed by the BRE (Ref. 3) as potentially containing elevated levels of pyrite, which may oxidise to sulphates and lead to aggressive attack on buried concrete. Depending on its parent bedrock origin, the Head Deposits, or River Terrace Deposits anticipated beneath the site could possibly contain elevated levels of pyrite.

2.6 Hydrology, Hydrogeology and Environmental Setting

Key points relating to the hydrology of the site, together with its hydrogeology and environmental setting are summarised as follows on the basis of the information included within the Envirocheck report.

- The Environment Agency ascribes a bedrock aquifer designation of Principal Aquifer to the underlying Chalk bedrock.
- The site is shown to be located in a Source Protection Zone 1 associated with various abstractions operated by Portsmouth Water for public supply.

- Brockhampton Springs comprise a network of underground springs where groundwater from the catchment area of Horndean emerge under pressure from the confinement of the overlying clay soils. There are a series of springs within the immediate vicinity of the site, together with one historical spring possibly on site, that are piped underground towards the pumping station at the western end of the nearby Water Works for treatment and onward distribution to homes and businesses. It is understood that these springs provide a significant proportion of the potable water supply for Portsmouth and are an extremely sensitive resource.
- There are no known historical or active landfills in the vicinity of the site.

2.7 Regulatory Authority Information

Information supplied by Hampshire Trading Standards, in connection with the earlier investigatory works undertaken by others, indicates that the underground petrol storage tank on site was installed in 1964, then subsequently slurry filled and decommissioned in 1994. The tank is shown to have passed pressure testing and there are no records of any leakages.

A representative of Portsmouth Water is reported to have been present during the original investigation and provided plans indicating the presence of a spring located beneath the hard standing in the south-western corner of the site. Anecdotal evidence provided by the Portsmouth Water representative suggested that it was likely that the spring would have an associated brick built collecting chamber and clay pipes leading off site to the south-west. The earliest published historical mapping supports this conclusion, showing a watercourse issuing from the south-western corner of the site, together with a spring just outside the south-eastern corner.

2.8 Brief Summary of Previous Intrusive Investigation

The earlier Phase 1 & Phase 2 Geo-Environmental Site Investigation (Ref. 4) provided the following information:

Site Investigation

The investigation consisted of five shallow boreholes formed using a tracked dynamic sampling rig, together with 7 shallow trial pits and a hand augered borehole. Monitoring wells were installed within three of the boreholes.

Physical Findings

The boreholes encountered Made Ground to depths of between 0.5 and at least 1.3 m, which typically comprised fine grained soils (clay) with a variable mix of coarse grained minor constituents such as brick, clinker, flint, chalk and fragments and sheets of potential asbestos containing material.

Head Deposits were then described, which consisted of a variable sequence of soft to firm light brown slightly sandy gravelly clay and pale brown clayey gravel, intermixed with sandy gravel and light brown sand. The gravel fraction comprised subangular to subrounded, fine to coarse flint, with medium cobble content and rare subangular chalk deposits. The base of the head deposits was not thought to have been encountered during the intrusive phase of investigation within the maximum depth of investigation of 3.45 m.

Groundwater was found to be standing at depths as shallow as 0.9 to 1.2 m.

Geotechnical Implications

The previous report states that:

- 'Based on the ground conditions encountered, it is envisaged that an allowable bearing pressure of circa 100kN/m² above the water table and 50kN/m² below the water table could be adopted for the proposed scheme limiting total settlement to less than 25mm, with a factor of safety of 3. This is based on assumed relative density of loose for the coarse grained soils and a consistency of firm for the fine grained soils.
- Due to the presence of a substantial thickness of Made Ground and the high groundwater table across the site it is considered that ground bearing floor slabs, whilst viable, will require detailed design to accommodate variability of the formation and account for differential settlement. Where suspended floor slabs are employed ventilation of the under floor void will be required to address condensation issues. This would also assist in the mitigation of potential gas ingress issues.'
- A preliminary design value for CBRs of between 2-3 % was recommended. Due to the shallow groundwater, in-situ soil infiltration tests were not carried out, such that careful consideration should be afforded to the design of surface water drainage.

It should be appreciated in the above context that this supplementary investigation has confirmed the presence of a shallow water table, coupled with deposits of Made Ground and/or disturbance due to historical construction activities, which may hamper the construction of conventional foundations extending entirely into the undisturbed natural deposits.

Contamination

The previous report states that:

- Although some minor exceedances of lead and benzo(a)pyrene were recorded in the soil samples recovered from the exploratory holes, there is no significant risk of significant harm to future site users. However, a risk remains from potential contaminants in the Made Ground to the underlying controlled water receptors, which are sensitive due to the site's location over the Chalk aquifer.
- A number of potential sources of hazardous ground gas have been identified such that further works and assessment are warranted.
- Two of the exploratory holes encountered potential asbestos containing material within the Made Ground. Subsequent laboratory analysis revealed the presence of Chrysotile and Amosite at these positions.

Recommendations

The earlier investigatory works identified a requirement for the historic underground fuel storage tank to be removed, together with any associated pipework and adjacent hydrocarbon impacted soils, such works being undertaken by an experienced and competent contractor, and validated on completion by an appropriately qualified specialist consultant.

With regards to additional investigatory works, the following requirements were identified:

- It was recommended that a period of ground gas and groundwater level monitoring should be undertaken to facilitate an assessment of the risks posed by ground gas in line with CIRIA C665.
- Given the presence of a spring beneath the site, together with the presence of a high groundwater level, taking into consideration the close proximity of springs utilised by Portsmouth Water for the supply of potable water, coupled with an adjacent surface watercourse, it was recommended that groundwater sampling and analysis be undertaken to determine whether the shallow groundwater has been impacted by potential contamination arising from the site.

3. Fieldworks & Laboratory Testing

3.1 General

The general scope of the fieldworks and laboratory testing is summarised below.

- The intrusive investigatory works comprised the drilling of eleven dynamic percussive sampler boreholes, extending to between approximately 3.45 and 4.45 m below existing ground level.
- Disturbed samples of the strata revealed within the boreholes have been extracted and in-situ standard penetration tests (SPTs) were completed at 1 m intervals.
- General observations have been recorded concerning the incidence and behaviour of groundwater seepages, together with any obvious visual or olfactory evidence of ground or groundwater contamination.
- Groundwater/gas monitoring wells have been installed in eight of the boreholes, and three subsequent monitoring visits have been undertaken prior to the date of this report.
- Laboratory chemical analysis has been carried out on selected soil samples recovered from the exploratory holes, together with groundwater samples from the monitoring wells.

This section of the report describes the fieldworks and provides details of the subsequent laboratory testing.

3.2 Intrusive Investigatory Works

The intrusive investigatory works were carried out on 31st July and 1st August, 2014, under the supervision of Ground Investigation (South West) Limited.

The positions of investigation were determined on the basis of the proposed architectural layout, also taking into considerations the findings of the desk-based research and site walkover, paying particular attention to the fact that there are numerous point sources of potential contamination such as tanks and a fuel store. A summary of the exploratory holes and the rationale for the locations is presented below and a drawing showing their locations is presented as Figure 1.

Borehole Number	Reason for Location
WS01	Target the above ground storage tank.
WS02	Provide spatial coverage.
WS03	Target the stockpile of paint, coating and detergent containers.
WS04	Provide spatial coverage.
WS05	Target the oil/solvent store, vehicle filling point, ground level and roof mounted storage tanks.
WS06	Target the probable underground storage tank and dispenser pump.

WS07	Target the garages/workshops.
WS08	Provide spatial coverage and target the former building footprint.
WS09	Provide spatial coverage.
WS10	Provide spatial coverage.
WS11	Provide spatial coverage.

The fieldworks are readily divisible into and described under the following headings.

3.2.1 Lined Dynamic Sampling Boreholes

A rubber tracked Archway Competitor rig was used to form the dynamic sampling boreholes. Where hardstanding was present at the surface, it was penetrated by a rotary core drill attachment to the rig. Lined steel core barrels of 1 m length were then percussively driven into the ground, enabling the extraction of virtually continuous disturbed 'core' samples of the subsoil within polythene liners. Sub-samples were collected from the liners, sealed in polythene tubs and amber glass jars, as appropriate, and returned to the laboratory for analysis.

Boring commenced initially at approximately 102 mm diameter, reducing progressively with depth to approximately 65 mm. Standard penetration tests (SPTs) were carried out at 1 m intervals, the results of which are included on the individual borehole records.

As the drilling progressed, details of the strata succession were recorded, together with observations concerning the incidence and behaviour of groundwater ingress and any obvious visual or olfactory evidence of soil or groundwater contamination. Temporary casings were installed as necessary to support the sides of the boreholes and it is important to note that these may affect groundwater observations during the fieldworks.

On completion of eight of the boreholes, groundwater/gas monitoring standpipes were installed to between 2.6 and 4.0 m depth. Details of these installations are included on the individual borehole records. In general, however, they consisted of 50 mm diameter slotted screen surrounded by non-calcareous aggregate, with a bentonite seal around a 1.0 m length plain section of pipe extending just below the ground surface. Each installation was fitted with a gas valve and a secure steel cover.

The engineering records of the dynamic sampling boreholes are presented in Appendix A.

3.2.2 Field Monitoring

Following completion of the intrusive investigatory works, three return visits have been undertaken to date for gas and groundwater monitoring purposes. During each of these visits, concentrations of methane, carbon dioxide and oxygen, together with gas flow rates, were measured within the monitoring wells using a Geotechnical Instruments GA2000 infrared gas analyser. This instrument was also used to record the prevailing atmospheric pressure conditions.

A cable reel interface dipmeter was used to determine standing water levels within the installations.

The results of the field monitoring are presented in Appendix B.

3.3 Laboratory Testing

Chemical tests have been completed on selected soil samples appropriate for the consideration of potentially harmful effects on human health and the aggressive effects towards buried concrete. Chemical tests have also been undertaken on samples of groundwater recovered from the monitoring wells for the consideration of potential pollution risks to controlled waters. The laboratory analysis undertaken on the selected samples, based on the contaminants of concern identified within Section 6.2.3 of this report are summarised below.

- (i) inorganics suite comprising: metals, cyanides, total and water soluble sulphate, pH and asbestos screening; and
- (ii) organics suite comprising: speciated polycyclic aromatic hydrocarbons (PAHs), speciated petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), phenols and soil organic matter (SOM).

Waste assessment criteria (WAC) analyses were also undertaken on a combination of soil samples delivered to the laboratory.

The laboratory test certificates for the soil and groundwater testing are presented in Appendices C and D, respectively.

4. Physical Ground & Groundwater Conditions

4.1 General

Based on the findings of the exploratory holes the following general sequence of strata has been tentatively interpreted within the depth of investigation (from ground level down).

- (i) Made Ground;
- (ii) Probable Head Deposits;
- (iii) Probable River Terrace Deposits; and
- (iv) Probable Lambeth Group.

The solid bedrock of the White Chalk Subgroup, expected to underlie the site at depth, was not encountered within the depth of this investigation.

The general characteristics of these strata, as inferred from field observations are discussed below.

4.2 Strata Descriptions

4.2.1 Made Ground

Made Ground extended to between 0.5 and 2.0 m below the ground surface at the selected positions.

As discussed previously, the site is predominantly surfaced with a hardstanding of tarmacadam. The tarmacadam and an underlying, generally coarse-grained, granular material, was encountered to depths ranging from around 0.2 to 0.4 m. This granular material typically comprised flint, limestone, brick, concrete and sandstone. At one location (i.e. WS02), the tarmacadam was underlain by a 150 mm thick layer of mass concrete.

In areas where a tarmacadam surface was not encountered (i.e. WS03, WS04, WS08) a granular surface was encountered to around 0.3 to 0.5 m and was typically composed of brick, flint, limestone and sandstone.

Beneath the surface veneer of tarmacadam or granular materials, the Made Ground comprised a heterogeneous mixture of coarse- and fine-grained material. Typically, the coarser fragments were composed of brick, limestone, flint, sandstone, charcoal, chalk and occasional wood. The finer grained constituents generally comprised varying fractions of clay, silt and sand.

Deeper Made Ground and disturbance should be anticipated between the selected positions of investigation, associated for example, with earlier construction, and indeed any historic underground fuel storage facilities.

4.2.2 Probable Head Deposits

Beneath the deposits of Made Ground, Probable Head Deposits, consistent with the anticipated geology, were often revealed to depths ranging between 0.8 and 2.2 m. The Head Deposits were typically composed of yellowish brown sandy flint gravel within a dark grey clay matrix.

SPT N-values recorded in the probable Head Deposits ranged between 7 and 11, indicating generally loose to medium dense states.

4.2.3 Probable River Terrace Deposits

Beneath the deposits of Made Ground or probable Head Deposits, materials comprising yellowish brown, sandy flint gravel were encountered to depths ranging between 1.6 and 3.9 m. These materials differed from the overlying Head Deposits with regards to the general absence of fine-grained material, such that they have been tentatively interpreted as River Terrace Deposits. However, it should be appreciated that at one location, a fine-grained horizon was encountered within the gravels, and at another location a finer grained sand horizon was present.

SPT N-values recorded in the probable River Terrace Deposits ranged between 2 and 30, indicating widely variable states ranging between very loose and dense.

4.2.4 Probable Lambeth Group

Beneath the superficial deposits, extending to the full depth of the investigation, grey, brown and red, variegated, slightly silty clay was encountered. Based on our experience of such deposits, and the information on the geological sheet for the area, we have tentatively interpreted these clays as being part of the Lambeth Group. It should be appreciated in this context, however, that such deposits can be difficult to distinguish from the overlying superficial deposits where the constituents originate from the parent material.

SPT N-values recorded in the Lambeth Group ranged between 7 and 20, indicating consistencies predominantly in the firm to stiff range, although were locally soft to firm.

4.3 Groundwater

Groundwater strikes were recorded within the boreholes at depths of between 1.0 and 1.6 m below ground level, and subsequently rose to depths ranging between 0.80 and 1.19 m after a period of 20 minutes.

Monitoring of groundwater levels within the wells installed within the boreholes, following completion of the intrusive fieldworks, indicates that groundwater is standing at depths ranging between 0.81 and 1.15 m below existing ground level.

Subsequent variations in groundwater and hydrological conditions could occur in response to future seasonal or climatic changes, and on this site could also be influenced by water levels in adjacent or nearby surface watercourses.

5. Ground and Groundwater Contamination

5.1 Introduction

The chemical test results have been considered within a risk assessment framework, whereby a conceptual model of possible pollutant linkage has been developed for the site and is described in the context of the proposed development. This considers the relationship between potential contamination sources, pathways and receptors in the light of the available information concerning the site history, geology, hydrology, and environmental setting, together with details of the proposed development, as set out in the preceding sections of this report.

This section of the report considers the level of risk posed by potential contaminants to human health and controlled waters in the context of the proposed development.

5.2 Conceptual Site Model

5.2.1 Ground and Groundwater Conditions

It is possible to summarise the general ground and groundwater conditions as follows, on the basis of the information contained within the preceding sections of this report.

- The underlying geology revealed by the boreholes comprises Made Ground followed by generally relatively coarse-grained superficial deposits and finally dominantly fine-grained deposits of the Lambeth Group. The underlying deposits of the White Chalk Subgroup were not encountered within the depth range of this investigation.
- The revealed deposits of Made Ground at the site have been proven to depths of up to around 2.0 m; however, deeper pockets of Made Ground cannot be discounted due to the presence of possible historic buried sub-structures, such as the underground fuel tank. The majority of the Made Ground appears to comprise hard construction and reworked natural materials, with inclusions of anthropogenic materials such as brick, concrete etc. In the previous investigation, Chrysotile and Amosite asbestos was encountered at two locations within the Made Ground.
- It is believed that at least one underground fuel storage tank (UST) is still present at the site, this having been decommissioned in 1994.
- Groundwater strikes were recorded within the boreholes at depths of between 1.0 and 1.6 m below ground level and subsequent monitoring of groundwater levels indicates that groundwater is standing at depths ranging between 0.81 and 1.15 m below existing ground level.

5.2.2 Possible Sources of Contamination

It is possible to make the following comments in the light of the findings of the desk-based research, site inspection, and intrusive investigatory works referred to herein.

- The site has an established past and recent commercial usage as a Parchment Works and Builder's Yard (Joinery business) with associated workshops, solvent/oil storage etc. These land uses are the principal risk driver for risks arising from potential ground contamination.

- There is a risk of contamination associated with the storage of fuel/oil at the site, associated, for example, within the above ground fuel storage tanks and underground fuel storage tanks that are present at the site. General contamination of the ground surface could also have occurred due, for example, to site operations such as spillage/leakage from vehicles, maintenance of machinery and arising from the past commercial activities at the site
- Deposits of Made Ground have been revealed at the site, containing pockets of anthropogenic materials, including in two instances during the previous investigation, Chrysotile and Amosite asbestos. Deeper deposits of unknown composition are expected in the areas of the USTs.
- The deposits of Made Ground, together with degradation of organic contaminants that could be present, are potential sources of hazardous gas generation, albeit of low production potential considering their limited depth and the general absence of significant organic accumulations.
- The proposed redevelopment of the site as residential properties does not represent a potentially contaminative use.

5.2.3 Contaminants of Concern

Based on the summary presented in Section 5.2.2 above, the following broad range of potential contaminants has been considered in quantifiable terms by this assessment.

- Metals and semi-metals: arsenic, boron, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc.
- Organic compounds: total petroleum hydrocarbons (TPH) including BTEX, volatile organic compounds (VOCs), phenols and polycyclic aromatic hydrocarbons (PAHs).
- Inorganic compounds: cyanides, sulphates and asbestos.
- Acids and alkalis.
- Carbon dioxide and methane.

In addition to the above, careful vigilance has been exercised throughout the intrusive investigatory works for visual or olfactory evidence of hydrocarbon contamination and/or likely asbestos containing materials.

5.2.4 Receptors and Pathways

5.2.4.1 Chronic Human Health Risks

In respect of chronic human health risks arising from the presence of potentially contaminated soils at the site following completion of the proposed development, the eventual occupiers of the residential development are considered to represent the most vulnerable receptors.

The most significant pathways for the purposes of assessing the risk posed to the identified receptors, from the aforementioned list of contaminants, would be considered to be the ingestion of soil and fugitive soil dust within soft landscaped garden areas, ingestion of soil due to plant uptake, together with the indoor inhalation of soil vapours/gasses, arising from volatile organic contaminants.

The standard residential land use, with plant uptake, has been utilised for screening purposes in the context of this assessment.

5.2.4.2 Acute Human Health Risks

During construction, site workers, occupiers of nearby housing, and members of the public using the adjacent footpaths could potentially be exposed to contaminants present in the ground via a number of pathways, including dermal contact with contaminated soils, or ingestion of airborne particulate matter during bulk earthmoving operations. Such risks will need to be addressed in the context of the pre-construction health and safety plan prepared by the building/groundworks contractor.

In addition to the normal precautions anticipated on a site of this nature, including for example the provision of appropriate personal protective equipment and hygiene facilities, it would be prudent on this site to ensure measures are taken to suppress airborne particulate matter during earthmoving activities.

5.2.4.3 Controlled Waters

The most significant controlled water receptors, for the purposes of this assessment, is considered to be the Principal Aquifer that underlies the site, and the associated Source Protection Zone.

It should also be appreciated, however, that the site is immediately bordered in the west by a narrow surface watercourse, and that there are historic springs reported to be located in the south-western corner of the site, and a short distance outside the south-eastern corner.

Given the site history, together with the high sensitivity of the receptor that underlies the site, a quantitative controlled waters risk assessment is warranted and is presented below in Section 5.4.

5.3 Assessment of Chronic Human Health Risks

5.3.1 Methodology

Chronic human health risks associated with possible land contamination at the site have been assessed using the generic quantitative risk assessment (GQRA) methods published by DEFRA and the Environment Agency in CLR 11 (Ref. 5).

The GQRA presented herein is based on the generic residential land use as described in the Environment Agency publication SR3 (Ref. 6).

It should be noted that the Environment Agency has withdrawn its original SGV reports, some of which, at the time of writing, have been replaced. In order of preference, the Generic Assessment Criteria (GAC) adopted for the purpose of this GQRA have been taken as:

- (i) revised Soil Guideline Values (SGVs);
- (ii) withdrawn SGVs (for lead only);
- (iii) GAC derived by the Chartered Institute of Environmental Health (CIEH)/Land Quality Management; and
- (iv) GAC derived in-house by Ground Investigation Limited.

5.3.2 Sampling and Laboratory testing

The investigation has established that the entire site is underlain by variable thicknesses of Made Ground. In order to provide supplementary information on soil chemistry at the site, 5 selected soil samples have been analysed in the laboratory. Where practicable, sampling was targeted on the positions of potentially contaminative features as detailed in Section 3.2. In this regard, it should be appreciated that soil sampling and laboratory chemical testing was completed as part of the previous investigation, and is discussed in Section 2.8.

The primary purpose of soil sampling was to determine the concentrations of soil contaminants to inform an assessment of chronic human health risks. Attention has therefore focussed on recovering soil samples from within around 0.7 m of existing ground levels.

Concentrations of all of the potential contaminants identified in Section 5.2 were determined in the soil samples selected for chemical analysis.

The laboratory test certificates presenting the results of the chemical analyses conducted on the selected soil samples are presented in Appendix C.

5.3.3 Risk Assessment

Table 1 summarises the laboratory test data and compares measured contaminant concentrations in the selected soil samples with their respective GAC. Statistical analysis of the results has not been carried out due to the targeted nature of the investigation.

It should be noted that all VOCs were below detection limits, including BTEX and MTBE, all TPH fractions were below GAC and no asbestos was observed in any of the soil samples.

However, as was discovered during the previous investigation, there were some recorded elevated concentrations of lead and benzo(a)pyrene.

Based on the composition of the Made Ground, and the potential for elevated concentrations of PAH and metal/semi-metals, it is our opinion, that these shallow Made Ground deposits would not be suitable for use in the near surface garden areas of the proposed residential properties, leading to a requirement for appropriate remedial works to ensure that the site is suitable for the proposed residential land use.

It is recommended some further investigatory works are undertaken beneath the building footprints and potential point sources of contamination such as the underground fuel tanks in due course, following vacation of the site and demolition of the structures, when suitable access is available. These works will likely be most practically and economically undertaken using further mechanically excavated trial pits. However, based on the present findings, also taking into consideration the findings of the previous works, a summary of the proposed remedial works is presented in the following section.

5.3.4 Recommended Remedial Works (Human Health)

For the contaminants identified as potentially posing an unacceptable chronic human health risk, the critical exposure pathways would be the direct and indirect ingestion of contaminated soil and dust and consumption of homegrown produce. These exposure pathways could be eliminated by providing an adequate thickness of clean cover material within gardens and areas of communal soft landscaping with such Made Ground soils at or near the surface.

The clean cover system should be composed of material that is inert and not itself contaminated. The thickness of clean cover should be agreed with the Local Authority's Contaminated Land Officer and with warranty providers, but we recommend that it be not less than 600 mm thick in any private garden areas, and at least 300 mm within areas of communal soft landscaping. It would be prudent to install a low-cost geotextile at the base of the clean cover to separate it from the underlying in-situ soils and to act as a marker for any post construction verification works that will likely be required to confirm its thickness.

It may be possible to place the Made Ground in the proposed soft landscaped areas beneath areas of hardstanding (e.g. roads, buildings) such that they are isolated from the end users at the site. The shortfall in the garden areas could potentially be made up, at least in part, with natural excavation spoil derived from elsewhere at the site, subject to an appropriate quality assurance regime, the surface being finished with an appropriate thickness of good quality imported topsoil sufficient to promote plant growth.

The works described above are intended as a precautionary measure to remove the principal pathways through which the most vulnerable receptors, taken as the occupiers of the completed development, could potentially be exposed to the unsuitable near surface Made Ground. Subject to regulatory approval of the proposed remedial works described above, these works should be undertaken by an experienced contractor, fully documented, and validated on completion by a competent geo-environmental specialist.

As with any redevelopment site, however, particularly one such as this with a significant past history of industrial land use, vigilance should be exercised during the proposed construction works for evidence of more significant contamination or materials differing to those encountered during the investigation detailed in this report. Should such deposits be encountered, this could lead to a requirement for further analysis and assessment. Further analysis could also be required in due course to classify such deposits for off-site disposal.

Notwithstanding the above, specific remedial actions will also need to be taken to address the presence of the former fuel storage tank that is believed to be present at the site. Subject to consultation with the Local Authority, this structure, together with any other such structures revealed during the groundworks phase of construction, will need to be removed from site, or permanently and effectively decommissioned, such that they do not present any ongoing risk to human health or the environment.

If the suspected underground fuel storage tanks are discovered and it is established that they should be removed, then any surrounding or underlying contaminated soils should also be excavated and disposed of to a suitably licensed facility. Sampling of the sides and base of the resultant excavation will need to be undertaken to validate that this exercise has been completed to an acceptable standard, and samples of the excavated soil will need to be analysed to provide waste acceptance parameters. Associated pipework such as the supply lines to any pumps should also be removed, together with any significantly hydrocarbon impacted soils in their immediate vicinity.

5.4 Assessment of Risk to Controlled Waters

5.4.1 Context

Water pollution risks arising from possible land contamination at the site are considered solely in the context of the proposed land use. No attempt is made to evaluate water pollution risks such as might arise as a consequence of activities that take place to facilitate and realise the redevelopment of the site. These matters should, however, be considered by the Principle Contractor who, where necessary, should ensure that appropriate actions are taken to adequately mitigate such risks.

5.4.2 Receptors and Pollutant Linkage

As discussed above, the most significant controlled water receptor, for the purposes of this assessment, is considered to be the Principal Aquifer, and the associated Source Protection Zone that underlies the site. This risk assessment therefore focuses on evaluating pollution risks to potable water supplies.

However, due to the proximity of surface water and springs which are understood to be utilised for potable water supply purposes, it is also necessary to consider any potential impact on these relatively shallow receptors.

5.4.3 Methodology

Water pollution risks have been assessed using the methodologies described in the Environment Agency's publication titled 'Hydrogeological Risk Assessment for Land Contamination' (Ref. 7). In this report, such assessments have been confined to consideration of groundwater chemistry (i.e. a Level 2 groundwater assessment).

Since the most vulnerable water receptor identified by this study is the Principal Aquifer beneath the site, possible water pollution risks have been gauged by comparing the results of groundwater analyses with UK drinking water standards.

The Level 2 assessment presented in this report takes no account of attenuation mechanisms such as dilution, dispersion, retardation, sorption, and degradation; the outputs are therefore likely to provide conservative (i.e. safe) estimates of pollution risk.

5.4.4 Environmental Sampling and Laboratory Analysis

A total of 8 groundwater samples were taken from the observation wells and have been analysed for the contaminants of concern listed in Section 5.2.3, above.

The groundwater samples were recovered on 7th August 2014 and the results of the laboratory analyses conducted on the groundwater samples are presented in Appendix D.

5.4.5 Level 2 Groundwater Risk Assessment

The outcome of the Level 2 groundwater assessment, which involves a simple comparison of contaminant concentrations in groundwater samples with water quality standard (WQS) values, is presented in Table 2.

The analytical data reveals that the groundwater beneath the site is not significantly or widely affected by the potential contaminants of concern. However, it should be appreciated that one sample recorded slightly elevated concentrations of TPH, and a second sample recorded very marginally elevated concentrations of TPH and some elevated PAH compounds. Conversely, the water samples that were recovered from the monitoring wells targeted at the fuel storage tanks, recorded concentrations below the water quality standard values.

Given the above, further discussion is warranted and presented below.

It should be appreciated in the above context that the elevated concentrations of TPH and PAH are heavy-end and immobile hydrocarbons which are regarded by the Environment Agency as exhibiting a low risk ranking. It should also be noted that the concentrations at which these fractions were detected are significantly above the aqueous solubilities such that the recorded concentrations are likely to have been detected as remnant heavy oil or grease sorbed to fine soil particles suspended in the water

column. In this context, it should be noted that no visual or olfactory evidence of hydrocarbon contamination was observed during the intrusive exploratory works or subsequent monitoring.

Given the generally low mobility of the detected hydrocarbons, the potential for contaminant mobilisation and associated lateral migration is considered to be very low. It should also be acknowledged in this context that the fine-grained strata of the suspected Lambeth Group that were encountered beneath the Made Ground and superficial deposits would likely act as a barrier to potential downward migration of mobile contaminants into the underlying aquifer.

Based on the aforementioned considerations, subject to the agreement of the regulatory authorities, it is our opinion that due to the marginal elevation of relatively immobile, potential contamination and the low risk ranking, together with a geological barrier above the Principal Aquifer, the site and proposed development do not present a significant threat to water quality. It should also be appreciated in this context, that following completion of the development, any primary or secondary sources of potential hydrocarbon contamination will be removed, providing site wide environmental betterment, as is detailed in Section 5.3.4, above.

Such measures will effectively reduce the pollution risk to controlled waters by removing the primary and secondary sources of potential hydrocarbon contamination.

5.5 Gas Risk Assessment

5.5.1 Methodology

Risks arising from the possible presence of methane and carbon dioxide gas have been assessed using the methodology described in CIRIA C665 (Ref. 8).

5.5.2 Possible Gas Sources

The ground investigation has established that the site is underlain by variable thicknesses of Made Ground. Although the encountered deposits of Made Ground did not contain materials that would be expected to have a potential to generate methane or carbon dioxide gas at appreciable rates, the possibility of a significant gas source within the Made Ground could not be wholly discounted on the basis of strata inspection alone.

5.5.3 Gas Monitoring

In order to examine the soil gas regime at the site a total of 8 monitoring wells have been constructed in the boreholes. These observation wells have been monitored for gas concentrations and gas flow rates on three occasions to date, from 7th August to 11th September 2014, at atmospheric pressures ranging between 1009 mB and 1020 mB. The gas monitoring data are presented in Appendix B.

Concentrations of methane were generally low (i.e. 0.1 % volume or less). Carbon dioxide has been found at a maximum concentration of 7.1 %.

Such characteristics are consistent with soil gases originating from typical Made Ground.

5.5.4 Gas Screening Value and Characterisation

The gas screening value (GSV) for the site has been calculated as follows.

$$\text{GSV} = (0.3 \text{ L/hr}) \times (7.1 \% \text{ vol. CO}_2) = 0.021 \text{ L/hr}$$

In the absence of any measurable gas flows, the borehole flow rate has, for the purpose of calculating a safe GSV, been taken as 0.3 L/hr which is the limit of detection for the field measuring device. The gas concentration of 7.1 % volume used to calculate the GSV relates to the maximum recorded concentration of carbon dioxide.

Based on this GSV and depending on the types of building of the proposed development, the site's gas classification is Characteristic Situation 1 (CS1) or NHBC classification 'Green' as defined in CIRIA C665. However, as concentrations of carbon dioxide exceed a typical maximum value of 5 %, the published guidance recommends that the characterisation is upgraded to CS-2 or Amber 1. It is recommended accordingly, that gas protective measures complying with the requirements of Characteristic Situation 2/Amber 1 are incorporated into the design of the proposed buildings. This would typically be expected to comprise the combination of a gas-proof membrane and a ventilated sub-floor void.

The published guidance suggests, that for a high sensitivity development (i.e. residential) and a low generation potential source, ideally, six gas readings should be undertaken during a six month period. It is recommended accordingly that a number of further monitoring visits are undertaken, if possible targeting low and falling atmospheric pressure. It should be noted in this context, however, that the guidance indicates that there is a balance to be considered between the cost of additional monitoring and the improvement in technical confidence which will result. As the requirement for gas protection has been identified as a precautionary measure in respect of only slightly elevated carbon dioxide concentrations, it is considered unlikely that the additional monitoring will significantly affect the above recommendations.

5.6 Aggressive Chemical Environment for Concrete

The aggressive chemical environment for concrete (ACEC) for the site has been estimated using the methodology described in BRE Special Digest 1 (see Ref. 9).

Concentrations of water soluble sulphate, total sulphate and total potential sulphate, together with pH values have been measured in the five samples distributed throughout the Made Ground. Two of the five samples contained oxidisable sulphates in excess of 0.3 %, such that pyrite may be present. However, eight groundwater samples were also analysed for sulphate such that these should also be taken into consideration.

Based on Table C2 of the published guidance, using a characteristic value derived from the highest soil and groundwater results, taking into consideration mobile groundwater conditions, concrete conforming to ACEC Class AC-2, with a design class of DS-2 should be suitable for use below ground level.

5.7 Waste Classification & Waste Assessment Criteria

The results of the chemical tests have been used to classify the encountered soils in terms of hazardous or non-hazardous in the context of potential disposal at landfill.

The results were inputted into the HazWasteOnline proprietary software tool which indicated that the encountered soils would be classified as non-hazardous. However, the concentrations of lead were slightly elevated, such that if the chemical species used in the assessment for lead is lead chromate, then the material would classify as hazardous. However, due to the absence of chromate (or chromium (VI)) based on the laboratory test results, the presence of lead chromate is unlikely such that the assessment was based on lead compounds in general.

It should also be appreciated that some asbestos fibres were observed during the previous investigation, although no asbestos was detected during this current phase.

WAC testing has been undertaken on two composite soil samples. The full results of the WAC testing are presented in Appendix C. Further discussion is presented below.

WAC testing has been undertaken by batch leaching methods to supplement the analysis of solid samples undertaken as part of the assessment of potential human health risks from ground contamination, in order that waste disposal options can be considered for materials that are likely to be generated during construction activities.

Two composite soil samples were analysed in the laboratory for waste assessment criteria (WAC) using bulk composite samples considered broadly representative of the soils expected to be derived from excavations at the site.

The results indicate that in general, landfill waste acceptance criteria for inert waste were not exceeded. However, sample WAC 1, a combination of the encountered Made Ground, exhibited 7.8 % total organic carbon (TOC) which is above the waste assessment criteria of 3-6 %. However, if the TOC value is not achieved, a higher limit value may be admitted by the competent authority, provided that the dissolved organic carbon (DOC) thresholds are met, which in this case they are significantly lower.

We advise that all laboratory test results be presented to prospective landfill recipients of excavation spoil derived from the site, for consideration in the context of their specific license conditions. The ultimate decision whether to accept such materials lies with the individual landfill.

6. Ground Engineering

6.1 Context

This section of the report considers the ground conditions in the context of the engineering design and construction of the proposed development. Advice is given in relation to the design of foundations and ground floor slabs.

The use of conventional shallow spread foundations to support the proposed structures is unlikely to be feasible due to the presence of variable thicknesses of Made Ground and disturbance associated with pre-existing subsurface construction, coupled with a very shallow groundwater table. Consideration will therefore need to be afforded to providing an alternative foundation solution.

In addition to considering the normal geotechnical implications of various foundation options, the suitability of particular foundation solutions for the subject site will need to afford full consideration to the environmental sensitivity of the site in the context of protecting the adjacent and underlying potable water supply sources. In this context, full consultation with the regulatory will be required during the design stage of the development.

6.2 Site Preparation

Prior to commencing the earthworks or ground works, all live services on, and in the vicinity of, the proposed development should be accurately located and, if necessary, diverted or protected. The ends of existing drains and sewers no longer required because of alterations to the drainage layout should be effectively sealed so as to prevent any residual or persisting seepages from adversely affecting the integrity and/or stability of the formations and/or foundations.

Any old foundations and sub-structures within the footprint of the proposed buildings should be cleared. Sub-structure walls should be grubbed up to a depth of at least 1.5 m below any proposed shallow foundations. Basements or service conduits, and surface voids resulting from the site preparation work, should be filled with well compacted, acceptable granular material (e.g. DoT Type 1, or similar approved).

Specific remedial actions will need to be taken to address the presence of the fuel storage tank that is expected to be located on the site, together with any other such features encountered during the initial site preparation or groundworks phase of construction. Any tanks will likely need to be removed from site together with the supply pipes and surrounding bund structures, in the presence of a suitably qualified Geo-environmental Engineer. If any surrounding or underlying contaminated soils are encountered, they should be excavated and disposed of to a suitably licensed facility. Sampling of the sides and base of the resultant excavation will need to be undertaken to validate that this exercise has been completed to an acceptable standard, and samples of the excavated soil will need to be analysed to provide waste acceptance parameters.

6.3 Foundations

As discussed above, the construction of conventional shallow spread foundations is unlikely to prove feasible on this site, due to the combination of significant depths of Made Ground and disturbance due to pre-existing construction, coupled with shallow groundwater, which would likely affect the stability and practicality of excavations extending down into the undisturbed natural deposits in some areas of the site. It should be acknowledged in this context that whilst around 2 m of Made ground has been

revealed by the present investigation, considerably deeper disturbance could be present within the site boundaries, associated, for example, with the reported buried fuel tank, and the historic watercourse encroaching into the south-western corner of the site, identified on early OS mapping.

A number of foundation options may be feasible which will depend upon the economics of each type, together with environmental considerations.

- Vibrated stone columns (VSC) could be installed into the ground to increase the load bearing characteristics. The suitability and design of any specific solution based on VSC will depend on the layout and loading details of the structures together with the type of foundation and the particular ground conditions. The advice of a specialist ground treatment contractor(s) should be sought in order to confirm the suitability of the ground with respect to their particular proprietary systems and where appropriate to provide information on suitable treatment and costs. Consideration would also need to be afforded the environmental impact of such techniques including, for example, the potential for damage to nearby structures caused by vibration or displacement, and to the possible creation of preferential pathways through which mobile contaminants could impact upon the quality of groundwater within the underlying Chalk aquifer and/or nearby surface waters. It should be appreciated in this context, however, that by restricting the installation of stone columns to the primarily granular superficial deposits, such that they terminate above, or within, the underlying fine-grained suspected Lambeth Group strata, the potential for creating preferential pathways would be largely removed, due to the presence of surrounding largely granular subsoils of likely high permeability.
- Piled foundations extending into competent horizons of the Chalk bedrock could be a suitable option for the proposed development, subject to the completion of further boreholes, extending to greater depth, to prove the depth to the bedrock and inform the necessary design parameters. The piled foundations should be designed by an experienced and competent specialist piling contractor who should select appropriate design parameters and guarantee safe working loads together with maximum total and differential settlements, which should be within acceptable tolerances for the proposed structures. The choice of piling technique should be agreed with the contractor. Soil parameters for the strata to be penetrated will depend on the piling technique selected and the precise method of working. Driven piles should only be considered if vibrations and environmental constraints can be maintained within acceptable limits, with regard to the proximity of neighbouring buildings. As with the use of ground improvement techniques, full consideration would need to be afforded to the possible creation of preferential pathways through which contamination could impact upon the underlying aquifer in the Chalk. Consultation with the Environment Agency is likely to prove necessary in this respect, and it is possible that such a foundation solution would be discouraged by the regulators on this site.
- Subject to appropriate treatment of the underlying subsoils and provision of a suitably engineered blanket of granular fill, the use of rigid reinforced raft foundations could possibly be considered. The loose and variable deposits of Made Ground would ideally need to be removed in their entirety from beneath the proposed construction footprint and immediately surrounding areas, and the exposed formation proof rolled prior to placing a suitable thickness of selected granular fill, compacted to an appropriate engineering solution. Such a foundation solution would, however, need to be designed to resist differential settlement, and to span and/or cantilever over any areas of relatively soft/loose soils which extend down below the water table and cannot be excavated and replaced by conventional methods, which could prove problematic. Furthermore this foundation solution could potentially generate relatively large volumes of Made Ground for off site disposal. However, in environmental terms, the regulatory authorities would most likely welcome the use of a foundation solution of this type, which would have minimal impact on the existing environmental equilibrium. It is

recommended warranty providers are consulted regarding the proposed use of a raft foundation solution of this type.

6.4 Ground Floor Slabs

A requirement for precautionary measures to be incorporated into the design of the floor slab in respect of possible risks from flammable/asphyxiant gases is highlighted in Section 5.5 of this report, which would normally be associated with the provision of a suspended floor slab with a suitably dimensioned sub-floor void. Notwithstanding this requirement, suspended ground floor slabs would be recommended throughout the proposed development in the light of the variable depth and nature of the Made Ground encountered, together with anticipated disturbance due to subsurface construction.

If a raft foundation solution is adopted, then measures will likely need to be taken to provide a pressure differential beneath, for example in the form of proprietary geo-composite strips, in conjunction with the provision of gas protection.

TABLES

West Street, Havant									
Table 1 - Estimation of Chronic Human Health Risks for									
Standard Residential Land Use with Plant Uptake (1% SOM)									
Contaminant		Units	GAC	Pass Criteria?	WS01	WS03	WS06	WS07	WS10
			1%		0.7m	0.7m	0.6m	0.6m	0.6m
pH value		-	-	-	7.9	8.0	8.2	7.8	8.4
Soil Organic Matter		%	-	-	4.9	2.3	2.8	2.6	0.7
Metals and inorganics	Arsenic	mg/kg	32 ^{SGV}	✓	19.9	13.1	10.7	20.6	5.3
	Boron	mg/kg	291 ^{CIEH}	✓	2.7	1.3	1.9	2.2	1.9
	Cadmium	mg/kg	10 ^{SGV}	✓	0.5	<0.5	<0.5	<0.5	<0.5
	Chromium	mg/kg	3000 ^{CIEH}	✓	17.5	11.3	11.4	11.1	14.1
	Chromium (VI)	mg/kg	4.3 ^{CIEH}	✓	<2	<2	<2	<2	<2
	Copper	mg/kg	2330 ^{CIEH}	✓	137.9	64.6	104.9	66.7	25.8
	Lead	mg/kg	450 ^{SGV*}	x	682.6	497.8	197.9	1257.8	176.9
	Inorganic Mercury	mg/kg	170 ^{SGV}	✓	2.1	1.1	<0.5	<0.5	<0.5
	Nickel	mg/kg	130 ^{SGV}	✓	26.7	12.1	23.7	27.5	10.2
	Selenium	mg/kg	350 ^{SGV}	✓	1.2	<0.5	1.0	0.7	<0.5
	Zinc	mg/kg	3750 ^{CIEH}	✓	179.6	96.9	88.4	126.7	87.8
Organics	Cyanide	mg/kg	53 ^{GI}	✓	<1	<1	<1	<1	<1
	Phenols	mg/kg	210 ^{CIEH}	✓	<1	<1	<1	<1	<1
PAHs	Naphthalene	mg/kg	1.5 ^{CIEH}	✓	<0.5	<0.5	<0.5	<0.5	<0.5
	Acenaphthylene	mg/kg	170 ^{CIEH}	✓	<0.5	<0.5	<0.5	<0.5	<0.5
	Acenaphthene	mg/kg	210 ^{CIEH}	✓	<0.5	<0.5	<0.5	<0.5	<0.5
	Fluorene	mg/kg	160 ^{CIEH}	✓	<0.5	<0.5	<0.5	<0.5	<0.5
	Phenanthrene	mg/kg	92 ^{CIEH}	✓	<0.5	0.9	<0.5	1.1	<0.5
	Anthracene	mg/kg	2300 ^{CIEH}	✓	<0.5	<0.5	<0.5	<0.5	<0.5
	Fluoranthene	mg/kg	260 ^{CIEH}	✓	<0.5	1.6	0.7	4.4	<0.5
	Pyrene	mg/kg	560 ^{CIEH}	✓	<0.5	1.2	0.5	3.7	<0.5
	Benzo(a)anthracene	mg/kg	3.1 ^{CIEH}	✓	<0.5	1.0	<0.5	2.9	<0.5
	Chrysene	mg/kg	6.0 ^{CIEH}	✓	<0.5	1.3	0.6	2.9	<0.5
	Benzo(b)fluoranthene	mg/kg	5.6 ^{CIEH}	✓	<0.5	0.9	0.5	1.8	<0.5
	Benzo(k)fluoranthene	mg/kg	8.5 ^{CIEH}	✓	<0.5	1.5	<0.5	2.6	<0.5
	Benzo(a)pyrene	mg/kg	0.83 ^{CIEH}	x	<0.5	1.0	<0.5	2.3	<0.5
	Indeno(1,2,3-c,d)pyrene	mg/kg	3.2 ^{CIEH}	✓	<0.5	0.8	0.7	1.6	<0.5
	Dibenzo(ah)anthracene	mg/kg	0.76 ^{CIEH}	✓	<0.5	<0.5	<0.5	0.6	<0.5
	Benzo(g,h,i)perylene	mg/kg	44 ^{CIEH}	✓	<0.5	1.1	1.0	1.9	<0.5
BTEX	Benzene	mg/kg	0.08 ^{GI}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	Toluene	mg/kg	120 ^{GI}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	Ethyl Benzene	mg/kg	65 ^{GI}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	Xylenes	mg/kg	42 ^{GI}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
TPHs (Aromatics)	>nC ₅ -nC ₇	mg/kg	0.08 ^{GI}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	>nC ₇ -nC ₈	mg/kg	120 ^{GI}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	>nC ₈ -nC ₁₀	mg/kg	27 ^{CIEH}	✓	<0.1	<0.1	<0.1	<0.1	0.1
	>nC ₁₀ -nC ₁₂	mg/kg	69 ^{CIEH}	✓	<0.1	<0.1	<0.1	<0.1	0.2
	>nC ₁₂ -nC ₁₆	mg/kg	140 ^{CIEH}	✓	<0.1	<0.1	<0.1	0.1	0.3
	>nC ₁₆ -nC ₂₁	mg/kg	250 ^{CIEH}	✓	0.1	0.3	<0.1	0.7	0.2
	>nC ₂₁ -nC ₃₅	mg/kg	890 ^{CIEH}	✓	<0.1	0.9	<0.1	3.1	<0.1
TPHs (Aliphatics)	>nC ₅ -nC ₆	mg/kg	30 ^{CIEH}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	>nC ₆ -nC ₈	mg/kg	73 ^{CIEH}	✓	<0.01	<0.01	<0.01	<0.01	<0.01
	>nC ₈ -nC ₁₀	mg/kg	19 ^{CIEH}	✓	<0.1	<0.1	<0.1	<0.1	<0.1
	>nC ₁₀ -nC ₁₂	mg/kg	93 ^{CIEH}	✓	<0.1	<0.1	<0.1	<0.1	<0.1
	>nC ₁₂ -nC ₁₆	mg/kg	740 ^{CIEH}	✓	<0.1	<0.1	<0.1	<0.1	<0.1
	>nC ₁₆ -nC ₂₁	mg/kg	45,000 ^{CIEH}	✓	0.2	0.2	0.2	0.2	<0.1
	>nC ₂₁ -nC ₃₅	mg/kg	45,000 ^{CIEH}	✓	<0.1	<0.1	<0.1	<0.1	<0.1
VOC	All VOC in suite	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	<0.01

Notes

GAC	Generic Assessment Criteria.
SGV	Soil Guideline Value published by DEFRA/EA, marked with * recently withdrawn.
CIEH	GAC derived by LQM/CIEH.
GI	GAC derived in-house by GI.
Value	Cells filled black indicate samples in which GAC is exceeded.

WEST SREET, HAVANT

TABLE 2 - Water Pollution Risk Assessment

Contaminant	Units	WQS Value	Source of WQS Value	Sample Concentrations							
				WS01	WS02	WS03	WS04	WS05	WS06	WS07	WS10
pH	Units	9.5	WSR	7.1	7.2	6.7	6.7	6.5	6.6	7.3	7.3
Metals and semi-metals:											
Arsenic	µg/l	10	WSR	<5	<5	<5	<5	<5	<5	6	<5
Cadmium	µg/l	5	WSR	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	µg/l	50	WSR	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/l	2,000	WSR	<5	<5	6	<5	<5	<5	10	6
Lead	µg/l	25	WSR	<1	<1	3	<1	<1	<1	2	3
Mercury	µg/l	1	WSR	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	µg/l	20	WSR	<1	1	1	<1	6	<1	4	<1
Selenium	µg/l	10	WSR	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/l	75	WSR	11	6	17	6	8	11	11	11
Inorganic compounds:											
Sulphate	mg/l	400	WSR	31	49	40	30	30	38	49	33
Cyanide	ug/l	50	WSR	<5	<5	<5	<5	<5	<5	<5	<5
Organic compounds:											
Total Petroleum Hydrocarbons	ug/l	10	PWSR	<10	<10	<10	58	<10	<10	11	<10
Benzene	ug/l	1	WSR	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/l	700	WHO	<1	<1	<1	<1	<1	<1	<1	<1
Ethyl Benzene	ug/l	300	WHO	<1	<1	<1	<1	<1	<1	<1	<1
Xylenes	ug/l	500	WHO	<1	<1	<1	<1	<1	<1	<1	<1
PAHs	µg/l	0.1	WSR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.91	<0.05
Benzo(a)pyrene	µg/l	0.01	WSR	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.06	<0.05
Naphthalene	µg/l	290	SRC	0.05	0.05	<0.05	0.05	0.06	<0.05	0.28	0.05
Phenols	µg/l	0.5	WSR	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
VOC (all in suite)	µg/l	-	-	<1	<1	<1	<1	<1	<1	<1	<1

- Notes**
- (1) WQS = Water Quality Standard.
 - (2) WSR = Water Supply Regulations, 2001.
 - (3) PWSR = Private Water Supply Regulations, 1991.
 - (4) WHO = WHO drinking water standards.
 - (5) SRC = Serious Risk Concentration
 - (6) The WSR value for PAHs applies to the sum of the concentrations of the following four compounds: benzo(b)flouranthene, benzo(k)flouranthene, benzo(ghi)perylene, and indeno(1,2,3-cd)pyrene.
 - (7) Grey shading indicates samples in which contaminant concentrations exceed water quality standard values.

FIGURES



GROUND INVESTIGATION

geotechnical & geo-environmental consultants



Unit 3 Custom House Court,
Cleveland, Bristol. BS21 6EX.
Tel: 01275 876903 Fax: 01275 879662
Email: tim.gillbanks@ground-investigation.com

SITE: West Street, Havant

CLIENT: Mansell Homes

PROJECT ID: sw-536

SCALE: Not to Scale

FILENAME: p-sw-536 Figure 1

FIGURE 1

EXPLORATORY HOLE
LOCATION PLAN

APPENDIX A

Engineering Records of Continuous Percussion Boreholes



Site: West Street, Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date: 31/07/14

End Date: 31/07/14

Logged By: DH

Easting:

Nothing:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

Backfill
& Inst

Depth	Type / No	Result / Remark	Water	Legend	Depth (thick.)	Description	& Inst
0.50-0.60	ES/1				0.10	Tarmac surface.	
					0.25	MADE GROUND Mass concrete recovered as medium to coarse gravel and cobbles.	
					0.40	MADE GROUND Poorly compacted yellowish grey gravelly SAND. Gravel is fine to coarse angular to sub-rounded flint. Frequent medium gravel sized fragments of broken brick.	
					0.60	MADE GROUND Poorly compacted black gravelly silty CLAY. Gravel is fine to coarse angular to sub-rounded flint. Occasional fine to coarse gravel sized fragments of broken brick and chalk.	
1.00-1.45	C	N=7 (1,1;2,2,1,2)			0.80	MADE GROUND Loose yellowish brown slightly sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint.	
						PROBABLE HEAD GRAVEL Loose yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
1.90-2.00	D/2				(1.40)		
2.00-2.45	C	N=9 (3,3;2,2,2,3)					
2.90-3.00	D/3						
3.00-3.45	C	N=20 (1,2;3,4,5,8)					
4.00-4.45	C	N=10 (0,1;1,2,3,4)					

Boring Progress and Water Observations					Water Strikes					Hole Diameter		Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)
31/07/14	00:00	4.00	3.00	0.95	1.00		0.95	20		1.00	102	3.00	110
										2.00	87		
										3.00	75		
										4.00	65		

General Remarks:

- General Remarks:
- 1) Borehole terminated at 4.0m depth.
 - 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
 - 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street, Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date: 31/07/14

End Date: 31/07/14

Logged By: DH

Easting:

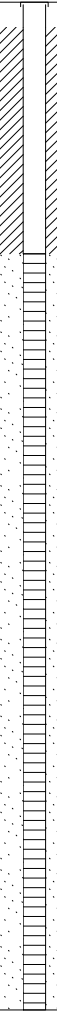
Northing:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

[illegible]

Depth	Type / No	Result / Remark	Legend	Depth (thick.)	Description	& Inst
0.60-0.70	ES/1			(0.30) 0.30	Poorly compacted light brown sandy GRAVEL of fine to medium sub-angular to sub-rounded quartzitic sandstone. MADE GROUND	
1.00-1.45	C	N=7 (2,2:1,2,2,2)		(0.90) 1.20	Poorly compacted yellowish brown gravelly SAND. Gravel is fine to coarse angular to sub-rounded flint. Frequent medium gravel sized fragments of broken brick and ceramic pipe and rare bivalve shells. MADE GROUND	
1.90-2.00	D/2			(1.40) 2.60	Loose to medium dense yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
2.00-2.45	C	N=10 (1,1:1,2,3,4)		(1.40) 2.60	...Loose from 1.8m to 1.85mbGL.	
3.00-3.45	C	N=13 (0,1:1,3,3,6)		(1.40) 4.00	Firm to stiff grey variegated light brown locally red slightly silty CLAY. PROBABLE LAMBETH GROUP	
4.00-4.45	C	N=15 (1,2,2,3,4,6)				

Boring Progress and Water Observations					Water Strikes					Hole Diameter			Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)	
31/07/14	00:00	4.00	3.00	1.17	1.60		1.17	20		1.00	102	3.00	110	
										2.00	87			
										3.00	75			
										4.00	65			

General Remarks:

- 1) Borehole terminated at 4.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street, Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date: 31/07/14

End Date: 31/07/14

Logged By: DH

Easting:

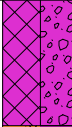
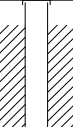
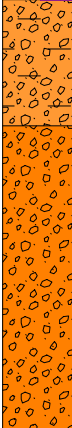
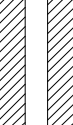
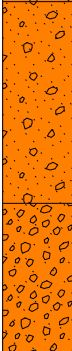
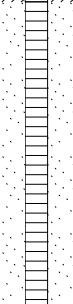
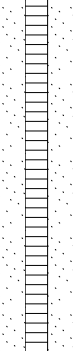
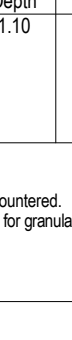
Northing:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

Backfill
& Inst

Depth	Type / No	Result / Remark	ter	Legend	Depth (thick.)	Description	& inst
0.40-0.50	ES/1				(0.50) 0.50	Poorly compacted black sandy GRAVEL of fine to coarse angular to sub-rounded flint. Occasional fine gravel sized broken brick fragments and bivalve shells. MADE GROUND	
1.00-1.45	C	N=11 (1,2,3,3,2,3)			(0.50) 1.00	Loose to medium dense yellowish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. PROBABLE HEAD GRAVEL	
2.00-2.45	C	N=7 (1,1:1,2,1,3)			(1.20) 2.20	Loose to medium dense yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
2.90-3.00	D/2				(0.80) 3.00	Loose cream slightly gravelly SAND. Gravel is fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
3.00-3.45	C	N=30 (2,8,8,7,7,8)			(0.60) 3.60	Dense yellowish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
3.90-4.00	D/3				(0.40) 4.00	Soft grey slightly sandy silty CLAY. PROBABLE LAMBETH GROUP	
4.00-4.45	C	N=7 (1,1:1,1,2,3)					

Boring Progress and Water Observations					Water Strikes					Hole Diameter		Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)
31/07/14	00:00	4.00	4.00	1.01	1.10		1.01	20		1.00	102	4.00	110
										2.00	87		
										3.00	75		
										4.00	65		

General Remarks:

- 1) Borehole terminated at 4.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street, Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date: 31/07/14

End Date: 31/07/14

Logged By: DH

Easting:

Northing:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

	Backfill & Inst
--	--------------------

Depth	Type / No	Result / Remark	Legend	Depth (thick.)	Description	& Inst
0.50-0.60	ES/1			0.10	Tarmac surface. MADE GROUND	
				0.30	Poorly to moderately compacted yellowish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. MADE GROUND	
				(0.90)	Moderately compacted becoming stiff black gravelly sandy SILT / CLAY. Gravel is fine to coarse angular to sub-rounded flint. Occasional fine to coarse gravel sized fragments of broken brick, chalk, quartzitic sandstone and concrete. MADE GROUND	
1.00-1.45	C	N=10 (3,4,3,2,2,3)		1.20	...Cobble of broken brick from 0.8m to 0.9mbGL.	
				(0.40)	Loose to medium dense orangish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. PROBABLE HEAD GRAVEL	
				1.60	Medium dense yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
2.00-2.45	C	N=16 (1,2,4,4,4,4)		(0.90)		
				2.50	Soft to firm grey variegated light brown locally red slightly silty CLAY. PROBABLE LAMBETH GROUP	
2.90-3.00	D/2			(1.50)		
3.00-3.45	C	N=8 (0,0,1,2,2,3)		4.00	...Stiff from 3.8m to 4.0mbGL.	
4.00-4.45	C	N=9 (0,1,1,2,2,4)				

Boring Progress and Water Observations					Water Strikes					Hole Diameter			Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)	
31/07/14	00:00	4.00	3.00	1.16	1.20		1.16	20		1.00 2.00 3.00 4.00	102 87 75 65	3.00	110	

General Remarks:

- 1) Borehole terminated at 4.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street, Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date:	01/08/14
-------------	----------

End Date: 01/08/14

Logged By: DH

Easting:

Northings:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

	Backfill & Inst
--	--------------------

Depth	Type / No	Result / Remark	Test	Legend	Depth (thick.)	Description	& Inst
0.50-0.60	ES/1				0.10 0.20 (0.80)	Tarmac surface. MADE GROUND Poorly compacted yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. MADE GROUND Poorly compacted dark grey locally black gravelly sandy silty CLAY. Gravel is fine to coarse angular to sub-rounded flint. Frequent fine to coarse gravel sized fragments of oolitic limestone, broken brick, chalk, clinker, charcoal and possibly ash. MADE GROUND	
1.00-1.45	C	N=3 (1,1,1,1,1,0)			1.00 (1.00)	No recovery due to concrete cobble in barrel.	
2.00-2.45	C	N=14 (0,1,1,4,5,4)			2.00 (0.50)	Medium dense light brown, cream and orangey brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
2.40-2.50	D/2				2.50 (0.50)	Firm grey variegated orangish brown silty CLAY. PROBABLE LAMBETH GROUP	
2.90-3.00	D/3				3.00 (0.60)	Firm grey variegated greenish grey, red and orangish brown slightly sandy gravelly silty CLAY. Gravel is fine to coarse angular to sub-rounded flint. PROBABLE LAMBETH GROUP	
3.00-3.45	C	N=14 (0,1,1,2,5,6)			3.60 (0.40)	Soft to firm pale grey slightly gravelly silty CLAY. Gravel is medium to coarse angular to sub-rounded flint. PROBABLE LAMBETH GROUP	
3.40-3.50	D/4				4.00		
3.90-4.00	D/5						
4.00-4.45	C	N=8 (1,1,1,2,2,3)					

Boring Progress and Water Observations					Water Strikes					Hole Diameter			Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)	
01/08/14	00:00	4.00	3.00	0.80	1.00		0.80	20		1.00	102	3.00	110	
										2.00	87			
										3.00	75			
										4.00	65			

General Remarks:

- 1) Borehole terminated at 4.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street. Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date: 01/08/14

End Date: 01/08/14

Logged By: DH

Easting:

Nothing:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

Backfill
& Inst

Depth	Type / No	Result / Remark	Legend	Depth (thick.)	Description	& Inst
0.50-0.60	ES/1			0.10	Tarmac surface. MADE GROUND	
				(0.30)	Poorly compacted yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. Frequent fine to coarse gravel sized fragments of broken brick, concrete and quartzitic sandstone.	
				0.40	MADE GROUND	
				(0.40)	Poorly to moderately compacted dark grey silty sandy gravelly CLAY. Gravel is fine to coarse angular to sub-rounded flint. Frequent fine to coarse gravel sized fragments of broken brick, chalk and quartzitic sandstone.	
				0.80	MADE GROUND	
0.90-1.00	ES/2				Loose to medium dense yellowish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint.	
1.00-1.45	C	N=11 (1,2,3,2,2,4)			PROBABLE HEAD GRAVEL	
				(0.70)		
				1.50	Loose to medium dense cream sandy GRAVEL within a light grey clay. Gravel is fine to coarse angular to sub-rounded flint.	
				(0.70)	PROBABLE HEAD GRAVEL	
1.90-2.00	D/3					
2.00-2.45	C	N=9 (3,3,2,2,2,3)				
				2.20	Soft to firm grey variegated light brown locally red slightly silty CLAY.	
					PROBABLE LAMBETH GROUP	
2.90-3.00	D/4					
3.00-3.45	C	N=9 (1,0,1,2,3,3)		(1.80)		
				4.00		
4.00-4.45	C	N=14 (2,2,2,3,4,5)				

Boring Progress and Water Observations					Water Strikes					Hole Diameter		Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)
01/08/14	00:00	4.00	3.00	1.05	1.40		1.05	20		1.00 2.00 3.00 4.00	102 87 75 65	3.00	110

General Remarks:

- 1) Borehole terminated at 4.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street. Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date: 01/08/14

End Date: 01/08/14

Logged By: DH

Easting:

Northing:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

	Backfill & Inst
--	--------------------

Depth	Type / No	Result / Remark	Legend	Depth (thick.)	Description	& Inst
0.50-0.60	ES/1			0.10 0.20	Tarmac surface. MADE GROUND Poorly to moderately compacted yellowish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. MADE GROUND Moderately compacted brown locally black sandy gravelly silty CLAY. Gravel is fine to coarse angular to sub-rounded flint. Frequent fine to coarse gravel sized fragments of broken brick, chalk, concrete, clinker and possible ash. MADE GROUND ...Cobble of broken brick from 0.4m to 0.5mbGL.	
1.00-1.45	C	N=14 (1,1:2,5,3,4)		(1.20)		
1.90-2.00	D/2			1.40	Medium dense yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint.	
2.00-2.45	C	N=14 (1,2:2,3,4,5)		1.60	RIVER TERRACE DEPOSITS Soft to firm grey variegated light brown locally red slightly silty CLAY. PROBABLE LAMBETH GROUP	
3.00-3.45	C	N=8 (1,1:1,2,2,3)		(1.40) 3.00		

Boring Progress and Water Observations					Water Strikes					Hole Diameter			Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)	
01/08/14	00:00	3.00	2.00	0.88	1.40		0.88	20		1.00 2.00 3.00	102 87 75	2.00	110	

General Remarks:

- 1) Borehole terminated at 3.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.



Site: West Street, Havant

Client: Mansell Homes

Job No: p-sw-536

Method/Plant Used: Archway Competitor Rig

Start date:	01/08/14
-------------	----------

End Date: 01/08/14

Logged By: DH

Easting:

Northings:

Elevation:

SAMPLES & IN-SITU TESTS

STRATA

	Backfill & Inst
--	--------------------

Depth	Type / No	Result / Remark	Test	Legend	Depth (thick.)	Description	& Inst
0.50-0.60	ES/1				0.10	Tarmac surface. MADE GROUND	
					0.30	Poorly compacted light brown variegated reddish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint and crystalline limestone. MADE GROUND	
					(0.60)	Poorly to moderately compacted black silty sandy gravelly CLAY. Gravel is fine to coarse angular to sub-rounded flint. Occasional fine to coarse gravel sized fragments of broken brick. MADE GROUND	
0.90-1.00 1.00-1.45	ES/2 C	N=11 (1,2,3,3,2,3)			0.90		
					(0.30)	Medium dense yellowish brown sandy GRAVEL within a dark grey clay. Gravel is fine to coarse angular to sub-rounded flint. PROBABLE HEAD GRAVEL	
1.90-2.00 2.00-2.45	D/3 C	N=9 (1,1:1,2,3,3)			1.20	Loose yellowish brown sandy GRAVEL of fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
					(1.00)		
					2.20	Firm grey variegated light brown locally red slightly silty CLAY. RIVER TERRACE DEPOSITS	
					(0.40)		
2.90-3.00 3.00-3.45	D/4 C	N=10 (1,1:1,2,3,4)			2.60		
					(0.30)	Loose cream SAND / GRAVEL. Gravel is fine to coarse angular to sub-rounded flint. RIVER TERRACE DEPOSITS	
					2.90		
4.00-4.45	C	N=7 (1,1:1,1,2,3)				Soft to firm grey variegated light brown locally red slightly silty CLAY. PROBABLE LAMBETH GROUP	
					(1.10)		
					4.00		

Boring Progress and Water Observations

Water Strikes

Hole Diameter	
---------------	--

Casing Diameter	
-----------------	--

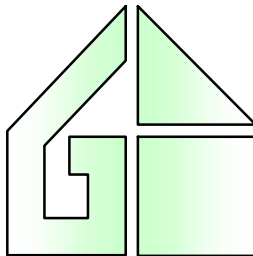
Logging Progress and Water Section Data							Water Status		Post Strike Depth	Hole Diameter		Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Elapsed Minutes	Depth Sealed		Depth	Diameter (mm)	Depth	Diameter (mm)
01/08/14	00:00	4.00	3.00	1.19	1.50		1.19	20		1.00	102	3.00	110
										2.00	87		
										3.00	75		
										4.00	65		

General Remarks:

- 1) Borehole terminated at 4.0m depth.
- 2) No visual or olfactory evidence of hydrocarbon contamination encountered.
- 3) All strengths for cohesive materials based on field tests. Strengths for granular materials are based on SPT N-values where available, or observations of penetration rate.

APPENDIX B

Records of Field Monitoring



Field Gas Monitoring Records

Job Reference: p-sw-536
Site: West Street, Havant
Client: Mansell Homes

Page 1 of 1

Well ID	Date	Depth to Water (mbGL)	Depth to Base (mbGL)	Atmos. Pressure (mb)	Gas Flow (Peak) (L/hr)	Gas Flow (Steady) (L/hr)	Methane (Peak) (% Vol)	Methane (Steady) (% Vol)	Carbon Dioxide (Peak) (% Vol)	Carbon Dioxide (Steady) (% Vol)	Oxygen (Minimum) (% Vol)
WS01	07/08/2014	1.07	4.0	1012	<0.1	<0.1	<0.1	<0.1	1.0	1.0	18.6
	22/08/2014	1.08	4.0	1009	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	19.7
	11/09/2014	1.09	4.0	1020	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	20.0
WS02	07/08/2014	1.04	3.0	1012	0.1	<0.1	0.1	0.1	2.2	2.2	17.9
	22/08/2014	1.04	3.0	1009	<0.1	<0.1	0.1	0.1	0.7	0.5	19.5
	11/09/2014	1.05	3.0	1020	<0.1	<0.1	<0.1	<0.1	2.7	2.7	15.0
WS03	07/08/2014	1.14	4.0	1012	<0.1	<0.1	0.1	0.1	2.6	2.6	18.1
	22/08/2014	1.15	4.0	1009	<0.1	<0.1	<0.1	<0.1	1.6	1.6	17.5
	11/09/2014	1.16	4.0	1020	<0.1	<0.1	<0.1	<0.1	1.8	1.8	19.0
WS04	07/08/2014	1.08	4.0	1012	<0.1	<0.1	0.1	0.1	1.5	1.5	18.8
	22/08/2014	1.03	4.0	1009	<0.1	<0.1	<0.1	<0.1	1.9	1.9	19.1
	11/09/2014	1.04	4.0	1020	<0.1	<0.1	<0.1	<0.1	1.5	1.5	19.1
WS05	07/08/2014	1.08	2.6	1012	<0.1	<0.1	<0.1	<0.1	5.6	5.5	15.0
	22/08/2014	1.09	2.6	1009	<0.1	<0.1	<0.1	<0.1	7.1	7.1	12.6
	11/09/2014	1.09	2.6	1020	<0.1	<0.1	<0.1	<0.1	3.0	2.8	17.5
WS06	07/08/2014	1.14	4.0	1012	<0.1	<0.1	<0.1	<0.1	5.1	5.1	14.4
	22/08/2014	1.14	4.0	1009	<0.1	<0.1	<0.1	<0.1	2.9	2.9	17.9
	11/09/2014	1.15	4.0	1020	<0.1	<0.1	<0.1	<0.1	4.4	4.4	12.8
WS07	07/08/2014	0.81	4.0	1012	0.1	<0.1	<0.1	<0.1	0.8	0.4	20.0
	22/08/2014	0.81	4.0	1009	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.1
	11/09/2014	0.81	4.0	1020	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.6
WS10	07/08/2014	1.05	3.0	1012	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.6
	22/08/2014	1.07	3.0	1009	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	20.2
	11/09/2014	1.07	3.0	1020	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.6

Notes

- Monitoring carried out using Geotechnical Instruments GA2000 infrared gas analyser with internal flow measurement, and cable reel dipmeter.
- Atmospheric pressure trends
07/08/2014: Moderate, falling.
22/08/2014: Moderate, falling.
11/09/2014: Moderate, falling.
- Prevailing weather conditions
07/08/2014: Hot and clear.
22/08/2014: Sunny with some cloud.
11/09/2014: Overcast.

APPENDIX C

Results of Chemical Laboratory Tests - Soils



2683



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Reporting Date: 20 August 2014

ANALYTICAL REPORT No. AR55674

Samples Received By: Courier
Sample Receipt Date: 05/08/14
Your Job No: 536
Your Order No: ---
Site Location: West Street, Havant
ELAB Sales Order: 55674
No Samples Received: 5
Date of Sampling: 04/08/14

This report was written by: Katie Baillie

Authorised By;

Steve Knight
Reporting Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)



THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55674

Location: West Street, Havant



Your Job No: 536
Your Order No: ---
Reporting Date: 20/08/14

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Soils		Characteristic	Silt loam	Silt loam	Silt loam	Sandy silt loam	Silt loam
		Date Sampled	04/08/14	04/08/14	04/08/14	04/08/14	04/08/14
		TP/BH	WS01	WS03	WS06	WS07	WS10
		Depth (m)	0.70	0.70	0.60	0.60	0.60
		Our ref	28024	28027	28032	28033	28038
Stone Content	(%)		20	47	40	36	41
Arsenic**	(mg/kg)		19.9	13.1	10.7	20.6	5.3
Cadmium**	(mg/kg)		0.5	<0.5	<0.5	<0.5	<0.5
Chromium**	(mg/kg)		17	11	11	11	14
Lead**	(mg/kg)		683	498	198	1258	177
Mercury**	(mg/kg)		2.1	1.1	<0.5	<0.5	<0.5
West Street, Havant	(mg/kg)		27	12	24	28	10
Copper**	(mg/kg)		138	65	105	67	26
Zinc**	(mg/kg)		180	97	88	127	88
Selenium**	(mg/kg)		1.2	<0.5	1.0	0.7	<0.5
Hexavalent Chromium	(mg/kg)		<2	<2	<2	<2	<2
Water Soluble Boron	(mg/kg)		2.7	1.3	1.9	2.2	1.9
pH Value**	(Units)		7.9	8.0	8.2	7.8	8.4
Water Soluble Sulphate	(mg/l as SO ₄)		56.4	23.1	51.5	153.8	77.7
Total Sulphate	(% as SO ₄)		0.05	<0.05	<0.05	0.08	<0.05
Total Potential Sulphate	(% as SO ₄)		0.37	0.15	0.21	0.45	0.13
Total Cyanide**	(mg/kg)		<1	<1	<1	<1	<1
Total Sulphur	(% as S)		0.12	0.05	0.07	0.15	0.04
Soil Organic Matter*	(%)		4.9	2.3	2.8	2.6	0.7
Total Monohydric Phenols***	(mg/kg)		<1	<1	<1	<1	<1

All results expressed on dry weight basis

** - MCERTS accredited test

* = UKAS accredited test

*** - Sum of Phenol, 2, 3, 5-Trimethylphenol, 2, 3-Dimethylphenol, 3, 4-Dimethylphenol, Resorcinol/Catechol, o-Cresol, m, p-Cresol & Naphthol

Katie Baillie



THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55674

Location: West Street, Havant



Your Job No: 536
Your Order No: ---
Reporting Date: 20/08/14

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Soils	Characteristic	Silt loam	Silt loam	Silt loam	Sandy silt loam	Silt loam
	Date Sampled	04/08/14	04/08/14	04/08/14	04/08/14	04/08/14
	TP/BH	WS01	WS03	WS06	WS07	WS10
	Depth (m)	0.70	0.70	0.60	0.60	0.60
	Our ref	28024	28027	28032	28033	28038
Naphthalene**	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene**	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene**	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene**	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene**	(mg/kg)	<0.5	0.9	<0.5	1.1	<0.5
West Street, Havant	(mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene**	(mg/kg)	<0.5	1.6	0.7	4.4	<0.5
Pyrene**	(mg/kg)	<0.5	1.2	0.5	3.7	<0.5
Benz(a)anthracene**	(mg/kg)	<0.5	1.0	<0.5	2.9	<0.5
Chrysene**	(mg/kg)	<0.5	1.3	0.6	2.9	<0.5
Benzo(b)fluoranthene**	(mg/kg)	<0.5	0.9	0.5	1.8	<0.5
Benzo(k)fluoranthene**	(mg/kg)	<0.5	1.5	<0.5	2.6	<0.5
Benzo(a)pyrene**	(mg/kg)	<0.5	1.0	<0.5	2.3	<0.5
Indeno(123-cd)pyrene**	(mg/kg)	<0.5	0.8	0.7	1.6	<0.5
Dibenz(ah)anthracene**	(mg/kg)	<0.5	<0.5	<0.5	0.6	<0.5
Benzo(ghi)perylene**	(mg/kg)	<0.5	1.1	1.0	1.9	<0.5
Total PAH(16)**	(mg/kg)	<0.5	11.4	4.0	25.8	<0.5

All results expressed on dry weight basis

** - MCERTS accredited test

Katie Baillie



THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55674

Location: West Street, Havant



Your Job No: 536

Your Order No: —

Reporting Date: 20/08/14

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

TPH CWG - Soil

Characteristic	Silt loam	Silt loam	Silt loam	Sandy silt loam	Silt loam
Date Sampled	04/08/14	04/08/14	04/08/14	04/08/14	04/08/14
TP/BH	WS01	WS03	WS06	WS07	WS10
Depth (m)	0.70	0.70	0.60	0.60	0.60
Our ref	28024	28027	28032	28033	28038
Aromatic					
>EC ₅ -EC ₇ (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01
>EC ₇ -EC ₈ (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01
>EC ₈ -EC ₁₀ (mg/kg)	<0.1	<0.1	<0.1	<0.1	0.1
>EC ₁₀ -EC ₁₂ (mg/kg)	<0.1	<0.1	<0.1	<0.1	0.2
West Street, Havant (mg/kg)	<0.1	<0.1	<0.1	0.1	0.3
>EC ₁₆ -EC ₂₁ (mg/kg)	0.1	0.3	<0.1	0.7	0.2
>EC ₂₁ -EC ₃₅ (mg/kg)	<0.1	0.9	<0.1	3.1	<0.1
Aliphatic					
>EC ₅ -EC ₆ (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01
>EC ₆ -EC ₈ (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01
>EC ₈ -EC ₁₀ (mg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1
>EC ₁₀ -EC ₁₂ (mg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1
>EC ₁₂ -EC ₁₆ (mg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1
>EC ₁₆ -EC ₂₁ (mg/kg)	0.2	0.2	0.2	0.2	<0.1
>EC ₂₁ -EC ₃₅ (mg/kg)	<0.1	<0.1	<0.1	<0.1	<0.1
TPH (C ₅ - C ₃₅) (mg/kg)	0.3	1.4	0.2	4.1	0.7
Benzene** (µg/kg)	<10	<10	<10	<10	<10
Toluene** (µg/kg)	<10	<10	<10	<10	<10
Ethyl Benzene** (µg/kg)	<10	<10	<10	<10	<10
Xylenes** (µg/kg)	<10	<10	<10	<10	<10
MTBE (µg/kg)	<10	<10	<10	<10	<10

All results expressed on dry weight basis

Katie Baillie



THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55674

Location: West Street, Havant

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Your Job No: 536
Your Order No: —
Reporting Date: 20/08/14

Asbestos Identification

Sample ref:	WS01
Depth (m)	0.70
Our ref:	28024
#Description of Sample Matrix:	Silt loam
Result	No asbestos identified

Sample ref:	West Street, Havant	WS02
Depth (m)		0.60
Our ref:		28026
#Description of Sample Matrix:		Clay loam
Result		No asbestos identified

Sample ref:	WS03
Depth (m)	0.70
Our ref:	28027
#Description of Sample Matrix:	Silt loam
Result	No asbestos identified

Sample ref:	WS04
Depth (m)	0.50
Our ref:	28028
#Description of Sample Matrix:	Sandy clay loam
Result	No asbestos identified

Sample ref:	WS05
Depth (m)	0.50
Our ref:	28029
#Description of Sample Matrix:	Clay loam
Result	No asbestos identified

Sample ref:	WS05
Depth (m)	2.00
Our ref:	28031
#Description of Sample Matrix:	Chalky loam
Result	No asbestos identified

*= UKAS accredited

Analytical result only applies to the sample as submitted by the client

Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client

Katie Baillie



THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55674

Location: West Street, Havant

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Your Job No: 536
Your Order No: —
Reporting Date: 20/08/14

Asbestos Identification

Sample ref:	WS06
Depth (m)	0.60
Our ref:	28032
#Description of Sample Matrix:	Silt loam
Result	No asbestos identified

Sample ref:	WS07
Depth (m)	0.60
Our ref:	28033
#Description of Sample Matrix:	Sandy silt loam
Result	No asbestos identified

Sample ref:	WS08
Depth (m)	0.50
Our ref:	28034
#Description of Sample Matrix:	Sandy clay loam
Result	No asbestos identified

Sample ref:	WS09
Depth (m)	0.60
Our ref:	28036
#Description of Sample Matrix:	Clay loam
Result	No asbestos identified

Sample ref:	WS10
Depth (m)	0.60
Our ref:	28038
#Description of Sample Matrix:	Silt loam
Result	No asbestos identified

Sample ref:	WS11
Depth (m)	0.60
Our ref:	28039
#Description of Sample Matrix:	Clay loam
Result	No asbestos identified

*= UKAS accredited

Analytical result only applies to the sample as submitted by the client

Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client

Katie Baillie

F.A.O. Tim Gillbanks
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Your Ref No: 536

Reporting Date: 20/08/14

VOC ANALYSIS

Soils

Characteristic		Silt loam	Silt loam	Silt loam	Sandy silt loam	Silt loam
Date Sampled		04/08/14	04/08/14	04/08/14	04/08/14	04/08/14
TP/BH		WS01	WS03	WS06	WS07	WS10
Depth (m)		0.70	0.70	0.60	0.60	0.60
Our ref		28024	28027	28032	28033	28038
Benzene**	(µg/kg)	<10	<10	<10	<10	<10
Toluene**	(µg/kg)	<10	<10	<10	<10	<10
Ethyl Benzene**	(µg/kg)	<10	<10	<10	<10	<10
mpXylene**	(µg/kg)	<10	<10	<10	<10	<10
oXylene**	(µg/kg)	<10	<10	<10	<10	<10
1, 2-Dichloroethene-cis**	st Street, Havant	<10	<10	<10	<10	<10
1, 1-Dichloroethane**	(µg/kg)	<10	<10	<10	<10	<10
Chloroform**	(µg/kg)	<10	<10	<10	<10	<10
Carbontetrachloride**	(µg/kg)	<10	<10	<10	<10	<10
1, 1, 1-Trichloroethane**	(µg/kg)	<10	<10	<10	<10	<10
Trichloroethylene**	(µg/kg)	<10	<10	<10	<10	<10
Tetrachloroethylene**	(µg/kg)	<10	<10	<10	<10	<10
1, 1, 1, 2-Tetrachloroethane**	(µg/kg)	<10	<10	<10	<10	<10
1, 1, 2, 2-Tetrachloroethane**	(µg/kg)	<10	<10	<10	<10	<10
Chlorobenzene**	(µg/kg)	<10	<10	<10	<10	<10
Bromobenzene**	(µg/kg)	<10	<10	<10	<10	<10
Bromodichloromethane**	(µg/kg)	<10	<10	<10	<10	<10
Methylethylbenzene**	(µg/kg)	<10	<10	<10	<10	<10
1, 1-Dichloro-1-propene**	(µg/kg)	<10	<10	<10	<10	<10
1, 2-Dichloroethene-trans	(µg/kg)	<10	<10	<10	<10	<10
2, 2-Dichloropropane	(µg/kg)	<10	<10	<10	<10	<10
Bromochloromethane	(µg/kg)	<10	<10	<10	<10	<10
1, 2-Dichloroethane	(µg/kg)	<10	<10	<10	<10	<10
Dibromomethane**	(µg/kg)	<10	<10	<10	<10	<10
1, 2-Dichloropropane**	(µg/kg)	<10	<10	<10	<10	<10
1, 3-Dichloro1propene**	(µg/kg)	<10	<10	<10	<10	<10
1, 3-Dichloro1propene trans	(µg/kg)	<10	<10	<10	<10	<10
1, 1, 2-Trichloroethane	(µg/kg)	<10	<10	<10	<10	<10
Dibromochloromethane	(µg/kg)	<10	<10	<10	<10	<10
1, 3-Dichloropropane	(µg/kg)	<10	<10	<10	<10	<10
Dibromoethane**	(µg/kg)	<10	<10	<10	<10	<10
Styrene	(µg/kg)	<10	<10	<10	<10	<10
Propylbenzene	(µg/kg)	<10	<10	<10	<10	<10
2-Chlorotoluene	(µg/kg)	<10	<10	<10	<10	<10
1, 2, 4-Trimethylbenzene	(µg/kg)	<10	<10	<10	<10	<10
4-Chlorotoluene	(µg/kg)	<10	<10	<10	<10	<10
t-Butylbenzene	(µg/kg)	<10	<10	<10	<10	<10
Trimethylbenzene	(µg/kg)	<10	<10	<10	<10	<10
1-Methylpropylbenzene	(µg/kg)	<10	<10	<10	<10	<10
o-Cymene	(µg/kg)	<10	<10	<10	<10	<10
1, 4-Dichlorobenzene	(µg/kg)	<10	<10	<10	<10	<10
Butylbenzene	(µg/kg)	<10	<10	<10	<10	<10
1, 2-Dibromo-3-chloropropane	(µg/kg)	<10	<10	<10	<10	<10
Hexachlorobutadiene	(µg/kg)	<10	<10	<10	<10	<10
1, 2, 3-Trichlorobenzene	(µg/kg)	<10	<10	<10	<10	<10
1, 2, 4-Trichlorobenzene	(µg/kg)	<10	<10	<10	<10	<10
1, 3-Dichlorobenzene	(µg/kg)	<10	<10	<10	<10	<10
1, 2-Dichlorobenzene	(µg/kg)	<10	<10	<10	<10	<10
Bromoform	(µg/kg)	<10	<10	<10	<10	<10

** - MCERTS accredited test

PRB



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

SAMPLE RECEIPT AND TEST DATES

Our Analytical Report Number AR55674
Your Job No: 536
Sample Receipt Date: 05/08/14
Reporting Date: 20/08/14

Registered: 05/08/14
Prepared: 06/08/14
Analysis complete: 20/08/14

TEST METHOD SUMMARY

PARAMETER	Analysis Undertaken on	West Street, Havr	Method Number	Technique
Arsenic**	Air dried sample	19/08/14	118	ICPMS
Cadmium**	Air dried sample	19/08/14	118	ICPMS
Chromium**	Air dried sample	19/08/14	118	ICPMS
Lead**	Air dried sample	19/08/14	118	ICPMS
Mercury**	Air dried sample	19/08/14	118	ICPMS
West Street, Havant	Air dried sample	19/08/14	118	ICPMS
Copper**	Air dried sample	19/08/14	118	ICPMS
Zinc**	Air dried sample	19/08/14	118	ICPMS
Selenium**	Air dried sample	19/08/14	118	ICPMS
Water Soluble Boron	Air dried sample	15/08/14	202	Colorimetry
Hexavalent Chromium	As submitted sample	06/08/14	110	Colorimetry
pH Value**	Air dried sample	14/08/14	113	BRE SD1
Total Sulphate	Air dried sample	18/08/14	208	Colorimetry
Water Soluble Sulphate	Air dried sample	18/08/14	209	Colorimetry
Total Potential Sulphate	Air dried sample	11/08/14	116	BRE SD1
Total Cyanide**	As submitted sample	07/08/14	204	Colorimetry
Total Sulphur	Air dried sample	11/08/14	116	BRE SD1
Soil Organic Matter*	Air dried sample	15/08/14	111	Titration
Total Monohydric Phenols	As submitted sample	07/08/14	121	HPLC
Speciated PAH**	As submitted sample	07/08/14	133	Gas Chromatography
Carbon Banding (TPH)	As submitted sample	07/08/14	214	Gas chromatography
BTEX**	As submitted sample	08/08/14	154	GCMS
MTBE	As submitted sample	08/08/14	154	GCMS
Asbestos*	As submitted sample	19/08/14	179	See Note
VOC**	As submitted sample	08/08/14	181	GCMS

Asbestos analysis qualitative only

Note:- Documented In-house procedure based on HSG 248 2005

* = UKAS Accredited test

** - MCERTS Accredited test

Determinands not marked with * or ** are not accredited

MCERTS accreditation covers samples which are predominantly sand, clay, loam or combinations of these three soil types

All results have been expressed on a dry weight basis and where appropriate have been corrected for moisture and stone content accordingly

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)



2683



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

F.A.O. Richard Cowill
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Reporting Date: 16 September 2014

ANALYTICAL REPORT No. AR55941

Samples Received By: Laboratory Courier
Sample Receipt Date: 09/09/14
Your Job No: ----
Your Order No: ---
Site Location: West Street, Havant
No Samples Received: 2
Date of Sampling: 04/08/14

This report was written by: N. Williams

Authorised By;

John Wilson
Project & Business Development
Manager (CChem, MRSC)

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

Waste Acceptance Criteria ANALYTICAL RESULTS								
Report No:	ANALYTICAL REPORT No. AR55941				Page 2 of 5			
						CLIENT:	Ground Investigation (South West) Limited	
Project Name:	West Street, Havant							
Lab Reference	29954				Landfill Waste Acceptance Criteria			
					Limits			
Sampling Date	04/08/14				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill	
Sample ID	WAC1							
Depth	---							
Solid Waste Analysis								
TOC (%)	7.8				3%	5%	6%	
Loss on Ignition (%)**	7.8				--	--	10%	
BTEX (mg/kg)**	<0.01				6	--	--	
Sum of PCBs (mg/kg)**	<0.01				1	--	--	
Mineral Oil (mg/kg)**	<2				500	--	--	
Total PAH (mg/kg)**	5.9				100	--	--	
pH (Units)**	8.1				--	--	--	
Acid Neutralisation Capacity (mol/kg)	<0.1				--	To be evaluated	To be evaluated	
Eluate Analysis	2:1	8:1		Cumulative 10:1	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)			
	mg/l	mg/l		mg/kg				
Arsenic*	0.013	0.013		0.1	0.5	2	25	
Barium*	0.017	0.009		<0.1	20	100	300	
Cadmium*	<0.001	<0.001		<0.01	0.04	1	5	
Chromium*	<0.005	<0.005		<0.1	0.5	10	70	
Copper*	0.011	0.009		<0.1	2	50	100	
Mercury*	<0.0001	<0.0001		<0.001	0.01	0.2	2	
Molybdenum*	0.022	0.010		0.1	0.5	10	30	
Nickel*	<0.005	<0.005		<0.1	0.4	10	40	
Lead*	<0.005	0.005		<0.1	0.5	10	50	
Antimony	0.008	<0.005		<0.01	0.06	0.7	5	
Selenium*	0.005	<0.005		<0.01	0.1	0.5	7	
Zinc*	0.006	0.006		<0.1	4	50	200	
Chloride	9	<5		105	800	15000	25000	
Fluoride	<1	<1		<1	10	150	500	
Sulphate	84	7		167	1000	20000	50000	
TDS	370	220		2387	4000	60000	100000	
Phenol Index	<0.5	<0.5		<0.5	1	-	-	
DOC	16.6	15.3		155	500	800	1000	
Leach Test Information								
pH *	8.2	8.0						
EC*	427	269						
Sample Mass (kg)	0.211							
Dry Matter (%)	83							
Moisture (%)	21							
Stage 1								
Volume Eluate L2 (litres)	0.314							
Filtered Eluate VE1 (litres)	0.218							
Results are expressed on a dry weight basis, after correction for moisture content where applicable Stated limits are for guidance only and ELAB cannot be held responsible for any discrepancies with current legislation								

* = UKAS accredited

** - MCERTS accredited test



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

Waste Acceptance Criteria ANALYTICAL RESULTS								
Report No:		ANALYTICAL REPORT No. AR55941			Page 3 of 5			
					CLIENT:	Ground Investigation (South West) Limited		
Project Name:		West Street, Havant						
					Landfill Waste Acceptance Criteria			
Lab Reference		29955			Limits			
Sampling Date		--			Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill	
Sample ID		WAC2						
Depth		--						
Solid Waste Analysis								
TOC (%)		0.2			3%	5%	6%	
Loss on Ignition (%)**		1.4			--	--	10%	
BTEX (mg/kg)**		<0.01			6	--	--	
Sum of PCBs (mg/kg)**		<0.01			1	--	--	
Mineral Oil (mg/kg)**		<2			500	--	--	
Total PAH (mg/kg)**		<0.5			100	--	--	
pH (Units)**		8.5			--	--	--	
Acid Neutralisation Capacity (mol/kg)		<0.1			--	To be evaluated	To be evaluated	
Eluate Analysis		2:1	8:1		Cumulative 10:1	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
		mg/l	mg/l			mg/kg		
Arsenic*		<0.005	<0.005		<0.1	0.5	2	25
Barium*		0.006	<0.005		<0.1	20	100	300
Cadmium*		<0.001	<0.001		<0.01	0.04	1	5
Chromium*		<0.005	<0.005		<0.1	0.5	10	70
Copper*		<0.005	<0.005		<0.1	2	50	100
Mercury*		<0.0001	<0.0001		<0.001	0.01	0.2	2
Molybdenum*		<0.005	<0.005		<0.1	0.5	10	30
Nickel*		<0.005	<0.005		<0.1	0.4	10	40
Lead*		<0.005	<0.005		<0.1	0.5	10	50
Antimony		<0.005	<0.005		<0.01	0.06	0.7	5
Selenium*		0.010	0.005		0.06	0.1	0.5	7
Zinc*		<0.005	<0.005		<0.1	4	50	200
Chloride*		<5	<5		<1	800	15000	25000
Fluoride*		<1	<1		<1	10	150	500
Sulphate*		3	1		11	1000	20000	50000
TDS		180	160		1624	4000	60000	100000
Phenol Index		<0.5	<0.5		<0.5	1	-	-
DOC		18.8	14.5		150	500	800	1000
Leach Test Information								
pH *		8.3	8.0					
EC*		171	155					
Sample Mass (kg)		0.198						
Dry Matter (%)		89						
Moisture (%)		13						
Stage 1								
Volume Eluate L2 (litres)		0.327						
Filtered Eluate VE1 (litres)		0.212						
Results are expressed on a dry weight basis, after correction for moisture content where applicable								
Stated limits are for guidance only and ELAB cannot be held responsible for any discrepancies with current legislation								

* = UKAS accredited

** - MCERTS accredited test



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

SAMPLE RECEIPT AND TEST DATES

Our Analytical Report Number 55941
Your Job No: ---
Sample Receipt Date: 09/09/14
Reporting Date: 16/09/14

Registered: 09/09/14
Prepared: 10/09/14
Analysis complete: 16/09/14

TEST METHOD SUMMARY

PARAMETER	Undertaken on	Date Tested	Method Number	Technique
pH Value**	Air dried sample	11/09/14	113	Electrometric
Total Organic Carbon	Air dried sample	16/09/14	210	Automated IR Absorption
Loss on Ignition**	Air dried sample	11/09/14	129	Gravimetric
Neutralization Capacity to pH 7	Air dried sample	11/09/14	-	EA
Benzene**	As submitted sample	11/09/14	181	GCMS
Toluene**	As submitted sample	11/09/14	181	GCMS
Ethyl Benzene**	As submitted sample	11/09/14	181	GCMS
Xylenes**	As submitted sample	11/09/14	181	GCMS
Mineral Oil**	As submitted sample	12/09/14	117	GCFID
PCB 28**	Air dried sample	12/09/14	120	GCMS
PCB 52**	Air dried sample	12/09/14	120	GCMS
PCB 101**	Air dried sample	12/09/14	120	GCMS
PCB 118**	Air dried sample	12/09/14	120	GCMS
PCB 138**	Air dried sample	12/09/14	120	GCMS
PCB 153**	Air dried sample	12/09/14	120	GCMS
PCB 180**	Air dried sample	12/09/14	120	GCMS
Speciated PAH**	As submitted sample	12/09/14	133	GCFID

The analysts' guide for sampling, analysis and clearance procedures

* = UKAS Accredited test

** - MCERTS Accredited test

Determinands not marked with a * or ** are not accredited

MCERTS accreditation covers samples which are predominantly sand, clay, loam or combinations of these three soil types

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

LEACHATE SAMPLE RECEIPT AND TEST DATES

Our Analytical Report Number 55941
Your Job No: ----
Sample Receipt Date: 09/09/14
Reporting Date: 16/09/14

Registered: 09/09/14
Prepared: 10/09/14
Analysis complete: 16/09/14

LEACHATE TEST METHOD SUMMARY

PARAMETER	Method Number	Technique
Arsenic*	101	ICPMS
Cadmium*	101	ICPMS
Chromium*	101	ICPMS
Lead*	101	ICPMS
Nickel*	101	ICPMS
Copper*	101	ICPMS
Zinc*	101	ICPMS
Mercury*	101	ICPMS
Selenium*	101	ICPMS
Antimony	101	ICPMS
Barium*	101	ICPMS
Molybdenum*	101	ICPMS
pH Value*	113	Electrometric
Electrical Conductivity*	136	Probe
Dissolved Organic Carbon	102	TOC analyser
Chloride	131	Ion Chromatography
Fluoride	131	Ion Chromatography
Sulphate	131	Ion Chromatography
Total Dissolved Solids	144	Gravimetric
Phenol Index	121	HPLC

* = UKAS Accredited test

Determinands not marked with * are not accredited

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

APPENDIX D

Results of Chemical Laboratory Tests - Waters



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

F.A.O. David Hornibrook
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Reporting Date: 27/08/2014

ANALYTICAL REPORT No. AR55730

Samples Received By:-	Courier
Samples Received:-	11/08/14
Your Job No:	536
Site Location:-	West Street, Havant
No Samples Received:-	8
Date of Sampling	07/08/14

Report Checked By:-

Steve Knight
Reporting Manager

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)



2683

THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55730

Location: West Street, Havant



Your Job No: 536

Reporting Date: 27/08/2014

F.A.O. David Hornibrook
 Ground Investigation (South West) Limited
 Unit 3, Custom House Court
 Kenn Road, Clevedon
 Bristol, BS21 6EX

Waters

	Date Sampled	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014
	TP/BH	WS01	WS02	WS03	WS04	WS05	WS06	WS07	WS10
	Depth	---	---	---	---	---	---	---	---
	Our ref	28424	28425	28426	28427	28428	28429	28430	28431
Arsenic*	(µg/l)	<5	<5	<5	<5	<5	<5	6	<5
Cadmium*	(µg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Chromium*	(µg/l)	<5	<5	<5	<5	<5	<5	<5	<5
Lead*	(µg/l)	<1	<1	3	<1	<1	<1	2	3
Nickel*	(µg/l)	<1	1	1	<1	6	<1	4	<1
Copper*	(µg/l)	<5	<5	6	<5	<5	<5	10	6
Zinc*	(µg/l)	11	6	17	6	8	11	11	11
Mercury*	(µg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium*	(µg/l)	<5	<5	<5	<5	<5	<5	<5	<5
Boron	(µg/l)	304	318	328	297	333	290	322	219
pH Value*	(Units)	7.1	7.2	6.7	6.7	6.5	6.6	7.3	7.3
Total Cyanide	(µg/l)	<5	<5	<5	<5	<5	<5	<5	<5
Elemental Sulphur	(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Phenols	(µg/l)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexavalent Chromium	(µg/l)	<100	<100	<100	<100	<100	<100	<100	<100
Sulphate*	(mg/l)	31	49	40	30	30	38	49	33

* = UKAS Accredited test

K. Baillie

THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55730

Location: West Street, Havant



Your Job No: 536

Reporting Date: 27/08/2014

F.A.O. David Hornibrook
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

<u>Waters</u>	Date Sampled	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14
	TP/BH	WS01	WS02	WS03	WS04	WS05	WS06	WS07	WS10
	Depth	---	---	---	---	---	---	---	---
	Our ref	28424	28425	28426	28427	28428	28429	28430	28431
Naphthalene	(µg/l)	0.05	0.05	<0.05	0.05	0.06	<0.05	0.28	0.05
Acenaphthylene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.22	<0.05
Acenaphthene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Fluorene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Phenanthrene	(µg/l)	<0.05	0.10	<0.05	<0.05	0.07	0.05	0.61	0.08
Anthracene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.24	<0.05
Fluoranthene	(µg/l)	<0.05	0.08	<0.05	<0.05	0.05	<0.05	1.45	0.08
Pyrene	(µg/l)	<0.05	0.09	<0.05	<0.05	0.05	<0.05	1.22	0.07
Benz(a)anthracene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.72	<0.05
Chrysene	(µg/l)	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	1.07	0.05
Benzo(b)fluoranthene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.78	<0.05
Benzo(k)fluoranthene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.98	<0.05
Benzo(a)pyrene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.06	<0.05
Indeno(123-cd)pyrene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.50	<0.05
Dibenz(ah)anthracene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	<0.05
Benzo(ghi)perylene	(µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.65	<0.05
Total PAH(16)	(µg/l)	0.05	0.37	<0.05	0.05	0.23	0.05	10.02	0.33

THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55730

Location: West Street, Havant



Your Job No: 536

Reporting Date: 27/08/2014

F.A.O. David Hornibrook
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Waters

Date Sampled	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14	07/08/14
TP/BH	WS01	WS02	WS03	WS04	WS05	WS06	WS07	WS10	
Depth	---	---	---	---	---	---	---	---	---
Our ref	28424	28425	28426	28427	28428	28429	28430	28431	

Aromatic

>C ₅ -C ₇	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₇ -C ₈	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₈ -C ₁₀	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₁₀ -C ₁₂	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₁₂ -C ₁₆	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₁₆ -C ₂₁	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₂₁ -C ₃₅	(µg/l)	<10	<10	<10	21	<10	<10	11	<10

Aliphatic

>C ₅ -C ₆	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₆ -C ₈	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₈ -C ₁₀	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₁₀ -C ₁₂	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₁₂ -C ₁₆	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₁₆ -C ₂₁	(µg/l)	<10	<10	<10	<10	<10	<10	<10	<10
>C ₂₁ -C ₃₅	(µg/l)	<10	<10	<10	36	<10	<10	<10	<10
TPH (C ₅ - C ₃₅)	(µg/l)	<10	<10	<10	58	<10	<10	11	<10
Benzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	(µg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Ethyl Benzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Xylenes	(µg/l)	<1	<1	<1	<1	<1	<1	<1	<1
MTBE	(µg/l)	<1	<1	<1	<1	<1	<1	<1	<1

THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618

Fax: 01424 729911

ANALYTICAL REPORT No. AR55730

Location: West Street, Havant

F.A.O. David Hornibrook
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Your Ref No: 536

Reporting Date: 27/08/14

VOC ANALYSIS

Waters	TP/BH	WS01	WS02	WS03	WS04	WS05	WS06	WS07
	Depth (m)	---	---	---	---	---	---	---
	Our ref	28424	28425	28426	28427	28428	28429	28430
Benzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Toluene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
m&p-Xylene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
o-Xylene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
cis 1,2-Dichloroethene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloroethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Chloroform	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Carbontetrachloride	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,1,1-Trichloroethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Trichloroethylene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethylene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,1,1,2-Tetrachloroethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Chlorobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Bromobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Bromodichloromethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Methylethylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,1-Dichloro-1-Propene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2-Dichloroethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
2-2-Dichloropropane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Bromochloromethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
trans 1,2-Dichloroethene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Dibromomethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2-Dichloropropane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
cis 1,3-Dichloro-1-Propene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
trans 1,3-Dichloro-1-Propene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Dibromochloromethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,3-Dichloropropane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Dibromoethane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Styrene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Propylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
2-Chlorotoluene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2,4-Trimethylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
4-Chlorotoluene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
tert-Butylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,3,5-Trimethylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1-methylpropylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
o-Cymene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,4-Dichlorobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
sec-Butylbenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2-Dibromo-3-chloropropane	(µg/l)	<1	<1	<1	<1	<1	<1	<1
Hexachlorobutadiene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2,3-Trichlorobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2,4-Trichlorobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,3-Dichlorobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1
1,2-Dichlorobenzene	(µg/l)	<1	<1	<1	<1	<1	<1	<1

THE ENVIRONMENTAL LABORATORY LTD

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards On Sea, East Sussex, TN38 9BY

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR55730

Location: West Street, Havant

F.A.O. David Hornibrook
Ground Investigation (South West) Limited
Unit 3, Custom House Court
Kenn Road, Clevedon
Bristol, BS21 6EX

Your Ref No: 536

Reporting Date: 27/08/14

VOC ANALYSIS

<u>Waters</u>	TP/BH	WS10
	Depth (m)	---
	Our ref	28431
Benzene	(µg/l)	<1
Toluene	(µg/l)	<1
Ethylbenzene	(µg/l)	<1
m&p-Xylene	(µg/l)	<1
o-Xylene	(µg/l)	<1
cis 1,2-Dichloroethene	(µg/l)	<1
1,1-Dichloroethane	(µg/l)	<1
Chloroform	(µg/l)	<1
Carbontetrachloride	(µg/l)	<1
1,1,1-Trichloroethane	(µg/l)	<1
Trichloroethylene	(µg/l)	<1
Tetrachloroethylene	(µg/l)	<1
1,1,1,2-Tetrachloroethane	(µg/l)	<1
1,1,2,2-Tetrachloroethane	(µg/l)	<1
Chlorobenzene	(µg/l)	<1
Bromobenzene	(µg/l)	<1
Bromodichloromethane	(µg/l)	<1
Methylethylbenzene	(µg/l)	<1
1,1-Dichloro-1-Propene	(µg/l)	<1
1,2-Dichloroethane	(µg/l)	<1
2-2-Dichloropropane	(µg/l)	<1
Bromochloromethane	(µg/l)	<1
trans 1,2-Dichloroethene	(µg/l)	<1
Dibromomethane	(µg/l)	<1
1,2-Dichloropropane	(µg/l)	<1
cis 1,3-Dichloro-1-Propene	(µg/l)	<1
trans 1,3-Dichloro-1-Propene	(µg/l)	<1
1,1,2-Trichloroethane	(µg/l)	<1
Dibromochloromethane	(µg/l)	<1
1,3-Dichloropropane	(µg/l)	<1
Dibromoethane	(µg/l)	<1
Styrene	(µg/l)	<1
Propylbenzene	(µg/l)	<1
2-Chlorotoluene	(µg/l)	<1
1,2,4-Trimethylbenzene	(µg/l)	<1
4-Chlorotoluene	(µg/l)	<1
tert-Butylbenzene	(µg/l)	<1
1,3,5-Trimethylbenzene	(µg/l)	<1
1-methylpropylbenzene	(µg/l)	<1
o-Cymene	(µg/l)	<1
1,4-Dichlorobenzene	(µg/l)	<1
sec-Butylbenzene	(µg/l)	<1
1,2-Dibromo-3-chloropropane	(µg/l)	<1
Hexachlorobutadiene	(µg/l)	<1
1,2,3-Trichlorobenzene	(µg/l)	<1
1,2,4-Trichlorobenzene	(µg/l)	<1
1,3-Dichlorobenzene	(µg/l)	<1
1,2-Dichlorobenzene	(µg/l)	<1



Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

WATER SAMPLE RECEIPT AND TEST DATES

Our Analytical Report Number 55730
Your Job No: 536
Sample Receipt Date: 11/08/14
Reporting Date: 27/08/14

Registered: 11/08/14
Prepared: 12/08/14
Analysis complete: 27/08/14

WATER TEST METHOD SUMMARY

PARAMETER	Method Number	Technique
Arsenic*	101	ICPMS
Cadmium*	101	ICPMS
Chromium*	101	ICPMS
Lead*	101	ICPMS
Nickel*	101	ICPMS
Copper*	101	ICPMS
Zinc*	101	ICPMS
Mercury*	101	ICPMS
Selenium*	101	ICPMS
Boron	203	Colorimetry
pH Value*	113	Electrometric
Total Cyanide	205	Colorimetry
Elemental Sulphur	206	HPLC
Total Phenols	121	HPLC
Hexavalent Chromium	123	Colorimetry
Speciated PAH	135	GCMS
Carbon Banding (TPH CWG)	178	GCFID
BTEX	154	GCMS
VOC	154	GCMS

* = UKAS Accredited test

Determinands not marked with * are not accredited

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

APPENDIX E

References

REFERENCES

1. **Ordnance Survey**, Landranger Series, 1:50,000 Scale, Sheet 196, *The Solent and Isle of Wight*, 2012.
2. **British Geological Survey**, 1:50,000 Series, England & Wales, Sheet E331, *Portsmouth Solid and Drift Geology Map*, 1994.
3. **Wilson Bailey**, *Contaminated Land Desk Study and Preliminary Risk Assessment*. 2012.
4. **Resource & Environmental Consultants Ltd**, *Phase 1 & Phase 2 Geo-Environmental Site Investigation*. 2014
5. **DEFRA**, *Model Procedures for the Management of Contaminated Land*, CLR11, 2004.
6. **Environment Agency**, *SR3 Updated Technical Background to the CLEA model: Science Report Final SC050021/SR3 [replaces CLR10] (EA, 2009)*.
7. **Environment Agency**, *Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination*, 2006.
8. **CIRIA**, *Assessing risks posed by hazardous ground gases to buildings*, C665, 2007.
9. **BRE**, *Concrete in Aggressive Ground*, Special Digest 1, 2005.