MOTT MACDONALD

Oxford United Football Stadium

Geotechnical and Geo-Environmental Desk Study

December 2023

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December 2023

Issue and Revision Record

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1 Introduction

Mott MacDonald (MM) has been commissioned by Oxford United Football Club to provide a RIBA 2 Geotechnical and Geo-environmental Desk Study for a new football stadium, with associated infrastructure and buildings.

The main proposed works at the site include a new 16,000 seat stadium along with ancillary infrastructure and a possible associated hotel.

1.1 Objectives

The purpose of this report is to summarise the available ground related information for the site and identify potential geotechnical and geo-environmental hazards which may place a constraint upon the proposed development. These hazards may pose a risk to the proposed development itself, human health, or the environment. By identifying these risks at an early stage, opportunity is provided to consider them while undertaking the optioneering process and thereby minimise or take into account abnormal development costs associated with ground related risks.

Recommendations are provided at the end of this report to aid management of the identified ground related risks.

1.2 Sources of Information

The following sources of information have been consulted in writing this report:

- 6 Alpha Associates. (May 2022). *Preliminary Unexploded Ordnance (UXO) Threat Assessment: Report No. 16019.*
- BES Geomatics. (December 2022). Topographical Survey: Land off Oxford Road, Oxford OX5 1PH. Dwg No: BES22583 Sheets 1B to 14B.
- British Geological Survey. (May 2023). *GeoIndex Onshore.* Retrieved from GeoIndex – British Geological Survey (bgs.ac.uk)
- British Geological Survey. (1982). *Geological Survey of England and Wales 1:50,000 Series – Solid and Drift Geology – Sheet 236 – Witney.* Retrieved from https://largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001729
- British Geological Survey. (1987). *Ordnance Survey Scale 1:10,560 or 6 Inches to 1 Mile – Provisional Edition – Sheet SP 41 SE – Oxfordshire.* Retrieved from British Geological Survey (BGS) | large image viewer | IIPMooViewer 2.0
- British Standard 10175:2011+A2:2017. Investigation of potentially contaminated sites: Code of _____Practice.
- British Standard 85768:2013. Guidance on investigations for ground gas - permanent gases _____and volatile organic compounds (VOCs).
- CIRIA C552. 2001. Contaminated Land Assessment: A Guide to Good Practice.
- CIRIA C665. 2007. Assessing risks posed by hazardous ground gases to buildings.
- Enzygo. (2017). *Phase 1 Desk Study, Holiday Inn, Peartree Roundabout, Oxford OX2 8JD.*
- Landmark Information Group. (2023). *Envirocheck Report Datasheet, Order Number 310784179_1.*
- MEC Piling. (2020). *Method Statement & Risk Assessment for Holiday Inn, Oxford.*NHBC R&D 66. 2008. Guidance on the safe development of housing on land affected by contamination.

- Open Database License. (May 2023). *OpenStreetMap*. Retrieved from https://ww.openstreetmap.org/
- Pick Everard Consulting Engineers. (2016). *Report on a Ground Investigation at Oxford High School, Charlbury Road, Oxford.*
- UK Government. (July 2021). *National Policy Planning Framework (NPPF).* Retrieved from Government Publications: https://www.gov.uk/government/publications/national-planning-policy-framework-2
- 6 Alpha Associates. (May 2022). Preliminary Unexploded Ordnance (UXO) Threat Assessment: Report No. 16019.
- BES Geomatics. (2022, December). Topographical Survey: land off Oxford Road, Oxford OX5 1PH. Dwg No: BES22583 Sheets 1B to 14B.
- British Geological Society. (2023, May). GeoIndex Onshore. Retrieved from GeoIndex – British Geological Survey (bgs.ac.uk)
- British Geological Survey. (1982). Geological Survey of England and Wales 1:50,000 Series – Solid and Drift Geology – Sheet 236 – Witney. Retrieved from https://largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001729
- Enzygo. (2017). Phae 1 Desk Study, Holiday Inn, Peartree Roundabout, Oxford OX2 8JD.
- Landmark Information Group. (2023). Envirocheck Report Datasheet, Order Number 310784179_1.
- MEC Piling. (2020). Method Statement & Risk Assessment for Holiday Inn, Oxford.
- Open Database License. (2023, May). OpenStreetMap. Retrieved from https://www.openstreetmap.org/
- Pick Everard Consulting Engineers. (2016). Report on a Ground Investigation at Oxford High School, Charlbury Road, Oxford.
- UK Government. (2021, July 20). National Policy Planning Framework (NPPF). Retrieved from Government Publications: https://www.gov.uk/government/publications/national-planning-policy-framework--2

1.3 Limitations and Uncertainties

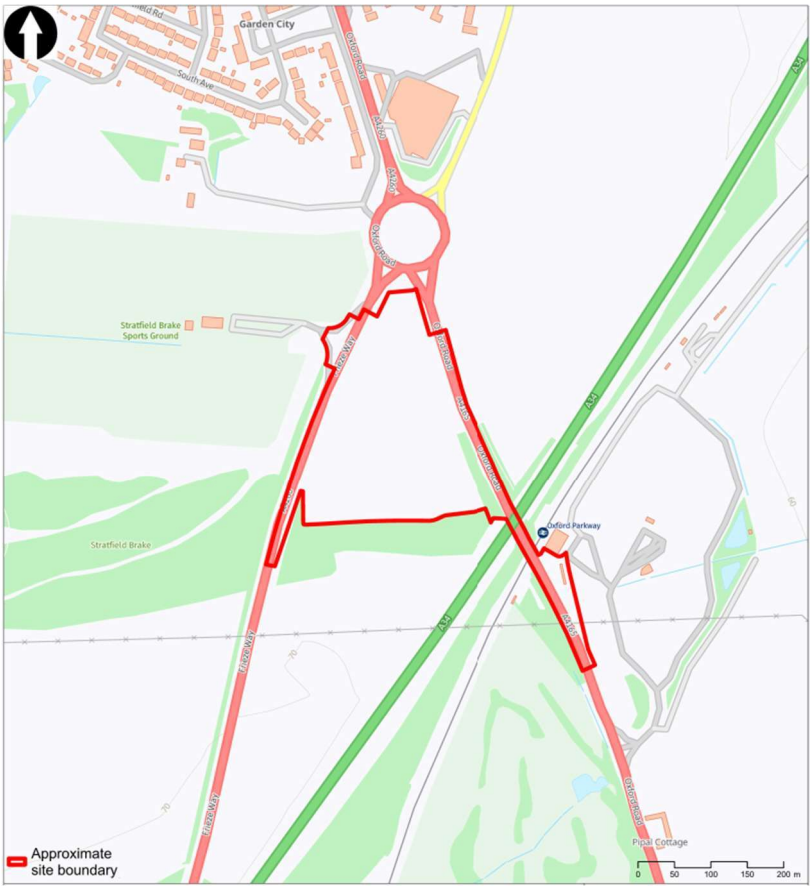
To the extent that this document is based on information obtained in available geological maps and memoirs. A person using or relying on it should recognise that any such investigation can examine only a fraction of the subsurface conditions. In any ground investigation, there remains a risk that pockets or “hot spots” of contamination or other ground hazards may not be identified, because investigations are necessarily based on sampling at localised points. Certain indicators or evidence of hazardous substances or conditions may have been outside the portion of the subsurface investigated or monitored, and thus may not have been identified or their full significance appreciated.

Mott MacDonald is not insured for toxic mould. Should the presence of asbestos or toxic mould be suspected during the study, Mott MacDonald would recommend the appointment of a specialist contractor to address the issue and would not provide advice on risk or remedial measures.

2 Summary of Phase 1 Assessment

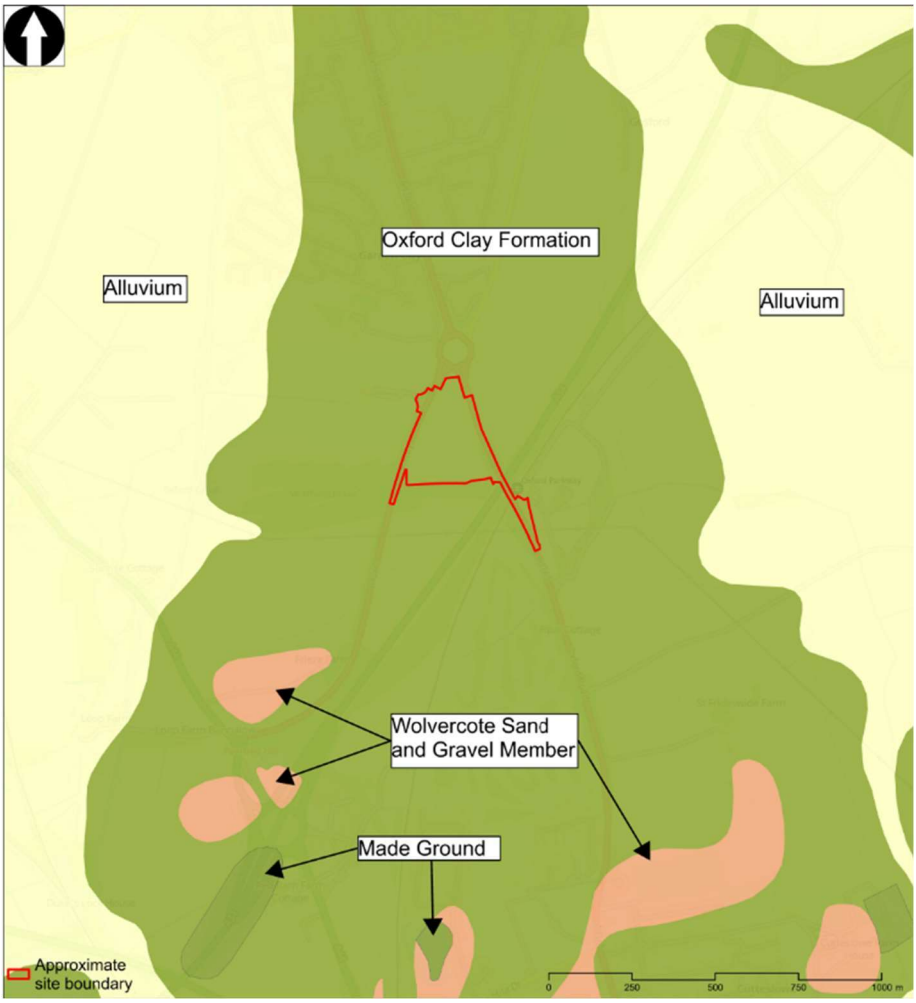
Table 2.1 below provides a summary of the geotechnical and geo-environmental information available for the site location, from both historical and current data sources. The sources for the information below are included within the Appendices, including the Envirocheck Report (Appendix A)

Table 2.1: Summary of Information

Site Location	The site is located approximately 5.8km north of Oxford City Centre, centred at 449860E, 212029N. The site is in a land parcel centred approximately 0.25m northwest of Oxford Parkway Station, between the A34, A4260 and A4165. The approximate site location is shown in **Figure 2.1.** **Figure 2.1: Approximate site location plan**  Source: Contains OS Data © Crown Copyright and database right 2023. Contains data from OS Zoomstack, Esri UK, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS
Description of the Site and Surrounding Area	The site is greenfield and is a Willow tree farm. However, the site is seen to be well-maintained – it is not overgrown. There is a track way on site which may relate to the field maintenance. The site also contains a section of the A4260 (Frieze way) to the west and southwest, the A4165 (Oxford Road) to the east and southeast. The A34 runs along the northeast-southwest along the southeast of the site. The A4260 and A4165 meet at the Kidlington Roundabout, approximately 200m north

	of the centre of the site. The surrounding highways are on embankments raised above the ground level of the site. The remainder of the south is bounded by greenfield land. The Oxford-Bichester rail line lies approximately 50m to the southeast of the A34. Oxford Parkway Station and station car park are located 100m to the east of the southeast corner of the site, along with Water Eaton Park and Ride. Kidlington Cricket Club and Gosford All Blacks Rugby Football Club are located to the west of the A4260, centred approximately 300m west of the centre of the site. Oxford Canal runs north to south approximately 750m west of the site, with four water features approximately 600m west of the site, adjacent to the Oxford Canal. A site walkover was undertaken by representatives of Mott MacDonald Limited on 20th July 2023, summarised in the following document: ● Mott MacDonald, Oxford United Stadium, Site Walkover Key Observations 20/07/2023 A summary of key observations from the walkover is presented separately in the technical note as included Appendix H. Reference should be made to the technical note for further detail.
Utilities	A landmark request status report (C2 Returns) has been undertaken and indicated that there are overhead power lines that run east-west in the north of the site. There are gas lines that run parallel to these beneath them. There are watermains, electricity and telecommunications utilities that run north-south along Oxford Road which is to the east of the site. For further information reference report 304819835_1 and Digital Utility overview Plan 304819835_1. A GPR survey has also been carried out on site and has identified previously unknown services and provided updates to the services alignment in comparison to the original C2 utility returns. The GPR drawing can be seen in Appendix G: ○ Solum Surveying Ltd. Parkway Oxford Banbury Road Water Eaton PAS 128 Utility Survey Sheet 1-5, Project Number: 10780, July 2023.
Proposed Works	At the time of writing, the proposed works are still subject to change, but include a new 16,000 seat stadium along with ancillary infrastructure and a possible associated hotel
Topography	A topographical survey has been undertaken for the site, summarised in the following drawing: ● BES Geomatics, Land off Oxford Road, Oxford, OX5 1PH, Topographical Survey, December 2022. Dwg No: BES22583 Sheets 1B to 14B The topographical survey indicates the site level ranges approximately from 63.6mAOD to 64.7mAOD. At the Kidlington Roundabout, the road embankment height is approximately 66.6mAOD. The road embankment height of the A4260 to the west of the site varies from approximately 66.6mAOD to 64.6mAOD. A ditch lines the east side of the A4260, with its invert level varying from approximately 63.1 – 64.0mAOD. To the east of the site, the A4165 road embankment varies from 65.5mAOD, to a maximum of 70.3mAOD where it crosses the A34 next to the Oxford Parkway Station. The A4260 and A4165 road embankments are approximately 1.5m higher than the ground level of the site. The topographical survey notes dense vegetation with restricted access across the northern section of the site, with a band of woodland 5 – 10m in height across the southern section of the site. The woodland is bordered by 0.5m deep ditches to the north and south, and a dilapidated barbed wire (B/W) fence (with an approximate height of 1m) to the south of the woodland, along the south extent of the proposed site. Reference should be made to the above referenced drawing, included within Appendix C, for more detail.
Published Geology	The Geology of Britain Viewer, GeoIndex Onshore, Envirocheck Report and British Geological Society, (1982). Geological Survey of England and Wales 1:50,000 Series – Solid and Drift Geology – Sheet 236 – Witney and British Geological Survey Ordnance Survey 1:10560 Sheet SP 41 SE Berkishire – Oxfordshire were all consulted when assessing the geology at the site. Figure 2.2 details the artificial, superficial and the bedrock geology surrounding the site.

Figure 2.2: Artificial, Superficial and Bedrock Deposits



Source: Contains OS Data © Crown Copyright and database right 2023. Contains data from OS Zoomstack, Esri UK, Esri, HERE, Garmin, Foursquare, METI/NASA, USGS , British Geological Survey (2023).

Artificial Ground

It is not indicated on BGS mapping that Artificial Ground will be encountered within the approximate site boundary. Made Ground is indicated approximately 1.3km to the south at the Peartree Roundabout along the Western By-pass Road. However, due to the presence of embankments associated with the A4260 and A4165, it is likely there is Made Ground directly along the north, east and west boundaries of the site will be encountered.

Superficial Ground

BGS mapping indicates there are no superficial deposits within the site boundary. The closest mapped superficial deposits are Alluvium approximately 450m west of the site and 750m east of the site. The Wolvercote Sand and Gravel, a 3rd terrace river gravel and loam are mapped approximately 650m to the southwest of the site. Furthermore the 1:10,000 mapping indicates that the Wolvercote Sand and Gravel underlies the alluvium west of the site suggesting it is more widespread than indicated in the BGS Geoindex. It is not anticipated that the Alluvium and Wolvercote Sand and Gravel deposits will be encountered on site.

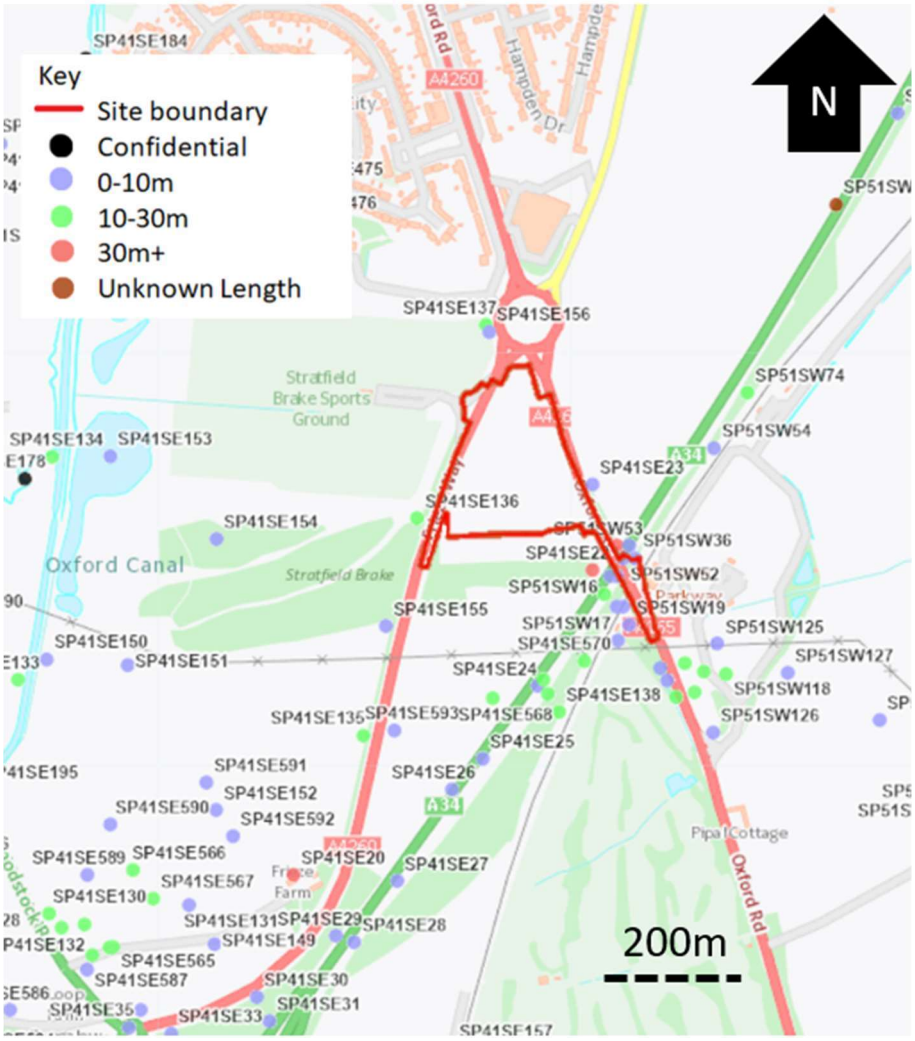
Bedrock Geology

Oxford Clay Formation (OxC)

BGS Mapping indicates the site is underlain by the Oxford Clay Formation.

	The BGS Lexicon of Rock Units describes the Oxford Clay Formation (OXC) in three units, known as 'Members', as follows: ● **Weymouth Member (WEY)** of the Oxford Clay Formation, formerly known as the Upper Oxford Clay. According to the BGS Lexicon of Rock Units, this mainly comprises pale grey blocky calcareous mudstones, generally only slightly silty. Thin dark gey carbonaceous beds and thin calcareous siltstones may occur. Poorly fossiliferous. ● **Stewartby Member (SBY)** of the Oxford Clay Formation, formerly known as the Middle Oxford Clay. According to the BGS Lexicon of Rock Units, this mainly comprises pale to medium grey, variable silty, calcareous, blocky mudstone, with subordinate beds of highly fossiliferous silty mudstones. ● **Peterborough Member (PET)** of the Oxford Clay Formation, formerly known as the Lower Oxford Clay. According to the BGS Lexicon of Rock Units, this mainly comprises brownish-grey, fissile, organic-rich (bituminous) mudstones with shell-beds and subordinate beds of pale-medium grey, blocky mudstone. It includes several bands of cementstone nodules/concretions. The basal beds are commonly silty, with shell beds. Whilst there are differences between the various Members within this Formation, there are also many similarities. On the published maps the Oxford Clay members are not always separately identified, and this is the case for the proposed site, so the general term Oxford Clay is used for current purposes. **Structural Geology** BGS mapping indicates the nearest fault to the site is approximately 2.3km to the north of the site. Although not mapped, this does not preclude the presence of faults at the site.
BGS Exploratory Hole Information	One BGS borehole is recorded within the site boundary, and many BGS boreholes are recorded within the immediate and wider surrounding area of the site and are shown in Figure 2.3. Following review of the BGS Borehole Scan Database, a series of 11 exploratory holes within 50m of the site have been reviewed and are summarised in Table 2.2. These are thought to best represent the underlying anticipated geology. It should be noted that the distance and compass direction presented are relative to the closest section of the site boundary to each borehole.

Figure 2.3: BGS borehole records



Source: (British Geological Society, 2023)

Table 2.2: Summary of historical BGS boreholes

BGS Reference	Easting	Northing	Distance from site (m)	Compass Direction	Depth (m bgl)
SP41SE22	449990	211920	0	-	32.9
SP51SW50	450020	211910	17	E	4
SP51SW52	450040	211940	23	E	4
SP51SW37	450030	211960	25	E	32
SP51SW51	450030	211910	27	E	3
SP41SE23	449990	212060	30	E	10
SP51SW16	450010	211880	30	E	27
SP41SE155	449652	211828	35	W	4
SP41SE136	449703	212005	37	W	20
SP51SW53	450050	211960	42	E	4
SP51SW36	450060	211940	45	E	10

Based on the available historical BGS boreholes, a summary ground model has been developed, and is presented in Table 2.3.

Made Ground (Embankment Fill) was identified in two locations associated with the A4165 and the A34 highways embankments, and is not expected to be representative of the site.

It should be noted that Alluvium was identified in four boreholes: one within the site boundary, two to the east of the site and one to the west. Head deposits were also identified in five boreholes to the east of the site. However, based on the description of the soil, these layers have been re-assigned as Weathered Oxford Clay Formation. Descriptions of the Alluvium include "firm yellow brown slightly sandy silty CLAY with occasional fine gravel" and "firm brown fissured silty CLAY". Descriptions of the Head include "stiff becoming very stiff pale brown extremely fissured silty CLAY, fissures randomly orientated mostly smooth and polished" and "very stiff pale brown extremely closely fissured silty CLAY with occasional coarse gravel." Fissures randomly orientated mostly smooth polished and occasionally persistence greater than 0.5m."

Three boreholes extend below the base of the Oxford Clay Formation. However, the base is not expected to be encountered or to impact the proposed works. Therefore, strata encountered below the base of the Oxford Clay Formation is not included in the summary BGS boreholes.

Table 2.3: BGS Borehole Summary

Strata	Top Level (mAOD)	Thickness (m)	Top Depth (mbgl)	Base Depth (mbgl)
Topsoil	69.50 – 63.94	0.1 – 0.4	0	0.1 – 0.3
Embankment Fill Loose pale to dark brown subangular to rounded very sandy fine to coarse limestone and sandstone gravel.	69.44 – 64.81	2.6 – 4.25*	0 – 0.3	2.6 – 4.25
Weathered Oxford Clay Formation Firm to very stiff grey and brown, orange-brown mottled, closely fissured, irregularly thinly to thickly laminated silty CLAY with shell fragments, gypsum crystals and pockets of friable white silt. Lenses and partings up to 5mm thickness of white calcareous silt.	67.12 – 62.78	1.6 – 4.6	0.1 – 0.3	2.6 – 5.9
Oxford Clay Formation Stiff becoming very stiff dark brown, grey, orangish green, slightly carbonaceous extremely closely fissured and irregularly laminated silty CLAY with occasional to frequent shell fragments. Occasional thin bands of argillaceous limestone.	64.37 – 60.88	0.9 – 23.1*	2.6 – 5.9	4.1 – 26.5*

*Base depth not confirmed in trial pits.

**Embankment Fill was encountered in two boreholes: SW51SW51 and SP51SW52

Table 2.4 presents a summary of the groundwater strikes encountered in the historical boreholes outlined in Table 2.2. Groundwater was encountered in six of the 11 historic boreholes, with the remaining five recorded as dry.

It should be noted that in SP41SE22, it is not possible to read the notes relating to groundwater and therefore only the first groundwater strike is summarised.

The current use of the site as a Willow tree farm indicates that groundwater is likely to be near ground level.

Table 2.4: Summary of Groundwater Strikes

Borehole	Strike Depth (mBGL)	Rose to (mBGL)	Strata
SP41SE22	6.1	N/A	Oxford Clay
SP51SW51	2.5	N/A	Weathered Oxford Clay

SP41SE23	0.25	N/A	Topsoil
SP41SE23	3.2	N/A	Weathered Oxford Clay
SP41SE23	3.77	N/A	Oxford Clay Formation
SP51SW16	4.45	4.0m in 5 mins	Weathered Oxford Clay
SP51SW36	9.4	N/A	Oxford Clay Formation

Table 2.5 presents a summary of the hand vane tests which were undertaken within one of the historical boreholes reviewed, SP51SW16. It should be noted that hand shear vane tests are indicative and should not be treated as a direct measure of the undrained shear strength.

Table 2.5: Summary of Hand Vane Tests

Strata	No. of Tests	Minimum Strength (kPa)	Maximum Strength (kPa)	Average Strength (kPa)
Weathered Oxford Clay Formation	2	72	>120*	96
Oxford Clay Formation	3	>120*	>120*	>120*

*Maximum of 120kPa with hand vane.

Table 2.6 presents a summary of the strength tests performed on undrained samples from within one of the historical boreholes reviewed: SP51SW16. The exact test method is not recorded, and therefore these should be treated with caution.

Table 2.6: Summary of Strength Tests on Undrained Samples

Strata	No. of Tests	Minimum Strength (kPa)	Maximum Strength (kPa)	Average Strength (kPa)
Weathered Oxford Clay Formation	1	200	200	200
Oxford Clay Formation	2	150	180	165

Third Party Reports

There documents associated with the construction of the Holliday Inn, Peartree Roundabout, Oxford are freely available through the Oxfordshire County Council Planning Portal.

A Phase 1 Desk Study was produced by Enzygo Limited in 2017 for the Holiday Inn at Peartree Roundabout. The Holiday Inn at Peartree Roundabout is located approximately 1km south of the site. A Method Statement and Risk Assessment were also produced for the Holiday Inn at Peartree Roundabout in 2020 which outlines the pile type, diameter and lengths to be constructed. However, the associated pile design is not available for review. A summary of these reports is provided below.

A Report on a Ground Investigation at Oxford High School, Charlbury Road, Oxford, produced in February 2016, was also attached to the planning application for the Holiday Inn. However, Oxford High School is located 3.5km south of the site and is therefore not relevant to the site and so has not been reviewed further.

Phase 1 Desk Study, Holiday Inn, Peartree Roundabout, Oxford OX2 8JD

A brief summary of the information contained within the above referenced report is provided below. This is focused on information that may be relevant to the proposed site covered by this report for the new Oxford Utd stadium.

The site was previously occupied by a two-storey building with soft landscaping and block paved footways to the south and west, and a service yard to the north of the building. No tanks of chemical storage were noted on the site and no significant contamination sources were identified on or adjacent to the site.

A summary of the British Geological Survey (BGS) geological sequence at the site was provided, and suggested that the site directly underlain by the Oxford Clay Formation, which was classified as an unproductive aquifer. The report highlighted a moderate risk of clay heave associated with the Oxford Clay; no other risks associated with the ground conditions were identified.

Method Statement & Risk Assessment for Holiday Inn, Oxford

The scope of works for bored piles and construction was outlined in the Method Statement, and is summaries in Table 2.7. It is worth noting that pile design and setting out information were not detailed in the Method Statement. The method for installing reinforcement cages and braces is outlined but details of the reinforcement are not specified.

Table 2.7: Summary of Scope of Works

Pile Type	No. of Piles	Pile Diameter (mm)	Minimum Pile Length (m)	Maximum Pile Length (m)	Reinforcement
CFA Bearing / Tension Piles	108	450	8.5	13.0	Details not provided.

Geotechnical Risks

Potential geotechnical issues recorded in the Envirocheck Report are summarised below. For further information, reference should be made to the Envirocheck Report in Appendix A.

- Collapsible Ground Stability Hazards – very low;
- Compressible Ground Stability Hazards – no hazard;
- Dissolution Stability Hazards – no hazard;
- Landslide Ground Stability Hazards – very low;
- Running Sand Ground Stability Hazards – no hazard; and
- Potential for Shrinking or Swelling Clay Ground Stability Hazards – moderate.

BGS Measured Soil Chemistry

The BGS soil chemistry concentration values were measured at two locations within the site boundary and are summarised in Table 2.8.

Table 2.8: Soil Chemistry Values

Chemical	Estimated Soil Chemistry (mg/kg)
Arsenic	15 – 35
Cadmium	<1.8
Chromium	90 – 120
Lead	<100 – 200
Nickel	30 – 45

Hydrogeology

The bedrock of the Oxford Clay Formation is classed as an Unproductive Strata. The groundwater vulnerability is also designated as Unproductive.

The site is not located within 1km of a groundwater Source Protection Zone.

Limited groundwater flow may occur within more permeable beds within the Oxford Clay Formation. The site location is close to a likely groundwater flow divide between tributaries of the River Cherwell and River Isis. Consequently, the groundwater flow direction is uncertain and localised variations are possible. A worst case has been assumed when assessing potential contaminant linkages.

Perched groundwater may be present within higher permeability strata within the Oxford Clay Formation.

Hydrology

The Oxford Canal runs parallel to the site approximately 0.65km to the west. Kingsbridge Brook is approximately a further 0.2km to the west of the site from the Oxford Canal. Three ponds / small lakes lie between the site and Oxford Canal, the closest being approximately 0.5km west of the site.

The site is located within a Drinking Water Safeguard Zone for surface water. This means the site is located in a catchment area which influences the water quality of an associated Drinking Water Protected Zone. This associated Protected Zone begins immediately to the west of the site boundary.

Flooding from Rivers and the Sea

The site is not located within an area at risk of flooding from rivers or the sea.

Surface Water and Groundwater Flooding

The site is not within an area with potential for groundwater or surface water flooding to occur.

Site History

A summary of historical land use and development within approximately 500m of the site is detailed below, highlighting the major changes observed from the Envirocheck historical maps. Only maps where significant changes are observed are included within the summary.

The full set of historical maps is presented within the Envirocheck Report in Appendix A.

Table 2.9: Summary of Historical Land Use

Year	Scale	Land Use and Development
1876	1:2,500	**On site** ● The majority of the site is shown to be agricultural land. ● Stratfield Brake – coniferous and non-coniferous trees across the southern section of the site. ● Oxford Road along the east boundary of the site, extends into site at the southeast corner. **Off site** ● Oxford Road runs parallel to the east boundary of the site. ● Stratfield Brake extends west from on site. ● London and Northwest Railway Oxford & Bletchley railway line approximately 50m to the southeast of the site, running northeast to southwest. ● Oxford Road Crossing, Oxford Road crosses beneath railway approximately 100m southeast of the site. ● Railway station and buildings to the southeast of Oxford Road Crossing.
1884 - 1887	1:10,560	**Off site** ● Stratfield Brake extends from on site to approximately 500m to the west of the site. ● Stratfield Farm approximately 250m northwest of the farm. ● Frize Farm approximately 500m southwest of the site.
1936	1:2,500	**On site** ● Realignment of Oxford Road to the boundary of the site. Previous alignment turned into slip road off Oxford Road at the southeast of the site.
1945	No scale	**On Site** ● Some minor structures with a narrow road/track running east to west.
1947	1:10,560	**On Site** ● Old alignment of Oxford Road removed from within site boundary. **Off site** ● Group of buildings approximately 200m north-northeast of the site. ● Group of buildings approximately 400m north of the site.
1960	1:10,560	**Off site** ● Roundabout immediately north of the site under construction. ● Road immediately to the west of the site under construction.
1967	1:10,000	**Off Site** ● Roundabout immediately north of the site. ● Road immediately to the west of the site is shown as constructed.
1969	1:10,000	**Off Site** ● Building and road development approximately 250m north of the site.

	1971 – 1978	1:2,500	**Off Site** ● Electricity transmission line approximately 100m south of the site running parallel to south boundary.
	1981	1:10,000	**Off Site** ● Additional buildings approximately 200m north-northeast of the site. ● Electric Sub Station approximately 50m east of the southeast corner of the site.
	1992 – 1993	1:10,000 1:2,500	**Off Site** ● Road (A34) directly southeast of the site, parallel to the railway. ● Building 250m north of site removed. ● Grain Silo approximately 200m east of the southeast corner of the site.
	1999	1:10,000	**On Site** ● Earthworks a couple metres in height associated with the track. **Off Site** ● Superstore 200m north of site.
	2006	1:10,000	**Off Site** ● Sports ground and building approximately 100m to the west. ● Car Park and Water Eaton Park and Ride 200m southeast of the site
Unexploded Ordnance (UXO) Risk	The Preliminary UXO Threat Assessment undertaken by 6 Alpha Associates indicates that the potential for a UXO hazard (more specifically the potential for unexploded WWI and WWII ordnance to exist at the site) is unlikely. The report recommends no further action is required to address the UXO risk at the site. Full details of the UXO risk are presented in Appendix B.		
Contemporary Trade Directory Entries	There are 14 contemporary trade entries between 251m – 1km of the site, 5 of which are active. The five active contemporary trade entries include car dealers, petrol filling station, garage services, car breakdown and recovery services. Full details on all contemporary trade directory entries are presented within the Envirocheck Report in Appendix A.		
Fuel Station Entries	There is one fuel stations within 500m of the site, the details of which are listed below: ● Sainsbury's Kidlington; Petrol Station 289, Oxford Road, Kidlington, OX5 2PE, 244m N (NGR 449852, 212516); Status: Open. Full details on fuel station entries are presented within the Envirocheck Report in Appendix A.		
Recorded Tanks	There are no recorded tanks within 500m of the site. There is one recorded tank approximately 750m from the site. Full details on the recorded tank are presented within the Envirocheck Report in Appendix A.		
Pollution Incidents to Controlled Waters	There is one pollution incident to controlled waters recorded within 500m of the site, the details of which are listed below: ● Property type not given, Kidlington, 496m NW (NGR 449500, 212600); 2nd November 1994; Oils – unknown; Category 3 – Minor Incident. A further nine pollution incidents to controlled waters are recorded within 1km of the site. Full details on the recorded pollution incidents to controlled waters are presented within the Envirocheck Report in Appendix A.		
Local Authority Pollution Prevention and Controls	There is one local authority pollution prevention and control within 500m of the site, the details of which are listed below: ● Sainsbury's Supermarket; Oxford Road, Kidlington, Oxfordshire OX5 2PE, 222m N (NGR 449904, 212495); Permit Ref: CDC/98/9; 27th November 1998; PG1/14 Petrol filling station; Authorised. There are no further local authority pollution prevention and controls within 1km of the site. Full details are presented within the Envirocheck Report in Appendix A.		

Prosecutions Relating to Authorised Processes	There are no prosecutions relating to authorised processes within 1km of the site.
Water Abstractions	There are no water abstractions within 1km of the site, with four within 2km of the site. Full details are presented within the Envirocheck Report in Appendix A.
Discharge Consents	There are two discharge consents recorded within 500m of the site, the details of which are listed below: ● The Chief Executive – Oxfordshire County Council; North Oxford Park and Ride A4165, Kiddington, Oxford, Oxon; 243m East (NGR 450250, 211870); Reference: Cawm.050; Discharge Type: Sewage Discharges – Final/Treated Effluent – Not Water Company; Discharge: Freshwater Stream/River; Receiving Water: Tributary of River Cherwell; and ● Collexoncotoo Ltd; Frieze Farm Woodstock Road, Wolvercote, Oxfordshire OX2 8JX; 449m south west (NGR 449549, 211422); Reference: Cawm.1441; Discharge Type: Sewage Discharges – Final/Treated Effluent – Not Water Company; Discharge: Underground Water; Receiving Water: Groundwater. There are three further discharge consents within 1km of the site. Full details are presented within the Envirocheck Report in Appendix A.
Registered Radioactive Substances	There are no registered radioactive substances recorded within 1km of the site.
Waste Related Activities	There is one local authority recorded landfill site within 500m of the site, the details of which are listed below: ● Pear Tree Hill Railway Cutting, Oxford, Oxfordshire; 376m south (NGR 449825, 211487); Provider Reference: 24; Specified Waste: Domestic. There are two further local authority landfill sites recorded within 1km of the site. There are no further historical landfill sites within 1km of the site. There are no licensed waste management facilities, registered waste transfer sites or registered treatment or disposal sites within 1km of the site. Full details of all waste related activities are presented within the Envirocheck Report in Appendix A.
Infilled Land	There are no areas of potentially infilled land (non-water) recorded within 500m of the site, and one area recorded within 1km of the site. There are no areas of potentially infilled land (water) recorded within 500m of the site, with seven recorded within 1km of the site. Full details are presented within the Envirocheck Report in Appendix A.
BGS Recorded Mineral Sites	There is one BGS recorded mineral site within 500m of the site, the details of which are listed below: ● Banbury Road Rail Depot, Kidlington, Oxfordshire; 480m NE (NGR 450383, 212307); Reference: 17333; Commodity: Crushed Rock; Status: Active. There is one further BGS recorded mineral site within 1km of the site. Full details are presented within the Envirocheck Report in Appendix A.
Notification of Installations Handling Hazardous Substances (NIHHS)	There are no Notification of Installations Handling Hazardous Substances (NIHHS) sites recorded within 1km of the site.
Registered Explosive Sites	There are no registered explosive sites within 1km of the site.
Control of Major Accident Hazard Sites (COMAH)	There are no Control of Major Accident Hazards (COMAH) sites within 1km of the site.
Sensitive Land Uses and	The site is within a Nitrate Vulnerable Zone. There are no Special Protection Areas (SPA) within 1km of the site.

Statutory Designations	
Radon Potential	Public Health England UK Radon Map suggests the site is located within an area with the lowest radon potential, where less than 1% of homes are above the action level.
Archaeology	Satellite imagery shows scars on the land adjacent to the site to the northeast. An Archaeological Desk-Based Assessment and Heritage Settings Assessment have been undertaken for the site by Cotswold Archaeology, summarised in the following reports: ● Cotswold Archaeology, Oxford United New Stadium Development, Oxford, Oxfordshire, Archaeological Desk-Based Assessment, November 2023. Report reference: CR1442_2. ● Cotswold Archaeology, Oxford United New Stadium Development, Oxford, Oxfordshire, Heritage Settings Assessment, November 2023. Report reference: CR1442_2. The Heritage Settings Assessment indicated no instances of harm to the significance of any designated heritage assets in the vicinity of the site (see report for further information). The site has potential to contain evidence of early prehistoric activity and buried remains of former ridge and furrow cultivation practices. Any potential buried archaeological remains which are present are not considered likely to be of sufficient significance as to warrant preservation in situ. Reference should be made to the above report for further details.
Ecology	Ecology Solutions are advising on any potential site-specific ecological constraints such as the presence of any protected species. Several surveys for protected species have been undertaken at the site including badger, bats, breeding birds and reptiles. It is noted that there are trees present at the site which could potentially support roosting bats and there is potential to encounter reptiles at the site. At the time of writing some areas of the site were not accessible during the ecological surveys. Full details of the ecological constraints and the required mitigation measures (e.g. vegetation clearance, ecological supervision or watching briefs) are to be confirmed prior to any intrusive or construction works by Ecology Solutions, reference should be made to the below reports for further information. ● Environmental Statement – Chapter 8 – Ecology and Nature Conversation (prepared by Ecology Solutions); and, ● Ecology Solutions, EIA Environmental Statement – Technical Appendix 8.1 to Chapter 8: Ecology and Nature Conservation, November 2023. Report reference: 10736.ES Ecology.vf1.
Additional Client Provided Information	No additional information has been provided at the time of writing.

3 Preliminary Geotechnical Assessment

The following sections identify potential geotechnical risks to the proposed development based on the geological units likely to be encountered at the site. Following GI works these will be reviewed and revised accordingly. A detailed risk register of geotechnical risks is given in Section 4.

3.1 Geological Considerations

Below is a summary of the possible risks associated with the geology likely to be encountered on the site. It has been assumed that, if present, topsoil would be removed before any work.

3.1.1 Made Ground (Embankment Fill)

Made Ground in the form of Embankment Fill was encountered in two of the 14 BGS historical exploratory holes within 50m of the site, however, as it is associated with the highway embankments bounding the site and is not expected within the site boundary. However, Made Ground may be encountered at the site boundary if proposed works extend to the kerb line of the adjacent roads. It is anticipated that Made Ground will be present in the southeast corner of the site, where Oxford Road used to cross the southeast corner of the site before its realignment in the 1930s. Despite the site being a greenfield site it is anticipated that some disturbed Made Ground will be encountered as a result of the earthworks associated with the track on site, although this is unlikely to require extensive control measures.

3.1.2 Oxford Clay Formation

The Oxford Clay Formation was encountered in all the BGS historical boreholes within 50m of the site.

The top 1.5 – 4.6m of the Oxford Clay Formation was recorded as being weathered and was described as firm to very stiff grey and brown, orange-brown mottled, closely fissured, irregularly thinly to thickly laminated silty clay with shell fragments, gypsum crystals and pockets of friable white silt with lenses and partings up to 5mm thickness of white calcareous silt.

The underlying Oxford Clay Formation was described as stiff becoming very stiff dark brown, grey, orangish green, slightly carbonaceous extremely closely fissured and irregularly laminated silty clay with occasional to frequent shell fragments. Occasional thin bands of argillaceous limestone.

Below is a geotechnical assessment of the potential risks that could be associated with the Oxford Clay Formation:

- Weathered profile may be of variable weathering and thickness, as seen in surrounding boreholes;
- Weathering may result in reduced bearing capacity which could lead to excessive total / differential settlement;
- It is likely that gypsum is present in the Oxford Clay Formation (as noted on borehole logs surrounding the site) which may mean this is aggressive towards concrete elements with the ground;
- There is potential for layers of weak mudstone within the Oxford Clay Formation which may pose an obstruction to drilling / piling activities; and
- The Oxford Clay Formation has a moderate potential for shrink / swell behaviour, particularly in areas of existing vegetation (see also Section 3.1.3).

3.1.3 Willow Tree Farm

The current and historical use of the site as a Willow Tree farm means existing trees are present across the site. According to NHBC Building near trees guidance, Willow Trees have a high water demand and a zone of influence of 1.25x mature tree height. Based on the geological mapping and historical boreholes, the site is underlain by material with a moderate potential for shrink/swell behaviour which may cause ground movements and cause damage to proposed works.

The area is likely to have been desiccated by the presence of the willow trees, which once removed is likely swell.

The extent of the Willow Tree and zone of influence should be investigated as part of the ground investigation and specialist advice should be sought from an arboriculturist.

Information provided by Ridge and Partners LLP states discussions with the tenant farmer have provided the following information:

- The willow plantation is less than 20 years old.
- The willow is harvested after 1 to 5 years, depending on intended use and the farmer harvests the area in patches according to the age.
- There is a mix of aged willow over the farm which takes 5 years to develop.
- Areas outside of the willow are cut back once to twice a year.

3.2 Groundwater Considerations

Groundwater was encountered in six of the 11 historic boreholes. Groundwater was encountered at a depth of 0.25mbgl in the topsoil. In the Oxford Clay formation groundwater was encountered between depths of 2.5 mbgl – 9.4mbgl, with groundwater being encountered at shallower depths (2.5 mbgl – 4.45mbgl) in the strata especially in the upper weathered zone of the Oxford Clay.

Anecdotal evidence suggests that the site is wet at surface, which could indicate shallow groundwater. This appeared to correlate with observations and evidence obtained as part of the site walkover (see Appendix H for full details).

The Oxford Clay Formation is classified as an Unproductive Aquifer and the site is not located within a groundwater Source Protection Zone (SPZ).

3.3 Engineering Options

Based on the proposed works at the site, and review of recent developments within the surrounding area, it is likely that any moderately loaded structures, such as the stadium, will require a piled foundation solution. Due to the risk of swell, tension will need to be accounted for in pile design, and a slip coating on the piles may be necessary. For more lightly loaded elements, a shallow foundation solution may be feasible, however consideration to the founding level along with total and differential settlements limits, and potential for swell would be necessary.

Due to the sites current use as a Willow Tree Farm the risk of shrink/swell behaviour is likely and will require consideration in any engineering works for any ground bearing elements including slabs, pavements and drainage. This will also require consideration for design of the pitch. Solutions such as a void former beneath any ground bearing elements may be necessary to mitigate the risk of swell. Consideration may also need to be made with respect to stabilisation of the founding material, or ground improvement, dependent upon the findings of

the ground investigation. This could take the form of deep soil mixing and/or mass stabilisation may be required.

For the proposed earthworks on site, consideration will need to be given to suitable separation of the Topsoil and re-use. For the underlying Oxford Clay Formation, and based on the anticipated depth of cut, this is likely to be from the weathered zone, and also that influenced by the current site use as a willow tree farm. The risk of swell will need to be considered in the design of any earthworks, and consideration should be given to stabilisation and/or improvement.

Based on the anticipated ground conditions, infiltration rates are anticipated to low, meaning that soakaway drainage is unlikely to be feasible.

4 Geotechnical Risk Register

The Geotechnical Risk Register for the project is detailed in Table 4.4.

The methodology is based on advice given in the document CD622. The Geotechnical Risk Register should be considered as a live document and updated throughout the course of the scheme. It is incumbent on all parties involved in the scheme to advise the other members when the risks change.

Various threats are identified and the potential consequences of these occurring are described. The risk is derived by considering the severity and likelihood for each threat and opportunity. Both the severity and likelihood have been assessed using a scale of 1 to 5, corresponding to "Minor" to "Catastrophic" for severity and "Extremely unlikely" to "Almost certain" for likelihood. These ratings are summarised in Table 4.1 and Table 4.2. A summary of risk classification is provided in Table 4.3.

Table 4.1: Risk Level Matrix

Likelihood		Severity				
		1	2	3	4	5
		Minor	Moderate	Serious	Major	Catastrophic
1	Extremely unlikely	1	2	3	4	5
2	Unlikely	2	4	6	8	10
3	Likely	3	6	9	12	15
4	Extremely likely	4	8	12	16	20
5	Almost certain	5	10	15	20	25

Table 4.2: Hazard Severity Table

Potential severity of harm occurring		
1	Minor	Minor damage or loss – (no human injury)
2	Moderate	Moderate damage or loss – (slight injury or illness)
3	Serious	Substantial damage or loss – (serious injury or illness)
4	Major	Major damage or loss – (fatal injury)
5	Catastrophic	Catastrophic loss or damage – (multiple fatalities)

Table 4.3: Risk Classification Table

Risk Classification	
Low (1-8)	Ensure control measures are maintained and reviewed as necessary.
Medium (9-19)	Additional control measures needed to reduce risk rating to a level that is equivalent to a test of "reasonably required" for.
High (20-25)	Activity not permitted. Hazard to be avoided or risk to be reduced to tolerable level.

Ground investigation can help to mitigate ground and groundwater risks; however, these risks cannot be eliminated. Ground investigations by nature can only investigate and monitor a small part of the sub-surface conditions for a limited duration. Conditions on site identified during construction could reveal ground conditions that could not have been taken into account from the results of ground investigation.

It is recommended that adequate and appropriate supervision must be provided during construction to assess the ground conditions encountered and interpret the results of the site testing. When appropriate this supervision during construction should be undertaken by a suitably experienced and qualified Engineering Geologist / Geotechnical Engineer.

Table 4.4 highlights the potential hazards that could be encountered during the site investigation and/or construction. The consequence of the hazard is outlined, and a sore is given for the impact and likelihood for this hazard, giving an overall risk. From this, potential control measures are stated to alleviate hazard, leading to a rescoring of the impact and likelihood, resulting in a residual risk.

Table 4.4: Geotechnical Risk Register

ID	Hazard	Consequence	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Residual Risk
1.	Oxford Clay Weathering Profile	• Top 1.5 – 4.5m of Oxford Clay Formation likely to be weathered • Reduced bearing capacity resulting in excessive total/differential settlement • Constraint to suitability of shallow foundations for structure • Presence/formation of gypsum which may be aggressive to concrete elements	4	2	8	• Ground investigation to confirm weathering profile and geotechnical parameters • Detailed design to include settlement analysis	1	2	2
2.	Potential shrink/swell behaviour – specifically based on the sites current land use	• The Oxford Clay Formation has a moderate potential for shrink/swell behaviour, particularly in areas of existing vegetation (e.g., Willow Tree farm) • Heave/consolidation resulting in ground movement damage to structures and infrastructure • Willow Trees have a high water demand, associated with volume change of the soil, and a large zone of influence. • Risk of swell impacting the suitability of material for re-use in earthworks	5	4	20	• Ground investigation to obtain samples of Oxford Clay Formation • Laboratory testing to determine geotechnical properties and parameters of the material, specifically focused on swell potential • Specialist advice from an arboriculturalist to be sought. • Compliance with NHBC Guidelines 2019 Chapter 4.3 Building Near Trees in any design works • Detailed design to take into account the findings of the GI	2	4	8
3.	Shallow groundwater	• Potential for groundwater within shelly sandy horizons within the Oxford Clay Formation • Disruption to site works resulting in increased cost and programme delays	4	2	8	• Ground investigation to confirm groundwater levels within depth of influence with post fieldwork monitoring to determine long term rest levels • Suitable consideration in design of both permanent and temporary works	2	2	4
4.	Mudstone layers in Oxford Clay Formation	• Potential obstruction to any intrusive works e.g,. GI or piling	2	2	4	• Ground investigation to determine presence at the site	1	2	2

ID	Hazard	Consequence	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Residual Risk
						• Laboratory testing to determine geotechnical properties			
5.	Inadequate Ground Investigation	• Limited understanding of site-specific information, leading to conservative design and poor understanding of site-specific ground risk • Unforeseen ground conditions	5	4	20	• Undertake a detailed ground investigation to inform the next stage of design and inform proposed design works	1	4	4
6.	Ecology	• Disruption to site works resulting in increased cost and programme delays. • Ecological surveys indicate there are trees present at the site which could potentially support roosting bats, and there is potential for reptiles to be encountered at the site. Reference should be made to the ecology reports for further information (Ecology Solutions, EIA Environmental Statement – Technical Appendix 8.1 to Chapter 8: Ecology and Nature Conservation, November 2023. Report reference: 10736.ES Ecology.vf1, and associated Chapter 8 within the Environmental statement) • At the time of writing some areas of the site were not accessible during the ecological surveys, therefore there is potential for additional ecological constraints within these areas	2	2	4	• Ecological supervision of intrusive / construction works at the site are likely to be required, including the potential for watching briefs. The exact nature of the ecological mitigation measures should be confirmed prior to any intrusive / construction works by Ecology Solutions, including for areas at the site which had not previously been surveyed.	1	2	2
7.	Archaeology	• Satellite imagery indicates archaeological investigation has been undertaken at an adjacent site to the northeast. • An Archaeological Desk-Based Assessment and Heritage Settings Assessment have been undertaken and indicated no instances of harm to the significance of any designated heritage assets in the vicinity of the site. Any potential buried archaeological remains within the site are not considered likely to be of sufficient significance • Disruption to site works resulting in increased cost and programme delays.	2	2	4	• Best practice during any excavation works. • Should any archaeological features be identified these should be recorded and an appropriately qualified archaeologist informed.	2	2	4

ID	Hazard	Consequence	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Residual Risk
8.	Unexploded Ordnance (UXO)	• The Preliminary UXO Threat Assessment indicates the potential for a UXO hazard is unlikely. • Potential serious injury to construction workers, damage to plant and/or structures.	1	5	5	• The Preliminary UXO Risk Assessment report recommends no further action is required. • Best practice during any excavation works.	1	5	5
9.	Suitability of excavated material for re-use	• Material within the Oxford Clay Formation not suitable for re-use on site	4	3	12	• Ground investigation to obtain samples of Oxford Clay Formation • Laboratory testing to determine geotechnical properties and parameters, including earthworks relationship testing, of the material and suitability for re-use • Testing to ascertain the feasibility of improvement and stabilisation techniques	2	3	6
10.	Overhead / buried services	• Potential serious injury to construction workers and disruption of service. • Delays to construction, severe financial and political repercussion.	3	5	15	• Thorough review of detailed service records prior to conduction works. • Carry out a GPR survey to identify and locate existing services. • Contractor to check each exploratory hole location for buried services during GI – hand dug inspection pit and CAT scanning	1	5	5
11.	Presence of Made Ground	• Anticipated Made Ground at the southeast of the site and at site boundaries of unknown thickness and consistency • Potential for encountering earthworks associated with the track.	4	2	8	• Ground investigation to determine presence at the site. • Laboratory testing to determine geotechnical properties	1	2	2

5 Preliminary Qualitative Contamination Risk Assessment

5.1 Statutory regime

There are two complementary systems in the UK for dealing with issues of land contamination. Part IIA of the Environmental Protection Act (EPA), 1990 primarily deals with the identification and remediation of historical contaminated sites by determining land as 'contaminated land'.

For those sites that enter the planning and redevelopment process, the developer is required to undertake sufficient assessment of the site to show whether the site is contaminated or not, and if so, to design, undertake and verify adequate remediation as part of the development to ensure that a site is suitable for its intended use.

To support assessment of sites through the development process, the Environment Agency has developed its Land Contamination: Risk Management (LCRM) guidance. In addition to this, there are numerous industry guidance documents as well as British Standards that provide practitioners and developers with guidance on specific aspects of contamination assessments.

Guidance that has been used in the preparation of this assessment includes the LCRM, as well as:

- BS 10175: Investigation of potentially contaminated sites: Code of Practice (2017);
- NHBC R&D 66: Guidance on the safe development of housing on land affected by contamination (2008);
- BS 8576: Guidance on investigations for ground gas – Permanent gases and volatile organic compounds (VOCs) (2013); and
- CIRIA C665: Assessing the risks posed by hazardous ground gases to buildings (2007).

Following the procedures in LCRM, a key element of the Preliminary Risk Assessment is the development of a conceptual model which may be refined or revised as more information and understanding is obtained through the risk assessment process. The conceptual model is described in terms of the contaminant Sources, transport Pathways and possible Receptors that may be present, and the potential 'Pollutant Linkages' between them, as defined in the relevant legislation and guidance.

5.2 Planning framework

New development is regulated under the Town and Country Planning Act 1990 (as amended). This regime provides a mechanism for the planning authority to enforce the proper investigation of a development site in order to ensure that once development has occurred the site is suitable for its intended use. In England, the National Planning Policy Framework (NPPF) provides guidance on the implementation of contaminated land and pollution management requirements to address contamination risks associated with future site uses through the planning system. Paragraphs 174, 183, 184, and 185 of the NPPF state the following:

174: Planning policies and decisions should contribute to and enhance the natural and local environment by:

- preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local

environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

- remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

183: Planning Policies and decisions should ensure that:

- A site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential threats on the natural environment arising from that remediation);
- After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and
- Adequate site investigation information, prepared by a competent person, is available to inform these assessments.

184: Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

185: Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. Framework for the assessment of contamination

The key aspects of the framework are the development of a CSM, which demonstrates the connectivity and interaction between the potential sources and receptors on-site as potentially complete pollutant linkages. The CSM may be refined or reviewed as more information and understanding is obtained through the risk assessment process.

For risk of pollution or environmental harm to occur because of ground contamination, all of the following must be present:

- A **source** – a substance capable of causing pollution or harm;
- A **receptor** – something that could be adversely affected by the contaminants; and
- A **pathway** – a route by which the contaminant source can reach the receptor.

If one of the above is absent, there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptors and the nature of the migration pathway.

It is assumed that a robust construction environmental management plan (CEMP) will be adopted during construction works and as a result, no contamination will occur as a result of leaks and spills during construction. If asbestos is identified, an asbestos specialist should be consulted to advise on the risks.

5.3 Conceptual site model

For proposed development of the site, the following sources, pathways and receptors have been identified:

5.3.1 Sources

On-site

S1: Potential application of herbicides and pesticides

S2: Disturbed ground associated with the track way (hydrocarbon spills)

Off-site

S3: Made Ground associated with the construction of the A34, A4165 and A4260

S4: Leaks and spills of fuels and oils from vehicles on the A34, A4165 and A4260

S5: Historical and current railway land use

S6: Sainsbury's petrol station

5.3.2 Pathways

P1: Direct contact (human uptake pathway)

P2: Horizontal and vertical movement of groundwater

P3: Man-made pathways (e.g. excavation for foundations)

P4: Surface run-off

P5: Ground gas and/or vapour migration

5.3.3 Receptors

R1: Construction workers

R2: Groundwater in the Oxford Clay (Unproductive aquifer)

The identified contamination linkages are analysed in Table 5.2. The risk assessment methodology followed is included in Appendix D, with a graphical representation of the CSM included in Appendix E. It is assumed that a robust environmental management plan will be adopted during the construction works and as a result, no contamination will occur as a result of leaks and spills during construct

Table 5.1: Qualitative Risk Assessment

Source	Pathway	Receptor	Consequence	Probability	Risk	Comments
S1: Potential application of herbicides and pesticides **S2:** Disturbed ground associated with the track way (hydrocarbon spills) **S3:** Made Ground associated with the construction of the A34, A4165 and A4260 **S5:** Historical and current railway use	**P1:** Human uptake pathway (e.g. ingestion, dermal contact)	**S1:** Construction workers	Mild	Unlikely	Very low	From aerial photographs, it is apparent that the site has been generally well maintained. Therefore, it is possible that herbicides and pesticides have been used recently on-site. Construction workers may come into contact with soils contaminated with herbicides and/or pesticides during construction. It is possible that vehicles using the on-site track way have leaked or spilt hydrocarbons. It is noted that spills have not been recorded in the Envirocheck report. Due to the low permeability of on-site soils, and general relative weight of fuel oils, it is unlikely that any spills will have migrated a significant distance from their original location. To mitigate this risk, good practice should be followed on-site, with the possibility of encountering hydrocarbon contamination reflected in risk assessments. Visual and olfactory evidence of hydrocarbon contamination should be recorded in borehole logs. Embankment fill associated with the A34 has been identified in historic BGS boreholes (SP51SW52, 23m east; SP51SW51, 27m east). Further east than this is historical and current railway land. As both of these potential sources of contamination are outside of the development footprint, it is evaluated as unlikely that construction workers will come into contact with off-site contaminated materials. Limited testing of superficial materials is recommended to characterise the geo-chemical soil profiles. Commonly occurring herbicides and pesticides should be incorporated into testing suites, with these tests focusing on the uppermost 0.50m of topsoil. Testing should involve standard suites of organic contaminants due to the potential of on-site hydrocarbon pollution. The risk to construction workers will be mitigated through the use of appropriate Personal Protective Equipment (PPE) at all times during construction, and the following of good hygiene by on-site personnel.
S1: Potential application of, herbicides and pesticides	**P3:** Man-made pathways (e.g. excavation for design foundations) **P4:** Surface run-off Then: **P2:** Horizontal and vertical movement of groundwater	**R3:** Groundwater in the Oxford Clay (Unproductive aquifer)	Mild	Unlikely	Very low	It is likely that soils will be stripped prior to excavations beginning as topsoil is geotechnically unsuitable to support design foundations. This will remove the majority of the potential contamination source to groundwater. However, some soil may not be stripped and construction activities could create a pathway to groundwater. The aquifer is designated as low sensitivity. A robust CEMP should be followed to ensure that no new contamination pathways arise due to construction.
S2: Disturbed ground associated with the track way (hydrocarbon spills) **S4:** Leaks and spills of fuels and oils from	**P5:** Ground gas and/or vapour migration of hydrocarbons **P2:** Horizontal and vertical movement of groundwater Then:	**R1:** Construction workers	Mild	Unlikely	Very low	Although not recorded in the Envirocheck report, it is possible that there has been historic leaks and spills from vehicles associated with the roads which border the development footprint. Historical fuel spills may have occurred on site. The Sainsbury's petrol station (244m north) could have underground spills which have migrated south. The aquifer which underlies the development footprint is designated as Unproductive, and therefore has low permeability and flow rates. It is unlikely that fuel spills have occurred within

Table 5.1: Qualitative Risk Assessment

Source	Pathway	Receptor	Consequence	Probability	Risk	Comments
vehicles on the A34, A4165 and A4260 **S6:** Sainsbury's petrol station	**P1:** Direct contact (human uptake pathway)					proximity of the site, then migrated through this low permeability geology to under the site footprint. By extension, this makes it very unlikely that hydrocarbons will have travelled over 200m south to impact upon the development footprint. If fuel spills have occurred inside the site boundary, and are noted in ground investigations or analyses, this should inform a Foundation Works Risk Assessment (FWRA).

6 Conclusions and Recommendations

The below sections summarise the main geotechnical and geo-environmental findings from this report. However, no reliance should be placed on any part of this summary without referring to the relevant Sections in the report. Sections within the main body of the report contain information which puts into context the findings that are captured within this summary.

6.1 Geotechnical Conclusions

The site is underlain by the Oxford Clay Formation, the top 1.5 – 4.5m of which is likely to be weathered based on nearby BGS records reviewed. It is possible for disturbed ground/fill is encountered associated with the track way on site, which could be aggressive to shallow construction elements. It is unlikely that superficial deposits will be present on site.

There may be perched groundwater encountered in the Topsoil and shallow groundwater in the upper weathered zone of the Oxford Clay Formation, based on nearby BGS records.

The Oxford Clay has moderate shrink/swell potential which will need to be assessed as part of the ground investigation, particularly given the sites current land use as a willow tree farm and the high water demand of this species.

It is likely that a piled foundation solution will be required, and consideration to any ground bearing elements will need to be made, specifically in relation to the risk of heave due to the sites current land use as a willow tree farm.

Excavated Oxford Clay Formation may be suitable for re-use as engineered fill, however, suitable earthworks relationship testing will be required to characterise the soils properties. In addition, it is likely that stabilisation would require consideration. This will be assessed as part of the ground investigation.

The key residual risks are:

- It is possible that disturbed ground/fill may be encountered associated with the track way on site. Potential for material to be aggressive or be contaminated.
- The Oxford Clay Formation has a moderate potential for shrink/swell behaviour, particularly in areas of existing vegetation (e.g., Willow Tree farm). Heave/consolidation may occur following the removal of the Willow Trees, resulting in ground movement and damage to structures and infrastructure.
- Lack of site specific ground investigation, particularly to fully understand the properties of the material, and the influence from the willow trees.

6.2 Geo-Environmental Conclusions

The proposed development location is on undeveloped land. However, as the land has been maintained, there is a very low contamination risk to construction workers posed by potential presence of herbicides and pesticides.

As topsoil will be mostly stripped to uncover suitable founding geology, this forms a very low contamination risk to the underlying Unproductive aquifer. Due to the distance of surface water receptors, there is no contamination linkage to these receptors.

Several off site sources have been identified but, given the low permeability of the underlying strata, these have been assessed as very low risk.

It should be noted that there remains the possibility of encountering unexpected contamination on-site, potentially associated with the use of the track way. This must be considered during any below-ground works. Unexpected contamination can be managed through the use of a discovery strategy and unexpected contamination protocol which should be detailed in the project's CEMP. Should unexpected contamination be identified, this should form part of a risk assessment.

6.3 Further Assessment / Recommendations

On the basis of this desk study, the following recommendations are made:

- A project specific geotechnical ground investigation be undertaken to:
  - Confirm the materials present underlying the site.
  - Assess the potential geotechnical risks identified within this report.
  - Determine the thickness and properties of materials present.
  - This should involve limited geo-environmental testing, including commonly occurring pesticides and herbicides, with the testing methodologies reviewed and approved by a suitably qualified person. Testing should also involve standard suites of organic contaminants due to the potential of on-site hydrocarbon pollution.
  - If hydrocarbon contamination is noted, this should inform a Foundations Work Risk Assessment.
  - Specific consideration of suitable geotechnical testing to understand the swelling potential of the material will be required.
  - Consideration of testing to inform potential design solutions to mitigate likely swelling at the site.
  - Appropriate earthworks testing to assess the potential for re-use.
  - Testing to assess the feasibility of stabilisation e.g. by lime and/or cement.
- If unexpected contamination is encountered, a discovery strategy with an inclusive unexpected contamination protocol should be followed to address this. The identification of unexpected contamination shall form part of a risk assessment; and,
- To ensure no contamination risk is raised as a result of construction activities, a CEMP shall be implemented during construction *and* workers shall wear appropriate PPE at all times.

Appendices

A. Envirocheck Report