

FINAL

Reading Borough Council

Ground Investigation Report

Land Behind Wensley Road

Reading

RG1 6DQ

Report No: 20-03-24

January 2021



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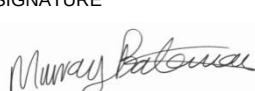
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EXECUTIVE SUMMARY

Site Location	Wensley Road, Reading, RG1 6DQ
OS Grid Reference	SU706722
Development Proposals	It is proposed to redevelop the site to construct two new residential properties on an existing domestic garage plot at Wensley Road, Reading, RG1 6DQ.
Published Geology	Geological maps identify that the investigation area is that the site is directly underlain by Bedrock Lambeth Group of the Paleogene, overlying the Upper Chalk of Cretaceous Age.
Topography	The general topography of the investigation area, is generally flat lying, sloping down towards the southwest.
Vegetation	The investigation area is bordered mature trees & vegetation.
Site History	Prior to the existing land use as a domestic garage/hardstanding area, the site has historically been an open undeveloped agricultural field. Additionally this area of reading has a history of mineral excavation (near the site area itself)
Ground Conditions Encountered	The exploratory field work undertaken during this investigation has identified that the site is underlain by localised hard-standing and Made Ground deposits to a depth of between 0.15m and 0.30m bgl, overlying the Lambeth Group, encountered at each of the deeper exploratory locations as a loose sand to approximately 4.10m bgl overlying a firm to stiff clay to a depth in excess of the base of the borehole at 5mbgl. The desk study and ground model identified a risk from the potential collapse and/or instability from unrecorded, underground chalk mines, given the area of Reading and the history of the nearby area. Super-Heavy Dynamic probes were therefore undertaken adjacent to each borehole, located within the proposed footprint, which identified variable strength strata to 10mbgl. It is unknown weather chalk deposits were encountered by the probe-tip, however no significantly weak, broken or voided ground was encountered to a depth of 10mbgl, and therefore it is considered that the proposed development is unlikely to be at significant risk from such hazards.
Groundwater Encountered	Groundwater was encountered within each of the deeper boreholes at the site during the initial intrusive works, between 3.50m and 4.0m bgl as a slight water seepage, however no rise was noted, and the borehole was dry at end of drilling. Monitoring of the standpipes, undertaken as part of the project did however reveal boreholes were dry to 3.50m bgl.
Ground/Groundwater Contamination	There is no significantly elevated risk perceived to Human Health or the Environment at the site.
Foundations	The Made Ground (including reworked deposits hardstanding and topsoil) is considered unsuitable as a bearing stratum due to its variability, and potential for unacceptable total and differential settlement under applied foundation loadings. However, the underlying bedrock Lambeth Group is considered to be a suitable bearing stratum for conventional shallow foundations at not less than 0.75m below existing ground level or 0.20m into the top of the formation, whichever is the deeper. At this depth a net allowable bearing pressure of 100kPa may be adopted for foundations not exceeding 1.0m in width. This allows for a factor of safety of three against failure and for settlements generally not to exceed 25mm with the majority likely taking place during construction.
Gas Protection	Based on the conditions measured during the monitoring visits carried out to date, In accordance with BS8485:2015 and CIRIA C665, 2007 the site is classified as a Characteristic Situation 1 (CS1). Therefore it is currently considered that ground gas protection is required with regard to methane or carbon dioxide gas.
Chemical Attack On Buried Concrete	Made Ground: DS-1 , AC-1 Lambeth Group: DS-1 , AC-1
Waste Soil Classification	From the results of the HazWasteOnline spread sheets and the WAC testing and in accordance with EU Council Decision 2003/33/EC para. 2.1.1, currently, the waste soil on this site is classified as Inert.
Recommendations	We recommend a watching brief should be undertaken during the construction phase, and if during development any previously undiscovered contamination (including visual or olfactory evidence) is found then site management should be immediately informed and inspection by a suitably qualified person should be undertaken.

This executive summary must be read in conjunction with the full report text.

GROUND INVESTIGATION REPORT

INTRODUCTION

Geo-Integrity Ltd were commissioned by Reading Borough Council, on the 27th March 2020, to undertake a site investigation on land behind Wensley Road, Reading, RG1 6DQ (Purchase Order Number RB623611R). This Phase I desk study and Phase II intrusive investigation has been completed to gather geotechnical and geo-environmental data.

This report describes desk based searches of geological, environmental and historical information, the fieldwork and laboratory testing undertaken and provides an interpretative section of the geotechnical and geo-environmental data from this investigation to inform the proposed development.

The site is located at National Grid Reference SU706722.

The report is likely to be reviewed by the Council with reference to the NPPF. Once the development is completed, and as a minimum, land must not be capable of being determined as 'contaminated land' under the terms of Part IIA of the Environmental Protection Act 1990. However, it also states that "Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner." As such this desk study report is the first stage in investigating whether the site is likely to be considered "contaminated", in accordance with clause 179.

The objectives of this phase I and phase II interpretative report are:-

-  To undertake a site walkover to identify any potential pollution sources or geotechnical hazards on the site.
-  To gather historical, geological and environmental information.
-  To complete a preliminary site conceptual model so that potential pollutant linkages can be established and investigated further.
-  Briefly summarise the site development proposals and site setting.
-  To describe and report the fieldwork undertaken at the site.
-  To describe and report the chemical laboratory work undertaken on selected samples.
-  To describe and report the geotechnical laboratory work undertaken on selected samples.
-  To provide an interpretation of the results of this investigation with regards to the geo-environmental and waste disposal implications for the proposed development.

The investigation was performed in accordance with the general requirements of BS 5930:2015, BS EN 1997-2 (2007), BS EN ISO 22475-1 (2006) and other relevant related standards identified below. The initial fieldwork took place on the 17th March 2020.

SOURCES OF INFORMATION

The following sources of information have been used to compile this report:-

-  Extracts of available historical Ordnance Survey (OS) maps covering the period from 1879 to 2020, which are presented in the Appendices.
-  Groundsure Report Ref GS-6735350 included in the Appendices.
-  The British Geological Survey (BGS) and Environment Agency (EA) websites.
-  A site reconnaissance visit undertaken on the 15th March 2020.
-  Information from various internet sites on site history and environmental setting.

It should be noted that the information provided in the desk study is obtained from independent third party sources. It is provided in good faith, but no guarantee can be provided as to its accuracy. The desk study information is not necessarily exhaustive and further information relevant to the site may be available from other sources.

DEVELOPMENT PROPOSALS

It is proposed to redevelop the site to construct two new residential properties on an existing domestic garage plot at Wensley Road, Reading, RG1 6DQ. The proposals include the creation of associated soft landscaping, gardens, parking and pavement areas at the site, with associated amenities.

PHASE I DESK STUDY

WALKOVER SURVEY

A site walkover survey was initially undertaken on the 15th March 2020. Site location and layout plans are included in the Appendices, along with a selection of photographs taken during the survey.

The site is located within a sub-urban residential area of Reading. The site consists of demolished domestic garages located behind (to the south) of No51-65 Wensley Road. The investigation area comprised a hardstanding access road located between No49-51 Wensley Road, leading from Wensley Road, to an irregular shaped site area. The site comprised rough ground parking areas (used by the adjacent dwellings), with localised hardcore and concrete slabs (bases of removed garages). The western section of the site was overgrown with brambles.

The general topography of the investigation area, is generally flat lying, sloping down towards the southwest. Some mature vegetation was located along the boundaries, with the investigation area bordered by residential garden plots to all sides.

During the site walkover there were no significant potential point sources of contamination encountered, excluding the parked cars and apparent historical usage for vehicle storage. However there was no indication of any leakages/spillages or any visual or olfactory evidence of contamination.

GEOLOGY

Published Geology

Reference to the British Geological Survey website and Sheet 268; Reading; 2000; indicates that the site is directly underlain by Bedrock Lambeth Group of the Paleogene, overlying the Upper Chalk of Cretaceous Age.

Superficial deposits of the Lynch Hill Gravel Member, a sand and gravel are recorded within the surrounding area, within 25m of the site, and therefore may be present as a thin overlying layer at the site.

The Lambeth Group is described as “Vertically and laterally variable sequences mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and lignites and occasional

sandstone and conglomerate.” in the BGS memoir. The Lambeth Group may be present up to 39m in thickness beneath the site.

In the site area the Upper Chalk is divided into differing subunits which exhibit different material qualities and structure. The underlying unit is the Lewes Nodular Chalk Formation and Seaford Chalk Formation. This formation comprises chalk with flints with discrete marl seams, nodular chalk, sponge-rich and flint seams throughout. The Upper Chalk is likely to be present up to 130m in thickness beneath the site.

Historical Boreholes

The British Geological Survey holds records of exploratory holes, historically put down during previous investigations.

A sequence of four boreholes located approximately 550m north of the site, within similarly recorded underlying strata, generally recorded Reading Beds (subunit of the Lambeth Group) down to a depth of between 2.50m and 3.25m bgl, as a clayey & sand, overlying the Upper Chalk as a weak, white block chalk with few flints to >18.0m bgl.

Solution Features

Additionally chalk, as a calcium-carbonate rich rock, is highly susceptible to dissolution by water containing carbon dioxide. This dissolution can create three common types of features within the chalk, grouped together under the generic term ‘dissolution features’. These features include:

- *Sinkholes*: Depressions at the ground surface caused by the collapse of overlying chalk or superficial deposits into underground voids created by dissolution. Shape and size dependent on underlying void feature
- *Solution pipes*: A feature in the surface of the Chalk caused by increased dissolution in an area of closely spaced discontinuities. These features may, or may not, have a ground surface expression. Up to 20 metres diameter though commonly much smaller
- *Swallow Holes*: A void within the surface of the Chalk where a stream is ‘swallowed’ by the Chalk to flow underground. Often occur at the junction of impermeable strata and Chalk. Infilled ancient swallow holes do exist where streams used to flow and may not have any surface expression. Up to 14m in diameter, though commonly a few metres.

Reference to the Groundsure GeoInsight report indicates that the risk of ground dissolution of soluble rocks is low at the site, however the Peter Brett Associates natural cavities database

indicates there are six records of natural solution features within 500m of the site, as both sinkholes and solution pipes. The nearest is recorded 235m northwest of the site.

Natural Cavities Risk Assessment

A natural cavities risk assessment has been undertaken following the paper written by Clive Edmonds in 2001, 'Predicting natural cavities in chalk'. This gives a score to various factors including; type of chalk, topography, groundwater level, strata overlying the chalk, periglacial and glacial history. The score for this site was 308, which means there is predicted to be a moderately high subsidence hazard of natural cavities beneath this site (11.9% occurrence).

HISTORY OF THE SITE

The history of the site has been established by the review of freely available information and old Ordnance Survey maps going back to 1879. The maps and any other relevant information are included in the appendices and indicated the following.

Ordnance Survey

The earliest maps dated 1870s, record the investigation area to be located within a large open undeveloped field, within a rural area. During this timeframe the Avenue Brick Tile & Pottery Works is recorded approximately 150m northeast of the site, with records of kilns and quarried back scarps, indicating mineral excavation at the works.

The next available maps dated 1899, record the Avenue Works to within 40m of the site boundary, furthermore a chalk pit is also recorded 175m south of the site.

The next available maps dated 1911, show no evidence of any works, or mineral excavation at the site or the old Avenue Works, showing likely grading and backfilling of the area.

Development of the surrounding area is recorded in the 1950s with the contemporary residential development along Wensley Road to the north of the site area. The area historically recorded as likely workings, becomes the semi-circular soft landscaped area fronting Wensley Road to the east.

The first record of significant changes to the site area occurred between 1960 and 1965s when the investigation area is developed into the garage plots, consisting of six in the central area, five in the western area and four in the southeaster section of the site. Furthermore during this timeframe the location of the historical chalk pit has been constructed upon with residential houses.

No further significant change is recorded at the site to date, however freely available satellite imagery indicates that from 2003 the site still appeared as the most contemporary maps. However in 2006 the southwestern-most garage was removed to allow vehicular access to the rear of No67 Wensley Road. Furthermore between 2006 and 2010, each of the remaining garage plots were removed, leaving the visible concrete floor slabs at the site. Between 2010 and 2017, the site boundary was altered (southwestern site area annexed by No67) to its present day shape. At this point the site appears to its present day layout. Vehicles have been visibly parked at the site since 2003 to present day.

VICTORIAN BRICK WORKS IN READING

Geotechnical Hazards in the Coley Area of Reading are known to provide risks to existing and new developments, relating to ground subsidence occurred on 4 January 2000 outside the front of two residential properties on Field Road Reading, (located approximately 500m northeast of the site) with a crater 8m diameter and 4m maximum depth being formed, which caused part of the front and party walls of these properties to collapse.

The investigations showed that there were extensive historical chalk mines in the Field Road area. The mine tunnel roofs varied in depth from about 7.5m to 11m below ground level. The tunnel floors were typically around 13m to 14m below ground level and their width is typically 3m to 4m. The condition of the mines was generally found to be poor, with many areas of the roof having collapsed.

A scheme of stabilisation was developed from the results of the investigations. Grouting techniques were employed to fill the open voids beneath the ground and to improve areas of poor ground conditions resulting from previous collapses of the mines.

Stabilisation of Field Road Phase 1 was completed and all affected houses were reinstated together with the gardens and the Highway. The residents of the properties that were evacuated moved back into their properties in December 2001. Full details are provided by Reading Borough Council at <https://www.reading.gov.uk/article/6120/Field-Road>.

The chalk mines dated back to 1800 civil war, and later brick works, which abstracted chalk beneath the site in unrecorded subterranean caves. It was concluded that as Victorian brick works were typically located where the resources were readily available (clay) in the ground that once the clay had been extracted, unrecorded excavation into the chalk likely took place. The chalk would

have been mixed with clay from the overlying Lambeth Group for brickmaking. Some chalk may also have been burned to produce lime mortar for building purposes.

No indications of the excavations under Field Road are noted on the earliest available maps collected for this investigations desk study (being disused by the late 1800s). However there is record of the operational Avenue brick and tile Works located approximately 30m of the site area. Whilst these works are younger than those at Field Road, there is the potential for unrecorded undermining of the chalk as a brick additive occurred at the Avenue Works.

Should a similar process have occurred at the Avenue Works then a significant risk of subsidence collapse may be present at the site.

Surface Quarrying and Mining Cavities

Reference to historical mapping and the Groundsure GeoInsight report has recorded the presence of three former surface workings within 250m of the site area:-

-  Unspecified Pit – Located 31m Northeast of the site(identified as part of the Avenue Works)
-  Chalk Mining Cavity – Located 43m northeast of the site
-  Chalk Mining Cavity – Located 149m northeast of the site
-  Coley Park Chalk Pit – Located 167m south of the site
-  Shale & Clay at the Avenue Works – Located 232m northeast of the site

Other than the above dataset, no further information is available relating to these instances or any other within close proximity to the site.

However unrecorded excavations such as those encountered at Field Road and deneholes (medieval chalk extraction pits); may be present within the site or surrounding area. Therefore based on the available data-sets and the current ground model it is considered that localised small scale underground mining may have occurred and that the potential for difficult ground conditions is possible and are at a level where they should be considered by a Phase II investigation.

ARTIFICIAL GROUND

Information supplied by the desk study material identified two instances of artificial and Made Ground, within 250m of the site area:-

-  Worked Ground (undivided) – Located 169m northeast of the site.
-  Worked Ground (undivided) – Located 239m east of the site.

The areas of worked ground are likely to have been backfilled to some degree, as no significant workings are currently present in the areas (residential housing). There are no recorded of any likely backfill.

UNEXPLODED ORDNANCE AND BOMB SITES

Reference to the site specific unexploded bomb risk map (UXO) produced by Zetica indicates that the site is located in an area where there is a low risk of unexploded ordnance. Low risk regions are those with a bombing density of <15 bombs per 1000 acres.

Care is however required when assessing the risk for specific sites where the risk may be higher because of local wartime activity, such as munitions factories, pivotal infrastructure, airfields and dummy airfields, many of which were removed from historical maps in the interest of national security.

HYDROLOGY

The nearest surface watercourse is recorded as an inland river named Holy Brook located approximately 269m southeast of the site.

There are no current surface water abstraction license located within 1000m of the site.

HYDROGEOLOGY

Reference to the Environment Agency website indicates that the site is located on the following groundwater aquifers/aquicludes:-

-  Secondary A Aquifer - associated with the underlying Lambeth Group.

-  Principal Aquifer - associated with the underlying Upper Chalk,

The aquifer designation data is based on geological mapping provided by the British Geological Survey. The maps are divided into two different types of aquifer designation:

Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels.

Bedrock - solid permeable formations e.g. sandstone, chalk and limestone.

For each type there are four designations:-Principal, Secondary A, Secondary B and Unproductive Strata, ranked by importance.

The site is recorded to be located outside of any Source Protection Zones.

A Source Protection Zone (SPZ) is a designated area around a well or abstraction borehole. An SPZ is generally divided into three zones (but can be a fourth) defined as follows:

There are no recorded groundwater abstraction license located within 1000m of the site.

There has been no significant recorded pollution incident to controlled waters within the surrounding area.

WASTE TREATMENT AND LANDFILL SITES

Landfills

There are no records of operational or historical landfill sites within vicinity to the site area.

Other Waste Treatment Sites

There are no records of other waste treatment sites in close vicinity to the site area.

INDUSTRIAL USAGE SITES

Records of historical land use include “ unspecified works located 31m east of the site, which match the layout of the 1800s Brick Works, kilns and quarries, other historical instances include a nursery located 189m south of the site, and electrical substations (the closest located 105m southwest of the site.

The historical Tank Database identified the nearest unspecified tank was located 225m northeast of the site in 1879.

There are no recorded significant potentially contaminative activities that have been found within 250m of the site.

There nearest active fuel filling station is identified 411m northeast of the site.

There nearest inactive fuel filling station is identified 397m northeast of the site.

Historical Site Usage

Prior to the existing land use as a domestic garage/hardstanding area, the site has historically been an open undeveloped agricultural field.

Therefore it is considered that Made Ground is possibly present beneath the site, relating to this historical development/redevelopment at the site. Furthermore given the age of the building, there

is a possibility for asbestos containing materials within the made soils or structure of the existing features at the site.

Additionally given the usage as a vehicle storage area, small scale areas of TPH/PAHs may be present where vehicles have historically been parked/stored.

There was however no significant or obvious identification of any potential contaminant sources at the investigation area or surrounding area, identified during the site walkover.

GROUND GASES

Radon

Information obtained from the BGS and the National Geoscience Information Service indicates that the site lies within an area where less than 1% of homes exceed the action level of 200Bq/m³ for radon gas. Therefore, no radon protection measures are necessary in the construction of new dwellings or extensions, on this site.

However should the development proposals change to include a basement, as radon levels may be higher in an underground room and in accordance with BRE Quick Guide 7, Reducing Radon, Underground Rooms – Cellars and Basements, 2015, mitigation measures should be included in any basement design.

Landfill Gases

In accordance with BS8576:2013 the site has provisionally assessed for the risk of ground gases. This has been done with reference to “A pragmatic approach to ground gas risk assessment for the 21st Century” Card and Wilson, 2011.

-  No credible sources or pathways for landfill gas migration from an off-site landfill have been identified.
-  The site has not been a registered landfill
-  The Made Ground is not expected to be 5m deep or an average of 3m in thickness at the site.
-  The site is not located on a carbonate rich rock that can produce carbon dioxide.
-  Radon protection measures are not recommended for this site.
-  The site does not significantly lie on a potential naturally organic soil or humic or degradable Made Ground soil.

However the presence of likely backfilled excavations within 50m of the site provides a potential risk from ground gasses to the proposed development. Therefore, confirmatory ground gas monitoring is to be undertaken as part of the Phase II investigation.

POTENTIAL GEOTECHNICAL HAZARDS

The desk study information identified that the site does not lie within an area likely to be affected by coal mining. However both natural cavities and mining cavities are known to persist in this area of Reading, as described in the analysis above.

The risk of naturally occurring geotechnical hazards at the site is recorded in the Groundsure report to be as follows:

Ground Stability Hazard	Maximum Hazard Potential Rating
Collapsible deposits	Very Low
Compressible deposits	Negligible
Ground dissolution of soluble rocks	Low
Shrinking and swelling clays	Moderate
Landslides	Very Low
Running sand	Very Low

INITIAL GEOTECHNICAL CONCEPTUAL SITE MODEL

Reference to the walkover survey indicates that there were no significant or obvious identification of any potential land instability issues on the site. However reference to the desk study material indicates that this area of reading is subject to sporadic natural cavities within the underlying chalk, and unrecorded Victorian chalk mines.

During the 2000s unrecorded chalk mines beneath Field Road Reading (located approximately 500m northeast of the site) collapsed creating a crater 8m diameter and 4m maximum depth being formed.

No indications of the excavations under field road are noted on the earliest available maps collected for this investigations desk study (being disused by the late 1800s). However there is record of the operational Avenue brick and tile Works located approximately 30m of the site area.

Whilst these works are younger than those at Field Road, there is the potential for unrecorded undermining of the chalk as a brick additive occurred at the Avenue Works.

Should a similar process have occurred at the Avenue Works then a significant risk of subsidence collapse may be present at the site.

It is recommended that exploratory holes are conducted at the site during a phase II investigation, below the proposed footprints of the new dwellings to a significant depth in order to identify if any broken ground is present. Furthermore particle size distribution tests are recommended on underlying soils given the presence of the highly variably Lambeth Group soils, in order to determined foundation parameters, and requirements.

INITIAL GEOENVIRONMENTAL CONCEPTUAL SITE MODEL

In accord with the Environment Agency guidance LCRM *Land Contamination: Risk Management*, (EA, 2019), this desk study and site reconnaissance report constitutes a preliminary risk assessment in order to establish the potential presence of pollutant linkages. The diagram below illustrates the potential linkages.

Reference to the desk study and walkover survey indicates that there were no significant or obvious identification of any potential contaminantative sources at the investigation area or surrounding area, identified during the site walkover,

However it is considered that Made Ground is possibly present beneath the site, relating to the historical development/redevelopment at the site. Furthermore given the age of the building, there is a possibility for asbestos containing materials within the made soils or structure of the existing features at the site. Additionally given the usage as an area for car parking/storage, small scale areas of TPH/PAHs may be present were vehicles have historically been parked.

Furthermore given the presence of a likely backfilled brick pit within 30m of the site may also be a potential source of migrating contamination to the site.

It is considered that there may be a potential risk of contamination at the site, which may impact on both human health and the environment, via a source/pathway/receptors linkage. Therefore as part of the Phase II investigation both a Human Health and Environmental risk assessment has been undertaken, including sampling of the soils across the investigation area.

Potential Source	Potential Pathway	Potential Receptor	Considered Risk
Historic metals within the ground from long human history	Ingestion, inhalation or absorption from direct contact with soil.	End Users	Low to medium
	Leaching through the ground	Controlled Waters	Low to medium
	Possible contact during work phase	Construction Workers	Low to medium
Historic hydrocarbons within the ground from long human history	Volatile vapours possible	End Users	Low to medium
	Leaching through the ground	Controlled Waters	Low to medium
	Possible contact during work phase	Construction Workers	Low to medium
	Possible contact	Underground services	Low to medium
Historic asbestos within the made ground from long human history	Ingestion, inhalation or absorption from direct contact with soil.	End Users	Low to medium
	Possible contact during work phase	Construction Workers	Low to medium

PHASE II INTRUSIVE INVESTIGATION

SITE WORK AND SAMPLING STRATEGY

The fieldwork was undertaken in accordance with BS 5930:2015, BS EN 1997-2 (2007) and BS EN ISO 22475-1 (2006), with the exploratory locations being selected by Geo-Integrity Ltd. The exploratory hole locations can be seen in the Appendices.

The initial fieldwork was undertaken on the 17th April 2020 and consisted of three continuous tube (window) sampler boreholes to 5m bgl, one foundation excavation pits, and two machine excavated infiltration pits, undertaken in general accord with 'BRE 365'.

Three in-situ super heavy dynamic probes were also conducted adjacent to boreholes CT1-CT3 to a depth of 10m bgl.

Furthermore four in-situ TRL DCP-CBR probes were undertaken across the proposed new pavement areas.

Disturbed samples were taken at selected depths down to the base of the holes for subsequent laboratory testing and inspection. On completion, all trial pits were carefully backfilled with arisings in thin layers, ensuring that excavated material was replaced in the same order as it had been removed.

Additionally within CT1 a groundwater and gas monitoring standpipe was installed to 4.5m depth.

GROUND CONDITIONS

Summary

The site and laboratory test work revealed that the general succession of strata can be represented by localised hard-standing and Made Ground, overlying the Lambeth Group. The downward succession was generally consistent across the site, and was in accordance with published geology. Descriptions of the strata encountered are given on the exploratory hole records, and are summarised below. Further information is provided on the exploratory hole logs within the appendices.

Hard-standing

Encountered three of the exploratory holes (CT3, SA2 & TP1), as a 0.20m thick concrete slab (the remains of a demolished domestic garage) in CT3 and TP1, locally overlying hardcore flint cobbles to 0.30m bgl. Within SA2 a brick floor was encountered at 0.05m-0.10m bgl, underlain by a tarmac gravel.

Made Ground

Encountered at four of the test locations, from ground level, down to a depth of between 0.15m and 0.20m depth. The material varied across the site and consisted of a Greyish brown slightly clayey silty sandy gravel, with small inclusions of brick and other man made materials.

Lambeth Group

Encountered at each of the deeper exploratory locations as a loose sand overlying a firm to stiff clay at depth.

The near surface sand layer was encountered from depths of between 0.15m and 0.30m below ground level, down to a depth range of 4.10m-4.30m bgl. Represented in general as a loose brown/orange slightly silty sand.

Laboratory tests undertaken on representative samples revealed a fines fraction of 1-4%, and is therefore a non-shrinkable soil.

The basal clay layer was encountered from depths of between 4.10m-4.30m below ground level, and in excess of the base of the borehole at 5.0m bgl. Represented in general as a firm to stiff mottled brown and grey silty clay.

Laboratory tests undertaken on representative samples revealed moisture contents range from 17% to 26% and a plasticity index ranging from 28% to 31%, which equates to an NHBC Volume Change Potential of medium.

The desk study and ground model identified a risk from the potential collapse and/or instability from unrecorded, underground chalk mines, given the area of reading and the history of the nearby area. Super-Heavy Dynamic probes were therefore undertaken adjacent to each borehole, located within the proposed footprint, which identified variable strength strata to 10mbgl. It is unknown whether chalk deposits were encountered by the probe-tip, however no significantly weak, broken or voided ground was encountered to a depth of 10mbgl.

Groundwater

Groundwater was encountered within each of the deeper boreholes at the site during the initial intrusive works, between 3.50m and 4.0m bgl as a slight water seepage, however no rise was noted, and the borehole was dry at end of drilling.

Monitoring of the standpipes, undertaken as part of the project did however reveal the following groundwater levels.

Date	Standpipe Installation	Depth to Groundwater (m bgl)
1 st May 2020	CT1	Dry
12 th May 2020	CT1	Dry

BRE365 Infiltration Testing

The two exploratory holes (SA1 & SA2) were tested for their infiltration potential using the general methods set out in BRE 365. The calculated infiltration rates, and average infiltration rates for the specified locations are shown in the table below.

Location	Response Medium and Depth	Calculated Infiltration Rate			
		Test 1	Test 2	Test 3	Average
SA1	Lambeth Group - Sand at 1.10m depth	$2.92 \times 10^{-5} \text{m/s}$	$2.23 \times 10^{-5} \text{m/s}$	$1.46 \times 10^{-5} \text{m/s}$	$2.20 \times 10^{-5} \text{m/s}$
SA2	Lambeth Group - Sand at 1.0m depth	$8.31 \times 10^{-6} \text{m/s}$	$1.29 \times 10^{-5} \text{m/s}$ (extrapolated)	-	-

The result for SA2 test 2 should be treated with caution as the results have been extrapolated, as required volume permeation exceeded three hours.

Ground Gas

Ground gas monitoring was undertaken within the borehole standpipe at CT1 as part of this investigation, on two occasions (1st & 12th April 2020), using a calibrated Gas Data GFM Series gas analyser.

The results revealed oxygen levels of between 18.9% and 19.7% by volume, a carbon dioxide level of between 0.7% and 1.6% and a methane level below detectable limits.

Peak ground gas flow rates were recorded at <0l/hr.

Sulphate and pH Tests

Soluble sulphate and pH tests were carried out on nine soil samples recovered from the exploratory holes. These recorded values as shown in the table below:

Parameter	Range
Soluble Sulphate (g/l)	<0.010
Total Sulphur %	<0.010 – 0.024
Sulphate (Acid Soluble) %	<0.010 – 0.013
pH units	8.0 – 8.9

Existing Foundations

TP1 was undertaken alongside the existing retaining wall, located along the northern site boundary with the adjacent residential garden.

Excavation beneath the foundation to expose the footing depth, projection and founding soil type, identified a concrete foundation to 0.20m bgl, with no projection. The founding material was flint hardcore to 0.30m bgl overlying Lambeth sand.

A diagram is presented in Appendix B.

California Bearing Ratio (CBR) Tests

In-situ TRL Dynamic Cone Penetrometer (DCP) tests were undertaken within the near surface Made Ground and underlying Lambeth Group, at four locations within the proposed pavement area of the site. Results provided a value range of 17% to 43%.

Evidence of Contamination

No obvious or significant contamination was identified within the natural or Made Ground soils encountered during the field work. However some man-made materials were encountered within the Made Ground such as brick, tarmac and concrete, which may contain elevated levels of possible contaminants. Therefore chemical testing has been undertaken at the site, see environmental risk assessments below.

GEOENVIRONMENTAL TESTING

Geo-environmental laboratory testing was scheduled by Geo-Integrity on four soil samples recovered during the fieldwork. The testing was carried out at a MCERTS and UKAS accredited laboratory. The results are presented in the Appendices.

Soil samples were tested for a varied suite containing the following

-  Metals and inorganic substances
-  Speciated Polyaromatic Hydrocarbons (PAH)
-  Benzene, Toluene, Ethylbenzene and Xylene (BTEX)
-  Total Petroleum Hydrocarbons (TPH), with eight band split
-  The presence or absence of Asbestos.

Furthermore a sample of representative Made Ground was tested for a single stage inert WAC test for final waste classification.

GEOTECHNICAL INTERPRETATIVE SECTION

GENERAL GROUND CONDITIONS INTERPRETATION

The exploratory field work undertaken during this investigation has identified that the site is underlain by localised hard-standing and Made Ground deposits to a depth of between 0.15m and 0.30m bgl, overlying the Lambeth Group, encountered at each of the deeper exploratory locations as a loose sand to approximately 4.10m bgl overlying a firm to stiff clay to a depth in excess of the base of the borehole at 5mbgl.

The desk study and ground model identified a risk from the potential collapse and/or instability from unrecorded, underground chalk mines, given the area of reading and the history of the nearby area. Super-Heavy Dynamic probes were therefore undertaken adjacent to each borehole, located within the proposed footprint, which identified variable strength strata to 10mbgl. It is unknown whether chalk deposits were encountered by the probe-tip, however no significantly weak, broken or voided ground was encountered to a depth of 10mbgl, and therefore it is considered that the proposed development is unlikely to be at significant risk from such hazards.

Groundwater was encountered within each of the deeper boreholes at the site during the initial intrusive works, between 3.50m and 4.0m bgl as a slight water seepage, however no rise was noted, and the borehole was dry at end of drilling. Monitoring of the standpipes, undertaken as part of the project did however reveal boreholes were dry to 3.50m bgl.

The desk study recorded the site at a moderate risk from shrinking and swelling clays, likely due to the inherent variability of the Lambeth Group. Laboratory tests however identified a zone of non-shrinkable granular sand deposits beneath the proposed footprint to a depth of 4.10m to 4.30m bgl. Whilst the underlying Lambeth Group clays do exhibit a medium volume change potential, but these are below 4.30m bgl. Therefore shrinkability doesn't need to be taken into account.

Therefore it is considered that based on the findings of the investigation and the ground, the risk of underground instability is considered to be low beneath the existing proposed footprint, as probe results show no significantly weak, broken or voided ground to a depth of 10mbgl. However should the proposed development change, with development at another area of the site, it is strongly recommended that further probing is undertaken to prove competent ground to depth. In line with the risks identified from possible natural and manmade cavities.

EXCAVATIONS

Conventional excavation equipment and plant should be sufficient for excavating shallow foundations and service trenches at the site.

It is considered likely that shallow excavations should remain dry in the short term. It is also worth noting that excavations are likely to be unstable across the site, suitable edge protection and shoring should be used, and benching of excavations should be considered.

FOUNDATIONS

Shallow Foundations

Shallow foundations may be considered at the site providing the following criterion is followed;

The Made Ground (including reworked deposits hardstanding and topsoil) is considered unsuitable as a bearing stratum due to its variability, and potential for unacceptable total and differential settlement under applied foundation loadings.

However, the underlying bedrock Lambeth Group is considered to be a suitable bearing stratum for conventional shallow foundations at not less than 0.75m below existing ground level or 0.20m into the top of the formation, whichever is the deeper.

At this depth a net allowable bearing pressure of 100kPa may be adopted for foundations not exceeding 1.0m in width. This allows for a factor of safety of three against failure and for settlements generally not to exceed 25mm with the majority likely taking place during construction.

The soils to 4.10m bgl should be considered as being non-shrinkable.

FLOOR SLAB DESIGN

Floor slabs at the site can be ground bearing, provided the Made Ground is stripped and removed and is based on a blanket of good quality, free draining, well compacted granular material, placed prior to the construction of the floor slab, in order to make up the level.

Alternatively in areas of thicker Made Ground >600mm, suspended ground floors could be used.

It should also be noted that gas protection may also dictate that suspended floors are required.

SULPHATE ATTACK ON UNDERGROUND CONCRETE

Four soil samples from this investigation were scheduled for the measurement of water soluble sulphate, pH, Total Sulphur and Acid Soluble Sulphate (to investigate the potential for sulphate ions/pyrite) and to give an indication of the aggressivity of the ground in relation to buried concrete, as set out in the Building Research Establishment (BRE) Special Digest 1 (2005) Concrete in Aggressive Ground, Part 1: Assessing the aggressive chemical environment. The samples were recovered from depths ranging from 0.20m to 4.0m, and were sourced from representative areas of Made Ground and Lambeth Group Soils.

Therefore in accordance with the BRE Special Digest, these results have been given in the table below, in relation to strata type and required Design Sulphate Class and site Aggressive Chemical Environment Classification (ACEC).

Strata	Design Sulphate Class	Aggressive Chemical Environment Classification
Made Ground	DS-1	AC-1
Lambeth Group	DS-1	AC-1

The recommendations given in the above digest, with respect to suitable concrete design and other associated precautions against sulphate attack, should be followed for all below ground level concrete.

ACCESS ROADS AND PARKING

The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio (CBR) scale.

In-situ CBR tests undertaken in the near surface Lambeth Group, provided equivalent CBR values from 17% to 43%. Therefore we recommend a worst case value of 17%% is therefore adopted for design within the near surface granular Lambeth Group.

Made Ground

Made Ground has been proven across the site, and given the unknown origin of the soil, its variability and the likelihood and proven possibility for soft-spots, we recommend that any areas of soft or deleterious material should be excavated, replaced with a properly compacted coarse-grained fill and proof rolled prior to construction.

In addition, to avoid uneven and excessive settlement in hard-standing areas it is recommended that the following precautions are taken:-

-  Heavy proof-rolling of the exposed sub-grade strata
-  Excavation of soft spots encountered and replacement with well compacted granular material
-  The usage of a geo-textile separator layer above the sub-grade

INFILTRATION MEASURES

Appropriately designed sustainable drainage systems (SuDS) are more sustainable than using piped drainage to local sewer systems. However, infiltration measures close to buildings may result in undermining of foundations and softening of soils leading to instability. Attenuation measures should be located at suitable distances from foundations and infrastructure.

Two soakaway tests were undertaken, at the site, within the near surface Lambeth Group Sand at depths of approximately 1.0m bgl. The test results indicated a moderate infiltration rate range therefore it is considered that infiltration measures are likely to be suitable at the site.

GAS PROTECTION

The risk of ground gases impacting the site was assessed by reference to the paper “A pragmatic approach to ground gas risk assessment for the 21st Century” Card and Wilson, 2011. And determined that the site is unlikely to be at risk from ground gases and there was no significant source of ground gasses or a significant amenable pathway for any gas source to significantly affect the site or proposed development.

Confirmatory monitoring visits undertaken at the site, in conjuncture with groundwater level monitoring, recorded no carbon dioxide levels above 5% or methane gas above detectable limits. A flow rate of <0l/h was also recorded.

Based on the conditions measured during the monitoring visits carried out to date, In accordance with BS8485:2015 and CIRIA C665, 2007 the site is classified as a Characteristic Situation 1 (CS1). Therefore it is currently considered that no ground gas protection is required with regard to methane or carbon dioxide gas.

Furthermore the site is located in an area where less than 1% of homes exceed the action level of 200Bq/m³ for radon gas, and no radon protection measures are necessary in the construction of new dwellings or extensions.

Full details of gas concentrations and gas flow data recorded during the monitoring visits are given in Appendices.

GEO-ENVIRONMENTAL INTERPRETATION SECTION

RISKS TO HUMAN HEALTH

Introduction

Environment Agency guidance LCRM *Land Contamination: Risk Management*, (EA, 2019), states that human health risk assessment should be undertaken by a tiered approach using the source-pathway-receptor principle. A desk study constitutes the first tier and this has been undertaken as part of this investigation. The conclusions of this phase were that:-

“Reference to the desk study and walkover survey indicates that there were no significant or obvious identification of any potential contaminantative sources at the investigation area or surrounding area, identified during the site walkover,

However it is considered that Made Ground is possibly present beneath the site, relating to the historical development/redevelopment at the site. Furthermore given the age of the building, there is a possibility for asbestos containing materials within the made soils or structure of the existing features at the site. Additionally given the usage as an area for car parking/storage, small scale areas of TPH/PAHs may be present were vehicles have historically been parked.

Furthermore given the presence of a likely backfilled brick pit within 30m of the site may also be a potential source of migrating contamination to the site.

It is considered that there may be a potential risk of contamination at the site, which may impact on both human health and the environment, via a source/pathway/receptors linkage”.

Therefore as part of the investigation chemical testing was undertaken at the site. Results are analysed under the second tier, known as a Generic Quantitative Risk Assessment (GQRA), which uses generic guideline values to compare site chemical data against, and the final tier would be a Detailed Quantitative Risk Assessment (DQRA), which use data derived from the ground investigation to assess risks to identified receptors.

The assessment included in this report comprises a GQRA, which is undertaken by comparing soil contaminant concentrations from this investigation with conservative Generic Assessment Criteria (GAC). GAC for various land use and exposure scenarios have been selected from the following sources:

 CL:AIRE Category 4 Screening Levels (C4SL);

-  LQM Suitable for Use Levels (S4UL);
-  CL:AIRE/EIC/AGS GAC

The GAC have been derived using the Environment Agency Contaminated Land Exposure Assessment (CLEA) model, for a range of land uses and exposure scenarios, including:

-  Residential with the consumption of home-grown produce;
-  Residential without the consumption of home-grown produce;
-  Commercial;
-  Allotments;
-  Public Open Space near residential housing (POS_{resi}); and
-  Public Open Space public park scenario (POS_{park})

As the development at the site will include residential dwellings with associated gardens and soft-landscaped areas, for the purposes of this assessment a “Residential with the consumption of home-grown produce” has been selected.

Results of Chemical Testing

Of the four soil samples (Made Ground and near surface Lambeth soils) screened as part of this investigation, screened against the relevant GAC for a ‘Residential with the consumption of home-grown produce’ land use scenario as described above, none have exceeded the relevant GACs land use scenario.

Asbestos

Screening for the presence of asbestos did not reveal any asbestos containing material (ACM) or fibres in the three samples of soils tested.

Risk to End Users, Construction Workers or Surrounding Residents

Given the results of the desk study, intrusive investigation and laboratory testing, no significant source-pathway-receptor linkage exists at the site and consequently no additional human health risk assessment is considered necessary. However, this should be confirmed by the relevant Regulatory Authority as soon as possible prior to development.

RISK TO CONTROLLED WATERS

None of the metal and inorganic contaminants tested for within the total soil chemical tests recorded significantly elevated values. Therefore it is considered that, there is no elevated risk of Controlled Waters pollution from development at this site.

The Environment Agency is the regulatory body charged with protection of controlled waters and may be a consultee in the planning process. We recommend that the conclusions of this report are agreed with the relevant Local Authority at the earliest stage, to reduce potential delays to the development.

WASTE DISPOSAL CLASSIFICATION

INTRODUCTION

Excavation for foundations or services will produce waste soil and possibly other waste streams. As a waste producer you have a duty of care under section 34 of the Environmental Protection Act 1990 to ensure, amongst other things that these wastes are:-

-  Correctly stored
-  Correctly classify
-  Handed only to an authorised person
-  Disposed of properly.

To aid with these obligations we have used HazWasteOnline to undertake the Hazard Assessment Screen as part of this investigation, to establish whether the sampled soils should be considered as either hazardous or non-hazardous waste. This classification process is in line with the Environment Agency's guidance WM3 "Guidance on the classification and assessment of waste", 1st edition May 2015.

RESULTS OF HAZARD ASSESSMENT

The full results of the HazWasteOnline analyses can be seen in the Appendices.

The HazWasteOnline classification summary sheet from this investigation provides a waste classification of non-hazardous waste for all samples tested.

Also no visible pieces of asbestos were detected (by the naked eye) in any of the exploratory holes. Therefore, asbestos was not considered further from a waste perspective.

Waste Acceptance Criteria (WAC) Testing Results

To further classify the waste soil for landfill disposal, Waste Acceptance Criteria (WAC) testing has been carried out on a representative sample of the near surface Lambeth Group soils from depths of between 0.20m and 0.50m depth.

The results show that this soil fails the inert waste criteria. The laboratory testing results are presented in Appendices.

Furthermore uncontaminated soil can be classified as inert without testing, in accordance with EU Council Decision 2003/33/EC para. 2.1.1. As such, given the testing results, currently the underlying soils from the site can be disposed of at an INERT Landfill site. In addition, the HazWasteOnline results corroborate this.

Analytical results relevant to the materials being disposed of should be provided to the landfill operators or waste management contractors to confirm whether it meets their license agreements and to confirm tipping costs.

All wastes removed from site should be consigned, transported and disposed of in full accordance with all relevant UK legislation.

WASTE CLASSIFICATION

From the results of the HazWasteOnline spread sheets and the WAC testing and in accordance with EU Council Decision 2003/33/EC para. 2.1.1, currently, the waste soil on this site is classified as Inert.

Analytical results relevant to the materials being disposed of should be provided to the landfill operators or waste management contractors to confirm whether it meets their license agreements and to confirm tipping costs.

All wastes removed from site should be consigned, transported and disposed of in full accordance with all relevant UK legislation.

RE-USE OF MATERIAL ON SITE

Currently, if surplus arisings are 'fit for re-use' on the site and have not been treated, its re-use is allowed within the planning law. If it needs treating prior to re-use, exemptions can be sought from the Environment Agency to allow this activity.

Based upon the human health and groundwater risk assessments, the underlying soil is currently considered suitable for re-use on site. This analysis is however, dependent on the agreement of the Local Authority.

RECOMMENDATIONS

We recommend a watching brief should be undertaken during the construction phase, and if during development any previously undiscovered contamination (including visual or olfactory evidence) is found then site management should be immediately informed and inspection by a suitably qualified person should be undertaken.

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APPENDIX A



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REV	DESCRIPTION	DATE	BY	CHKD
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Reading Borough Council



Reading
Borough Council
Working better with you

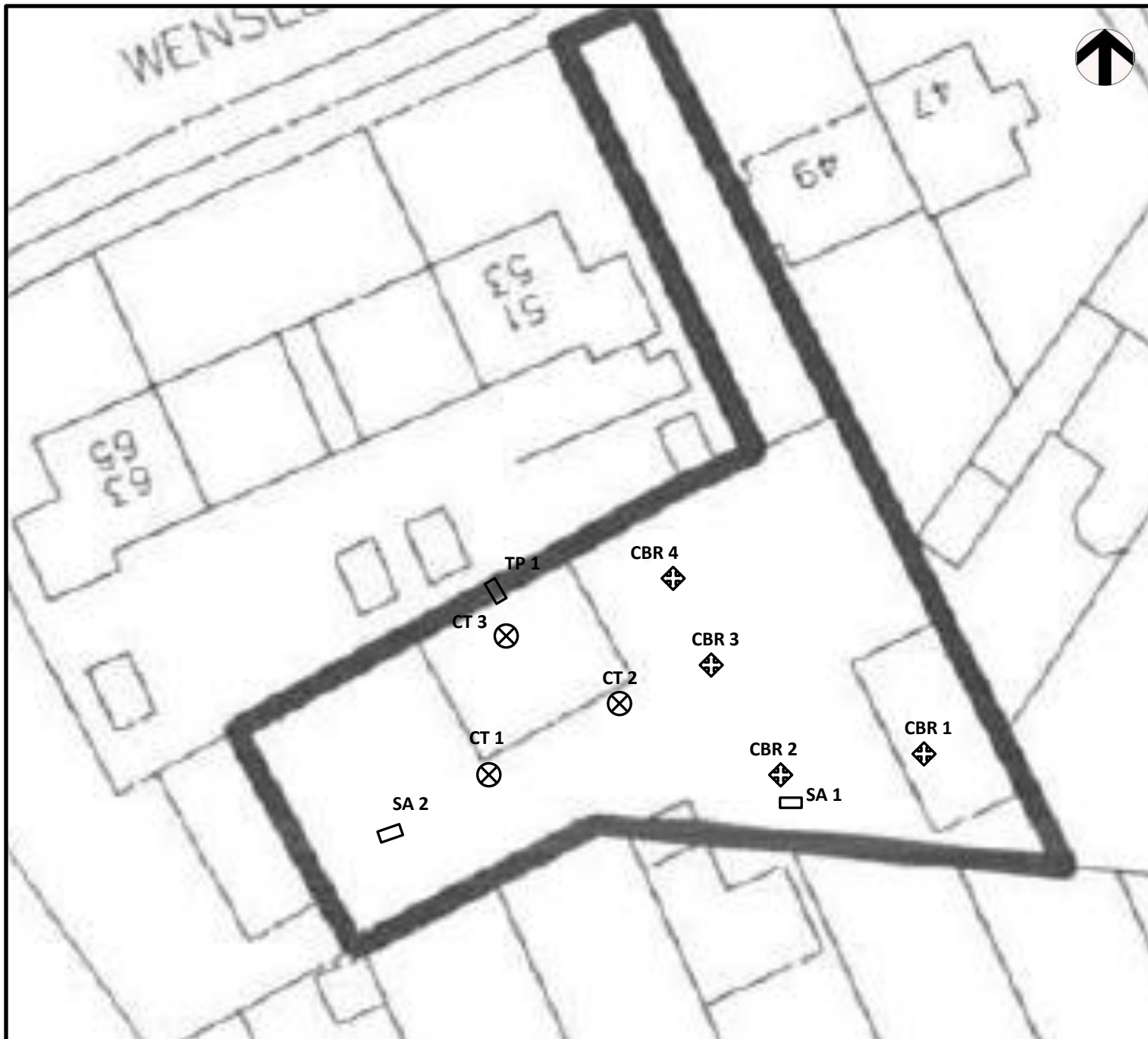
Former Garage Site To Rear Of
51-65 Wensley Road, Reading, RG1 6DQ

Site Location Plan

DRAWN BY: SRQ	SCALE: 1:1250 @ A
CHECKED BY: MF	DATE: 11/04/2018

STATUS:	PLANNING
---------	----------

DRAWING No:							
PROJECT:	ORG:	ZONE:	LEVEL:	TYPE:	ROLE:	NUMBER:	REVISION:
5004159	RDG	XX	ST	PL	A	600	-



Key

⊗ Continuous Borehole

⊕ CBR Location

□ Trial pit/Soakaway



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Exploratory Hole Location Plan

SITE:- 51-65 Wensley
Road, READING RG1 6DQ

JOB NO.:- 20-03-24

CLIENT:- Reading
Borough Council

Drawn
DL

Checked
LA

Scale: Not To Scale, for
indicative purposes only



Key

⊗ Continuous Borehole

⬢ CBR Location

□ Trial pit/Soakaway



4 Church Street
Maids Moreton
MK18 1QE

Tel:- 01280 816409
Mob:- 07858 367 125
www. geo-integrity.co.uk

Exploratory Hole Location Plan Proposed

SITE:- 51-65 Wensley
Road, READING RG1 6DQ

JOB NO.:- 20-03-24

CLIENT:- Reading
Borough Council

Drawn
DL

Checked
LA

Scale: Not To Scale, for
indicative purposes only



Site access to Wensley Road



Southern section of the site

May 2020

SITE PHOTOGRAPHS

Report No.:- 20-03-24



Western section of the site



View of north-western site area

May 2020

SITE PHOTOGRAPHS

Report No.:- 20-03-24