Report

Basement Impact Assessment

42 High Street, Teddington,
London
TW11 8EW

for

Unico Developments Ltd

Ref: GGC18675/R1.1 November 2018

Gabriel GeoConsulting Limited
Henwood Pavilion, Henwood, Ashford, TN24 8DH
Company No. 6455714, registered in England and Wales. Registered office: Highfield House, TN17 4EH
Tel: 01580 241044
e: info@gabrielgeo.co.uk www.gabrielgeo.co.uk

Basement Impact Assessment

Site: **42 High Street, Teddington, London TW11 8EW**

Client: **Unico Developments Ltd**

Report Status: **FINAL**		
Role	**By**	**Signature**
Ground investigation reporting by: PDISP analyses and damage category assessments by:	Alexander Goodsell BSc ACSM FGS	
PDISP input data checked by:	Heather Baker MSci FGS	
Report prepared and approved by:	Keith Gabriel MSc DIC CGeol FGS UK Registered Ground Engineering Adviser	

Foreword

This report has been prepared in accordance with the scope and terms agreed with the Client, and the resources available, using all reasonable professional skill and care. The report is for the exclusive use of the Client and shall not be relied upon by any third party without explicit written agreement from Gabriel GeoConsulting Ltd.

This report is specific to the proposed site use or development, as appropriate, and as described in the report; Gabriel GeoConsulting Ltd accept no liability for any use of the report or its contents for any purpose other than the development or proposed site use described herein.

This assessment has involved consideration, using normal professional skill and care, of the findings of ground investigation data obtained from the Client and other sources. Ground investigations involve sampling a very small proportion of the ground of interest as a result of which it is inevitable that variations in ground conditions, including groundwater, will remain unrecorded around and between the exploratory hole locations; groundwater levels/pressures will also vary seasonally and with other man-induced influences; no liability can be accepted for any adverse consequences of such variations.

This report must be read in its entirety in order to obtain a full understanding of our recommendations and conclusions.

Contents Page

Cover image: Proposed front elevation (extract from Chandler Browne Drg 01-A-1010, P10)

1. INTRODUCTION

1.1 This Basement Impact Assessment (BIA) has been prepared in support of a planning application for the demolition of the existing bank building at No.42 High Street, Teddington and mixed use redevelopment of the site with a three-/four-storey building plus partial basement. A restaurant is proposed in the ground floor and basement while the upper storeys will contain eight apartments. Further details of the proposed development are given in Section 3. This assessment is in accordance with the requirements of development policies adopted by London Borough of Richmond-upon-Thames (LBRuT), in particular their Planning Advice Note 'Good Practice Guide on Basement Developments' (May 2015), Section 5 of which provides guidance on the contents of the Structural Impact Assessment (SIA).

1.2 SIAs are required for all "basements under or adjacent to Listed Buildings…". It is understood that an SIA has been requested because the site adjoins the Teddington Arms public house, which is considered to be a 'Building of Townscape Merit'. The good practice guide includes a tabulated list of requirements (A to G) for SIAs. This report provides the following components of the SIA:

Part A - **Desk study** – all identified components, excluding a topographic/building survey. A site inspection (walk-over survey) was undertaken on 4th October 2018, photos from which are presented in Appendix A. Desk study data have been collected from various sources including searches of planning applications for adjacent properties, searches of the BGS database for borehole/well logs from the vicinity of the site (Appendix B), review of published studies/models of historic and predicted flooding, and provision of factual geological and geonvironmental Insight reports from Groundsure (Appendices C & D) and historic maps (Appendix E). Relevant information from the desk study and site inspection is presented in Sections 2–6. The search for adopted utilities/underground infrastructure has been reported separately.

Part C - **Site investigation** – Drilling was undertaken on 12th October 2018, the findings from which are presented in Section 7 and Appendix F.

Part D - **Engineering design** – This report provides recommendations (but not design analyses or drawings) in relation to the following components:

- Ground conditions and groundwater (Sections 8.1 & 8.3)
- Sustainable surface water drainage systems (SuDS, Section8.2)
- Flooding (Section 8.2).

Part E - Qualitative analysis of the **Upper Aquifer** and how the basement may impact on any groundwater flow (see Sections 6, 8.1, 8.3 and 8.4).

Part F - An assessment of **movements** expected and how these will affect adjoining or adjacent properties. A qualitative Ground Movement Assessment (GMA) and Damage Category Assessment (DCA) using methodologies as set out in CIRIA Report C760 is presented in in Section 8.6. Quantitative assessments including PDISP analyses of vertical heave and settlement will be provided once the laboratory test results are available.

1.3 This assessment has been prepared by Keith Gabriel, a Chartered Geologist and UK Registered Ground Engineering Adviser with an MSc degree in Engineering Geology. The author has previously undertaken assessments of more than 200 basements in twenty London Boroughs.

1.4 The following site-specific documents in relation to the proposed basement have been considered:

- **Tower Surveys Ltd:**

  Existing

Drg No. R-11682_201	Topographical Survey as of 08/04/2016
Drg No. R-11682_202	Floor Plans Survey as of 08/04/2016

- **Chandler Browne Architects (CBA):**

  Pre-planning, Issue P5/P10/P11/P12

Drg No. 01-A-1001, P13	Basement Plan Proposed
Drg No. 01-A-1002, P13	Ground Floor Plan Proposed
Drg No. 01-A-1003, P13	First Floor Plan Proposed
Drg No. 01-A-1004, P13	Second Floor Plan Proposed
Drg No. 01-A-1005, P13	Third Floor Plan Proposed
Drg No. 01-A-1006, P13	Roof Plan Proposed
Drg No. 01-A-1010, P13	Elevation A [North] Proposed
Drg No. 01-A-1011, P13	Elevation B [East] Proposed
Drg No. 01-A-1012, P13	Elevation C [South] Proposed
Drg No. 01-A-1013, P13	Elevation D [West] Proposed
Drg No. 01-A-1014, P13	Section A-A (Proposed)
Drg No. 01-A-1015, P13	Section B-B (Proposed)
Drg No. 01-A-1016, P13	Section C-C (Proposed)

- **Green Structural Engineering Ltd (GSE):**

  Construction Method Statement, including Structural Impact Assessment (October 2018, Ref: J001237). Includes:

Drg No. GA/01, Rev.P1	Basement GA (Preliminary)
Drg No. S/01, Rev.P1	Section Sheet 1, Section R1 (Preliminary)
Drg No. S/02, Rev.P1	Section Sheet 2, Sections R2 & R3 (Preliminary)
Drg No. TW/01, Rev.P1	Temporary Works to Basement GA (Preliminary)
Drg No's MS/01+02, Rev.P1	Construction Sequence for Typ. Underpin Section (Preliminary).

This report should be read in conjunction with all the documents and drawings listed above. No structural drawings were available at the time of writing this report

1.5 Instructions to prepare this Basement Impact Assessment (BIA) report were confirmed by email from Jeremy Chandler Browne dated 22nd August 2018. A preliminary report was submitted on 21st October 2018.

2. THE PROPERTY, TOPOGRAPHIC SETTING AND PLANNING SEARCHES

2.1 No.42 High Street, Teddington is a 1960s two-storey, purpose-built bank located in the London Borough of Richmond upon Thames (LBRuT). On the first floor there are ancillary offices and a one-bedroom flat. A single-storey rear extension was added in the 1970s. The property is located on the south side of the High Street (the A313) and on the west side of the junction with Cedar Road (as shown in Figure 1 and Photo 1 in Appendix A). The bank adjoins the east flank wall of the Teddington Arms public house, though appears to have a separate parapet wall, so giving a double party wall.

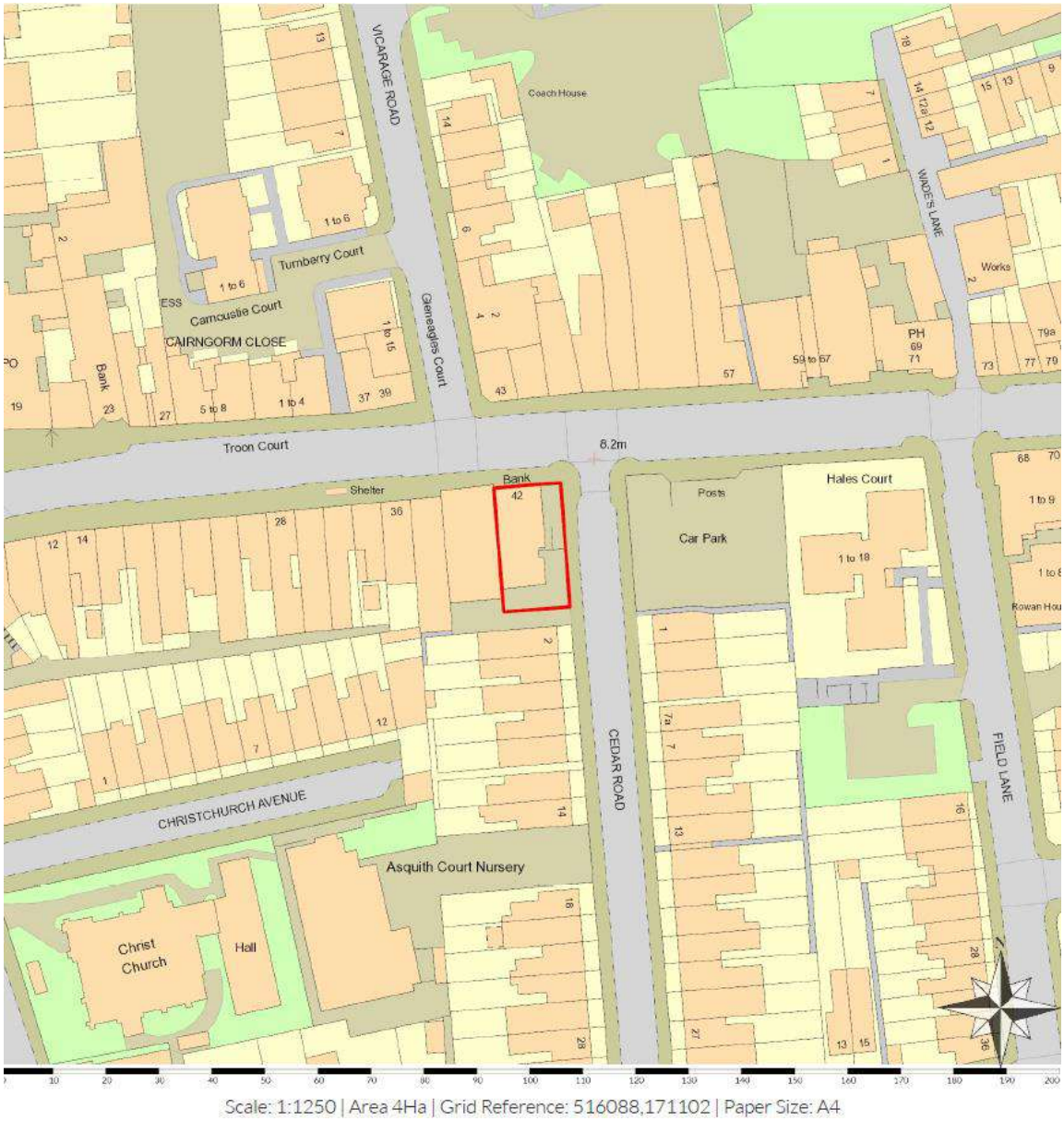


Figure 1: Extract from 1:1,250 OS map (not to scale) with No.42 outlined in red.

2.2 The site is within the Teddington High Street Conservation Area (No.37 in LBRuT).

2.3 Externally, there is a brick paved parking area to the rear and side of the single-storey extension, and a fenced-off area alongside the original part of the building (see Photo 2). The latter is surfaced with asphalt and can be accessed by a pedestrian gate. Three manhole covers are evident in these areas; it is understood that these drains serve only this site.

2.4 Historic Ordnance Survey (OS) maps centred on No.42 have been obtained and are presented Appendix E. These include 'large' scale maps at 1:1,056, 1:1,250 & 2,500 scales followed by 'small' scale maps at 1:10,560 & 1:10,000. The history of the site and the immediate surrounding area as evident from these maps is summarised below:

1865 Site was part of an orchard in the grounds of The Cedars, and backed onto a field. Sparse development on the south side of the High Street; more houses to the north. One well recorded to the south of the site.

1896 Site was still in the grounds of The Cedars, but the orchard had been removed and a sun dial had appeared. 'P' close to east could have been a groundwater pump (or a flag pole).

1898/9 No change in the immediate vicinity.

1915 Site now split into two halves, with an end of terrace house on the western half. Teddington Arms was also present, with a terrace of houses to the west. Tram lines were present in the middle of the High Street and Cedar Road had been built with most of its terraced housing.

1933 Outbuildings(?) on the west side of The Cedars had been removed.

1934 The Cedars had been demolished and its plot was vacant. The tram lines had gone and No's 1, 3 & 5 Cedar Road had been built, as had a large garage to the NW.

1938 No relevant changes.

1948 (1940 survey) No relevant changes.

1959 West side of site: Outbuildings and greenhouse had been built in the garden.

East side of site: A small building had appeared at the south end of the plot.

1961, 1962, 1963: No relevant changes.

1968 Site vacant, though possibly not correct as planning permission for the bank was granted in August 1964.

1974 (1973 survey) Site still vacant, which is almost certainly incorrect as a planning application for the bank's single-storey rear extension was submitted in 1973.

1978 First of the available maps to show the bank. To the east of Cedar Road, the western half of The Cedars site had become a car park (as it is now).

1991 Rear extension to the bank building shown. Area to north-west of the site had been extensively re-developed.

1994 (Last of the large scale maps) No relevant changes.

2.5 The current 1:1,250 scale map (Figure 1) shows that larger rear extensions have been added to the Teddington Arms and the adjoining No.38 since 1994.

2.6 A bomb map for the area at www.bombsight.org shows no recorded hits close to No.42. The nearest in the surrounding area are recorded as 'close to' Waldegrave Road and Elmfield Avenue to the WNW and NW of the site respectively.

Topographic Setting:

2.7 The Teddington High Street is broadly level, at 8.2-8.7m above Ordnance Datum (AOD), except where it rises (to 13.4m) to cross the railway lines to the west of the site. External ground levels within the site vary from 8.12m to 8.31m. Spot heights on the 1896 OS map show that the low point on the High Street was 28.3ft AOD, located to the east of No.42 (in front of The Cedars) which is consistent with current surface water flood modelling (see Section 5). This is only 0.06m below the road level adjacent to No.42 (28.5ft AOD); the absolute levels differ from the modern mapping, but the comparative levels remain valid.

2.8 The contours on Figure 2 show that the ground levels across most of the map area broadly fall very gently north-eastwards, towards the Thames where the 5.0m contour line closely follows the banks of the river.

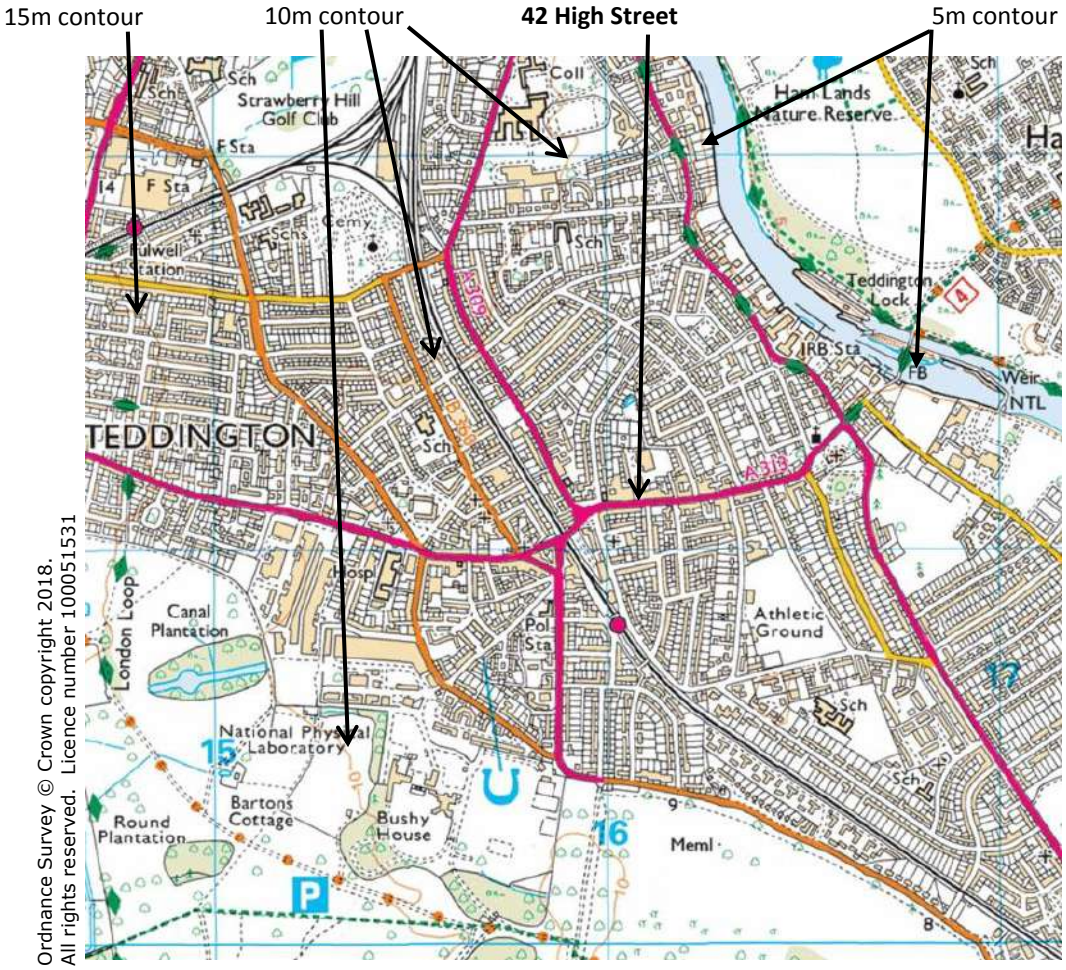


Figure 2: Extract from 1:25,000 Ordnance Survey map (not to scale) showing site location and topography.

2.9 The Groundsure Geoinsight report in Appendix C includes information about surface workings, the nearest of which was a 'Pond' located 170m to the west of the site (Section 2.1). None of the recorded workings are relevant to the aspects of the proposed basement considered by this report.

Planning Searches:

2.10 A search was made of planning applications on the London Borough of Richmond upon Thames' website in order to obtain details of any other basements which have been constructed or are planned in the vicinity of No.42 High Street, Teddington. This search found several applications in the vicinity. Some had flood risk assessment reports in addition to scheme drawings, but none of them had any documents relating to a site-specific ground investigation.

- **No.42 High Street, Teddington** (the application property)**:**
  - Application (64/0437) for the "*Erection of bank premises with offices and flat over*" was granted consent on 17th August 1964.
  - Application (73/2482) for the "*Erection of single-storey rear extension to provide additional office floor space, interview room and enquires section*" was granted consent on 9th April 1974.
  - Application (73/2482/DD01) for approval of details relating to "*Erection of a single storey rear extension to provide additional office floor space, interview room and enquiries section (height, design, external appearance). Condition No (a) of planning permission 73/2482 dated 9th April 1974*" was granted approval on 16th February 1977.
  - Application (10/3486/FUL) for the "*alterations to main entrance to improve disabled access*" was granted planning permission on 18th January 2011. Existing and proposed ground floor plans were available with the application (which included work on breaking out the threshold and laying new concrete in the entrance).
- **No.40 High Street, Teddington (Teddington Arms PH):**
  - Application (93/1649/CAC) for the "*Demolition of outside W.C*" was granted permission on 20th January 1994.
  - Application (18/01/1994) for the "*Single storey rear extension to provide additional accommodation for the existing café/delicatessen maintaining separate access to the upper floor*" was granted planning permission on 18th January 1994.
  - Application (90/0561/FUL) for the "*partial demolition of existing rear extension and erection of larger rear extension and refurbishment of existing car showroom*" was granted consent on 22nd May 1990. The address is given very clearly as this property, though apparently it was the rear extension to No.42 which was formerly used as a car showroom.
  - Application (90/0562/CAC) for the "*Partial demolition of single storey rear extension*" was also granted consent on 22nd May 1990.

- **No.36 High Street, Teddington:**
  - Application (88/0333) for the "*Change of use of basement and ground floors to solicitors/estate agents office*" was granted planning permission on 26th April 1988. There were no relevant documents attached to the application, but this suggests that basements are likely to be present beneath the whole of this terrace.
  - Application (90/1866/FUL) for the "*Change of use of ground floor and basement to Class A1 (retail) use on ground floor with ancillary use in basement*" was granted planning permission on 17th December 1990. There were no relevant documents attached to the application.
- **No.6 Cedar Road:** Application (14/2854/HOT) for the "*Removal of the rear conservatory extension. Erection of a new replacement rear extension*" was granted planning permission on 29th August 2014. Building plans attached to application do not include a basement.
- **No.5 Cedar Road:** Application (07/2383/HOT) for a "single storey rear extension" was granted planning permission on 14th August 2007. Building plans attached to application do not show a basement.
- **No.7 Cedar Road:** Application (05/3241/FUL) for the "Erection of a new dwelling and single storey rear extension to existing dwelling" was granted planning permission on 23rd December 2005. Although the available drawings do not show a basement, there is a staircase on the ground floor which may lead to an existing basement/cellar below.
- **Christchurch Road (to south-west of No.41):**
  - Land adjacent to No.12 (and to rear of No.36 High Street): Application (85/1630) for the "*Erection of a two storey attached dwelling with rear dormers and erection of a double garage*" was granted planning permission on 6th May 1986 and details were subsequently approved on 12th January and 23rd June 1987. No drawings were available on the website, but this property is believed to be No.14.
  - No.14: Application (15/2466) for the "Alterations and extension to property including ground floor…" was granted planning permission on 5th October 2015 and a Non-material Amendment (NMA) was consented on 30th June 2016. The attached floor plans and elevations do not show any evidence of a basement beneath the property.

3. PROPOSED BASEMENT

3.1 The proposed development for which planning permission will be sought, as shown in the architectural drawings (see paragraph 1.4), will comprise:

- The demolition of the existing bank building, including the parapet wall against the east gable wall of the Teddington Arms.
- Construction of a new three-/four-storey building plus basement, to include a restaurant in the ground floor and basement, and eight apartments in the upper storeys.
- The extent of single-storey basement will be smaller than the ground floor of the new building, such that most of its perimeter walls do not align with the ground floor footprint.
- The ground floor will occupy the whole of the site with the exception of a recessed area on the Cedar Road frontage, a lightwell alongside the single-storey rear extension to the Teddington Arms and undercroft stores accessible from the access track to the south.
- All roofs will be flat except for a section of pitched, tiled roof on the High Street frontage which will follow the same line as the roof to the Teddington Arms.

3.2 Chandler Browne Architects have proposed a finished floor level (FFL) at **5.23m AOD** for the basement, **3.06m** below the proposed ground floor FFL at **8.29m AOD**. With an allowance of 0.15m for insulation, cavity drainage and floor structure, and 0.40m for underpin/retaining wall bases as advised by Green Structural Engineering (email on 17/10/2018), the founding level (formation) of the proposed basement's retaining walls is anticipated to be **4.68m AOD**.

3.3 The depths of excavation required to achieve this founding level would be **3.44-3.63m** from external ground levels and **3.76m** from most of the internal FFL (at 8.44m AOD), which is assumed to be ground-bearing based on the absence of air bricks in the external walls of the property. The depth of excavation from the floor within the bank's vault (8.47m AOD) would be approximately **3.79m**.

4. GEOLOGICAL SETTING

4.1 Mapping by the British Geological Survey (BGS) indicates that the site is underlain by the Kempton Park Gravel Member, over the London Clay Formation. Around 500m to the north-east of the site beneath the River Thames, Alluvium can be found overlying the Kempton Park Gravel Formation, and further to the south-west, the London Clay formation can be found at surface. Figure 3, taken from Groundsure's GeoInsight Report (Appendix C), illustrates the superficial geology beneath the site and the surrounding area.

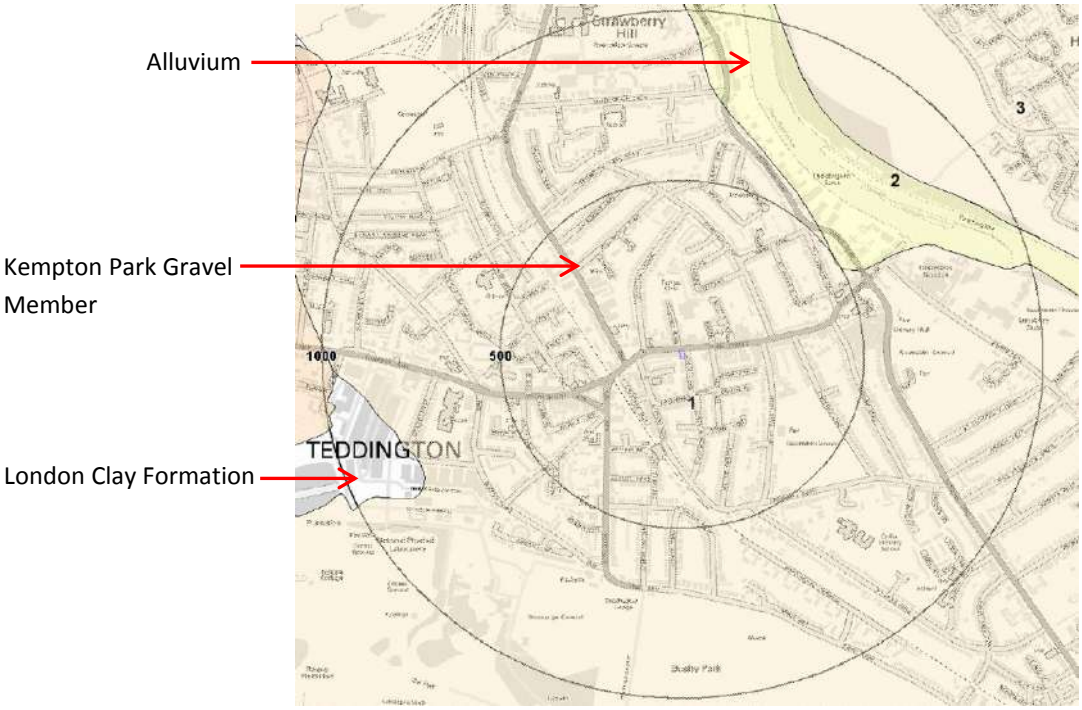


Figure 3: Extract from BGS 'Drift' map, centred on No.42 High Street (from Groundsure GeoInsight Report, Appendix C, Section 1.2).

4.2 In urban parts of London, these natural strata are typically overlain by Made Ground.

4.3 The Kempton Park Gravel Member is the lowest (youngest) of the River Terrace Deposits associated with the River Thames and its tributaries. It is part of the Maidenhead Formation, and is attributed to the post-diversionary River Terrace Deposits. All the post-diversionary River Terrace Deposits are described together in the relevant BGS memoir (Ellison et al., 2004) as consisting of varying proportions of well-bedded sands and gravels, along with local and impersistent beds of clayey and silty sand. The thickness of the Kempton Park Gravel Member increases from 3-8m between Hounslow and Barnes, to the west of the site, to 10-15m between South Lambeth and Deptford, to the east of the site. The thickness can also vary significantly locally over short distances owing to the presence of deep drift-filled hollows (sometimes called scour features).

4.4 The London Clay Formation is well documented (e.g. Ellison et al., 2004) as consisting of over-consolidated, firm to very stiff, fissured, bioturbated, grey to blueish grey, slightly calcareous, silty to very silty clay. It contains well-graded (i.e.: poorly sorted, with a range of particle sizes) beds of clayey silt to silty fine sand, pyrite, and variously sized carbonate concretions (claystones) which sometimes obstruct boreholes and piles. The London Clay Formation is known to have a weathered, oxidised zone at its top (usually between 3m and 6m thick where the London Clay is not overlain by other strata). This weathered zone and the transitional zone below are typically brown in colour, often becoming grey-brown or chocolate brown with depth, and contains selenite (a form of gypsum), which is aggressive to buried concrete. The clays of the London Clay Formation are typically of high or very high plasticity and high volume change potential. As a result, the clays undergo considerable volume changes in response to variations in natural moisture content (they shrink on drying and swell on subsequent rehydration). These changes can occur seasonally in response to normal climatic variations to depths of up to 1.50m, and to much greater depths in the presence of trees whose roots abstract moisture from the clays. The clays may also swell when unloaded by excavations such as those required for foundations and basements.

4.5 The London Clay Formation is known to reach thicknesses of between 90m and 130m below parts of London, therefore exceeds the depth considered relevant to the proposed basement. As a result, the geology expected beneath the London Clay Formation is not discussed.

4.6 The results of the BGS classifications of six natural ground subsidence/stability hazards are presented in the GroundSure GeoInsight report (see Appendix C, Section 6); all indicated 'negligible' or 'very low' hazard ratings for this site, however directly opposite the site, on the north side of Teddington High Street, and further to the west, a 'moderate' hazard rating has been given for shrink-swell clay. This could possibly reflect a shallow presence of the London Clay Formation, beneath a thin layer of the Kempton Park Gravel Member.

4.7 The Groundsure Geoinsight report (see Appendix C) records:

- Eleven historical surface ground working features within 250m of the site, including 'Ponds', located 170 & 212m to the west of the site, and 221 to 238m to the north of the site, as well as an 'Unspecified Pit' located 246m to the north of the site (App. C, Section 4.1).
- No historical underground working features within 1000m of the site (App. C, Section 4.2).
- Three current ground workings within 1000m of the site. These are the 'Bushy House Gravel Pit' located 699m to the south-west, the 'Kingston Road Sand Pit' 963m to the south-east, and 'Ham' located 990m to the north-east of the site, with 'Sand & Gravel' or 'Sand' the Commodity. The status of all of these is recorded as 'Ceased' (App. C, Section 4.3).
- No mining or extraction features within 1000m of the site (App. C, Sections 5.1-5.10);

- No railway tunnels within 250m of the site (App. D, Section 9.1); however historical railways and railway sidings are recorded 148-213m to the south-west, 195-196m to the west, and 220-231m to the south of the site, and active railway lines are recorded 191-195m to the south-west of the site (App. C, Sections 9.2-9.4).

It should be noted that these databases are based on mapping evidence, so inevitably will provide an incomplete record of tunnels and underground workings.

4.8 A search of the BGS borehole database was undertaken for information on previous ground investigations and any wells in the vicinity of the site, the locations of which are presented on the location plan in Appendix B. The strata depths in a selection of these boreholes are summarised in Table 1. For full strata descriptions, reference should be made to the logs in Appendix B. The gravels recorded in borehole TQ17SE/112 are recorded as 'Drift' and in boreholes TQ17SE/9 & 10, the gravel is recorded as 'Thames Ballast'; both relate to the Kempton Park Gravel Member. Formation names are not given to the sand & gravel in BGS Boreholes TQ17SE/181 & 156, thus in Table 1, these have been assigned based on the limited geological descriptions provided in the logs, and the location of the boreholes.

Table 1: Summary of Strata in BGS Boreholes

Strata (abbreviated descriptions) **GL (mAOD)**	**Depths (m) and levels (m AOD) to base of strata**					
	TQ17SE/112		**TQ17SE/156**		**TQ17SE/9 & 10**	**TQ17SE/181**
	Depth	**Level 8.53**	Depth	**Level 7.20**	Depth	Depth
Date Drilled	March 1924		May 1988		January 1952	December 1978
Made Ground/ Topsoil	1.22 inc pit	**7.31**	0.30	**6.90**	0.46 / 1.45	0.60
Clayey SAND to sandy CLAY (Kempton Park Gravel Member)	-	**-**	2.10	**5.10**	0.79/-	-
SAND and/or GRAVEL (Kempton Park Gravel Member)	5.03	**3.50**	4.40	**2.80**	>4.57 / >3.61	4.00
Brown CLAY (Weathered London Clay Fm)	-	**-**	-	**-**		4.40
Grey/blue CLAY (London Clay Fm)	>5.26	**<3.27**	>12.00	**<-4.80**		>10.00
Seepage/Strike	-	-	3.50	**3.70**	-	**-**
Groundwater standing level	2.97	**5.56**	3.20	**4.00-**	-	3.20

5. HYDROLOGICAL SETTING (SURFACE WATER)

5.1 The site lies within the former floodplain of the River Thames which, at its closest point, is approximately 620m to the north-east of the site (see Figure 2).

5.2 The Environment Agency's 'Flood Map for Planning (Rivers and Sea)' on the government's GOV.UK website shows that:

- The property lies within flood risk Zone 1 which is defined by the Environment Agency as "*Land having a less than 1 in 1,000 annual probability of river or sea flooding*". This is classed as a Low risk, though ignores the presence of flood defences and does not allow for climate change.

5.3 The Environment Agency's 'Long-term flood risk' maps on the government's GOV.UK website show that:

- The Agency's 'Risk of Flooding from Rivers and Sea' (RoFRaS) dataset gives a **Very Low** risk of such flooding for the area around No.42, which is defined as a less than 1 in 1000 (0.1%) chance of flooding in any given year. This data includes consideration, on a 50m grid, of the probability that the flood defences will overtop or breach by considering their location, type, condition and standard of protection.
- The property does not fall within an area at risk of reservoir flooding.

The implications of these risk ratings are considered further in Section 8.2.

5.4 Some other hydrological data for the site have been obtained from the Groundsure Enviroinsight report (see Appendix D), including:

- No surface water abstraction licences within 2000m of the site (App.E, Section 6.4).
- There are no flood defences, areas benefitting from flood defences or flood storage areas within 250m of the site (App.D, Sections 7.4 to 7.6).

5.5 The whole of No.42's site is either built over or hard surfaced, so surface water infiltration is likely to be minimal, being limited to minor seepage through the joints in the block paving). In addition, the presence of clays in the lower part of the Made Ground at the top of River Terrace Deposits (see Section 7) also means that there is very unlikely to be any recharge to the Upper Aquifer.

5.6 Three major studies of flooding in the borough have been conducted in recent years:

- **SFRA:** 'London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA) Level 1 Update' (August 2010). This update was prepared in accordance with the March 2010 revision of PPS25 (Planning Policy Statement 25, Development and Flood Risk). The update superseded the original SFRA for LBRuT (Jacobs, 2008) and was required because 10 new Acts, Regulations and guidance documents had been published since the original version was written. The SFRA considered flooding risks from rivers (fluvial), the sea (tidal), local surface water, sewers and groundwater.

- **PFRA:** 'Preliminary Flood Risk Assessment for the London Borough of Richmond upon Thames' (URS/Scott Wilson, May 2011). Part of the wider Drain London project, undertaken in compliance with the Flood Risk Regulation (2009) which implemented the EU Floods Directive in the UK. Such PFRAs are high level screening exercises which compile information on past and future **local** flood risk; local flood risk excludes flooding from main rivers, the sea or large reservoirs and considers only flooding from the following sources; "*surface runoff, groundwater, sewers and ordinary watercourses and any interaction these have with main rivers and the sea*".
- **SWMP:** 'Surface Water Management Plan for the London Borough of Richmond upon Thames' (URS/Scott Wilson, September 2011). Also part of the Drain London project, the Draft SWMP is a live document. New modelling of heavy rainfall events was used to identify Local Flood Risk Zones (LFRZs) from which Critical Drainage Areas (CDAs) were identified. Generic measures for alleviating flood risk were identified in a borough-wide 'Policy Area' and preferred mitigation options were proposed on an "area-by-area" basis (sometimes referred to as "site-by-site" or "site-specific") for each CDA. A draft action plan was proposed to implement the policies and preferred options.

5.7 Records of past surface water and fluvial flooding incidents were presented in Figure 1 of the PFRA (dated May 2011); no incidents were recorded in the vicinity of No.42 or any part of the centre of Teddington. However, the SWMP records anecdotal reports of 300mm depth of flooding in the topographic low spots of the High Street and Broad Street in 2007, sufficient to flood a number of shops, and flooding in another eight locations in Teddington.

5.8 The SWMP shows that Teddington High Street is within Critical Drainage Area 'Group8_006', as shown in Figure 4 below which presents an extract of the flood modelling for a 1 in 100 chance (1% AEP) rainfall event. A flood depth of 0.1-0.25m was predicted for the carriageways of the High Street and Cedar Road whereas the flood depth for the bank building was given as <0.1m which is the national background level. This flood modelling has been superseded by more detailed modelling by the Environment Agency.

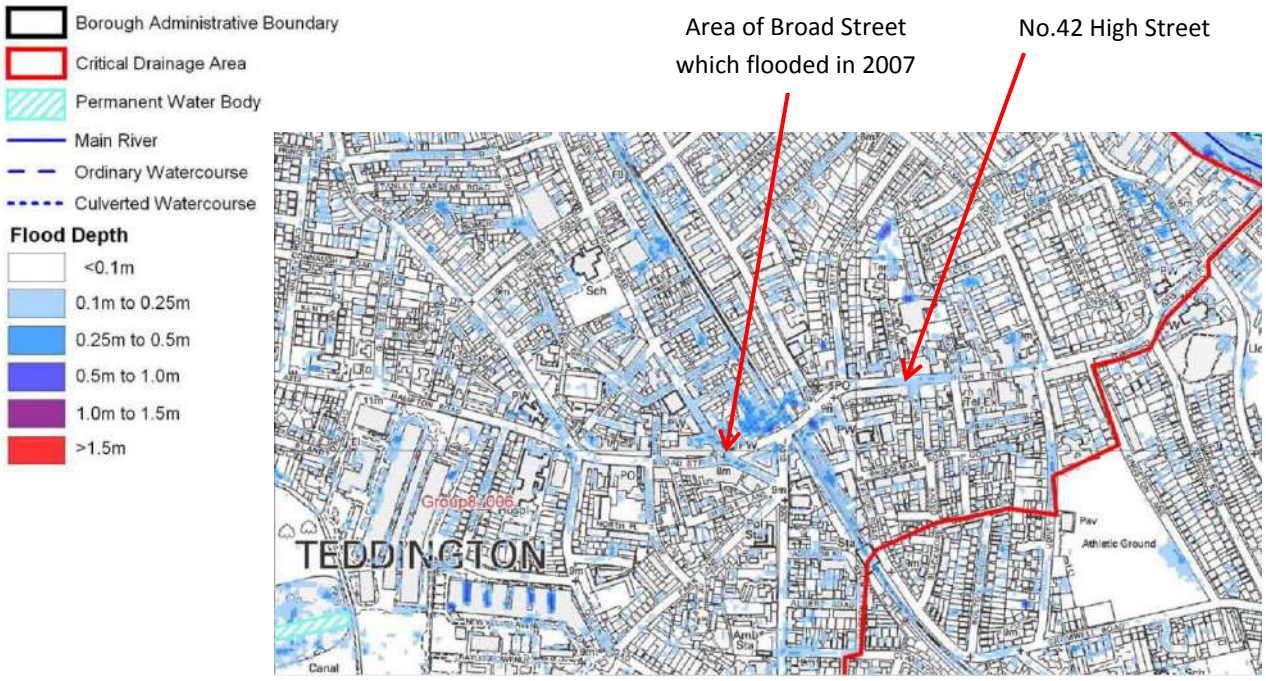


Figure 4: Enlarged extract from SWMP, Figure 3.8.6a: 'Group8_006 (Teddington). Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)'.

5.9 The Environment Agency (EA) published a new map of 'Risk of Flooding from Surface Water' in January 2014, which has since been enhanced and is now more detailed than the modelling in LBRuT's SWMP. An extract from the Agency's map, which is now available on the government's GOV.UK website, is presented in Figure 5. While this map identifies four levels of risk (high, medium, low and very low) it appears to be based primarily on topographic levels, flood depths and resultant flow routes. The EA's definitions of the categories are:

'Very low' risk: Each year, these areas have a chance of flooding of less than 1 in 1000 (0.1%).

'Low' risk: Each year, these areas have a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)

'Medium' risk: Each year, these areas have a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).

'High' risk: Each year, these areas have a chance of flooding of greater than 1 in 30 (3.3%).

5.10 The EA's map in Figure 5 indicates that the risk of flooding to the existing building at No.42 and the adjoining terrace is 'Very Low' (the lowest category for the national background level of risk), whereas the external areas of No.42's site have a 'Low' risk of flooding from surface water. The adjacent part of Cedar Road carriageway is shown at a 'Low' to 'Medium' risk of flooding from surface water, while the High Street carriageway directly in-front of No.42 and to the east are predicted to have a 'Low' to

'High' risk of flooding. This is consistent with the spot heights on the 1896 OS map, which illustrate a low point on the High Street to the east of Cedar Road (see paragraph 2.7).

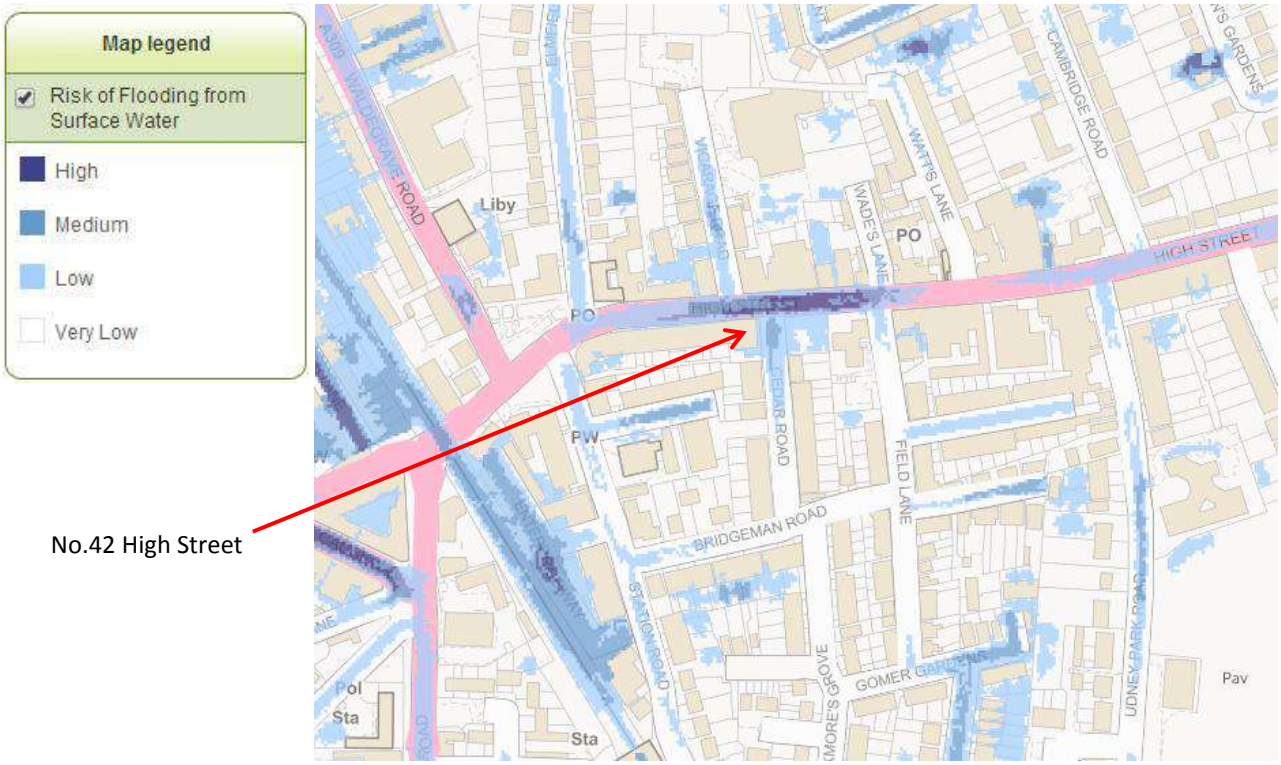


Figure 5: Environment Agency's "Risk of Flooding from Surface Water": Enlarged extract from GOV.UK website.

5.11 A 'Sewer Flooding History Enquiry' report has been obtained from Thames Water Utilities Ltd (TWU). In response to the question 'Is the requested address or area at risk of flooding due to overloaded public sewers?' (TWU's wording) the response given was: "*The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers*". A copy of the report is available on request.

6. HYDROGEOLOGICAL SETTING (GROUNDWATER)

6.1 The River Terrace Deposits are classified by the Environment Agency as a superficial 'Principal Aquifer', whereas the Alluvium which overlies the River Terrace Deposits to the north-east is classified as a superficial 'Secondary Aquifer – Undifferentiated Layers'. The underlying London Clay is an 'Unproductive Stratum'. Figure 6 shows the extent of these aquifers in the vicinity of the site of current interest.

Figure 6: Extract from Environment Agency's map of superficial aquifer designations (centred on No.42).

6.2 The Chalk Principal Aquifer which occurs at depth beneath the London Clay is not considered relevant to the proposed basement so is not considered further.

6.3 Under the Environment Agency's groundwater vulnerability and soil leachability classification scheme, which was updated in 2017, the site is in an area which is classed as 'Major Aquifer High' groundwater vulnerability.

6.4 Other hydrogeological data obtained from the Groundsure Enviroinsight report (see Appendix D) include:

- The nearest groundwater abstraction licences are 600m to the east of the site where The Lensbury Club has two active licences for spray irrigation (App.D, Section 6.3).
- There are no abstraction licences for potable water within 2000m of the site (App.D, Section 6.5).
- There are no Source Protection Zones (SPZ) within 500m of the site (App.D, Sections 6.6 & 6.7).
- For an area within 50m of No.42 the BGS has classified the susceptibility to groundwater flooding as '**Potential at Surface**', at a 'Moderate' confidence level (App.D, Sections 7.7 & 7.8). Such groundwater flooding is defined as "*the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded*". This classification relates to the groundwater in the River

Terrace Deposits; the basis of this classification and guidance on interpretation are provided in Section 8.3.

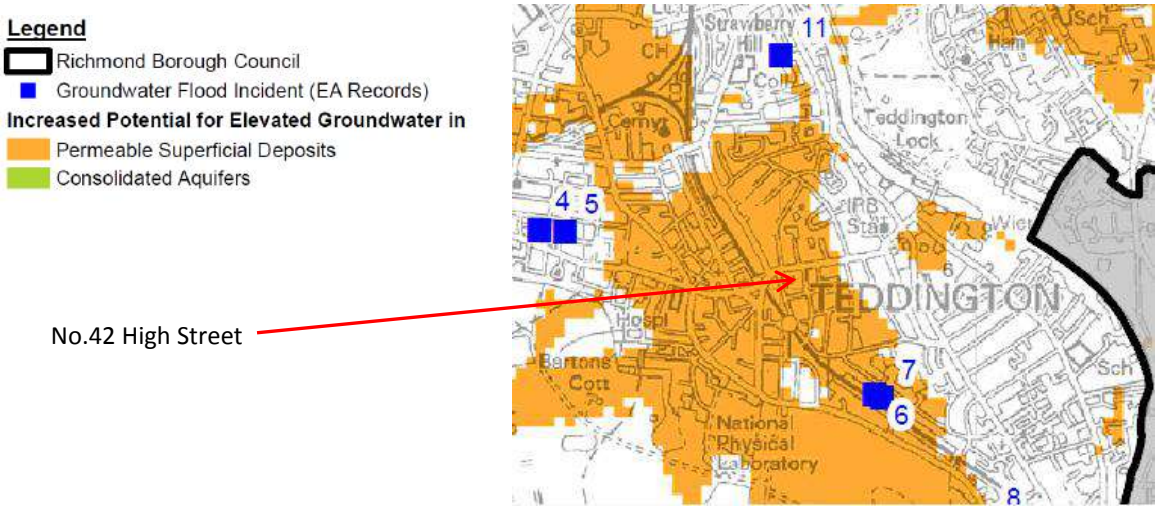


Figure 7: Increased potential for elevated groundwater – extract from Figure 3.5.1 of the SWMP. Ordnance Survey © Crown copyright 2011. All rights reserved. Licence No. 100051531.

6.5 Groundwater flooding incidents were presented on Figure 3.5.1 of the Draft SWMP (see Figures 7). A total of 22 incidents have been reported within the borough, however none were close to Teddington High Street. Table 3-3 in the SWMP provides details of each of the groundwater flooding incidents; the nearest were as follows:

Incident No.6: Occurred in 2001; recorded as "Water in air raid shelter in garden".

Incident No.7 (the closest to No.42): Occurred in 2007; the only incident detail recorded was "Groundwater flooding enquiry".

6.6 Figure 7 also presents the increased potential for elevated groundwater from permeable superficial deposits (coloured orange). Given the very few records of groundwater flooding in this part of London, the probability of groundwater emergence at surface within the site of No.42 is considered to be very low, as discussed in paragraphs 8.3.10 and 8.3.11.

6.7 The Upper Aquifer generally occurs in the lower part of the River Terrace Deposits (Kempton Park Gravel Formation) although multiple areas of perched groundwater may be present above the main groundwater table in this Upper Aquifer. In 1924 the nearby BGS borehole TQ17SE/112 at No.41 High Street (then a dairy) recorded groundwater rest level at 2.97m (9'9") bgl, 5.66m AOD. This borehole was lined with 150mm (6") diameter perforated tubes and when pumped yielded 3.3m^3 (720 gallons)/hr which resulted in a drawdown 0.99m to 3.96m bgl. When reviewed in 1940, the owner reported that the borehole had only run dry once in the previous 8 years.

6.8 The groundwater levels recorded in the Upper Aquifer during the recent site-specific ground investigation boreholes are presented in paragraphs 7.6 and 7.7 below.

7. GROUND INVESTIGATION

7.1 A site-specific ground investigation was carried out on 12h October 2018, which consisted of one cable percussion borehole (BH1), drilled within the parking area to the rear of the property, as shown on the Borehole Location Plan (Figure GI-01 in Appendix F).

7.2 The borehole was hand dug to 1.00m below ground level (bgl), before being drilled to a depth of 6.00m bgl. A standpipe was installed in BH1 in order to enable monitoring of groundwater pressures. Logging of the samples from the borehole was undertaken on site by Gabriel GeoConsulting Ltd (Alexander Goodsell). The factual results from the ground investigation are presented in Appendix F, including:

- Figure GI-01 Borehole Location Plan
- Figure GI-02 Borehole Log (BH1)
- Standard Penetration Test Results sheet.
- Laboratory test results.

7.3 The site's geology, as recorded in borehole BH1, may be summarised as:

- 0 – 0.11m: Surfacing: Brick pavers laid on sharp SAND bedding
- 0.11-0.50m: Made Ground: The upper part of this Made Ground consisted predominantly of hardcore, though the formal description is: slightly clayey, sandy GRAVEL, with the gravel consisting predominantly of lightweight clinker concrete and brick fragments, with some half & whole bricks, glass, and concrete. The clay content generally increased with depth, such that from 0.35m below ground level (bgl) the Made Ground consisted of sandy, very clayey GRAVEL to sandy, very gravelly CLAY, with the gravel consisting of brick fragments, ceramics, concrete and flint.
- 0.50-4.10m: Kempton Park Gravel Member: The upper part of the Kempton Park Gravel Member found in BH1 consisted of soft to firm, orangey-reddish brown, locally mottled greyish brown, moist, slightly gravelly, very sandy CLAY, and was recorded to a depth of 1.15m bgl. Underlying this upper horizon of clay, the rest of the Kempton Park Gravel Member consisted of dense, clean, orangey brown, sandy GRAVEL with occasional cobbles, with the gravel and cobbles consisting of angular to sub-angular flint.
- 4.10-4.40m: Weathered London Clay Formation: Firm to stiff, fissured, greyish brown to mid grey, mottled orangey brown and locally reddish orange, silty CLAY.
- 4.40m to base of borehole (6.00m): 'Un-weathered' London Clay Formation: Stiff to very stiff, fissured, mid grey, silty CLAY, with occasional fine crystals (mica/selenite?), and slightly stronger 'relict' clay clasts. The fissure surfaces were smooth and polished.

7.4 Standard Penetration Tests (SPTs) were carried out at 1.0m intervals starting from 1.0m bgl. The resulting 'N' values (blows to drive the 300mm test length) are recorded on the Standard Penetration Test Results sheet and on the borehole log (Figure GI-02), both of which are presented in Appendix F, and have also been plotted as a profile

against depth in Figure 8 below. The SPTs showed the River Terrace gravels to be 'dense (N = 33-47), whereas the lower values recorded in the underlying clays (N = 10-17) may be correlated with undrained shear strengths of Cu = 45-82kPa (after Stroud, 1987).

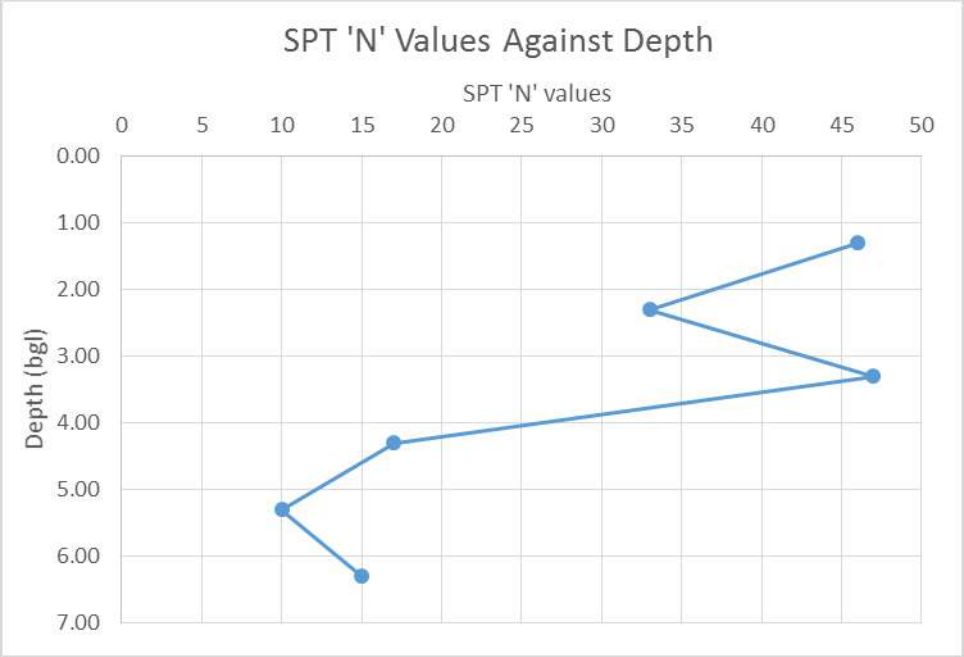


Figure 8: SPT 'N' values with depth.

7.5 No roots (live or dead) were recorded in BH1

7.6 No groundwater strike was recorded in BH1, though a minor groundwater strike near the base of the gravels may have been masked due to the addition of water into the borehole to aid drilling through the gravels. On completion, a groundwater standing level of 3.31m bgl was recorded.

7.7 A 50mm diameter standpipe was installed in the borehole to a depth of 5.0m, with response zone from 1.0m to 5.0m. Monitoring readings taken on 19th October 2018 recorded the groundwater level at 3.23m bgl (4.99m AOD).

Laboratory Testing:

7.8 Laboratory tests on samples recovered from BH1 were carried out by Geolabs Ltd. The testing comprised classification tests, including water content, plasticity and particle size distribution analysis, and chemical testing to assess the potential for acid or sulphate attack on buried concrete. The results are presented in Appendix F and summarised below.

7.9 Plasticity tests were performed on one sample of CLAY from the top of the River Terrace Deposits sequence at 0.6-0.7m bgl and on two samples of London Clay from 4.5m and 6.0m bgl. The samples from the London Clay were both found to be of Very High Plasticity, as defined by BS5930 (1999, 2010), and High volume change potential, as defined by the NHBC (NHBC Standards, 2018, Chapter 4.2, Building near Trees). The sample recovered from the River Terrace clays was found to be of Low Plasticity and Low volume change potential.

7.10 The water contents of the samples tested from the London Clay BH1 were found to vary between 28.9% and 32.2%, with a consistent decrease over the uppermost 0.5+m then a broadly constant value. The water content of the sample from the River Terrace clays (13.8%) was well below the sample's Plastic Limit (18%) which probably reflected the 34% content of material above 425micron particle size.

7.11 The particle size distribution analysis (grading) was undertaken by dry sieving. The results indicate that the material tested was a very sandy, fine to coarse GRAVEL with minimal/no silt or clay.

7.12 Chemical tests were undertaken on three samples, in order to assess the potential for acid or sulphate attack on buried concrete. The samples were recovered from BH1 at 0.25-0.35m bgl, 0.60-0.70mm bgl and 5.50m bgl, so included Made Ground, the River Terrace Deposits and London Clay. The following ranges of results were recorded.

pH value:	7.6-8.2
Water-soluble sulphate:	<10 - 140 mg/l
Total (acid-soluble) sulphate:	<0.01 – 0.03%

These results indicated that the samples from the Made Ground and River Terrace Deposits fell within Design Sulphate Class DS-1, as defined by BRE Special Digest 1 (2005), while, if disturbed by piling or other excavations, then for the London Clay would be in Class DS-3 (and the presence of pyrite was indicated).

8. BASEMENT IMPACT ASSESSMENT

8.1 Preliminary Ground Model

8.1.1 The desk study evidence together with the ground investigation findings suggest a preliminary ground model, including hydrogeological model, for the site characterised by:

- Made Ground: Expected to be present throughout the site to variable depths. Beneath the brick paved parking area at the rear of the site the Made Ground included an upper layer which was predominantly composed of hardcore (lightweight clinker, whole and half bricks, brick fragments and other artificial matter) which became increasingly clayey with depth. Below 0.35m this became a moist, sandy very gravelly CLAY to very clayey GRAVEL in which the gravel comprised brick fragments, ceramics, concrete & flint. Other materials, as well as other soil types and greater thicknesses/depths are also likely to be present on site, owing to the inherent variability of Made Ground.
  Perched groundwater may occur locally within this Made Ground, supported on horizons of lower permeability (such as the moist clays in the lower part of the Made Ground or the underlying clays); such perched groundwater may only be present during the wetter winter and spring seasons.
- Kempton Park Gravel Member: At the rear of the site these River Terrace Deposits included an upper 0.65m thick layer of soft to firm, slightly gravelly, very sandy CLAY, over 2.95m of sandy, fine to coarse GRAVEL with occasional cobbles. Lateral variations must be expected in the River Terrace Deposits. Standard Penetration Tests indicated these gravels to be in a 'dense' state of compaction.
  The thickness and base level of these River Terrace Deposits can be quite variable, especially where deep drift-filled (scour) hollows are present. The 4.10m depth to the base of these deposits recorded by the site-specific ground investigation at No.42 is consistent with the 4.00-5.03m range recorded in the surrounding BGS boreholes, though some variation across the site should be expected.
- The Upper Aquifer: The unconfined Upper Aquifer is generally in the middle to lower part of the River Terrace Deposits, although perched groundwater may be present above the main groundwater table. The brief groundwater monitoring exercise in the standpipe installed at No.42 recorded a maximum groundwater level at 3.23m bgl (4.99m AOD), which is 0.30m above the anticipated founding level (formation) for the proposed basement.
  These gravels had a low clay/silt content so the permeability is expected to be moderately high, which is supported by the 270 gallons/hr pumping rate achieved at No.41 High Street (albeit in 1924).
  Natural groundwater flow in this part of the aquifer would be expected to be in a broadly easterly or north-easterly direction, downstream along the Thames valley, with very low flow rates owing to the low topographic relief. Other local influences may alter both the flow rate and direction, as summarised below.

- London Clay Formation: The London Clay which underlies the Kempton Park Gravel Member was stiff to very stiff, fissured, grey, silty CLAY with partings of grey silt and fine sand and selenite crystals. A 0.30m thick layer of firm to stiff weathered clay was found at the very top of the London Clay sequence.
  The fissures in these clays reduce their shear strength. They contain claystone nodules/horizons which can be difficult to excavate, the included selenite (a form of gypsum) is aggressive towards buried concrete, and they will undergo heave movements in response to unloading.
  Groundwater pressures in the London Clay are expected to be hydrostatic within the depth of current interest (ie: increase linearly with depth). Only very limited groundwater seepage is anticipated through any silt/sand partings which may be present and which are sufficiently interconnected. The claystone horizons can also be water-bearing.
- Other influences on the Groundwater regime:
  - The hydrogeology is likely to be complicated further by the backfill in some footing trenches, service trenches and granular pipe bedding (where present) forming preferential groundwater flow pathways within the strata they pass through. These may provide a route for any perched water to enter the basement excavations.
  - The terraced house on the western half of the site prior to construction of the existing bank may have had a cellar/basement (as at least some of the houses to the west of the Teddington Arms do); while this is unlikely to reach the groundwater level, any remnant substructure and floor could support perched groundwater.
  - Local abstractions from the River Terrace Deposits, as well as any deep boreholes into the Chalk which have not been adequately sealed, would cause further local variations in the groundwater levels and flow directions in the Upper Aquifer.

8.1.2 This hydrogeological regime (ie: groundwater levels and pressures) will be affected by long-term climatic variations as well as seasonal fluctuations and other man-induced influences, all of which must be taken into account when selecting a design water level for the permanent works. No long term, multi-seasonal groundwater monitoring data are available so a conservative approach will be needed, as required by current geotechnical design standards.

8.1.3 The services search indicated that there is no adopted infrastructure beneath the site (including tunnels, sewers, water supply pipes, cables or communications) other than that which serves the site. None of the private services to the building would have been identified by the services search. The one possible exception would be any lateral drains, which the water companies seldom have any records of because they only became legally responsible for them in 2011.

8.2 Hydrology - Surface Water and Flooding

River and Sea Flooding:

8.2.1 The evidence presented in Section 5 has shown that the site lies within flood risk Zone 1, is more than 250m from any flood defences, areas benefitting from flood defences or flood storage areas, and has a Very Low risk of flooding from river or sea (RoFRaS dataset). Thus, no precautions are required in relation to potential flooding from river or sea (fluvial or tidal flooding).

Reservoir Flooding:

8.2.2 No.42 is **not** in an area shown by modelling to be at risk of flooding from any reservoir (following breach of an impounding dam or embankment).

Surface Water (Pluvial) Flooding:

8.2.3 The evidence presented in Section 5 has shown that:

- Surface water flooding probably did occur in the topographic low spot on the High Street close to No.42 in 2007.
- Teddington High Street does fall within Critical Drainage Area (CDA) Group8_006, based on modelling of future floods presented in the Surface Water Management Plan (SWMP, URS/Scott Wilson, September 2011). A CDA is defined in the SWMP as: "*a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal*) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure*".
- There are no surface water features within 250m of the site.

8.2.4 The concept of Local Flood Risk Zones (LFRZs) is used in LBRuT's SWMP although, unlike some other boroughs, their extent is not formally mapped. LFRZs are defined as "*Discrete areas of flooding that affect houses, businesses or infrastructure*", and Figure 3-1 happens to identify the area of potential surface water flooding around the railway to the west of the site as an example of a LFRZ.

8.2.5 Surface water flood models for the area (see Section 5) have been presented in:

- the Surface Water Management Plan (SWMP) which presented the same model as was used for the PFRA but with more return periods considered,
- the UK government/Environment Agency website (from January 2014).

The SWMP flood model for a 1 in 100 chance event without climate change (Figure 3.8.6a, at 1:9,000 scale) shows modelled flood depths of between 0.1m and 0.25m, on the carriageways adjacent to No.42's site (see Figure 4 above). Figure D-13 in the SWMP includes climate change but is only presented at 1:45,000 scale so shows a few small indistinct areas of potential flooding near No.42. The poor definition of this flood model limits its usefulness.

8.2.6 The Environment Agency's latest map 'Risk of Flooding from Surface Water' (Figure 5) shows only a Very Low risk of flooding within the bank building; this is the national background level of risk. A Low risk of surface water flooding is shown in external parts of No.42's site with a predicted depth in the 300-900mm category. Low to Medium risk and Low to High risk were predicted respectively for the Cedar Road and High Street carriageways adjacent to No.42. This EA modelling is not entirely consistent as flooding deeper than 300mm would be expected to have flooded within the bank building. The appropriate scope of flood resistance measures will therefore need to be considered for the proposed new building.

8.2.7 Only internal access to the basement is proposed, so surface water flood resistance measures have to consider only the ground floor access points. The internal finished floor level (FFL) in the existing bank building is predominantly 8.44m AOD, at which level none of the models have predicted flooding (for the storm intensities modelled). The current proposed FFL for the ground floor in the new building is 0.15m lower at 8.29m AOD. Consideration should the given to the options for flood resistance measures for the proposed building. The options section of the SWMP for The Teddington CDA (Group 8_006) concludes: "*…it is particularly important that local residents and commercial property at Teddington are aware of potential surface water flood risks and how they can protect themselves through raising of thresholds of property or re-designing shop frontages and doorways*".

8.2.8 During the 2007 floods some shops in Broad Street initially escaped flooding, but when vehicles drove through the flood water the wash they created caused indirect flooding. Use of watertight doors would therefore be prudent.

Change in Paved Surfacing & Sustainable Drainage Systems (SuDS):

8.2.9 The site is already fully paved or built over, so there will be no increase in hard surfacing. The block paving is laid on sand bedding so it is possible that a small proportion of surface water does infiltrate through the gaps between pavers (which is probably why the clays in the lower part of the Made Ground were moist). No infiltration is likely through the existing asphalt surfaced area.

8.2.10 In order to mitigate the potential tiny increase in surface water run-off, and thereby prevent an increase in discharge of surface water to the mains drainage system, inclusion of one or more appropriate Sustainable Drainage Systems (SuDS) in the scheme is recommended, such as:

- Use of a green (sedum) roof on one or more of the proposed flat roofs; these provide 'treatment' to improve the quality of the surface water (although they provide only limited hydraulic benefit once they become fully saturated under storm condition);
- Provision of permeable paving in the external areas at ground level.

It is understood that use of a green roof is proposed by CBA. Owing to the tiny amount of infiltration currently anticipated, this mitigation measure will not require formal design.

Sewer Flooding:

8.2.11 Thames Water has no records of flooding from public sewers affecting this property (see 5.11). However, no drainage system can be guaranteed to have adequate capacity for all storm eventualities and all drainage systems only work at full capacity when they are properly maintained, including emptying gullies and regular checks of the sewers themselves for condition and blockages. Maintenance of the adopted sewers is the responsibility of Thames Water, so is outside both the Applicant's and the Council's control. Thus, given that Thames Water have no record of historic sewer flooding affecting No.42, the probability of future sewer flooding affecting No.42 is considered to be low, provided that the sewer system is well maintained and appropriate flood resistance measures are implemented, as set out below.

8.2.12 Drainage systems are designed to operate under 'surcharge' at times of peak rainfall, which means that the level of effluent in the sewers and manholes may rise to ground level. When this happens the effluent can back-up into un-protected properties with basements or lower ground floors. During major rainfall events it is possible for some sewers to overflow at ground level, while this is rare it was suspected to have affected some of the floodwater in Teddington in 2007.

8.2.13 Non-return valves, preferably with pumped above ground loop systems, must therefore be fitted on the drains serving the basement and the lightwells, in order to ensure that water from the mains sewer system cannot enter the basement when the adjacent sewer is operating under surcharge. All drains which discharge via the same outfall as the basement must be protected, including those carrying foul water (and any roof water). A battery powered reserve pump should be fitted to ensure that the system remains functional during power cuts.

8.2.14 If non-return valves are used without an above-ground loop, then no effluent would at times be able to enter the mains sewer system when the flow in that sewer is sufficient to close the valves. The basement could then be vulnerable to flooding via low entry points on the drainage system within the basement. Sufficient temporary interception storage would therefore be required to hold temporarily the predicted maximum volume of water from all relevant sources which discharge via the valve-protected outfall (surface water from roofs and the lightwell and foul water) for the duration of the predicted surcharged flows in the sewer. This temporary interception storage would require formal design to ensure satisfactory performance.

8.2.15 If a non-return valve is fitted with an above-ground loop, then the loop must rise high enough above ground level to create sufficient pressure head to open the valve when the sewer flow is surcharged to ground level, otherwise the basement would once again be vulnerable to flooding while the surcharged flow continues. If it is not possible to achieve a sufficient rise of the loop above ground level, then temporary interception storage should be provided as recommended above.

8.3 Hydrogeology (Groundwater) – Permanent Works

8.3.1 The standing level of the Upper Aquifer in the River Terrace Deposits (in BH1) during the limited groundwater monitoring exercise in October 2018 was recorded at 3.23m bgl/4.99m AOD. This is slightly deeper than the 2.97m depth of groundwater recorded in the nearby BGS borehole. Additional groundwater monitoring readings should therefore be taken during the coming winter/spring in order to assess further the degree of fluctuation of the groundwater in Upper Aquifer.

Existing Basements:

8.3.2 No planning consents have been identified for modern basements in the vicinity of No.42 (see paragraph 2.10 above). Enquiries were made at the Teddington Arms; the staff informed us that there is no cellar/basement beneath that building. No.36 High Street has a basement which is understood to be an original feature, so some/all of the remainder of the terrace which adjoins the west side of the Teddington Arms may have similar cellars/basements. These are likely to be of limited depth in order to keep them above the groundwater level, so they are expected to have no impact on groundwater levels or flow in the Upper Aquifer.

8.3.3 It is possible that the terraced house which occupied the west side of this site before the bank was built could have had a cellar/basement.

Other Proposed Basements:

8.3.4 No planning consents for other basements in the immediate vicinity of No.42 were found by our searches.

Proposed Basement at No.42:

8.3.5 The proposed founding level (formation) for the new basement will be approximately 4.69m AOD, at 3.60m below the ground floor's FFL (see paragraph 3.2). These formation levels are 0.30m/0.15m below the groundwater level recorded by the monitoring to date.

8.3.6 Groundwater levels in the Upper Aquifer are known to fluctuate seasonally in some areas and the brief monitoring period was following a dry summer, so higher groundwater levels than those recorded by the monitoring must be included in the design in order to allow for both seasonal variations and climate change (see also paragraphs 8.1.1, 8.1.2 and 8.3.1 above). No long-term monitoring has been undertaken so at least one further set of monitoring readings should be taken during detailed design, preferably during late winter/early spring when groundwater levels may be at the highest point in the annual cycle, and the standpipe should be maintained so that the contractor can take further readings immediately prior to the start of construction, in order to confirm whether groundwater control measures will be required.

8.3.7 Subject to the recommended further monitoring, it is likely that the basement beneath No.42 will be founded a short distance below the groundwater table in the Upper Aquifer when it is built. Flow would still be able to continue through the gravels beneath the completed basement and around the perimeter so no adverse impact is expected other than a slight rise in groundwater level on the up-gradient side of the basement.

8.3.8 Useful evidence in support of such behaviour is available from the City of London. The large-scale removal of the River Terrace Deposits from the City of London has not caused significant problems associated with localised "damming" in the shallow groundwater table. The groundwater, where it is present and if it is moving, simply finds another route if it becomes "blocked" by a subterranean structure at a particular location, although there may be local rises in level. This opinion was expressed by Arup in reports for at least two other London boroughs (eg: Phase 1 Scoping Study for RBKC's Town Planning Policy on Subterranean Development, 2008). These "local rises in level" are likely to be significantly less than the natural variations in the water table associated with seasonal variations.

8.3.9 The proposed basement is not expected to create any cumulative effect on groundwater flow because no other adjoining or sufficiently close and deep basements have been identified.

8.3.10 The BGS has classified the susceptibility to groundwater flooding as 'Potential for groundwater flooding to occur at surface' which GroundSure has abbreviated to '**Potential at Surface**' (see paragraph 6.4). The 'Exploratory notes for users' prepared by the BGS for this dataset state that the "*data can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come to surface. Note, it is a susceptibility dataset and does not indicate hazard or risk*" (our underlining). The classification is based on a theoretical model of "high groundwater levels" in areas where permeable strata are present at surface which was then compared with a terrain model. It does not include any attempt to predict future changes so should reflect only the current groundwater situation.

8.3.11 The BGS exploratory notes also state that:

"The susceptibility data is suitable for use for regional or national planning purposes where the groundwater flooding information will be used along with a range of other relevant information to inform land-use planning decisions. It might also be used in conjunction with a large number of other factors, e.g. records of previous incidence of groundwater flooding, rainfall, property type, and land drainage information, to establish relative, but not absolute, risk of groundwater flooding at a resolution of greater than a few hundred metres. The confidence dataset will help in this assessment. The susceptibility data should not be used on its own to make planning decisions at any scale, and, in particular, should ***not be used to inform planning decisions at the site scale****. The susceptibility data cannot be used on its own to indicate risk of groundwater flooding."*

The BGS have also confirmed to the author (pers comm, 21/05/2014) that wherever there is local knowledge of groundwater conditions that knowledge should be used in preference to the susceptibility model.

8.3.12 Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. The BGS classification of the area as 'Potential at Surface' for the risk of groundwater emergence need not be taken as justification for taking groundwater levels at ground level, for the reasons set out in 8.3.10 and 8.3.11 above. In order to allow for both any perched groundwater in the Made Ground or upper part of the River Terrace Deposits and the possible future fluctuations of the main Upper Aquifer, a conservative provisional design groundwater level at **7.3m AOD** (approximately 1m below ground level) is recommended. This allows for future climate change and local areas of perched / infiltrating groundwater at higher levels. These recommendations should be reviewed prior to completion of the detailed design stage in light of the recommended further groundwater monitoring readings (with only upward, shallower revision of the groundwater level to be considered).

8.3.13 The basement structure should be designed to resist buoyant uplift pressure that would be generated by the 'worst credible' groundwater levels. For the provisional design groundwater level suggested above the maximum buoyant uplift pressure to be accommodated would be 26kPa (un-factored). The value used for the final design should be based on the final design groundwater level.

8.4 Hydrogeology (Groundwater) – Temporary Works

8.4.1 Local entries may occur from perched groundwater in the Made Ground and/or the upper part of the River Terrace Deposits. Once the excavations have passed through the clays into the gravels, any such entries may drain away naturally without any intervention. If ponding of any such seepages does occur within the excavations, then sump pumping should be adequate to deal with such entries provided that they are minor, are not causing any erosion of fines, and are not being fed by defective drains or water supply pipes. It would be prudent to ensure the external isolation stopcock is both accessible and operational before the start of the works.

8.4.2 The lower part of the excavations for the basement will encounter groundwater of the Upper Aquifer. The gravels are expected to have moderate to high permeabilities because those recovered from BH1 contained minimal fines, so pumping to dewater the excavations for underpinning or construction in-situ of 'L' shaped cantilevered retaining walls could require removal of significant volumes of water. The particle size distribution test being undertaken by Geolabs will enable an approximate assessment of the permeability of the gravels using Hazen's formula. If doubt then remains about the ability to dewater these gravels without having to remove excessive quantities of groundwater then a trial excavation to the full depth of the basement would be warranted.

8.4.3 If the permeability is confirmed to be sufficiently high to render dewatering impractical then the alternative options would include:

1. Grouting a perimeter 'bund' in the lower part of the gravels in order to reduce the permeability of the gravels sufficiently to enable dewatering of the excavations and the use of 'L' shaped cantilevered RC retaining walls (constructed in panels of limited width on the same basis as 'hit and miss' underpinning). A low strength grout would be used to enable easy excavation where required.
2. A combination secant/contiguous bored pile wall (BPW) around the whole perimeter of the basement, with the alternate shorter piles only embedded sufficiently into the London Clay to seal out the groundwater, or a contiguous BPW with grouting of the gaps between the piles before the basement is excavated. These options would mean that the basement would extend close to but not right up to the party wall with the Teddington Arms. Groundwater would be fully sealed out, allowing excavation in 'dry' conditions once the trapped groundwater has been pumped out.
3. A combination of the above, with a bored pile wall around most of the perimeter and a grouted bund beneath the Teddington Arms party wall in order to allow underpinning of that wall.

8.4.4 All groundwater control measures should be supervised by an appropriately competent person. A careful watch must be maintained to check that fine soils are not removed with the groundwater. If any such erosion/removal of fines is noticed then pumping should cease and the area affected may need to be backfilled temporarily while advice is sought from a suitably experienced and competent ground engineer or dewatering specialist.

8.4.5 A suitable discharge location will need to be identified for all water removed from these excavations.

8.5 Waterproofing

8.5.1 The proposed basement will need to be fully waterproofed in order to provide adequate long-term control of moisture ingress from groundwater and infiltrating surface water. Detailed recommendations for the waterproofing system are beyond the scope of this report although it is noted that, as a minimum, it would be prudent for the system to be designed in compliance with the requirements of BS8102:2009. Good workmanship will be crucial to the success of whatever system is selected.

8.5.2 The National House Building Council published new guidance on waterproofing of basements in November 2014 (NHBC Standards, Chapter 5.4). Compliance would be compulsory if an NHBC warranty is required, otherwise it may provide a useful guide to best practice.

8.5.3 Watertight seals will be required at all construction joints, including where any sumps extend below the basement slab.

8.6 Ground Stability and Bearing Capacity

8.6.1 The currently proposed method of construction for the proposed basement's perimeter walls involves a combination of underpinning a short section of the party wall with the Teddington Arms, and, for the remainder, reinforced concrete (RC) 'L' shaped cantilevered retaining walls constructed in panels of limited width using a traditional 'hit and miss', 1 to 5 sequence. Groundwater control requirements may necessitate a switch to a piled perimeter as explained in paragraph 8.4.2, but for the purposes of this section the currently proposed method has been assessed. The whole basement will be founded at approximately 4.69-4.84m AOD (see paragraphs 3.2 and 8.3.5), with depths of excavation below existing ground levels varying between 3.28m up to possibly 3.78m. The founding depth of the adjoining Teddington Arms must be determined during detailed design stage or, if a former cellar is present and has been backfilled with brick rubble, then that may have to be delayed till after demolition of the existing building.

8.6.2 If the Teddington Arms' existing foundations are found to bear onto the sands/gravels of the River Terrace Deposit sequence (below 1.15m in BH1), then the ground alongside the foundations should be left in place until each underpinning base is excavated, because, when excavating in sands and gravels it can be essential to maintain the beneficial surcharge which the ground alongside the existing footings provides. (Ie: it would not be appropriate for a trench to be dug down to foundation level alongside the whole section of the party wall to be underpinned in advance of excavating the underpinning bases, as is common practice on sites where the foundations bear onto cohesive soils).

8.6.3 Some ground movement is inevitable when basements are constructed. When underpinning methods are used the magnitude of the movements in the ground being supported by the new basement walls is dependent primarily on:

- the geology,
- the adequacy of temporary support to both the underpinning excavations and the partially complete underpins prior to installation of full permanent support;
- the quality of workmanship when constructing the permanent structure.

A high quality of workmanship and use of best practice methods of temporary support are therefore crucial to the satisfactory control of ground movements alongside basement excavations (see 8.6.5 & 8.6.6 below). Any structural defects in the Teddington Arms' party wall which have weakened its structural integrity should be fully repaired in accordance with recommendations from the appointed structural engineer before any underpinning is carried out. The tie bar end plates on the adjacent flank wall of No.2 Cedar Road (see Photo 4 in Appendix A) indicate past movement of that wall, so that wall should also be checked for any evidence of continuing movement, and repaired if necessary.

8.6.4 Under UK standard practice, the contractor is responsible for designing and implementing the temporary works, so it is considered essential that the contractor employed for these works should have completed similar schemes successfully. For

this reason, careful pre-selection of the contractors who will be invited to tender for these works is recommended. Full details of the temporary works should be provided in the contractor's method statements.

8.6.5 In accordance with normal health and safety good practice, the requirements for temporary support of any excavation must be assessed by a competent person at the start of every shift and at each significant change in the geometry of the excavations as the work progresses.

8.6.6 The minimum temporary support requirements recommended for the proposed underpins and RC retaining walls at No.42, subject to inspection and review as described in 8.6.5 above, are:

- Full face support must be installed as the excavations progress for all excavations in Made Ground and the River Terrace Deposits.
- Temporary support must also be installed to support all the new underpins and RC retaining wall panels and must be maintained until the full permanent support has been completed, including allowing time for the concrete to gain adequate strength.

All temporary support should use high stiffness systems installed in a timely manner in accordance with best practice in order to minimise the ground movements. Full details of the temporary works should be provided in the contractor's method statements.

8.6.7 The construction sequence will be covered in the structural engineer's Construction Method Statement.

<u>Design Considerations – Retaining Walls:</u>

8.6.8 Design of the basement retaining walls must include all normal design scenarios (sliding, over-turning and bearing failure) and must take into consideration:

- Earth pressures from the surrounding ground (see 8.6.9 below);
- Dead and live loads from the superstructure, including loads on the party wall from the Teddington Arms;
- Loads from any adjacent walls (Teddington Arms and No.2 Cedar Road) which are within the potential zone of influence of active pressures acting on the basement;
- Loads from vehicles on the public footways and the driveway to the rear of the site, and normal surcharge allowances elsewhere;
- Swelling displacements/pressures from the underlying London Clay;
- Groundwater pressures from an appropriate depth of groundwater above basement formation level, subject to review based on the findings from the recommended further monitoring (see 8.3.12, 8.3.13).
- Precautions to protect the concrete from sulphate attack. Use of sulphate-resisting cement would be recommended as a minimum precaution against such attack.

8.6.9 The following geotechnical parameters should be used when calculating earth pressures:

Made Ground:	Unit weight, γ_b:	18.0 kN/m^3
(clays, as worst case)	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	25°
Sandy CLAYS in River Terrace Deposits:		
	Unit weight, γ_b:	18.0 kN/m^3
	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	26°
River Terrace Deposits:	Unit weight, γ_b:	21.0 kN/m^3
(dense sandy gravels)	Effective cohesion, c':	0 kPa
	Angle of internal friction, φ':	36°

These parameters should be used in conjunction with appropriate partial factors dependent upon the design method selected.

8.6.10 Normal good practice in foundation construction requires progressive stepping up between foundations of different depths beneath a single structure. Inclusion in the scheme of transitional underpins/footings is therefore recommended in the following locations:

1. beneath the party wall on both sides of the section to be underpinned, subject to agreement under the Party Wall Act processes;
2. beneath all load-bearing walls of the proposed building which adjoin the basement.

Bearing Capacity:

8.6.11 The dense gravels will provide a good founding stratum for the basement, with bearing capacity in the sandy GRAVELS restricted primarily in relation to allowable settlement. However, the SPT tests indicated a weaker layer in the London Clay at 5.00-5.45m where N = 10 which indicates a much lower undrained shear strength (in the order of 45kPa) than the visual description of the strata as 'stiff to very stiff' (100-150+kPa) would suggest. For an underpin base founded directly onto this layer the allowable bearing capacity could be as low as 87kPa depending on the geometry of the retaining wall's footing (and down to 78kPa for a square pad footing).

8.6.12 The top of this weaker layer, at the position of BH1, could be between 0.8m and 1.5m below the proposed founding level (the uncertainty arises from the gap between the SPT tests at 4.0m and 5.0m). Using the worst-case assumption that the weaker conditions apply from the top of the 'unweathered' London Clay at 4.40m bgl, so 0.8m below the currently proposed founding level, the spread of load through the gravels and weathered London Clay would increase the allowable bearing pressure to **130kPa**.

8.6.13 For the current basement geometry, as shown on Chandler Browne Drg No.01-A-1001-P12, most of the perimeter walls of the proposed building will not be aligned with the basement. Shallow foundations would be acceptable for these walls/columns, subject to the requirements for transition stepping (see 8.6.10 above) and precautions in relation to the Sycamore pavement tree, as given below. Any such shallow footings should be taken through the near-surface clays and all Made Ground associated with the current/previous developments, and founded at a minimum of 0.15m below the top of the gravels (1.30m bgl/6.92m AOD at BH1's location). Allowable bearing pressures at 1.30m bgl for footings up to 2.0m wide would be in excess of 300kPa. However, in order to minimise differential settlements between the basement and the remainder of the building and between the new building and the Teddington Arms, it is recommended that bearing pressures do no exceed **150kPa**.

Trees:

8.6.14 The canopy of the Sycamore pavement tree close to the site's Cedar Road frontage appeared to overlap the site slightly. An arboricultural impact analysis and a draft arboricultural method statement have already been prepared for this tree by Raphael Skerratt; the recommendations given in those reports should be followed. Additionally, the recommendation given in the current edition of NHBC Standards Chapter 4.2 should be followed for any shallow footings which are founded within the zone of influence of this tree, including heave protection on the inside face of foundations where they pass through clays.

8.6.15 The ground floor slabs in the parts of the building not underlain by the basement should be suspended.

8.7 PDISP Heave/Settlement Assessment

Basement Geometry and Stresses:

8.7.1 Analyses of the vertical ground movements (heave or settlement) have been undertaken using PDISP software in order to assess the potential magnitudes of movements which may result from the changes in vertical stresses caused by excavation of the basement. These preliminary analyses have simplified the stress regime.

8.7.2 Figure G1 in Appendix G illustrates the layout of the PDISP zones superimposed on the proposed basement layout using an extract from Drg No. 01-A-1001 by Chandler Browne Architects. These PDISP zones were used to model the underpins, the transition underpins beneath the adjoining Teddington Arms and the basement slab, based on information received from Green Structural Engineering (GSE). The load takedown data for the proposed building have also been provided by GSE, these were received in an email dated 17th October 2018 and have been summarised in Table 4 below.

8.7.3 The overall dimensions of the proposed basement, to the outside of the perimeter walls, are approximately 7.35m wide by 17.50m long, with an additional 3.63m wide by 3.71m long section extending to the party wall with the Teddington Arms. The proposed basement levels and depths of excavation are given in Section 3. For these analyses the founding level for the underpins and retaining walls was taken as **4.69m AOD** and the basement slab level was taken as **4.79m AOD** based on a 300mm thick slab as given on GSE's drawings (Basement GA and Section Sheet 1, Drg No's GA/01 & S/01). These founding levels would give gross reductions of vertical stress (unloading) which range from 69.4kPa to 71.3kPa.

Table 4: Summary of loads provided by GSE

Wall	PDISP Zones affected	Dead Load (kN/m)	Live Load (kN/m)
Party Wall (Teddington Arms)	21	85.3	3.5
Party Wall (No.42)	4 & 11-16	79.0	17.5
Non-Party Wall	1-3 & 5-8	110.25	26.25

8.7.4 Table 5 presents the net bearing pressures for the five main stages of the stress changes which will result from excavation and construction of the basement (see 8.7.8 below for details of those stages). Zones 1 to 8 represent the perimeter retaining walls and underpins, using the load takedown provided by GSE, with Zones 9 and 10 representing the basement slab. Zones 11 to 16 (coloured red) have been used to model the transition underpins, with their widths increased to 0.75m to allow for underpinning the double wall thickness including the (assumed) corbels. Zone 21 modelled the mass concrete underpinning of the Teddington Arms' flank wall adjacent

to the proposed basement; no increased width could be justified, owing to the de-coupling by the double layer of plastic between these underpins and the proposed basement retaining wall. As a result, the bearing pressure is relatively high, at 196.4kPa and potentially would cause a bearing failure; this will need to be reviewed during detailed design and negotiations for the Party Wall agreement. Zones 17 to 20 allow for the lower ground level outside the existing No.42, the levels of which have been taken from Tower Surveys Ltd's 'Topographical Survey' (Drg No. R-11682-201).

Table 5: Net pressure changes for PDISP Zones

ZONE	Net change in vertical pressure (kPa)			
#	Stage 1	Stage 2	Stage 3	Stage 4 & 5
1	-38.94	-38.94	-38.94	64.96
2	-45.41	-45.41	-45.41	28.38
3	-47.85	-47.85	-47.85	14.56
4	-31.54	-31.54	-31.54	83.93
5	-47.85	-47.85	-47.85	14.56
6	-45.41	-45.41	-45.41	28.38
7	-38.94	-38.94	-38.94	64.96
8	-45.41	-45.41	-45.41	28.38
9	0.00	-69.35	-61.85	-61.85
10	0.00	-69.35	-61.85	-61.85
11	124.52	124.52	124.52	124.52
12	128.00	128.00	128.00	128.00
13	132.02	132.02	132.02	132.02
14	132.02	132.02	132.02	132.02
15	128.00	128.00	128.00	128.00
16	124.58	124.58	124.58	124.58
17	4.18	4.18	4.18	4.18
18	4.18	4.18	4.18	4.18
19	4.18	4.18	4.18	4.18
20	4.18	4.18	4.18	4.18
21	196.38	196.38	196.38	196.38

Ground Conditions:

8.7.5 The ground profile was based on the site-specific ground investigation, as presented in Section 7 and 8.1 above, and the desk study information in Sections 4 to 6.

8.7.6 The short-term and long-term geotechnical properties of the soil strata used for the PDISP analyses are presented in Table 6, based on this investigation and data from other projects.

Table 6: Soil parameters for PDISP analyses

Strata	**Level** (m AOD)	**Undrained Shear Strength,** Cu (kPa)	**Short term, undrained Young's Modulus,** Eu (MPa)	**Long term, drained Young's Modulus,** E' (MPa)
River Terrace Deposits (SANDS & GRAVELS)	8.22 4.12	-	80	80
London Clay	4.12 -10.23	55.0 162.63	27.5 81.31	16.5 48.79

Where:

For SANDS and/or GRAVELS:

Eu = E' = 2 * N

N = Conservative average of SPT values between 1.00-3.00m (GGC BH1)

For London Clay:

Undrained Shear Strength, Cu at top of stratum is based on the SPT profile

Cu profile taken as Cu = 55 + 7.5z

where z = depth below the top of the stratum.

Undrained Young's Modulus, Eu = 500 * Cu

Drained Young's Modulus, E' = 0.6 * Eu

PDISP Analyses:

8.7.8 Three dimensional analyses of vertical ground movements in response to construction of the proposed basement have been undertaken using PDISP software and the basement geometry, loads/stresses and ground conditions outlined above. PDISP analyses have been carried out as follows:

- Stage 1: Excavation and construction of underpins and transition pins – Short-term (undrained) condition.
- Stage 2: Bulk excavation of central area to basement formation level – Short-term (undrained) condition.
- Stage 3: Construction of the basement slab – Short-term (undrained) condition.
- Stage 4: Construction of No.42's new superstructure – Short-term (undrained) condition.
- Stage 5: As Stage 4, except - Long-term (drained) condition.

8.7.9 The results of the analyses for Stages 1-5 are presented as contour plots on the appended Figures G2 to G6 respectively (see Appendix G).

Heave/Settlement Assessment:

8.7.10 Construction of the underpins and excavation of the basement will cause immediate elastic heave/settlements in response to the stress changes, followed by long-term plastic swelling/consolidation as the underlying clays take up groundwater and/or consolidation occurs. The rate of plastic swelling/consolidation will be determined by the availability of water and the permeability of the soils concerned; the low permeability of the London Clay typically results in these adjustments taking many decades to reach full equilibrium. The basement slab will need to be designed so as to enable it to accommodate the swelling displacements/pressures developed underneath it.

Table 7: Summary of predicted displacements

Location within Basement	Stage 1 (Figure G2)	Stage 2 (Figure G3)	Stage 3 (Figure G4)	Stage 4 (Figure G5)	Stage 5 (Figure G6)
Front (north) & rear (south) walls	1-3mm Heave	2-7mm Heave	2-7mm Heave	0.5-4mm Settlement	1 - 6mm Settlement
Flank (eastern) wall	1-3mm Heave	2-8mm Heave	2-7.5mm Heave	3.5mm Settlement – 2.5mm Heave	6mm Settlement – 4mm Heave
Flank (western) wall	1-3mm Heave	2-8.5mm Heave	2-8mm Heave	3.5mm Settlement – 3.5mm Heave	6mm Settlement – 6mm Heave
Linking passage to party wall	3mm Settlement - 3mm Heave	2mm Settlement - 7mm Heave	2mm Settlement – 6.5mm Heave	1 - 8.5mm Settlement	13mm Settlement – 1mm Heave
No.40 Party Wall	3-4mm Settlement	2-3mm Settlement	2-4mm Settlement	5-8.5mm Settlement	8-13mm Settlement
Central basement slab	2-3mm Heave (No slab present)	6.5-9.5mm Heave (No slab present)	5.5-9mm Heave	2mm Settlement – 6.5mm Heave	3mm Settlement – 9mm Heave
Transition Underpins (at 6.80m AOD)	1-3.5mm Settlement	0.5-3mm Settlement	0.5-3mm Settlement	2 – 6.5mm Settlement	3-10mm Settlement

8.7.11 The ranges of predicted short-term and long-term movements for each of the main parts of the proposed basement are presented in Table 7 above. During Stages 1-3, when the works will be entirely below ground, these analyses predicted up to 8mm of heave beneath the perimeter walls to the main part of the basement, and up to 4mm of settlement beneath the party wall with No.40 (the Teddington Arms), with the linking passageway acting as a transition between heave and settlement. In the central area of the basement up to 9.5mm of heave was predicted prior to casting the central basement slab. Construction of the building's superstructure (Stage 4) will cause a reversal of most of the heave, with total and differential settlements of up to 9mm, and only the central slab and parts of the adjoining retaining wall bases to the flank walls remaining in heave (up to 6.5mm) at the end of construction.

8.7.12 In the long-term, there will be up to 6mm of settlement beneath the perimeter walls to the main part of the basement, which is predicted to increase to 13mm of settlement beneath the party wall with No.40. The linking passageway acting will continue to act as a transition between these two areas, while heave of up to 9mm was predicted beneath the basement slab.

8.7.13 The range of displacements quoted in Table 7 cover approximately the full range of predicted deflections, however the stiffness of the underpin bases is likely to reduce the range of displacements actually experienced.

8.7.14 The maximum short-term elastic heave would have occurred before the central basement slab is cast, though, as the superstructure will be built after the slab has been cast, post-construction incremental displacements in the order of 10mm were predicted beneath the central slab, subject to the specific construction sequence adopted. All predicted displacements are approximate.

8.8 Damage Category Assessment:

8.8.1 When underpinning it is inevitable that the ground will be un-supported or only partially supported for a short period during the excavation of each pin, even when support is installed sequentially as the excavation progresses. This means that the behaviour of the ground will depend on the quality of the workmanship and suitability of the methods used, so rigorous calculations of predicted ground movements are not practical. However, provided that the temporary support follows best practice as outlined in Section 8.6 above, then extensive past experience has shown that the bulk movements of the ground alongside a single-storey basement (typical depth 3.5m) should not exceed 5mm horizontally.

8.8.2 In order to relate these typical ground movements to possible damage which adjoining properties might suffer, it is necessary to consider the strains and angular distortion (as a deflection ratio) which they might generate using the method proposed by Burland (2001, in CIRIA Special Publication 200, which developed earlier work by himself and others).

8.8.3 There are no plans available on the London Borough of Richmond's planning website for the adjoining Teddington Arms (No.40 High Street). During the site inspection it was reported by the owner that the pub had a cellar but that it was located to the rear of the property, not adjacent to the party wall with No.42. Assumed foundation depths have been used for No.40 broadly as shown on GSE's Section R2. The potentially critical locations will be determined by the displacements predicted by the PDISP analyses and the geometries of the adjoining building. For these damage category assessments we are interested in the ground movements at the foundation level of the neighbouring buildings, whereas the empirical data for ground movements alongside excavations presented in CIRIA Report C760 (Gaba et al, 2017) concerns movements at ground surface. [C760 presents data for embedded retaining walls of much greater depth than required here but, as no equivalent data exist for underpins, this data is the best available though must be interpreted very cautiously].

8.8.4 The worst case scenario as predicted by the PDISP analyses will occur along the No.42/40 party wall, where the narrow section of basement connects to the party wall, as the PDISP analyses predicted the maximum settlements in that area. There are no internal transverse walls in the main part of The Teddington Arms which adjoin the party wall with No.42 (at ground floor level) and the proposed transition pins will not reach the front or rear walls of the Teddington Arms. Thus the worst case scenario for damage category to the adjoining Teddington Arms will be the party wall to the rear of the section to be underpinned, because it is a longer length of wall and the rear extension is only a single-storey structure, so the length to height ratio is less favourable (see L/H calculation in 8.8.6 below). The nearest part of No.2 Cedar Road to the rear of the site will be approximately 9.7m from the basement, so will be at a much lower risk of damage than the adjoining Teddington Arms; no further consideration of the Cedar Road houses is therefore warranted.

8.8.5 A single damage category assessment has been undertaken for the along the section of the party wall with No.40 as identified above, which considered:

- ground movements arising from the vertical stress changes, as assessed by the PDISP analyses (see Section 10.5), including an allowance for the stiffness of the foundations; and
- ground movements alongside the proposed underpins caused by relaxation of the ground in response to the excavations, without any allowance for the beneficial presence of the transition underpins.

Ground movements associated with the construction of retaining walls in sand and gravel soils have been shown to extend to a distance up to 2 times the depth of the excavation.

<u>Flank Wall of No.40 (Teddington Arms):</u>

8.8.6 The relevant geometries, based on information in Section 3 and from the structural sections provided by GSE, are summarised below:

Depth of excavation alongside flank wall = 3.13m (from base of footing, 0.62m below existing ground floor level of 8.44m AOD based on GSE's Section R2).
Zone of influence (horizontal displ't) **=** 3.13 x 4 = **12.52**
Width (L) = 3.13 x 2 = **6.26m**
Depth of foundations to rear wall = approx. 0.4m below external ground level, at 8.2m AOD)
Height (H) = 3.75 (single storey rear flank wall) + 0.4 = **4.15m**
Hence L/H = **1.51**

8.8.7 The anticipated (theoretical) horizontal displacement of 5mm (see 8.8.1) can be halved to account for the beneficial presence of the corner of the basement, thus the strain beneath No.40 would be in the order of ε_h = 1.997 x 10^{-4} (0.020%).

8.8.8 The maximum settlement predicted by the PDISP analysis beneath the flank wall of No.40 was 12mm in Stage 5. This must be combined with the settlement caused by relaxation of the ground alongside the basement in response to excavation of the underpins, which can be estimated using the settlement profile for the worst case (low stiffness) scenario presented in Figure 6.15 of CIRIA Report C760. The settlement profiles are then summed to find the maximum deflection, Δ. Figure 9 presents these settlement profiles for the flank wall of No.40. The maximum Δ = 3.18mm, which represents a deflection ratio, Δ/L = 5.079 x 10^{-4} (0.051%).

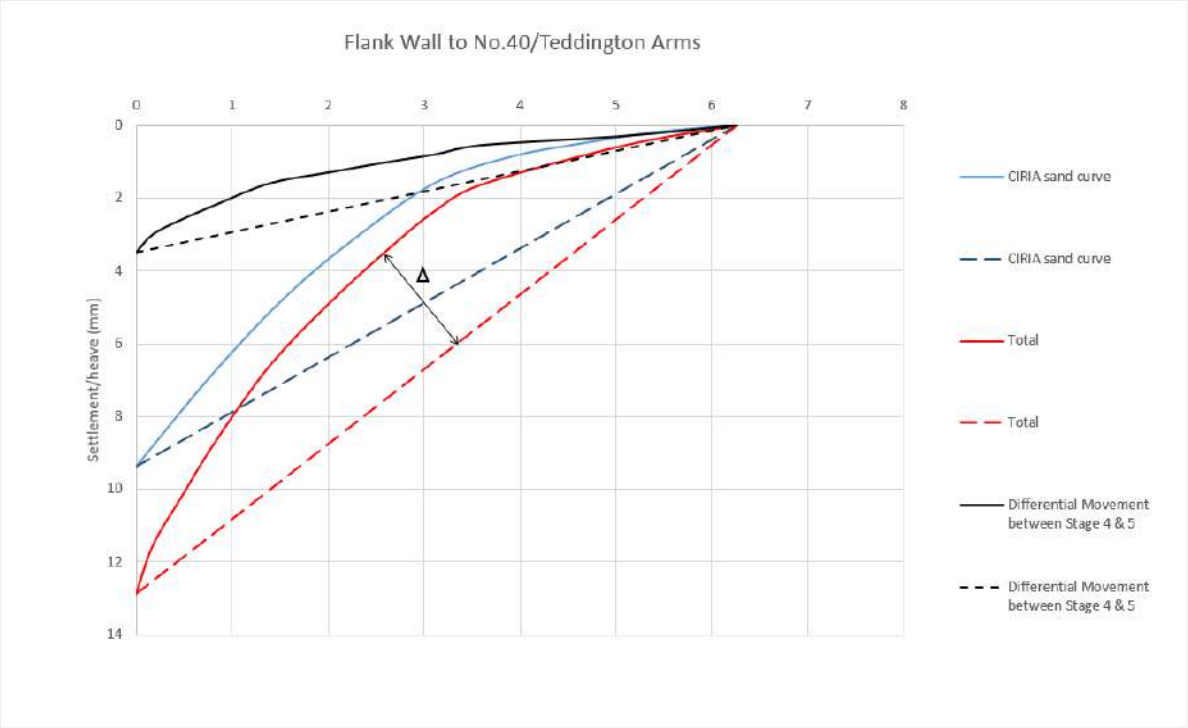


Figure 9: Displacement profile for flank wall of No.40 (Teddington Arms).

8.8.9 Using the graphs for L/H = 1.5, these deformations represent a damage category of 'very slight' (Burland Category 1, ε_{lim} = 0.05-0.075%), as given in CIRIA SP200, Table 3.1, and illustrated in Figure 10 below. As the movement will be of a sagging nature, which masonry walls are more resistant to than hogging deformations, there are no window or door openings in the party wall and the beneficial presence of the transition underpins has not been allowed for, this wall is likely to perform better than the theory would suggest.

8.8.10 Use of best practice construction methods, as outlined in Section 8.6, will be essential in order to ensure that the ground movements are kept in line with the these predictions.

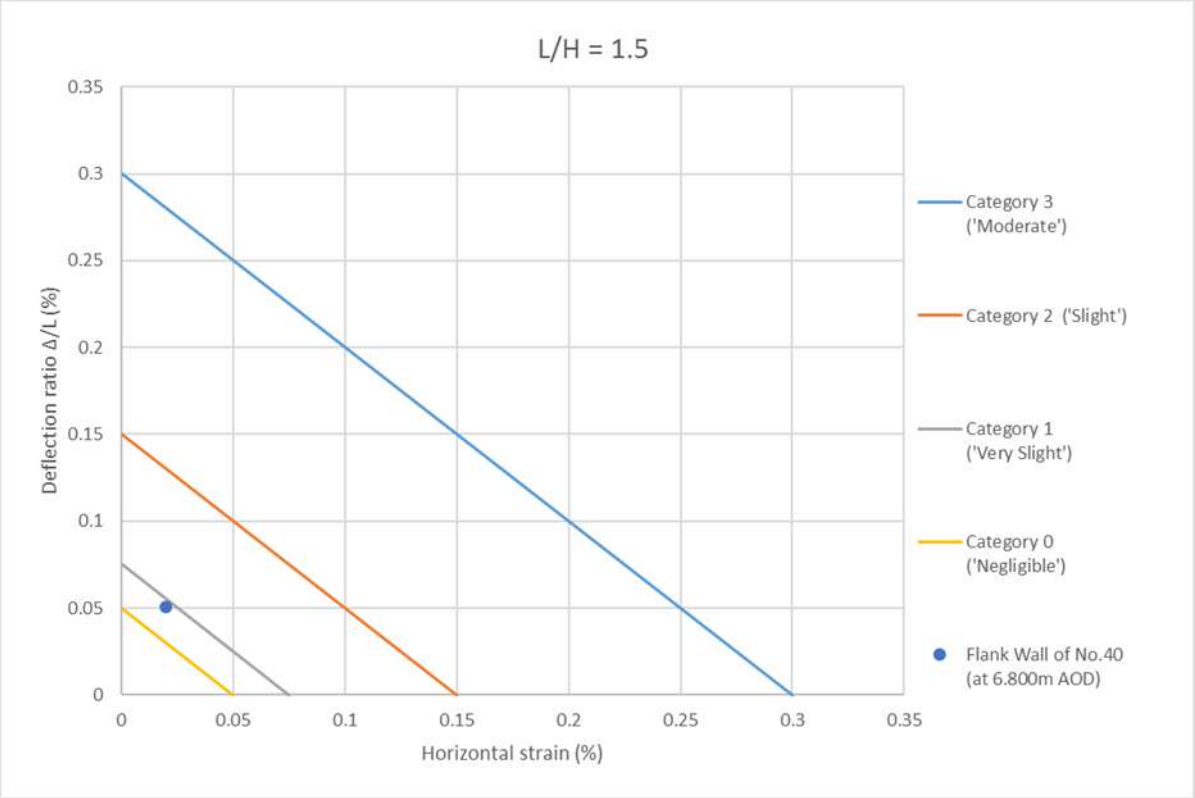


Figure 10: Damage category assessment for flank wall of No.40 (Teddington Arms).

8.9 Monitoring

8.9.1 Condition surveys should be undertaken of the neighbouring properties before the works commence in order to provide a factual record of any pre-existing damage. Such surveys are usually carried out while negotiating a Party Wall Agreement and are beneficial to all parties concerned.

8.9.2 Precise movement monitoring should be undertaken weekly throughout the period during which the basement walls and slab are constructed with initial readings taken before excavation of the basement starts. Ideally, three sets of initial readings should be taken in order to assess the extent of 'normal' movements within these buildings. Readings may revert to monthly for the remainder of the build duration once all the perimeter walls, the basement slab and the RC ground floor slab have been completed. This monitoring should be undertaken with a total station instrument and targets attached at two or more levels at each of the following locations:

- Internally/externally on the party wall with the Teddington Arms – three locations on the three-storey part of the building and one further set on the pub's single-storey rear extension;
- externally on the front and rear walls of the Teddington Arms, on the line of the party wall with the site and the party wall with No.38;
- externally, at the front, middle and rear of the 2-storey gable wall to No.2 Cedar Road.

8.9.3 The accuracy of this system of monitoring is usually quoted as +/- 2mm. Thus, if recorded movements in either direction reach 5mm, then the frequency of readings should be increased as appropriate to the severity of the movement, and consideration should be given to installing additional targets. If the recorded movements in either direction reach 8mm, then work should stop until new method statements have been prepared and approved by the appointed structural engineer. It may also be necessary to backfill temporarily affected parts of the excavations in order to arrest any such excessive movements.

8.9.4 If any structural cracks appear in the main loadbearing walls then those cracks should be monitored using the Demec system (or similar) on the same frequency as the target monitoring.

9. CONCLUSIONS

9.1 These conclusions consider only the primary findings of this assessment; the whole report should be read to obtain a full understanding of the matters considered.

9.2 The site lies in flood risk Zone 1, and has a Very Low risk of flooding from rivers or the sea (5.2, 5.3 and 8.2.1).

9.3 No.42 is not at risk of reservoir flooding (5.3 and 8.2.2).

9.4 In 2007, surface water flooding occurred at the low points of the High Street and Broad Street. As a result, Teddington High Street is in Critical Drainage Area Group8_006 (5.7, 5.8, 8.2.3 & 8.2.4).

9.5 None of the recorded groundwater flooding incidents in London Borough of Richmond upon Thames (LBRuT) were close to Teddington High Street (6.5).

9.6 The flood model presented in the SWMP lacks detail so is of little use. The Environment Agency's more detailed model predicted only a Very Low risk of surface water flooding within the existing bank building, but a Low risk of flooding with the flood depth into the 300-900mm depth range in the external parts of No.42's plot. The modelled risk of surface water flooding increased to Low to Medium on the adjacent part of Cedar Road and Low to High on the High Street. The appropriate scope of flood resistance measures to protect the ground floor and basement should be considered (5.8 to 5.10, 8.2.5 to 8.2.8).

9.7 The proposed basement will not create any increase in paved area, though might result in a very slight reduction of infiltration. Recommendations are given to mitigate the potential tiny increase in the volume of surface water entering the public sewer system (8.2.9 and 8.2.10).

9.8 Thames Water have no records of sewer flooding affecting No.42, though there is anecdotal evidence that sewer flooding did contribute to the surface water flooding in Teddington in 2007. The risk of future sewer flooding affecting No.42 is considered to be low provided that the sewer system is well maintained and that appropriate flood resistance measures are implemented (8.2.11).

9.9 Non-return valves, preferably with pumped above-ground loop systems, should be fitted to the drains serving the basement, and temporary interception storage may need to be provided (8.2.12 to 8.2.15).

9.10 The ground investigation and limited monitoring recorded groundwater (of the Upper Aquifer) at 3.23m bgl/4.99m AOD in the Kempton Park Gravel Formation. The nearby BGS borehole recorded groundwater at 2.97m bgl/5.56m AOD. Groundwater levels in the Upper Aquifer are known to fluctuate so higher groundwater levels must be expected. At least one further monitoring reading should be taken this winter, and the standpipe should be maintained to enable the contractor to take additional readings prior to the start of the construction works (8.3.1 and 8.3.6).

9.11 No other modern basements, existing or proposed, have been identified in the vicinity of No.42, though at least one of the adjoining terraced houses to the west (No.36) does have a basement and it is possible that the terraced house on this site before the bank was built had a cellar. The existing basement and cellars (if any) are likely to be above the groundwater levels recorded by the ground investigation, so have no influence on groundwater under current conditions. The proposed basement will extend below the groundwater level in the Upper Aquifer, but should have no adverse impact on groundwater levels or flows (8.3.2 to 8.3.9).

9.12 The site's 'Potential at surface' BGS classification for susceptibility to groundwater flooding is secondary to site-specific groundwater data, so can be set aside when determining a design groundwater level (8.3.10, 8.3.11).

9.13 A conservative provisional design groundwater level at 7.3m AOD, approximately 1.0m below ground level, is proposed subject to (upwards-only) review following further groundwater monitoring (8.3.12). The basement should be designed to resist a provisional buoyant uplift pressure (un-factored) of up to 26kPa (8.3.13).

9.14 Local inflows of water (if any) from the Made Ground and the upper part of the River Terrace Deposits may drain away naturally; if ponding does occur then sump pumping should be adequate for dealing with such entries (8.4.1). The lower part of the excavations for the basement will be below the main groundwater table in the Upper Aquifer. The gravels contained minimal fines, so dewatering could require removal of significant quantities of water; options for alternative groundwater control methods are given (8.4.2 and 8.4.3).

9.15 The basement will need to be fully waterproofed (Section 8.5).

9.16 The required depths of excavation for the underpins and RC retaining walls will vary from 3.28m to nearly 3.78m. The ground alongside the foundations which bear onto granular soils should be left in place until each underpinning base is excavated (8.6.1, 8.6.2). Provided best working practices are followed when constructing the underpins, especially in relation to use of high-stiffness temporary support systems, then ground movements and the resultant structural distortions can be kept within acceptable limits (8.6.3 to 8.6.6).

9.17 Various other guidance is provided in relation to the geotechnical design and construction of the basement's perimeter walls, including the use of transition underpins beneath the Teddington Arms party wall, to both front and rear of the basement, and beneath load-bearing walls of the proposed building which will adjoin the basement (8.6.8 to 8.6.10).

9.18 The available bearing capacity for the basement's retaining walls will be limited by a relatively weak layer near the top of the London Clay. Thus, for the basement founded at the level currently proposed the allowable bearing pressure would be 130kPa (8.6.12).

9.19 The allowable bearing pressure for shallow footings founded in the top of the River Terrace Gravels should be limited to 150kPa in order to minimise differential settlements (8.6.13).

9.20 Guidance provided in the arboricultural reports should be followed in relation to the adjacent Sycamore pavement tree, together with NHBC guidance in relation to heave protection measures (8.6.14).

9.21 The basement slab must be designed to accommodate swelling displacements/ pressures generated by heave of the underlying clays. A preliminary heave/settlement assessment has been undertaken (using PDISP software) which predicted between 4mm of settlement and 8mm of heave initially beneath the basement's underpins and RC retaining walls, while the works are entirely below ground and up to 9.5mm of heave below the central basement slab. Construction of the building's superstructure will cause a reversal of most of the heave, with total and differential settlements of up to 9mm, and only the central slab and parts of the adjoining retaining wall bases to the flank walls remaining in heave (up to 6.5mm) at the end of construction. In the long-term, there will be up to 6-13mm of settlement beneath the perimeter walls of the basement, including the party wall with No.40, and heave movements of up to 9mm are predicted beneath the basement slabs. For design of the RC basement slab, post-construction incremental total/differential displacement were predicted to be up to approximately 10mm, subject to the specific construction sequence adopted. All predicted displacements are approximate (Section 8.7).

9.22 The flank wall of the Teddington Arms, to the rear of the section to be underpinned was assessed to be critical for displacements because the rear extension is only single storey (so height to length ratio is unfavourable). A damage category assessment indicated that, provided best practice construction methods are employed, the worst case predicted deformation is likely to fall within Burland Category 1, termed 'very slight', provided that best practice methods of temporary support are implemented (Section 8.8).

9.23 Condition surveys of the neighbouring properties should be commissioned and a system of monitoring the adjoining and adjacent structures should be established before the works start (Section 8.9).

References

Barton N (1992) The Lost Rivers of London. Historical Publications Ltd, London.

BS 8102 (2009) Code of practice for protection of below ground structures against water from the ground. British Standards Institution, London.

Ellison RA et al (2004) Geology of London. Special Memoir for 1:50,000 Geological sheets 256 (North London), 257 (Romford), 270 (South London) and 271 (Dartford) (England and Wales). British Geological Survey, Keyworth.

Gaba AR et al (2003) Embedded retaining walls – guidance for economic design. CIRIA Report C580.

London Borough of Richmond upon Thames (August 2010) Strategic Flood Risk Assessment (SFRA) Level 1 SFRA Update, Final version.

NHBC (2011) NHBC Standards, Chapter 4.2, Building Near Trees.

NHBC (November 2014) NHBC Standards, Chapter 5.4, Waterproofing of basements and other below ground structures.

URS/Scott Wilson (May 2011) Preliminary Flood Risk Assessment for the London Borough of Richmond upon Thames. Version V05, Final report.

URS/Scott Wilson (September 2011) Surface Water Management Plan for the London Borough of Richmond upon Thames. Version V0pt2.

APPENDIX A

Photographs

Project:

42 High Street, Teddington, TW11 8EW

18675

Photo 1: Front elevation, with Teddington Arms public house on right of photo.

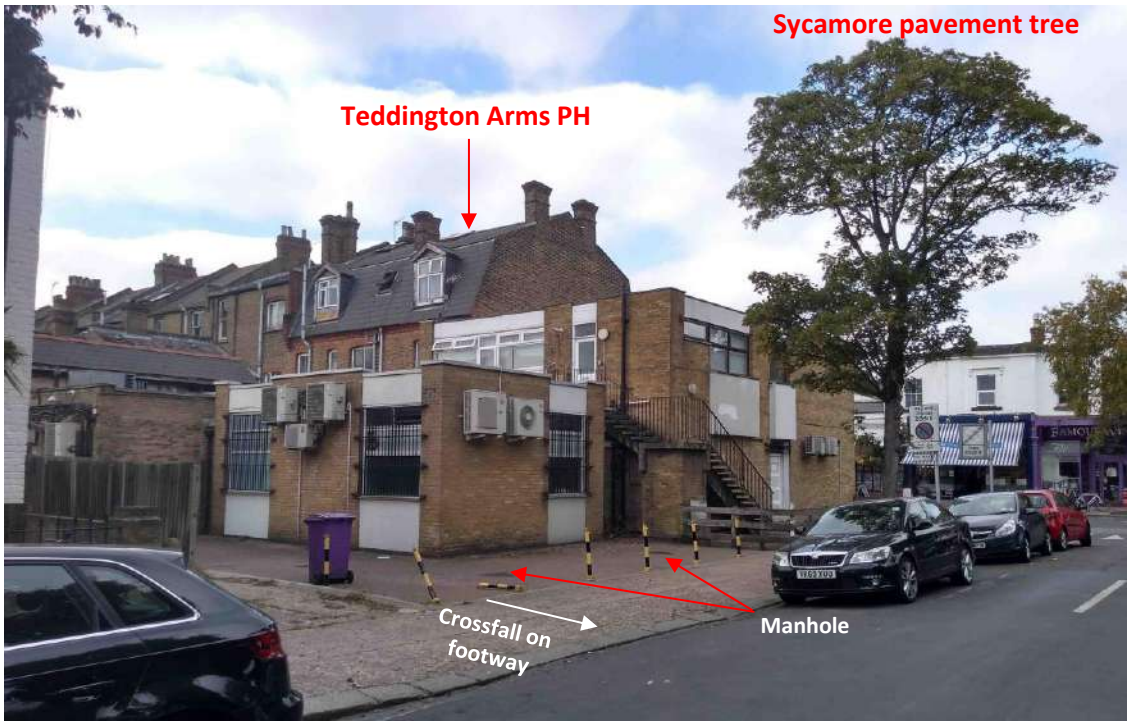


Photo 2: The intersection between St Mark's Crescent and Gloucester Avenue, showing the fall of Gloucester Avenue towards St Mark's Crescent.

Title:	**Photographs - Sheet 1**					Sheet	**A1**
Date:	4 October 2018	Checked:		Approved:	KRG	Scale :	NTS

Project:

42 High Street, Teddington, TW11 8EW

18675

Photo 3: Gentle crossfall on High Street footway to front of No.42.

Photo 4: Terraced housing to rear of site. Tie bars supporting gable wall suggest that there has been past structural damage.

Title:	**Photographs - Sheet 2**					Sheet	**A2**
Date:	4 October 2018	Checked:		Approved:	KRG	Scale :	NTS

APPENDIX B

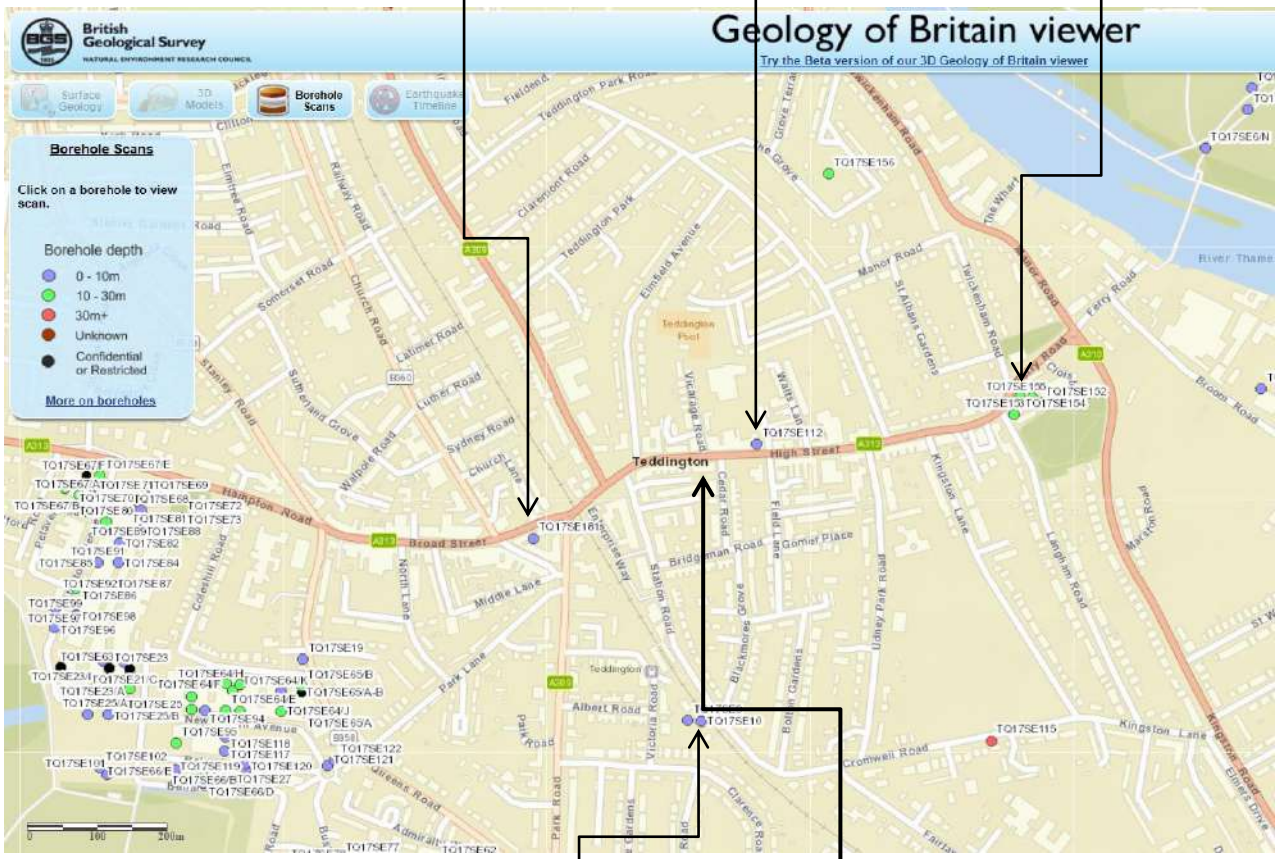
Desk Study Data – Borehole records from other sites

Project:

42 High Street, Teddington, TW11 8EW

18675

BH TQ17SE/181 BH TQ17SE/112 BH TQ17SE/156



BH TQ17SE/9-10 **42 Teddington High Street**

Title:	**Location Plan of BGS Boreholes**					Sheet	**B1**
Date:	April 2018	Checked:	HB	Approved:	KRG	Scale :	NTS

Norwest Holst Soil Engineering Ltd.

Borehole No. **5**

BOREHOLE LOG

Contract No. F7925
Location Ferry Rd. Teddington
Client Copp and Wilson
Method of Boring Percussion
Diameter of Borehole 150mm

TQ17SE 156
16245 71550

Sheet 1 of 2
Chainage
Ground Level ca. 7.2m m.A.O.D.
Date 24/5/88

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
Brown sandy TOPSOIL		0.10					
MADE GROUND: Brown clay with brick fragments		0.30			0.50 (25)		
Medium dense brown clayey medium SAND		2.10			1.50 (45)		
Dense brown SAND and GRAVEL		4.40			2.50	51	
					3.50	58	
Stiff grey fissured silty CLAY					4.50 (40)		
					6.50 (45)		
					8.00 (50)		
					9.50 (50)		

Type of Sample
S.P.T. Undisturbed
C.P.T. Vane
Jar Water
Bulk Piezometer

Remarks (Observations of Ground Water etc.) () U100 blows

Water struck at 3.50m, level rose after 20 mins to 3.20m

Norwest Holst Soil Engineering Ltd.

Borehole No. **5**

BOREHOLE LOG

Contract No. F7925
Location. Ferry Rd, Teddington
Client. Copp and Wilson
Method of Boring. Percussion
Diameter of Borehole. 150mm

TQ17SE 156

Sheet 2 of 2
Chainage.
Ground Level. ca. 3.3 m.A.O.D.
Date. 24/5/88

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
Stiff grey fissured silty CLAY		12.00			11.00 (55)		

Type of Sample

- Is S.P.T. ■ Undisturbed
- Ic. C.P.T. × Vane
- O Jar Δ Water
- ● Bulk ▒ Piezometer

Remarks (Observations of Ground Water etc.)

NGR 1615 7116

TQ17/63

TQ17SE/112

14/1/63

Survey No.

1"N.S. 270.

1" O.S.

RECORD of WELL or BORING

at (Position of boring) 41 High St, (Dairy)

Town, Village, &c. Teddington County Middlesex Six-inch map 25 NE E.

Exact site (unless a tracing from a map is supplied, give distance and direction from parish church, cross-roads, or other object shown on maps). See 6 in. Survey GSE. Popular Edition Sheet of one-inch map. Square

Surface level of ground 28. ft. above Ordnance Datum. Well or Bore commenced at ... ft. below surface level of ground.

Sunk 3½ ft., diameter ... ft. Bored ... ft.; diameter of boring: at top ... in., at bottom ... in.

Details of lining tubes (internal diameters preferred) 6 ft. of 6 in. tubes 15 ft. b/o
9 " " 6 " perf. 7 5 "

Water struck at depths of (feet) –

Rest-level of water below top of well or bore 9'9" ft. Pumping level 13 ft. Time of recovery ... hours.

Suction at ... ft. depth. Yield: (i) on test 720 galls. per hour, (ii) normal ... galls. per ...

Quality (attach copy of analysis if available)

Made by LE GRAND, SUTCLIFF & GELL, LD. for Mr. H.A. Job Ltd. Date of boring March, 1934.

Information from LE GRAND, SUTCLIFF & GELL, LD. Sub 4, p. 175.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA (and any additional remarks)	THICKNESS Feet.	THICKNESS Inches.	DEPTH Feet.	DEPTH Inches.
	Existing pit			3	6
	Concrete & made up ground		6	4	.
Drift	Sandy gravel	2	6	6	6
Drift	Gravel	10	.	16	6
London Clay	Blue clay	.	9	17	3

+3.50

5.25m

SCH. 9.8.40.

Information from the dairy, 6.5.40:
Well in use, except for period at the present when suction of pump is being replaced.
Only ran dry once during last 8 years.
Supply for cooling and washing.

S.C.A.H.

For Survey use only.

Date received.	G.S.M.	M. of H. notified.	Site marked on 1" map.
Feb/1935			

Geological Survey and Museum, South Kensington, London, S.W.7.

(E9465) Wt 81290/1175 2,500 9/32 H. J. R & L, Ltd Gp 616

RECORD of WELL or BORING

TQ 17/63 270 208

Survey No. 270

O.S. 6"

1/2500

Sheet on map 25 NE

Popular Edition Sheet

one-inch map

Scale

at (house or farm) High St. (Dairy)

Town, Village, &c. Sedlescombe County Middlesex

Exact site (unless a tracing from a map is supplied, give distance and direction from parish church, cross-roads, or other object shown on maps). Sec 6 cm. Surrey GSE. TQ 1604 7114

Surface level of ground 28 ft. above Ordnance Datum. Well or Bore commenced at ft. below surface level of ground.

Sunk 3½ ft., diameter ft. Bored ft.; diameter of boring: at top in., at bottom in.

Details of lining tubes (internal diameters preferred) 6 ft. of 6 in. tubes 15 lbs. l/o
9 " " 6 " perf. 75 " "

Water struck at depths of (feet)

Rest-level of water below above top of well or bore 9'9" ft. Pumping level 13 ft. Time of recovery hours.

Suction at ft. depth. Yield: (i) on test 720 galls. per hour (ii) normal galls. per

Quality (attach copy of analysis if available)

Made by LE GRAND, SUTCLIFF & GELL, LD. for Mr. H.Q. Gobbett Esq. Date of boring March, 1924.

Information from LE GRAND, SUTCLIFF & GELL, LD. Lib. 4, p. 175.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches.
	Existing pit			3	6
	Concrete & made up ground		6	4	.
Drift	Sandy gravel	2	6	6	6
	Gravel	10	.	16	6
London Clay	Blue clay	.	9	17	3
T.Q.H. 9.8.40.					

Information from the diary, 6.5.40:
Well in use except for period at the present when suction pump is being replaced.
Only run dry once during last 8 years.
Supply for cooling and washing.
S.C.H.

GEOLOGICAL SURVEY AND MUSEUM, SOUTH KENSINGTON, LONDON, S.W.7.

For Survey use only.

Date received.	G.S.M.	M. of H. notified.	Site marked on 1" map.
Feb/1935			

(11960B) Wt 60576/6575 2,500 9/31 H, J, R & L, Ld Gp 616

270/208

TQ17/63

Thickness Drift.

ft	ins	
4	0	4
12	6	16½
0	9	17¼

270/208 Made ground
Drift
London Clay

Surrendra 1975

Data Bank

TQ 17/63

§270/205 H. A. Job Ltd., Dairy, High Street, Teddington.

Surface + 28. Shaft 3½; cast bore. lining tubes 15 x bin from 1½ down (perforated 7½ to 16½). R.W.L. + 18½. P.W.L. + 15

Yield 720 g.p.h. (test). Le Grand, Mar. 1924.

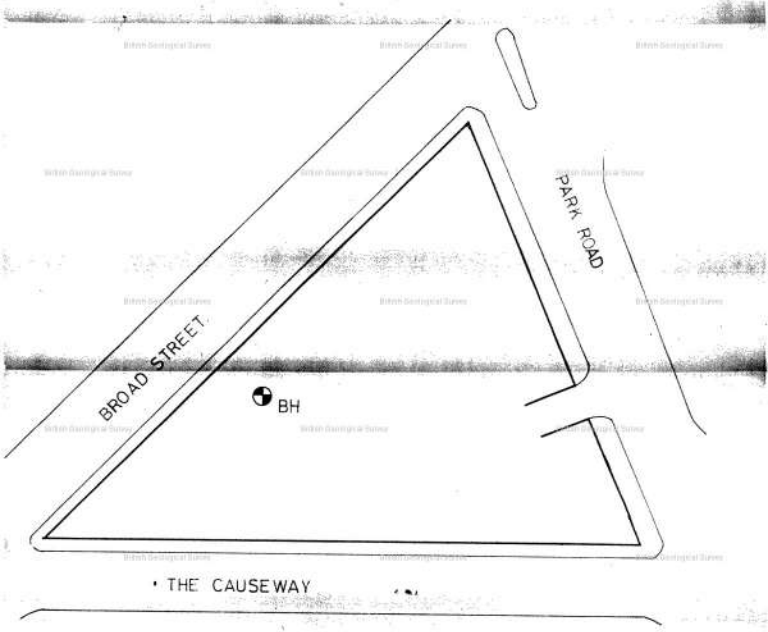
Made	4	4
Dept	12½	16½
LC	3/4	17¼

TQ17SE 181

MAY, GURNEY (TECHNICAL SERVICES) LTD.

Site plan showing borehole position.

scale 1:500 ref: 41413/SP1



TQ 1758 181

MAY GURNEY (TECHNICAL SERVICES) Ltd., NORWICH 1583 7099

LOCATION: The Causeway, Teddington, Middlesex.

JOB No. 41413 BORE HOLE No. 1 Sheet 1

COMMENCED: 16.12.78 COMPLETED: 16.12.78 DIAMETER: 150mm

GROUND WATER struck at.....m. below ground level. Standing at 3.20 m. below ground level

DESCRIPTION	LEGEND	DEPTH METRES	O.D. LEVEL	SAMPLE/ TEST	DEPTH METRES	REMARKS
GROUND LEVEL		0.00		J_1	0.20	
Dark grey-brown, clay, sand, gravel, glass etc - FILL.		0.60		B_1	0.20-0.60	
VERY DENSE, brown, clayey, fine to coarse SAND and GRAVEL.		1.20		J_2	0.70	
				B_2	0.70-1.20	
				SPT	1.00	N=67
				SPT	1.50	65 BLOWS FOR 225mm
DENSE, brown, fine to coarse SAND and fine to coarse GRAVEL.				B_3	1.20-3.00	
				B_4	3.00-4.00	
				SPT	3.00	N=31
FIRM, brown, silty, CLAY		4.00		J_3	4.10	
		4.40		J_4	4.40	
				U_1	4.50	20 BLOWS
FIRM to STIFF, grey-brown, fissured, silty CLAY				J_5	4.95	
				J_6	5.00	
				U_2	6.00	30 BLOWS
100mm layer of clay stone at 5.00M				J_7	6.50	
				B_5	8.00	
CONTINUED		9.00				

WATER ADDED TO ASSIST BORING

KEY: B = Bulk sample; J = Jar sample; U = 100mm undisturbed sample.
W = Water sample; S.P.T. = Standard Penetration Test.
N = Number of blows per 300mm penetration in S.P.T.
H.V. = Hand Vane Test; C = Undrained shear strength.

MAY GURNEY (TECHNICAL SERVICES) Ltd., NORWICH

LOCATION: The Causeway, Teddington, Middlesex.

JOB No. 41413 | BORE HOLE No. 1 | Sheet 2

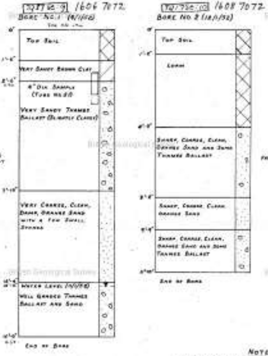
COMMENCED: 16.12.78 COMPLETED: 16.12.78 DIAMETER: 150mm

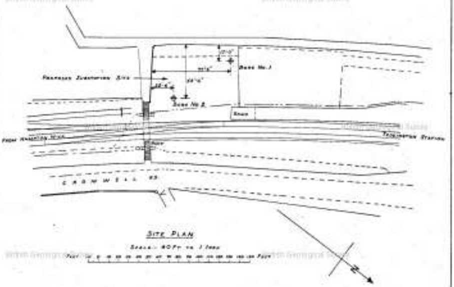
GROUND WATER struck at.....m. below ground level. Standing at 3.20 m. below ground level

DESCRIPTION	LEGEND	DEPTH METRES	O.D. LEVEL	SAMPLE/ TEST	DEPTH METRES	REMARKS
CONTINUED		9.00				
FIRM to STIFF, grey-brown fissured, silty CLAY				U_3	9.50	38 BLOWS
				J_8	10.00	
END OF BOREHOLE		10.00				

WATER ADDED TO ASSIST BORING

KEY: B = Bulk sample; J = Jar sample; U = 100mm undisturbed sample.
W = Water sample; S.P.T. = Standard Penetration Test.
N = Number of blows per 300mm penetration in S.P.T.
H.V. = Hand Vane Test; C = Undrained shear strength.





NOTES

SITE PLAN TAKEN FROM C.E.'s DRAWING No. ...
BORINGS CARRIED OUT BY R.A. ...

THE RAILWAY EXECUTIVE CIVIL ENGINEER'S DEPT.		SOUTHERN REGION RESEARCH SECTION
REVISED	SOIL MECHANICS INVESTIGATION **TEDDINGTON** PROPOSED SITE FOR SUBSTATION	
SECT / COPIES / C.E.	APPROVED JAN. 1952	SCALES:- 2 FT. TO 1 INCH 40 FT. TO 1 INCH
R.C.A.C.		SECT No
SHEET 1 OF 1		C.E.'S No. 10/22620/P18

APPENDIX C

Desk Study Data – Geological Data (Groundsure GeoInsight)

Groundsure
LOCATION INTELLIGENCE

Gabriel GeoConsulting Ltd

Highfield House, Rolvenden Road,
Benenden, TN17 4EH

Groundsure Reference:	HMD-5503218
Your Reference:	GGC18675
Report Date	4 Oct 2018
Report Delivery Method:	Email - pdf

Geo Insight

Address: 42, HIGH STREET, TEDDINGTON, TW11 8EW

Dear Sir/ Madam,

Thank you for placing your order with Groundsure. Please find enclosed the **Groundsure Geo Insight** as requested.

If you need any further assistance, please do not hesitate to contact our helpline on 08444 159000 quoting the above Groundsure reference number.

Yours faithfully,

Managing Director
Groundsure Limited

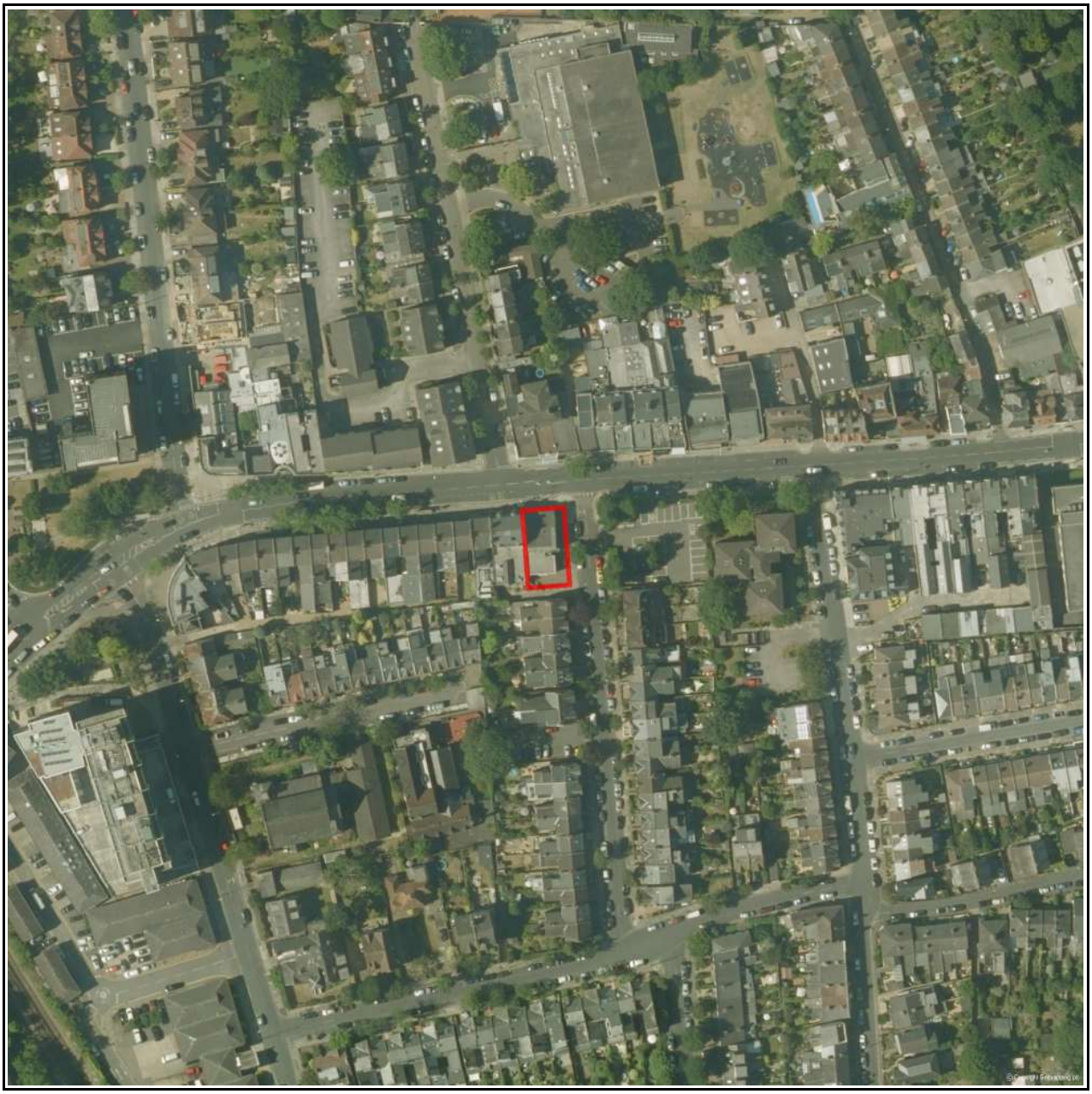
Enc.
Groundsure Geo Insight

Geo Insight

Address:	**42, HIGH STREET, TEDDINGTON, TW11 8EW**
Date:	**4 Oct 2018**
Reference:	**HMD-5503218**
Client:	**Gabriel GeoConsulting Ltd**

NW N NE

W E



SW S SE

Aerial Photograph Capture date:	30-Jun-2015
Grid Reference:	516088,171102
Site Size:	0.03ha

Contents Page

Overview of Findings

The Groundsure Geo Insight provides high quality geo-environmental information that allows geo-environmental professionals and their clients to make informed decisions and be forewarned of potential ground instability problems that may affect the ground investigation, foundation design and possibly remediation options that could lead to possible additional costs.

The report is based on the BGS 1:50,000 and 1:10,000 Digital Geological Map of Great Britain, BGS Geosure data; BRITPITS database; Non-coal mining data and Borehole Records, Coal Authority data including brine extraction areas, PBA non-coal mining and natural cavities database, Johnson Poole and Bloomer mining data and Groundsure's unique database including historical surface ground and underground workings.

For further details on each dataset, please refer to each individual section in the report as listed. Where the database has been searched a numerical result will be recorded. Where the database has not been searched '-' will be recorded.

Section 1: Geology 1:10,000 Scale		
1.1 Artificial Ground	1.1 Is there any Artificial Ground/ Made Ground present beneath the study site at 1:10,000 scale?	No
1.2 Superficial Geology and Landslips	1.2.1 Is there any Superficial Ground/Drift Geology present beneath the study site at 1:10,000 scale?*	Yes
	1.2.2 Are there any records of landslip within 500m of the study site boundary at 1:10,000 scale?	No
1.3 Bedrock, Solid Geology and linear features	1.3.1 For records of Bedrock and Solid Geology beneath the study site* see the detailed findings section.	
	1.3.2 Are there any records of linear features within 500m of the study site boundary at 1:10,000 scale?	No

Section 2: Geology 1:50,000 Scale		
2.1 Artificial Ground	2.1.1 Is there any Artificial Ground/ Made Ground present beneath the study site?	No
	2.1.2 Are there any records relating to permeability of artificial ground within the study site*boundary?	No
2.2 Superficial Geology and Landslips	2.2.1 Is there any Superficial Ground/Drift Geology present beneath the study site?*	Yes
	2.2.2 Are there any records of permeability of superficial ground within 500m of the study site?	Yes
	2.2.3 Are there any records of landslip within 500m of the study site boundary?	No
	2.2.4 Are there any records relating to permeability of landslips within the study site* boundary?	No

Section 2: Geology 1:50,000 Scale

2.3 Bedrock, Solid Geology and linear features	2.3.1 For records of Bedrock and Solid Geology beneath the study site* see the detailed findings section.	
	2.3.2 Are there any records relating to permeability of bedrock ground within the study site boundary?	Yes
	2.3.3 Are there any records of linear features within 500m of the study site boundary?	No

Section 3: Radon

3. Radon	3.1Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level?	The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.
	3.2Radon Protection	No radon protective measures are necessary.

Section 4: Ground Workings	On-site	0-50m	51-250	251-500	501-1000
4.1 Historical Surface Ground Working Features from Small Scale Mapping	0	0	11	Not Searched	Not Searched
4.2 Historical Underground Workings from Small Scale Mapping	0	0	0	0	0
4.3 Current Ground Workings	0	0	0	0	3

Section 5: Mining, Extraction & Natural Cavities	On-site	0-50m	51-250	251-500	501-1000
5.1 Historical Mining	0	0	0	0	0
5.2 Coal Mining	0	0	0	0	0
5.3 Johnson Poole and Bloomer Mining Area	0	0	0	0	0
5.4 Non-Coal Mining*	0	0	0	0	0
5.5 Non–Coal Mining Cavities	0	0	0	0	0
5.5 Natural Cavities	0	0	0	0	0

Section 5: Mining, Extraction & Natural Cavities	On-site	0-50m	51-250	251-500	501-1000
5.6 Brine Extraction	0	0	0	0	0
5.7 Gypsum Extraction	0	0	0	0	0
5.8 Tin Mining	0	0	0	0	0
5.9 Clay Mining	0	0	0	0	0

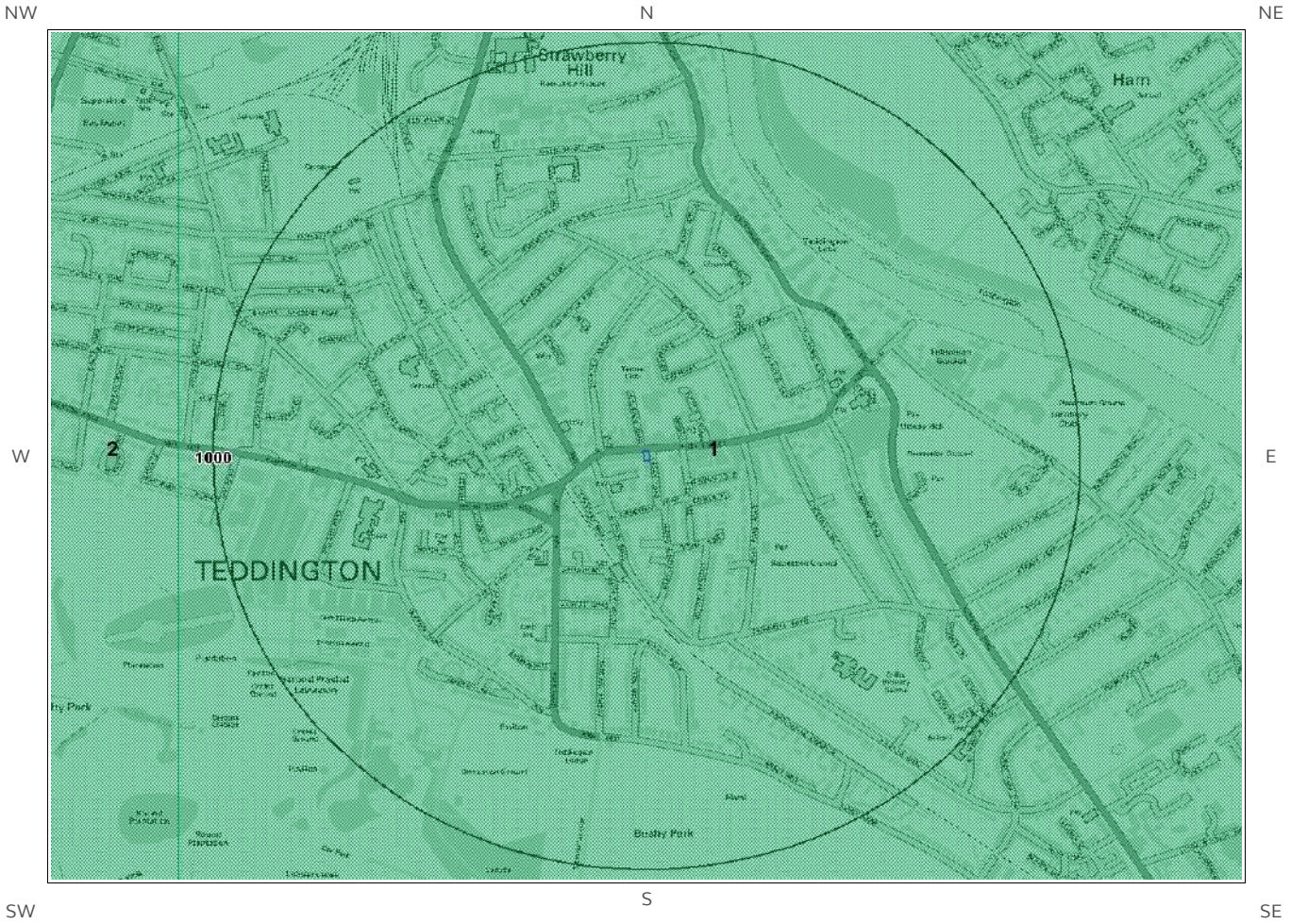
Section 6: Natural Ground Subsidence	On-site
6.1 Shrink-Swell Clay	Moderate
6.2 Landslides	Very Low
6.3 Ground Dissolution of Soluble Rocks	Negligible
6.4 Compressible Deposits	Negligible
6.5 Collapsible Deposits	Very Low
6.5 Running Sand	Very Low

Section 7: Borehole Records	On-site	0-50m	51-250
7 BGS Recorded Boreholes	0	0	1

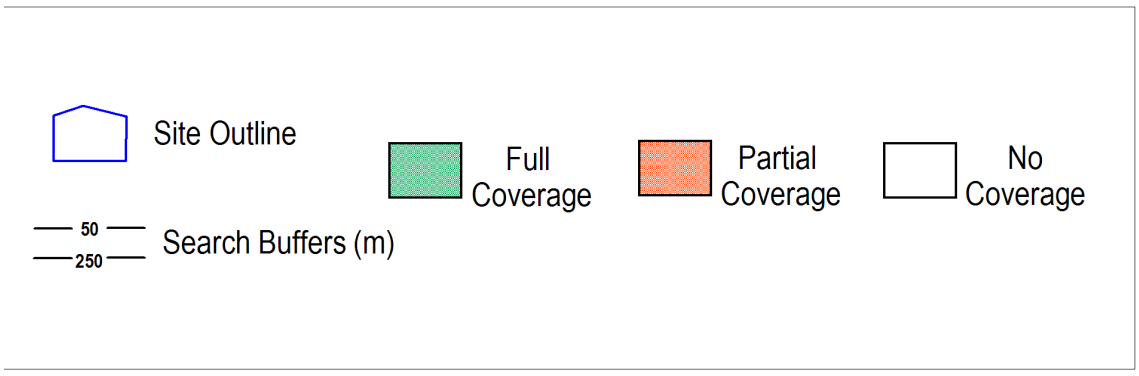
Section 8: Estimated Background Soil Chemistry	On-site	0-50m	51-250
8 Records of Background Soil Chemistry	1	0	0

Section 9: Railways and Tunnels	On-site	0-50m	51-250	250-500
9.1 Tunnels	0	0	0	Not Searched
9.2 Historical Railway and Tunnel Features	0	0	40	Not Searched
9.3 Historical Railways	0	0	0	Not Searched
9.4 Active Railways	0	0	6	Not Searched
9.5 Railway Projects	0	0	0	0

1:10,000 Scale Availability



1_10,000 Availability Legend



Availability of 1:10,000 Scale Geology Mapping

The following information represents the availability of the key components of the 1:10,000 scale geological data.

ID	Distance	Artificial Coverage	Superficial Coverage	Bedrock Coverage	Mass Movement Coverage
1	0.0	Some deposits are mapped	Full	Full	Some deposits are mapped
2	1081.0	Some deposits are mapped	Full	Full	No coverage
N3	1088.0	Some deposits are mapped	Full	Full	No coverage
N4	1535.0	Some deposits are mapped	Full	Full	No coverage

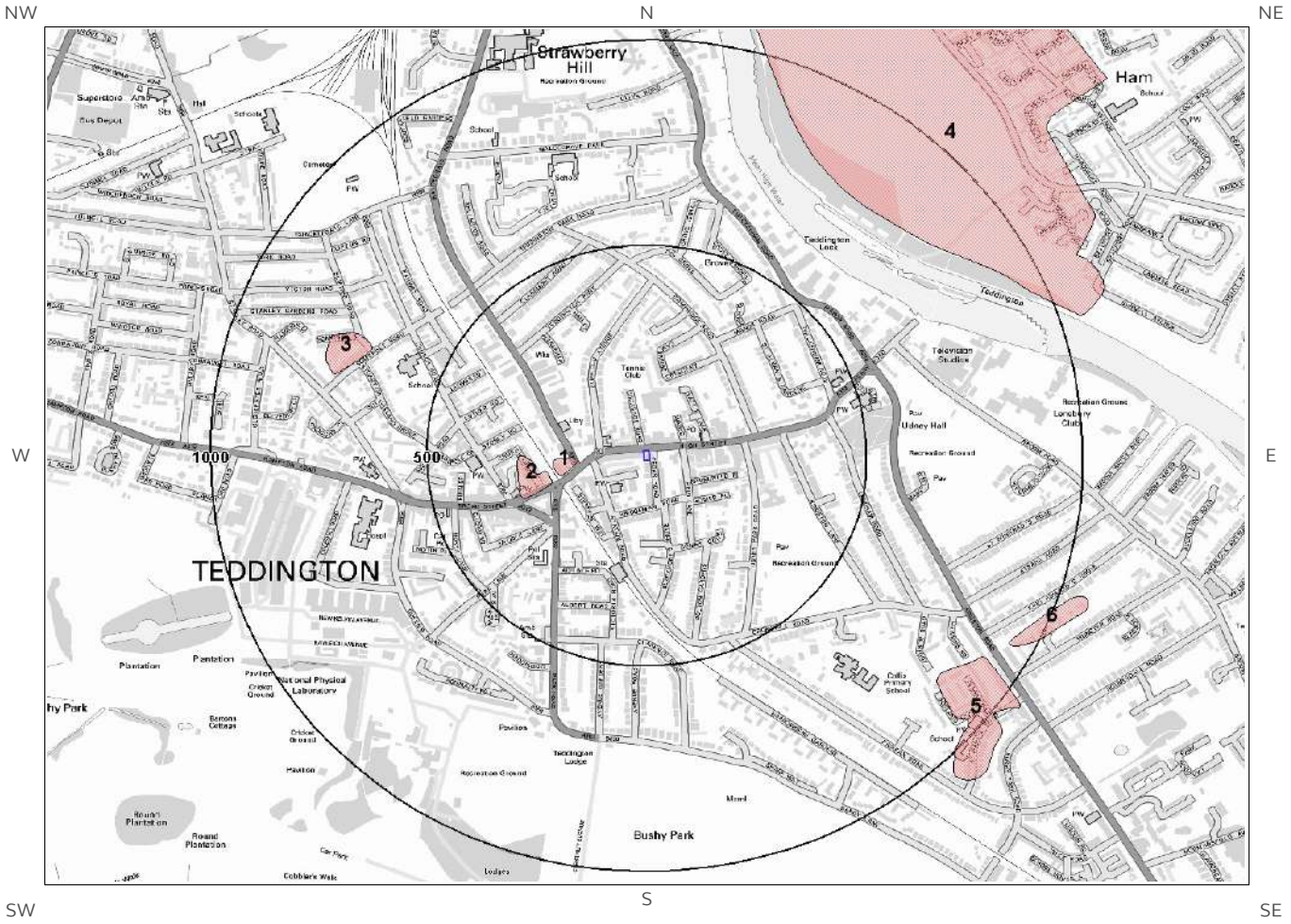
Guidance: The 1:10,000 scale geological interpretation is the most detailed generally available from BGS and is the scale at which most geological surveying is carried out in the field. The database is presented as four types of geology (artificial, mass movement, superficial and bedrock), although not all themes are mapped or available on every map sheet. Therefore a coverage layer showing the availability of the four themes is presented above.

The definitions of coverage are as follows:

Geology	Full Coverage	Partial Coverage	No Coverage
Bedrock	The whole tile has been mapped	Some but not all the tile has been mapped	No coverage
Superficial	The whole tile has been mapped	Some but not all of the tile has been mapped	No coverage
Artificial	Some deposits are mapped on this tile	-	No deposits are mapped
Mass Movement	Some deposits are mapped on this tile	-	No coverage

1 Geology (1:10,000 scale).

1.1 Artificial Ground map (1:10,000 scale)



Artificial Ground Legend

Site Outline

500
1000
Search Buffers (m)

Made Ground (undivided)

Disturbed Ground (undivided)

Worked Ground (undivided)

Landscaped Ground (undivided)

Infilled Ground

Reclaimed Ground

1. Geology 1:10,000 scale

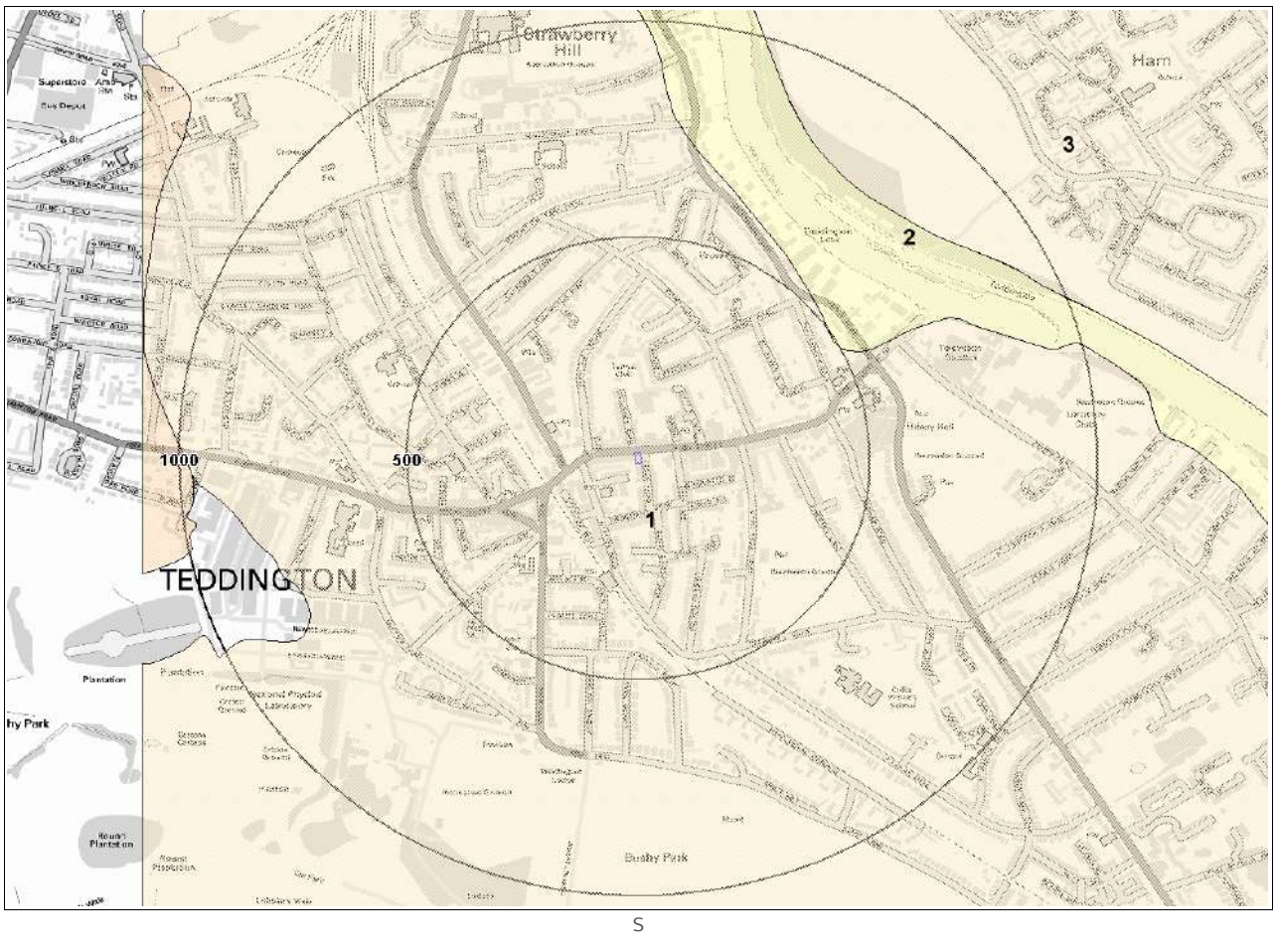
1.1 Artificial Ground

The following geological information represented on the mapping is derived from 1:10,000 scale BGS Geological mapping.

Are there any records of Artificial/ Made Ground within 500m of the study site boundary at 1:10,000 scale? Yes

ID	Distance	Direction	LEX Code	Description	Rock Description
1	154.0	W	WMGR-UKNOWN	Infilled Ground	Unknown/unclassified Entry
2	219.0	W	WMGR-UKNOWN	Infilled Ground	Unknown/unclassified Entry

1.2 Superficial Deposits and Landslips map (1:10,000 scale)



Artificial Ground Legend

Site Outline

500
1000
Search Buffers (m)

1.2 Superficial Deposits and Landslips

The following geological information represented on the mapping is derived from 1:10,000 scale BGS Geological mapping

1.2.1 Superficial Deposits/ Drift Geology

Are there any records of Superficial Deposits/ Drift Geology within 500m of the study site boundary at 1:10,000 scale? Yes

ID	Distance (m)	Direction	LEX Code	Description	Rock Description
1	0.0	On Site	KPGR-XSV	Kempton Park Gravel Formation - Sand And Gravel	Sand And Gravel
2	495.0	NE	ALV-Z	Alluvium - Silt (unlithified Deposits Coding Scheme)	Silt

1.2.2 Landslip

Are there any records of Landslip within 500m of the study site boundary at 1:10,000 scale?

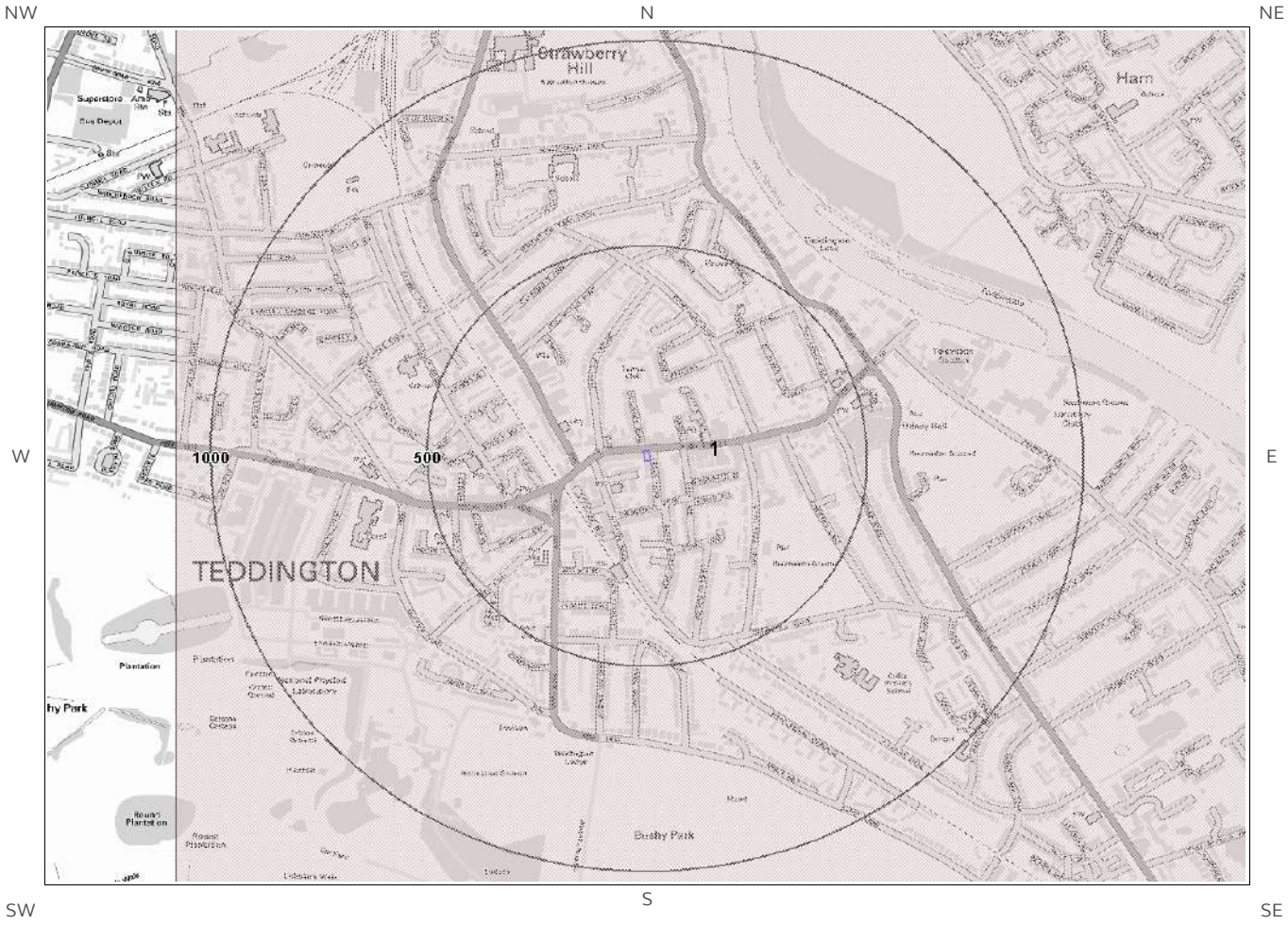
No

Database searched and no data found.

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of Great Britain at 1:10,000 scale

This Geology shows the main components as discrete layers, these are: Artificial / Made Ground, Superficial / Drift Geology and Landslips. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

1.3 Bedrock and linear features map (1:10,000 scale)



Bedrock and linear features Legend

Site Outline

500
1000
Search Buffers (m)

1.3 Bedrock and linear features

The following geological information represented on the mapping is derived from 1:10,000 scale BGS Geological mapping.

1.3.1 Bedrock/ Solid Geology

Records of Bedrock/Solid Geology within 500m of the study site boundary at 1:10,000 scale.

ID	Distance (m)	Direction	LEX Code	Description	Rock Age
1	0.0	On Site	LC-CLAY	London Clay Formation - Clay	Eocene Epoch

1.3.2 Linear features

Are there any records of linear features within 500m of the study site boundary at 1:10,000 scale? No

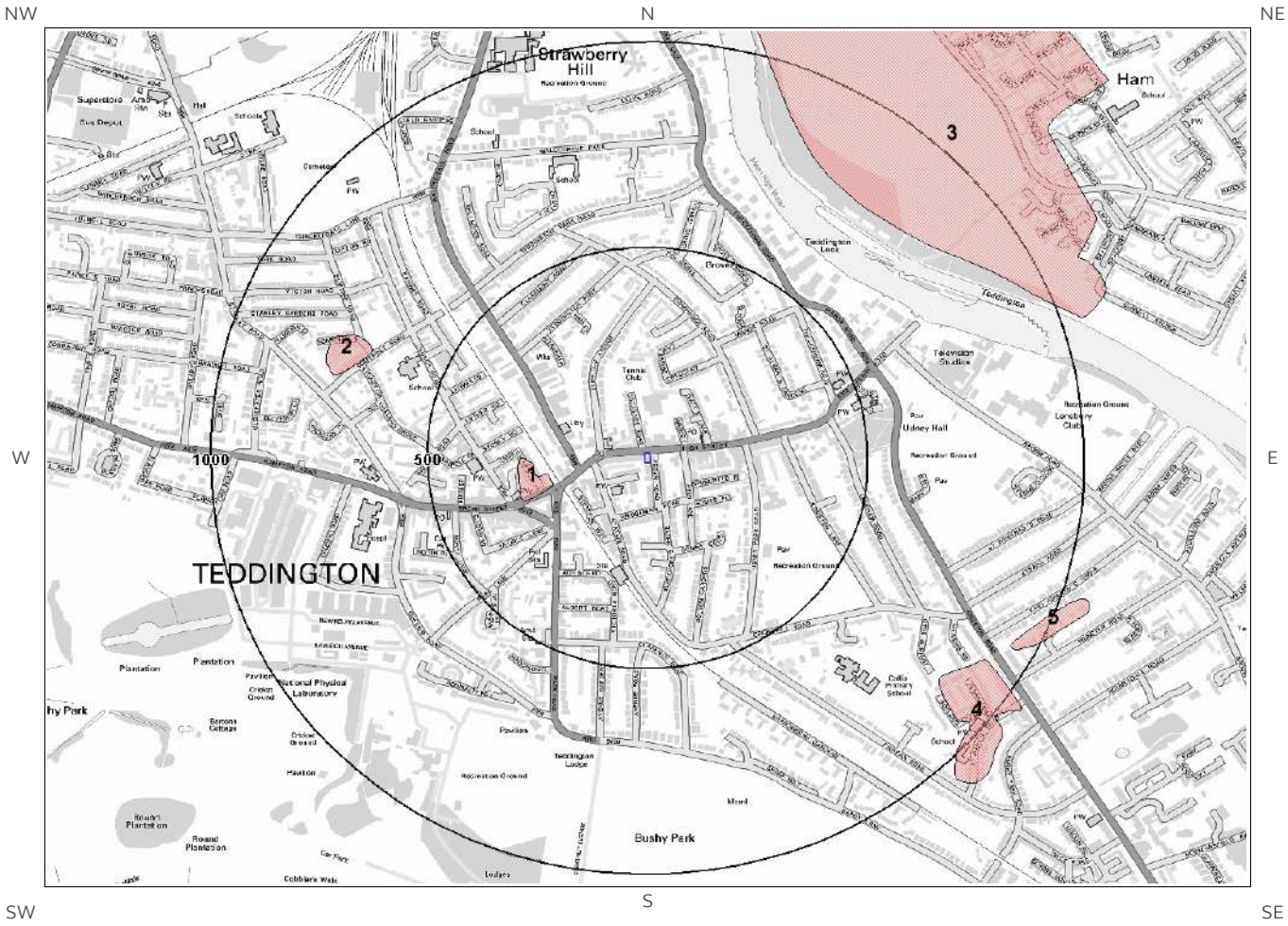
Database searched and no data found at this scale.

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of great Britain at 1:10,000 scale.

This Geology shows the main components as discrete layers, these are: Bedrock/ Solid Geology and linear features such as faults. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

2 Geology 1:50,000 Scale

2.1 Artificial Ground map



Site Outline

500
1000
Search Buffers (m)

Made Ground (undivided)

Worked Ground (undivided)

Infilled Ground

Disturbed Ground (undivided)

Landscaped Ground (undivided)

Reclaimed Ground

2. Geology 1:50,000 scale

2.1 Artificial Ground

The following geological information represented on the mapping is derived from 1:50,000 scale BGS Geological mapping, Sheet No: 270

2.1.1 Artificial/ Made Ground

Are there any records of Artificial/ Made Ground within 500m of the study site boundary? Yes

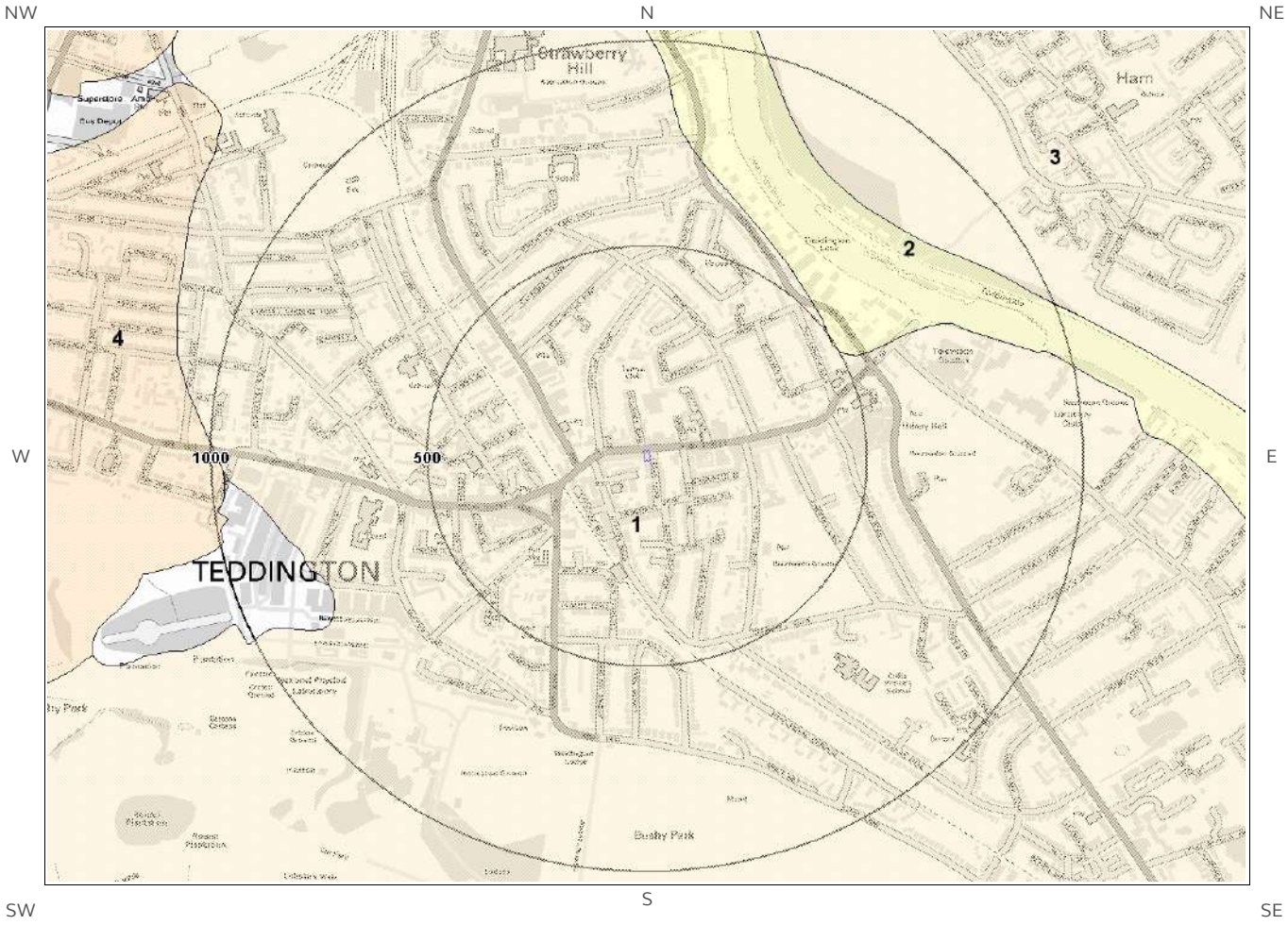
ID	Distance (m)	Direction	LEX Code	Description	Rock Description
1	219.0	W	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT

2.1.2 Permeability of Artificial Ground

Are there any records relating to permeability of artificial ground within the study site boundary? No

Database searched and no data found.

2.2 Superficial Deposits and Landslips map (1:50,000 scale)



Site Outline

500
1000
Search Buffers (m)

2.2 Superficial Deposits and Landslips

2.2.1 Superficial Deposits/ Drift Geology

Are there any records of Superficial Deposits/ Drift Geology within 500m of the study site boundary? Yes

ID	Distance	Direction	LEX Code	Description	Rock Description
1	0.0	On Site	KPGR-XSV	KEMPTON PARK GRAVEL MEMBER	SAND AND GRAVEL
2	495.0	NE	ALV-XCZSP	ALLUVIUM	CLAY, SILT, SAND AND PEAT

2.2.2 Permeability of Superficial Ground

Are there any records relating to permeability of superficial ground within the study site boundary? Yes

Distance (m)	Direction	Flow Type	Maximum Permeability	Minimum Permeability
0.0	On Site	Intergranular	Very High	High

2.2.3 Landslip

Are there any records of Landslip within 500m of the study site boundary? No

Database searched and no data found.

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of Great Britain at 1:50,000 scale.

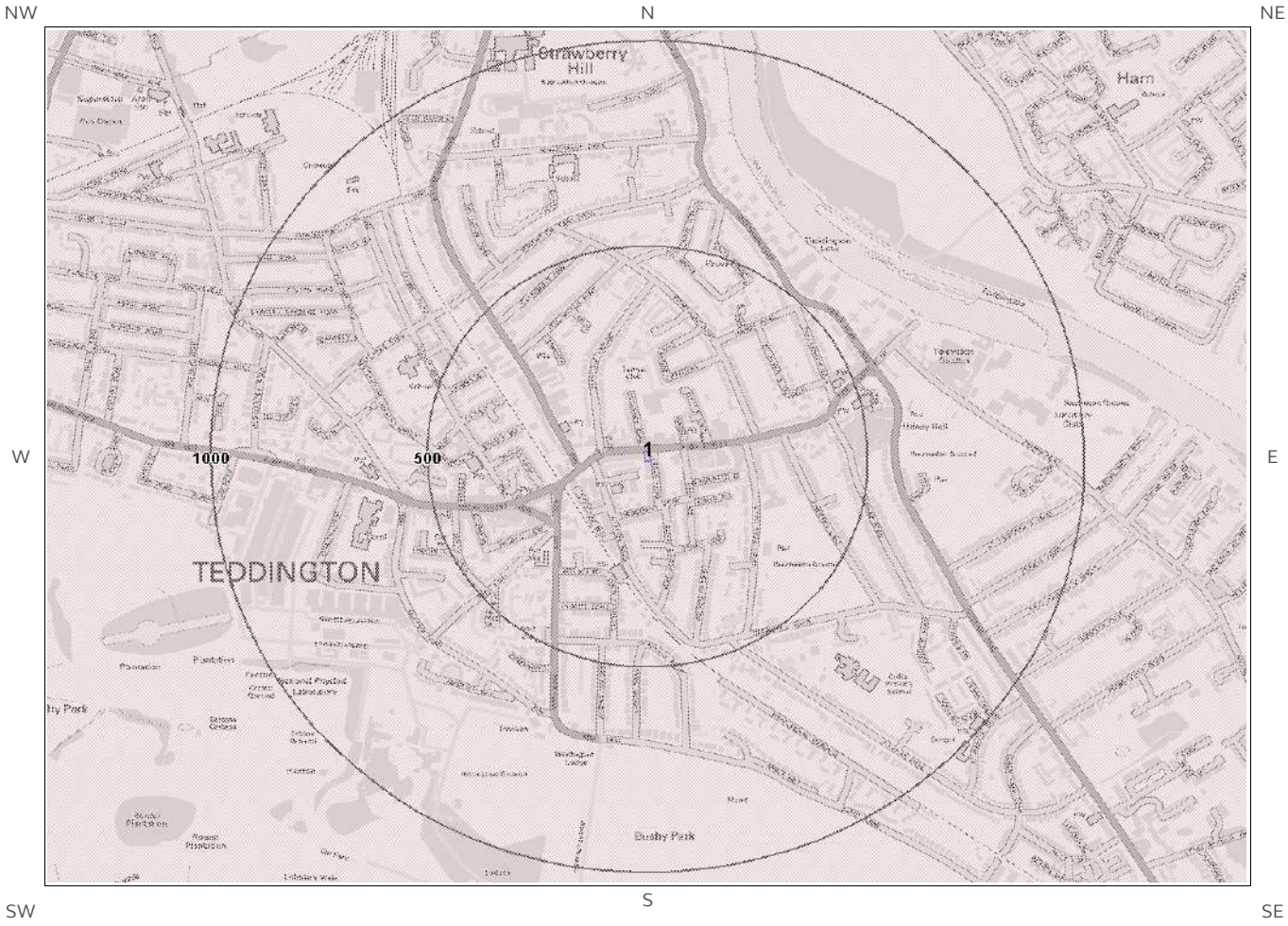
This Geology shows the main components as discrete layers, there are: Artificial/ Made Ground, Superficial/ Drift Geology and Landslips. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nationwide coverage.

2.2.4 Landslip Permeability

Are there any records relating to permeability of landslips within the study site boundary? No

Database searched and no data found.

2.3 Bedrock and linear features map (1:50,000 scale)



Site Outline

500
1000
Search Buffers (m)

2.3 Bedrock, Solid Geology & linear features

The following geological information represented on the mapping is derived from 1:50,000 scale BGS Geological mapping, Sheet No: 270

2.3.1 Bedrock/Solid Geology

Records of Bedrock/Solid Geology within 500m of the study site boundary:

ID	Distance	Direction	LEX Code	Rock Description	Rock Age
1	0.0	On Site	LC-XCZ	LONDON CLAY FORMATION - CLAY AND SILT	YPRESIAN

2.3.2 Permeability of Bedrock Ground

Are there any records relating to permeability of bedrock ground within the study site boundary? Yes

Distance	Direction	Flow Type	Maximum Permeability	Minimum Permeability
0.0	On Site	Mixed	Low	Very Low

2.3.3 Linear features

Are there any records of linear features within 500m of the study site boundary? No

Database searched and no data found.

The geology map for the site and surrounding area are extracted from the BGS Digital Geological Map of Great Britain at 1:50,000 scale.

This Geology shows the main components as discrete layers, these are: Bedrock/Solid Geology and linear features such as faults. These are all displayed with the BGS Lexicon code for the rock unit and BGS sheet number. Not all of the main geological components have nation wide coverage.

3 Radon Data

3.1 Radon Affected Areas

Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level? The property is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

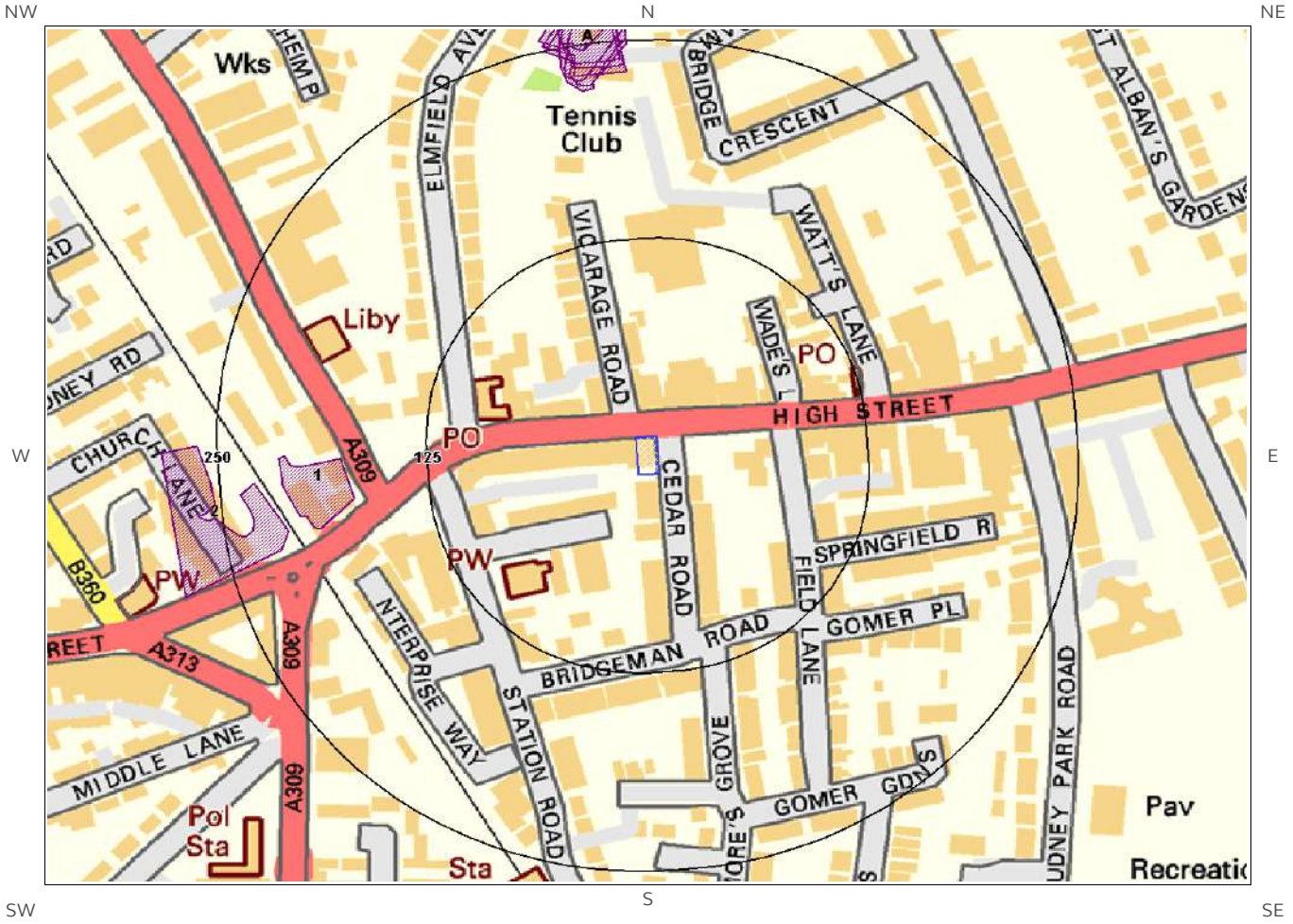
The radon data in this report is supplied by the BGS/Public Health England and is the definitive map of Radon Affected Areas in Great Britain and Northern Ireland. The dataset was created using long-term radon measurements in over 479,000 homes across Great Britain and 23,000 homes across Northern Ireland, combined with geological data. The dataset is considered accurate to 50m to allow for the margin of error in geological lines, and the findings of this report supercede any answer given in the less accurate Indicative Atlas of Radon in Great Britain, which simplifies the data to give the highest risk within any given 1km grid square. As such, the radon atlas is considered indicative, whereas the data given in this report is considered definitive.

3.2 Radon Protection

Is the property in an area where Radon Protection are required for new properties or extensions to existing ones as described in publication BR211 by the Building Research Establishment? No radon protective measures are necessary.

---

4 Ground Workings map



Ground Workings Legend

Site Outline

125
250
Search Buffers (m)

Historic Surface Ground Workings

Historic Underground Workings

Current Ground Workings

4 Ground Workings

4.1 Historical Surface Ground Working Features derived from Historical Mapping

This dataset is based on Groundsure's unique Historical Land Use Database derived from 1:10,560 and 1:10,000 scale historical mapping

Are there any Historical Surface Ground Working Features within 250m of the study site boundary? Yes

ID	Distance (m)	Direction	NGR	Use	Date
1	170.0	W	515890 171077	Pond	1865
2	212.0	W	515818 171058	Pond	1865
3A	221.0	N	516054 171362	Pond	1973
4A	221.0	N	516054 171362	Pond	1966
5A	224.0	N	516057 171362	Pond	1938
6A	227.0	N	516054 171364	Pond	1940
7A	230.0	N	516051 171364	Pond	1913
8A	234.0	N	516049 171369	Pond	1913
9A	238.0	N	516047 171371	Pond	1912
10A	238.0	N	516047 171371	Pond	1938
11	246.0	N	516055 171375	Unspecified Pit	1991

4.2 Historical Underground Working Features derived from Historical Mapping

This data is derived from the Groundsure unique Historical Land Use Database. It contains data derived from 1:10,000 and 1:10,560 historical Ordnance Survey Mapping and includes some natural topographical features (Shake Holes for example) as well as manmade features that may have implications for ground stability. Underground and mining features have been identified from surface features such as shafts. The distance that these extend underground is not shown.

Are there any Historical Underground Working Features within 1000m of the study site boundary? No

Database searched and no data found.

4.3 Current Ground Workings

This dataset is derived from the BGS BRITPITS database covering active; inactive mines; quarries; oil wells; gas wells and mineral wharves; and rail deposits throughout the British Isles.

Are there any BGS Current Ground Workings within 1000m of the study site boundary? Yes

The following Current Ground Workings information is provided by British Geological Survey:

ID	Distance (m)	Direction	NGR	Commodity Produced	Pit Name	Type of working	Status
Not shown	699.0	SW	515638 170548	Sand & Gravel	Bushy House Gravel Pit	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased
Not shown	963.0	SE	516850 170490	Sand	Kingston Road Sand Pit	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased
Not shown	998.0	NE	516825 171790	Sand & Gravel	Ham	A surface mineral working. It may be termed Quarry, Sand Pit, Clay Pit or Opencast Coal Site	Ceased

5 Mining, Extraction & Natural Cavities map

Mining, Extraction and Natural Cavities Legend

Site Outline

Search Buffers (m)

Historical Mining

Non-Coal Mining Cavities

Natural Cavities (point data)

Natural Cavities (polygon data)

Non-Coal Mining

Highly likely

Likely

Unlikely

Highly unlikely

Rare

5 Mining, Extraction & Natural Cavities

5.1 Historical Mining

This dataset is derived from Groundsure unique Historical Land-use Database that are indicative of mining or extraction activities.

Are there any Historical Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.2 Coal Mining

This dataset provides information as to whether the study site lies within a known coal mining affected area as defined by the coal authority.

Are there any Coal Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.3 Johnson Poole and Bloomer

This dataset provides information as to whether the study site lies within an area where JPB hold information relating to mining.

Are there any JPB Mining areas within 1000m of the study site boundary? No

The following information provided by JPB is not represented on mapping: Database searched and no data found.

5.4 Non-Coal Mining

This dataset provides information as to whether the study site lies within an area which may have been subject to non-coal historic mining.

Are there any Non-Coal Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.5 Non-Coal Mining Cavities

This dataset provides information from the Peter Brett Associates (PBA) mining cavities database (compiled for the national study entitled "Review of mining instability in Great Britain, 1990" PBA has also continued adding to this database) on mineral extraction by mining.

Are there any Non-Coal Mining cavities within 1000m of the study site boundary? No

Database searched and no data found.

5.6 Natural Cavities

This dataset provides information based on the Peter Brett Associates natural cavities database. The dataset is made up of points and polygons. Where polygons are used these represent an area in which it is expected the cavities could be found. It does not indicate that cavities are present everywhere within the polygon, and caution should be used in the interpretation of this data.

Are there any Natural Cavities within 1000m of the study site boundary? No

Database searched and no data found.

5.7 Brine Extraction

This data provides information from the Coal Authority issued on behalf of the Cheshire Brine Subsidence Compensation Board.

Are there any Brine Extraction areas within 1000m of the study site boundary? No

Database searched and no data found.

5.8 Gypsum Extraction

This dataset provides information on Gypsum extraction from British Gypsum records.

Are there any Gypsum Extraction areas within 1000m of the study site boundary? No

Database searched and no data found.

5.9 Tin Mining

This dataset provides information on tin mining areas and is derived from tin mining records. This search is based upon postcode information to a sector level..

Are there any Tin Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

5.10 Clay Mining

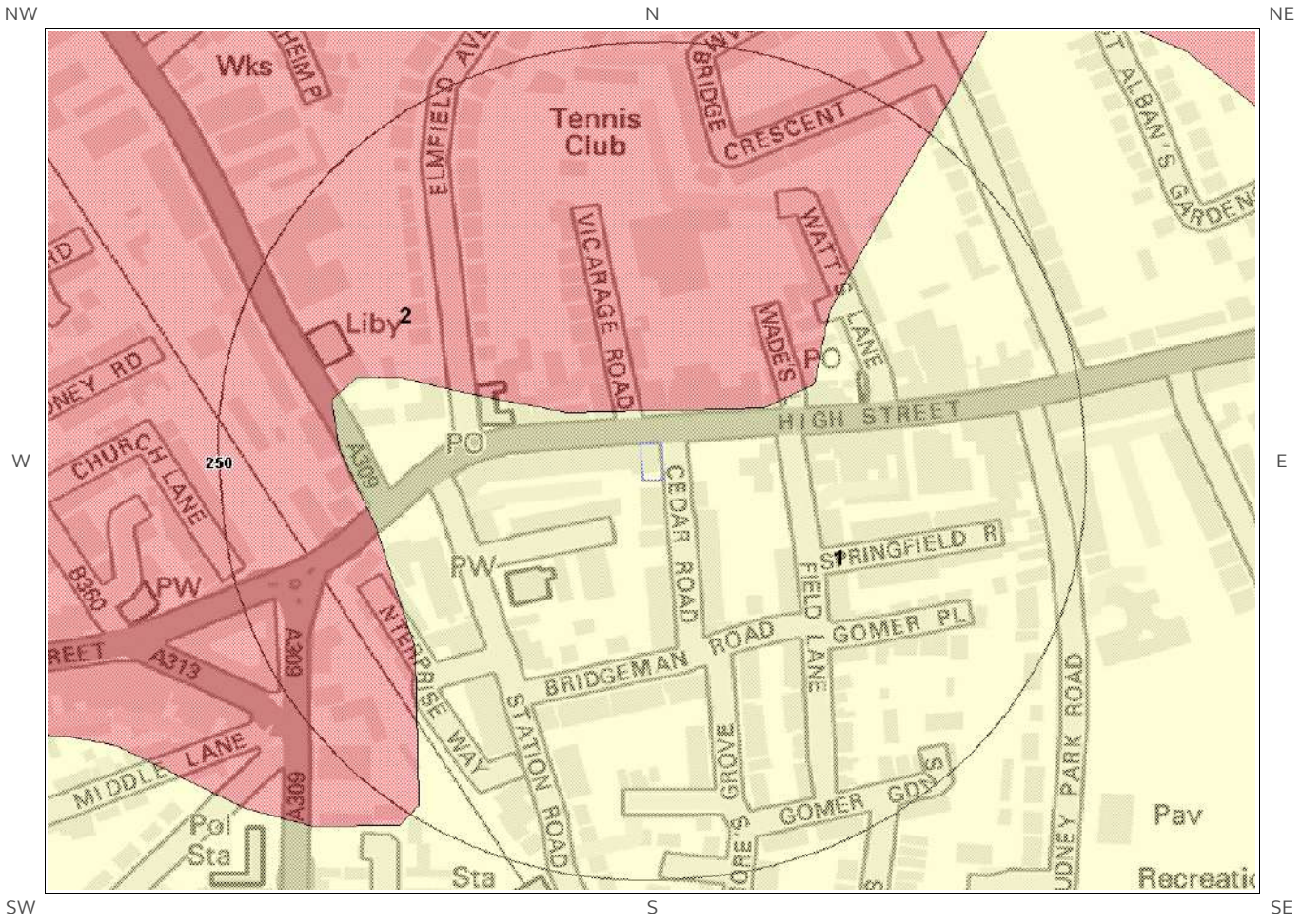
This dataset provides information on Kaolin and Ball Clay mining from relevant mining records.

Are there any Clay Mining areas within 1000m of the study site boundary? No

Database searched and no data found.

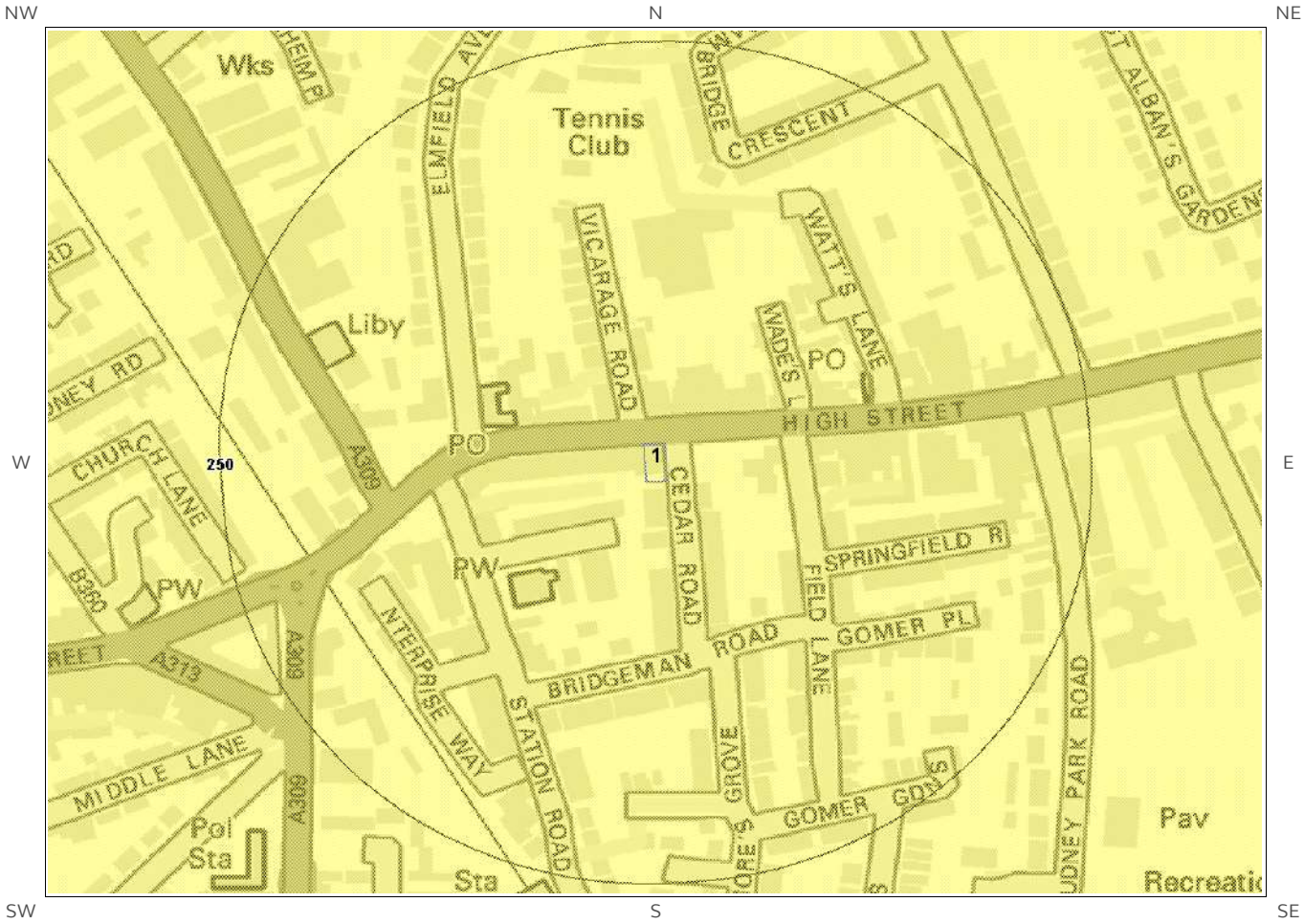
6 Natural Ground Subsidence

6.1 Shrink-Swell Clay map



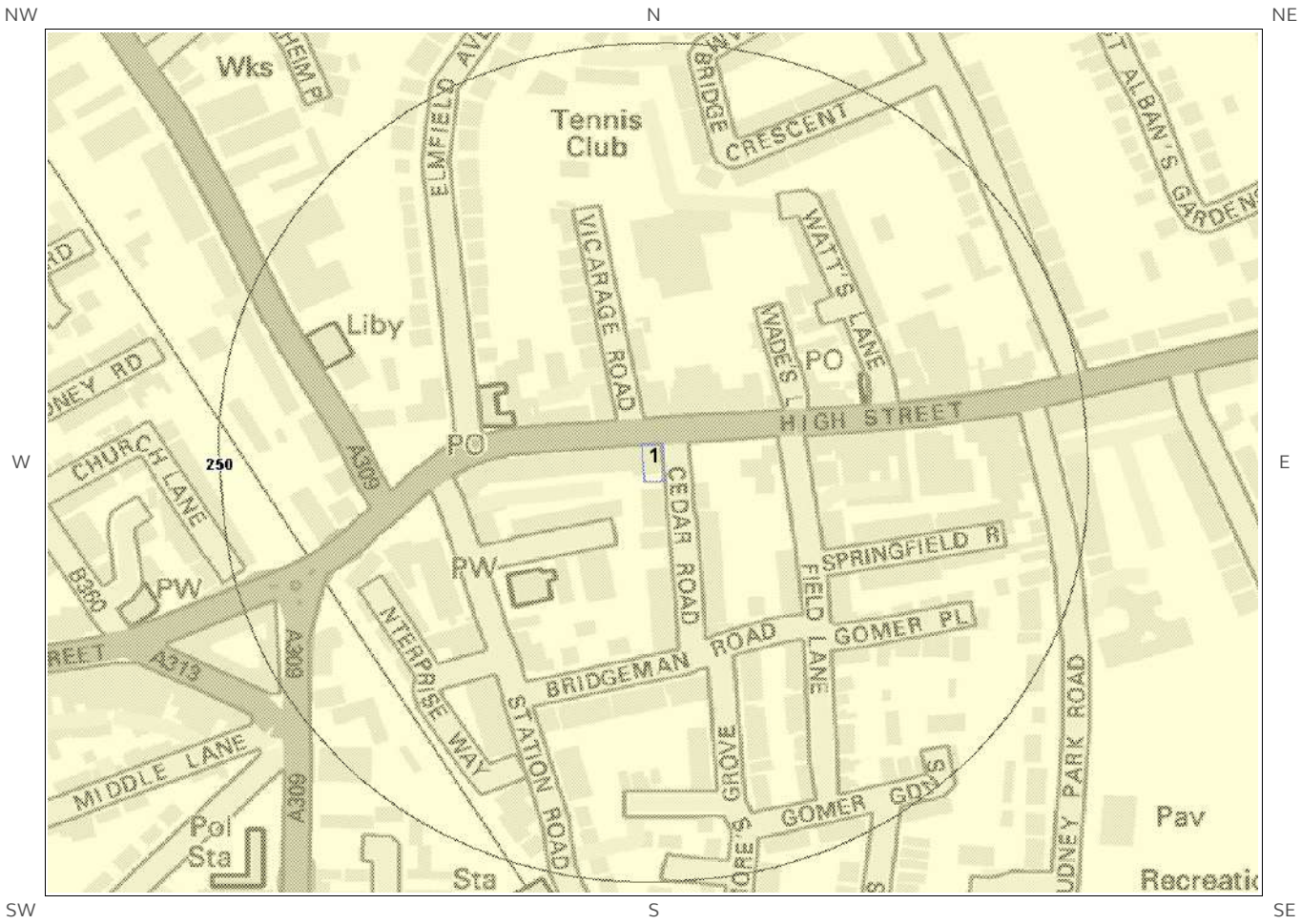
Shrink Swell Clay Legend

6.2 Landslides map



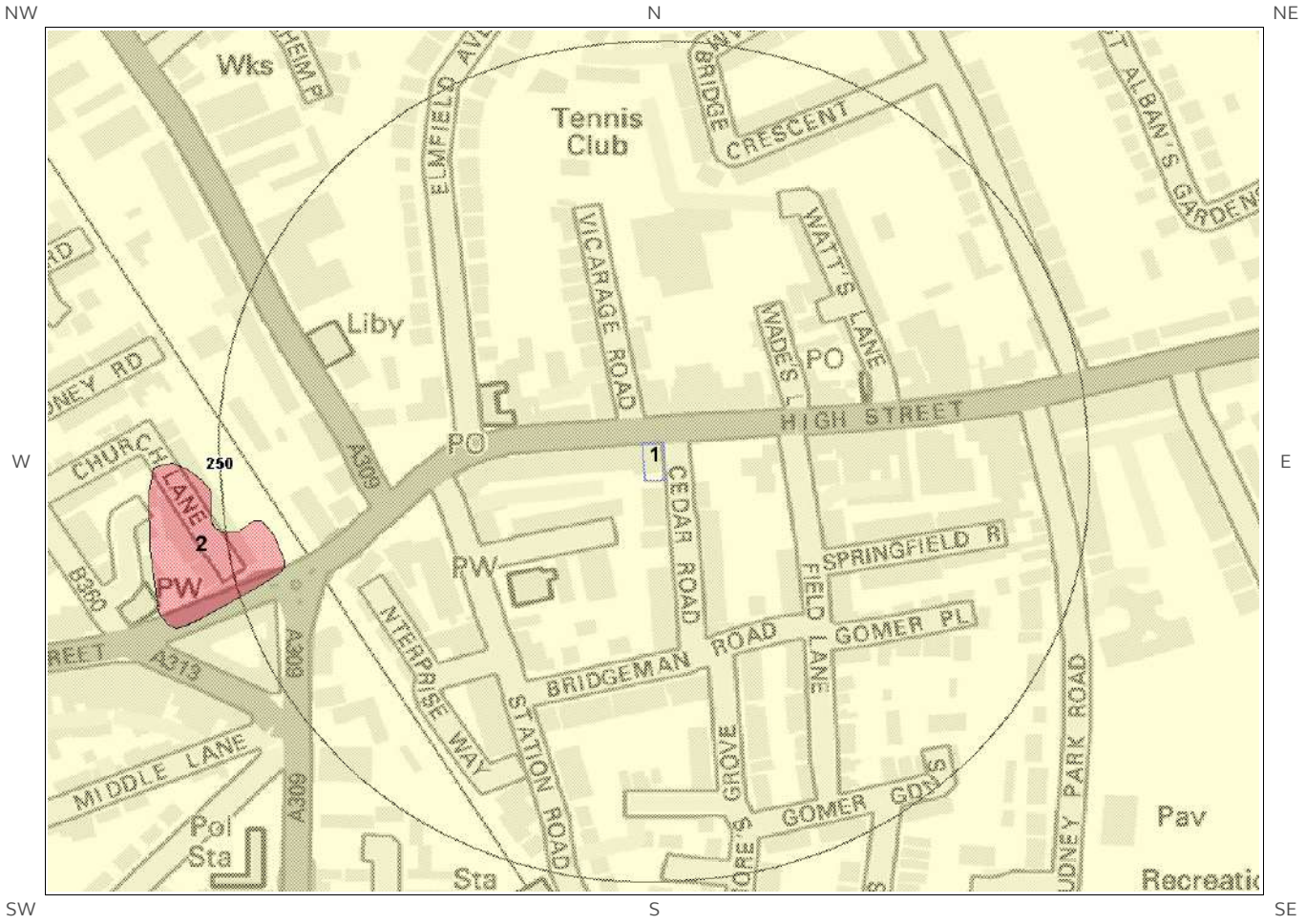
Landslides Legend

6.3 Ground Dissolution of Soluble Rocks map



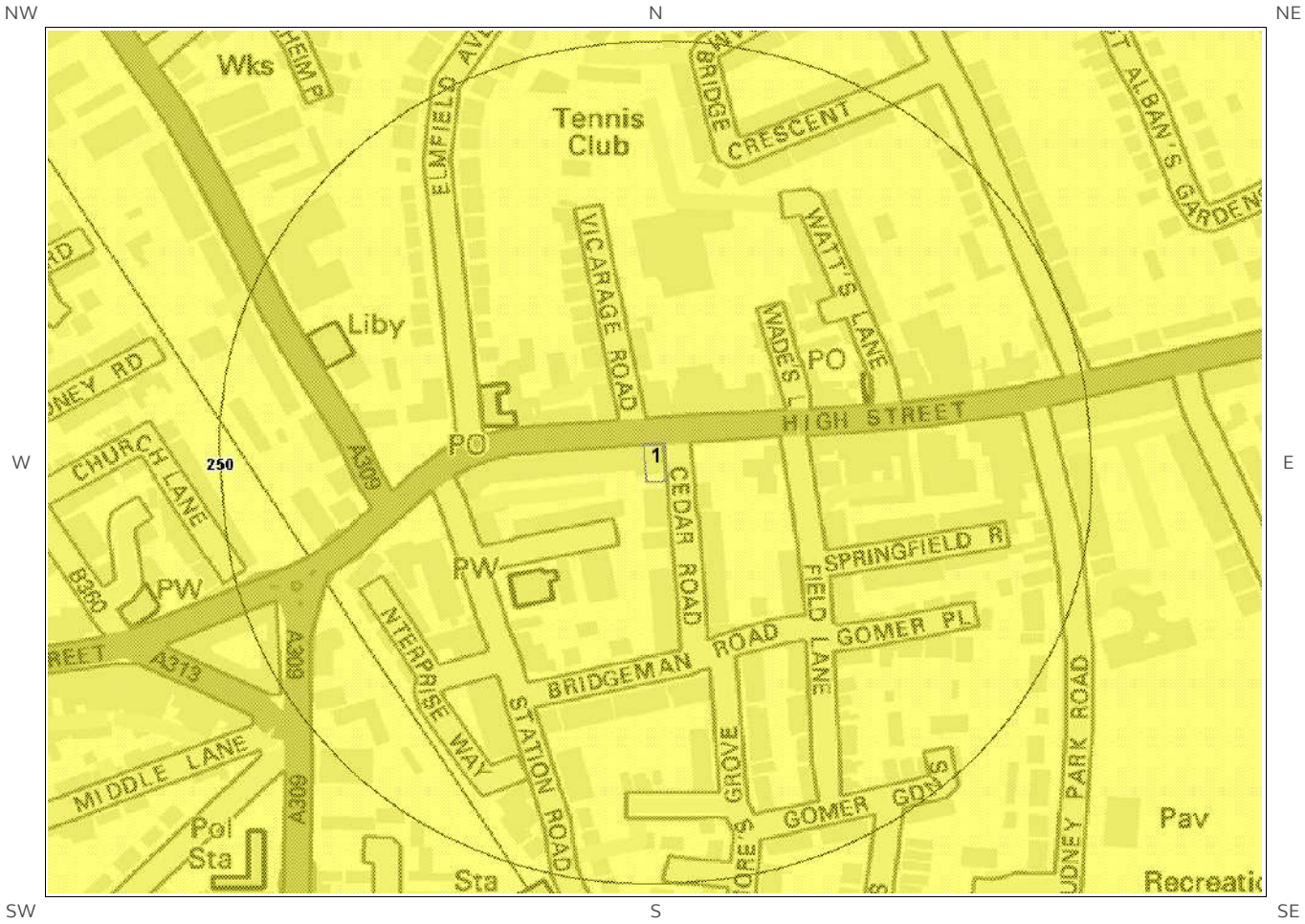
Ground Dissolution Soluble Rocks Legend

6.4 Compressible Deposits map



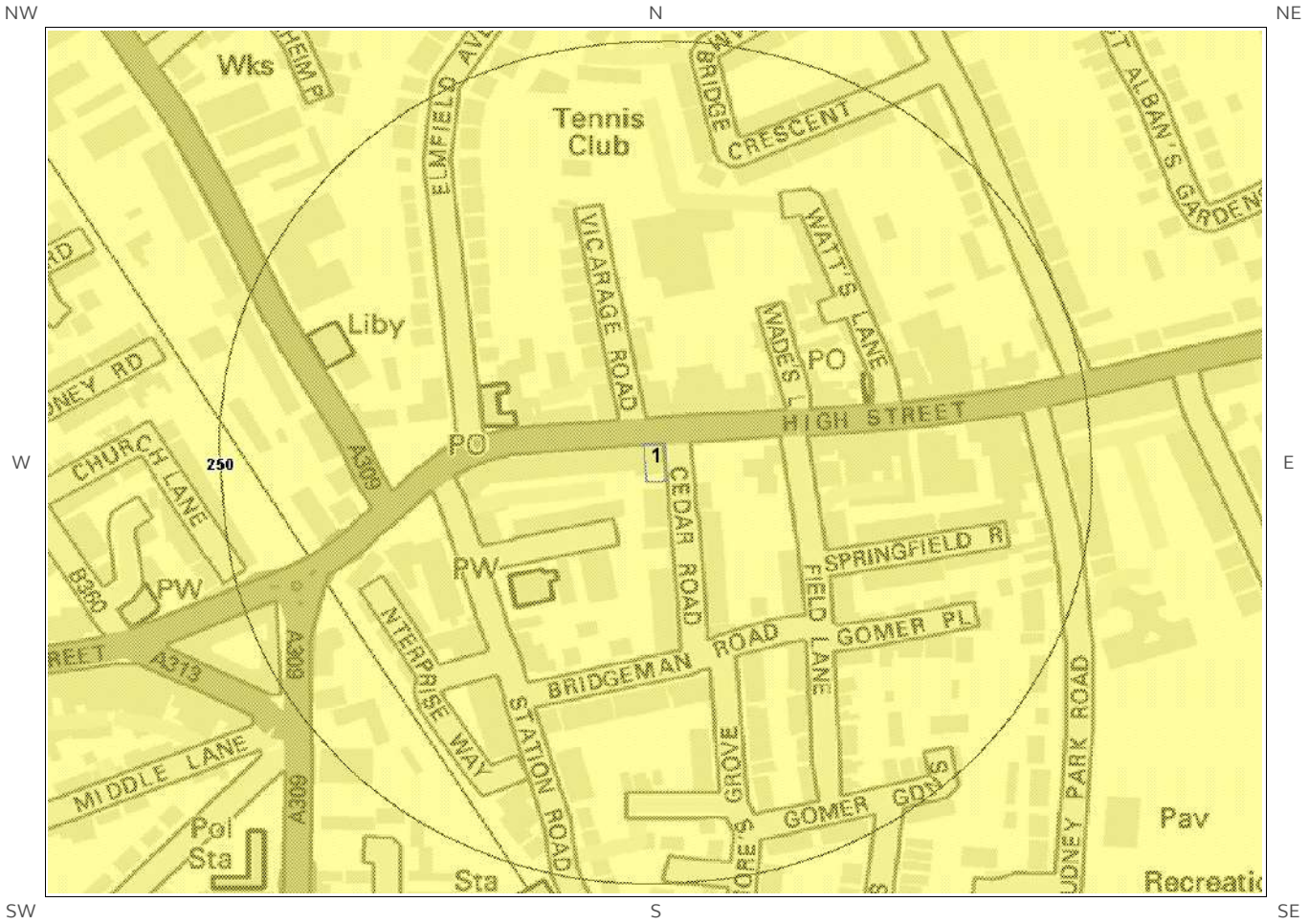
Compressible Deposits Legend

6.5 Collapsible Deposits map



Collapsible Deposits Legend

6.6 Running Sand map



Running Sand Legend

6 Natural Ground Subsidence

The National Ground Subsidence rating is obtained through the 6 natural ground stability hazard datasets, which are supplied by the British Geological Survey (BGS).

The following GeoSure data represented on the mapping is derived from the BGS Digital Geological map of Great Britain at 1:50,000 scale.

What is the maximum hazard rating of natural subsidence within the study site*[*] boundary? Moderate

6.1 Shrink-Swell Clays

The following Shrink Swell information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	Ground conditions predominantly non-plastic. No special actions required to avoid problems due to shrink-swell clays. No special ground investigation required, and increased construction costs or increased financial risks are unlikely likely due to potential problems with shrink-swell clays.
2	20.0	N	Moderate	Ground conditions predominantly high plasticity. Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. For new build, consideration should be given to advice published by the National House Building Council (NHBC) and the Building Research Establishment (BRE). There is a probable increase in construction cost to reduce potential shrink-swell problems. For existing property, there is a probable increase in insurance risk during droughts or where vegetation with high moisture demands is present.

6.2 Landslides

The following Landslides information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Very Low	Slope instability problems are unlikely to be present. No special actions required to avoid problems due to landslides. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with landslides.

* This includes an automatically generated 50m buffer zone around the site

6.3 Ground Dissolution of Soluble Rocks

The following Ground Dissolution information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with soluble rocks.

6.4 Compressible Deposits

The following Compressible Deposits information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Negligible	No indicators for compressible deposits identified. No special actions required to avoid problems due to compressible deposits. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with compressible deposits.

6.5 Collapsible Deposits

The following Collapsible Rocks information provided by the British Geological Survey:

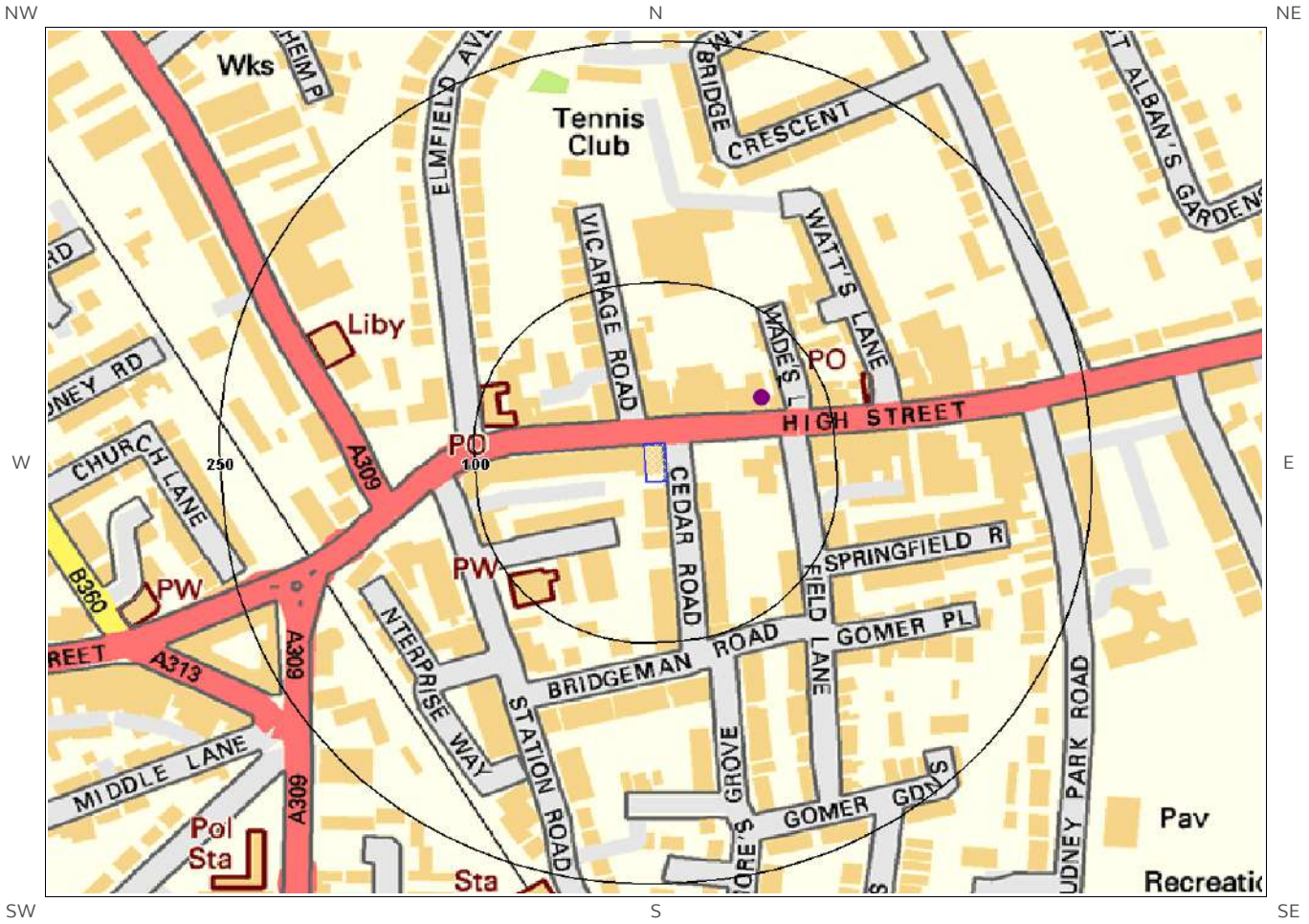
ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Very Low	Deposits with potential to collapse when loaded and saturated are unlikely to be present. No special ground investigation required or increased construction costs or increased financial risk due to potential problems with collapsible deposits.

6.6 Running Sands

The following Running Sands information provided by the British Geological Survey:

ID	Distance (m)	Direction	Hazard Rating	Details
1	0.0	On Site	Very Low	Very low potential for running sand problems if water table rises or if sandy strata are exposed to water. No special actions required, to avoid problems due to running sand. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with running sand.

7 Borehole Records map



Borehole Records Legend

Site Outline

Borehole Locations

125
250
Search Buffers (m)

7 Borehole Records

The systematic analysis of data extracted from the BGS Borehole Records database provides the following information.

Records of boreholes within 250m of the study site boundary: 1

ID	Distance (m)	Direction	NGR	BGS Reference	Drilled Length	Borehole Name
1	63.0	NE	516150 171140	TQ17SE112	5.0	41 HIGH STREET TEDDINGTON

The borehole records are available using the hyperlinks below: Please note that if the donor of the borehole record has requested the information be held as commercial-in-confidence, the additional data will be held separately by the BGS and a formal request must be made for its release.

#1: scans.bgs.ac.uk/sobi_scans/boreholes/581549

8 Estimated Background Soil Chemistry

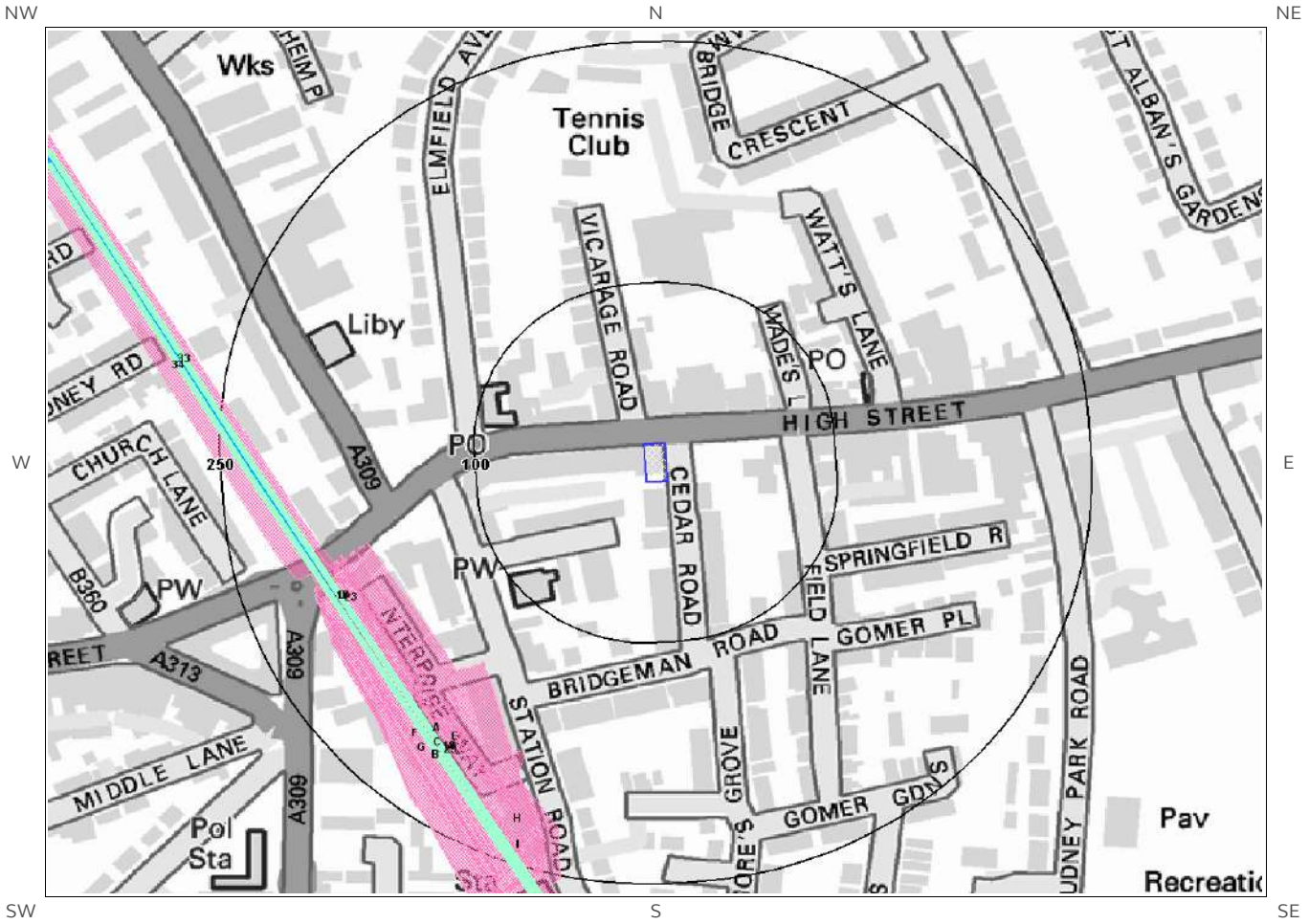
Records of background estimated soil chemistry within 250m of the study site boundary: 1

For further information on how this data is calculated and limitations upon its use, please see the Groundsure Geo Insight User Guide, available on request.

Distance (m)	Direction	Sample Type	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Nickel (Ni)	Lead (Pb)
0.0	On Site	London	No data	No data	No data	No data	No data

*As this data is based upon underlying 1:50,000 scale geological information, a 50m buffer has been added to the search radius.

9 Railways and Tunnels map



Railways and Tunnels Legend

- Site Outline
- 250 / 500 Search Buffers (m)
- Underground or Partially Underground Railway / Subway System
- Railway Tunnel (OS Mapping)
- Abandoned or Dismantled Railway (OpenStreetMap)
- Railway Track (OS Mapping)
- Railway Track (OpenStreetMap)
- High Speed 2
- High Speed 2 Revised Proposed Route
- Crossrail 1
- Railway and/or Tunnel Feature from Historical Mapping

9 Railways and Tunnels

9.1 Tunnels

This data is derived from OpenStreetMap and provides information on the possible locations of underground railway systems in the UK - the London Underground, the Tyne & Wear Metro and the Glasgow Subway.

Have any underground railway lines been identified within the study site boundary? No

Have any underground railway lines been identified within 250m of the study site boundary? No

Database searched and no data found.

Any records that have been identified are represented on the Railways and Tunnels map.

This data is derived from Ordnance Survey mapping and provides information on the possible locations of railway tunnels forming part of the UK overground railway network.

Have any other railway tunnels been identified within the site boundary? No

Have any other railway tunnels been identified within 250m of the site boundary? No

Database searched and no data found.

Any records that have been identified are represented on the Railways and Tunnels map.

9.2 Historical Railway and Tunnel Features

This data is derived from Groundsure's unique Historical Land-use Database and contains features relating to tunnels, railway tracks or associated works that have been identified from historical Ordnance Survey mapping.

Have any historical railway or tunnel features been identified within the study site boundary? No

Have any historical railway or tunnel features been identified within 250m of the study site boundary? Yes

ID	Distance (m)	Direction	NGR	Details	Date
1A	148	SW	515952 170938	Railway Sidings	1912
2A	148	SW	515952 170938	Railway Sidings	1938
3A	154	SW	515957 170925	Railway Sidings	1913
4A	157	SW	515953 170939	Railway Sidings	1973
5A	157	SW	515953 170939	Railway Sidings	1966
6A	157	SW	515953 170939	Railway Sidings	1948

ID	Distance (m)	Direction	NGR	Details	Date
15D	169	SW	n/a	Railway	1918
16	169	SW	n/a	Railway	1936
17	169	SW	n/a	Railway	1915
18	169	SW	n/a	Railway	1857
7A	177	SW	515955 170940	Railway Sidings	1865
8A	177	SW	515953 170936	Railway Sidings	1938
19E	180	SW	515958 170943	Railway Sidings	1896
9C	181	SW	515956 170933	Railway Sidings	1934
10A	181	SW	515955 170945	Railway Sidings	1933
11B	181	SW	515955 170950	Railway Sidings	1938
12B	181	SW	515955 170950	Railway Sidings	1913
20D	183	SW	515824 171152	Railway Sidings	1960
21A	183	SW	515957 170933	Railway Sidings	1963
22A	183	SW	515957 170933	Railway Sidings	1959
23	184	SW	515909 171015	Railway Sidings	1959
24A	184	SW	515964 170934	Railway Sidings	1973
13C	185	SW	515956 170937	Railway Sidings	1913
25C	185	SW	515956 170921	Railway Sidings	1898
26E	186	SW	515970 170928	Railway Sidings	1960
27C	186	SW	515956 170932	Railway Sidings	1915
28C	186	SW	515956 170932	Railway Sidings	1934
29	187	SW	515958 170934	Railway Sidings	1864
30F	193	SW	515951 170921	Railway Sidings	1960
14B	195	SW	515956 170915	Railway Sidings	1933
31F	195	SW	515951 170921	Railway Sidings	1963
32F	195	SW	515951 170921	Railway Sidings	1959
33	195	W	515811 171158	Railway Sidings	1915
34	196	W	n/a	Railway	1897
35G	197	SW	515951 170920	Railway Sidings	1973
36G	199	SW	515947 170923	Railway Sidings	1864
37H	213	SW	516008 170878	Railway Sidings	1959

ID	Distance (m)	Direction	NGR	Details	Date
38H	220	S	516008 170875	Railway Sidings	1958
39I	231	S	516007 170861	Railway Sidings	1959
40I	231	S	516007 170861	Railway Sidings	1958

Any records that have been identified are represented on the Railways and Tunnels map.

9.3 Historical Railways

This data is derived from OpenStreetMap and provides information on the possible alignments of abandoned or dismantled railway lines in proximity to the study site.

Have any historical railway lines been identified within the study site boundary? No

Have any historical railway lines been identified within 250m of the study site boundary? No

Database searched and no data found.

Multiple sections of the same track may be listed in the detail above
Any records that have been identified are represented on the Railways and Tunnels map.

9.4 Active Railways

These datasets are derived from Ordnance Survey mapping and OpenStreetMap and provide information on the possible locations of active railway lines in proximity to the study site.

Have any active railway lines been identified within the study site boundary? No

Have any active railway lines been identified within 250m of the study site boundary? Yes

Distance (m)	Direction	Name	Type
191	SW	Kingston Loop Line	Rail
191	SW	Kingston Loop Line	Rail
194	SW	Not given	Multi Track
194	SW	Not given	Multi Track
195	SW	Kingston Loop Line	Rail
195	SW	Kingston Loop Line	Rail

Multiple sections of the same track may be listed in the detail above
Any records that have been identified are represented on the Railways and Tunnels map.

9.5 Railway Projects

These datasets provide information on the location of large scale railway projects High Speed 2 and Crossrail 1 .

Is the study site within 5km of the route of the High Speed 2 rail project?	No
Is the study site within 500m of the route of the Crossrail 1 rail project?	No

Further information on proximity to these routes, the project construction status and associated works can be obtained through the purchase of a ***Groundsure HS2 and Crossrail 1 Report****.*

The route data has been digitised from publicly available maps by Groundsure. The route as provided relates to the Crossrail 1 project only, and does not include any details of the Crossrail 2 project, as final details of the route for Crossrail 2 are still under consultation.

Please note that this assessment takes account of both the original Phase 2b proposed route and the amended route proposed in 2016. As the Phase 2b route is still under consultation, Groundsure are providing information on both options until the final route is formally confirmed. Practitioners should take account of this uncertainty when advising clients.

Contact Details

Groundsure Helpline

Telephone: 08444 159 000
info@groundsure.com

British Geological Survey Enquiries

Kingsley Dunham Centre
Keyworth, Nottingham NG12 5GG
Tel: 0115 936 3143.
Fax: 0115 936 3276.
Email:**enquiries@bgs.ac.uk**
Web:**www.bgs.ac.uk**
BGS Geological Hazards Reports and general geological enquiries

British Gypsum

British Gypsum Ltd
East Leake
Loughborough
Leicestershire
LE12 6HX

The Coal Authority

200 Lichfield Lane
Mansfield
Notts NG18 4RG
Tel: 0345 7626 848
DX 716176 Mansfield 5
www.coal.gov.uk

Public Health England

Public information access office
Public Health England, Wellington House
133-155 Waterloo Road, London, SE1 8UG
https://www.gov.uk/government/organisations/public-health-england
Email: **enquiries@phe.gov.uk**
Main switchboard: 020 7654 8000

Johnson Poole & Bloomer Limited

Harris and Pearson Building, Brettel Lane
Brierley Hill, West Midlands
DY5 3LH
Tel: +44 (0) 1384 262 000
Email:**enquiries.gs@jpb.co.uk**
Website: **www.jpb.co.uk**

Ordnance Survey

Adanac Drive, Southampton
SO16 0AS

Tel: 08456 050505
Website: http://www.ordnancesurvey.co.uk/

Getmapping PLC

Virginia Villas, High Street, Hartley Witney,
Hampshire RG27 8NW
Tel: 01252 845444
Website:**http://www1.getmapping.com/**

Peter Brett Associates
Caversham Bridge House
Waterman Place
Reading
Berkshire RG1 8DN
Tel: +44 (0)118 950 0761 E-mail:**reading@pba.co.uk**
Website:**http://www.peterbrett.com/home**

Standard Terms and Conditions

Groundsure's Terms and Conditions can be viewed online at this link:
https://www.groundsure.com/terms-and-conditions-may25-2018

APPENDIX D

Desk Study Data – Environmental Data (Groundsure EnviroInsight)

Gabriel GeoConsulting Ltd

Highfield House, Rolvenden Road,
Benenden, TN17 4EH

Groundsure Reference:	HMD-5503217
Your Reference:	GGC18675
Report Date	4 Oct 2018
Report Delivery Method:	Email - pdf

Enviro Insight

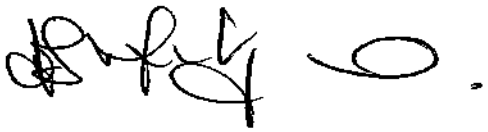
Address: 42, HIGH STREET, TEDDINGTON, TW11 8EW

Dear Sir/ Madam,

Thank you for placing your order with Groundsure. Please find enclosed the **Groundsure Enviro Insight** as requested.

If you need any further assistance, please do not hesitate to contact our helpline on 08444 159000 quoting the above Groundsure reference number.

Yours faithfully,



Managing Director
Groundsure Limited

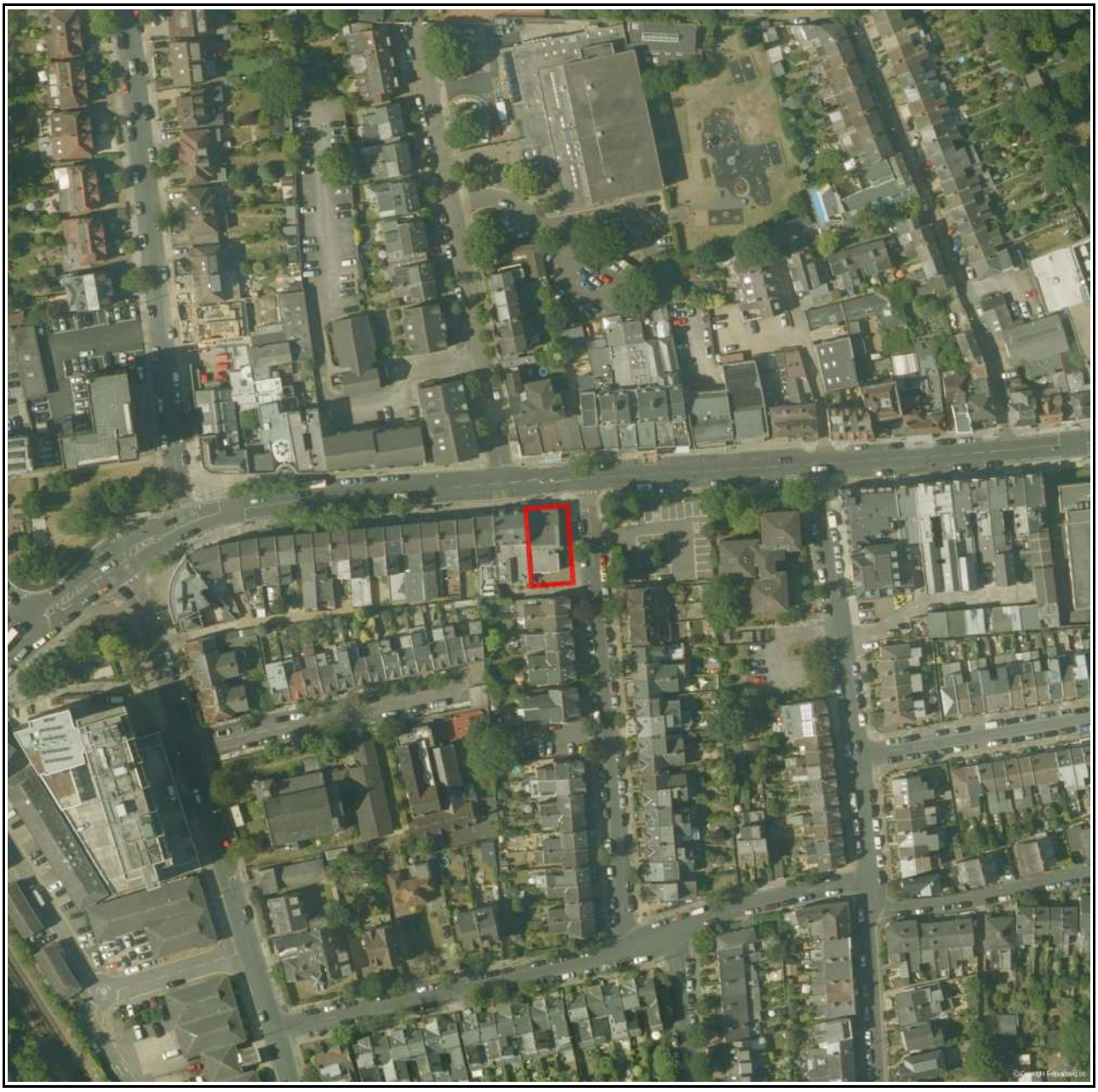
Enc.
Groundsure Enviroinsight

Enviro Insight

Address:	**42, HIGH STREET, TEDDINGTON, TW11 8EW**
Date:	**4 Oct 2018**
Reference:	**HMD-5503217**
Client:	**Gabriel GeoConsulting Ltd**

NW N NE

W E



SW S SE

Aerial Photograph Capture date:	30-Jun-2015
Grid Reference:	516088,171102
Site Size:	0.03ha

Report Reference: HMD-5503217
Client Reference: GGC18675

Contents Page

Overview of Findings

For further details on each dataset, please refer to each individual section in the main report as listed. Where the database has been searched a numerical result will be recorded. Where the database has not been searched '-' will be recorded.

Section 1: Historical Industrial Sites	On-site	0-50	51-250	251-500
1.1 Potentially Contaminative Uses identified from 1:10,000 scale mapping	0	0	66	53
1.2 Additional Information – Historical Tank Database	0	0	1	4
1.3 Additional Information – Historical Energy Features Database	0	0	10	40
1.4 Additional Information – Historical Petrol and Fuel Site Database	0	0	0	0
1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database	0	4	9	24
1.6 Historical military sites	0	0	0	0
1.7 Potentially Infilled Land	0	0	13	6

Section 2: Environmental Permits, Incidents and Registers	On-site	0-50m	51-250	251-500
2.1 Industrial Sites Holding Environmental Permits and/or Authorisations				
2.1.1 Records of historic IPC Authorisations	0	0	0	0
2.1.2 Records of Part A(1) and IPPC Authorised Activities	0	0	0	0
2.1.3 Records of Red List Discharge Consents	0	0	0	0
2.1.4 Records of List 1 Dangerous Substances Inventory sites	0	0	0	0
2.1.5 Records of List 2 Dangerous Substances Inventory sites	0	0	0	0
2.1.6 Records of Part A(2) and Part B Activities and Enforcements	0	1	1	3
2.1.7 Records of Category 3 or 4 Radioactive Substances Authorisations	0	0	3	2
2.1.8 Records of Licensed Discharge Consents	0	0	0	0
2.1.9 Records of Water Industry Referrals	0	0	0	0
2.1.10 Records of Planning Hazardous Substance Consents and Enforcements within 500m of the study site	0	0	0	0
2.2 Records of COMAH and NIHHS sites	0	0	0	0
2.3 Environment Agency/Natural Resources Wales Recorded Pollution Incidents				
2.3.1 National Incidents Recording System, List 2	0	0	0	0
2.3.2 National Incidents Recording System, List 1	0	0	0	0
2.4 Sites Determined as Contaminated Land under Part 2A EPA 1990	0	0	0	0

Section 3: Landfill and Other Waste Sites	On-site	0-50m	51-250	251-500	501-1000	1000-1500
3.1 Landfill Sites						
3.1.1 Environment Agency/Natural Resources Wales Registered Landfill Sites	0	0	0	0	0	Not searched
3.1.2 Environment Agency/Natural Resources Wales Historic Landfill Sites	0	0	0	0	0	1
3.1.3 BGS/DoE Landfill Site Survey	0	0	0	0	0	0
3.1.4 Records of Landfills in Local Authority and Historical Mapping Records	0	0	0	0	0	0
3.2 Landfill and Other Waste Sites Findings						
3.2.1 Operational and Non-Operational Waste Treatment, Transfer and Disposal Sites	0	0	0	0	Not searched	Not searched
3.2.2 Environment Agency/Natural Resources Wales Licensed Waste Sites	0	0	0	0	0	0

Section 4: Current Land Use	On-site	0-50m	51-250	251-500
4.1 Current Industrial Sites Data	0	1	28	Not searched
4.2 Records of Petrol and Fuel Sites	0	0	0	0
4.3 National Grid Underground Electricity Cables	0	0	0	0
4.4 National Grid Gas Transmission Pipelines	0	0	0	0

Section 5: Geology	
5.1 Records of Artificial Ground and Made Ground present beneath the study site	None identified
5.2 Records of Superficial Ground and Drift Geology present beneath the study site	Identified
5.3 For records of Bedrock and Solid Geology beneath the study site see the detailed findings section.	

Section 6: Hydrogeology and Hydrology	0-500m
6.1 Records of Strata Classification in the Superficial Geology within 500m of the study site	Identified
6.2 Records of Strata Classification in the Bedrock Geology within 500m of the study site	Identified

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
6.3 Groundwater Abstraction Licences (within 2000m of the study site)	0	0	0	0	5	0
6.4 Surface Water Abstraction Licences (within 2000m of the study site)	0	0	0	0	0	0
6.5 Potable Water Abstraction Licences (within 2000m of the study site)	0	0	0	0	0	0
6.6 Source Protection Zones (within 500m of the study site)	0	0	0	0	Not searched	Not searched
6.7 Source Protection Zones within Confined Aquifer	0	0	0	0	Not searched	Not searched
6.8 Groundwater Vulnerability and Soil Leaching Potential (within 500m of the study site)	1	0	#250GWV#	#500GWV#	Not searched	Not searched

Section 6: Hydrogeology and Hydrology

	0-500m					
	On-site	0-50m	51-250	251-500	501-1000	1000-1500
6.9 Environment Agency/Natural Resources Wales information on river quality within 1500m of the study site	No	No	No	No	Yes	No
6.10 Ordnance Survey MasterMap Water Network entries within 500m of the site	0	0	0	0	Not searched	Not searched
6.11 Surface water features within 250m of the study site	No	No	No	Not searched	Not searched	Not searched

Section 7: Flooding

7.1 Enviroment Agency Zone 2 floodplains within 250m of the study site	None identified
7.2 Environment Agency/Natural Resources Wales Zone 3 floodplains within 250m of the study site	None identified
7.3 Risk of flooding from Rivers and the Sea (RoFRaS) rating for the study site	Very Low
7.4 Flood Defences within 250m of the study site	None identified
7.5 Areas benefiting from Flood Defences within 250m of the study site	None identified
7.6 Areas used for Flood Storage within 250m of the study site	None identified
7.7 Maximum BGS Groundwater Flooding susceptibility within 50m of the study site	Potential at Surface
7.8 BGS confidence rating for the Groundwater Flooding susceptibility areas	Moderate

Section 8: Designated Environmentally Sensitive Sites

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
8.1 Records of Sites of Special Scientific Interest (SSSI)	0	0	0	0	5	5
8.2 Records of National Nature Reserves (NNR)	0	0	0	0	0	0
8.3 Records of Special Areas of Conservation (SAC)	0	0	0	0	0	0
8.4 Records of Special Protection Areas (SPA)	0	0	0	0	0	0
8.5 Records of Ramsar sites	0	0	0	0	0	0
8.6 Records of Ancient Woodlands	0	0	0	0	0	0
8.7 Records of Local Nature Reserves (LNR)	0	0	0	0	1	2
8.8 Records of World Heritage Sites	0	0	0	0	0	0
8.9 Records of Environmentally Sensitive Areas	0	0	0	0	0	0

Section 8: Designated Environmentally Sensitive Sites

	On-site	0-50m	51-250	251-500	501-1000	1000-2000
8.10 Records of Areas of Outstanding Natural Beauty (AONB)	0	0	0	0	0	0
8.11 Records of National Parks	0	0	0	0	0	0
8.12 Records of Nitrate Sensitive Areas	0	0	0	0	0	0
8.13 Records of Nitrate Vulnerable Zones	0	0	0	0	0	0
8.14 Records of Green Belt land	0	0	0	0	0	0

Section 9: Natural Hazards

9.1 Maximum risk of natural ground subsidence	Moderate
9.1.1 Maximum Shrink-Swell hazard rating identified on the study site	Moderate
9.1.2 Maximum Landslides hazard rating identified on the study site	Very Low
9.1.3 Maximum Soluble Rocks hazard rating identified on the study site	Negligible
9.1.4 Maximum Compressible Ground hazard rating identified on the study site	Negligible
9.1.5 Maximum Collapsible Rocks hazard rating identified on the study site	Very Low
9.1.6 Maximum Running Sand hazard rating identified on the study site	Very Low
9.2 Radon	
9.2.1 Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level?	The site is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.
9.2.2 Is the property in an area where Radon Protection are required for new properties or extensions to existing ones as described in publication BR211 by the Building Research Establishment?	No radon protective measures are necessary.

Section 10: Mining

10.1 Coal mining areas within 75m of the study site	None identified
10.2 Non-Coal Mining areas within 50m of the study site boundary	None identified
10.3 Brine affected areas within 75m of the study site	None identified

Using this report

The following report is designed by Environmental Consultants for Environmental Professionals bringing together the most up-to-date market leading environmental data. This report is provided under and subject to the Terms & Conditions agreed between Groundsure and the Client. The document contains the following sections:

1. Historical Industrial Sites

Provides information on past land uses that may pose a risk to the study site in terms of potential contamination from activities or processes. Potentially Infilled Land features are also included. This search is conducted using radii of up to 500m.

2. Environmental Permits, Incidents and Registers

Provides information on Regulated Industrial Activities and Pollution Incidents as recorded by Regulatory Authorities, and sites determined as Contaminated Land. This search is conducted using radii up to 500m.

3. Landfills and Other Waste Sites

Provides information on landfills and other waste sites that may pose a risk to the study site. This search is conducted using radii up to 1500m.

4. Current Land Uses

Provides information on current land uses that may pose a risk to the study site in terms of potential contamination from activities or processes. These searches are conducted using radii of up to 500m. This includes information on potentially contaminative industrial sites, petrol stations and fuel sites as well as high pressure gas pipelines and underground electricity transmission lines.

5. Geology

Provides information on artificial and superficial deposits and bedrock beneath the study site.

6. Hydrogeology and Hydrology

Provides information on productive strata within the bedrock and superficial geological layers, abstraction licences, Source Protection Zones (SPZs) and river quality. These searches are conducted using radii of up to 2000m.

7. Flooding

Provides information on river and coastal flooding, flood defences, flood storage areas and groundwater flood areas. This search is conducted using radii of up to 250m.

8. Designated Environmentally Sensitive Sites

Provides information on the Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar sites, Local Nature Reserves (LNR), Areas of Outstanding Natural Beauty (AONB), National Parks (NP), Environmentally Sensitive Areas, Nitrate Sensitive Areas, Nitrate Vulnerable Zones and World Heritage Sites and Scheduled Ancient Woodland. These searches are conducted using radii of up to 2000m.

9. Natural Hazards

Provides information on a range of natural hazards that may pose a risk to the study site. These factors include natural ground subsidence and radon..

10. Mining

Provides information on areas of coal and non-coal mining and brine affected areas.

11. Contacts

This section of the report provides contact points for statutory bodies and data providers that may be able to provide further information on issues raised within this report. Alternatively, Groundsure provide a free Technical Helpline (08444 159000) for further information and guidance.

Note: Maps

Only certain features are placed on the maps within the report. All features represented on maps found within this search are given an identification number. This number identifies the feature on the mapping and correlates it to the additional information provided below. This identification number precedes all other information and takes the following format -Id: 1, Id: 2, etc. Where numerous features on the same map are in such close proximity that the numbers would obscure each other a letter identifier is used instead to represent the features. (e.g. Three features which overlap may be given the identifier “A” on the map and would be identified separately as features 1A, 3A, 10A on the data tables provided).

Where a feature is reported in the data tables to a distance greater than the map area, it is noted in the data table as “Not Shown”.

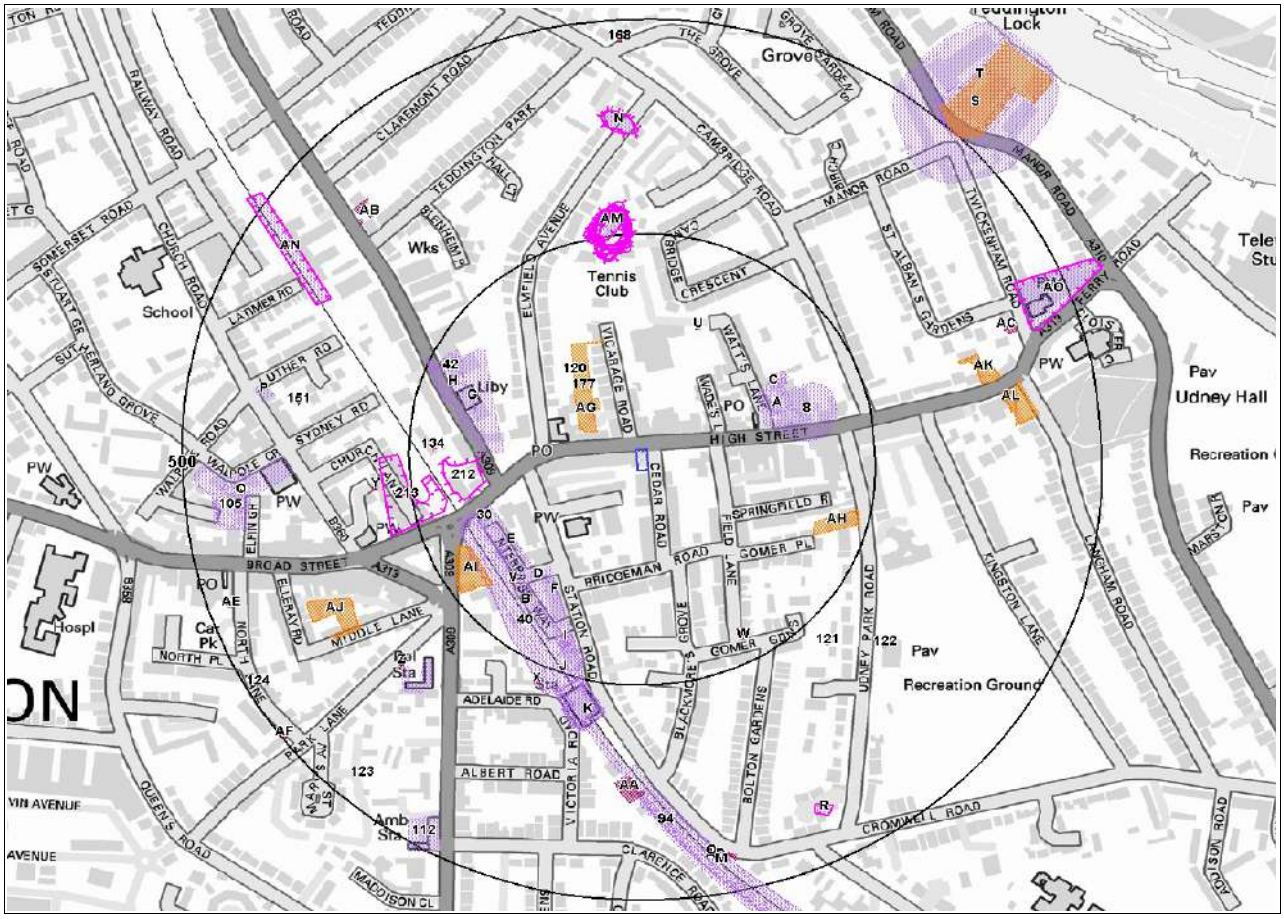
All distances given in this report are in Metres (m). Directions are given as compass headings such as N: North, E: East, NE: North East from the nearest point of the study site boundary.

1. Historical Land Use

NW N NE

W E

SW S SE



Site Outline

250 500 Search Buffers (m)

Historical 1:10,000 and 1:10,560 scale mapping

Industrial Land Use

Potentially Infilled Land

Historical 1:2,500, 1:1,250 and 1:500 scale mapping

Energy Features

Petrol Stations

Historical military sites

Tanks

Garages

1. Historical Industrial Sites

1.1 Potentially Contaminative Uses identified from 1:10,000 scale Mapping

The systematic analysis of data extracted from standard 1:10,560 and 1:10,000 scale historical maps provides the following information:

Records of sites with a potentially contaminative past land use within 500m of the search boundary: 119

ID	Distance [m]	Direction	Use	Date
1A	132	E	Smithy	1894
2A	138	E	Smithy	1895
3G	145	W	Wax Candle Factory	1913
4C	145	NE	Smithy	1894
5A	146	NE	Smithy	1913
6B	148	SW	Railway Sidings	1938
7B	148	SW	Railway Sidings	1912
8	149	E	Smithy	1913
9A	151	NE	Smithy	1899
10B	154	SW	Railway Sidings	1913
11C	155	NE	Smithy	1913
12C	155	NE	Smithy	1912
13C	155	NE	Smithy	1938
14D	156	SW	Railway Building	1938
15D	156	SW	Railway Building	1912
16C	157	NE	Smithy	1938
17B	157	SW	Railway Sidings	1948
18B	157	SW	Railway Sidings	1973
19B	157	SW	Railway Sidings	1966
20C	159	NE	Smithy	1933
21E	160	SW	Railway Building	1912
22E	160	SW	Railway Building	1938
23F	165	SW	Railway Building	1948
24E	168	SW	Railway Building	1933
25F	170	SW	Railway Building	1913
26E	171	SW	Railway Building	1938
27E	173	SW	Railway Building	1938
28E	173	SW	Railway Building	1912
29E	175	SW	Railway Building	1913
30	175	W	Railway Building	1913
31G	177	W	Candle Factory	1913
32B	177	SW	Railway Sidings	1865
33B	177	SW	Railway Sidings	1938
34B	181	SW	Railway Sidings	1934

35B	181	SW	Railway Sidings	1933
36B	181	SW	Railway Sidings	1913
37B	181	SW	Railway Sidings	1938
38H	182	W	Wax Candle Factory	1912
39B	185	SW	Railway Sidings	1913
40	195	SW	Railway Sidings	1933
41H	202	NW	Wax Candle Factory	1913
42	205	NW	Wax Candle Factory	1933
43I	206	SW	Railway Building	1933
44I	207	SW	Railway Building	1938
45I	209	SW	Railway Building	1966
46I	209	SW	Railway Building	1948
47I	209	SW	Railway Building	1973
48I	210	SW	Railway Building	1912
49I	210	SW	Railway Building	1938
50I	212	S	Railway Building	1934
51I	214	SW	Railway Building	1938
52I	214	SW	Railway Building	1913
53I	215	SW	Railway Building	1913
54I	216	S	Railway Building	1913
55J	240	S	Railway Building	1948
56J	241	S	Railway Building	1934
57J	241	S	Railway Building	1938
58AM	246	N	Unspecified Pit	1991
59K	247	S	Railway Station	1933
60K	248	S	Railway Station	1938
61K	250	S	Railway Station	1912
62K	250	S	Railway Station	1938
63K	250	S	Railway Station	1948
64K	250	S	Railway Station	1973
65K	250	S	Railway Station	1966
66K	250	S	Railway Station	1991
67K	252	S	Railway Station	1894
68K	252	S	Railway Station	1934
69K	253	S	Railway Station	1895
70K	254	S	Railway Station	1894
71K	254	S	Railway Station	1913
72K	254	S	Railway Station	1938
73K	256	S	Railway Station	1899
74K	256	S	Railway Station	1913
75K	258	S	Railway Station	1913
76K	268	S	Railway Station	1865
77L	317	SW	Police Station	1973
78L	317	SW	Police Station	1991
79O	340	S	Railway Sidings	1948
80M	365	S	Railway Sidings	1912

81M	365	S	Railway Sidings	1938
82N	367	N	Unspecified Ground Workings	1894
83N	367	N	Unspecified Pits	1894
84AD	369	S	Railway Sidings	1894
85O	371	S	Railway Sidings	1938
86O	371	S	Railway Sidings	1934
87M	373	S	Railway Sidings	1895
88M	376	S	Railway Sidings	1894
89O	376	S	Railway Sidings	1913
90M	377	S	Railway Sidings	1938
91Q	378	W	Hospital	1899
92M	378	S	Railway Sidings	1913
93AN	380	NW	Cuttings	1865
94	383	S	Railway Sidings	1913
95P	403	W	Police Station	1973
96P	403	W	Police Station	1966
97Q	417	W	Hospital	1894
98Q	425	W	Hospital	1938
99R	431	SE	Unspecified Pit	1938
100R	431	SE	Unspecified Pit	1938
101Q	431	W	Hospital	1895
102Q	432	W	Hospital	1933
103Q	434	W	Hospital	1913
104Q	434	W	Hospital	1894
105	436	W	Hospital	1913
106Q	437	W	Hospital	1912
107Q	438	W	Hospital	1938
108O	439	S	Railway Sidings	1933
109O	442	S	Railway Sidings	1913
110S	442	NE	Timber Yard	1913
111AO	445	E	Grave Yard	1865
112	457	SW	Ambulance Station	1991
113S	492	NE	Timber Yard	1913
114S	494	NE	Timber Yard	1913
115T	495	NE	Unspecified Commercial/Industrial	1938
116S	495	NE	Timber Yard	1912
117S	495	NE	Timber Yard	1938
118T	497	NE	Timber Yard	1938
119S	500	NE	Timber Yard	1933

1.2 Additional Information – Historical Tank Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical tanks within 500m of the search boundary: 5

ID	Distance (m)	Direction	Use	Date
120	111	NW	Unspecified Tank	1978
121	281	SE	Unspecified Tank	1994
122	329	SE	Unspecified Tank	1934
123	465	SW	Unspecified Tank	1896
124	484	SW	Unspecified Tank	1865

1.3 Additional Information – Historical Energy Features Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical energy features within 500m of the search boundary: 50

ID	Distance (m)	Direction	Use	Date
125U	149	N	Electricity Substation	1991
126U	149	N	Electricity Substation	1989
127U	149	N	Electricity Substation	1989
128U	150	N	Electricity Substation	1978
129V	186	SW	Electricity Substation	1987
130V	188	SW	Electricity Substation	1994
131V	188	SW	Electricity Substation	1992
132W	218	SE	Electricity Substation	1994
133W	219	SE	Electricity Substation	1971
134	220	W	Electricity Substation	1979
135X	267	SW	Electricity Substation	1987
136X	267	SW	Electricity Substation	1983
137X	267	SW	Electricity Substation	1986
138X	267	SW	Electricity Substation	1983
139X	267	SW	Electricity Substation	1992
140X	267	SW	Electricity Substation	1994
141Y	288	W	Electricity Substation	1996
142Y	288	W	Electricity Substation	1989
143Z	341	SW	Electricity Substation	1987
144Z	341	SW	Electricity Substation	1986
145Z	341	SW	Electricity Substation	1983

146Z	341	SW	Electricity Substation	1983
147Z	341	SW	Electricity Substation	1994
148Z	341	SW	Electricity Substation	1992
149AA	354	S	Electricity Substation	1971
150AA	361	S	Electricity Substation	1994
151	372	W	Electricity Substation	1996
152AB	398	NW	Electricity Substation	1979
153AB	400	NW	Electricity Substation	1996
154AB	410	NW	Electricity Substation	1989
155AC	417	E	Electricity Substation	1989
156AC	417	E	Electricity Substation	1989
157AC	417	E	Electricity Substation	1991
158AC	420	E	Electricity Substation	1978
159AC	429	E	Electricity Substation	1978
160AD	454	S	Electricity Substation	1971
161AD	454	S	Electricity Substation	1994
162AE	472	W	Electricity Substation	1994
163AE	472	W	Electricity Substation	1992
164AE	472	W	Electricity Substation	1986
165AE	472	W	Electricity Substation	1983
166AE	472	W	Electricity Substation	1983
167AE	472	W	Electricity Substation	1987
168	474	N	Electricity Substation	1978
169AF	495	SW	Electricity Substation	1987
170AF	496	SW	Electricity Substation	1983
171AF	496	SW	Electricity Substation	1986
172AF	496	SW	Electricity Substation	1983
173AF	496	SW	Electricity Substation	1992
174AF	496	SW	Electricity Substation	1994

1.4 Additional Information – Historical Petrol and Fuel Site Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical petrol stations and fuel sites within 500m of the search boundary: 0

Database searched and no data found.

1.5 Additional Information – Historical Garage and Motor Vehicle Repair Database

The systematic analysis of data extracted from High Detailed 1:1,250 and 1:2,500 scale historical maps provides the following information.

Records of historical garage and motor vehicle repair sites within 500m of the search boundary: 37

ID	Distance (m)	Direction	Use	Date
175AG	47	NW	Garage	1959
176AG	47	NW	Garage	1959
177	47	NW	Garage	1958
178AG	48	NW	Garage	1978
179AH	192	E	Garage	1958
180AH	193	E	Garage	1959
181AH	193	E	Garage	1959
182AI	204	SW	Garage	1959
183AI	204	SW	Garage	1963
184AI	204	SW	Garage	1960
185AI	205	SW	Garage	1983
186AI	205	SW	Garage	1986
187AI	205	SW	Garage	1983
188AJ	349	SW	Garage	1963
189AJ	349	SW	Garage	1987
190AJ	349	SW	Garage	1992
191AJ	349	SW	Garage	1994
192AJ	350	SW	Garage	1986
193AJ	350	SW	Garage	1983
194AJ	350	SW	Garage	1983
195AK	358	E	Garage	1958
196AK	359	E	Garage	1959
197AK	359	E	Garage	1959
198AK	367	E	Garage	1978
199AK	373	E	Garage	1989
200AK	373	E	Garage	1989
201AK	373	E	Garage	1991
202AL	395	E	Garage	1989
203AL	395	E	Garage	1989
204AL	395	E	Garage	1958
205AL	396	E	Garage	1978
206AL	396	E	Garage	1991
207AL	396	E	Garage	1959
208AL	396	E	Garage	1959
209AL	407	E	Garage	1993
210AL	408	E	Garage	1978
211S	498	NE	Motor Repair Works	1934

1.6 Historical military sites

Certain military installations were not noted on historic mapping for security reasons. Whilst not all military land is necessarily of concern, Groundsure has researched and digitised a number of Ordnance Factories and other military industrial features (e.g. Ordnance Depots, Munitions Testing Grounds) which may be of contaminative concern. This research was drawn from a number of different sources, and should not be regarded as a definitive or exhaustive database of potentially contaminative military installations. The boundaries of sites within this database have been estimated from the best evidence available to Groundsure at the time of compilation.

Records of historical military sites within 500m of the search boundary: 0

Database searched and no data found.

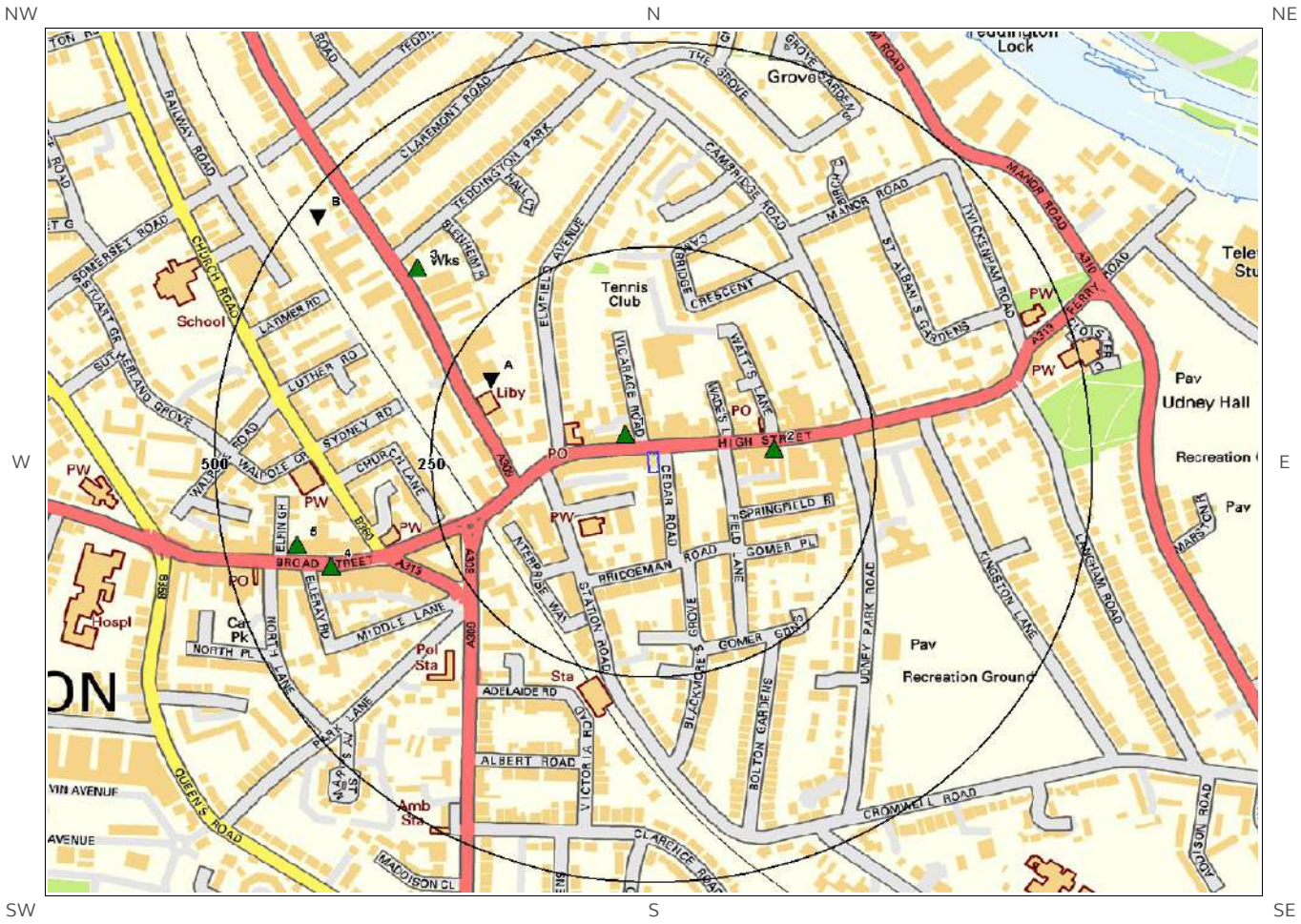
1.7 Potentially Infilled Land

Records of Potentially Infilled Features from 1:10,000 scale mapping within 500m of the study site: 19

The following Historical Potentially Infilled Features derived from the Historical Mapping information is provided by Groundsure:

ID	Distance(m)	Direction	Use	Date
212	170	W	Pond	1865
213	212	W	Pond	1865
214AM	221	N	Pond	1973
215AM	221	N	Pond	1966
216AM	223	N	Pond	1934
217AM	224	N	Pond	1938
218AM	227	N	Pond	1948
219AM	230	N	Pond	1913
220AM	234	N	Pond	1913
221AM	238	N	Pond	1912
222AM	238	N	Pond	1938
223AM	240	N	Pond	1933
224AM	246	N	Unspecified Pit	1991
225N	367	N	Unspecified Ground Workings	1894
226N	367	N	Unspecified Pits	1894
227AN	380	NW	Cuttings	1865
228R	431	SE	Unspecified Pit	1938
229R	431	SE	Unspecified Pit	1938
230AO	445	E	Grave Yard	1865

2. Environmental Permits, Incidents and Registers Map



- Site Outline
- 250 / 500 Search Buffers (m)
- Recorded Pollution Incident
- Dangerous Substances (List 1)
- Dangerous Substances (List 2)
- Water Industry Referrals
- Licenced Discharge Consents
- Red List Discharge Consents
- RAS 3 & 4 Authorisations
- Part A(1) Authorised Processes and Historic IPC Authorisations
- Part A(2) and Part B Authorised Processes
- COMAH / NIHHS Sites
- Sites Determined as Contaminated Land
- Hazardous Substance Consents and Enforcements

2. Environmental Permits, Incidents and Registers

2.1 Industrial Sites Holding Licences and/or Authorisations

Searches of information provided by the Environment Agency/Natural Resources Wales and Local Authorities reveal the following information:

2.1.1 Records of historic IPC Authorisations within 500m of the study site:

0

Database searched and no data found.

2.1.2 Records of Part A(1) and IPPC Authorised Activities within 500m of the study site:

0

Database searched and no data found.

2.1.3 Records of Red List Discharge Consents (potentially harmful discharges to controlled waters) within 500m of the study site:

0

Database searched and no data found.

2.1.4 Records of List 1 Dangerous Substances Inventory Sites within 500m of the study site:

0

Database searched and no data found.

2.1.5 Records of List 2 Dangerous Substance Inventory Sites within 500m of the study site:

0

Database searched and no data found.

2.1.6 Records of Part A(2) and Part B Activities and Enforcements within 500m of the study site:

5

The following Part A(2) and Part B Activities are represented as points on the Environmental Permits, Incidents and Registers Map:

ID	Distance (m)	Direction	NGR	Details	
1	33	NW	516055 171132	Address: Pristine Laundries, 37 High Street, Teddington, TW11 8ET Process: Dry Cleaning Status: Current Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of Enforcement: No Enforcements Notified Comment: No Enforcements Notified
2	133	E	516226 171113	Address: Oceana Dry Cleaners, 84 High Street, Teddington, TW11 8JD Process: Dry Cleaning Status: Current Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of Enforcement: No Enforcements Notified Comment: No Enforcements Notified
3	347	NW	515815 171334	Address: Jacksons Ford, 50 Waldegrave Road, Teddington, TW11 8NY Process: Waste Oil Burner <0.4 MW Status: Historical Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of Enforcement: No Enforcements Notified Comment: No Enforcements Notified
4	386	W	515715 170971	Address: Silks Dry Cleaners, 54 Broad Street, Teddington, TW11 8QY Process: Dry Cleaning Status: Current Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of Enforcement: No Enforcements Notified Comment: No Enforcements Notified
5	417	W	515676 170997	Address: Johnson Cleaners UK Ltd, 51 Broad Street, Teddington, TW11 8QZ Process: Dry Cleaning Status: Historical Permit Permit Type: Part B	Enforcement: No Enforcements Notified Date of Enforcement: No Enforcements Notified Comment: No Enforcements Notified

2.1.7 Records of Category 3 or 4 Radioactive Substances Authorisations:

5

The following RAS Licence (3 or 4) records are represented as points on the Environmental Permits, Incidents and Registers Map:

ID	Distance (m)	Direction	NGR	Address	Operator	Type	Permission Number	Dates	Status
11A	201	NW	515900 171200	Paint Research Association, 8 Waldegrave Road, Teddington, Middlesex, TW11 8LD	Paint Research Association	Disposal Of Radioactive Waste (was Rsa60 Section 6).	AY2257	Date of Approval:5/12/1997 Effective from:9/12/1997 Last date of update:2015-01-01	Revoked/cancelled

ID	Distance (m)	Direction	NGR	Address	Operator	Type	Permission Number	Dates	Status
12A	201	NW	515900 171200	Paint Research Association, 8 Waldegrave Road, Teddington, Middlesex, TW11 8LD	Paint Research Association	Disposal Of Radioactive Waste (was Rsa60 Section 6).	AY2257	Date of Approval:3/6/1997 Effective from:17/6/1997 Last date of update:2015-01-01	Superseded By Variation
13A	201	NW	515900 171200	Paint Research Association, 8 Waldegrave Road, Teddington, Middlesex, TW11 8LD	Paint Research Association	Disposal Of Radioactive Waste (was Rsa60 Section 6).	AD2344	Date of Approval:31/3/1991 Effective from:31/3/1991 Last date of update:2015-01-01	Revoked/cancelled
14B	478	NW	515700 171400	Laboratory Impex Systems Ltd, 111-113 Waldegrave Road, Teddington, Middlesex, TW11 8LL	Laboratory Impex Systems Ltd	Disposal Of Radioactive Waste (was Rsa60 Section 6).	AC4180	Date of Approval:31/3/1991 Effective from:31/3/1991 Last date of update:2015-01-01	Revoked/cancelled
15B	478	NW	515700 171400	Hybaid Ltd, 111-113 Waldegrave Road, Teddington, Middlesex, TW11 8LL	Hybaid Ltd	Disposal Of Radioactive Waste (was Rsa60 Section 6).	AY7500	Date of Approval:28/7/1997 Effective from:1/8/1997 Last date of update:2015-01-01	Revoked/cancelled

2.1.8 Records of Licensed Discharge Consents within 500m of the study site:

0

Database searched and no data found.

2.1.9 Records of Water Industry Referrals (potentially harmful discharges to the public sewer) within 500m of the study site:

0

Database searched and no data found.

2.1.10 Records of Planning Hazardous Substance Consents and Enforcements within 500m of the study site:

0

Database searched and no data found.

2.2 Dangerous or Hazardous Sites

Records of COMAH & NIHHS sites within 500m of the study site: 0

Database searched and no data found.

2.3 Environment Agency/Natural Resources Wales Recorded Pollution Incidents

2.3.1 Records of National Incidents Recording System, List 2 within 500m of the study site:

0

Database searched and no data found.

2.3.2 Records of National Incidents Recording System, List 1 within 500m of the study site:

0

Database searched and no data found.

2.4 Sites Determined as Contaminated Land under Part 2A EPA 1990

Records of sites determined as contaminated land under Section 78R of the Environmental Protection Act 1990 are there within 500m of the study site 0

Database searched and no data found.

---

3. Landfill and Other Waste Sites Map

Site Outline

250 / 500 Search Buffers (m)

EA/NRW Active Landfill

EA/NRW Historic Landfill

BGS / DoE Survey Landfill

Historic and Planned Waste Sites

EA/NRW Licensed Waste Site

Local Authority/Historical Mapping Landfill Records

3. Landfill and Other Waste Sites

3.1 Landfill Sites

3.1.1 Records from Environment Agency/Natural Resources Wales landfill data within 1000m of the study site:

0

Database searched and no data found.

3.1.2 Records of Environment Agency/Natural Resources Wales historic landfill sites within 1500m of the study site:

1

The following landfill records are represented as either points or polygons on the Landfill and Other Waste Sites map:

ID	Distance (m)	Direction	NGR	Details	
Not shown	1486	E		Site Address: Broom Road Recreation Ground, Broom Road Waste Licence: - Site Reference: 8RI001, RIC001 Waste Type: - Environmental Permitting Regulations (Waste) Reference: -	Licence Issue: Licence Surrendered: Licence Holder Address: - Operator: - Licence Holder: - First Recorded: - Last Recorded: -

3.1.3 Records of BGS/DoE non-operational landfill sites within 1500m of the study site:

0

Database searched and no data found.

3.1.4 Records of Landfills from Local Authority and Historical Mapping Records within 1500m of the study site:

0

Database searched and no data found.

3.2 Other Waste Sites

3.2.1 Records of waste treatment, transfer or disposal sites within 500m of the study site:

0

Database searched and no data found.

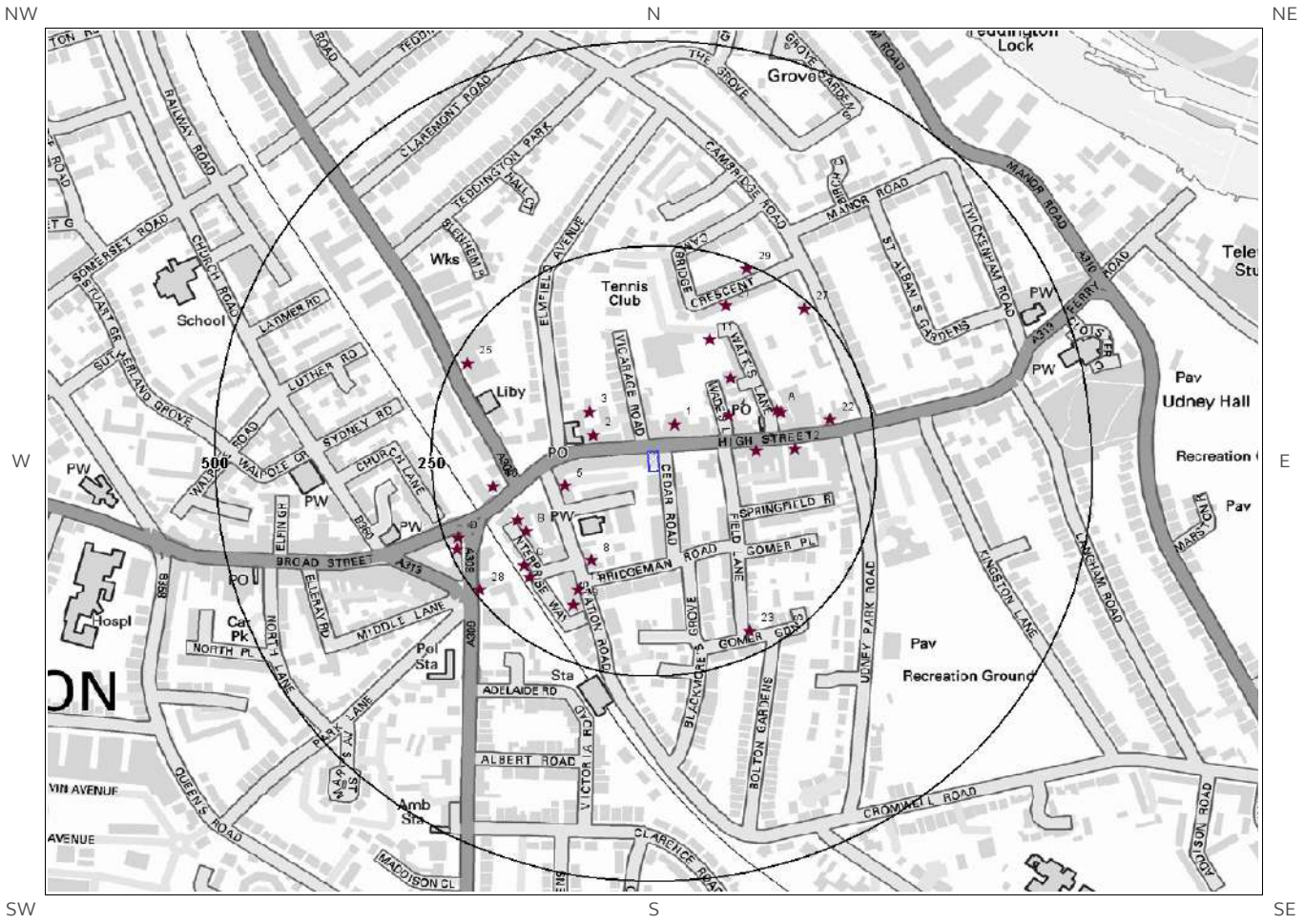
3.2.2 Records of Environment Agency/Natural Resources Wales licensed waste sites within 1500m of the study site:

0

Database searched and no data found.

---

4. Current Land Use Map



Site Outline

Search Buffers (m)
250
500

Current Industrial Sites

Petrol & Fuel Sites

Electricity Transmission Cables

Gas Transmission Pipelines

4. Current Land Uses

4.1 Current Industrial Data

Records of potentially contaminative industrial sites within 250m of the study site: 29

The following records are represented as points on the Current Land Uses map.

ID	Distance (m)	Direction	Company	NGR	Address	Activity	Category
1	38	NE	Day2Day Hearing	516112 171145	53, High Street, Teddington, TW11 8HD	Disability and Mobility Equipment	Consumer Products
2	66	W	Teddington Instant Print	516017 171132	27, High Street, Teddington, TW11 8ET	Published Goods	Industrial Products
3	83	NW	Works	516014 171161	TW11	Unspecified Works Or Factories	Industrial Features
4	92	NE	Works	516174 171156	TW11	Unspecified Works Or Factories	Industrial Features
5	99	W	Kindle Stoves	515985 171070	1, Station Road, Teddington, TW11 9AA	Fireplaces and Mantelpieces	Consumer Products
6	113	E	Works	516206 171114	TW11	Unspecified Works Or Factories	Industrial Features
7	123	NE	Works	516177 171202	TW11	Unspecified Works Or Factories	Industrial Features
8	127	SW	Churcham House LLP	516016 170979	1, Bridgeman Road, Teddington, TW11 9AJ	Business Parks and Industrial Estates	Industrial Features
9A	146	E	Works	516230 171163	TW11	Unspecified Works Or Factories	Industrial Features
10A	149	E	Apollo Garage	516234 171160	2-8, Watts Lane, Teddington, TW11 8HQ	Vehicle Repair, Testing and Servicing	Repair and Servicing
11	149	NE	Electricity Sub Station	516152 171249	TW11	Electrical Features	Infrastructure and Facilities
12	158	E	Telephone Exchange	516251 171116	TW11	Telecommunications Features	Infrastructure and Facilities
13B	160	SW	J C P Construction Products	515940 171015	Unit 14 Teddington Business Park, Station Road, Teddington, TW11 9BQ	General Construction Supplies	Industrial Products
14B	163	W	Air Conditioning Associates Ltd	515930 171029	Unit 11 Teddington Business Park, Station Road, Teddington, TW11 9BQ	Construction Completion Services	Construction Services
15	165	SW	Teddington Cheese	516000 170944	42, Station Road, Teddington, TW11 9AA	Dairy Products	Foodstuffs
16	181	W	B M T Group Ltd	515902 171070	Goodrich House 1, Waldegrave Road, Teddington, TW11 8LZ	Civil Engineers	Engineering Services
17C	184	SW	Alfresco Floors	515937 170973	Unit 6 Teddington Business Park, Station Road, Teddington, TW11 9BQ	Construction Completion Services	Construction Services

ID	Distance (m)	Direction	Company	NGR	Address	Activity	Category
18C	184	SW	The Outdoor Deck Co	515937 170973	Unit 6 Teddington Business Park, Station Road, Teddington, TW11 9BQ	Garden Goods	Consumer Products
19	185	SW	Halfords Autocentre	515994 170925	Unit 2 Teddington Business Park, Station Road, Teddington, TW11 9BQ	Vehicle Repair, Testing and Servicing	Repair and Servicing
20C	188	SW	Electricity Sub Station	515945 170959	TW11	Electrical Features	Infrastructure and Facilities
21	195	NE	Edwina Laurie Home Furnishings	516170 171290	21, Cambridge Crescent, Teddington, TW11 8DX	Curtains and Blinds	Consumer Products
22	202	E	Nichols Jewellers	516291 171151	121a, High Street, Teddington, TW11 8HG	Jewellery, Gems, Clocks and Watches	Consumer Products
23	220	SE	Electricity Sub Station	516198 170894	TW11	Electrical Features	Infrastructure and Facilities
24D	235	W	The Repair Station	515862 171007	86, Broad Street, Teddington, TW11 8QT	Electrical Equipment Repair and Servicing	Repair and Servicing
25	235	NW	The Brand Architekts Ltd	515872 171220	Suite X1 2nd Floor 8, Waldegrave Road, Teddington, TW11 8GT	Medical Equipment, Supplies and Pharmaceuticals	Industrial Products
26D	242	SW	Communicate Mobile Ltd	515860 170992	6, Park Road, Teddington, TW11 0AA	Radar and Telecommunications Equipment	Industrial Products
27	242	NE	Glass Coat	516261 171286	25a, Cambridge Road, Teddington, TW11 8DT	Glass	Industrial Products
28	243	SW	Electricity Sub Station	515887 170944	TW11	Electrical Features	Infrastructure and Facilities
29	245	NE	Clothing & Manufacturing	516195 171335	8, Cambridge Crescent, Teddington, TW11 8DY	Clothing, Components and Accessories	Consumer Products

4.2 Petrol and Fuel Sites

Records of petrol or fuel sites within 500m of the study site: 0

Database searched and no data found.

4.3 National Grid High Voltage Underground Electricity Transmission Cables

This dataset identifies the high voltage electricity transmission lines running between generating power plants and electricity substations. The dataset does not include the electricity distribution network (smaller, lower voltage cables distributing power from substations to the local user network). This information has been extracted from databases held by National Grid and is provided for information only with no guarantee as to its completeness or accuracy. National Grid do not offer any warranty as to the accuracy of the available data and are excluded from any liability for any such inaccuracies or errors.

Records of National Grid high voltage underground electricity transmission cables within 500m of the study site: 0

Database searched and no data found.

4.4 National Grid High Pressure Gas Transmission Pipelines

This dataset identifies high-pressure, large diameter pipelines which carry gas between gas terminals, power stations, compressors and storage facilities. The dataset does not include the Local Transmission System (LTS) which supplies gas directly into homes and businesses. This information has been extracted from databases held by National Grid and is provided for information only with no guarantee as to its completeness or accuracy. National Grid do not offer any warranty as to the accuracy of the available data and are excluded from any liability for any such inaccuracies or errors.

Records of National Grid high pressure gas transmission pipelines within 500m of the study site: 0

Database searched and no data found.

5. Geology

5.1 Artificial Ground and Made Ground

Database searched and no data found.

The database has been searched on site, including a 50m buffer.

5.2 Superficial Ground and Drift Geology

The database has been searched on site, including a 50m buffer.

Lex Code	Description	Rock Type
KPGR-XSV	KEMPTON PARK GRAVEL MEMBER	SAND AND GRAVEL

5.3 Bedrock and Solid Geology

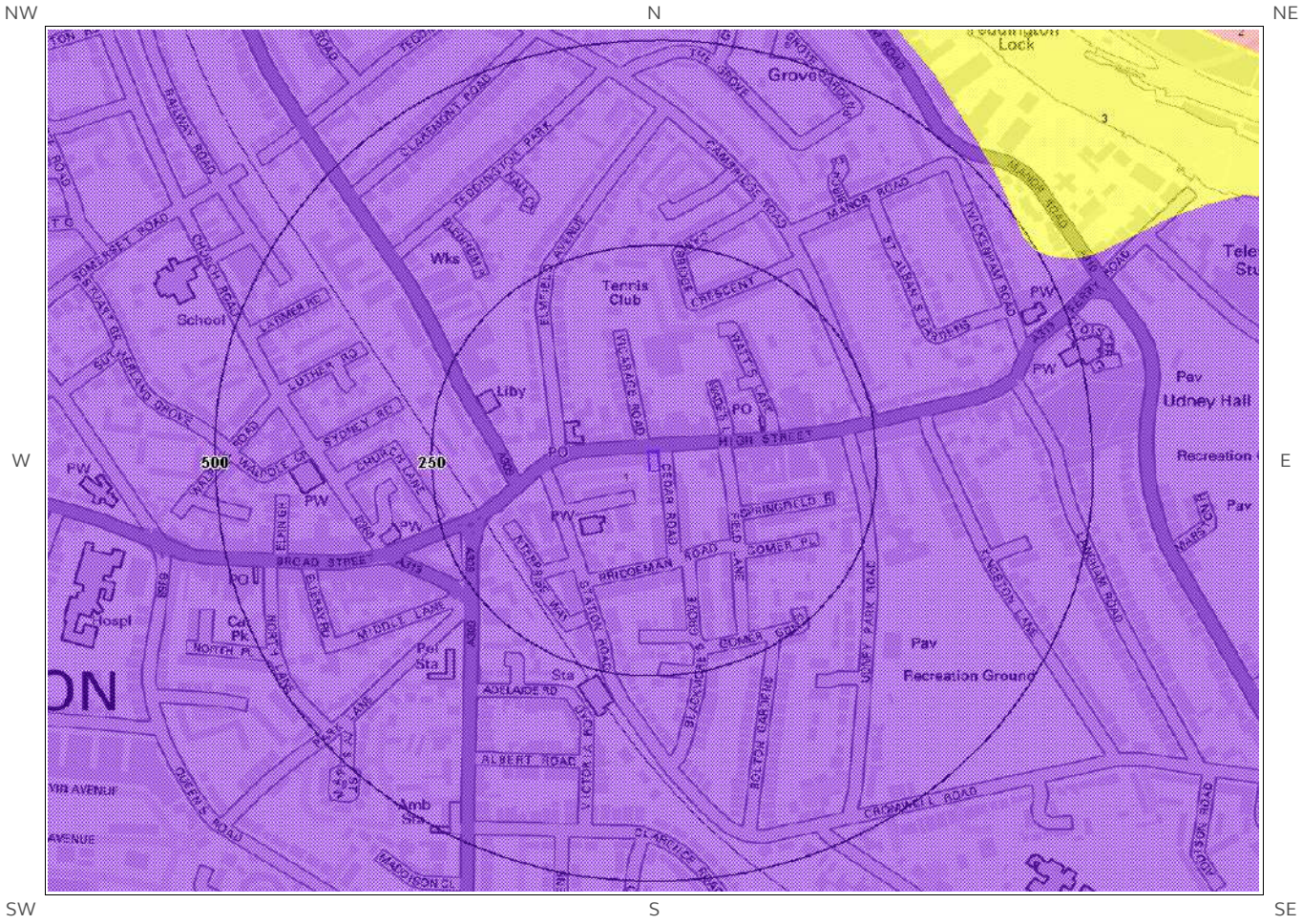
The database has been searched on site, including a 50m buffer.

Lex Code	Description	Rock Type
LC-XCZ	LONDON CLAY FORMATION	CLAY AND SILT

(Derived from the BGS 1:50,000 Digital Geological Map of Great Britain)

6 Hydrogeology and Hydrology

6a. Aquifer Within Superficial Geology



6b. Aquifer Within Bedrock Geology and Abstraction Licences

Site Outline

250
500
Search Buffers (m)

Principal Aquifer

Secondary (A) Aquifer - Permeable Layers

Secondary (B) Aquifer - Lower Permeability Layers

Groundwater Abstraction Licence

Secondary Aquifer - Undifferentiated Layers

Unproductive

Unknown (lakes and landslip)

Surface Water Abstraction Licence

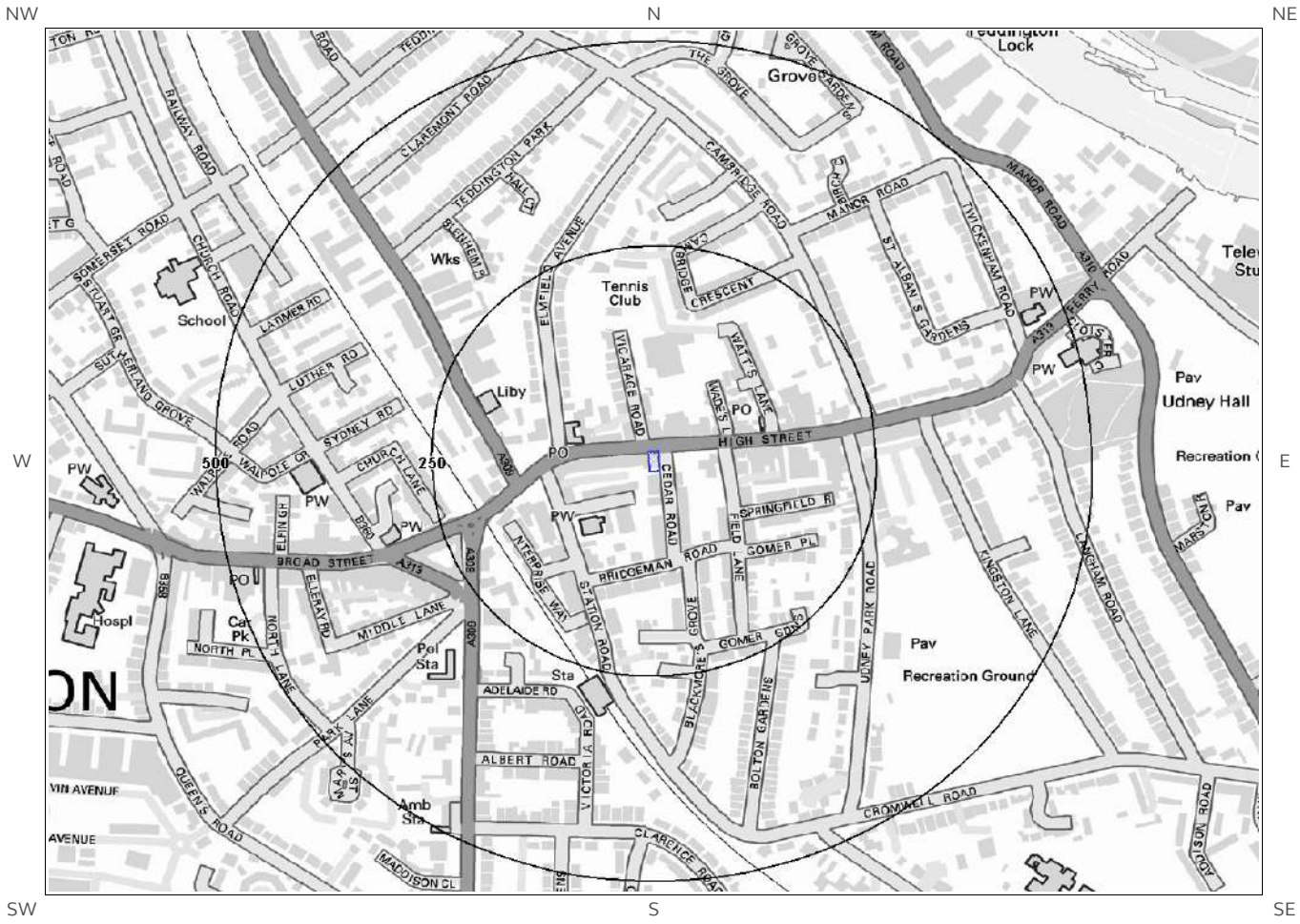
6c. Hydrogeology – Source Protection Zones and Potable Water Abstraction Licences

NW N NE

W E

SW S SE

6d. Hydrogeology – Source Protection Zones within confined aquifer



Site Outline

250 Search Buffers (m)
500

Source Protection Zone 1 - Inner Catchment

Source Protection Zone 2C - Outer Catchment within Confined Aquifer

Source Protection Zone 3C - Total Catchment within Confined Aquifer

Potable Water Abstraction Licence

6e. Hydrology – Watercourse Network and River Quality

NW N NE

W E

SW S SE

Site Outline

250
500
Search Buffers (m)

Tidal River

Inland River

Underground or Elevated Tidal River

Underground or Elevated Inland River

Foreshore

General Quality Assessment: Chemistry

Canal

Underground or Elevated Canal

Lock or Flight of Locks

Lake, Reservoir, or Marsh

Drain or Transfer

General Quality Assessment: Biology

6.Hydrogeology and Hydrology

6.1 Aquifer within Superficial Deposits

Records of strata classification within the superficial geology at or in proximity to the property Yes

From 1 April 2010, the Environment Agency/Natural Resources Wales's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive. For further details on the designation and interpretation of this information, please refer to the Groundsure Enviro Insight User Guide.

The following aquifer records are shown on the Aquifer within Superficial Geology Map (6a):

ID	Distance (m)	Direction	Designation	Description
1	0	On Site	Principal	Geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale. Generally principal aquifers were previously major aquifers
3	495	NE	Secondary (undifferentiated)	Assigned where it is not possible to attribute either category A or B to a rock type. In general these layers have previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type

6.2 Aquifer within Bedrock Deposits

Records of strata classification within the bedrock geology at or in proximity to the property Yes

From 1 April 2010, the Environment Agency/Natural Resources Wales's Groundwater Protection Policy has been using aquifer designations consistent with the Water Framework Directive. For further details on the designation and interpretation of this information, please refer to the Groundsure Enviro Insight User Guide.

The following aquifer records are shown on the Aquifer within Bedrock Geology Map (6b):

ID	Distance (m)	Direction	Designation	Description
1	0	On Site	Unproductive	These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow

6.3 Groundwater Abstraction Licences

Groundwater Abstraction Licences within 2000m of the study site — Identified

The following Abstraction Licences records are represented as points, lines and regions on the Aquifer within Bedrock Geology Map (6b):

ID	Distance (m)	Direction	NGR	Details	
2A	600	E	516680 171240	Status: Active Licence No: 28/39/34/0010 Details: Spray Irrigation - Direct Direct Source: THAMES GROUNDWATER Point: BOREHOLE 'A' AT LENSBURY CLUB, TEDDINGTON Data Type: Point Name: THE CATHOLIC EDUCATION SERVICE	Annual Volume (m^3): 3000 Max Daily Volume (m^3): 45.45 Original Application No: - Original Start Date: 22/12/2000 Expiry Date: - Issue No: 1 Version Start Date: 01/04/2008 Version End Date:
3A	600	E	516680 171240	Status: Active Licence No: 28/39/34/0010 Details: Spray Irrigation - Direct Direct Source: THAMES GROUNDWATER Point: BOREHOLE 'A' AT LENSBURY CLUB, TEDDINGTON Data Type: Point Name: THE CATHOLIC EDUCATION SERVICE	Annual Volume (m^3): 3000 Max Daily Volume (m^3): 45.45 Original Application No: - Original Start Date: 22/12/2000 Expiry Date: - Issue No: 1 Version Start Date: 01/04/2008 Version End Date:
Not shown	938	E	517020 171260	Status: Historical Licence No: 28/39/34/0007 Details: Spray Irrigation - Direct Direct Source: THAMES GROUNDWATER Point: BOREHOLE 'B' AT LENSBURY CLUB, TEDDINGTON Data Type: Point Name: LENSBURY LIMITED	Annual Volume (m^3): 7000 Max Daily Volume (m^3): 100 Original Application No: - Original Start Date: 28/11/1986 Expiry Date: - Issue No: 102 Version Start Date: 23/11/2001 Version End Date:
Not shown	938	E	517020 171260	Status: Historical Licence No: 28/39/34/0007 Details: Spray Irrigation - Direct Direct Source: THAMES GROUNDWATER Point: BOREHOLE 'B' AT LENSBURY CLUB, TEDDINGTON Data Type: Point Name: LENSBURY LIMITED	Annual Volume (m^3): - Max Daily Volume (m^3): - Original Application No: - Original Start Date: 28/11/1986 Expiry Date: - Issue No: 101 Version Start Date: 22/12/2000 Version End Date:
Not shown	942	E	517024 171257	Status: Active Licence No: 28/39/34/0007 Details: Spray Irrigation - Direct Direct Source: THAMES GROUNDWATER Point: BOREHOLE AT LENSBURY CLUB, TEDDINGTON Data Type: Point Name: LENSBURY LIMITED	Annual Volume (m^3): 7000 Max Daily Volume (m^3): 100 Original Application No: - Original Start Date: 28/11/1986 Expiry Date: - Issue No: 104 Version Start Date: 29/02/2016 Version End Date:

6.4 Surface Water Abstraction Licences

Surface Water Abstraction Licences within 2000m of the study site — None identified

Database searched and no data found.

6.5 Potable Water Abstraction Licences

Potable Water Abstraction Licences within 2000m of the study site — None identified

Database searched and no data found.

6.6 Source Protection Zones

Source Protection Zones within 500m of the study site — None identified

Database searched and no data found.

6.7 Source Protection Zones within Confined Aquifer

Source Protection Zones within the Confined Aquifer within 500m of the study site — None identified

Historically, Source Protection Zone maps have been focused on regulation of activities which occur at or near the ground surface, such as prevention of point source pollution and bacterial contamination of water supplies. Sources in confined aquifers were often considered to be protected from these surface pressures due to the presence of a low permeability confining layer (e.g. glacial till, clay). The increased interest in subsurface activities such as onshore oil and gas exploration, ground source heating and cooling requires protection zones for confined sources to be marked on SPZ maps where this has not already been done.

Database searched and no data found.

6.8 Groundwater Vulnerability and Soil Leaching Potential

Environment Agency/Natural Resources Wales information on groundwater vulnerability and soil leaching potential within 500m of the study site — Identified

Distance (m)	Direction	Classification	Soil Vulnerability Category	Description
0	On Site	Major Aquifer/High Leaching Potential	HU	Soil information for urban areas and restored mineral workings. These soils are therefore assumed to be highly permeable in the absence of site-specific information.

6.9 River Quality

Environment Agency/Natural Resources Wales information on river quality within 1500m of the study site — Identified

6.9.1 Biological Quality:

Biological Quality data describes water quality in terms of 83 groups of macroinvertebrates, some of which are pollution sensitive. The results are graded from A ('Very Good') to F ('Bad').

The following Biological Quality records are shown on the Hydrology Map (6e):

ID	Distance (m)	Direction	NGR	River Quality Grade	Biological Quality Grade				
					2005	2006	2007	2008	2009
Not shown	951	E	517000 171400	River Name: Thames (se Area) Reach: Hogsmill - Teddington End/Start of Stretch: End of Stretch NGR	C	C	B	B	B

6.9.2 Chemical Quality:

Chemical quality data is based on the General Quality Assessment Headline Indicators scheme (GQAHI). In England, each chemical sample is measured for ammonia and dissolved oxygen. In Wales, the samples are measured for biological oxygen demand (BOD), ammonia and dissolved oxygen. The results are graded from A ('Very Good') to F ('Bad').

The following Chemical Quality records are shown on the Hydrology Map (6e):

ID	Distance (m)	Direction	NGR	River Quality Grade	Chemical Quality Grade				
					2005	2006	2007	2008	2009
Not shown	951	E	517000 171400	River Name: Thames Reach: Hogsmill - Teddington End/Start of Stretch: End of Stretch NGR	A	A	B	B	B
Not shown	962	E	517020 171370	River Name: Thames Reach: Hogsmill - Teddington End/Start of Stretch: Sample Point NGR	A	A	B	B	B

6.10 Ordnance Survey MasterMap Water Network

Ordnance Survey MasterMap Water Network entries within 500m of the study site

Database searched and no data found.

6.11 Surface Water Features

Surface water features within 250m of the study site None identified

Database searched and no data found.

7a. Environment Agency/Natural Resources Wales Flood Map for Planning (from rivers and the sea)

NW N NE

W E

SW S SE

Site Outline

100
250
Search Buffers (m)

Zone 2 Floodplain

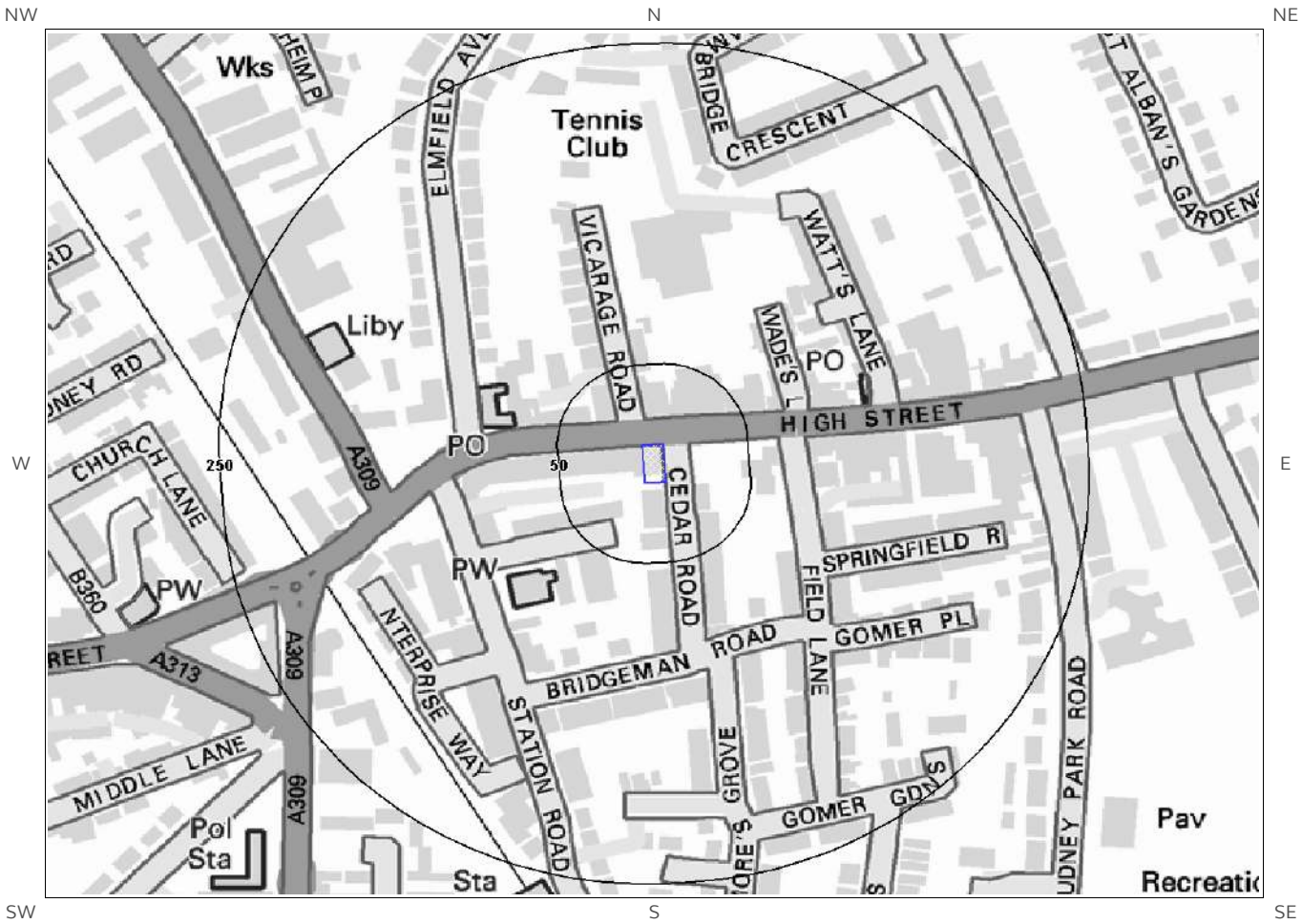
Zone 3 Floodplain

Flood Defences

Area used for Flood Storage

Area Benefiting from Flood Defences

7b. Environment Agency/Natural Resources Wales Risk of Flooding from Rivers and the Sea (RoFRaS) Map



Site Outline

100
250
Search Buffers (m)

RoFRaS Rating

- Very Low
- Low
- Medium
- High

7 Flooding

7.1 River and Coastal Zone 2 Flooding

Environment Agency/Natural Resources Wales Zone 2 floodplain within 250m — None identified

Environment Agency/Natural Resources Wales Zone 2 floodplains estimate the annual probability of flooding as between 1 in 1000 (0.1%) and 1 in 100 (1%) from rivers and between 1 in 1000 (0.1%) and 1 in 200 (0.5%) from the sea. Any relevant data is represented on Map 7a – Flood Map for Planning:

Database searched and no data found.

7.2 River and Coastal Zone 3 Flooding

Environment Agency/Natural Resources Wales Zone 3 floodplain within 250m — None identified

Zone 3 shows the extent of a river flood with a 1 in 100 (1%) or greater chance of occurring in any year or a sea flood with a 1 in 200 (0.5%) or greater chance of occurring in any year. Any relevant data is represented on Map 7a – Flood Map for Planning.

Database searched and no data found.

7.3 Risk of Flooding from Rivers and the Sea (RoFRaS) Flood Rating

Highest risk of flooding onsite — Very Low

The Environment Agency/Natural Resources Wales RoFRaS database provides an indication of river and coastal flood risk at a national level on a 50m grid with the flood rating at the centre of the grid calculated and given above. The data considers the probability that the flood defences will overtop or breach by considering their location, type, condition and standard of protection.

RoFRaS data for the study site indicates the property is in an area with a Very Low (less than 1 in 1000) chance of flooding in any given year.

7.4 Flood Defences

Flood Defences within 250m of the study site — None identified

Database searched and no data found.

7.5 Areas benefiting from Flood Defences

Areas benefiting from Flood Defences within 250m of the study site — None identified

7.6 Areas benefiting from Flood Storage

Areas used for Flood Storage within 250m of the study site	None identified

7.7 Groundwater Flooding Susceptibility Areas

7.7.1 British Geological Survey groundwater flooding susceptibility areas within 50m of the boundary of the study site	Identified
Clearwater Flooding or Superficial Deposits Flooding	Superficial Deposits Flooding

Notes: Groundwater flooding may either be associated with shallow unconsolidated sedimentary aquifers which overlie unproductive aquifers (Superficial Deposits Flooding), or with unconfined aquifers (Clearwater Flooding).

7.7.2 Highest susceptibility to groundwater flooding in the search area based on the underlying geological conditions

Potential at Surface

Where potential for groundwater flooding to occur at surface is indicated, this means that given the geological conditions in the area groundwater flooding hazard should be considered in all land-use planning decisions. It is recommended that other relevant information e.g. records of previous incidence of groundwater flooding, rainfall, property type, and land drainage information be investigated in order to establish relative, but not absolute, risk of groundwater flooding.

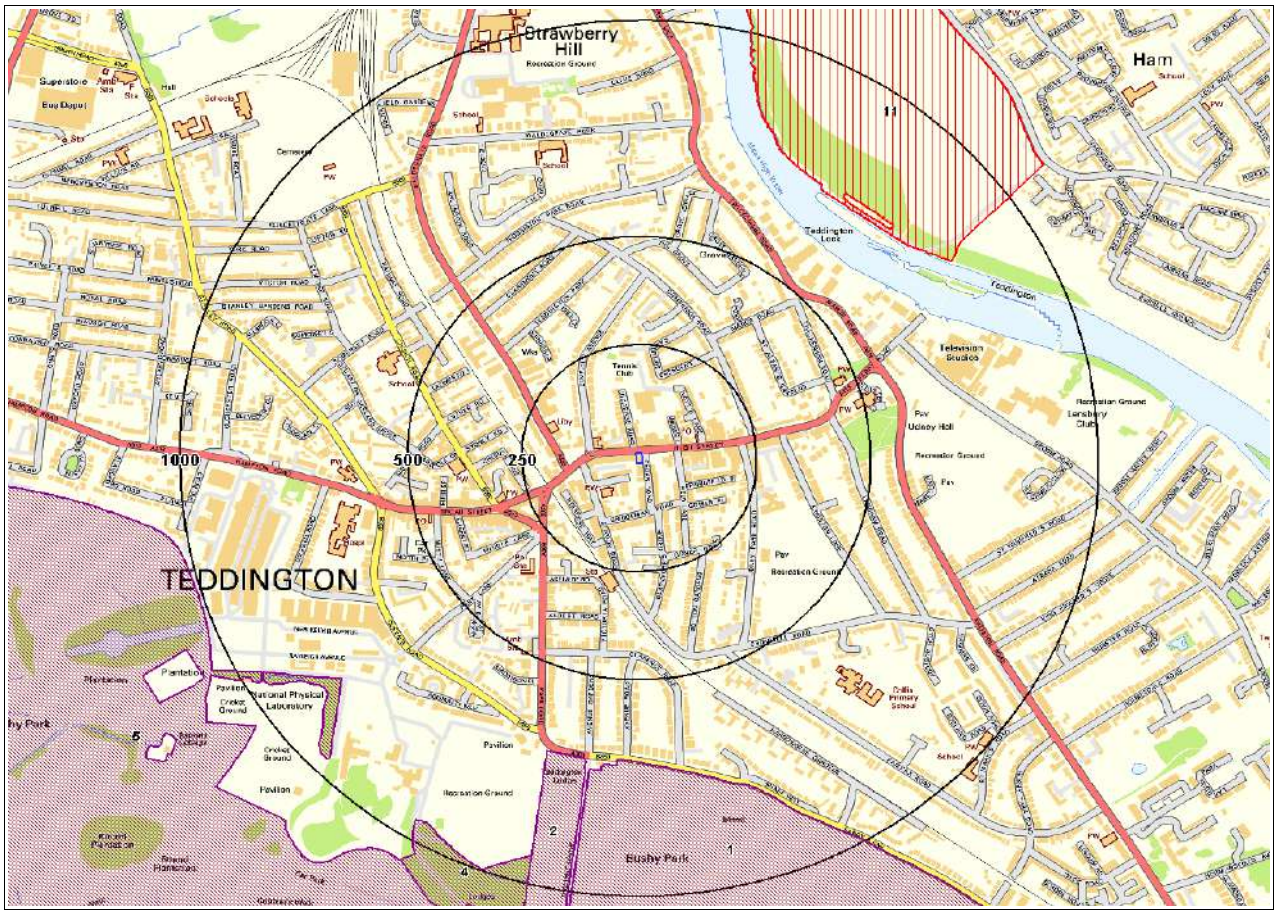
7.8 Groundwater Flooding Confidence Areas

British Geological Survey confidence rating in this result	Moderate

Notes: Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded.

The confidence rating is on a threefold scale - Low, Moderate and High. This provides a relative indication of the BGS confidence in the accuracy of the susceptibility result for groundwater flooding. This is based on the amount and precision of the information used in the assessment. In areas with a relatively lower level of confidence the susceptibility result should be treated with more caution. In other areas with higher levels of confidence the susceptibility result can be used with more confidence.

8. Designated Environmentally Sensitive Sites Map



Site Outline

100
250
Search Buffers (m)

AONB

National Park

SSSI

Special Protection Areas

Nitrate Vulnerable Zones

Green Belt

Environmentally Sensitive Areas

Special Areas of Conservation

World Heritage Sites

Nitrate Sensitive Areas

Ancient Woodland

National Nature Reserve

Local Nature Reserves

Ramsar Sites

8. Designated Environmentally Sensitive Sites

Designated Environmentally Sensitive Sites within 2000m of the study site | Identified

8.1 Records of Sites of Special Scientific Interest (SSSI) within 2000m of the study site:

10

The following Site of Special Scientific Interest (SSSI) records provided by Natural England/Natural Resources Wales are represented as polygons on the Designated Environmentally Sensitive Sites Map:

ID	Distance (m)	Direction	SSSI Name	Data Source
1	686	S	Bushy Park and Home Park	Natural England
2	689	S	Bushy Park and Home Park	Natural England
3	816	SW	Bushy Park and Home Park	Natural England
4	933	S	Bushy Park and Home Park	Natural England
5	952	SW	Bushy Park and Home Park	Natural England
Not shown	1088	S	Bushy Park and Home Park	Natural England
Not shown	1100	S	Bushy Park and Home Park	Natural England
Not shown	1173	S	Bushy Park and Home Park	Natural England
Not shown	1591	SW	Bushy Park and Home Park	Natural England
Not shown	1774	SW	Bushy Park and Home Park	Natural England

8.2 Records of National Nature Reserves (NNR) within 2000m of the study site:

0

Database searched and no data found.

8.3 Records of Special Areas of Conservation (SAC) within 2000m of the study site:

0

Database searched and no data found.

8.4 Records of Special Protection Areas (SPA) within 2000m of the study site:

0

Database searched and no data found.

8.5 Records of Ramsar sites within 2000m of the study site:

0

Database searched and no data found.

8.6 Records of Ancient Woodland within 2000m of the study site:

0

Database searched and no data found.

8.7 Records of Local Nature Reserves (LNR) within 2000m of the study site:

3

The following Local Nature Reserve (LNR) records provided by Natural England/Natural Resources Wales are represented as polygons on the Designated Environmentally Sensitive Sites Map:

ID	Distance (m)	Direction	LNR Name	Data Source
11	724	NE	Ham Lands	Natural England
Not shown	1235	N	Ham Lands	Natural England
Not shown	1936	NE	Ham Common, Richmond, London	Natural England

8.8 Records of World Heritage Sites within 2000m of the study site:

0

Database searched and no data found.

8.9 Records of Environmentally Sensitive Areas within 2000m of the study site:

0

Database searched and no data found.

8.10 Records of Areas of Outstanding Natural Beauty (AONB) within 2000m of the study site:

0

Database searched and no data found.

8.11 Records of National Parks (NP) within 2000m of the study site:

0

Database searched and no data found.

8.12 Records of Nitrate Sensitive Areas within 2000m of the study site:

0

Database searched and no data found.

8.13 Records of Nitrate Vulnerable Zones within 2000m of the study site:

0

Database searched and no data found.

8.14 Records of Green Belt land within 2000m of the study site:

0

Database searched and no data found.

9. Natural Hazards Findings

9.1 Detailed BGS GeoSure Data

BGS GeoSure Data has been searched to 50m. The data is included in tabular format. If you require further information on geology and ground stability, please obtain a Groundsure Geo Insight, available from our website. The following information has been found:

9.1.1 Shrink Swell

Maximum Shrink-Swell*[*] hazard rating identified on the study site — Moderate

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Ground conditions predominantly high plasticity. Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. For new build, consideration should be given to advice published by the National House Building Council (NHBC) and the Building Research Establishment (BRE). There is a probable increase in construction cost to reduce potential shrink-swell problems. For existing property, there is a probable increase in insurance risk during droughts or where vegetation with high moisture demands is present.

9.1.2 Landslides

Maximum Landslide* hazard rating identified on the study site — Very Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Slope instability problems are unlikely to be present. No special actions required to avoid problems due to landslides. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with landslides.

9.1.3 Soluble Rocks

Maximum Soluble Rocks* hazard rating identified on the study site — Negligible

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with soluble rocks.

* This indicates an automatically generated 50m buffer and site.

9.1.4 Compressible Ground

Maximum Compressible Ground* hazard rating identified on the study site — Negligible

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
No indicators for compressible deposits identified. No special actions required to avoid problems due to compressible deposits. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with compressible deposits.

9.1.5 Collapsible Rocks

Maximum Collapsible Rocks* hazard rating identified on the study site — Very Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Deposits with potential to collapse when loaded and saturated are unlikely to be present. No special ground investigation required or increased construction costs or increased financial risk due to potential problems with collapsible deposits.

9.1.6 Running Sand

Maximum Running Sand** hazard rating identified on the study site — Very Low

The following natural subsidence information provided by the British Geological Survey is not represented on mapping:

Hazard
Very low potential for running sand problems if water table rises or if sandy strata are exposed to water. No special actions required, to avoid problems due to running sand. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with running sand.

* This indicates an automatically generated 50m buffer and site.

9.2 Radon

9.2.1 Radon Affected Areas

Is the property in a Radon Affected Area as defined by the Health Protection Agency (HPA) and if so what percentage of homes are above the Action Level? The site is not in a Radon Affected Area, as less than 1% of properties are above the Action Level.

The radon data in this report is supplied by the BGS/Public Health England and is the definitive map of Radon Affected Areas in Great Britain and Northern Ireland. The dataset was created using long-term radon measurements in over 479,000 homes across Great Britain and 23,000 homes across Northern Ireland, combined with geological data. The dataset is considered accurate to 50m to allow for the margin of error in geological lines, and the findings of this report supercede any answer given in the less accurate Indicative Atlas of Radon in Great Britain, which simplifies the data to give the highest risk within any given 1km grid square. As such, the radon atlas is considered indicative, whereas the data given in this report is considered definitive.

9.2.2 Radon Protection

Is the property in an area where Radon Protection are required for new properties or extensions to existing
ones as described in publication BR211 by the Building Research Establishment? No radon protective measures are necessary.

10. Mining

10.1 Coal Mining

Coal mining areas within 75m of the study site — None identified

Database searched and no data found.

10.2 Non-Coal Mining

Non-Coal Mining areas within 50m of the study site boundary — None identified

Database searched and no data found.

10.3 Brine Affected Areas

Brine affected areas within 75m of the study site — None identified
Guidance: No Guidance Required.

Contact Details

Groundsure Helpline
Telephone: 08444 159 000
info@groundsure.com

British Geological Survey Enquiries
Kingsley Dunham Centre
Keyworth, Nottingham NG12 5GG
Tel: 0115 936 3143.
Fax: 0115 936 3276.
Email:
Web:**www.bgs.ac.uk**
BGS Geological Hazards Reports and general geological enquiries:
enquiries@bgs.ac.uk

Environment Agency
National Customer Contact Centre, PO Box 544
Rotherham, S60 1BY
Tel: 03708 506 506
Web: **www.environment-agency.gov.uk**
Email: enquiries@environment-agency.gov.uk

Public Health England
Public information access office
Public Health England, Wellington House
133-155 Waterloo Road, London, SE1 8UG
www.gov.uk/phe
Email:**enquiries@phe.gov.uk**
Main switchboard**: 020 7654 8000**

The Coal Authority
200 Lichfield Lane
Mansfield
Notts NG18 4RG
Tel: 0345 7626 848
DX 716176 Mansfield 5
www.coal.gov.uk

Ordnance Survey
Adanac Drive, Southampton
SO16 0AS
Tel: 08456 050505

Local Authority
Authority: London Borough of Richmond upon Thames
Phone: 08456 122 660
Web: http://www.richmond.gov.uk/
Address: Civic Centre, 44 York Street, Twickenham, Middlesex, TW1

Gemapping PLC
Virginia Villas, High Street, Hartley Witney,
Hampshire RG27 8NW
Tel: 01252 845444

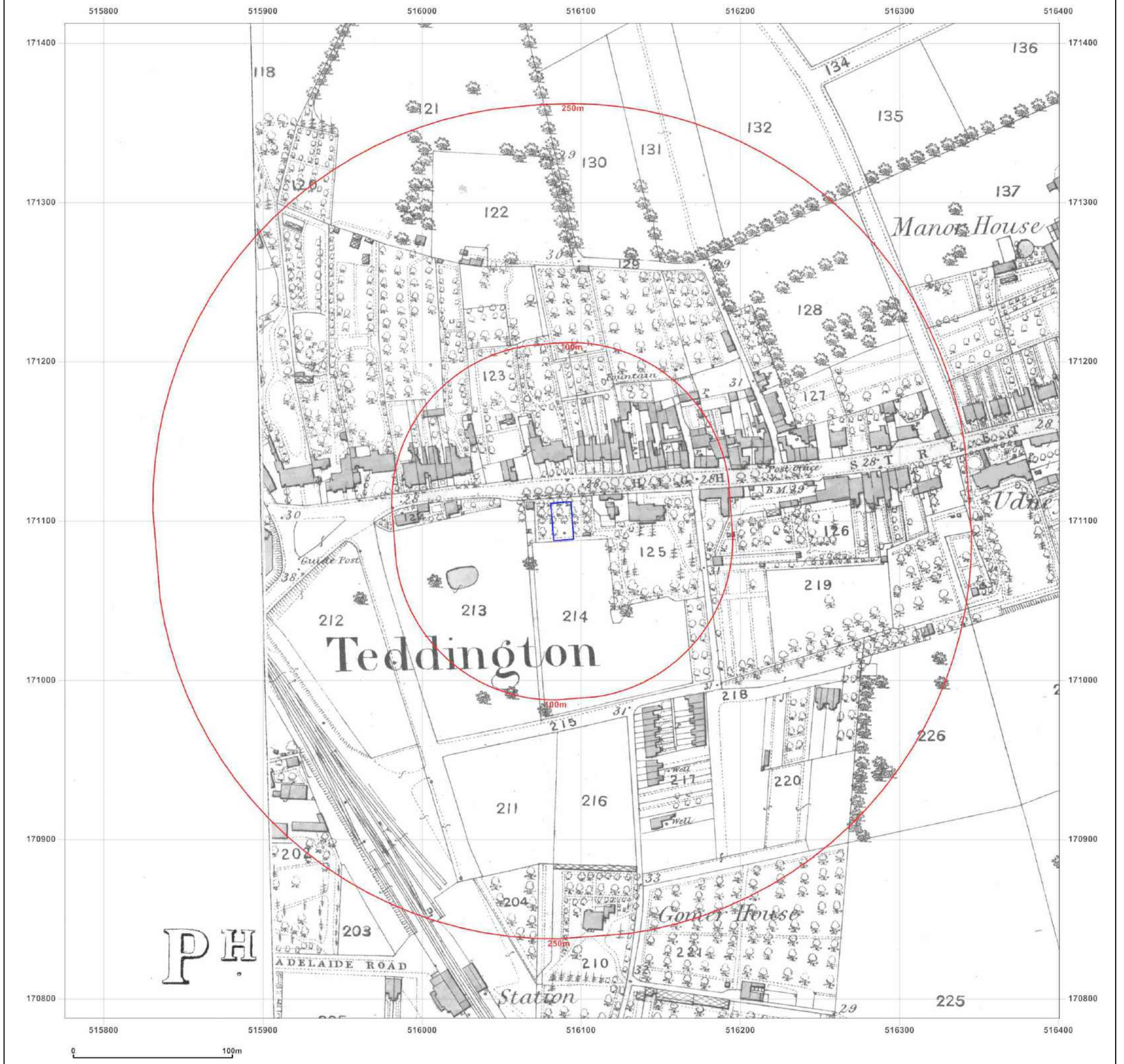
Standard Terms and Conditions

Groundsure's Terms and Conditions can be viewed online at this link:

https://www.groundsure.com/terms-and-conditions-may25-2018

APPENDIX E

Desk Study Data – Historical Maps – Large Scale and Small Scale



Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

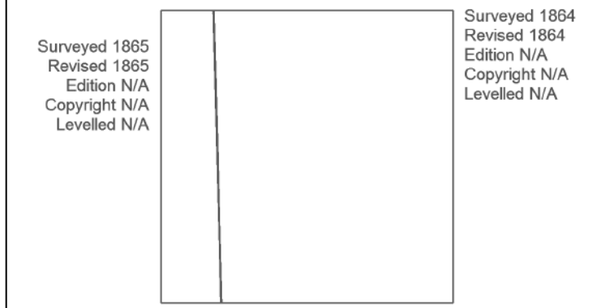
Map Name: County Series

Map date: **1864-1865**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

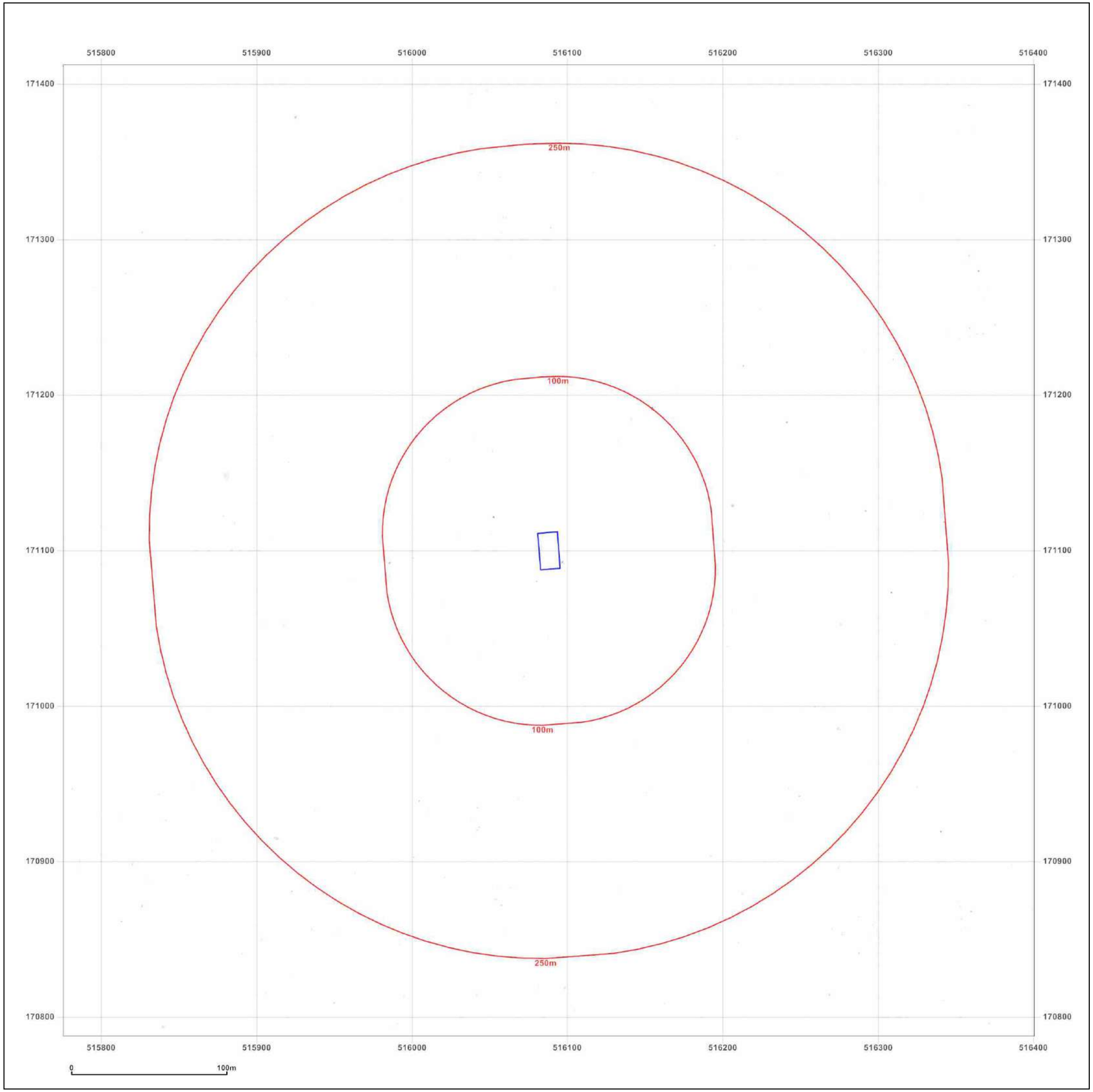


Powered by OS

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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



Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: County Series

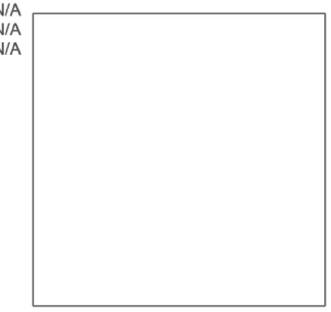
Map date: **1868**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1868
Revised N/A
Edition N/A
Copyright N/A
Levelled N/A



Powered by

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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

Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: 1056 Scale Town Plan

Map date: **1896**

Scale: 1:1,056

Printed at: 1:1,056

N
W E
S

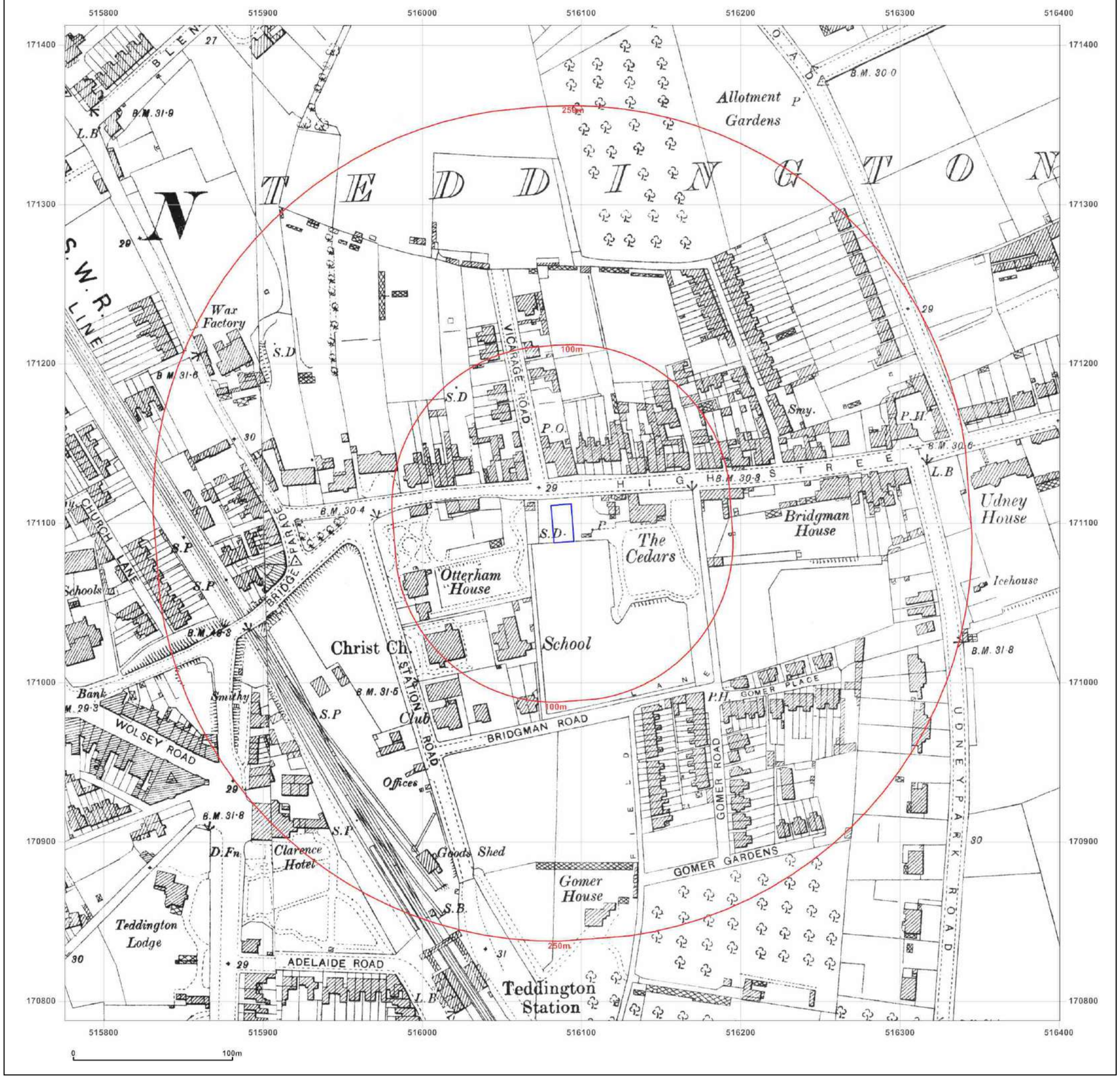
Surveyed 1894
Revised N/A
Edition 1896
Copyright N/A
Levelled N/A

Powered by OS

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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



Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: County Series

Map date: **1896**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1896
Revised 1896
Edition N/A
Copyright N/A
Levelled N/A

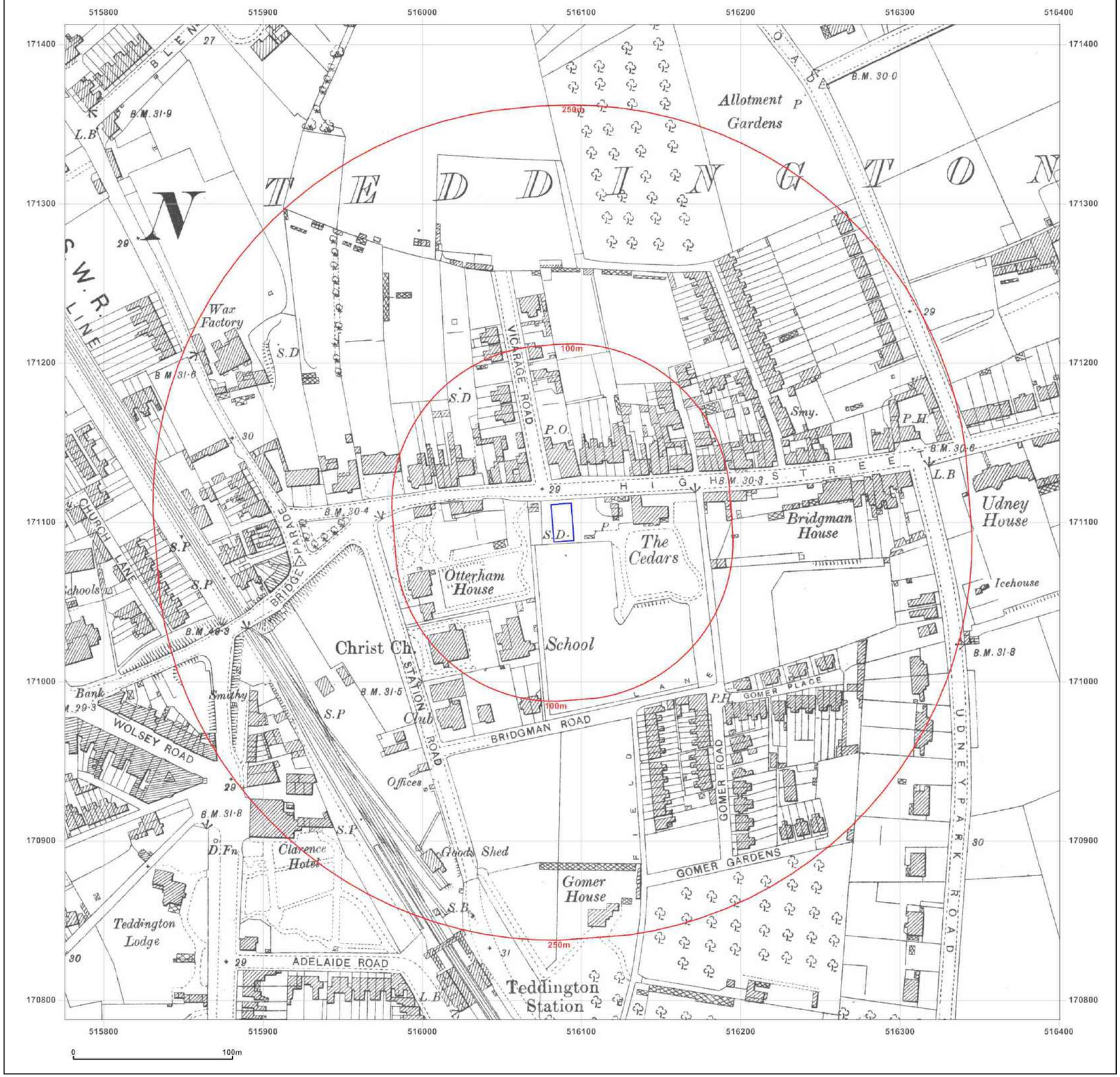
Surveyed 1896
Revised 1896
Edition N/A
Copyright N/A
Levelled N/A

Powered by

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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



Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: County Series

Map date: **1898**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

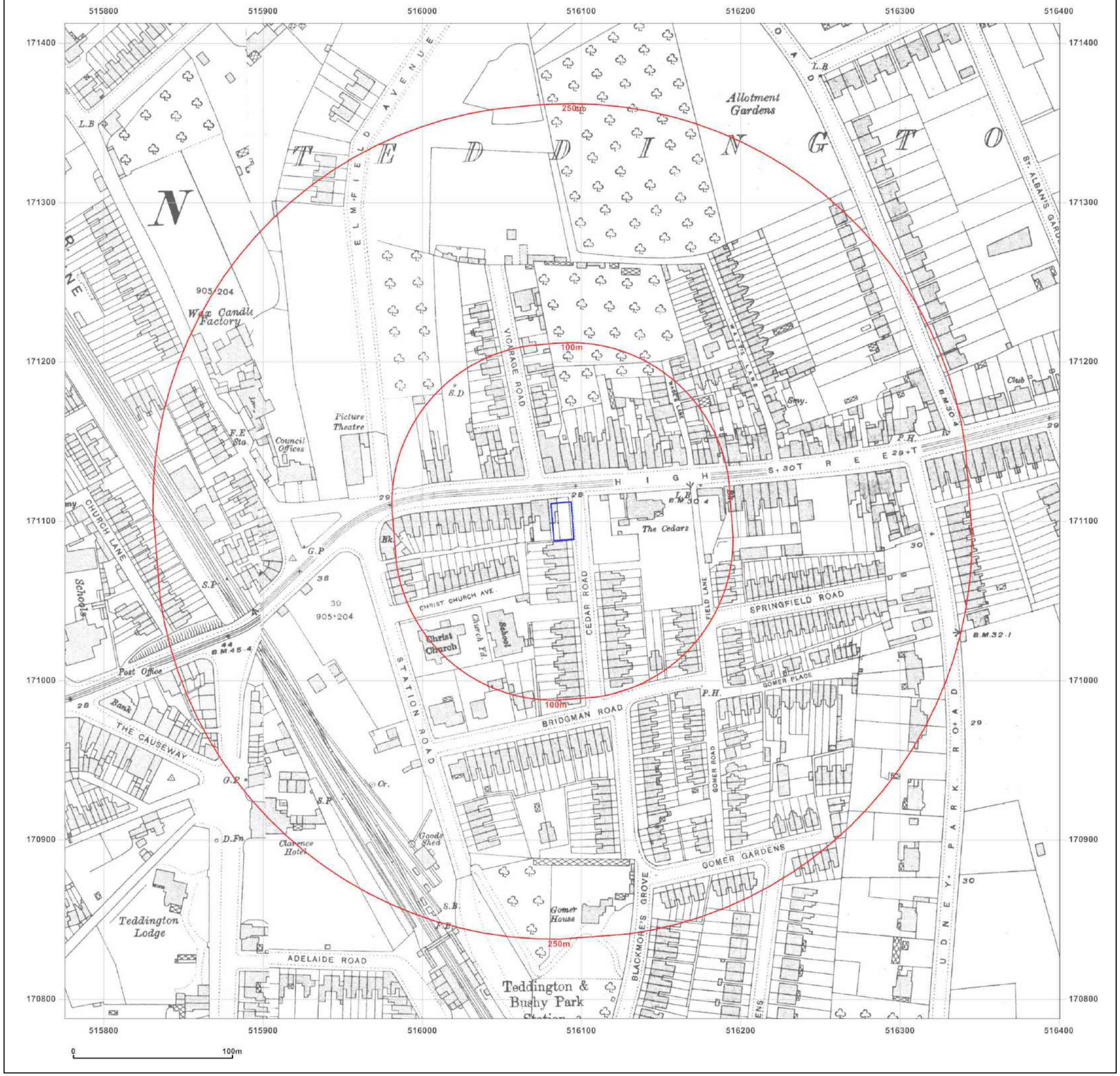
Surveyed 1898
Revised 1898
Edition N/A
Copyright N/A
Levelled N/A

Powered by OS

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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



Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: County Series

Map date: **1915**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1915
Revised 1915
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1915
Revised 1915
Edition N/A
Copyright N/A
Levelled N/A

Powered by OS

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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

Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: County Series

Map date: **1934**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1934
Revised 1934
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1934
Revised 1934
Edition N/A
Copyright N/A
Levelled N/A

Powered by

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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

Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: National Grid

Map date: **1959**

Scale: 1:1,250

Printed at: 1:2,000

N
W E
S

Surveyed 1958 Revised 1958 Edition N/A Copyright 1959 Levelled 1957	Surveyed 1958 Revised 1958 Edition N/A Copyright 1959 Levelled 1957
Surveyed 1958 Revised 1958 Edition N/A Copyright 1959 Levelled 1957	Surveyed 1958 Revised 1958 Edition N/A Copyright N/A Levelled N/A

Powered by OS

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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

Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: National Grid

Map date: **1960-1961**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

Surveyed 1960
Revised 1960
Edition 1962
Copyright 1962
Levelled 1957

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

Surveyed 1958
Revised 1958
Edition 1961
Copyright 1961
Levelled 1957

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

Powered by

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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

Groundsure INSIGHTS

Site Details:

42, HIGH STREET,
TEDDINGTON, TW11 8EW

Client Ref: GGC18675
Report Ref: HMD-5503219
Grid Ref: 516088, 171100

Map Name: National Grid

Map date: **1960-1962**

Scale: 1:2,500

Printed at: 1:2,500

N
W E
S

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

Surveyed 1958
Revised 1958
Edition 1960
Copyright 1960
Levelled 1957

Surveyed 1960
Revised 1960
Edition 1961
Copyright 1961
Levelled 1957

Surveyed 1958
Revised 1958
Edition 1960
Copyright 1960
Levelled 1953

Powered by

Produced by
Groundsure Insights
T: 08444 159000
E: info@groundsure.com
W: www.groundsure.com

Production date: 04 October 2018

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