



**The Laurels
Dappers Lane
Angmering
West Sussex**

**Ground Contamination
Risk Assessment Report**

Report Beneficiary:

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EXECUTIVE SUMMARY

The following presents a summary of the main findings of the report. It is emphasised that no reliance should be placed on any individual point until the whole of the report has been read as other sections of the report may put into context the information contained herein.

It is proposed to redevelop a parcel of land located off Dappers Lane, Angmering, West Sussex, for residential use. The development proposals are understood to comprise the construction of 9 No. detached/semi-detached dwellings with associated private gardens, parking and access.

The site currently comprises a largely disused parcel of land, the western part of which is occupied by former nursery buildings/structures and the eastern part of which is overgrown with vegetation.

The site is shown to comprise part of an open field at the time of the earliest inspected historical map, dated 1876. The site appears to have remained undeveloped until around the 1960's, after which time buildings associated with a nursery are shown to occupy the western part of the site. It is understood from the client that the site was in commercial use until around 1990.

Reference to geological datasets indicates that the site is expected to be underlain by the Head overlying the London Clay Formation. The ground investigation confirmed the underlying soils to comprise a shallow thickness of made ground, overlying Head deposits.

The Head is classed as a Secondary Undifferentiated Strata. The London Clay Formation is classed as a Unproductive Strata. The site does not lie within an Environment Agency Source Protection Zone with regard to the protection of the quality of groundwater that is abstracted for potable supply. Groundwater was encountered at a depth of 3.50m in borehole WS04.

The preliminary contamination risk assessment identified potential pollutant linkages relating to both proposed end users of the site.

The ground investigation has identified elevated concentrations of lead and PAH compounds and localised asbestos contamination within the shallow soils. Concentrations of petroleum hydrocarbons above threshold levels for the use of PE pipe were also recorded. Remedial works will be required to safeguard the proposed end users of the development.

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1. INTRODUCTION

It is proposed to redevelop a parcel of land located off Dappers Lane, Angmering, West Sussex, for residential use. The development proposals are understood to comprise the construction of 9 No. detached/semi-detached dwellings with associated private gardens, parking and access road. A copy of the proposed development layout is included in Appendix A.

The scope of the works covered by this report, and the terms and conditions under they were undertaken, were set out within the offer letter Q18-7718, dated 17th September 2018. The instruction to proceed was received from the client, Andrew Carter.

The objectives of the works were to:

- a) Establish the expected geology, hydrogeology and hydrology at the site;
- b) Ascertain the development history and current site use;
- c) Develop a preliminary conceptual model of the site identifying potential complete pollutant linkages relating to end users of the proposed development works, to controlled waters beneath and in the vicinity of the site, or to other off-site sensitive receptors, if identified;
- d) Investigate the shallow ground and groundwater conditions across the site;
- e) Test for the presence of contaminants identified by the preliminary conceptual model; and
- f) Develop a quantitative conceptual model of the site, refining the preliminary model to identify any remaining pollutant linkages.

The preliminary conceptual model has been based on the findings of a walkover survey and reference to historical Ordnance Survey maps and published geological and environmental information obtained from various sources.

Copies of the historical maps and geo-environmental data referred to in this report are included in a separate volume¹.

An In Situ Infiltration Testing Report has been prepared for the site by Ashdown Site Investigation Ltd² and issued under separate cover.

¹ Geo-Environmental Data and Historical Maps (Ashdown Site Investigation Limited, Report Number R18-13291/map, dated 10th October 2018.

² Ashdown Site Investigation Report No. R18-13291, dated 1st November 2018.

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2. WALKOVER SURVEY

The site comprises an approximately 'L' shaped plot of land located at Dappers Lane, Angmering, West Sussex, and is centred on the approximate Ordnance Survey national grid reference TQ 07350 04860. A site location plan and site plan are presented as Figure 1 and Figure 2, respectively. Photographs taken during the walkover survey are included in Appendix B.

The site is bounded by Dappers Lane and an existing residential property 'The Laurels' to the west, commercial premises/workshops to the north and east and former nursery/farm buildings to the south, a number of which are utilised as vehicle repair workshops.

Information provided by the client indicates that the site operated as a nursery from c. 1960 to c. 1980 and thereafter was used to pack mushroom compost until c. 1990.

At the time of the walkover survey the site comprised a largely disused parcel of land, accessed via a gated entrance off Dappers Lane at the westernmost end of the site. Within the western 'neck' of the site several former plant nursery buildings were present, including a semi-derelict brick/glass shed with adjoining timber store and a former polytunnel type structure with partial textile covering and corrugated metal panelling to either end.

The roof of the former structure was noted in part to comprise corrugated suspected asbestos cement sheeting. The buildings appeared to be being used for ad hoc storage purposes, including timber, general building materials and other miscellaneous items. Some areas of relic concrete hardstanding were present around the buildings and a pile of waste wood and pallets was located close to the site entrance. A number of loose corrugated suspected asbestos cement panels were observed on the ground adjacent to the former nursery buildings.

The larger, eastern portion of the site was found to be overgrown with vegetation and some small trees. No existing structures were evident in this part of the site. An above ground storage tank was observed approximately 2-3m beyond the boundary of the northeast corner of the site.

Numerous mature trees were present predominantly along the boundaries of the site.

The site is generally level with no significant slopes.

3. ENVIRONMENTAL AND GEO-ENVIRONMENTAL DATA REVIEW

3.1 Geological, Hydrogeological and Hydrological Information

3.1.1 Expected Geology and Aquifer Designation

The stratigraphic succession that may be expected to underlie the site is presented in the following table.

Table 1. Expected Strata and Aquifer Designation

Type	Stratum	Aquifer Designation
Superficial	Head	Secondary Undifferentiated Aquifer
Bedrock	London Clay Formation	Unproductive Stratum

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The superficial Head is a polymict deposit generally comprising clay and sandy clay with variable amounts of gravel. The lithology of the Head reflects the nature of the parent solid strata. The material is likely to have been disturbed by intense frost action in a periglacial environment. It is usually poorly sorted but may be stratified where it has been subject to solifluction and/or hillwash and soil creep.

The London Clay Formation comprises a blue grey silty clay, which tends to weather to brown near to the upper surface. With depth, the clay becomes very stiff/hard, is frequently fissured and can contain some inclusions and beds of weak mudstone and siltstone.

3.1.2 Mining and Natural Ground Hazards

Table 2. Mining and Natural Ground Subsidence Hazards from Envirocheck Data

Section	Risk Assessment
Coal Mining Affected Areas	In an area that might not be affected by coal mining
Non-Coal Mining Areas of Great Britain	Rare
Potential for Collapsible Ground Stability Hazards	Very Low
Potential for Compressible Ground Stability Hazards	No Hazard Identified
Potential for Ground Dissolution Stability Hazards	No Hazard Identified
Potential for Landslide Ground Stability Hazards	Very Low
Potential for Running Sand Ground Stability Hazards	Very Low
Potential for Shrinking or Swelling Clay Ground Stability Hazards	Low

It should be noted that the assessment provided within the data represents a generic assessment only. A site-specific assessment would require the undertaking of an intrusive geotechnical ground investigation.

Screening of the site was also undertaken by Terra Firma for past underground mining hazards. The screening report is included in Appendix C.

Based on this initial screen the site is located within an area that has experienced past underground mining. Whilst the screening assessment assigns a generic risk to the underlying geology, the screening process does also consider the locations of known mines. Further assessment can be undertaken, if required, to provide more detailed comment specific to the site.

3.1.3 Radon

Table 3. Radon

Section	Risk Assessment
Radon Affected Areas	The site is reported to be within an area where between 1% and 3% of properties are above the action level requiring radon gas protection measures to be installed in new buildings.
Radon Protection Measures	No radon protection measures are reported by the British Geological Survey to be necessary in the construction of new dwellings or extensions.

3.1.4 Groundwater Source Protection Zones

The site does not lie within an Environment Agency Source Protection Zone with regard to the protection of the quality of groundwater that is abstracted for potable supply.

3.1.5 Groundwater and Surface Water Abstraction Licences

No groundwater abstraction licences are indicated within 1km of the site.

The closest surface water abstraction licence is recorded to lie 896m to the west of the site. The abstraction is for spray irrigation.

3.1.6 Surface Water Features

The nearest recorded significant surface water feature is located 136m to the south east of the site.

Environment Agency information on river quality within 250m of the site indicates that Black Ditch, located approximately 108m southeast, received a GQA Grade D in 2000.

3.1.7 Flooding

The site lies within an Environment Agency Flood Zone 1.

The site lies within an area where the British Geological Survey report the "Potential for Groundwater Flooding of Property Situated Below Ground Level".

The GeoSmart Groundwater Flood Risk (GW5) Map (GeoSmart, 2018)³ states that the risk of groundwater flooding at the site is 'negligible'.

Based on the susceptibility of the site to groundwater flooding, a groundwater flood risk assessment is not considered necessary for the site.

³ GeoSmart Information Limited, 2018. National Groundwater Flood Risk Map (GW5)
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3.2 Data Review

3.2.1 Agency & Hydrological Data

The data has been reviewed and any entries referring to locations on, or in close proximity to, the site that may pose a potential risk are discussed within the following table.

Table 4. Agency & Hydrogeological Data

Section	Discussion
Discharge Consents	Mr Anthony Perella discharge consent is located on site. Discharge Type: Sewage Discharges – Final/Treated Effluent – Not Water Company. Issued Date: 5 th October 2005. Status: New Consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by Environment Act 1995)

3.2.2 Waste

The data has been reviewed and none of the entries within this section are considered to pose a significant risk to the site.

3.2.3 Hazardous Substance

The data has been reviewed and none of the entries within this section are considered to pose a significant risk to the site.

3.2.4 Industrial Land Use

The data has been reviewed and any entries referring to locations on, or in close proximity to, the site that may pose a potential risk are discussed within the following table.

Table 5. Industrial Land Use Data

Section	Discussion
Contemporary Trade Directory Entries	There are multiple entries within 50m of the site referring to existing and former businesses located within "The Acre", a small business park located immediately to the north, and St Denys Nursery, a larger business park located immediately to the south. A number of the entries refer to vehicle repair and small-scale engineering.

3.2.5 Sensitive Land Use

The data has been reviewed and no sensitive land uses relevant to the proposed development have been identified within 500m of the site.

4. HISTORICAL MAP REVIEW

Historical Ordnance Survey maps covering the area of the site have been reviewed and are summarised in the following table.

It is noted that each map presents information applicable at the time of the survey (or revision date) and is subject to surveying and cartographic errors and/or advances. Revisions to maps are made at irregular intervals and it is possible that significant developments may have taken place on or within the vicinity of the site that are not shown on the maps.

'In the Vicinity of the Site' generally refers to features of relevance within approximately 250m of the site boundary but may also include more distant features if considered to be pertinent to the assessment of the development history.

Table 6. Summary of Significant Features Identified on Historical Maps

Map Details	On-Site	In the Vicinity of the Site
1876 1:2,500	The site comprises part of an open field.	Dappers Lane is shown running north-south on the western boundary.
1971 1:2,500	A number of rectangular structures and glasshouses are shown either fully or partly within the elongated western portion of the site.	Several large glasshouses and smaller buildings associated with a nursery are shown immediately adjacent to the southern boundary. A glasshouse and numerous small units are shown adjacent to the north of the site. Further nurseries are shown from ~50m to the north of the site. A single residential dwelling 'Two Acres' occupies the plot of land adjacent to the northwest of the site. Residential properties are shown beyond Dappers Lane to the west.
1994 1:2,500	The largest glasshouse in the western part of the site appears to have been removed.	The group of buildings to the south are now identified as St Deny's Farm. The residential property adjacent to the northwest is labelled as 'The Laurels'. Further new residential properties are shown beyond Dappers Lane to the west.

5. PRELIMINARY CONTAMINATION RISK ASSESSMENT

5.1 Introduction

The risk assessment considers the potential sources of contamination identified, the receptors that may be present in view of the development proposals and the contaminant pathways by which these may be linked. A complete pollutant linkage is only deemed to exist where all three are present and a site is considered suitable for use where no complete pollutant linkages are identified.

Where a complete pollutant linkage is deemed to be present, an assessment of the level of risk associated with the pollutant linkage has been carried out in line with current guidance⁴.

The level of risk is determined using the risk matrix presented in the following table. Classifications of probability, consequence and risk are presented in Appendix D.

Table 7. Risk Assessment Matrix

		Probability			
		Very Low	Low	Moderate	High
Consequence	Very Minor	Negligible	Very Low	Low	Low/Moderate
	Minor	Very Low	Low	Low/Moderate	Moderate
	Moderate	Low	Low/Moderate	Moderate	High
	Severe	Low/Moderate	Moderate	High	Very High

5.2 Basis of Assessment

The development is to comprise new residential buildings together with areas of private garden where end users can expect to come into contact with the underlying soils, where soil derived dusts may be generated and where the growing of fruit and vegetables may feasibly occur.

The proposed development layout is presented in Appendix A. Should the proposed development plans be altered, a revised risk assessment may be required.

It is noted that an asbestos survey of existing structures and infrastructure⁵ was beyond the brief of this report. The risk assessment has been undertaken on the basis that should asbestos be identified within buildings or infrastructure, with particular attention to the possible suspected asbestos cement roof panels, these materials will be removed appropriately by licensed contractors and asbestos materials disposed of in accordance with legal requirements prior to demolition or other works in order to avoid contaminating soils at the site.

The findings of the preliminary contamination assessment have been used to inform the ground investigation works which are discussed in the following sections of the report.

⁴ Contaminated Land Risk Assessment: A guide to good practice, CIRIA C552, 2001.

⁵ As defined under Section 5(a) of the Control of Asbestos Regulations, 2012.

5.3 Potential Contamination Sources Identified

The following potential sources of contamination have been identified by the preliminary contamination risk assessment:

- Former site use as nursery.
- Made ground associated with the demolition of former buildings/structures.
- Off-site vehicle workshops and industrial units, including above ground storage tank adjacent to NE of site.
- Suspected asbestos cement corrugated sheets stored on ground surface in western part of site.

5.4 Preliminary Conceptual Model

The preliminary conceptual model for the proposed development is presented in Appendix E.

6. GROUND INVESTIGATION

6.1 Introduction

The ground investigation comprised the excavation of a series of dynamic sampler boreholes, together with hand dug pits and a hand augered borehole. A groundwater monitoring standpipe and datalogger were installed in one of the exploratory holes. The fieldwork was carried out on 17th October 2018. The exploratory hole locations are shown on Figure 2.

Descriptions of the strata encountered and comments on groundwater conditions are shown in the exploratory hole records given in Appendix F, together with notes to assist in their interpretation.

6.2 Exploratory Holes

6.2.1 *Dynamic Sampler Boreholes*

Six boreholes, designated WS01 to WS06, were drilled to depths of between 1.30m and 5.00m below ground level.

The boreholes were formed by a series of 1.0m long, open ended, hollow steel tubes of up to 100mm diameter, each containing a removable plastic liner. The tubes, progressively reducing in diameter, were driven into the ground by means of a track-mounted drop weight. Each tube was extracted from the ground using a hydraulically operated jack and the enclosed sample was recovered in its plastic liner.

The system enables sub-samples to be taken for detailed examination and laboratory testing.

6.2.2 *Trial Pits*

Two trial pits, designated TP01 to TP02, were dug using hand tools to a depth of 1.00m below ground level to enable in-situ testing to be carried out.

6.2.3 *Hand Auger Boreholes*

One borehole, designated HA1, was bored to a depth of 0.25m. The hand auger enables disturbed soil samples to be taken using a cutting tool twisted into the soil by hand.

6.3 Sampling

Disturbed samples of soil were taken at the depths shown in the exploratory hole records and were collected in plastic bags, plastic tubs or amber jars fitted with gas tight lids.

On collection the amber jars were stored in cool boxes with cooling blocks to maintain temperatures below 4°C until transferred to refrigerators upon return to the office and subsequently forwarded to the external accredited chemical testing laboratory.

6.4 Installations

A groundwater monitoring standpipe was installed to a depth of 5.00m in borehole WS04. A description of the installation is shown on the exploratory hole record in Appendix F.

A groundwater data logger was installed within the standpipe on the 17th October 2018, was programmed to collect readings at 15 minute intervals for a six month period over the winter. The results will be issued separately on completion of the monitoring.

6.5 Laboratory Testing

Laboratory testing was scheduled by Ashdown Site Investigation Ltd. Results from the laboratory tests are provided in Appendix G.

Chemical testing of selected samples was undertaken by a laboratory with recognised (UKAS and MCERTS) accreditation for quality control.

7. GROUND CONDITIONS

7.1 Stratigraphy

7.1.1 Surface Covering

In general, the exploratory holes were excavated through a surface cover of topsoil some 50mm to 400mm in thickness. The topsoil was recorded to contain gravel of brick, flint, charcoal-like material, concrete, asphalt and glass in variable quantities.

A layer of concrete some 150mm thick was encountered at borehole WS04.

7.1.2 Made Ground

Made ground, generally comprising gravelly clay, was encountered to a depth of 0.20m and 0.65m in exploratory holes WS04 and TP02, respectively, and to the full depth of borehole HA1 of 0.25m. The gravel fraction comprised variable quantities of flint, brick, concrete, plastic, asphalt, chalk, nylon string, glass and clinker/charcoal-like material.

7.1.3 Head

Beneath the topsoil/made ground, the investigation progressed into slightly gravelly clay deposits, which continued to depths of between 0.70m and 1.20m below ground level. Underlying the clay deposits, the boreholes progressed into clayey fine to coarse gravel of flint. This stratum was proven to a depth of 3.50m in borehole WS04, below which depth the stratum graded back into gravelly clay deposits, which persisted to the full depth of the investigation of 5.0m below ground level.

These soils are considered to represent the Head deposits indicated on the published geological map.

7.2 Stability

Each of the exploratory holes was recorded to remain stable during the course of drilling/excavation.

7.3 Groundwater Conditions

Groundwater was encountered at a depth of 3.50m in borehole WS04, rising to 3.00m on completion of drilling. The remaining exploratory holes were recorded to remain dry.

Winter groundwater monitoring of the standpipe installed at borehole WS04 is currently ongoing and the results will be issued under separate cover on completion of the monitoring programme.

8. QUANTITATIVE CONTAMINATION ASSESSMENT

8.1 Assessment Strategy

The design of the ground investigation considered the potential contaminant sources identified by the preliminary ground contamination risk assessment. The investigation strategy employed to assess the potential sources is detailed in the following table.

Table 8. Investigation Works Carried Out

Contaminant source	Exploratory Positions
Former use of site as a nursery and potential made ground associated with demolished former nursery buildings/structures.	All positions
Off-site vehicle workshops and commercial/industrial units adjacent to the N, S and E of the site.	WS03, WS05 & WS06
Above ground storage tank adjacent to NE corner of site.	HA1

The site covers an area of approximately 5500m² and the nine sampling positions were spread across the site at relatively regular positions. As such each position crudely represents around 600m², which equates to sample positions at approximately 25m centres. Such a sampling density falls within the upper end of the recommended range for an exploratory investigation as outlined in BS10175:2011+A2:2017.

8.2 Analysis of Contamination Test Results

Statistical analysis of the concentrations of heavy metals and polycyclic aromatic hydrocarbon (PAH) compounds within eight samples of the shallow made ground soils and topsoil (samples were tested from depths of up to 0.50m below ground level) has been undertaken in line with CIEH/CL:AIRE guidance⁶.

The CIEH/CL:AIRE guidance provides a framework for assessing measured contaminant concentrations on a site against user defined critical concentrations – or indicators of risk.

Under a planning scenario, the null hypothesis tested is that the true population mean is greater than a “critical concentration”. The critical concentration used within this assessment is the relevant screening value for the proposed end use.

The null hypothesis can be rejected if it can be shown (with a sufficient degree of confidence) that the true population mean lies below the critical concentration. The confidence level recommended within the guidance is 95% i.e. the statistical evidence must show that there is 95% likelihood that the true population mean lies below the critical concentration. In this instance the site is considered suitable for the proposed use.

⁶ Comparing Soil Contamination Data with a Critical Concentration, published by the CIEH/ CL:AIRE, May 2008.
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Where there is insufficient evidence to reject the null hypothesis, further risk assessment and/or remediation may be necessary.

Guidance on comparing soil contamination data with a critical concentration is provided in Appendix H along with the summary sheets from the statistical analysis.

The “critical concentration” used in this assessment are the ‘Suitable For Use Levels’ (S4UL)⁷ or, in lieu of an S4UL being developed for lead, the Category 4 Screening Level (C4SL)⁸. These are collectively referred to as soil screening values (SSV).

For petroleum hydrocarbons, statistical analysis has not been undertaken. The results of the testing have been compared directly with calculated S4UL.

In view of the proposed development the assessment has been made against SSV calculated using the generic “Residential” land use⁹. The critical receptor for this land use is considered to be a young female child resident on site from birth to age 6. Exposure routes that are considered include the potential for direct ingestion of the soil, the outdoor and indoor ingestion of dust, the potential inhalation of dust and vapours, ingestion of site grown vegetables and ingestion of soil attached to vegetables.

For the assessment of risk to controlled waters a qualitative assessment has been undertaken based upon the concentrations of contaminants recorded within the soil samples and the information obtained about the sensitivity of the underlying strata or nearby surface water receptors.

8.2.1 Heavy Metals

The following table summarises the SSV, maximum, minimum and mean concentrations and the 95th percentile upper confidence limits for the heavy metals tested for.

Table 9. Summary of Test Results and Statistical Analysis for Heavy Metals

Contaminant	SSV (mg/kg)	No. of Samples	Minimum Concentration (mg/kg)	Maximum concentration (mg/kg)	Limit of Detection (mg/kg)	Mean Concentration (mg/kg)	95% Upper Confidence Limit (mg/kg)	No of exceedances	Can H ₀ be rejected
Arsenic	37	8	4	13	<2	8.25	10.14	0	Yes
Water Soluble Boron	290	8	<1	2.2	<1	0.71	1.64	0	Yes
Cadmium	11	8	<0.2	2.7	<0.2	0.60	1.94	0	Yes
Chromium	910	8	17	24	<2	20.25	21.80	0	Yes
Hexavalent Chromium	6	8	<2	<2	<2	1.00	1.00	0	Yes
Copper	2400	8	9	27	<4	19.00	22.95	0	Yes

⁷ The LQM/CIEH Suitable 4 Use Levels, 2015.

⁸ SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Final Project Report, published by DEFRA, 2014.

⁹ As defined within Science Report SC050021/SR3, January 2009, with the amendments discussed in the LQM/CIEH report.

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Contaminant	SSV (mg/kg)	No. of Samples	Minimum Concentration (mg/kg)	Maximum concentration (mg/kg)	Limit of Detection (mg/kg)	Mean Concentration (mg/kg)	95% Upper Confidence Limit (mg/kg)	No of exceedances	Can H ₀ be rejected
Lead	200	8	28	770	<3	139.8 8	534.04	1	No
Mercury	40	8	<1	<1	<1	0.50	0.50	0	Yes
Nickel	180	8	7	13	<3	10.50	11.84	0	Yes
Selenium	250	8	<3	<3	<3	1.50	1.50	0	Yes
Zinc	3700	8	56	1710	<3	332.5 0	1205.2 9	0	Yes

The statistical analysis undertaken indicates that the 95th percentile concentration of lead within the shallow soils exceeds the SSV. On this basis, the concentrations of lead within the made ground soils are considered to pose an unacceptable risk to end users should the soils remain within areas of soft landscaping where contact with soils and soil generated dust could occur.

At the concentrations recorded, none of the heavy metals tested for would be expected to exhibit any significant mobility and they are not considered to pose an unacceptable risk to controlled waters beneath the site.

8.2.2 Asbestos

The eight samples of topsoil/made ground were screened for the presence of asbestos. The topsoil sample from borehole WS03 at 0.10m tested positive for the presence of asbestos, in the form of chrysotile fibre bundles.

Whilst widespread asbestos contamination of the shallow soils at the site does not appear to be present, as suspected asbestos materials were observed on the ground surface at a number of locations, there remains the potential for localised asbestos contamination within the shallow soils which is considered to pose an unacceptable risk to the proposed end users of the development.

Any asbestos materials present on site, including within the existing buildings or infrastructure, should be appropriately removed by licensed contractors prior to undertaking any demolition or other works at the site, and all asbestos materials disposed of in accordance with legal requirements, in order to avoid contaminating soils at the site.

8.2.3 Polycyclic Aromatic Hydrocarbon (PAH) Compounds

The following table summarises the SSV, maximum, minimum and mean concentrations and the 95th percentile upper confidence limits for the PAH compounds tested for.

Table 10. Summary of Test Results and Statistical Analysis for PAH Compounds

Contaminant	SSV (mg/kg)	No. of Samples	Minimum Concentration (mg/kg)	Maximum concentration (mg/kg)	Limit of Detection (mg/kg)	Mean Concentration (mg/kg)	95% Upper Confidence Limit (mg/kg)	No of exceedances	Can H ₀ be rejected
Naphthalene	2.3	8	<0.1	0.32	<0.1	0.08	0.23	0	Yes
Acenaphthylene	170	8	<0.1	0.3	<0.1	0.12	0.27	0	Yes
Acenaphthene	210	8	<0.1	1.35	<0.1	0.27	0.96	0	Yes
Fluorene	170	8	<0.1	1.34	<0.1	0.28	0.97	0	Yes
Phenanthrene	95	8	<0.1	13.3	<0.1	2.62	9.82	0	Yes
Anthracene	2400	8	<0.1	3.58	<0.1	0.71	2.59	0	Yes
Fluoranthene	280	8	0.15	31.7	<0.1	6.36	23.38	0	Yes
Pyrene	620	8	0.13	26.3	<0.1	5.40	19.56	0	Yes
Benz(a)anthracene	7.2	8	0.22	15.4	<0.1	3.20	11.29	1	Yes
Chrysene	15	8	<0.1	11.2	<0.1	2.49	8.61	0	Yes
Benzo(b)fluoranthene	2.6	8	0.37	17.4	<0.1	3.94	13.08	3	Yes
Benzo(k)fluoranthene	77	8	<0.1	4.85	<0.1	1.15	3.77	0	Yes
Benzo(a)pyrene	2.2	8	0.2	13.7	<0.1	3.08	10.36	3	Yes
Indeno(123-cd)pyrene	27	8	<0.1	6.93	<0.1	2.00	5.69	0	Yes
Dibenz(ah)anthracene	0.24	8	<0.1	1.05	<0.1	0.40	1.03	4	Yes
Benzo(ghi)perylene	320	8	<0.1	5.13	<0.1	1.45	4.30	0	Yes

The statistical analysis undertaken indicates that the 95th percentile concentration of Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(a)pyrene and Dibenz(ah)anthracene within the shallow soils exceeds the SSV. On this basis, the concentrations of PAHs within the topsoil/made ground soils may be considered to pose an unacceptable risk to end users should the soils remain unremediated within areas of soft landscaping where contact with soils and soil generated dust could occur.

At the concentrations recorded, PAH compounds would not be expected to exhibit any significant mobility and are not considered to pose an unacceptable risk to controlled waters beneath the site.

8.2.4 Petroleum Hydrocarbons

The same samples were tested to determine their total concentrations of petroleum hydrocarbon,s with the results speciated by equivalent carbon weight fractions.

The following table lists the screening values for petroleum hydrocarbon equivalent carbon weight fractions calculated for 1% organic content.

Table 11. Soil Screening Values for petroleum hydrocarbon equivalent carbon weight fractions

Petroleum Hydrocarbon Fraction	SSV (mg/kg)	Petroleum Hydrocarbon Fraction	SSV (mg/kg)
Aliphatic EC 5-6	42	Aromatic EC 5-7	70
Aliphatic EC >6-8	100	Aromatic EC >7-8	130
Aliphatic EC >8-10	27	Aromatic EC >8-10	34
Aliphatic EC >10-12	130	Aromatic EC >10-12	74
Aliphatic EC >12-16	1100	Aromatic EC >12-16	140
Aliphatic EC >16-35	65000	Aromatic EC >16-21	260
Aliphatic EC >35-44	65000	Aromatic EC >21-35	1100
		Aromatic EC >35-44	1100

Full speciation of petroleum hydrocarbons by aromatic and aliphatic fractions was not undertaken. However, the results of the testing undertaken can still be compared with the more stringent of the screening values for the respective equivalent carbon weight fraction and, where the concentration recorded is found to be lower, then it can be concluded that no significant risk is present.

None of the samples tested recorded petroleum hydrocarbons above screening values for a residential land use.

It is noted that the made ground sample from trial pit TP02 at 0.50m depth recorded a total hydrocarbon concentration in excess of 1000mg/kg, although no suspected fuel odours and/or visual indications of hydrocarbon contamination were observed at this location. In addition, no suspected fuel odours and/or visual indications of hydrocarbon contamination were noted at exploratory hole HA1, which was positioned close to an above ground storage tank located off-site to the northeast.

Where recorded, the hydrocarbons were primarily associated with the heavier, C21-C40, carbon fractions and, similar to PAH compounds, would not be expected to exhibit significant mobility. Furthermore, in view of the generally low sensitivity of the site with respect to groundwater, the soil hydrocarbon concentrations recorded are not considered to pose an unacceptable risk to controlled waters beneath the site.

Comparison of the test results with screening criteria for water supply pipes¹⁰ indicates that the protection of water supply services is likely to be required. Notwithstanding the above it is strongly recommended that designers consult with the proposed water supply company to ascertain if further laboratory testing and assessment specific to proposed routes of services is required.

¹⁰ Set out within Table 3.1 of the Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites, UK Water Industry Research, 2010.

8.3 Quantitative Contamination Risk Assessment

8.3.1 Contamination Sources Identified

The following sources of contamination have been identified by the quantitative contamination risk assessment:

- Elevated concentrations of lead and PAH compounds and potential for localised asbestos contamination within the shallow soils across the site.
- Concentrations of petroleum hydrocarbons in soils above screening criteria for PE water supply pipes.

8.3.2 Quantitative Conceptual Model

The quantitative conceptual model for the proposed development is presented in Appendix I.

8.4 Risks to Other Potential Receptors

The following general guidance is given with regard to other potential on site receptors, which may not necessarily be statutory drivers for remedial works.

As a minimum and in accordance with industry best practice all ground-workers should be issued with the appropriate PPE and should be instructed in safe working methods, particularly in view of the potential for asbestos to be encountered within the made ground soils.

As a precautionary measure instruction should be given in the recognition of potentially hazardous materials, including oily and odorous soil and water and discoloured or fibrous substances. Any oil-like substances contacting the skin must be washed off immediately using an appropriate cleanser. Operatives should be warned to avoid contact between hands and mouth before washing. The consumption of food and smoking must be confined to designated clean areas. Suitable welfare (washing) facilities should be provided. These precautions should be taken in addition to anything highlighted by a site-specific risk assessment which should be undertaken by any contractor prior to commencing work.

All site personnel should be appropriately briefed on what actions to take in the event that evidence of significant contamination is identified or suspected.

8.5 Recommendations

The ground investigation has recorded complete pollutant linkages relating to the presence of contaminants within the shallow soils across the site. In view of this it is considered that remedial measures will be required to safeguard end users of the site.

Given the sources of contamination identified it is considered that such works should likely best comprise either the removal of the identified source (the contaminated topsoil/made ground) or the provision of a suitable depth of cover soils within all private garden or soft landscaped areas to sever the contaminant pathways.

Due to the presence of numerous mature trees within areas of proposed soft landscaping it is recommended that the local Tree Protection Officer should be consulted at an early stage to ascertain whether any of these trees are subject to tree protection orders, as remedial measures

within tree protection zones may need to be specified differently to elsewhere on the site. It may be necessary to undertake more detailed testing and assessment of the soils within any root protection zones.

The remediation works ultimately adopted should be detailed within a separate remediation strategy, along with a verification plan. This should be produced once this risk assessment report has been reviewed and approved by the appropriate authority.

In addition to the above, should materials not previously identified by the investigation and that are suspected of being 'contaminants' be encountered during the course of the works, advice should be sought immediately on their identification and how they should be treated.

If necessary, the newly identified contaminants will be subject to a revised risk assessment and remediation strategy.

Ashdown Site Investigation Ltd.

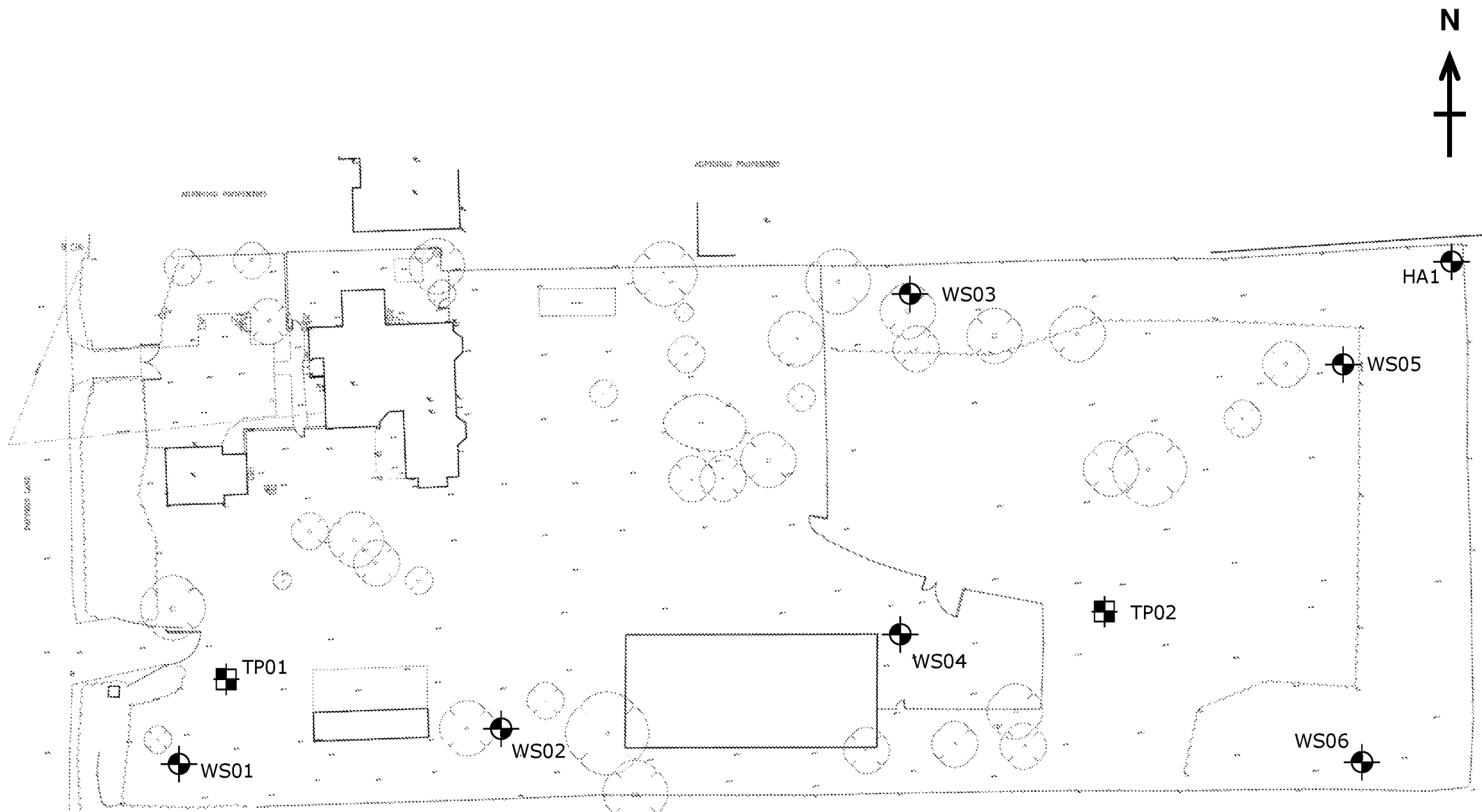
FIGURES

Figure 1 Site Location Plan

Figure 2 Site Plan



© OpenStreetMap contributors, CC BY-SA



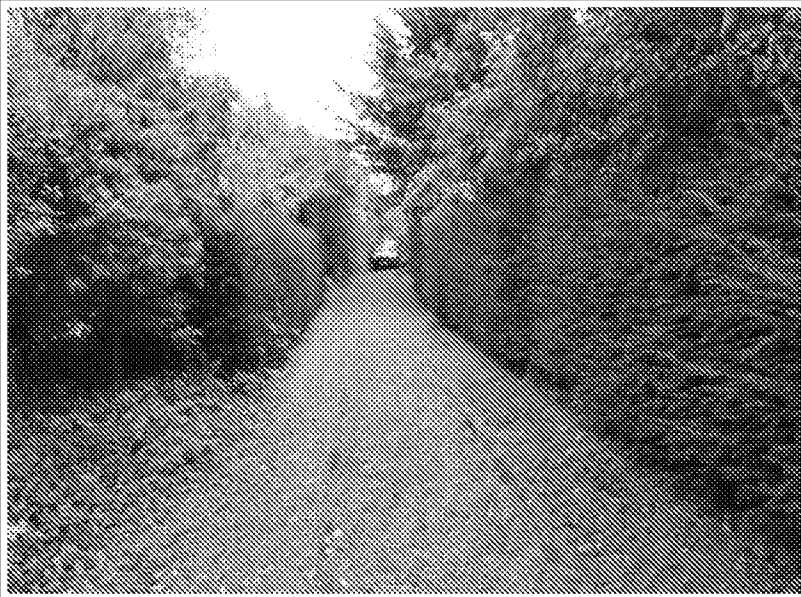
APPENDIX A

Proposed Development Layout

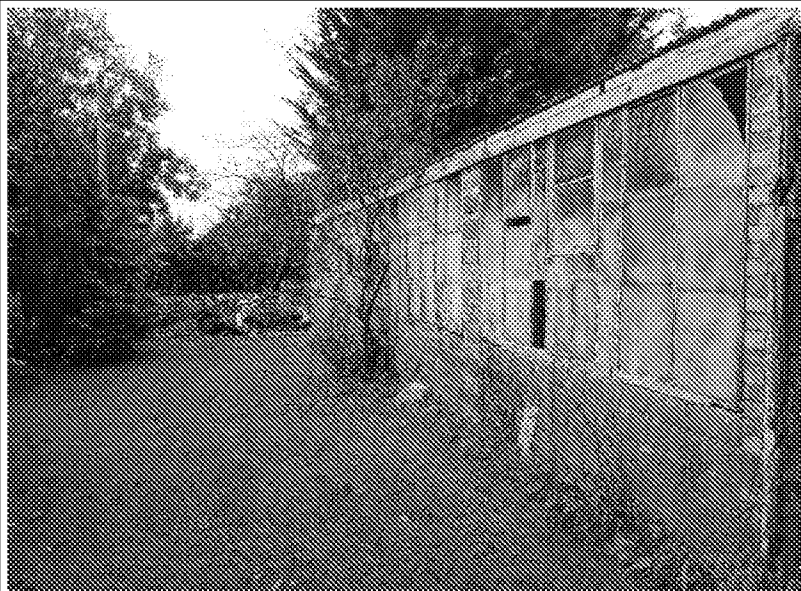
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cooper**
ARCHITECTS

APPENDIX B

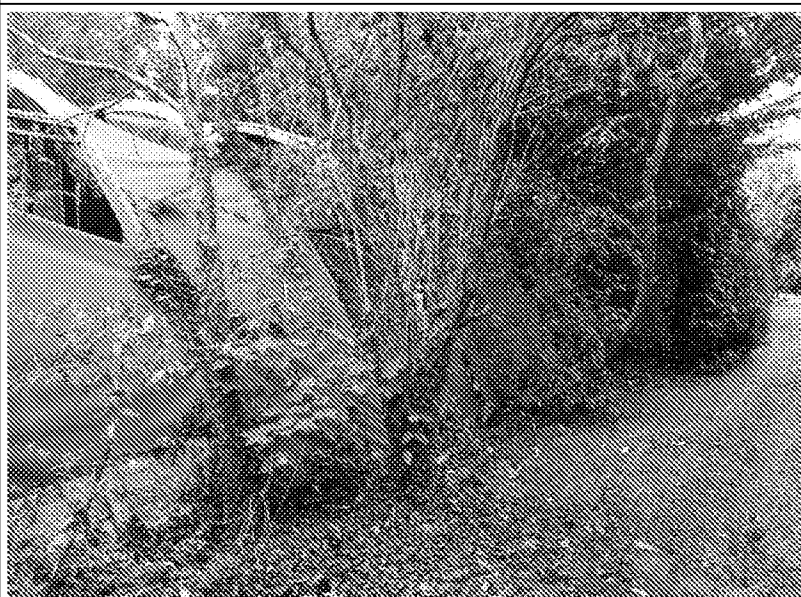
Site Walkover Photographs



Site access off Dappers Lane



Former nursery building in western part of site



Former polytunnel structure in western part of site



Suspected asbestos cement panels on ground observed adjacent to former polytunnel structure.



Looking north-eastwards across eastern portion of site.



Above ground storage tank observed adjacent to northeast of site.

APPENDIX C

Terra Firma TerraSearch Report

FURTHER ACTION

The scope of this service is run the TerraSearch® Hazard Alert Service to screen for past underground mining hazards and natural ground hazards.

This site (Property & Land) is considered to be located within an area that has experienced past underground mining and/or natural ground perils. It is recommended that a **TerraSearch® Ground report** is purchased to obtain a professional assessment.

Report on:

**The Laurels, Dappers Lane,
Angmering, Littlehampton,
West Sussex, BN164EN**

Latitude:
507295

Longitude:
104879

Important Information

This is a search alert report recommendation service and is not to be used in a property transaction as evidence of ground instability and/or the impact from present and planned mineral extraction.

This alert is not covered by TerraSearch® terms and conditions and is to be used solely for the purpose of highlighting a risk.

No liability will be held by ourselves to any persons not party to the commissioning of this Terrasearch® Hazard Alert.

Date:

11/10/2018

Our Ref:

**TFC20181010131950-
BN164EN**

Client Ref:

66163.243.01

Recommendations

The TerraSearch® Ground search report is available where the TerraSearch® Hazard Alert Service identifies the site is situated within an 'Affected Area' for past underground mining hazards and/or natural ground perils. TerraSearch® Ground is a professional desktop assessment by a mining geologist that comprehensively assesses the risk to a site (Property & Land) from ground hazards in a single search report.

TerraSearch® Ground is provided within 2 – 5 days and for an additional fee can be expedited to be provided within 24hrs.

GROUND

**WE TRUST THIS REPORT PROVIDES THE INFORMATION YOU REQUIRE. PLEASE CONTACT US
IF YOU HAVE ANY QUERIES OR IF WE CAN BE OF ANY FURTHER ASSISTANCE.**

understand the ground



2440 The Quadrant · Aztec West · Bristol · BS32 4AQ · T: 0330 900 7500

E: info@terrafirmasearch.co.uk · www.terrafirmasearch.co.uk · Registered No: 09726669

APPENDIX D

Classification of Probability, Consequence and Risk

Probability of risk being realised	
Classification	Definition
High	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Moderate	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term.
Very Low	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Consequence of risk being realised		
Classification	Category	Definition
Severe	Human Health	Short term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA.
	Controlled Waters	Short term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource.
	Property	Catastrophic damage to buildings/property.
	Ecological Systems	A short term risk to a particular ecosystem or organisation forming part of such ecosystem.
Moderate	Human Health	Chronic damage to Human Health.
	Controlled Waters	Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution).
	Ecological System	A significant change in a particular ecosystem or organism forming part of such ecosystem.
Minor	Controlled Waters	Pollution of non-sensitive water resources.
	Property	Significant damage to crops, buildings, structures and services.
	Ecological Systems	Damage to sensitive buildings/structures/services or the environment.
Very Minor	Human Health	Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc).
	Property	Easily repairable effects of damage to buildings, structures and services.
	Project	Harm, although not necessarily significant harm, which may result in a financial loss or expenditure to resolve.

Risk classification definitions	
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the long term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but there is a low likelihood of this hazard occurring and if realised, harm would at worst normally be mild.
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

APPENDIX E

Preliminary Conceptual Model

The Laurels, Dappers Lane, Angmering, West Sussex				Preliminary Conceptual Model		R18-13291	
Potential Source	Potential Receptor	Potential Contaminants	Potential Pathway	Complete Linkage Present?	Probability	Consequence	Risk
Historical use of the site as a nursery	End Users	Heavy Metals	Dermal contact with soil and dust (indoor & outdoor)	Yes	P2: Low	C2: Minor	Low
			Ingestion of soil and indoor dust	Yes	P2: Low	C2: Minor	Low
			Consumption of home-grown produce and attached soil	Yes	P2: Low	C2: Minor	Low
			Inhalation of soil dust (indoor and outdoor)	Yes	P2: Low	C2: Minor	Low
			Inhalation of soil vapours	No potential contaminants identified			N/A
			Inhalation of soil gases/ Risk of explosion	No potential gas source identified			N/A
	End Users (via Water Supply Pipework)		Contamination of incoming services	No potential contaminants identified			N/A
	Groundwater	Heavy Metals	Migration to groundwater	Yes	P1: Very Low	C1: Very Minor	Negligible
Made ground associated with the demolition of former buildings/structures.	End Users	Asbestos, Heavy Metals and PAH Compounds	Dermal contact with soil and dust (indoor & outdoor)	Yes	P3: Moderate	C2: Minor	Low/Moderate
			Ingestion of soil and indoor dust	Yes	P3: Moderate	C2: Minor	Low/Moderate
			Consumption of home-grown produce and attached soil	Yes	P3: Moderate	C2: Minor	Low/Moderate
			Inhalation of soil dust (indoor and outdoor)	Yes	P3: Moderate	C2: Minor	Low/Moderate
			Inhalation of soil vapours	No potential contaminants identified			N/A
			Inhalation of soil gases/ Risk of explosion	No potential gas source identified			N/A
	End Users (via Water Supply Pipework)		Contamination of incoming services	No potential contaminants identified			N/A
	Groundwater	Heavy Metals and PAH Compounds	Migration to groundwater	Yes	P1: Very Low	C1: Very Minor	Negligible

The Laurels, Dappers Lane, Angmering, West Sussex				Preliminary Conceptual Model		R18-13291	
Potential Source	Potential Receptor	Potential Contaminants	Potential Pathway	Complete Linkage Present?	Probability	Consequence	Risk
Off-site vehicle workshops and industrial units, including above ground storage tank adjacent to NE of site.	End Users	Petroleum Hydrocarbons	Dermal contact with soil and dust (indoor & outdoor)	Yes	P1: Very Low	C2: Minor	Very Low
			Ingestion of soil and indoor dust	Yes	P1: Very Low	C2: Minor	Very Low
			Consumption of home-grown produce and attached soil	Yes	P1: Very Low	C2: Minor	Very Low
			Inhalation of soil dust (indoor and outdoor)	Yes	P1: Very Low	C2: Minor	Very Low
			Inhalation of soil vapours	Yes	P1: Very Low	C2: Minor	Very Low
			Inhalation of soil gases/ Risk of explosion	No potential gas source identified			N/A
	End Users (via Water Supply Pipework)	Petroleum Hydrocarbons	Contamination of incoming services	Yes	P1: Very Low	C2: Minor	Very Low
	Groundwater	Petroleum Hydrocarbons	Migration to groundwater	Yes	P1: Very Low	C1: Very Minor	Negligible
Suspected asbestos cement corrugated sheets stored on ground surface in western part of site.	End Users	Asbestos	Dermal contact with soil and dust (indoor & outdoor)	No potential contaminants identified			N/A
			Ingestion of soil and indoor dust	No potential contaminants identified			N/A
			Consumption of home-grown produce and attached soil	No potential contaminants identified			N/A
			Inhalation of soil dust (indoor and outdoor)	Yes	P2: Low	C3: Moderate	Low/Moderate
			Inhalation of soil vapours	No potential contaminants identified			N/A
			Inhalation of soil gases/ Risk of explosion	No potential gas source identified			N/A
	End Users (via Water Supply Pipework)		Contamination of incoming services	No potential contaminants identified			N/A
	Groundwater		Migration to groundwater	No contaminants likely to impact groundwater identified			N/A

APPENDIX F

Exploratory Hole Notes
Exploratory Hole Records

NOTES FOR THE INTERPRETATION OF EXPLORATORY HOLE RECORDS

1 Symbols and abbreviations

Samples

U	'Undisturbed' Sample: - 100mm diameter by 450mm long. The number of blows to drive in the sampling tube is shown after the test index letter in the SPT column.
Uo	Sample not obtained.
U*	Full penetration of sample not obtained.
Pi	Piston Sample: 'Undisturbed' sample 100mm diameter by 600mm long.
D	Disturbed Sample.
R	Root Sample.
B	Bulk Disturbed Sample.
W	Water Sample.
J	Jar Sample (sample taken in amber glass jar fitted with gas tight lid)
T	Tub Sample
Vi	Vial Sample

In situ Testing

S	Standard penetration test (SPT): Using the split spoon sampler.
C	Standard Penetration Test (SPT): using a solid cone instead of the sampler - conducted usually in coarse grained soils or weak rocks.
V	Shear Vane Test: Undrained shear strength (cohesion) (kN/m ²) shown within the Vane/Pen Test and N Value column.
H	Hand penetrometer Test: Undrained shear strength (cohesion) (kN/m ²) shown within the Vane/Pen Test and N Value column.
P	Perth Penetrometer Test: Number of blows for 300mm penetration shown under Vane/Pen Test and N Value column.

Excavation Method

CP	Cable Percussion Borehole
WLS	Dynamic Sampler Borehole using windowless sampler tubes
WS	Dynamic Sampler Borehole using window sampler tubes
TP	Trial Pit excavated using mechanic excavator
HDP	Trial Pit excavated using hand tools

2 Soil Description

Description and classification of soils has been carried out using as a general basis the British Standard Geotechnical investigation and testing – Identification and classification of soil, Part 1 Identification and description (BS EN ISO 14688-1:2002+A1:2013) and Part 2 Principles of classification (BS EN 14688-2:2004+A1:2013) as well as the BS5930:2015 code of Practice for Ground Investigations.

3 Rock Description

Description and classification of rocks has been carried out using as a general basis the British Standard Geotechnical investigation and testing – Identification and classification of rock, Part 1 Identification and classification (BS EN ISO 14689-1:2003) as well as the BS5930:2015 code of Practice for Ground Investigations.

4 Chalk Description

Chalk description is based on BS EN ISO 14688, BS EN ISO 14689 and BS5930. The classification of chalk generally follows the guidance offered by the Construction Industry Research and Information Association (CIRIA) C574, 'Engineering in Chalk'. This is based on assessment of chalk density, discontinuity and aperture spacing, and the proportion of intact chalk to silt of chalk. See additional chalk classification notes.

End Date: 17/10/2018

Sheet 1 of 1

Remarks Groundwater: Borehole dry on completion. Stability: Borehole stable on completion. Notes: n/a	Excavation Method: HA
	Borehole Diameter: Various
	Made By: PM

Site Name: The Laurels, Dappers Lane, Angmering, West Sussex

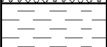
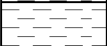
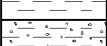
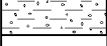
Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Trial Pit Number: **TP01**

Sheet 1 of 1

Samples and In Situ Testing				Legend	Depth/ Reduced Level	Stratum Description
Sample/ Test Type	Depth From (m)	Depth To (m)	Test Result			
J T	0.10				0.00	Topsoil with gravel of concrete and asphalt.
J T	0.25				0.15	Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine to coarse flint and occasional chalk. (Head)
D	0.28				0.30	
J T	0.60					Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine to coarse flint. (Head)
D	0.70					
D	0.90				0.80	Orange very gravelly CLAY. Gravel is angular to subangular fine to coarse flint. (Head)
					1.00	
						End of trial pit at 1.00m

Remarks

Groundwater: Trial pit dry on completion.

Stability: Trial pit stable on completion.

Notes: n/a

Excavation Method: HDP

Pit Length: 1.00m

Pit Width: 0.30m

Made By: PM

Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Trial Pit Number: **TP02**

Sheet 1 of 1

Remarks Groundwater: Trial pit dry on completion. Stability: Trial pit stable on completion. Notes: n/a	Excavation Method: HDP
	Pit Length: 1.00m
	Pit Width: 0.30m
	Made By: PM

Site Name: The Laurels, Dappers Lane, Angmering, West Sussex

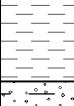
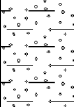
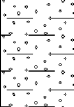
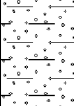
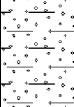
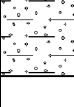
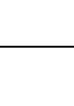
Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Borehole Number: **WS01**

Sheet 1 of 1

Samples and In Situ Testing						Stratum Description	
Standpipe	Sample/ Test Type	Depth From (m)	Depth To (m)	Test Result	Legend	Depth	
	J T	0.15				0.00	Topsoil with occasional charcoal-like material, flint and roots.
	J T	0.60				0.40	Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine to medium flint. (Head)
	D	0.80				1.05	Brown orange clayey angular to subangular fine to coarse GRAVEL of flint. (Head)
	D	1.50					
	D	2.50					
							
							
							
							
							
							
							
							
							
							
							
							

Site Name: The Laurels, Dappers Lane, Angmering, West Sussex

Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Borehole Number: **WS02**

Sheet 1 of 1

Samples and In Situ Testing					Legend	Depth	Stratum Description
Standpipe	Sample/ Test Type	Depth From (m)	Depth To (m)	Test Result			
	J T	0.10				0.00	Topsoil with gravel of flint, occasional brick and glass.
	J T	0.30				0.15	Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine to medium flint. (Head)
	D	0.50					
	J T	0.90				0.70	Orange brown clayey angular to subangular fine to coarse GRAVEL of flint. (Head)
	D	1.50					
	D	2.60					
						3.00	End of borehole at 3.00m

Remarks

Groundwater: Borehole dry on completion.

Stability: Borehole stable on completion.

Notes: n/a

Excavation Method: WLS

Borehole Diameter: Various

Made By: PM



E-mail: contact@ashdownsi.co.uk
Web: www.ashdownsi.co.uk
Tel: 01273 483119

Site Name: The Laurels, Dappers Lane, Angmering, West Sussex

Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Borehole Number: **WS03**

Sheet 1 of 1

Samples and In Situ Testing						Depth	Stratum Description
Standpipe	Sample/ Test Type	Depth From (m)	Depth To (m)	Test Result	Legend		
	J T	0.10				0.00	Topsoil with gravel of brick, charcoal-like material and flint.
						0.25	Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine to medium flint. (Head)
	J T	0.50					
	D	0.55					
						1.00	Brown orange clayey angular to subangular fine to coarse GRAVEL of flint. (Head)
	J T	1.50					
	D	1.60					
							
							
		D	2.60				
							
							
							
							
							
							
							
							
							
							
							
							
							

Site Name: The Laurels, Dappers Lane, Angmering, West Sussex

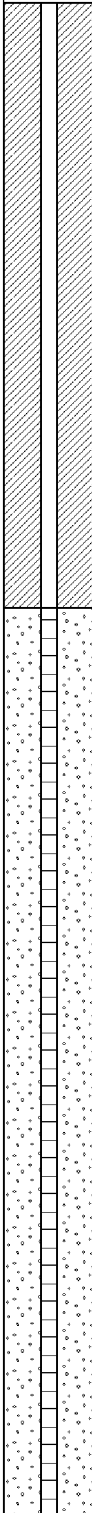
Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Borehole Number:
WS04

Sheet 1 of 1

Samples and In Situ Testing					Legend	Depth	Stratum Description
Standpipe	Sample/ Test Type	Depth From (m)	Depth To (m)	Test Result			
	J T	0.18				0.00	Concrete.
						0.15	MADE GROUND: Dark brown slightly gravelly clay. Gravel is angular to subrounded fine to medium flint, roots and occasional brick. Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine to medium flint. (Head)
						0.20	
	J T	0.70					
			D	0.80			
						1.20	Brown orange clayey angular to subangular fine to coarse GRAVEL of flint. (Head)
	J T	1.70					
			D	1.80			
							
	J T	2.70					
							
	D	3.10					
						3.50	Orange very gravelly CLAY. Gravel is angular to subangular fine to coarse flint. (Head)
	J T	3.70					
							
	D	4.10					
							
J T	4.50						
					4.60	Orange brown slightly gravelly CLAY. Gravel is angular to subangular fine siltstone and ironstone. (Head)	
D	4.80						
					5.00	End of borehole at 5.00m	

Remarks
Groundwater: Groundwater encountered at 3.50m depth.
Standing water at 3.00m depth on completion of borehole.

Stability: Borehole stable on completion.

Notes: Standpipe installed to 5.00m depth; 5.00m to 2.00m slotted pipe with gravel surround; 2.00m to ground level plain pipe with bentonite seal; completed with end cap and security cover concreted flush with ground surface.

Excavation Method: WLS

Borehole Diameter: Various

Made By: PM

Site Name: The Laurels, Dappers Lane, Angmering, West Sussex

Job Number: R18-13291

Start Date: 17/10/2018

End Date: 17/10/2018

Borehole Number: **WS05**

Sheet 1 of 1

Samples and In Situ Testing					Legend	Depth	Stratum Description
Standpipe	Sample/ Test Type	Depth From (m)	Depth To (m)	Test Result			
	J T	0.20				0.00	Topsoil with gravel of brick, flint and glass.
	J T	0.40				0.30	Orange slightly gravelly CLAY. Gravel is angular to subangular fine to coarse flint.
	D	0.50					(Head)
						0.70	Brown orange clayey angular to subangular fine to coarse GRAVEL of flint.
							(Head)
							
							
							
							
							
	D	1.50					
							
	J T	1.80					
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							

End Date: 17/10/2018

Sheet 1 of 1

Remarks Groundwater: Borehole dry on completion. Stability: Borehole stable on completion. Notes: No further progress below 1.30m depth - too dense.	Excavation Method: WLS
	Borehole Diameter: Various
	Made By: PM

APPENDIX G

Contamination Test Results



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Ashdown Site Investigations Ltd
Unit 3 The Grain Store
Ditchling Common Business Park
Ditchling Common
West Sussex
BN6 8SG

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russell.jarvis@deis.co.uk

DETS Report No: 18-83918

Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex

Project / Job Ref: R18-13291

Order No: P18-6816

Sample Receipt Date: 22/10/2018

Sample Scheduled Date: 22/10/2018

Report Issue Number: 1

Reporting Date: 26/10/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

Authorised by:



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Soil Analysis Certificate						
DETS Report No: 18-83918	Date Sampled	17/10/18	17/10/18	17/10/18	17/10/18	17/10/18
Ashdown Site Investigations Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	TP / BH No	WS01	WS02	WS03	WS04	WS05
Project / Job Ref: R18-13291	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: P18-6816	Depth (m)	0.15	0.10	0.10	0.18	0.20
Reporting Date: 26/10/2018	DETS Sample No	367611	367612	367613	367614	367615

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Detected	Not Detected	Not Detected
Sample Matrix ^(S)	Material Type	N/a	NONE			Fibre bundles in soil		
Asbestos Type ^(S)	PLM Result	N/a	ISO17025			Chrysotile		
pH	pH Units	N/a	MCERTS	7.8	7.6	7.9	8.2	7.6
Organic Matter	%	< 0.1	MCERTS	3.8	5.5	5.8	2.5	9.1
Arsenic (As)	mg/kg	< 2	MCERTS	13	11	8	9	6
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	2.2
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	2.7	0.6	0.4	< 0.2	0.4
Chromium (Cr)	mg/kg	< 2	MCERTS	20	24	22	19	20
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	20	27	21	15	22
Lead (Pb)	mg/kg	< 3	MCERTS	104	770	49	30	60
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	13	13	10	11	10
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3	< 3	< 3
Zinc (Zn)	mg/kg	< 3	MCERTS	1710	384	117	66	126

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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Soil Analysis Certificate						
DETS Report No: 18-83918	Date Sampled	17/10/18	17/10/18	17/10/18		
Ashdown Site Investigations Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	TP / BH No	WS06	TP01	TP02		
Project / Job Ref: R18-13291	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: P18-6816	Depth (m)	0.05	0.25	0.50		
Reporting Date: 26/10/2018	DETS Sample No	367616	367617	367618		

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected		
Sample Matrix ^(S)	Material Type	N/a	NONE					
Asbestos Type ^(S)	PLM Result	N/a	ISO17025					
pH	pH Units	N/a	MCERTS	7.9	8.1	8.2		
Organic Matter	%	< 0.1	MCERTS	5.5	1.5	4.4		
Arsenic (As)	mg/kg	< 2	MCERTS	4	7	8		
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1		
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	< 0.2	0.4		
Chromium (Cr)	mg/kg	< 2	MCERTS	18	17	22		
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2		
Copper (Cu)	mg/kg	< 4	MCERTS	14	9	24		
Lead (Pb)	mg/kg	< 3	MCERTS	28	38	40		
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		
Nickel (Ni)	mg/kg	< 3	MCERTS	7	9	11		
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		
Zinc (Zn)	mg/kg	< 3	MCERTS	80	56	121		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C
Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs

DETS Report No: 18-83918	Date Sampled	17/10/18	17/10/18	17/10/18	17/10/18	17/10/18
Ashdown Site Investigations Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	TP / BH No	WS01	WS02	WS03	WS04	WS05
Project / Job Ref: R18-13291	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: P18-6816	Depth (m)	0.15	0.10	0.10	0.18	0.20
Reporting Date: 26/10/2018	DETS Sample No	367611	367612	367613	367614	367615

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	0.21	< 0.1	< 0.1	< 0.1	0.19
Acenaphthene	mg/kg	< 0.1	MCERTS	0.33	< 0.1	< 0.1	< 0.1	0.21
Fluorene	mg/kg	< 0.1	MCERTS	0.38	< 0.1	< 0.1	< 0.1	0.24
Phenanthrene	mg/kg	< 0.1	MCERTS	5.02	< 0.1	< 0.1	< 0.1	2.35
Anthracene	mg/kg	< 0.1	MCERTS	1.03	< 0.1	< 0.1	< 0.1	0.77
Fluoranthene	mg/kg	< 0.1	MCERTS	11.70	0.40	0.37	0.21	5.90
Pyrene	mg/kg	< 0.1	MCERTS	10.30	0.38	0.33	0.19	5.09
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	5.14	0.43	0.37	0.27	3.28
Chrysene	mg/kg	< 0.1	MCERTS	5.06	0.12	0.19	< 0.1	2.99
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	6.62	0.50	0.68	0.45	4.69
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	2.23	0.15	0.17	< 0.1	1.47
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	5.61	0.38	0.42	0.27	3.51
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	3.82	0.53	0.63	0.50	2.85
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	0.85	0.38	< 0.1	< 0.1	0.69
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	3.13	0.24	0.35	0.23	2.05
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	61.4	3.5	3.5	2.1	36.3

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - Speciated PAHs

DETS Report No: 18-83918	Date Sampled	17/10/18	17/10/18	17/10/18		
Ashdown Site Investigations Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	TP / BH No	WS06	TP01	TP02		
Project / Job Ref: R18-13291	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: P18-6816	Depth (m)	0.05	0.25	0.50		
Reporting Date: 26/10/2018	DETS Sample No	367616	367617	367618		

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.32		
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.30		
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.35		
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.34		
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	13.30		
Anthracene	mg/kg	< 0.1	MCERTS	0.11	< 0.1	3.58		
Fluoranthene	mg/kg	< 0.1	MCERTS	0.48	0.15	31.70		
Pyrene	mg/kg	< 0.1	MCERTS	0.45	0.13	26.30		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.47	0.22	15.40		
Chrysene	mg/kg	< 0.1	MCERTS	0.28	< 0.1	11.20		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.81	0.37	17.40		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.22	< 0.1	4.85		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.52	0.20	13.70		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.71	< 0.1	6.93		
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	1.05		
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.39	< 0.1	5.13		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	4.4	< 1.6	154		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - EPH Banded (Type F)						
DETS Report No: 18-83918	Date Sampled	17/10/18	17/10/18	17/10/18	17/10/18	17/10/18
Ashdown Site Investigations Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	TP / BH No	WS01	WS02	WS03	WS04	WS05
Project / Job Ref: R18-13291	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: P18-6816	Depth (m)	0.15	0.10	0.10	0.18	0.20
Reporting Date: 26/10/2018	DETS Sample No	367611	367612	367613	367614	367615

Determinand	Unit	RL	Accreditation					
EPH (>C8 - C10)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
EPH (>C10 - C12)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
EPH (>C12 - C16)	mg/kg	< 1	MCERTS	3	< 1	< 1	8	2
EPH (>C16 - C21)	mg/kg	< 1	MCERTS	43	< 1	5	6	30
EPH (>C21 - C40)	mg/kg	< 6	MCERTS	140	< 6	57	119	151
EPH (C8 - C40)	mg/kg	< 6	MCERTS	186	< 6	61	133	182

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - EPH Banded (Type F)						
DETS Report No: 18-83918	Date Sampled	17/10/18	17/10/18	17/10/18		
Ashdown Site Investigations Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	TP / BH No	WS06	TP01	TP02		
Project / Job Ref: R18-13291	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: P18-6816	Depth (m)	0.05	0.25	0.50		
Reporting Date: 26/10/2018	DETS Sample No	367616	367617	367618		

Determinand	Unit	RL	Accreditation					
EPH (>C8 - C10)	mg/kg	< 1	MCERTS	2	< 1	< 1		
EPH (>C10 - C12)	mg/kg	< 1	MCERTS	< 1	< 1	< 1		
EPH (>C12 - C16)	mg/kg	< 1	MCERTS	< 1	< 1	21		
EPH (>C16 - C21)	mg/kg	< 1	MCERTS	4	< 1	130		
EPH (>C21 - C40)	mg/kg	< 6	MCERTS	53	< 6	856		
EPH (C8 - C40)	mg/kg	< 6	MCERTS	60	< 6	1007		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C



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Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-83918	
Ashdown Site Investigations Ltd	
Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex	
Project / Job Ref: R18-13291	
Order No: P18-6816	
Reporting Date: 26/10/2018	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
367611	WS01	None Supplied	0.15	18.6	Brown sandy clay
367612	WS02	None Supplied	0.10	18.1	Brown sandy clay
367613	WS03	None Supplied	0.10	11.5	Brown sandy clay
367614	WS04	None Supplied	0.18	10.1	Brown sandy clay
367615	WS05	None Supplied	0.20	27.7	Brown sandy clay
367616	WS06	None Supplied	0.05	10.2	Brown sandy clay
367617	TP01	None Supplied	0.25	7.1	Brown sandy clay
367618	TP02	None Supplied	0.50	11.3	Brown sandy clay

Moisture content is part of procedure E003 & is not an accredited test
Insufficient Sample ^{1/5}
Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 18-83918

Ashdown Site Investigations Ltd

Site Reference: The Laurels, Dappers Lane, Angmering, West Sussex

Project / Job Ref: R18-13291

Order No: P18-6816

Reporting Date: 26/10/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

APPENDIX H

Guidance on Comparing Soil Contamination Data with a Critical Concentration
Statistical Analysis Summary Sheets

ASHDOWN SITE INVESTIGATION LIMITED

Notes on the “Guidance on Comparing Soil Contamination Data with a Critical Concentration” (CIEH & CL: AIRE, May 2008)

The Chartered Institute of Environmental Health & CL:AIRE, have published updated guidance on the statistical assessment of contaminated land data, “*Guidance on Comparing Soil Contamination Data with a Critical Concentration*” (May 2008). This is an update to previous guidance published within Contaminated Land Report CLR7 (Defra, 2002).

The CIEH/CL:AIRE guidance forms part of a package of proposed improved UK guidance highlighted in the Defra discussion paper, “*Assessing risks from land contamination –a proportionate approach. Soil guideline values: The Way Forward (CLAN 06/2006)*”. This discussion paper discussed the role and use of SGVs for managing the risks associated with soil contamination.

The guidance states that its overall aim is to “increase understanding amongst stakeholders of the role that statistics can play in quantifying the uncertainty attached to estimates of the mean concentration of contaminants in soil, thereby creating a more informed basis for regulatory decision-making”.

The initial question, on which the guidance is based, is whether the Site under consideration is to be assessed under the Planning System or under Part 2A of the Environmental Protection Act 1990. The key questions asked when considering contaminant concentrations vary depending on the scenario under consideration. The key questions will generally be:

- **Planning Scenario** – “can we confidently say that the level of contamination on this land is low relative to some appropriate measure of risk?” or “that the level of contamination is lower than the critical concentration” (alternative hypothesis).
- **Part 2A Scenario** – “can we confidently say that the level of contamination on this land is high relative to some appropriate measure of risk?” or “that the level of contamination is higher than the critical concentration” (alternative hypothesis).

Within the guidance, to ‘answer’ the relevant question above, a null hypothesis has been outlined for each scenario, which, if rejected with a high degree of confidence, means that the alternative hypothesis can be accepted. The null hypothesis for a planning scenario is that the soils contain levels of contamination above the critical concentration (i.e. the soils are assumed to be unsuitable for use until proven otherwise). Under the Part 2A scenario, the null hypothesis is that the soils contain levels of contamination below the critical concentration (i.e. the land is assumed not to fall within Part 2A legislation until proved otherwise).

For the planning scenario the null hypothesis may be rejected if it is considered that the 95th percentile of the normally distributed population as a whole lies below the critical concentration i.e. there is a 95% probability that your true population mean lies below the critical concentration. A lower probability of the true mean lying below the critical concentration may be used, but deviation from the standard 95% requires justification.

For the Part 2A scenario the null hypothesis may be rejected if it can be shown that the lower 95th percentile lies above the critical concentration. If the lower 95th percentile lies below the critical concentration but the true population mean lies above the critical concentration further assessment should be undertaken before the Site can be classified under Part 2A.

Guidance on the treatment of outliers (results that are not representative of a sample population), is also provided in the report. The guidance confirms that outliers should only be excluded from the dataset where they are either demonstrably the result of an error that can be identified and explained, or clearly indicate that more than one soil population exists within the dataset.

Where an individual result is recognised as a ‘statistical outlier’ or ‘contamination hot-spot’ within the data set (and where the critical concentration for that contaminant is exceeded), remediation work and or further investigation may be required.

Client ref: 1518-1321
 Site ref: The Laurels, Dappers Lane, Angmering, West Sussex.
 Data description: Made ground/topsoil
 Contaminants: Heavy metals
 Test scenario: Planning
 Date: 5 November 2018
 User profile: SA

	Arsenic	Water Soluble Boron	Cadmium	Chromium	Hexavalent Chromium	Copper	Lead	Mercury	Nickel	Selenium	Zinc
Critical concentration, C _c	37	290	11	910	6	2400	200	40	180	250	3700
Notes											
Full dataset size	8	8	8	8	8	8	8	8	8	8	8
Outliers present?	No	No	No	No	No	No	No	No	No	No	No
Number of outliers temporarily excluded	0										
Number removed by filter	0	0	0	0	0	0	0	0	0	0	0
Sample size, n	8	8	8	8	8	8	8	8	8	8	8
Sample mean, $\bar{x}$	6.25	0.7125	0.6	20.25	1	19	139.875	0.5	10.5	1.5	332.5
Standard deviation, s	2.81577191	0.60104076	0.86849624	2.31455025	0	5.90399381	255.769113	0	2	0	566.342148
Number of non-detects	0	7	3	0	8	0	0	8	0	8	0
Has non-detect values to	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit	Half detection limit
Distribution	Normal	Non-normal	Non-normal	Normal	Single value	Normal	Non-normal	Single value	Normal	Single value	Non-normal
Distribution approach	Auto: One sample t; Auto: Chebyshev	Auto: Chebyshev	Auto: Chebyshev	Auto: One sample t; Auto: Chebyshev	Auto: One sample t; Auto: Chebyshev	Auto: One sample t; Auto: Chebyshev	Auto: Chebyshev	Auto: Chebyshev	Auto: One sample t; Auto: Chebyshev	Auto: Chebyshev	Auto: Chebyshev
Test scenario	Planning: is true mean lower than critical concentration ($\mu < C_c$)					Evidence level: minimal		95%	Use Normal distribution to test for outliers		
Test statistic, test ₀	-28.87921413	-1261.252941	-33.86962526	-1087.29246	N/A	-1140.665998	-0.664893344	N/A	-239.7091868	N/A	-16.81797545
Upper confidence limit for non-normal distributions, UCL	10.1361017	1.63876603	1.93844259	21.800366	1	22.9546999	534.041676	0.5	11.8396694	1.5	1205.29187
Evidence level	100%	100%	100%	100%	100%	100%	31%	100%	100%	100%	100%
Base decision rule	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level	evidence level
Result	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu \geq C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$	$\mu < C_c$

Discontinued: ☐
 Proper ref: P18-12201
 Site ref: The Laurels, Dappers Lane,
 Aspinwall, West Sussex
 Date constructed: Made ground/topsoil
 Contaminant(s): PAH
 Test scenario: Planning
 Date: 3 November 2016

Report ref: P19-12001 Project ref: P19-12001 Site ref: The Laurels, Drapers Lane, Aylesham, Maidstone Data description: Data description (optional) Comments: Part Test results: Pending Date: 9 November 2019		Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo[a]anthracene	Chrysene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Indeno[1,2,3-cd]pyrene	Dibenz[a,h]anthracene	Benzophenanthrene
Median concentration, $\mu\text{g/L}$	2.3	170	210	170	95	2400	280	620	7.2	15	2.6	77	2.2	27	0.24	320	
Range																	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	
Number of outlying government analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Number of outlying government analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Standard deviation, $\mu\text{g/L}$	0.08375	0.11875	0.2675	0.27625	2.615	0.71125	6.36375	5.93625	3.1975	2.4925	0.934375	1.14875	0.6075	2.0025	0.619375	1.44825	
Standard deviation, $\mu\text{g/L}$	0.09545942	0.09991961	0.44969037	0.44714771	4.67393358	1.22154981	11.0402212	9.19037375	5.2537059	3.97163424	5.92934109	1.69891089	4.7280287	2.39326883	0.41393366	1.85051296	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0	0	2	0	2	0	1	4	1	
First detection limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
Outlying government	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	Non-normal	
Number of outlying analysis	7	5	5	5	5	4	0	0									

APPENDIX I

Quantitative Conceptual Model

The Laurels, Dappers Lane, Angmering, West Sussex				Quantitative Conceptual Model		R18-13291	
Source	Receptor	Contaminants	Pathway	Complete Linkage Present?	Probability	Consequence	Risk
Elevated concentrations of lead and PAH compounds and potential for localised asbestos contamination within the shallow soils across the site	End Users	Lead, PAH Compounds and Asbestos	Dermal contact with soil and dust (indoor & outdoor)	Yes	P2: Low	C2: Minor	Low
			Ingestion of soil and indoor dust	Yes	P2: Low	C2: Minor	Low
			Consumption of home-grown produce and attached soil	Yes	P2: Low	C2: Minor	Low
			Inhalation of soil dust (indoor and outdoor)	Yes	P2: Low	C2: Minor	Low
			Inhalation of soil vapours	Identified contaminant(s) do not pose a risk via this pathway			N/A
			Inhalation of soil gases/ Risk of explosion	No potential source of ground gases identified			N/A
	End Users (via Water Supply Pipework)		Contamination of incoming services	Identified contaminant(s) do not pose a risk via this pathway			N/A
	Groundwater		Migration to groundwater	No contaminants present at concentrations posing risk to groundwater			N/A
Concentrations of petroleum hydrocarbons in soils above screening criteria for PE water supply pipes	End Users		Dermal contact with soil and dust (indoor & outdoor)	No contaminants present above SSVs			N/A
			Ingestion of soil and indoor dust	No contaminants present above SSVs			N/A
			Consumption of home-grown produce and attached soil	No contaminants present above SSVs			N/A
			Inhalation of soil dust (indoor and outdoor)	No contaminants present above SSVs			N/A
			Inhalation of soil vapours	No contaminants present above SSVs			N/A
			Inhalation of soil gases/ Risk of explosion	No potential source of ground gases identified			N/A
	End Users (via Water Supply Pipework)	Petroleum Hydrocarbons	Contamination of incoming services	Yes	P2: Low	C2: Minor	Low
	Groundwater		Migration to groundwater	No contaminants present at concentrations posing risk to groundwater			N/A