
Phase I Desk Study, Site Reconnaissance & Phase II Site Investigation Report

at The Barn, Dabbs Place
Farm, Dabbs Place Lane,
Cobham, Gravesend, DA13
9BL

for Mr Nichols

Report Reference : LP01436/Rev. 1

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Leap Environmental Ltd
Kent Regional Office

Spelmonden Old Oast, Spelmonden
Farm, Goudhurst, Kent, TN17 1HE

tel/fax +44 (0) 1580 211605
www.leapenvironmental.com

Head Office The Atrium, Curtis Road, Dorking, Surrey, RH4 1XA

Registered in England No 6552502



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EXECUTIVE SUMMARY

The site is located on Dabbs Place Farm, Dabbs Place Lane, Cobham in Gravesend, Kent.

The site comprises a disused single storey asbestos-clad barn within adjacent green open space and several small stockpiles of topsoil and made ground.

It is proposed to convert the barn to a residential dwelling with associated areas of hardstanding and limited areas of soft landscaping (a hedgerow is proposed along the perimeter of the site).

From a review of historical maps, the site was an open field with a small pond in the western area from the first maps in 1864. In 1960 the pond was infilled and the present-day barn was erected. The site has generally been set within agricultural land.

The site is mapped as being underlain by Thanet Sand Formation, classed as a Secondary A Aquifer with Seaford and Newhaven Chalk Formation mapped along the northern site boundary (classed as a Principal Aquifer).

According to the Envirocheck database search, the site is in an intermediate probability radon area. However, no special protective measures are reported to be required in the construction of buildings on this site, in respect of radon gas.

The desk study has identified a number of potential sources of contamination including:

- Made ground associated with the infilled pond and stockpiles on site;
- Asbestos associated with the cladding and roofing on the barn.

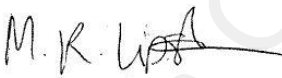
The site has been the subject of a previous investigation by W. K. Elson for Bloomfield's Chartered Town Planners who undertook a contamination assessment report in September 2016. LEAP carried out a second phase of investigation in August 2017.

Ground conditions generally comprised made ground containing clinker, concrete, brick and metal fragments or topsoil containing occasional chalk, brick and clinker over made ground comprising off-white chalk.

Contamination testing of the soils by LEAP identified elevated levels of benzo(a)pyrene and lead above their respective Tier I Generic Assessment Criteria. These results are similar to those recorded during the previous investigation by W. K. Elson, where elevated PAH was recorded within made ground.

Remediation is required on site within the limited proposed areas of soft landscaping (the hedgerow along the perimeter of the site). Remediation is to comprise the placement of 400mm clean cover within areas of soft landscaping to protect against elevated benzo(a)pyrene and lead recorded during the investigation.

One made ground soil sample underwent a Waste Acceptance Criteria test, the high organic content in the sample suggests a hazardous classification. Early discussions with haulage contractors and receiving landfill sites is recommended to confirm waste costs associated with provision of cover systems in the limited soft covered areas.

Signed :	 Melanie Lipsham MESci
Countersigned :	 Darren Beesley BSc MSc
Date :	2 October 2017
Revision:	Issue 2

A INTRODUCTION

1 Authority

Leap Environmental Ltd (hereafter referred to as **LEAP**) has been appointed by Mr Nichols to undertake a Phase I Desk Study, and Phase II intrusive Site Investigation of a site referred to as The Barn, Cobham. The instruction was given in an email from Mr Nichols dated 25th July 2017. A site location plan is attached as Figure 1 in Appendix B.

2 Objective

LEAP understands that the development proposals are to convert the barn on site to a residential dwelling with an area of hardstanding to the north, and a limited area of soft landscaping (a hedgerow) along the site perimeter as per the attached plan in Figure 2, Appendix B. The planning application boundary is shown in red on Figure 4 in Appendix B, with the boundary of the land within the Client's ownership shown in blue.

The proposed development is currently at a planning phase and has been assessed in accordance with BS EN 1997¹, as being a Geotechnical Category I structure.

The objectives of this report are to:

- Provide information on the environmental quality of the ground present on the site;
- Assess the potential health and other environmental risks posed by the site to the proposed development and to other specifically identified receptors; and
- Assess the potential for offsite contamination to adversely affect the proposed development.

3 Previous Studies

The site has been the subject of one previous investigation by W. K. Elson for Bloomfield's Chartered Town Planners who undertook a contamination assessment report in September 2016. The report is summarised below in Section 8.

¹ BS EN 1997-1(2004) Eurocode 7:Geotechnical Design - Part 1:General Rules

4 Scope of Works

This report describes a two-stage process whereby the site is investigated and risks are assessed. The terms geotechnical and geoenvironmental are referred to throughout the report.

Geoenvironmental refers principally to the chemical nature of the ground and the degree of soil, water and/or land gas contamination and the impact that contamination may have on current or future development and also on the wider environment.

Geotechnical refers to all other aspects of the ground conditions and the impact they may have on the physical construction of existing or future development, principally foundations, slope stability, drainage, pavement and road design and groundwater control.

4.1 Phase I Scope

The first part of this report presents the results of a desk study and site reconnaissance. It provides a review of a previous site investigation report, where they have been made available by the Client. The following sources of information have also been reviewed:

- Envirocheck database report
- Envirocheck Historical map Search
- British Geological Survey (BGS) mapping
- British Geological Survey website (www.bgs.ac.uk) including historic BGS borehole data
- Unexploded WWII aerial delivered bomb (UXB) regional risk maps produced by Zetica

A site reconnaissance was carried out on 3rd August 2017. The current user and owner of the site Mr Nichols attended the walkover and provided additional information.

The desk study and site reconnaissance have been used to develop an initial conceptual site model, which forms the basis for the site investigation strategy. The initial site conceptual model is used to identify geotechnical and geoenvironmental hazards and the qualitative degree of risk associated with them. In terms of the geoenvironmental assessment the conceptual site model is used to identify potential sources of contamination, potential receptors and pathways by which the two may be connected. These are known as possible pollutant linkages and it is these pollutant linkages that are key to contaminated land risk assessment.

The Phase I investigation is also referred to as a Preliminary Investigation².

4.2 Intrusive Investigation Scope

This phase of site investigation comprised the following tasks:

- 6 No. hand augers to depths of between 0.4m and 0.6m;
- Chemical Laboratory tests including 6 No. LEAP standard soil suite tests, 1 No. petroleum hydrocarbon test and 1 No. Waste Acceptance Criteria test.

The intrusive works were completed by LEAP engineers, with 5 No. hand augers undertaken within the planning application boundary, and one hand auger in the adjacent land (adjacent grassed area within the Client's ownership).

Selected samples of soil were scheduled for laboratory testing for a wide range of potential contaminants including metals, polyaromatic and petroleum hydrocarbons and asbestos. The laboratory testing has been carried out by The Environmental Laboratory Ltd at its laboratories in East Sussex.

The final stage in the geoenvironmental assessment comprises a quantitative risk assessment and revision of the preliminary Conceptual Site Model. Preliminary recommendations for remediation have been provided, based on various development assumptions which are detailed in the following section and in the text of this report. The risk assessment has been carried out in accordance with UK industry standards and in particular in accordance with CLR11³ and BS10175:2011.

5 Limitations

This report has been prepared by Leap Environmental Ltd on the basis of information received from a variety of sources which Leap Environmental Ltd believes to be accurate. Nevertheless, Leap Environmental Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

Leap Environmental Ltd has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all

² BS 10175:2011 Investigation of Potentially Contaminated Sites – Code of Practice.

³ Environment Agency, 2004. Model Procedures for the management of land contamination. Contaminated Land Report 11.

relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed.

The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk.

Full details of the limitations are provided in Appendix A.

B PHASE I – DESK STUDY

6 Environmental Setting

6.1 Site Location and Description

The site is located at Dabbs Place Cottage, Dabbs Place Lane, Cobham, Gravesend, DA13 9BL (a site location plan is attached as Figure 1 in Appendix B).

Figure 4 in Appendix B shows the boundary for the planning application (in red) and the boundary of the land within the Client's ownership (in blue).

The approximate National Grid Reference of the site is 565800, 169180. The site lies at an estimated elevation of 78m Above Ordnance Datum (mAOD).

6.1.1 General Description and Boundaries

The current site layout is shown in Figure 3 in Appendix B. A walkover survey was carried out on 3rd August 2017 and example photographs are included within Appendix E.

The site within the planning application boundary comprises a disused single storey asbestos-sheeting clad barn within green open space and several small stockpiles of topsoil and made ground (comprising tyres, wood, brick, concrete, slate, plastic, flint and metal fragments). Topsoil has recently been placed along the eastern and western edges of the barn. The barn is disused and areas of cladding along the walls are damaged and broken. The client advised that there was previously an above ground storage tank on a stillage to the north of the barn.

The site is level and at the same elevation as the adjacent land. The adjacent land comprises open green space (this is not within the planning application boundary, but is owned by the Client).

The site is bounded by farm buildings including stables to the north and Dabbs Place Cottage farmhouse to the west. To the south are agricultural fields and Dabbs Place Lane which runs adjacent to the southern boundary.

The wider surrounding area comprises open fields.

6.2 Geology

The geology of the site has been ascertained by the BGS website (www.bgs.ac.uk) and the Envirocheck report. The site is mapped as being underlain by the Thanet Sand Formation. The Seaford Chalk Formation and Newhaven Chalk Formation boundary is mapped immediately north of the site, and hence there is the possibility Chalk will be present beneath the site.

There is no drift geology mapped on site but Head deposits can be found within 0.4 km north of the boundary.

6.2.1 The Thanet Sand Formation

The Thanet Sand Formation consists of fine grained pale yellow and grey mottled silty sands. On the Isle of Thanet, in east Kent they are generally more clayey. The boundary with the underlying chalk is very irregular and often marked by a bed of green coated flints and glauconitic sand and clay (the Bullhead Beds).

Solution features are commonly encountered in or near Thanet Sands outcrops (particularly where there was a layer of overlying clay). This formation and the underlying chalk were also often worked.

6.2.2 Seaford Chalk Formation and Newhaven Chalk Member

Chalk is a very fine grained white limestone. It consists predominantly of the disaggregated skeletal remains of tiny planktonic algae, composed of almost pure calcium carbonate.

The Newhaven Chalk Member comprises white soft chalk with many marl seams and some nodular flints. Flint is composed of silica derived from the dissolved skeletons of siliceous sponges and microfossils.

The chalk is a Principal Aquifer in SE England.

Chalk is affected by its weathering, particularly the effects of dissolution. The top surface of the chalk is usually irregular and may include deep drift filled solution pipes for example. Chalk is also susceptible to frost action.

6.2.3 BGS Boreholes

The online BGS Geoindex (<http://www.bgs.ac.uk/geoindex/>) has been reviewed for detailed local geological and hydrogeological information. 4 No. Boreholes have been identified within 600m of the site. Borehole ref TQ66NE291, located approximately 300m east of the site indicates ground conditions comprise of topsoil to 0.5m, over sandy clay to 3.5m, over sands to 5.0m, over clay with flints to 6.0m over chalk to 81m. The log shows groundwater was encountered at 62.0m.

6.3 Hydrogeology

The hydrogeology of the site has been ascertained from the Envirocheck data report. The source of the data is reported to be the Environment Agency groundwater vulnerability mapping.

The Thanet Sand Formation mapped beneath the site is classified as a Secondary A Aquifer.

The Seaford Chalk Formation and Newhaven Chalk Formation is classed as a Principal Aquifer.

The site is situated within a total catchment zone (Zone 3) of a Groundwater Source Protection Zone (SPZ). An outer protection zone (Zone 2) of a SPZ is located 504m west of the site.

The Envirocheck lists no active abstraction licences within 1000m of the subject site.

6.4 Hydrology

The Envirocheck lists the nearest surface water feature as a pond, located 25m to the south east of the site.

The Envirocheck report indicates that there is one discharge consent within 500m of the site. It is located 479m north of the site and discharges final/treated effluent sewage from private domestic properties into the land/soakaway, by Gravesham Borough Council. It has had two permits which have run continuously from 13th March 2003 up to the present day.

6.5 Flooding

According to the Environment Agency, the site is not located within a flood zone.

6.6 Designated Environmentally Sensitive Sites

A review of designated environmentally sensitive sites presented within the Envirocheck report has been carried out. The dataset refers to a number of sensitive sites including the following:

- Sites of Special Scientific Interest (SSSI);
- Records of National Nature Reserves (NNR);
- Areas of Special Conservation (SAC);
- Records of Special Protection Areas (SPA);
- Records of Ramsar Sites;
- Records of Local Nature Reserves;
- Ancient Woodland Records.

5 No. environmentally sensitive areas have been located within 1000m of the site.

The site is located within an area of adopted green belt under the Gravesham Local Plan- Core Strategy. The Kent Downs area of outstanding natural beauty is located 774m south east of the site. The nearest ancient woodland is Cozenden Wood, located 941m west of the site.

The site is located within a Nitrate Vulnerable Zone. This is an area where water draining from the land can impact nitrate levels in surface water or groundwater.

6.7 Ground Workings

The Envirocheck report indicates that in 1961 there was an area of infilled water along the western boundary of the site between the barn and stables.

An infilled area was also recorded 336m south of the site in 1978. Its original use is unknown but likely to be a pit/quarry.

6.8 Mining, Extraction and Natural Cavities

The Envirocheck report indicates the site is not situated within an area affected by coal mining.

Several BGS Recorded Mineral Sites are located around the site. The nearest is the ceased Cobham Chalk Pit located 332m south which mined chalk from an opencast mine.

7 Site Usage

7.1 Current Land Use

The current site layout is shown in Figure 3, in Appendix B.

The site is currently used as disused single storey barn within green open space and several small stockpiles of topsoil and made ground.

7.2 Evidence of Onsite Contamination

A walkover survey was carried out on 3rd August 2017.

The following features were identified as possible sources of contamination:

- Asbestos cladding and roof on the barn
- Made ground stockpiles on site which included evidence of tyres, wood, brick, concrete, slate, plastic and metal fragments.
- Former above ground storage tank.

7.2.1 Chemical Storage

The client advised that there was previously an above ground storage tank to the north of the barn. It has now been removed and the size and storage use is unknown. No evidence of fuel leakage was recorded during the walkover.

7.3 Neighbouring Land Use

No contemporary trade directory entries have been recorded within 250m of the site.

No off-site sources of potential contamination were recorded during the walkover.

The Envirocheck report details no fuel stations within 250m of the subject site.

7.4 Site History

The contaminative and development history of the site has been ascertained with reference to the Ordnance Survey historical maps.

In summary, the site was mapped as open land with a pond from the first maps in 1864 to 1960. In 1960 the pond was infilled and the present-day barn was erected.

Generally, the site has been set within agricultural fields from the first maps in 1864. Two tanks were shown within 250m of the site from 1931 to 1968.

7.4.1 Historical Map Evidence

The historical Ordnance Survey maps provided spanned the period from 1864 to present day at scales of 1:10,000, 1:2,500 and 1:1,250. The maps are included in full in Appendix C.

Table 1: Summary of Historical Map Evidence

Year	On site	Surrounding area
1864	A pond is present along the western site boundary, extending off-site to the west. A small track runs along the south eastern and southern boundaries.	A number of buildings associated with Dabbs Place (including Dabbs Place Cottage) are shown within 50m of the site to the north, south and west. An orchard is present immediately to the north east and a pond is shown immediately east of the site. Dabbs Place Lane runs adjacent to the southern boundary of the site. Generally, the site is set within open agricultural fields.
1931	A farm track runs along the eastern and northern boundaries of the site. The farm track previously along the southern boundary has been removed.	Tanks are shown 100m south west of the site and 250m to the south east.

1933	No further changes.	The site is set within orchards to the south, east and west.
1960-1964	The pond on the western side of the site (extending off-site to the west) is no longer present. The tracks in the northern area of the site are no longer mapped. The current-day barn is now present in the southern area of the site	The pond immediately east of the site has been infilled. A pond is shown 25m east of the site.
1968	No further changes.	The tanks 100m and 250m from the site are no longer shown.
2017	No further changes.	No further changes.

7.5 Unexploded Ordnance (UXO)

The risks from unexploded ordnance have been assessed in accordance with CIRIA guidance⁴. A non-UXO specialist preliminary screening assessment has been carried out. The risks have been assessed by considering firstly the likelihood of military activities on, or in the vicinity of the site as determined from the desk study and historical review. Secondly the risk of UXO has been assessed by reference to the unexploded WWII aerial delivered bomb (UXB) regional risk maps produced by Zetica.

The Zetica risk maps indicate a HIGH risk. Analysis of Envirocheck historical maps shows no evidence of post WWII bomb damage within the area and hence the overall risk of UXO is considered to be MODERATE.

7.6 Waste Planning and Landfill Records

7.6.1 Recorded Landfill Sites

The Environment Agency website and Envirocheck contain details on areas of historic and active landfilling in the vicinity of the site.

There are no areas of historic or active landfill listed within 500m of the subject site.

⁴ CIRIA C681 2009. Unexploded ordnance (UXO) - A guide for the construction industry

7.6.2 Waste Management, Transfer and Treatment Facilities

Analysis of the Envirocheck report indicates that there are no Waste Management, Transfer and Treatment facilities within 250m of the site.

7.7 Other Regulatory Records

No pollution incidents have been recorded within 250m of the site.

7.8 Radon

According to the Envirocheck database search, the site is in an intermediate probability radon area, as between 1 and 3% of homes are above the action level. However, no special protective measures are reported to be required in the construction of buildings on this site, in respect of radon gas.

8 Previous Investigations

The site has been the subject of a previous report by W. K. Elson for Bloomfields Chartered Town Planners, 'Contamination Assessment' dated September 2016 and is summarised below.

The report describes the site as comprising a pre-cast concrete barn with asbestos cladding surrounded by mown grass and several piles of rubble (including asbestos fragments). Oil stains were noted on the concrete base of the barn, but no signs of significant pollution within the barn or the surrounding land were recorded. A stillage was present at the front of the barn (thought to have previously supported an above ground fuel tank).

The report mapped the site as being underlain by Head deposits over the Seaford Chalk and Thanet Sands. The site is within a total catchment (Zone 3) of the Nash Street public water supply borehole and above a major chalk aquifer, whereby groundwater is expected to be several tens of meters below ground level. No landfills or pollution incidents have been recorded within 250m of the site.

Works undertaken include 5 No. hand augers in the vicinity of the barn. Samples were collected and tested for contaminants of concern.

Laboratory testing recorded one elevated concentration of PAH above 2.5mg/kg (the DEFRA Category 4 Screening Value 2014) within TP3 where 13.6mg/kg Benzo(a)Pyrene was recorded. The source of this elevated PAH concentration was thought to have been the clinker mixed within the topsoil around the southern and eastern boundaries of the barn.

No fuel odours were recorded in the vicinity of the stillage and laboratory testing did not record elevated petroleum hydrocarbon concentrations.

The elevated PAH concentration recorded was considered to be a moderate risk to human health if found within rear garden areas. The asbestos cladding on the barn was only considered a risk to the operatives removing it.

Gravesham Borough Council

C PRELIMINARY CONCEPTUAL SITE MODEL

9 Environmental Risk Assessment

9.1 Conceptual Site Model (CSM)

A risk based approach is used to assess contaminated or potentially contaminated land within the UK. For a potential risk to exist, there must be a pollutant linkage in place, i.e. there must be a source of contamination, a potential receptor, and a pathway linking the two.

In order to quantify the magnitude of the risk, it is necessary to first calculate the potential exposure of the receptor as a result of all the individual active pollutant linkages affecting that receptor. Secondly it is necessary to ascertain “what is an acceptable exposure level for each of the identified receptors and contaminants?”.

The purpose of the Conceptual Site Model, in this instance, is to identify all of the potential pollutant linkages by considering, in turn, the potential sources, receptors and pathways.

9.2 Sources

9.2.1 Onsite Sources

Based on a review of the available site information, the following contaminants of concern are proposed:

Table 2: Onsite sources of contamination

Source	Contaminants of Concern
Asbestos cladding on the barn	Asbestos
Made ground from the infilled pond in the western area of the site and stockpiles of made ground on site	Metals, PAH and asbestos
Former above ground storage tank	Petroleum hydrocarbons

9.2.2 Offsite Sources

No significant off-site sources of contamination were recorded for the site.

The recorded infilled pond/ water feature and off landfills are assessed as not posing a significant risk of gas generation/on site migration due to the recorded size and or distance to the site.

9.3 Receptors

Potential receptors are those which may be impacted by any of the contaminants of concern identified above, and include the following:-

- Future residents
- Construction workers
- Groundwater –Thanet Sand Formation (Secondary A Aquifer) and Seaford and Newhaven Chalk Formation (Principal Aquifer)

9.4 Pathways and Potential Pollutant Linkages

The development will include a private garden comprising hardstanding and a limited area of soft landscaping around the perimeter (a hedgerow). All potential pollutant linkages involving resident humans and soil contaminants could therefore be active in areas of soft landscaping i.e. direct ingestion of soil, ingestion of soil attached to plants as well as via plant uptake, inhalation of indoor and outdoor vapour and of dust tracked back into the house and finally ingestion of water carried by plastic water pipes through contaminated ground.

Ground workers are at risk as a result from all of the above, except for those involving edible plants.

The site is underlain by a Secondary A Aquifer (Thanet Sand Formation) and Seaford and Newhaven Chalk Formation (Principal Aquifer) is mapped immediately north of the site. The soils beneath the site are of intermediate leaching potential. Hence there is a potential pathway for leachate from soil pollutants and for mobile liquid contaminants to enter the groundwater. The water table is anticipated to be some distance below ground surface, as noted in the historical borehole referenced TQ66NE29I from the BGS website (approximately 62m below ground level).

9.5 Qualitative Risk Assessment of Pollutant Linkages

Risk levels within the preliminary CSM are determined on a qualitative basis following review of the available desk-based information. The significance of particular pollutant linkages is dependant both upon the severity and likelihood of the risk.

The potential pollutant linkages are summarised in the table appended in Appendix D and given a qualitative risk classification in accordance with current guidance. The details of the risk assessment methodology are presented in Appendix D.

9.6 Conclusions

The following pollutant linkages are rated as Low to Moderate.

Table 3: Pollutant Linkages QRA Summary

Receptor	Contaminants of concern	Overall score	Comments
Future residents	Polyaromatic Hydrocarbons	Low	There is the potential for localised PAH contamination on site associated with the made ground and within topsoil where PAH contamination was recorded previously.
	Petroleum Hydrocarbons	Low	There is the potential for localised petroleum hydrocarbon contamination associated with the former above ground fuel tank in the northern area of the site
	Asbestos	Moderate	There is the potential for asbestos associated with made ground on site and the ACM cladding and roofing on the barn.

The likelihood of occurrence is considered to be low given the proposed hardstanding for the private garden area (with only limited areas of hedgerow proposed for the perimeter of the site).

10 Geotechnical Risk Assessment

10.1 Geotechnical Risk Register

The preliminary geotechnical risk register for the proposed development is summarised in the table in Appendix D. Details of the risk assessment methodology are presented in Appendix D.

10.2 Conclusions

The following geotechnical hazards have been identified as substantial risks:

Table 4: Geotechnical Risk Register Summary

Hazard	Overall score	Comments
Ground dissolution/ natural cavities	Substantial	The boundary between the Thanet Sand Formation and the Chalk is along the northern site boundary. As such, there is the potential for chalk beneath the site which could promote solution feature initiation.

On the basis of the initial review and preliminary risk assessment, the site is given a Geotechnical Classification of **Geotechnical Category I** in accordance with EN1997-1 §2.1(14)-(21).

D PHASE II - INTRUSIVE INVESTIGATION

II Investigation Rationale

A total of 6 No. hand auger trial holes were excavated across the site by LEAP in August 2017. HA105 was excavated in an area of adjacent grassland which whilst outside of the current development boundary is within the client ownership.

The trial holes were located to give general coverage, taking into consideration the proposed development and the potential geoenvironmental risks/hazards highlighted by the CSM in accordance with BS10175. In particular, trial holes were targeted on the location of the proposed construction and the garden areas.

The investigation rationale for the trial holes is summarised below:

Table 5: Rationale for Investigation Locations

Trial Hole/Test Location	Rationale	Proposed Depth (mbGL)	Notes
HA101-104 and HA106	Provide information on ground conditions for geoenvironmental analysis and chemical testing within planning application boundary.	0.4-0.6m	N/A
HA105	Provide information on ground conditions for geoenvironmental analysis and chemical testing within the adjacent grass covered area within Client ownership but outside of the planning boundary.	0.4-0.6m	N/A

The site investigation locations are shown on Figure 5 in Appendix B.

12 Site Work

12.1 Date and Weather Conditions

The intrusive investigations were undertaken in a single phase on 3rd August 2017. At the time of the investigations, the weather was mild and overcast with occasional showers and sunny spells.

12.2 Site Work Methods

12.2.1 Hand Pitting

Hand pits were excavated using hand tools/ a hand auger at 50mm diameter. Spoil was placed on plastic sheeting to prevent cross contamination and was reinstated in reverse order.

12.2.2 Soil Logging and Sampling

Soil samples were recovered from the hand pits for field screening, logging and sampling.

The hand augered hand pits were logged in general accordance with the requirements of BS 5930: 1999+A2:2010 and BS EN ISO 14688 Pt 1&2. Borehole logs are presented in Appendix G.

Visual and olfactory evidence of contamination was noted if encountered. These observations were used to aid scheduling of samples for chemical laboratory analyses, and are included on the borehole logs in Appendix G.

Samples were collected with a clean sampling trowel or by hand (using dedicated nitrile gloves for each sampling location). Samples were placed into laboratory supplied sampling containers, specific to the type of analyses required.

All sample containers were sealed and labelled with a unique location identity, depth and date of sampling.

12.3 Laboratory Analysis

12.3.1 Chemical Soil Analysis

Selected samples of soil have been subjected to laboratory testing. Sampling techniques and storage have been undertaken as per BS 10175:2011 Code of Practice for Investigation of Potentially Contaminated Sites. The laboratory testing has been carried out by The Environmental Laboratory Ltd at its laboratories in East Sussex. Where available, the tests procedures are UKAS and MCERTS accredited.

The following analyses were completed on selected samples:-

- LEAP standard Soil suite (metals, speciated PAHs, asbestos)
- Petroleum hydrocarbon tests

- Asbestos Quantification
- WAC test

The full laboratory test results are presented in Appendix F.

13 Ground Conditions

The ground conditions are described in detail in the logs attached in Appendix G. In summary the soil conditions were as follows:

Table 6: Summary of soils encountered

Depth From (m)	Depth To (m)	Soil Type	Description
GL	0.2 / 0.4	TOPSOIL	TOPSOIL with fine to coarse gravel of flint, chalk, wood and rare ash.
GL	0.3 / 0.4	MADE GROUND	MADE GROUND: Dark brown gravelly sand. Gravel is fine to coarse flint, concrete, clinker and brick with occasional cobbles of brick and concrete.
0.2 / 0.4	0.4 / 0.6	MADE GROUND/ REWORKED CHALK	Off white and brown chalk with occasional pockets of grey brown clay.

It is considered likely that the chalk material encountered below 0.4m was used to fill the pre-1960 pond on the site. Topsoil was only recorded within hand augers HA102, HA104 and HA105.

13.1.1 Groundwater

No ground water was encountered during the intrusive investigations.

13.1.2 Visual Evidence of Contamination

No significant visual and olfactory evidence of contamination was noted during the investigation work.

E GEO-ENVIRONMENTAL APPRAISAL

14 Conceptual Site Model

The preliminary conceptual site model has identified a number of potential pollutant linkages.

On-site sources of contamination likely to impact the site include petroleum hydrocarbons from the former above ground fuel tank and heavy metal, PAH and asbestos within made ground from the infilled pond and made ground recorded on site during the walkover.

These sources are considered to pose a low to moderate risk to human receptors.

15 Testing Strategy

15.1 Soil Sampling

Trial hole locations were spread across the site to provide coverage. Selected samples were targeted in close proximity to the barn (where the rear garden area is proposed).

Samples have been tested for the presence of the identified contaminants of concern (heavy metals, PAH compounds, petroleum hydrocarbons, and asbestos).

One sample was tested for waste acceptance criteria analysis purposes.

16 Assessment Criteria

16.1 Human Health Assessment Criteria

Pollutant linkages containing human health have been risk assessed by comparing the soil laboratory test results to Tier I Generic Assessment Criteria. These are based on published Suitable for Use Levels (S4UL⁵) and Category Four Screening Levels (C4SL⁶) assuming a residential land use.

⁵ The LQM/CIEH S4ULs for Human Health Risk Assessment, Nathaniel P et al, 2015. Copyright Land Quality Management Ltd, reproduced with permission: Publication Number S4UL3509

⁶ CL:AIRE Final Project Report. SPI010 – Development of Category 4 Screening Levels for assessment of land affected by contamination. CL:AIRE, December 2013

In accordance with current HPA guidance⁷, the assessment of PAHs has been carried out using a surrogate marker approach, whereby the assessment of risk from Benzo(a)Pyrene also captures potential risks from other carcinogenic PAHs that may be present. The threshold PAHs have been assessed similarly, by using Naphthalene as a marker compound.

16.1.1 Statistical Assessment

In assessing soil test results and comparing them to any threshold or screening value, an assessment must first be made as to how accurately the test results reflect the true mean of the contaminant level within the ground. In this assessment for each parameter the test data have been subjected to statistical assessment based on the methodology set out in *CIEH report 2008: Guidance on comparing Soil Contamination Data with a Critical Concentration*. The Upper Confidence Level or U₉₅ value is thereby calculated as being the level at which we would be 95% confident that the true mean is **less** than this value. For the purposes of this assessment, a conservative approach has been adopted in the statistics. All non-detect values have been treated as being equal to half the limit of detection.

It should be noted that for the purposes of these assessments, no statistical outliers have been excluded. The CIEH guidance document that accompanies the statistics calculator states:

outliers should be excluded from a dataset ONLY where they:

- *are obviously and 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 and this can be justified by (or informs the further development of) the conceptual model*

17 Analytical Test Results – Soils

17.1 Metals and Non Metals

The test results have been subject to statistical analysis as described above and the results tabulated below:

⁷ HPA Contaminated Land Information Sheet. Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs). Version 3. Health Protection Agency, 2010.

Table 7: Summary of soil contamination test results within HA101-106 (6 samples)

Determinant	Arithmetic Mean (mg/kg)	Number of samples	UCL U ₉₅ (mg/kg)	Evidence Level (%)	Tier I Generic Assessment Criteria (mg/kg)	Samples which exceed GAC (Including outliers)
Arsenic	13.9	6	17.3	100	37	None
Cadmium	0.7	6	0.7	100	11	None
Hexavalent Chromium	0.8	6	0.8	100	6	None
Copper	78.9	6	177.5	100	2400	None
Lead	144.7	6	275.0	77	200	HA103 @ 0.0-0.4m
Mercury	0.5	6	0.5	100	40 ¹	None
Nickel	35.0	6	40.4	100	130	None
Zinc	149.7	6	261.6	100	3700	None

Notes to table

1. Assessment criterion based on inorganic Mercury

Excluding lead, there is at least a 95% confidence limit that the true mean of the above parameters is below the Acceptance Criteria. That is to say that, statistically, there is an acceptable degree of confidence that the soils are not contaminated with any of the above parameters, excluding Lead.

One elevated lead concentration was recorded on site within HA103 at 0.0-0.4m (286mg/kg) above the screening value of 200mg/kg.

The sample tested at HA105 (outside of the planning application boundary) did not record any elevated levels of the contaminants tested for.

17.2 Polyaromatic Hydrocarbons (PAH)

PAH are widespread within made ground and the urban environment generally. They are one of the most common contaminants in made ground and the one that most commonly drives remediation. Benzo(a)Pyrene is a particular problem, being very commonly found in association with tarmac, clinker and any burnt products and also being highly toxic to human

health. The BaP and naphthalene results have been subject to statistical analysis as for the metals.

The mean Soil Organic Matter of the material has been used to determine an appropriate Tier I GAC. The results are summarised as follows:

Table 8: Summary of BaP and Naphthalene in HA101 to HA106 (6 samples)- mean SOM 6%

Determinant	Arithmetic Mean (mg/kg)	UCL U ₉₅ (mg/kg)	Evidence Level (%)	Tier I Generic Assessment Criteria ¹ (mg/kg) Residential with plant uptake 6% SOM	Samples that exceed GAC (Including outliers)
Benzo(a)Pyrene	4.93	8.9	51	5	HA103 at 0-0.4m and HA106 at 0-0.3m
Naphthalene	0.15	0.2	100	13	None

2 No. samples of made ground recorded elevated BaP above the screening value of 5mg/kg, HA103 (11.3mg/kg) and HA106 (10.6mg/kg). Similarly elevated levels of BaP were recorded in the earlier phase of investigation completed by others.

No samples recorded elevated Naphthalene.

The sample tested at HA105 (outside of the planning application boundary) did not record any elevated levels of the contaminants tested for.

17.3 Petroleum Hydrocarbons (PHC)

One sample was tested for petroleum hydrocarbons (taken from HA101 in the vicinity of the former above ground fuel tank). The concentration of PHC was not significantly elevated above screening values for a residential end use, with 26mg/kg total PHC recorded within HA101.

17.4 Asbestos

All 6 No. soil samples tested were screened for the presence of asbestos containing materials and/or loose asbestos fibres.

No asbestos was detected in any of the samples.

18 Risk Assessment

18.1 Human Health

The works carried out to date have indicated that localised topsoil beneath the site is impacted with lead and the PAH compound benzo(a)pyrene.

Whilst the assessment has not found any other significant contamination, access into some areas, including those that may be impacted by on and off site sources, has not been possible and there remains the possibility that as yet unidentified contamination may be present.

The lead and benzo(a)pyrene contamination identified poses a risk to human health, where present in critical areas such as areas of soft landscaping. Contamination may impact human health through the direct ingestion, inhalation, skin contact and/or plant uptake pathways that would be present in a residential setting. The contaminated ground is considered to pose an unacceptable risk if it is to be retained in the near surface of outdoor soft covered areas where direct human contact is feasible.

The contamination may pose a risk to incoming water via permeation into supply lines. The use of barrier/protective piling may be required by the water supplier.

Some remediation to mitigate risk to human health from benzo(a)pyrene and lead impacted made ground soils is required.

18.2 Controlled Waters

18.2.1 Groundwater

The site is located above a Secondary A Aquifer in the Thanet Sand Formation. A Principal Aquifer (Seaford and Newhaven Chalk Formation) is mapped along the northern site boundary. The site is situated within the zone 3 of a Total Catchment Source Protection Zone, and the nearest groundwater abstraction borehole is situated 1117m to the north east.

Specific laboratory testing has not been carried out as part of this investigation to enable a detailed quantitative risk assessment in respect of groundwater. The measured levels of potential contaminants within the made ground soils are generally low, with only lead and benzo(a)pyrene contamination recorded at levels considered to pose a risk to human health. The concentrations recorded are unlikely to pose a significant risk to groundwater. Additionally, groundwater was not encountered within any of the boreholes excavated and is expected to be at a significant depth below ground level within the Chalk Aquifer. On this basis, the recorded contamination is not considered to pose a significant risk to groundwater.

18.2.2 Surface Water

There are no surface water features on site. The closest surface water feature is the pond some 25m east of the site. Based on this information and the recorded concentrations of