



Abbreviations

Abbreviation	Full name	Abbreviation	Full name
ACM	Asbestos-containing Material	PCBs	Polychlorinated Biphenyls
BGS	British Geological Survey	PID	Photo Ionisation Detector
BOD	Biological Oxygen Demand	PL	Plastic Limit
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes	PI	Plasticity Index
BH	Borehole	PSD	Particle Size Distribution
BRE	Building Research Establishment	SGV	Soil Guideline Value
BSI	British Standards Institution	SOM	Soil Organic Matter
BS	British Standard	SPT	Standard Penetration Test
CIRIA	Construction Industry Research and Information Association	SPZ	Source Protection Zone
COD	Chemical Oxygen Demand	SVOC	Semi-volatile Organic Compounds
GAC	Generic Assessment Criteria	TPH	Total Petroleum Hydrocarbon
LL	Liquid Limit	UST	Underground Storage Tank
m bgl	Metres Below Ground Level	UXO	Unexploded Ordnance
m OD	Metres Ordnance Datum	VOC	Volatile Organic Compound
MTBE	Methel Tert Butyl Ether	WAC	Waste Acceptance Criteria
PAH	Polycyclic Aromatic Hydrocarbons		



Executive Summary

A2 Site Investigation Ltd (A2SI) has been engaged by Weybourne Limited to prepare a geotechnical and geoenvironmental interpretative report based on a ground investigation at Scours Lane, Tilehurst, Reading, RG30 6AX. The report will inform the design of the proposed development, which is understood to comprise the construction of a new single-storey drive through restaurant in the centre of the site and areas of hard standing surrounding the building to be used as a car park and access road, with limited areas of soft landscaping around the boundaries of the site.

A Preliminary Risk Assessment (PRA) was previously completed for the site by Ashfield Solutions Group Ltd, which considered that no on-site potential contamination source is present. The contaminative potential of off-site sources is considered low due to the industrial units at Stadium Trade and Business Park.

The present ground investigation encountered a significant thickness of Made Ground (up to 3m thick) over superficial deposits including Alluvium (predominantly cohesive soils) and the Taplow Gravel Member (predominantly granular soils). The superficial deposits are underlain by chalk of the Seaford Chalk Formation and Newhaven Chalk Formation, recovered as silty subangular to angular fine to coarse gravel with frequent black flint from a depth of 7.60m bgl. The Chalk is expected to be in excess of 50m thick beneath the site. A groundwater strike was encountered within the Taplow Gravel Member at approximately 5.20m bgl, and subsequently monitored at a minimum depth of 3.80m bgl.

Contaminant concentrations in the shallow Made Ground are below the assessment criteria for a commercial land use and no asbestos was detected within the five samples screened. Based on these findings, the potential risks to human health receptors are low and no specific remediation is considered to be necessary for the proposed development. Based on the conceptual site model and supported by ground gas monitoring, the site conforms to Characteristic Situation 1 and no specific protection measures are required. No viable contaminant linkages have been identified for controlled waters. The potential risks to new water supply pipes are generally considered to be low, although the water company should be consulted for their requirements. The potential risks to plant growth due to phytotoxic contaminants are considered to be low.

Based on an initial waste characterisation, the Made Ground is non-hazardous for off-site disposal and potentially suitable for disposal at a suitably licensed inert waste facility subject to Waste Acceptance Criteria (WAC) testing. The natural uncontaminated soils, by definition, may be disposed at an inert waste facility. Alluvium may need to be disposed of at a non-hazardous waste facility due to the organic content of the material. Notwithstanding this, the contractor is responsible for classifying waste prior to off-site disposal. Subject to final levels, it may be possible to re-use site won soils.

Shallow foundations are not considered to be suitable for this development due to the significant thickness of Made Ground and Alluvium. Therefore, piled foundations extending into the chalk are considered to be the most appropriate foundation solution for this development.

Buried concrete may be designed to Design Sulphate (DS) Class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) Class AC-1s, for Made Ground and Alluvium, and DS-1 and AC-1 for Taplow Gravel Member and Chalk.

Based on the ground and groundwater conditions encountered, conventional infiltration soakaways are not for the development and alternative SuDS should be considered. A design CBR value of the underlying soils of 2% within the Made Ground can be used for pavement design.



1. Introduction

A2 Site Investigation (A2SI) were appointed to undertake a ground investigation at Scours Lane, Tilehurst, Reading, RG30 6AX. The ground investigation was agreed with the consulting engineers Simpson Engineering TWS Ltd, prior to commencement.

A desk study has previously been completed for the site by Simpson Engineering TWS Ltd (report ref 205024-S01-Scours Lane-P1ESA, dated August 2024), which has been referred to in this report.

1.1. Study Aims and Objectives

The scope of this report comprises the following elements:

- Summary of the previous desk study and preliminary risk assessment.
- Details of the ground investigation completed.
- Technical assessment and interpretation of ground investigation data carried out for geotechnical design parameters.
- Recommendations for geotechnical design including soil parameters, foundations (shallow and deep, as appropriate), excavations, floor slabs, buried concrete and drainage.
- Geo-environmental assessment (Generic Quantitative Risk Assessment – GQRA) based on the ground investigation results and recommendations for remediation (as necessary) and material management / waste disposal.

This report may be used to inform the detailed design or the development and to support a planning application and/or discharge of the relevant planning conditions relating to contamination and remediation.



2. Site Setting

2.1. Development Location and Current Site Use

The development site is located on a plot of land adjacent to Scours Lane, Tilehurst, Reading, RG30 6AX as shown in Figure 2.1. The site is located at the approximate British National Grid coordinates of 468546E, 174544 and has an area of approximately 0.23 ha. The site is parcel of undeveloped land located within the southwestern corner of Stadium Way Industrial Estate and to the northeast of the junction between Scours Lane and Oxford Road. Vehicular access to the site is possible from the car park to the northeast side of the site. The remainder of the site is bound by low-rise wooden fencing. At the time of the investigation, there were nine deciduous trees located on the site.

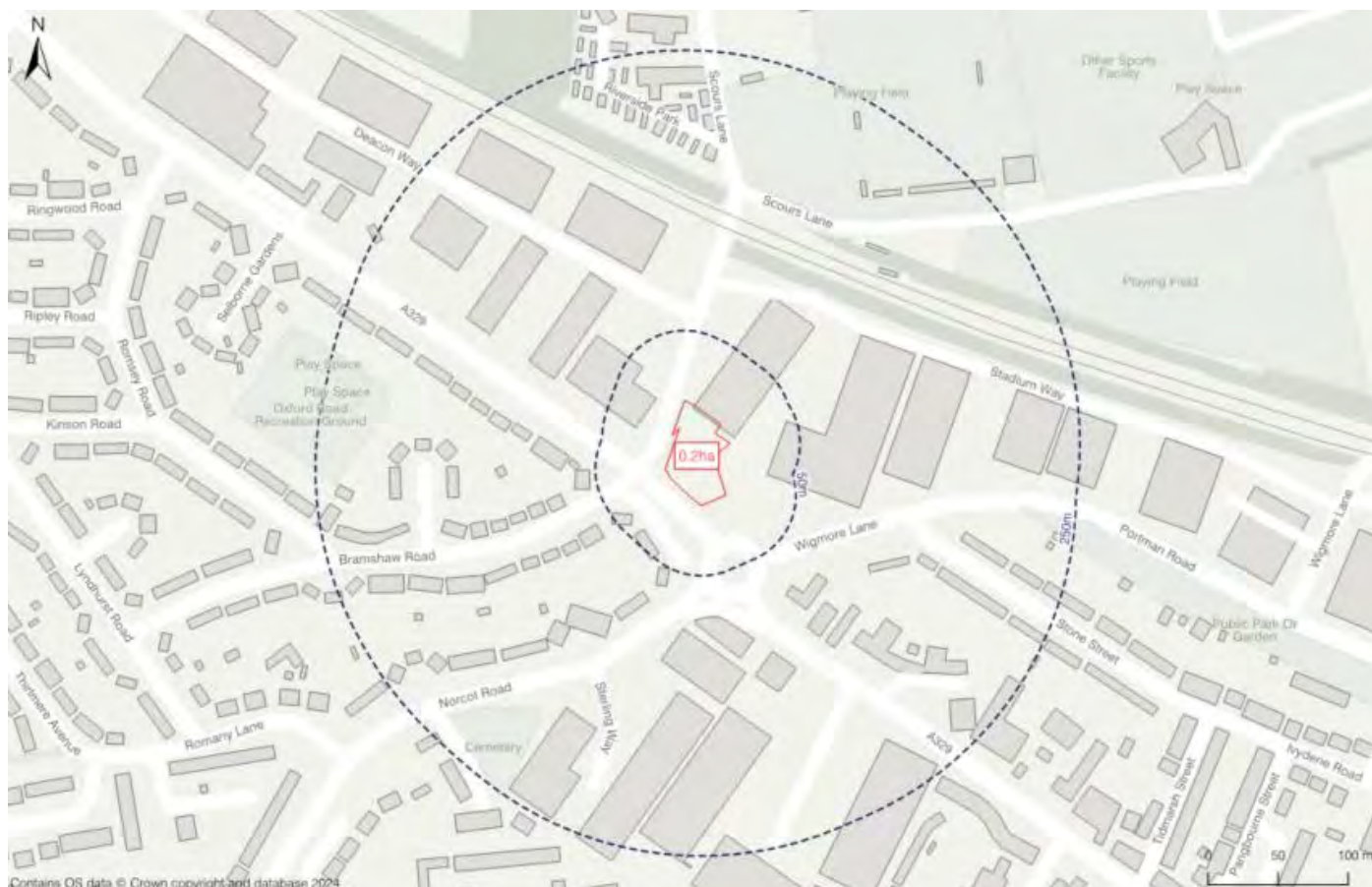


Figure 2.1 Location of the site, red line reflects the site boundary used for this assessment. (Ashfield Ltd, 2024 Report No:205024-S01)

The site topography is generally flat in the south and west area, sloping towards northeast area, away from Oxford Road.

The wider area is generally occupied by commercial uses to the north-west, north and east and semi-detached and terraced housing to the west, southwest, and southeast. To the south of Norcot Roundabout, and along Oxford Road heading eastward, there is a range of various commercial and retail uses, including Reading Retail Park, 145 m to the south of the site. Proposed Development

The proposed development of the site comprises of the construction of a single-story drive through restaurant in the centre of the site with areas of hard standing surrounding the building to be used as a car park and an access road for the drive through service. Additionally, soft landscaped areas are proposed around the boundaries of the site, comprising of new and all existing trees. Figure 2.2 shows the proposed development of the site. It is understood that basement space is not proposed.



Figure 2.2 Location of the proposed development (Drawing ref: QD784.401; Quartet Design Landscape Architects, July 24)



3. Summary Previous Desk Study

A Phase 1 Desk Study has previously been completed for the site by Simpson Engineering TWS (report ref 205024-S01-Scours Lane-P1ESA, dated August 2024). This section summarises the key findings of this report.

3.1. Environmental Setting

Based upon the site being an undeveloped parcel of land, there is a very low potential for contaminative activities and no obvious sources of contamination were observed. The historical maps indicate that the site has remained undeveloped land to the immediate southwest of Stadium Way Industrial Estate which was developed Ca.1983, thus indicating a very low on-site contamination source potential. There is a limited (low risk) from potential off-site sources associated with the industrial estate. A summary of the key points identified within the desk study is outlined below;

- This desk study identified a low potential for soil and groundwater contamination beneath the site and within the surrounding area that could affect the proposed development.
- The site is not located within a groundwater Source Protection Zone and no potable groundwater abstractions have been identified within the vicinity of the site. Furthermore, based upon the low potential for significant sources of groundwater contamination on the site, the potential risk to groundwater resources was considered to be low.
- Based upon a review of environmental records, no permitted or licenced landfill sites or other activities with the potential to adversely impact the environmental condition of the site were identified.
- No pollution incidents have been identified on or within the immediate vicinity of the site with the potential to impact the environmental quality of the site.
- No ground gas-generating sources of significance have been identified beneath or in proximity of the site.

3.2. Geology

An overview of the site geology has been inferred from British Geological Survey (“BGS”) 1:50,000-scale mapping for artificial, superficial and bedrock deposits. Where available and relevant we have also included additional information from BGS archive borehole records and the findings of third-party reports. Table 3.1 summarises the Geological context of the site.

Table 3.1 - Geological context of the site

Unit	Description
Artificial Deposits	The BGS mapping does now show artificial deposits beneath the site.
Superficial	The site is underlain by the Taplow Gravel Member comprising deposits of Sand and Gravel.
Bedrock	The bedrock beneath the site is mapped as Seaford Chalk Formation and Newhaven Chalk Formation

The BGS mapping shows that Langley Silt Member and Head Deposits are also encountered in the proximities of the site.

Notwithstanding this, Made Ground may be present at the site due to disturbance / changes in level associated with development of the wider area.



3.3. Hydrogeology and Hydrology

The Kempton Park Gravel are classified as Secondary A Aquifer, defined as containing permeable layers capable of supporting water supplies at a local rather than stratigraphic scale, in some cases forming an important source of base flow to rivers.

The Chalk are classified as a Principal Aquifer, meaning the aquifer may support water supply and/or river base flow on a strategic scale.

The River Thames is located 295m north/northwest of the site.

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

3.4. Ground Stability

The BGS natural subsidence hazard data indicates that the risk of dissolution at the site is considered to be low, associated with the Chalk. The site is in an area of very low susceptibility to shrink-swell subsidence. The highest hazard rating for compressive soils and all other natural subsidence hazards within the vicinity of the site is moderate.

3.5. Unexploded Ordnance (UXO)

The desk study included a review of online ZeticaUXO Unexploded Bomb (UXB) risk maps. The site is situated within a low-risk region (bombing density <10 per 1,000 acres). In general, should the site be redeveloped, further action is not necessary.

3.6. Preliminary Risk Assessment (PRA)

The preliminary risk assessment included in the previous Desk Study, is presented as Table 3.2 based on the plausible contaminant linkages based on the identified sources, pathways and receptors is presented.

Table 3.2 Qualitative Risk Assessment

Potential Source	(media)	Potential Pathway	Potential Receptor	Severity	Probability	Risk Rating
Made Ground, if present	Soil	Ingestion, inhalation and/or dermal contact	Future users	Medium	Unlikely	Low
			Off-site users	Medium	Unlikely	Low
	Ground gas & vapour	Inhalation	Future users	Medium	Unlikely	Low
		Migration, accumulation and explosion	Future users	Medium	Unlikely	Low
	Soil and water	Leaching and migration from contaminated soil	Groundwater	Medium	Unlikely	Low
			Surface Water	Medium	Unlikely	Low



4. Current Ground Investigation

4.1. Purpose and Scope of the Investigation

The primary purpose of the ground investigation works was to manage and mitigate the geotechnical and geo-environmental risk profile associated with the proposed redevelopment of the site and to achieve the geo-environmental objectives outlined in Section 1.1. The aims of the ground investigation were to:

- Develop a suitable ground model regarding the types and spatial extent of soils.
- Assess the engineering performance of the soil deposits to enable recommendations of suitable parameters for geotechnical design.
- Establish groundwater conditions at the site.
- Identify potential geological hazards and evaluate risks with regards to both design and construction.
- Collect data to inform a generic quantitative risk assessment (GQRA).

The general scope of the investigation was summarised as follows:

- 1 No. cable percussion borehole up to 20.00m bgl
- 6 No. dynamic sampling boreholes up to 3.00m bgl
- 1 No. machine excavated trial pit up to 2.00m bgl to facilitate infiltration testing.
- 5 No. dynamic cone penetrometer (DCP) tests to determine CBR values for shallow strata
- Appropriate soil sampling
- Geotechnical in situ testing
- Geotechnical / geoenvironmental laboratory testing
- Monitoring of groundwater levels and ground gas concentrations (4 No. visits over 4 weeks), including 1no. groundwater sampling visit.

Table 4.1 summarises the rationale for the phases of the intrusive investigation

Table 4.4.1 Summary of investigation rationale

Location ID	Method	Purpose/Comments
BH01	Cable percussion borehole to 20.00m bgl	To determine the deeper ground conditions to facilitate geotechnical design, to obtain samples and enable installation of groundwater / gas monitoring wells.
WS01 to WS06	Dynamic sampling boreholes to a depth of 3.00m bgl or refusal.	To determine the shallow ground conditions across the site, to obtain samples and enable installation of groundwater / gas monitoring wells.
DCP01 to DCP10	Dynamic cone penetrometer test (DCP) in each WS location 0.30m bgl and 0.50m bgl.	To determine CBR values for shallow strata
TP01	Machine excavated trial pit to 2.00m bgl	To determine the shallow ground conditions and to facilitate infiltration testing

A summary of the exploratory hole locations is provided as Appendix A and the exploratory hole locations plan of the investigation is presented in Appendix B.



4.1.1. Limitations of Report

This report has been prepared in accordance with the specification provided by the client. The data reported relates to the specific locations where each exploratory hole was formed and may not represent the ground and groundwater conditions of the site as a whole. Furthermore, it should be considered that groundwater levels may vary throughout the year due to seasonal conditions and other influences such as flooding, leaking mains, storm drainage and foul water systems.

4.2. Fieldwork Overview

The fieldwork was carried out between 23rd and 28th September 2024. A site walkover was conducted during the first day of the ground investigation and confirmed the anticipated layout of the site.

Up to date utility drawings were procured prior to the site work and can be downloaded using the following link - [Statutory Utility Drawings](#).

After reviewing the available service information and site reconnaissance, the locations were scanned using Ground Penetrating Radar (GPR) & Electromagnetic (CAT & Genny) techniques, to check for services within proximity to exploratory hole locations.

The works were supervised by an experienced ground engineer.

An exploratory hole location plan and detailed exploratory hole logs are presented in Appendix B and Appendix C, respectively.

4.3. Cable Percussion Boreholes

1 No. cable percussion boreholes (BH01) was advanced to a maximum depth of 20.00m bgl. Due to the thickness of soft / loose soils, the borehole was extended from the original depth of 15.00m to 20.00m bgl to sufficient data was obtained.

BH01 was completed to 20.00m bgl. UT100 sampling and Standard Penetration Tests (SPTs) were undertaken at alternate 1.00m intervals in cohesive / granular / all soils until 5.00m below top of stratum, then alternate 1.50m intervals. The soils encountered were logged on site and sampled accordingly for geotechnical and geo-environmental laboratory analysis.

A standpipe was installed in the borehole for monitoring of ground gas and groundwater levels.

4.4. Dynamic Sampling Boreholes

5 No. dynamic sampling boreholes were progressed using a tracked dynamic sampling rig to a maximum depth of 3.00m bgl. The boreholes were advanced for geotechnical, geo-environmental and well installation purposes.

During the inspection pit at WS05, an unknown concrete obstruction was found at 0.50m bgl, the borehole was therefore moved to location WS05A. The same concrete obstruction was found at 0.50m bgl, so a third position was attempted at WS05B, which found the same concrete obstruction. The borehole was subsequently cancelled.

SPTs were carried out in the boreholes. The soils encountered were logged on site and samples recovered for geotechnical and geo-environmental laboratory analysis.

4no. standpipes were installed within locations WS01 to WS04 for monitoring of ground gas and groundwater levels.

4.5. Gas and Groundwater Monitoring Installations

A total 5 No. monitoring pipes were installed, comprising of 1 No. groundwater monitoring standpipe (BH01) and 4 No. ground gas monitoring standpipes (WS01 to WS04). The monitoring installations comprise of a 50mm internal diameter HDPE casing and well screen. Details are presented in Table 4.2.



Table 4.2 Gas and groundwater monitoring installations

Location Ref	Base of Borehole (m bgl)	Top of Response Zone (m bgl)	Bottom of Response Zone (m bgl)	Target Strata
BH01	20.00	4.75	7.60	Taplow Gravel Member
WS01	3.00	0.50	1.70	Made Ground
WS02	3.00	0.50	2.00	Made Ground
WS03	3.00	0.50	2.50	Made Ground
WS04	3.00	1.00	3.00	Made Ground

4.6. In-Situ Testing

4.6.1. Standard Penetration Tests

Standard Penetration Tests (SPTs) were completed in the cable percussion and dynamic sampling boreholes. The tests were completed in accordance with BS EN ISO 22476-3.

4.6.2. Dynamic Cone Penetrometer testing (DCP)

8 No. In-Situ Dynamic Cone Penetrometer testing (DCP) tests were completed, in accordance with BS 1377-9:1990, 4.3, across the site (DCP01 to DCP08) to determine CBR values for shallow strata. 2 No DCP test were carried out in each dynamic sampling borehole, from depths 0.30mbgl and 0.50m bgl. The DCPs were completed using a TRL – DCP instrument. The results can be found in Appendix C.

4.6.3. Soakaway Testing

Soakaway testing was undertaken broadly according to the relevant standard, BRE Digest 365. This involves excavating a trial pit to a sufficient size and depth representative of the proposed soakaway (excavated a minimum of 1.0m long by 0.3m wide) and filling the pits several times in quick succession. This procedure is intended to recreate the soil moisture conditions typical of the site when the soakaway becomes operative, resulting in reliable infiltration characteristics.

1 no. machine excavated trial pit was progressed using a tracked 3 tonne excavator and was advanced to a depth of 2.1m bgl. Soakaway testing was facilitated by a 2,000 litre water bowser and water pump. Due to the low permeability of the soil, the testing was terminated. A summary is shown in Table 4.3 below. Full results of the tests are detailed in Appendix C.

Table 4.3 Soakaway test results

Exploratory Hole Reference	Test No.	Base of Pit (m bgl)	Groundwater Level Before Test (m bgl)	Water Level at Start of Test (m bgl)	Duration of Soakage Test (min)	Water Level at End of Test (m bgl)
TP01 (INFL01)	1	2.10	Dry	0.80	392	1.35
TP01 (INFL01)	2	2.10	Dry	0.80	300	1.29



4.7. Laboratory Testing

A selection of the recovered samples was submitted to an MCERTs accredited laboratory to undertake a programme of geotechnical and geo-environmental testing appropriate to the site and development. All geotechnical and geo-environmental laboratory testing can be found in Appendix E and Appendix F, respectively.

4.7.1. Geotechnical Laboratory Testing

- 3no. Moisture content tests.
- 3no. Atterberg Limit tests.
- 3no. Particle size distribution tests (PSDs).
- 1no. Mechanical analysis by Pipette method
- 2no. Intact Dry Density of Chalk
- 3no. Point load on Chalk
- 4no. BRE Suite D test.

4.7.2. Geo-environmental Laboratory Testing (Soil)

- 5no. Soil Organic Matter (SOM).
- 5no. Total Organic Carbon (TOC).
- 5no. Fraction Organic Carbon (FOC).
- 5no. pH.
- 5no. Water Soluble Sulphate.
- 5no. Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG) including Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) and Methyl Tert-Butyl Ether (MTBE).
- 5no. Speciated Polycyclic Aromatic Hydrocarbons (PAHs) (EPA16).
- 5no. Asbestos Screen/Identification.
- 5no. Heavy Metals and Metalloids Suite.

4.7.3. Geo-environmental Laboratory Testing (Water)

- 1 no. Heavy Metals and Metalloids Suite.
- 1no. Sulphate.
- 1no. pH.
- 1no. Dissolved Organic Carbon (DOC).
- 1no. Suspended Solids
- 1no. Total Organic Carbon (TOC).
- 1no. Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG) including Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX) and Methyl Tert-Butyl Ether (MTBE).
- 1no. Speciated Polycyclic Aromatic Hydrocarbons (PAHs) (EPA16).



5. Ground and Groundwater Conditions

5.1. Summary

Table 5.1 summarises the ground conditions that were encountered at the site. Detailed exploratory hole logs are presented in Appendix C.

Table 5.1 Ground conditions encountered

Unit	Depth to top of stratum (m bgl)	Elevation at top of stratum (m OD)	Strata Thickness (m)	Description
Topsoil	0.00	39.59 to 41.38	0.20 to 0.30	Soft dark brown slightly sandy slightly gravelly CLAY with frequent thin rootlets (<2mm). Gravel is subangular to subrounded fine to coarse of flint and quartzite. Sand is fine to coarse.
Made Ground	0.20 to 0.30	38.60 to 41.15	1.45 to 2.70	Firm dark and light brown gravelly sandy silty CLAY. Gravel is subangular to subrounded fine to coarse of flint, quartzite and red brick. Sand is fine to coarse Brown locally dark greyish brown slightly gravelly clayey fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of flint, chalk and redbrick. Concrete obstruction encountered at 0.5m in WS05, WS05A and WS05B. <i>TP01, WS04 and WS05/WS05A/WS05B terminated in the Made Ground.</i>
Alluvium	1.70 to 1.75	38.15 to 39.63	3.00	Soft brown locally mottled gravelly sandy silty CLAY. Gravel is subangular to subrounded fine to coarse of flint and chalk. Sandy is fine to coarse. <i>Only encountered in BH01 and WS01.</i>
Taplow Gravel Member	2.00 to 4.75	36.63 to 38.73	2.85	Medium dense brown SAND and GRAVEL. Sand is fine to coarse. Gravel is rounded to angular fine to coarse of flint and chalk. <i>Only encountered in BH01, WS02, WS03 and WS06.</i>
Seaford Chalk Formation	7.60	33.78	>13.40 (Not Proven)	Recovered as Structureless CHALK composed of silty subangular to angular fine to coarse GRAVEL with frequent black flint. Chalk clasts are off white extremely weak low density. ...clasts becoming weak, medium and high density at 10.50m bgl. <i>Only encountered in BH01.</i>

Figure 5.1 and Figure 5.2 presents the geological section across the site.



Figure 5.1 Geological cross-section (blue line represents the section presented in Figure 4.2)



Figure 5.2 Geological cross-section



The SPT N_{60} results are plotted in Figure 5.3. Approximate interpreted strata boundaries marked by dashed lines – these are indicative only as the stratum boundaries are variable.

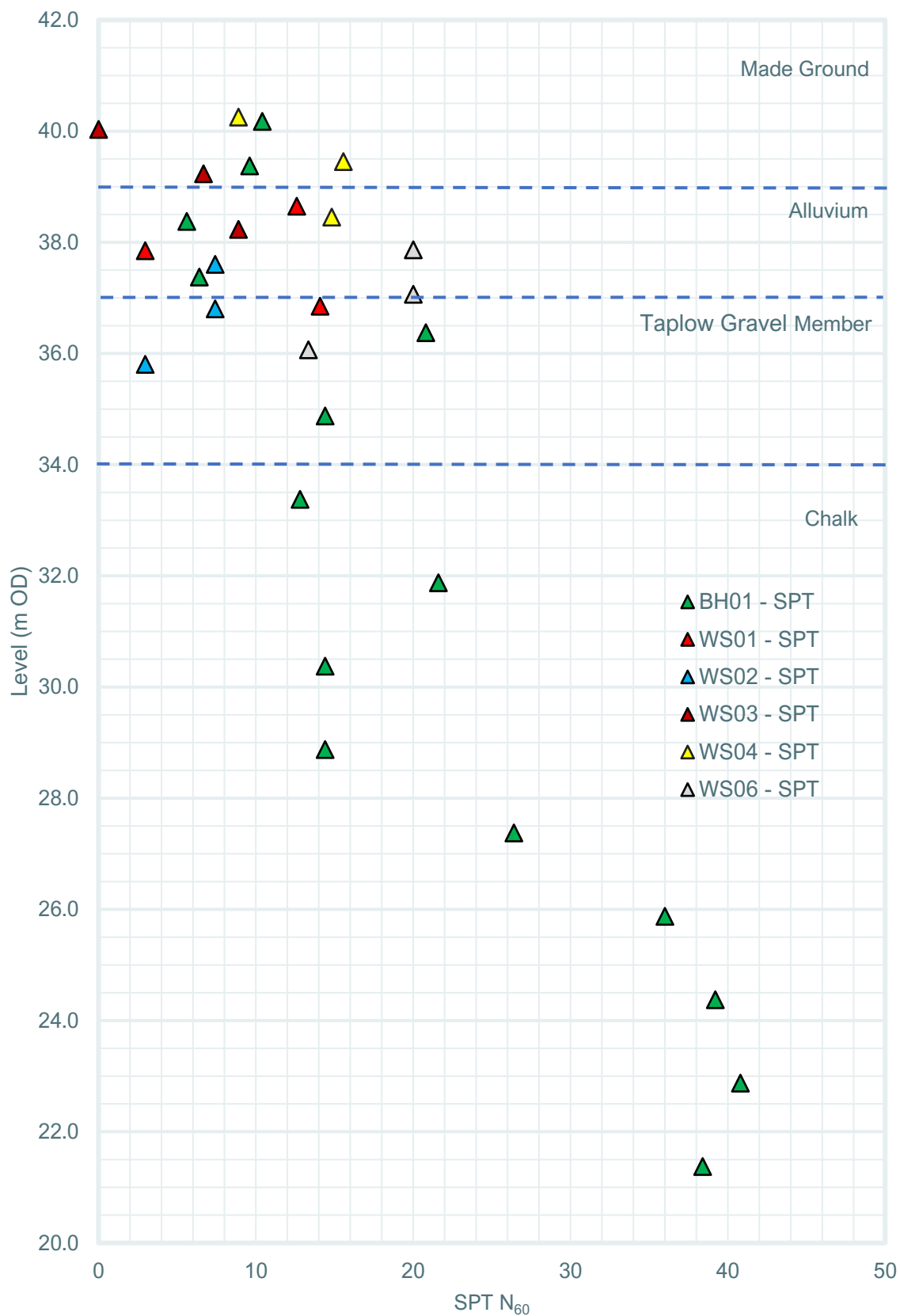


Figure 5.3 SPT N_{60} results



5.2. Made Ground / Topsoil

The Made Ground is a heterogeneous mixture of natural soils and material of anthropogenic origin. Made Ground was encountered in each exploratory hole location across the site to depths of up to 3.00m bgl, underlying Topsoil of 0.2m bgl to 0.30m bgl of thickness.

The Made Ground typically comprises cohesive soil, although the composition varies both vertically and laterally and some deposits of non-cohesive material were encountered in various locations

Topsoil was encountered throughout the whole site, comprising of soft brown slightly gravelly sandy organic clay with frequent rootlets. A summary of the in-situ and laboratory tests results are summarised in Table 5.1.

Table 5.1 Summary of the in situ and laboratory tests results in Made Ground

SPT results (N ₆₀ Value)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Percentage passing 425 um sieve (%)	Modified Plasticity Index (%)
0 to 20	16.6	26	15	11	88	9.7

It is noted that the Made Ground is inherently variable in terms of its consistency, characteristic, and engineering properties. This stratum is not recommended to be relied upon to support any engineered structures.

The moisture content for the Made Ground was 16.6%, and the plasticity index 11% indicating low plasticity clay.

SPT N₆₀ values in the Made Ground were recorded in the range of 0 to 20, correlating to values of undrained shear strength (c_u) between 13kPa and 63kPa (where $f_t = 3.5$) or a relative consistency of very soft to firm.

Based on the site logging of the soil, moisture content and plasticity index values, there is no indication that Made Ground was desiccated by the current vegetation.

5.3. Alluvium

Although the Alluvium is not mapped on the site, the stratum is present in the vicinity of the site. The shallow predominantly cohesive natural soils have been interpreted to represent this stratum based on the composition and relative consistency. This stratum was encountered only in boreholes BH01 and WS01, to depths of between 1.70m bgl and 4.75m bgl and typically comprised soft to firm, light brown mottled orangish brown, slightly sandy, slightly gravelly, silty clay.

These deposits are commonly present in flood plain areas. They have therefore undergone very little consolidation resulting in the generally low, but variable SPT results. The in-situ and laboratory tests results are summarised in Table 5.3.

Table 5.3 Summary of the in situ and laboratory tests results in Alluvium

SPT results (N ₆₀ Value)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Percentage passing 425 um sieve (%)	Modified Plasticity Index (%)
3 to 14	18	25	13	12	86	10.3

Based on the above, the Alluvium may be classified as clays of low plasticity (*ref. BS 5930*) with a low volume change potential (*ref. NHBC Standards Chapter 4.2*). The Alluvium is also known to be very compressible.

SPT N₆₀ values in the Alluvium were recorded in the range of 3 to 14, correlating to values of undrained shear strength (c_u) between 13kPa and 63kPa (where $f_t = 3.5$) or a relative consistency of very soft to firm.



5.4. Taplow Gravel Member

The Taplow Gravel Member was encountered across the site in the cable percussion and dynamic sampler boreholes (BH01, WS02, WS03 and WS06) from depths of between 2.00m bgl to 4.75m bgl, with the base proven at 7.50m bgl (BH01). The thickness of this stratum was proven to be 2.85m bgl in BH01 location, with boreholes WS02, WS03 and WS06 terminating within the stratum. The stratum typically comprises loose to medium dense, yellowish grey, silty sand and gravel. The in-situ and laboratory test results for the Taplow Gravel Member are summarised in Table 5.4.

Table 5.4 Summary of the in situ and laboratory tests results in Taplow Gravel Member

SPT results (N ₆₀ Value)	Cobble Content (%)	Gravel Content (%)	Sand Content (%)	Clay/Silt Content (%)
3 to 21	0	24 to 90	9 to 54	1 to 22

The Taplow Gravel Member was deposited recently in geological terms and has therefore not been subjected to significant mechanical loading due to overburden or subsequent erosion and unloading. The deposit is expected to be normally consolidated. Notwithstanding this, uncharacteristically low SPT N₆₀ values (in the range of 3 to 9) have been recorded in the Taplow Gravel Member, suggesting that the stratum may have been subjected to some natural re-working to depths up to 3.00m bg. Below this depth, SPT N₆₀ values were typically in the range of 19 to 40, corresponding to a relative density of medium dense to dense (*ref. BS 5930*).

Whilst the Taplow Gravel Member generally represents a competent engineering, the loose soils (possibly re-worked) noted in WS02 differ markedly and will require careful consideration in geotechnical design of foundations.

5.5. Seaford Chalk Formation and Newhaven Chalk Formation

The Chalk was encountered in the deep borehole underlying the Taplow Gravel Member at a depth of 7.60m bgl and extended to the base of the borehole (20.00m bgl). The Chalk was recovered as silty subangular to angular fine to coarse gravel with frequent black flint. The clasts are extremely weak, low density, off white, becoming weak and moderate to high density from 10.5m bgl. Due to the sample recovery, it was not possible to fully determine the grade of the Chalk, but with the onsite description, SPTs and laboratory tests, it was noticeable that Chalk gets more competent from 10.50m bgl and therefore is likely to become structured below this depth. The in-situ and laboratory test results for the Chalk are summarised in Table 5.5.

Table 5.5 Summary of the in situ and laboratory tests results in chalk

SPT results (N ₆₀ Value)	Moisture Content (%)	Saturation Moisture Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Point Load Strength Index (MPa)
13 to 41	19.1 to 25.7	20.7 to 26.5	1.98 to 2.06	1.57 to 1.73	0.29 to 0.36

Point Load tests record an average strength in the order of 0.32 MPa. A total of 9no SPT tests were carried out within the chalk, and SPT N₆₀ values ranged from 13 to 41. 2no dry density and saturation moisture content tests were carried out on samples at 9.00m and 17.00m bgl, with results ranging from 1.57Mg/m³ to 1.73Mg/m³ and 20.7% to 26.5%, respectively, classifying them as medium to high density, based on recommendations from CIRIA C574.

Although the desk study indicated there to be a low risk of dissolution, any site with chalk close to the surface has the potential for dissolution features to be present. This is particularly prevalent where groundwater is also known to be relatively shallow. The ground investigation has not highlighted the presence of any dissolution features below the site, but given their limited lateral extent, the risk of a feature being present on site cannot be eliminated.



5.6. Groundwater

During drilling of location BH01, water was added to aid drilling through the non-cohesive material from 4.10m bgl to 7.60m bgl. A groundwater strike was encountered at 5.20m bgl and rose to 4.70m bgl after 20 minutes.

4 No. rounds of groundwater level monitoring have been undertaken between 7th and 28th October 2024. The groundwater levels and any free phase liquids were measured using a Geotech Oil/Water Interface meter. The groundwater levels recorded in the wells during the monitoring programme are presented in Table 5.8.

Table 5.8 Groundwater monitoring results

Exploratory hole reference	Response zone (m bgl)	Target Strata	Round 1	Round 2	Round 3	Round 4
			07/10/2024 (m bgl)	14/10/2024 (m bgl)	21/10/2024 (m bgl)	28/10/2024 (m bgl)
BH01	4.75 to 7.60	Taplow Gravel Member	3.84	3.80	3.81	3.88
WS01	0.50 to 1.70	Made Ground	Dry	Dry	Dry	Dry
WS02	0.50 to 2.00	Made Ground	1.27	1.28	1.22	1.29
WS03	0.50 to 2.50	Made Ground	Dry	Dry	Dry	Dry
WS04	1.00 to 3.00	Made Ground	Dry	Dry	Dry	Dry

Although monitoring well at BH01 location was installed within the Taplow Gravel Member, the groundwater readings during monitoring visits show that the groundwater level is within the Alluvium, indicating to be under sub-artesian pressure. During drilling works, groundwater strike was encountered within the Taplow Gravel Member, at 5.20m bgl, rising to 4.70 m bgl after 20 minutes of observation.

During monitoring visits. groundwater was encountered in WS02 monitoring well location, this is believed to be perched water within the Made Ground.

5.6.1. Groundwater Sampling

Water sampling was undertaken during one of the monitoring visits from BH01 in accordance with the latest version of BS EN ISO 5667-1: 2023. Groundwater was sampled using low-flow methods. New tubing was inserted into the middle of the water column with the pump intake located at a depth of 1.00m to 2.00m below the lowest level of groundwater fluctuation, where possible before the peristaltic pump was turned on. Groundwater was run through the YSI multiparameter probe. The water purged from the well before sampling was collected and disposed of appropriately.

The monitoring results and geoenvironmental laboratory analysis are presented in Appendix D and Appendix F, respectively.

5.7. Ground Gas/Vapour Monitoring

4 No. rounds of gas monitoring have been undertaken between 7th and 28th October 2024. A summary is presented in Tables 5.6 while the results are presented in Appendix D.

Gas monitoring was undertaken using a calibrated Gas Data GFM436 hand-held gas analyser and a calibrated MiniRae Lite ATEX Photo Ionisation Detector (PID) with a 10.6eV lamp and a summary is presented in Table 5.6.



Table 5.6 Summarised ground gas/vapour monitoring results

Exploratory hole reference	Minimum steady O ₂ (%)	Maximum steady CO ₂ (%)	Maximum steady CH ₄ (%)	Maximum steady LEL (%)	Maximum steady H ₂ S (ppm)	Maximum steady CO (ppm)	Maximum PID (ppmv)	Steady-state Flow Rate (l/hr)
BH01	18.90	0.70	<0.1	<0.1	<0.1	<0.1	1.4	0.1
WS01	11.20	7.60	<0.1	<0.1	<0.1	<0.1	0.9	<0.1
WS02	13.60	3.20	<0.1	<0.1	<0.1	<0.1	1.1	<0.1
WS03	11.90	9.80	<0.1	<0.1	<0.1	<0.1	2.8	<0.1
WS04	9.50	4.90	<0.1	<0.1	<0.1	<0.1	3.0	<0.1

The results highlighted in red were collected from wells with completely flooded response zones

The monitoring programme includes 1 No. round during falling atmospheric pressure conditions. The atmospheric pressure recorded during each visit is presented in Table 5.7.

Table 5.7 Atmospheric pressure trends

Date (dd/mm/yyyy)	Time (hh:mm)	Atmospheric pressure reading	Barometric Pressure Trend
07/10/2024	08:00	988	Falling
07/10/2024	10:15	986	
14/10/2024	08:30	1001	Rising
14/10/2024	10:20	1008	
21/10/2024	08:00	1012	Rising
21/10/2024	10:50	1016	
28/10/2024	08:00	1013	Rising
28/10/2024	10:40	1017	

5.8. Visual / Olfactory Evidence of Contamination

There was no visual / olfactory evidence of contamination identified during the intrusive investigation.

No visual / olfactory evidence of contamination was recorded during the return monitoring.



6. Generic Quantitative Risk Assessment (GQRA)

6.1. Approach and Targeted Potential Sources of Contamination

The GQRA has been undertaken in general accordance with *Land Contamination Risk Management* (LCRM) guidance, published by the Environmental Agency of the UK Government website, and in the context of *National Planning Policy Framework* (NPPF) requirements and *The Building Regulations 2010, Approved Document C - Site preparation and resistance to contaminants and moisture (2004 Edition incorporating 2010 and 2013 amendments)*. The assessments have been undertaken specifically for the proposed development to assess whether there are any unacceptable risks which require either further assessment or remediation.

The recent ground investigation and reporting has been undertaken in general accordance with *BS10175:2011 Investigation of Potentially Contaminated Sites – Code of Practice*.

The targeting of potential off-site sources of contamination identified in the *Phase 1 Environmental Site Assessment* is summarised in Table 6.1. Although there were no onsite sources, a series of chemical analyses were undertaken to confirm the findings of the risk assessment. During site works, the Made Ground was found to be much thicker than expected, which might have been due to the development of the surrounding area. As such, samples were taken more frequently for a better assessment of the soil which has been considered as a potential source of contamination going forward.

Table 6.1 Targeting of Potential Off-Sources of Contamination

Potential Source	Targeted Exploratory Locations
Made Ground	All Exploratory Locations

A summary of the visual / olfactory evidence of contamination identified and the sampling undertaken is presented in Section 5.8.

The installed monitoring well network provides coverage for potential contamination migrating onto the site via the saturated or unsaturated zones e.g. contaminated groundwater, ground gas and / or soil vapour from off-site sources. Potential off-site sources of contamination are identified in the *Phase 1 Desk Study*.

The results of the GQRA have been considered in view of the risk assessment matrix in Appendix G. Where risk classifications (e.g. low risk, low to moderate risk etc.) are stated this is in accordance with the risk assessment matrix.

Risks to site workers and the environment during the construction phase of the proposed redevelopment can be appropriately managed by successful implementation of construction phase risk assessments and method statements (RAMS). Therefore, the associated construction phase land contamination risks are not considered further in this document but should be appropriately considered and mitigated by the Principal Contractor in their preparation and implementation of construction phase RAMS and Construction Phase Plan (CPP).

6.2. Soil Assessment

6.2.1. Risks to Human Health

The soil sample laboratory analytical results have been compared to human health generic assessment criteria (GAC) appropriate for assessing risks for the specifically proposed development. The selected human health GAC include the LQM/CIEH 'Suitable 4 Use Levels' (S4ULs). The S4ULs are based on Health Criteria Values that represent minimal or tolerable levels of risks to health as described in the Environment Agency's SR2 guidance, ensuring that the resulting assessment criteria are 'suitable for use' under Planning.



For each chemical substance, S4ULs include individual GAC for 6 no. generic land-uses (residential with home grown produce, residential without home grown produce, allotments, commercial and 2 no. public open space land uses) and a range of Soil Organic Matter (SOM) contents. All toxicological and physical-chemical parameters used in the derivation of the S4ULs are presented and discussed in the source publication.

In some instances, selected human health GAC used in this report have been applied from the DEFRA 'Category 4 Screening Levels' (C4SLs), CL:AIRE GAC, Environment Agency (EA) Soil Guideline Values (SGVs) and Atkins AtRisk Soil Screening Values (SSVs). The human health GAC source reference used for each chemical determinant is presented in the GQRA screening tables included as Appendix F. C4SLs have been used preferentially where available.

The proposed development comprises the construction of a single story drive through restaurant. Therefore, a human health GAC has been applied to each chemical determinant based on the 'commercial' generic land-use scenario. In future, should the site redevelopment plans change from those considered herein then the geo-environmental risk assessments presented in this report will need to be reconsidered.

No exceedances of the selected human health GAC were identified for soil.

There is no published human health GAC with respect to asbestos or asbestos containing materials (ACMs) in soil. Industry best practice document 'Asbestos in soil and made ground: a guide to understanding and managing risks', CIRIA C733, 2014, indicates that soils containing asbestos concentrations of 0.001 % w/w may be able to liberate airborne fibre concentrations that exceed contemporary occupational exposure limits for nuisance dust. However, as detailed in other research, including publications such as the *CAR-SOIL Industry Guidance (2016)*, in circumstances where very low concentrations of asbestos are identified in soils, the associated risks are considered low. In this study an initial asbestos human health GAC of 'no asbestos detected above laboratory detection limit' is adopted i.e. mitigation or further assessment is required if asbestos in soil is detected at or above <0.001 % w/w. No asbestos was detected within any of the samples analysed.

Based on the above, the potential risks to human health receptors due to contaminant concentrations in the shallow soils are low and no specific remediation is necessary.

6.2.2. Risks to Plant Growth

The potential risks to plant growth have been assessed based on GAC presented in BS 3882:2015 and Nable et al. and a summary is presented in Table 6.2.

Table 6.2 Summary of Phytotoxic Assessment

Contaminant	GAC Source	GAC (mg/kg)	Min recorded (mg/kg)	Max recorded (mg/kg)	No. Samples analysed	No. Samples <LOD	No. Samples exceeding GAC
Copper	BS 3882:2015	135	6	36	5	0	0
Nickel	BS 3882:2015	75	12	22	5	0	0
Zinc	BS 3882:2015	200	33	100	5	0	0
Boron	Nable et al.	5	0.3	0.8	5	0	0

Notes

Nickel, zinc, copper: BSI, (2015). Specification for topsoil and requirements for use. BS 3882:2015. Values taken for pH 6-7
Boron: Limit for phytotoxic effect. Nable, Banuelos and Paul, (1997). Boron Toxicity. Plant and Soil, Volume 193, pp 181-198



Based on these results, the potential risks to plant growth due to contaminant concentrations in the Made Ground are low and no specific remediation is necessary in this regard. Notwithstanding this, the landscape architect should assess the quality of the shallow soils to confirm if a growing medium is required for new areas of soft landscaping.

6.2.3. Risks to Water Supply Pipes

The potential risks to water supply pipes has been assessed using the UK WIR threshold values and a summary is provided in

Table 6.3.

Table 6.3 Water Supply Pipe Material Assessment

Contaminant Group	PE Threshold	Metal Pipes / Barrier Pipes	Maximum concentration (mg/kg) at proposed pipeline depth <i>See Notes [1] & [2]</i>	Maximum site concentration (mg/kg) <i>See Note [3]</i>	Locations and depths where concentrations exceed proposed pipeline threshold at proposed pipeline depth [all depths]
Total BTEX & MTBE	0.1	Pass	< LOD	< LOD	
EC5-EC10 aliphatic and aromatic hydrocarbons	2	Pass	< LOD	< LOD	
EC10-EC16 aliphatic and aromatic hydrocarbons	10	Pass	36.3	36.3	BH01 at 1m bgl
EC16-EC40 aliphatic and aromatic hydrocarbons	500	Pass	320	320	
Corrosive (pH) - PE / Barrier Pipe	Pass	Pass	9.5 to 9.5	7.6 to 9.5	
Corrosive (pH) - Wrapped Steel	Pass	7	9.5 to 9.5	7.6 to 9.5	
Corrosive (pH) - Ductile Iron	Pass	5	9.5 to 9.5	7.6 to 9.5	
Corrosive (pH) - Copper	Pass	5 to > 8	9.5 to 9.5	7.6 to 9.5	[BH01 at 1m bgl, BH01 at 3m bgl, BH01 at 6m bgl, BH01 at 9m bgl, BH01 at 15m bgl, WS02 at 1.5m bgl, WS03 at 0.5m bgl, WS04 at 0.6m bgl]

Note [1] Concentrations based on values >LOD only, zero value indicates no values >LOD for each compound within contaminant group.

Note [2] Water pipes are normally laid at 0.75-1.35m below finished ground level.

Based on these results, the risks to new water supply pipes in the Made Ground is generally low, although the final pipework material should be agreed with the water company.

6.3. Groundwater Assessment

6.3.1. Risks to Controlled Waters

Groundwater laboratory analytical results have been compared to generic assessment criteria (GAC) considered appropriate for assessing controlled waters risks. Controlled waters GAC have been selected to assess risks to drinking water quality and the aquatic environment in surface waters.

The selected drinking water GAC are based on Drinking Water Standards (DWS) published by the UK and EU, as well as Guidance Values (GVs) published by the World Health Organisation (WHO). The DWS and GV are used as values indicative of low risk to drinking water quality and have been selected to provide a conservative risk assessment of the groundwater.



The selected environmental quality GAC are based on freshwater Environmental Quality Standards (EQS) published by the UK and EU, and also operational targets published by the Environment Agency (EA). The environmental quality GAC and operational targets are used as values indicative of low risk to the aquatic environment and have been selected given the presence of a principal chalk aquifer below the site.

The environmental quality GAC and drinking water GAC used in this assessment are generally considered to be highly conservative for the manner used in this report, but technically robust for a GQRA.

The groundwater laboratory analytical results are presented in a screening table comparing the detected chemical concentrations to the selected GAC in 0. Where laboratory method detection limits are greater than the GAC this is not recorded as an exceedance. No exceedances of the drinking water GAC have been detected while two exceedances of the environmental quality GAC have been detected, and these are summarised in Table 6.4.

Table 6.4 Human Health GAC Exceedances Summary – Controlled Waters

Contaminant	GAC Source	GAC (µg/l)	Concentration in BH01 (µg/l)
Copper	UK EQS (bioavailable)	1	2.2
Nickel	EU EQS	4	13
Anthracene	EU EQS	0.1	0.29
Fluoranthene	EU EQS	0.0063	0.58

The marginal exceedances in the dissolved phase state for Environmental Quality GAC indicate that a significant source is not present in the unsaturated zone on the site. They may instead be associated with the historical use of the surrounding area or previous off site pollution incidents, identified by the *Phase 1 Environmental Site Assessment*. It is understood that the proposed development will comprise a commercial building with hardstanding paved road surrounding it, therefore, the risk to the site associated with the exceedance is considered to be low.

Additionally, the results are not indicative of free phase contamination resulting from the site. It is known that the groundwater beneath the site might have been impacted by the wider site's surrounding history. The groundwater monitoring results undertaken as part of this investigation are consistent with what is expected in the wider site setting. The site itself is not considered to be a point source of contamination to controlled waters receptors and no further assessment is considered to be necessary in this regard.

6.3.2. Risks to Human Health (Vapours)

The potential risks to human health receptors from vapours generated from the groundwater have been assessed with comparison of volatile organic compounds (VOCs) to the SoBRA groundwater vapour GAC (GAC_{gwap}) and a summary is provided in Table 6.5.

Table 6.5 SoBRA Groundwater Vapour GAC Summary

Contaminant	GAC (µg/l)	Concentration in BH01 (µg/l)	No. Samples <LOD	No. Samples exceeding GAC
Acenaphthene	15,000,000	0.38	0	0
Acenaphthylene	20,000,000	0.01	1	0



Contaminant	GAC (µg/l)	Concentration in BH01 (µg/l)	No. Samples <LOD	No. Samples exceeding GAC
Fluorene	18,000,000	0.26	0	0
Naphthalene	190,000	0.01	1	0
TPH Aliphatics >C5-6	190,000	1	1	0
TPH Aliphatics >C6-8	150,000	1	1	0
TPH Aliphatics >C8-10	5,700	1	1	0
TPH Aliphatics >C10-12	3,600	10	1	0
TPH Aromatics >C5-7	20,000,000	1	1	0
TPH Aromatics >C7-8	21,000,000	1	1	0
TPH Aromatics >C8-10	190,000	1	1	0
TPH Aromatics >C10-12	660,000	10	1	0
TPH Aromatics >C12-16	3,700,000	25	0	0
Benzene	20,000	3	1	0
Toluene	21,000,000	3	1	0
Ethylbenzene	960,000	3	1	0
O-Xylene	1,100,000	3	1	0
Methyl tert-butyl ether (MTBE)	7,800,000	3	1	0
m,p xylenes	980,000	3	1	0

It is noted that most VOC concentrations are below the laboratory method limit of detection (LOD), or where measurable, are below the SoBRA GAC_{gwvap}. On this basis, the potential risks to human health receptors due to contaminant concentrations in groundwater are low and no specific remediation is required in this regard.

6.4. Ground Gas Assessment

No potential sources of significant ground gases (i.e. no landfill sites) have been identified on the site or within the surrounding area. Made Ground has been identified during the ground investigation, overlying Alluvium in places, which may represent a limited source of ground gases.



Ground gas monitoring installations were installed in the Made Ground and/or Alluvium as part of the ground investigation (WS01 to WS04). Monitoring well construction details are summarised in Table 4.5 and monitoring was undertaken on four occasions, as summarised in Section 5.7.

The ground gas monitoring recorded concentrations of carbon dioxide (CO₂) up to 9.8%, however, no measurable methane (CH₄) was detected, and flow rates were typically below the gas analysers detection limit. The concentrations of CO₂, in the absence of measurable CH₄, is consistent with microbial respiration of the soils within the monitoring installations.

The ground gas assessment has been undertaken in general accordance with guidance contained within CIRIA 665, 'Assessing risks posed by hazardous ground gases to buildings' and BS8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. The method requires the use of both gas concentrations and ground gas well flow rates to calculate a gas screening value (GSV). The GSV is calculated as follows:

$$GSV = \frac{\text{Analyte Concentration (\%)} \times \text{Flow rate (L/hr)}}{100}$$

The calculation is carried out for CH₄ and CO₂. BS8485 utilises the GSV and categorises the ground gas risk into 6 no. different hazard potentials, referred to as Characteristic Situations (CS1 – CS6). These are summarised in Figure 8.3.

CS	Hazard potential	Site characteristic GSV ^{A)} L/h	Additional factors
CS1	Very low	<0.07	Typically <1% methane concentration and <5% carbon dioxide concentration (otherwise consider an increase to CS2)
CS2	Low	0.07 to <0.7	Typical measured flow rate <70 L/h (otherwise consider an increase to CS3)
CS3	Moderate	0.7 to <3.5	–
CS4	Moderate to high	3.5 to <15	–
CS5	High	15 to <70	–
CS6	Very high	>70	–

^{A)} The figures used in this column are empirical.

NOTE The CS is equivalent to the characteristic GSV in CIRIA C665 [6].

Figure 8.1 CS vs. GSV (ref. BS8485)

GSV have been calculated to define the gas regime at the site as per BS8485. The measured worst-case parameters across all wells have been adopted for the calculation on a conservative basis. The GSV for carbon dioxide and methane have been calculated using the maximum concentrations of carbon dioxide (9.8%) and methane (<0.1%) detected during the return monitoring visits. In the absence of measurable flow in the monitoring wells installed in the Made Ground, the gas analysers detection limit (0.1 l/hr) has been used in the calculation. Where parameter values are recorded below the equipment detection limit then the limit of detection has been assumed for the calculation.

The calculated GSV for CO₂ and CH₄ are:

- Carbon dioxide: 0.0098l/hr
- Methane: 0.0001 l/hr

On the basis of the calculated GSV the site is classified as characteristic situation 1 (CS1) – 'very low risk' – with respect to ground gas generated from on-site Made Ground. Whilst concentrations of CO₂ greater than 5% were recorded, this is due to microbial respiration of the soils and gases will not be generated in volumes sufficient to drive migration, as evidenced by the absence of measurable flow during the monitoring. On this basis, the site conforms to CS1 and no further monitoring, assessment or specific ground gas mitigation is required for the proposed development.



6.4.1. Vapour Assessment

The chemical laboratory results for soils indicate that volatile contamination is generally not present at the site. For example, TPH analysis identified no elevated determinants. These results are consistent with the soil sample VOC head-space readings across the remainder of the site, which are all low (see Section 5.4). During the return monitoring visits the PID readings were all low (<5ppm) and not indicative of vapour impacts at the site.

Taking into consideration the multiple lines of evidence, there is low risk (i.e. no unacceptable risk) to human health and buildings and structures due to volatile contaminants.

6.5. Revised CSM and Risk Assessment

The preliminary CSM (see Section 3) and PRA (presented in Table 3.2) have been refined based on the findings of the ground investigation and is presented in Table 8.2. The pathways and severity rating have been refined based on the relative contribution to total exposure for the relevant GAC (displayed in descending order of relative contribution for each contaminant).

Table 8.2 Quantitative Risk Assessment

Potential Source	(media)	Potential Pathway	Potential Receptor	Severity	Probability	Risk Rating
Made Ground	Soil	Ingestion, inhalation and/or dermal contact	Future users	Medium	Unlikely	Low
			Off-site users	Medium	Unlikely	Low
	Ground gas & vapour	Inhalation	Future users	Medium	Unlikely	Low
		Migration, accumulation and explosion	Future users	Medium	Unlikely	Low
	Soil and water	Leaching and migration from contaminated soil	Groundwater	Medium	Unlikely	Low
			Surface Water	Medium	Unlikely	Low
Controlled Waters	Groundwater	Digestion and dermal contact	Future users	Medium	Unlikely	Low
			Construction workers	Medium	Unlikely	Low

The refined risk assessment has identified a low risk to identified receptors. On this basis, no potentially 'unacceptable risks' have been identified and no specific remediation is required as part of the proposed redevelopment of the site.

6.6. Preliminary Waste Characterisation

The results of the geo-environmental soil analysis have been considered in view of potential soil waste classification. The waste assessment presented below is preliminary and based on the soil chemical laboratory results only. Any excavation and subsequent disposal of soils from the site should be informed by a full waste assessment for the specific excavation and disposal activities being undertaken in accordance with *Technical Guidance WM3 - Waste Classification: Guidance on the classification and assessment of waste (1st Edition v1.2.GB)*.



The available soil sample analytical results indicate that on-site Made Ground can be classified as non-hazardous waste if excavated and sent for off-site disposal. Excess arisings of Made Ground may be disposed at a suitably licensed inert or non-hazardous landfill subject to Waste Acceptance Criteria (WAC) tests.

The natural, uncontaminated soils, are, by definition, inert waste.

Notwithstanding this, the Made Ground and natural soils are chemically acceptable for re-use within the development subject to appropriate materials management plan or waste exemptions; re-use options are dependant on the geotechnical acceptability of material.



7. Recommendations

7.1. Overview

The proposed development comprises the construction of a single-story drive through restaurant in the centre of the site with areas of hard standing surrounding the building to be used as a car park and an access road for the drive through service. Additionally, soft landscaped areas are proposed around the boundaries of the site, comprising of new and existing trees.

Recommendations for geotechnical design and remediation (if required) are provided in the following sections of this report.

7.2. Contamination and Remediation

Based on the findings of the GQRA, the potential risks to identified receptors due to contaminant concentrations in the shallow soil and groundwater are low and no specific remediation is necessary.

Notwithstanding this, a contamination watching brief and discovery strategy should be implemented by the contractor during groundworks.

7.3. Geotechnical Parameters

The characteristic geotechnical parameters determined for the main geological units are shown in Table 7.1.

Table 7.1 Characteristic geotechnical parameters adopted for design

Stratum	Top of strata (m OD)	γ_b (kN/m ³) ^[1]	ϕ'_{cv} (°)	c' (kPa)	c_u (kPa)	E' (MPa)	E_u (MPa)	ν	K_0 ^[8]
Made Ground ^[2]	41.4	18	26	0	10	4.0 ^[8]	5.0 ^[7]	$\nu' = 0.2$	0.5
Alluvium	39.6	18	26 ^[3]	0 ^[3]	10 ^[6]	4.0 ^[8]	5.0 ^[7]	$\nu' = 0.2$ $\nu_u = 0.5$ ^[10]	0.5
Taplow Gravel Member	36.6	19	34 ^[4]	0 ^[4]	-	6.0 to 46.0	-	$\nu' = 0.2$	0.5
Chalk	33.8	19	34 ^[5]	0 ^[5]	-	70 ^[9]	-	$\nu' = 0.2$	0.5

γ_b : bulk unit weight ϕ'_{cv} : effective critical state angle of shearing resistance c' : effective cohesion c_u : undrained shear strength E' : drained Young's Modulus
 E_u : undrained Young's Modulus ν : Poisson's Ratio K_0 : in-situ lateral earth pressure coefficient

[1] Bulk unit weights are based on material descriptions and dry and bulk density testing.

[2] Moderately conservative geotechnical parameters representative of the variable nature of the Made Ground have been provided based on the material description.

[3] The effective critical state angle of shearing resistance for the Alluvium stratum has been calculated from an average plasticity index of 42% using Equation 7 from BS 8002:2015 Code of practice for earth retaining structures. Per BS 8002:2015 §4.3.1.4.9. c' is taken as 0kPa.

[4] The effective angle of shearing resistance for the Taplow Gravel Member has been calculated based on the material description, SPT values and particle size distribution test results using Equation 3 and Table 1 from BS 8002:2015 Code of practice for earth retaining structures. c' is taken as 0kPa. Note that the density of the Taplow Gravel Member is variable, and caution should be exercised in the selection of ϕ' during design

[5] The effective critical state angle of shearing resistance for the Chalk has conservatively been determined based on material description and in-situ testing results.

[6] The undrained shear strength, c_u , of the Alluvium has been estimated from SPT N60 values. SPT N60 and c_u have been correlated using the ratio $c_u = N60 \times f1$ where $f1 = 3.5$, per CIRIA C143.

[7] The undrained stiffness has been estimated using the relationship $E_u/C_u = 500$.

[8] The drained stiffness of Made Ground and Alluvium has been estimated using the relationship $E'/E_u = 0.8$.

[9] The drained stiffness of Chalk has been determined using the correlation $E' = 5N_{60}$ from CIRIA C574

[10] ν_u is the undrained Poisson's Ratio (no volume change undrained condition).

[11] K_0 calculated from $1 - \sin \phi'_{cv}$ for normally consolidated and lightly overconsolidated materials. K_0 for the Chalk based on overconsolidated nature of the material.



7.4. Excavations

Based on the proposed scheme information provided, Made Ground and Alluvium will be excavated to form the foundation elements; excavations in these materials are likely to be unstable and require temporary support or battering back to a safe angle. It is anticipated that the Made Ground could be re-used as general fill, however, the Alluvium is unlikely to be geotechnically suitable for reuse.

There are no current buildings on the site and no significant changes in ground level are proposed, so no overburden removal and subsequent heave is anticipated.

7.5. Foundations

Based on the ground conditions encountered, shallow foundations in the Made Ground and/or Alluvium are not recommended, and structural loads should be transferred to the more competent strata (Taplow Gravel Member or Chalk) via ground improvement or piled foundations.

7.5.1. Shallow Spread and Raft Foundations

Considering the ground conditions of the site and the proposed scheme, it is concluded that any form of shallow foundations, including ground bearing raft / slab, strip and pad footings, do not present a viable foundation solution for the proposed buildings. Shallow foundations may be considered for smaller structures and features, but this will be dependent on verification of the subgrade material strength and performance characteristics, particularly considering the presence of substantial thicknesses of Made Ground and Alluvium.

Ground improvement, such as vibro- stone or concrete columns (VSC or VCC) may be feasible and early engagement with specialist contractor is recommended.

7.5.2. Pile Foundations

Pile foundations are currently considered as the base foundation option, transferring structural loads below the Made Ground and Alluvium into competent strata. Pile construction methods that would suit the site include contiguous flight auger (CFA) piling and rotary bored piling techniques (dry boring in the River Terrace Deposits and Chalk). Temporary casing or support fluid may be required to support superficial deposits and Made Ground for the rotary piling technique. The high water table should be considered when finalising the design.

Equivalent compressive (C) safe working loads in general accordance with Eurocode 7 and BS 8004:2015 have been provided in Table 7.2 for piles of varying diameters and lengths without pile testing.



Table 7.2 Pile equivalent safe working loads (kN) in axial compression for CFA piles

		Pile Diameter (mm)	
		450	600
Pile Length (m)	10.0	320	490
	11.0	380	570
	12.0	445	650
	13.0	510	740
	14.0	580	835
	15.0	655	935

1. Pile capacities calculated using EC7 NA Design Approach 1 Combination 2 partial factors.
2. Diameters are tool diameters.
3. Permanent/variable load split taken as 70%/30%.
4. Lateral pile loading has not been considered in the provided capacities.
5. Long-term water table adopted.
6. GEO evaluation only. STR verification to be completed in accordance with BS EN 1992.
7. Guidance from PR11 for pile design in Chalk.
8. Made Ground and Structureless Chalk ignored in pile capacity calculation.

The final pile design should be undertaken by an experience piling contractor / designer with experience in similar ground conditions.

7.6. Buried Concrete

The Design Sulphate Class for the Made Ground and natural soils is DS-1, and the corresponding Aggressive Chemical Environment for Concrete (ACEC) Class is AC-1s (for static groundwater) in the Made Ground / Alluvium and AC-1 in the Taplow Gravel Member and Chalk.

7.7. Drainage

2 No. Soakaway tests were carried out in TP01 location. Both soakaway tests were proven to be inefficient in the Made Ground due to the poor drainage characteristics. In any case, it is not recommended to dispose of surface water directly into Made Ground.

During monitoring visits, groundwater levels in BH01 (targeting Taplow Gravel Member) were encountered at depths of between 3.81m and 3.88m bgl. As such, any soakaway designed within deeper strata is also unlikely to be feasible.

Based on the above findings, the ground is not considered to be suitable for disposal of surface water.

7.8. Pavement Design

10 No. In-situ DCP testing was undertaken at 5 No. locations (WS01-WS04 and WS06) during the ground investigation. The testing was undertaken using a handheld equipment from depths of 0.3mbgl and 0.5m bgl, at each location. These tests were carried out in general accordance with ASTM D 6951 / D 6951M-18 TRL Report 587.



Table 7.2 below summarises the findings of the in-situ DCP testing and provides a correlative California Bearing Ratio (CBR). A mean CBR value for all the locations was calculated as 8%, within a minimum CBR value of 3% at WS02 location. In addition, the plasticity index of the underlying natural strata (averaging around 11.5%) has been assessed against the Suction Index Method, as described in Appendix C of LR1132 (Powell et. all. 1984). This method of assessment concludes a CBR value of the underlying soils as 3%. Therefore, a design CBR value of 3% is recommended for pavement design. It should be noted that in order to achieve a CBR of 3% the subgrade should be protected during the construction process. If the subgrade is left unprotected during the construction process the CBR may reduce.

Table 7.2 CBR Test Data

Exploratory Hole	Test	Start Depth (m bgl)	Surface Type	Subgrade CBR (%)
WS01	DCP01	0.30	Unpaved	6
	DCP02	0.50	Unpaved	26
WS02	DCP03	0.30	Unpaved	4
	DCP04	0.50	Unpaved	3
WS03	DCP05	0.30	Unpaved	5
	DCP06	0.50	Unpaved	7
WS04	DCP07	0.30	Unpaved	8
	DCP08	0.50	Unpaved	12
WS06	DCP09	0.30	Unpaved	9
	DCP10	0.50	Unpaved	7

7.9. Other Risks/Further Considerations

Further ground engineering considerations are summarised below:

- **Below ground obstructions:** A concrete obstruction was encountered in the vicinities of WS05 at 0.50m bgl during the ground investigation; the project team should consider the presence of any other potential below ground obstructions across the site (natural and anthropogenic).
- **Site logistics and construction means and methods:** Specialist contractor advice should be sought in relation to plant limitations and constraints.
- **Pile foundations:** Where piled foundations are adopted, appropriate construction methods and means should be considered to facilitate piling from within the site footprint.
- **Dissolution Features:** Although no dissolution features were believed to have been encountered within the investigation, the potential for such a feature to be present, cannot be ruled out. Further investigation can be considered to mitigate this risk.



- **Monitoring:** It is suggested that monitoring of the surrounding assets, buildings and infrastructure is undertaken during the progression of the works in conjunction with a project specific Action Plan.
- **Durability/aggressivity:** The DS and ACEC design classes presented in Section 7.5 should be adopted for both proposed concrete substructure elements.



8. Sources and References

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Appendix A Summary of Exploratory Holes

Exploratory Hole Reference	Easting	Northing	Level (m OD)	Final Depth (m bgl)
BH01	468574.38	174270.52	41.38	20.00
TP01	468571.90	174303.13	39.99	2.10
WS01	468569.22	174309.80	39.85	3.00
WS02	468591.76	174294.05	38.80	3.00
WS03	468564.32	174292.08	41.23	3.00
WS04	468573.73	174263.19	41.45	3.00
WS05	468594.08	174262.24	40.20	0.50
WS05A	468594.48	174262.31	40.20	0.50
WS05B	468594.08	174262.21	40.20	0.50
WS06	468608.51	174261.37	39.07	3.00



Appendix B Exploratory Site Plan



Key:

-  Cable Percussion Borehole
-  Trial Pit
-  Dynamic Sampling Borehole

Rev	Date	By	Chkd	Appd
00	31/10/24	FA	GC	DS

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Client
Weybourne Limite

Project Title
Scours Lane

Drawing Title
Exploratory Hole Location Plan

A2SI Project Number	Rev
53924	00

Drawing Number
53924-A2SI-XX-XX-
DR-Y-0001-00