

A stylized, light gray map of Northwest Cambridge is positioned on the left side of the page, partially overlapping a dark blue background. The map shows the irregular coastline and internal land divisions of the area.

NORTH WEST **cambridge**

Land Contamination

Condition 49a

May 2013



North West Cambridge – Phase 1 Development

Phase I Geo-
Environmental Desk Study
Report

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TABLE OF CONTENTS	1.	INTRODUCTION.....	1
	1.1	Terms of Reference	1
	1.2	Purpose of the Report	1
	1.3	Proposed Development.....	2
	1.4	Methodology.....	3
	1.5	Information Sources	4
	2.	ENVIRONMENTAL SETTING	5
	2.1	Site Description	5
	2.2	Surrounding Area	5
	2.3	Published Geology and BGS Borehole Data	5
	2.3.1	Ground Stability.....	6
	2.3.2	Mining.....	6
	2.3.3	Mineral Safeguarding Area (MSA)	6
	2.3.4	Radon.....	6
	2.4	Hydrogeology	7
	2.5	Hydrology	7
	2.6	Sensitive Sites.....	7
	2.7	Water Abstractions.....	8
	3.	HISTORICAL REVIEW AND REGULATORY RECORDS.....	9
	3.1	Site History from Ordnance Maps.....	9
	3.2	Site History from other Sources	9
	3.3	Regulatory Controls	9
	3.4	Waste Management Facilities.....	10
	3.5	Radioactive Substances.....	10
	3.6	Fuel Station Entries.....	10
	4.	SUMMARY OF 2010 URS SITE INVESTIGATION	11
	4.1	Ground Conditions	11
	4.1.1	Geology	11
	4.1.2	Hydrogeology	12
	4.2	Soil Sampling, Screening and Laboratory Analysis	12
	4.3	Groundwater Monitoring and Laboratory Analysis.....	13
	4.4	Contamination Assessment	13
	4.4.1	Soil Screening Guidance Criteria.....	13
	4.4.2	Soil Laboratory Results	13
	4.4.3	Groundwater Screening Criteria	14
	4.4.4	Groundwater Results	14
	4.5	Gas Monitoring	14
	5.	CONCEPTUAL SITE MODEL AND PROPOSED MAIN INVESTIGATION STRATEGY	16
	5.1	Sources of Potential Contamination.....	16
	5.2	Receptors, Pathways and CSM	17
	5.3	Risk Assessment.....	17
	5.3.1	Risk to Future Site Users	18

5.3.2	Risk to Construction Workers	18
5.3.3	Risk to Site Neighbours.....	18
5.3.4	Risk to Controlled Waters	18
5.4	Proposed Main Investigation Strategy	19
5.5	Summary.....	20
6.	REFERENCES.....	21

FIGURES

APPENDIX A: 2011 SITE WALKOVER PHOTO

TABLE OF FIGURES

FIGURE 1 SITE LOCATION PLAN

FIGURE 2 PHASE 1 LOCATION IN RELATION TO WIDER SITE

FIGURE 3 PHASE 1 ILLUSTRATIVE MASTERPLAN WITH
PROPOSED BOREHOLES (SHEET 1 OF 2)

FIGURE 4 PHASE 1 ILLUSTRATIVE MASTERPLAN WITH
PROPOSED BOREHOLES (SHEET 2 OF 2)

1. INTRODUCTION

1.1 Terms of Reference

URS was appointed by the University of Cambridge (the client) to undertake a desktop study (Phase I assessment) at the North West Cambridge site located at Huntingdon Road, Girton, Cambridge, CB3 0LH, in support of a reserved matters planning application for the Phase 1 package of development works.

The wider site is located at National Grid Reference 542580E 260140N, a site location plan is included in Figure 1.

1.2 Purpose of the Report

An outline planning application was submitted for the North West Cambridge site in September 2011 with additional information provided in March 2012.

Resolution to grant planning consent, subject to legal agreement, was received for the development in August 2012. Attached to the outline planning consent were reserved matters conditions. Condition 49 related to land contamination at the site. Condition 49 is as follows:

Notwithstanding the submitted contamination report as part of the Environmental Statement, prior to the commencement of development on any land parcel, a contaminated land assessment and associated remedial strategy, together with a timetable of works for that development parcel, shall be submitted to and approved in writing by the local planning authority. The contaminated land assessment and associated remedial strategy shall adhere to the following points:

a) The contaminated land assessment shall include a desk study to be submitted to the Local Planning Authority for approval. The desk study shall detail the history of the site uses for that particular area of the site and propose a site investigation strategy based on the relevant information discovered by the desk study. The strategy shall be approved by the Local Planning Authority prior to investigations commencing on site.

b) The site investigation, including relevant soil, soil gas, surface and groundwater sampling, shall be carried out by a suitable qualified and accredited consultant/contractor in accordance with a quality assured sampling and analysis methodology.

c) A site investigation report detailing all investigative works and sampling on site, together with the results of the analysis, risk assessment to any receptors and a proposed remediation strategy shall be submitted to the Local Planning Authority. The Local Planning Authority shall approve such remedial works as required prior to any remediation commencing on that development parcel. The works shall be of such a nature as to render harmless the identified contamination given the proposed end use of the site and surrounding environment including any controlled waters.

No development within that parcel shall commence until a contaminated land assessment and associated remedial strategy, has been submitted to, and been approved by the local planning authority. This applies to paragraphs a), b) and c). The results of each stage will help decide if the following stage is necessary.

d) Approved remediation works shall be carried out in full on each development parcel under a quality assurance scheme to demonstrate compliance with the proposed methodology and best practice guidance.

e) If, during the works contamination is encountered which has not previously been identified then the additional contamination shall be fully assessed and an appropriate remediation scheme agreed with the Local Planning Authority. Upon completion of the works, this condition shall not be discharged until a closure report has been submitted to and approved by the Local Planning Authority. The closure report shall include details of the proposed remediation works and quality assurance certificates to show that the works have been carried out in full in accordance with the approved methodology.

f) Details of any post-remedial sampling and analysis to show the site has reached the required clean-up criteria shall be included in the closure report together with the necessary documentation detailing what waste materials have been removed from site.

No buildings with the development parcel shall be occupied prior to the completion of any remedial works and a validation report(s) being submitted to, and approval from, the Local Planning Authority. This applies to paragraphs d), e) and f).

REASON *In order to ensure that any contamination of the site is identified and remediation measures are appropriately undertaken to secure full mitigation in the interests of environmental and public safety. North West Cambridge Area Action Plan Policy NW2.*

The client is now seeking to develop the North West Cambridge site in several phases. The first phase (Phase 1) comprises a building and associated infrastructure development area of approximately 24 hectares. In addition, the Phase 1 area takes in large areas of landscaping associated away from the building development areas, to the west of the main development along Washpit Brook, and smaller corridors of landscaping to the north, south and east of the main development area.

The purpose of this report is to address Condition 49 (a) for the Phase 1 development, through the preparation of a desktop study and proposed site investigation strategy for in-principle agreement with the local planning authority's Environmental Health Officers (EHOs).

1.3

Proposed Development

At the time of report preparation, the proposed building and infrastructure land-use for the Phase 1 development comprised:

- A foodstore and retail/shops;
- Energy centre;
- Residential– flats, duplexes, maisonettes, terraced housing, detached housing;
- Student housing;
- Health care building, community centre, police office, senior care centre;
- School and nursery;

- Car parking and basement car parking;
- Areas of open landscaping away from buildings.

A site plan indicating the position of the Phase 1 development in relation to the wider North West Cambridge site is displayed in Figure 2 and a master plan drawing showing the Phase 1 development infrastructure is displayed in Figures 3 and 4.

1.4 Methodology

The assessment presented in this report and the recommendations provided have been prepared in accordance with the following guidance:

- British Standards 10175 'Investigation of Potentially Contaminated Sites – Code of Practice' (2001);
- Contaminated Land Report (CLR) 11 'Model Procedures for the Management of Land Contamination' (2004);
- DEFRA Statutory Guidance 'Environment Protection Act 1990 Part 2a Contaminated Land' (2012); and
- Environment Agency (EA) GP3 'Groundwater Protection: Policy and Practice'.

The following methodology was adopted:

- A review of the geological, hydrological and hydrogeological setting at the site, and public domain geo-environmental information to build up an accurate understanding of the site and surrounding environmental setting/sensitivity;
- Review of historical land uses for the site and surrounds with a particular emphasis on identifying potential ground hazards and on-site and off-site contamination sources;
- Review of previous ground investigation data obtained for the site;
- An inspection of the site to review current and recent site activities, the condition of the site, potential ground related hazards and activities or areas that might have the potential to cause ground contamination as well as possible indicators of contamination; and
- Preparation of a Conceptual Site Model (CSM) with a view to identifying any significant source-pathway-receptor linkages followed by a qualitative risk assessment.

A Phase I contaminated land and geotechnical report was previously prepared for the wider development site in 2008 by Peter Brett Associates (PBA) and an Exploratory Stage Phase II Ground Investigation (GI) was undertaken for the wider development site by URS (then Scott Wilson) in 2010.

Consequently, where applicable, information from these sources was used in the formulation of this report, supplemented by updated information as necessary.

The Envirocheck Extracts and both the 2007 and 2010 contamination reports have previously been submitted to the Planning Authority and hence due to their size have not been included as appendices to this report.

1.5 Information Sources

The following sources of information were used in the preparation of this report:

- Outline development plans;
- North West Cambridge – Preliminary Geotechnical and Geo-environmental Baseline Condition Study, Peter Brett Associates (March 2007);
- Traveller's Rest Pit, SSSI Report – UoC/NWC/AAP/B8;
- Geological mapping data from the British Geological Survey;
- The Environment Agency website (www.environment-agency.gov.uk);
- Landmark Envirocheck Report (Reference 31572446_1_1 dated 16 June 2010);
- North West Cambridge Geo-environmental Ground Conditions Report, Scott Wilson (February 2011);
- North West Cambridge Mineral Safeguarding Area Report, Scott Wilson (February 2011); and
- Site walkover (2010 and 2012).

The most recent site walkover was undertaken by a URS representative on 13 September 2012, focussing on the Phase 1 development area.

2. ENVIRONMENTAL SETTING

2.1 Site Description

Information obtained from the 2012 site walkover is provided in Table 2.1. Photographs taken during the site walkover are labelled P1 – P6 and included as Appendix A.

The Phase 1 building development area of the site, and large area of proposed landscaping area by Washpit Brook comprised open land or agricultural fields for the growing of crops, primarily barley and wheat, with some tracks running through the site, and small hedgerows/wooded areas in the south of the site. No university buildings or other associated infrastructure is located within the building development area of the Phase 1 part of the site.

In addition to barley and wheat, a proportion of the farming area located within the northern part of the building development area of the Phase 1 site is used for potato research/growing.

Some buildings including the Astronomy department and 'Gravel Hill Farm' are located close to or within the landscaping areas to the east of the main development site. Buildings associated with the former university applied biology field station, agronomy centre and genetics field station are located in the proposed landscaping areas to the north of the main development site.

2.2 Surrounding Area

Land use surrounding the proposed development site was determined from the site walkover and is summarised in Table 2.1 below.

Table 2.1 Surrounding Land Use

North	Trees and residential properties to the north. Huntingdon Road beyond
East	A Site of Special Scientific Interest (SSSI). The SSSI refers to a Traveller's Rest Pit, based on the presence of ' <i>a unique exposure in fossiliferous cold stage gravels, sands and silts of a high level terrace (Observatory Gravels) of the River Cam</i> '. University Buildings beyond
South	Agricultural Land (other areas of the North West Cambridge Site), M11 Motorway beyond
West	Agricultural Land (other areas of the North West Cambridge Site)

2.3 Published Geology and BGS Borehole Data

Reference to the British Geological Survey 1:50 000 scale geological map of the area, Sheet 188 (Cambridge), indicates that the site is underlain in part by Head Gravels and Observatory Gravels, in the northern two thirds of the Phase 1 site, and to the east in the areas of proposed landscaping. These overlie the Lower Beds (Chalk Marl) of the Lower Chalk and the Gault Clay Formation with the Lower Greensand at depth. Only Gault Clay is shown in the southern third of the Phase 1 development site and the landscaped areas to the west.

2.3.1 **Ground Stability**

The Envirocheck report indicates that there is no hazard on-site for potential for compressible ground stability or potential for ground dissolution, whilst a very low and low potential for ground stability hazards including running sand and landslides exists on-site.

There is a moderate potential for shrinking or swelling clays at the site, probably associated with the presence of the Gault Clay Formation which is anticipated to be near the surface in many areas of the site.

2.3.2 **Mining**

The Envirocheck Report indicates that the site is in an area which would not be affected by coal mining.

The Envirocheck Report shows that Coprolite was mined off-site to the east of the Phase 1 development area, within the wider North West Cambridge site.

Coprolite diggings were a major industry in the Cambridge area during the late 1800s, being used for agriculture, and briefly, by the explosives industry. The workings were typically continued to depths of 6.00m to 8.00m beneath the overlying soils forming a worked belt up to approximately 0.80m wide. Since only a bed approximately 0.25m thick is removed and the area restored, little trace is left of the workings on the ground.

The PBA report (2007) notes how, in addition to the Coprolite workings, it is known that the Head Gravels on the eastern part of the site were excavated between the mid-1920s and about 1960 from the area known as the Traveller's Rest Pit. A report on the archaeological evaluation of Gravel Hill Farm referred to by PBA indicates that gravel workings are present to the east of the Phase 1 development area, adjacent to the pit.

The Envirocheck Report lists one BGS Recorded Mineral Site. This relates to the former opencast mining of sand and gravel outside of the Phase 1 development site, but further east in the wider North West Cambridge site (Traveller's Rest Pit).

According to PBA (2007), no record was found of natural cavities within a 2.5 km radius of the site. Although the absence of existing records does not, in itself, demonstrate that there are no natural cavities on the site, the geological and geomorphological site setting is such that the potential presence for such features is considered to be very low.

According to the Envirocheck report, there are no shallow mining hazards at the site.

2.3.3 **Mineral Safeguarding Area (MSA)**

The Cambridgeshire and Peterborough Minerals and Waste Plan sets the framework for minerals development in the area over the period 2006 to 2026. Within the plan MSAs are identified and a MSA has been indicated as extending into the northern half of the Phase 1 development site.

2.3.4 **Radon**

According to the Envirocheck report, the site lies within a Radon affected area, as between 1 and 3% of homes are above the action level. However, the report also states that no radon protective measures are necessary in the construction of new dwellings or extensions. This is confirmed by the mapping within BRE Report BR211 *Guidance on protective measures for new buildings* (2nd edition 2007).

2.4 Hydrogeology

According to the EA website, the Phase 1 part of the site lies over a Secondary 'undifferentiated' aquifer. This relates to the overlying Head Gravels and Observatory Gravels. The 'undifferentiated' classification is assigned in cases where it has not been possible to attribute secondary category A or B to a rock or soil type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

The deep Lower Greensand Formation is classed a Principal Aquifer, but this is confined by the Gault Clay.

The Soil Classification of the site has been determined using the EA's older Groundwater Vulnerability map for the site presented in the Envirocheck Report. The soil classification in relation to the vast majority of the Principal Aquifer at the site is 'High Leaching Potential (H3)'. This applies to coarse textured or moderately shallow soils which readily transmit non-absorbed pollutants and liquid discharges but which have some ability to attenuate absorbed pollutants because of their large clay or organic matter contents.

Soil Classification in relation to the Secondary Undifferentiated Aquifer is 'Intermediate Leaching Potential (I1)' – this applies to soils which can possibly transmit a wide range of pollutants. Soils are not classified in relation to Unproductive Strata.

It should be noted that, despite the various soil classifications, the eastern parts of the site are known from historical map data to have been extensively quarried and backfilled with imported material that might have different leaching properties.

According to the Environment Agency website, the site is not located within a groundwater Source Protection Zone (SPZ).

2.5 Hydrology

PBA (2007) note that the nearest significant surface watercourse to the site is the River Cam which flows north approximately 2.5 km to the south east of the site.

The Envirocheck Report shows the closest surface water feature of note to be the Washpit Brook (a tributary of the River Great Ouse), which flows to the west of the Phase 1 development site from a small area of woodland named Pheasant Plantation. No River Quality Data is available via the Environment Agency website for the brook. Several ditches are present in the fields on-site which drain into the Washpit Brook whilst Pellow's Pond is located in the east of the site.

PBA (2007) also highlight Trinity Head Conduit (to the south-east of the site) which flows south-west. This forms the origin for the water supply for the fountain at Trinity Hall. PBA state that the original source was likely to have been a spring at the base of the Head Gravels.

2.6 Sensitive Sites

The site is located in a Nitrate Vulnerable Zone (NVZ), which means that regional nitrate concentrations in groundwater are a potential issue.

The areas that will remain as primary open land within the development site are within Green Belt.

The Traveller's Rest Pit located to the east of the site is a designated SSSI. The citation was varied on 23 July 2010 (originally designated on 1 December 1983) to show an area of 2.25 hectares.

2.7**Water Abstractions**

There are no active groundwater abstractions within 500m of the site.

3. HISTORICAL REVIEW AND REGULATORY RECORDS

3.1 Site History from Ordnance Maps

Historical maps dating from 1888 onwards show the Phase 1 area of the development continually comprising agricultural land. The only feature of note within the site is a rural district boundary which is shown to bisect the site from north to the south.

A nursery is shown off-site to the north in the 1903 map.

Gravel workings are shown to the east of the Phase 1 site from approximately 1927 onwards. Roman archaeological ruins are also noted to the east of the Phase 1 site.

Various university development works, residential development and gravel workings are shown off-site in subsequent maps.

3.2 Site History from other Sources

The PBA report (2007) provides brief information on the early history of the wider site as obtained from two reports prepared by the Cambridge Archaeological Unit (CAU) in 2001 and 2002. The CAU studies provide details of the known development of the area of the site between the Prehistoric and Post Medieval Periods. This development included excavation of gravels and Coprolite from the eastern part of the site. PBA (2007) note that it is expected that these workings were backfilled with the excavated overburden material and locally with imported excavated natural materials; there is little trace of the workings on the ground in the fields today, with the exception of the ground level being lower in the area of the SSSI.

The wider site area has yielded important assemblages of Lower Palaeolithic stone artefacts and minor quantities of Pleistocene mammalian and molluscan remains. The Traveller's Rest Pit is designated a SSSI notified under Section 28 of the Wildlife and Countryside Act 1981. It is also a Geological Conservation Review site. The report notes how, from the work of J. E. Marr (1920), it appears that a thickness of between 4.00m and 6.00m of gravel was removed from the pit before Gault Clay (Cretaceous) bedrock was encountered.

3.3 Regulatory Controls

The following table summarises the regulatory entries applicable to the wider North West Cambridge site and immediate surroundings (within 250m).

Table 3.1 Regulatory Controls

Type/Description	Name	Location	Distance/Direction with regards to the wider site	Date issued/ Status
LARLS	University Farm, Cambridge	Huntingdon Road, Cambridge	On-site (former gravel pit site)	Licence cancelled. Received inert excavated natural material waste (~50,000 m3) between 1984 and 1986.
LAPPC (PG1/14 Petrol filling station)	Texaco	Huntingdon Road, Cambridge	146m east	Revoked

Type/Description	Name	Location	Distance/Direction with regards to the wider site	Date issued/ Status
LAPPC (PG1/14 Petrol filling station)	Q8 Girton	Huntingdon Road, Girton	167m north-east	Authorised
PICW	Unknown pollutant	Tributary of River Cam	248m south	17th March 1992 / Category 1 - Major Incident
WIAR	University of Cambridge	Madingley Rd, Cambridge	98m south-east	28th December 2001 / Authorised

LARLS: Local Authority Recorded Landfill sites (related entries for 'Historical Landfill Sites' and 'Registered Landfill Sites' are also present)

LAPPC: Local Authority Pollution Prevention and Control

PICW: Pollution Incident to Controlled Waters

WIAR: Water Industry Act Referrals

3.4 Waste Management Facilities

One registered landfill is recorded as being present on the site, to the east of the main Phase 1 development site, but extending into the proposed landscape corridor to the east. This relates to the deposition of approximately 50 000 m³ of excavated natural materials between 1984 and 1986.

The only other recorded waste management facility relates to the storage of tyres at a car service centre located approximately 0.7 km east of the wider North West Cambridge site.

3.5 Radioactive Substances

The University of Cambridge has been registered under the Radioactive Substances Act for the storage, use and disposal of radioactive materials. The nearest licensed site was 117m to the south-east although this appears to no longer be applicable. The closest active licensed site is currently reported to be 162m south of the wider site at the University of Cambridge's waste stores.

3.6 Fuel Station Entries

The Envirocheck Report lists one fuel station within 250m of the wider North West Cambridge site. This relates to an open petrol station located 167m north-east of the site on Huntingdon Road.

4. SUMMARY OF 2010 URS SITE INVESTIGATION

An intrusive ground investigation for the wider North West Cambridge site was specified by URS and took place between 11 and 26 August 2010. The purpose of the investigation was to assess ground conditions in support of the Master planning application for the site.

Brownfield Solutions Ltd (BSL) was commissioned to undertake the works under the part-time supervision of URS. The investigation comprised a mixture of trial pits, cable percussion boreholes and window sample boreholes. The investigation comprised a mixture of trial pits, cable percussion boreholes and window sample boreholes and comprised two components:

Part 1 involved GI works to gain geotechnical information on likely foundation and pavement design requirements, and contamination conditions at the site for the purpose of masterplan input; and

Part 2 involved GI works specific to assessing the significance (i.e. extent and nature) of the Mineral Safeguarding Area (MSA) identified within the site.

The following exploratory hole locations, with depths shown, were drilled within or immediately adjacent to the Phase 1 area of the site:

- Cable percussion holes: BH101 (25m deep), BH102 (25m deep), BH103 (25m deep), BH104 (25m deep), BH105 (25m deep), BH107 (25m deep), BH304 (6m deep) BH306 (7m deep), BH308 (4.1m) and BH309 (4.0m deep);
- Window sample holes: WS201 (3.5m deep), WS202 (3.5m deep), WS203 (3.5m deep), WS204 (3.5m deep), WS208 (3.5m deep), WS210 (3.5m deep), WS211 (3.5m deep), WS212 (3.5m deep), WS213 (3.5m deep), WS214 (3.5m deep), WS215 (3.5m deep), WS216 (3.5m deep), WS217 (2.8m deep) and WS218 (3.5m deep);
- Trial Pit Scrapes in the northern area of the site, in order to attempt to identify the expected margins of the MSA to determine the lateral extent of this area.

BH101, BH102, BH103, BH104, BH105 and BH107 were fitted with combined ground gas and ground water filter wrapped HDPE 50 mm diameter standpipes to facilitate groundwater monitoring.

4.1 Ground Conditions

4.1.1 *Geology*

Encountered ground conditions within the Phase 1 development area comprised topsoil in all locations. With the exception of WS201, WS202 and BH106 located within and adjacent to the proposed landscaping corridor to the east of the site no Made Ground was encountered.

Within BH106 and WS201, Made Ground was noted below the topsoil to 1.7m bgl and 0.9m bgl respectively. Material was logged as gravel or clay with flint brick, chalk and coarse gravel. This material was underlain by gravels indicative of the observatory gravels/head deposits.

In WS202, a similar Made Ground material was noted to 1.2m. Below this however, a separate layer of made Ground containing brick and occasional plastic polyethylene was identified to 3.4m bgl. This material is considered to be indicative of the former registered landfill area.

Sand and gravels, indicative of the shallow head deposits and observatory gravels was generally present immediately beneath the topsoil. The two lithologies could not be distinguished from borehole log information, and instead have been described as one unit. The general trend was for this layer to be thicker in the northern half of the Phase 1 development site, likely associated with the MSA, with thicknesses ranging between 1 – 5m. In the southern half of the site, these deposits were less than 1m.

In BH105 and BH107, Chalk was identified within the superficial deposits.

Very little to no head deposits and observatory gravels were noted in boreholes within the proposed large landscape areas to the west of the development, which is consistent with the geological mapping data.

The superficial deposits were underlain by Gault Clay, which was not fully penetrated in any exploratory holes drilled to 25m below ground level (bgl). The Gault Clay typically comprised stiff to very stiff (becoming hard) grey/brown occasionally mottled orange brown desiccated clay with occasional calcareous nodules and locally occasional shell fragments.

The underlying Lower Greensand Formation was not encountered in any locations.

4.1.2 **Hydrogeology**

Groundwater was encountered during drilling within the shallow gravel deposits at two locations, WS214 at 0.9m bgl and WS217 at 2.2m bgl.

In the subsequent groundwater installation monitoring visits, groundwater was identified in BH103 in one of two occasions, and BH102 and BH103 on one occasion, but not the other locations.

Assessment within the wider North West Cambridge site indicates the inconsistent presence of shallow groundwater and variation in relative levels across the site, suggesting that encountered groundwater is largely indicative of perched water above the Gault Clay, strongly influenced by seasonal fluctuations in rainfall, and in the shorter term can be affected by antecedent weather conditions.

4.2 **Soil Sampling, Screening and Laboratory Analysis**

Soil samples were taken from a range of depths and from within different soil types. Samples were placed into laboratory supplied glass jars and tubs. These samples were labelled and then stored in a cool box prior to and during transit to an MCERTS and UKAS accredited laboratory for contamination analysis.

Within Phase 1, the following number of samples from each of the encountered lithologies were selected for analysis:

- Topsoil = 6 samples
- Made Ground = 2 samples
- Superficial Deposits = 5 samples
- Chalk = 1 sample
- Gault Clay = 6 samples

Laboratory analysis was undertaken for a range of analytes comprising:

- Suite of metals;
- Speciated PAHs;
- CWG TPH;
- Phenols;
- pH, sulphur, sulphate, total organic carbon;

In addition, pesticide analysis was undertaken on two topsoil samples tested, and PCB analysis was undertaken on one sample, located adjacent to an electricity substation..

4.3 Groundwater Monitoring and Laboratory Analysis

Two rounds of groundwater level monitoring and one round of groundwater sampling was undertaken over the wider North West Cambridge site following the completion of field works, with recovered samples submitted for laboratory testing. BH101, BH102, BH103, BH104, BH105 and were dry at the time of groundwater sampling however and hence no groundwater samples were collected from these installations.

Where groundwater was present in other installations within the wider site, samples were recovered using dedicated disposable bailers for each location to avoid potential cross contamination. Prior to taking a sample the well was first purged to ensure that sampled groundwater was representative of the underlying aquifer. A sample was then decanted into two one-litre amber glass jars and transferred immediately into a cool box for storage prior to and during transit to the analytical laboratory.

4.4 Contamination Assessment

4.4.1 Soil Screening Guidance Criteria

Where available, laboratory results were compared to Soil Guideline Values (SGVs) for a '*residential with plant uptake*' land-use, published by the Environment Agency (EA), which have been generated by the Contaminated Land Exposure Assessment (CLEA) model.

In addition to the above, derived Generic Assessment Criteria (GACs) for 30 compounds have recently been published by Contaminated Land Applications in Real Environments (CLAIRE).

In the absence of EA SGVs and CLAIRE GACs, URS derived GACs, also generated in accordance with the CLEA methodology in accordance with recommended EA guidance (using CLEA Software V1.06) were adopted.

4.4.2 Soil Laboratory Results

Analytical results for all soil samples tested from within the Phase 1 development site were below adopted assessment criteria, consistent with the historical uses of the site and field observations.

Additionally, no hydrocarbons, PCBs or pesticides were identified above laboratory detection limits.

4.4.3 **Groundwater Screening Criteria**

The basis for the selection of waters screening criteria was to ensure that selected values were protective of receptors.

The maximum concentration for each determinant was initially compared against the Environmental Quality Standards (EQS) for freshwaters. Where an EQS was not published for a particular determinant reference was made, generally in order of preference, to the following:

- Surface Water Abstraction Classification (A2); and
- Drinking Water Quality Standards.

Exceedances of the DWS were viewed in the context of the resource value of groundwater i.e. groundwater is not being extracted for potable use within 1km of the site.

4.4.4 **Groundwater Results**

As noted in Section 4.1.2, no groundwater samples were collected from the majority of boreholes due to installations being dry during the groundwater sampling event.

For other installations within the wider North West Cambridge site, groundwater assessment identified elevated nitrate, however, this is likely to be the result of a high background level since the site is located within a Nitrate Vulnerable Zone.

Selenium exceeded the EQS in one sample, but further Tier 2 (DQRA) assessment using Washpit Brook as the receptor, identified a low risk to Controlled Waters.

4.5 **Gas Monitoring**

Following the completion of GI drilling works, two rounds of ground-gas monitoring of the 10 cable percussion installations and one window sample installation were undertaken. The following parameters were monitored for both peak and steady readings:

- Oxygen (% volume);
- Methane (% volume);
- Carbon Dioxide (% volume);
- Gas Flow (litres/hour);
- Atmospheric Pressure (mB); and
- Groundwater Level (mbgl).

For the wider North West Cambridge site, the maximum carbon dioxide reading reported was 1.3%. No methane was detected in any installations and no gas flow was detected.

In accordance with CIRIA C655 guidance, the maximum Gas Screening Values (GSVs) across the wider site were as follows:

- Wider North West Cambridge Site: $1.3\% \times \text{Flow rate of } 0\text{L/hr} = <0.013$

Hence, in accordance with CIRIA C655 the site falls under a Characteristic Situation 1 (CS1), indicating that ground-gas does not pose a risk to the future development of the site.

These results are consistent with the historical uses of the site and encountered ground conditions, namely natural gravels and head deposits directly overlying stiff clays.

5. CONCEPTUAL SITE MODEL AND PROPOSED MAIN INVESTIGATION STRATEGY

Current legislation relating to contaminated land in the UK is contained within Part 2a of the Environmental Protection Act 1990, which was inserted by section 57 of the Environment Act 1995, and by section 86 of the Water Act 2003.

The “suitable for use” approach is adopted for the assessment of contaminated land where remedial measures are only undertaken when unacceptable risks to human health or the environment are realised taking into account the use (or proposed use) of the land in question together with the environmental setting.

Current best practice recommends that the determination of health hazard due to contaminated land is based on the principle of risk assessment, as outlined in Part 2a of the Environmental Protection Act 1990.

The risk assessment process for the environmental contaminants is based on a source-pathway-receptor analysis. These terms can be defined as follows:

- **Source:** hazardous substance that has the potential to cause adverse impacts.
- **Pathway:** route whereby a hazardous substance may come into contact with the receptor: examples include ingestion of contaminated soil and leaching of contaminants from soil into watercourses.
- **Receptor:** target that may be affected by contamination: examples include human occupants/users of site, water resources (surface waters or groundwater), or structures.

For a risk to be present, there must be a viable pollutant linkage; i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway.

The following sections detail the CSM, which has been developed for the site with a view to assessing the potential risks.

5.1 Sources of Potential Contamination

No contamination was identified within the Phase 1 development area from desktop study and prior GI works undertaken across the site.

However, it is acknowledged that while the exploratory hole density in the 2010 investigation was sufficient for master plan submission purposes, the relatively low sampling density means that the potential exists for isolated areas of Made Ground to be present within the Phase 1 development site. Additionally, a low risk currently remains with respect to the presence of pesticides at the site.

Consequently potential contamination sources have been identified as follows:

- Made Ground potentially historically imported to site;
- General chemical spills and leaks associated with former university building operations;
- Pesticides potentially historically applied to the site;

2010 GI assessment identified no PCBs associated with the electrical substation in the northern landscaping area and hence this is no longer considered to present a contamination source.

Potential contaminants of concern associated with the above sources sources comprise:

- Metals, Polycyclic Aromatic Hydrocarbons (PAHs), hydrocarbons and asbestos in soils as a result of potentially imported Made Ground and university building operations;
- Pesticides.

5.2 Receptors, Pathways and CSM

The CSM which summarises source-pathway-receptor linkages and associated risks, without remediation/mitigation measures in place, is presented in Table 5.1. The magnitude of the risk associated with potential contamination at the site has been based on criteria presented in Section 6.3 of the CIRIA Report “Contaminated Land Risk Assessment: A Guide to Good Practice” (CIRIA Report C552).

Table 5.1: Conceptual Site Model

Contamination Source	Pathway	Receptor	Assessed Risk
Potential localised sources of Made Ground	Inhalation, ingestion and dermal contact with contaminated soils, groundwater and/or ground gases/volatiles.	Future site users	Very Low to Low
	Inhalation, ingestion and dermal contact with contaminated soils, groundwater and/or ground gases/volatiles.	Site construction/development workers	Low
Potential areas of elevated pesticides	Inhalation, ingestion and dermal contact with contaminated soils, groundwater and/or ground gases/volatiles.	Neighbours	Very low
	Leaching from overlying soils, direct pollution, lateral migration through groundwater	Groundwater: Secondary Aquifer (Superficial Deposits) Surface Water	Low

5.3 Risk Assessment

The significance of the pollutant linkage risks summarised in the table above is discussed in more detail in the subsections that follow.

5.3.1 *Risk to Future Site Users*

Investigations undertaken to date did not identify the presence of Made Ground within the Phase 1 development site, nor did it identify concentrations of any tested contaminants above human-health screening criteria. Furthermore, no significant ground-gas sources were identified, and two rounds of ground-gas monitoring confirmed this assessment.

Taking this into consideration, the risk to future site users from direct contact with contaminated soils is **low**, and **very low** with respect to ground-gas inhalation risks.

5.3.2 *Risk to Construction Workers*

Chemical analysis of shallow soils at the site indicated that concentrations of contaminants are well below human health guideline values for a commercial end-use. This is a good indication of risk to construction workers from direct contact with soils since commercial GAC values are based on short term exposure to contaminants by adult receptors. The 2010 GI showed that groundwater in the wider North West Cambridge site does not appear to have been impacted and no ground gas was detected. In view of the above, risk to construction workers is considered to be **low**.

5.3.3 *Risk to Site Neighbours*

The Phase 1 development site is predominantly surrounded by agricultural land of the wider North West Cambridge site. Taking this surrounding site use into consideration, the risk posed to site neighbours is considered to be **very low**.

5.3.4 *Risk to Controlled Waters*

The Head Gravels and Observatory Gravels at the site are classified as a Secondary Undifferentiated aquifer; however there is an absence of groundwater abstractions from this stratum within vicinity of the site, and 2010 GI works identified low contaminant concentrations within this aquifer.

Furthermore, a number of installations remained dry throughout the monitoring rounds. This indicates that the shallow/perched groundwater is discontinuous in nature across the site and unlikely to be suitable for abstraction.

Groundwater within the Lower Greensand Formation is considered to be a receptor of low sensitivity given the anticipated significant thickness of overlying Gault Clay. The presence of the Gault Clay is considered to prevent downward migration of contaminants from the shallow soils/groundwater. The site is not within a groundwater source protection zone.

The risk to groundwater within permeable layers within Gault Clay (unproductive strata) from contaminated soil/leachate in Made Ground/soils was assessed as very low. The groundwater risk assessment identified elevated nitrate, however, this is likely to be the result of a high background level since the site is located within a Nitrate Vulnerable Zone.

The results of the groundwater assessment did not indicate a potential risk to Washpit Brook via groundwater flow through the weathered Gault Clay. It can be concluded that there is no conceivable significant risk from the groundwater sampled at the site to the nearest surface water course.

Taking all of the above into consideration, risks to Controlled Waters are assessed as being **low**.

5.4 Proposed Main Investigation Strategy

It is acknowledged that in accordance with BS10175:2011, and planning authority pre-application comments, further investigation is required for a site of this size. Consequently, a 'Main Investigation' has been designed so as either to conclude that no mitigation is necessary, or alternatively formulate a remediation strategy for the site, should the 'Main Investigation' identify contamination.

The CSM risk assessment formulated as a result of the 2007 Phase I and 2010 Exploratory Hole investigation and detailed in Section 5.3 above identified low concentrations of contaminants at the site, and a low overall contamination risk to future site users, construction workers, neighbours and Controlled Waters. This corresponds with field observations where no visual or olfactory evidence of contamination was observed.

However, because of the low sampling density, some potential exists for localised areas of contaminated Made Ground to be present within the Phase 1 development that were not identified in the 2010 investigation. Additionally, a small potential exists for groundwater to be present in areas not previously identified, with possible contamination. With respect to source-pathway-receptor linkages, the potential therefore exists for future users to come into contact with soils in soft landscaped areas.

Consequently, the proposed scope of works is to undertake shallow investigations across the site, focussing primarily in areas of proposed soft landscaping within the main development area, as well as within proposed landscaping corridors to the north and east where the potential for contamination is higher due to university operations and the former registered landfill, with subsequent installation of shallow monitoring wells down to the top of the Gault Clay to allow for a more detailed assessment of groundwater to be made.

As topsoil was immediately underlain by Gault Clay within the large proposed landscaping area to the west by Washpit Brook with no impacts identified in 2010, no additional investigations are considered necessary in this area.

The following scope of works is proposed:

- Drilling of 38 No. trial pits or window samples to extend beyond the base of Made Ground should it be encountered (nominally to 3m depth), for logging, soil contamination sampling and analysis;
- Drilling of 7 No. Cable Percussion (CP) boreholes into the Gault Clay, to intercept groundwater that may be present;
- Collection of 190 soil samples from the trial pits/window samples and CP boreholes;
- Conversion of the CP boreholes into groundwater monitoring standpipes;
- One round of groundwater monitoring and sampling from the 7 No. standpipes;
- Preparation of a Phase II interpretative report for the site.

Laboratory analysis for soil and groundwater samples will be undertaken by MCERTS and UKAS accredited laboratories, for the following contaminants:

- 60 soil samples to be analysed for: TPH, PAHs and Metals;
- 5 soil samples to be analysed for organochlorine and organophosphorous pesticides;

- Selected soil samples will be tested for volatile organic compounds and PCBs. A photoionisation detector (PID) will be used during groundworks in order to screen soil samples for the presence of volatiles (VOCs). If elevated concentrations are detected then these samples will be tested for VOCs;
- Asbestos for Made Ground samples where identified;
- Where present, groundwater samples from the seven CP boreholes will be tested for a wide range of contaminants including metals and hydrocarbons.

The proposed location of window sample/trial pits and CP boreholes in relation to the proposed Phase 1 development are attached as Figures 3 and 4.

Although ground-gas was previously assessed as posing a low risk to the site, only two rounds of monitoring were undertaken, and from communications with Council EHOs it is understood that ground investigations undertaken in other parts of West Cambridge have recorded elevated carbon dioxide concentrations, possibly originating from Chalk in the region.

Consequently six rounds of ground-gas monitoring will initially be undertaken from the 7No. CP boreholes. In-line with CIRIA C655 atmospheric trend data will be collected, and at least one visit as far as it is practicable will be undertaken while atmospheric pressure is falling.

Additional monitoring may be conducted following discussions with Council EHOs if ground-gas issues are identified from these six initial visits.

Assessment findings from the above will be incorporated into a site investigation report detailing all investigative works and sampling on site, together with the results of the analysis, risk assessment to any receptors and if required, a proposed remediation strategy. This information will be submitted to the Planning Authority for its approval.

Interpretation of risks will be undertaken in accordance with EA guidance for CLR11 – Model Procedures for the Management of Land Contamination, and guidance specified in BS10175.

Soil results will initially be compared against Tier 1 EA Soil Guideline Values (SGVs) and Generic Assessment Criteria (GACs) derived by URS and CLAIRE using CLEA V1.06 software. Groundwater and leachate results will initially be compared against EQS values and UK Drinking Water criteria. Depending on the results of Tier 1 soil and groundwater screening, there may be a requirement to undertake Detailed Quantitative Risk Assessment (DQRA), although this is not expected based on the 2010 GI findings.

5.5 Summary

The 2007 Desk top study and 2010 'Exploratory Investigation' have identified a low risk of contamination at the site. The proposed 'Main Investigation' has been designed to provide sufficient information to confirm that no remediation is required, or alternatively design a remediation strategy, for the Phase 1 development area.

Consequently, once completed, the proposed 'Main Investigation' Phase II GI and associated remediation strategy is considered sufficient to allow for the discharge of condition 49 parts a, b, and c.

6. REFERENCES

- Association of Geotechnical and Geo-environmental Specialists 'Guidelines for Combined Geo-environmental and Geotechnical Investigations' (2000);
- British Geological Survey website (www.bgs.ac.uk);
- Building Research Establishment BR211 'Radon: Guidance on protective measures for new buildings' (2007, 2nd edition)
- British Standards 5930+A2 'Code of Practice for Site Investigations' (as amended 2010);
- British Standards 10175 'Investigation of Potentially Contaminated Sites – Code of Practice' (2001);
- CIRIA Publication C692 'Environmental Good Practice on Site' (2010), 3rd edition;
- CIRIA Publication C665 'Assessing risks posed by Hazardous Ground Gases to Buildings' (2007);
- CIRIA Report C552 'Contaminated Land Risk Assessment: A Guide to Good Practice';
- DEFRA Statutory Guidance 'Environment Protection Act 1990 Part 2a Contaminated Land' (2012);
- DEFRA & Environment Agency CLR 11 'Model Procedures for the Management of Land Contamination' (2004);
- Environment Act (1995);
- Environment Agency GP3 'Groundwater Protection: Policy and Practice';
- Environment Agency TR P5-065/TR 'Technical Aspects of Site Investigation (Volumes I and II)' (2002);
- Environment Agency website (www.environment-agency.gov.uk);
- Environmental Protection Act (1990);
- North West Cambridge, Preliminary Geotechnical and Geo-environmental Baseline Condition Study, PBA, Project Ref: 12992/008 Document: R01/rev0 (2007);
- North West Cambridge Geo-environmental Ground Conditions Report, URS Scott Wilson (February 2011).

FIGURES

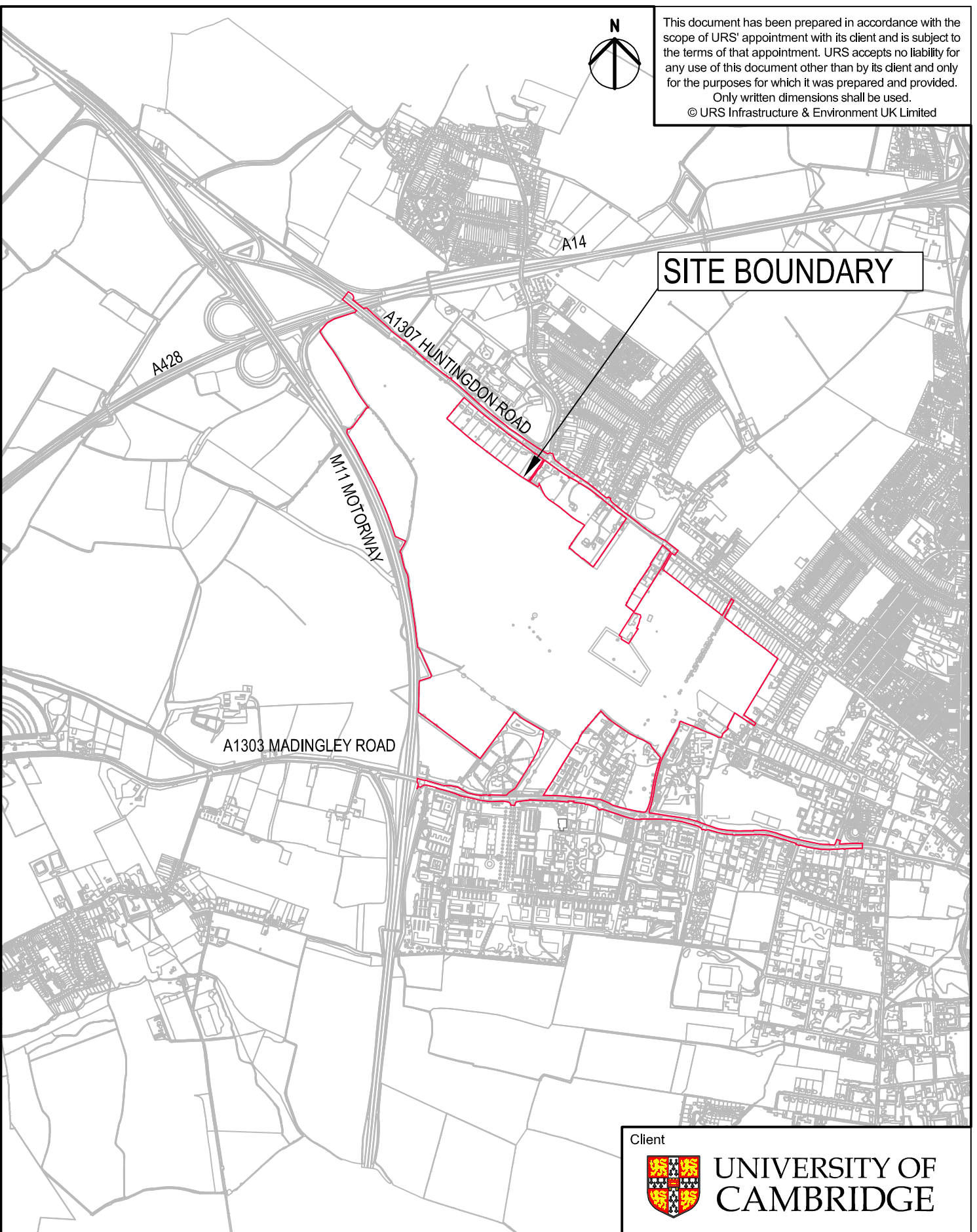


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SITE BOUNDARY



Client



**UNIVERSITY OF
CAMBRIDGE**

Drawing Title

**SITE LOCATION
PLAN**

Scale @ A4
1:20000

Drawn SH	Checked SES	Approved SES
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Date 24.09.12

Drawing Number FIGURE 1

Rev -

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BH REF	EASTING	NORTHING
BH101	542135.41	260734.77
BH102	542420.73	260411.90
BH103	542643.06	260135.89
BH104	542334.90	259853.17
BH105	542654.37	259607.21
BH106	543040.46	259777.89
BH107	543272.17	259757.58
BH108	543520.42	259843.11
BH109	542658.49	260484.79
BH110	Borehole relocated to BH110A	
BH110A	542098.70	261042.48
BH301	542132.59	260847.81
BH302	542258.09	260755.00
BH303	542425.81	260623.76
BH304	542504.92	260483.05
BH305	542737.09	260347.99
BH306	542776.43	260235.14
BH307	542593.55	260402.82
BH308	542676.51	260009.12
BH309	542582.62	260103.72
BH310	542590.16	260308.41

TABLE 1
BOREHOLE CO-ORDINATES

WS REF	EASTING	NORTHING
WS201	543128.91	259549.83
WS202	543148.37	259764.13
WS203	543126.60	260145.80
WS204	543050.05	260356.46
WS205	542202.57	260911.50
WS206	Not undertaken	
WS207	542023.16	260939.08
WS208	541955.85	260685.73
WS209	542310.60	260700.82
WS210	542245.06	260561.81
WS211	542338.55	260280.59
WS212	542194.01	260136.95
WS213	542397.14	260068.23
WS214	542635.70	260276.91
WS215	542611.70	259876.86
WS216	542360.71	259543.52
WS217	542861.37	260136.42
WS218	542840.05	259871.17
WS219	543248.21	259952.88
WS220	543364.51	259802.89

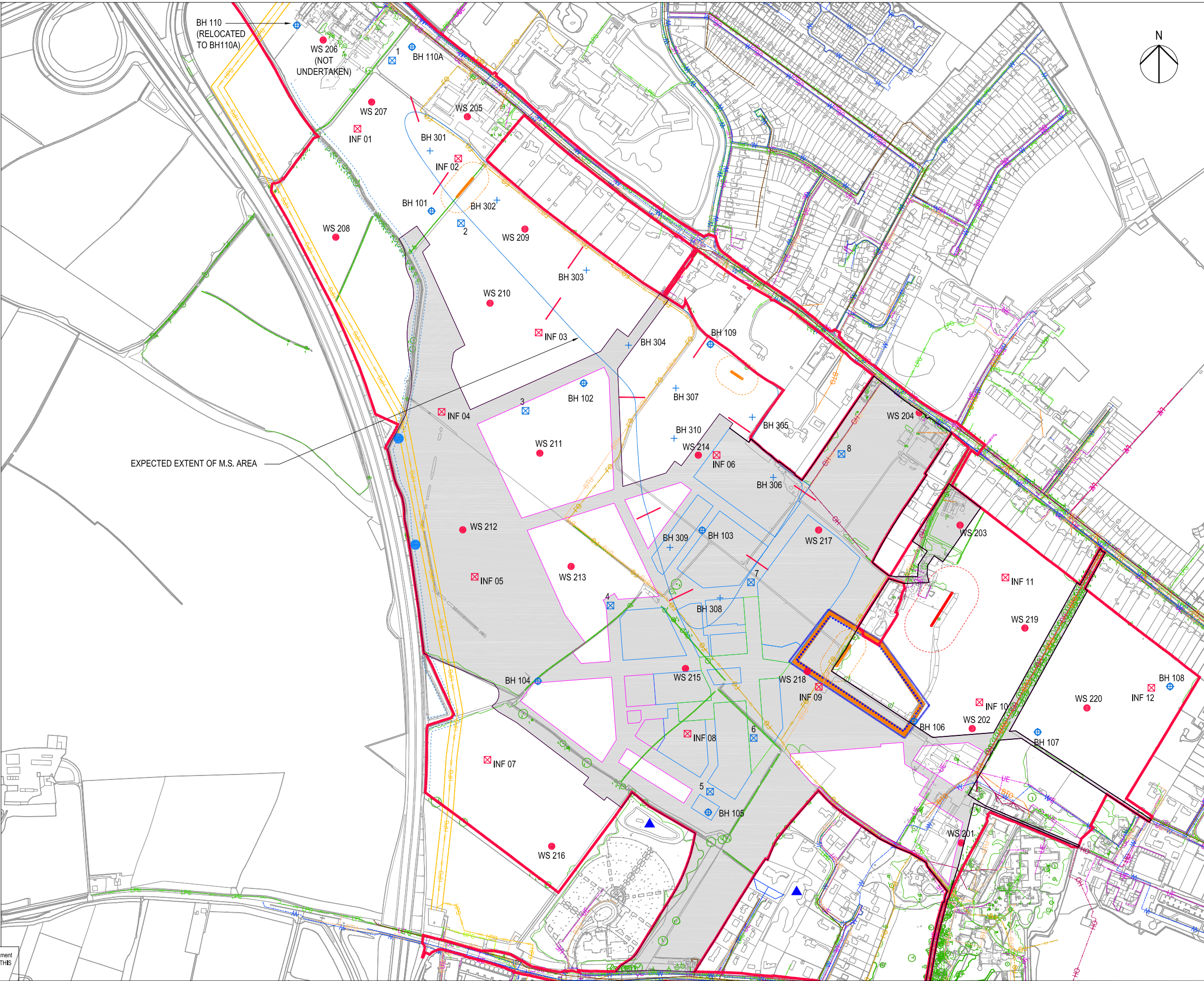
TABLE 2
WINDOW SAMPLE CO-ORDINATES

CBR REF	EASTING	NORTHING
CBR1	542061.50	261016.93
CBR2	542190.72	260711.82
CBR3	542311.71	260360.15
CBR4	542471.09	259994.94
CBR5	542657.83	259646.00
CBR6	542739.52	259746.45
CBR7	542734.54	260038.40
CBR8	542904.22	260279.07

TABLE 3
CBR TEST CO-ORDINATES

CBR REF	EASTING	NORTHING
INF1	541996.50	260889.02
INF2	542185.53	260833.11
INF3	542336.33	260506.81
INF4	542154.41	260358.17
INF5	542216.42	260048.87
INF6	542670.01	260277.13
INF7	542240.33	259705.62
INF8	542615.44	259754.57
INF9	542861.77	259842.55
INF10	543162.93	259813.49
INF11	543211.70	260047.52
INF12	543485.57	259840.66

TABLE 4
INFILTRATION TEST CO-ORDINATES



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX
NOTES: THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RISK REGISTER PRODUCED FOR INCLUSION IN THE HEALTH AND SAFETY PLAN. THE HAZARDS NOTED ARE IN ADDITION TO THE NORMAL HAZARDS AND RISKS FACED BY A COMPETENT CONTRACTOR WHEN DEALING WITH THE TYPE OF WORKS DETAILED ON THIS DRAWING.

- NOTES:
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS, SERVICES AND SPECIALIST DRAWINGS AND SPECIFICATION.
 - ANY DISCREPANCIES IN DIMENSIONS OR DETAILS ON OR BETWEEN THESE DRAWINGS SHOULD BE DRAWN TO THE ATTENTION OF THE ARCHITECT AND / OR THE ENGINEER FOR CLARIFICATION.
 - ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
 - DO NOT SCALE THIS DRAWING.
 - THE LOCATION OF ALL EXISTING SERVICES SHOWN ON THIS PLAN IS INDICATIVE ONLY.

- KEY:
- GROUND INVESTIGATION WORKS
- BH 101 - BH 107 25m CABLE PERCUSSION BOREHOLES FROM MAIN G.L. (REFER TO TABLE 1 FOR CO-ORDINATES)
 - BH 108 - BH 110 10m CABLE PERCUSSION BOREHOLES FROM MAIN G.L. (REFER TO TABLE 2 FOR CO-ORDINATES)
 - WS 201 - WS 220 3.5m WINDOW SAMPLE (REFER TO TABLE 3 FOR COORDINATES)

- 1 - 8 CBR TEST LOCATIONS
- TRIAL PIT SCRAPES
- BH 301 - BH 310 6m MSA CABLE PERCUSSION BOREHOLES (REFER TO TABLE 1 FOR CO-ORDINATES)
- INF 1 - INF 12 INFILTRATION TEST TO BRE DIGEST 365 (REFER TO TABLE 4 FOR CO-ORDINATES)

- CONSTRAINTS
- SITE BOUNDARY
 - EXISTING TREES TO BE RETAINED
 - RIPIARIAN ZONE TO EXISTING WATERCOURSE
 - 10m EASEMENT TO AREA OF GEOLOGICAL INTEREST
 - SITE OF SPECIAL SCIENTIFIC INTEREST
 - EXISTING BT OVERHEAD
 - EXISTING HIGH PRESSURE GAS MAIN
 - EXISTING MEDIUM PRESSURE GAS MAIN
 - EXISTING GAS RESTRICTION ZONE
 - EXISTING ELECTRICITY OVERHEAD
 - EXISTING ELECTRICITY 11kV / 33kV
 - EXISTING FIBRE OPTIC CABLE
 - EXISTING WATER DISTRIBUTION MAIN
 - EXISTING SURFACE DRAIN
 - EXISTING FOUL WATER DRAIN

- MAIN BADGER SETT & 50m PROTECTION ZONE
- SUBSIDIARY BADGER SETT & 30m PROTECTION ZONE
- WATERVOLE HABITAT
- GREAT CRESTED NEWT HABITAT
- PHASE 1

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NOTES				Purpose of Issue		Project Title		Drawing Title		Designed by SH		Drawn SH		Checked SES		Approved SES		Date 24.08.12		URS Infrastructure & Environment UK Limited Scott House Alconon Link, Basingstoke Hampshire, RG21 7PP +44 (0)1256 310 200 +44 (0)1256 310 201 www.ursinf.co.uk	
CONSTRUCTION RISKS				MAINTENANCE / CLEANING RISK		DEMOLITION RISKS		Client UNIVERSITY OF CAMBRIDGE		North West Cambridge		Exploratory Hole Location Plan		Sustainability		Sustainability		Sustainability		Drawing Number FIGURE 2	
In addition to the hazards risks normally associated with the types of work detailed on this drawing take note of above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.				SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX																Rev 0	
Revision Details				By Check		Date		Suffix													

APPENDIX A: 2011 SITE WALKOVER PHOTO



Photo 1 – Looking north towards Huntingdon Road



Photo 2 – Northeast towards Huntingdon Road



Photo 3 – Concrete track bisecting the main development area site (looking northwest)



Photo 4 – View from northwest corner looking south



Photo 5 – View from northeast area looking south



Photo 6 – Southeast boundary of the main development area looking north