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**Welbeck Estates
Company Ltd**

P21-00134

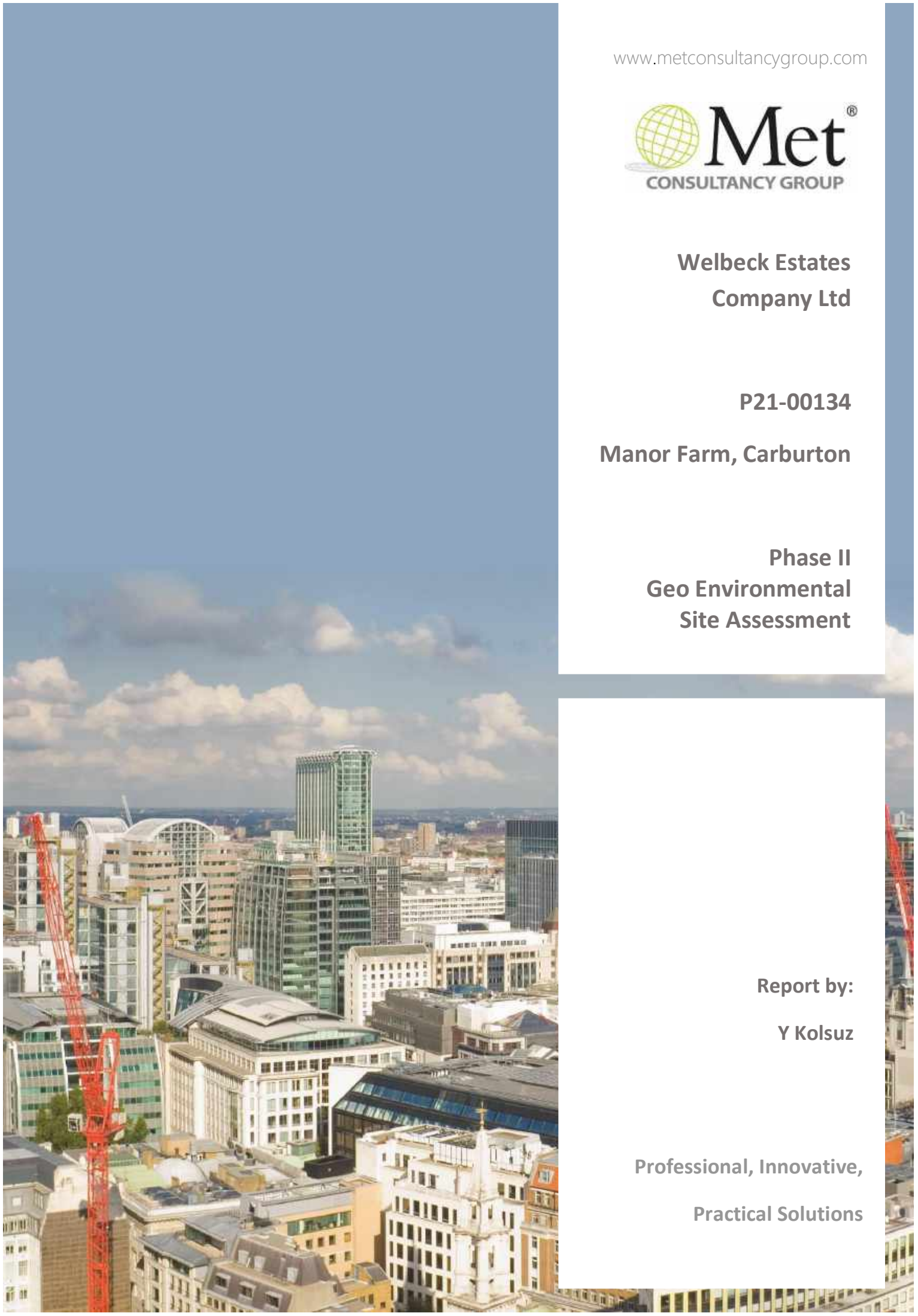
Manor Farm, Carburton

**Phase II
Geo Environmental
Site Assessment**

Report by:

Y Kolsuz

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1. REVISION RECORD

Report Ref: P21-00134-Met-RP-GE-002 / Phase II					
Rev	Description	Date	Originator	Checked	Approved
1	Initial Issue	21/12/2021	Y Kolsuz	AEC	RJS

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2. INTRODUCTION

2.1. GENERAL INTRODUCTION

This Report presents the findings of a Phase II Geo-environmental assessment of a site at Manor Farm, Piper Lane, Carburton, Nottinghamshire, S80 3BT (Grid Reference: 461072, 373272) for Welbeck Estates Company Ltd.

The Intrusive Site Investigation (Phase II) comprised of windowless sampler boreholes, trial pits, hand dug pits, foundation pits and road cores to establish the sub surface strata and remove samples for contamination and geotechnical testing. The test results combined with the findings of the intrusions will then be used to make recommendations for any remedial works which may be necessary. In-situ CBR testing and soakaway testing was also carried out as part of these works. A site plan including positions of the boreholes trial pits, hand dug pits, foundations pits and road cores can be found in Appendix I of this report.

2.2. OBJECTIVES

The intrusive investigation was conducted to assess and confirm the immediate sub-surface ground conditions and extract in-situ soil samples for laboratory testing as recommended in Phase I Report dated 9th July 2021 by Met Engineers Ltd, to determine the geotechnical and environmental position of the site.

2.3. SCOPE OF WORKS

Based upon the recommendations of the Desk Study and a visual assessment of the sub-surface materials during the intrusive works, soil samples were taken for laboratory testing. CLEA Guidelines and recommendations given in Land Quality Management General Assessment Criteria have been applied to establish a risk based CLEA Model to assess the likely contamination issues and to comment on potential constraints for development of the site.

Judgement is based strictly on the findings of the specific boreholes, trial pits, hand dug pits, foundation pits and soil samples tested and therefore may not be representative of the site as a whole. The findings of the intrusive investigation will also be used in conjunction with the findings of the Desk Study to establish parameters which may be used in formulating a foundation design. Soakaway testing was carried out on site to confirm the suitability for soakaway drainage. Land rover mounted CBR tests were instructed by the client within the existing roadway and the existing field along the proposed roadway.

2.4. LIMITATIONS OF THE REPORT

Welbeck Estates Company Ltd (the Client) has requested that a Phase II Site Investigation, CLEA Conceptual Model and Risk Assessment be undertaken in order to assess the suitability of the site for redevelopment. The report is not a comprehensive site characterisation and should not be construed as such.

This report has been prepared for the sole internal use and reliance of Welbeck Estates Company Ltd. The report shall not be relied upon or transferred to any other parties without the express written authority of Met Engineers Limited. If any unauthorised third party comes into possession of the report, they rely on it at their own risk and Met Engineers Limited owes them no duty of care.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report and which Met Engineers Limited, believes are reliable. Nevertheless, Met Engineers Limited, cannot and does not guarantee the authenticity or reliability of the information it has relied upon. The information contained in this report is to the best of our knowledge accurate at the date of issue, however, sub-surface conditions, including ground water levels, may vary, especially with time.

In preparing this report it has been assumed that all past and present occupants and Third Parties have provided accurate information, especially relating to known or potential hazards. This report does not identify deficiencies or mistakes in the information provided by the user/owner, or from any other source, except where obvious in the light of other information.

This report is relevant at the date the report was written and should be read in the light of any subsequent changes in legislation, statutory requirement or industry practices.

The report represents the technical findings and opinions of Met Engineers Limited, and does not constitute any legal advice. As such, the advice of a Solicitor may also be required.

3. SITE HISTORY AND ENVIRONMENTAL SETTING

A detailed review of the published history, hydrological, geological and available environmental information was carried out by Met Engineers in a Phase I Desk Study report dated 9th July 2021. The following is a brief summary of those findings.

The area of land referred to as ‘The Site’ within this document is indicated in Appendix I.

3.1. SITE DESCRIPTION

Site Name	Manor Farm, Piper Lane, Carburton, Nottinghamshire, S80 3BT
Location	Grid Reference: 461072, 373272
Setting	<p>The site is located in the village of Carburton, approximately 6.6km south east of Worksop town centre. The site is irregular in shape and is approximately 4.6 hectares (Ha) in size. Both pedestrian and vehicular access to the site is possible via access tracks off Piper Lane which connect to Limetree Avenue south east of the site.</p> <p>The central area of the site is occupied by St. Gile’s Church, an associated graveyard, and semi-detached residential housing. Manor House and associated soft landscaping is located in the east of the site, and groups of buildings including barns and stables associated with Manor Farm are located in the eastern and western areas of the site. Flood Dyke and the River Poulter intersect the site in the central and southern areas respectively, and run in a south west to north east direction through culverts beneath Piper Lane. A small pumping station was observed in the south west of the site off Poulter River during the site walkover on 24th June 2021. It should be noted that during the site walkover, an oil tank with a strong hydrocarbon odour and a propane tank were noted to the west of Manor House. A mound of inert material comprising wood, brick and soil was also noted in the eastern area of the site. Anecdotal evidence suggests a potential hot-spot of oil contamination in the eastern on-site barns. The location of this is shown on the plan provided in Appendix I. The perimeter of the site is generally unbound. The ground cover is a mixture of hardstanding comprising tarmac, gravel and concrete along Piper Lane and the access tracks across the site, as well as soft landscaping and overgrown vegetation in the private garden areas, graveyard and around the Manor Farm buildings. The site generally slopes gently down to the south east.</p> <p>The adjacent land use is agricultural in all directions of the site. In the wider surrounding area, residential housing is located from approximately 55m east and 80m south of Piper Lane, as well as from 200m east of the site. Areas of woodland are located from 115m south and 220m east of the site extending out.</p>

Site History	<p>The earliest OS maps show that the site was initially established with groups of unspecified buildings and footpaths in the east and west of the site, with a church building, associated graveyard and additional small buildings in the central area. Piper Lane was established in the north west of the site running down to the south, with Flood Dyke and the River Poulter intersecting the site in the central and southern areas respectively. By 1897, the on-site buildings were labelled Manor Farm and St. Gile’s Church, and small buildings were developed in the east and west of the site. By 1918 and 1959, additional Manor Farm buildings were developed in the east and west of the site and a small building in the centre was demolished. A Manor Farm building in the west of the site was demolished by 1960, at which time two larger buildings were developed in this area. By 1985, Manor Farm buildings in the east of the site were extended further to the east, small Manor Farm buildings in the centre and west were removed, and small residential buildings labelled New Houses were developed in the central area. Additional Manor Farm buildings were developed in the west of the site by 1994, and underwent minor redevelopment by 2001 and 2010.</p>
Development Proposal	<p>The site proposal includes the conversion of existing residential housing in the central area to self-catered accommodation, minor upgrades to the existing deconstructed church, the partial demolition of barn buildings in the west, a new driveway and footpath in the east, numerous areas of new/ upgraded soft landscaping, and car parks in the eastern, central and western areas. In addition, holiday cottages are proposed in the western area if the site and shepherd huts in the south west. The current proposed site layout plan (Reference: 2056_P101, Proposed Site Plan, Revision N, by Seven Architecture) updated at the time of this report is included in Appendix IX.</p>

3.2. GEOLOGY & SOILS

Geology	<p>Artificial Ground – The Groundsure report does not record any artificial ground on the site; however, some Made Ground is expected across the site based on the various developments observed over the last century.</p> <p>Superficial Deposits – The Groundsure report does not record any superficial deposits on the site.</p> <p>Bedrock Geology – The Groundsure report records the Chester Formation comprising gravelly sandstone underlying the site and the surrounding area.</p> <p>Faults – The Groundsure report does not record any faults within 250m of the site.</p> <p>Coal Outcrops – The Groundsure report does not record any coal seams within 250m of the site.</p>
Radon	<p><1% of properties in the area are above the radon action level. Therefore, radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.</p>
Ground workings	<p>There are no ground workings shown within 250m of the site.</p>

Mining

The site is within a Coal Mine Reporting Area therefore a Coal Report has been obtained from The Coal Authority, which can be found within Appendix III of the Phase I Desk Study.

The Coal Authority have 15N^o records at the site for past underground mining of the Top Hard and Parkgate coal seams at depths of between 640mbgl and 873mbgl last mined between 1961 and 2004. The site is not affected by any present or planned underground mining.

There are no recorded mine entries within 100m of the site.

There are no recorded opencast mines recorded within 500m of the site.

It is understood the land is at risk of subsidence. The Coal Authority have received a total of 16N^o damage notices or claims for coal mine related subsidence for any property within 50m of the site since 1994. 14N^o of these are recorded on the site itself.

2N^o of these claims were rejected. The remainder of the claims were settled with a combination of repair works and compensation.

The site is located adjacent to the south of a Development High Risk Area with regards to shallow coal mining, therefore a Coal Mining Risk Assessment has been carried out as part of this report and is presented in Section 5 of the Phase I Desk Study. This concluded that the risks to the site from migration of crown holes towards the surface is considered to be low and no further works related to this mater were considered necessary.

Natural Ground Subsidence	<p>Shrink-Swell Clay – The Groundsure report identifies the hazard rating on site as negligible. Ground conditions are predominantly non-plastic.</p> <p>Landslides – The Groundsure report identifies the hazard rating on site as very low. Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered. It should be noted that an area with a moderate hazard rating is shown from approximately 190m east of the site.</p> <p>Soluble Rocks – The Groundsure report identifies the hazard rating on site as negligible. Soluble rocks are either not thought to be present within the ground, or not prone to dissolution. Dissolution features are unlikely to be present.</p> <p>Compressible deposits – The Groundsure report identifies the hazard rating on site as negligible. Compressible strata are not thought to occur.</p> <p>Collapsible Deposits – The Groundsure report identifies the hazard rating on site as very low. Deposits with potential to collapse when loaded and saturated are unlikely to be present.</p> <p>Running Sands – The Groundsure report identifies the hazard rating on site as LOW. Running sand conditions may be present. Constraints may apply to and uses involving excavation or the addition or removal of water.</p>
Boreholes	<p>There are no BGS borehole records are held for positions located within 250m of the site.</p> <p>The nearest borehole recorded, ref. SK67SW17, is located from approximately 700m west of the site, was drilled to a depth of 262.25mbgl. This shows bedrock at a top depth of 6.81mbgl. Bedrock comprises interbedded mudstone, siltstone, sandstone and a number of coal seams to the base of the borehole.</p>

3.3. ENVIRONMENTAL OVERVIEW

Historical Land Use	<p>There is 1No potentially contaminative historical land use shown within 250m of the site. This is recorded to be a pumping station located from 180m north east of the site.</p>
Current Land Use	<p>There is 1No potentially contaminative current industrial land use shown within 250m of the site. This is recorded to be C Harris Transport Ltd located from 157m south east of the site, which is understood to be a distribution and haulage business.</p>
Invasive Species	<p>No evidence of invasive species was identified during the site walkover. However, it should be noted that Met Engineers are not invasive species specialists. It is understood that an ecology survey has been carried out for the site.</p>

Environmental Permits	<p>There are 4N^o environmental permits shown within 250m of the site. These are recorded as Licensed Discharges to Controlled Waters.</p> <p>The nearest, permit no. 3/28/73/1922, is located in the south of the site for sewage discharges comprising final/ treated effluent, and was issued in March 1972 with no recorded revocation date. The remaining 3N^o permits are also for sewage discharges comprising final/ treated effluent, and were issued in March 1972 with no recorded revocation date. These are located from 38m south east, 62m south west and 127m east of the site.</p>
Pollution Incidents	<p>There are no pollution incidents shown within 250m of the site.</p>
Landfill Sites	<p>There are no current or historical landfills shown within 250m of the site.</p>
Waste Transfer & Processing Stations	<p>There are no waste transfer and processing stations shown within 250m of the site.</p> <p>There are 3N^o waste exemptions recorded within 250m of the site, and these are recorded on the site. Ref. WEX131193 is for use of waste for a specified purpose. Ref. WEX079546 and ref. EPR/RF0431MP/A001 are for the deposition of waste from dredging of inland waters, burning waste in the open, storage of waste in a secure place, use of waste in construction, spreading waste/ plant matter on agricultural land to confer benefit, and use of mulch.</p>
Hydrogeology	<p>There is a Principal Aquifer within the bedrock.</p> <p>The site and surrounding area is located within a Source Protection Zone 3.</p> <p>There are no ground water abstractions within the vicinity of the site.</p>
Hydrology	<p>Based on the hydrology map within the Groundsure report, 2N^o watercourses are shown within 250m of the site. These are recorded as inland rivers named Flood Dyke and the River Poulter, which intersect the central and southern areas of the site respectively and run through a culvert in a south west to north east direction beneath Piper Lane.</p> <p>There are 2N^o active surface water abstractions within 250m of the site, located in the western area of the site and from 64m south west of the site. These are detailed to be for spray irrigation.</p>

Flooding	<p>There is a MEDIUM-HIGH recorded Risk of Flooding from Rivers and the Sea (RoFRaS) in the southern area of the site extending out to the north east and south west in the surrounding area.</p> <p>In addition, there is a recorded Flood Zone 2 and Flood Zone 3 in the southern area of the site extending out to the north east and south west in the surrounding area.</p> <p>The highest risk of on-site surface water flooding is recorded to be a 1 in 30-year rainfall event with a maximum modelled flood depth of greater than 1.0m.</p> <p>The risk of on-site groundwater flooding is recorded to be predominantly MODERATE across the site with a HIGH risk in the southern area.</p> <p>A full Flood Risk Assessment may be required as part of any future planning application.</p>
Unexploded Ordnance	<p>A review of online records indicates that the site is in a low-risk area with regards to unexploded ordnance. The results of an online Zetica search are provided in Appendix V of the Phase I Desk Study.</p>
Environmental Sensitivity	<p>The site is located within a nitrate vulnerable zone.</p> <p>Habitats of principal importance are recorded on the site, including coastal and floodplain grazing marsh and lowland fens, which extend out to the south west and north east. Additional habitats of principal importance comprising heathland, deciduous woodland and grassland are located in the surrounding area from 196m north east and 203m east extending out. Clumber Park, an SSSI, is located from 203m east of the site. It should also be noted that 3N^o Grade II listed buildings are recorded on the site.</p>

3.4. PHASE I PRELIMINARY RECOMMENDATIONS

The Phase I report identified a number of potential pollution linkages that may be present within the site, and recommended that representative soil samples were removed from the site and submitted for contamination analysis. This included hydrocarbon testing targeting the existing above ground tank area, and the potential oil hotspot area in the eastern on-site barn.

It also recommended that a number of boreholes and/ or trial pits were undertaken in order to make comment on the foundation solution for the proposed development. In addition, a series of hand dug pits was recommended against the existing buildings proposed for refurbishment, to confirm the nature and depth of existing foundations.

CBR testing was also recommended along proposed roadways to confirm the requirements for pavement design.

A preliminary coal mining risk assessment was undertaken which identified the risk from shallow depth coal mining works was low. As such no further works relating to this matter were deemed necessary.

4. INTRUSIVE INVESTIGATION

4.1. FIELDWORK

The intrusive investigation consisted of 5N^o windowless sampler boreholes, 18N^o trial pits excavated by JCB, 19N^o hand dug pits and 11N^o foundation pits. The intrusive investigations were carried out on between 18th October 2021 and 2nd November 2021; the locations of which can be found within Appendix I. The intrusions aimed to target specific areas of proposed development and soft landscaping to give a good overview of the underlying strata. On 2nd and 3rd November 2021, following the initial intrusive investigation, cores were undertaken followed by hand-digging/drilling along Piper Lane and the existing access roadway in the east of the site to confirm the depth and thickness of tarmac, concrete and sub-base. Additionally, land rover mounted CBR tests were carried out within Piper Lane and within the eastern field along the proposed roadway. The weather ranged from clear to overcast with occasional showers of light rain.

The boreholes and trial pits identified concrete to 0.09mbgl in WS01, 0.19mbgl in WS03 and 0.2mbgl in WS04. In all remaining locations, with the exception of WS02 and TP17 which identified Made Ground at the ground surface, topsoil and subsoil was identified to depths of between 0.3mbgl (TP16) and 0.9mbgl (TP14). Made Ground was recorded in 9N^o locations, reworked ground in 5N^o locations and fill in 4N^o locations. A summary of this material, including the depths in each location, is provided below.

Material Type	Location	Top Depth (mbgl)	Bottom Depth (mbgl)	General Composition
Made Ground	WS01	0.09	0.30	Sandy gravel, gravelly sand and silty sandy gravelly clay. Fragments of ceramic and glass, warped metal, wood, animal bone and clay pipe noted, as well as brick, tarmac and concrete cobbles, and whole bricks.
	WS02	0.00	0.50	
	WS03	0.28	0.60	
	WS04	0.20	0.79	
	TP04	0.00	0.35	
	TP05	0.05	0.30	
	TP11	1.50	2.00	
	TP15	0.50	2.00	
Reworked Ground	WS03	0.60	0.70	Gravelly sand and sandy gravelly clay with fragments of coal and brick.
	WS04	0.79	0.90	
	WS05	0.35	1.40	
	TP11	0.65	1.50	
	TP13	0.60	1.40	
Fill	WS03	0.19	0.28	Concrete sub-base comprising sandy gravel, and tarmac gravel.
	TP02	0.15	0.20	
	TP03	0.15	0.25	
	TP06	0.05	0.20	

Superficial deposits comprising sand and gravelly sand were identified in all locations with the exception of TP11 and TP15. These were identified at top depths of between 0.3mbgl (WS01 and TP16) and 1.4mbgl (WS05 and TP13), with thicknesses ranging from 0.1m (TP13) to 2.7m (TP07). TP11 and TP15 were terminated in Made Ground.

Bedrock was not encountered during this site investigation.

Logs of the windowless sampler boreholes and trial pits can be found in Appendix II and III of this report respectively. In addition, logs of the foundation pits and cores can be found in Appendix IV and V of this report respectively.

Soil samples were removed for laboratory analysis from 41No intrusive locations.

4.2. GROUNDWATER

During the site investigation works, water strikes were recorded within TP12 at 2.6mbgl and 2.8mbgl, TP13 at 1.5mbgl, TP15 at 2.0mbgl and WS05 at 1.5mbgl. In addition, some sitting water was noted within TP11 at 1.8mbgl associated with a potential service.

4.3. GAS MONITORING

Extensive Made Ground associated with building demolition was not encountered during the ground investigation, and no significant external sources of land gas were identified from a review of the historical maps included within the Phase I Desk Study. Therefore, as per the CL:AIRE RB17 document¹, gas monitoring is not considered necessary.

4.4. LABORATORY TESTING

The Desk Study recommended a regime of contamination testing on soil samples recovered from the intrusive investigation. Samples were obtained during the site investigation and tested at a UKAS accredited laboratory for contaminants including:

- 30No Heavy Metals
- 30No Polycyclic Aromatic Hydrocarbons
- 30No Total Petroleum Hydrocarbons
- 31No Asbestos

Geotechnical testing was also carried out on the soils. The samples were tested for:

- 10No pH
- 10No Water Soluble Sulphate (2:1)
- 2No Atterberg limits

A limited number of Atterberg samples were taken during the ground investigation due to the lack of cohesive deposits identified.

¹ CL:AIRE RB 17, A Pragmatic Approach to Ground Gas Risk Assessment, CL:AIRE, 2012

5. CONTAMINATION ASSESSMENT

5.1. GENERAL

Current Environmental Legislation, in particular Part IIA of the Environmental Protection Act 1990, adopts a risk-based approach to the evaluation of contaminated sites, based on the proposed end use of the site. The commonly accepted approach is to adopt a Source-Pathway-Receptor model where the Source of the contaminant is examined in relation to potential Receptors (i.e. humans, controlled waters etc.) to determine if there is a Pathway (i.e. contaminant linkage) connecting them. If any of these elements (i.e. contaminant, pathway or receptor) are absent or removed, then there is no risk.

The Department of the Environment, Food and Rural Affairs (DEFRA) have published a series of guidelines in connection with Risk Assessment. In addition The Environment Agency has produced the Contaminated Land Exposure Model (CLEA) which models guideline values for those elements which pose the greatest risk to human health.² Using values derived from CLEA, a site specific, conceptual model has been used to determine any significant contaminant linkages and identify suitable risk management proposals on which remediation design (if any required) can be based. The conceptual model is summarised at the end of this section in tabular form.

By considering the Source-Pathway-Receptors Model, an assessment can be made as to whether the source contamination can reach a receptor. The degree and significance of any resulting risk is then determined. The categorisation of the risk is based on consideration of both:

- The likelihood or probability of an event (taking into account both the presence of the Source and the Receptor, and the integrity of the Pathway).
- The severity of the potential consequence (taking into account both the potential severity of the Source and the sensitivity of the Receptor).

The following categorisation of risk has been adopted in this report:

Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High	Harm is likely to arise to a designated receptor from an identified hazard without appropriate remedial action.
Moderate	It is possible that, without appropriate remedial action, harm could arise to a designated receptor, but it is relatively unlikely that any such harm would be severe and, if harm were to occur, it is more likely that such harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that, at worst, this harm, if realised, would normally be mild.
Negligible	The presence of an identified hazard does not give rise to the potential to cause any significant harm to a designated receptor on this site.

² Updated technical background to the CLEA model, Science Report SC050021/SR3, The Environment Agency, 2009

5.2. PRELIMINARY CONCEPTUAL SITE MODEL

The following table provides a list of the potential Sources, Pathways and Receptors that have potential to exist on this site as determined within the Phase I Desk Study.

Potential Source	Contaminants	Receptor	Pathway	Potential Risk
Soil based Contaminants (Solid)	Heavy Metals PAH TPH	Construction Workers	Direct contact with soil Ingestion of soils Inhalation of soil dust Inhalation of vapours (PAH/ TPH only)	Moderate
		Maintenance Workers End user	Direct contact with soil Ingestion of soils Inhalation of soil dust Inhalation of vapours (PAH/ TPH only)	Moderate
		Off-Site Resident	Inhalation of soil dust Inhalation of vapours (PAH/ TPH only)	Low
		Flora & Fauna	Plant uptake	Low/ Moderate
		Buildings & Infrastructure	Direct Contact with soil	Low
Soil based Contaminants (as Leachate)	Heavy Metals PAH TPH	Flora & Fauna	Plant uptake	Low/ Moderate
		Surface Water Surface Water Abstraction	Leaching/ migration via groundwater	Low/ Moderate
		Aquifer	Leaching/ migration via groundwater	Low/ Moderate
Asbestos within building fabric	Asbestos Fibres	Construction Workers	Inhalation of asbestos fibres	High*
Asbestos within Made Ground	Asbestos Fibres	Construction Workers Maintenance Workers End user	Inhalation of asbestos fibres	High
Land Gas*		Construction Workers Maintenance Workers End user	Inhalation of gases	Low/ Moderate

Based on the above conceptual site model, the following sources of contamination have been investigated;

- Soils
 - Heavy Metals
 - Poly Aromatic Hydrocarbons
 - Total Petroleum Hydrocarbons
 - Asbestos

*Based on ground conditions recorded during the site investigation works and lack of significant external sources of land gas, gas monitoring has not been carried out as part of this assessment.

5.3. CONTAMINATION CRITERIA FOR SOIL TESTING

Suitable 4 Use Levels (S4ULs) published by Land Quality Management, have been used to assess risk.³ Where there are no S4ULs, Defra Category 4 Screening Levels (C4SLs) have been used as intervention values to assess risk.⁴

It is proposed that the site will be developed with holiday accommodation buildings and shepherds’ huts, with existing buildings to be converted accordingly, a new driveway and footpath in the east, numerous areas of new/ upgraded soft landscaping across the site, and car parks in the eastern, central and western areas. Therefore, the proposed land use can be classified as ‘Residential with Home Produce’ in accordance with the CLEA Guidelines.

Soils were taken from site and tested for % Soil Organic Matter (SOM).

Taking the lowest SOM recorded as the worst-case scenario, the results of the chemical analysis on the soil samples are compared against the S4ULs for ‘Residential with Home Produce’ developments with 1% SOM (where there are published S4ULs) and C4SLs where there are no published S4ULs. These values are then used as Intervention Values (IV) to assess the risk.

5.4. RESULTS OF CONTAMINATION TESTING

The following tables are summaries of the laboratory test results. Please see the key below for the origin of each intervention value.

Intervention Value Key

Author	Type	Land Use
Land Quality Management	S4UL	Residential with Home Produce
DEFRA	C4SL	Residential with Home Produce

³ The LQM/CIEH S4ULs for Human Health Risk Assessment, Land Quality Press, Nathanail et. al, 2015.

⁴ SP1010, Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, DEFRA 2014

Summary of Soil Exceedances

Location	Bottom Depth	Strata	Exceeding Contaminants (Exceeding Concentration)	Intervention Values – Residential with Home Produce (1% SOM)
HDP01	0.40mbgl	Subsoil	Arsenic (42mg/kg)	Arsenic (37mg/kg)
HDP02	0.30mbgl	Subsoil	Chrysotile asbestos fibres (0.007%) Benzo(a)anthracene (11.9mg/kg) Benzo(a)pyrene (10.9mg/kg) Benzo(b)fluoranthene (11.6mg/kg) Chrysene (16.2mg/kg) Dibenzo(ah)anthracene (0.73mg/kg) TPH Aro>C16-21 (365mg/kg)	Chrysotile asbestos fibres (NAD) Benzo(a)anthracene (7.2mg/kg) Benzo(a)pyrene (2.2mg/kg) Benzo(b)fluoranthene (2.6mg/kg) Chrysene (15mg/kg) Dibenzo(ah)anthracene (0.24mg/kg) TPH Aro>C16-21 (260mg/kg)
HDP03	0.20mbgl	Made Ground	Chrysotile asbestos fibres (0.001%) Benzo(a)anthracene (28.3mg/kg) Benzo(a)pyrene (18.1mg/kg) Benzo(b)fluoranthene (18.8mg/kg) Chrysene (35.2mg/kg) Dibenzo(ah)anthracene (1.5mg/kg) Naphthalene (6.95mg/kg) Phenanthrene (123mg/kg) TPH Aro>C16-21 (604mg/kg) TPH Aro>C21-35 (1830mg/kg)	Chrysotile asbestos fibres (NAD) Benzo(a)anthracene (7.2mg/kg) Benzo(a)pyrene (2.2mg/kg) Benzo(b)fluoranthene (2.6mg/kg) Chrysene (15mg/kg) Dibenzo(ah)anthracene (0.24mg/kg) Naphthalene (2.3mg/kg) Phenanthrene (95mg/kg) TPH Aro>C16-21 (260mg/kg) TPH Aro>C21-35 (1100mg/kg)

Location	Bottom Depth	Strata	Exceeding Contaminants (Exceeding Concentration)	Intervention Values – Residential with Home Produce (1% SOM)
HDP13	0.20mbgl	Topsoil	Lead (216mg/kg)	Lead (200mg/kg)
HDP14	0.20mbgl	Topsoil	Lead (239mg/kg)	Lead (200mg/kg)
HDP16	0.40mbgl	Made Ground	Lead (478mg/kg)	Lead (200mg/kg)
WS01	0.30mbgl	Made Ground	Lead (326mg/kg)	Lead (200mg/kg)
WS03a	0.50mbgl	Made Ground	Lead (408mg/kg)	Lead (200mg/kg)
WS04a	0.40mbgl	Made Ground	Arsenic (45mg/kg)	Arsenic (37mg/kg)

The full test certificates and screened results are included in Appendix VII and Appendix VIII of this report respectively.

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5.5. RADON AND LAND GAS

<1% of properties in the area are above the radon action level. Therefore, radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.⁵

Extensive Made Ground associated with building demolition was not encountered during the ground investigation, and no external sources of land gas were identified from a review of the historical maps included within the Phase I Desk Study. Therefore, as per the CL:AIRE RB17 document, gas monitoring is not considered necessary.

5.6. CONTAMINATION SOURCES

Elevated concentrations of heavy metals, PAH, TPH and asbestos have been identified on the site.

This contamination is considered to be predominantly isolated in the south western area in the location of the proposed shepherd huts (HDP02 and HDP03). A plan showing these soil contamination exceedances is provided within Appendix IX. The remainder of the contamination was found within the rear garden areas of the existing residential buildings in the west of the site, the courtyard of the western barn building, and adjacent to the eastern barn buildings.

Source	Elevated Levels Present?
Heavy Metals	Yes
Poly Aromatic Hydrocarbons	Yes
Total Petroleum Hydrocarbons	Yes
Asbestos	Yes
Radon	No
Land Gas	N/A

5.7. PATHWAYS

Based on the proposed land use, the possible pathways that exist on site for any possible source of contamination are as follows;

⁵ BRE 211, Radon: guidance on protective measures for new buildings, BREPress, Scivyer, 2007

Pathway	Pathway Present	Comments
Direct Contact with soil/ water	Yes	Potential for contact with soil/ water during future landscaping/ development works
Incidental ingestion	Yes	Potential for ingestion of soils/ water during future landscaping/ development works
Inhalation of soil dust/ asbestos fibres	Yes	Potential for inhalation of soil dust/ asbestos during future landscaping/ development works and ground disturbance
Leaching/ migration of liquids	Yes	Potential for leaching to aquifer in areas of the site already developed with soft, vegetative cover which are proposed to be upgraded
Surface water run-off	No	Site is developed with both hardstanding cover, providing a capping layer between any rainwater run-off and potential underlying contaminants, and soft landscaped areas in which rainwater will infiltrate
Migration/ emission/accumulation inhalation of land gas/ vapours	Yes	Migration and emission of land gas/ vapours possible, with potential for accumulation in any proposed new buildings on site
Plant uptake/ plant uptake followed by ingestion	Yes	Potential for plant uptake in any existing soft landscaped areas which are proposed to be upgraded

5.8. RECEPTORS

Based on the identified sources of contamination, and the present pathways, the potential receptors for the development are:-

Receptor	Receptor Present	Comments
Site worker	Yes	Staff involved in proposed redevelopment works and ground works at the site
Maintenance staff	Yes	Carrying out routine maintenance in the future (assumes workers will visit the site on an infrequent basis and will not carry out intrusive works)
Long term site user/ future resident	Yes	Long term site users/ existing and future residents
Off-site resident	Yes	Residential housing is located from approximately 55m east and 80m south of Piper Lane, as well as from 200m east of the site
Flora & Fauna	Yes	Flora on existing and proposed upgraded landscaped areas
Aquifer	Yes	There is a Principal Aquifer within the bedrock. The site and surrounding area is located within a Source Protection Zone 3, however there are no ground water abstractions within the vicinity of the site
Surface water	Yes	2N ^o watercourses are shown within 250m of the site, recorded as inland rivers named Flood Dyke and the River Poulter. These intersect the central and southern areas of the site respectively and run through a culvert in a south west to north east direction beneath Piper Lane. There are 2N ^o active surface water abstractions within 250m of the site, located in the western area of the site and from 64m south west of the site. These are detailed to be for spray irrigation.
Buildings & Infrastructure	Yes	Building substructure/ services, drainage etc.

5.9. SITE SPECIFIC MODEL

Source	Contaminant	Receptor	Pathway	Risk
Soil based contaminants (Solid)	Heavy Metals ¹	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹ E – Flora & Fauna ¹ F – Aquifer ¹ G – Surface Water ¹ H – Buildings & Infrastructure ¹	a – Direct contact with soil/ water ¹ b – Incidental ingestion ¹ c – Inhalation of soil dust/ asbestos fibres ¹ d – Leaching/ migration ¹ e – Surface water run off ² g – Plant uptake/ plant uptake followed by ingestion ¹	Moderate
	Polycyclic Aromatic Hydrocarbons ¹	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹ E – Flora & Fauna ¹ F – Aquifer ¹ G – Surface Water ¹ H – Buildings & Infrastructure ¹	a – Direct contact with soil/ water ¹ b – Incidental ingestion ¹ c – Inhalation of soil dust/ asbestos fibres ¹ d – Leaching/ migration ¹ e – Surface water run off ² f – Migration/ emission/ inhalation of land gas/ vapours ¹ g – Plant uptake/ plant uptake followed by ingestion ¹	Moderate
	Total Petroleum Hydrocarbon ¹	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹ E – Flora & Fauna ¹ F – Aquifer ¹ G – Surface Water ¹ H – Buildings & Infrastructure ¹	a – Direct contact with soil/ water ¹ b – Incidental ingestion ¹ c – Inhalation of soil dust/ asbestos fibres ¹ d – Leaching/ migration ¹ e – Surface water run off ² f – Migration/ emission/ inhalation of land gas/ vapours ¹ g – Plant uptake/ plant uptake followed by ingestion ¹	Moderate
Asbestos in Made Ground	Asbestos fibres ¹	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹	c – Inhalation of soil dust/ asbestos fibres ¹	High

Source	Contaminant	Receptor	Pathway	Risk
Asbestos in Building Fabric	Asbestos fibres ¹	A – Construction Workers ¹	c – Inhalation of soil dust/ asbestos fibres ¹	High*
Radon ²		C – Future End user ¹	f – Inhalation of gases ¹	Negligible
Land Gas ²		C – Future End user ¹	f – Inhalation of gases ¹	Negligible

¹ Source/ Pathway/ Receptor PRESENT on site

²Source/ Pathway/ Receptor NOT PRESENT on site

5.10. CONTAMINATION ISSUES

Based upon the conceptual site model, there are 28No contamination linkages present for the sources tested for.

1. Heavy Metals with respect to Construction Workers
2. Heavy Metals with respect to Maintenance Workers
3. Heavy Metals with respect to Future End User
4. Heavy Metals with respect to Off-Site Resident
5. Heavy Metals with respect to Flora and Fauna
6. Heavy Metals with respect to the Aquifer
7. Heavy Metals with respect to the Surface Water
8. Heavy Metals with respect to the Buildings and Infrastructure.
9. PAH with respect to Construction Workers
10. PAH with respect to Maintenance Workers
11. PAH with respect to Future End User
12. PAH with respect to Off-Site Resident
13. PAH with respect to Flora and Fauna
14. PAH with respect to the Aquifer
15. PAH with respect to the Surface Water
16. PAH with respect to the Buildings and Infrastructure
17. TPH with respect to Construction Workers
18. TPH with respect to Maintenance Workers
19. TPH with respect to Future End User
20. TPH with respect to Off-Site Resident
21. TPH with respect to Flora and Fauna
22. TPH with respect to the Aquifer
23. TPH with respect to the Surface Water
24. TPH with respect to the Buildings and Infrastructure
25. Asbestos with respect to Construction Workers
26. Asbestos with respect to Maintenance Workers
27. Asbestos with respect to Future End User
28. Asbestos with respect to Off-Site Resident

5.11. ASSESSED RISKS AND MANAGEMENT

Elevated heavy metals, PAH, TPH and asbestos fibers are predominantly contained within 3No locations in the south western area of the site in the area of the proposed shepherd huts (HDP01, HDP02 and HDP03). In addition, elevated concentrations of heavy metals have been identified within 6No locations in the wider area of the site, including the existing rear residential garden areas in the west of the site (HDP13 and HDP14), the courtyard in the west (HDP16, WS01), and the area of the eastern barns (WS03 and WS04).

A site induction should warn construction workers as to the presence of contaminated material onsite. Appropriate personal protective equipment should be worn, accompanied with employing

good personal hygiene standards (especially before eating) in order to minimise the risk to construction workers on site.

The following measures are recommended in order to create a suitable barrier to prevent a pathway between the contamination and the potential receptors on site:

- Within the south western area of the site in the area of the proposed shepherd huts, surface soils should be removed from all proposed soft landscaped areas in order to allow the placement of 600mm of clean, certified, topsoil and subsoil overlain by a high-visibility membrane. Based on the quantification testing on the asbestos (0.007% w/w and 0.001% w/w respectively), the surface material can be removed from the site and classified as non-hazardous with respect to asbestos. This area should either be delineated by land use including fencing to separate this from other areas of the site, or by additional hotspot testing, to confirm the extents of asbestos contamination.
- Any existing/ proposed soft landscaped areas within the courtyard area and the residential rear garden areas in the west should have surface soils removed in order to allow the placement of 600mm of clean, certified, topsoil and subsoil. The extents of these areas should be confirmed depending on final soft landscaping proposals and land use boundaries. Alternative options may be available subject to final landscaping proposals including additional testing and risk assessment.
- Existing Made Ground material is considered unsuitable for use within the top 600mm of soft landscaped areas. Any re-used topsoil to be used as capping within the top 600mm should be tested in accordance with YALPAG Guidance Verification Requirements for Cover Systems to confirm suitability for use.
- It is understood the area of the site in which windowless sampler boreholes WS03a and WS04a were carried out are to remain hardstanding. As such, this is considered a suitable barrier between the contamination and future end users of the site.

The following table details the assessed risk from the Site-Specific conceptual site model, the recommended Management/Remediation proposals and the Residual Risk after these proposals have been implemented.

Site Area	Source	Pathway	Receptor	Risk	Management / Remediation Proposals	Residual Risk
	Asbestos In Building Fabric	C	A	High	There is the potential for asbestos to be present within the existing building fabric, it is assumed that all proposed building works will be carried out in accordance with current guidelines and that any asbestos on site will be removed prior to any works.	Negligible
Area of proposed shepherds' huts	Heavy Metals TPH PAH	a, b, c, f, g	A	Moderate	Site induction to cover the potential for contaminants existing on site.	Negligible

Site Area	Source	Pathway	Receptor	Risk	Management / Remediation Proposals	Residual Risk
in south west (HDP01, HDP02, HDP03)	Asbestos				Personal Protective Equipment to be used at all times including gloves. Good levels of Personal hygiene to be maintained including washing hands before eating.	
		d	F	Moderate	There is a Principal Aquifer within the bedrock. The site and surrounding area are located within a Source Protection Zone 3. There is the potential for contaminants within the site surface materials to migrate into the aquifer. However, it is assumed that the majority of the contaminated material will be removed from site as part of the site strip, therefore the risk of contaminants leaching into the aquifer is reduced.	Low
		d	D	Negligible	There are no groundwater abstractions within 250m of the site, therefore the risk to humans as a result of contamination migrating into the aquifer is negligible.	Negligible
		d	G	Negligible	Flood Dyke and the River Poulter intersect the central and southern areas of the site respectively and run through a culvert in a south west to north east direction beneath Piper Lane. There are 2Ne active surface water abstractions within 250m of the site, located in the western area of the site and from 64m south west of the site. However, these are detailed to be for spray irrigation, therefore the risk to humans as a result of contamination migrating into the surface waters is negligible.	Negligible
		a, b, c, f, g	B, C, D, E, F, G, H	Moderate	Surface soils should be removed from all proposed soft landscaped areas in order to allow the placement of 600mm of clean, certified, topsoil and subsoil overlain by a high-visibility membrane.	

Site Area	Source	Pathway	Receptor	Risk	Management / Remediation Proposals	Residual Risk
					Based on the quantification testing on the asbestos (0.007% w/w and 0.001% w/w respectively), the surface material can be removed from the site and classified as non-hazardous with respect to asbestos. This area should either be delineated by land use including fencing to separate this from other areas of the site, or by additional hotspot testing, to confirm the extents of asbestos contamination.	
Existing/ proposed soft landscaping in courtyard area and residential rear gardens in west (HDP13, HDP14, HDP16, WS01)		a, b, c, f, g	A	Moderate	Site induction to cover the potential for contaminants existing on site. Personal Protective Equipment to be used at all times including gloves. Good levels of Personal hygiene to be maintained including washing hands before eating.	Negligible
		d	F	Moderate	There is a Principal Aquifer within the bedrock. The site and surrounding area are located within a Source Protection Zone 3. There is the potential for contaminants within the site surface materials to migrate into the aquifer. However, it is assumed that the majority of the contaminated material will be removed from site as part of the site strip, therefore the risk of contaminants leaching into the aquifer is reduced.	Low
		d	D	Negligible	There are no groundwater abstractions within 250m of the site, therefore the risk to humans as a result of contamination migrating into the aquifer is negligible.	Negligible
		d	G	Negligible	Flood Dyke and the River Poulter intersect the central and southern areas of the site respectively and run through a culvert in a south west to north east direction beneath Piper Lane. There are 2Ne	Negligible

Site Area	Source	Pathway	Receptor	Risk	Management / Remediation Proposals	Residual Risk
					active surface water abstractions within 250m of the site, located in the western area of the site and from 64m south west of the site. However, these are detailed to be for spray irrigation, therefore the risk to humans as a result of contamination migrating into the surface waters is negligible.	
	Heavy Metals	a, b, c, f, g	A	Moderate	Surface soils should be removed in order to allow the placement of 600mm of clean, certified, topsoil and subsoil. The extents of these areas should be confirmed depending on final soft landscaping proposals and land use boundaries. Alternative options may be available subject to final landscaping proposals including additional testing and risk assessment.	Negligible
Area of eastern barns (WS03 and WS04)	Heavy Metals	a, b, c, d, g	A, B, C, D, E, F, G, H	Moderate	Elevated concentrations of heavy metals have been identified in the windowless sampler boreholes WS03 and WS04. However, it is understood this area is to remain hardstanding. This is considered a suitable barrier between the contamination and future end users of the site.	Negligible

All ground works should be monitored by a suitably qualified person and significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further works.

5.12. ENVIRONMENTAL SUMMARY

Elevated concentrations of heavy metals, PAH, TPH and asbestos are present on site.

A site induction and appropriate PPE should mitigate any risk towards construction workers.

The following measures are recommended in order to create a suitable barrier to prevent a pathway between the contamination and the potential receptors on site:

- Within the south western area of the site in the area of the proposed shepherd huts, surface soils should be removed from all proposed soft landscaped areas in order to allow the placement of 600mm of clean, certified, topsoil and subsoil overlain by a high-visibility membrane. Based on the quantification testing on the asbestos (0.007% w/w and 0.001% w/w respectively), the surface material can be removed from the site and classified as non-hazardous with respect to asbestos. This area should either be delineated by land use including fencing to separate this from other areas of the site, or by additional hotspot testing, to confirm the extents of asbestos contamination.
- Any existing/ proposed soft landscaped areas within the courtyard area and the residential rear garden areas in the west should have surface soils removed in order to allow the placement of 600mm of clean, certified, topsoil and subsoil. The extents of these areas should be confirmed depending on final soft landscaping proposals and land use boundaries. Alternative options may be available subject to final landscaping proposals including additional testing and risk assessment.
- Existing Made Ground material is considered unsuitable for use within the top 600mm of soft landscaped areas. Any re-used topsoil to be used as capping within the top 600mm should be tested in accordance with YALPAG Guidance Verification Requirements for Cover Systems to confirm suitability for use.
- It is understood the area of the site in which windowless sampler boreholes WS03a and WS04a were carried out are to remain hardstanding. As such, this is considered a suitable barrier between the contamination and future end users of the site.

A remediation statement will be required to accompany any planning application detailing the risks identified and the mitigation measures prescribed.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further works.

6. GEOTECHNICAL ASSESSMENT

6.1. GENERAL

The site investigation was required to make recommendations as to a suitable foundation solution for the proposed development. 18N^o trial pits and 5N^o boreholes were undertaken to depths of between 1.5mbgl (TP01 and TP13) and 3.3mbgl (TP07) in order to achieve this aim. 11N^o foundation pits were undertaken in order to confirm the foundations of existing buildings.

Additionally, 14N^o cores were undertaken followed by hand-digging/ drilling along Piper Lane and the existing access roadway in the east of the site to confirm the depth and thickness of the tarmac, concrete and sub-base. 16N^o land rover mounted CBR tests were carried out within Piper Lane running through the site and within the eastern field along the proposed roadway.

6.2. GEOLOGICAL ASSESSMENT

Artificial Deposits

The boreholes and trial pits identified concrete to 0.09mbgl in WS01, 0.19mbgl in WS03 and 0.2mbgl in WS04. In all remaining locations, with the exception of WS02 and TP17 which identified Made Ground at the ground surface, topsoil and subsoil was identified to depths of between 0.3mbgl (TP16) and 0.9mbgl (TP14). Made Ground was recorded in 9N^o locations, reworked ground in 5N^o locations and fill in 4N^o locations. A summary of this material, including the depths in each location, is provided below.

Material Type	Location	Top Depth (mbgl)	Bottom Depth (mbgl)	General Composition
Made Ground	WS01	0.09	0.30	Sandy gravel, gravelly sand and silty sandy gravelly clay. Fragments of ceramic and glass, warped metal, wood, animal bone and clay pipe noted, as well as brick, tarmac and concrete cobbles, and whole bricks.
	WS02	0.00	0.50	
	WS03	0.28	0.60	
	WS04	0.20	0.79	
	TP04	0.00	0.35	
	TP05	0.05	0.30	
	TP11	1.50	2.00	
	TP15	0.50	2.00	
Reworked Ground	WS03	0.60	0.70	Gravelly sand and sandy gravelly clay with fragments of coal and brick.
	WS04	0.79	0.90	
	WS05	0.35	1.40	
	TP11	0.65	1.50	
	TP13	0.60	1.40	
Fill	WS03	0.19	0.28	Concrete sub-base comprising sandy gravel, and tarmac gravel.
	TP02	0.15	0.20	
	TP03	0.15	0.25	
	TP06	0.05	0.20	

Superficial Deposits

Superficial deposits comprising sand and gravelly sand were identified in all locations with the exception of TP11 and TP15. These were identified at top depths of between 0.3mbgl (WS01 and TP16) and 1.4mbgl (WS05 and TP13), with thicknesses ranging from 0.1m (TP13) to 2.7m (TP07).

Bedrock

Bedrock was not encountered during this site investigation.

6.3. MINING

No evidence of mining was uncovered during the site investigation and no further works related to this matter are considered necessary.

6.4. FOUNDATION PITS

11No foundation pits were excavated against the east and west barns in order to confirm the nature and depth of the existing foundations. Pits were excavated to depths of between 750mmbgl (FP01 and FP11) and 1400mmbgl (FP04 - FP07). These were generally terminated on loose sand or loose gravelly sand with the exception of FP10 and FP11 carried out against the east barns which terminated in Made Ground. Full logs and photographs of the foundation pits are provided in Appendix IV.

6.5. FOUNDATIONS AND SUBSTRUCTURES

Based on the geological conditions found below the site, reinforced shallow depth spread foundations are deemed suitable for the proposed holiday cottages in the west and the proposed shepherds' huts in the south west. The foundations should be onto the natural gravelly sand deposits identified at top depths of between 0.3mbgl (WS01 and TP16) and 1.4mbgl (WS05 and TP13). The sands should be compacted with a compaction plate before concrete is poured. An allowable bearing pressure of 100kN/m² should be assumed.

It is understood all other proposed development works will comprise renovation of existing buildings. A suitably qualified structural engineer should comment on the suitability of existing foundations for the proposed development works in these areas.

6.6. GEOTECHNICAL TEST RESULTS

Soil samples were taken from site and submitted for the following geotechnical testing.

Location	TP03	TP06	TP10	TP11	TP13	TP17	WS01	WS02	WS03	WS05
Depth (m)	2.0	2.0	1.5	1.7	1.3	1.3	1.8-2.0	1.3-1.4	1.5-1.6	1.8-1.9
pH	9.46	8.05	8.22	7.03	6.93	7.64	8.42	8.84	8.66	8.67
SO ₄ (2:1)	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
Plasticity Index	-	-	-	35	NP	-	-	-	-	-
% <425µm	-	-	-	91	68	-	-	-	-	-
Modified Plasticity	-	-	-	31.85	NP	-	-	-	-	-

Based on the soil sulphate concentrations and pH levels, AC-1s conditions exist for buried concrete in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.⁶

The Plasticity Index for the soils tested has been modified as per chapter 4.2 of NHBC guidelines. The results show medium volume change soils exist on site. However, it should be noted that this is based on one sample (from TP11) taken from Made Ground material, which is not considered representative of ground conditions across the site. Foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.⁷

6.7. GROUND FLOOR CONSTRUCTION

Suspended ground floors are preferable for the ground floor of the proposed holiday cottages in the west of the site, substation and energy centre locations. It is understood the proposed shepherd's huts will be pre-fabricated with an internal floor.

6.8. ROAD CORING

14N^o cores were carried out along the existing access roadways along Piper Lane and leading to the eastern barns in order to confirm the depth and thickness of the concrete and tarmac. The depth and thickness of the sub-base was confirmed with additional hand digging and drilling to depths of between 0.60m (Core 12) and 1.6mbgl (Cores 3 and 6).

Tarmac was identified in all locations excepting Cores 1, 2 and 14, and thicknesses ranged from 6cm (Cores 3 and 13) to 21cm (Core 9). Concrete was identified in 1N^o location (Core 1) with a thickness of 13cm. Neither tarmac nor concrete were identified in the Core 2 and Core 14 locations.

The underlying deposits included Fill in 6N^o locations at top depths of between 6cmbgl (Cores 3 and 13) and 20cmbgl (Core 12) with thicknesses ranging from between 5cm (Core 10) and 11.5cm (Core 13). Made Ground was identified in 8N^o locations at top depths of between ground level (Cores 2 and 14) and 21cmbgl (Core 9) with thicknesses ranging from between 5cm (Core 6) and 100cm (Core 2). Reworked ground was identified in 5N^o locations at top depths of between 15cmbgl and 100cmbgl (Cores 6 and 7) with thicknesses ranging from between 5cm (Core 10) and 100cm (Cores 6 and 7).

Made Ground generally comprised sands and gravels with brick, coal and tarmac and occasional ceramic fragments. Fill generally comprised clean gravels and reworked ground generally comprised gravelly sand.

Natural deposits generally comprising gravelly sand were encountered at top depths of between 17.5cm (Core 13) and 120cm (Cores 6 and 7).

Photographs and full descriptions of each core and the underlying material are provided in Appendix V.

⁶ BRE Special Digest 1, Concrete in Aggressive Ground, BRE Press, 2005

⁷ NHBC Standards, Chapter 4.2 Building Near Trees, NHBC, 2014

6.9. LAND ROVER MOUNTED CBR TESTING

16No land rover mounted CBR tests were carried out across the site; 13No within Piper Lane (CBR01-CBR13) and 3No within the existing field in the location of the proposed access roadway (CBR14-CBR16). The locations of these can be found within Appendix I of this report.

Within Piper Lane, the CBR values ranged from 13% (CBR06) to >39% (CBR01-CBR05, CBR07, CBR09-11, CBR13). Within the existing field in the location of the proposed access roadway, the CBR values ranged from 5.2% (CBR16) to 6.6% (CBR15). The full testing results are provided within Appendix VI of this report.

6.10. GEOTECHNICAL SUMMARY

Based on the geological conditions found below the site, reinforced shallow depth spread foundations are deemed suitable for the proposed holiday cottages in the west and the proposed shepherds' huts in the south west. The foundations should be onto the natural gravelly sand deposits identified at top depths of between 0.3mbgl (WS01 and TP16) and 1.4mbgl (WS05 and TP13). The sands should be compacted with a compaction plate before concrete is poured. An allowable bearing pressure of 100kN/m² should be assumed.

Suspended ground floors are preferable for the ground floor of the proposed holiday cottages in the west of the site, with ground bearing floor slabs for the proposed substation and energy centre. It is understood the proposed shepherds' huts will be pre-fabricated with an internal floor.

Based on the soluble sulphate levels found, AC-1s conditions exist on site in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further.

7. SOAKAWAY TESTING

7.1. SOAKAWAY TESTING SUMMARY

Trial pit soakaway testing was proposed to confirm the suitability for soakaway drainage being utilised for the proposed development. This testing was carried out in 6No trial pit locations (TP01, TP02, TP04, TP06, TP14 and TP16). The soakaway tests were carried out at depths of between 1.5mbgl (TP01) and 2.1mbgl (TP04, TP06 and TP14) within generally gravelly cobbly sand.

During each test, the trial pits were filled with 300mm of clean water. Trial pits TP01, TP06, TP14 and TP16 did not completely drain over the 120-minute monitoring periods. Water levels in these trial pits fell by between 30mm (TP01) and 230mm (TP14).

The water within TP02 and TP04 completely drained within times of between 30 minutes and 60 minutes over the 3No tests.

The tests proved soakaway drainage may be suitable at the site within the TP02 and TP04 locations, however may not be suitable within the remaining locations. It is recommended that additional trial pit soakaway testing is carried out in the final proposed soakaway locations to confirm the suitability of soakaway drainage on the site. The full soakaway testing results can be found in Appendix IX.

8. CONCLUSIONS AND RECOMMENDATIONS

In conclusion:

- Elevated heavy metals, PAH, TPH and asbestos have been identified in the south western area of the site in the area of the proposed shepherd huts. In addition, elevated concentrations of heavy metals have been identified within the existing rear residential garden areas in the west of the site, the courtyard in the west, and in the area of the eastern barns.
- Within the south western area of the site in the area of the proposed shepherd huts, surface soils should be removed from all proposed soft landscaped areas in order to allow the placement of 600mm of clean, certified, topsoil and subsoil overlain by a high-visibility membrane. Based on the quantification testing on the asbestos (0.007% w/w and 0.001% w/w respectively), the surface material can be removed from the site and classified as non-hazardous with respect to asbestos. This area should either be delineated by land use including fencing to separate this from other areas of the site, or by additional hotspot testing, to confirm the extents of asbestos contamination.
- Any existing/ proposed soft landscaped areas within the courtyard area and the residential rear garden areas in the west should have surface soils removed in order to allow the placement of 600mm of clean, certified, topsoil and subsoil. The extents of these areas should be confirmed depending on final soft landscaping proposals and land use boundaries. Alternative options may be available subject to final landscaping proposals including additional testing and risk assessment.
- It is understood the area of the site in which windowless sampler boreholes WS03a and WS04a were carried out are to remain hardstanding. As such, this is considered a suitable barrier between the contamination and future end users of the site.
- Extensive Made Ground associated with building demolition was not encountered during the ground investigation, and no significant external sources of land gas were identified from a review of the historical maps included within the Phase I Desk Study. Therefore, as per the CL:AIRE RB17 document, gas monitoring is not considered necessary.
- Concrete was identified to 0.09mbgl in WS01, 0.19mbgl in WS03 and 0.2mbgl in WS04. In all remaining locations, with the exception of WS02 and TP17 which identified Made Ground at the ground surface, topsoil and subsoil was identified to depths of between 0.3mbgl (TP16) and 0.9mbgl (TP14). Made Ground was recorded in 9N^o locations, reworked ground in 5N^o locations and fill in 4N^o locations. A summary of this material can be found in Section 6.2 of this report.
- Superficial deposits comprising sand and gravelly sand were identified in all locations with the exception of TP11 and TP15. These were identified at top depths of between 0.3mbgl (WS01 and TP16), with thicknesses ranging from 0.1m (TP13) to 2.7m (TP07). Bedrock was not identified during this site investigation.
- Based on the geological conditions found below the site, reinforced shallow depth spread foundations are deemed suitable for the proposed holiday cottages in the west and the proposed shepherds' huts in the south west. The foundations should be onto the natural gravelly sand deposits identified at top depths of between 0.3mbgl (WS01 and TP16) and

1.4mbgl (WS05 and TP13). The sands should be compacted with a compaction plate before concrete is poured. An allowable bearing pressure of 100kN/m² should be assumed.

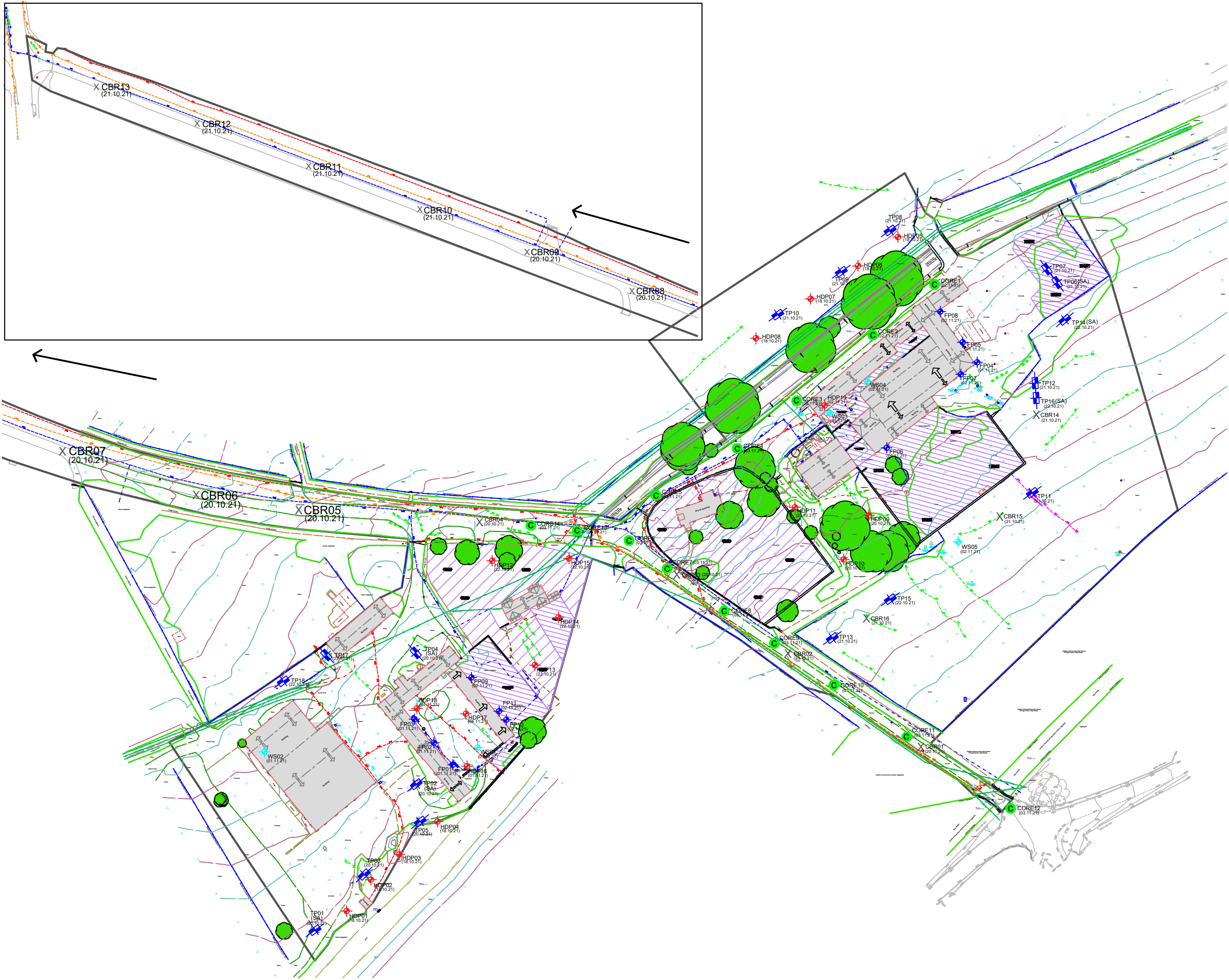
- Suspended ground floors are preferable for the ground floor of the proposed holiday cottages in the west of the site, with ground bearing floor slabs for the proposed shepherds' huts.
- 14N^o cores were carried out along the existing access roadways along Piper Lane and leading to the eastern barns in order to confirm the depth and thickness of the concrete and tarmac. The depth and thickness of the sub-base was confirmed with additional hand digging and drilling to depths of between 0.60m (Core 12) and 1.6mbgl (Cores 3 and 6). Photographs and full descriptions of each core and the underlying material are provided in Appendix V.
- 16N^o land rover mounted CBR tests were carried out across the site; 13N^o within Piper Lane and 3N^o within the existing field in the location of the proposed access roadway. Within Piper Lane, the CBR values ranged from 13% (CBR06) to >39% (CBR01-CBR05, CBR07, CBR09-11, CBR13). Within the existing field in the location of the proposed access roadway, the CBR values ranged from 5.2% (CBR16) to 6.6% (CBR15). The full testing results are provided within Appendix VI of this report.
- Soakaway testing showed that soakaway drainage may be suitable at the site within the TP02 and TP04 locations, however may not be suitable within the remaining locations.

Based on these findings, we recommend that the following should be undertaken:

- A remediation statement will need to be prepared to accompany any planning application, detailing all remedial measures for the site as well as detailed guidance on the verification of the measures employed.
- Additional trial pit soakaway testing should be carried out in the final proposed soakaway locations to confirm the suitability of soakaway drainage on the site.

Appendix I

Site Investigation Plan



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1. Do not scale dimensions from this drawing in either paper or electronic format.
2. To be read in conjunction with all relevant Engineer's, Architect's and Other Drawings and specifications.
3. All building products to be used in strict accordance with the manufacturer's recommendations.
4. Any discrepancies are to be reported to the Engineer immediately.
5. Main Contractor to provide a detailed method statement for all works prior to commencement on site.

- = Windowless Sampler Borehole Location
- = Hand Dug Pit Location
- = Hand Dug Foundation Pit Location
- = Trial Pit Location
- = Road Core Hole Location
- = CBR Testing Location
- = Soakaway Testing Location

Issue	Date	Drawn	Description	Chk'd
2	19.10.21 YK		Final site investigation intrusive locations	
1	15.07.21 YK		Proposed site investigation intrusive locations	



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Client
Welbeck Estates Company Ltd

Project
**P21-00134
 Manor Farm, Carburton**

Title
**Site Investigation
 Location Plan**

Drawn	YK	Checked	Scale	NTS
Date	19.10.21	Date	Original Size	A3
Status	Final	Version		

Drawing No
P21-00134-Met-M2-GE-001 2

Appendix II

Windowless Sampler Borehole Logs



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Windowless Sampler Borehole Log

Borehole No.

WS01

Sheet 1 of 1

Project Name: Manor Farm, Carburton	Project No. P21-00134	Co-ords: 461028E - 373209N	Hole Type WS
Location: Manor Farm, Piper Lane, Carburton, S80 3BT		Level: 42.00	Scale 1:26
Client: Wellbeck Estates Company Ltd		Dates: 01/11/2021	Logged By YK

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.09	41.92	CONCRETE: No rebar.		
					0.30	41.70	MADE GROUND: Grey clayey sandy GRAVEL. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of mixed lithologies including sandstone, mudstone, concrete and brick. Occasional whole bricks noted.		
					1.00	41.00	Medium dense orangish brown very gravelly SAND with moderate cobble content. Sand is fine to medium. Gravel is subangular to rounded fine to coarse of mixed lithologies. Cobbles are subrounded to rounded of mixed lithologies up to 75mm across.	1	
		1.80	D						
		2.00	SPT	N=50 (4,6/50 for 270mm)				2	
		2.70	SPT	50 (25 for 125mm/50 for 125mm)	2.70	39.30	Medium dense, very dense from 2.0mbgl, reddish orange fine grained SAND. Slightly gravelly from 2.5mbgl. Gravel is subrounded to rounded fine to coarse of mixed lithologies.		
					2.90	39.10	Very dense reddish orange slightly gravelly SAND. Sand is fine. Gravel is subangular to subrounded fine to coarse sandstone.		
							End of Borehole at 2.90m	3	
								4	
								5	

Remarks
 Terminated due to SPT refusal.



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Windowless Sampler Borehole Log

Borehole No.

WS02

Sheet 1 of 1

Project Name: Manor Farm, Carburton

Project No.
P21-00134

Co-ords: 460957E - 373209N

Hole Type
WS

Location: Manor Farm, Piper Lane, Carburton, S80 3BT

Level: 44.00

Scale
1:26

Client: Wellbeck Estates Company Ltd

Dates: 01/11/2021

Logged By
YK

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.05			43.95		MADE GROUND: Dark brown slightly gravelly SAND. Sand is fine. Gravel is subangular to subrounded fine to medium of mixed lithologies including brick.		
		0.50			43.50		MADE GROUND: Cream/light brown gravelly SAND. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse of mixed lithologies including sandstone, mudstone, chalk and brick. Frequent fragments of ceramic and glass noted.		
		0.85			43.15		Medium dense orangish light brown gravelly SAND with a moderate to high cobble content. Sand is fine. Gravel is subrounded to rounded fine to coarse of mixed lithologies. Cobbles are subrounded to rounded of mixed lithologies up to 80mm across.		
		1.00	SPT	N=32 (4,5/5,7,10,10)			Dense, very dense between 1.8mbgl and 2.0mbgl, reddish orange SAND. Band of clay noted at 1.3mbgl. Slightly gravelly at 1.8mbgl. Sand is fine. Gravel is subrounded to rounded fine to coarse of mixed lithologies.	1	
		1.30	D						
		1.80	SPT	50 (25 for 55mm/50 for 65mm)					
		2.00	SPT	22 (25,28/22 for 50mm)				2	
		2.20			41.80		End of Borehole at 2.20m		
								3	
								4	
								5	

Remarks

Terminated due to SPT refusals on gravel and/or cobbles.



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Windowless Sampler Borehole Log

Borehole No.

WS03

Sheet 1 of 1

Project Name: Manor Farm, Carburton

Project No.
P21-00134

Co-ords: 461154E - 373324N

Hole Type
WS

Location: Manor Farm, Piper Lane, Carburton, S80 3BT

Level: 42.00

Scale
1:26

Client: Wellbeck Estates Company Ltd

Dates: 01/11/2021

Logged By
YK

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.19	41.81		CONCRETE: No rebar.	
					0.28	41.72		Cream/grey sandy GRAVEL (sub-base).	
					0.60	41.40		MADE GROUND: Multicoloured (brown/ black/ red) very gravelly SAND with moderate cobble content. Sand is fine to medium. Gravel is angular to subrounded fine to coarse of mixed lithologies including sandstone, mudstone, coal and brick. Cobbles are subangular of brick up to 130mm across. Whole brick noted at 0.6mbgl. Reworked: Medium dense reddish orange gravelly SAND. Sand is fine. Gravel is angular to subrounded fine to coarse of mixed lithologies including sandstone, mudstone, coal and brick. Medium dense reddish orange SAND. Slightly gravelly at 1.3mbgl. Sand is fine. Gravel is rounded coarse of mixed lithologies.	
					0.70	41.30			
		1.00	SPT	N=15 (3,3/3,4,4,4)					1
		1.50	D						
		2.00	SPT	50 (7,14/50 for 130mm)	2.00	40.00		Very dense reddish light brown fine SAND.	2
		2.25			2.25	39.75		End of Borehole at 2.25m	
		2.40	SPT	50 (25 for 110mm/50 for 115mm)					3
									4
									5

Remarks

Terminated due to SPT refusal.



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Windowless Sampler Borehole Log

Borehole No.

WS04

Sheet 1 of 1

Project Name: Manor Farm, Carburton	Project No. P21-00134	Co-ords: 461163E - 373333N	Hole Type WS
Location: Manor Farm, Piper Lane, Carburton, S80 3BT	Level: 42.00		Scale 1:26
Client: Wellbeck Estates Company Ltd	Dates: 02/11/2021		Logged By YK

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		1.00	SPT	N=18 (3,3/4,4,4,6)	0.11	41.89		CONCRETE. No rebar.	
					0.20	41.80		Pinkish SANDSTONE slab.	
								MADE GROUND: Reddish light brown slightly clayey very gravelly SAND with a high cobble content. Sand is fine to medium. Gravel is angular to rounded of mixed lithologies including sandstone, mudstone and brick. Cobbles are angular to subangular of sandstone, brick and concrete up to 200mm across. Land drain noted at 0.3mbgl.	
					0.79	41.21		Reworked: Medium dense reddish orange gravelly SAND. Sand is fine. Gravel is angular to rounded fine to coarse of mixed lithologies including sandstone and fragments of coal.	
					0.90	41.10		Damp medium dense, very dense from 2.0mbgl, reddish orange becoming pinkish from 2.0mbgl SAND. Slightly gravelly to 1.5mbgl. Sand is fine. Gravel is subrounded to rounded fine to coarse of mixed lithologies.	
		1.90	D						
		2.00	SPT	50 (9,16/50 for 125mm)					
					2.75	39.25		End of Borehole at 2.75m	

Remarks
 Terminated due to SPT refusal.



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Windowless Sampler Borehole Log

Borehole No.

WS05

Sheet 1 of 1

Project Name: Manor Farm, Carburton	Project No. P21-00134	Co-ords: 461197E - 373276N	Hole Type WS
Location: Manor Farm, Piper Lane, Carburton, S80 3BT	Level: 40.00		Scale 1:26
Client: Wellbeck Estates Company Ltd	Dates: 02/11/2021		Logged By YK

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.18			39.82		Grass overlying dark brown silty gravelly SAND (TOPSOIL) with frequent rootlets. Sand is fine. Gravel is subangular to rounded fine to coarse of mixed lithologies including mudstone, sandstone coal and brick.	1		
		0.35			39.65					Medium brown very gravelly SAND (SUBSOIL) with medium cobble content. Sand is fine grained. Gravel is subrounded to rounded fine to coarse of mixed lithologies. Cobbles are subrounded to rounded of mixed lithologies up to 65mm across.
		1.00	SPT	N=9 (0,0/1,2,2,4)	1.10	38.90		Reworked: Loose light brown gravelly SAND with medium cobble content. Sand is fine. Gravel is subrounded to rounded fine to coarse of mixed lithologies. Cobbles are subrounded to rounded of mixed lithologies up to 65mm across. Land drain noted at 1.0mbgl surrounded by grey subangular coarse gravels.		
		1.40			1.40	38.60				
		1.80	D					Wet medium dense, very dense from 2.7mbgl, reddish orange SAND, gravelly with low cobble content to 1.8mbgl. Sand is fine to medium. Gravel is subrounded to rounded fine to coarse of mixed lithologies. Cobbles are subrounded to rounded of mixed lithologies up to 70mm across.		
	2.00	SPT	N=21 (1,3/3,4,5,9)							2
		2.70	SPT	50 (6,10/50 for 215mm)	2.70	37.30	End of Borehole at 2.70m		3	
Remarks									4	
Terminated due to SPT refusal. Water strike noted at 1.5mbgl.									5	

Appendix III

Trial Pit Logs



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Trial Pit Log

TrialPit No
 TP01
 Sheet 1 of 1

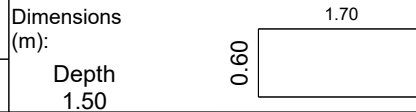
Project Name: Manor Farm, Carburton

Project No.
 P21-00134

Co-ords: 460966.00 - 373144.00
 Level: 40.12

Date
 20/10/2021

Location: Manor Farm, Piper Lane, Carburton, S80 3BT



Scale
 1:25

Logged
 YK

Client: Wellbeck Estates Company Ltd

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.50	39.62		Medium brown silty sandy gravelly SAND (TOPSOIL) with medium cobble content. Sand is fine to medium. Gravel is subangular to rounded fine to coarse of mixed lithologies including sandstone, mudstone, brick and concrete. Cobbles are subangular to subrounded of mixed lithologies up to 150mm across. Whole bricks and frequent fragments of ceramic, glass and plastic noted at 0.2mbgl.
				1.50	38.62		Reddish orange gravelly SAND with medium cobble content. Sand is fine to medium. Gravel is subangular to rounded fine to coarse of mixed lithologies. Cobbles are rounded of mixed lithologies up to 70mm across.
							End of Pit at 1.50m

Remarks: Ground observed to be generally loose during excavation by JCB. Terminated to allow for soakaway testing.

Stability: Unstable Weather: Light Rain

Trial Pit Photos

TP01

Manor Farm, Carburton

P21-00134



Photograph 01: TP01. Trial Pit.



Photograph 02: TP01. Topsoil Arisings.

Trial Pit Photos

TP01

Manor Farm, Carburton

P21-00134



Photograph 03: TP01. Arisings.



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Trial Pit Log

Trial Pit No
 TP02
 Sheet 1 of 1

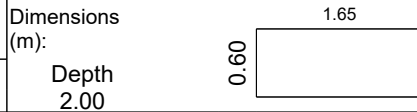
Project Name: Manor Farm, Carburton

Project No.
 P21-00134

Co-ords: 461008.00 - 373187.00
 Level: 39.79

Date
 20/10/2021

Location: Manor Farm, Piper Lane, Carburton, S80 3BT



Scale
 1:25

Logged
 YK

Client: Wellbeck Estates Company Ltd

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.15	39.64		Grass overlying dark brown silty very gravelly SAND (TOPSOIL) with low cobble content and frequent rootlets. Sand is fine. Gravel is angular to subangular fine to coarse of mixed lithologies. Cobbles are subangular to rounded of mixed lithologies up to 90mm across. FILL: Black angular to subangular fine to coarse TARMAC gravels.
				0.20	39.59		
				0.70	39.09		Medium brown very gravelly SAND (SUBSOIL) with medium cobble content. Sand is fine to medium. Gravel is angular to rounded fine to coarse of mixed lithologies including some brick. Cobbles are subrounded to rounded of mixed lithologies up to 100mm across. Orange gravelly SAND with very high cobble content. Sand is fine to medium. Gravel is subangular to rounded of mixed lithologies. Cobbles are subrounded to rounded of mixed lithologies up to 120mm across.
				2.00	37.79		End of Pit at 2.00m

Remarks: Ground observed to be generally loose during excavation by JCB. Terminated to allow for soakaway testing.

Stability: Unstable Weather: Light Rain

Trial Pit Photos

TP02

Manor Farm, Carburton

P21-00134



Photograph 04: TP02. Trial Pit.



Photograph 05: TP02. Trial Pit (2).