Groundsure
LOCATION INTELLIGENCE

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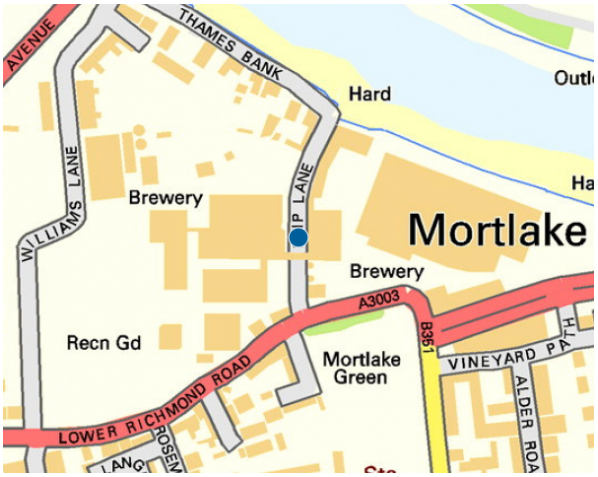
Preliminary Unexploded Ordnance Risk Assessment



Project: STAG BREWING CO LTD, THE STAG BREWERY, MORTLAKE, LONDON, SW14 7ET

Groundsure Ref: SCL-3318495

Report prepared by Dynasafe BACTEC Limited and FIND Mapping Limited

Report reference: 501990

Preliminary Unexploded Ordnance Threat Assessment

STAG BREWING CO LTD, THE STAG BREWERY, MORTLAKE, LONDON, SW14 7ET

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1 Executive Summary

1 Has a potential unexploded ordnance (UXO) risk been identified at the site in question?

YES

Indicative British / Allied UXO Risk	**LOW**
Indicative German UXO Risk	**MEDIUM**

2 Does the site in question require further research to clarify the unexploded ordnance (UXO) risk to future ground works?

YES

3 Dynasafe BACTEC's recommendation:

A Stage 2 Detailed Unexploded Ordnance Desktop Threat Assessment of the site is carried out.

To request a quotation please call Dynasafe BACTEC Limited on 01322 284 550

If you order the recommended Stage 2 Detailed Desktop Threat Assessment, you will be refunded the fee for this BombRisk Preliminary Threat Assessment.

2 Introduction

About Dynasafe BACTEC Limited

Since 1991, Dynasafe BACTEC Limited has supported the UK construction industry by assessing the risk of encountering items of unexploded ordnance (UXO) during intrusive works. Dynasafe BACTEC's specialist advice provides essential information for threat assessments, improving safety and enhancing reputations, helping contractors avoid costly delays.

Dynasafe BACTEC holds the following accreditations: Occupational Health & Safety Management Systems (OHAS 18001:2007), Environmental Management Systems (ISO 14001:2004) and Quality Management Systems (ISO 9001:2008).

The risk of encountering UXO on most sites in the UK is low. However, where a site is at increased risk it is necessary to take measures to mitigate that risk. The factors affecting UXO threat assessment are based upon the history and previous usage of a site and its surroundings.

In 2009, the Construction Industry Research and Information Association (CIRIA) established a set of guidelines to assist industry professionals.

CIRIA recommends a four stage risk management process:

- **Preliminary threat assessment**
- **Detailed threat assessment**
- **Risk mitigation**
- **Implementation**

The preliminary threat assessment enables a non-UXO specialist to place a site in context and to identify whether a more detailed assessment is necessary. The assessment is based upon data obtained from desktop reviews of the site's history and its proximity to potential indicators of UXO contamination.

There are two principal groups of onshore UXO in the UK:

- **British / Allied Army, Air Force and Navy activities – domestic military activity**
- **Enemy bombing during WWI and WWII – aerial bombing and naval bombardment**

These two groups comprise many potential UXO risk contributing sources within the UK, the most significant of which are listed below. Georeferenced databases containing this information are used by BombRisk.com to identify areas of potentially elevated UXO risk.

- **Historic army, navy and air-force facilities**
- **Explosives / ammunition factories**
- **Munitions storage depots**
- **Historic military training areas and firing ranges**

- **British army explosive ordnance clearance tasks / recces**
- **WWII heavy anti-aircraft batteries**
- **WWII anti-invasion defensive fortifications**
- **Miscellaneous WWII pipe mined locations**
- **WWII prisoner of war camps**
- **WWII German bombing density statistics**
- **WWII bombing decoy sites**
- **Press articles regarding UXO finds**
- **Locations of Dynasafe BACTEC UXO finds**
- **Locations of Dynasafe BACTEC desktop threat assessments**
- **Locations of Dynasafe BACTEC on-site support services**

About FIND Mapping Limited

Established in 2006, FIND Mapping Limited is a pioneering web mapping and spatial data technology company offering online mapping and consultancy services. FIND technology powers the generation of this report.

www.findmaps.co.uk provides detailed mapping and a wealth of data sets to hundreds of the UK's top property, environmental and design/build companies.

FIND's consultancy services provide bespoke internet mapping solutions to a range of businesses enabling them to manage their spatial data more effectively.

While working closely with a wide range of reputable data providers including Ordnance Survey and the Environment Agency, FIND works independently of these organisations. A similar arm's-length relationship is maintained in terms of software and hardware providers. This enables the team at FIND to offer truly independent advice.

3 Methodology

Dynasafe BACTEC Limited and FIND have compiled a geo-referenced database of potential sources of UXO risk within the UK. From this information a range of risk zones have been defined.

The weighting of these zones is based upon the influence of all relevant factors. A WWII-era RAF airfield, for example, has a far greater zone of influence than a single WWII-era Anti-Aircraft Battery, as it would have covered a larger area, housed a much greater quantity / variety of munitions, seen more domestic troop training activities and would have been a more likely target for enemy bombers.

An online Preliminary Automated UXO Threat Assessment will determine an indicative level of UXO risk relating to a site. Note that these risk levels could be subject to change following the completion of any Detailed Desktop Threat Assessment for the same site.

The assessment will list all factors contributing to this weighting and will also give appropriate recommendations for further action, if considered necessary.

4 Search Results

London during WWII

As a Capital city, London was an obvious target for the Luftwaffe. The city was home to the British government, the largest docks system in the UK and numerous historic and cultural monuments.

The night time “carpet bombing” Blitz on London began on 7th September 1940 with concentrated attacks coming to an end in May 1941 as the Luftwaffe was diverted east to prepare for ‘Operation Barbarossa’; the invasion of the Soviet Union. By the end of the war London had become the most heavily bombed city in Britain. Between 1940 and 1945 there were a total of 71 ‘major’ air raids on the city, resulting in an estimated 190,000 bombs dropped; approximately 18,000 tons. This left some 29,000 people dead.

During 1942 and 1943 there were a number of minor intruder raids carried out by small formations of fighter bombers and then between January and May 1944 the Luftwaffe returned to London in mass, for Operation Steinbock, a series of large Blitz style raids.

From mid-1944 the “V-weapon” (for Vengeance) campaign, using unmanned cruise missiles and rockets carrying 1,000kg warheads, represented Hitler’s final attempt to reverse Germany’s imminent defeat. The V1 (Flying Bomb or Doodlebug) and the V2 (Long Range Rocket) were launched from bases in Germany and occupied Europe. Totals of 2,419 V1s and 517 V2s were recorded in the London Civil Defence region.

The map included at the end of this report shows the high explosive bombs recorded falling in the region of the site on the available bomb census mapping for the area. Please note that this information comes from a single source and should not be considered definitive in its accuracy or coverage.

Dynasafe BACTEC Limited's UXO Source Database

Within 10km of the site the following potential sources of explosive ordnance have been recorded:

Source	*Number within 10km*
Military Airfield Sites	1
Bombing Decoy Sites	1
Abandoned Bombs	15
Press Articles regarding UXO Finds	2
WWII Defence Related Positions & Pillboxes	63
Historic Army Camps	4
Prisoner of War Camps	6
Military Training Areas and Firing Ranges	1
Heavy Anti-Aircraft Batteries	10
Army Explosive Ordnance Clearance Tasks/Recces	20
Sites Related to the Manufacture of Explosives and Explosive Ordnance	9
Dynasafe BACTEC Desk-top Threat Assessments	135
Pipe Mined WWII Airfields	None recorded
Miscellaneous WWII Pipe Mined Locations	None recorded
Dynasafe BACTEC Unexploded Ordnance Finds	None recorded
Dynasafe BACTEC On-Site Support Services	None recorded

Of these sources, the following are deemed the most significant:

Abandoned Bombs

Description	Approximate distance (km) from site
1 x unknown size. 27 Grove Park Gardens, Chiswick	1.4

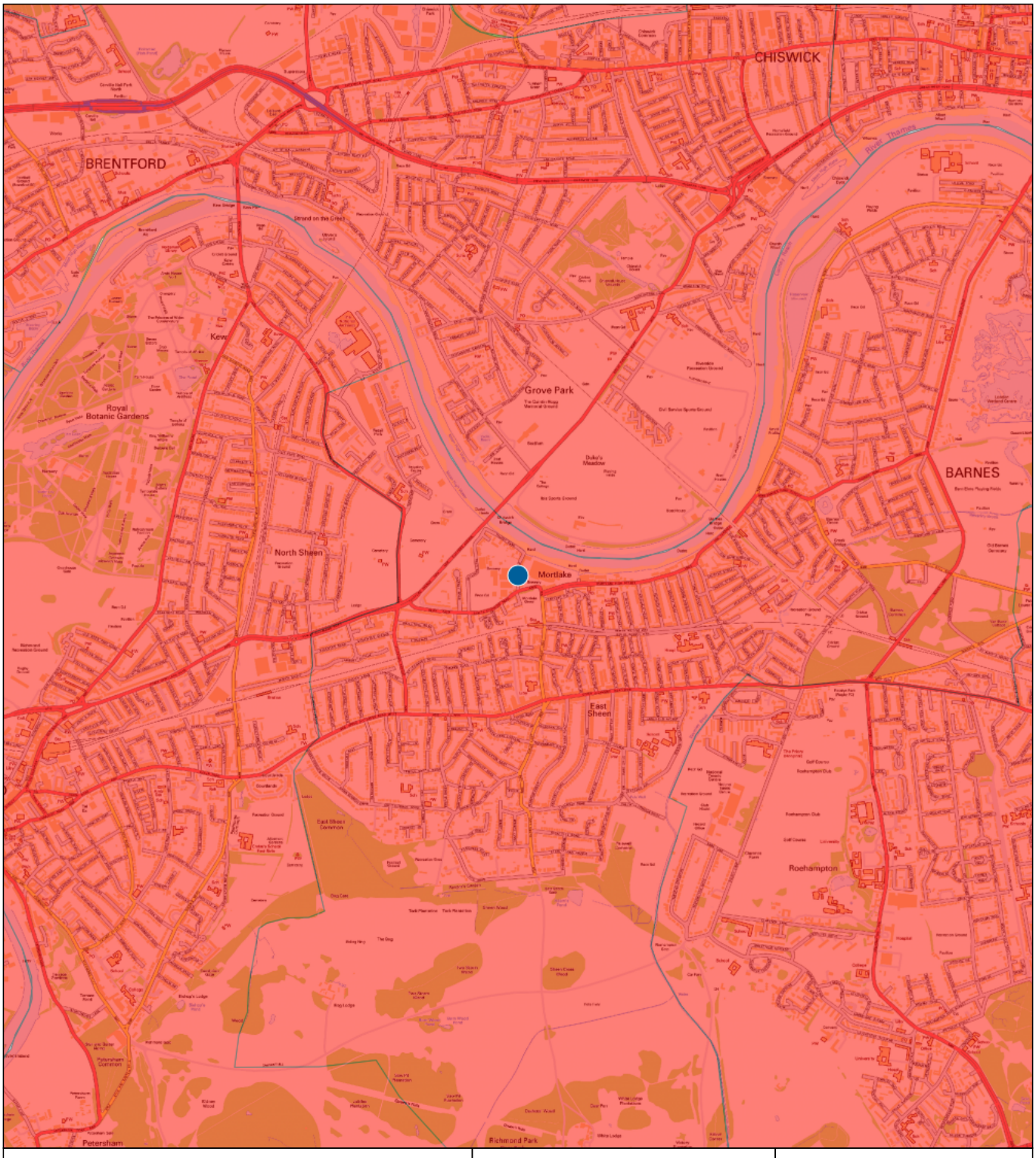
An Abandoned Bomb (AB) is a suspected unexploded WWII bomb or anti-aircraft projectile recorded during 1940-1945, but not definitively located/removed at the time.

A typical post-air raid survey of buildings, facilities and installations included a search for evidence of bomb entry holes. Where entry holes were identified, a bomb disposal team would usually be called upon to locate, render safe and dispose of any unexploded bomb (UXB). However, when the position of a UXB

was considered relatively benign, where access was problematic or resources short, the UXB may not have been exposed and rendered safe. Such incidents were noted AB.

Given the inaccuracy of WWII records the location of ABs cannot be considered definitive. The geographic location of ABs must therefore be regarded as approximate.

5 Risk of UXO based on WWII German bombing density



BombRisk.com

Dynasafe BACTEC Limited

DYNASAFE Area Clearance

FIND PROFESSIONAL MAPPING INTELLIGENCE

Map data

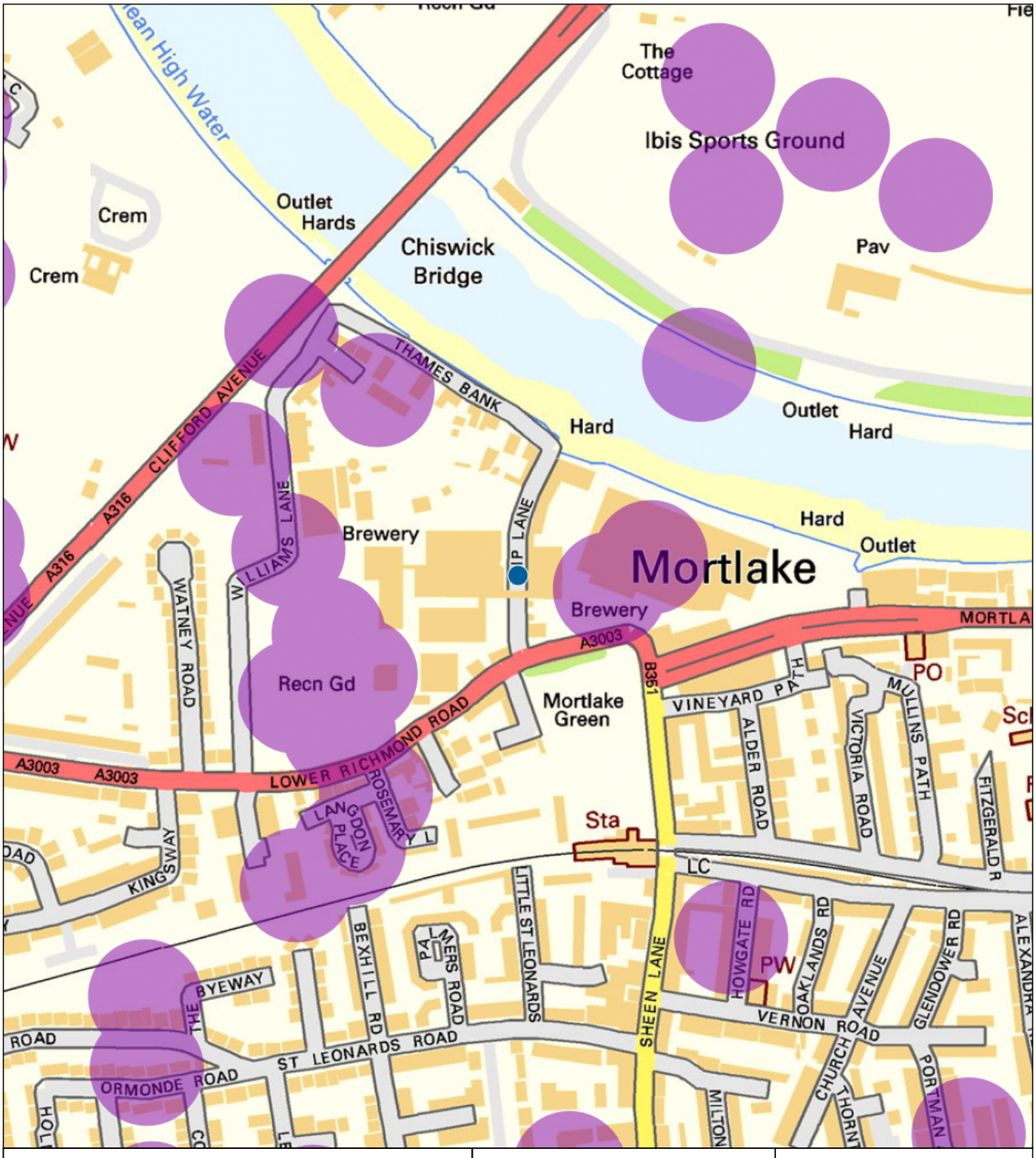
NEGLIGIBLE
LOW
MEDIUM
HIGH

1:20000

N W E S

0 400 800
Metres

6 Risk of UXO based on WWII German bomb strikes



BombRisk.com

Dynasafe BACTEC Limited

DYNASAFE Area Clearance

FIND PROFESSIONAL MAPPING INTELLIGENCE

Map data

BOMB STRIKES WITH BUFFER

1:5000

N W E S

0 100 200

Metres

7 Conclusions

Risk Levels and Recommendation

Indicative British / Allied UXO Risk

LOW

There are potential sources of British / Allied UXO recorded in Dynasafe BACTEC's historical database in the general area surrounding the site. However, they are not considered close enough to the site or significant enough to warrant further research. If there is any empirical evidence of actual or potential contamination, Dynasafe BACTEC should be contacted for advice. Otherwise, the risk on site from UXO is considered to be Low.

Indicative German UXO Risk

MEDIUM

Historical records indicate that the borough within which the site was situated during WWII sustained an overall high density of bombing. However, no bomb strikes were recorded within 50m of the site on the London ARP Bomb Census Maps.

It is possible that bombs fell in the area after the main Blitz period, given the high density of bombing recorded over the region. It is recommended that further research is undertaken to ascertain historical land use on site and whether or not any damage was sustained.

This preliminary assessment has identified a Medium risk from German unexploded bombs at this site.

Conclusion

This preliminary assessment has resulted in an overall Medium risk from UXO. Dynasafe BACTEC would recommend that a Detailed UXO Threat Assessment Desk Top Study is undertaken for this site.

Detailed assessments are conducted offline by Dynasafe BACTEC's researchers and use information such as historical mapping, WWII-era aerial photography, written air-raid precaution records and where necessary local archive research to fully qualify the risk on site. Land use, changes to building layout during WWII and post war redevelopment will also have an impact on any remaining level of risk from UXO. It is often possible to 'zone' sites into different risk categories. The lead time for a detailed assessment will vary between 3-10 working days dependent upon the complexity of the site and the additional site specific information required.

For a quotation, or more information, please contact Dynasafe BACTEC on 01322 284 550.

www.bombrisk.com

DYNASAFE
Area Clearance

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Appendix D Risk Rating Matrix

Table D.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 E Environmental Receptors

The Contaminated Land Statutory Guidance has a four category system that considers harm to human health, controlled waters, flora and fauna, property, livestock and crops. The Categories are broadly defined as follows:

1 Contaminated Land – similar to land where it is known that significant harm has been caused or significant harm is being caused

2 Contaminated Land – no significant harm being caused but there is a significant possibility for significant harm to be caused in the future

3 Not Contaminated Land – there may be harm being caused but no significant possibility for significant harm to be caused in the future

4 Not Contaminated Land – no pollutant linkage, normal levels of contaminants and no significant harm being caused and no significant possibility for significant harm to be caused in the future.

Table E.1: Significant pollution to controlled waters

Pollution of controlled waters
Under Section 78A(9) of Part 2A the term "pollution of controlled waters means the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter. The term "controlled waters" in relation to England has the same meaning as in Part 3 of the Water Resources Act 1991, except that "ground waters" does not include water contained in underground strata but above the saturation zones. (Paragraph 4.36)
Given that the Part 2A regime seeks to identify and deal with significant pollution (rather than lesser levels of pollution), the local authority should seek to focus on pollution which: (i) may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; (ii) which may result in damage to material property; or (iii) which may impair or interfere with amenities and other legitimate uses of the environment. (Paragraph 4.37)
Significant pollution of controlled waters
Paragraph 4.38 states that "The following types of pollution should be considered to constitute significant pollution of controlled waters:
(a) Pollution equivalent to "environmental damage" to surface water or groundwater as defined by The Environmental Damage (Prevention and Remediation) Regulations 2009, but which cannot be dealt with under those Regulations.
(b) Inputs resulting in deterioration of the quality of water abstracted, or intended to be used in the future, for human consumption such that additional treatment would be required to enable that use.
(c) A breach of a statutory surface water Environment Quality Standard, either directly or via a groundwater pathway.
(d) Input of a substance into groundwater resulting in a significant and sustained upward trend in concentration of contaminants (as defined in Article 2(3) of the Groundwater Daughter Directive (2006/118/EC)5)".
Paragraph 4.39 states that "In some circumstances, the local authority may consider that the following types of pollution may constitute significant pollution: (a) significant concentrations6 of hazardous substances or non-hazardous pollutants in groundwater; or (b) significant concentrations of priority hazardous substances, priority substances or other specific polluting substances in surface water; at an appropriate, risk based compliance point. The local authority should only conclude that pollution 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). This would normally mean that the authority should conclude that less serious forms of pollution are not significant. In such cases the authority should consult the Environment Agency".
The following types of circumstance should not be considered to be contaminated land on water pollution grounds:
(a) The fact that substances are merely entering water and none of the conditions for considering that significant

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

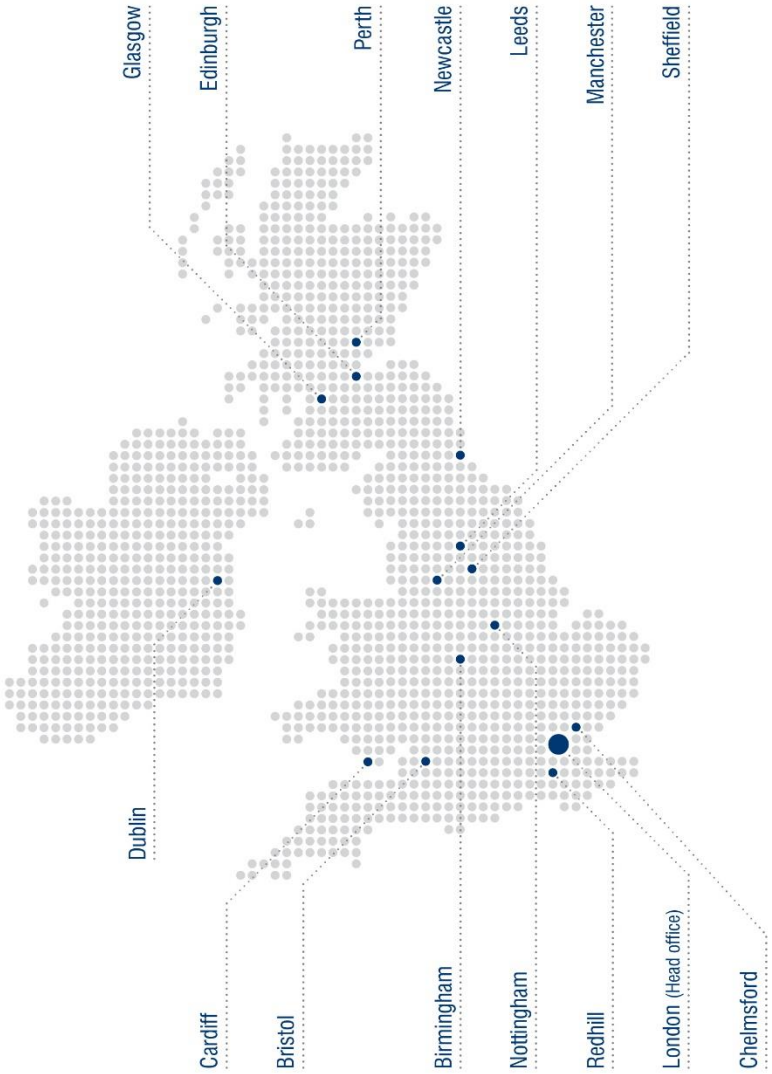
Relevant types of receptor	Significant harm	Significant possibility of significant harm
Human beings	The following health effects should always be considered to constitute significant harm to human health: death; life threatening diseases (eg cancers); other diseases likely to have serious impacts on 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.

Relevant types of receptor	Significant harm	Significant possibility of significant harm
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 (WCA) 1981 (as amended) and Part 4 of the Natural Environment and Rural Communitites Act 2006 (as amended)); • a national nature reserve (under Section 35 of the WCA 1981 (as amended)); • a marine nature reserve (under Section 36 of the WCA 1981 (as amended)); • an area of special protection for birds (under Section 3 of the WCA 1981 (as amended)); • a "European site" within the meaning of regulation 8 of the Conservation of Habitats and Species Regulations 2010 (as amended); • any habitat or site afforded policy protection under Section 11 of The National Planning Policy Framework (NPPF) on conserving and enhancing the natural environment (i.e. possible Special Areas of Conservation, potential Special Protection Areas and listed or proposed Ramsar sites); or • any nature reserve established under Section 21 of the National Parks and Access to the Countryside Act 1949.	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 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 (as amended).	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 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	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

Relevant types of receptor	Significant harm	Significant possibility of significant harm
	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".	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 services such as sewers, water pipes or electricity cables.	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 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'.	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 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.

UK and Ireland Office Locations



B. Appendix 11.2: Environmental Risk Assessment (The Stag Brewery East Site)

APPENDIX 11.2
ENVIRONMENTAL RISK ASSESSMENT (THE STAG BREWERY EAST SITE)

Environmental Risk Assessment

The Former Stag Brewery East Site, Mortlake, London

February 2018

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www.watermangroup.com

Client Name: Reselton Properties Ltd.
Document Reference: WIE10667-101-R-4.2.1 RJM
Project Number: WIE10667-101

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
4.2.1	February 2018	Robbie Moore	Jon Coates	Freddie Alcock

Comments

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.

Contents

Tables

Appendices

Executive Summary

Objectives

Waterman Infrastructure & Environment Limited ("Waterman") was instructed by Reselton Properties Ltd. to undertake a Preliminary Generic Quantitative Environmental Risk Assessment on the East Site of the Stag Brewery plot. The Stag Brewery is divided in to two areas. Ship Lane, running from north to south divides the brewery into a West Site and East Site. This report covers investigation at the East Site only.

The purpose of this phase of site investigation (SI) was an initial assessment of the contamination status, ground conditions and preliminary waste characterisation of soil at the Site.

Site Setting

Current Use	Disused brewery.
History	Brewery since the late 15th Century, expanded to occupy the entire Site by 1974. Brewery activities ceased on the Site in December 2015.
Ground Conditions	The Site is underlain by Made Ground, over Alluvium then Kempton Park Gravel Formation. This in turn is underlain by London Clay Formation, followed by the Lambeth Group, Thanet Formation and Chalk Group at depth.
Controlled Waters	The Made Ground and Alluvium have not been classified as aquifers by the Environment Agency, but contain some groundwater. The Kempton Park Gravel Formation is a Secondary A aquifer. The London Clay Formation is an Unproductive Stratum.

Conceptual Model

Potential pollutant linkages have been identified between contamination in shallow soils, groundwater, ground gas and vapours and future Site users, off-Site users, construction workers, the River Thames.

Conclusions

Given the proposed end use, and following successful implementation of the recommendations outlined below, the overall risk rating for the Site is assessed as low and should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990.

Recommendations

Environmental

Further ground investigation should be undertaken following acquisition of planning permission for the development, targeting sections of the Site inaccessible during this study in order to further characterise the ground conditions in these areas. This should include further sampling of the Made Ground and soil, groundwater sampling, and ground gas and vapour monitoring.

A Construction Environmental Management Plan (CEMP) should be developed detailing how fugitive emissions will be mitigated.

Potentially contaminative substances should be stored and handled appropriately to prevent contaminants reaching the ground or the River Thames. Construction workers should use personal protective equipment (PPE)

and respiratory protective equipment (RPE), and be informed of good hygiene measures relevant to the working environment.

An attempt should be made to locate the historical abstraction wells and decommission them in line with EA guidance.

Dewatering is likely to be necessary during excavation for basement areas. Allowance should be made for the management of impacted groundwater during the Site works.

Soft landscaping areas at the development should be planted using an appropriate thickness of imported, certified clean cover material. The use of barrier water pipes at the completed development should be agreed with the relevant water authorities.

The recommendations and details relating to geotechnical elements and protection against chemical attack at the completed development provided within the Soil Consultants geotechnical report (November 2016, report reference: 10022/OT/JRCB) should be followed.

Preliminary Waste Classification

Allowance should be made for some waste soils from the development to contain hazardous properties. However, the majority of soil samples screened did not return hazardous properties.

The removal of soils from the Site can be minimised by their reuse to facilitate raising the Site level for flood defences where required, provided they are chemically and geotechnically suitable. This re-use of soils should be in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP), subject to appropriate sampling and testing, risk assessment and compliance with the requirements of the DoWCoP.

Further validation and waste classification pursuant to WM3, should be undertaken on materials to be removed from Site to confirm the most appropriate waste classification and receiving site.

Natural uncontaminated soils may be acceptable as inert waste without testing at some landfills and may be used directly at sites operating in accordance with the DoWCoP.

1. Introduction

1.1 Objectives

Waterman Infrastructure & Environment Limited ("Waterman IE") was instructed by Reselton Properties Ltd. to undertake a Preliminary Generic Quantitative Environmental Risk Assessment on the East Site (hereafter termed "the Site") of the Stag Brewery plot. A site location plan and site layout plan is presented in Appendix A.

The Former Stag Brewery is divided in to two areas. Ship Lane, running from north to south divides the brewery into a West Site and East Site. The current development proposals include three phases (Phases 1 to 3). Phases 1 and 2 will take place on the East Site, Phase 3 will occupy the West Site. This report covers investigation works at the East Site only. A plan showing the extent of the East Site and West Site boundaries is included in Figure A3 of Appendix A.

The purpose of this phase of ground investigation (SI) was an initial assessment of the contamination status, ground conditions and preliminary waste characterisation of soil at the Site. Soil Consultants Limited completed a geotechnical investigation for the Site as part of the overall works, this is reported under a separate cover and is included in Appendix C (*report ref. 10022/OT/JRCB*).

The Site is occupied by disused offices, staff facilities, warehouses, hardstanding parking and loading areas, and various tanks. The majority of buildings have been stripped internally of soft furnishings along with some of the brewery infrastructure. Tanks, bunds and pipework across the whole Stag Brewery plot were drained, cleaned and certified as decommissioned by Bale Group between December 2015 and January 2016.

1.2 Proposed Development

The Stag Brewery plot will comprise a residential-led mixed use development. The majority of buildings and structures within the Site will be demolished. The Maltings building and former Hotel will be retained and refurbished. New mid-rise buildings will be constructed, with a single-level basement excavated below the majority of the Site.

1.3 Regulatory Context

This investigation was preliminary in nature therefore additional phases of investigation will be required to characterise the contamination status of the Site and the Stag Brewery plot to satisfy the requirements of the National Planning Policy Framework (NPPF).

The 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 ground 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.

1.4 Constraints

This report covers investigation works at the East Site only, outlined in Figure A5 of Appendix A.

The information contained in this report is based on the findings of the Preliminary Environmental Risk Assessment (PERA) for the entire Site prepared by Waterman (*report ref. WIE10667-101-R-3.1.7-RB*,), observations made on-Site during inspections and the ground investigation works, exploratory hole records, laboratory test results, groundwater monitoring and ground gas/vapour 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 scope of this ground 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 (e.g. basements and buried service ducts, etc).

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

2. Procedures

This Generic Quantitative Environmental Risk Assessment has been undertaken in general accordance with the Model Procedures for Management of Land Contamination (Contaminated Land Report 11 – Environment Agency, September 2004).

The report includes the following:

- outline Conceptual Model for the Site;
- results of Intrusive Ground Investigation;
- confirmation of Generic Assessment Criteria used to assess risks;
- assessment of results against Generic Assessment Criteria;
- formulation of a new Conceptual Model for the Site;
- identification of potentially unacceptable risks; and
- recommendations for further action.

This report forms a decision record for the pollutant linkages identified, the generic assessment criteria used to assess risks, the unacceptable risks identified and the proposed next steps in relation to the Site. The report also provides an explanation of the refinement of the outline conceptual model following the ground investigation, the selection of criteria and assumptions, the evaluation of potential risks and the basis for the decision on what happens next.

3. Outline Conceptual Model

The outline conceptual model for the Site developed in the PERA is reproduced below.

3.1 Ground Conditions

3.1.1 Site History

The Site

Historical records show brewing activities at the Site since the late 15th Century. By 1868 terraced residences were present alongside brewery buildings in the west and southwest, and a riding school had established in the northwest corner. By 1935, the brewery buildings had expanded to encompass the entire area aside from the terraced housing in the southwest and by 1974 the brewery occupied the entire Site. Circa 1988, the brewery buildings in the northern part of the Site were demolished, and circa 1999 a packaging warehouse replaced buildings in the centre of the Site. Brewery activities ceased late 2015, after which the Site became disused.

Surrounding Area

Circa 1868 the land surrounding the Site was occupied by a malthouse and smithy to the east, and railway land to the south. Land to the west was occupied by an orchard and manor house. By 1933 this orchard had been taken over by as part of the expansion of the brewery. Further off-Site land uses included a coal wharf, drainage works, bus garage and various works. Multiple new works expanded across the surrounding area up to 1974, then gradually declined to 1999.

Between 1999 to present day, the majority of the off-Site area was redeveloped as residential.

3.1.2 Geology and Hydrogeology

The geology beneath the Site has been established from previous ground investigations by Dames and Moore (*report reference 146R/01279-140/DFP/kdg; 1995*), CRA (*report reference 019592(2); 2003*) and Aecom (*report reference 47074683; 2015*), alongside British Geological Survey 1:50,000 map Sheet 270 (South London, Solid and Drift Edition), hydrogeological information from the Environment Agency (EA), BGS borehole records TQ27/NW-596 and TQ27/NW-597, and the BGS website (all accessed online 29/06/2016).

A summary of the anticipated geology and hydrogeology collated from these information sources is outlined in Table 1.

Table 1: Site geology and hydrogeology

Stratum	Area Covered	Estimated Thickness (m)	Hydrogeology – EA Aquifer Classification	Typical Description from Previous Investigations
Made Ground	Whole Site	0.4 – 2.7	Not classified	Predominantly coarse sand and gravel, including pieces of brick and black clinker.
Alluvium	Sporadic across Site	0.3 – 1.5	Not classified	Soft brown grey slightly gravelly clay.
Kempton Park Gravel Formation	Whole Site	1.4 – 3.9	Secondary A Aquifer	Clayey, silty sand with varying gravel content with areas of soft, brown, sandy clay.
London Clay Formation	Whole Site	73 (estimated from historic boreholes)	Unproductive Stratum	Stiff grey to brown clay, with occasional pockets of silt and sand.
Lambeth Group	Whole Site	15 – 20	Secondary A Aquifer	Clay, some silty or sandy, with sands and gravels.
Thanet Formation	Whole Site	5 – 10	Secondary A Aquifer	Fine grained sand that can be clayey and glauconitic. Flints at the base of the formation.
Chalk Group	Whole Site	Not proven	Principal Aquifer	Chalk and flints.

3.1.3 Controlled Waters

Surface Water

The nearest surface water to the Site is the River Thames, adjacent to the north. The ecological potential of the River Thames has been assessed as 'Moderate' under the Water Framework Directive.

There are no surface water abstractions within 1km of the Site. The closest is 1.3km northeast, drawing water from the River Thames to supply a lake/pond.

The EA records a single pollution incident to surface water from the Site, involving a spill of unknown chemicals. The spill was recorded as a Category 3 (minor incident). Two Category 2 (significant incident) spills to water are recorded at Ship Lane involving miscellaneous chemicals and unknown chemicals.

Environmental Incident Reports kept by the brewery during its operation referred to 15no. spill incidents between 2009 and 2015. These included spills to drainage of brewing substances (wort, beer, grain, yeast and sugar) and mechanical fluids (lubricant, hydraulic oil, oxafoam, diesel and unidentified substances). Information pertaining to the clean-up of these spills was not included in the reports.

Groundwater

The Site is not located within a groundwater Source Protection Zone (SPZ). Based on available information from previous investigations, it is anticipated shallow groundwater in the Alluvium and Kempton Park Gravel Formation is in hydraulic continuity with the tidal River Thames adjacent north of the Site.

There are two recorded historical groundwater abstractions within the Site boundary, references TQ27/NW-596 and TQ27/NW-597. These wells were initially drilled in 1836, then extended to 101m and 121m below ground level in 1858 and abstracted groundwater from the Chalk Group Aquifer. Details of abstraction volumes were not recorded.

A further two groundwater abstractions are recorded within a 1km radius of the Site. The closest of these is located 228m north at Dukes Meadow Golf Club, drawing 8,000l of groundwater per year from the Chalk Group aquifer for irrigation of the playing green. The further abstraction is located 663m northeast, also for irrigation purposes at Dukes Meadow Golf Club and drawing a further 5,000l per year.

There are no Environmental Permits for discharges to groundwater recorded within 1km of the Site.

3.1.4 Previous ground investigations at the Site

Findings from the following previous environmental reports were reviewed for the Site as part of the Waterman PERA.

Table 2: List of previous environmental assessments and documents reviewed

Author	Title	Reference and Date
Dames & Moore	Final Report Environmental Assessment Courage Brewery, Mortlake	146R/01279-140/DFP/kdg; March 1995
CRA	Baseline Soil & Groundwater Investigation, Stag Brewery Lower Richmond Road, Mortlake, London SW14 7ET	019592(2); October 2003
SPMP	Groundwater Monitoring Reports Review report	2003 – 2012 2008
Aecom	Stag Brewery: Phase 1 Environmental Site Assessment	47074683; July 2015
Aecom	Stag Brewery, Mortlake: Phase 2 Environmental Site Assessment Report	47075502; September 2015

The asbestos risk register for the Site, drainage survey, environmental incident reports and periodic environmental inspections undertaken while the Site was in active use were also reviewed.

Geology and Hydrogeology

Geology encountered during the ground investigations comprised Made Ground over Alluvium (sporadically absent in many locations) and Kempton Park Gravel Formation, then London Clay Formation to maximum depth drilled.

Groundwater was encountered at between 4 and 5.5m bgl within the Kempton Park Gravel Formation and is considered to flow east/north east towards the river.

The Dames & Moore, CRA and Aecom intrusive ground investigations comprised soil and groundwater sampling at a total of 46 exploratory holes drilled to between 2.5m and 7.9m bgl.

Soil samples from the Made Ground, Alluvium and Kempton Park Gravel Formation were analysed as part of these ground investigations for a range of organic and inorganic contaminants. These included metals, polycyclic aromatic hydrocarbons (PAH), volatile and semi-volatile organic compounds (VOCs and SVOCs), speciated total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs), pH and asbestos. Groundwater samples from the Kempton Park Gravel Formation aquifer were analysed for metals, ammoniacal nitrogen, nitrate, phosphate, sulphate, VOCs, SVOCs, TPH and pH.

Dames & Moore results

No exceedances of Dutch Intervention Values (DIV; applicable as soil guidance values in 1995 but superseded since) were detected. In groundwater, a single exceedance of chromium and copper above DIV was recorded in one borehole, but this was not considered to be representative of the water body as a whole.

CRA results

No exceedances of DIV were identified within soil samples. In groundwater, concentrations of TPH of 51ug/l and 1,114ug/l were recorded in two boreholes, in the vicinity of the fuel oil tanks.

Aecom results

Levels of arsenic exceeded Aecom Generic Assessment Criteria (GAC) for a residential end-use with private gardens in a single location. Levels of lead exceeded GAC for commercial end-use in one location, residential end-use without private gardens in two locations and human health with private gardens in six locations. Three exceedances of coal tar above residential GAC without private gardens were also identified. Asbestos was detected in laboratory analysis of eight samples across the Site, however this was quantified at levels less than 0.1%.

Groundwater results were contrasted against Environmental Quality Standards (EQS), and UK Drinking Water Standards (DWS) for contaminants where no EQS value was available.

During recovery of groundwater samples, no measurable free phase, oily sheen or staining was observed and no hydrocarbon odours or significantly elevated PID readings were detected. Groundwater results found some elevated levels of metals above DWS and EQS. Three samples contained elevated TPH, and a single sample contained phenol above EQS. The average ammoniacal nitrogen concentration from groundwater samples marginally exceeded the DWS. However, the measured concentrations were variable and in many cases were only slightly above GAC.

All Aecom exploratory holes were sealed following completion of the groundwater monitoring as part of the Brewery's decommissioning.

Potential contamination sources identified at the Site

With consideration to the results of the previous ground investigations and baseline environmental information, the potential contaminant sources and associated contaminants are outlined in Table 3.

Table 3: Potential contamination sources identified at the Site

Source	Associated Contaminants
On-Site (current)	
Electrical substations	Metals, PCBs
On-Site (historic)	
Brewery	Coal tar, TPH, phenol, asbestos
Off-Site (current)	
Garages and petrol filling stations	Metals, TPH, PAH, VOCs, SVOCs, asbestos
Off-Site (historic)	
Incinerator	Metals and metalloids, asbestos
Smithy	Metals, VOCs, SVOCs, asbestos
Coal depot	Metals, sulphates, sulphides, cyanide
Electricity works and electrical substations	Metals, PCBs

3.2 Potentially Significant Pollution Linkages

Potentially significant pollutant linkages between contamination hazard sources and relevant receptors identified for the Site are summarised in Table 4.

Table 4: Potentially significant pollutant linkages at the Site

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Human Health					
Future Site Users	Contamination in Made Ground and shallow soils from on-Site and adjacent off-Site land uses. Contamination in perched groundwater, and the shallow Secondary A Aquifer in the Kempton Park Gravel Formation.	Dermal contact and ingestion of contaminated soils and groundwater. Ingestion of contamination via plant uptake in private gardens.	Low	The brewery has been decommissioned. Therefore, it is unlikely that any contamination will arise from the remaining buildings and plant. Historically, ground contamination may have occurred during operation of the brewery and off-Site land uses. Previous ground investigations by Dames & Moore, CRA and Aecom between 1995 and 2015 found that some elevated concentrations of organic and inorganic contamination are present in Made Ground beneath the Site, when compared against relevant generic assessment criteria. However, in the majority of samples targeted at potential contamination hotspots as part of the Aecom investigation, no significant elevations were identified. Where elevated levels were encountered, it was not thought to represent a significant risk to future Site users in either a residential or commercial end-use scenario. The development design has not yet been finalised but is anticipated to involve basements beneath much of the Site. This will remove a significant volume of potentially contaminated material from the Site. Where soil excavated from basements is proposed to be reused on-Site to raise levels as part of the flood mitigation measures, this should be demonstrated suitable for re-use. New buildings, the retained Maltings and former Hotel buildings and the use of appropriate thickness of imported clean subsoil/topsoil in private gardens and soft landscaping at the completed development will prevent future Site users from contacting residual ground contamination.	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
	Ground gas arising from Made Ground and Alluvium. Vapours from hydrocarbon contamination in shallow groundwater.	Accumulation in confined spaces, leading to inhalation followed by asphyxiation and risk of explosion.	Medium	Geological information for the Site from previous ground investigations suggests there is approximately 0.7m – 4.2m Made Ground and Alluvium beneath the majority of the Site, which could act as a source of ground gas at the completed development stage. Although previous ground investigations found that soil and groundwater samples did not indicate extensive hydrocarbon contamination at the Site, there is still the potential for it to be present within perched groundwater and the Secondary A aquifer. Hydrocarbon contamination, if present could volatilise, resulting in vapour ingress to buildings of the completed development. An intrusive ground investigation with subsequent ground gas and vapour monitoring will be undertaken. This would determine the risk posed by ground gas and vapours, and inform whether protection measures are necessary at buildings and basements at the completed development.	Low
Off-Site residents/users	Contamination in Made Ground and shallow soils.	Windborne, potentially contaminated construction dust. Runoff from stockpiled soils.	Medium	A Construction Environmental Monitoring Plan (CEMP) will be prepared for the works, including measures to minimise runoff from stockpiled soils, manage groundwater in excavations and suppress the generation of dust. Construction materials brought on-Site as part of works will be appropriately stored to prevent spills and leaks. This will prevent potentially contaminated material reaching off-Site residents or users.	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Construction Workers	Contamination in Made Ground, shallow soils, and shallow groundwater.	Dermal contact and ingestion. Ground gas and vapour Accumulation in trenches and confined spaces, leading to inhalation followed by asphyxiation and risk of explosion. Dust inhalation.	Medium	Construction workers will be provided with personal protective equipment (PPE) and respiratory protective equipment (RPE) where appropriate. Workers should be aware of good hygiene measures as protection against direct contact with contaminated Made Ground, contaminated groundwater, ground gas, vapours and dust inhalation.	Low
Property					
Future on-Site structures	Contamination in Made Ground, shallow soils, and shallow groundwater.	Direct contact with building foundations and buried services leading to chemical attack.	Medium	Geotechnical investigation as part of design works for the development should include sampling and testing of soils to assess the risk posed by chemical attack. Appropriately designed buried concrete and barrier water supply pipes should be used for the development.	Low
	Ground gas and vapours.	Accumulation in confined spaces, leading to risk of explosion.	Medium	The proposed intrusive ground investigation with subsequent ground gas and vapour monitoring will determine the risk posed by ground gas and vapours, and inform whether protection measures are necessary for the development.	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Off-Site structures	Contamination in Made Ground, shallow soils, and shallow groundwater.	Migration off-Site. Direct contact with building foundations and buried services leading to chemical attack.	Low	No significant contamination elevations were identified in soils and groundwater during previous investigations at the Site. Where elevated levels were encountered, it was not thought to represent a significant contamination risk.	Low
Ecological Receptors					
Soft landscaping	Contamination in Made Ground, shallow natural soils, and shallow groundwater.	Direct contact of roots.	Low	All soft landscaping at the completed development would be situated in an appropriate thickness of imported, certified clean cover material. This would prevent plants at the completed development contacting contamination beneath the Site.	Low
River Thames ecology	Contamination in Made Ground, shallow soils, and shallow groundwater.	Windborne, potentially contaminated construction dust. Runoff from stockpiled soils.	Medium	A CEMP should be prepared for the demolition and construction works on-Site, detailing measures to minimise the potential risk to controlled waters. Construction materials brought on-Site as part of works should be appropriately stored to prevent spills and leaks. This should prevent potentially contaminated material reaching the River Thames.	Low
Controlled Waters					

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
The River Thames	Contamination in Made Ground, shallow soils, and shallow groundwater.	Migration through granular deposits and via sewer bedding materials to the River Thames. Runoff from stockpiled soils.	Medium	Previous ground investigations found that soil and groundwater samples did not indicate extensive contamination is present beneath the Site. Therefore, the potential for contamination mobilisation is assessed as low. On-Site sewer records indicate that some areas of the Site currently drain to the Thames Water surface water sewer network, ultimately discharging to the River Thames. Measures will be undertaken during demolition and construction works to minimise runoff from stockpiled soils, and prevent contamination reaching the River Thames via Site drainage. This will prevent potentially contaminated material reaching the River Thames.	Low
Shallow Secondary A aquifer in the Alluvium and Kempton Park Gravel Formation	Contamination in Made Ground and shallow soils.	Remobilisation of contamination by rainfall infiltration following removal of hardstanding during construction works.	Medium	The CEMP will include measures to minimise rainwater infiltration to exposed ground, or the potential for construction spills during the demolition and construction works. Rainwater infiltration via soft landscaping and private gardens is possible at the completed development. However, this is likely to be limited as the majority of the Site will be covered by buildings and hardstanding. Previous ground investigations found that contamination in Made Ground and shallow soils is minor, meaning that there are unlikely to be significant impacts from any mobilisation.	Low
Deep Secondary A aquifers in the Lambeth Group and Thanet Formation Principal Aquifer in the Chalk Group	Contamination in shallow groundwater.	Migration via historical abstraction wells.	Medium	The Site is underlain by about 73m of London Clay Formation. This prevents the migration of contaminants to the deep Secondary A and Principal Aquifers. The proposed development involves mid-rise buildings whose foundations are unlikely to penetrate this layer. This should prevent downward migration of potentially contaminated shallow groundwater from the Made Ground or Kempton Park Gravel Formation to the deeper aquifers. Following demolition of the current buildings on-Site, the two redundant historical abstraction wells should be located and decommissioned to remove this potential pathway to the Principal Aquifer in the Chalk Group.	Low

4. Rationale and Specific Objectives

The preliminary intrusive environmental ground investigation was undertaken between September and October 2016. This report comprises the findings from this preliminary investigation into ground conditions at the Site.

Specific objectives include:

- To preliminary assess if contamination is present in the Made Ground, shallow soils and shallow groundwater, and if there is a risk to future Site users, future structures and future vegetation;
- preliminary characterisation of the ground gas and vapour regime and determine whether ground gas or vapours within the strata likely to remain on-Site as part of the development potentially poses a risk to future Site users and structures;
- determine the potential risk posed by to underlying aquifers;
- preliminary assessment of the likely waste classification of soils arising from the development, in particular the Made Ground to be removed from the Site as part of basement excavation, piling and services trenches; and
- geotechnical investigation by Soil Consultants to inform preliminary foundation design, and identify potential geotechnical issues which could impact the development (Detailed in factual report and included in Appendix C (*report reference 10022/OT/JRCB*).

5. Methodology

The intrusive investigation work was undertaken in general accordance with the Code of Practice for Ground investigation BS:5930 (2015) and the Code of Practice for the Investigation of Potentially Contaminated Sites BS:10175 (2011).

5.1 Design of Investigation

The design of the investigation was informed by the findings of the PERA and previous investigations, the key parameters of the proposed development, the requirements for geo-environmental information and to collect information necessary to complete preliminary waste classification assessment (PWCA).

The works involved drilling two boreholes and eleven window sample holes, sampling of soils and groundwater, ground gas and vapour monitoring and in-situ geotechnical testing. The findings the geotechnical investigation and testing are reported in the Soil Consultants factual report in Appendix C.

The rationale for the works undertaken is presented in Table 5. Further details of features targeted by the exploratory hole locations are provided in Table 6. A plan showing all exploratory hole locations is included in Appendix A.

Table 5: Ground investigation strategy

Activity	Method	Target Layer	Exploratory Holes	Comments
Soil sampling for human health risk assessment and risk to soft landscaping and vegetation	Window sample holes, boreholes	Made Ground, Alluvium and Kempton Park Gravel Formation	WS1 to WS11 BH1, BH2	Identify potential historical spills from brewery tanks and chemical stores. Collect samples of Made Ground to assess the potential contamination risk to construction workers, and contamination risk to future Site users where soils are to remain as part of the development. Screen samples for organic and inorganic contamination.
Groundwater sampling for groundwater quality assessment	Sampling at installations within window samples and boreholes	Shallow groundwater in Alluvium and Kempton Park Gravel Formation	WS1, WS2, WS4, WS6, WS7 - WS9 BH1, BH2	Collect samples groundwater in the Made Ground and Alluvium, and Secondary A aquifer Kempton Park Gravel Formation. Screen samples for organic and inorganic contamination.
Ground gas and vapour monitoring	Monitoring at installations within boreholes and window samples	Made Ground, Alluvium and Kempton Park Gravel Formation	WS1, WS2, WS4, WS6, WS7 - WS9 BH1, BH2	Single round of ground gas and vapour monitoring.

Activity	Method	Target Layer	Exploratory Holes	Comments
				Establish the depth to the top of the London Clay Formation and prove it to a minimum thickness of 10m.
Geotechnical investigation	Boreholes	Existing building foundations, Kempton Park Gravel Formation and London Clay Formation	BH1, BH2	Collect samples of the Kempton Park Gravel Formation and London Clay Formation for geotechnical testing. (Findings reported in Soil Consultants factual report presented in Appendix C.).
Preliminary Waste Classification Assessment	Window sample holes and boreholes	Made Ground, Alluvium and Kempton Park Gravel Formation	WS1 to WS11 BH1, BH2	Collect samples of material likely to be excavated for basements at the development, for PWCA.

5.2 Exploratory Hole Location Target Features

BH1 and BH2 were located at opposing ends of the Site, in order to provide the widest possible range of geotechnical conditions and variance over the total area. WS1 – WS4, WS9 and WS11 were situated targeting potentially contaminative former activities at the brewery, with WS5 – WS8 and WS10 located to provide a spread of exploratory holes across the Site area.

A summary of the investigation locations and features investigated is presented in Table 6.

Table 6: Exploratory hole location target features

Exploratory Location	Target feature	Installation targets
WS1	Former brew tanks	Shallow groundwater Ground gas and vapours in Made Ground
WS2	Energy Centre building	Shallow groundwater Ground gas and vapours in Made Ground
WS3	Chemical storage containers	None
WS4	Waste oil tank	Shallow groundwater Ground gas and vapours in Made Ground
WS5	Site coverage	None
WS6	Site coverage	None
WS7	Site coverage	Ground gas and vapours in Made Ground
WS8	Site coverage	Shallow groundwater Ground gas and vapours in Made Ground
WS9	Workshop building	Shallow groundwater Ground gas and vapours in Made Ground

WS10	Site coverage	Ground gas and vapours in Made Ground
WS11	Loading yard	None
BH1	Site coverage and geotechnical testing	Shallow groundwater Ground gas and vapours in Made Ground
BH2B	Site coverage and geotechnical testing	Shallow groundwater Ground gas and vapours in Made Ground

Sampling Strategy

Soil samples were collected at 0.5m intervals in the Made Ground, at every change of strata, and where material with evidence of visual or olfactory contamination was identified. In the underlying superficial deposits samples were collected at 1.0m intervals up to the head of the London Clay Formation. Sufficient soil samples were collected to allow for analysis of a range of organic and inorganic contaminants, asbestos identification and quantification, and WAC analysis.

Headspace analysis to monitor for volatile organic compounds (VOC) was carried out on all samples collected.

5.3 Quality Control

Environmental samples were despatched in regularly under a chain of custody procedure to Jones Environmental, a UKAS accredited laboratory. Samples were stored within cool boxes containing ice packs during transport.

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.

5.4 Health and Safety

All supervision work carried out on-Site by Waterman was in accordance with Waterman Group Health & Safety policy. Contractors and subcontractors worked to their own risk assessments and method statements.

6. Site Activities

The ground investigation work was carried out in stages shown in Table 7.

Table 7: Summary of fieldwork activities

Phase of Work.	Activity	Contractor	Date	Supervision
Services survey	Scanning for buried services.	Point Zero Surveys	3 October – 13 October 2016	Soil Consultants
UXO survey	Downhole magnetometer probing at each location.	RPS Explosives Engineering Services	3 October – 13 October 2016	Soil Consultants
Archaeological survey	Watching brief during works for archaeological remains.	CgMs Consulting	3 October – 13 October 2016	Soil Consultants
Ground investigation	10no. window sampler holes to 5.5m bgl max. depth.	Soil Consultants	3 October – 13 October 2016	Waterman and Soil Consultants
	2no. cable percussion boreholes to 30m bgl max. depth.	Soil Consultants		
Monitoring well installation	10no. monitoring wells to 30m bgl max. depth.	Soil Consultants	3 October – 13 October 2016	Waterman and Soil Consultants
Groundwater sampling	Sampling of groundwater in monitoring wells using low-flow techniques.	Waterman	27 October 2016	N/A
Groundwater, ground gas and vapour monitoring	Monitoring, sampling and analysis of monitoring wells on one occasion.	Waterman	27 October 2016	N/A

Note: m bgl = metres below ground level

6.1 Services, UXO and Archaeological Surveys

Site management provided drainage plans for the investigation area. A services survey utilising CAT scanning and ground-penetrating radar (GPR) scanning was undertaken ahead of drilling at each location. Hand pits were also dug at each location to 1.2m depth before drilling commenced to check for unmapped buried services.

Historical information available for the Site highlighted a potential risk of unexploded bombs and ordnance (UXO) present beneath the Site. To reduce the risk of encountering UXO during the works, all exploratory holes were cleared by RPS Explosives Engineering Services before commencement of the ground investigation operations.

During excavation and drilling works, the absence of UXO was determined in trial pits using observational methods and a hand-held magnetometer. Within boreholes, the magnetometer was used to clear the hole at 1m intervals as drilling progressed. All on-Site personnel were briefed on UXO mitigation procedures.

Historical mapping identified that there was a potential to unearth remains of historic significance beneath the Site. An archaeologist from CgMs Consulting was present during the works to complete visual observation of arisings recovered from each exploratory hole location.

6.2 Window Sample Holes

Window sample holes were drilled to a maximum depth of 5.5m bgl with a tracked percussion window sample rig.

Variations to planned works

As the investigation works progressed, multiple concrete obstructions at shallow depths were encountered which could not be advanced through. This prevented several of the window sample holes reaching their target depths.

WS1 – WS5 and WS11 were completed to target depth as planned, with no issues encountered.

WS6 was terminated at 0.5m bgl in Made Ground due to thick concrete which could not be broken out.

WS7 was terminated at 0.8m bgl in the Made Ground due to concrete obstructions. An alternative location, WS7A was drilled nearby but hit further obstructions at 1.4m bgl and was terminated. A ground gas and vapour monitoring well was installed at WS7A screening the Made Ground.

WS8 was terminated at 1.0m bgl due to concrete obstructions. An alternative location, WS8A was drilled to 2.5m bgl into to the top of the Kempton Park Gravel Formation then terminated due to refusal on the gravel material. A ground gas and vapour monitoring well was installed screening the Made Ground.

WS9 was terminated at 1.2m bgl in the Made Ground due to concrete obstructions. An alternative location, WS9A was drilled to 4.0m bgl into to the top of the London Clay Formation by advancing the hole through an adjacent trial pit, (TP5) excavated as part of a previous archaeological investigation.

WS10 was terminated at 1.6m bgl in the Made Ground due to concrete obstructions. An alternative location, WS10A was drilled to 5.0m bgl into to the top of the London Clay Formation by advancing the hole through an adjacent trial pit excavated by during the archaeological investigation.

6.3 Boreholes

The two boreholes were drilled to 30m bgl with a tracked percussion rig using techniques to minimise cross-contamination between individual strata. On completion, both boreholes were installed with a 50mm diameter slotted HDPE standpipe with gas tap and bung. Both installations targeted the Kempton Park Gravel Formation.

Variations to planned works

BH2 was terminated at 0.5m bgl in the Made Ground due to thick concrete which could not be broken out. An attempt to relocate this borehole nearby as BH2A also encountered this obstruction. Following this, the borehole was drilled through the completed WS11 hole, which was extended to 30m depth as BH2B.

A plan showing obstructions encountered at the exploratory hole locations is included in Figure A6 of Appendix A.

6.4 Soil Sampling

Environmental sampling

Representative soil samples were collected from arisings every 0.5m in the Made Ground, and every 1.0m in the natural material. Samples were 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 with a photoionisation detector (PID).

Samples collected were analysed for a range of inorganic and hydrocarbon contaminants including metals, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAHs) volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs).

Samples of the Made Ground, Alluvium and Kempton Park Gravel Formation were also submitted for Waste Acceptance Criteria testing.

All exploratory holes were logged and sampled for contamination purposes by Soil Consultants Ltd, their report is presented in Appendix C.

6.5 Installations

A 50mm diameter slotted HDPE standpipe with gas tap and bung was installed in eight of the window sample holes and both boreholes. Installations were targeted to enable ground gas and vapour monitoring, and groundwater monitoring and sampling.

The intake section for each installation comprised a length of slotted HDPE pipe surrounded by pea shingle. The remainder of the installation used plain pipe to ground level, surrounded by bentonite. A secure cap finished each location at ground level. Details of the individual installation depths and response zones are included within the Soil Consultants factual report in Appendix C.

6.6 Groundwater Monitoring

Groundwater sampling was carried out on 27 October 2016. Prior to sample collection, groundwater was pumped from each well whilst parameters including conductivity, temperature and pH were measured until they had stabilised.

The presence of hydrocarbon free product on the groundwater was investigated by examining groundwater retrieved during purging. No evidence of hydrocarbon sheen was identified.

Groundwater samples were obtained from the monitoring wells with a peristaltic pump. Samples were collected from each well once the readings had stabilised. The collected water samples were then sealed into bottles with pre-measured fixatives where necessary, and transported in cool boxes or refrigerated for 24hrs prior to despatch to the testing laboratory.

Full groundwater monitoring results including the model type and detection limits of the on-Site equipment used for the fieldwork are presented in the respective fieldwork report sheet in Appendix D.

6.7 Ground Gas and Vapour Monitoring

A round of ground gas and vapour monitoring was carried out on 27 October 2016. Barometric atmospheric pressure was 1029 mBar upon arrival, and fell to 1028 mBar by completion of the monitoring.

The peak and steady concentration readings of methane, carbon dioxide and oxygen as % volume of total gas (% v/v), the % of lower explosive limit, hydrogen sulphide and carbon monoxide levels as parts per million (ppm) were recorded at each installed monitoring standpipe. Readings were collected with a GFM430 infrared gas analyser. Vapour levels in monitoring wells were recorded as ppm with a photo-ionisation detector (PID).

Full ground gas and vapour monitoring results including the model type and detection limits of the on-Site equipment used for the fieldwork are presented in Appendix E.

7. Results

Detailed logs of the strata encountered, together with records of soil samples taken, installation details and PID headspace analysis, are provided in the Soil Consultants Factual Report in Appendix C. A summary of the geological strata and underground structures encountered is presented below.

7.1 Geological Strata

A summary of the geological strata encountered is in Table 8.

Table 8: Geological strata encountered

Soil Type	Depth of top of stratum (m bgl)	Thickness (m)	Typical Description
Hardstanding	0m	0.25 to 0.8	Tarmac or reinforced concrete floor slab at surface level. In the eastern half of the Site concrete was encountered as two or three separate layers up to 0.5m thick, each separated by up to 0.5m Made Ground.
Made Ground	0.25 to 0.8	1.5 to 4.6	Dark brown and reddish brown very clayey sandy gravel. Gravel is fine to coarse brick, crushed concrete, flint, clinker. Rare pipe fragments.
Alluvium	1.3 to 3.5 (where present)	0.45 to 1.5	Locally present. Encountered in southern and western areas only. Firm orange brown, mottled dark brown, sandy clay with frequent black flecks and rare rounded, fine to medium flint gravel. Gravel is fine to coarse flint.
Kempton Park Gravel Formation	1.8 to 4.9	1.2 to 6	Orange brown very gravelly sand and light brown sandy gravel. Gravel is sub-angular to rounded, fine to coarse flint.
London Clay Formation	5.3 to 8	Not proven at 30m bgl	Stiff, fissured, dark greyish brown clay with frequent pockets and partings of dark grey fine sand and grey silt infilled burrows. Rare white foram fossils.

7.2 Underground Structures and Obstructions

Underground obstructions were encountered in all the exploratory holes advanced in the central and eastern sections of the Site, as described in Section 6.2 and 6.3. Details of the obstructions encountered are in Table 9, a plan for the location of these obstructions is in Appendix A6.

Table 9: Obstructions encountered

Exploratory Hole Location	Area of Site	Obstruction	Depth (m bgl)	Thickness (m)
WS1	Northwest	Reinforced concrete	Surface level	0.5
WS2	West	Asphalt and reinforced concrete	Surface level	0.4
WS3	Northwest	Asphalt	Surface level	0.15
WS4	West	Asphalt	Surface level	0.2
WS5	Southwest	Asphalt	Surface level	0.1
WS6	Central	Concrete slab	Surface level	>0.5 (not penetrated)
WS7	Central	Reinforced concrete	Surface level	0.6
	Central	Concrete obstruction	0.8	>0.2 (not penetrated)
WS7A	Central	Concrete slab	Surface level	0.25
	Central	Concrete obstruction	1.4m	Not broken into
WS8	North	Concrete slab	Surface level	0.7
	North	Concrete obstruction	1.0	Not broken into
WS8A	North	Concrete slab	Surface level	0.7
WS9	South	Asphalt	Surface level	0.2
	South	Concrete obstruction	0.5	>0.7 (not penetrated)
WS10	Northeast	Reinforced concrete	Surface level	0.25
	Northeast	Concrete obstruction	1.6	Not broken into
BH1	Southwest	Concrete slab	Surface level	0.25
BH2	West	Asphalt and concrete	Surface level	0.4
	West	Concrete obstruction	1.8	0.2
	West	Concrete obstruction	2.25	0.2
	West	Concrete obstruction	3.4	>0.2 (not penetrated)
BH2A	West	Concrete slab	Surface level	0.25
	West	Concrete obstruction	3.45	>0.05 (not penetrated)
BH2B	Southwest	Asphalt	Surface level	0.3

7.3 Chemical Analysis

The laboratory test results for these samples collected during the ground investigation works are presented in Appendix F.

No visual or olfactory evidence of soil or groundwater contamination was observed during the ground investigation or groundwater sampling.

7.4 Controlled Waters

During ground investigation

Groundwater levels were monitored as drilling progressed. Groundwater inflows were noted within the Kempton Park Gravel Formation in BH1 (at 4.3m, sealed out by the casing at 5.0m) and in BH2B (at 3.20m, sealed out at 4.15m). The abandoned boreholes BH2 and BH2A also encountered shallow groundwater at 2.3m. In several of the deeper window sample holes (WS1, WS5 and WS10A) water was recorded at 4.5m depth, and in WS9A water was encountered at 2.9m depth. The remainder of the exploratory hole locations remained dry during drilling.

Follow-up monitoring

Groundwater levels were measured and samples collected on 27 October 2016. The laboratory test results are included in Appendix F.

Varying levels of groundwater were measured in the Made Ground and Alluvium at 2.3m bgl (+2.6 m OD) in the northeast of the Site, to between 3.09m bgl (+2.8m OD) and 4.48m bgl (+1.57m OD) in the west and northwest. Groundwater was not encountered in several wells targeting these layers across the Site.

Groundwater monitoring indicates water levels in the Kempton Park Gravel Formation are between 3.51m bgl (+1.65 m OD) and 3.82m bgl (+1.76 m OD).

7.5 Ground Gas and Vapours

Soil arisings from the investigation locations were screened for vapours with a PID as the ground investigation works progressed. The peak vapour level recorded during the investigation was 16.3ppm, at location WS5 at 4.5m bgl. A reading of 8.8ppm was also detected in WS3 at 3.5m bgl, and a reading of 5.5ppm at BH2 at 3m bgl. The ground gas and vapour concentrations from the monitoring visit are presented in Table 10. Full results are detailed in Appendix E.

Table 10: Ground gas and vapour monitoring summary

Monitoring Point	Peak Concentration							Peak flow
	Peak (% v/v)			(%)	(ppm)			
	CH_4	CO_2	O_2 (MIN)	LEL	H2S	CO	Vapours	(l/hour)
WS1	<0.1	0.4	19.3	<0.1	<0.1	<0.1	<0.1	0.4
WS2	<0.1	0.6	18.8	<0.1	<0.1	<0.1	<0.1	<0.1
WS4	<0.1	1.5	16	<0.1	<0.1	<0.1	<0.1	<0.1
WS5	<0.1	<0.1	19.9	<0.1	<0.1	<0.1	<0.1	<0.1
WS7A	<0.1	4.0	12.8	<0.1	<0.1	<0.1	<0.1	0.1
WS8	<0.1	<0.1	19.5	<0.1	<0.1	<0.1	<0.1	<0.1
WS9	<0.1	0.1	18.5	<0.1	<0.1	<0.1	<0.1	0.3
WS10	<0.1	<0.1	20.2	<0.1	<0.1	<0.1	<0.1	<0.1
BH1	<0.1	0.5	10.5	<0.1	<0.1	<0.1	<0.1	0.1
BH2B	<0.1	0.3	15.5	<0.1	<0.1	<0.1	<0.1	<0.1

Gas flows in the monitoring wells ranged between <0.01 (below the instruments limit of detection) to +0.04 litres per hour. Negative flows (inflow) were not recorded during the monitoring.

8. Generic Assessment Criteria

The information requirements for generic quantitative risk assessment will depend on:

- The substance being assessed;
- The receptors being considered;
- The pathways being considered; and
- The complexity of the Site.

The outline conceptual model developed for the Site has identified several 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 11, and in Appendix J.

Table 11: Assessment criteria

Source	Pathway	Receptor	Generic Assessment Criteria
Contamination in Made Ground and shallow soils from on-Site and adjacent off-Site land uses	Dermal contact and ingestion of contaminated soils.	Construction workers	Qualitative assessment
		Future users of the proposed development	Waterman Generic Assessment Criteria for land with a residential end-use without plant uptake, and 1% soil organic matter
Contamination groundwater in the Made Ground, Alluvium, and Kempton Park Gravel Formation	Lateral migration to the River Thames	River Thames and Thames ecology	Waterman Generic Assessment Criteria for groundwater with an ecological receptor
	Direct Contact	New water supply pipes	UKWIR Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites
		Buried structures	BRE Special Digest 1 (2005): 3rd Edition guidance
Ground gas arising from Made Ground and Alluvium and vapours from hydrocarbon contamination	Accumulation in confined spaces, leading to inhalation followed by asphyxiation and risk of explosion	Future users of the proposed development	Gas Screening Value determination and assessment in accordance with CIRIA C665 Quantitative assessment for vapours in accordance with CIRIA C682

8.1 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:

Risks to Human Health from Ground Contamination

The proposed development at the Site involves mid-rise buildings. These buildings will be predominantly residential, along with retail, office, hotel, leisure and community uses. A single-level basement will be

excavated beneath the majority of the Site, and it is proposed to raise the ground level as part of the flood mitigation measures.

The eastern Development side will comprise communal and residential end uses at ground floor level, and will include communal soft landscaping areas. Private soft landscaping will not be proposed on the eastern Development side.

The results of laboratory analyses for soil samples collected during the Aecom 2015 ground investigation and Waterman 2016 ground investigation were assessed against generic assessment criteria for land with a residential end use, and without private gardens. Soil organic matter (SOM) within soil samples collected ranged from <0.2% to 1.5%, with an average of 0.8% and median of 0.9%. Therefore, results were compared against GAC for soils with 1% SOM as this is considered to be most representative of Site conditions.

Future Site users will not come into contact with groundwater at the completed development due to the buildings and hardstanding, therefore they have not been considered as a potential groundwater receptor.

Risks to Construction Workers from Ground Contamination

There are no assessment criteria for constructions workers. Construction workers will likely come into contact with potential contamination in shallow soils and groundwater, and potential ground gas and vapours during development works. Therefore, the risks to construction workers have been assessed with respect to the PPE, RPE and best practice necessary to negate potential contaminant pathways.

Risks to Controlled Waters from Ground Contamination

To facilitate the proposed development, piled foundations will need to be installed. The piles will be a maximum length of 25m, and will not penetrate the London Clay Formation. Therefore, this stratum will remain as an aquiclude preventing contaminated groundwater migrating to aquifers in the Lambeth Group, Thanet Formation and Chalk Group. No abstractions are recorded drawing water from the Kempton Park Gravel Formation within 1km of the Site.

There are no surface water abstractions from the adjacent River Thames or the Kempton Park Gravel Formation for drinking purposes within 1km of the Site. The potential exists for shallow groundwater to migrate to the adjacent River Thames. The results of testing have been compared against Waterman GAC for groundwater with an ecological receptor, to assess the risks posed to the River Thames ecology.

Risks posed by Ground Gas and Vapours

Derivation of a gas screening value (GSV) for the Site provided an indication of the potential risk posed by ground gas in accordance with CIRIA Report C665. The proposed development is considered to be a Situation A property (all development types except low rise housing with a 150mm ventilated underfloor void), and therefore the Modified Wilson and Card classification system has been used to inform the required protection measures.

The risk posed by vapours has been assessed qualitatively in accordance with CIRIA Report C682.

Risk to Vegetation

The Site is currently completely covered by hardstanding, with no soft landscaping present. Topsoil will need to be imported onto the Site to construct the proposed areas of soft landscaping and gardens. This will prevent vegetation coming into contact with any ground contamination.

Risks to Structures

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

Risks to Water Supply Pipes

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

9. Quantitative Environmental Risk Assessment

The potential pollutant linkages identified in Section 3.2 have been evaluated using the Generic Assessment Criteria described in Section 8 and Appendix J. The results of this evaluation are reported below:

9.1 Risks to Human Health from Ground Contamination

Results from the Aecom 2015 and Waterman 2016 ground investigations have been compared against GAC for land with a residential end-use without plant uptake, and 1% SOM. Some elevated concentrations of organic and inorganic contamination were identified in soils as detailed in Table 12. Laboratory microscopic examination identified asbestos in some soils samples, listed in Table 13.

Table 12: Summary of soil exceedances of GAC for human health

Stratum	Contaminant	Locations	Depth (m bgl)	Concentration (mg/kg)	GAC (mg/kg)	Investigation
Made Ground	Aromatic TPH EC21-EC35	WS2	1.5	3,553	1,900	Waterman 2016
Made Ground	Aromatic TPH EC35-EC44	WS5	1.0	2,178	1,900	
Made Ground	Arsenic	BH7A	0.7	94	40	Aecom 2015

Table 13: Summary of laboratory results for asbestos during quantification analysis

Stratum	Contaminant	Locations	Depth (m bgl)	Concentration (mg/kg)	Investigation
Made Ground	Chrysotile fibre bundles	WS1	0.5	<0.001 (%)	Waterman 2016
Made Ground	Amosite free fibres	WS1	1.5	<0.001 (%)	
Made Ground	Chrysotile fibre bundles	WS5	1.0	<0.001 (%)	
Made Ground	Chrysotile fibre bundles	WS7A	1.0	<0.001 (%)	
Made Ground	Chrysotile fibre bundles Amosite free fibres	WS8	1.0	<0.001 (%)	
Made Ground	Amosite fibre bundles Chrysotile fibre bundles Asbestos cement debris	WS10	1.0	0.262 (%)	
Made Ground	Chrysotile fibre bundles	BH2A	1.0	<0.001 (%)	
Made Ground	Amosite asbestos	BH201A	0.7	<0.1 (%)	Aecom 2015
Made Ground	Asbestos-containing bitumen	BH203A	0.5	<0.1 (%)	
Made Ground	Chrysotile asbestos	BH207, BH208, BH209	0.7 0.8 0.5	<0.1 (%)	

Inorganic contamination

No metal contamination was identified above the residential without plant uptake GAC in soil samples submitted from the Waterman 2016 ground investigation. The Aecom 2015 ground investigation identified elevated levels of arsenic in one sample of Made Ground.

Organic contamination

Some exceedances of organic contamination were highlighted in soil samples from the Waterman 2016 investigation. Fractions of aromatic TPH (EC21-EC35 and EC35-EC44) were recorded across three sampling locations in the western half of the Site, close to historical tank bases and the decommissioned waste oil tank.

No visual or olfactory evidence for contamination was observed in arisings during the ground investigation. Vapour monitoring of soil arisings in the western half of the Site showed readings, up to 8.8ppm at WS3 at 3.5m bgl and 16.3ppm at WS5 at 4.5m bgl. A single reading of 5.5ppm was also identified at BH2 at 3m bgl.

No organic contamination was identified above the residential GAC in any of the Aecom 2015 ground investigation soil samples analysed.

Asbestos

Asbestos was not visually identified during the ground investigation works. Following laboratory microscopic analysis and quantification, chrysotile asbestos as fibre bundles was identified in six of the fourteen Waterman samples of Made Ground, and three of the Aecom Made Ground samples submitted for analysis. Amosite asbestos as free fibres, fibre bundles and cement debris was also identified in three of the Waterman samples, collected from the Made Ground at WS1, WS8 and WS10. Amosite asbestos and asbestos-containing bitumen were recorded in two samples from the Aecom investigation.

Quantification results found the concentrations of asbestos found comprised less than 0.001% of the total sample for samples from WS1, WS5, WS7A, WS8 and BH2A. In WS10, the asbestos was quantified at 0.262% of the total sample.

Summary

The development will involve excavation of a basement beneath the majority of the Site. The excavation of this basement will remove all of the Made Ground, Alluvium and the uppermost Kempton Park Gravel Formation, whilst the lowermost Kempton Park Gravel Formation is likely to remain. The excavation of material for the basement will likely remove contamination not identified by the ground investigations potentially present inside the proposed basement footprint.

The current Maltings and the former Hotel building will be retained and refurbished for the development. This will break potential contaminant pathways (direct contact, inhalation and ingestion) to future Site users from organic or inorganic ground contamination.

The development proposal includes the potential for re-use of soil to excavated for the basements on-Site to raise the ground level, as part of the flood mitigation measures. Where this is the case, the material should be demonstrated as chemically and geotechnically suitable for re-use.

The Site is currently completely covered by hardstanding. Topsoil/subsoil would need to be imported onto the Site to construct the proposed areas of soft landscaping and gardens. The use of a suitable thickness

of certified clean topsoil for these areas will prevent future Site users coming into contact with any ground contamination beneath the Site. All other areas of the Site will be covered by hardstanding in the form of roadways or pavements, which will form a barrier between users and ground contamination in these areas.

9.2 Risks to Construction Workers from Ground Contamination

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

Although only minor inorganic and organic contamination was identified in the shallow soils at the Site, Site construction and maintenance workers should minimise their potential for exposure to ground contamination. The use of personal protective equipment (PPE), and if necessary respiratory protective equipment (RPE) during any below ground works should be undertaken to reduce direct contact, dermal absorption, ingestion and inhalation of contaminants.

Construction workers would be subject to mandatory health and safety requirements under the Health and Safety at Work Act 1974, Construction (Design and Management) (CDM) Regulations 2015 and the Control of Substances Hazardous to Health (COSHH). These requirements include the use of regulation PPE and RPE should be used where there is a risk of exposure to potentially contaminated soils, dust and groundwater.

Slightly elevated concentrations of carbon dioxide (up to 4% v/v), reduced oxygen levels (down to a minimum of 10.5% v/v) and vapours (up to 16.8ppm) have also been recorded during ground gas and vapour monitoring and therefore all ground works should be carried out in line with the Confined Space Regulations 1997.

Sampling and laboratory testing of the Made Ground beneath the Site detected the presence of chrysotile asbestos as fibre bundles, and amosite as free fibres, fibre bundles and asbestos cement debris. However, subsequent quantification found these fibres to constitute less than 0.001% of the total sample in all except one sample, where it was quantified as 0.262% of the sample. Construction workers should take appropriate precautions when conducting ground works such as the use of PPE and RPE where necessary.

9.3 Risk to Controlled Waters

Aecom submitted two groundwater samples from the Kempton Park Gravel Formation for testing, collected from boreholes in the northwest and southwest corners of the Site. As part of the Waterman monitoring, groundwater samples were collected from each of the two boreholes drilled into the Kempton Park Gravel Formation, and one sample from groundwater in the Made Ground and Alluvium.

Two receptors for potential groundwater contamination have been identified at the Site, the River Thames as a water body and ecology living in the River Thames. The relevant GAC for both of these receptors have been compared, and the more conservative has been used for this assessment. Therefore, results from the Aecom 2015 and Waterman 2016 groundwater monitoring have been compared against a combination of GAC for the protection of inland freshwaters (UK Standard) and >100mg/l $CaCO_3$, and GAC for groundwater with an ecological receptor.

Contamination levels above the applied GAC were not identified in the Kempton Park Gravel Formation Secondary A Aquifer by either investigation. The Waterman investigation identified exceedances for two

metals (copper and zinc) within the perched groundwater in the Made Ground and Alluvium. This is detailed in Table 14.

Table 14: Summary of generic quantitative risk assessment for groundwater with an ecological receptor

Stratum	Contaminant	Locations	Peak Concentration (µg/l)	Generic Assessment Criteria (µg/l)	Investigation
Made Ground and Alluvium	Chromium	WS10	35.1	3.40	Waterman 2016
	Copper		32	28	
	Iron		3720	1000	
	Vanadium		21.6	20	
	Zinc		13	8	
Kempton Park Gravel Formation	Iron	BH1	40,770	1000.00	Waterman 2016
	Nickel	BH1	147	20.00	
	Zinc	BH1	13	8.00	
Kempton Park Gravel Formation	Zinc	BH2, BH201A	15.7 17.5	8.00	Aecom 2015
	Total Sulphur as Sulphate	BH2	457,000	200,000	

Inorganic contamination

The Waterman groundwater samples from the Kempton Park Gravel Formation identified iron, nickel and zinc contamination at BH1, in the southwest of the Site.

The Aecom 2015 investigation found that for the western section of the Site where groundwater was sampled, the Kempton Park Gravel Formation did not contain significant contamination. Exceedances of zinc and sulphur as SO_4 were identified, however these were not greatly above the applied GAC.

Organic contamination

No elevated levels of organic contamination were identified in samples from either the 2015 Aecom study, or the 2016 Waterman investigation.

Summary

Although the metals contamination identified indicates the Secondary A Aquifer in the Kempton Park Gravel Formation has been impacted by contamination, this is to be expected in post-industrial sites. The River Thames has been assessed as having a moderate ecological potential under the Water Framework Directive. This water body is therefore not anticipated to be extremely sensitive to groundwater migration from the Site.

Further ground investigation will be required to fully characterise groundwater quality and the potential impact the River Thames.

The Site is underlain by about 73m of London Clay Formation, proven to a depth of 30m bgl by the Waterman study. This material will prevent the migration of potentially contaminated groundwater to underlying aquifers. The proposed development involves mid-rise buildings whose foundations are

unlikely to penetrate the London Clay Formation, preventing the creation of a pathway from shallow to the deep aquifers.

Following demolition of the current buildings on-Site, the redundant historical abstraction wells should be located and decommissioned in line with EA guidance to remove this potential pathway aquifers underlying the London Clay Formation.

9.4 Risk posed by Ground Gas and Vapours

Ground Gas

Waterman conducted a preliminary round of ground gas monitoring at the Site. During this monitoring, Methane concentrations were not recorded above the limit of detection for the equipment (<0.1% v/v). A maximum concentration of 4% v/v carbon dioxide was detected. Depleted oxygen levels (down to a minimum of 10.5% v/v) were observed in some boreholes. A maximum flow rate of +0.4 l/hour was recorded.

To assess the likely risk posed by ground gases a preliminary gas screening value (GSV) is calculated using the recorded gas flow (l/hr) and the maximum gas concentration (%), outlined below.

$$\mathbf{GSV} = \left(\frac{\text{(Measured Maximum } CO_2 \text{ or } CH_4 \text{ Gas Concentration (\%)}}{100} \right) \times \text{Maximum Measured Gas Flow Rate from boreholes (l/hr)}$$

GSVs are calculated using the highest value of carbon dioxide or methane recorded during monitoring, with the result compared against the characteristic situations described within CIRIA C665, presented in Appendix J.

Based on the highest carbon dioxide concentration recorded of 4% v/v and the peak flow rate of +0.4 l/hr, the preliminary GSV is calculated as **0.016l/hr** for the Site.

Based on this preliminary GSV, the Site is categorised as a “Characteristic Situation 1 (CS1)” according to the modified Wilson and Card Classification System. The CS1 characterisation is designated “Very Low Risk”, with no requirement for ground gas protection measures. This preliminary assessment should be confirmed by further monitoring.

Vapours

Soil arisings at the investigation locations were screened for vapours with a PID. A maximum concentration of 16.3ppm was recorded in a sample of the Kempton Park Gravel Formation in the west of the Site. An isolated maximum vapour reading of 5.5ppm was also encountered in the Made Ground in the eastern section. However, the majority of readings were less than this, or below the limit of detection entirely.

Follow-up hydrocarbon vapour monitoring was carried out in the monitoring wells using a PID. Vapour concentrations were not recorded above the limit of detection (<0.1% v/v).

Soil sampling did not identify any levels of VOCs or SVOCs above the applied GAC. For the majority of soil samples and all water samples the results of testing for hydrocarbon contamination were below the GAC, and in almost all examples were below the limit of detection.

Vapour monitoring during the ground investigation works and follow-up monitoring at the installed wells did not indicate widespread contamination present beneath the Site with the potential to give rise to vapours. Therefore, vapour ingress arising from soils or groundwater beneath the Site is not considered a significant risk. This should be confirmed by further monitoring.

9.5 Risk to Vegetation

The Site is currently completely covered by hardstanding, with no soft landscaping present. Topsoil will need to be imported onto the Site to construct the proposed areas of soft landscaping and gardens.

The use of a suitable thickness of certified clean topsoil in these areas will prevent future Site users coming into contact with any ground contamination beneath the Site. All other areas of the Site will be covered by hardstanding in the form of roadways or pavements, which will for a barrier between users and ground contamination in these areas.

9.6 Risk to Structures

Soil and Groundwater contamination

Soil Consultants undertook an assessment of the risk ground conditions posed to buried concrete at the completed development via chemical attack. Concentrations of soluble sulphates within soil and groundwater samples collected as part of the Aecom 2015 and Waterman 2016 investigations were assessed. Soil Consultants recommended a preliminary overall Site Design Class DS-1/AC-1 for concrete.

The full results are available within the Soil Consultants geotechnical report included within Appendix C (*report ref. 10022/OT/JRCB*).

Ground Gas and Vapours

Preliminary ground gas monitoring at the Site did not identify significantly elevated levels of methane or carbon dioxide. Preliminary classification of the Site was “Characteristic Situation 1” (Very Low Risk) with no protective measures required.

The results of soil and groundwater sampling and follow-up vapour monitoring did not indicate vapours to present a risk to the completed development.

The ground gas and vapour assessment is preliminary, and should be confirmed with further monitoring.

9.7 Risk to Water Supply Pipes

According to the UKWIR project steering group, 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.

10. Preliminary Waste Classification Assessment

The process of waste classification is set out in Appendix G.

10.1 Introduction

A Preliminary Waste Classification Assessment (PWCA) has been undertaken on discreet soil samples recovered from boreholes and window sample hole. Development proposals are still evolving, therefore, the likely volume and type of waste soil arisings from the development have not been established. As such, all soil samples that underwent chemical analysis have been screened for hazardous properties as part of this PWCA.

The samples collected from each location are discreet and have not been sampled in strict accordance with UK Environment Agencies Waste Classification – Guidance on the classification and assessment of waste (1st edition 2015) Technical Guidance WM3. The assessment should be regarded as indicative only. Further assessment will be required once it is known how the waste will arise, and what off-Site recovery or disposal options are available.

Our assessment includes firstly considering whether or not the waste displays hazardous properties and secondly, should landfill disposal be a potential off-Site option for the wastes the findings of additional waste acceptance criteria (WAC) testing.

The hazardous property assessment has been undertaken using HazWasteOnline™, a web-based tool for classifying hazardous waste. The tool follows the latest Environment Agencies guidance and European regulations. A summary of the assessment results is provided in Section 10.2.

10.2 Hazardous Property Assessment

The dry soils chemical analysis results from the ground investigation have been entered into HazWasteOnline™ and dry weight moisture correction applied. A total of thirteen samples have been screened for hazardous properties. These include eleven samples of Made Ground, one sample of Alluvium and one sample of Kempton Park Gravels. Dry weight correction was applied.

Results from the HazWasteOnline™ assessment are included in Appendix G

Three of the thirteen dry soils samples screened have been reported as containing hazardous properties by HazWasteOnline™.

Details of the samples identified as containing hazardous properties are provided in Table 15.

Table 15: Summary of samples reported as containing hazardous properties by HazWasteOnline™

Sample Reference	Strata	Hazardous Properties	Assessment Notes
WS4 – 0.5m bgl	Made Ground	TPH (C6 – C40) petroleum group (3085.8mg/kg / 0.309%). (HP7 – Carcinogenic, HP11 – Mutagenic).	Benzo(a)pyrene concentration = 0.027% of TPH concentration.
WS5 – 1.0m bgl	Made Ground	TPH (C6 – C40) petroleum group (3496.2mg/kg / 0.35%). (HP7 – Carcinogenic, HP11 – Mutagenic).	Benzo(a)pyrene concentration = 0.015% of TPH concentration.
WS11 – 0.5m bgl	Made Ground	TPH (C6 – C40) petroleum group (2269.7mg/kg / 0.227%). (HP7 – Carcinogenic, HP11 – Mutagenic).	Benzo(a)pyrene concentration = 0.012% of TPH concentration.

Three samples of Made Ground were identified as containing hazardous properties. All three samples were identified as containing hazardous properties due to elevated TPH (C6 – C40) petroleum group.

The TPH in these samples was identified as not petrol or diesel (i.e. unknown oil) and the concentrations of benzo(a)pyrene were used as a marker compound to establish if the oil contained HP7 Carcinogenic and HP11 Mutagenic properties.

For the TPH of an unknown oil to contain the Carcinogenic and Mutagenic properties the concentration of benzo(a)pyrene needs be greater than 0.01% of the TPH concentration. The benzo(a)pyrene concentration in these samples was above 0.01% of the sample's TPH concentrations. Therefore, these samples contain HP7 Carcinogenic and HP11 Mutagenic properties.

A TPH concentration of 1,123.81mg/kg (1.123%) was recorded in WS2 at 1.5m bgl. The TPH was assessed as unknown oil. However, the concentration of benzo(a)pyrene was below 0.01% of the TPH concentration. Therefore, the HP7 Carcinogenic and HP11 Mutagenic hazardous properties do not apply.

The samples of Alluvium and Kempton Park Gravels were not identified as containing hazardous properties.

All thirteen samples of Made Ground were screened for the presence of asbestos. Seven of the samples were identified as containing asbestos. Details are presented in Table 16.

Table 16: Samples identified containing asbestos

Sample Reference	Type of Asbestos Identified in Sample	Concentration of Asbestos in Sample (% of sample by weight)
WS1 – 0.5m bgl	Chrysotile fibre bundles	<0.001
WS1 – 1.5m bgl	Amosite free fibres	<0.001
WS5 – 1.0m bgl	Chrysotile fibre bundles	<0.001
WS7A – 1.0m bgl	Chrysotile fibre bundles	<0.001
WS8 – 1.0m bgl	Chrysotile fibre bundles, amosite free fibres	<0.001
WS10 – 1.0m bgl	Amosite fibre bundles, chrysotile fibre bundles, asbestos cement debris.	0.262
BH2A – 1.0m bgl	Chrysotile fibre bundles	<0.001

Asbestos quantification analysis of the samples indicates asbestos concentrations of below the laboratory limit of detection (<0.001% by dried weight of the sample) in all but one sample.

Asbestos quantification of sample WS10 – 1.0m bgl reported an asbestos concentration of 0.262% by weight of the sample. However, visible fragments of potential asbestos containing materials were not identified in soils during ground works. If a waste contains asbestos fibres that are free and dispersed at a concentration of 0.1% or more then it will be classified as hazardous by HP7 – Carcinogenic. Therefore, sample WS10 – 1.0m bgl is classified as hazardous by HP7 – Carcinogenic.

Concentrations of asbestos in the other samples were below the hazardous waste threshold (<0.1% by weight). However, the presence of asbestos fibres can be indicative of the presence of weathered asbestos containing materials in the soil.

Should waste soils contain identifiable pieces of asbestos containing material (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye) then these pieces should be assessed separately. The waste soil is hazardous if the concentration of asbestos in the piece of asbestos containing material is 0.1% or more and waste soil would be regarded as mixed waste.

10.3 Waste Acceptance Criteria

In addition to the HazWasteOnline™ assessment, Waste Acceptance Criteria (WAC) analysis was undertaken on the following samples to indicate whether soils would likely pass inert landfill criteria if non-hazardous or would likely require treatment prior to disposal at a hazardous landfill:

- WS1 – 1.5m bgl (Made Ground);
- WS8A – 2.5m bgl (Made Ground);
- BH1 – 1.5m bgl (Alluvium); and
- BH2A – 2.5m bgl (Kempton Park Gravel Formation).

Table 17: Summary of waste acceptance criteria results

Sample Reference	Strata	Hazard Property Assessment	Failed Waste Acceptance Criteria	Comment
WS1 – 1.5m bgl	Made Ground	N/A	None	Soils would pass the inert waste landfill criteria if containing no hazardous properties. Soils would not require treatment prior to disposal if containing hazardous properties.
WS8A – 2.5m bgl	Made Ground	N/A	None	Soils would pass the inert waste landfill criteria if containing no hazardous properties. Soils would not require treatment prior to disposal if containing hazardous properties.
BH1 – 1.5m bgl	Alluvium	N/A	None	Soils would pass the inert waste landfill criteria if containing no hazardous properties. Soils would not require treatment prior to disposal if containing hazardous properties.
BH2A – 2.5m bgl	Kempton Park Gravel Formation	N/A	None	Soils would pass the inert waste landfill criteria if containing no hazardous properties. Soils would not require treatment prior to disposal if containing hazardous properties.

Results indicate these samples from the Made Ground, Alluvium and Kempton Park Gravel Formation are not leaching contaminants in significant quantities.

10.4 Preliminary Waste Classification Assessment Summary

The Preliminary Waste Classification Assessment has indicated that the relevant EWC codes for the disposal of the soils are as shown in Table 18.

Table 18: Summary of likely waste soil streams

Material	EMC Code	EWC Code Description	Description of Material
Made Ground containing no hazardous properties	17 05 04	Soils and stones other than those mentioned in 17 05 03	Dark brown and reddish brown very clayey sandy gravel. Gravel is fine to coarse brick, crushed concrete, flint, clinker. Rare pipe fragments.
Made Ground containing hazardous properties	17 05 03*	Soils and stones containing hazardous substances	Dark brown and reddish brown very clayey sandy gravel. Gravel is fine to coarse brick, crushed concrete, flint, clinker. Rare pipe fragments. WS4 - 0.5m bgl, WS5 – 1.0m bgl, and WS11 – 0.5m bgl hazardous due to TPH (C6 – C40) petroleum group. HP7 – Carcinogenic, HP11 – Mutagenic. WS10 – 1.0m bgl Hazardous by HP7 - Carcinogenic due to asbestos concentration (>0.1%).
Natural soil (Alluvium)	17 05 04	Soils and stones other than those mentioned in 17 05 03	Orange brown, mottled dark brown, sandy clay with frequent black flecks and rare rounded, fine to medium flint gravel. Gravel is fine to coarse flint.
Natural soil (Kempton Park Gravel Formation)	17 05 04	Soils and stones other than those mentioned in 17 05 03	Orange brown very gravelly sand and light brown sandy gravel. Gravel is sub-angular to rounded, fine to coarse flint.

It is considered that the removal of soils from the Site can be minimised by their reuse on-Site to facilitate filling or increasing levels as part of flood mitigation provided they are chemically and geotechnically suitable.

Any re-use of soils on Site should be in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP), subject to appropriate sampling and testing, risk assessment and compliance with the requirements of the DoWCoP.

Further validation and waste classification pursuant to WM3, in particular Appendix D on waste sampling should be undertaken on materials to be removed from Site to confirm the most appropriate waste classification and receiving site. In accordance with the waste hierarchy, preference should be given to receiving sites able to recover value from the excavation wastes rather than landfill disposal facilities.

Natural uncontaminated soils may be acceptable as inert waste without testing at some landfills and may be used directly at sites operating in accordance with the DoWCoP.

Acceptance of waste is at the discretion of the receiving site. It is recommended that the receiving site operator is consulted at the appropriate time to discuss the conditions of its Environmental Permit

Segregation of different waste streams would be required prior to disposal of materials off-Site.

11. Conclusions

Following the implementation of the ground investigation, the pollutant linkages identified in the PERA have been re-evaluated and reclassified in relation to the additional information obtained. The results of the reassessment are summarised in Table 19 below:

Table 19: Reassessment of potentially significant pollutant linkages at the Site

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Human Health					
Future Site Users	Contamination in Made Ground and shallow soils from on-Site and adjacent off-Site land uses. Contamination groundwater in the Made Ground and Alluvium, and Kempton Park Gravel Formation.	Dermal contact and ingestion of contaminated soils and groundwater.	Low	Some exceedances for TPH were present in soil samples from the Waterman 2016 investigation, close to historical tank bases and a decommissioned waste oil tank in the western section of the Site. No organic contamination was identified above the residential GAC in any of the Aecom 2015 ground investigation soil samples. Laboratory analysis identified asbestos in the Made Ground across the Site. Both the Waterman and Aecom studies identified inorganic contamination above the applied GAC in groundwater samples. The development would involve basements beneath much of the Site. This will remove a significant volume of potentially contaminated material. New buildings across the majority of the Site, the retained Maltings and former Hotel buildings will prevent future Site users from contacting residual ground contamination in buildings. Where soil excavated from basements is proposed to be reused on the Site to raise levels as part of the flood mitigation measures, this should be demonstrated suitable for re-use, both chemically and geotechnically. Topsoil/subsoil will need to be imported onto the Site for the proposed areas of soft landscaping. The use of a suitable thickness of certified clean topsoil/subsoil as a capping layer for these areas will prevent future Site users coming into contact with any ground contamination beneath the Site. The findings of this study are preliminary in nature. Further investigation in areas of the Site not currently accessible will be needed to confirm the ground conditions. This investigation should include further sampling and testing of the Made Ground to delineate the extent of asbestos in this material.	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
	Ground gas arising from Made Ground and Alluvium and vapours from shallow groundwater.	Accumulation in confined spaces, leading to inhalation followed by asphyxiation and risk of explosion.	Medium	Based on the highest carbon dioxide concentration recorded of 4% v/v and the peak flow rate of +0.4 l/hr, a preliminary Gas Screening Value of 0.016 has been calculated for the Site. Based on this preliminary GSV, the Site is categorised as a "Characteristic Situation 1 (CS1). The CS1 characterisation is designated "Very Low Risk", with no requirement for protection measures. The evidence obtained from this investigation does not indicate the Site is generating significant concentrations of ground gas or vapours. This preliminary ground gas and vapour regime assessment will need to be confirmed by additional monitoring. Six further monitoring visits should be completed over a three-month period in line with CIRIA C665 guidance. Creation of basements in use for car parking will further mitigate the risk of ground gas or vapour impact for new buildings by removing potential gas/vapour material and creating ventilation pathways beneath the building.	Low
Off-Site residents/users	Contamination in Made Ground and shallow soils.	Windborne, potentially contaminated construction dust. Runoff from stockpiled soils.	Medium	A Construction Environmental Monitoring Plan (CEMP) will be prepared for the works, including measures to minimise runoff from stockpiled soils, manage groundwater in excavations and suppress the generation of dust. Construction materials brought on-Site as part of works will be appropriately stored to prevent spills and leaks. This will prevent potentially contaminated material reaching off-Site residents or users.	Low
Construction Workers	Contamination in Made Ground, shallow soils, and shallow groundwater.	Dermal contact and ingestion. Ground gas and vapour Accumulation in trenches and confined spaces, leading to inhalation followed by asphyxiation and risk of explosion. Dust inhalation.	Medium	Construction workers will be provided with personal protective equipment (PPE) and respiratory protective equipment (RPE) where appropriate. Workers should be aware of good hygiene measures as protection against direct contact with contaminated Made Ground, contaminated groundwater, ground gas, vapours and dust inhalation.	Low
Property					

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
Future on-Site structures	Contamination in Made Ground, shallow soils, and shallow groundwater.	Direct contact with building foundations and buried services leading to chemical attack.	Medium	Concentrations of soluble sulphates within soil and groundwater samples collected as part of the Aecom 2015 and Waterman 2016 investigations were assessed by Soil Consultants for the risk ground conditions posed to buried concrete at the completed development via chemical attack. The preliminary results indicated an overall Site Design Class DS-1/AC-1 for concrete. This should be confirmed by further investigation in areas of the Site not currently accessible.	Low
	Ground gas and vapours.	Accumulation in confined spaces, leading to risk of explosion.	Medium	Preliminary ground gas monitoring at the Site did not identify significantly elevated levels of methane or carbon dioxide. Preliminary classification of the Site was Characteristic Situation 1 (Very Low Risk) with no protective measures required. This preliminary ground gas and vapour regime assessment will need to be confirmed by additional monitoring. Six further monitoring visits should be completed over a three-month period in line with CIRIA C665 guidance. Creation of basements in use for car parking will further the risk for new buildings.	Low
Off-Site structures	Contamination in Made Ground, shallow soils, and shallow groundwater.	Direct contact with building foundations and buried services leading to chemical attack.	Low	No significant contamination was identified in soils and groundwater during investigations that would give rise to off-Site risk of damage to structures. Where contaminants were encountered, it is considered not to represent a significant contamination risk to current or future off-Site structures. This should be confirmed by further investigation in areas of the Site not currently accessible.	Low
Ecological Receptors					
Soft landscaping	Contamination in Made Ground, shallow soils, and shallow groundwater.	Direct contact of roots. Plant uptake.	Low	All soft landscaping at the completed development would be situated in an appropriate thickness of imported, certified clean cover material. This would prevent plants at the completed development contacting any ground contamination beneath the Site.	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
River Thames ecology	Contamination in Made Ground, shallow soils, and shallow groundwater.	Windborne, potentially contaminated construction dust. Runoff from stockpiled soils.	Medium	A CEMP will be prepared for the demolition and construction works on-Site, detailing measures to minimise the potential risk to controlled waters. Construction materials brought on-Site as part of works should be appropriately stored to prevent spills and leaks. This should prevent potentially contaminated material reaching the River Thames.	Low
Controlled Waters					
The River Thames	Contamination in Made Ground, shallow soils, and shallow groundwater.	Migration through granular deposits to the River Thames. Runoff from stockpiled soils.	Medium	Elevated levels of metals above the GAC for groundwater with an ecological receptor were identified in groundwater, indicating that it has been impacted by ground contamination. This is to be expected in areas where land has a long history of industrial use. The River Thames adjacent to the Site has been assessed as having a moderate ecological potential under the Water Framework Directive. This water body is therefore not anticipated to be extremely sensitive to groundwater migration from the Site. Further ground investigation will be required to better quantify the extent of this contamination, and its potential to impact the River Thames.	Low
Aquifer in the Kempton Park Gravel Formation	Contamination in Made Ground and shallow soils.	Remobilisation of contamination by rainfall infiltration following removal of hardstanding during construction works.	Medium	The CEMP will include measures to minimise rainwater infiltration to exposed ground, or the potential for construction spills during the demolition and construction works. Rainwater infiltration via soft landscaping and private gardens is possible at the completed development. However, this is likely to be limited as the majority of the Site will be covered by buildings and hardstanding. Preliminary analysis found contamination in Made Ground and shallow soils is minor, meaning that there are unlikely to be significant impacts from any mobilisation. This should be confirmed by further investigation in areas of the Site not currently accessible.	Low
Deep Secondary A aquifers in the Lambeth Group	Contamination in shallow groundwater.	Migration via historical abstraction wells.	Low	The Site is underlain by 73m of London Clay Formation, which presents an impermeable barrier for the migration of contaminants to the deep Secondary A and Principal Aquifers. The proposed development involves mid-rise buildings founded on piles 25m long. The pile tow will therefore	Low

Receptor	Potential Sources	Pathways	Risk	Justification / Mitigation	Residual Risk
and Thanet Formation Principal Aquifer in the Chalk Group				not penetrate the base of the London Clay Formation. A preferential pathway to the underlying aquifers will therefore not be created. Following demolition of the current buildings on-Site, the redundant historical abstraction wells should be located and decommissioned to remove the pathway to the Principal Aquifer in the Chalk Group	

12. Recommendations

The following actions are recommended to address the potentially unacceptable risks that remain:

Environmental

- Further ground investigation should be undertaken following acquisition of planning permission for the development, targeting sections of the Site inaccessible during this study in order to further characterise the ground conditions in these areas. This should include:
  - Sampling and testing of the Made Ground for contaminants and preliminary waste classification;
  - Additional groundwater sampling to better understand the contamination and hydrogeological status of groundwater;
- The preliminary results of the ground gas and vapour monitoring found that the Site is “Characteristic Situation 1 – Very Low Risk”. Six rounds of ground gas and vapour monitoring over a period of three months should be undertaken in line with CIRIA C665 guidance. The results will confirm the risk category for the Site, and whether any gas protection measures are necessary within buildings at the completed development;
- A Construction Environmental Management Plan (CEMP) should be developed for the Site, detailing measures to minimise the potential risk to the River Thames and shallow Secondary A aquifer during the demolition and construction works. Measures should also be taken to prevent run-off from stockpiled soils reaching the River Thames, and to supress the generation of dust;
- During construction works, potentially contaminative substances should be stored and handled in accordance with the COSHH (Control of Substances hazardous to Health) regulations 2002, to prevent contaminants reaching the ground or the River Thames;
- Construction workers should be provided with and use personal protective equipment (PPE), respiratory protective equipment (RPE) and informed of good hygiene measures as protection against direct contact with contaminated Made Ground, contaminated groundwater or ground gas / vapours. Construction workers should avoid entry to confined spaces, if required should only be carried out in line with Confine Space Regulations 1997;
- Following removal of hardstanding across the Site post-demolition, an attempt should be made to locate the historical abstraction wells and decommission them in line with EA Guidance if necessary;
- Where soil excavated from basements is proposed to be reused on-Site to raise levels as part of the flood mitigation measures, it should be demonstrated suitable for use from chemical and geotechnical perspective. Re-use of soils should be in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice;
- Dewatering is likely to be necessary during excavation of the basement. Allowance should be made for the management of impacted groundwater during the Site works;
- The recommendations and details relating to geotechnical elements and protection against chemical attack at the completed development provided within the Soil Consultants geotechnical report (November 2016, *report reference: 10022/OT/JRCB*) should be followed;
- The use of barrier water pipes at the completed development (as per UKWIR project steering group guidance) should be agreed with the relevant water authorities; and
- Soft landscaping areas at the development should be planted using an appropriate thickness of imported, certified clean cover material.

- A significant amount of crushed aggregate will be generated as a result of demolition of current buildings and removal of concrete hardstanding. The production of aggregates should be controlled by the Wrap Quality Protocol for Aggregates.

Preliminary Waste Classification

- Three soil samples were identified has hazardous due to elevated TPH. One sample was identified as hazardous due to asbestos concentrations. Therefore, allowance should be made for some waste soils from the Development to contain hazardous properties. However, the majority of soil samples screened did not return hazardous properties;
- It is considered that the removal of soils from the Site can be minimised by their reuse on-Site to facilitate raising of the Site level for flood defences where required, provided they are chemically and geotechnically suitable.
- Re-use of soils on Site should be in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP), subject to appropriate sampling and testing, risk assessment and compliance with the requirements of the DoWCoP;
- Further validation and waste classification pursuant to WM3, in particular Appendix D on waste sampling should be undertaken on materials to be removed from Site to confirm the most appropriate waste classification and receiving site. In accordance with the waste hierarchy, preference should be given to receiving sites able to recover value from the excavation wastes rather than landfill disposal facilities;
- Natural uncontaminated soils may be acceptable as inert waste without testing at some landfills and may be used directly at sites operating in accordance with the DoWCoP;
- Acceptance of waste is at the discretion of the receiving site. It is recommended that the receiving site operator is consulted at the appropriate time to discuss the conditions of its Environmental Permit;
- Segregation of different waste streams would be required prior to disposal of materials off-Site.

13. Statement of Remediation Principles

Given the Site's proposed end use the following remedial approach is likely to break potential pollutant linkages. The scope and extent of the below works will need to be reviewed based on the findings of the further investigation.

13.1 Breaking Linkage between Contaminants and Future Site Users

13.1.1 Soils

Following an assessment of the results against the relevant GAC, elevated concentrations of contaminants have been identified for residential land use without plant uptake and 1% SOM. Laboratory analysis also detected asbestos as free fibres, fibre bundles and cement debris in samples of Made Ground collected.

Construction of basements, buildings and hardstanding of the completed development will prevent future Site users contacting contaminated soils.

In soft landscaped areas it will be necessary to place a suitable thickness of certified clean topsoil/subsoil. All materials should be certified as clean prior to being brought to Site. Details of the cover layer should be agreed with the regulatory authorities.

13.1.2 Groundwater

Buildings, hardstanding and its depth will prevent future Site users contacting any contaminated groundwater.

13.1.3 Ground Gas and Vapours

The preliminary ground gas assessment undertaken to date has identified that the Site is classified as "Characteristic Situation 1 – Very Low Risk". No protection measures are considered necessary at developments in this risk category, however as the assessment is based on a single monitoring visit this will need to be confirmed. Six further monitoring visits using a wider array of monitoring points should be undertaken at the Site to confirm it is 'Very Low Risk'.

The results from the investigation do not indicate widespread contamination present beneath the Site with the potential to give rise to vapours. Therefore, there is not considered to be a significant risk of any vapour ingress to the completed development arising from soils or groundwater beneath the Site. Six further monitoring visits should be undertaken at the Site to confirm this assessment.

The excavation of basement for carparking will further reduce this risk.

13.2 Appropriate Management of Groundwater during Redevelopment.

The results of groundwater analysis indicated groundwater in the aquifer above the London Clay Formation has been slightly impacted by historical activities. Measures should be employed to ensure construction works do not further impact the quality of the aquifer, such as adequate fuel storage, provision of spill kits, appropriate handling storage of contaminated arisings and appropriate reporting and management of unforeseen contamination. Dewatering of excavation may be required during the construction works, water should be treated to the appropriate quality prior to being discharged under license to a sewer or to ground.

13.3 Buried Infrastructure

Buried infrastructure at the brewery such as underground pipes, tanks, drainage runs and the historical abstraction wells will need to be identified, decommissioned and removed from the Site where necessary. This work should be carried out by an experienced contractor and accompanied by monitoring and relevant inspection/supervision, with relevant validation sampling and testing where the potential exists for the infrastructure to have caused ground contamination.

13.4 Unforeseen Contamination

Unforeseen contamination encountered during the development should be dealt with in accordance with a strategy agreed with the regulatory authorities. This may comprise halting work in the particular area until an appropriate method for dealing with the contamination has been agreed. The Environmental Health Officer (EHO) and EA officer should also be kept informed.

13.5 Appropriate Handling and Reuse of Materials on-Site

The ground investigation encountered asbestos in samples collected from Made Ground. During moving and handling Made Ground, consideration will need to be given to dust control. Laboratory analysis identified the asbestos as fibre bundles, free fibres and cement debris within the samples, meaning specific measures will need to be employed to prevent exposure to Site staff during the redevelopment works. These typically comprise visual inspection of soil, damping down and raising staff awareness via a 'toolbox talks' style induction.

Material management is likely to be a significant aspect during the development works given a basement is proposed to underlay much of the Site. Where soil will be reused to raise levels as flood mitigation it should be confirmed as suitable for use from a contamination and geotechnical perspective.

Reuse should be in accordance with the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP), subject to appropriate sampling and testing, risk assessment and compliance with the above requirements of the DoWCoP.

Removal of material from Site should focus on minimising removal of material classified as hazardous or non-hazardous provided it can be reused appropriately. This may include use of designed capping layers and or cover systems.

A significant amount of crushed aggregate will be generated as a result of demolition of current buildings and removal of concrete hardstanding. The production of aggregates should be controlled by the Wrap Quality Protocol for Aggregates.

13.6 Reporting

Soil and groundwater findings from further investigation in the areas of the Site not currently accessible, and the further ground gas and vapour monitoring should also be reported.

It is recommended a Remediation Strategy be developed for the Site that would seek to draw together the specifics of the proposed works and relate them to the findings of the investigations and re-evaluated historical data.

It is also recommended a Construction Environmental Management Plan be developed in order to ensure potential impacts are minimised where possible.

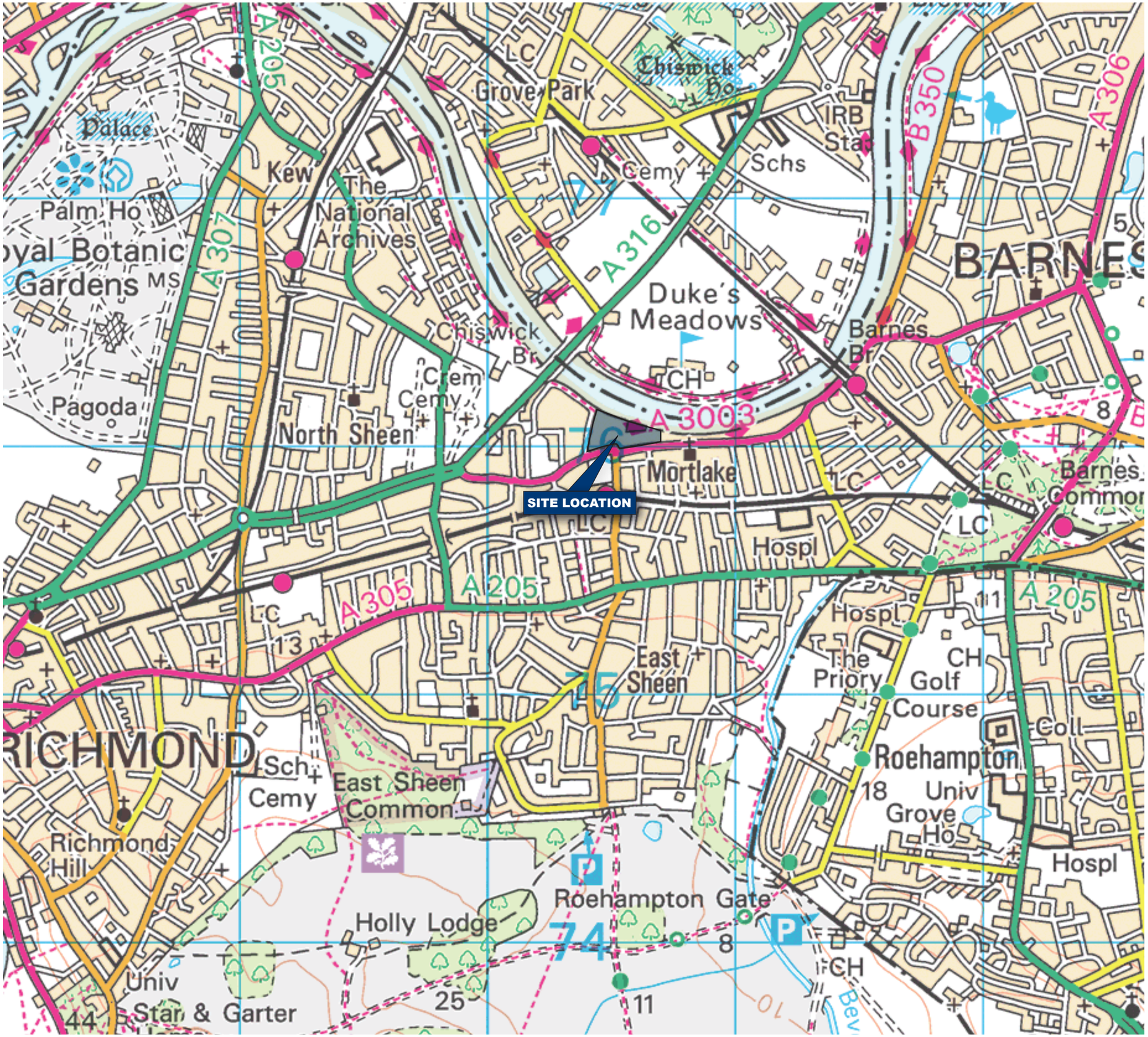
13.7 Statutory Consultation

Consultation with the EA and the London Borough of Richmond-Upon-Thames should be undertaken when appropriate in order to seek approval for any proposed scheme and its associated remedial approach. A closure report should be completed at the end of the Site's development detailing the works undertaken and any variations from the Remediation Strategy initially proposed.

APPENDICES

Appendix A Site Plans

- **Site Location Plan (Fig. A1)**
- **Site Plan (Fig. A2)**
- **Est Site Plot (Fig A3)**
- **Ground Investigation Plan (Fig. A4)**
- **Obstructions encountered during ground investigation plan (Fig. A5)**
- **Conceptual Site Model (Fig. A6)**
- **Proposed Development Plans**
- **Outline design plans – Proposed ground levels plan**
- **Outline design plans – Basement plan**
- **Outline design plans – Building heights plan**



Project Details	WIE10667-101: Stag Brewery, Mortlake
Figure Title	Figure A1: Site Location Plan
Figure Ref	WIE10667-101_GR_GERA_A1A
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\gera\issued figures

waterman

Site Boundary

DIESEL TANK
CAR PARK
Cottage
Aynescombe Cottage
Aynescombe
Path
Ship Lane Passage
The Ship (PH)
4.4m
MALTING BUILDING
Navigation Light
MP
Jetty
SM
MP
Sloping masonry
Path
Sloping masonry
Mooring Posts
Hard
Hard
BULLS ALLEY
BULLS ALLEY
SHIP LANE
CHEMICAL STORAGE CONTAINERS
CHEMICAL STORAGE CONTAINER
FB
5.9m
FINISHING BUILDING
BOTTLING WAREHOUSE
FB
POWERHOUSE
BREWHOUSE
WASTE OIL TANK
FB
Brewery
SALT TANK
CAUSTIC SODA TANK
HYDROCHLORIC ACID TANK
BREWHOUSE
SHIP LANE
GLYCOL CARBON FILTER TANK
Brewery
THE (FORMER) HOTEL
THE (FORMER) BOTTLING HALL
5.0m
5.4m
09
1 to 24
PH
18 to 32
1 to 12
31
2 to 12
Sorting Office
PRODUCTION OFFICE
PH
36
38
40
42
44
5.2m
TCB
Posts
5.3m
PH
1
2
CROMWELL PLACE
6
9
10
22
33
35
37
5.2m
MORTLAKE
N

Project Details	WIE10667-101: Stag Brewery, Mortlake
Figure Title	Figure A2: Site Plan
Figure Ref	WIE10667-101_GR_GERA_A2A
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\pera\issued figures

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SITE EXTENT

PROPOSED BUILDING

PROPOSED BUILDING

WINDBOURNE DUST PRVENTED BY DUST SUPRESSION

CLEAN IMPORTED TOPSOIL PREVENTS FUTURE SITE USERS CONTACTING CONTAMINATION VIA PLANT UPTAKE

CONSTRUCTION MATERIALS AND SOILS APPROPRIATELY STORED TO PREVENT CONTAMINATION RERACHING SURFACE DRAINAGE RUNNING TO THE RIVER THAMES

SOILS STOCKPILED DURING CONSTRUCTION WORKS

RIVER THAMES

GROUND GAS AND VAPOUR PROTECTION MEASURES IN BUILDINGS INFORMED BY SITE INVESTIGATION

BUILDING FOUNDATIONS APPROPRIATELY PROTECTED AGAINST CHEMICAL ATTACK

SITE RAISED AS PART OF FLOOD MITIGATION

RUN-OFF PROVENTED BY APPROPRIATE CONSTRUCTION TECHNIQUES

PERCHED GROUNDWATER

CONSTRUCTION WORKERS IN TRENCHES USING APPROPRIATE PPE / RPE

PROPOSED BASEMENT

RIVER WALL

SECONDARY AQUIFER

HISTORICAL ABSTRACTION WELL SEALED TO PREVENT GROUNDWATER MIGRATION

MADE GROUND

ALLUVIUM AND RIVER TERRACE DEPOSITS

LONDON CLAY FORMATION

Project Details	WIE10667-101: Stag Brewery, Mortlake
Figure Title	Figure A3: Conceptual Site Model
Figure Ref	WIE10667-101_GR_PERA_A3B
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\pera\issued figures

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Groundwater Flow from Previous Investigations

- Site Boundary
- Geotechnical Borehole to 30m
- Window Sample
- Monitoring Installation Completed

Note:

Locations are indicative only and dependant on available access.

WS1 TARGETING FORMER TANKS

WS2 TARGETING ENERGY CENTRE

WS3 TARGETING CHEMICAL STORAGE CONTAINERS

WS4 TARGETING WASTE OIL TANK

WS5 GENERAL CONTAMINATION

WS6 ABANDONED

WS7 GENERAL CONTAMINATION

WS7A GENERAL CONTAMINATION

WS8 ABANDONED

WS8A GENERAL CONTAMINATION

WS9 ABANDONED

WS9A TARGETING WORKSHOP

WS10 GENERAL CONTAMINATION

WS10A GENERAL CONTAMINATION

BH1 GENERAL CONTAMINATION

BH2 ABANDONED

BH2A ABANDONED

BH2B TARGETING LOADING YARD

GLYCOL CARBON FILTER TANK

MALTING BUILDING

BOTTLING WAREHOUSE

ENERGY CENTRE

HEALTH CENTRE

WORKSHOP, BAR AND CANTEEN

16m FROM RIVERWALL

MORTLAKE

Brewery

Sorting Office

Old Stables

Tudor Lodge

Thames Bank House

Asplin Cottage

Aynescombe Cottage

The Ship (PH)

Ship Lane Passage

Aynescombe Path

Hard

Sluice

Navigation Light

MP

Jetty

SM

Sloping masonry

Path

Mooring Posts

SHIP LANE

BULLS ALLEY

FB

LB

PH

TCB

4.4m

5.9m

5.0m

5.2m

5.3m

5.4m

N

Project Details	WIE10667-101: Stag Brewery
Figure Title	Figure A4: Site Investigation Plan
Figure Ref	WIE10667-101_GR_GERA_A4A
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\gera\issued figures

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Site Boundary - East Site

Site Boundary - West Site

MEWS
THAMES BANK
Shingle
Leyden House
Old Stables
Tudor Lodge
LB
Thames Bank House
Asplin Cottage
Aynescombe Cottage
The Ship (PH)
Hard
Sluice
Navigation Light
MP
Jetty
SM
Sloping masonry
Path
Ship Lane Pipework
Red Court
Combe House
WILLIAMS LANE
Posts
Post
El Sub Sta
Tank
MAINTENANCE BUILDING
PROPAGATION TANK
CHEMICAL STORAGE CONTAINERS AND WASTE OIL TANK 1
HYDROCHLORIC ACID, CAUSTIC SODA AND LCT TANKS
EFFLUENT TANK
CHEMICAL STORAGE CONTAINER
FINISHING BUILDING
FILTRATION BUILDING
WEST SITE
BREWHOUSE
SALT TANK
CAUSTIC SODA TANK
HYDROCHLORIC ACID TANK
ENERGY CENTRE
GLYCOL CARBON FILTER TANK
SHIP LANE
MALTING BUILDING
CHEMICAL STORAGE CONTAINERS
BOTTLING WAREHOUSE
EAST SITE
Mooring Posts
BULLS ALLEY
HEALTH CENTRE
WORKSHOP, BAR AND CANTEEN
Sorting Office
PLAYING FIELD
CLUB HOUSE
PRODUCTION OFFICE
WB
PH
CROMWELL PLACE
WADDEN ROAD
Scrap Yard
LOWER RICHMOND ROAD
CR
Ward Bdy
MORTLAKE
N

Project Details	WIE10667-101: Stag Brewery
Figure Title	Figure A5: Stag Brewery Plot
Figure Ref	WIE10667-101_GR_GERA_A5A
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\gera\issued figures

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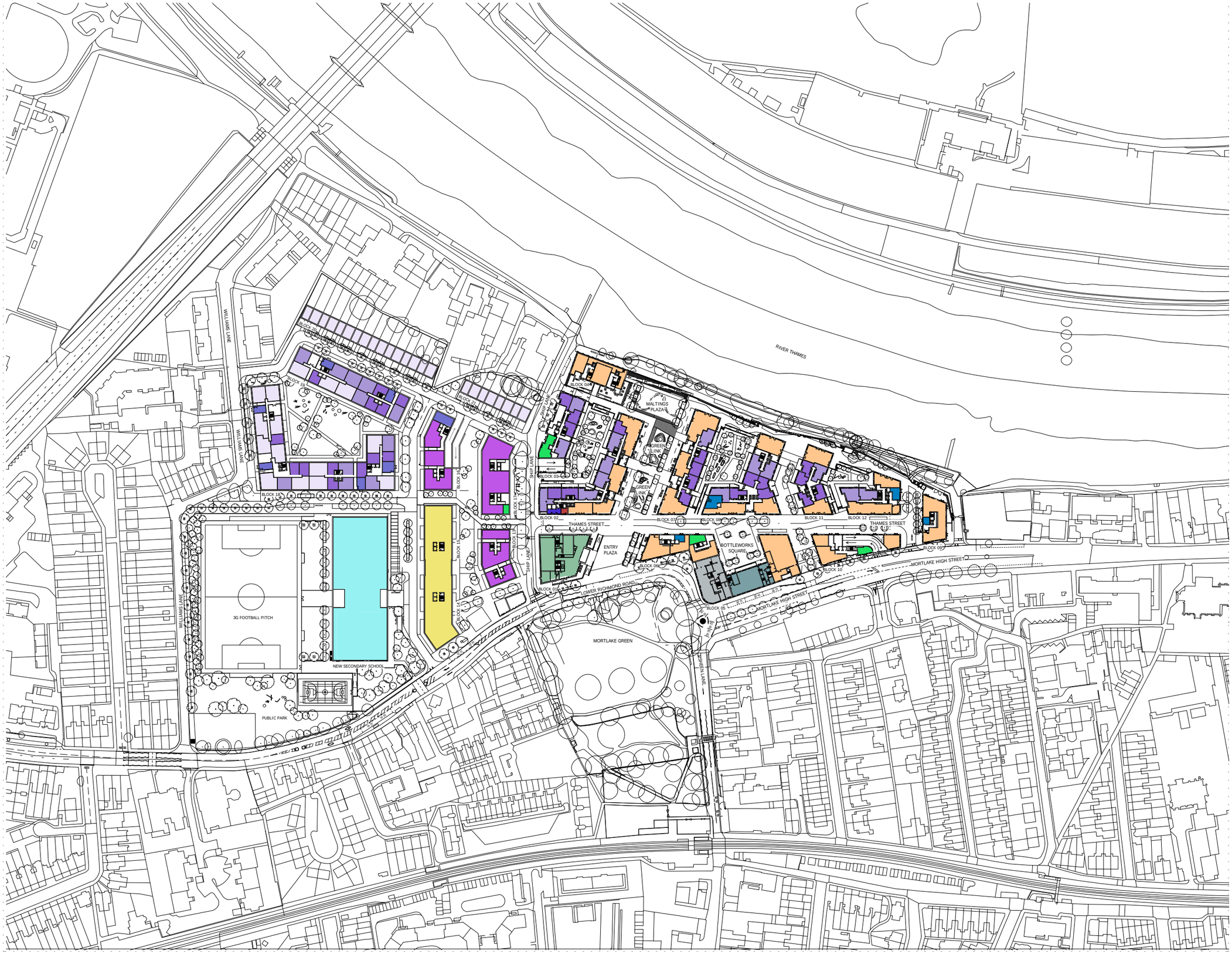

NOTES:

DO NOT SCALE FROM THIS DRAWING. ALL DIMENSIONS TO BE CHECKED ON SITE. ALL OMISSIONS AND DISCREPANCIES TO BE REPORTED TO THE ARCHITECT IMMEDIATELY.

NORTH

- 1 BED
- 1 BED (L)
- 1 BED (S)
- 2 BED
- 2 BED (L)
- 2 BED (M)
- 3 BED
- 3 BED (H)
- 4 BED
- 4 BED (H)
- ASSISTED LIVING
- CAR PARK ENTRANCE
- CARE HOME
- CINEMA
- CORE
- FLEXIBLE USE
- GAS METER ROOM
- HOTEL
- OFFICE
- PLANT
- REFUSE
- REFUSE STORE
- RESTAURANT/BAR
- SCHOOL
- SMOKE
- SUBSTATION

Revision description	Date	Check	Rev
FINAL DRAFT PLANNING APPLICATION	18/01/18	BJ	-

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Project

Stag Brewery
Richmond

Drawing

PROPOSED MASTERPLAN
GROUND FLOOR LEVEL

Drawn	Date	Scale
TC	01/18/18	1 : 1250 @ A1 1 : 2500 @ A3

Job Number	Drawing number	Revision
16019	C645_MP_P_00_001	-