

Sword Properties Ltd

Phase 2 Geotechnical and Geoenvironmental Investigation

**Model Farm
Mill Lane
Hexton
Hitchin
SG5 3JE**

**Report Ref: 24.07.023-f01
September 2024**

DOCUMENT RECORD

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Development	Residential Development
Project Address	Model Farm, Mill Lane, Hexton, Hitchin, SG5 3JE
Project Ref	24.07.023
Client	Sword Properties Ltd

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For and on behalf of ListersGeo, trading name of Listers Geotechnical Consultants Ltd

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EXECUTIVE SUMMARY

Project Reference	24.07.023
Site Location	Model Farm, Mill Lane, Hexton, Hitchin, SG5 3JE
OS Grid Reference	510680, 230610
Development Proposals	Two new single-storey residential houses with associated gardens, courtyards and car parking.
Current Site Use	Single-storey disused barns.
Existing Buildings	
Topography	The surrounding areas appears to slope down towards the north and the site itself appears to slope gently to the northwest.
Vegetation	The surrounding area is covered by grass and there are large trees located adjacent to the east of the barns and several smaller trees to the south.
Published Geology	Artificial Ground: None, but Made Ground anticipated with the construction of the existing barns. Superficial geology: None Bedrock geology: West Melbury Marly Chalk Formation
Hydrology	Groundwater vulnerability maps for the area show that the underlying bedrock geology is classified as a Principal Aquifer. The site does not lie within a Source Protection Zone for local groundwater abstraction. There are no recorded groundwater abstractions within 1km of the site.
Hydrogeology	The nearest surface water feature is a small east-west trending inland river, located around 33m south of site.
Site History	The previous desk study report indicated that the earliest maps show the barns on site with the exception of the northeast corner which appear to be shown in their current layout by 1924. The site is named as Model Farm from 1977. At this time, two tanks are shown to the north of the site associated with Grange Farm (formerly Park Farm) and another two on Manor Farm to the north of the site. A smithy is indicated some 25m to the west between 1881 to 1924.
Unexploded Ordnance	Low risk
Potential Sources of Contamination	Thickness of Made Ground, spills and leaks of hydrocarbons from vehicles, asbestos containing building materials.
Ground Conditions Encountered	Shallow Topsoil or Fill onto Made Ground down to depths between 0.15m and 1.10m, overlying the West Melbury Marly Chalk Formation proven to the full depth of the investigation at 4.80m.
Groundwater Encountered	Groundwater was not encountered in any of the exploratory holes during the fieldwork down to 4.80m depth below the existing ground level, for the short time that the holes were open.
Risks to Human Health	Lead was recorded in the Topsoil in the south of the site. Remedial measures are considered necessary in areas of proposed soft landscaping to protect the future residents. Further sampling and testing of the Topsoil could be considered in order to provide greater confidence of the nature of the lead, specifically in the areas of proposed soft landscaping. This further testing may potentially negate the implementation of a cover system from some of the proposed areas of soft landscaping.
Ground Gas Risks	No special gas protection measures will be necessary with regard to methane or carbon dioxide gas. Radon protection measures are not required in the construction of new dwellings or extensions without underground rooms on this site.
Risks to Controlled Waters	No significant risk to Controlled Waters receptors identified.
Remediation Required	Unless further sampling and testing of lead proves otherwise, in areas of proposed soft-landscaping: an Engineered Cover System or, a Source Removal remedial solution. A Remedial Strategy will be required followed by Post Remediation Verification of the measures undertaken.
Chemical Attack on Buried Concrete	Design Sulphate Class DS-1 ACEC Class AC-1

Geotechnical Hazards	The foundations will require deepening in accordance with NHBC Guidelines given the shrinkable soils encountered and the trees at the site. Inevitable ground disturbances associated with the demolition of the existing buildings and removal of existing foundations, which may result in increased thickness of Made Ground to depths beyond that encountered during this investigation.
Potential Foundation Solutions	Conventional spread foundations / Piled foundations Depth: At least 1.0m bgl or 0.2m into the West Melbury Marly Chalk Formation, locally extending to 1.30m beyond Made Ground recorded to 1.10m Volume change potential: Medium
Allowable Bearing Pressure	150kPa may be adopted for isolated, uniformly loaded, conventional 600mm wide strip footings /1.00m wide pad foundations.
Floor Slabs	Suspended recommended
Limitations and Recommendations	- Should ground conditions vary noticeably from our Ground Model, then we recommend further assessment by a suitably qualified person. - Remedial measures and verification in areas of proposed soft landscaping. - Further sampling and testing of the Made Ground could also be considered in order to provide greater confidence of the nature of the lead, specifically in the areas of proposed soft landscaping. This further testing may potentially negate the implementation of a cover system from some of the proposed areas of soft landscaping. - Waste classification sampling and testing could be considered to assist the classification of soils for removal, if required. - A tree survey is recommended to assess the required depth of the proposed shallow pad/strip foundations based on soils of a medium volume change potential. Alternatively, if a piled solution is preferred then we recommend supplementary boreholes in order to aid design. - Due consideration should be given to the inevitable ground disturbances associated with the demolition works and the removal of existing foundations. Records of ground disturbances should be maintained during demolition works and passed on to the structural engineer to assist with foundation design.

This executive summary should be read in conjunction with the main report.

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APPENDICES

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- Site Location Plan
- Exploratory Hole Location Plan - Existing Site Layout
- Exploratory Hole Location Plan - Showing Development Proposals
- Site Photographs

APPENDIX B - FIELDWORK AND TESTING

- Legends and Abbreviations Log Key
- Continuous Tube Sampler Borehole Logs
- Standard Penetration Test Summary
- Trial Pit Logs

APPENDIX C - LABORATORY TEST REPORTS

- Geotechnical Laboratory Test Report
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APPENDIX D - CONTAMINATION RISK ASSESSMENT

- Contaminated Land Risk Assessment Methodology

PHASE 2 GEOTECHNICAL AND GEOENVIRONMENTAL REPORT

INTRODUCTION

A Phase 2 Geotechnical and Geoenvironmental has been undertaken for a residential development at Model Farm, Mill Lane, Hexton, Hitchin, SG5 3JE. A Site Location Plan is provided in Appendix A. The Ordnance Survey National Grid reference for the approximate centre of the site is 510680, 230610.

Instructions to undertake the investigation were received from Sword Properties Ltd, in their letter email dated 11th July 2024.

This report describes intrusive site investigation activities carried out by ListersGeo in order to provide an evaluation of the ground conditions and the extent of any soil, gas or groundwater contamination present on the site. The report presents human health and groundwater risk assessments based on the findings of the desk study information and subsequent contamination laboratory testing.

The report also discusses the geotechnical implications with regard to the proposed development based on the findings of the fieldwork and subsequent laboratory testing.

This report supplements a previous Phase 1 desk study report prepared by EPS Ltd, report reference UK21.5418, dated 10th June 2021. We understand that Sword Properties Ltd has obtained reliance upon this report and, therefore, we have relied on information within this report to aid our recommendations. We accept no responsibility for third party data presented to us, and our report would be based on any necessary reliance being obtained, on our behalf, by the client.

This current report should be read in conjunction with the previous report for full details of the investigations undertaken at the site.

This report has been prepared for the sole use of the client and their professional advisors. This report shall not be relied upon by third parties without the express written authority of ListersGeo. If an unauthorised third-party comes into possession of this report, they must not rely on it and the authors owe them no duty of care and skill.

SCOPE OF THE INVESTIGATION

The scope of the investigation was to undertake a review of the previous desk study and walkover survey, provide an assessment of the geotechnical engineering properties of the ground and the extent of any soil, gas or groundwater contamination on the site. A contaminated land risk assessment was undertaken based on the Contaminated Land Exposure Assessment (CLEA) and Environment Agency (EA) Remedial Targets Methodology (RTM) guidelines.

Following our brief, the report does not include any assessment of the waste characteristics of the soils.

PROPOSALS

It is proposed to demolish the existing single-storey barns and construct two single-storey residential houses with associated gardens, courtyards and car parking. A proposed site layout plan is provided in Appendix A.

The report is based upon the above development proposals and the existing ground levels. Should either of these alter significantly following issue of this report, then the contents will require re-evaluation.

SITE INFORMATION AND RECONNAISSANCE

A reconnaissance of the site and its immediate surrounds was undertaken on the 16th July 2024, preceding the fieldwork. A selection of site photographs is presented in Appendix A along with a plan showing the existing site layout annotated with the salient features identified.

The site lies in a predominantly arable/residential area and is currently occupied by single-storey barns. Access to the site was afforded via Mill Lane to the west of the site.

The site consists of a parcel of land with dimensions of approximately 35m north to south and 40m east to west the site extends to approximately 0.12ha.

On the site area itself, there were several single-storey barns constructed of both brick and wood with both tiled and corrugated suspected asbestos cement roofs. They form a rectangle with a broken concrete covered courtyard in the centre. There is a metal cover flush to the surface in the centre of the courtyard possibly associated with surface water drainage. The barns were empty at the time of the investigation. There is a looped gravel access track to the north of the barns, and we understand from the client that there may have been a soakaway located in this area.

The site is bordered by:

Direction	Feature
North	Open grass with a village hall beyond
East	Dense vegetation and trees with open fields beyond
South	Dilapidated barn with residential property with associated gardens beyond
West	Mill Lane with residential property with associated gardens beyond

The surrounding areas appear to slope down towards the north and the site itself appears to slope gently to the northwest. There was a large puddle of water in the north of the site in the area of the looped access track.

There was a small suspected hydrocarbon staining on the surface of the broken concrete in the north of the courtyard along with a rusty black stained empty barrel to the north of the barns.

The surrounding area is covered by grass and there are large trees located adjacent to the east of the barns and several smaller trees to the south.

PREVIOUS WORK

A previous Phase 1 desk study report was prepared by EPS Ltd, report reference UK21.5418, dated 10th June 2021. The salient points relevant to this report are included here, but the full report should be referred to for more detail.

Walkover

The previous site walkover carried out on the 26th May 2021, identified that several of the barns were previously used for vehicle storage and maintenance with a partially dismantled vehicle, two motorbikes and various vehicle parts in the barn in the northeast and vehicle storage and repairs with a partially disassembled engine in the barn in the southeast of the site. Several oil barrels and small petrol containers were stored with possible evidence of spillage shown by a slight staining on the concrete floor in the north of the courtyard and a metal barrel with similar staining was noted in the centre of the courtyard.

Geology

The site is underlain by the Bedrock geology, the West Melbury Marly Chalk Formation.

Hydrogeology

Groundwater vulnerability maps for the area show that the underlying bedrock geology is classified as a Principal Aquifer. The site does not lie within a Source Protection Zone for local groundwater abstraction. There are no recorded groundwater abstractions within 1km of the site.

Hydrology

The nearest surface water feature is a small east-west trending inland river, located around 33m south of site. There are three surface water discharge consents within 500m, the closest of which is located approximately 140m northeast and is related to agricultural effluents discharge. The discharge consent was issued in 1963, and was revoked in 1992. There are eleven recorded surface water abstractions within 500m, the closest of which is located 151m east, and is used for spray irrigation, with the permit issued in March 1982.

Geotechnical Hazards

There are no hazards recorded associated with compressible ground, ground dissolution, running sand, landslides or shrinking/swelling clay and a very low risk associated with collapsible ground. A rare risk is recorded associated with mining (non-coal). The previous desk study records two mineral sites within 1,000m of the site, the nearest of which is Hexton Chalk Pit located 610m south which is a former open cast pit.

Landfills

There are no landfills or potentially infilled land within 500m of the site.

Flood Risk

Review of the EA flood zone map for the area indicated that site is located within Flood Zone 1, which is defined as the area with a low potential risk from fluvial or tidal sources. It should be noted that the EA maps do not take into account flooding from other potential sources of floodwater, such as from poor drainage, or

groundwater. BGS groundwater flooding map (BGS Flood GFS Data) do however, identify that the site lies within an area of potential for groundwater flooding of any property situated below ground level.

These data do not constitute a site-specific Flood Risk Assessment and we recommend further enquiries to determine if such an assessment would be required to support a development application for the site.

History

The previous desk study report indicated that the earliest maps show the barns on site with the exception of the northeast corner which appear to be shown in their current layout by 1924. The site is named as Model Farm from 1977. At this time, two tanks are shown to the north of the site associated with Grange Farm (formerly Park Farm) and another two on Manor Farm to the north of the site. A smithy is indicated some 25m to the west between 1881 to 1924.

Ground Gas

The previous desk study information indicates that the site lies within an area where less than 1% of homes exceed the action level of 200Bq/m³ for radon gas. Therefore, in accordance with BR 211, 'Radon: guidance on protective measures for new dwellings', no radon protection measures are necessary in the construction of new dwellings or extensions without underground rooms on this site.

Industrial Use Sites

The following table summarises the historical potentially contaminative activities and current industrial land uses that have been identified within 150m from the site:

Distance (m)	Direction	Feature/Activity
128	NE	Inactive - Fortune Products Technical Solutions Ltd Engineering Machine Services)
157	E	Inactive - Aromatic UK Ltd (Food colouring, flavouring and additive manufacturers and distributors)
241	SE	Active - United Oddsocks (Clothing Accessory Manufacturers)

The previous Envirocheck report also lists one industrial tank located 105m east of site.

Site Sensitivity

The site is located within an area of outstanding natural beauty.

UPDATED CONTAMINATION CONCEPTUAL SITE MODEL

An updated qualitative Preliminary Risk Assessment (PRA) has been undertaken in line with the EA's online guidance, Land Contamination: Risk Management (LCRM).

It is understood that the development proposals are for residential houses with private gardens.

Potential sources of contamination and potential receptors have been assessed using the source-pathway-receptor principle to create a Conceptual Site Model (CSM). This takes into account the fact that a complete pathway must exist between a potential source of contamination and a potential receptor for there to be considered a risk.

POTENTIAL CONTAMINATION SOURCES

Potential Solid-, Liquid- and Vapour-phase Contamination Sources

The results of the desk study and walkover indicate that the following potential sources of soil or groundwater contamination are present at, or in close proximity to, the site:

- Made Ground is likely to be present at the site associated with construction of the barns on site.
- Used as a barn for livestock, machinery and vehicle maintenance - possible contaminants including fuels/oils from tractors, machinery or vehicles. Small suspected hydrocarbon staining noted on the surface in the north of the courtyard.
- Potential for asbestos in the soils from degradation of the building materials including the corrugated suspected asbestos cement sheets on the roof of the existing barn.
- On site migration of contaminants from former smithy located 25m to the west and above ground tanks on the farms some 90m and 200m to the north (although considered unlikely considered distance away).

Potential Ground Gas Contamination Sources

Two main groups of gaseous-phase contamination have been considered: the gases (including methane and carbon-dioxide) that result from organic decomposition of constituents in the ground; and Radon gas that results from the radioactive decay of thorium and uranium (found, in varying quantities, in most soils and rocks).

In consideration of the source-pathway-receptor methodology for ground gas risk assessment set out in CIRIA C665, the sensitivity of the residential/commercial/industrial development is considered to be high.

The site is located in an area where the risks from ground gases are considered to be low. We have therefore provisionally assessed the risk of ground gas impacting the site, by reference to the CL:AIRE research bulletin RB17, "A pragmatic approach to ground gas risk assessment" 2012.

The following potential sources have been assessed:

- No credible sources or pathways for landfill gas migration from an off-site landfill have been identified.
- The site has not been a registered landfill.
- Any Made Ground present is not expected to be 5m deep or an average of 3m in thickness.

- The site does not lie on a potential naturally organic soil such as Alluvium/Peat.
- Radon protection measures are not required for developments without underground rooms.

RECEPTORS

The following most sensitive receptors have been identified at the site:

Human Health – Long Term Exposure

- End users of the site - the future residents
- Nearby residents

The critical receptor is a child under the age of six/ an adult.

Human Health – Short Term Exposure

- Construction workers (during redevelopment)
- General Public (during redevelopment)
- Maintenance Workers

The critical receptor is an adult.

Controlled Waters and Environment

- The small east-west trending inland river, located around 33m south of site
- The West Melbury Marly Chalk Formation, Principal Aquifer beneath the site
- The site is located within an area of outstanding natural beauty

However, the surrounding areas appears to slope down towards the north and the site itself appears to slope gently to the northwest. Therefore, the direction of surface water run off flow is anticipated to be towards the north and the closest watercourse in this direction (NW) is located some 300m away.

Infrastructure

- Substructures
- Water supply pipes

PATHWAYS

It is considered that a number of potential pathways exist between these potential sources and the above identified receptors. The viability of these pathways is discussed in the preliminary risk assessment.

Human Health

- Direct soil ingestion in areas of exposed soil
- Ingestion of soil attached to homegrown produce
- Ingestion of homegrown produce with contamination uptake
- Inhalation of indoor and outdoor vapours and dust
- Dermal contact with contaminated soil

Controlled Waters and Environment

- Migration/leaching of contaminants through the unsaturated zone

- Migration of contaminants through the groundwater
- Movement of contaminants through drains or services runs

Infrastructure

- Leachable or corrosive contaminants within the soil
- Corrosive contaminants within the groundwater

PRELIMINARY RISK ASSESSMENT

Based on the desk study research, the following potentially-complete pollutant linkages have been assessed and in accordance with CIRIA C552, a consequence and probability rating has been applied to each potential contamination source to create an overall risk rating. The definitions and methodology are presented in Appendix D and the results are presented in the following table:

Potential			Probability	Consequence	Risk Classification
Source	Pathway/s	Receptor			
Made Ground associated with the construction of the barns; which may have been locally impacted by spills/leak of hydrocarbons from vehicles or asbestos containing building materials Off-site smithy located 25m to the west and above ground tanks on the farms to the north	Ingestion	End Users: Residents	Low	Medium	Moderate/Low
	Dermal Contact	Construction Workers and general public			
	Inhalation				
	Explanation: On-site contamination is anticipated to be minimal. On completion of the development, the areas of the site proposed to be covered by hardstanding will significantly limit the exposure routes to the future residents; it is in the soft landscaped areas of the site (such as the gardens) where it is considered complete pollutant linkages may occur. Whilst a moderate/low risk classification has been established for construction workers, exposure to this receptor can be mitigated by use of appropriate PPE, work practices and maintaining good hygiene levels.				
	Migration through unsaturated zone, groundwater, drains and/or service runs	Inland river 33m to the south. Although hydraulic flow anticipated to the north	Low likelihood	Mild	Low
		Principal Aquifer beneath the site	Low likelihood	Mild	Low
	Explanation: Widespread gross levels of contamination (that pose a risk to controlled waters) are not anticipated (unlikely).				
	Direct contact	Water supply pipes	Low	Medium	Moderate/Low
	Explanation: Organic contaminants, such as polycyclic aromatic hydrocarbons, may attack plastic pipes. Utility companies often have their own local guidelines and standards that should be referenced prior to installation.				
	Direct contact	Substructures	Unlikely	Medium	Low
Explanation: The soils beneath the site may potentially contain sulphates at concentrations that may accelerate the degradation of buried concrete.					

The geoenvironmental investigation and risk assessment detailed in the remainder of this report have been conducted to validate this CSM.

INITIAL GEOTECHNICAL GROUND MODEL

The site is mapped to be directly underlain by bedrock geology of the West Melbury Marly Chalk Formation, although a surface covering of Artificial Ground/Made Ground is anticipated associated with the construction of the existing barns.

The West Melbury Marly Chalk Formation maybe suitable for pad, or strip/trench foundations depending upon the thickness of Made Ground/depth to natural soils and strength of the natural soils at a shallow depth.

The West Melbury Marly Chalk Formation may contain shrinking and swelling clays. This may pose a particular risk to the proposed building which is likely to be within the zone of influence of trees.

A rare risk is recorded associated with mining (non coal). The previous desk study records two mineral sites within 1,000m of the site, the nearest of which is Hexton Chalk Pit located 610m south which is a former open cast pit. There are no former pits indicated on site. However, there is considered to be a low risk of former unchartered mining on site.

From a geotechnical perspective, the intrusive investigation has been implemented to address these main issues and establish any potential problems for foundations and the general development of the site.

EXPLORATION AND TESTING

As part of the Phase 2 intrusive investigation, a total of eight exploratory holes were formed at the site. The works comprised:

- Four continuous tube sampler boreholes (CT01 to CT04)
- Four mechanically-excavated trial pits (TP01 to TP04) – previously excavated by the client
- In-situ testing (including Standard Penetration Tests and Hand Shear Vane tests)
- Geotechnical laboratory testing
- Chemical laboratory testing

The exploratory holes were formed on the 15th July 2024.

Ground levels and co-ordinates of the boreholes and trial pits were approximated on the basis of field measurements, public-domain GIS data and from freely available georeferenced on-line information.

The positions of all exploratory holes undertaken at the site as part of this investigation can be seen on the Exploratory Hole Location Plans in Appendix A. The logs and field test are provided in Appendix B and the results of the laboratory testing are provided in Appendix C.

Engineering conclusions given in this report are based on data obtained from these sources, but it should be noted that variations, which affect these conclusions, may inevitably occur between and beyond the test locations. Also, water levels may vary seasonally and with other factors.

SAMPLING STRATEGY

The investigation was undertaken in accordance with the scope of works agreed with Sword Properties Ltd.

As the desk study and walkover survey had identified some potential pollution sources at the site several of the exploratory holes were targeted on these sources. These included:

Potential Source	Exploratory Hole(s)
Vehicle storage area and suspected hydrocarbon staining	CT01
Potential asbestos associated with the barns on site including the suspected cement asbestos roofing noted	CT01, CT02 and CT03

The other exploratory holes were positioned to provide a spread of information across the site and beneath/in close proximity to the proposed building to assist the geotechnical assessment.

METHODOLOGY

Health and Safety

Prior to commencement of boring/testing/excavation, to minimise the dangers from/to buried services, the proposed locations were scanned using a Cable Avoidance Tool. At the borehole locations, a service avoidance pit was dug, using insulated hand tools, to a depth of around 1.2m below ground level (bgl). No buried services were encountered in the location of the borehole. A water pipe and clay drainage pipe was

encountered at 0.50m and 0.45m respectively, in TP02 during excavations carried out by the client prior to the site work.

Exploratory Holes

At positions located on existing concrete floor slab (CT01 and CT02), the surfacing was broken-out using a hand held hydraulic breaker.

Trial pits TP01 to TP04 were previously excavated by the client prior to the fieldwork down to depths between 0.55m and 0.80m.

Continuous tube sample boreholes CT01 to CT04, were put down using an Archway Competitor Dart rig to a maximum depth of 4.80m, where refusal was met on rock quality strata. Boreholes were advanced using a plastic lined steel tube sampling system, driven into the ground by a top drive percussive hammer. A near continuous 85mm to 55mm diameter core sample was recovered for subsequent examination, sub-sampling and laboratory testing. Standard Penetration Tests (SPTs) were taken at 1.0m intervals and the energy ratio for the hammer used for these SPT tests was 79%. Measurements of unconfined compressive strength were made in the tube samples in the field using a pocket penetrometer.

Correction to the field 'N' values (to 'N₆₀') for the effects of energy delivery have been applied to the SPT (Standard Penetration Test) results from this investigation, in line with the recommendations given in BS EN ISO 22476-3, 2005, National Annex A.

In-situ Testing

A slight hydrocarbon odour was noted in CT01 and therefore soil samples were screened on site using a PhoCheck TIGER photo-ionisation detector (PID) fitted with a 10.6eV ultra-violet lamp, to detect volatile organic compounds. The results of the PID tests are included on the borehole logs included in Appendix B.

GROUND CONDITIONS

The intrusive investigation revealed that the general succession of strata was as follows: a layer of Topsoil or Fill onto Made Ground overlying the West Melbury Marly Chalk Formation, proven to the full depth of the investigation at 4.80m.

The general succession of strata revealed by the fieldwork is summarised below, followed by further details of each:

Stratum	Locations encountered	Stratum			Comments
		Top (m)	Base (m)	Thickness (m)	
Topsoil	CT03, TP03 and TP04	GL	0.10 to 0.50		In the areas of soft landscaping
Fill	CT01, CT02, TP01 and TP02	GL	0.10 to 0.12		
Made Ground	CT02 to CT04, TP01 to TP03	0.10 to 0.40	0.15 to 1.10	0.30 to 1.00	
West Melbury Marly Chalk Formation	CT01 to CT04, TP02 to TP04	0.15 to 1.10	>0.55 to >4.80	>0.05 to >4.00	

TOPSOIL

Topsoil was encountered at CT03, TP03 and TP04 in the areas of soft landscaping surrounding the barns, from ground level down to depths of between 0.10m and 0.50m. The Topsoil comprised, in general, dark brown slightly gravelly slightly sandy silty clay with fine to coarse angular to subangular gravel of chalk and siltstone.

(It should be noted that use of the term, Topsoil, is in accordance with BS 5930 alone and does not imply compliance of these horizons with any other standard).

FILL

Fill was encountered at CT01, CT02, TP01 and TP02 from ground level down to depths of between 0.10m and 0.12m, and comprised a layer of cement-concrete (100mm to 120mm thick) in CT01, CT02 and TP01 over a course of bricks in TP01.

(It should be noted that use of the term, Fill, is in accordance with BS 5930 alone and does not imply compliance any particular performance standard).

MADE GROUND

Made Ground was encountered at CT02 to CT04, TP01 to TP03 from 0.10m to 0.40m, down to depths of between 0.15m to 1.10m. The Made Ground soils comprised a variable mix of loose dark brown sand and gravel or firm and stiff grey, light grey locally light brown silty gravelly clay with occasional flint and limestone

cobbles. The gravel fraction comprised chalk, slate, ceramic, flint, quartzite, limestone, coal and brick. Occasional cobbles of brick and quartzite were encountered in TP02.

WEST MELBURY MARLY CHALK FORMATION

The West Melbury Marly Chalk Formation was encountered at CT01 to CT04, TP02 to TP04 from between 0.15m to 1.10m depth, down to the base of the trial pits at a maximum depth of 0.55m and the base of the boreholes 4.80m. The West Melbury Marly Chalk Formation comprised, in general, firm to very stiff light brown, light grey and white gravelly calcareous silty slightly gravelly clay. The gravel fraction comprised fine to coarse subrounded to subangular chalk. The SPT N_{60} values at base of boreholes indicate very weak rock (marl/chalk).

The results of the field strength tests, and other relevant data, are summarised below:

Parameter	Range	Comments
Undrained Shear Strength (kPa)	30 to >150	Converted from Pocket Penetrometer (using conversion factor of 30). Low to very High strength (BS 5930-2015, Table 9)
SPT ' N_{60} ' value *Extrapolated result	21 to 125*	Tentatively equivalent to undrained shear strengths of between 95kPa and 563kPa (using Stroud, f_1 , conversion factor = 4.5). High to Extremely High strength (BS 5930-2015, Table 9). Values at base of boreholes indicate very weak rock (marl/chalk)

Laboratory testing revealed the following:

Parameter	Range	Comments
Water Content (%)	18 to 32	-
Liquid Limit (%)	45 to 58	CLAY of Intermediate and High Plasticity (BS5930 Casagrande)
Plastic Limit (%)	23 to 29	
Plasticity Index (%)	16 to 35	
Modified Plasticity Index (%)	14 to 35	Shrinkable soil of Low and Medium Volume-Change Potential (NHBC Standards)
Retained on 425 μ m sieve (%)	0 to 12	BS1377 'coarse soil' fraction
Passing 63 μ m sieve (%)	74 to 98	Fines (silt/clay) fraction

GROUNDWATER

Groundwater was not encountered in any of the exploratory holes during the fieldwork down to 4.80m depth below the existing ground level, for the short time that the holes were open.

OBSERVED SOIL CONTAMINATION

During the fieldwork, a slight hydrocarbon odour was noted in the Fill from ground level to 0.10m and in the West Melbury Marly Chalk Formation soils between 0.10m and 0.15m depth with a faint odour between 1.00m and 2.50m and some black staining noted at the surface of the borehole.

No further visual or olfactory signs of contamination were noted during the fieldwork.

CONCRETE AGGRESSION TEST RESULTS

The results of laboratory concrete aggression tests on selected samples of soil are summarised below:

Stratum	Water-soluble Sulphate SO₄ (mg/l)	pH (pH units)	Number tested
Made Ground	20 and 40	7.4 to 7.9	2
West Melbury Marly Chalk Formation	20 to 40	7.6 to 8.0	4

GROUND CONTAMINATION ASSESSMENT

The following is a description of: the testing schedule (number of tests from each stratum and the tests performed); the guidelines adopted for assessing the results, and a comparison of the test results from this investigation with those adopted guideline values. The implications of these comparisons are provided in the Risk Assessment sections that follow.

The contamination risk assessment has been undertaken in line with the EA's new online guidance Land Contamination: Risk Management (LCRM) in order to validate the Preliminary Risk Assessment (PRA) using a Generic Quantitative Risk Assessment (GQRA), followed by a Detailed Quantitative Risk Assessment (DQRA), if required.

SOIL TESTING

Two samples of the Made Ground (CT03 and CT04), two samples of Topsoil (CT03 and CT04) collected on site during this investigation were tested for a range of constituents of potential concern (CoPC). The majority of the samples to be tested were recovered from the test locations targeting the potential sources of contamination listed in the Conceptual Site Model. Additionally, one sample of Fill (CT01) and three samples of West Melbury Marly Chalk Formation (CT01) which identified slight/faint hydrocarbon odours were tested for Total Petroleum Hydrocarbons (TPH).

The suite of testing carried out on the samples was decided upon potential contaminants identified in the CSM and following consultation of R&D CLR Publications, published as part of the Contaminated Land Exposure Assessment (CLEA), a joint venture between the Department for Environment, Food and Rural Affairs (DEFRA) and the EA. The test suite included:

Group	Details
Asbestos	Screening for ACMs and fibres with the naked eye and microscopy
Inorganic substances	Arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc Sulphates
Organic substances	16 (EPA) Speciated Polycyclic Aromatic Hydrocarbons (PAH) Total Petroleum Hydrocarbons (TPH) with four-band determination Total Petroleum Hydrocarbons (TPH) with Aliphatic-Aromatic split
Other	pH

Unless explicitly stated on the laboratory report, the soil samples were tested to obtain 'Total' values within the soil. The results of the chemical tests from this investigation are included in Appendix C.

RISK ASSESSMENT GUIDELINES – HUMAN HEALTH

The human health risk assessment has been undertaken using the guidance provided in the EA's LCRM guidance and the CLEA guidelines.

This assesses risks associated with the ingestion, dermal contact, and vapour inhalation pathways related to contaminated soils and groundwater. Risks associated with the inhalation of Ground Gas, for example that resulting from landfill, is not addressed by LCRM. The assessment for ground gases has been undertaken separately in the Ground Gas Risk Assessment section of this report.

Human health assessment criteria used are based upon the proposed final land use of the site. As the site is to be redeveloped to accommodate new residential properties with private gardens the Generic Assessment Criteria (GACs) for a standard 'Residential with homegrown produce' setting have been used.

The results of the soil samples tested have been compared to the following published assessment criteria:

Category 4 Screening Levels (C4SLs)

Published in March 2014 by DEFRA, a limited number of generic Category 4 Screening Levels (C4SLs) were produced to support the revised Statutory Guidance to support Part 2A of the Environmental Protection Act 1990, which was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health, where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low.

Further C4SLs have been and are being produced by CL:AIRE, with support from SoBRA and SAGTA, for a limited number of volatile organic compounds, as time allows.

Suitable 4 Use Levels (S4ULs)

To supplement the small number of C4SL, a set of Suitable for Use Levels (S4UL) were produced, in 2015, by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH), using the EA's Contaminated Land Exposure Assessment (CLEA) software, version 1.06 (2009), and the revised assumptions used in deriving the C4SL. The S4UL are more conservative than the C4SL and are derived to represent the minimal levels of risk to human health as described in the EA's SR2 guidance, with the intention of being 'suitable for use' under planning.

RISK ASSESSMENT GUIDELINES – CONTROLLED WATERS

The procedures set out in EA's RTM *Hydrogeological risk assessment for contaminated land* (2006), have been followed.

RESULTS OF ASBESTOS SCREENING

Screening for the presence of asbestos did not reveal any asbestos containing material (ACM) or fibres in the one sample of Made Ground and two samples of Topsoil tested.

RESULTS OF TOTAL SOIL TESTS

Results of the total soil testing have been compared to relevant published GAC as discussed above. For S4ULs, a range of values have been published for the organic contaminants based on the soil's organic matter content. Where S4ULs have been adopted for the organic contaminants, analytical results have been compared to the most conservative value, which is that for soils of 1% soil organic matter (SOM).

Of the remaining determinands tested for, lead recorded values higher than the relevant GAC for human health for a residential setting with homegrown produce end use.

Lead

Of the two samples of Topsoil and one sample of Made Ground and tested, the values obtained ranged from 19mg/kg to 13,000mg/kg. The C4SL for lead is 200mg/kg for a residential with homegrown produce end use setting. One sample from CT03 within the Topsoil between 0.10m and 0.40m depth recorded lead of 13,000mg/kg which was above the C4SL.

Petroleum Hydrocarbons

The headspace testing using the PID meter revealed concentrations of detectable hydrocarbons of between 0.1ppm and 7.7ppm in the samples from CT01. The samples from CT01 at depths of 0.12m within the Fill and at depths of 1.95m from within the West Melbury Marly Chalk Formation exhibiting the highest readings were then subject to TPH aliphatic-aromatic split laboratory testing. The testing indicated values above detection within the sample at 0.12m within the Fill with the majority of hydrocarbons fell within the aromatic/aliphatic C21 to C35 ranges, which is indicative of heavy oil such as lubricating oil used in vehicle engines. However, the values were all below the referenced GACs for a residential with homegrown produce end use.

The one Made Ground and two samples of Topsoil along with two samples of the West Melbury Marly Chalk Formation (CT01) at 1.45m and 2.90m which identified the slight hydrocarbon odour were tested for TPH with four-band determination. The testing recorded total TPH (C10 to C40) concentrations <10mg/kg to 23mg/kg and the individual bands were all below the referenced GACs for a residential with homegrown produce end use.

Polycyclic Aromatic Hydrocarbons (PAHs)

Of the two samples of Topsoil and one sample of Made Ground and tested, none of the polycyclic aromatic hydrocarbon (PAH) compounds recorded values exceeding the GACs for a residential with homegrown produce end use.

HUMAN HEALTH RISK ASSESSMENT

The following quantitative risk assessment has been carried out using the source-pathway-receptor principle. Potential sources of contamination identified in the Conceptual Site Model (CSM) have been assessed using the CLEA Guidelines. This takes into account the fact that a complete pathway must exist between a potential source of contamination and a potential receptor for there to be considered a risk.

The potential human receptors evaluated for their individual risk are:

Long-Term Exposure

- End users of the site – the future residents.
- Nearby residents.

Short-Term Exposure

- Construction workers and the general public (during redevelopment).
- Maintenance workers

If the proposed site use or layout should alter significantly, then the human health risk assessment will require re-evaluation.

SOIL CONTAMINATION RISK

The preliminary risk assessment (PRA) identified Made Ground, asbestos containing building materials and spills and leaks of petroleum hydrocarbons from vehicles as potential on site sources of contamination at the site.

The intrusive investigation has revealed that the site is underlain by shallow Topsoil or Fill onto Made Ground down to depths between 0.15m and 1.10m, overlying the West Melbury Marly Chalk Formation proven to the full depth of the investigation at 4.80m.

No asbestos was identified in the soils during the fieldwork and screening for the presence of asbestos did not reveal any asbestos containing material (ACM) or fibres in the samples tested.

During the fieldwork, a slight hydrocarbon odour was noted in the Fill from ground level to 0.10m and in the West Melbury Marly Chalk Formation soils between 0.10m and 0.15m depth with a faint odour between 1.00m and 2.50m and some black staining noted at the surface of the borehole. It is considered that the odour may have been associated with the oil barrels and small petrol containers in the north of the courtyard or the vehicle storage and maintenance within the barn in the northeast, noted during the previous walkover. The headspace testing using the PID meter revealed concentrations of detectable hydrocarbons of between 0.1ppm and 7.7ppm (1.95m depth) in the samples from CT01. The TPH testing on the samples which identified slight hydrocarbon were tested and revealed possible heavy oils in the Fill at the surface. However, the values recorded were all below the referenced GACs for a residential with homegrown produce end use.

The remaining soil contamination testing carried out as part of this investigation revealed elevated concentrations of lead in the Topsoil in the south of the site when compared to the relevant GACs for a residential with homegrown produce end use.

Limitations

It should be appreciated that the intrusive investigation was limited to four small diameter boreholes and four previously excavated machine excavated trial pits. We therefore recommend that a Discovery Strategy is prepared to deal with the event that any further contamination (that differs from our ground model) is encountered during the development. This is discussed further in the *Remediation* section of this report.

SHORT-TERM EXPOSURE RISK

For construction workers and maintenance workers that are exposed to the ground, there is a short-term exposure risk (at each site they attend, which contributes to an overall lifetime exposure risk).

Given the presence of lead in the near surface soils at the site, there is considered to be significant short-term exposure risk if suitable controls are not implemented. The exposure route of primary concern for the groundworkers is 'direct soil ingestion'.

Therefore, measures should be taken to manage the short-term exposure risk to ground workers and surrounding residents. Potential mitigating measures to minimise the risks are discussed in the following *Remediation* section.

Our investigations were conducted based on the site being at a low risk of significant contamination being present. As contamination, albeit at one location in the south of the site, has been detected, consideration could be given to supplementary sampling, testing and analysis to increase the data statistical assessment. This may enable relaxation of remedial measures or further zoning of remedial measures at the site.

LONG-TERM EXPOSURE RISK

The presence of lead recorded within the near surface Topsoil in the south of the site have the potential to cause significant harm to the future residents. The exposure route of primary concern for the lead is direct soil ingestion. This pathway will be most prevalent in the residential gardens and soft landscaped areas.

Unless further sampling and testing proves otherwise, it is therefore considered necessary to undertake remedial work in proposed areas of gardens and soft landscaping to protect the future residents of the proposed property and surrounding residents (discussed further in the following *Remediation* section).

The areas of the site proposed to be covered by hardstanding (floor slabs, pavements, access roads, car parking) will prove a permanent barrier between the impacted soils and future residents, significantly reducing the potential source-pathway-receptor linkage. It is therefore considered, at this stage, that no remediation is required in these areas.

CONCLUSIONS

The intrusive investigation has revealed that the near surface Topsoil in the south of the site have been impacted by lead. Control measures will therefore be required to protect groundworkers and the general public during the development; and remedial measure are considered necessary to protect the future residents. This is discussed further in the following *Remediation* section.

Further sampling and testing of the Topsoil should be considered in order to provide greater confidence of the nature of the lead. This may enable relaxation of remedial measures at the site or possibly allow for delineation and zoning.

REGULATORY APPROVAL

We recommend that the conclusions of this report are agreed with the relevant Local Authority at the earliest stage, to reduce potential delays to the development.

GROUND GAS RISK ASSESSMENT

The preliminary ground gas risk assessment did not identify any potential sources of ground gas which would likely affect the proposed properties.

The intrusive investigation has revealed that the site is underlain by shallow Topsoil or Fill onto Made Ground down to depths between 0.15m and 1.10m, overlying the West Melbury Marly Chalk Formation proven to the full depth of the investigation at 4.80m. Deep Made Ground or significant organic rich soils were not encountered during the fieldwork.

The calcareous clay of the West Melbury Marly Chalk encountered down to 4.80m is considered to be practically impermeable and therefore will likely prevent a pathway for any potential ground gas to the proposed residential properties.

Therefore, there is considered to be no significant sources of methane or carbon dioxide gas which would likely impact the proposed residential properties.

GROUND GAS PROTECTION MEASURES

Carbon Dioxide and Methane Gas

Therefore, for this residential development it is considered that no gas protection is necessary with regard to methane or carbon dioxide gas.

Radon Gas

The BGS advises that no radon gas protection measures are necessary for buildings without underground rooms at this site.

REGULATORY APPROVAL

The above conclusions regarding ground gases should be agreed with the relevant local Regulatory Authority as soon as possible prior to development.

CONTROLLED WATERS RISK ASSESSMENT

The following Controlled Waters risk assessment has been carried out in accordance with the procedures set out in the EA's RTM *Hydrogeological risk assessment for contaminated land* (2006). Using the source-pathway-receptor principle, this takes into account the fact that a complete pathway must exist between a potential source of contamination and a potential receptor for there to be considered a risk.

There were no potential Controlled Waters receptors identified during the initial risk assessment. However, the Dollis Hill Gravel Member was encountered above the London Clay Formation during the fieldwork and therefore the following potential Controlled Waters receptors were considered during this risk assessment:

- The small east-west trending inland river, located around 33m south of site
- The West Melbury Marly Chalk Formation, Principal Aquifer beneath the site
- The site is located within an area of outstanding natural beauty

However, the surrounding areas appear to slope down towards the north and the site itself appears to slope gently to the northwest. Therefore, the direction of surface water run off flow is anticipated to be towards the north and the closest watercourse in this direction (NW) is located some 300m away.

DISCUSSION

The preliminary risk assessment (PRA) identified Made Ground, asbestos containing building materials and spills and leaks of petroleum hydrocarbons from vehicles as potential on site sources of contamination at the site.

The intrusive investigation revealed that the site is underlain by shallow Topsoil or Fill onto Made Ground down to depths between 0.15m and 1.10m, overlying the West Melbury Marly Chalk Formation proven to the full depth of the investigation at 4.80m.

During the fieldwork, a slight hydrocarbon odour was noted in the Fill from ground level to 0.10m and in the West Melbury Marly Chalk Formation soils between 0.10m and 0.15m depth with a faint odour between 1.00m and 2.50m and some black staining noted at the surface of the borehole. However, the results of the soil testing did not identify any significantly elevated concentrations of hydrocarbons or potential mobile contaminants in the soils. The testing indicated that the hydrocarbon odours were likely associated with heavy oils possibly spilled at the surface which will likely be removed as part of the redevelopment.

The results of the soil testing identified concentrations of lead in the Topsoil in the south of the site. However, the lead is not considered to be significantly mobile and the Topsoil in this area of the site will be removed as part of the remedial cover layer system required at the site.

It is therefore considered that the site does not pose a significant risk to Controlled Waters. As previously noted, we recommend that a Discovery Strategy be prepared, and this initial assessment be updated accordingly should any unexpected contamination be encountered during the development.

REGULATORY APPROVAL

We recommend that the conclusions of this report are agreed with the relevant Local Authority at the earliest stage, to reduce potential delays to the development.

INFRASTRUCTURE RISK ASSESSMENT

SUBSURFACE CONCRETE

Using the results of the concrete aggression tests, the concrete design mix recommendations for subsurface concrete have been assessed in terms of BRE Special Digest 1. The classification is as follows:

Type of Site	Groundwater	Characteristic Sulphate			Characteristic	
		Soil Soluble (mg/l)	Ground-water (mg/l)	Total Potential (%)	Design Sulphate Class	pH (pH units)
Brownfield	Mobile	40	n/a	n/a	DS-1	7.4

The above assessment provides an Aggressive Chemical Environment for Concrete (ACEC) class of AC-1.

UNDERGROUND SERVICES

Organic contaminants, such as petroleum or polycyclic aromatic hydrocarbons, may attack plastic pipes and remedial measures may be required. The pathway with the contaminated soils could be removed by sleeving the pipe with another material or by removing the contamination source itself.

It should be noted that the utility companies often have their own local guidelines and standards on levels of shallow soil contamination in the ground that may or may not be acceptable for the installation of below ground services. These standards may be different to those specified for assessing risks to human health and groundwater. The local requirements should be obtained from the particular service supply company as soon as possible to avoid unexpected delays or additional development costs. Approval should be sought for the type of pipes proposed before they are installed.

Consideration should be given to the effects of trees and shrubs on service runs that cross the site. Soil movements brought on by the influence of vegetation can severely disrupt the drain runs and mains services, and measures should be incorporated into the excavations to allow for future ground movements.

REMEDICATION

It has been established that the presence of lead in the Topsoil in the south of the site pose a significant short-term exposure risk to construction workers and long-term exposure risk to the end users of the site if suitable controls are not implemented.

Our investigations were conducted based on the site being at a low risk of significant contamination being present. As contamination, albeit at an isolate location, has been detected, consideration could be given to supplementary sampling, testing and analysis to increase the data statistical assessment. This may enable relaxation of remedial measures or further zoning of the remediation at the site.

SHORT-TERM EXPOSURE RISK

The presence of lead in the ground means that groundworks will need to be suitably controlled. To reduce the 'direct soil ingestion' risk to as low as reasonably practicable, it is recommended that appropriate health and safety measures be implemented along with the use of Personal Protective Equipment (PPE). All personnel coming into contact with the soil, groundworkers in particular, should be instructed to use gloves when on site to avoid dermal contact and restrict inadvertent hand-to-mouth ingestion. Washing facilities should be provided for the site staff to use and should be used prior to eating or smoking. Reference should be made to the HSE Document, "Protection of Workers and the General Public during Development of Contaminated Land".

Although no asbestos was identified in the soils at the site, the presence of asbestos containing material (ACM) and fibres within Made Ground at any site cannot be ruled out. Groundworkers should be made aware of potential risks of asbestos during the groundworks.

DISCOVERY STRATEGY

In addition to the above, we recommend that a Discovery Strategy method statement is prepared for any groundworks at the site to cater for any unexpected contamination uncovered during the groundworks. Should any suspicious soils be encountered that differ from our ground model, work should cease in that area and further assessment will be necessary by a suitably qualified geoenvironmental engineer. This may require further intrusive investigation or soil sampling along with supplementary contamination risk assessment and potentially remediation. Any further recommendations will require regulatory approval.

The Discovery Strategy should be implemented throughout the groundworks and the Remediation Strategy updated and approved by the regulators if necessary. The site manager and all groundworkers should be made aware of the Discovery Strategy and their responsibilities in its regard. Associated records should be maintained and kept as they may form a required component of a Post Remediation Verification report on completion of the project.

LONG-TERM EXPOSURE RISK

To break the source-pathway-receptor linkage between the impacted soils and the future residents it is recommended that a Source Removal and/or Engineered Cover System remedial solutions are considered in the proposed areas of soft-landscaping (gardens).

The areas of the site proposed to be covered by hardstanding (floor slabs, pavements, access roads, car parking) will prove a permanent barrier between the impacted soils and future residents, thus significantly reducing the source-pathway-receptor linkage potential. It is therefore considered that no remediation is required in these areas.

Engineered Cover System

This solution involves the removal of the pathway between the contaminated soil and end users, thus breaking the pollutant linkage.

A 600mm thick engineered cover system should be adopted in all of the proposed soft landscaped areas comprising at least 420mm of clean subsoil and at least 180mm clean Topsoil. The depth is based upon the maximum likely digging depth of 600mm, or two spade depths, as defined in the guidance document BRE 465, 'Cover Thickness Design for Regeneration', produced by ENSR International Ltd.

A permeable geo-textile membrane should be placed at the base of the engineered cover system that will act as a capillary break layer and a deterrent to dig.

Dependant on final site levels, this can be achieved by either raising site levels or removing the soil to create the depth required. However, given the high levels of lead recorded we would recommend that the Topsoil in the south of the site is removed.

Source Removal

Unless further testing can prove otherwise, this would involve the total removal of the impacted Topsoil from the proposed soft landscaped areas at the site, down to the naturally deposited West Melbury Marly Chalk Formation. Based on the findings of this investigation, this would be in the order of some 0.10m to 0.50m depth (based on CT03, TP30 and TP04) below current ground levels. If all of the contaminated Topsoil is removed then the landscaping specification may revert back to the guidelines provided in the NHBC Standards.

SITE WON SUBSOIL

The subsoil portion of the Engineered Cover System described above could comprise site won natural soils of the West Melbury Marly Chalk Formation, if this material is considered suitable for the landscaping regime. If this is the case, then approval will be necessary from the Local Authority and the soils must be clearly segregated from any Made Ground/Topsoil prior to re-use.

Disturbed natural soils can be difficult to validate if they are mixed with other materials on site, such as fragments of building materials including brick or concrete.

IMPORTED TOPSOIL AND SUBSOIL SPECIFICATION

Any new Topsoil or Subsoil imported to the site requires testing for a range of contaminants to ensure that the soil is suitable for the particular development. The analysis should include a range of inorganic and organic contaminants and samples should be screened for asbestos.

The geoenvironmental engineer performing the remediation verification will need a copy of the chemical testing results to assess the suitability of the supply prior to the cover system being constructed. If there are no chemical testing results available for the soils to be imported, or the soils are not naturally sourced, then additional chemical testing must be undertaken to demonstrate that the imported soils are suitable for use.

Recycled soils which have been screened from demolition rubble often contain visible contaminants or sharps, such as fragments of glass, ceramic, metal, plastic, textiles or treated wood, which are physically unsuitable for the landscaping scheme.

If the imported soil is found to be chemically or physically unsuitable, it will need removal and replacing with a more suitable supply.

To ensure that the requirements of the 600mm cover system are fulfilled, any Imported Subsoil or Topsoil should contain levels of contaminants at or below the current C4SLs or S4ULs or the SACs established for this site.

Following the EA regulatory position statement, *RPS 190 Use of manufactured topsoil*, up to 1,000 tonnes of manufactured Topsoil may be imported to a site without an environmental permit, must be used within one year and not to a thickness of greater than 300mm.

Topsoil should comply with *BS3882:2015 Specification for topsoil* and the Subsoil with *BS8601:2013 Specification for subsoil*. It is recommended that confirmation on the soil quality is sought from a landscape architect.

It should be noted that newly placed Topsoil will settle over time and may not then fulfil the full thickness requirement of the cover system. Over compaction of fine-grained soils may lead to reduced drainage capacity. Consideration to a combination of Topsoil and Subsoil, or overfilling of the areas, should be given to reduce these effects.

REMEDIAL STRATEGY

Once remediation methods have been finalised it is recommended that a Remediation Strategy is prepared so that all parties involved in the development are clear about the chosen methods, implementation programmes and verification testing regimes that are required.

Should unexpected contamination be encountered during the groundworks or remediation, then the Human Health Risk Assessment and Remedial Strategy will require updating.

POST REMEDIATION VERIFICATION

Any remedial measures undertaken at the site will require independent verification once completed to ensure the pollutant linkage to the end users of the site has been removed. This is undertaken to satisfy the relevant

regulatory authorities and other interested parties, including future owners of the site, banks, insurers and mortgage companies.

This usually involves a small verification investigation to confirm that the remediation has been implemented in accordance with the Remedial Strategy. A Post Remediation Verification Report will be prepared detailing the verification and validation works once completed.

FURTHER WORK

Further sampling and testing of the Topsoil should be considered in order to provide greater confidence of the nature of the lead, specifically in the areas of proposed soft landscaping at the site. This further testing may potentially negate the implementation of a cover system from some of the proposed areas of soft landscaping or possibly allow for delineation and zoning.

REGULATORY APPROVAL

Any remedial measures concerning human health will need to be approved by the relevant Local Authority Environmental Health Department or warranty provider prior to development, who should be provided with a copy of this report and any other related reports as soon as possible prior to development to avoid delays.

GEOTECHNICAL ENGINEERING CONCLUSIONS

We understand that the existing barns are to be demolished and two new single-storey residential houses constructed with associated courtyards, gardens and car parking. A proposed site layout plan is provided in Appendix A. The anticipated foundation loads were not available at the time of issuing this report.

If site conditions should be altered significantly, such as changes to existing levels, then this report may require re-evaluation.

REVISED GROUND MODEL

The exploratory work from this investigation has revealed that the site is underlain by a layer of Topsoil or Fill onto Made Ground overlying the West Melbury Marly Chalk Formation, proven to the full depth of the investigation at 4.80m.

The following table summarises our ground model of the site:

Strata	Depth to base (m)	General Composition
Fill	0.10 to 0.12	Cement-concrete
Topsoil	0.10 to 0.50	Dark brown slightly gravelly slightly sandy silty clay with fine to coarse angular to subangular gravel of chalk and siltstone.
Made Ground	0.15 to 1.10	Variable: Loose dark brown sand and gravel Or Firm and stiff grey, light grey locally light brown silty gravelly clay with occasional flint and limestone cobbles
West Melbury Marly Chalk Formation	>4.80	Firm to very stiff light brown, light grey and white gravelly calcareous silty slightly gravelly clay. The gravel fraction comprised fine to coarse subrounded to subangular chalk. SPT N60 values at the base of boreholes indicate very weak rock (marl/chalk)

Laboratory testing shows the West Melbury Marly Chalk Formation as shrinkable soil of low to medium volume change potential, as defined by NHBC Building Standards, Chapter 4.2. Therefore, medium volume change potential should be used as a worst case.

There were no significant weak/loose soils encountered which may be associated with former mining on site. However, although considered to be a low risk there may still be uncharted mining beneath the site and therefore as a minimum, we recommend a watching brief is prepared during the groundworks and should any evidence of loosened or weak zones of ground be encountered, further advice should be sought from a geotechnical specialist.

Groundwater was not encountered in any of the exploratory holes during the fieldwork down to 4.80m depth below the existing ground level, for the short time that the holes were open.

Limitations & Considerations

It should be appreciated that the investigation was limited to four small diameter boreholes and four previously excavated trial pits put down in the external areas of the site. Due consideration should be given to the inevitable ground disturbances associated with the demolition of the existing buildings and removal of existing foundations. Records of ground disturbances should be maintained during demolition works and passed on to the structural engineer to assist with foundation design.

SITE EXCAVATION

Conventional hydraulic plant should be satisfactory for excavating foundation and service trenches. Specialist breaking plant will be required to assist in the removal of the existing hardstanding and foundations.

In line with HSE guidelines, all excavations requiring personnel access should be adequately supported to avoid the risk of collapse. Consideration should also be given to the stability of open trenches where personnel are working in close proximity.

Shallow excavations are likely to remain dry in the short term. Conventional pumping from sumps may be satisfactory in order to maintain a dry excavation if any seepages occur. It should be appreciated, however, that seasonal variations may exist and hence groundwater entries may occur particularly during wetter months or after periods of inclement weather.

Foundation excavations should be inspected by a suitably qualified person to assess the soil and groundwater conditions. If conditions differ from those identified within this report, then further assessment may be required. Any roots, organic matter, 'soft/loose' ground, or otherwise unsuitable material, encountered at founding depth should be removed prior to pouring of concrete.

There may be areas of deeper disturbed ground where foundations are to be removed for the existing barns.

Consideration should be given to the effects of trees and shrubs on service runs that cross the site. Soil movements brought on by the influence of vegetation can severely disrupt the drain runs and mains services, and measures should be incorporated into the excavations to allow for future ground movements.

Should any trees be removed from site, care should be taken to ensure the root ball of each tree is completely removed from the ground. Given time, any remnant root fragments may weather down to produce localised areas of soft organic soils which may induce local differential settlements.

Where new foundations are placed over a felled tree, consideration should be given to spanning these features to ensure no soft spots result in localised settlement.

Excavations at the site should be designed so as not to undermine existing structures or affect adjacent buildings.

FOUNDATION SOLUTIONS

The Fill, Topsoil and Made Ground are considered unsuitable as a bearing stratum due to their variability, and potential for unacceptable total and differential settlement under applied foundation loadings.

The West Melbury Marly Chalk Formation is considered to be a suitable bearing stratum for traditional spread foundations. A minimum foundation depth of 1.00m below ground level is recommended, or 0.20m into the top of the formation, whichever is the deeper. The Made Ground was encountered down to 1.10m depth and therefore the foundations will have to extend beyond this to some 1.30m depth or below this if any deeper Made Ground is encountered.

The allowable bearing pressure recommended below is made on the assumption of an acceptable total settlement for the proposed structures of 25mm. Should the building design require a significantly different serviceability limit state (tolerance to settlement) then it is recommended that these recommendations be revised accordingly.

At the minimum founding depth provided above, an allowable bearing pressure (or net loading intensity increase) of 150kPa may be adopted for isolated, uniformly loaded, conventional 600mm wide strip footings / 1.0m wide pad foundations. This allows for a suitable factor of safety against shear failure and should result in acceptable levels of differential and total vertical settlement.

Where foundations are to be constructed within the vicinity of existing or recently removed trees or shrubs on this site then they will require deepening in accord with guidelines given in NHBC Building Standards Chapter 4.2. For trees that are not to be removed, mature tree heights should be assumed when determining the foundation depths. The soils should be considered as being of medium volume change potential.

Where shrinkable soils are present, reference should be made to the NHBC guidelines for the specific requirements for compressible layers, such as Claymaster or Clayshield, to be placed along the sides of foundation excavations or beneath ground beams, in order to accommodate heave forces in the ground where any trees and shrubs are removed in the vicinity of the proposed foundations or if the existing vegetation should die.

If there is any significant layer of puttyed chalk at the base of the excavations, this should be removed and a blinding layer of concrete should be placed in the base of the open excavations to prevent the occurrence of softening due to potential water ingress.

Pile Foundations

Due to the presence of trees and shrinkable soils, the depth of conventional foundations may prove to be uneconomical and piled foundations could be considered as an alternative solution. Deeper investigation, such as with rotary boreholes, is likely to be required, in order to provide the piling contractor with design parameters.

A specialist piling contractor should be consulted as to the efficiency and suitability of piles installed using their particular systems in these ground conditions.

GROUND FLOOR SLABS

A suspended ground floor slab is recommended given the depth of Made Ground encountered and the shrinkable soils and trees present on site.

LIMITATIONS AND RECOMMENDATIONS FOR FURTHER WORK

The ground is seldom homogeneous and variations, which affect our conclusions, may inevitably occur between and beyond the test locations. Should ground conditions vary noticeably from our Ground Model, then we recommend further assessment by a suitably qualified person.

Environmental

Elevated levels of lead have been detected in the Topsoil in the south of the site. Remedial measures will be required to reduce the long-term exposure risk to the future residents to an acceptable level. A Remedial Strategy will be required followed by Post Remediation Verification of the measures undertaken. Consideration could be given to supplementary sampling, testing and analysis to increase the data statistical assessment. This may enable relaxation of remedial measures or further zoning of the remediation at the site.

Waste classification sampling and testing could be considered to assist the classification of soils for removal, if required.

Geotechnical

Given the shrinkable soils encountered beneath the site associated with the calcareous clay of the West Melbury Marly Chalk Formation, a tree survey is recommended to assess the required depth of the proposed shallow strip/pad foundations based on soils of a medium volume change potential.

Alternatively, if a piled solution is preferred then we recommend supplementary boreholes in order to aid design.

Due consideration should be given to the inevitable ground disturbances associated with the demolition of the existing barns and removal of existing foundations. Records of ground disturbances should be maintained during demolition works and passed on to the structural engineer to assist with foundation design.

A watching brief is recommended during the groundworks and should any evidence of loosened or weak zones of ground be encountered, further advice should be sought from a geotechnical specialist.

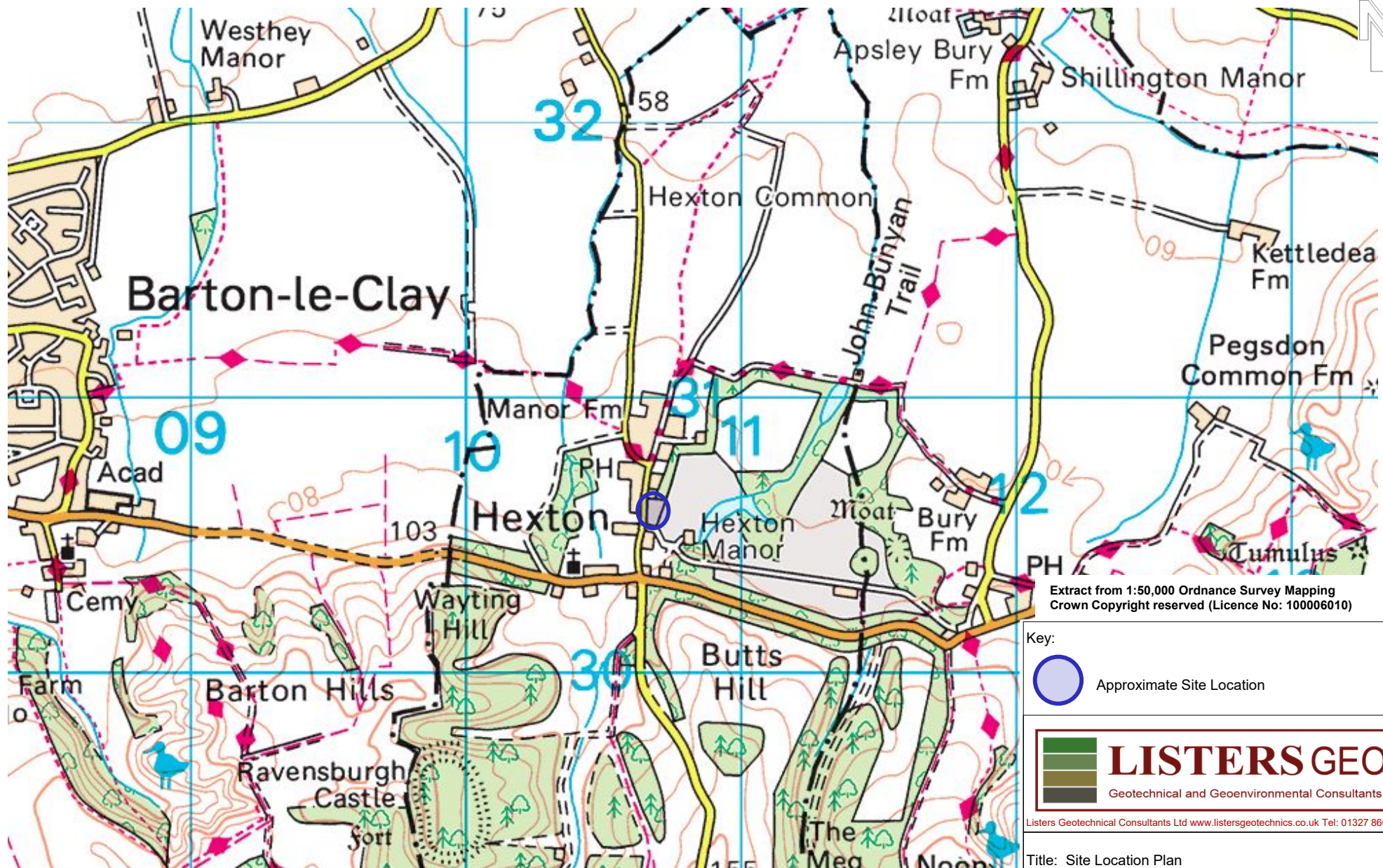
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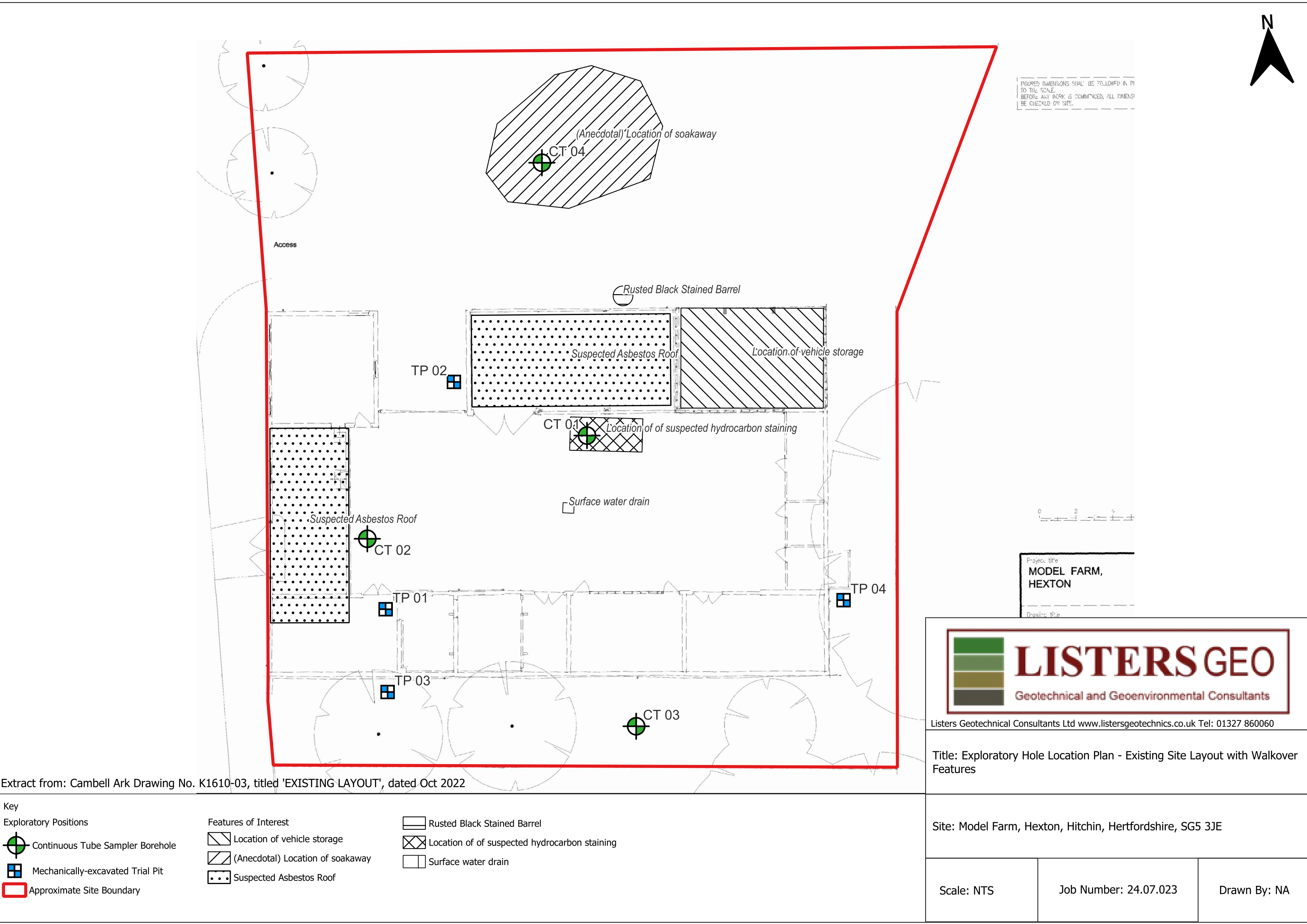
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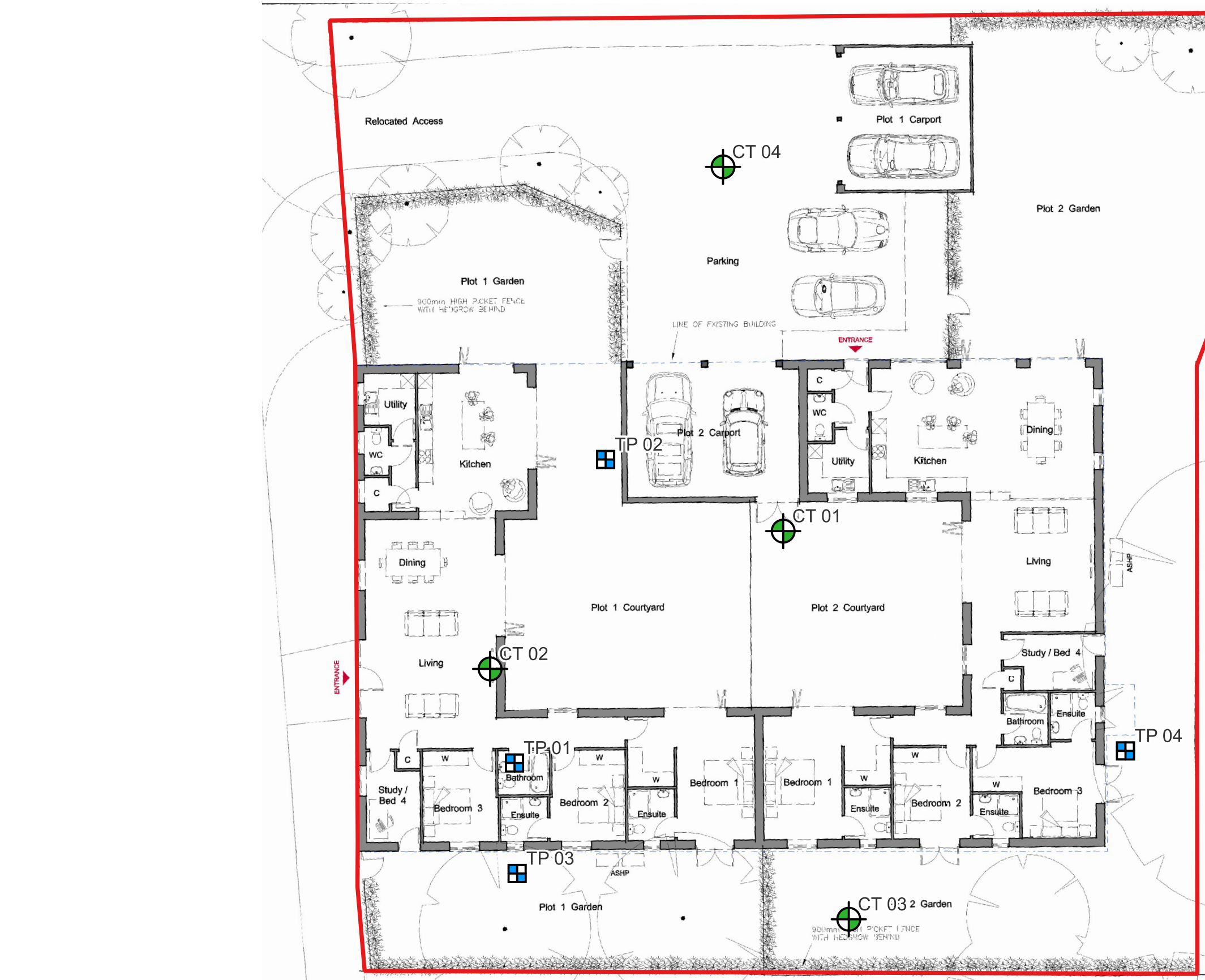
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BRE=Building Research Establishment. BSI=British Standards Institution. CIRIA=Construction Industry Research and Information Association. AGS=Association of Geotechnical and Geoenvironmental Specialists. EA=Environment Agency. HSE=Health and Safety Executive. NHBC=National House Building Council. DEFRA=Department for Environment, Food and Rural Affairs. ASP=Amherst Scientific Publishers. CL:AIRE=Contaminated Land: Applications in Real Environments. LQM=Land Quality Management. BGS=British Geological Survey. WHO=World Health Organisation. SoBRA=Society of Brownfield Risk Assessment. TRRL=Transport and Road Research Laboratory. UKWIR=UK Water Industry Research

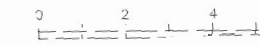
APPENDIX A PLANS & PHOTOGRAPHS







FIGURED DIMENSIONS SHALL BE FOLLOWED IN P
TO THE SCALE.
BEFORE ANY WORK IS COMMENCED, ALL DIMENS
BE CHECKED ON SITE.



B - Updated
A - Updated

Project title
**MODEL FARM,
HEXTON**
Drawing title



Listers Geotechnical Consultants Ltd www.listersgeotechnics.co.uk Tel: 01327 860060

Title: Exploratory Hole Location Plan - Proposed Site Layout

Site: Model Farm, Hexton, Hitchin, Hertfordshire, SG5 3JE

Scale: NTS	Job Number: 24.07.023	Drawn By: NA
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Extract from: Cambell Ark Drawing No. K1610-05, titled 'PROPOSED LAYOUT', dated Oct 2022

Key

Exploratory Positions

Mechanically-excavated Trial Pit

Approximate Site Boundary

Continuous Tube Sampler Borehole



Photo 1: View to the east showing the barn in the west of the site



Photo 2: View to the northwest showing TP03 in the south of the site

SITE PHOTOGRAPHS

Project ref:
24.07.023



Photo 3: View to the southwest showing the location of CT02 within the courtyard



Photo 4: View to the southeast showing the northeastern corner of the barn

SITE PHOTOGRAPHS

Project ref:
24.07.023



Photo 5: View to the east of the site showing the location of CT01 within the courtyard



Photo 6: View to the northwest showing the access track in the north of the site

SITE PHOTOGRAPHS

Project ref:
24.07.023



Photo 7: View to the southeast showing the northeastern corner of the barn



Photo 8: View to the north showing the location of TP04

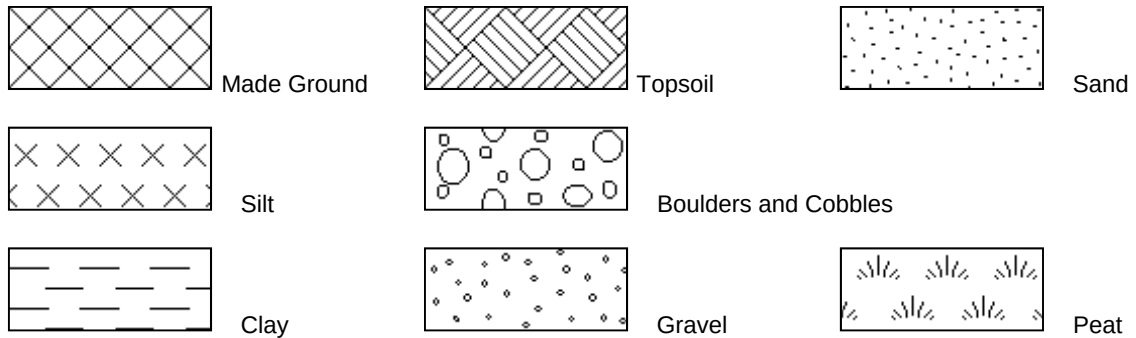
SITE PHOTOGRAPHS

Report:
24.07.023

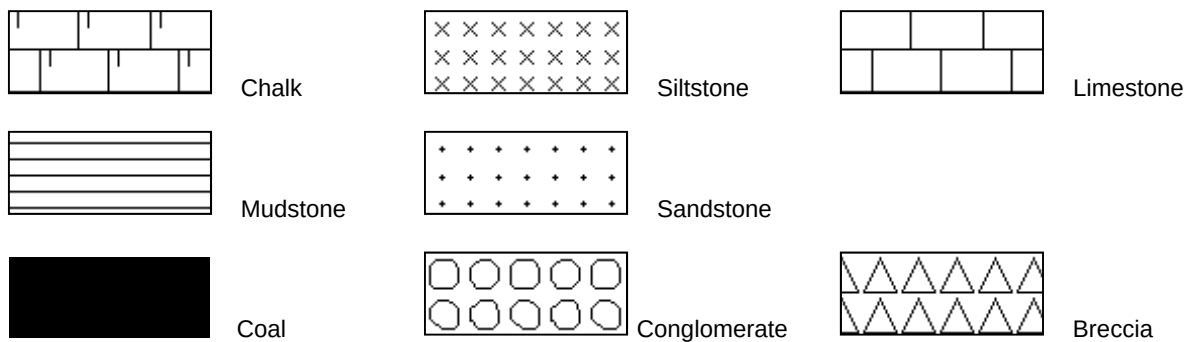
APPENDIX B

FIELDWORK AND TESTING

LEGEND - Soils



LEGEND - Rocks (Sedimentary)



LOG ABBREVIATIONS

W	Water Sample		Water Strike
B	Bulk Sample		Water (Standing Level)
D	Disturbed Sample	PP	Pocket Penetrometer
J	Jar Sample	HV	Hand Vane
U	Undisturbed Sample	SPT	Standard Penetration Test
(No. of blows shown in brackets for U100 samples)		CPT	Cone Penetration Test
WAC	Waste Acceptance Criteria Sample	CBR	California Bearing Ratio
		*	Extrapolated Value

Pocket penetrometer testing provides values of unconfined compressive strength. The results have been converted to an approximate equivalent shear strength which should be used with due circumspection. As the pocket penetrometer tends to overestimate shear strength, we have used an appropriate reduction factor.

LOG KEY