Appendix 8.2 Applied Geology Ground Investigation Report (November 2018)

## REPORT ON GROUND INVESTIGATION AT THE PROMISED LAND FARM, BICESTER











### **REPORT STATUS SHEET**

Client:	Albion Land Ltd
Report Title:	Report on Ground Investigation at The Promised Land Farm, Bicester
Report Number:	AG2875-18-AF37
Report Status:	Validated Issue 1
Date:	November 2018



		Date	Signed for and on behalf of Applied Geology Limited
Report Author	F Hadley-Jones BSc (Hons) MSc, FGS Lead Project Engineer	5/11/2018	
Checked & Authorised	G P Wiggin BSc (Hons) MSc, FGS Associate Director	5/11/2018	

### **CONTENTS**

1.0	INTRODUCTION	1
1.1	Objectives and Scope of Investigation	1
1.2	Report Layout	1
2.0	SITE DESCRIPTION	2
2.1	Site Proposals	3
3.0	DESK STUDY INFORMATION	3
4.0	CONCEPTUAL SITE MODEL	4
4.1	Diagrammatical Illustration	4
4.2	Sources	4
4.3	Pathways	5
4.4	Receptors	5
4.5	Source/Pathway/Receptor Linkage and Assessed Risk	5
5.0	GROUND INVESTIGATION WORKS	6
5.1	Fieldwork	6
5.2	Laboratory Testing	6
6.0	GROUND CONDITIONS	7
6.1	Topsoil and Subsoil	7
6.2	Alluvium	8
6.3	River Terrace Deposits	8
6.4	Kellaways Formation	8
6.5	Groundwater	9
6.6	Contamination1	0
7.0	ASSESSMENT 1	0
7.1	Geo-environmental Overview1	0
7.2	Geotechnical Overview1	1
7.3	Conclusions and Recommendations1	2

#### EXECUTIVE SUMMARY

#### APPENDICES

APPENDIX A

#### **DRAWINGS & FIGURES**

- Site Location Plan, Dwg No AG2875-18-01
- Exploratory Hole Location Plan, Dwg No AG2875-18-02
- Conceptual Site Model, Dwg No AG2875-18-03

APPENDIX B	DESK STUDY DATA
APPENDIX C	EXPLORATORY HOLE LOGS
APPENDIX D	LABORATORY TEST RESULTS & DATA SHEETS
APPENDIX E	STANDARD FIELDWORK AND ASSESSMENT PROCEDURES

#### EXECUTIVE SUMMARY

In the standard	Description of the second second state description of the second state of the second
Investigation	Pre-acquisition survey – comprising desk study and trial pitting investigation to assess potential
Objective	geotechnical nazaros and contaminated land issues associated with the site and inform the Client
Cita Decerintian	regarding possible nabilities relating to the ownership of the site.
Site Description	Promised Land Farm, located off Wendlebury Road, approximately 1.5km southwest of Bicester
	town centre. Site covers an area of approximately 15.35na and comprises three undeveloped
	Tields. Langford Brook bounds the site to the east, Wendlebury Farm to the southwest,
	to the works
	to the north.
Site History	The site has comprised undeveloped fields since 1885. The site was bounded to the east by
	Langrord Brook, the west by Roman Road (now Wendlebury Road) and the north and south by
	fields, with farm buildings relating to the Promised Land Farm 150m to the southwest and a
	Sewage Works 200m to the northeast. I wo old clay pits were also shown approximately 225m
	southwest. By 1950, the MOD Bicester, military storage and distribution centre had been
	developed 400m to the east. By 1967, a drain was shown along the southern boundary of the site.
	The north of the site was bound by an access road, connecting to the sewage works, which had
	been redeveloped and expanded to approximately 150m east of the site. By 1983, development of
	wendlebury Farm (consistent with the current layout) had taken place adjacent to the southwest
	or the site. A hursery was located sum to the north of the site, which was later developed into a
	garden centre. By 2002, the Bicester Village Retail Park had been developed approximately 725m
	to the north and a nature reserve was located 150m to the east.
Anticipated Geology	Published information indicates that the majority of the site is initially underlain by Alluvium. The
	Alluvium is absent in the northwest and southwest of the stile, where River Terrace Deposits are
	shown. Solid geology of the Kellaways Formation is anticipated below, comprising interbedded
	sandstone and sitistone of the Kellaways Sand Member, underian by mudstone, interbedded with
	sitistolle and sandstolle of the kellaways Clay Methode. Kellaways Sand is shown to be absent in the parts of the site. The kellaways Examples is antioinstal to be underlain by lighter and the
	Compare Formation is anticipated to be underlain by innestone of the
Other Pertinent Deck	No surrent or historical reports of landfills sites within 250m of the site:
Study Data	One recorded collection incident within 250m of the site located 160m path past associated with
Sludy Dala	microbiological pollutant (2002):
	No recorded petrol/fuel sites identified within 250m;
	Five current industrial land uses, relating to electricity substations and the Sewage Works;
	Superficial Deposits and Kellaways Sand Member are designated as Secondary A Aquifers
	Superioral Depusits and Reliaways Sand Memodule are designated as Secondary A Aquilets.
	Tellaways olay includer is designated as onproductive strata,
	The site is within a Zone 3 Floodolain, where probability of annual flooding estimated as 1 in 100.
	No ecologically sensitive areas within 1000m of the site;
Scope of Investigation	Eighteen machine excavated trial and chemical and geotechnical laboratory testing of soils.
Ground Conditions	Made Ground was not encountered. Topsoil and subsoil was encountered at surface across the
	site and underlain by Superficial Deposits comprising Alluvium and River Terrace Deposits. The
	Superficial Deposits were underlain by the Kellaways Formation, predominantly comprising clay,
	with initial horizons of sand in the southeast of the site.
	Groundwater was recorded as seepages in nearly all of the trial pits, within the River Terrace
	Deposits from depths of between 0.5m and 1.3m bgl, with a fast inflow noted in the north of the
	site. Seepages were also noted within the Kellaways Clay in three locations in the east of the site
	at depths of between 1.3m and 2.7m.
Geo-environmental	Contamination related risks appear to be negligible. Hence, in this respect, potential liabilities
Assessment	associated with ownership are extremely limited.
Geotechnical	Conventional shallow foundations should be considered for light or moderate loads, although
Overview	some construction difficulty may arise owing to shallow groundwater.
	An alternative consideration could be given to a piled foundation.
	No an aid an anti-dation and an an an an an air de trachestar (and the second states of the second states of the
	I No special concrete design measures are required for shallow foundations placed within the River
	renace Deposits. Deeper roundations praced in the underlying Kellaways Formation, will require
	Suprate resisting concrete (DS-4/AC-4).
	Soakaway drainage canacity is likely to be severely restricted by shallow groundwater occurrence
Further	It is understand that the site has now been acquired and further site investigation is recommanded
Recommendations	to provide sufficient information for design and compliance

#### 1.0 INTRODUCTION

#### 1.1 Objectives and Scope of Investigation

Applied Geology were instructed in June 2018 by Bailey Johnson Hayes (Engineer to the Client) on behalf of Albion Land Ltd (the Client) to undertake a pre-acquisition ground investigation at an area of land at The Promised Land Farm, Bicester (the site).

The site comprises three unoccupied tree-lined fields, forming part of the Promised Land Farm.

The objectives of this pre-acquisition ground investigation are to provide information to assess geotechnical hazards and potential contaminated land issues associated with the site in order to inform the Client regarding possible liabilities relating to the ownership of the site.

The terms of reference/brief for the works were mutually developed between Bailey Johnson Hayes and Applied Geology in accordance with Bailey Johnson Hayes Scope of Works and Proposed Trial Pit Location Plan, (reference S1358-Ext-01) and Applied Geology's proposal and estimate (reference AG18-6435-01, dated 30<sup>th</sup> May 2018).

The full scope of works undertaken by Applied Geology comprised:

- A site inspection and walkover survey
- A review of the following desk study sources:
  - GroundSure GeoInsight & EnviroInsight environmental databases.
  - GroundSure MapInsight historical maps.
  - British Geological Survey (BGS) published information & on-line borehole database.
  - Multi-Agency Geographical Information for the Countryside (MAGIC) online database.
  - □ Environment Agency Web Site.
- Ground investigation, comprising trial pitting together with sampling and a programme of geo-environmental and geotechnical laboratory testing.
- Assessment and reporting of the results of the works.

Underground service plans for the site were obtained by Applied Geology in advance of the investigation. At the time of the ground investigation and subsequent reporting a topographic survey was not available.

#### 1.2 Report Layout

This report presents a description of the site, the desk study data and the factual results of the intrusive investigations carried out. An interpretation of the ground conditions and a discussion/assessment of the findings is presented in the later report text sections. The report should be read in conjunction with the general procedures detailed in Appendix E, which provides details of investigation techniques, assessment methodology and standards, health & safety and limitations and exceptions of the report. Drawings and factual data including

exploratory hole records, laboratory testing results and desk study records are presented in the other Appendices.

#### 2.0 SITE DESCRIPTION

The site is located off Wendlebury Road, approximately 1.5km to the southwest of Bicester town centre. The Ordnance Survey grid reference for the centre of the site is 457226 220693 as shown on the Site Location Plan included in Appendix A. Access to the site was gained through a gate off Wendlebury Road in the northwest of the site.

The site is approximately 'L-shaped', tapering slightly towards the eastern boundary with dimensions of approximately 360m from east to west, and between approximately 335m (western boundary) and 430m (eastern boundary) from north to south. The site covers an approximate area of 15.35ha. A topographic survey was not available; however, the site appears to slope gently to the southeast.

At the time of the walkover the site comprised three undeveloped grassed fields, understood to be used as grazing for cattle. The fields were unoccupied at the time of the walkover; however, it is understood that the farmer had relocated the cattle for the duration of the investigation works. With the exception of the northern boundary of the site and the boundary with Wendlebury Farm in the south, the fields were all lined with hedgerows and semi-mature and mature trees. Electricity pylons with associated overhead cables, orientated north-south were located along the west of the site with two sets also located in the east. A pond, which was almost entirely hidden by overgrown vegetation and reeds, was present in the south of the site, covering an area of circa  $10m \times 20m$ .

The site was bound to the north by an access road to the Severn Trent sewage works, which was segregated by a post and rail fence line, to the east by Langford Brook, to the south by Wendlebury Farm and further fields belonging to the Promised Land Farm and to the west by Wendlebury Road.

No obvious sources of potential contamination or potentially contaminative activities were observed at the site during the investigation.





### 2.1 Site Proposals

It is understood that the site has now been acquired and it is intended that as much of the site as possible will be developed, together with the adjacent Wendlebury Farm, also under Client ownership. Specific redevelopment purposes are not formulated as yet.

#### 3.0 DESK STUDY INFORMATION

Site History	<ul> <li>1885 – Site and surrounding area are agricultural fields, the Oxford to Bletchley railway line runs northeast – southwest approximately 105m southeast of the site. Two 'Old Clay Pits' are indicated 225m southwest of the site. Roman Road, orientated north-south bounds the site to the west. Buildings associated with the Promised Land Farm are located approximately 150m southwest. A sewage works is located 200m to the northeast.</li> <li>1950 – The A41 is located 55m to the northwest of the site, orientated northeast – southwest. MOD Bicester, military storage and distribution centre has been developed 400m to the east.</li> <li>1966 – A drain is shown along the southern boundary of the site. The north of the site is bound by an access road, connecting to the sewage works, which has been redeveloped and expanded to approximately 150m east of the site.</li> <li>1983 – Wendlebury Farm is now shown (consistent with the current layout) adjacent to the southwest of the site. A nursery is located 50m to the north of the site.</li> <li>1992-95 – The A41 has been widened.</li> <li>1995 – The nursery to the north is now a garden centre and has expanded south.</li> <li>2002 - Bicester Village Retail Park has been developed approximately 725m to the north and a nature reserve is located 150m to the east.</li> </ul>
Anticipated Geology and Ground Conditions	<ul> <li>Published BGS Map shows Alluvium across the majority of the site. The Alluvium is absent in the northwest and southwest of the site, where River Terrace Deposits are shown. Solid geology of the Kellaways Formation is anticipated below, comprising interbedded sandstone and siltstone of the Kellaways Sand Member, underlain by mudstone, interbedded with siltstone and sandstone of the Kellaways Clay Member. Kellaways Sand is shown to be absent in the north of the site. The Kellaways Formation is anticipated to be underlain by limestone of the Cornbrash Formation.</li> <li>Nearest BGS archive borehole, undertaken at Wendlebury Farm (28m to southwest) recorded Alluvium to 1.37m bgl, over Kellaways Clay Member to 5.49m and the Great Oolite Group (Cornbrash Formation) to 15.24m.</li> </ul>

	<ul> <li>the base of the borehole. Artesian groundwater was encountered within the borehole and was at rest at 0.83m above ground level at the end of boring. There is no record of what depth the artesian groundwater was encountered, however it is likely to be near the base of the borehole, within the Cornbrash Formation.</li> <li>Site is not in a radon affected area, with &lt;1% of homes above the Action Level. No radon protection measures are therefore considered necessary for new properties.</li> </ul>
Mining/Quarrying and Other Geohazards	<ul> <li>Site not indicated to be within area of underground coal or other mining.</li> <li>Site not in area associated with natural cavity formation.</li> <li>The BGS have indicated a moderate risk of shrinkable/swelling clay and compressible deposits on the site.</li> <li>The earliest OS map editions indicate the extraction of clay 225m</li> </ul>
	<ul> <li>Southwest of the site.</li> <li>Although archaeological findings are noted within the GroundSure report, the Roman Road (now Wendlebury Road), which bounds the site to the west, is an indication that there may be possible archaeology on the site.</li> </ul>
Hydrology	<ul> <li>The hearest surface watercourse is Langford Brook, which bounds the site to the east.</li> <li>Water quality data, taken from Langford Brook, 45m southeast of the site, indicated a chemical and biological grade of B in 2009.</li> <li>There are no surface water abstractions within 500m of site.</li> <li>There are 10 no. licensed discharges within 250m of site, the nearest being located 45m to the southeast of the site and associated with sewage discharges into Langford Brook. This license was revoked on 01/11/1989.</li> <li>The site is within a Zone 2 and Zone 3 floodplain and the highest RoFRaS flood rating is High.</li> </ul>
Hydrogeology	<ul> <li>The superficial deposits underlying the site are a Secondary A Aquifer, The Kellaways Sand Member is a Secondary A Aquifer and the Kellaways Clay Member is listed as unproductive strata.</li> <li>4 No. groundwater abstraction licenses are shown within 1000m of the site, with the closest being located at Faccenda Chicken Ltd, 58m west, for general farming and domestic uses.</li> <li>Most likely groundwater flow direction is to the southeast, following the topography and towards Langford Brook.</li> <li>The site is not located within a Source Protection Zone.</li> </ul>
Other Environmental data	<ul> <li>No landfills or licensed waste sites within 500m.</li> <li>Five potentially contaminative industries are located within 250m of the site, relating to electricity substations (26m and 169m northeast) and the Sewage Works from 175m east.</li> <li>No petrol or fuel sites are located within 500m of the site.</li> <li>One pollution incident was recorded within 500m of the site, located 160m to the northeast, relating to a microbiological pollutant on 09/02/2002 and was assigned a Category 3 (minor) impact to water.</li> <li>The site is within a Nitrate Vulnerable Zone.</li> </ul>

#### 4.0 CONCEPTUAL SITE MODEL

#### 4.1 Diagrammatical Illustration

The Conceptual Model for the site, showing the main elements of the surface and subsurface conditions and including the potential contaminant sources, pathways and receptors identified from the desk study information is presented in Appendix A as Drawing No AG2875-18-03. The potential sources, pathways and receptors are defined in the following sections:

#### 4.2 Sources

Made Ground soils on site associated with adjacent site development;

- Hydrocarbon leaks from farming vehicles/plant;
- On site ground gases associated with decomposition of organic material in Made Ground or hydrocarbon spillages;
- Sulphates in Made Ground or underlying natural strata;
- Pesticides within the near surface materials.

The substation located 26m to the northeast of the site is not considered to be a viable source, due to the distance from the site and the low mobility of PCBs.

#### 4.3 Pathways

- Human dermal contact;
- Human ingestion via soil directly or via bioavailable contaminants within vegetables grown in contaminated soils;
- Human inhalation of dust or vapours;
- Leaching and/or migration through permeable soils (granular Made Ground, River Terrace Deposits and Kellaways Sand);
- Direct contact with buried concrete/water supply services.

### 4.4 Receptors

- End user residents, workers and visitors, (Human Health);
- Superficial Deposits and Kellaways Sand Member Secondary A Aquifer (Controlled Waters);
- Buried foundation/substructure concrete (Building Materials);
- Water supply services (Building Materials).

#### 4.5 Source/Pathway/Receptor Linkage and Assessed Risk

Source-pathway-receptor (SPR) linkages are tabulated below together with the qualitatively assessed risk. The risk to ground workers and construction workers is not included in the table as it is assumed that these risks will be sensibly negated by the adoption of good hygiene practices and the appropriate use of relevant PPE/RPE when exposed to potentially contaminated soils. Comments regarding contamination issues with respect to ground workers and construction workers are included in the health and safety section of the Standard Procedures included as Appendix E.

Source	Pathway	Receptor	Risk*
Potential contaminants within Made Ground or	Inhalation, ingestion, dermal contact.	End users, adjacent residents	Low
resulting from adjacent site development.	Migration and Leaching	Superficial Deposits and Kellaways Sand Member (Secondary A Aquifers)	Negligible
Soil gas from Made Ground – both on site and off site sources (methane, carbon dioxide)	Migration into buildings, service ducts etc.	End users	Low
Elevated sulphates in Made ground or natural	Direct contact, leaching and contact with	Buried concrete	Low-medium (see 7.2)

Source	Pathway	Receptor	Risk*
soils	groundwater		
Hydrocarbon contaminants from vehicle/plant leaks	Inhalation, ingestion, dermal contact.	End users	Low
	Migration/leaching	Superficial Deposits and Kellaways Sand Member (Secondary A Aquifers)	Negligible
	Direct contact	Water supply services	Low

#### \* Definition of Risk Categories

Negligible - Contaminants that might have unacceptable impact on key receptors, are unlikely to be present, or, no pathway is envisaged.

Low Risk: Contaminants may be present but are unlikely to be at levels to have unacceptable impact on key receptors, or pathways are likely to be minimal.

Medium Risk: Contaminants are probably present and might have an unacceptable impact on key receptors. Pathways may also be present therefore remedial measures may be necessary to reduce the risks.

High Risk – Contaminants probably or certainly present and pathways are probably also present. Therefore, contaminants are likely to have an unacceptable impact on key receptors and remedial measures are likely to be necessary to reduce the risks to acceptable levels.

#### 5.0 GROUND INVESTIGATION WORKS

#### 5.1 Fieldwork

The following scope of fieldwork was undertaken:

• 18 No Machine excavated trial pits (ref: TP1 to TP18) to depths of between 2.35m and 4.1m below ground level (bgl).

The locations of the exploratory holes were selected in general accordance with the proposed borehole location plan provided by Bailey Johnson Hayes and set out on site by Applied Geology Limited. A number of the positions were constrained by the presence of a sewer, which bisected the site, orientated northeast to southwest and also the pylons and associated overhead cables. The sampling strategy for the exploratory hole locations was to provide best overall coverage. The locations of the trial pits are presented on Drawing No. AG2875-18-02 in Appendix A. The positions are approximated in relation to field boundaries and identifiable features on the site plan.

#### 5.2 Laboratory Testing

Geotechnical laboratory testing was undertaken on selected samples and comprised the following:

- 8 No natural moisture content tests;
- 8 No Atterberg limit tests;
- 5 No particle size distribution tests;
- 5 No BRE SD1 suite tests;
- 4 No BRE SD1 with pyrite suite tests.

Chemical testing was undertaken based upon the desk study, walkover and site observations during the fieldwork. Selected samples were analysed for the following suite of contaminants:

- Selected metals suite [arsenic, beryllium, boron, cadmium, chromium (total), copper, mercury, nickel, lead, zinc, selenium, vanadium] (10 samples);
- Chromium hexavalent and trivalent (2 samples);
- Speciated (16 US EPA) Polycyclic Aromatic Hydrocarbons (PAH) (10 samples);
- Phenols (total) (2 samples);
- Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG) (3 samples);
- pH (10 samples);
- Soluble sulphate (10 samples);
- Organic matter (10 samples);
- Asbestos Containing Material (ACM) (5 samples);
- Pesticides (5 samples).

Laboratory test results are included in Appendix D.

#### 6.0 **GROUND CONDITIONS**

Topsoil and subsoil was encountered at surface across the site and was underlain by Superficial Deposits comprising Alluvium and River Terrace Deposits, which in turn was underlain by the Kellaways Formation, predominantly comprising clay, with initial horizons of sand in the southeast of the site. This is broadly consistent with the published geological records. Full details of the strata encountered are given on the borehole records presented in Appendix C, however, a generalised ground profile is presented below to summarise the information.

Stratum	Depth to Top of Strata (m bgl)	Thickness range (m)	Comments
Topsoil	GL	0.15 – 0.35	Encountered at all locations
Subsoil	0.15 – 0.30	0.10 – 0.45	Encountered in TP1, TP2, TP7-12 and TP14
Alluvium	0.15 – 0.45	0.15 – 1.25	Not encountered in TP1, TP2, TP7 or TP14
River Terrace Deposits	0.35 – 1.20	0.20 – 1.30	Not encountered in TP3, TP11 or TP12
Kellaways Formation	0.60 – 1.80	>2.65	Encountered at all locations, base not proven

#### 6.1 Topsoil and Subsoil

Topsoil was encountered from ground level at all locations, to a depth of between 0.15m and 0.35m bgl and generally comprised firm dark brown slightly sandy friable clay with rootlets and occasional shell fragments.

Underlying subsoil was encountered at around half of the locations to depths of between 0.35m and 0.7m bgl and generally comprised stiff brown friable clay, with

occasional rootlets and occasional fine to coarse subangular to subrounded limestone.

#### 6.2 Alluvium

Strata considered to represent alluvial deposits were encountered at all locations, with the exception of TP1, TP2, TP7 and TP14 (generally absent in the northwest of the site), beneath the Topsoil or Subsoil to depths of between 0.5m and 1.6m bgl. The Alluvium generally comprised soft to firm orangish-brown and light greyish brown mottled slightly sandy silty clay.

The results of two Atterberg limit tests undertaken on the Alluvium have indicated plasticity indices of 20% and 51% (corrected to between 16.8% and 48.96%), indicating these soils to be of moderate to high shrinkability as defined by NHBC Standards. Uncorrected liquid limits of 32% and 73%, plastic limits of 12% and 22% and moisture contents of 17.2% and 26.4% were also recorded. These results indicate the clays to be of medium to high plasticity.

#### 6.3 River Terrace Deposits

River Terrace Deposits were encountered at all locations with the exception of TP3, TP11 and TP12, beneath the Subsoil or Alluvium to depths of between 0.6m and 1.8m, generally shallower in the northwest of the site. The strata generally comprised orangish-brown silty sand and gravel, with the gravel comprising fine to coarse subangular to subrounded limestone.

The results of two particle size distribution tests undertaken on the River Terrace Deposits at depths of 0.6m and 1.2m bgl, have indicated the following proportions: 30 to 40% sand, 47 to 54% gravel and 13 to 16% fines (clay and silt).

#### 6.4 Kellaways Formation

Strata considered to represent the Kellaways Formation were encountered beneath the Superficial Deposits, to depths of between 2.35m and 4.1m bgl. The strata typically comprised firm becoming stiff bluish grey silty clay, occasionally with thin indistinct laminations, occasional fine to coarse subrounded to subangular limestone gravel and with rare fossil shell fragments. Occasional gypsum crystals were noted within the clay within nine of the trial pits (generally absent in the southeast of the site) from depths of between 1.25m and 3.5m bgl. In the southeast of the site, the strata often initially comprised a granular layer, generally comprising bluish grey slightly clayey silty gravelly fine to coarse sand (silt in TP13), with the gravel comprising fine to coarse subangular to subrounded limestone. The granular layer was encountered directly beneath the Superficial Deposits to depths of between 1.75m and 3.3m bgl and underlain by further cohesive deposits of the Kellaways Formation.

Hand shear vane tests undertaken on the cohesive Kellaways Formation, recorded undrained shear strengths of between 35kN/m<sup>2</sup> and 90kN/m<sup>2</sup>, generally increasing in strength with depth.

The results of a number of particle size distribution tests undertaken on granular horizons of the Kellaways Formation at depths of between 0.8m and 2.3m bgl, have

indicated the following proportions: 35 to 60% sand, 11 to 44% gravel and 21 to 39% fines (clay and silt).

The results of Atterberg limit tests undertaken on the cohesive Kellaways Formation have indicated plasticity indices of between 10% and 51% (corrected to between 8.1% and 51%), indicating these soils to vary substantially between low and high shrinkability as defined by NHBC Standards. Uncorrected liquid limits of between 26% and 75%, plastic limits of between 13% and 25% and moisture contents of between 14.3% and 38.2% were also recorded. These results indicate the clays to be of low to high plasticity.

#### 6.5 Groundwater

Groundwater was recorded as seepages in all trial pits, with the exception of TP12 (no River Terrace Deposits present) within the River Terrace Deposits at depths of between 0.5m and 1.3m bgl. The groundwater generally occurred as seepages, although fast inflows were noted in TP4 (from 0.8m) and TP5 (from 1.2m). Seepages were also noted within the Kellaways Formation in TP3 from 2.7m, TP11 from 1.3m and TP15 from 1.9m bgl. Details of the groundwater occurrence are summarised in the following table:

Trial Pit	Depth	Behaviour
TP1	0.5m	Seepage
TP2	0.6m	Seepage
TP3	2.7m	Seepage
TP4	0.8m	Fast inflow, causing continual collapse of the long sides of the trial pit.
TP5	1.2m	Fast inflow, causing continual collapse of the long sides of the trial pit.
TP6	0.9m	Seepage
TP7	1.0m	Seepage
TP8	2.9m	Seepage rising from base of trial pit
TP9	1.3m	Seepage
TP10	1.2m	Seepage
TP11	1.3m	Seepage
TP12	Dry	N/A
TP13	0.9m	Medium inflow, causing collapse of trial pit between 0.7m and 1.35m bgl.
TP14	0.7m	Seepage
TP15	1.9m	Seepage

Trial Pit	Depth	Behaviour
TP16	1.2m	Seepage
TP17	0.6m and 3.0m	Seepage
TP18	0.35m	Seepage

#### 6.6 Contamination

No obvious visual or olfactory evidence of potential contamination was observed during the fieldwork undertaken by Applied Geology.

#### 7.0 ASSESSMENT

#### 7.1 Geo-environmental Overview

The results of the chemical testing on soils have been subjected to human health risk assessment as described in Appendix E, with specific details as follows:

- Proposed end-use not yet known;
- Screening criteria residential with plan uptake (for a conservative initial assessment), assuming 6% SOM;
- Assuming a single dataset based on the site's history and current land-use.

The spreadsheets summarising the laboratory results and relevant screening values for each dataset are presented in Appendix D. The spreadsheet shows that none of the results of the testing for the proposed development exceed the conservative human health screening criteria.

TPH concentrations were recorded at below the laboratory detection limits.

The Asbestos screening tests did not detect the presence of any ACM.

The pesticides/herbicides screening tests did not detect the presence of any pesticides.

Based on the above assessments, it is considered that the risks to human health at the site are negligible.

The testing has not found concentrations of any determinants within the soils, which would be considered representative of contamination. Given the absence of a significant source and no pollutant linkage to controlled waters, there is considered to be a negligible risk to Controlled Waters.

Furthermore, the TPH results have not given concentrations that would exceed UKWIR limits for the use of polyurethane (PE) or polyvinylchloride (PVC) water supply pipes. Barrier supply pipes are therefore not likely to be required. Further guidance on this subject is included within Appendix E.

In the light of the trial pit investigation findings, the risks relating to contamination issues, as assessed above, have been updated in the following table:

Source	Pathway	Receptor	Notes from Investigation	Updated Risk*
Potential contaminants within Made Ground or resulting from adjacent site	Inhalation, ingestion, dermal contact.	End users, adjacent residents	No Made Ground encountered on site. Low concentrations of contaminants identified in near surface soils	Negligible
development.	Migration and Leaching	Superficial Deposits and Kellaways Sand Member (Secondary A Aquifers)	No Made Ground encountered on site. Low concentrations of contaminants identified in near surface soils	Negligible
Soil gas from Made Ground – both on site and off site sources (methane, carbon dioxide)	Migration into buildings, service ducts etc.	End users	No Made Ground encountered at the site. Ground gases from alluvium or underlying strata has not yet been assessed.	Low
Elevated sulphates	Direct contact,	Buried	River Terrace Deposits	Low
in Made ground or natural soils	leaching and contact with groundwater	concrete	Kellaways Formation – Granular	Low
	9		Kellaways Formation - Cohesive	High
Hydrocarbon contaminants from vehicle/plant leaks	Inhalation, ingestion, dermal contact.	End users	Low/trace concentrations of contaminants identified	Negligible
	Migration/leaching	Superficial Deposits and Kellaways Sand Member (Secondary A Aquifers)	Low/trace concentrations of contaminants identified	Negligible
	Direct contact	Water supply services	Low/trace concentrations of contaminants identified	Negligible

#### 7.2 Geotechnical Overview

The dominant factors affecting the design options for any new foundations at the site are the presence of soft Alluvium, which was encountered to depths of up to 1.6m bgl, together with shallow groundwater levels.

For typical light to moderate loads, conventional pads or strips/trenchfill foundations could be considered, taken down below any Topsoil/Subsoil, Alluvium or loose/soft zones and placed within the underlying competent River Terrace Deposits or Kellaways Formation.

A minimum founding depth of 0.75m is likely generally for foundations placed within the granular River Terrace Deposits. For foundations placed within the Kellaways Formation, a minimum founding depth of 1.0m is likely to be needed to cater for seasonal effects. Further deepening with be required in the influencing zone of existing, recently felled or proposed trees, in line with requirements for soils up to high shrinkage potential. We understand that conventional foundations are preferred and hence, comments on potential construction difficulties are provided as follows.

Groundwater occurrence appears to be associated predominantly with the variations in the depths and thickness of the granular River Terrace Deposits across the site. In the northwest, the groundwater appears to be perched within shallow River Terrace Deposits and separated from areas to the east by a thicker wedge of cohesive alluvium (TP3). Hence, in the northwest, the groundwater should be relatively easily sealed off, such that foundations can be placed into the underlying Kellaways Clay. Progressing southeast through the site, the granular deposits generally become thicker and are more saturated. A faster inflow was noted in the northeast of the site (TP4 and TP5) and this, together with an increased depth to the underlying Kellaways Clay, may result in greater difficulties in sealing off the groundwater. In central and southern areas, the ground appears to be generally less saturated. Here, it is likely to be possible to place some foundations within the granular River Terrace Deposits above the groundwater. In other areas, excavations may need to involve cutting off the groundwater by sealing into the underlying clay.

Owing to the potential for construction difficulties to arise locally, alternative foundation solutions, such as ground improvement or piles could be considered in those areas. If this is to be further considered, it would be prudent to seek the advice of an appropriate specialist contractor.

It is understood that ground bearing floor slabs will be required. Owing to the presence of shrinkable subsoil generally underlying the site, there will be a need to ensure that any soft, loose or potentially desiccated materials are removed and replaced with compacted granular material. In areas where the River Terrace Deposits are present with reasonable thickness, the need for excavation and treatment is unlikely. The floor slab should be constructed on a compacted granular mattress of appropriately designed thickness.

Excavations of typical dimensions for foundations and service trenches should generally be achievable using conventional hydraulic plant. As discussed above, the groundwater occurrence will lead to a requirement for control measures, depending upon depth and location. Appropriate trench supports/cut offs are likely to be required to achieve stability together with sump pumping to maintain dry excavations.

For foundations placed in the River Terrace Deposits, testing suggests that DS-1 conditions will apply, which no special measures are required. For foundations placed in the cohesive Kellaways Formation, sulphate resisting concrete appropriate to DS-4/AC-4 is likely to be required.

The capacity for soakaway drainage is likely to be severely restricted on the site, owing to the generally shallow groundwater levels. It would therefore be prudent to seek an offsite source for drainage.

#### 7.3 Conclusions and Recommendations

Based on the pre-acquisition investigation, contamination related to risks to human health and Controlled Water receptors appear to be negligible. It is considered that

remedial measures in this regard, are very unlikely and hence, associated potential liability is extremely limited.

Conventional shallow foundations should be considered for light to moderate loads, but some construction difficulties may arise, associated with shallow groundwater. The trial pits suggest that these risks may be greatest in the northeast of the site, although localised difficulties could be experienced in the central and southern parts of the site. To avoid such difficulties, a piled foundation could be considered.

No special measures relating to buried concrete are required for foundations placed in the River Terrace Deposits, although foundations placed in the Kellaways Formation are likely to require sulphate resisting concrete appropriate to DS-4/AC-4 conditions.

It is recommended that an offsite source of drainage is sought for the site.

It is understood that the site has now been acquired and further site investigation will be required based on the proposed development layout. This should include a number of boreholes, geared towards the proposed site layout, with a programme of groundwater and groundgas monitoring to provide sufficient information for final engineering designs. Some further contamination testing should be included to ensure appropriate coverage for compliance and audit trail.

Applied Geology Limited Unit 23 Abbey Park Stareton Kenilworth Warwickshire CV8 2LY

Tel: 02476 511822







Drawn By: JS	Checked By: FHJ		Paper Size: A3
<sup>Scale:</sup> NTS	Date: 2	4.07.	2018
Drawing No: AG2875-	18-02	R	evision: O





## County Series 1:10,560 scale



 County Boundary
 Parish Boundary
 Contours

 			Parliamentary Division Boundary
×	х	х	Union Boundary
v	V	V	Rural District Boundary

## National Grid 1:10,000 scale

Loose rock

Outcrop

Scree

ROCK FEATURES

als

的影

CONVERSION SCALE

Metres - Feet

\_\_\_\_\_6500 \_\_\_\_\_Feet

- 6000

4000

2000 Metres

#### HEIGHTS (METRES)

at Newlyn.		
Surface heights	ground survey	• 163m
determined by	air survey	<ul> <li>138 m</li> </ul>

scale maps, and bench mark lists containing fuller and possibly later levelling information are obtainable from the Director General, Ordnance Survey.

Contours are at 5 metres vertical interval

### ABBREVIATIONS

BP,BS	Boundary Post or Stone	PO	Post Office	-
Ch	Church	PC	Public Convenience	
СН	Club House	РН	Public House	- 5000
F Sta	Fire Station	S	Stone	1500
FB	Foot Bridge	Spr	Spring	
Fn	Fountain	TCB	Telephone Call Box	
GP	Guide Post	TCP	Telephone Call Post	-
MP,MS	Mile Post or Stone	тн	Town Hall	F
Р	Pole or Post	w	Well	
Pol Sta	Police Station	Y	Youth hostel	-

#### ROADS

 Road	Track Track	Path P	ath
	Where unfenced shown by pecked lines.		





VEGETA	TION				
, . T.,	Bracken, rough grassland	<u></u>	Marsh		Coppice
00_	Scrub	- <u>&gt;_5</u>	Saltings	中 本 未 余	Orchard Coniferous trees
amme	Heath	551¥/17	Reeds	$\phi_{\phi}\phi$	Non-coniferous trees

In some areas bracken (  $\widetilde{\gamma}$  ) and rough grassland (  $\widetilde{\gamma}$  )  $\widetilde{\gamma}$  ) are shown separately.



# **Historical Map Pack** Legend

# **County Series & National Grid**

# 1:10,560 scale

Information present on these legends is sourced from the same Ordnance Survey mapping as the maps used in this product.

If you have a query regarding any of the maps provided please contact GroundSure's technical helpline. We will endeavour to answer any queries you may have.

**Technical Helpline** 

Tel 08444159000

groundsureinsight@groundsure.com www.groundsure.com





The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007	
Map Name:	County Series	Ν
Map date:	1880	
Scale:	1:10,560	···
Printed at:	1:10,560	S

Surveyed 1880 Revised 1880 Edition N/A Copyright N/A Levelled N/A







The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007	
Map Name:	County Series	Ν
Map date:	1885	
Scale:	1:10,560	
Printed at:	1:10,560	S

Surveyed 1880 Revised N/A Edition 1885 Copyright N/A Levelled N/A







The Promised Land Farm, Wendlebury Road, Bicester

Client Ref:	EMS_482678_647813
Report Ref:	EMS-482678_647813
Grid Ref:	457539, 221007
Map Name:	County Series

Map date: 1898

Scale: 1:10,560

Printed at: 1:10,560











The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007
Map Name:	County Series
Map date:	1919-1920
Scale:	1:10,560

Printed at: 1:10,560



Ν

 $\oplus$ 

F

W







The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007	
Map Name:	County Series	
Map date:	1950	14/
Scale:	1:10,560	vv
Printed at:	1:10,560	



Ν

F





P M



#### Site Details:

The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007	
Map Name:	Provisional	Ν
Map date:	1955	
Scale:	1:10,560	··· 丁 -
Printed at:	1:10,560	S





Map legend available at: www.groundsure.com/sites/default/files/groundsure\_legend.pdf





The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007	
Map Name:	Provisional	Ν
Map date:	1966	
Scale:	1:10,560	Ť
Printed at:	1:10,560	S









The Promised Land Farm,Wendlebury Road,Bicester

Client Ref: Report Ref: Grid Ref:	EMS_482678_647813 EMS-482678_647813 457539, 221007	
Map Name:	Provisional	Ν
Map date:	1970	
Scale:	1:10,560	
Printed at:	1:10,560	S







P M



#### Site Details:

The Promised Land Farm,Wendlebury Road,Bicester

Client Ref:	EMS_482678_647813
Report Ref:	EMS-482678_647813
Grid Ref:	457539, 221007

- Map Name: National Grid
- Map date: 1980-1985

Scale: 1:10,000

**Printed at:** 1:10,000





![](_page_32_Picture_12.jpeg)

Map legend available at: www.groundsure.com/sites/default/files/groundsure\_legend.pdf

![](_page_33_Figure_0.jpeg)

P M W

![](_page_33_Picture_2.jpeg)

#### Site Details:

The Promised Land Farm,Wendlebury Road,Bicester

Client Ref:	EMS_482678_647813
Report Ref: Grid Ref:	EMS-482678_647813 457539, 221007

- Map Name: National Grid
- Map date: 1992-1995

Scale: 1:10,000

**Printed at:** 1:10,000

![](_page_33_Figure_10.jpeg)

![](_page_33_Figure_11.jpeg)

![](_page_33_Picture_12.jpeg)

Map legend available at: www.groundsure.com/sites/default/files/groundsure\_legend.pdf