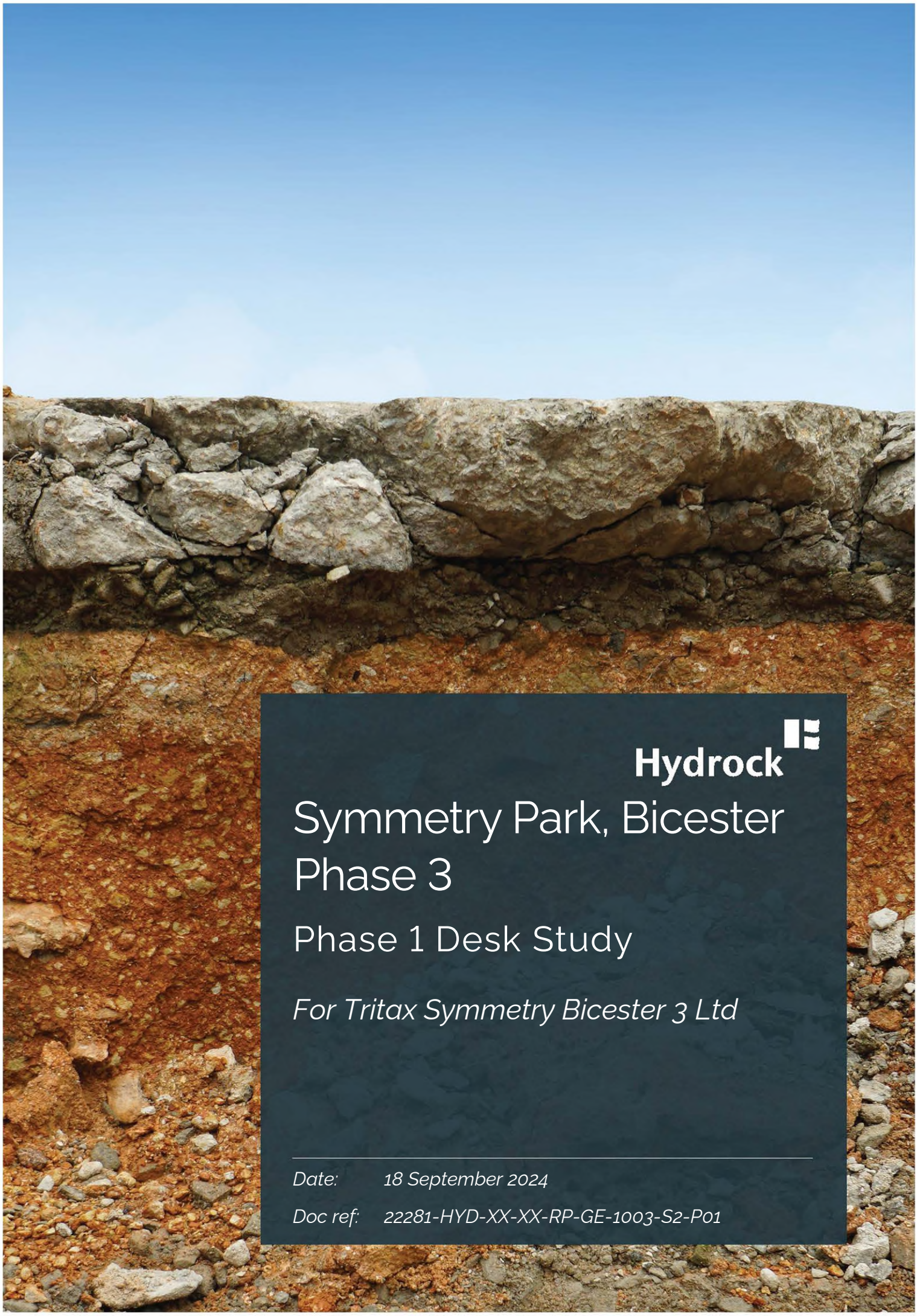

Hydrock

Symmetry Park, Bicester Phase 3

Phase 1 Desk Study

For Tritax Symmetry Bicester 3 Ltd

Date: *18 September 2024*

Doc ref: *22281-HYD-XX-XX-RP-GE-1003-S2-P01*

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Executive summary

Site information and setting	
Objectives	To formulate and present a Preliminary Conceptual Site Model of the site to determine geo-environmental and geotechnical site conditions and in doing so, identify potential risks to the proposed development
Client	Tritax Symmetry Bicester 3 Ltd
Site name and location	Symmetry Park, Bicester- Phase 3. The site is located to the immediate north of the A41, Aylesbury Road, Bicester, Oxfordshire.
Proposed development	The site development proposals are understood to comprise two units for use as distribution centres with associated lorry parking/loading bays, car parking, infrastructure and areas of soft landscaping.
Site description	The site currently comprises 2 larger and one smaller agricultural field with a disused barn area to the north-east comprising a number of structures of brick and iron sheeting. Asbestos cement sheeting is noted in a number of locations. Overhead cables dissect the centre of the trending southeast to northwest. The site is located between the existing Tritax Symmetry development (Bentley Designs and Medline Services immediately west and DPD to the north-west), and an existing industrial estate to the northeast comprising a caravan dealer, metal recycling and car breakers yard and field in the southeast To the south of the site is the A41 single carriageway road and to the north agricultural land.
Desk study summary	
Topography	The site is generally flat at approximately 65mOD across the site The general topography of the surrounding area falls from 80mOAD towards the site from the east.
Hydrology	The only current surface water feature on site is a drainage ditch on the western site boundary. There is also a pond located to the immediate north-west of the site. A tributary to the River Ray (located 1.6km to the southeast) is located approximately 20m south of the site boundary
Site History	The site has only been used as agricultural farmland from the first mapping date in 1880. Two ponds are shown in the southwest and northwest of the site although both now appear infilled. A camp site (maybe a WWII POW camp) is shown from 1967 immediately east of the site and later a scrap yard from 1996. Warehouses are shown immediately adjacent to the west of the site from 2018 as part of the wider Tritax Symmetry development.
Geology	According to BGS records, the geology of the site comprises Peterborough Member, overlying Kellaways Sand, Kellaways Clay and Cornbrash Formation. Made Ground is likely to be present around current farm buildings. Previous investigations to the northwest of the site indicates that the outcrop of the Kellaways Clay Member is further west than shown on the BGS map, and the Peterborough Member is likely not present on site. It is likely that the Kellaways Clay outcrops on site and that the Cornbrash Limestone Member will be present at relatively shallow depth and potentially outcropping to the east of the site. Several inferred faults can be identified within 250m of the site, the closest is located on-site trending approximately east west with a downthrow to the north-west.
Hydrogeology	The Peterborough Member and Kellaways Clay are classified as Unproductive Aquifer, with the Kellaways Sand and the Cornbrash Formation classified as Secondary A Aquifer. There are no Source Protection Zones in proximity to the site. The site is in Flood Zone 1.
UXO risk	A non-specialist UXO assessment indicates a low bomb risk.

Preliminary conceptual site model based on desk study	
Potential contaminant sources	Potential contamination sources on site include: » The possible use of pesticides and herbicides that have been used on site from historical farming practices; » Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks associated with the use of farm machinery and storage of unknown chemicals within the barn structure; » Potential for Asbestos Containing Materials / Asbestos fibres to be present in soils arising from known presence of asbestos containing materials forming part of the farm buildings fabric; » Uncontrolled Made Ground in the locations of the infilled ponds in the northern and south-western corners of the site and around farm buildings. » Elevated ground gases (particularly carbon dioxide and methane) from natural organic rich soils within ponds. Potential off-site sources of contamination include: » Elevated ground gases (particularly carbon dioxide and methane) from Made Ground material associated with the scrap yard. » Elevated ground gases (particularly carbon dioxide and methane) from Made Ground materials associated with various infilled ground surrounding the site to the south and east. » Potential contaminants associated with the scrap yard located to the east of the site, including metals, metalloids, PAH and petroleum hydrocarbons. » Ground gases (carbon dioxide and methane) from organic materials in the ponds immediately north of the site.
Potential contaminant linkages (for receptors for which there is or will be a pathway)	» People (site end users). » Development end use (buildings, utilities and landscaping). » Surface water: on-site drainage ditch and pond to the south of the site. » Shallow groundwater perched between the permeable and impermeable strata.
Summary of geotechnical conclusions	
Preliminary geotechnical hazards	The following plausible geotechnical risks are identified: » Potential for Made Ground soils arising from agricultural use of the site. » Low strength compressible ground and running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls - associated with the weathered Kellaways Sand Member, Kellaways Clay Member – experience from the wider site shows these materials to be softened. » Settlement in association with possible soft/ loose compressible ground – likely associated with weathered Kellaways Sand Member and Kellaways Clay Member. » Variable lateral and vertical changes in ground conditions – research indicates the geology at the site is changeable. » Shrinkage or swelling of predominantly clay soils under the influence of vegetation. Site boundaries are dominated by hedgerows and trees – all shallow soils are dominantly fine (clay) based and therefore potentially shrinkable. » Obstructions associated with current barn structures – potential for foundations and other infrastructure associated with previous development. » Elevated concentrations of sulphates - risk to buried concrete arising from pyrite rich natural soils. » Earthworks - settlement of new fill and potential impact on foundations, floor slabs, roads and infrastructure. » Potential for unforeseen ground conditions and the risks associated with limited data.

Future considerations	
Further work	In order to confirm the risk to receptors and confirm the ground conditions with respect to potential geotechnical and geo-environmental risks, an appropriate intrusive investigation will be required to be undertaken. The investigation will need to: » Determine the soil strength/ density beneath the site; » Determine the depth/ level of groundwater beneath the site; » Determine the ground gas concentrations beneath the site; » Determine CBRs to assist with pavement design; » Allow for soil infiltration rate testing; » Allow for chemical and geotechnical laboratory testing; » Obtain information in terms of Aggressive Chemical Environment for Concrete Class (ACEC Class)

This Executive Summary forms part of Hydrock Consultants Limited report number 22281-HYD-XX-XX-RP-GE-1003-S2-P01 and should not be used as a separate document.

1. Introduction

1.1 Terms of reference

In May 2024, Hydrock Consultants Limited (Hydrock) was commissioned by Savills on behalf of Tritax Symmetry Bicester 3 Ltd (the Client) to undertake a Phase 1 Desk Study for a site known as Symmetry Park, Bicester Phase 3 as part of the wider Tritax symmetry development.

The site currently comprises two larger and one smaller agricultural field with a disused barn area to the north-east. The site is located between the existing Tritax Symmetry development (Bentley Designs and Medline Services immediately west and DPD to the north-west), and an existing industrial estate to the northeast comprising a caravan dealer, metal recycling and car breakers yard and field in the southeast

The site is approximately 6.7 hectares in area and is located to the immediate north of the A41, Aylesbury Road, Bicester, Oxfordshire with a nearest post code of OX26 6GF and comprises 3 agricultural fields, an area in the northeast comprises numerous barn structures and an area of woodland in the southeast. The site location is shown on Hydrock Drawing 22281-HYD-PH3-XX-DR-GE-1001.

Hydrock understands that the proposed development is to comprise two distribution centres with offices and associated hard standing, attenuation storage and areas of public open space (POS).

The works have been undertaken in accordance with Hydrock's proposal referenced 22281-HYD-XX-XX-FP-GE-0005-P01 dated 14 May 2024 and the Client's instructions to proceed (PO8290).

1.2 Objectives

The works have been commissioned to support the planning application for the development.

The objectives of the Phase 1 Desk Study are to formulate a preliminary Ground Model and an Initial Conceptual Site Model of the site to identify and make a preliminary assessment of any potential geo-environmental and geotechnical risks to the proposed development.

1.3 Scope

The scope of the Phase 1 Desk Study comprises:

- a field reconnaissance (walkover) to determine the nature of the site and its surroundings including current and former land uses, topography, geology and hydrology
- acquisition and review of:
  - historical Ordnance Survey maps, to identify any; former potentially contaminative uses shown at the site and immediately surrounding it, and an assessment of the associated contamination risks;
  - a third-party environmental report to identify any; flooding warning areas, local landfills, pollution incidents, abstractions, environmental permits etc. All of which may have had the potential to have environmental impact on the site;
  - topographical, geological and hydrogeological maps;
  - regional UXO risk maps;
  - British Geological Survey (BGS) archive records;
- a review of previous investigations carried out adjacent to the site as part of previous works on behalf of Tritax Symmetry;
- development of a preliminary Ground Model representing ground conditions at the site;

- development of an initial Conceptual Site Model (iCSM), including identification of potential contaminant linkages;
- a qualitative assessment of any geo-environmental risks identified; and
- identification of any plausible geotechnical hazards.

1.4 Available information

The following information has been provided to Hydrock ~~by Tritax Symmetry~~ for use in the preparation of this report:

- pHp Architects. October 2023. 'Phase 3- Site Layout- Symmetry Park, Bicester'. Ref: 4036-X-SK025, P7;
- pHp Architects, October 2019, 'Estate Plan- Warehouse Development Symmetry Park, Bicester, A41, Bicester;'. Ref 4036-X01-007, P11.
- Greenhatch. August 2024. 'Tritax Symmetry Park, Bicester, Phase 3. Topogrpahical Survey'. Ref. 51633_T. and
- Vintec. August 2024. 'demolition Asbestos Survey report. Land Adjacent Symmetry Park Bicester, OX26 6GF'. Ref J088599.

Hydrock have also previously undertaken intrusive investigation of the DPD parcel to the north-west of the site on behalf of Tritax Symmetry (reference: Hydrock, March 2020, 'Land Adjacent to Symmetry Park, Bicester- Unit D'. Ref 10942-HYD-XX-XX-RP-GE-1001). Whilst not within the current Phase 3 site area, the information has been reviewed as part of the wider environmental and geological setting.

1.5 Regulatory context and guidance

The geo-environmental section of this report is written in broad accordance with BS 10175:2011+A2:2017 and EA LCRM (2023).

The methods used follow a risk-based approach, the first stage of which is a Phase 1 desk study and field reconnaissance, with any potential geo-environmental risks assessed qualitatively. This is done using the 'source-pathway-receptor contaminant linkage' concept to assess risk as introduced in the Environmental Protection Act 1990 (EPA, 1990). Any potential geotechnical risks are also assessed from the Phase 1 desk study and site reconnaissance stage.

Professional judgement is then used to evaluate the findings of the risk assessments and to provide recommendations for the development.

The geotechnical section of this report is prepared in general accordance with BS EN 1997-1+A1: 2013, BS EN 1997-2:2007 and BS 8004:2015+A1:2020.

Remaining uncertainties and recommendations for further work are listed in Section 5and Section 6.

2. Desk study (and field reconnaissance)

2.1 Data

A number of desk study sources have been used to assemble the following information. These are presented in Appendix D and include:

- Third-party environmental report (Groundsure report reference: HYD-ARU-14C-AUM-FKA);
- Historical Ordnance Survey mapping;
- BGS Archive Records;
- Zetica UXB Risk Maps.

As part of the desk study, a previous ground investigation undertaken by Hydrock to the north-west of the site (now DPD) has been reviewed and where suitable (See section 1.4), data from this report is included within this desk study for reference.

2.2 Site referencing

Table 2.1: Site referencing information

Item	Brief Description
Site name	Symmetry Park, Phase 3 Bicester.
Site address	Site to the north of the A41, Aylesbury Road, Bicester, Oxfordshire which in turn is to the east of the wider Tritax Symmetry development. The nearest postcode is OX26 6GF.
Site location and grid reference	The National Grid Reference of the approximate centre of the site is 460711, 220645. The site is rectangular in shape, approximately 6.7 Ha in area and measures approximately 410m by 160m.
Site boundaries	The north of the site is confined by agricultural fields separated by hedgerows and trees, as well as an existing estate to the north-east which comprises Bicester caravan and leisure centre, LC Hughes metal recycling centre and a car breakers yard with an access road adjacent to the eastern boundary of the site. To the west, the site is located between the existing Tritax Symmetry development which includes Bentley Designs and Medline Services and DPD to the north-west. To the south of the site is the A41 single carriageway road with agricultural fields beyond.

Figure 2.1: Site location
(Reproduced with permission from Groundsure)

Figure 2.2: Extract from the Ordnance Survey Map.
(OS licence 100023353)

A site location plan (Hydrock Drawing 22281-HYD-XX-XX-DR-GE-1001) is presented in 0

2.3 Site description and field reconnaissance survey

A field reconnaissance survey was undertaken on 24 July 2024 to visually identify assess potential geotechnical hazards, contaminant sources for future investigation and identification of possible source-pathway-receptor linkages. The weather during the field reconnaissance survey was dry and sunny.

A description of the site is presented in and selected photographs are presented in Figure 2.3 to Figure 2.6. Additional photographs are presented in Appendix B.

Table 2.2: Site description

Item	Brief Description
Site access	The site was accessed in the north-east corner of the site using the adjacent access road from the A41 to the south of the site.
Site area	The site is roughly rectangular in shape and has an area of approximately 6.7 ha.
Elevation, topography and any geomorphic features	The site is generally flat at approximately 65mOD across the site. The general topography of the surrounding area falls from 80mOAD towards the site from the east. Graven Hill the highest point in the area, located approximately 1.6km to the south-west of the site at 115mAOD.
Site boundaries and surrounding land	The site is in a general area of agricultural land use, with further agricultural fields to the north, south-east and beyond the A41 single carriageway to the south. To the north-east of the site is a scrapyard (LC Hughes recycling centre) and Bicester Caravan and Leisure Park. To the south-west and west the site is located between the existing Tritax Symmetry development which includes Bentley Designs and Medline Services and DPD to the north-west. The site is delineated by mature hedgerows and trees.
Present land use	The sites current land use is as an agricultural field, with no structures apart from a collection of disused farm buildings in the north-eastern corner. Many of the buildings are in disrepair. Probable asbestos cement sheeting and pipe were noted within structures as well as adjacent to the buildings amongst the vegetation surrounding the buildings. A number of canisters were noted including paints / lubricants / oils drums. Overhead electricity cables bisect through the centre of the site running from north-west to south-east with on-site field boundaries formed by fencing and open ditches. A wooded area is present in the southeast corner of the site.
Vegetation	The site is bordered by mature hedgerows and sporadic mature trees. An approximate 30m x 20m wooden area is present I the south-east corner of the site with mature trees sporadically present around the farmyard area.
General site sensitivity	The site is within a generally rural agricultural area.

A site features plan (Hydrock Drawing 22281-HYD-XX-XX-DR-GE-1002) are presented in 0.

Figure 2.3: Photograph of general site overview from the centre of the site looking west

Figure 2.4: General site overview including overhead electricity pylon from the central west of the site looking southeast.

Figure 2.5: Photograph of disused barn structures on site.

Figure 2.6: Photograph of various containers stored in the disused farm buildings on site.

2.4 Site history

A study of historical Ordnance Survey maps (Appendix D) has been undertaken to identify any former land uses at the site and surrounding areas which may have geotechnical or geo-environmental implications for the proposed development. The key findings are summarised in Table 2.3.

Table 2.3: Site history review

Reference	Key features on site	Key features off-site
OS Map[1] 1875-1876 1:2,500 1800 1:10,560	The site appears to have been in regular agricultural use since the earliest mapping date. Field boundaries are delineated by mature trees and hedgerows and a pond is located in the south-western corner of the site. A footpath runs east to west through the centre of the site.	The site area is surrounded by further agricultural fields, footpaths, mature trees/hedgerows and a road (Akeman Street) to the south. A kiln and brick works is shown approximately 150m to the south-east of the site, along with associated ground workings along with a second Brick & Tile yard approximately 650m to the east.
OS Map 1898 1:10.560	No significant changes shown.	A quarry is shown approximately 470m east of the site.

[1] Ordnance Survey Historical Map Information provided by Groundsure.
[2] Google Earth© Imagery

Reference	Key features on site	Key features off-site
		Further brick and tile works, quarry and gravel pits are located approximately 650m to the east and south east of the site boundary.
OS Map 1919 1:10,560		The brick and tile works to the south-east of the site is shown as disused. To the southwest of the site, beyond Akeman Street, a watercourse with rises is shown.
OS Map 1923 1:10,560		A tributary of the River Ray is noted to the south-east of the site, flowing north-east to south-west.
OS Map 1967 1:2,500	Structures are present in the north-eastern corner of the site, as well as a pond in the north-west corner and appearing to extend off-site.	A disused camp site (anecdotal information suggests a possible POW camp from WWII) is noted to the immediate east of the site, with several associated structures. The ground workings associated with the brick and tile works to the south-east of the site appear to have been infilled. A pond is noted approximately 100m to the south of the site and on the northern site boundary.
OS Map 1993 1:2,500	The pond in the south-western corner of the site is no longer shown and assumed to be been filled in.	No significant changes shown within 500m of the site boundary.
Google Earth© Imagery 2004[2]	A series of structures, most likely farm buildings are shown to the north-eastern corner of the site and appear to be derelict.	A scrap yard is shown to the immediate north-east of the site boundary.
Google Earth© Imagery 2018.	The site has not changed since the previous map.	A warehouse is present on the south-western site boundary.
Google Earth© Imagery 2022.	The site has not changed since the previous map.	A warehouse is present along the north western site boundary.

2.5 Geology

The geology of the site area is shown on the 1:50,000 British Geological Survey (BGS) map extract reproduced as part of the Groundsure report and is summarised below:

The British Geological Survey (BGS) shows the geology of the area to be underlain by the Peterborough Member (Oxford Clay Formation), comprising greyish brown organic shelly mudstone, weathering to a firm-stiff clay overlying the Kellaways Sand Member, Kellaways Clay Member with the Cornbrash Limestone Member present at depth.

Hydrock previously undertook intrusive investigation of the parcels to the north-west and west of the site, and determined that the BGS mapped outcrop of the Kellaways Clay Member is further west than shown and the Peterborough Member is unlikely to be present at the site. It is likely that the Kellaways Clay Member outcrops on site (and possibly the Kellaways Sand Member) and that the Cornbrash Limestone Member will be present at relatively shallow depth and potentially outcropping to the east of the site.

Table 2.4: Geology

Ref. for Figures	Location	Stratigraphic Name	Description
Superficial Deposits (Figure 2.7)			
n/a	On site	Non recorded	Non recorded
1	212m south-west	Alluvium	Variable soft silts and clays with sands and gravels.
Solid Geology (Figure 2.8)			
2	On site.	Peterborough Member (Oxford Clay Formation)	Weathering as brownish grey firm to stiff clay grading to organic mudstones with frequent fossils of ammonites. Potential for pyrite crystals to be present.
1	On site.	Kellaways Sand Member	Pale grey, silicate sandstone and siltstone with interbedded sandy and silty mudstone.
4	Outcropping 76m south. (but likely present beneath the site)	Kellaways Clay Member	Grey, silicate mudstone with beds of siltstone and sandstone.
5	Outcropping 113m south (but present beneath the site at depth)	Cornbrash Formation-Limestone	Poorly bedded and bioturbated limestone.
7	144m east (but present beneath the site at depth)	Forest Marble Formation	Greenish grey calcareous silicate mudstones with a variety of limestones.
11	235m south-east (but present beneath the site at depth)	White Limestone Formation	Pale grey to off-white limestone.

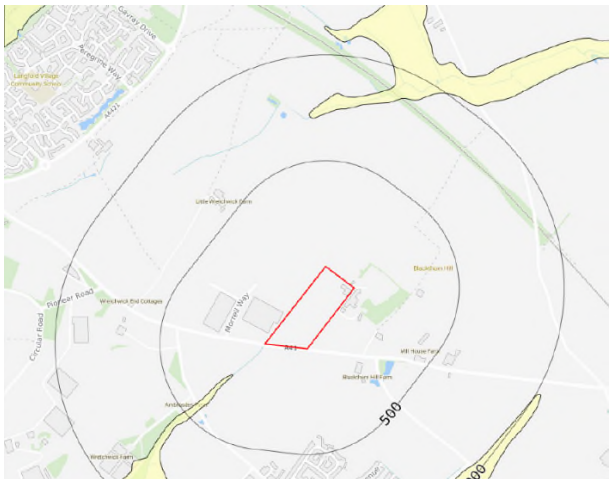

Figure 2.7: Superficial deposit.
(Reproduced with permission from Groundsure)

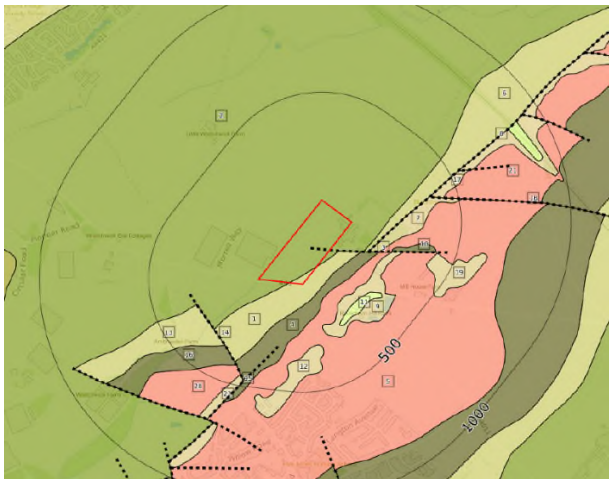

Figure 2.8. Bedrock deposits.
(Reproduced with permission from Groundsure)

2.6 Structural Geology

A normal fault is shown on BGS Sheet 219, approximately 200m south-east of the site. The fault trends north-east to south-west with a down-throw to the north-west. The normal fault has uplifted

the older geological units to the surface, south-east of the site. Numerous transverse faults are associated with the normal fault, which trend approximately south-east to north-west, as shown in Figure 2.9 and Figure 2.10. The transverse faults have caused lateral movement of geology to the north-west, therefore, there is a potential for the older sequence of geology (Kellaways Sand Member, Kellaways Clay Member and Cornbrash Formation) to be at, or near, the surface on the site.

Figure 2.9: Part of BGS Geological Sheet 219 showing faults to south-east of site.
(Reproduced with permission from British Geological Survey)
Contains British Geological Survey materials © UKRI 2024

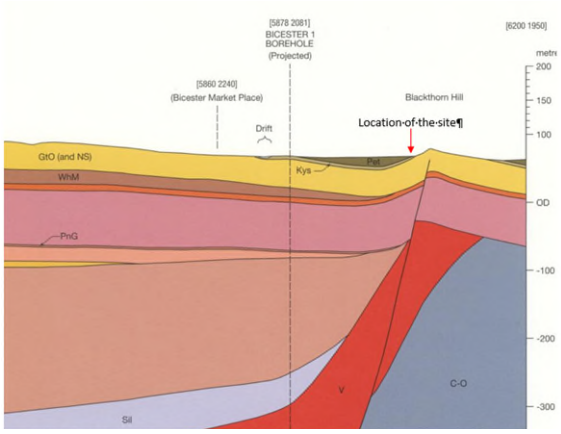

Figure 2.10: Part of BGS Geological Sheet 219 showing an indicative cross section below the site
(Reproduced with permission from British Geological Survey)

A number of borehole logs from the BGS archive have been reviewed. Selected records are summarised below:

- SP62SW2, located 157m to the south-east of the site for the A41 Thame Turn Improvement (NGR 460870E, 220450N), drilled to a depth of 2.30m and recorded:
  - Topsoil between ground level and 0.10m below ground level (bgl);
  - slightly sandy clay with limestone gravel between 0.10m and 0.60m bgl;
  - gravelly clay between 0.60m and 1.80m; and
  - clay with gypsum crystals between 1.80m and 2.30m bgl.
- SP62SW3, located 220m to the south-east of the site for the A41 Thame Turn Improvement (NGR 460910E, 220400N), drilled to a depth of 5.10m and recorded:
  - Topsoil between ground level and 0.20m bgl;
  - silty sandy occasionally friable clay with some brick between 0.20m and 0.60m bgl;
  - calcareous, occasionally fissured and jointed clay with some limestone gravel between 0.60m and 3.27m bgl;
  - thinly bedded shelly limestone with calcareous mudstone inclusions between 3.27m and 4.40m bgl; and
  - silty calcareous clay with organic inclusions between 4.40m and 5.10m bgl.

The ground conditions proven by previous investigation undertaken to the immediate west of the site (Hydrock, March 2020), recorded:

- Topsoil between ground level and 0.15m comprising dark brown slightly sandy clay with rootlets,
- Subsoil comprising brown slightly sandy clay with many rootlets between 0.10m and 0.40m bgl;

- Kellaways Sand Member comprising variable sandy to very sandy clays, clayey sand or weekly cemented sandstone between 0.30m and 3.30m bgl;
- Kellaways Clay Member comprising dark grey silty clay from 0.30m bgl with the base not proven during investigation.

The strata were observed to dip gently towards the west, with the Cornbrash Formation shallowing towards the Phase 3 boundary in the east, with the Kellaways Clay Member overlying the Cornbrash Limestone Formation at approximately 4-5m bgl.

Groundwater was encountered between 0.50m and 3.90m bgl during the 2020 investigation to the north-west, with post-fieldwork monitoring results recording groundwater between 0.30m and 2.60m bgl. The groundwater was noted at the interface between the Kellaways Sand Member and the underlying lower permeability Kellaways Clay Member.

2.7 Hydrogeology

2.7.1 Aquifer designations

Based on the inferred geological sequence presented in Section 2.5 and the Environment Agency's interactive aquifer designation map, the aquifer system presented in Table 2.5 applies.

Table 2.5: Aquifer system

Stratum	Aquifer designation	Comments
Superficial Deposits		
None recorded on site	n/a	n/a
Solid Geology		
Peterborough Member (if present)	Unproductive Strata	Dominated by low permeability and low porosity mudstone and weathered clay soils which have negligible significance to water supply or river base flow.
Kellaways Sand Member (likely present beneath the site)	Secondary A Aquifer	Generally high porosity and high permeability due to interbedded moderate to high permeability layers of sandstone, capable of supporting water supplies at a local scale.
Kellaways Clay Member (likely present beneath the site)	Unproductive Strata	Low permeability mudstone and weathered clay soils which have negligible significance for water supply or river base flow.
Cornbrash Formation (likely present beneath the site)	Secondary A Aquifer	Generally high porosity and high permeability due to high permeability layers of limestone, capable of supporting water supplies at a local scale.
Forest Marble Formation (likely present beneath the site at depth)	Secondary A Aquifer	Generally high porosity and high permeability due to high permeability layers of limestone, with some low permeability layers of interbedded mudstone, capable of supporting water supplies at a local scale.
White Limestone Formation (likely present beneath the site at depth)	Principal Aquifer	High intergranular and/or fracture permeability in the limestone, providing a high level of water storage and supports water supply.

2.7.2 Groundwater abstraction

There are no current licensed groundwater abstractions within 1km of the site

2.7.3 Groundwater source protection zones and groundwater vulnerability

The site is not within a groundwater Source Protection Zone (SPZ).

2.7.4 Groundwater levels, recharge, and flow

There are no superficial deposits located on site, therefore any groundwater within the Kellaways Sand Member is likely to be confined vertically by the underlying lower permeability Kellaways Clay with a further groundwater body likely present within the underlying Cornbrash Limestone Formation / Forest Marble Formation and White Limestone Formation. The presence of the largely fine grained (clay) Kellaways Clay Member will limit the potential for vertical migration of surface waters at the site to the deeper aquifers..

Reference can be made to the previous Hydrock ground investigation which identified groundwater at depths at between 0.50m and 3.90m bgl during investigation and subsequent groundwater monitoring visits at between 0.30m and 2.60m bgl. It is likely that infiltrating surface water could be perched at the interface between the Kellaways Sand and the underlying lower permeability Kellaways Clay.

2.7.5 Groundwater quality

The groundwater body beneath the site (Bicester-Otmoor Cornbrash Water Body) is currently (2019 Cycle 3) classified under the Water Framework Directive as 'poor' due to chemical status elements, and chemical dependant surface water body status. There is no available information for the future groundwater quality outlook.

2.7.6 Groundwater flooding

The environmental data report indicates a negligible risk of groundwater flooding across the site and within 500m of the site area.

2.8 Hydrology

2.8.1 Surface water system and drainage

The surface water features in the vicinity of the site are listed in Table 2.6.

Table 2.6: Surface water features

Feature	Location Relative to Site
Drainage ditch	Along the western site boundary.
Pond	Immediately north-west of the site.
Tributary to the River Ray	20m south of the site boundary.
Stream	15m south-west of the site boundary
	111m south-west of the site boundary
	208m south-west of the site boundary

Surface water flows towards way towards the River Ray located approximately 1.6km to the southeast.

2.8.2 Surface water abstractions and discharges

There are no surface water abstractions within 1km of the site. There are no licensed surface water discharges within 1km of the site.

2.8.3 Surface water quality

Reference to the Environment Agency web site shows the site is located within the catchment known as the Oxon Ray Operational Catchment. The specific river water body being the Oxon Ray (upstream

to A41 Cherwell) including Otmoor Water Body. The current (2022 cycle 3) overall status under the Water Framework Directive is described as 'bad'.

The reason for the water body currently having a 'bad' status is due to ecological constraints 'poor' dissolved oxygen being disproportionately expensive with an unfavourable balance of costs and benefits. There are no shown objectives for improvement of ecological constraints.

2.8.4 Surface water flooding

The desk study information indicates the overall proposed development is within an area where the risk associated with surface water flooding is high in the south-western corner with a chance of flooding of greater than 1 in 30 (3.3%).

The site is in Flood Zone 1 with a low probability of flooding from rivers or the sea.

No further consideration of flood risk is undertaken in this report. Specialist flood risk advice should be sought with regard to drainage and flooding.

2.9 Natural ground instability

Trees and hedges are present around the site boundaries and therefore, cohesive deposits of the Peterborough Member may be affected by potential for shrink-swell ground movements in potentially high plasticity clays as a result of changes in moisture content from removal or growth of trees.

2.10 Waste management

There is one waste management site within 250m of the site, recorded on four separate occasions as modified or transferred as noted in Table 2.7.

There are no historical landfills within 250m of the site. However, it is probable that infilled ground will be present to the east and south of the site, associated with historic brick, tile works, quarries and pits which appear to have been backfilled during the period between the 1930s and 1960s.

Table 2.7: Waste management sites

Site Name and Location	Details
LC Hughes, Windmill Nurseries, Aylesbury Road, Bicester (north-eastern site boundary).	Status: Open Operational dates: 1996-present Size: medium (450-24999 tonnes). Wastes accepted: noted as metal recycling site with mixed MRS's (cars and scrap metals). Prohibited wastes: none noted.

2.11 Regulatory Information

Information in the Groundsure Report (Appendix D), relating to various regulatory controls has been reviewed, with a summary presented below in Table 2.8.

Table 2.8: Regulatory information within 500m of the site

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Discharge Consents	North-western site boundary	Sewage discharges for the DPD warehouse to Ditch Trib Ambrosden Brook. Effective from 2022.	No	Treated effluent.

	North-eastern site boundary	Site drainage for the scrap metal breaking yard to the north-east of the site to Tributary Ofambrosden Brook effective from 1993.	Yes	Potential for surface runoff to contain contaminants potentially including hydrocarbons.
Local Authority Pollution Prevention and Controls	None	No entries of local authority pollution prevention and controls within 500m of the site.	No	-
Pollution Incidents	None	No entries on registered pollution instances were recorded within 500m of the site.	No	-
Fuel Station Entries	None	No entries of current or historical fuel stations within 500m of the site.	No	-
Control of major accident hazards sites (COMAH)	None	No entries of COMAH were recorded within 500m of the site.	No	-
Registered radioactive substances	None	No entries on registered radioactive substances were recorded within 500m of the site.	No	-
Notification of installations handling hazardous substances	None	No entries on notification of installations handling hazardous substances were recorded within 500m of the site.	No	-

2.12 Natural soil chemistry

Information contained within the environmental report (Appendix D) gives indicative (estimated) concentration values for the natural soils at the site for a selection of Contaminants of Potential Concern (CoPC). These have been reproduced in Table 2.9.

As well as the below, the Peterborough Member of the Oxford Clay Formation is typically high in sulphates.

Table 2.9: Natural soil chemistry

Element	Arsenic	Cadmium	Chromium	Lead	Nickel
Concentration (mg/kg)	15 mg/kg	1.8 mg/kg	60 - 90 mg/kg	100 mg/kg	15 - 30 mg/kg

2.13 Evidence of contamination

During the site reconnaissance walkover, containerised storage for lubricants, oils and unknown chemicals were identified within the various the disused barn structures to the north-east corner of the site that could have, or be, leaking. As well as this, the Demolition Asbestos Survey Report

undertaken by Vintec indicate the presence of asbestos cement, pipe, bitumen felt and paint to be present around the farm structures.

2.14 Radon

The radon risk is reported in the environmental report. The guidance indicates that the site is not in a Radon Affected Area and no radon protection measures are required.

2.15 Unexploded ordnance (UXO)

In general accordance with CIRIA Report C681 (Stone et al 2009) a non-specialist UXO screening exercise has been undertaken for the purposes of ground investigation and is presented in Table 2.10.

Table 2.10: Non-specialist UXO screening (for the purposes of ground investigation)

Data	Comment	Further Assessment Required
Site History	There is no indication of former military use from the desk study information. A possible POW camp from WWII may have been present immediately east of the site. The site of the current St Davids Barracks Bicester is noted to be present 800m to the west which opened as part of a military logistics facility in 1941.	No
Post War Development	OS mapping does not show any evidence of bombing damage to the site or surrounding area.	No
Geology Type	The ground conditions comprise largely clay soils with bedrock potentially present at relatively shallow (6m) depth.	No
Surface Cover during WWII	The surface cover during WWII comprised open fields. There is the potential that UXO, if present, would remain undetected.	Yes
Indicator of Aerial Delivered UXO	Screening against the regional bomb risk map (Northamptonshire) Appendix D indicates the site to be in an area where the bomb risk is very low.	No

The non-specialist UXO screening exercise has indicated that whilst there is the potential for UXO to remain undetected due to the presence of open fields at the site during WWII and while there are military facilities in the surrounding area, there are no military or industrial uses recorded for the site itself. As such, the UXO risk is classified as low and no further assessment is required with regard to UXO in relation to ground investigation. Assessment may be considered prudent for construction activities based on surrounding land uses.

3. Initial conceptual site model

3.1 Introduction

The initial Conceptual Site Model (CSM) incorporates evidence from the site walkover, the Desk Study and previous investigations carried out at the site. The formulation of an initial CSM is a key component of the LCRM methodology, and incorporates: a ground model of the site physical conditions; and an exposure model of the possible contaminant linkages. It forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines.

3.2 Ground model

The preliminary ground model provides an understanding of the ground conditions and is the basis for preparing the preliminary geotechnical hazard assessment (Section 3.3) and the preliminary geo-environmental exposure model (Section 3.4).

3.3 Geotechnical hazard identification

3.3.1 Context

The preliminary geotechnical hazard identification has been undertaken in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and the HE documents CS 641 and CD 622.

The following section sets out the identified geotechnical hazards and the development elements potentially affected (see Table E1 in Appendix E for further information).

3.3.2 Plausible geotechnical hazards

Plausible geotechnical hazards identified at the site are:

- Potential for Made Ground soils arising from agricultural use of the site.
- Low strength compressible ground and running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls - associated with the weathered Kellaways Sand Member, Kellaways Clay Member – experience from the wider site shows these materials to be softened.
- Settlement in association with possible soft/ loose compressible ground – likely associated with weathered Kellaways Sand Member and Kellaways Clay Member.
- Variable lateral and vertical changes in ground conditions – research indicates the geology at the site is changeable.
- Shrinkage or swelling of predominantly clay soils under the influence of vegetation. Site boundaries are dominated by hedgerows and trees – all shallow soils are dominantly fine (clay) based and therefore potentially shrinkable.
- Obstructions associated with current barn structures – potential for foundations and other infrastructure associated with previous development.
- Elevated concentrations of sulphates - risk to buried concrete arising from pyrite rich natural soils.
- Earthworks - settlement of new fill and potential impact on foundations, floor slabs, roads and infrastructure.

3.3.3 Potential development elements affected

Development elements potentially affected by geotechnical hazards are:

- Buildings – foundations and floor slabs.
- Roads and pavements.
- Services.
- Construction staff, vehicles and plant operators.
- Concrete below ground.

Health and safety risks to site Contractors and maintenance workers have not been assessed during these works and will need to be considered separately during design.

3.4 Geo-environmental exposure model

3.4.1 Context

The preliminary exposure model is used to identify geo-environmental hazards and to establish potential contaminant linkages, based on the source-pathway-receptor (SPR) approach.

A viable contaminant linkage requires all the components of an SPR to be present. If only one or two are present, there is no linkage and no further assessment is required.

3.4.2 Potential contaminants

For the purpose of this assessment the potential contaminants have been separated according to whether they are likely to have originated from an on-site or off-site source.

3.4.2.1 Potential on-site sources of contamination

- The possible use of pesticides and herbicides that have been used on site from historical farming practices (S1)
- Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks associated with the use of farm machinery and storage of unknown chemicals within the barn structure (S2)
- Potential for Asbestos Containing Materials / Asbestos fibres to be present in soils arising from known presence of asbestos containing materials forming part of the farm buildings fabric (S3)
- Uncontrolled Made Ground in the locations of the infilled ponds in the northern and south-western corners of the site and around farm buildings. (S4).
- Elevated ground gases (particularly carbon dioxide and methane) from natural organic rich soils within ponds. (S5)

3.4.2.2 Potential off-site sources of contamination

- Elevated ground gases (particularly carbon dioxide and methane) from Made Ground material associated with the scrap yard. (S6)
- Elevated ground gases (particularly carbon dioxide and methane) from Made Ground materials associated with various infilled ground surrounding the site to the south and east. (S7)
- Potential contaminants associated with the scrap yard located to the east of the site, including metals, metalloids, PAH and petroleum hydrocarbons. (S8)
- Ground gases (carbon dioxide and methane) from organic materials in the ponds immediately north of the site (S9).

3.4.3 Potential receptors

The following potential receptors in relation to the proposed land use have been identified.

- People (site end users) (R1).
- Development end use (buildings, utilities and landscaping) (R2)
- Surface water: on-site drainage ditch and pond to the south of the site (R3)
- Shallow groundwater perched between the permeable and impermeable strata (R4).

3.4.4 Potential pathways

The following potential pathways have been identified.

- Ingestion, skin contact, inhalation of dust and outdoor air by people (P1)
- VOC and petroleum hydrocarbon contact with water supply pipes (P2)

- VOC and petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps (P3).
- Root uptake by plant (P4)
- Surface water via surface runoff (P5).

Health and safety risks to site development contractors and maintenance workers have not been assessed as part of this study and will need to be considered separately.

The above sources, pathways and receptors have been considered as part of the Preliminary Risk Assessment in accordance with LCRM (2023), are considered to be plausible in the context of this site and have been carried forward for investigation and assessment. An assessment of the Source – Pathway – Receptor linkages is presented in Appendix F (Table F.2).

3.4.5 Potential implications of climate change

Climate change has the potential to change the risk profile for conceptual site models and associated contaminant linkages. The impact of climate change on the CSM is site-specific, and a qualitative assessment of the potential impact of climate change on the CSM for this site is summarised below. The assessment has primarily utilised the guidance in Environment Agency (2010)[3] and SoBRA (2022)[4] which set out the UK context to climate change and land contamination. Both guidance documents advocate a "what if" scenario approach in the context of changes in ambient temperatures, an increase in the frequency of extreme rainfall/storm events and heatwaves/droughts, and long-term changes in groundwater and sea levels.

Those "what if" scenarios that are relevant to this CSM are:

- Increased long-term rainfall leading to increased infiltration and seasonally higher groundwater and water levels in surface waters.
- Increased frequency and/or magnitude of extreme rainfall events leading to short-term surface flooding, surface water run-off, groundwater flooding, and/or land-based erosion.
- Long-term decrease in rainfall leading to lower infiltration and fall in groundwater and surface water levels.

[3] Environment Agency, 2010. Guiding Principles for Land Contamination. Part 2. FAQs, technical information, detailed advice and references, March 2010.
[4] SoBRA, 2022. Guidance on Assessing Risk to Controlled Waters from UK Land Contamination Under Conditions of Future Climate Change, Society of Brownfield Risk Assessment, August 2022.

4. Desk study conclusions

4.1 Geotechnical conclusions

The following plausible geotechnical risks are identified:

- Potential for Made Ground soils arising from agricultural use of the site.
- Low strength compressible ground and running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls - associated with the weathered Kellaways Sand Member, Kellaways Clay Member – experience from the wider site shows these materials to be softened.
- Settlement in association with possible soft/ loose compressible ground – likely associated with weathered Kellaways Sand Member and Kellaways Clay Member.
- Variable lateral and vertical changes in ground conditions – research indicates the geology at the site is changeable.
- Shrinkage or swelling of predominantly clay soils under the influence of vegetation. Site boundaries are dominated by hedgerows and trees – all shallow soils are dominantly fine (clay) based and therefore potentially shrinkable.
- Obstructions associated with current barn structures – potential for foundations and other infrastructure associated with previous development.
- Elevated concentrations of sulphates - risk to buried concrete arising from pyrite rich natural soils.
- Earthworks - settlement of new fill and potential impact on foundations, floor slabs, roads and infrastructure.
- Potential for unforeseen ground conditions and the risks associated with limited data.

These plausible risks require further investigation and assessment (see Section 6).

4.2 Geoenvironmental conclusions

Based on historical and current land uses:

- It is considered that it is unlikely that the site would be classified as Contaminated Land under Part 2A of the EPA 1990.
- The overall risk from land contamination at the site is considered to be low to moderate for its proposed use, as the development will be largely covered by hardstanding reducing the possibility of contact with any impacted soils.
- The overall risk to controlled waters from land contamination at the site is considered to be low for its proposed use, as the site will largely be covered by hardstanding, reducing the possibility of contact with the soils, as well as the risk of significant rainwater infiltration leading to leaching. In addition, there is likely a low permeability band between any surface soils and the deeper aquifers beneath the site, reducing the probability of vertical migration.

The possible pollutant linkages (for risk levels of moderate or greater) on an unremediated redeveloped site, as determined by the desk study and walk-over, are summarised in Table 4.1:

Table 4.1: Possible Pollutant Linkages (for Risk Levels of Moderate or Greater)

Source(s)	◄ potential Impact on ►	Receptor(s)
Pesticides and herbicides from agricultural activities		Site users Groundwater Surface Water
Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks associated with the use of farm machinery and storage of unknown chemicals within the barn structure		Site Users Groundwater Surface Water
Asbestos fibres and Asbestos Containing Materials from the farm structures in the near surface soils		Site users
Uncontrolled Made Ground in the locations of the infilled ponds in the northern and south-western corners of the site		Site Users Groundwater

These possible pollutant linkages require further investigation and assessment (see Section 6.2).