

Significant pollution of controlled waters

pollution is being caused set out in paragraphs 4.38 and 4.39 above are being met.

- (b) The fact that land is causing a discharge that is not discernible at a location immediately downstream or down-gradient of the land (when compared to upstream or up-gradient concentrations).
- (c) Substances entering water in compliance with a discharge authorised under the Environmental Permitting Regulations.

Significant pollution of controlled waters is being caused

In deciding whether significant pollution of controlled waters is being caused, the local authority should consider that this test is only met where it is satisfied that the substances in question are continuing to enter controlled waters; or that they have already entered the waters and are likely to do so again in such a manner that past and likely future entry in effect constitutes ongoing pollution. For these purposes, the local authority should:

- (a) Regard substances as having entered controlled waters where they are dissolved or suspended in those waters, or (if they are immiscible with water) they have direct contact with those waters on or beneath the surface of the water.
- (b) Take the term “continuing to enter” to mean any measurable entry of the substance(s) into controlled waters additional to any which has already occurred.
- (c) Take the term “likely to do so again” to mean more likely than not to occur again.

Land should not be determined as contaminated land on grounds that significant pollution of controlled waters is being caused where: (a) the relevant substance(s) are already present in controlled waters; (b) entry into controlled waters of the substance(s) from land has ceased; and (c) it is not likely that further entry will take place.

Significant Possibility of Significant Pollution of Controlled Waters

In deciding whether or not a significant possibility of significant pollution of controlled waters exists, the local authority should first understand the possibility of significant pollution of controlled waters posed by the land, and the levels of certainty/uncertainty attached to that understanding, before it goes on to decide whether or not that possibility is significant. The term “possibility of significant pollution of controlled waters” means the estimated likelihood that significant pollution of controlled waters might occur. In assessing the possibility of significant pollution of controlled waters from land, the local authority should act in accordance with the advice on risk assessment in Section 3 and the guidance in this sub-section.

In deciding whether the possibility of significant pollution of controlled waters is significant the local authority should bear in mind that Part 2A makes the decision a positive legal test. In other words, for particular land to meet the test the authority needs reasonably to believe that there is a significant possibility of such pollution, rather than to demonstrate that there is not.

Before making its decision on whether a given possibility of significant pollution of controlled waters is significant, the local authority should consider:

- (a) The estimated likelihood that the potential significant pollution of controlled waters would become manifest; the strength of evidence underlying the estimate; and the level of uncertainty underlying the estimate;
- (b) The estimated impact of the potential significant pollution if it did occur. This should include consideration of whether the pollution would be likely to cause a breach of European water legislation, or make a major contribution to such a breach;
- (c) The estimated timescale over which the significant pollution might become manifest;
- (d) The authority’s initial estimate of whether remediation is feasible, and if so what it would involve and the extent to which it might provide a solution to the problem; how long it would take; what benefit it would be likely to bring; and whether the benefits would outweigh the costs and any impacts on local society or the environment from taking action.

Reproduced from DEFRA (2012) Contaminated Land Statutory Guidance pursuant to section 78YA of the Environmental Protection Act 1990 as amended by Section 57 of the Environment Act 1995.

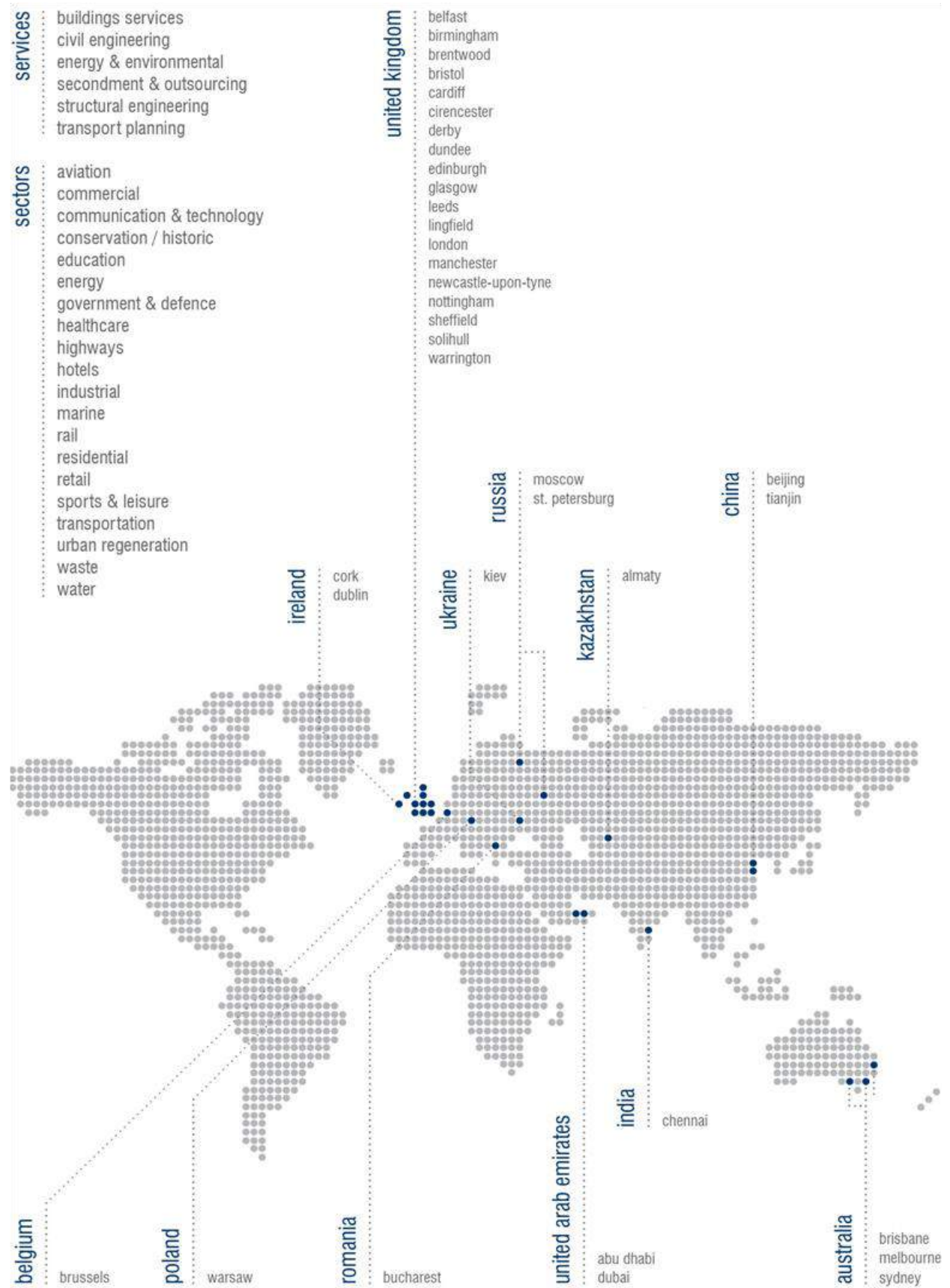
Table E.2: Significant harm to human health, ecological systems and property

Relevant types of receptor	Significant harm	Significant possibility of significant harm
Human beings	The following health effects should always be considered to constitute significant harm to human health: death; life threatening diseases (eg cancers); other diseases likely to have serious impacts on health; serious injury; birth defects; and impairment of reproductive functions. Other health effects may be considered by the local authority to constitute significant harm. For example, a wide range of conditions may or may not constitute significant harm (alone or in combination) including: physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. In deciding whether or not a particular form of harm is significant harm, the local authority should consider the seriousness of the harm in question: including the impact on the health, and quality of life, of any person suffering the harm; and the scale of the harm. The authority should only conclude that harm is significant if it considers that treating the land as contaminated land would be in accordance with the broad objectives of the regime as described in Section 1 of the Contaminated Land Statutory Guidance.	The risk posed by one or more relevant contaminant linkage(s) relating to the land comprises: (a) The estimated likelihood that significant harm might occur to an identified receptor, taking account of the current use of the land in question. (b) The estimated impact if the significant harm did occur – i.e. the nature of the harm, the seriousness of the harm to any person who might suffer it, and (where relevant) the extent of the harm in terms of how many people might suffer it. In estimating the likelihood that a specific form of significant harm might occur the local authority should, among other things, consider: (a) The estimated probability that the significant harm might occur: (i) if the land continues to be used as it is currently being used; and (ii) where relevant, if the land were to be used in a different way (or ways) in the future having regard to the guidance on “current use” in Section 3 of the Contaminated Land Statutory Guidance. (b) The strength of evidence underlying the risk estimate. It should also consider the key assumptions on which the estimate of likelihood is based, and the level of uncertainty underlying the estimate.
Any ecological system, or living organism forming part of such a system, within a location which is: • a site of special scientific interest (under section 28 of the Wildlife and Countryside Act 1981) • a national nature reserve (under Section 35 of the 1981 Act) • a marine nature reserve (under Section 36 of the 1981 Act) • an area of special protection for	The following types of harm should be considered to be significant harm: • harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or • harm which significantly affects any species of special interest within that location and which endangers the long-term maintenance of the	Conditions would exist for considering that a significant possibility of significant harm exists to a relevant ecological receptor where the local authority considers that: • significant harm of that description is more likely than not to result from the contaminant linkage in question; or • there is a reasonable

Relevant types of receptor	Significant harm	Significant possibility of significant harm
birds (under Section 3 of the 1981 Act) - a “European site” within the meaning of regulation 8 of the Conservation of Habitats and Species Regulations 2010 - any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS9) on nature conservation (i.e. candidate Special Areas of Conservation, potential Special protection Areas and listed Ramsar sites); or - any nature reserve established under Section 21 of the National Parks and Access to the Countryside Act 1949.	population of that species at that location. In the case of European sites, harm should also be considered to be significant harm if it endangers the favourable conservation status of natural habitats at such locations or species typically found there. In deciding what constitutes such harm, the local authority should have regard to the advice of Natural England and to the requirements of the Conservation of Habitats and Species Regulations 2010.	possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration. Any assessment made for these purposes should take into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.
Property in the form of: - crops, including timber - produce grown domestically, or on allotments, for consumption - livestock - other owned or domesticated animals; - wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in their value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage. The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a diminution in yield or loss in value is caused by a pollutant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss. In the Guidance states that this description of significant harm is referred to as an “animal or crop effect”.	Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely than not to result from the contaminant linkage in question, taking into account relevant information for that type of contaminant linkage, particularly in relation to the ecotoxicological effects of the contaminant.
Property in the form of buildings. For this purpose 'building' means any structure or erection and any part of a building, including any part below ground level, but does not include plant or machinery comprised in a building, or buried	Structural failure, substantial damage or substantial interference with any right of occupation. The local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the	Conditions would exist for considering that a significant possibility of significant harm exists to the relevant types of receptor where the local authority considers that significant harm is more likely

Relevant types of receptor	Significant harm	Significant possibility of significant harm
services such as sewers, water pipes or electricity cables.	purpose for which it is or was intended. In the case of a scheduled Ancient Monument, substantial damage should be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled. The Guidance states that this description of significant harm is referred to as a 'building effect'.	than not to result from the contaminant linkage in question during the expected economic life of the building (or in the case of a scheduled Ancient Monument the foreseeable future), taking into account relevant information for that type of contaminant linkage.

Reproduced from DEFRA (2012) Contaminated Land Statutory Guidance pursuant to section 78YA of the Environmental Protection Act 1990 as amended by Section 57 of the Environment Act 1995.



Appendix 12.2

Geo-Environmental and Geotechnical Assessment
(September 2014)



Geo-Environmental and Geotechnical Assessment

Station Hill, Reading

September 2014

Waterman Energy, Environment & Design Limited

Pickfords Wharf, Clink Street, London SE1 9DG,
www.watermangroup.com

Geo-Environmental and Geotechnical Assessment

Station Hill, Reading

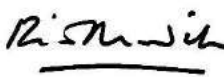
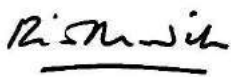
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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007))

Issue	Date	Prepared by	Checked by	Approved by
First	September 2014	Nicola Swallow Graduate Consultant	Richard Meredith Associate Director	Richard Meredith Associate Director
				

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Appendices

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Executive Summary

Objectives

Waterman Energy, Environment & Design Limited was instructed by Sackville Developments (Reading) to undertake a Geo-environmental Assessment for the proposed redevelopment of two areas of Station Hill, Reading known as the Temporary Events Space Area and the Outline Application Area.

The objectives of the work are to: 1) Develop a refined conceptual site model for the site and assist in discharging planning conditions relating to the investigation and remediation of contaminated land; and 2) Provide a geotechnical assessment of the ground conditions for foundations, including its aggressiveness to below-ground concrete.

Site Setting

Current Use

Outline Application Area

The Outline Application Area comprises several buildings including the northern extent of the now disused Friars Walk Shopping Centre, a multi-storey car park, a six storey office block (Xafinity House) with undercroft parking at ground level, and a former club (bingo hall). A taxi rank and bus stops are present at ground level below the former club. The taxi rank extends from Garrard Street up to Station Road.

Temporary Events Space

The Temporary Events Space Area is contained entirely within the Outline Application Area and comprises two vacant structurally isolated buildings, Western Tower and a three storey building. The Western Tower is a fifteen storey, rectangular concrete structure which provided office accommodation over access to underground car parking. A substation is located below ground at the north end of this building along with a small tank. A reinforced concrete framed structure lies to the east which is arranged over 5 levels. The lower two levels provide car parking which is accessed from Garrard Street immediately to the south. The upper three levels provide a single level of retail accommodation along Station Hill at ground level and two levels of offices above.

Ground Conditions

The exploratory holes revealed that the Site is underlain by up to 5.0m of Made Ground over up to 2.8m of alluvium. Sands and gravels of the Taplow Gravel Formation up to 6.4m in thickness were encountered underlying the alluvium.

Structureless chalk was encountered at depths from 3.60m bgl to 15.2m bgl.

Very weak to weak medium density chalk was encountered from depths of 15.2m bgl to depths in excess of 40m bgl.

Controlled Waters

The nearest surface water body to the Site is the River Thames (420m northeast).

The Site is underlain by Alluvium and Taplow Gravel Formation which are classified as Secondary A Aquifers, and by the Upper Chalk which is a Principal Aquifer.

Ground Gas Regime

Measured concentrations of methane and volatile organic compounds were low. Concentrations of carbon dioxide were slightly elevated. Ground gas monitoring has categorised the Site as Characteristic Situation 2, and consequently low level protective measures are required in foundations.

Conceptual Model

Risk Rating

Low level sources of contamination have been identified within the Made Ground. Marginal exceedances of organic contaminants have also been identified within the shallow groundwater.

Potential pathways and receptors have been identified however with appropriate mitigation on completion of the Development it is considered that the risk rating for the Site would be **Low** and the Site would not be capable of being classified as contaminated land under Part IIA of the Environmental Protection Act.).

Conclusions and Recommendations

Geotechnical

A post-demolition ground investigation should be undertaken to provide coverage in currently inaccessible areas; this should include additional geotechnical and environmental assessments.

When the development proposals are finalised, it may be necessary to review the conclusions and recommendations made in this report and Waterman EED should be contacted to provide further advice.

The Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications are DS-1 / AC-1.

Piled foundations are considered to be the most viable founding option. Piles could derive frictional support from the medium dense sands and gravels and structureless chalk present at depths up to 15m bgl and end bearing support from the very weak to weak medium dense chalk present at greater depth.

A specialist piling contractor should confirm the suitability of piling and the most appropriate pile type. The specialist contractor should be requested to provide a design and build foundation solution. Preliminary estimates of pile capacity have been provided in this report.

Suspended floor slabs should be adopted due to the low CBR value of the natural subgrade, the presence of organic alluvium in places and the depth and variability of Made Ground.

Groundwater levels measured during fieldwork were in excess of 2m below ground level. Based on observations made during fieldwork, shallow excavations (<1.2m) likely to be stable in the short term.

It may be necessary to prepare a foundation works risk assessment in line with the EA's advice "Piling and Penetrative Ground Improvement Methods on Land Affected by contamination: Guidance on Pollution Prevention. NC/99/73. This recommendation should be reviewed on completion of the post demolition site investigation.

Environmental

The following recommendations should be implemented during the redevelopment of the site:

A Materials Management Plan and Remediation Strategy should be produced to ensure that excavated materials are suitable for re-use on the Site. The re-use of materials should be identified and designated under the CL:AIRE Protocol i.e. The earthworks phase of the development should be planned and managed such that re-use of suitable site won arisings is maximised and waste is minimised;

Topsoil, Subsoil and any Engineered Fill imported for use at the Site should be certified as suitable for use. Samples of imported soils should be taken and scheduled for laboratory testing to verify certification. All supplier and verification chemical results should be collated by a contractor for inclusion in a Completion Report;

Construction and Maintenance workers should undertake risk assessments and prepare method statements before commencing work and should be provided with and make use of appropriate Personal Protective Equipment (PPE). Appropriate hygiene facilities should also be provided on Site;

Asbestos was identified at a number of locations during the ground investigation; therefore, it is recommended that all future works at the Site are undertaken in accordance with an Asbestos Management Plan and site method statement, and that appropriate Risk Assessments and Method Statements are prepared by Contractors prior undertaking works at the Site;

Construction and Maintenance workers should also be aware of the potential to encounter contaminated groundwater in excavations and it is recommended that Contractors prepare a method statement to cover the potential discovery of contaminated groundwater in excavations;

Planters and/or capping layers with a minimum thickness of 450mm of clean imported soils are to be used for areas of vegetation, in areas of soft landscaping;

This report should be issued to Reading Borough Council to discharge planning conditions.

1. Introduction

1.1 Objectives and Brief

Waterman Energy, Environment & Design Limited was instructed by Sackville Developments (Reading) to undertake a Geo-environmental Assessment for the proposed redevelopment of two areas of Station Hill, Reading known as the Temporary Events Space Area and the Outline Application Area. A site layout plan identifying the site and the two areas is presented in Appendix A.

The main objectives of the report are to:

- Provide an exploratory investigation as defined by BS10175;
- Develop a refined conceptual site model based on the investigation;
- Assist in discharging planning conditions relating to the investigation and remediation of contaminated land;
- Derive representative geotechnical parameters in accordance with Eurocode 7 and characterize the ground for the purposes of geotechnical design
- Provide an assessment of suitable foundation types for the proposed development
- Assess the suitability of materials arising in earthworks activities for re-use on site or disposal
- Provide an assessment of hazardous gas risk in accordance with Ciria Report C665 / BS8485 and preliminary recommendations relating to protective measures required in foundations (if any); and
- Allow feasible remediation options to be evaluated and determine the most appropriate remediation strategy to be developed.

This assessment has been undertaken in general accordance with the Model Procedures for Management of Land Contamination (Contaminated Land Report 11 – Environment Agency, September 2004) and forms a decision record in relation to the assessment of the Site. The report also provides a refined conceptual based on the findings of the ground investigation, an evaluation of potential risks and recommendations relating to any necessary remediation.

The assessment was undertaken in accordance with the scope agreed between Waterman and Sackville Developments (Reading), as documented in Waterman's fee letter (EED12350-110.F.002.HF-RM), and with Waterman's standard Terms of Appointment. The benefit of this report is made to Sackville Developments (Reading).

1.2 Outline Application Area

The Outline Application Area comprises several buildings including the northern extent of the now disused Friars Walk Shopping Centre, a multi-storey car park, a six storey office block (Xafinity House) with undercroft parking at ground level, and a former bingo hall / club. A taxi rank and bus stops are present at ground level below the former club. The taxi rank extends from Garrard Street up to Station Road.

The open areas of the Site comprise concrete, paved surfaces and tarmac with some soft landscaping present to the north and north west of Xafinity House in the west of the Site. Friars Walk comprises a three storey concrete and glass structure shopping centre with a roof top car park. The multi storey car park is on ten floors and is of concrete construction with open roof parking space.

The proposed development in the Outline Application Area to the north of Garrard Street comprises predominantly office use, divided into five plots, four of which are commercial/office space and the fifth being a refurbished multi-storey car park.

“Each of the commercial plots may have terrace areas at the level where the buildings are set back to form pavilions, which provides amenity space for the office workers and an opportunity for the installation of green/ brown roof systems. The very top of each pavilion is likely to be given over mainly to plant areas, which are to be concealed and appear part of the overall composition of the building. For the MSCP the roof is allocated for leisure use and the Illustrative Scheme shows the potential to install a multisport pitch with a running track around the perimeter.”

1.3 Temporary Events Space

The Temporary Events Space area is entirely contained within the Outline Application Area and comprises of two vacant structurally isolated buildings, Western Tower and a three storey building. The Western Tower comprises a fifteen storey, rectangular concrete structure which provided office accommodation over access to underground car parking. A substation is located below ground at the north end of this building along with a small tank. A reinforced concrete framed structure lies to the east which is arranged over 5 levels. The lower two levels provide car parking which is accessed from Garrard Street immediately to the south. The upper three levels provide a single level of retail accommodation along Station Hill at ground level and two levels of offices above.

A separate planning application (Ref. 130440), which has been granted in full, is for a Temporary Flexible Event Space on 0.35ha of land. The proposal comprises demolition of the former Station Hill retail parade (including 26 to 58 Station Hill), and Western Tower to create a landscaped area and multipurpose events platform for temporary use (Use Classes A1 to A5, D1, D2 and *Sui Generis*). In addition, works of hard and soft landscaping and other incidental works is proposed. Soft landscaping is to include a raised lawn and planting beds.

1.4 Regulatory Context

The National Planning Policy Framework (NPPF) sets out Government planning policy for England and how this is expected to be applied to development. Paragraphs 120 to 122 of Section 11 – Conserving and enhancing the natural environment of the NPPF relate to contaminated land matters and state the following:

“To prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

Planning policies and decisions should ensure that:

- *the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
- *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
- *Adequate site investigation information, prepared by a competent person, is presented.*

In doing so, local planning authorities should focus on whether the development itself is an acceptable use of the land and the impact of the use, rather than the control of processes or emissions themselves where these are subject to approval under pollution control regimes. Local planning authorities should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a

particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities.”

In order to assess the contamination status of the Site, with respect to the proposed end use, it is necessary to assess whether the Site could potentially be classified as “Contaminated Land”, as defined in Part IIA of the Environmental Protection Act 1990 and Contaminated Land Statutory Guidance 2012. This is assessed by the identification and assessment of potential pollutant linkages. The linkage between the potential sources and potential receptors identified needs to be established and evaluated.

To fall within this definition, it is necessary that, as a result of the condition of the land, substances may be present in, on or under the land such that:

- a) significant harm is being caused or there is a significant possibility of such harm being caused; or
- b) significant pollution of controlled waters is being caused, or there is significant possibility of such pollution being caused.

It should be noted that DEFRA has advised (Ref. Section 4, DEFRA Contaminated Land Statutory Guidance 2012) Local Authorities that land should not be designated as “Contaminated Land” where:

- a) the relevant substance(s) are already present in controlled waters;
- b) entry into controlled waters of the substance(s) from land has ceased; and
- c) it is not likely that that further entry will take place.

These exclusions do not necessarily preclude regulatory action under the Environmental Permitting (England and Wales) Regulations 2010, which make it a criminal offence to cause or knowingly permit a water discharge of any poisonous, noxious or polluting matter to controlled waters. In England and Wales, under The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009, a works notice may be served by the regulator requiring appropriate investigation and clean-up.

1.5 Constraints and Limitations

The information contained in this report is based on the findings of the Preliminary Environmental Risk Assessment (Report Ref. EED12350-104_R_1_1_3_KH), observations made on the sites and additional land within the Outline Application Area to the south, exploratory hole records, laboratory test results, groundwater monitoring and ground gas monitoring.

The ground conditions reported relate only to the point of excavation and do not necessarily guarantee a continuation of the ground conditions throughout the non-inspected area of the site. Whilst such exploratory holes would usually provide a reasonable indication as to the general ground conditions, these cannot be determined with complete certainty.

Waterman has endeavoured to assess all information provided to them during this investigation, but makes no guarantees or warranties as to the accuracy or completeness of this information.

The site investigation was undertaken to cover both the Temporary Events Space and the Outline Application Area together. Waterman has endeavoured to provide individual assessments of these areas where is deemed necessary.

With regard to the Outline Application Area, there was no access to investigate the areas south of Garrard Street as these areas are still actively tenanted. There was no access to the multi-storey car park as this is actively tenanted and is an active car park.

A site layout plan is presented in Appendix A which details the areas of the Site which have been considered during the intrusive site investigation.



The scope of this site investigation includes an assessment of the presence of asbestos containing materials in the ground at the site but not within buildings or structures or below ground structures (basements, buried service ducts and the like).

The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the Site.

2. Outline Conceptual Model

The outline conceptual model is contained in the Preliminary Environmental Risk Assessment (Ref. EED12350-104_R_1_1_3_KH) and is summarised below.

2.1 Anticipated Ground Conditions

The geology beneath the both the Temporary Events Space and the Outline Application Area was established from the British Geological Survey (BGS) 1: 50, 000 scale Geological Map, Sheet 256, Reading. Aquifer designations were established using Environmental Agency (EA) Groundwater Vulnerability Mapping (Groundwater Vulnerability Map Sheet 39 and EA online groundwater vulnerability maps).

The anticipated ground conditions are summarised in Table 1 below.

Table 1: Ground conditions

Stratum	Area Covered	Estimated Thickness	Typical Description	Environment Agency (EA) Aquifer Designation	Hydrogeological Significance
Made Ground	Whole Site	0.5m to 2.0m	Concrete, tarmac and paving slabs	Not classified	May contain small quantities of perched water.
Alluvium	Whole Site	1m to 2m	Peat, clay and gravel.	Secondary A Aquifer	Small quantities of water of importance for local abstraction.
Taplow Gravel Formation	Whole Site	8m to 10m	Stratified with sub-angular flints, flint pebbles and sand fragments, no quartz or quartzite pebbles.	Secondary A Aquifer	Small quantities of water of importance for base flow to Rivers and local abstraction.
Upper Chalk Formation	Whole Site	Not proven	Soft, white evenly bedded limestone with numerous irregular flints	Principal Aquifer	Highly permeable strata, contains large quantities of groundwater for abstraction.

The Outline Application Area is not located within a source protection zone (SPZ). There are 12 recorded groundwater abstractions within a 1km radius of the Site, the closest of which is located 0.16km to the south west of the Site. The abstraction from a single point is licensed to Primark stores that utilise the water for drinking, cooking, sanitary and washing (small garden) purposes. The abstraction stratum is not specified but is likely to be from the Chalk.

2.2 Historical Land Uses and Potentially Significant Sources of Contamination

A review of historical maps and environmental data sources was undertaken as part of the Preliminary Environmental Risk Assessment to determine the likelihood of historical and current potentially contaminative sources. Subsequent Site reconnaissance was undertaken for the Site Investigation. A summary is provided below and are presented graphically within Appendix A.

2.2.1 Historical Land Uses

Temporary Events Space

Historical potential sources of contamination on site were identified as:

- Livery Stables in the east of the site in the late 1800's;
- An irregular oval feature in the centre of the Site between the late 1800's and early 1900's;
- A station across the site in the early 1900s;
- A car park in the 1980s.

Outline Application Area

Historical potential sources of contamination on site were identified as:

- A timer yard in the north west of the site in the late 1800's;
- An irregular oval feature in the centre of the site between the late 1800's and early 1900's;
- A malthouse in the late 1800s;
- A factory in the north west of the site from the late 1950's to circa 1980;
- A garage and tank in the central portion of the site from the late 1950's to circa 1970;
- A car park in the north of the site in the 1960s;
- A coal yard in the late 1860s; and
- A bus station in the western portion of the site from the 1960's.

Site Surroundings

Potentially sources of off-site contamination were identified as:

- A malthouse, coal yards, cattle market, rifle factory, timer yards, a brewery, railways and railway terminus, a gasworks company, and a veterinary infirmary all within a 200m radius of the Site in the late 1800's;
- Iron works and iron foundry within 300m of the northeast of the Site in the early to mid 1900's. A timber yard was later located on the site of the former iron works with an adjacent paint works;
- A smithy located adjacent to the southeastern boundary in the early 1900's;
- A garage located on the site of the former paintworks northeast of the Site by the mid 1900's;
- Several garages within 150m of the south of the Site by the mid 1900's; and
- Warehouses, a roof top car park, works, a builder's yard and electrical substations within a 150m radius of the Site from the mid to late 1900's.

2.2.2 Current Potential Sources of Contamination

Current potential sources of contamination identified in the Preliminary Environmental Risk Assessment and subsequent Site reconnaissance were identified as:

Temporary Events Space

- Car parking across the Site and oil staining and pigeon guano observed on the concrete hardstanding;
- A Fuel tank located below Western Tower; and
- An electrical substation within the car park below Western Tower.

Outline Application Area

- A taxi rank and bus station located in the central portion of the Site;
- Car parking across the Site and oil staining and pigeon guano observed on the concrete hardstanding;

- Fuel tanks located at ground floor level of the former bingo club and car park plant room in the north of the Site; and
- Two electrical substations across the Site.

Site Surroundings

Potential sources of off-site contamination were identified as:

- Railways to the north of the Site;
- Environmental Permits pertaining to dry cleaners to the south of the Site; and
- A licensed waste management facility located approximately 350m north east of the Site.

2.3 Potentially Significant Pollution Linkages

Potentially significant linkages between contamination hazard sources and relevant receptors are summarised below in Table 2.

Table 2: Preliminary Conceptual model for the Site

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation
Human Health				
Future Site Users, maintenance staff	Inorganic and organic Contamination in soils (including asbestos). Inorganic and organic contamination in groundwater.	Direct contact (ingestion, inhalation, dermal).	Low	A site investigation and generic quantitative risk assessment should be undertaken to determine the suitability of the Site for its proposed end use. The Site would be predominantly covered in buildings and hardstanding which would limit the potential for direct contact with potential contaminants in soils and groundwater.
	Ground gas and vapours.	Inhalation and explosion.	Low to medium	There is potential for ground gas generation from organic Alluvium deposits underlying the Site. Ground gas regime will be assessed as part of a site investigation to determine the requirement for ground gas protection measures in future buildings.
Off-site residents / users	Contaminated dust generation during redevelopment works.	Direct contact (ingestion, inhalation, dermal).	Low to medium	Exposure would be short term and unlikely to significantly affect human health. Good working practices include the damping down during construction reducing the potential for dust generation.
Construction Workers	Inorganic and organic Contamination in soils (including asbestos). Inorganic and organic contamination in groundwater.	Direct contact (ingestion, inhalation, dermal).	Low to medium	Potential inorganic and organic contaminants (including asbestos containing materials) in soils could impact both construction workers. The potential risks should be reviewed following an intrusive site investigation. However, the use of appropriate PPE and RPE and the provision of hygiene facilities should be adopted by both construction workers.
	Ground gas and vapours.	Inhalation and explosion.	Medium	Entrance into confined spaces should be avoided and only undertaken under controlled conditions. The use of appropriate PPE and RPE and the provision of hygiene facilities should be adopted by both construction workers.
Property				
On Site structures	Inorganic and organic Contamination in soils. Inorganic and organic contamination in groundwater.	Direct contact.	Low to medium	Any future development should consider the potential presence of any elevated contaminants identified during site investigations and ensure that infrastructure is suitably designed.
Adjacent properties/Offsite structures	Inorganic and organic Contamination in soils.	Soil leaching and lateral migration, direct contact	Low to Medium	Whilst it is unlikely that any identified potential contaminants will significantly impact on Site structures, this should be confirmed via site investigation works

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation
	Inorganic and organic contamination in groundwater.			which should target Site boundaries to identify any off-site migration plumes which may be present.
Ecological Systems				
Plants/Landscaping	Inorganic and organic Contamination in soils. Inorganic and organic contamination in groundwater.	Direct contact.	Low	Any proposed soft landscaping should be provided with an appropriate thickness of clean, inert soil. A site investigation would determine the suitability for reuse of existing soils.
Controlled Waters				
Rivers Kennet and River Thames	Inorganic and organic Contamination in soils. Inorganic and organic contamination in groundwater.	Soil leaching and lateral migration.	Low	The nearest watercourse is over 400m away from the Site. Furthermore, the Site would be predominantly covered in buildings and hardstanding which would limit the potential for leaching of contaminants in shallow soils.
Secondary A and Principal Aquifers	Inorganic and organic Contamination in soils. Inorganic and organic contamination in groundwater.	Soil leaching and lateral migration.	Low to medium	Hardstanding development will limit rainwater infiltration and Site investigation will confirm soil and groundwater quality. Piling through the superficial deposits could have the potential to create new pathways for contamination to be introduced into underlying aquifers. An appropriate piling technique would be agreed with RBC and the EA prior to commencement of works.

3. Methodology

The intrusive investigation was undertaken in general accordance with Eurocode 7, the Code of Practice for Site Investigation BS 5930 (1999) and the Code of Practice for the Investigation of Potentially Contaminated Sites and its Investigation BS 10175 (2001).

The objectives of the investigation are to:

- Characterise the ground conditions, the hazard sources, pathways and receptors and to reduce uncertainties associated with the proposed redevelopment.
- Provide a geotechnical assessment of the ground conditions for foundations, including its aggressiveness to below-ground concrete.

3.1 Design of Investigation

The site investigation was undertaken for both the Temporary Events Space and the Outline Application Area together. Environmental sampling locations were carefully selected in order to characterise the features identified in the conceptual model and to target, as far as possible, potentially contaminated areas identified in the preliminary environmental risk assessment and subsequent Site reconnaissance. Geotechnical sampling locations were selected based on the layout of the proposed Developments.

The scope of the works included the following:

- Drilling of 5No. shell and auger boreholes to penetrate bedrock;
- Drilling 1No. rotary cored borehole to a depth of 30m below ground level
- One flight auger borehole to 12m bgl;
- 22No. window sample boreholes to a maximum depth of 5.45m bgl;
- 7No. trial pits up to 4.2m bgl
- Installation of ground gas and groundwater monitoring wells;
- Environmental and geotechnical soil sampling, surveying and recording of the data obtained from the above;
- Chemical analysis of the environmental samples (soils and groundwater);
- In-situ and laboratory based testing of geotechnical soil samples; and
- Ground gas monitoring assessment.

A summary of the investigation locations and features investigated is presented in Table 3: Ground Investigation Strategy.

Table 3: Ground investigation strategy

SI Location	Target	Comments
BH1 – BH3, BH4 – BH7	Geotechnical design purposes.	Rock core at selected intervals. Bulk samples collected to help with geotechnical design. CP techniques to rockhead with rotary to follow on to 25m.
TP1 – TP9	Footings and foundations of existing buildings on Site.	Geotechnical soil samples taken to assist in characterising the ground for the purposes of geotechnical design.
WS3, WS12, WS20, WS22	Ground gas and groundwater monitoring wells	Groundwater samples taken from the monitoring wells to assess the contamination status and flow direction of groundwater at the Site.

		Ground gas monitoring undertaken to assess the requirement for gas protection measures in the future buildings.
BH1 – BH3, BH4 – BH7, WS1 – WS25	Made Ground and natural soils across the Site.	Environmental soil samples taken provide additional coverage and information on the nature of Made Ground and natural soils across the Site.

Discrete disturbed environmental samples were collected at depths that were representative of the strata encountered, and where any visual or olfactory evidence of contamination was observed. Each environmental soil sample comprised two plastic tubs, and two glass jars.

Bulk samples were also collected from shell and auger boreholes and trial pits, that were representative of the strata encountered.

3.2 Quality Control

A Waterman Geo-Environmental Engineer monitored the performance, quality of work and health and safety compliance throughout the investigation period. Samples were despatched in batches on a daily basis under a chain of custody procedure to Environmental Scientifics Group (ESG) who are a UKAS accredited laboratory, for subsequent chemical analysis.

Soil samples taken for geotechnical testing were transported to Professional Soils Laboratory.

All contractors, including laboratories, used during this project have been approved by Waterman as a part of in-house Integrated Management System (BS ISO 9001, BS ISO 14001) procedure. This requires all third parties to demonstrate competence and a high standard of work during a regular audit scheme.

3.3 Health and Safety

All work carried out on site was in accordance with Waterman Group Health & Safety policy.

4. Fieldwork

Fieldwork was carried out in six stages, comprising service survey, preliminary drainage survey, main ground investigation, groundwater investigation and rotary coring. The works were procured to various contractors, which, along with the main activities and supervision, are shown in chronological order of the works undertaken in Table 4.

Table 4: Summary of fieldwork activities

Phase of Work.	Activity	Contractor	Date	Supervision
Service survey	Scanning for services	Subcontracted by Southern Testing Limited	9 – 10 April 2014	None
Ground Investigation	5No. shell and auger boreholes to 25m bgl max.	Southern Testing Limited	13 April 2014 – 2 May 2014	Waterman
	1 rotary cored borehole to 30m.	Southern Testing Limited	1 st July 2014	
	1No. flight auger to 12m bgl.	Southern Testing Limited	13 April 2014 – 2 May 2014	
	22No. window sample boreholes to a max of 5.45m bgl.	Southern Testing Limited	13 April 2014 – 2 May 2014	
	7No. trial pits to 4.2m bgl max. depth	Southern Testing Limited	13 April 2014 – 2 May 2014	
Monitoring Well Installation	4No. monitoring wells to a maximum depth of 5.45m bgl	Southern Testing Limited Ltd	13 April 2014 – 2 May 2014	Waterman
Groundwater and Ground Gas Monitoring	Monitoring, sampling and analysis of four wells on six occasions	Waterman Environmental	12 May 2014 – June 2014	None

Note: m bgl = metres below ground level

4.1 Constraints

As the site work progressed, a number of restrictions dictated the termination of some exploratory holes:

- Window sample WS21 could not be drilled due to the detection of buried services by the Cable Avoidance Tool at the base of hand pit in this area. WS21 was designed to target soils in the vicinity of a fuel tank;
- WS25 could not be drilled due to a cable strike (telecoms) occurring in the hand pit of WS25;
- WS24 could not be drilled due to the detection of buried services by the Cable Avoidance Tool at the base of hand pit in this location;
- Alternative locations could not be located for WS24 and WS25 due to buried services identified in their vicinity. Window samples WS24 and WS25 were aimed to establish the extent of suspected hydrocarbon contamination identified in BH7.

4.2 Service Survey

Southern Testing Limited subcontracted the service survey. Scanning for services was at each location, as specified within the Site Investigation plan. In addition, service plans for the Site were used to position exploratory holes. Hand pits were dug in each borehole location to at least 1.2m bgl.

4.3 Ground Investigation

Trial pits were dug using a wheeled mechanical excavator with a backactor. Upon completion, excavations were backfilled as far as possible with arisings.

5No. shell and auger boreholes were drilled to depths between 6.5m bgl to 25.0m bgl. One flight auger borehole (BH7) was drilled to 12.0m bgl. Inspection pits were excavated at each location to confirm the absence of buried services at depths of up to 1.2m bgl. Standard Penetration Tests (SPT) and Cone Penetration Tests (CPT) were carried out at regular intervals to assess the relative density of granular deposits and the consistency of cohesive strata. 22No. window sample probeholes were also undertaken to depths between 0.5m bgl and 5.45m bgl. Monitoring wells were installed in all exploratory holes.

4.4 Soil Sampling

During excavation, samples for chemical analysis were placed on plastic sheeting to prevent cross-contamination of soil. Representative soil samples were obtained from the exposed strata and sealed in one litre plastic tubs with airtight lids, phials and glass jars containing preservatives, as appropriate. The soil samples taken were subject to screening by a photo ionisation detector (PID).

Disturbed and undisturbed samples were taken at regular intervals and retained for geotechnical and geo-environmental testing and logging.

4.5 Monitoring Wells

On completion of drilling, a 50mm diameter slotted ID standpipe with gas tap and bung was installed in WS3, WS12, WS20 and WS22. The monitoring wells were installed to enable future ground gas and groundwater monitoring and sampling. The response zone of the wells was within the Made Ground and upper horizons of the natural ground. The intake section comprised a slotted pipe. The boreholes are kept sealed by a lockable secure cap at ground level. All window samples with installations were backfilled with a bentonite seal up to the depth of the installation standpipes.

4.6 Groundwater Monitoring

Groundwater monitoring was undertaken on the 12 May 2014.

The depth of the standing water in the boreholes was measured using a dip meter. The presence of hydrocarbon free product on the groundwater was investigated by retrieving a surface sample of groundwater using a disposable bailer, which did not show evidence of hydrocarbon sheen on the surface in any of the monitoring wells to date.

Groundwater samples were obtained from the monitoring wells following purging of three well volumes using a disposable bailer. The collected water samples were then sealed into bottles with pre-measured fixatives where necessary, as supplied by the specialist laboratory, and transported in cool boxes to the testing laboratory. Samples were scheduled for a range of organic and inorganic contaminants.

A full set of groundwater monitoring results, including the model type and detection limits of the onsite equipment used for the fieldwork, is presented in the respective fieldwork report sheet in Appendix D.

4.7 Ground Gas Monitoring

Ground gas monitoring has been undertaken on six occasions between 12 May and 30 June 2014. Groundwater levels are also recorded during each ground gas monitoring visit.

During the monitoring visits, the peak and steady concentration readings of methane, carbon dioxide and oxygen were recorded at each installed monitoring standpipe, together with borehole gas flow readings and

atmospheric pressure. This was undertaken using a combined infrared gas analyser and gas flow data monitor. Monitoring for Volatile Organic Compounds (VOCs) was undertaken using a PID.

A full set of ground gas and vapour monitoring results, including the model type and detection limits of the on Site equipment used for fieldwork, is presented in the respective fieldwork reports sheet in Appendix D.

5. Results

Detailed logs of the strata encountered, together with records of the samples taken during both trial pitting and borehole installation and PID readings, are provided in Appendix C. A summary of the geological strata and manmade underground structures encountered is presented below.

5.1 Geological Strata

The strata encountered in the investigation were generally consistent with the anticipated geology identified in the Preliminary Environmental Risk Assessment. A summary of the geological strata encountered is shown in Table 5.

Table 5: Geological strata encountered

Soil Type	Depth of Top of Stratum (m bgl)	Thickness (m)	Typical Description
Made Ground 1	0m (ground level) – 0.02	0.04 - 0.45	Hardstanding - Reinforced concrete slab, Tarmac over concrete, Concrete paving slab
Made Ground 2	0m (ground level)	0.5	Dark brown slightly sandy silty TOPSOIL with abundant fine roots and fine to coarse flint gravel.
Made Ground 3	0m (ground level)	0.02 – 0.05	Blacktop
Made Ground 4	0.04	0.11	Brown cemented SAND
Made Ground 5	0.2	0.3	Subbase
Made Ground 6	0.10 - 0.25	0.2 – 1.57	Fine to coarse yellow brown to pinkish brown sand with coarse to cobble sized brick fragments and fine to coarse flint gravel.
Made Ground 7	0.75	1.05	Blackish grey sandy clayey gravel. Gravels comprise fine to cobble sized brick and concrete, ashy material and occasional organic material.
Made Ground 8	0.15 - 1.80	0.4 – 3.75	Firm orange brown to dark brown to black organic fine to medium sandy / gravelly / silty clay with frequent fine rounded chalk gravel, fine to coarse subrounded flint gravel, fine to coarse brick and concrete fragments, black ashy fragments, slate, rare metal, charcoal, porcelain, clay pipe fragments and weathered chalk fragments.
Alluvium	1.50 - 3.10	0.70 -2.8	Soft to firm, low to medium strength orange brown mottled greenish grey to black organic silty or sandy gravelly CLAY. Gravel is fine to medium of subrounded flint.
Taplow Gravel Formation (Sand)	3.00 - 6.50	0.70 - 3.00	Medium dense becoming loose, yellowish brown gravelly sometimes clayey or silty fine to coarse SAND. Gravels comprise fine to medium subrounded flint and rounded quartz.
Taplow Gravel Formation (Gravel)	3.20 - 4.40	0.60 - 1.80	Medium dense fine to coarse sandy GRAVEL. Gravel is fine to coarse subrounded flint and fine to medium rounded quartz.
Taplow Gravel Formation (Sand/Gravel)	2.95 – 4.30	0.4 - 2.70	Medium dense orange brown to dark grey fine to coarse SAND and GRAVEL. Gravel comprises fine to coarse subrounded to subangular flint and fine to medium rounded quartz.

Upper Chalk (Structureless Chalk)	3.60 – 9.50	8.7	The full thickness of Structureless Chalk is only logged in BH1. Recovered as fine to coarse, weak to moderately strong subangular CHALK gravel with abundant coarse to cobble sized flint gravel.
Upper Chalk (very weak to weak medium dense CHALK)	15.20	Not proven	Typically very weak to weak, medium density, white CHALK. Fractures extremely to closely spaced. Ciria Grade B5-B4 at 15.2m, improving to Ciria Grade B3 - B2 from 24m.

The exploratory holes revealed that the Site is underlain by up to 5.0m of Made Ground over up to 2.8m of alluvium. Sands and gravels of the Taplow Gravel Formation up to 6.4m in thickness were encountered underlying the alluvium.

The Structureless Chalk was encountered at depths from 3.60m bgl to 9.50m, and was proven to be 8.7m thick in BH1. More competent 'bedrock' comprising very weak to weak medium density Chalk was encountered at 15.2m in BH1.

5.2 Underground Structures and Obstructions

Only one obstruction was encountered during the site investigation. A cable was encountered at 0.4m bgl in WS24, the cable sheathe was nicked and the pit subsequently terminated. A strong signal from the CAT scanner was encountered within the hand excavations at window samples WS21 and WS25. No other underground structures and obstructions were encountered with the exception of the foundation exposure pits (BH4 – BH7) where each was terminated at depths between 1.3m bgl and 2.1m bgl.

5.3 Visual and Olfactory Evidence of Contamination

Visual and olfactory evidence of contamination was recorded at a number of locations across the Site during the drilling works. Table 6 below presents a summary of the observations.

Table 6: Visual and Olfactory Evidence of Contamination Encountered

Exploratory Hole Location	Depth (m bgl)	Strata	Observation
BH3	2.20	Alluvium	Faint hydrocarbon odour noted at 1.80m
BH3	3.20	Alluvium	Hydrocarbon odour / staining noted between 3.10 – 3.80m
BH3	4.00	River Terrace	Faint hydrocarbon odour
WS5	1.80 – 4.20	Alluvium	Strong Hydrocarbon odour
WS23	3.40	River Terrace	Hydrocarbon noted with slight odour and visual staining.

5.4 Chemical Analysis

The laboratory test results are presented in Appendix E.

5.5 Groundwater Levels

Groundwater was encountered in seven exploratory hole locations during the intrusive investigation. Shallow groundwater, associated with the Secondary A Aquifers and Principal Aquifer beneath the Site within the Alluvium, Taplow Gravel Formation and Upper Chalk Formation, was encountered at depths

between 2.70m bgl and 5.30m bgl in window sample WS12 and WS13, and within boreholes BH1 – BH3, BH5 and BH6.

Groundwater levels have been monitored on six occasions between 12 May 2014 and 30 June 2014. The results of the groundwater level monitoring are included in Appendix D.

Groundwater monitoring indicated water levels between 2.15m bgl and 2.75m bgl, and 36.07m AOD and 36.44m AOD.

5.6 Ground Gas

As part of the site investigation, four installed boreholes, one in the Temporary Events Space and three in the Outline Application Area, are to be monitored on six occasions over three months in order to detect the presence of ground gas. Ground gas monitoring has been undertaken on six occasions between 12 May 2014 and 30 June 2014. The design of the borehole installation resulted in gas concentrations being recorded from Made Ground or the uppermost horizons of natural ground.

A complete set of ground gas results is included within Appendix D. Below Table 7 summarises the peak carbon dioxide and methane gas results that were recorded on all visits over the monitoring period for each of the boreholes.

Table 7: Ground gas monitoring summary

Monitoring Point	Gas Concentration (%)					Flow rate (max L/hr)
	Methane (max %)	Carbon Dioxide (max %)	Oxygen (min %)	Carbon Monoxide (ppm)	Volatile Organic Compounds (max ppm)	
WS3	<0.1	0.5	20.3	1.0	<0.1	<0.1
WS12	<0.1	9.1	8.7	2.0	<0.1	0.6
WS20	0.2	4.3	17.6	8.0	<0.1	0.1
WS22	0.4	0.4	5.2	2.0	13.2	2.2

Gas flows in the monitoring wells ranged from being below the limit of detection to and 2.2 litres per hour.

6. Geotechnical Testing

6.1 In-Situ Testing

Standard Penetration Tests (SPT's) were undertaken at regular intervals within the boreholes to provide 'N' values for empirical assessment of strength and density parameters. Detailed results of the SPT tests and blow counts are included on the borehole logs included in Appendix C and a summary is presented in Table 8 below:

Table 8: Standard Penetration Test Results

Stratum / Geological Origin	Range of SPT 'N' Values	Density / Descriptor	Derived Values of ϕ'
Taplow Gravel Formation	N = 8 to 19	Medium dense	33 ⁰
Upper Chalk (Structureless Chalk)	N = 7 to 14	Loose to medium dense.	30 ⁰
Upper Chalk (very weak to weak medium dense CHALK)	N = 36 to 42	Very weak to weak. Ciria grade B2 to B5 (increasing with depth).	N/A

6.2 Laboratory Testing

Representative soil samples were scheduled for:

- Natural moisture content and plasticity index
- pH value and water soluble sulphate (SD1 Suite)
- Undrained Shear Strength Triaxial Tests
- One dimensional Consolidation Tests
- Unconfined compressive strength tests on samples of rock core
- Point load tests on samples of rock core
- Saturation moisture content on samples of rock core

The results are summarised below and presented in Appendix C.

6.3 Natural Moisture Content and Plasticity Index

Samples of natural cohesive material were taken for moisture content and plasticity index determinations. The test results are included in Appendix C and are summarised in Table 9 below. The modified plasticity index can be used as an indicator of volume change potential of the soil and is calculated as the plasticity index of the soil multiplied by the fraction of particles less than 425 μ m.

Table 9: Volume Change Potential

Stratum / Geological Origin	Range of Plasticity Indices % (Modified)	Volume Change Potential
Made Ground (cohesive)	2.7%	Low (organic silt)
Alluvium	29% - 32%	Medium

6.4 pH Value and Water Soluble Sulphate (SD1 Suite)

The Aggressive Chemical Environment for Concrete classifications for the soil types identified at the site have been determined in accordance with BRE Special Digest 1:2005 (SD1). SD1 requires that sites are first identified as being in one of four categories based on natural ground / 'Brownfield' conditions and pyrite content. The site has been categorised as: Brownfield - Non-pyrite.

The results of laboratory testing are included in Appendix C and summarised in Table 10 below:

Table 10: Summary of SD1 Suite Analysis

Stratum / Geological Origin	Characteristic Water Soluble Sulphate Value (mg/l SO ₄)	Characteristic pH Value
Made Ground	307	7.3
Alluvium	96	7.6
Taplow Gravels	19	8.1
Upper Chalk	125	7.9

As the characteristic value of sulphate is less than 3000mg/l and the characteristic pH is greater than 5.5, the concentrations of magnesium, nitrate and chloride are not considered significant in determining the design sulphate class.

6.5 Undrained Triaxial & Laboratory Shear Vane Testing

The shear strength of the cohesive alluvium was determined by a quick undrained triaxial test (single - stage) on a 100mm diameter specimen. In addition, samples of cohesive alluvium were scheduled for unconfined compressive (using a hand held penetrometer) to improve coverage. The results of these tests are presented in Appendix C, and are summarised in Table 11 below:

Table 11: Triaxial and Lab Vane Test Results

Stratum / Geological Origin	Apparent Cohesion Values – Quick Triaxial Tests (kN/m ²)	Apparent Cohesion Values – Field Penetrometer Values (kN/m ²)	Range of Derived Values	Undrained Shear Strength / Comments
Alluvium	25kPa	45 – 60kPa	N/A	Low to medium strength

The majority of the results for the alluvium ranged between 25kN/m² and 60kN/m², indicating clays of low to medium strength, which is generally consistent with the descriptions presented within the exploratory hole logs.

6.6 One Dimensional Consolidation

A one dimensional consolidation tests was undertaken on a 100mm diameter specimen of natural soils at a series of confining pressures. The results of the tests are presented within Appendix C and summarised within Table 12 below.

Table 12: Summary of 1D Consolidation Testing

Stratum / Geological Origin	mv value at	Qualitative Description of Compressibility / Comments
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	at overburden plus 100kPa (m2/MN)	
Alluvium	0.25	Medium compressibility

6.7 Uniaxial Compressive Strength

Where possible, core samples from the Upper Chalk were subjected to Uniaxial Compressive Strength (UCS) testing. The test results are included in Appendix C and is summarised in Table 13 below.

Table 13: Uniaxial Compressive Strength results

Stratum / Geological Origin	Range of UCS (MPa)	Density scale descriptor / Comments
Upper Chalk	2.4 – 3.5	Very weak.

The 3No. UCS results suggest that the Upper Chalk is typically very weak. UCS test results should be utilised with caution as the in-situ strength characteristics of the rock are likely to be determined more by the aperture and spacing of the discontinuities than by the strength of the rock itself.

6.8 Point Load Strength Testing

Point Load strength tests were scheduled at regular intervals in order to improve coverage. The results of the Point Load strength tests are included in Appendix C and are summarised in Table 14 below:

Table 14: Point Load Strength Test results

Stratum / Geological Origin	No of tests	Range of Point Load strength ($I_{s(50)}$) (MPa)	Density scale descriptor / Comments
Upper Chalk	15	0.02 – 0.37	Typically very weak to weak.

Point load tests undertaken on samples also scheduled for UCS testing suggest a conversion factor of approximately 20, when comparing $I_{s(50)}$ and UCS. Applying a conversion factor of 20 to the 13No. Point Load test results, suggests that the Upper Chalk is very weak to weak, supporting the descriptions in the borehole logs and the findings of the UCS testing. As with the UCS test results, point Load strengths should be utilised with caution as the in-situ strength characteristics of the chalk are likely to be determined more by the aperture and spacing of discontinuities than by the strength of the rock itself.

6.9 Dry Density/Saturation Moisture Content of Chalk

Saturation Moisture Content tests were scheduled on core samples from the Upper Chalk in order to determine the Chalk Classification. The test results are included in Appendix C and is summarised in Table 15 below.

Table 15: Bulk Density/Saturation Moisture Content results

Stratum / Geological Origin	Dry Density (Mg/m ³)	Saturation Moisture Content (%)
Upper Chalk	1.55 – 1.76	19.8 – 27.4

6.10 Excavations, Trench Shoring & Dewatering

All trenches should be excavated in accordance with CIRIA Report 97 'Trenching Practice'. Comments relating to the stability of excavations (i.e. trial pits) and groundwater seepages are included in the logs in Appendix C. Shallow excavations (<1.2m) likely to be stable in the short term.

7. Generic Environmental Assessment Criteria

The outline conceptual model developed for the Site has identified potential pollutant linkages. These potential pollutant linkages have been investigated and the results assessed against generic assessment criteria. The generic assessment criteria selected for each potential pollutant linkage are summarised in Table 8 below:

Table 16: Generic assessment criteria

Source	Pathway	Receptor	Generic Assessment Criteria
Contaminated soils, Made Ground and groundwater.	Direct contact (dermal, ingestion and inhalation).	Future users of the proposed Development. Off-site users.	Waterman Generic Assessment Criteria for Commercial End-use.
Ground gas and vapours from natural soils and Made Ground.	Migrations through the soil matrix and inhalation in internal spaces.	Future users of the Development.	Gas Screening Value determination and assessment in accordance with CIRIA C665.
Contaminated soils, Made Ground and groundwater. Vapours and ground gas.	Direct contact (dermal, ingestion and inhalation).	Construction workers.	Qualitative Risk Assessment.
Contaminated soils and Made Ground. Contaminated groundwater.	Leaching and migration.	Alluvium & Taplow Gravel Formation (Secondary A Aquifers), Upper Chalk Formation (Principal Aquifer) .	UK Drinking Water Standards (UK DWS)
Contaminated soils and Made Ground. Contaminated groundwater	Direct contact.	New water supply pipes and buried structures.	UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites. BRE Special Digest 1: 2005 Concrete in Aggressive Ground.
Contaminated soils and Made Ground.	Direct Contact.	Site vegetation.	Requirements for topsoil as specified in BS3882:2007.

The generic assessment criteria used in this report are included in Appendix H.

7.1 Site Specific Information used to Support the Generic Risk Assessment

The site specific information used to support the generic risk assessment undertaken as part of this investigation are described in the sections below.

Human Health Risk – Commercial End Use

The data obtained during the investigation has been compared to the Waterman GAC for a commercial end use with 1% Soil Organic Matter (SOM) content. This information will be used to inform a potential risk to human health from materials that are to be retained on Site.

The GAC for commercial end use is considered appropriate given the proposed Development will contain mainly commercial properties with limited areas of soft landscaping.

Human Health Risk – Construction Workers

A qualitative assessment of the risk to construction workers has been undertaken as part of this assessment, given that there are no specific GAC currently available for contamination risk to this receptor.

Controlled Waters

The Secondary A Aquifers associated with the alluvium and Taplow Gravel Formation, and the Principal Aquifer associated with the Upper Chalk Formation are considered to be the main controlled water receptors at the Site. There are 12 recorded groundwater abstractions within a 1km radius of the Site, the closest of which is located 0.16km to the southwest Site. The abstraction from a single point is licensed to Primark Stores that utilise the water for drinking, cooking, sanitary and washing (small garden) purposes. However, the Site is not located within a groundwater Source Protection Zone. Given the proximity of a potable water supply the groundwater results should be compared to UK Drinking Water Standards.

The River Thames is located about 420m to the northeast of the Site and flows in an easterly direction. Based on the Secondary A and Principal Aquifer at shallow depths beneath the Site, the Thames is considered to be a potential surface water receptor.

Ground Gas and Vapours

Potential receptors of ground gas generation are considered to be future Site users. A qualitative analysis of the potential risk arising from ground gas has been undertaken. This has been supplemented by a gas screening value (GSV) for the Site which have been derived based on the approach recommended in CIRIA C665.

Re-use of Topsoil

The risk to vegetation on the Site will be assessed in accordance with the requirements for topsoil as specified in BS3882:2007.

The risk to buried concrete has been assessed in accordance with the guidance provided in the BRE special Digest 1 (2005) 3rd Edition.

Water Supply Pipes

The risk to water supply pipes has been assessed in accordance with UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites.

8. Quantitative Environmental Risk Assessment

The potential pollutant linkages identified in Section 2 have been evaluated using the Generic Assessment Criteria describes in Section 6 and in Appendix H. The results of this evaluation are reported below:

8.1 Risk to Human Health

The results of the soil analysis for the Site were compared against the relevant GACs for inorganic and organic contaminants and a summary of the findings are presented in Tables 9 to 11.

8.1.1 Inorganic Contaminants

An overview of the comparison of inorganic contaminant concentrations with the relevant GACs for land intended for commercial end use is provided in Table 9 below.

Table 17: Summary of Generic Quantitative Risk Assessment for Human Health from Inorganic Contaminants (commercial end use)

Contaminant	Number of Samples Tested	Generic Assessment Criteria (mg/kg)	Maximum Concentration (mg/kg)	Number of Exceedances
Stratum: Made Ground				
Arsenic	24	640.00	94.9	None
Barium	13	22000.00	765	None
Beryllium	13	420.00	2.1	None
Boron (Water Soluble)	24	192000.00	5.0	None
Cadmium	24	230.00	9.24	None
Chromium (total)	24	30400.00	48.5	None
Chromium (VI)	13	35.00	0.2	None
Copper	24	71700.00	3660	None
Lead	24	750.00	1520	5
Mercury	24	26.00	3.59	None
Molybdenum	2	17000.00	0.14	None
Nickel	24	1800.00	71.7	None
Selenium	24	13000.00	0.8	None
Vanadium	24	3160.00	63.5	None
Zinc	24	665000.00	7740	None
Cyanide (Free)	24	16000.00	<0.7 (Below LOD)	None

8.1.2 Organic Contaminants

An overview of the comparison of organic contaminant concentrations with the relevant GACs for land intended for commercial use is provided in Table 10 and Table 11.

Table 18: Summary of Generic Quantitative Risk Assessment for Human Health from Organic Contaminants

(commercial end use)

Contaminant	Number of Samples Tested	Generic Assessment Criteria (mg/kg)	Maximum Concentration (mg/kg)	Number of Exceedances
Stratum: Made Ground				
Aliphatic EC8-EC10	14	2100.00	277	None
Aliphatic EC10-EC12	14	10000.00	148	None
Aliphatic EC12-EC16	14	61000.00	258	None
Aliphatic EC16-EC35	14	1600000.00	1130	None
Aliphatic EC35-EC44	14	1600000.00	17.2	None
Aromatic C8-C10	14	3700.00	87.3	None
Aromatic C10-C12	14	17000.00	79.2	None
Aromatic C12-C16	14	36000.00	105.2	None
Aromatic C16-C21	14	28000.00	424	None
Aromatic C21-C35	14	28000.00	2290	None
Benzene	13	0.08	0.64	None
Toluene	13	120.00	4.84	None
Ethyl Benzene	13	65.00	6.63	None
Xylene	13	45.00	41.95	None
MTBE	13	49	2.30	None
Stratum: Natural Ground (Alluvium/ Taplow Gravel Formation/Upper Chalk Formation)				
Aliphatic EC8-EC10	6	2100.00	<5 (Below LOD)	None
Aliphatic EC10-EC12	6	10000.00	26.2	None
Aliphatic EC12-EC16	6	61000.00	258	None
Aliphatic EC16-EC35	6	1600000.00	400	None
Aliphatic EC35-EC44	6	1600000.00	<7.14 (Below LOD)	None
Aromatic C8-C10	6	3700.00	<5 (Below LOD)	None
Aromatic C10-C12	6	17000.00	<5 (Below LOD)	None
Aromatic C12-C16	6	36000.00	105.2	None
Aromatic C16-C21	6	28000.00	199	None
Aromatic C21-C35	6	28000.00	54.9	None
Benzene	4	0.08	0.02	None
Toluene	4	120.00	0.06	None
Ethyl Benzene	4	65.00	0.13	None
Xylene	4	45.00	0.38	None

Soil samples were also submitted for speciated Poly Aromatic Hydrocarbon (PAH) analysis. The results are summarised below in Table 11.

Table 19: Summary of Generic Quantitative Risk Assessment for Human Health from Organic Contaminants – Speciated PAHs (commercial end use)

Contaminant	Number of Samples Tested	Generic Assessment Criteria (mg/kg)	Maximum Concentration (mg/kg)	Number of Exceedances
Stratum: Made Ground				
Naphthalene	18	200.00	2.3	None
Acenaphthylene	18	84000.00	19.6	None
Acenaphthene	18	85000.00	3.2	None
Fluorene	18	64000.00	4.9	None
Phenanthrene	18	22000.00	50.1	None
Anthracene	18	530000.00	25.1	None
Fluoranthene	18	23000.00	154	None
Pyrene	18	54000.00	141	None
Benzo(a)anthracene	18	90.00	77.2	None
Chrysene	18	140.00	67	None
Benzo(b)fluoranthene	18	100.00	105.4	1
Benzo(k)fluoranthene	18	140.00	36.2	None
Benzo(a)pyrene	18	14.00	103.7	4
Indeno(123-cd)pyrene	18	60.00	77.9	2
Dibenz(ah)anthracene	18	13.00	14.5	1
Benzo(ghi)perylene	18	650.00	62.4	None
Total PAH (Sum of 10) [#]	18	86400	940.7	None
Stratum: Natural Ground (Alluvium/ Taplow Gravel Formation/Upper Chalk Formation)				
Naphthalene	5	200.00	<0.11 (Below LOD)	None
Acenaphthylene	5	84000.00	<0.11 (Below LOD)	None
Acenaphthene	5	85000.00	<0.11 (Below LOD)	None
Fluorene	5	64000.00	0.28	None
Phenanthrene	5	22000.00	0.58	None
Anthracene	5	530000.00	<0.11 (Below LOD)	None
Fluoranthene	5	23000.00	0.15	None
Pyrene	5	54000.00	0.11	None
Benzo(a)anthracene	5	90.00	0.10	None
Chrysene	5	140.00	<0.11 (Below LOD)	None
Benzo(b)fluoranthene	5	100.00	0.10	None
Benzo(k)fluoranthene	5	140.00	<0.11 (Below LOD)	None
Benzo(a)pyrene	5	14.00	0.10	None
Indeno(123-cd)pyrene	5	60.00	<0.11 (Below LOD)	None
Dibenz(ah)anthracene	5	13.00	0.10	None
Benzo(ghi)perylene	5	650.00	<0.11 (Below LOD)	None
Total PAH (Sum of 10)	5	86400	0.56	None

[#] Sum of 10 PAH species: anthracene, benzo(a)anthracene; benzo(k)fluoranthene; benzo(a)pyrene; chrysene; phenanthrene; fluoranthene; ideno(1,2,3-cd)pyrene, naphthalene and benzo(ghi)perylene.

Made Ground

Temporary Events Space

Comparison against the relevant GAC for inorganic contaminants indicated one exceedance of Lead within the Made Ground within this area which was recorded at a concentration of 1,250mg/kg.

Comparison against the relevant GAC for organic contaminants did not reveal any exceedances within the Made Ground within the Temporary Events Space area.

Outline Application Area

Comparison against the relevant GAC for inorganic contaminants indicated four exceedances of Lead within the Made Ground at the Site. Concentrations were recorded at between 23.3mg/kg to 1,520mg/kg.

Comparison against the GAC for organic contaminants indicated a slightly elevated concentrations of benzo(a)pyrene in four samples of Made Ground from BH2, BH6, WS12 and WS13. In addition, within WS12, elevated concentrations of benzo(b)fluoranthene and Di-benzo(a,h)anthracene were identified. Indeno(1,2,3-cd)pyrene was also recorded above the GAC is window sample WS12 and WS13.

In view of the proposed Developments, potential pollutant pathways between contaminants in the Made Ground and the end-user would be broken by the presence of hardstanding and/or building footprints. Potential pollutant linkages between potentially contaminated dust and off site users can be broken by the use of dust suppression techniques.

However, in areas where soft landscaping is proposed, planters and capping layers with a minimum thickness of 450mm of certified clean inert soils would break potential pollutant linkages between end users and contaminants in the Made Ground.

Natural Ground (Alluvium / Taplow Gravel Formation / Upper Chalk Formation)

Comparison against the relevant GAC for inorganic contaminants indicated no exceedances within the natural ground at the Site.

Comparison against the GAC for organic contaminants indicated no exceedances within the natural ground at the Site.

8.1.3 Asbestos Screening

Temporary Events Space

Five of the eight Made Ground soil samples submitted for analysis from the Temporary Events Space area were screened for Asbestos. Two samples, WS14 and WS19, were flagged up as containing asbestos in the form of chrysotile free fibres and chrysotile cement, respectively. These samples were then subjected to asbestos quantification analysis of the soils which identified no asbestos within WS14 and 0.12% asbestos by weight of the total dried sample in WS19.

Outline Application Area

Eighteen out of the twenty-two Made Ground soil samples submitted for analysis from the Outline Application Area were screened for Asbestos. Asbestos was detected in six samples of Made Ground: Amosite free fibres in BH3 and Chrysotile in the form of free fibres lagging was identified in BH3, BH6, WS7, WS9, WS10 and WS11. Subsequent asbestos quantification analysis of the soil samples did not identify asbestos in BH3 and WS10. Asbestos was identified at <0.001% in WS11, 0.002% in BH6, and >0.1% in WS7 and WS9.

Potential pollutant pathways between asbestos containing materials and end users would be broken by the presence of buildings and hardstanding. Potential pollutant linkages between potentially contaminated dust and off site users can be broken by the use of dust suppression techniques.

In areas where soft landscaping is proposed, planters and capping layers with a minimum thickness of 450mm of certified clean inert soils would break potential pollutant linkages between end users and contaminants in the Made Ground.

8.1.4 Vapours and Ground Gas

Temporary Events Space

During the ground gas monitoring undertaken to date by Waterman, a maximum concentration of 4.3% carbon dioxide was detected. Depleted oxygen levels were recorded in the monitoring well with a minimum level of 17.6%. There was no flow or methane detected on either monitoring visit. Carbon monoxide was recorded up to a maximum of 8.0ppm at WS20.

Outline Application Area

During the ground gas monitoring undertaken to date by Waterman, a maximum concentration of 9.1% carbon dioxide was detected. Methane concentrations above the limit of detection (<0.1%) were detected on four occasions, with a peak of 0.4% in WS22. Depleted oxygen levels were recorded in several of the monitoring wells. The minimum concentration recorded for oxygen was 5.2% in WS22. A maximum flow rate of 2.2l/hr was detected.

A combined ground gas regime will be determined for the Temporary Events Space and the Northern Area in order to provide the most conservative assessment of ground gas across the Site. Therefore, for the purpose of modelling the potential impact of ground gas on the Site the flow rate of 2.2l/hr will be used.

To assess the likely risk posed by ground gases a GSV is calculated using the recorded gas flow (l/hr) multiplied by the maximum gas concentration (%). GSVs are calculated for both carbon dioxide and methane and are then compared against the characteristic situations described within CIRIA C665 as presented as Appendix I. Based on the highest carbon dioxide concentration of 9.1% and the flow rate of 2.2l/hr the GSV is calculated as 0.2002l/hr for the Site.

Based on these GSVs and the maximum carbon dioxide concentration the Site is categorised as a “Characteristic Situation 2”. The characterisation is classed as a “Low risk” and low-level gas protective measures are required.

Hydrocarbon vapour monitoring was also carried out using a PID as part of the ground gas monitoring regime undertaken by Waterman. Vapour concentrations were not recorded above detection limit in all but one borehole, WS22, where the recorded VOC level was 13.2ppm.

Headspace testing of soil samples recorded VOC concentrations of <0.1ppm to 690ppm in Made Ground with multiple locations recording VOC levels above 100ppm. VOC levels in the natural ground were recorded between <0.1ppm to 1,078ppm. The highest recording was in BH6 at 3.00m bgl to 3.70m bgl within the Alluvium.

A total number of 23 headspace tests recorded elevated VOC levels, nine of which underwent chemical analysis. Only one soil sample out of nine, borehole BH6 at 1.0m bgl, identified a concentration of contaminants above the generic assessment criteria for human health. Limited exceedances of volatile compounds were also identified within the site soils which did not record elevated VOC levels, therefore there is considered to be a low risk posed at the Site from volatile organic compounds.

8.2 Risk to Controlled Waters

The results of the groundwater analysis obtained on samples from 4 monitoring wells were compared against the relevant UK Drinking Water Standards. Where a UK DWS is not available an Environmental Quality Standard for freshwater will be used. A summary of the findings is presented in Tables 12 to 14.

8.2.1 Inorganic Contaminants

An overview of the comparison of inorganic contaminant concentrations with the relevant GAC is provided in Table 12.

Table 20: Summary of Generic Quantitative Assessment for Controlled Waters from Inorganic Contaminants

Contaminant	Maximum Concentration (ug/l)	UK DWS (ug/l)	Number of Exceedances
Arsenic	2	10	None
Barium	270	1000	None
Boron	190	1000	None
Cadmium	<0.1 (Below LOD)	5	None
Chromium (total)	5	50	None
Copper	2	2000	None
Lead	<1 (Below LOD)	25	None
Mercury	<0.1 (Below LOD)	1	None
Nickel	10	20	None
Selenium	3	10	None
Zinc	31	5000	None
Total Cyanide	<0.02 (Below LOD)	50	None
Free Cyanide	<0.02 (Below LOD)	50	None
Total Sulphur as Sulphate (mg/l)	121	400	None
Nitrate (mg/l)	6.8	50	None
Ammoniacal Nitrogen as N	0.6	0.021	3

Comparison against the relevant GAC indicates three elevated concentrations of Ammoniacal Nitrogen in WS12, WS20, and WS22.

8.2.2 Organic Contaminants

All groundwater samples were submitted for a suite of organic contaminants including TPH and BTEX compounds analysis. The results are summarised in Table 13. The comparison against the relevant GAC indicates the majority of the determinands were below limit of detection. Concentrations of total TPH ranged between 20 and 390ug/l (micro grams per litre). Hydrocarbon sheens were not observed on any of the groundwater samples.

Table 21: Summary of Generic Quantitative Assessment for Controlled Waters from Organic Contaminants

Contaminant	Maximum Concentration (ug/l)	Freshwater EQS (ug/l)	DWS (ug/l) where applicable	Number of Exceedances
Benzene	<5 (Below LOD)	1.0	Not Applicable	None
Toluene	<5 (Below LOD)	700	Not Applicable	None
Ethyl Benzene	<5 (Below LOD)	50	Not Applicable	None
m/p-Xylene	<10 (Below LOD)	0.5	Not Applicable	None
o-xylene	<5 (Below LOD)	0.5	Not Applicable	None

All groundwater samples were submitted for speciated Poly Aromatic Hydrocarbon (PAH) analysis. The results are summarised in Table 14.

Table 22: Summary of Speciated PAH Concentrations in Groundwater Samples

Contaminant	Maximum Concentration (ug/l)	Freshwater EQS (ug/l)	DWS (ug/l) where applicable	Number of Exceedances
Naphthalene	0.52	2.4	Not Applicable	None
Acenaphthylene	<0.010 (Below LOD)	None Available	None Available	None
Acenaphthene	0.01	None Available	None Available	None
Fluorene	<0.010 (Below LOD)	None Available	None Available	None
Phenanthrene	0.04	None Available	None Available	None
Anthracene	0.01	0.1	Not Applicable	None
Fluoranthene	0.03	0.1	Not Applicable	None
Pyrene	0.03	None Available	None Available	None
Benzo(a)anthracene	0.03	None Available	None Available	None
Chrysene	0.02	None Available	None Available	None
Benzo(b)fluoranthene	0.02	0.03	Not Applicable	None
Benzo(k)fluoranthene	0.01	0.03	Not Applicable	None
Benzo(a)pyrene	0.02	0.01	Not Applicable	2
Indeno(123-cd)pyrene	<0.010 (Below LOD)	0.002	Not Applicable	None
Di-benzo(a,h.)anthracene	<0.010 (Below LOD)	None Available	None Available	None
Benzo(ghi)perylene	0.01	0.002	Not Applicable	1

Temporary Events Space

The comparison against the relevant GAC indicates that there were no exceedances in organic contaminants at the Temporary Events Space area.

Outline Application Area

The comparison against the relevant GAC indicates that there were three exceedances of speciated PAHs. Two of these recordings were within WS3 with the additional exceedances being recorded in WS12.

The Secondary A Aquifers within the Alluvium, Taplow Gravel Formation and the Principal Aquifer within the Upper Chalk Formation are considered to be the main controlled water receptors at the Site. Given that there is no impermeable barrier between the site soils and the underlying aquifer there is the potential for a direct pollutant linkage. However the groundwater and soils data has indicated only marginal exceedances and consequently is not considered to be a significant pollutant linkage.

Given the levels of contaminants within the groundwater only moderately exceeding the UK DWS thresholds and the distance of over 100m to the receptor the Site is considered to pose a low risk to this surface water receptor.

8.3 Risk to Ecological Systems/Vegetation

All soil samples were assessed against criteria as set out in BS3882:2007 for soils with a pH of greater than 7. Table 15 summarises the results.

Table 23: Summary of Generic Quantitative Assessment of Potentially Phytotoxic Contaminants

Contaminant	Maximum Concentration (mg/kg)	Generic Assessment Criteria (mg/kg)	Number of Exceedances
Copper	3660	<200	6
Nickel	71.7	<110	None
Zinc	7740	<300	6

Exceedances of the assessment criteria were recorded for multiple samples across the Site. Pollutant pathways between soils containing potentially phytotoxic concentrations of contaminants and areas of proposed soft landscaping would be broken by the use of planters and capping layers with a minimum thickness of 450mm of certified clean inert soils.

8.4 Risk to Structures

Potential effects on buried concrete and structures can be mitigated by the use of appropriate concrete specifications. The Design Sulphate Class and an Aggressive Chemical Environment for Concrete (ACEC) will be discussed in a geotechnical section to be included at a later date.

8.5 Risk to Water Supply Pipes

The UKWIR project steering group decided that barrier pipes would provide sufficient protection for the supply of drinking water in all Brownfield site conditions. However, this approach needs to be agreed with the local water company.

8.6 Risk to Construction Workers

Redevelopment of the Site is planned therefore the risk to construction workers has been considered. A qualitative assessment of the risk to construction workers has been undertaken as part of this assessment, given that there are no specific GAC currently available for contamination risks to this receptor.

Contaminant concentrations were generally found to be low. However, there is the potential for elevated concentrations of organic contaminants and vapours in soils and shallow groundwater which could be exposed. Therefore, it is considered that Site construction and maintenance workers should wear appropriate PPE and if necessary RPE during any below ground works in order to reduce direct contact, dermal absorption, ingestion and inhalation of any potential contaminants.

Given the depth to groundwater across the Site (2.7m bgl to 5.3m bgl), it is considered likely that the ground works will expose the underlying groundwater. However, all construction workers would be subject to mandatory health and safety requirements under the Construction (Design and Management) (CDM) Regulations 2007 and the Control of Substances Hazardous to Health (COSHH) Regulations 2002. Construction workers would therefore be required to use appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE), thereby minimising the risk of exposure to potentially contaminated soils, dust, and groundwater.

Depleted oxygen and elevated carbon monoxide levels have been recorded during ground gas monitoring visits. Therefore, all ground works should be carried out in line with the Confined Space Regulations, 1997.

9. Geotechnical Assessment

9.1 Proposed Development

This assessment has been prepared on the understanding that the site is to be developed over five plots, four of which are commercial/office space and the fifth being a refurbished multi-storey car park. When the development proposals are finalised, it may be necessary to review the conclusions and recommendations made in this report and Waterman EED should be contacted to provide further advice.

9.2 Characteristic Values and Design Bearing Resistance

Based upon the site investigation data and a review of the derived values summarised in Section 6, characteristic values can be assigned to each strata. EC7 defines the characteristic value of a soil or rock as a cautious estimate of the value affecting the occurrence of the limit state. The characteristic values to be used in design are highlighted in Table 20 below.

Table 24: Characteristic Values for Geotechnical Design

Stratum / Geological Origin	Strength / Density Descriptor	Range of Derived Values	Strength	Angle of Shearing Resistance (ϕ' – deg)	Effective Cohesion (c' – kPa)
Taplow Gravel Formation	Medium dense.	N = 8 to 19	N/A	33 ⁰	N/A
Upper Chalk (Structureless Chalk)	Loose to medium dense.	N = 7 to 14	N/A	30 ⁰	N/A
Upper Chalk (very weak to weak medium dense CHALK)	Very weak to weak. Ciria grade B2 to B5.	N = 36 to 42	UCS = 2.8MPa	N/A	N/A

9.2.1 Design Class for Concrete

Based on the characteristic values derived from SD1 testing, the Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications are considered to be: DS-1 / AC-1 for both made and natural ground.

9.2.2 Piled Foundations

Made ground, organic alluvial clay and loose granular deposits are present to depths in excess of 3m below existing ground level and foundation loads are likely to be significantly in excess of the design bearing resistances of the made ground and shallow drift deposits.

Piled foundations are therefore considered to be the most viable founding option. It is recommended that the advice of a specialist piling contractor should be obtained to confirm the suitability of piling and the most appropriate pile type. However, based on the site investigation information, frictional support could be derived from the: medium dense sands and gravels; Structureless Chalk at depths of up to 15m and very weak to weak medium dense CHALK. End bearing support for piles could be provided by the very weak to weak medium dense CHALK at depths in excess of 15m.

The piles should be designed based on the requirements of Eurocode 7 and guidance such as *'The design of bored piles in chalk' Federation of Piling Specialists; CIRIA Project Report PR86 Shaft Friction of CFA piles in chalk (2003) and CIRIA Project Report 11, Foundations in Chalk (1994).*

Given that the site is affected by organic alluvial soils liable to settle and the site may be subject to increased loadings due to filling and construction activity, the effect of 'downdrag' or negative skin friction should be considered in the pile design.

For the purposes of preliminary design, the design resistances of single CFA piles at a range of diameters, keyed in to the very weak to weak medium dense chalk 20m below ground level have been estimated and are presented in the table below.

Table 25: Estimated Design Resistance (kN) of a Single CFA Pile keyed in to very weak to weak medium dense CHALK at 20m depth

Pile depth (m)	Pile Diameter (m) <i>Estimated Design Resistance (kN)</i>						
	0.15m	0.30m	0.45m	0.60m	0.75m	0.90m	1.05m
20.00m	175kN	475kN	875kN	1400kN	2025kN	2775kN	3625kN

The final design of the piles will be the responsibility of the piling contractor. An allowance for probing of pile positions and/or drilling of obstructions should be allocated. The carrying capacity of pile groups will in part depend on the number, type and size of pile chosen by the contractor and the quality of workmanship.

Subject to any piling trials, an acceptable percentage of piles should be load tested to at least twice working load. All piles should be integrity tested.

Significant underground obstructions were encountered in the site investigation (e.g. buried concrete obstructions, old foundations). The pile design should allow for the presence of any such obstructions.

On significantly contaminated sites, the Environment Agency may object to the use of piles on the basis that they can introduce pathways for contaminant migration. Such objections can usually be overcome if piles are designed in accordance with the EA's advice "Piling and Penetrative Ground Improvement Methods on Land Affected by contamination: Guidance on Pollution Prevention. NC/99/73.

Consideration should be given to the re-use of pile arisings if piles are used. It may be possible to re-use pile arisings subject to risk assessment; however, certainty of use and volume should be confirmed in accordance with the requirements of CLAIRE guidance.

Given the proximity of existing structures, the effects of noise and vibration (e.g. from piling plant) should be addressed as part of the contractors method statement.

9.2.3 Floor Slabs

It is recommended that suspended floor slabs should be adopted due to the low CBR value of the natural subgrade, the presence of organic alluvium in places and the depth and variability of Made Ground at the site.

9.2.4 Groundwater / Stability of Excavations

Comments relating to the stability of excavations (i.e. trial pits) and groundwater seepages are included in the logs in Appendix C. The groundwater levels measured during fieldwork were in excess of 2m below ground level. Based on observations made during fieldwork, shallow excavations (<1.2m) likely to be stable in the short term.

Consideration should be given to the re-use of arisings from foundation trenches / drainage runs etc. Where contamination has been encountered, it may be possible to re-use foundation arisings subject to risk assessment, however certainty of use and volume should be confirmed in accordance with the requirements of CLAIRE guidance.

In line with BS6031, all excavations should be examined daily by a competent person to ensure that they remain safe. Where the sides cannot be sloped back to a safe angle, as approved by a competent and experienced person, their continued stability should not be taken for granted. Vertical or steep faces should be provided with support unless instructed otherwise by a competent person.

10. Conclusions

Following the implementation of the ground investigation, the pollutant linkages identified during the Preliminary Environmental Risk Assessment have been re-evaluated and reclassified in relation to the additional information obtained. The results of the reassessment are summarised in Table 16 below.

Given the Site's current condition and the proposals for it to be redeveloped for commercial/office space the risk of contaminated liabilities as defined under the Environmental Protection Act 1990 are considered **Low to Medium**.

Table 26: Estimation of environmental risks associated with the subject Site

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Human Health					
Future Site Users	Elevated concentrations of inorganic and organic contaminants in Made Ground. Asbestos identified in Made Ground. Elevated concentrations of organic contaminants in shallow groundwater.	Direct contact (dermal, ingestion and inhalation)	Low to Medium	In view of the proposed hardstanding and buildings, with limited areas of soft landscaping, across the majority of the Development, the risk to future Site users is considered to be low to medium. Potential pollutant pathways between contaminants in underlying soils and shallow groundwater would be broken by the presence of buildings and hardstanding. In areas of soft landscaping, potential pollutant pathways would be broken by the use of planters and a capping layer with a minimum thickness of 450mm of imported clean soils.	Low
	Ground gas and vapours from Made Ground and natural deposits	Accumulation in internal spaces, inhalation and risk of explosion.	Low	- An assessment of the ground gas regime has indicated low concentrations of carbon dioxide. Gas flows were recorded as low to below the limit of detection. - The Site has been characterised as Characteristic Situation 2, low risk. Therefore, low level ground gas protection measures are required in new buildings and structures on-Site. - Hydrocarbon vapour monitoring was also carried out using a PID as part of the ground gas monitoring regime undertaken by Waterman. Vapour concentrations were recorded up to 13.2ppm.	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Off-site residents / users	Dust generation during redevelopment works.	Direct contact (dermal, ingestion and inhalation)	Low to Medium	Potential pollutant linkages would be broken by the use of good working practices and should include the dampening down during construction reducing the potential for dust generation.	Low
Construction Workers	Elevated concentrations of organic contaminants in Made Ground and natural soils. Asbestos identified in Made Ground. Elevated concentrations of organic and inorganic contaminants in shallow groundwater. Ground gas and vapours from Made Ground and natural deposits.	Direct contact (dermal, ingestion and inhalation)	Medium	Although contaminant concentrations were generally found to be low it is considered that Site construction and maintenance workers should wear appropriate PPE and if necessary RPE during any below ground works in order to reduce direct contact, dermal absorption, ingestion and inhalation of any potential contaminants. All construction workers would be subject to mandatory health and safety requirements under the Construction (Design and Management) (CDM) Regulations 2007 and the Control of Substances Hazardous to Health (COSHH) Regulations 2002. Construction workers would therefore be required to use appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE), thereby minimising the risk of exposure to potentially contaminated soils, dust, and groundwater. Depleted oxygen levels have been recorded during ground gas monitoring visits. In addition, following the removal of buried fuel tanks and associated infrastructure, there is the potential for elevated concentrations of vapours in the resultant voids. Therefore, all ground works should be carried out in line with the Confined Space Regulations, 1997.	Low
Property					
On site structures	Elevated concentrations of inorganic and organic contaminants in Made Ground. Elevated concentrations of organic contaminants in shallow groundwater. Ground gas and vapours from Made Ground and natural deposits.	Direct contact. Accumulation of ground gas in internal spaces and risk of explosion.	Medium	Concrete would be suitably designed in accordance with BRE Special Digest 1 "Concrete in aggressive ground".	Low
Ecological Systems					

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Proposed landscaped areas	Elevated concentrations of inorganic contaminants in Made Ground.	Absorption (root uptake)	Medium	Pollutant pathways between soils containing potentially phytotoxic concentrations of contaminants and areas of proposed soft landscaping would be broken by the use of planters and capping layers with a minimum thickness of 450mm of certified clean inert soils.	Low
Controlled Waters					
Alluvium, Taplow Gravel Formation and Upper Chalk Formation (Secondary A and Principal Aquifers)	Isolated Elevated concentrations of inorganic and organic contaminants in Made Ground. Elevated concentrations of organic contaminants in shallow groundwater.	Vertical migration	Low	The Secondary A Aquifers within the Alluvium, Taplow Gravel Formation and the Principal Aquifer within the Upper Chalk Formation are considered to be the main controlled water receptor at the Site. Given that there is no impermeable barrier between the site soils and the underlying aquifer there is the potential for a direct pollutant linkage. However the groundwater and soils data has indicated only marginal exceedances and consequently is considered not to be significant.	Low
River Thames and River Kennet	Elevated concentrations of organic contaminants in shallow groundwater.	Leaching and migration.	Low	Based on the presence of groundwater at shallow depths beneath the Site the River Thames and River Kennet are considered to be a potential surface water receptor. However, given the levels of contaminants within the groundwater only moderately exceeding the UK DWS thresholds and the distance of over 100m to the receptors the Site is considered to pose a low risk to this surface water receptor.	Low

The potential pollutant linkages described above can be managed by design of appropriate mitigation measures during the redevelopment of the Site.

With appropriate mitigation on completion of the Development it is considered that the risk rating for the Site would be **low** and it is likely that the Site would not be capable of being classified as contaminated land under Part IIA of the Environmental Protection Act, thus meeting the requirements of paragraphs 120 to 122 of the National Planning Policy Framework (NPPF).

Temporary Events Space

The following conclusions can be made:

- Significant widespread contamination of soils and groundwater has not been identified at the site;
- Some of the Made Ground on site contains an isolated elevated concentration of lead.
- Five of the eight Made Ground soil samples submitted for analysis from the Temporary Events Space area were screened for Asbestos. Two samples, WS14 and WS19, were flagged up as containing asbestos in the form of chrysotile free fibres and chrysotile cement, respectively. These samples were then subjected to asbestos quantification analysis of the soils which identified no asbestos within WS14 and 0.12% asbestos by weight of the total dried sample in WS19.

Outline Application Area

- Significant widespread contamination of soils and groundwater has not been identified at the site;
- Some of the Made Ground soil samples from this area were recorded as having elevated lead and speciated PAHs;
- Eighteen out of the twenty-two Made Ground soil samples submitted for analysis from the Outline Application Area area were screened for Asbestos. Asbestos was detected in six samples of Made Ground: Amosite free fibres in BH3 and Chrysotile in the form of free fibres lagging was identified in BH3, BH6, WS7, WS9, WS10 and WS11. Subsequent asbestos quantification analysis of the soil samples did not identify asbestos in BH3 and WS10. Asbestos was identified at <0.001% in WS11, 0.002% in BH6, and >0.1% in WS7 and WS9;
- Groundwater samples taken from boreholes within this area identified two cases of slightly elevated benzo(a)pyrene.

The Site

- In consideration of the proposed Development these soils are considered not to pose a significant risk to end users as the Development will mainly comprise buildings and hardstanding. Where soft landscaping is located a minimum thickness of 450mm of clean imported soils would be used for areas of vegetation. This will provide a barrier between the site soils and the end users. Potential pollutant linkages between potentially contaminated dust and off site users can be broken by the use of dust suppression techniques;
- Elevated concentrations of potentially phytotoxic contaminants have been identified in some areas of Made Ground. However, planters and capping layers with a minimum thickness of 450mm of clean imported soils would be used for areas of vegetation. Therefore, risks to proposed areas of vegetation are considered not to be significant;
- Ground gas monitoring has indicated that the Site is of low risk and it is considered that basic gas protection measures (CS2) are required for the proposed development;
- It is considered that the removal of soils from the Site, including those identified as containing hazardous properties for waste disposal, can be minimised by their reuse on Site to facilitate filling where required. Soils may be reused on Site under the CL:AIRE Definition of Waste: Development Industry Code of Practice;
- The Secondary A Aquifers within the Alluvium, Taplow Gravel Formation and the Principal Aquifer within the Chalk Formation are considered to be the main controlled water receptors at the Site. Given that

there is no continuous, impermeable barrier between the site soils and the underlying aquifer there is the potential for a direct pollutant linkage. However, the groundwater and soils data has indicated only marginal exceedances and consequently this is not considered to be significant;

- Based on the presence of groundwater at shallow depths beneath the Site the River Thames and River Kennet are considered to be a potential surface water receptor. However, given the levels of contaminants within the groundwater only moderately exceeding the UK DWS thresholds and the distance of over 100m to the receptors the Site is considered to pose a low risk to this surface water receptor;
- Potential risks to construction workers can be mitigated by the use of personal protective equipment (PPE) and respiratory protective equipment (RPE).

13.1 Geotechnical Conclusions

The Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications are DS-1 / AC-1 for both made ground and natural ground.

Piled foundations are considered to be the most viable founding option. Piles could derive frictional support from the medium dense sands and gravels and Structureless chalk present at depths up to 15m below ground level. End bearing support could be provided by the very weak to weak medium dense CHALK present at depths in excess of 15m.

Groundwater levels measured during fieldwork were in excess of 2m below ground level. Based on observations made during fieldwork, shallow excavations (<1.2m) likely to be stable in the short term.

14. Recommendations

The following recommendations should be implemented:

- When the development proposals are finalised, it may be necessary to review the conclusions and recommendations made in this report and Waterman EED should be contacted to provide further advice.
- The advice of a specialist piling contractor should be obtained to confirm the suitability of piling and the most appropriate pile type. It is further recommended that the specialist piling contractor is requested to provide a design and build foundation solution. Preliminary estimates of pile capacity have been provided in this report.
- Suspended floor slabs should be adopted due to the low CBR value of the natural subgrade, the presence of organic alluvium in places and the depth and variability of Made Ground.
- A post-demolition ground investigation should be undertaken to provide coverage in currently inaccessible areas; this should include additional geotechnical and environmental assessments.
- It may be necessary to prepare a foundation works risk assessment in line with the EA's advice "Piling and Penetrative Ground Improvement Methods on Land Affected by contamination: Guidance on Pollution Prevention. NC/99/73. This recommendation should be reviewed on completion of the post demolition site investigation.
- A Materials Management Plan and Remediation Strategy should be produced to ensure that materials that may be excavated may be suitable for re-use on the Site. The re-use of materials should be identified and designated under the CL:AIRE Protocol i.e. the earthworks phase of the development should be planned and managed such that re-use of suitable site won arisings is maximised and waste is minimised;
- Topsoil, Subsoil and any Engineered Fill imported for use at the Site should be certified as suitable for use. Samples of imported soils should be taken and scheduled for laboratory testing to verify certification. All supplier and verification chemical results should be collated by a contractor for inclusion in a Completion Report;
- Construction and Maintenance workers should undertake risk assessments and prepare method statements before commencing work and should be provided with and make use of appropriate Personal Protective Equipment (PPE). Appropriate hygiene facilities should also be provided on Site;
- Asbestos was identified at a number of locations during the ground investigation; therefore, it is recommended that all future works at the Site are undertaken in accordance with an Asbestos Management/Discovery Plan and site method statement, and that appropriate Risk Assessments and Method Statements are prepared by Contractors prior undertaking works at the Site;
- Construction and Maintenance workers should also be aware of the potential to encounter contaminated groundwater in excavations and it is recommended that Contractors prepare a method statement to cover the potential discovery of contaminated groundwater in excavations;
- An Environmental Management Plan (EMP) should be prepared including measures for managing waste during development work, and techniques for suppressing dust;
- Planters and/or capping layers with a minimum thickness of 450mm of clean imported soils are to be used for areas of vegetation, in areas of soft landscaping;
- This report should be issued to Reading Borough Council to discharge planning conditions.



APPENDICES

Appendix A

Site Plans

- **Site Location Plan (Fig. A1)**
- **Site Layout Plan (Fig. A2)**
- **Site Features Plan (Fig. A3)**
- **Potentially Contaminative Site Uses Plan (Fig. A4)**
- **Conceptual Site Model (Fig. A5)**
- **Ground Investigation Plan (Fig. A6)**
- **Geological Cross-section West to East (Fig. A7)**
- **Geological Cross-section North to South (Fig. A8)**
- **Soil Exceedance Plan (Fig. A9)**
- **Groundwater Exceedance Plan (Fig. A10)**



Appendix B

Site Photographs

- **Plates 1-14 (2 pages)**



Appendix C Factual Report

Appendix D Groundwater & Ground Gas Monitoring Results

- Equipment List
- Gas and Groundwater Results

Table D.1: Groundwater monitoring equipment list

Equipment	Description	Range/Accuracy
Gas Analyser	Geotechnical Instruments GA94 Infrared Gas Analyser	0 -100 % / ± 0.1 %
Gas Analyser Flow Pod	Geotechnical Instruments GA94 Flow Pods	0 -12 l/hr / ± 0.1 l/hr
Flame Ionisation Detector	Telegan Gastec MK3 Flame Ionisation Detector	0-1,000ppm or 0-10,000ppm / ± 1 ppm
Photo Ionisation Detector	2020 Photoionisation Aire Monitor (Serial No. EKG328)	0.5-2000ppm $\pm 10\%$ or ± 2 ppm, whichever is greater

Appendix E

Results of Laboratory analysis

- **Summary of Analytical Results**
- **Laboratory Report Sheets**

Appendix F Risk Rating Matrix

Table F.1: Risk rating for contaminated land qualitative risk assessment

Level of Severity	Likelihood		
	Most Likely	Reasonably Foreseeable	Unlikely
Acute harm or severe chronic harm. Direct pollution of sensitive water receptors or serious pollution of other water bodies.	High	High	Low
Harm from long-term exposure. Slight pollution of sensitive receptors or pollution of other water bodies.	Medium	Medium	Low
No significant harm in either short or long term. No pollution of water that is likely to affect sensitive receptors. No more than slight pollution of other water bodies.	Low	Low	Low

Appendix G Environmental Receptors

Table G.1: Pollution to controlled waters

'Section 78A(9) of the EPA 1990 defines the pollution of controlled waters as: "the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter".' (A35) 'Before determining that pollution of controlled water is being, or is likely to be, caused, the local authority should be satisfied that a substance is continuing to enter controlled waters or is likely to enter controlled waters. The local authority should regard something as being "likely" to be caused when the local authority judge it more likely than not to occur.' (A36) 'Land should not be designated as contaminated land where: (a) a substance is already present in controlled waters; (b) entry into controlled waters of that substance from land has ceased; and (c) it is not likely that further entry will take place.' (A37) 'Substances should be regarded as having entered controlled waters where: (a) they are dissolved or suspended in those waters; or (b) if they are immiscible with water, they have direct contact with those waters on or beneath the surface of the water.' (A38) The term 'continuing to enter' should be taken to mean any entry additional to any which has already occurred. (A39)

Reproduced from DEFRA (2006) Contaminated Land: Implementation of Part IIA of the Environmental Protection Act 1990 Circular 01/2006 and Scottish Executive Rural Affairs Department (2006) Edition 2 (Paper SE/2006/44). Environmental Protection Act 1990: Part IIA – Contaminated Land.

Table G.2: Significant harm to various receptors.

Type of receptor	Description of harm to that type of receptor that is to be regarded as significant harm
Human beings	Death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned. In the Guidance, this description of significant harm is referred to as a 'human health effect'.
Any ecological system, or living organism forming part of such a system, within a location which is: • an area notified as an Area of Special Scientific Interest under Section 28 of the Wildlife and Countryside Act 1981. • any land declared a National Nature Reserve under Section 35 of that Act • any area designated as a Marine Nature Reserve under Section 36 of that Act • an area of Special Protection of Birds, established under Section 3 of that Act • any European Site within the meaning of Regulation 10 of the Conservation (Natural	For any protected location: Harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or Harm which affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location. In addition, in the case of a protected location that is a European Site (or a candidate Special Area of Conservation or a potential Special Protection Area), harm which is

Type of receptor	Description of harm to that type of receptor that is to be regarded as significant harm
Habitats etc) Regulations 1994 (ie Special Areas of Conservation and Special protection Areas) - any candidate Special Areas of Conservation or potential Special Protection Areas given equivalent protection - any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS9) on nature conservation (i.e. candidate Special Areas of Conservation, potential Special protection Areas and listed Ramsar sites); or - any nature reserve established under Section 21 of the National Parks and Access to the Countryside Act 1949.	incompatible with the favourable conservation status of natural habitats at that location or species typically found there. In determining what constitutes such harm, the local authority should have regard to the advice of English nature and to the requirements of the Conservation (Natural Habitats etc) Regulations 1994. In the Guidance this description of significant harm is referred to as an 'ecological system effect'.
Property in the form of: - crops, including timber - produce grown domestically, or on allotments, for consumption - livestock - other owned or domesticated animals; - wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in their value, resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage. The local authority should regard a substantial loss in value as occurring only when a substantial proportion of the animals or crops are dead or otherwise no longer fit for their intended purpose. Food should be regarded as being no longer fit for purpose when it fails to comply with the provisions of the Food Safety Act 1990. Where a diminution in yield or loss in value is caused by a pollutant linkage, a 20% diminution or loss should be regarded as a benchmark for what constitutes a substantial diminution or loss. In the Guidance this description of significant ham is referred to as an 'animal or crop effect'.
Property in the form of buildings. For this purpose 'building' means any structure or erection and any part of a building, including any part below ground level, but does not include plant or machinery comprised in a building.	Structural failure, substantial damage or substantial interference with any right of occupation. For this purpose, the local authority should regard substantial damage or substantial interference as occurring when any part of the building ceases to be capable of being used for the purpose for which it is or was intended. Additionally, in the case of a scheduled Ancient Monument, substantial damage should be regarded as occurring when the damage significantly impairs the historic, architectural, traditional, artistic or archaeological interest by reason of which the monument was scheduled in the Guidance this description of significant harm is referred to as a 'building effect'.

Reproduced from DEFRA (2006) Contaminated Land: Implementation of Part IIA of the Environmental Protection Act 1990. Circular 01/2006 and Scottish Executive Rural Affairs Department (2006) Edition 2 (Paper SE/2006/44). Environmental Protection Act 1990: Part IIA – Contaminated Land.

Appendix H Generic Assessment Criteria

Human Health Generic Assessment Criteria

Background

In order to be able to make inference on whether the results obtained during the site investigation (e.g. chemical concentrations in soils, waters and gas) point to the presence of a potential hazard to human health, it is necessary to distinguish between the results, reflecting background and/or insignificantly elevated levels of contamination (i.e. with negligible potential to cause harm or pollution) and the results with significantly elevated concentrations (i.e. with significant potential to cause harm or pollution).

The approach to risk assessment with respect to risks to human health from contaminated land in the UK is set out in the publication Model Procedures for the Management of Land Contamination (CLR11) Environment Agency (2004).

This sets out a tiered approach:

- Preliminary Risk Assessment (e.g. establishing potential pollutant linkages);
- Generic Quantitative Risk Assessment (GQRA) (e.g. comparison of site contaminant concentrations against generic standards and compliance criteria e.g. Soil Guideline Values (SGV) or other Generic Assessment Criteria including an assessment of risk using the source pathway target model); and
- Detailed Quantitative Risk Assessment (DQRA) (e.g. the comparison of contaminant concentrations against site specific assessment criteria).

Preliminary Risk Assessment

This typically encompasses a desk based generation of a conceptual model to establish the potential pollutant linkages associated with the site and any proposed development. Works would typically involve:

- Evaluation of the potential sources of contamination on the site and in the locality and from both a current and historical perspective
- Statutory Consultation;
- Evaluation of a sites geology, hydrology and hydrogeology;
- Site inspection;
- Additional pertinent information as necessary on a site by site basis.

Where works indicate the presence of a potential pollutant linkage further evaluation and potentially site investigation works are necessary to determine the significance of the linkage.

Generic Quantitative Risk Assessment (GQRA)

In August 2008 the Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) announced the withdrawal of the Contaminated Land Reports CLR7 – 10, CLEA UK (beta) and existing SGV reports as they no-longer fully reflected the revised approach to human health risk assessment.

New partial guidance (in particular Science Reports SR2, SR3 and SR7) and new risk assessment tools (CLEA model version v1.04, v1.05 and currently v1.06) were published and these allow environmental practitioners to derive generic and site specific Soil Assessment Criteria (GAC and SAC). The EA and DEFRA are currently in the process of updating the existing TOX reports and Soil Guideline Values (SGVs)

to reflect the new guidance. Thus far SGVs for arsenic, nickel, mercury, selenium and BTEX compounds (benzene, toluene, ethylbenzene and xylenes) have been made available.

In addition Land Quality Management (LQM), Chartered Institute of Environmental Health (CIEH) and Contaminated Land Applications in Real Environments (CL:AIRE) have undertaken the production of GAC values using CLEA 1.04 for parameters not covered by SGV's.

Alterations have been made to the CLEA model since the GAC's calculated by LQM / CIEH and CL:AIRE, which used software version v1.04. The Environment Agency have however confirmed that v1.05 has only a "minor effect on assessment criteria calculated using the CLEA software 1.04" and consequently the GAC's derived are considered to remain valid. Environment Agency SGV's generated using v1.04 have also not been updated. Software version v1.06 is identical to v1.05 with some password protection enhancements that in no way effect the GAC values generated.

Waterman Energy Environment and Design have used the following hierarchy for the generic assessment of soils to evaluate Human Health.

- Published Soil Guideline Values (SGV's), or in their absence;
- GAC prepared in accordance with the CLEA v1.04 / v1.06 model by authoritative bodies (e.g. Chartered Institute of Environmental Health (CIEH), Land Quality Management (LQM) and Contaminated Land Applications in Real Environments (CL:AIRE), or in their absence,
- Waterman in-house GAC prepared in accordance with the CLEA V1.04 model or associated documents.

Tabulated values of the GACs used are presented overleaf. The references of the sources quoted in the table are:

- Environment Agency, 2009. CLEA Software, version 1.06.
- DEFRA, Environment Agency, 2004. Model Procedures for the Management of Land Contamination, Contaminated Land Report 11.
- Environment Agency, 2009. Human health toxicological assessment of contaminants in soil. Report SC050021/SR2.
- Environment Agency, 2009. Updated technical background to the CLEA model. Report SC050021/SR3.
- Environment Agency, 2008. Compilation of chemical data for priority organic pollutants for derivation of Soil Guideline Values. Report SC050021/SR7.
- LQM / CIEH, 2009. Generic assessment criteria for human health risk assessment, 2nd edition.
- EIC / CL:AIRE, 2010. Soil generic assessment criteria for human health risk assessment.

Detailed Quantitative Risk Assessment (DQRA)

Detailed Quantitative Risk Assessments are undertaken on a site specific basis and full details of the alterations to the CLEA model and generic land use scenarios will be described within the specific reports.

Generic Quantitative Risk Assessment Criteria

Proposed End Use	units	Residential			Allotments			Commercial			Source
Soil Organic Matter Content	%	1	2.5	6	1	2.5	6	1	2.5	6	
Arsenic	mg/kg	32	32	32	43	43	43	640	640	640	CLEA SGV 2009
Antimony	mg/kg	550	550	550	ND	ND	ND	7500	7500	7500	CL:AIRE 2009
Barium	mg/kg	1300	1300	1300	ND	ND	ND	22000	22000	22000	CL:AIRE 2009
Beryllium	mg/kg	51	51	51	55	55	55	420	420	420	LQM / CIEH
Boron (Water Soluble)	mg/kg	291	291	291	45	45	45	192000	192000	192000	LQM / CIEH
Cadmium	mg/kg	10	10	10	1.8	1.8	1.8	230	230	230	CLEA SGV 2009
Chromium (Total)	mg/kg	3000	3000	3000	34600	34600	34600	30400	30400	30400	LQM / CIEH
Chromium (VI)	mg/kg	4.3	4.3	4.3	2.1	2.1	2.1	35	35	35	LQM / CIEH
Cobalt	mg/kg	240	240	240	240	240	240	240	240	240	Dutch Intervention
Copper	mg/kg	2330	2330	2330	524	524	524	71700	71700	71700	LQM / CIEH
Lead	mg/kg	450	450	450	450	450	450	750	750	750	CLEA SGV 2002 (Withdrawn in 2008)
Mercury	mg/kg	1	1	1	26	26	26	26	26	26	CLEA SGV 2009
Molybdenum	mg/kg	670	670	670	ND	ND	ND	17000	17000	17000	CL:AIRE 2009
Nickel	mg/kg	130	130	130	230	230	230	1800	1800	1800	CLEA SGV 2009
Selenium	mg/kg	350	350	350	120	120	120	13000	13000	13000	CLEA SGV 2009
Vanadium	mg/kg	75	75	75	18	18	18	3160	3160	3160	LQM / CIEH
Zinc	mg/kg	3750	3750	3750	618	618	618	665000	665000	665000	LQM / CIEH
Cyanide (Free)	mg/kg	26	26	26	4.1	4.1	4.1	16000	16000	16000	Waterman GAC -

Proposed End Use	units	Residential			Allotments			Commercial			Source
Soil Organic Matter Content	%	1	2.5	6	1	2.5	6	1	2.5	6	
Complex Cyanide	mg/kg	6300 0	6300 0	6300 0	1200	1200	1200	4300 00	4300 00	4300 00	CLEA v1.06
Total Cyanide	mg/kg										
Thiocyanate	mg/kg	230	230	230	46	46	46	2200 0	2200 0	2200 0	Waterman GAC - CLEA v1.06
Aliphatic EC5 - EC6	mg/kg	30	55	110	740	1700	3900	3400	6200	1300 0	LQM / CIEH
Aliphatic EC6 - EC8	mg/kg	73	160	370	2300	5600	1300 0	8300	1800 0	4200 0	LQM / CIEH
Aliphatic EC8-EC10	mg/kg	19	46	110	320	770	1700	2100	5100	1200 0	LQM / CIEH
Aliphatic EC10-EC12	mg/kg	93	230	540	2200	4400	7300	1000 0	2400 0	4900 0	LQM / CIEH
Aliphatic EC12-EC16	mg/kg	740	1700	3000	1100 0	1300 0	1300 0	6100 0	8300 0	9100 0	LQM / CIEH
Aliphatic EC16-EC35	mg/kg	4500 0	6400 0	7600 0	2600 00	2700 00	2700 00	1600 000	1800 000	1800 000	LQM / CIEH
Aliphatic EC35-EC44	mg/kg	4500 0	6400 0	7600 0	2600 00	2700 00	2700 00	1600 000	1800 000	1800 000	LQM / CIEH
Aromatic C6-C7 (Benzene)	mg/kg	0.08	0.16	0.33	0.01 7	0.03 5	0.07	28	50	95	CLEA SGV 2009 / Waterman GACs - CLEA v1.04
Aromatic C7-C8 (Toluene)	mg/kg	120	270	610	22	50	120	870	1900	4400	
Aromatic C8-C10	mg/kg	27	65	151	8.6	21	51	3700	8600	1800 0	LQM / CIEH
Aromatic C10-C12	mg/kg	69	160	346	13	31	74	1700 0	2900 0	3450 0	LQM / CIEH
Aromatic C12-C16	mg/kg	140	310	593	23	57	130	3600 0	3700 0	3780 0	LQM / CIEH
Aromatic C16-C21	mg/kg	250	480	770	46	110	260	2800 0	2800 0	2800 0	LQM / CIEH
Aromatic C21-C35	mg/kg	890	1100	1230	370	820	1600	2800 0	2800 0	2800 0	LQM / CIEH
Benzene	mg/kg	0.08	0.16	0.33	0.01 7	0.03 5	0.07	28	50	95	CLEA SGV 2009 /

Proposed End Use	units	Residential			Allotments			Commercial			Source
Soil Organic Matter Content	%	1	2.5	6	1	2.5	6	1	2.5	6	
Toluene	mg/kg	120	270	610	22	50	120	870	1900	4400	Waterman GACs - CLEA v1.04
Ethyl Benzene	mg/kg	65	150	350	16	39	90	520	1200	2800	
Xylene - o	mg/kg	45	110	250	28	67	160	480	1100	2600	
Xylene - m	mg/kg	44	100	240	31	74	180	630	1500	3500	
Xylene - p	mg/kg	42	98	230	29	70	160	580	1400	3200	
MTBE (Methyl tert-butyl ether)	mg/kg	49	84	160	23	44	90	7900	13000	24000	CL:AIRE 2009
Naphthalene	mg/kg	1.5	3.7	8.7	4.1	9.9	23	200	480	1100	LQM / CIEH
Acenaphthylene	mg/kg	170	400	850	28	69	160	8400	9700	10000	LQM / CIEH
Acenaphthene	mg/kg	210	480	1000	34	85	200	8500	9800	10000	LQM / CIEH
Fluorene	mg/kg	160	380	780	27	67	160	6400	6900	7100	LQM / CIEH
Phenanthrene	mg/kg	92	200	380	16	38	90	2200	2200	2300	LQM / CIEH
Anthracene	mg/kg	2300	4900	9200	380	950	2200	5300	5400	5400	LQM / CIEH
Fluoranthene	mg/kg	260	460	670	52	130	290	2300	2300	2300	LQM / CIEH
Pyrene	mg/kg	560	1000	1600	110	270	620	5400	5400	5400	LQM / CIEH
Benzo(a)anthracene	mg/kg	3.1	4.7	5.9	2.5	5.5	10	90	95	97	LQM / CIEH
Chrysene	mg/kg	6	8	9.3	2.6	5.8	12	140	140	140	LQM / CIEH
Benzo(b)fluoranthene	mg/kg	5.6	6.5	7	3.5	7.4	13	100	100	100	LQM / CIEH
Benzo(k)fluoranthene	mg/kg	8.5	9.6	10	6.8	14	23	140	140	140	LQM / CIEH
Benzo(a)pyrene	mg/kg	0.83	0.94	1	0.6	1.2	2.1	14	14	14	LQM / CIEH
Indeno(1,2,3-cd)pyrene	mg/kg	3.2	3.9	4.2	1.8	3.8	7.1	60	61	62	LQM / CIEH

Proposed End Use	units	Residential			Allotments			Commercial			Source
Soil Organic Matter Content	%	1	2.5	6	1	2.5	6	1	2.5	6	
Di-benzo(a.h.)anthracene	mg/kg	0.76	0.86	0.9	0.76	1.5	2.3	13	13	13	LQM / CIEH
Benzo(g.h.i.) Perylene	mg/kg	44	46	47	70	120	160	650	660	660	LQM / CIEH
Phenols	mg/kg	210	390	420	32	60	280	3200	3200	3200	CLEA 2006 / CLEA SGV 1.04
Phenol	mg/kg	210	390	420	32	60	280	3200	3200	3200	
Pentachlorophenol (PCP)	mg/kg	0.55	1.3	2.96	0.084	0.21	0.49	1200	1300	1400	LQM / CIEH
2,4-Dimethylphenol	mg/kg	19	43	97	3.1	7.2	17	16000	24000	30000	CL:AIRE 2009
Total Cresols (2-, 3- and 4-methylphenol)	mg/kg	80	180	400	12	27	63	160000	180000	180000	CL:AIRE 2009
1,1,2,2 Tetrachloroethane	mg/kg	0.9	2.1	4.8	0.79	1.9	4.4	120	260	590	LQM / CIEH
1,1,2,2 Tetrachloroethene	mg/kg	0.9	2.1	4.8	1.6	3.7	8.7	130	290	660	LQM / CIEH
1,1,1 Trichloroethane	mg/kg	6.2	13	28	48	110	240	700	1400	3100	LQM / CIEH
Trichloroethane	mg/kg	0.018	0.039	0.089	0.16	0.37	0.85	3	6.6	15	LQM / CIEH
Tetrachloromethane (Carbon Tetrachloride)	mg/kg	0.0054	0.008	0.014	0.0046	0.0083	0.016	0.71	1	1.8	LQM / CIEH
1,2-Dichloroethane	mg/kg	0.00047	0.00064	0.00099	0.00055	0.001	0.0018	0.063	0.081	0.12	LQM / CIEH
Chloroethene (Vinyl chloride)	mg/kg	0.11	0.22	0.49	0.43	0.95	2.2	12	25	55	LQM / CIEH
Trichloroethene	mg/kg	0.94	2.1	4.8	1.6	3.7	8.7	130	290	660	LQM / CIEH
Sum of PCDDs, PCDFs and dioxins like PCBs	mg/kg			8			8			240	CLEA SGVs 2009
Isopropylbenzene	mg/kg	11	27	64	32	79	190	1400	3300	7700	CL:AIRE 2009
Propylbenzene	mg/kg	34	82	190	34	83	200	4100	9700	21000	CL:AIRE 2009

Proposed End Use	units	Residential			Allotments			Commercial			Source
Soil Organic Matter Content	%	1	2.5	6	1	2.5	6	1	2.5	6	
Styrene	mg/kg	8.1	19	43	1.6	3.7	8.7	3300	6500	11000	CL:AIRE 2009
Bromobenzene	mg/kg	0.87	2	4.7	3.2	7.6	18	97	220	520	CL:AIRE 2009
1,1,2 Trichloroethane	mg/kg	0.6	1.2	2.7	0.28	0.61	1.4	94	190	400	CL:AIRE 2009
1,1-Dichloroethane	mg/kg	2.4	3.9	7.4	9.2	17	35	280	450	850	CL:AIRE 2009
1,1-Dichloroethene	mg/kg	0.23	0.4	0.82	2.8	5.6	12	26	46	92	CL:AIRE 2009
1,2,4-Trimethylbenzene	mg/kg	0.35	0.85	2	0.38	0.93	2.2	42	99	220	CL:AIRE 2009
1,2-Dichloropropane	mg/kg	0.024	0.042	0.084	0.62	1.2	2.6	3.3	5.9	12	CL:AIRE 2009
2-Chloronaphthalene	mg/kg	3.7	9.2	22	40	98	230	390	960	2200	CL:AIRE 2009
Bromodichloromethane	mg/kg	0.016	0.03	0.061	0.016	0.032	0.068	2.1	3.7	7.6	CL:AIRE 2009
Bromoform	mg/kg	2.8	5.9	13	0.95	2.1	4.6	760	1500	3100	CL:AIRE 2009
Chloroethane	mg/kg	8.3	11	18	110	200	380	960	1300	2100	CL:AIRE 2009
Chloromethane	mg/kg	0.0083	0.0098	0.013	0.066	0.13	0.23	1	1.2	1.6	CL:AIRE 2009
Cis 1,2 Dichloroethene	mg/kg	0.11	0.19	0.37	0.26	0.5	1	14	24	47	CL:AIRE 2009
Dichloromethane	mg/kg	0.58	0.98	1.7	0.1	0.19	0.34	270	360	560	CL:AIRE 2009
Hexachloroethane	mg/kg	0.2	0.48	1.1	0.27	0.67	1.6	22	53	120	CL:AIRE 2009
Trans 1,2 Dichloroethene	mg/kg	0.19	0.34	0.7	0.93	1.9	4	22	40	81	CL:AIRE 2009
Bis (2-ethylhexyl) phthalate	mg/kg	280	610	1100	47	120	280	85000	86000	86000	CL:AIRE 2009
Butyl benzyl phthalate	mg/kg	1400	3300	7200	220	550	1300	940000	940000	950000	CL:AIRE 2009
Diethyl Phthalate	mg/kg	120	260	570	19	41	94	150000	220000	290000	CL:AIRE 2009
Di-n-butyl phthalate	mg/kg	13	31	67	2	5	12	15000	15000	15000	CL:AIRE 2009

Proposed End Use	units	Residential			Allotments			Commercial			Source
Soil Organic Matter Content	%	1	2.5	6	1	2.5	6	1	2.5	6	
Di-n-octyl phthalate	mg/kg	2300	2800	3100	940	2100	3900	8900 0	8900 0	8900 0	CL:AIRE 2009
Biphenyl	mg/kg	66	160	360	14	35	83	1800 0	3300 0	4800 0	CL:AIRE 2009
2,4-Dinitrotoluene	mg/kg	1.5	3.2	7.2	0.22	0.49	1.1	3700	3700	3800	CL:AIRE 2009
2,6-Dinitrotoluene	mg/kg	0.78	1.7	3.9	0.12	0.27	0.61	1900	1900	1900	CL:AIRE 2009
Tributyl tin oxide	mg/kg	0.25	0.59	1.3	0.04 2	0.1	0.24	130	180	200	CL:AIRE 2009

Soil Contamination – Risk of Harm to Property

Structures and Underground Services

Buried Concrete

BRE Special Digest 1 (2005), 3rd Edition, entitled *Concrete in aggressive ground*, provides guidance on the specification for concrete for installation in natural ground and in brownfield locations. The procedures given for the ground assessment and concrete specification cover the fairly common occurrences of sulfates, sulfides and acids, and the more rarely occurring aggressive carbon dioxide found in some ground and surface waters, which affects concrete foundations and sub-structures. It gives procedures for specification of concrete and applies to both buildings and civil engineering construction.

Water Supply Pipes

Guidance is provided in the Water Regulations Advisory Scheme Information and Guidance Note entitled “*The selection of materials for water supply pipes to be laid in contaminated land*” No. 9-04-03, October 2002.

Where soil concentrations exceed these threshold values, it is likely that special consideration of material selection will be required.

Notwithstanding the above, it is reasonable to assume that if contaminants are present above background concentrations, problems will arise and therefore materials should be selected accordingly. In cases where there is uncertainty; eg potentially aggressive contaminants are present for which there are no critical thresholds, some organic contaminants may have a greater effect on polyethylene (PE) pipes when present in mixtures than singly; this approach is recommended by the Water Suppliers,.

The material selection thresholds contained in this document are reproduced in the table below:

Contaminant concentrations in Soils

Contaminant	Material selection threshold mg/kg
Corrosion	
Sulphate	2000
Sulphur	5000
Sulphide	250
Ph	Less than pH5 greater than pH8
Toxic Substances	
Antimony	10
Arsenic	10*
Cadmium	3
Chromium (total)	600
Chromium (hexavalent)	25
Cyanide (free)	25*
Cyanide (complex)	250*
Lead	500
Mercury	1
Selenium	3
Thiocyanate	50

Contaminant	Material selection threshold mg/kg
Organic Contaminants	
Coal tar	50
Cyclohexane extractable	50
Phenol	5
PAHs	50
Toluene extractable	50
Petroleum hydrocarbons	50

Footnotes: * It is not recommended that water pipes should be laid in sites where these substances are identified or expected

Soil Contamination – Risk of Combustion

The combustibility of soils is a complex function of soil type, energy content, and availability of oxygen. The Building Research Establishment (BRE) has published guidance based on Calorific Value (i.e. energy content, alone), namely *IP 2/87, Fire and explosion hazards associated with the redevelopment of contaminated land*. This document provides a level below which combustibility is unlikely (2MJ/kg) and a level above which combustibility is likely (10MJ/kg). In the range between these two values combustibility is uncertain. Therefore, where the lower value is exceeded, the other key factors mentioned above need to be considered.

Soil Contamination – Risk of Harm to Vegetation

Where there is topsoil present on Site and it is being considered for reuse in landscaped areas then it needs to be assessed for its suitability for use by an appropriately qualified specialist. Topsoil can be both naturally-occurring and manufactured. The requirements for topsoil that is to be reused on site are specified in BS3882:2007 and cover a range of properties including texture, organic matter content, grading, pH, nutrients and phytotoxic contaminants. The specification for phytotoxic contaminants is reproduced in the table below:

Phytotoxic Contaminants (by soil pH) for Topsoil

Contaminant*	pH		
	<6	6.0 to 7.0	>7
Zinc (Nitric acid extractable**)	<200mg/kg	<200mg/kg	<300mg/kg
Copper (Nitric acid extractable**)	<100mg/kg	<135mg/kg	<200mg/kg
Nickel (Nitric acid extractable**)	<60mg/kg	<75mg/kg	<110mg/kg

Footnotes: * The lower of the Generic Assessment Criteria for chemical contaminants (human health and the environment) and phytotoxicity shall be used for topsoil

** The method of testing is given in Annex D to BS3882:2007 Specification for topsoil and requirements for use.

The risk to human health and the environment needs to be considered as well as phytotoxicity and this will be carried out using the Generic Assessment Criteria selected for these risks as described elsewhere in this appendix and this report.

In order to assess the suitability of topsoil to be reused the full range of testing specified needs to be carried out and assessed by an appropriately qualified specialist.

Controlled Waters Generic Assessment Criteria

The Screening Values adopted by Waterman for ground and surface water quality have been selected on the basis of the water quality standards that apply at the controlled water receptor considered to be at potential risk of harm. Where the receptor is to be assessed for potential harm to aquatic life then the Environmental Quality Standards (EQS) for List 1 and List 2 dangerous substances (EC Dangerous Substances Directive (76/464/EEC)) will be used. Where the receptor is to be assessed for potential harm with respect to use as a drinking water resource then the Water Supply (Water Quality) Regulations 1989 and 2000 as amended will be used. Where the receptor is to be used by aquatic life and for drinking water purposes both sets of criteria will be used. The standards for the substances tested for in this investigation are provided in Table D3 and D4 below.

Environmental Quality Standards

Environmental Quality Standards (EQS) annual average		Freshwater
pH (Acid)		6.0
pH (Alkaline)		9.0
Arsenic	µg/l	50
Cadmium	µg/l	5
Chromium	µg/l	5 – 250 ⁽¹⁾
Lead	µg/l	4 -250 ⁽¹⁾
Mercury	µg/l	1
Boron	µg/l	2000
Copper	µg/l	1 - 28 ⁽¹⁾
Nickel	µg/l	50 - 200 ⁽¹⁾
Zinc	µg/l	75 - 500 ⁽¹⁾
Tetrachloromethane (PCM)	µg/l	12
Trichloroethene (TCE)	µg/l	10
Tetrachloroethene (PCE)	µg/l	10
Benzene	µg/l	30
Toluene	µg/l	50
Xylene	µg/l	30

Footnotes:

NV – No value

(1) – Dependant on Hardness (See DoE circular 7/89).

UK Drinking Water Supply Standards

Water Supply (Water Quality) Regulations 1989 and 2000- as amended		
pH (Acid)		5.5
pH (Alkaline)		9.5
Arsenic	µg/l	10
Barium	µg/l	1000
Cadmium	µg/l	5
Chromium	µg/l	50
Lead	µg/l	25 (Reducing to 10 in 2013)
Mercury	µg/l	1

Water Supply (Water Quality) Regulations 1989 and 2000- as amended		
Selenium	µg/l	10
Boron	µg/l	1000
Copper	µg/l	2000
Nickel	µg/l	20
Zinc	µg/l	5000
Sulphate	mg/l	250
Total/Complex Cyanide	µg/l	50
Ammonium (NH ₄ ⁺)	µg/l	500
Nitrate (as NO ₃)	mg/l	50
Hydrocarbons (dissolved/emulsions)	µg/l	10
Polyaromatic Hydrocarbons (PAH)	µg/l	0.1
Benzo(a)pyrene	µg/l	0.01
Phenol	µg/l	0.5
Tetrachloromethane	µg/l	3
Trichloroethene (TCE)	µg/l	10 (combined total)
Tetrachloroethene (PCE)		
Benzene	µg/l	1
Ethyl Benzene	µg/l	NV
Toluene	µg/l	NV
Xylene	µg/l	NV
EU Surface Water Directive (75/440/EEC) - Class A1 – only simple treatment required.		
Sulphide	mg/l	150

Ground Gas and Volatile Organic Compounds Generic Assessment Criteria

Ground Gas

The Building Regulations 2000 Approved Document C (2004 Edition) require that methane and other gases from the ground are considered on a risk assessment basis. Methane and other gases from the ground are defined in this document as *“hazardous soil gases which originate from waste deposited in landfill sites or are generated naturally”*. Ground gas can also be generated by fill materials present on sites that are not classed as landfills. Therefore a preliminary ground gas risk assessment should consider the potential for methane or other gases to be present. This includes identification of the potential sources on or near to the site that could produce methane or other ground gas.

The most common gases assessed with respect to development are methane and carbon dioxide. Methane forms a potentially explosive mixture when mixed with air within certain concentration limits, known as the ‘explosive range’. The Lower Explosive Limit (LEL) for methane is 5%. Carbon dioxide (CO₂) is a dense gas, capable of accumulating in confined spaces such as basements, causing a potential asphyxiation hazard. The Occupational Exposure Limit (OEL) for a short-term exposure to carbon dioxide is 1.5% over a 15 minute period. Both methane and carbon dioxide when present at high concentrations can act as simple asphyxiants by reducing the oxygen content by dilution.

Reference in the Building Regulations is made to guidance documents produced by a variety of organisations, primarily those produced by the Construction Industry Research and Information Association (CIRIA). These include the following documents:

- CIRIA Report 149 Protecting development from methane, 1995
- CIRIA Report 131 The measurement of methane and other gases from the ground, 1993.
- CIRIA Report 150 Methane investigation strategies, 1995
- CIRIA Report 151 Interpreting measurements of gas in the ground, 1995
- CIRIA Report 152 Risk assessment for methane and other gases from the ground, 1995

In addition guidance is provided in the BRE document 'Construction of new buildings on gas-contaminated land (BRE Report BR212)'.

CIRIA, Report 131, 1993, suggests that there are no fixed rules for safe gas concentrations on a site since this risk is dependent on a number of factors that include gas emission rate from the ground and the potential for gas to enter into structures.

The Building Regulations relate to domestic dwellings. However, for non-domestic dwellings the same principle of risk assessment applies.

The latest guidance document is provided by CIRIA Report C665, "*Assessing risks posed by hazardous ground gases to buildings*", 2007 and BS8485:2007: "*Code of practice for the characterisation and remediation from ground gas in affected developments*".

CIRIA C665 aims to consolidate good practice in investigation, facilitate the collection of relevant data, instigate appropriate monitoring programmes, all in a risk based approach to gas contaminated land. As with BS8485, this document largely focuses on Methane and Carbon Dioxide. However, much of the text is also relevant to consideration of other contamination present in vapour phase.

BS8485, 2007 describes methods for the investigation and assessment of the ground gases methane and carbon dioxide provides recommendations for protection of new development on affected sites. This standard is not intended for the assessment of completed developments and considers only methane and carbon dioxide.

Both of these publications have been prepared to be generally consistent with CLR11, *Model Procedures for the management of land contamination*, (DEFRA and the Environment Agency, 2004a) and follow a step by step approach summarised below:-

1. Desk Study and Site Walkover
2. Development of a Preliminary Conceptual Model and Risk Assessment
3. Site Investigation (If deemed necessary from stage 2)
4. Risk Assessment and Site Characterisation
5. Recommendation and Mitigation

Where, the preliminary conceptual model has deemed further investigation necessary to characterise the ground gas regime, an appropriate site investigation and monitoring regime should be designed and undertaken. In-depth guidance to assist in the design of the investigation is provided within C665, which describes intrusive investigation techniques and provides guidance on selecting the number and location of monitoring wells based on the site specific conceptual model.

Waterman has generally followed the approach recommended in CIRIA C665 with respect to characterising a site and determining the levels of gas protection methods required. This approach is generally consistent with the guidance provided in BS8485.

In accordance with C665, to assess the ground gas regime at a site, the ground gas monitoring data should be assessed by determining the Gas Screening Value (GSV) (l/hr) (BS8485 refers to the GSV as the Hazardous Gas Flow Rate). The GSV is calculated as follows:

GSV = (Measured Maximum CO₂ or CH₄ Gas Concentration (%) / 100) x Maximum Measured Gas Flow Rate from boreholes (l/hr)

Where the gas flow rate has been measured as less than the detection limit of the instrument used (ie <0.1 l/hr), C665 recommends that the detection limit for the Gas Analyser is used as the gas flow rate (ie 0.1l/hr).

The Gas Screening Value is used to classify the site, subject to the proposed end use of the site, falling into either Situation A or Situation B, as described below.

Situation A – For All Development Types except Low Rise Housing with a ventilated underfloor void (150mm)

For situation A, the Modified Wilson and Card classification system is used. This system attributes a Characteristic Situation (CS) value to the site/zone depending upon the calculated GSV. When attributing a CS, additional factors including the maximum recorded gas concentration and the maximum recorded gas flow rate should also be taken into account and may result in an increase in the CS value. Table I.2 below, outlines the CS values associated GSV's and additional factors which must be taken into account.

Modified Wilson and Card Classification

Characteristic Situation (CIRIA 149)	Risk Classification	Gas screening value (CH ₄ CO ₂) l/hr	Additional Factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and / or carbon dioxide ≤5%. Otherwise consider increase to CS 2.	Natural soils with low organic content 'Typical' made ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider increase to CS 3.	Natural soil, high peat/organic content. 'Typical' made ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very High risk	>70		Recent landfill site

Notes:

- 1) Gas screening value: litres of gas / hour is calculated by multiplying the gas concentration (%) by the measured borehole flow rate (l/hr)
- 2) Source of gas and generation potential/performance must be identified.
- 3) If there is no detectable flow use the limit of detection of the instrument.

Once the characteristic situation has been determined, the requirements and scope of gas protection measures can be determined based on Table I.3 below (based on guidance provided within C665):

Modified Wilson and Card Protection Measures

CS*	Risk Classification	Residential building (not those subject to NHBC Classification Method)		Office/commercial/industrial development	
		No. of levels of protection	Typical scope of protective measures	No. of levels of protection	Typical scope of protective measures
1	Very low risk	None	No special precautions	None	
2	Low risk	2	a) Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft) with at least 1200g DPM ^{2,7} and underfloor venting. b) Beam and block or pre-cast concrete and 2000g DPM ⁷ /reinforced gas membrane and underfloor venting. All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in situ floor slab (Suspended, non-suspended or raft) with at least 1200g DPM ^{2,7} . b) Beam and block or pre-cast concrete slab and minimum 2000g DPM / reinforced gas membrane. c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use. All joints and penetrations sealed
3	Moderate risk	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space.	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space.
4	Moderate to high risk	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space,	2 to 3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space.

CS*	Risk Classification	Residential building (not those subject to NHBC Classification Method)		Office/commercial/industrial development	
		No. of levels of protection	Typical scope of protective measures	No. of levels of protection	Typical scope of protective measures
			oversite capping or binding and in ground venting layer.		
5	High risk	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting layer and in ground venting wells or barriers	3 to 4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers.
6	Very high risk	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design.	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetration sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

Notes:

- 1) Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.
- 2) Note, the type of protection is given for illustrative purposes only. Information on the detailing and construction of passive protection measures is given in BR414 [Ref: 16]. Individual site specific designs should provide the same number of separate protective methods for any given characteristic situation.
- 3) In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.
- 4) Foundation design must minimise differential settlement particularly between structural elements and ground bearing slabs.
- 5) Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block beam floor is used it should be well detailed so it has no voids in it that membranes have to span and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m³ and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membranes (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membranes).
- 6) The gas resistant membrane can also act as the damp proof membrane.
- 7) DPM = Damp Proof Membrane

Situation B – For Low Rise Housing with a ventilated underfloor void (min 150mm)

Situation B should be used for low-rise residential housing with gardens and sub-floor void. Where a sub-space void is not proposed, the development should be assessed using the situation A classification system above.

For situation B, the National House Building Council's (NHBC) Traffic Light classification system is used. This system attributes a colour to a site/zone depending upon the calculated GSV. As with the Wilson and Card system, in addition to the GSV, additional factors including the maximum recorded gas concentration and the maximum recorded gas flow rate must be taken into account when determining the Traffic Light classification. Table I.4, outlines the Traffic Light classification system, based on the calculated GSV's and additional factors which must be taken into account.

NHBC traffic light system for 150mm void

Traffic Light	Methane		Carbon Dioxide	
	Typical Maximum Concentration (% v/v)	Gas Screening Value (GSV) l/hr	Typical Maximum Concentration (% v/v)	Gas Screening Value (GSV) l/hr
Green				
Amber 1	1	0.16	5	0.78
Amber 2	5	0.63	10	1.56
Red	20	1.56	30	3.13

Notes:-

- The worst gas regime identified at the site, either methane or carbon dioxide, recorded from monitoring in the worst temporal conditions, will be the decider as to what Traffic Light and GSV is allocated.
- Generic GSVs are based on guidance contained within latest revision of Department of the Environment and the Welsh Office (2004 edition) "The Building Regulations: Approved Document C" [Ref:17] and used a sub-floor void of 150mm thickness.
- This assessment is based on a small room e.g. downstairs toilet with dimensions of 1.5 x 2.5m, with a soil pipe passing into the sub-floor void.

- The GSV, in litres per hour, is as defined as the bore hole flow rate multiplied by the concentration of the particular gas being considered.
- The typical maximum concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgement will be required based on a thorough understanding of the gas regime identified at the site where monitoring in the worst case temporal conditions has occurred.
- The GSV threshold should not generally be exceeded without completion of a detailed gas risk assessment taking into account site specific conditions.

Once the Traffic Light classification has been determined, the requirements and scope of gas protection / mitigation measures can also be determined based on Table I.5 below (based on guidance provided within CIRIA C665):

Gas Protection Measures for Low-Rise Housing Development Based Upon Allocation NHBC Traffic Light (Boyle and Witherington, 2006)

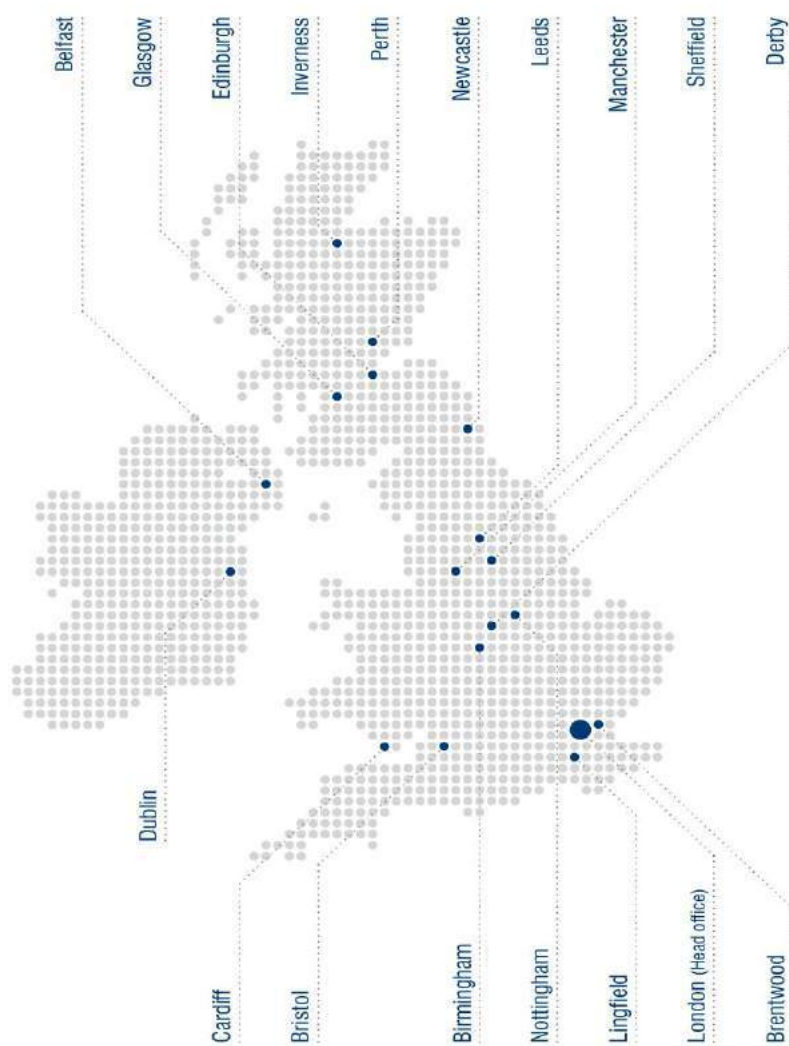
Traffic Light Classification	Protection Measures Required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1.	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress into buildings. Gas protection measures should be as prescribed in BRE Report 414 (Johnson 2001). Ventilation of sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2.	Intermediate to high gas regime identified, which requires high level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and / or possible remedial mitigation measures to reduce and / or remove the source of gas.

Volatile Organic Compounds

The Building Regulations 2000 Approved Document C (2004 Edition) also refers to volatile organic carbons (VOCs). These are primarily assessed by examination of the VOC content of site soils. Further guidance on VOCs is provided in *“The VOCs Handbook; Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination”*, CIRIA Report C682, 2009.

For former landfill sites the risk from a wider range of trace gases are considered on a site specific basis when appropriate.

UK and Ireland Office Locations



Appendix 12.3

Post Demolition Ground Investigation: Specification
(July 2015)



Post Demolition Ground Investigation at Station Hill, Reading

Specification

July 2015

Waterman Infrastructure & Environment Limited

2nd Floor, South Central, 11 Peter Street, Manchester, M2 5QR, United Kingdom
www.watermangroup.com



Client Name: Sackville Developments (Reading) Ltd
Document Reference: WIB12350-111-S-2-1-5-NS
Project Number: WIB12350-111

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
First	July 2015	Nicola Swallow Graduate Consultant	Rachael Tempest Senior Consultant	Richard Meredith Associate Director

Our Markets



Property & Buildings



Transport & Infrastructure



Energy & Utilities



Environment

Disclaimer

This report has been prepared by Waterman Infrastructure & Environment Limited, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporation of our General Terms and Condition of Business and taking account of the resources devoted to us by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at its own risk.

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1. Specification

The specification shall be the *UK Specification for Ground Investigation, Second Edition (2012)* by ICE Publishing, with information, amendments and additions as described in the following Schedules.

Schedule 1	Information and site-specific requirements.
Schedule 2	Exploratory holes.
Schedule 3	Investigation Supervisor's facilities.
Schedule 4	Specification amendments.
Schedule 5	Specification additions.

Schedule 1: Information and site specification requirements

General comments

S1.1 Name of Contract

Post Demolition Ground Investigation at Station Hill Reading.

S1.2 Investigation Supervisor

The Investigation Supervisor will be Waterman Energy, Environment & Design Limited.

S1.3 Description of site

The Site is located at National Grid Reference 471370, 173710 on Station Hill, located directly to the south of the Reading Mainline Station in Reading town centre. The northern part of the site, to the north of Garrard Street, which was formerly occupied by Station Hill retail parade, NCP Car Park, Western Tower, a bus station, a former Club and Xafinity House is currently undergoing demolition, with the exception of Xafinity House and the NCP Car Park. A subsequent phase or phases of demolition will be undertaken for the remaining areas of the site.

The SISG4 classification of the whole of the site is YELLOW.

S1.4 Main works proposed and purpose of this contract

The aim of the investigation is to provide assessments of the ground conditions for foundations, including its aggressiveness to below-ground concrete and the type and severity of ground/groundwater contamination within areas of the site that have not previously undergone investigation including the area to the south of Garrard Street and to provide greater coverage across the wider site.

S1.5 Scope of investigation

The outline scope of the investigation is:

- 16 trial pits (TP101 to TP116) to provide samples for chemical analysis from shallow depths within the northern half of the Site up to a maximum of 4.5m bgl;
- 18 trial pits (TP117 to TP135) to provide samples for chemical analysis from shallow depths within the southern half of the Site including Telecom House up to a maximum of 4.5m bgl;
- 4 cable percussive boreholes (BH101 to BH105) to a depth of approximately 15m;
- Gas and groundwater monitoring installations in selected boreholes;
- 6 return visits for gas and groundwater sampling/monitoring;
- Geoenvironmental analysis to be scheduled by Waterman EED Ltd; and
- Geotechnical aspects of the ground investigation are to be agreed with a suitable structural engineer.

The laboratory testing will be scheduled by the Engineer / Investigation Supervisor based on daily field logs provided by the Contractor.

Geotechnical aspects of the ground investigation are to be agreed with a suitable structural engineer.

The Contractor is to provide a Ground Investigation Report in accordance with the requirements of Eurocode 7.

S1.6 Geology and ground conditions

A general assessment of the geology of the site and ground conditions is contained in the documents referenced in S1.7. No assurance is given to its accuracy.

S1.7 Schedule of drawing(s) and documents

- Preliminary Environmental Risk Assessment Station Hill, Reading, (Waterman EED Ltd) June 2015, Report Ref: EED12350-111-R-4.1.5-NS;
- Site Location Plan: Ref EED12350-111_GR_PERA_A1A;
- Exploratory Hole Location Plan: EED12350-110-SA-80-001-A02 (project no. EED12350-110);
- Hoare Lea Station Hill, Reading Utility Infrastructure Report Rev P2.

S1.8 S1.8.1 Quality management system (Clause 3.3)

Quality management to BS EN ISO 9001, BS EN ISO 14001 and BS OHSAS 18001 required.

S1.8.2 Professional Attendance (Clause 3.5.2)

The Contractor shall provide Professional Attendance on site to technically supervise site activities, site liaison, logistics, logging, in situ testing and sampling, photography and the preparation of daily records and preliminary logs.

S1.8.3 Provision of ground practitioners and other personnel (Clauses 3.6.1 and 3.6.2)

As specified.

S1.8.4 Hazardous ground, land affected by contamination and notifiable and invasive weeds (Clauses 3.7.1 and 3.22)

Refer to information contained in reports referenced under S1.7.

S1.8.5 Additional information on services not shown on Contract drawings (Clause 3.7.2)

The Contractors attention is drawn to the utility infrastructure report referenced in S1.7 above.

S1.8.6 Known/suspected mine workings, mineral extractions etc (Clause 3.7.3)

None.

S1.8.7 Protected species (Clause 3.7.4)

Breeding birds are known to be present on the Site, including Black Redstart a rare breeding bird receiving National protection. The Contractor's method statement should incorporate actions to ensure breeding birds are not disturbed during the works.

S1.8.8 Archaeological remains (Clause 3.7.5)

Archaeological remains are present beneath the Site and a Written Scheme of Investigation has been prepared by Foundations Archaeology (referenced: SHR12m/fa.doc1b 29/05/14). This requires monitoring of all groundworks including test pits and boreholes. The Contractor's

Method Statement to be agreed with Foundations Archaeology and Contractor to liaise with Foundations Archaeology to ensure that they are present, as necessary during excavation of trial pits and boreholes.

S1.8.9 Security of site (Clause 3.11)

As specified.

S1.8.10 Traffic management measures (Clause 3.12)

As specified.

S1.8.11 Restricted working hours (Clause 3.13)

As specified.

S1.8.12 Trainee site operatives (Clause 3.14.1)

Not permitted.

S1.8.13 Contamination avoidance and/or aquifer protection measures required (Clauses 3.15.2 and 3.15.3)

As specified – the contractor should note the presence of permeable strata overlying a Principal Aquifer.

S1.8.14 Maximum period for boring, pitting or trenching through hard material, hard stratum or obstruction (Clauses 2.8, 4.3 and 6.4)

After 1 hour boring, trenching or pitting through hard material or obstructions, the Investigation Supervisor is to be contacted to agree a course of action.

S1.8.15 Reinstatement requirements (Clause 3.16)

As specified.

S1.8.16 Hygiene facilities required (Clauses 2.20 and 3.16.1)

The Contractor shall provide adequate toilet and washing facilities, a place to warm up and eat food and somewhere to store clothing, as a minimum to meet the requirements of HSE Construction Information Sheet 59: *Provision of welfare facilities during construction work*.

S1.8.17 Unavoidable damage to be reinstated by Contractor (Clause 3.16.1)

As specified.

S1.8.18 Accuracy of exploratory hole locations (Clauses 3.19 and 3.20)

As specified and as agreed on site by the Engineer.

S1.8.19 Photography requirements (Clause 3.25)

Core photographs are to be provided as Clause 5.8 of the Specification.

Photographs of each exploratory hole location are to be taken before commencing and after completing the exploratory hole. The purpose of the photographs is to provide a record of the

site condition before and after fieldwork in the working areas and the photographs should be design to provide this information.

S1.9 Percussion boring (Specification Section 4) Particular restrictions/relaxations

Contract specific restrictions/relaxations, if any, shall be inserted below.

S1.9.1 Permitted methods and restrictions (Clauses 4.1 to 4.4)

As specified.

S1.9.2 Backfilling (Clause 4.5)

As specified.

S1.9.3 Dynamic sampling (Clause 4.6)

Not applicable.

S1.10 Rotary drilling (Specification Section 5) Particular restrictions/relaxations

Contract specific restrictions/relaxations, if any, shall be inserted below.

S1.10.1 Augering requirements and restrictions (Clauses 5.1)

Not applicable.

S1.10.2 Particular rotary drilling techniques (Clause 5.2)

Both rotary open hole and rotary coring techniques are to be used to advance exploratory holes. Before commencing each rotary hole the Contractor should confirm the requirements for coring with the Engineer.

S1.10.3 Drilling fluid type and collection (Clause 5.3)

Clean water is to be used as the drilling fluid.

S1.10.4 Rotary core drilling equipment and core diameter (Clauses 5.4.1 and 5.4.2)

As specified.

S1.10.5 Core logging (Clause 5.4.6)

As specified.

S1.10.6 Core sub-samples for laboratory testing (Clause 5.4.7)

As specified.

S1.10.7 Address for delivery of selected cores (Clauses 5.4.8 and 5.4.9)

The Contractor will deliver samples for Geotechnical laboratory testing to:

Professional Soils Laboratory
5 / 7 Hexthorpe Road
Hexthorpe
Doncaster
DN4 0AR

- S1.10.8 Rotary open hole drilling general requirements (Clause 5.5.1)**
As specified.
- S1.10.9 Rotary open hole drilling for locating mineral seams, mine workings etc (Clause 5.5.2)**
Not required.
- S1.10.10 Open-hole resonance (sonic) drilling (Clause 5.6.1)**
Not required.
- S1.10.11 Resonance (sonic) drilling with sampling or continuous coring (Clause 5.6.2)**
Not required.
- S1.10.12 Backfilling (Clause 5.7)**
As specified.
- S1.10.13 Core photographic requirements (Clause 5.8)**
As specified.
- S1.11 Pitting and trenching (Specification Section 6) Particular restrictions/relaxations**
Contract specific restrictions/relaxations, if any, shall be inserted below.
- S1.11.1 Indirect detection of buried services and inspection pits (Clauses 3.8.3 and 6.1)**
As specified.
- S1.11.2 Restrictions on plant or pitting/trenching methods (Clauses 6.2 and 6.3)**
As specified.
- S1.11.3 Entry of personnel (Clause 6.5)**
As specified.
- S1.11.4 Alternative pit and trench dimensions (Clause 6.7)**
As specified.
- S1.11.5 Abstracted groundwater from land affected by contamination (Clause 6.9.2)**
As specified.
- S1.11.6 Backfilling (Clause 6.10)**
As specified.
- S1.11.7 Photographic requirements (Clause 6.12)**
As specified.
- S1.11.8 Artificial lighting (Clause 6.12.2)**
Not required.

- S1.11.9 Provision of pitting equipment and crew for Investigation Supervisor's use (Clause 6.13)**
Not required.
- S1.12 Sampling and monitoring during intrusive investigation (Specification Section 7)**
Particular restrictions / relaxations
To be confirmed
- S1.12.1 Address for delivery of selected geotechnical samples (Clause 7.6.1)**
To be confirmed.
- S1.12.2 Retention and disposal of geotechnical samples (Clause 7.6.2)**
To be confirmed.
- S1.12.3 Frequency of sampling for geotechnical purposes (Clause 7.6.3 to 7.6.11)**
As specified.
- S1.12.4 Open-tube and piston sample diameters (Clause 7.6.5)**
As specified.
- S1.12.5 Retention of cutting shoe samples (Clause 7.6.5)**
To be confirmed.
- S1.12.6 Delft and Mostap sampling (Clause 7.6.12)**
Not required.
- S1.12.7 Groundwater level measurements during exploratory hole construction (Clause 7.7)**
As specified.
- S1.12.8 Special geotechnical sampling (Clause 7.8)**
Not required.
- S1.12.9 Address for delivery of selected samples (Clause 7.9.2)**
To be confirmed.
- S1.12.10 Retention and disposal of contamination/WAC samples (Clause 7.9.3)**
To be confirmed.
- S1.12.11 Frequency of sampling (Clause 7.9.4)**
As specified.
- S1.12.12 Sampling method (Clause 7.9.5)**
As specified.

S1.12.13 Headspace testing (Clause 7.9.8)

A Photo Ionisation Detector (PID) shall be used to monitor head space concentrations of the soils placed within the 500ml glass amber sample jars. The methodology of the headspace testing will be approved by the Environmental Engineer and is to be carried out in a consistent manner throughout the contract;

S1.13 Probing and cone penetration testing (Specification Section 8) Particular restrictions/relaxations

Not required.

S1.14 Geophysical testing (Specification Section 9) Particular restrictions/relaxations

Not required.

S1.15 In situ testing (Specification Section 10) Particular restrictions/relaxations

As specified.

S1.16 Instrumentation (Section 11) Particular restrictions/relaxations

As specified.

S1.17 Installation monitoring and sampling (Specification Section 12) Particular restrictions/relaxations

Contract specific restrictions/relaxations, if any, shall be inserted below.

S1.17.1 Groundwater level readings in installations (Clause 12.2)

Groundwater level readings shall be taken on 6 return visits over a period of 3 months immediately following fieldwork.

S1.17.2 Groundwater sampling from installations (Clause 12.3.1)

One round of groundwater sampling shall be undertaken from the installed boreholes.

S1.17.3 Purging/micro-purging (Clause 12.3.2)

Not required.

S1.17.4 Ground gas monitoring (Clause 12.4)

Ground gas monitoring shall be taken on 6 monitoring visits over a period of 3 months immediately following fieldwork.

S1.17.5 Sampling from ground gas installations (Clause 12.5)

Not required.

S1.17.6 Other monitoring (Clause 12.8)

Not required.

S1.17.7 Sampling and testing of surface water bodies (Clause 12.9)

Not required.

S1.18 Daily records (Specification Section 13) Particular restrictions/relaxations

As specified.

S1.19 Geotechnical laboratory testing (Specification Section 14) Particular restrictions/relaxations

The Investigation Supervisor will schedule the geotechnical laboratory testing on the basis of the daily records provided by the Contractor. The Contractor will deliver samples for Geotechnical laboratory testing to:

Professional Soils Laboratory
5 / 7 Hexthorpe Road
Hexthorpe
Doncaster
DN4 0AR

Or to another laboratory as specified in the Job Sheet.

The results of all Geotechnical laboratory testing are to be issued by the laboratory to the Investigation Supervisor as identified on the Job sheet.

S1.20 Geoenvironmental laboratory testing (Specification Section 15) Particular restrictions/relaxations

The Engineer will schedule the Geoenvironmental laboratory testing on the basis of daily records provided by the Contractor.

The Contractor will deliver samples for Geoenvironmental laboratory testing to:

Environmental Scientifics Group

(Contact Person: Scott Stone, tel: **01283 554463**)

ESG House
Bretby Business Park
Ashby Road
Burton upon Trent
Staffordshire
DE15 0YZ

Or at another laboratory as specified in the Job Sheet.

The results of all Geoenvironmental laboratory testing are to be issued by the laboratory to the Investigation Supervisor as identified on the Job sheet.

Contract specific restrictions/relaxations, if any, are as specified in the Job Sheet.

S1.21 Reporting (Specification Section 16) Particular restrictions/relaxations

The Contractor is to provide a complete set of Engineer's Logs to the investigation supervisor within one week of completing fieldwork. If requested by the Investigation Supervisor, the Contractor edits the logs and provides an edited set of Engineer's Logs within one further week.

The Contractor is to provide a factual Ground Investigation Report to the investigation supervisor within two weeks of completing fieldwork. If requested by the Investigation Supervisor, the Contractor edits the report and provides a final report within one further week.

The Geotechnical Laboratory Test results are issued directly from the Geotechnical Laboratory to the Investigation Supervisor.

The Contractor is to provide all ground investigation data in AGS format in a single file. A complete set of digital data is to be supplied with draft and approved final copies of the report.

One electronic copy of the draft Ground Investigation Report required for submission 2 weeks after the completion of laboratory testing.

The Contractor is to provide a supplementary report on post fieldwork monitoring (e.g. gas and groundwater monitoring) within 1 week of the final monitoring visit to site.

Schedule 2: Exploratory Holes

S2.1 Hole number	S2.2 Type	S2.3 Scheduled depth (m)	S2.5 Approx ground level (mOD)	S2.6 Remarks
BH101	Cable Percussive with rotary follow on	25m	TBC	Purposes: to investigate soil and groundwater contamination; and allow gas and groundwater monitoring installations – details to be confirmed with Engineer on site. PID / headspace testing on all environmental samples and where visual/olfactory evidence of contamination is encountered.
BH102	Cable Percussive with rotary follow on	15m	TBC	Purposes: to investigate soil and groundwater contamination. PID / headspace testing on all environmental samples and where visual/olfactory evidence of contamination is encountered.
BH103	Cable Percussive with rotary follow on	25m	TBC	Purposes: to investigate soil and groundwater contamination; and allow gas and groundwater monitoring installations – details to be confirmed with Engineer on site. PID / headspace testing on all environmental samples and where visual/olfactory evidence of contamination is encountered.
BH104	Cable Percussive with rotary follow on	25m	TBC	Purposes: to investigate soil and groundwater contamination; and allow gas and groundwater monitoring installations – details to be confirmed with Engineer on site. PID / headspace testing on all environmental samples and where visual/olfactory evidence of contamination is encountered.
BH105	Cable Percussive with rotary follow on	15m	TBC	Purposes: to investigate soil and groundwater contamination. PID / headspace testing on all environmental samples and where visual/olfactory evidence of contamination is encountered.
TP101	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP102	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP103	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP104	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination.

S2.1 Hole number	S2.2 Type	S2.3 Scheduled depth (m)	S2.5 Approx ground level (mOD)	S2.6 Remarks
				Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP105	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP106	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP107	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP108	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP109	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP110	Trial Pits	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP111	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP112	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP113	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.
TP114	Trial Pit	4.5m	TBC	Purpose: to investigate shallow ground conditions including soil and groundwater contamination. Photos to be taken of trial pits and arisings. PID / headspace testing on all environmental samples.

Schedule 3: Investigation Supervisor's facilities

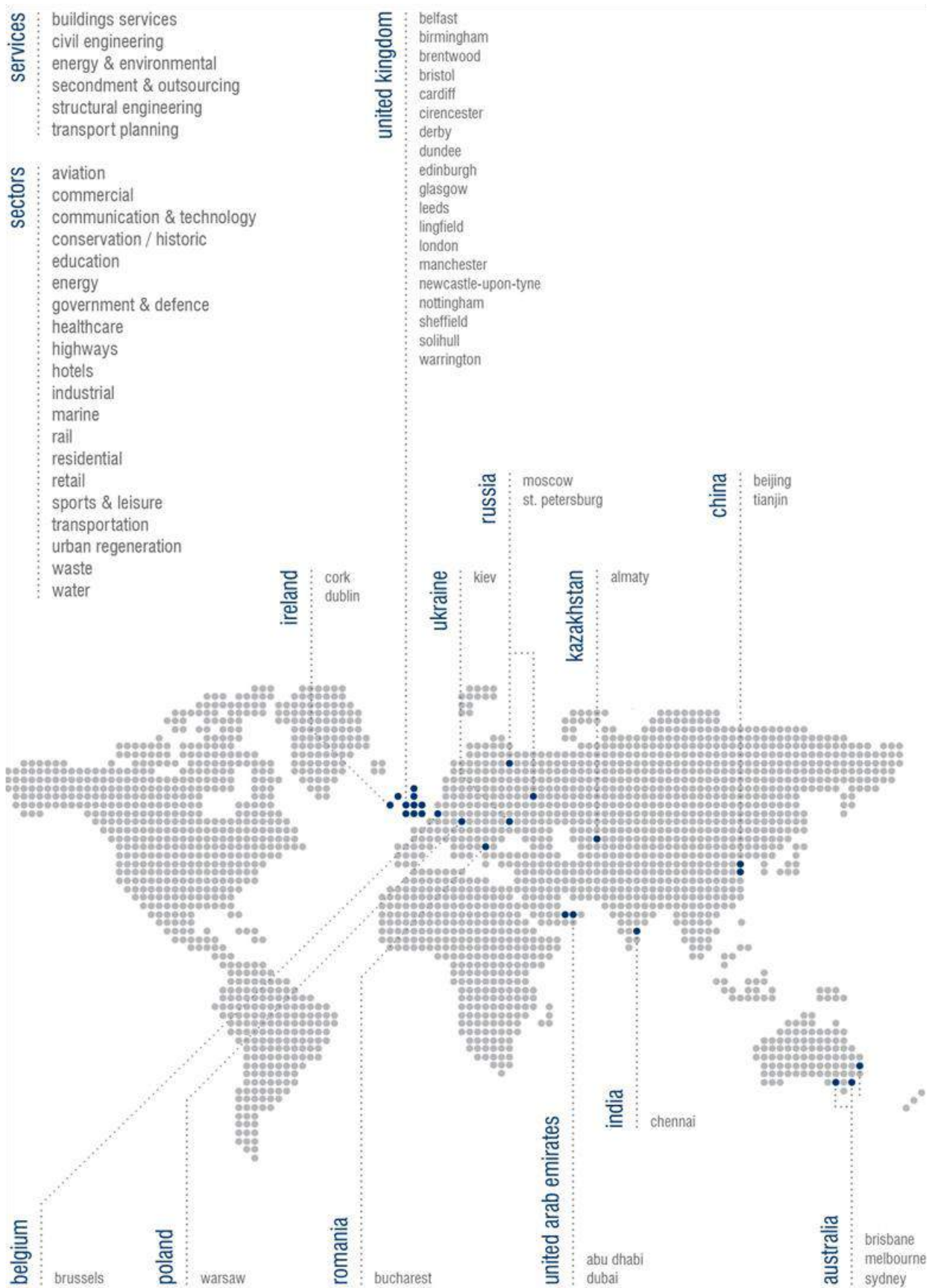
Not applicable at this stage.

Schedule 4: Specification amendments

Not used

Schedule 5: Specification additions

Not used.



Appendix 13.1

Flood Risk Assessment (July 2015)



Station Hill, Reading

Flood Risk Assessment

July 2015

Waterman Infrastructure & Environment Limited

Pickfords Wharf, Clink Street, London, SE1 9DG.
www.watermangroup.com

Client Name: Sackville Developments (Reading) Limited

Document Reference: CIV13174 ES 004

Project Number: CIV13174

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007)

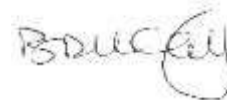
Issue	Date	Prepared by	Checked by	Approved by
A01	01/08/14	Donal O'Donovan	Sophie McCabe	Brendan McCarthy

Comments	Preliminary
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A02	25/09/14	Donal O'Donovan	Sophie McCabe	Brendan McCarthy
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Comments	Preliminary
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A03	14/07/15	Donal O'Donovan	Sophie McCabe	Brendan McCarthy
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Comments	Preliminary
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- B. Development Proposals
- C. Environment Agency Correspondence
- D. Thames Water Correspondence
- E. Hoare Lea Below Ground Drainage Design Note
- F. Reading Council's Strategic Flood Risk Assessment Map
- G. Hoare Lea Stormwater Drainage Strategy

Executive Summary

Waterman was commissioned by Sackville Developments (Reading) Limited to undertake a Flood Risk Assessment in relation to the proposed development at Station Hill, located within central Reading.

The Development proposals comprise demolition of the existing buildings on Site with the exception of the Multi Storey Car Park (which will be reconfigured and refurbished) and redevelopment to include offices, shops, restaurants and cafes, leisure uses and residential units.

Environment Agency mapping shows that the Site is located within Flood Zone 1, and is therefore classified as having a low probability of tidal and fluvial flooding.

The Environment Agency have confirmed that the peak 1 in 1000 year fluvial flood level closest to the Site is 38.45m AOD. Minimum ground levels at the Site are 38.5m AOD, confirming the Site lies within Flood Zone 1.

The risk of flooding from groundwater and artificial sources has been assessed and found to be low.

The Environment Agency's surface water flood maps show that there is a potential for surface water flooding within some of the highways in and around the Site. However, neither Thames Water nor the Strategic Flood Risk Assessment have records of surface water flooding in the vicinity.

Taking a precautionary approach, in order to ensure that the potential risk of surface water flooding is managed, it is recommended that finished floor levels of the proposed Development are reviewed against those of the surrounding highway network, to ensure that no new low points are created. If potential surface water flow/ponding cannot be ruled out, the drainage strategy should be designed to ensure that this water can be appropriately accommodated, and internal finished floor levels should be set nominally above the level of any adjacent highways. This could be achieved by gently ramping up from the external areas/highways to the building entrances.

Hoare Lea has confirmed that surface water runoff from the proposed development would discharge to the surrounding sewer network at the lesser of either the 1 year 30 minute runoff rate, or the capacity of the existing drainage connections into the Thames Water Sewers. Attenuation would be provided up to the 1 in 100 year rainfall event, including for 30% climate change.

This report demonstrates that the proposed Development is at a low risk of flooding. It also confirms that surface water runoff from the Site can be managed sustainably to ensure that flood risk is reduced elsewhere. It is considered that the information provided within this report satisfies the requirements of the National Planning Policy Framework.

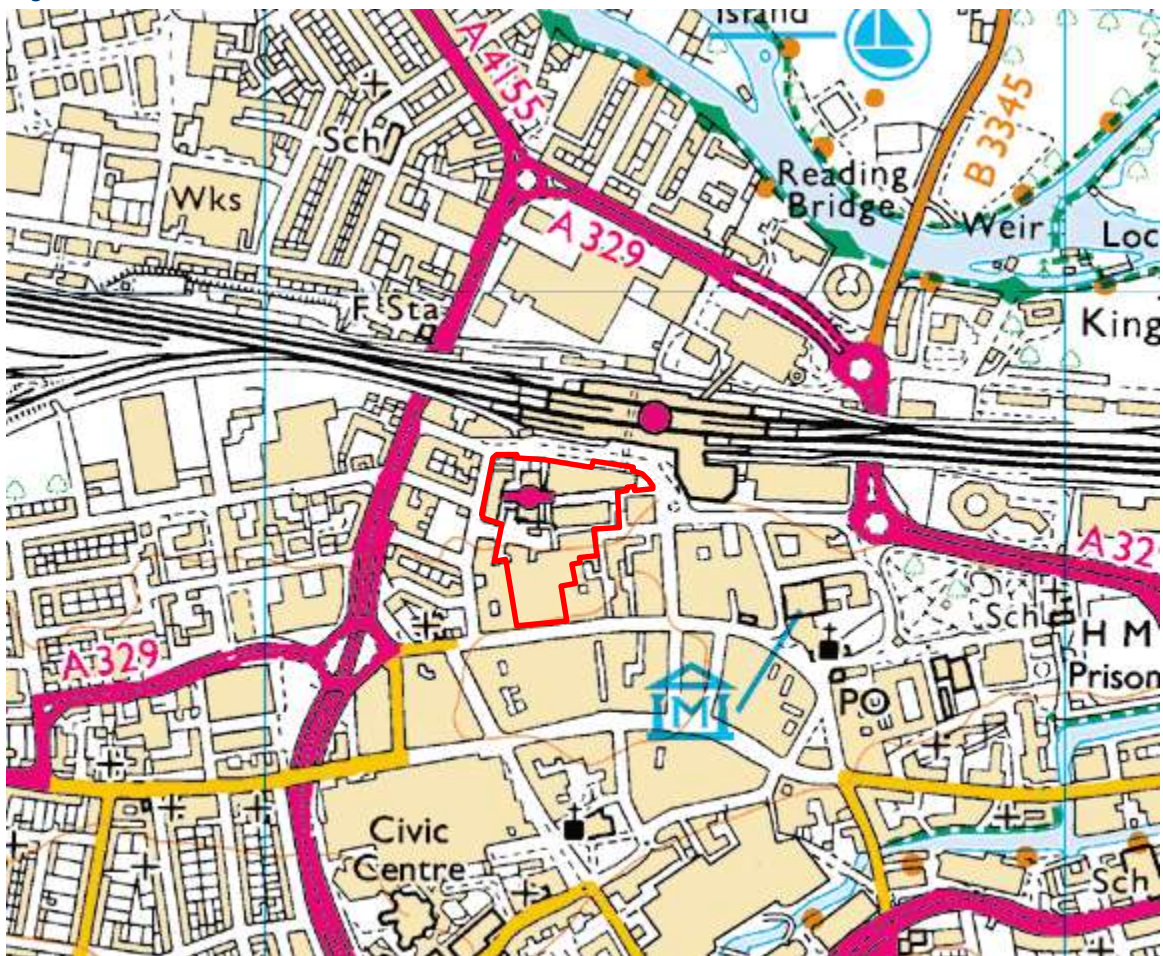
1. Introduction

- 1.1. Waterman was commissioned by Sackville Developments (Reading) Limited to undertake a Flood Risk Assessment (FRA) in relation to the proposed development at Station Hill (hereafter referred to as 'the Site'), located within central Reading.

Site Description

- 1.2. The existing Site is approximately 2.47 hectares (ha) in size and comprises of a number of existing buildings located to the south of Reading railway station. The Site is centred at National Grid Reference 471370, 173710 as shown in Figure 1.

Figure 1: Site Location Plan



Key

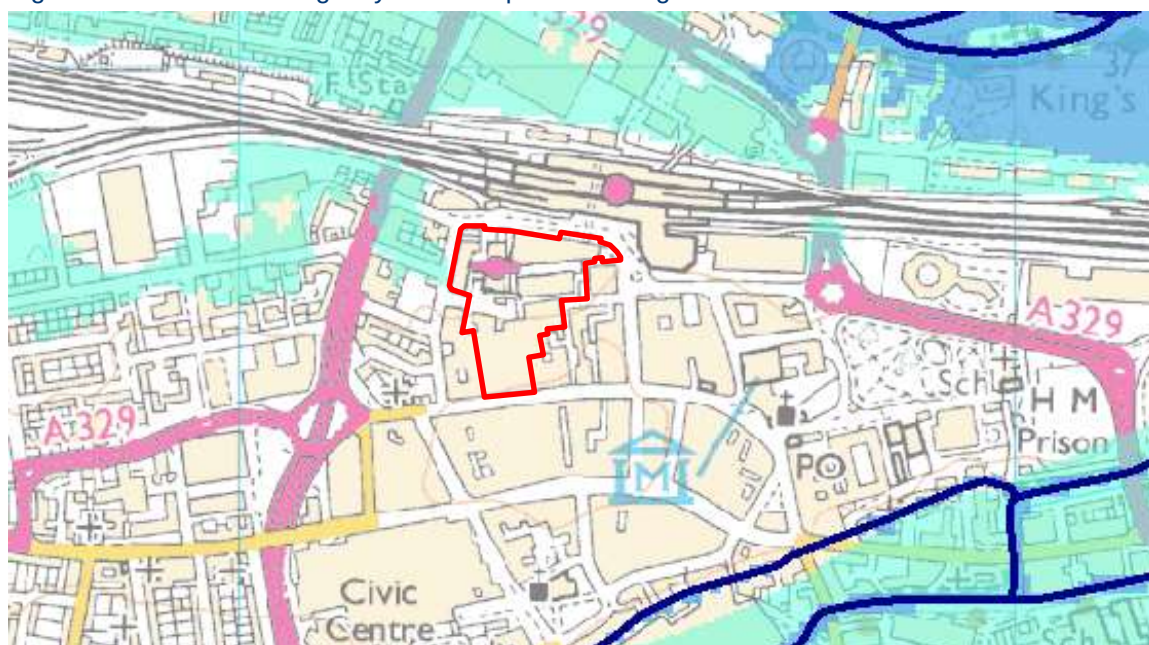


Site Location

- 1.3. The Site is bounded by Reading Station and Station Hill to the north, Greyfriars Road to the west, Friar Street to the south, and Thames Tower and various commercial buildings to the east. Garrard Street runs east-west through the centre of the Site.

- 1.4. The Site consists of a number of existing buildings including the former Reading bus station, Telecom House, NCP multi-storey car park, Western Tower, Friars Walk Shopping Centre and Xafinity House.
- 1.5. The topographic surveys of the Site (see Appendix A) carried out in 2003 and 2008 indicate that the Site falls to the northwest from approximately 45.8m AOD along Friar Street to 38.3m AOD at the junction of Greyfriars Road and Stanshawe Road. Garrard Street and Station Hill fall in a westerly direction from 44.0m to 38.7m AOD and 43.7m to 39.3m AOD respectively.
- 1.6. As seen in Figure 2, the Site is located within Flood Zone 1 according to the Environment Agency's (EA) Flood Map for Planning, indicating a low probability of flooding from fluvial or tidal sources.

Figure 2: Environment Agency Flood Map for Planning



Key



Site Location



Flood Zone 3, High Probability of flooding from rivers or the sea, without the presence of defences



Flood Zone 2, Medium Probability of flooding from rivers or the sea, without the presence of defences



Flood Zone 1, Low Probability of flooding from rivers or the sea



Flood defences



Areas benefiting from flood defences



Main River

Source: <http://maps.environment-agency.gov.uk>

Development Proposals

- 1.7. The Development proposals (included in Appendix B) comprise demolition of the existing buildings on Site with the exception of the Multi Storey Car Park (which will be reconfigured and refurbished) and redevelopment to include offices, shops, restaurants and cafes, leisure uses and residential units.
- 1.8. Office units would be provided on the ground floor in Plot A with retail units provided on the ground floor of Plots B to F. The upper levels would comprise a mixture of office units in Plots A to D to the north of the Site, with residential accommodation in Plots E and F to the south of Garrard Street. Car parking and some retail units would both be provided at ground level within Plot G with additional car parking provided in the upper levels.

Planning Policy and Guidance

National Planning Policy Framework

- 1.9. The National Planning Policy Frameworkⁱ (NPPF) states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. Where development is necessary, it must be made safe without increasing flood risk elsewhere.
- 1.10. The NPPF clarifies that the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. In addition, development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate. For the Exception Test to be passed:
 - A site-specific FRA must demonstrate that the development would be safe for its lifetime, taking account of the vulnerability of its users without increasing flood risk elsewhere, and, where possible would reduce flood risk overall; and
 - It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.
- 1.11. As the Site lies within Flood Zone 1 the Sequential Test would be passed and the Exception Test is not required.
- 1.12. The NPPF states that when determining planning applications, Local Planning Authorities (LPA) should ensure that flood risk is not increased elsewhere and only consider development in areas at risk of flooding where it can be demonstrated that:
 - Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location; and
 - Development is appropriately flood resilient and resistant, includes safe access and escape routes where required, any residual risk can be safely managed (including emergency planning), and priority is given to the use of Sustainable Drainage Systems (SuDS).
- 1.13. The Planning Practice Guidance (PPG)ⁱⁱ provides additional guidance to LPAs to ensure effective implementation of the planning policies set out within the NPPF regarding development in areas at risk of flooding. The guidance retains key elements of superseded NPPF Technical Guidanceⁱⁱⁱ and

Planning Policy Statement 25 Development and Flood Risk Practice Guide^{iv} (PPS25) and is accessed via a web-based portal.

- 1.14. The PPG states that developers and LPAs should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of SuDS. Referencing information provided by the EA, the PPG provides advice on taking climate change into account, setting out recommended contingency allowances for net sea level rise and peak rainfall intensities, which should be increased by between 5% and 30% from now until the year 2115. It also advises on flood resilience and resistance measures when dealing with the residual risks remaining after applying the sequential approach and mitigating actions.
- 1.15. The PPG also includes advice on flood risk vulnerability and flood zone compatibility. The following flood zones refer to the probability of river and sea flooding, without the presence of defences:
- Zone 1 - low probability: less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year;
 - Zone 2 - medium probability: between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% to 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% to 0.1%) in any year;
 - Zone 3a - high probability: 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability flooding from the sea (>0.5%) in any year; and
 - Zone 3b - the functional floodplain: where water has to flow or be stored in times of flood; identification should take account of local circumstances but would typically flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme 1 in 1000 (0.1%) flood.

Reading Borough Council's Strategic Flood Risk Assessment

- 1.16. Reading Borough Council's Strategic Flood Risk Assessment (SFRA)^v was published in March 2009. The report was primarily produced to determine how flood risk varied throughout the Borough. Its key aims are to:
- Collate all known sources of flooding that may affect development;
 - Identify areas of high, medium and low probability of flooding;
 - Recommend appropriate land uses within flood affected areas; and
 - Recommend possible mitigation measures.
- 1.17. In addition, it is used to support the local development framework, providing information on flood risk to be incorporated into local policies, and helped provide information to the Council when choosing their preferred options for site allocation. The SFRA also aids in the development of emergency planning procedures.
- 1.18. Relevant flood risk information from the SFRA is included within Section 2 of this report.

Reading Borough Council Core Strategy

- 1.19. The Core Strategy Document^{vi} was adopted in January 2008, and sets out the main strategy for development across the borough to 2026 and beyond.
- 1.20. Policy CS1 regarding Sustainable Construction and Design states that all developments should incorporate SuDS techniques as appropriate. Advice should be sought from the EA and the design

should aim to minimise the size of impermeable areas in order to reduce the peak runoff rates from the development. On no account should the peak runoff rate increase from the existing situation. In addition, particular care should be taken in areas where there is a flood risk.

- 1.21. Policy CS35 regarding flooding states that no development will be allowed within an area at high risk of flooding if it will reduce the capacity of the floodplain to store water, prevent the flow of floodwater or cause an increased risk to life and property. However, the policy states that appropriate weight will be given to the redevelopment of land at risk of flooding that provides significant regeneration benefits on previously developed land. Such developments will be required to pass the Sequential Test and where appropriate the Exception Test. As the Site lies within Flood Zone 1 the Sequential Test would be passed.

Reading Borough Council, Sites and Detailed Policies Document

- 1.22. The Sites and Detailed Policies Document^{vii} was adopted in October 2012 and forms part of the development plan used when determining planning applications. It contains detailed policies which should be followed when deciding planning applications, and identifies specific sites for development and protection.
- 1.23. Policy DM1 regarding Adaption to Climate Change states that all developments must demonstrate how their design incorporates measures to adapt to climate change. With regard to flood risk and surface water, the policy states that all developments should minimise the impact of surface water runoff from the development through the design of the drainage system.
- 1.24. Supplementary documentation regarding the Station Hill area of Reading^{viii} provides further guidance on development within the area. As part of this guidance, Principle 8 regarding Incorporating High Standards of Sustainable Design states that all developments should aim to include a specific water management scheme which addresses flood risk and water usage. The two key criteria regarding this aspect of the principle are:
- A water management scheme will need to address the management of rainfall to avoid flooding and the minimisation of water usage to reasonable levels; and
 - Applicants should investigate and incorporate SuDS where appropriate.

Reading Borough Council, Reading Station Area Framework

- 1.25. The Reading Station Area Framework Document^{ix} was adopted in December 2010 and sets out principles and guidelines for how development should take place around Reading Station.
- 1.26. Chapter 10 regarding sustainability indicates that all developments around the station should address the principles of sustainability and account for associated guidance. The chapter identifies a range of sustainability measures which could be incorporated into developments to help improve their sustainability, including green and brown roofs. There are also a number of measures highlighted which should be taken into consideration within all developments including:
- Residential uses should not be located on the ground floor within Flood Zone 3a.
 - Buildings, landscaping and infrastructure should be oriented within the site to avoid blocking overland flow routes. Where this cannot be achieved, appropriate management of these flow routes should be provided to ensure there will be no increase in flood risk to the surrounding area, aiming to improve flood risk where possible.
 - Ground floor levels for residential developments should be set at a minimum of 300mm above the 1 in 100 annual probability flood level, including an allowance for climate change.

Scope of Report

- 1.27. This report assesses the potential effects of tidal, fluvial, groundwater, pluvial and artificial sources of flooding upon the Development. In line with current policy, the management of surface water is also assessed, and a strategy to effectively manage runoff whilst working within the Site specific constraints is proposed, so as not to increase, and if possible decrease flood risk elsewhere.

2. Sources of Potential Flooding

Tidal and Fluvial

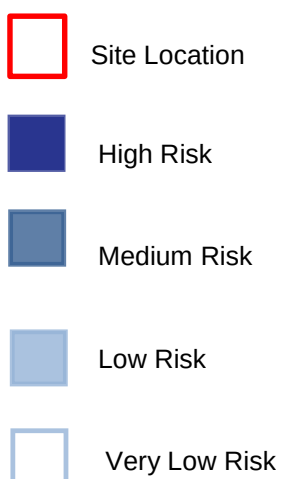
- 2.1. The EA has confirmed (Appendix C) that the Site is located within Flood Zone 1 and is therefore classified as having a low probability of tidal and fluvial flooding. An extract from the EA's Flood Map for Planning is shown in Figure 2.
- 2.2. The nearest watercourse to the Site is the River Thames which is located approximately 400m to the northeast. The EA has confirmed (Appendix C) that the peak 1 in 1000 year fluvial flood level nearest to the Site is 38.45m AOD. Minimum ground levels at the Site are 38.5m AOD, confirming the Site lies within Flood Zone 1.
- 2.3. The EA has provided maps (Appendix C) confirming that there have been no historic incidents of tidal or fluvial flooding at the Site. The Development is therefore considered to be at a low risk of flooding from both sources.

Pluvial

- 2.4. Pluvial flooding occurs when natural and engineered drainage systems have insufficient capacity to deal with the volume of rainfall. Pluvial flooding can sometimes occur in urban areas during an extreme, high intensity, short duration summer rainfall event which overwhelms the local surface water drainage systems, or in rural areas during medium intensity, long duration events where saturated ground conditions prevent infiltration into the subsoil. This flood water would then be conveyed via overland flow routes dictated by the local topography.
- 2.5. The EA's Risk of Flooding from Surface Water map (Figure 3 overleaf and Appendix C) indicates that the Site is generally at a very low risk of surface water flooding. However, there are some potential areas of surface water flooding indicated within the highways in and around the Site.
- 2.6. Post development it is likely that this potential flooding would remain within the highways, however it is recommended that the finished floor levels of the proposed Development are reviewed against those of the surrounding highway network, to ensure that no new low points are created. If potential surface water flow/ponding cannot be ruled out, the drainage strategy should be designed to ensure that this can be appropriately accommodated, and in line with best practice internal finished floor levels should be set nominally above the level of any adjacent highways. This could be achieved by gently ramping up from the external areas/highways to the building entrances.
- 2.7. The Thames Water Sewer records (Appendix D) show that there are a number of foul sewers that currently cross the Site. It is proposed to build over the primary sewer and divert others which are in poor condition. These will be relocated with a 3m easement provided either side to facilitate future maintenance access. A build over agreement is being sought from Thames Water for the primary sewer. Alternatively, this sewer could be diverted to Garrard Street. Please refer to Hoare Lea's Design Note on below ground drainage design (Appendix E) for further details. It is understood that any diversion or relocation would be undertaken on a like for like basis, and therefore these alterations would not change the risk of pluvial flooding at the Site.
- 2.8. Figure 3 of the SFRA (Appendix F) indicates that there have been six recorded incidents of sewer flooding within the city centre area. Of these, three incidents are located within 1km of the Site, the closest of which is located approximately 500m to the south.
- 2.9. Correspondence received from Thames Water (Appendix D) confirms that they have no records of sewer flooding occurring at the Site. It is therefore considered that although some highways in the vicinity of the Site may be at risk of surface water ponding, the risk of flooding to the Development

itself from overland surface water runoff or surcharged sewers is low.

Figure 3: Environment Agency Risk of Flooding from Surface Water



Source: <http://watermaps.environment-agency.gov.uk>

Groundwater

- 2.10. The natural geological sequence beneath the Site has been established from the Station Hill Geo-Environmental and Geotechnical Assessment^x produced by Waterman Energy, Environment & Design in 2014. In addition, review of the British Geological Survey's (BGS) online historic borehole

records further confirms the results of the above assessment. A summary of the predicted geology is provided in Table 1 below.

Table 1: Existing Site Geology

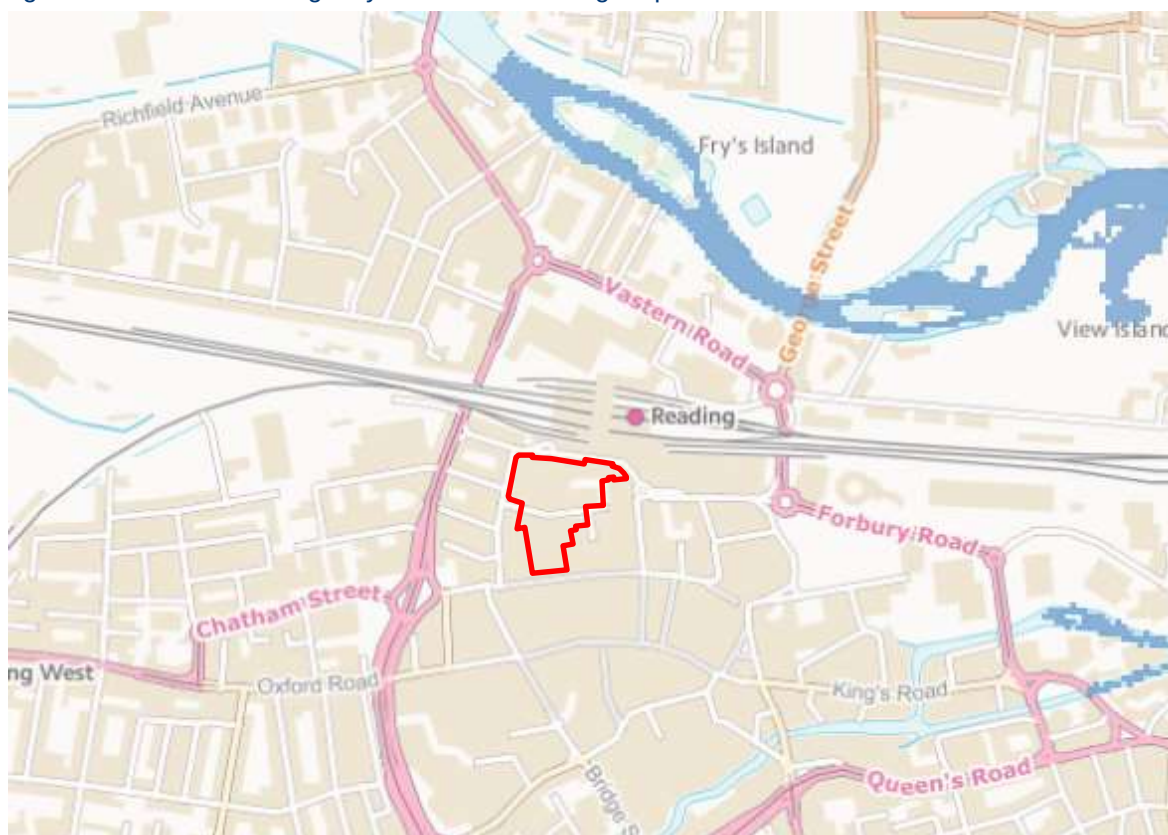
Stratum	Area Covered	Estimated Thickness of stratum	Hydrological Significance
Made Ground	Whole Site	0.5m to 2m	Unproductive Strata
Alluvium	Whole Site	1m to 2m	Secondary A Aquifer
Taplow Gravel Formation	Whole Site	8m to 10m	Secondary A Aquifer
Seaford Chalk Formation	Whole Site	Unknown (over 10m)	Principal Aquifer

- 2.11. The Made Ground at the Site is classified as an unproductive stratum, and the Alluvium and Gravels below as Secondary A Aquifers. The Chalk is classified as a Principal Aquifer.
- 2.12. Historic BGS boreholes at the Site indicate that groundwater has been recorded at between 6.1m and 12.2m below ground level (bgl).
- 2.13. As part of the Geo-Environmental and Geotechnical Assessment groundwater monitoring was undertaken in May and June 2014, which identified groundwater levels ranging between 2.15m and 2.75m bgl.
- 2.14. The SFRA (Figure 3, Appendix F) indicates that no groundwater flooding has been recorded within the Site boundary. However, three incidents have occurred within a 1km radius, the closest of which is located approximately 420m to the southeast.
- 2.15. As groundwater has been recorded at a minimum of 2.15m bgl, and there have been no historic incidents of groundwater flooding at the Site, it is assumed that the risk of flooding from this source is low. In addition, since the proposals do not include the construction of a basement there would be no impact on the flow of groundwater beneath the Site, or any increase in flood risk elsewhere.

Artificial Sources

- 2.16. Mapping shown on the EA website indicates the largest area that may be affected by flooding if a reservoir were to fail. The EA note that this is a worst case prediction and any flood event is unlikely to be this large. EA mapping (Figure 4) shows that the Site would not be subject to flooding due to failure of the reservoirs in the area. There are no other artificial water bodies in the vicinity of the Site, and the risk of flooding from this source is therefore considered to be low.

Figure 4: Environment Agency Reservoir Flooding Maps



Key



Site Location



Maximum extent of reservoir flooding

Source: <http://watermaps.environment-agency.gov.uk>

Summary

- 2.17. The Site is considered to be at a low risk of flooding from tidal, fluvial, pluvial, groundwater and artificial sources of flooding. It is also important to assess the potential for the Development to increase flood risk to others through increasing surface water runoff from the Site. This is discussed in Chapter 3.

3. Surface Water Drainage Strategy

Methods of Surface Water Disposal

- 3.1. In line with Building Regulations^{xi} and good practice the following hierarchy of surface water disposal should be adhered to, in decreasing order of preference.
- i. Discharge to ground
 - ii. Discharge to a surface water body
 - iii. Discharge to a surface water sewer
 - iv. Discharge to a combined sewer

Discharge to Ground

- 3.2. The most effective way to reduce surface water runoff is through infiltration into the subsoil which reduces the total volume of runoff, rather than simply reducing peak flows. This can include techniques such as infiltration trenches, soakaways, permeable paving and infiltration basins.
- 3.3. Hoare Lea have indicated within their Stormwater Drainage Strategy (Appendix G) that the use of soakaways is not feasible since there is a potential risk of contamination at the Site. They also highlight that there may be risk that any soakaways would adversely affected the ground bearing slabs and footings across the Site.

Discharge to a Surface Water Body

- 3.4. The River Thames is located approximately 400m to the north of the Site with dense development between the Site and the river. Discharge to a surface water body is therefore not possible without draining through third party land, which is not considered feasible.

Discharge to a Sewer

- 3.5. According to the Thames Water sewer records (Appendix D) there are foul and surface water sewers in the vicinity of the Site. It is therefore proposed to discharge surface water runoff into the surface water sewers, as per the existing situation.
- 3.6. The rate of runoff into these sewers would be controlled through the provision of attenuation.

Sustainable Drainage

- 3.7. Hoare Lea has considered the use of SuDS to provide sufficient attenuation in the most sustainable manner, whilst working within the Site-specific constraints. Please refer to their Stormwater Drainage Strategy for further details, included in Appendix G.

4. Conclusions

- 4.1. EA mapping shows that the Site is located within Flood Zone 1, and is therefore classified as having a low probability of tidal and fluvial flooding.
- 4.2. The EA has confirmed that the peak 1 in 1000 year fluvial flood level closest to the Site is 38.45m AOD. Minimum ground levels at the Site are 38.5m AOD, confirming the Site lies within Flood Zone 1.
- 4.3. The risk of flooding from groundwater and artificial sources has been assessed and found to be low.
- 4.4. The EA's surface water flood maps show that there is a potential for surface water flooding within some of the highways in and around the Site. However, neither Thames Water nor the SFRA have records of surface water flooding in the vicinity.
- 4.5. Taking a precautionary approach, in order to ensure that the potential risk of surface water flooding is managed, it is recommended that finished floor levels of the proposed Development are reviewed against those of the surrounding highway network, to ensure that no new low points are created. If potential surface water flow/ponding cannot be ruled out, the drainage strategy should be designed to ensure that this water can be appropriately accommodated, and internal finished floor levels should be set nominally above the level of any adjacent highways. This could be achieved by gently ramping up from the external areas/highways to the building entrances.
- 4.6. Hoare Lea have confirmed that surface water runoff from the proposed development would discharge to the surrounding sewer network at the lesser of either the 1 year 30 minute runoff rate, or the capacity of the existing drainage connections into the Thames Water Sewers. Attenuation would be provided up to the 1 in 100 year rainfall event, including for 30% climate change.
- 4.7. This report demonstrates that the proposed Development is at a low risk of flooding. It also confirms that surface water runoff from the Site can be managed sustainably to ensure that flood risk is reduced elsewhere. It is considered that the information provided within this report satisfies the requirements of the NPPF.

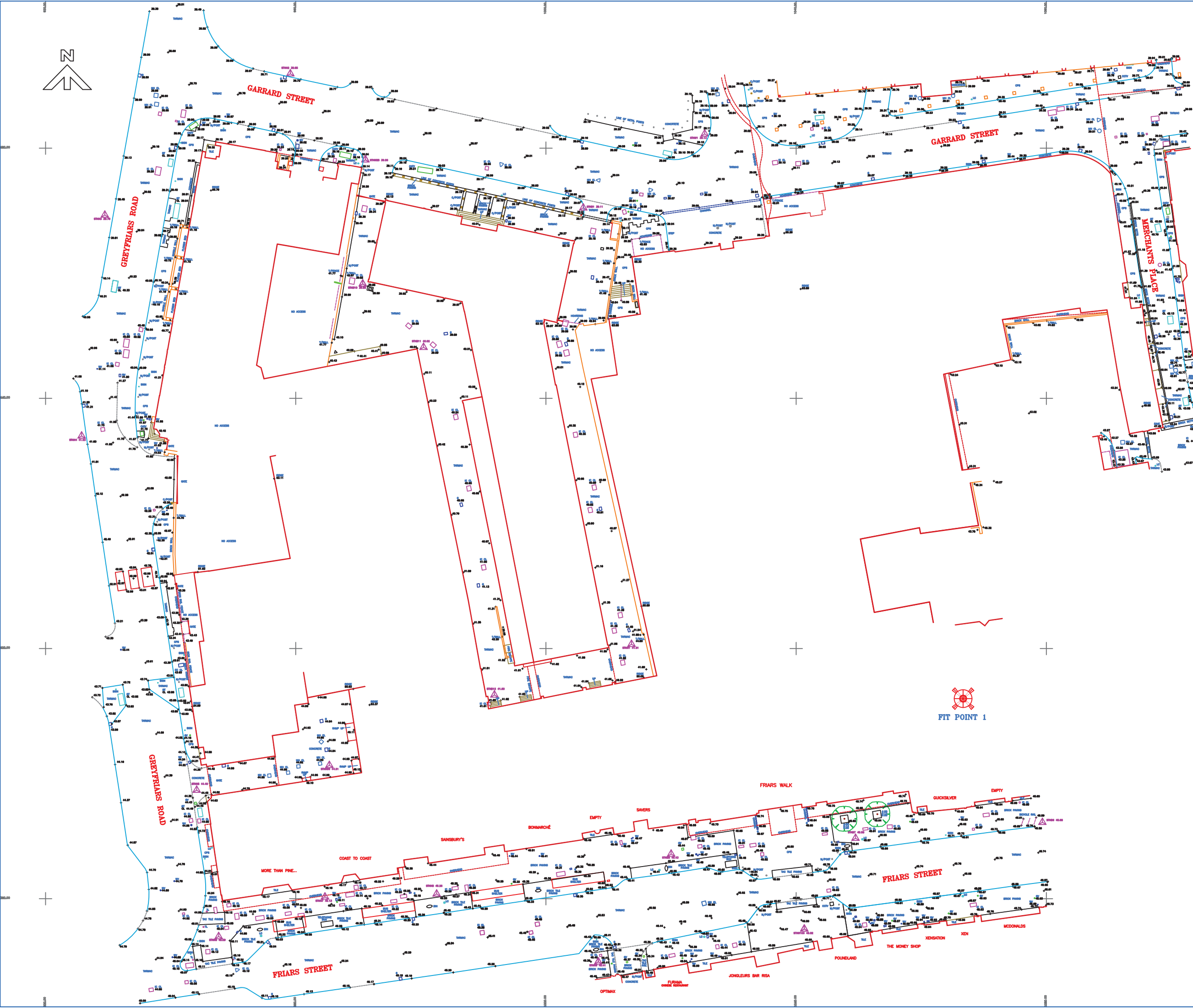
5. References

- ⁱ Department for Communities and Local Government, March 2012. *National Planning Policy Framework*
- ⁱⁱ Department for Communities and Local Government, March 2014. *Planning Practice Guidance*
- ⁱⁱⁱ Department for Communities and Local Government, March 2012. *National Planning Policy Framework Technical Guidance*
- ^{iv} Communities and Local Government, 2009. *Planning Policy Statement 25: Development and Flood Risk Practice Guide*
- ^v Jacobs on behalf of Reading Borough Council, March 2009. *Level 1 Strategic Flood Risk Assessment*
- ^{vi} Reading Borough Council, January 2008. *Local Development Framework Core Strategy*
- ^{vii} Reading Borough Council, October 2012. *Local Development Framework Sites and Detailed Policies Document*
- ^{viii} Entec on behalf of Reading Borough Council, 2007. *Station Hill South Planning and Urban Design Brief*
- ^{ix} Reading Borough Council, December 2010. *Reading Station Area Framework Document*
- ^x Waterman Energy, Environment and Design Limited, 2014. *Station Hill Geo-Environmental and Geotechnical Assessment (EED12350-110-R-3.1.1-RM)*
- ^{xi} HM Government, 2010. *The Building Regulations 2010: H, Drainage and Waste Disposal*



APPENDICES

A. Topographical Survey



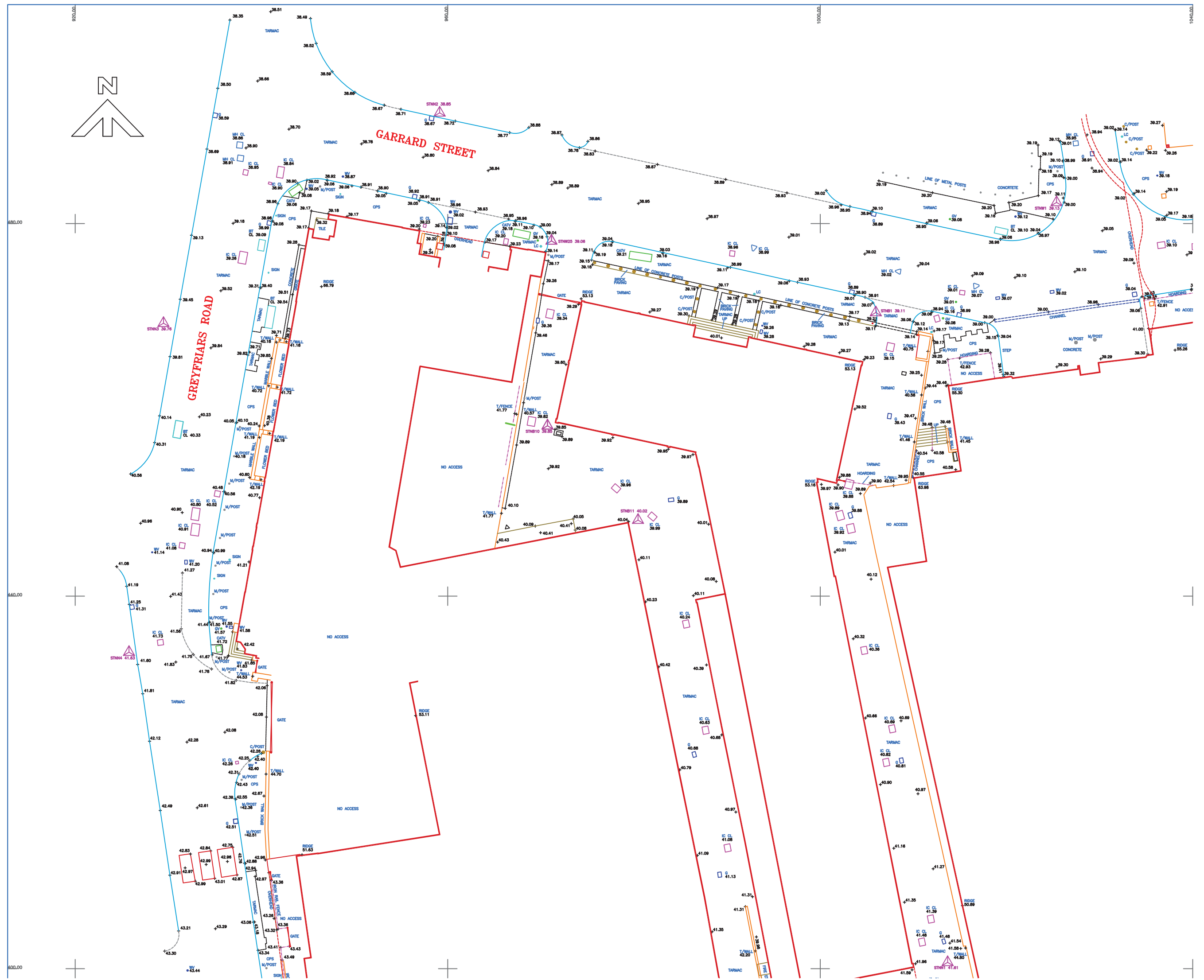
Coordinate Table				
Station	Description	Easting	Northing	Height
STW16	Control Station	1008.008	814.838	38.110
STW18	Control Station	1004.748	808.883	38.740
STW1	Control Station	1005.873	870.445	38.118
STW10	Control Station	870.711	458.281	38.648
STW11	Control Station	885.433	448.180	40.017
STW12	Control Station	891.788	382.676	41.005
STW13	Control Station	1007.771	478.879	38.448
STW14	Control Station	1003.542	460.439	41.637
STW15	Control Station	1078.498	438.885	43.181
STW16	Control Station	1077.538	418.274	45.281
STW17	Control Station	1079.380	372.808	45.880
STW18	Control Station	1048.486	389.686	45.076
STW19	Control Station	1003.011	387.140	45.038
STW2	Control Station	1037.894	488.286	64.285
STW3	Control Station	1084.816	483.437	65.378
STW4	Control Station	1005.378	482.271	38.131
STW10	Control Station	1011.810	448.810	40.008
STW11	Control Station	1013.688	448.888	38.158
STW12	Control Station	1007.873	479.779	38.688
STW13	Control Station	1100.748	487.247	41.884
STW14	Control Station	1105.135	431.870	43.885
STW15	Control Station	1111.889	438.088	44.334
STW16	Control Station	1109.334	433.712	45.023
STW17	Control Station	1111.830	381.433	45.888
STW18	Control Station	1101.786	384.888	45.887
STW19	Control Station	1071.204	385.721	45.827
STW20	Control Station	1030.880	448.088	40.023
STW21	Control Station	1041.297	385.180	45.814
STW22	Control Station	1008.818	380.888	45.814
STW23	Control Station	948.105	388.444	45.082
STW24	Control Station	897.888	448.881	38.888
STW25	Control Station	891.887	384.881	38.881
STW26	Control Station	871.138	478.135	38.882
STW27	Control Station	1010.333	389.338	41.813
STW28	Control Station	1021.389	448.873	38.823
STW29	Control Station	1035.582	433.883	41.311
STW30	Control Station	1041.880	431.785	41.300
STW31	Control Station	1041.888	418.182	41.304
STW32	Control Station	1048.831	418.287	41.314
STW33	Control Station	1043.273	404.888	41.309
STW34	Control Station	1002.633	401.480	41.309
STW35	Control Station	1017.113	438.484	41.887
STW36	Control Station	1011.844	434.880	41.308
STW37	Control Station	1018.281	444.141	41.389

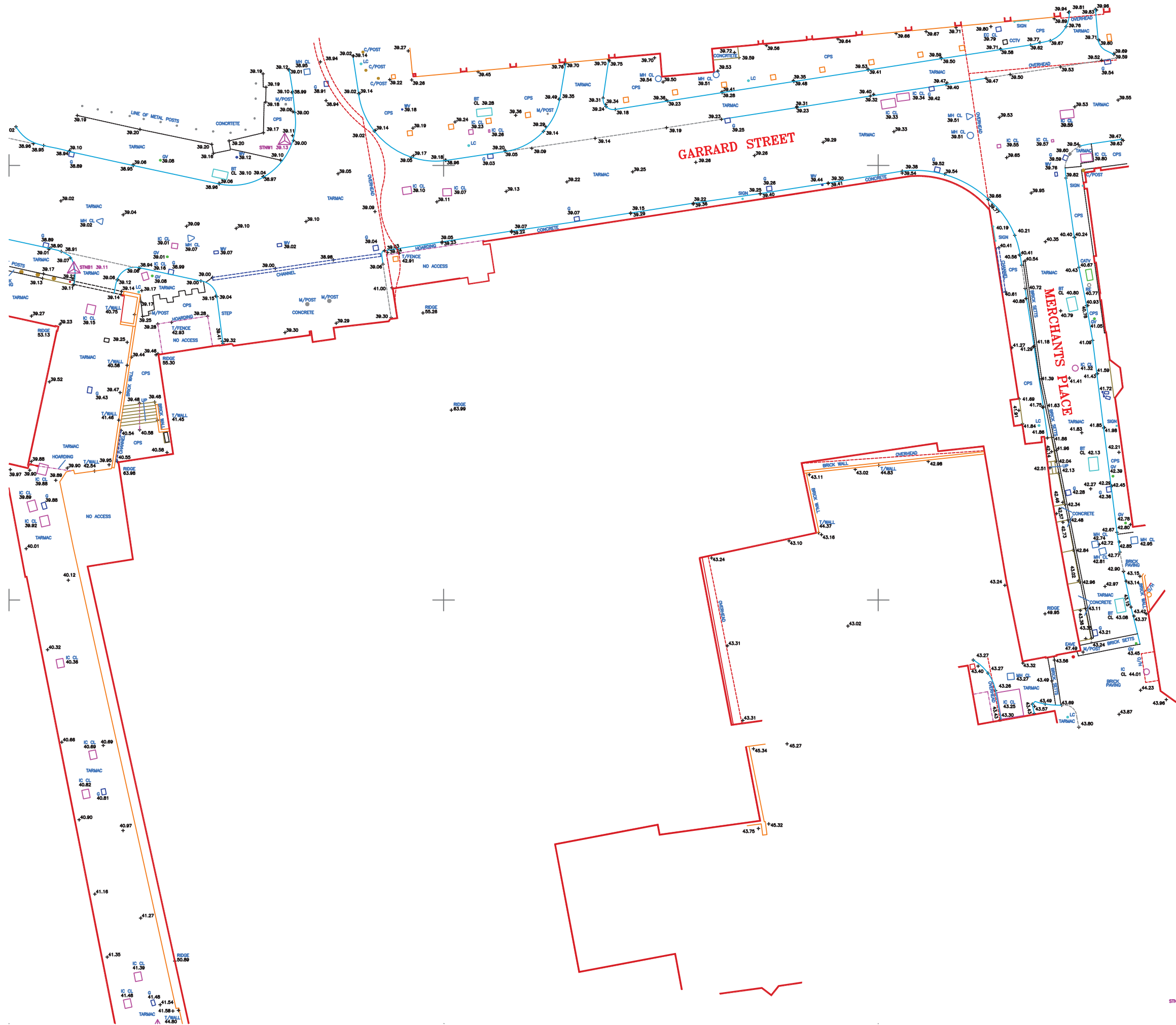
XYZ LAND SURVEYS
CHARTERED SURVEYORS
LAND AND BUILDING CONSULTANTS
DARTMOUTH, 116 ROXBURGH ROAD,
CHERRINGTON, SURREY, KT8 1BU
TEL: 0181 606 0000 - FAX: 0181 606 0001
WWW.XYZSURVEYS.CO.UK

SITE
PRIARS WALK
PRIARS STREET
READING

DRAWING
SITE SURVEY
Copyright XYZ Surveys Ltd, VA 001 Land Survey
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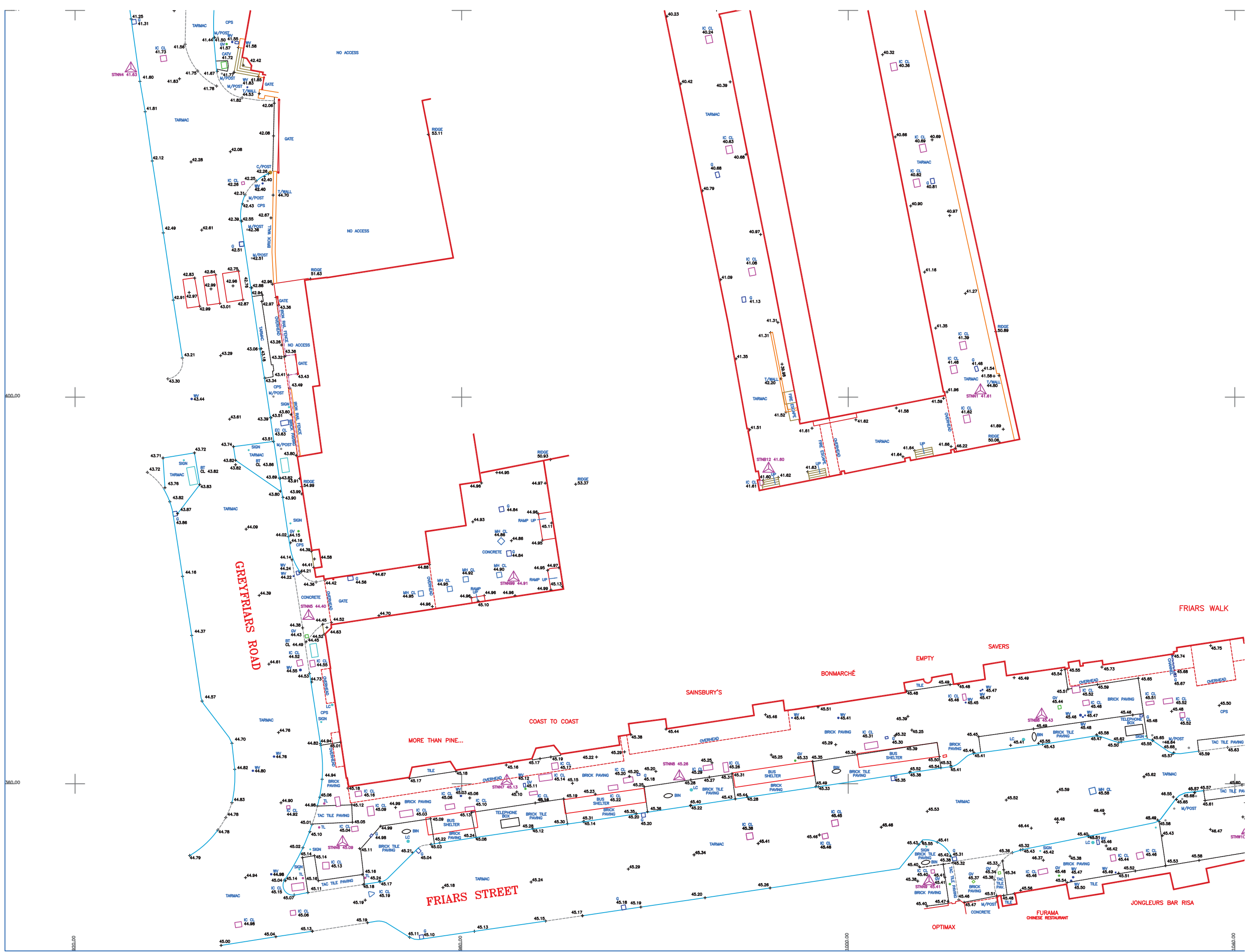
SCOTT BROWNRIGG
SURVEYOR & FIT POINT ADDED.
LEVELS RELATE TO 2m BENCHMARK LOCATED
AT CORNER OF STATION BUILDING
WITH A VALUE OF 41.82m

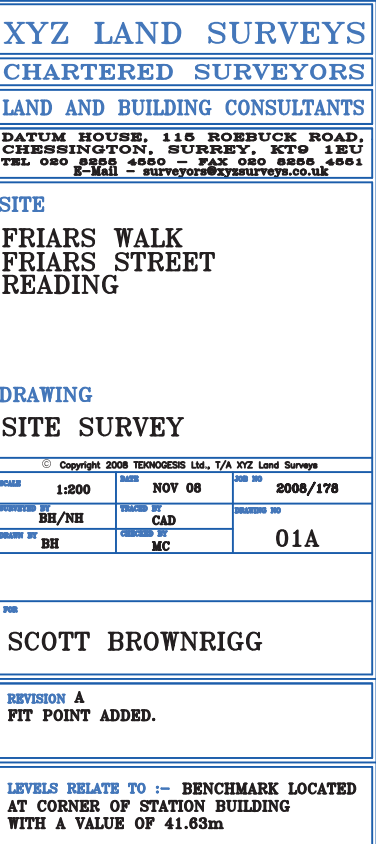




112020

Coordinate Table				
Station	Description	Easting	Northing	Height
STN1A	Control Station	1028.008	514.539	39.110
STN1B	Control Station	1034.748	529.563	38.740
STN1C	Control Station	1005.973	470.445	39.115
STN10	Control Station	970.711	458.291	38.849
STN11	Control Station	980.433	448.160	40.017
STN12	Control Station	991.758	392.576	41.605
STN2	Control Station	1057.771	475.975	39.165
STN3	Control Station	1093.542	460.429	41.537
STN4	Control Station	1076.456	436.955	43.191
STN5	Control Station	1071.936	416.374	45.291
STN6	Control Station	1079.360	372.208	45.680
STN7	Control Station	1048.486	369.666	45.576
STN8	Control Station	1020.011	367.140	45.428
STN1	Control Station	1037.894	498.292	64.295
STN2	Control Station	1084.916	493.447	64.279
STN1	Control Station	1025.375	482.271	39.131
STN10	Control Station	1011.610	448.910	40.558
STN11	Control Station	1012.682	468.558	39.156
STN12	Control Station	1097.673	479.779	39.866
STN13	Control Station	1100.746	457.347	41.884
STN14	Control Station	1105.135	431.870	43.865
STN15	Control Station	1111.659	426.068	44.334
STN16	Control Station	1108.334	403.712	45.023
STN17	Control Station	1111.530	381.433	45.598
STN18	Control Station	1101.766	364.865	45.667
STN19	Control Station	1071.204	360.721	45.627
STN2	Control Station	1030.660	449.095	40.253
STN20	Control Station	1041.297	355.160	45.514
STN21	Control Station	1009.918	350.865	45.404
STN22	Control Station	946.105	359.444	45.092
STN23	Control Station	927.862	465.521	39.985
STN24	Control Station	951.807	494.081	38.821
STN25	Control Station	971.138	478.135	39.062
STN26	Control Station	1010.323	399.538	41.613
STN27	Control Station	1001.399	449.873	39.933
STN3	Control Station	1035.252	423.863	41.311
STN4	Control Station	1041.080	421.755	41.300
STN5	Control Station	1041.526	415.162	41.304
STN5A	Control Station	1048.531	416.227	41.314
STN6	Control Station	1043.273	404.938	41.309
STN7	Control Station	1022.623	401.460	41.309
STN8	Control Station	1017.113	435.454	41.297
STN8A	Control Station	1011.664	434.040	41.308
STN9	Control Station	1015.291	444.141	41.289





REVISION
REVISED LEVELS, ADJUSTED BY 3 METRES

LEVELS RELATE TO :- BENCHMARK LOCATED AT
CORNER OF STATION BUILDING
WITH A VALUE OF 41.63m

ON BEAT, SURVEY	
1	ARMSTRONG BOB
2	ARMSTRONG BOB
3	ARMSTRONG BOB
4	ARMSTRONG BOB
5	ARMSTRONG BOB
6	ARMSTRONG BOB
7	ARMSTRONG BOB
8	ARMSTRONG BOB
9	ARMSTRONG BOB
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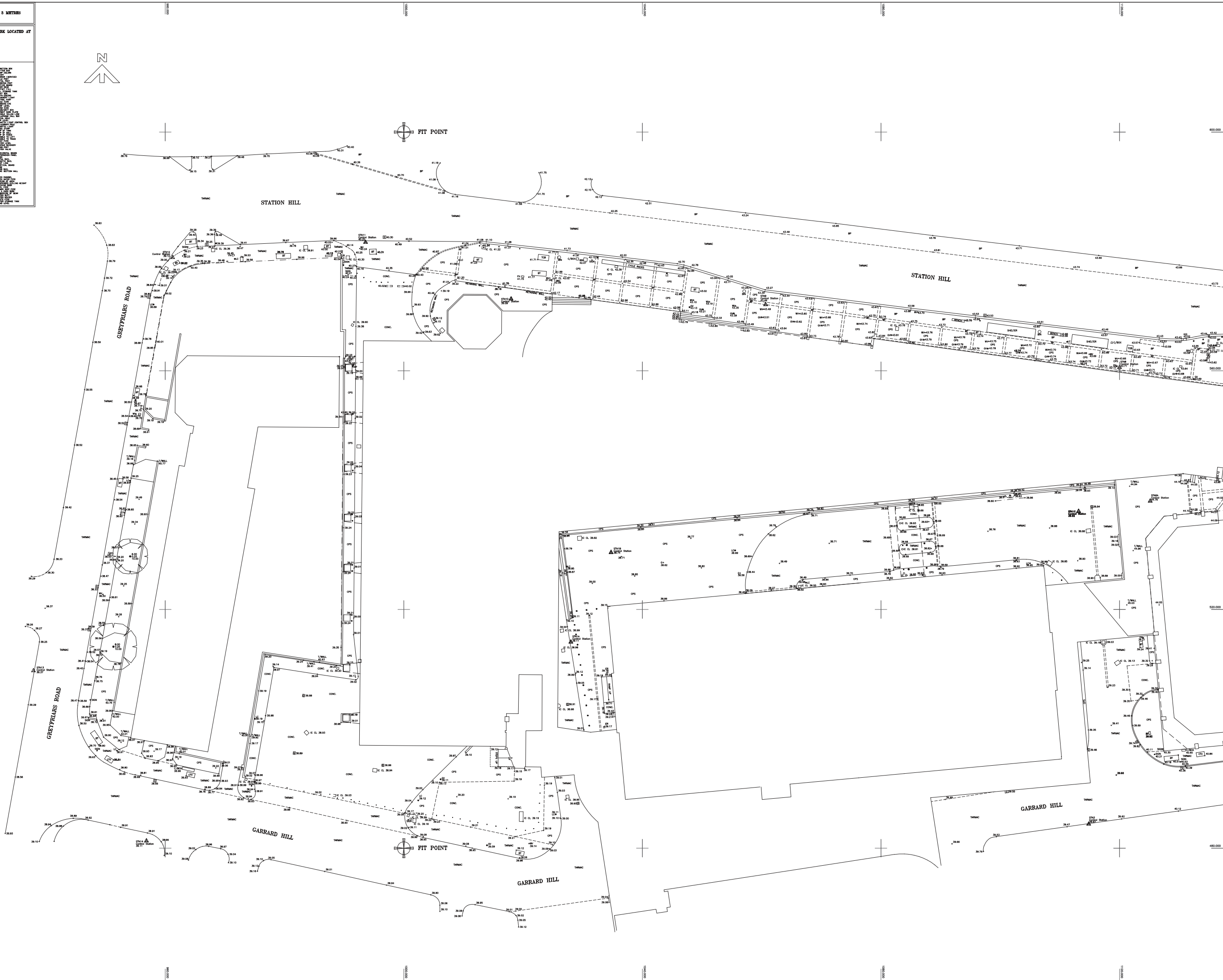
STATION HILL
READING

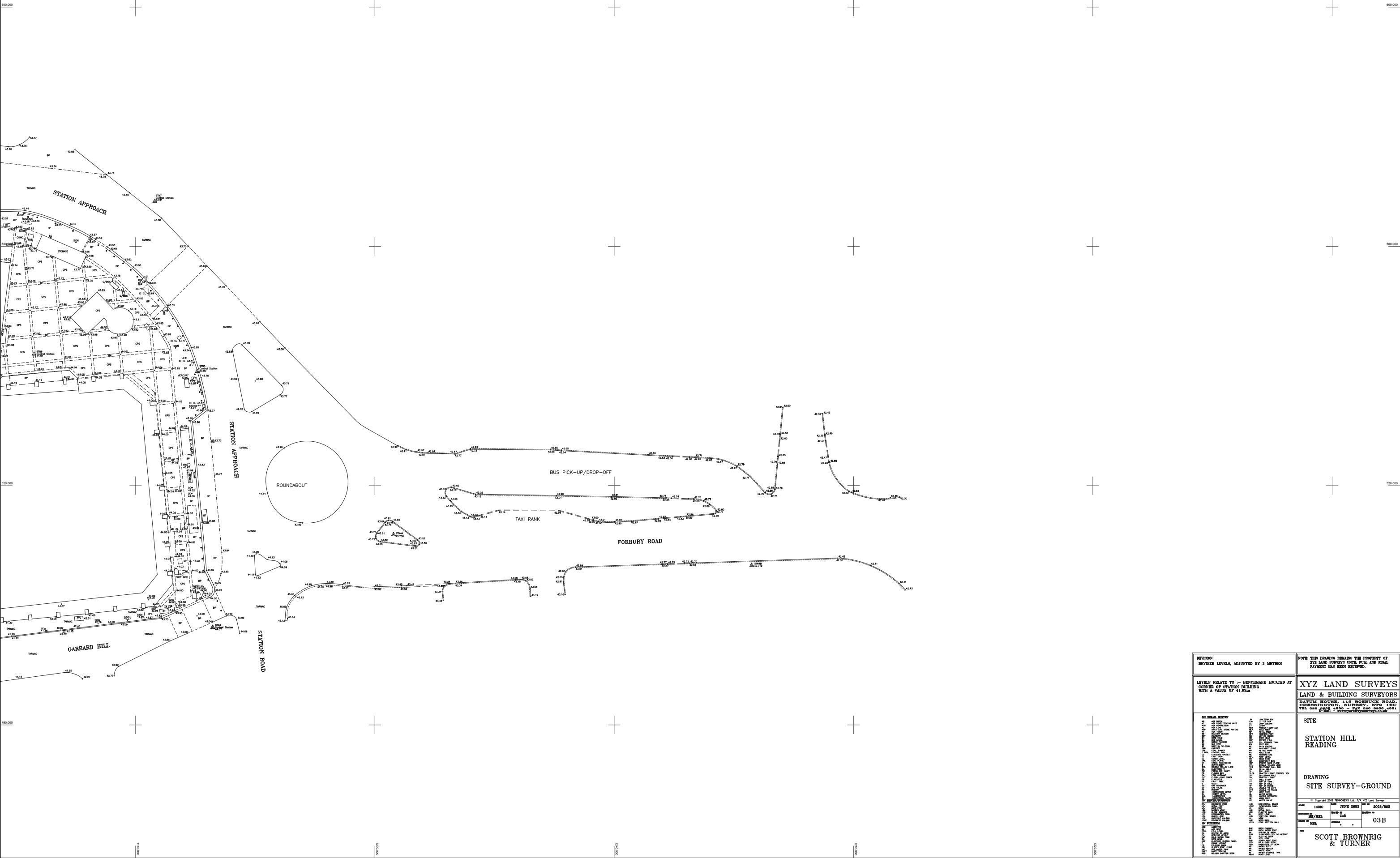
DRAWING
SITE SURVEY-GROUND

© Copyright 2002 TEXNOGENESIS LLC, T/A XYZ Land Surveys

1:200	JUNE 2003	2003/065
SEARCHED BY MR/MEL	INDEXED BY CAD	02 B
FILED BY MEL	APPROVED	

SCOTT BROWNRIG
& TURNER



[illegible]

NOTE: THIS DRAWING REMAINS THE PROPERTY OF XYZ LAND SURVEYS UNLESS FULL AND FINAL PAYMENT HAS BEEN RECEIVED.

XYZ LAND SURVEYS

LAND & BUILDING SURVEYORS

DATUM: HOUSE, 110 BOREBUCKE ROAD, CHERRINGTON, SURREY, KT9 1ST
T.M. CON. 44500 = FACT DATA 44500
E-Mail - SURVEYS@XYZSURVEYS.CO.UK

SITE

STATION HILL
READING

DRAWING
SITE SURVEY -
LOWER GROUND

DATE: 1-2009

DATE: JUNE 2003

DATE: 2003/06/5

BY: J.M.

BY: C.B.

BY: 01B

BY: SCOTT BROWNRIG
& TURNER

REVISION

REVISED LEVELS, ADJUSTED BY 3 METRES

LEVELS RELATE TO - BENCHMARK LOCATED AT
CORNER OF STATION BUILDING
WITH A VALUE OF 41.63m

BY: J.M.

BY: C.B.

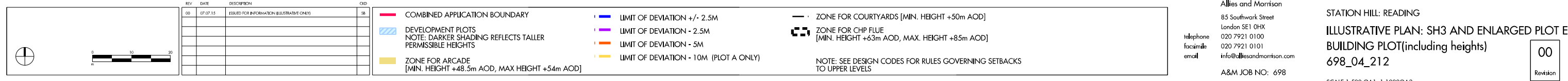
BY: 01B

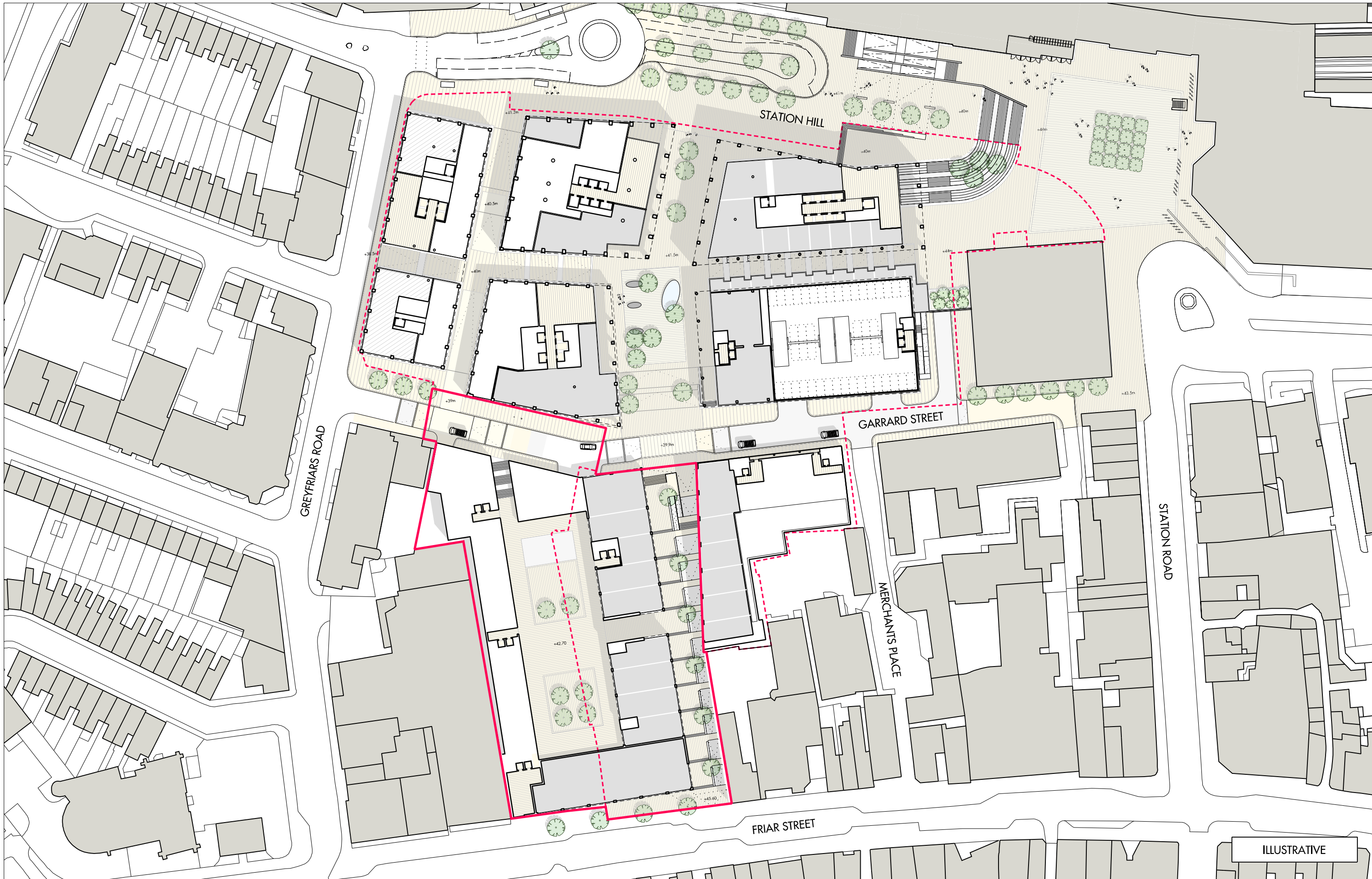
BY: SCOTT BROWNRIG
& TURNER



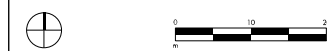


B. Development Proposals





REV	DATE	DESCRIPTION	CHKD
P1	28.04.15	INFORMATION FOR FIRST PRE-APPLICATION MEETING	JCH
P2	July 2015	OUTLINE PLANNING APPLICATION - FOR ILLUSTRATION ONLY	JCH



SOLID RED LINE	PLOT E/TELECOM HOUSE APPLICATION BOUNDARY
DASHED RED LINE	SH3 APPROVED BOUNDARY

Allies and Morrison
85 Southwark Street
London SE1 0HX
020 7921 0100
020 7921 0101
info@alliesandmorrison.com

telephone
facsimile
email

A&M JOB NO: 698

STATION HILL: READING
ILLUSTRATIVE PLAN
ILLUSTRATIVE MASTERPLAN
698_E_07_101

SCALE: 1:500 @A1 1:1000 @A3

ILLUSTRATIVE

P2
Revision



C. Environment Agency Correspondence

O'Donovan, Donal

From: WT Enquiries <WTenquiries@environment-agency.gov.uk>
Sent: 02 July 2014 12:58
To: O'Donovan, Donal
Subject: WT16308: CIV13174 140612 DODEA Station Hill - Flood Risk Enquiry
Attachments: WT16308 Product 4.pdf; Standard Notice.pdf; WT16308 Surface Water Map.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Donal

Thank you for your request for flood risk data.

I have attached our Product 4 flood level data to assist you with your flood risk assessment although the site of interest does not lie in a flood plain and the maps confirm that it lies in flood zone 1.

The site is not governed by any bylaws and the nearest water course is approximately 0.4 km from the site.

I have also attached surface water maps although the lead local authority for ground water, surface water and drainage is Reading Borough Council.

I hope that we have correctly interpreted your request. Please see the attached Standard Notice or license for the details of the permitted use.

We respond to requests for recorded information that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information, you can contact us within 2 calendar months to ask for our decision to be reviewed.

Kind regards

Julia Hewitt
Customers and Engagement Officer

Customers and Engagement
Environment Planning and Engagement
Environment Agency
West Thames Area
Red Kite House, Howbery Park, Wallingford, OX10 8BD

Telephone: 01491 828426

We would be really grateful if you could spare five minutes to help us improve our service. Please click on the link below and fill in our survey – we use every piece of feedback we receive:

<http://feedback1.environmentagency.uk.com/s3/2be3681a283f>

Product 4 (Detailed Flood Risk) for Station Hill, Reading, RG1 1NR

Our Ref: OX_0795_01

Product 4 is designed for developers where Flood Risk Standing Advice FRA (Flood Risk Assessment) Guidance Note 3 Applies. This is:

- i) "all applications in Flood Zone 3, other than non-domestic extensions less than 250 sq metres; and all domestic extensions", and
- ii) "all applications with a site area greater than 1 ha" in Flood Zone 2.

Product 4 includes the following information:

Ordnance Survey 1:25k colour raster base mapping;
Flood Zone 2 and Flood Zone 3;
Relevant model node locations and unique identifiers (for cross referencing to the water levels, depths and flows table);
Model extents showing *defended* scenarios;
FRA site boundary (where a suitable GIS layer is supplied);
Flood defence locations (where available/relevant) and unique identifiers; (supplied separately)
Flood Map areas benefiting from defences (where available/relevant);
Flood Map flood storage areas (where available/relevant);
Historic flood events outlines (where available/relevant, not the Historic Flood Map) and unique identifiers;
Statutory (Sealed) Main River (where available within map extents);

A table showing:

- i) Model node X/Y coordinate locations, unique identifiers, and levels and flows for *defended* scenarios.
- ii) Flood defence locations unique identifiers and attributes; (supplied separately)
- iii) Historic flood events outlines unique identifiers and attributes; and
- iv) Local flood history data (where available/relevant).

Please note:

If you will be carrying out computer modelling as part of your Flood Risk Assessment, please read the enclosed guidance which sets out our requirements and best practice for computer river modelling.

This information is based on that currently available as of the date of this letter. You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

This information is provided subject to the enclosed notice which you should read.

This letter is not a Flood Risk Assessment. The information supplied can be used to form part of your Flood Risk Assessment. Further advice and guidance regarding Flood Risk Assessments can be found on our website at

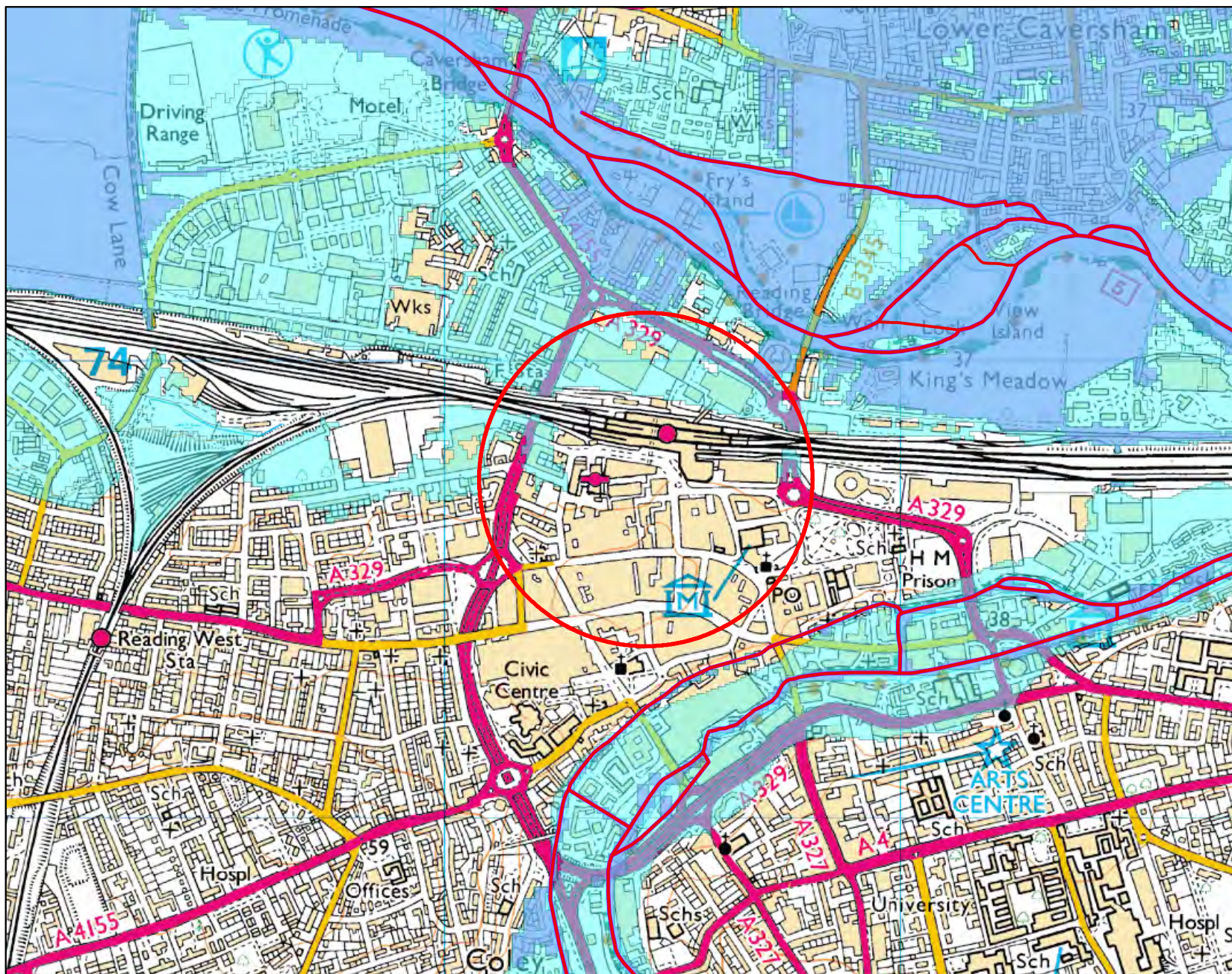
<http://www.environment-agency.gov.uk/research/planning/82584.aspx>

If you would like advice from us regarding your development proposals you can complete our pre application enquiry form which can be found at

<http://www.environment-agency.gov.uk/research/planning/33580.aspx>

Flood Map centred on Station Hill, Reading, RG1 1NR

Created on 30/06/2014 REF: OX_0795_01



Kilometres

0 0.15 0.3

Legend

- Main River
- Flood defences
- Areas benefiting from flood defences
- Flooding from rivers or sea (FZ3)
- Extent of extreme flood (FZ2)
- Flood Map - flood storage areas

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Defence information

OX_0795_01

Defence Location: No defences on Main River

Description: This location is not currently protected by any formal defences and we do not currently have any flood alleviation works planned for the area. However we continue to maintain certain watercourses and the schedule of these can be found on our internet pages.

Model information

OX_0795_01

Model: Thames (Mapledurham to Sonning) 2011

Description: The information provided is taken from the Thames (Reading Complex Change) Flood Alleviation Study completed in June 2011. The study was carried out using 2D modelling software (ISIS-Tuflow).

Model design runs:

1 in 5 / 20% AEP; 1 in 20 / 5% AEP; 1 in 50 / 2% AEP; 1 in 100 / 1% AEP; 1 in 1000 / 0.1% AEP and 1 in 100+20% / 1% AEP with climate change

Mapped Outputs:

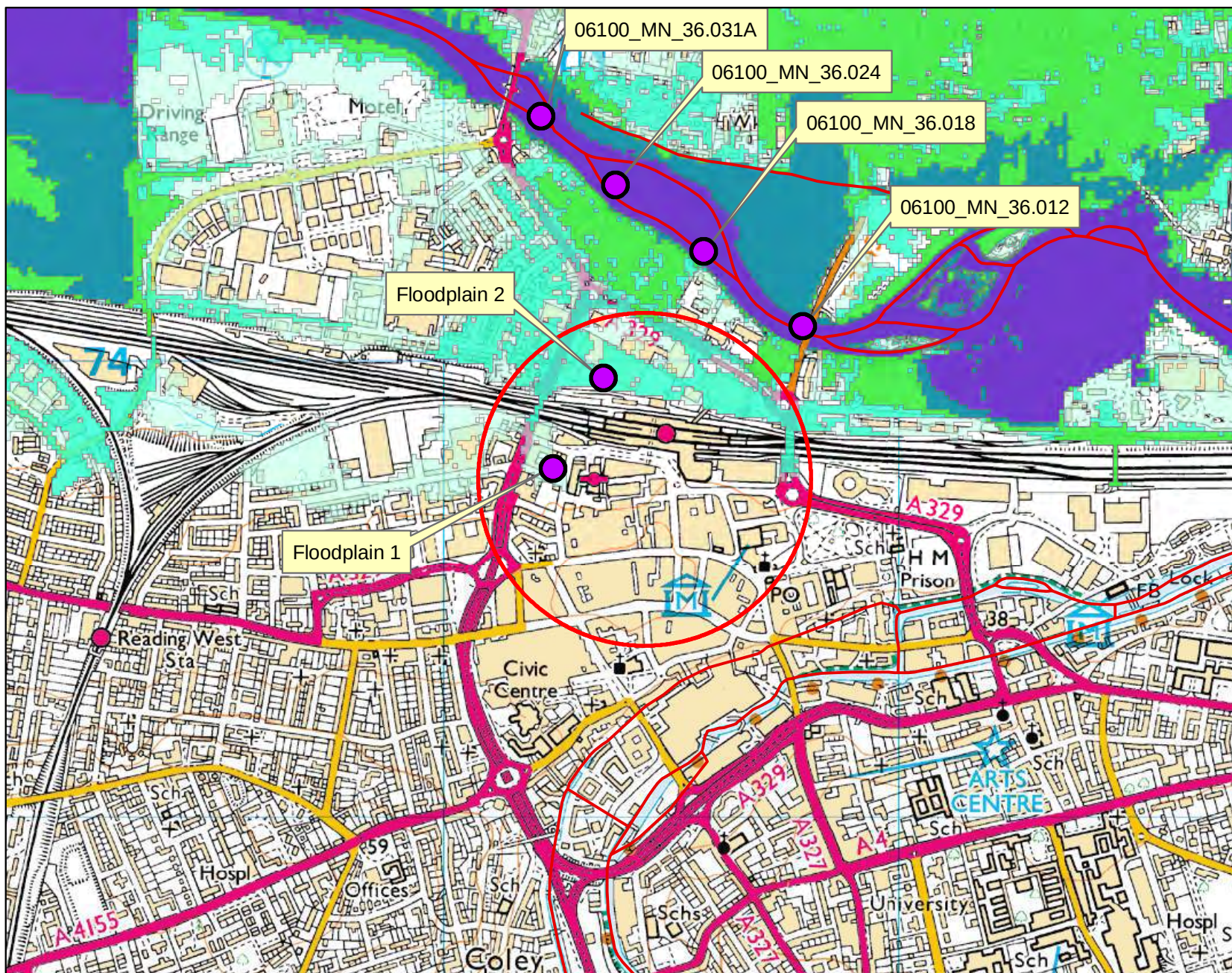
1 in 5 / 20% AEP; 1 in 20 / 5% AEP; 1 in 50 / 2% AEP; 1 in 100 / 1% AEP; 1 in 1000 / 0.1% AEP and 1 in 100+20% / 1% AEP with climate change

Model accuracy:

Levels $\pm$ 250mm

Detailed FRA centred on Station Hill, Reading, RG1 1NR

Created on 30/06/2014 REF: OX_0795_01



Kilometres

0 0.15 0.3

Legend

- Main River
- 20% AEP
- 5% AEP
- 1% AEP
- 1%CC
- 0.1% AEP

AEP = Annual Exceedance Probability
The probability of a flood of a particular magnitude, or greater, occurring in any given year

1%CC = 1% Climate Change extent
This is the 1% AEP event with an allowance for climate change (+20% on river flows)

Modelled in-channel flood flows and levels

OX_0795_01

The modelled flood levels and flows for the closest most appropriate model node points for your site that are within the river channel are provided below:

Node label	Model	Easting	Northing	Flood Levels (mAOD)				
				20% AEP	5% AEP	1% AEP	1% AEP with climate change allowance (+20% on river flows)	0.1% AEP
06100_MN_36.031A	Thames (Mapledurham to Sonning) 2011	471220	174537	37.20	37.59	38.06	38.26	38.51
06100_MN_36.024	Thames (Mapledurham to Sonning) 2011	471380	174382	37.15	37.55	38.02	38.23	38.47
06100_MN_36.018	Thames (Mapledurham to Sonning) 2011	471579	174240	37.07	37.48	37.98	38.18	38.43
06100_MN_36.012	Thames (Mapledurham to Sonning) 2011	471796	174061	36.98	37.35	37.82	38.00	38.23

Node label	Model	Easting	Northing	Flood Flows (m3/s)				
				20% AEP	5% AEP	1% AEP	1% AEP with climate change allowance (+20% on river flows)	0.1% AEP
06100_MN_36.031A	Thames (Mapledurham to Sonning) 2011	471220	174537	223.10	284.45	374.33	450.03	571.71
06100_MN_36.024	Thames (Mapledurham to Sonning) 2011	471380	174382	223.09	283.73	369.35	440.90	555.83
06100_MN_36.018	Thames (Mapledurham to Sonning) 2011	471579	174240	223.09	268.80	324.55	377.28	456.53
06100_MN_36.012	Thames (Mapledurham to Sonning) 2011	471796	174061	223.08	281.34	353.30	405.25	476.08

Modelled floodplain flood levels

OX_0795_01

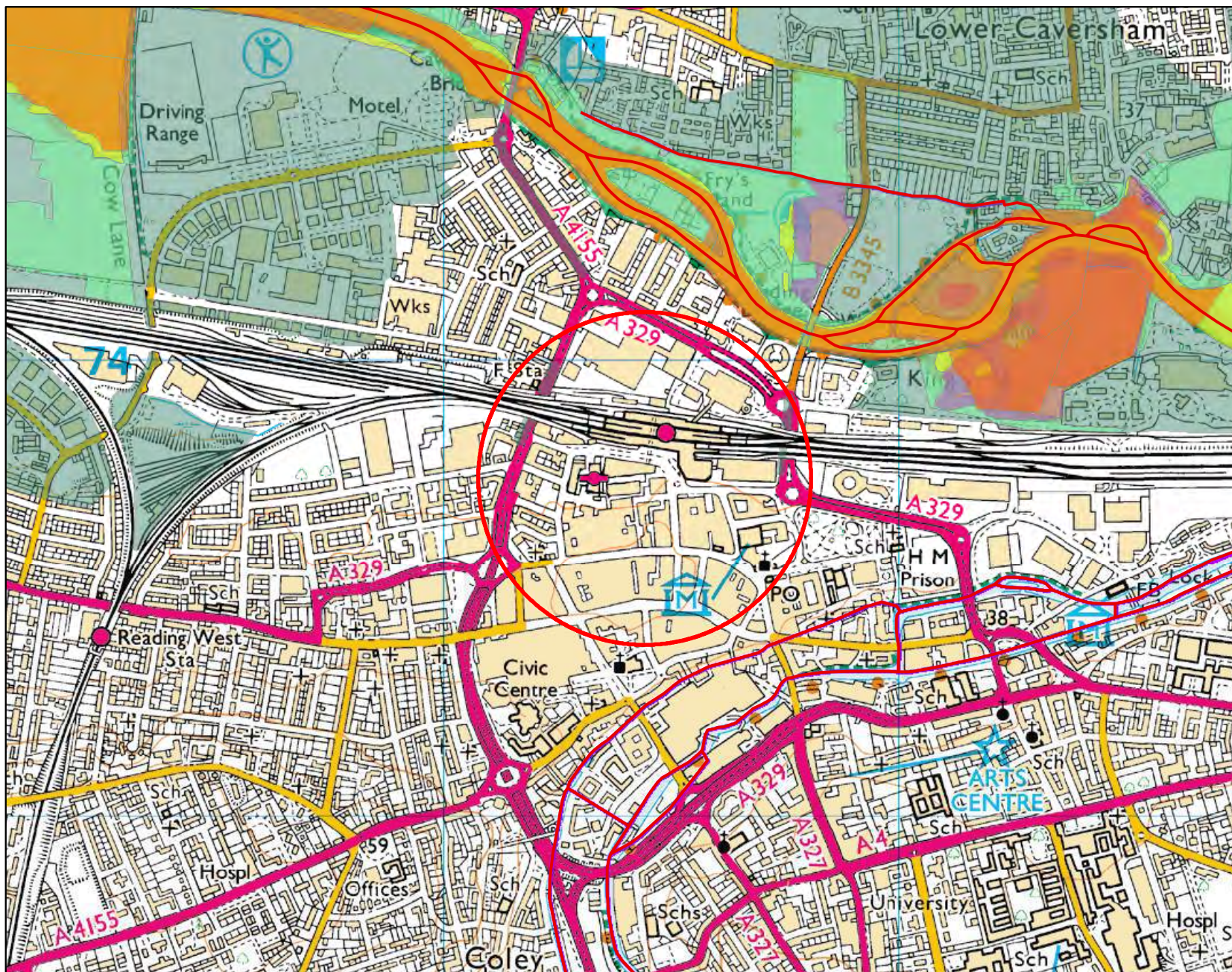
The modelled flood levels for the closest most appropriate model grid cells for your site are provided below:

2D grid cell reference	Model	Easting	Northing	flood levels (mAOD)				
				20% AEP	5% AEP	1% AEP	1% AEP with climate change allowance (+20% on river flows)	0.1% AEP
Floodplain 1	Thames (Mapledurham to Sonning) 2011	471,245	173,764					38.45
Floodplain 2	Thames (Mapledurham to Sonning) 2011	471,346	173,960				38.18	38.44

This flood model has represented the floodplain as a grid.
The flood water levels have been calculated for each grid cell.

Historic Map centred on Station Hill, Reading, RG1 1NR

Created on 30/06/2014 REF: OX_0795_01



Kilometres

0 0.15 0.3

Legend

— Main River

Flood Event Outline

year

- 1947
- 1974
- 1977
- 2000
- 2002
- 2007

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Historic flood data

OX_0795_01

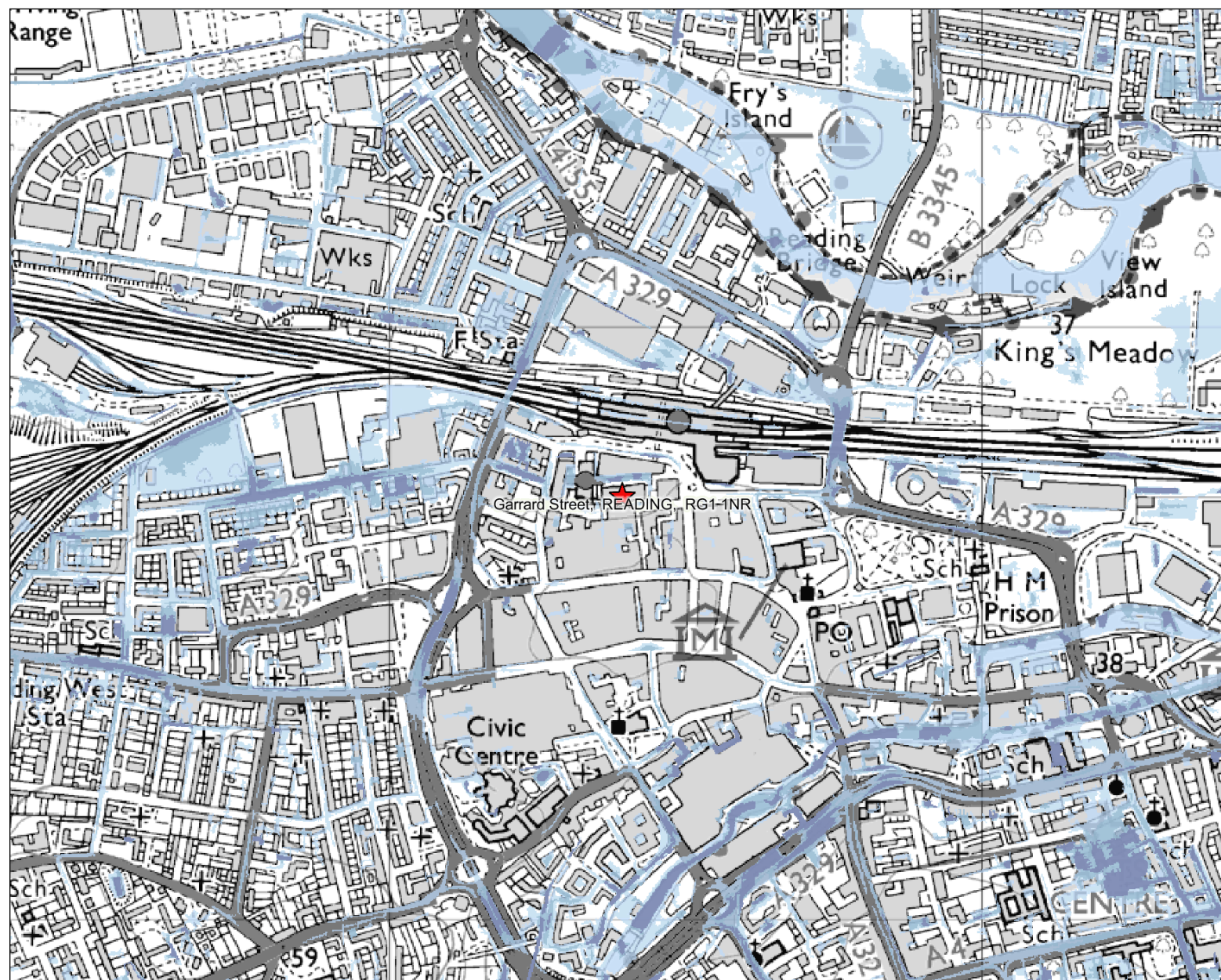
Our records show that the area of your site has been affected by flooding.
Information on the floods that have affected your site is provided in the table below:

Flood Event Code	Flood Event Name	Start Date	End Date	Source of Flooding	Cause of Flooding
EA0619470300429	06MarchSpring1947	01/01/1947	12/12/1947	main river	channel capacity exceeded (no raised defences)
EA0619741100359	06NovemberAutumn1974	01/01/1974	12/12/1974	main river	channel capacity exceeded (no raised defences)
EA0619770800424	06AugustSummer1977	01/01/1977	12/12/1977	main river	channel capacity exceeded (no raised defences)
EA0620001200992	06DecemberWinter2000	01/01/2000	12/12/2000	main river	channel capacity exceeded (no raised defences)
EA0620030101899	06JanuaryNewYear2003	23/12/2002	12/01/2003	main river	channel capacity exceeded (no raised defences)
ea061231434	Reading_Fluvial Water	19/07/2007	29/07/2007	main river	channel capacity exceeded (no raised defences)

Please note the Environment Agency maps flooding to land not individual properties. Floodplain extents are an indication of the geographical extent of a historic flood. They do not provide information regarding levels of individual properties, nor do they imply that a property has flooded internally.

Start and End Dates shown above may represent a wider range where the exact dates are not available.

Risk of flooding from Surface Water



Scale 1:10,001



Likelihood of flooding from Surface Water

- High
- Medium
- Low
- Very Low

Likelihood of flooding from Surface Water

- High: Greater than or equal to 1 in 30 (3.3%) chance in any given year
- Medium: Less than 1 in 30 (3.3%) but greater than or equal to 1 in 100 (1%) chance in any given year
- Low: Less than 1 in 100 (1%) but greater than or equal to 1 in 1,000 (0.1%) chance in any given year
- Very Low: Less than 1 in 1,000 (0.1%) chance in any given year

This information is shown on the Risk of Flooding from Surface Water map on our website.

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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk



D. Thames Water Correspondence

Asset Location Search



Steve Brown
Waterman Transport & Development Ltd
Pickfords Wharf
Clink Street
LONDON
SE1 9DG

Search address supplied Site In
Reading
RG1 1NR

Your reference N/A
Our reference ALS/ALS Standard/2009_1444288

Search date 9 April 2009

**PLEASE NOTE THAT CHANGES TO THE STANDARD VAT RATE TO 15%
WILL BE SHOWN ON ALL INVOICES DATED ON OR AFTER MONDAY 1st
DECEMBER, 2008**

Credit card payments are available. Please phone 01189 251509

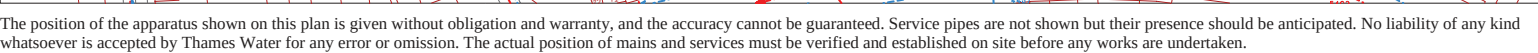
Thames Water Utilities Ltd

Property Insight
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
F 0118 923 6655/57
E searches@thameswater.co.uk
I www.twpropertyinsight.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB



EAGLE hardcopy facility - Normal Map.
The plot is centred on (471378 , 173707), which is in SU7173NW. Printed on 9 April 2009 at 15:34:49 by RIMISSON.

Page 1 of 1