APPENDIX 11.2
ENVIRONMENTAL RISK ASSESSMENT (DEVELOPMENT AREA 1)

Environmental Risk Assessment

The Former Stag Brewery East Site, Mortlake, London

February 2018

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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
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Comments

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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.

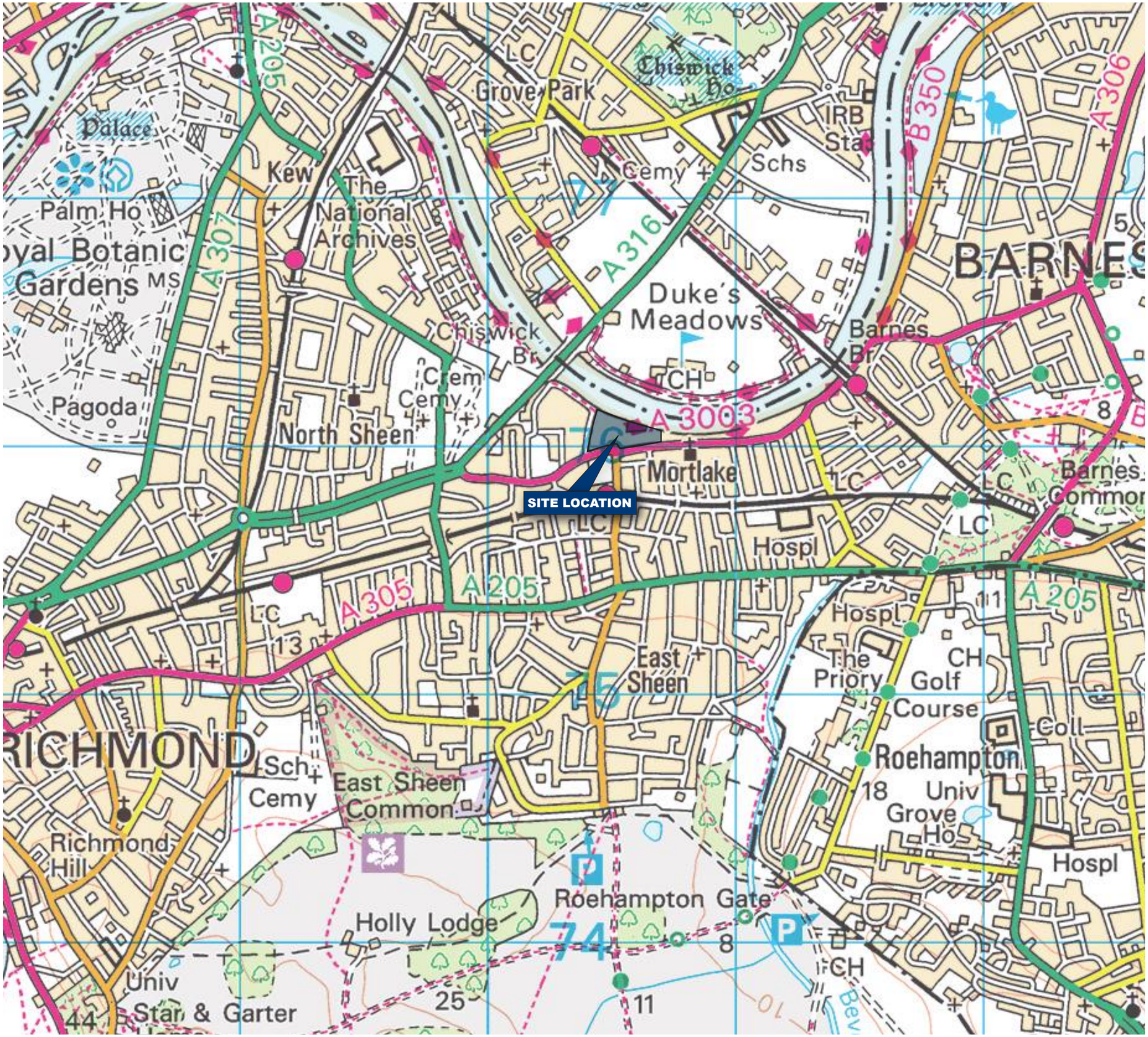
13.7 Statutory Consultation

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

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Site Boundary

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

S

N

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

16m FROM RIVERWALL

MALTING BUILDING

BOTTLING WAREHOUSE

ENERGY CENTRE

HEALTH CENTRE

WORKSHOP, BAR AND CANTEEN

MORTLAKE

Brewery

Sorting Office

Old Stables

Thames Bank House

Tudor Lodge

Asplin Cottage

Aynescombe Cottage

The Ship (PH)

Ship Lane Passage

Aynescombe Path

Hard

Sluice

Navigation Light

Jetty

SM

MP

Path

Sloping masonry

Mooring Posts

SHIP LANE

BULLS ALLEY

FB

PH

TCB

4.4m

5.9m

5.0m

5.2m

5.3m

5.4m

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
Mooring Posts
Combe House
WILLIAMS LANE
Red Court
Posts
Post
El Sub Sta
MAINTENANCE BUILDING
Tank
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
HEALTH CENTRE
WORKSHOP, BAR AND CANTEEN
Sorting Office
PLAYING FIELD
CLUB HOUSE
PRODUCTION OFFICE
MORTLAKE
CROMWELL PLACE
WADDEN ROAD
LOWER RICHMOND ROAD
Scrap Yard
BULLS ALLEY
PH
WB
CB
Ward Bdy
CR
8.5m
5.1m
5.2m
5.3m
5.9m
4.4m
5.0m
5.4m
4.1m

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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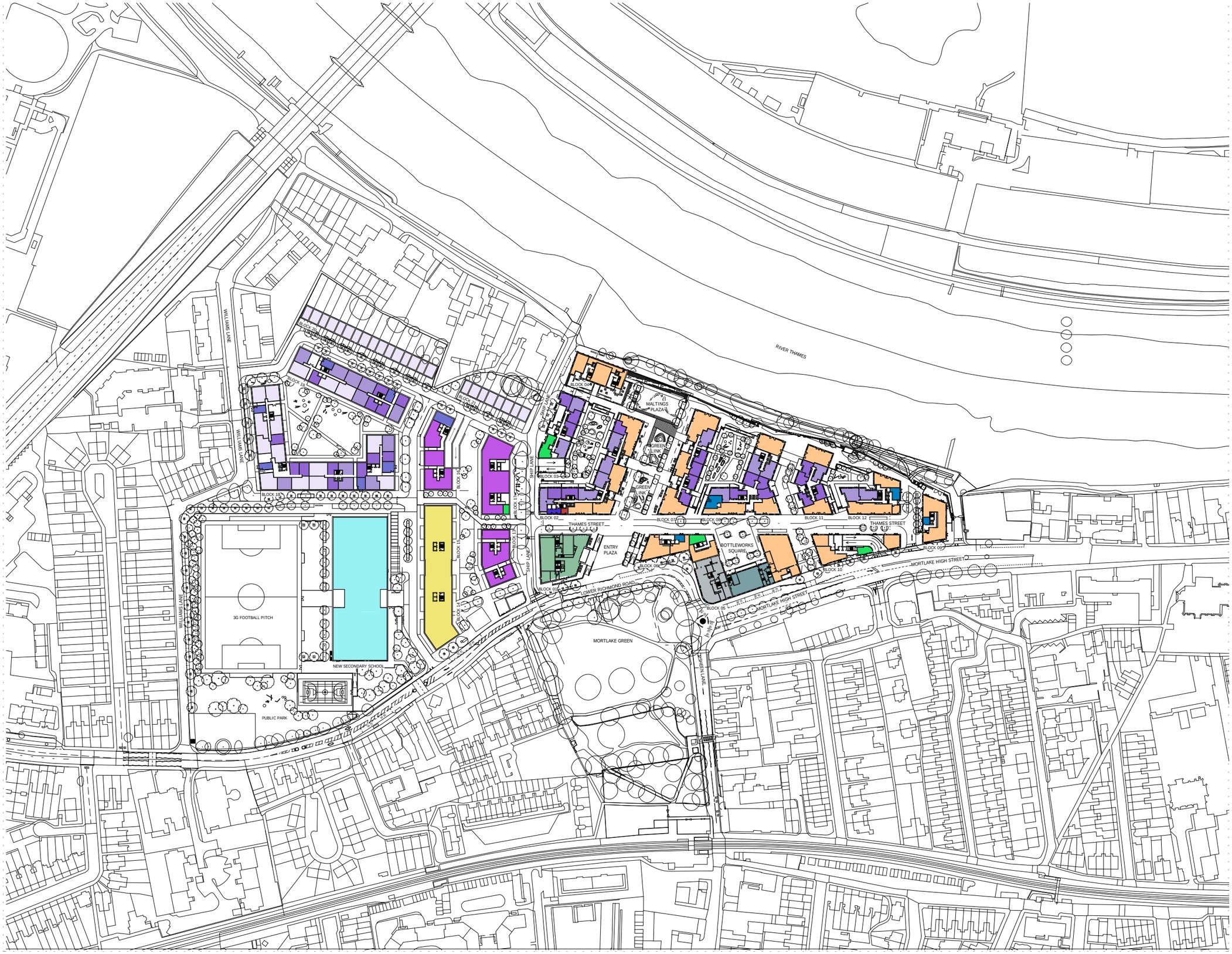

NOTES:

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
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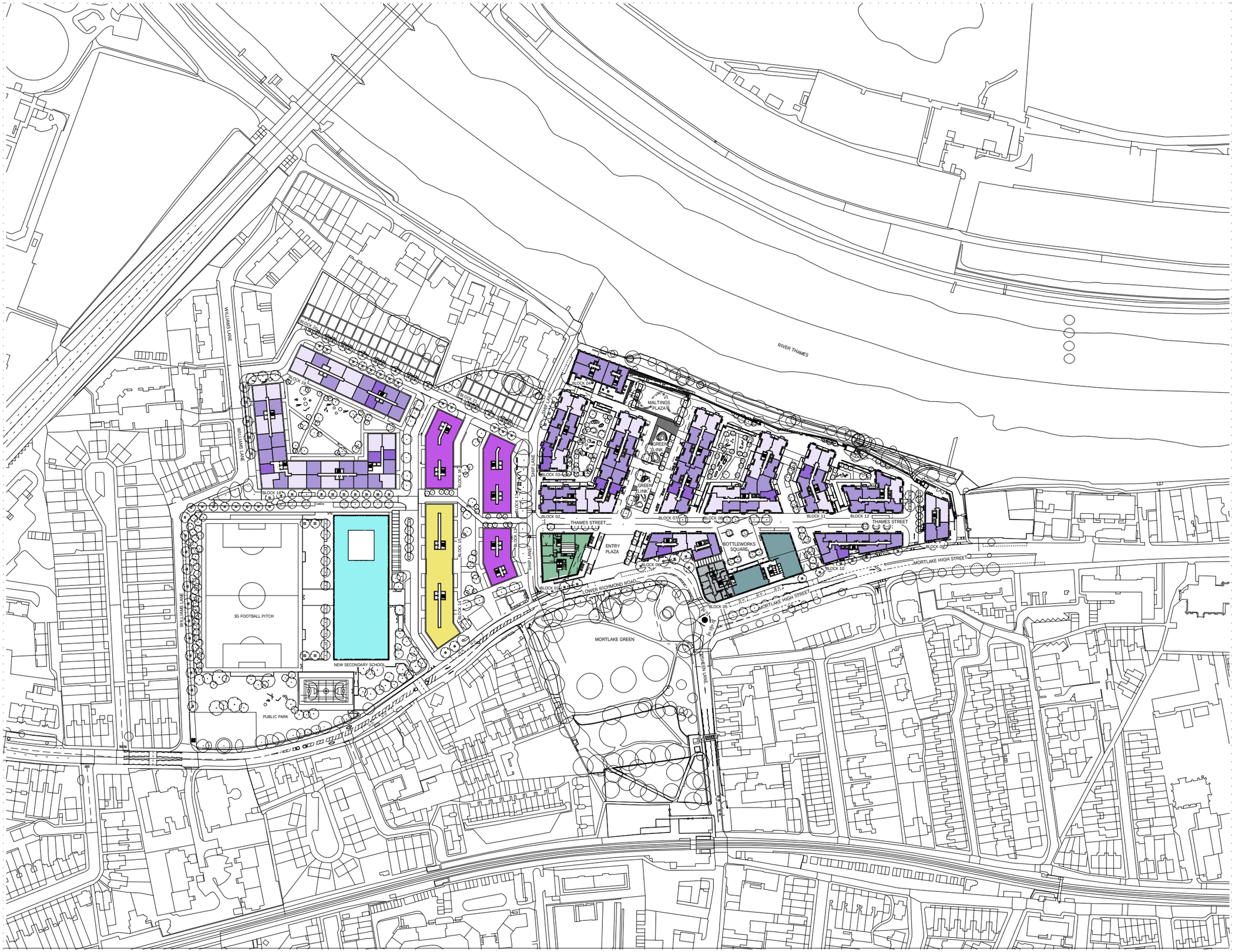

NOTES:

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)
- 2 BED (S)
- 3 BED
- 3 BED (L)
- 3 BED (S)
- 4 BED (7P)
- ASSISTED LIVING
- CARE HOME
- CINEMA
- CORE
- HOTEL
- KE
- OFFICE
- PLANT
- SCHOOL
- SMOKE

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

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Drawing

PROPOSED MASTERPLAN TYPICAL FLOOR LEVEL

Drawn	Date	Scale
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Job Number	Drawing number	Revision
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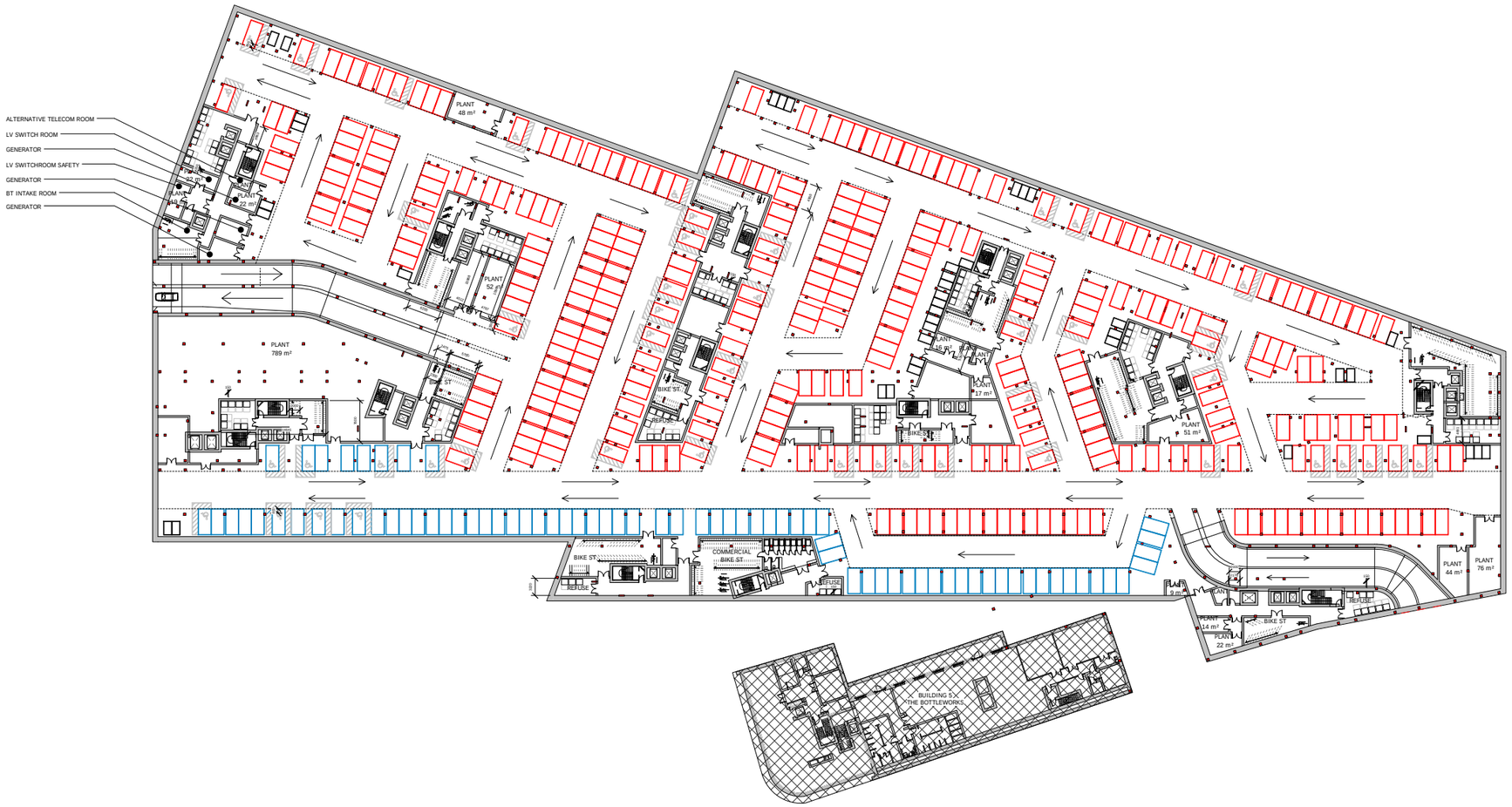

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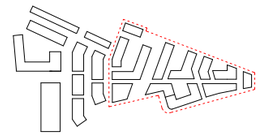

KEY

- 331 Residential Spaces
- 77 Commercial Spaces
- 42 Motorbike Spaces
- 1014 Cycle Spaces

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

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Richmond

Drawing

PROPOSED DEVELOPMENT AREA 01
BASEMENT PLAN

Drawn	Date	Scale
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Job Number	Drawing number	Revision
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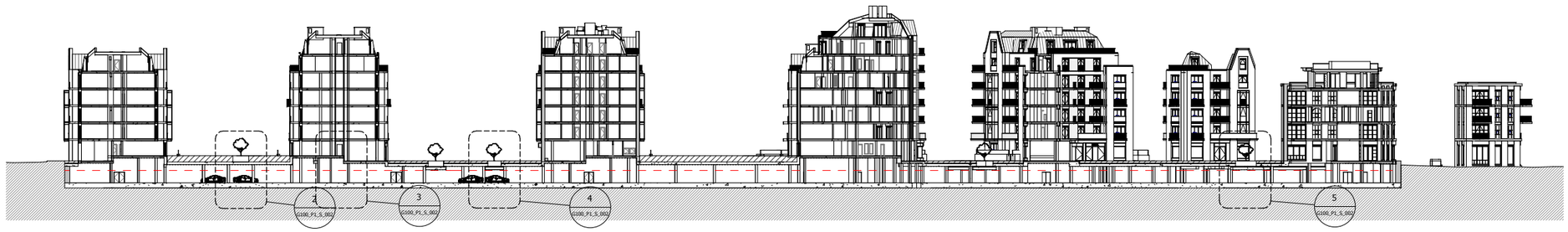
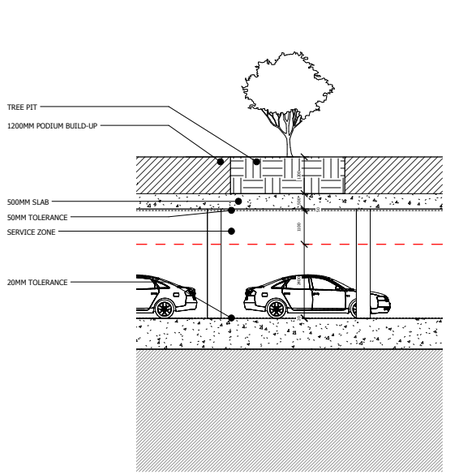
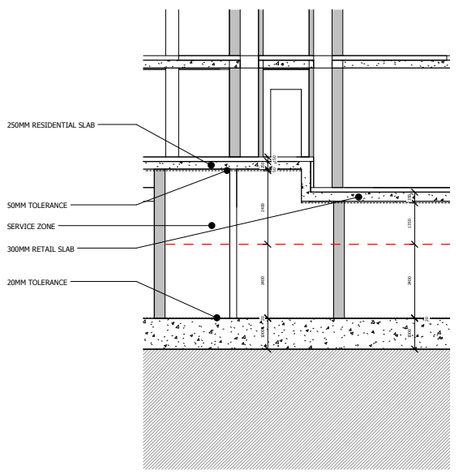


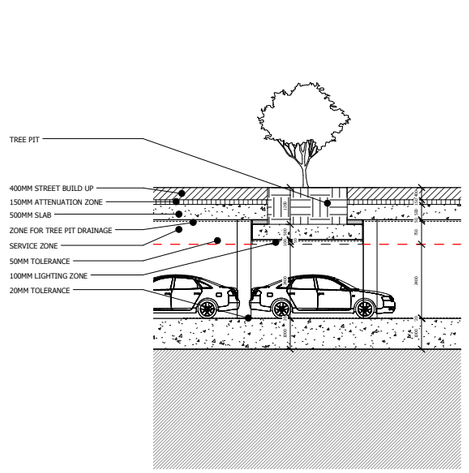
1 Basement Section_Phase 01_002
1 : 500



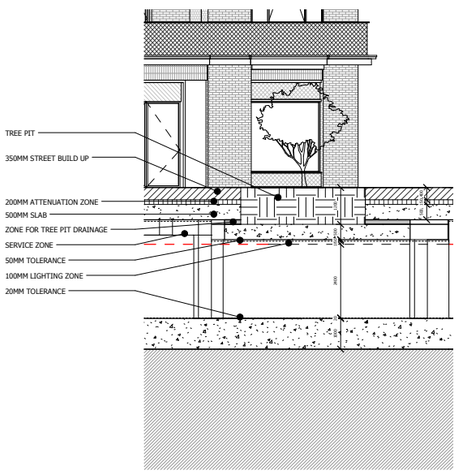
2 Basement Section_Phase 01_Podium
1 : 100



3 Basement Section_Phase 01_Slab Step
1 : 100



4 Basement Section_Phase 01_Boulevard
1 : 100



5 Basement Section_Phase 01_Main Street
1 : 100

Revision description	Date	Check	Rev
ISSUE TO DESIGN TEAM	25/10/17	BJ	A
SCENARIO 2 DESIGN FREEXE	11/08/17	BJ	-

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Richmond

Drawing
PHASE 01 - BASEMENT SECTIONS 02

Drawn	Date	Scale
RKL	12/02/16	As indicated@ A1 @ A3

Job Number	Drawing number	Revision
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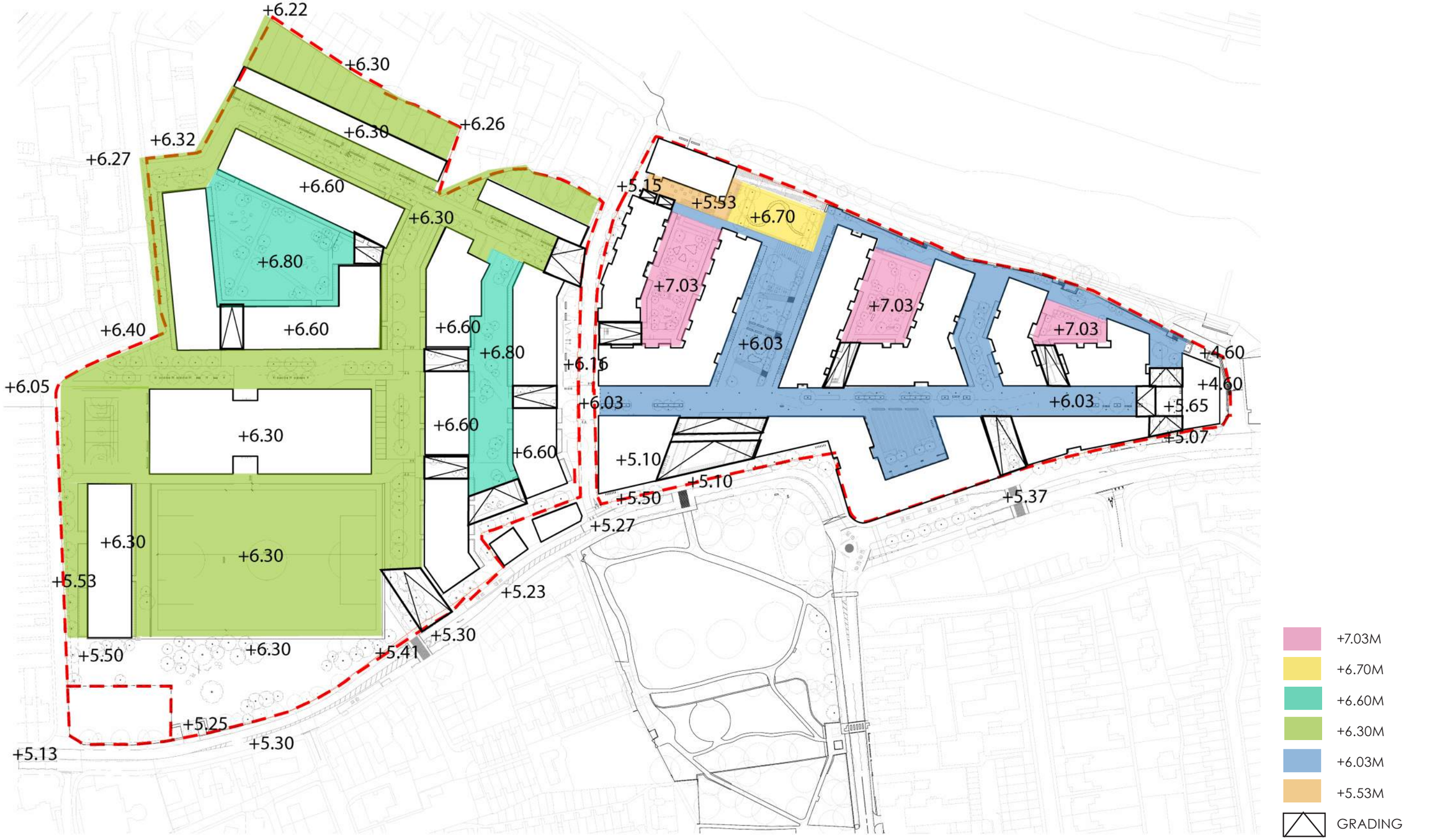

GILLESPIES

PROJECT TITLE

STAG BREWERY

DRAWING TITLE

LANDSCAPE LEVEL PLAN

SCALE

NOT TO SCALE @A3

DATE

06.09.2017

S

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SITE EXTENT

PROPOSED BUILDING

PROPOSED BUILDING

PRESENCE OF BASEMENT AND REMOVAL OF MADE GROUND WILL BREAK THE GROUND GAS AND VAPOUR PATHWAY FOR NEW BUILDINGS. RISK TO EXISTING BUILDINGS TO BE ASSESSED WITH FURTHER MONITORING.

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

WINDBOURNE DUST PRVENTED BY DUST SUPRESSION

RIVER THAMES

SITE RAISED AS PART OF FLOOD MITIGATION

BUILDING FOUNDATIONS APPROPRIATELY PROTECTED AGAINST CHEMICAL ATTACK

MATERIAL EXCAVATED FROM BASEMENT USED TO RAISE SITE LEVELS

RUN-OFF PROVENTED BY APPROPRIATE CONSTRUCTION TECHNIQUES

PERCHED GROUNDWATER

CONSTRUCTION WORKERS IN TRENCHES USING APPROPRIATE PPE / RPE

SOILS STOCKPILED DURING CONSTRUCTION WORKS

PROPOSED BASEMENT

RIVER WALL

SECONDARY AQUIFER

PILE DEPTH NOT LIKELY TO PENETRATE LONDON CLAY FORMATION, NO PATHWAY TO UNDERLYING AQUIFERS CREATED

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 A6: Conceptual Site Model
Figure Ref	WIE10667-101_GR_PERA_A6B
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\pera\issued figures

Appendix B Site Photographs

- **Plates 1-12**

Photograph 1. Entrance to the East Site

Photograph 2. General conditions at East Site

Photograph 3. Interior of packaging warehouse

Photograph 4. General conditions at East Site

Photograph 5. General conditions at East Site

Project Details	WIE10667-101: Stag Brewery, Mortlake
Figure Title	Figure B1: Site Photograhps
Figure Ref	WIE10667-101_GR_GERA_B1A
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\gera\issued figures

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Photograph 6. General condition of River Wall adjacent to the Site

Photograph 7. Ground investigation works in progress

Photograph 8. Typical completed borehole

Photograph 9. Follow-up groundwater monitoring works

Photograph 10. Typical completed borehole

N

Project Details	WIE10667-101: Stag Brewery, Mortlake
Figure Title	Figure B2: Site Photograhps
Figure Ref	WIE10667-101_GR_GERA_B2A
Date	2017
File Location	\\s-lncs\wiel\projects\wie10667\101\graphics\gera\issued figures

Appendix C Soil Consultants Geotechnical Report

- **Soil Consultants - Report On Preliminary Ground Investigation: Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET. November 2016 (*report ref. 10022/OT/JRCB*)**

Soil Consultants
Ground Investigation
Geotechnical Analysis
Contamination Assessment

REPORT ON PRELIMINARY GROUND INVESTIGATION

PROPOSED REDEVELOPMENT:

STAG BREWERY, LOWER RICHMOND ROAD, MORTLAKE, LONDON SW14 7ET

Client:	**RESELTON PROPERTIES LIMITED**
Agent:	**DARTMOUTH CAPITAL ADVISORS LIMITED**
Engineers:	**WATERMAN STRUCTURES LIMITED** **Pickfords Wharf, Clink Street** **London SE1 9DG**
Report reference:	**10022/OT/JRCB**
Date:	**08 November 2016 (Rev.0)**

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REPORT ON PRELIMINARY GROUND INVESTIGATION

PROPOSED REDEVELOPMENT:

STAG BREWERY, LOWER RICHMOND ROAD, MORTLAKE, LONDON SW14 7ET

DOCUMENT ISSUE STATUS:

Issue	Date	Description	Author	Checked/approved
Rev 0	**08 November 2016**	**First issue**	**Opher Tolkovsky** BSc, MSc, DIC, CGeol, FGS	**John Bartley** BSc, MSc, FGS, CGeol

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Fieldwork, in-situ testing

- Cable percussion borehole records
- Dynamic sample borehole records
- Standard Penetration Test (SPT) results
- SPT hammer energy certificates

Laboratory testing and monitoring

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- Plasticity charts
- Particle size distribution results
- Summary of undrained shear strength test results
- Soluble Sulphate/pH results (QTS Environmental)

Ground model/summary plots

- SPT and c_u vs depth
- Depth to top – River Terrace Deposits
- Depth to top – London Clay Formation
- Schematic geological cross sections

Plans & drawings

- Architectural drawings
- Topographical survey drawings
- Site Plan
- Location Maps

1.0 INTRODUCTION

Consideration is being given to the redevelopment of the former Stag Brewery site, Mortlake, which is to be demolished and replaced with educational, commercial, retail, leisure and residential apartment blocks (3-8 storeys) with a single storey basement to provide car parking facilities and plant rooms.

The redevelopment is to be carried out in three phases. The current preliminary exploratory work was restricted to Phases 1 and 2 (east of Ship lane) and this report specifically relates to those areas. However the review of available data does include some historical information within the Phase 3 area which we also comment on for completeness.

In connection with the proposed works, Soil Consultants Ltd (SCL) were commissioned by Dartmouth Capital Advisors Ltd, on behalf of Reselton Properties Ltd (the Client) to carry out a ground investigation to include the following elements:

- Review of existing geological/geotechnical information
- Limited intrusive work (eastern part of the site only) to identify the ground sequence
- Geotechnical and contamination sampling
- Geotechnical laboratory testing
- Factual and interpretative reporting of geotechnical results

This report reviews the existing information available, describes the investigation undertaken and then provides the exploratory and field/laboratory testing records together with preliminary geotechnical recommendations. Contamination/environmental assessment is being undertaken separately by Waterman Infrastructure & Environment (WIE), who have also undertaken the Desk Study of the site.

2.0 SITE DESCRIPTION

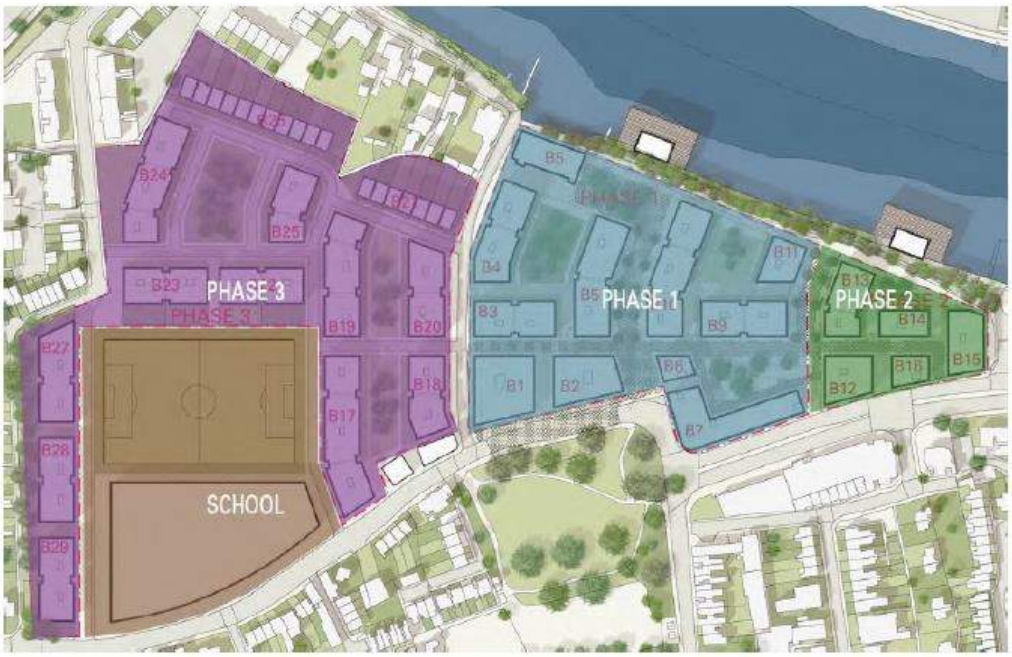
The site is located in Mortlake in the London Borough of Richmond upon Thames and is centred at approximate National Grid reference of 520410E, 176030N. The overall site is bound to the north by River Thames, to the south by Lower Richmond Road/Mortlake High Street, to the west by Williams Lane and to the east by Bulls Alley. The overall site is divided into two by Ship Lane.

The site is a triangular-shaped plot of land which covers an area of approximately 9 hectares (22 acres). The existing site level (shown on APR Services, 'Land Survey', Drawing No. 915213-7, July 2015 - see copy in the Appendix), lies at approximately +4.5m to +6.5mOD with the highest ground to the west falling down to the east. We understand that the proposed site levels will be similar to the existing.

The site contains many disused building with the majority of the remaining areas comprising access roads, loading bays and hardstanding. The bottling plant dominates the eastern half of the site whilst the south-western corner of the site comprises a grassed sports ground. The site is almost totally devoid of vegetation with the exception of a row of large trees (Sycamore or London Plane?) along the western side of Ship Lane, and on the periphery of the sports ground.

The current proposal is to carry out the majority of the development in three phases (Phases 1 to 3) as shown below. Phases 1 and 2 comprise the eastern half of the site, east of Ship Lane and Phase 3 comprises the western half of the site.

Whilst we discuss some elements of previous investigations and historical borehole information which fall into the Phase 3 area, at this stage the exploratory work carried out for this preliminary investigation was restricted to Phases 1 and 2.



3.0 PREVIOUS INVESTIGATIONS

Three previous investigation reports (within the site) have been obtained, which are summarised below.

1. *Soil Consultants Ltd - Project Stabilise, Budweiser Stag Brewing Company Ltd, Ref. 3665/JAD/TSR, January 2004*

    - This investigation comprised 3no boreholes, up to 12.5m deep located in the western site area between the sports ground and Ship Lane.

    - The boreholes proved a succession of made ground followed by localised superficial soils, River Terrace Deposits and the London Clay Formation

    - The made ground was highly variable, including soft clay, attaining a thickness of between 0.8m to 1.7m. At one location this overlay soft sandy clay with scattered gravel extending to about 2.2m depth. Generally dense sand and gravel to between about 5.5m and 6m depth was present in all boreholes. The London Clay Formation was then met, described as firm to stiff becoming stiff grey fissured clay, slightly silty in part and with local brown staining at top, which continued

to the base of the boreholes. Groundwater was recorded within the sand and gravel layer, at between 5.1m and 5.6m depth.

2. *Ground Explorations Ltd – Report on Exploration of ground conditions, Report No. 8320/RSW/vw, June 1980*

   - This investigation comprised 3no boreholes, up to 15.0m deep, located in the eastern part of the site

   - The boreholes proved a succession of made ground followed by River Terrace Deposits (two boreholes) and the London Clay Formation (all three boreholes)

   - The made ground was variable, including granular and cohesive deposits, attaining a thickness of between 1.5m to 4.6m. Generally dense or very dense sand and gravel was present in two of the boreholes to about 5.5m depth. The London Clay Formation was then present, directly beneath the made ground in one borehole, comprising stiff brown fissured clay becoming stiff to very stiff grey fissured silty clay with depth. Groundwater was recorded within the boreholes at between 3.0m and 4.0m depth, with standing water level recorded at 2.6m bgl in BH2

   - The eastern side of the site is indicated in the report to contain infilled basements

3. *AECOM – Phase 2 Environmental Site Assessment Report – Report Ref. 47075502, September 2015*

   - 31no shallow boreholes were drilled to a maximum depth of 6.0m

   - Where penetrated made ground was generally proven across the site to between 1.2m and 2.6m depth; buried obstructions (relict concrete slabs) were encountered at eleven locations, at a maximum depth of 3.6m in one of the boreholes (where the base of the made ground was not proven)

   - Superficial deposits were present beneath the made ground (where penetrated) comprising both soft cohesive soils, extending to a maximum of 2.6m bgl, followed by sands and gravels. The full thickness of the gravel was only recorded in one borehole at about 5m depth

   - The top of London Clay Formation was only proven in one borehole at about 5m depth. AECOM refer to an earlier investigation (2003) which investigated the western half of the site plus the south-western corner of the eastern site area, and this recorded the top of the London Clay at between 6.5m and 6.9m bgl, and at one position it was not present to the base of the BH at 7.2m depth. The report notes, however, that the use of auger drilling techniques means that the depths recorded may not be very accurate.

- Groundwater monitoring indicated water depths range between 3.57m and 5.14m bgl. A small tidal influence of 60mm was measured over a short period of 2.5 days – although it is not stated whether this reflects a spring tide condition where the water range differences between low and high tide are at their highest

4. In addition to the above investigations, several historical BGS borehole records are also available, the most recent and detailed of which are summarised below:

   - TQ27NW/393 – Cementation Ground Engineering borehole from 1972: located in the western part of the site, close to the SCL boreholes described above. Encountered made ground to 1.2m depth followed by soft to firm sandy clay to 1.5m, sand and gravel to 6.4m and stiff London Clay to the base of the borehole at 10.05m. Water strike at 6.1m

   - TQ27NW/394 – Cementation Ground Engineering borehole from 1972: located in the central area of the western part of the site. Encountered made ground to 0.9m depth followed by sand and gravel to 6.85m and stiff London Clay to the base of the borehole at 20.0m. Water strike at 6.1m

   - TQ27NW/398 – Cementation Ground Engineering borehole from 1972: located near Ship Lane in the western part of the site. Encountered made ground to 1.5m depth followed by firm silty clay to 1.85m, sand and gravel to 7.6m and stiff London Clay to the base of the borehole at 15.0m. Water at 4.9m and seepage at 4.55m

   - TQ27NW/924 – Exploration Associates borehole from 1995: located beneath the current bottling plant in the eastern part of the site. Encountered made ground to 1.4m depth followed by sand and gravel to 4.8m and very stiff London Clay to the base of the borehole at 15.0m. Groundwater not encountered during drilling

4.0 CURRENT SCL EXPLORATORY WORK

The SCL fieldwork was carried out in October 2016 and comprised the elements detailed below. The exploratory positions were determined following discussions with Waterman Structures Ltd. Sampling procedure for the environmental samples was in accordance with BS10175 and WI&E requirements. UXO specialist site attendance provided detection/clearance during the works.

Cable percussion boreholes

4no cable percussion boreholes (BH1 and BH2, 2A, 2B) were constructed using a cable percussion drilling rig. A summary of depths and inferred ground levels is given in the table below.

BH	Ground Elevation*	BH depth (below ground level)
1	+5.15m OD	30.00m
2	+4.81m OD	3.60m
2A*	+4.80m OD	3.50m
2B	+4.96m OD	30.00m

(Levels from GPS survey except for 2A whose level was inferred from the site survey drawing)

BH2 and BH2A were terminated due to encountering impenetrable concrete obstructions.

In situ Standard Penetration Tests (SPTs) were undertaken at regular intervals and representative soil samples, both disturbed and relatively undisturbed, collected for description and for testing.

The calibration certificate for the cable percussive drilling rig SPT equipment used indicates that Energy Ratio, Er, of 66% should be used to provide corrected N_{60} values in line with the recommendations given in BS EN 22476-3, 2005, National Annex A.

Dynamic sampler boreholes and dynamic probe tests

15no dynamic (windowless) sampler boreholes (WS1 to WS7, WS7A, WS8, WS8A, WS9, WS9A, WS10. WS10A and WS11) were completed using a small tracked rig, under the supervision of SCL, to depths of up to 5.5m bgl. SPTs were carried out in the natural strata and disturbed samples were taken for subsequent laboratory testing. Several of the boreholes were refused on obstructions within the made ground – WS6 at 0.5m, WS7 at 0.8m, WS7A at 1.4m, WS8 at 1.0m, BH10 at 1.6m, and WS11 at 0.7m depth.

The calibration certificate for the dynamic sampler drilling rig SPT equipment used indicates that Energy Ratio, Er, of 79% should be used to provide corrected N_{60} values in line with the recommendations given in BS EN 22476-3, 2005, National Annex A.

PID testing

PID (photo-ionisation detector) headspace testing was undertaken during the fieldwork on all made ground and shallow natural soil samples, and the results are shown on the relevant exploratory records in the Appendix.

Groundwater and gas installations

50mm ID HDPE monitoring standpipes were installed in most of the boreholes (with the exception of WS3, 6 & 11) into the London Clay Formation, with a filter/response zone generally within the Made Ground, to facilitate water/gas monitoring by Waterman Infrastructure & Environment.

A summary of the borehole installations is provided below:

Summary of pipe installation			
Installation reference (and nominal internal pipe diameter)	***Pipe tip***		***Response zone***
	Depth (m bgl)	***Approx. elevation (m OD)***	***Depth (m bgl)***
BH1	6.00	-0.85	1.00 to 6.00
BH2B	5.00	-0.05	1.00 to 5.00
WS1	5.00	+1.12	1.00 to 5.00
WS2	2.00	+4.10	1.00 to 2.00
WS4	5.00	+0.85	2.00 to 5.00
WS5	5.00	+0.76	2.00 to 5.00
WS7A	1.40	+3.83	0.50 to 1.40
WS8A	2.50	+2.65	1.00 to 2.50
WS9A	3.70	+1.20	1.00 to 3.70
WS10A	4.00	+0.90	1.00 to 4.00

Geotechnical laboratory testing

The following geotechnical laboratory testing was completed:

- Natural moisture content and index properties tests (Atterberg Limits)
- Undrained triaxial testing
- Particle size distribution
- Soluble sulphate/pH analyses (tested by QTS Environmental Ltd)

The borehole records are included in the Appendix, together with a Site Plan which shows the exploratory locations.

5.0 GEOLOGY AND GROUND CONDITIONS

Reference to published 1:50,000 scale BGS map indicates that the site is underlain by Kempton Park Gravel Formation, overlying the London Clay Formation, shown to extend to at least 45m depth in nearby historical boreholes. Alluvium, associated with The River Thames, is shown along the southern bank of The Thames, immediately to the north of the site. Historical BGS borehole from the 19th and early 20th centuries at the brewery site indicate that the London Clay Formation is about 60m thick and the chalk is present (below the Lambeth Group and Thanet Beds) at about 81m to 83m depth below ground level.

The various ground investigations (as discussed in Section 3.0) at the site confirmed the anticipated upper sequence as summarised below. The appended strength/depth graph and cross sections through boreholes should also be referred to as they readily illustrate the sequence.

It must be understood that the following summary is based on generally widely spaced boreholes (up to about 100m) and hence there can be expected to be further variation between these positions.

5.1 Made ground

Hard surfacing across the site comprised concrete (some reinforced) and/or asphalt. The underlying made ground typically ranged in thickness between about 1.0m and 3.0m, but locally, at the west of the site was <1.0m thick. In the extreme east, thicknesses of up to 4.6m of made ground were recorded.

The made ground varied in composition both laterally and vertically over short distances. It generally comprised variable, non-engineered mixtures of grey or brown silty sand, locally clay, and gravel size pieces of mostly concrete, flint and brick but also stone, asphalt, clinker, glass, metal, wood and occasional cobble to boulder size concrete and brick pieces. Obstructions from former structures were commonplace in the eastern part of the site, where made ground thicknesses were the greatest, with likely buried/infilled basements being present. The backfill to numerous service runs can also be expected. Several of the boreholes were terminated within concrete obstructions at this part of the site, between about 3.0m and 3.6m depth bgl.

5.2 Alluvium

Alluvium was recorded beneath the made ground in fourteen of the fifty one borehole records we have reviewed, which includes the current boreholes. Where present, the stratum was 0.35m to 1.5m thick (averaging about 0.9m), reaching depths of between 1.5m and 2.8m bgl, and approximate levels ranging between +3.0mOD and +4.9mOD. The stratum generally comprised brown/dark brown, locally grey/orange mottled clay/sandy clay, with occasional to some flint gravel. Occasional roots were also noted. The consistency of the clay was assessed as generally being soft, locally firm.

The distribution of the alluvium across the site has no discernible trend, being recorded in several boreholes in the southern area of the eastern part of the site, and, more frequently, at various locations across the western half. It is thus likely that this natural stratum has been removed from much of the site by the previous development and is now replaced by made ground.

Plasticity Indices (PI) of 14% and 19% and Liquid Limits of <40% were measured on two samples, indicating the alluvium to be low to intermediate plasticity (BS classification) and a low volume change potential (NHBC classification).

5.3 Kempton Park Gravel

The Kempton Park Gravel was present in almost all boreholes where the made ground was fully penetrated and described as brown or light brown, locally greyish or orange brown mixture of slightly silty/silty sand and gravel, locally clayey or very clayey. The gravel comprised fine to coarse flint.

The stratum attained a thickness of between 1.2m and 5.95m (averaging 3.67m), and where proven, extended to depths of between 3.7m and 7.6m bgl (average of 5.3m). We do not have information on the ground levels at the time of the historical investigations, however, assuming these were similar to the current ground levels these depths correspond to an elevation of approximately +1.2mOD to -0.65mOD across the site, generally rising from west to east. A single borehole record (BGS borehole 398), constructed in the southern central area of the site, identified that the base of the gravel possibly occurs

at about -1.7mOD. This is greater localised depth than recorded elsewhere may be due to either a) a higher ground level being present when the borehole was drilled or b) deeper geological scouring by the gravel.

An indicative plan in the Appendix gives approximate depth zones to the top of the stratum, based on all available boreholes. The top of the gravel stratum beneath the vast majority of the western site, and the central area of the eastern half of the site, are indicated to be in the range of 1m to 2m depth bgl, whilst the western and south-eastern corner of the western half of the site, and both the northern and southern zones of the eastern half are indicated to have a thicker made ground/alluvium, with the top of the gravel stratum occurring at 2m to 3m bgl. Local areas of either shallower or deeper occurrences are also recorded in part of the west and the extreme east of the overall site. In the east (BH GE03) the gravel was absent with the made ground resting upon the London Clay at 4.6m depth.

SPT N_{60} values of between 13 and >50 blows were measured by SCL, indicating a variable medium dense to very dense state of compaction. A few results from the historical boreholes are also available giving a similar range of values, although there is no SPT hammer energy information available to produce a 'corrected' N_{60} values, thus direct comparison with the current results is not possible.

Particle size distribution tests from the SCL boreholes indicated a predominance of sand (between 32% and 93%) with gravel (generally between 5% and 68%), together with low fines (clay and silt) content ranging between 1% and 13%. It should be noted that the drilling through the granular strata necessitated the addition of water which may have washed out some of the fines from the samples with the results that fine particles may be under-represented in the tests.

5.4 London Clay Formation

The London Clay Formation was encountered beneath the Kempton Park Gravel (where penetrated), and at one of the historical boreholes in the east of the site, directly beneath made ground at 4.6m depth. It generally comprised brown/dark brown (weathered) with depth becoming dark greyish brown/grey fissured clay with occasional partings/pockets of silt/fine sand, occasional silty/slightly sandy zones, small infilled burrows, shell fragments and claystone nodules. It was necessary to undertake chiselling techniques to bypass these claystones.

The top of the London Clay was present at between 3.7m and 7.6m bgl (average of 5.3m) depth bgl (about +1.2mOD and -1.7mOD across the site) and a thin layer of reworked clay, up to 0.3m thick, containing flint gravel, was recorded locally. Whilst some of the boreholes recorded the upper zone of the clay to be brown, others did not, which indicates a variable weathered profile. The depth to the top of the London Clay across the site is shown in the indicative zone plan in the Appendix, indicating a deepening from 3m to 4m bgl in the south-east to a depth of 5m to 6m in the north-west across the eastern half of the site. Only limited data are available for the western half of the site (only covering the south-eastern corner), and these indicate depths to the top of the clay to from 5m to 6m range to 7m to 8m depth from south to north.

Plasticity Indices (PI) of >40% and Liquid Limits of >70% were measured, indicating the London Clay to be very high plasticity (BS classification) and a high volume change potential (NHBC classification).

In situ SPTs and triaxial testing indicate that the clay strength increases with depth, from an initially medium to high strength (minimum c_u of around 60kPa) at the top of the stratum, becoming very high strength below about 10m to 15m depth. The strength vs depth profile is shown in the Appendix.

The London Clay was present to the full depth investigated, maximum of 30m bgl in our boreholes at the eastern half of the site (about -25mOD minimum); historical BGS boreholes indicate a thickness of around 60m beneath the site.

5.5 Groundwater

Groundwater inflows were noted within the Kempton Park Gravel in SCL BH1 (at 4.3m sealed out by the casing at 5.0m) and in BH2B (at 3.20m sealed out at 4.15m). In the deeper dynamic sampler boreholes water was recorded at between about 2.9m and 4.5m depth, whilst several of the boreholes remained dry throughout.

The historical BGS boreholes recorded groundwater depths at about 4.5m and 6.1m bgl. The Ground Explorations 1980 investigation reported water at between about 2.6m and 4.0m, and the SCL boreholes of 2004 recorded groundwater within the superficial deposits at between 5.1m and 5.6m depth. More recently, groundwater monitoring by AECOM indicated water depths ranging between 3.57m and 5.14m bgl. A small tidal influence (of 60mm) was measured over a short period of 2.5 days – although it is not stated whether this reflects a Spring tide condition where the water range differences between low and high tide are at their highest.

Standpipe monitoring was undertaken by Waterman following the current investigation fieldwork and the results at the time of writing are summarised below:

Summary of available groundwater monitoring by WIE				
Installation reference	***Approximate pipe base***		***Water depth/level 27 October 2016***	
(all pipe 50mm ID)	***Depth (m bgl)***	***Elevation (m OD)***	***Depth (m bgl)***	***Elevation (m OD)***
BH1	5.87	-0.72	3.82	+1.33
BH2B	4.90	+0.06	3.51	+1.45
WS1	4.70	+1.42	4.48	+1.64
WS2	2.07	+4.01	Dry	N/A
WS4	4.49	+1.36	4.10	+1.75
WS5	3.18	+2.58	3.09	+2.67
WS7A	4.52	+0.71	4.42	+0.81
WS8A	2.42	+2.73	Dry	N/A
WS9A	0.85	+4.05	Dry	N/A
WS10A	3.90	+1.00	2.30	+2.62

Notes:

1) Ground levels from GPS survey
2) Pipe base shown is as measured during monitoring – reflecting some silting up of the installation

There is no current information available for the western half of the site, however, the recorded levels in the eastern half are similar to those recorded historically and we do not anticipate significant variations between the eastern and western halves of the site. Some variability should, however, be expected due

to former structures and geological variations. Seasonal variations and some tidal influence should also be anticipated.

5.6 Environmental observations

No visual or olfactory signs of gross contamination were observed in any of the strata and all PID headspace measurement indicated nil or very low concentrations of volatile hydrocarbons (all <5ppm with the exception of three results, maximum 16.3ppm) within the made ground and upper natural soils. Asbestos containing materials (ACMs) were not visually observed in our boreholes but these are common in made ground and in buildings constructed before 2000. Reference should be made to the WIE report in this regard.

6.0 PRELIMINARY GEOTECHNICAL ASSESSMENT

The overall scheme proposal (Phases 1, 2 and3) is to demolish the existing buildings and infrastructure, and redevelop the site with educational, commercial, retail, leisure and residential apartment blocks, with a single storey basement to provide car parking facilities and plant rooms to the development. A minimum headroom height in the proposed basement is to be approx. 4.0m to 4.5m and a raft thickness of approx. 850mm thick is proposed. The total excavation depth is expected to be up to about 7m, equating to an elevation of approximately -2.0mOD.

There will be a mix of building heights across the site of between 3-8 storeys. The residential blocks are likely to be concrete framed buildings utilising flat slab construction on in situ reinforced concrete columns. The proposed structure for the retail/leisure buildings is envisaged to be steel framed with composite beams and floors.

Available architectural drawings showing the proposed construction are appended.

6.1 Basement excavation and retaining wall

Based on the available borehole records, the excavation for the proposed basement, which is expected to be about 7.0m deep, will generally encounter a sequence of variable made ground, locally followed by alluvium, and then the Kempton Park Gravel. The available borehole records indicate that the London Clay Formation would be encountered at the lower part of the basement excavation, in some areas towards/at the base of the excavation, but at this stage we have insufficient deep borehole information to fully assess the geological sequence at the western half (Phase 3) of the overall site in particular.

Based on limited/partial available information depth to the London Clay Formation appears to deepen (and be at a lower elevation) from east to west within the Phase 1 and 2 area, and within the Phase 3 area it appears to be slightly deeper.

From the historical information and recent monitoring in 2016 (by Waterman), steady-state groundwater levels are expected to be around 1.5m to 3.5m above the formation level, within the superficial deposits and made ground, although this must be verified by further monitoring as levels may rise during wet periods. Limited information available at the time of writing, from a previous investigation by AECOM,

indicates that tidal influences are not thought to be significant, however, we would recommend additional monitoring work is undertake to verify these results, as the monitoring period undertaken previously was only for 2.5 days and it is not clear whether it coincided with the highest tidal range.

As a relatively high groundwater is present we consider that an embedded water-tight retaining wall construction will be required to permit basement excavation and stop any water ingress; a sheet pile or secant bored pile wall will probably be the optimum type. Where the excavation is likely to adversely affect any remaining structures/infrastructure, a robust arrangement of temporary internal bracings/props, including support elements near the top of the basement wall, will be required to maintain wall stability and assist in controlling ground movements. The presence of reported previous basements and deep concrete obstructions, particularly in the eastern half (Phase 1 and 2) of the site, must be considered in the choice of retaining wall and measures to remove the obstructions will have to be carefully considered to avoid installation difficulties.

Careful selection of the appropriate temporary design parameters will be needed, incorporating allowances for factors such as the presence of groundwater and the possibility of soil softening – CIRIA Report C580 provides more detail.

In the permanent case the lateral earth pressures will be supported directly by the piled retaining wall or by a reinforced concrete lining wall cast within the piles. In either case horizontal support to the wall will be provided by the new ground and basement floor slabs.

The following table of coefficients may be used for the preliminary design of the basement retaining wall:

Stratum	Bulk density (Mg/m^3)	Effective cohesion, c′ (kN/m^2)	Effective friction angle, ϕ' (degrees)
Made ground and alluvium	1.80	0	25
Kempton Park Gravel	2.00	0	36
London Clay:			
<5m below basement level	2.00	0	22
>5m below basement level	2.00	5	22

The wall designer should use these parameters to derive the active and passive earth pressure coefficients, Ka and Kp. The determination of appropriate earth pressure coefficients, together with factors such as the pattern of earth pressure distribution, will depend upon the type/geometry of the wall and the overall design approach. Piled walls may of course also be used to provide vertical load capacity if required subject to the necessary allowance being made for interaction effects.

A specialist contractor/structural engineer must be consulted to confirm the most appropriate type of wall and to provide the final wall design.

6.2 Basement raft design

The current proposals are for a very large basement extending beneath the vast majority of the site. We understand that current proposals envisage the use of a reinforced concrete basement raft and consider that this should provide an eminently suitable foundation solution. We recommend that a detailed ground movement analysis is undertaken in due course to provide the design/performance information based on the findings of the ground investigations; such an analysis is outside the scope of this current report.

The basement excavation will involve the removal of approximately 7m of soil, resulting in unloading of about 130kN/m^2. This stress reduction will theoretically result in an element of heave in the London Clay beneath the site. The potential long term effect of this heave in the London Clay as it recovers should be considered during raft design and the raft must clearly be designed to withstand potential forces/movements. The stresses within a large raft will be complex and will be highly dependent on the column spacing and the relative soil and structure stiffnesses. There may be areas of net unload where some heave would be expected, with other areas of net loading where downward settlements will occur. As discussed above, these raft movements should be analysed in due course by a specialist ground movement analysis.

It will also be necessary to consider uplift of the raft due to potential hydrostatic pressures and in this respect the guidelines incorporated in BS8102:2009 should be followed. The raft design will need to take account of potential seasonal fluctuations and/or accidental/tidal and flood conditions. At this stage, subject to further monitoring and detailed hydrogeological assessment (outside our current scope) we consider that a design water level of say 2m below ground level could be used for preliminary design. Based on this water level we consider that a theoretical hydrostatic uplift pressure of 50kN/m^2 should be used for raft design (for a 7m deep excavation). This preliminary value can be regarded as the minimum design uplift pressure for the basement raft. This design water level may need to be agreed with the local building control in due course.

We understand that the site is within Flood Zones 2 & 3 and the potential effects from flooding should also be carefully considered in the design.

6.3 Piled foundations

Piles are envisaged to form the basement retaining walls and may also be required to carry structural loads as part of the retaining wall structure or within other areas of the site. For the ground conditions encountered, with groundwater being present within the superficial soils, we consider that CFA piles are likely to present the optimum type for load-bearing. Obstructions must be expected, some at depth within the made ground and these will require removal prior to piling.

The following table of coefficients may be used for the design of CFA piles, based upon the measured strength/level profile included in the Appendix.

Shaft adhesion

Stratum	Depth/level	Undrained cohesion (from strength profile)	Ultimate unit shaft adhesion 'q_s'
All made ground and natural strata (above basement excavation)	Above 7.0m depth (about -2.0mOD)	Ignore	Ignore
London Clay Formation	Below 7.0 depth (about -2.0mOD)	Increases linearly from 90kN/m^2 at a rate of 9.44kN/m^2/m	Increases linearly from 45kN/m^2 at a rate of 4.72kN/m^2/m (incorporates α = 0.50)

Notes:

a) Unit shaft adhesion 'q_s' = α x c_u (where α = 0.50 and c_u is the undrained cohesion from the design line)

b) The α value of 0.5 is based upon 102mm diameter triaxial tests and this should not be varied

c) The average shaft adhesion over the pile length should be limited to 110kN/m^2

d) The maximum value for unit shaft adhesion should be limited to 140kN/m^2

End bearing

Stratum	Depth/level	Undrained cohesion (from strength profile)	Ultimate unit base resistance 'q_b'
London Clay	Below say 15m depth (-10.0m OD approx)	Increases linearly from 165.5kN/m^2 at a rate of 9.44kN/m^2/m	Increases linearly from 1,489.5kN/m^2 at a rate of 85kN/m^2/m (incorporates Nc = 9)

Notes:

a) Unit base resistance in clay 'q_b' = Nc x c_u (where Nc = 9 and c_u is the equivalent undrained cohesion from the design line)

Using the traditional UK approach, an overall Factor of Safety of 2.6 should be appropriate when applied to these ultimate parameters, in accordance with the LDSA guidelines. Example working loads are provided below:

Pile diameter (mm)	Pile toe depth (m bgl)	Ultimate load (kN)	Working load (kN)
450	15	960	370
	20	1695	650
	25	2600	1000
600	15	1385	530
	20	2395	920
	25	3630	1395
750	15	1860	715
	20	3165	1215
	25	4745	1825
900	15	2395	920
	20	4000	1540
	25	5940	2285

Notes:

a) Working load is calculated using F_{shaft} and F_{base} = 2.6

b) Concrete stress should be considered in the final design

c) Pile length assumes top of pile at 7m depth (approximately -2.0mOD)

d) Pile capacities are given as a guide and are not constituted as design recommendations

Although groundwater inflows were not observed within the London Clay, it is noted that groundwater seepages may occur within the stratum, especially in silty/sandy zones or where claystones are present. Some modification of the pile parameters or downgrading of the pile capacities may be warranted to mitigate the possible risk of clay softening, although this should be minimal with well-installed CFA piles.

Any piles within the heave zone may be subject to an element of uplift as the clay responds to the excavation unloading, with tensile forces being generated within the shaft. The maximum tensile forces will occur if the piles are installed prior to the excavation (for example single piles with plunge columns), but even if installed following the basement excavation they could still be subjected to some tension until the axial loads are applied by the new structure. The final pile design should address the potential tensile forces and appropriate reinforcement should be incorporated.

Eurocode 7 adopts a slightly different approach, applying partial factors to the ultimate pile capacity in accordance with EC7 (BS EN 1997-1:2004 and UK National Annex) for the ultimate limit state GEO Design Approach 1, Combinations 1 and 2. The following partial factors, as recommended in the UK National Annex, are applied:

a] Model Factor, γ_{Rd} = 1.4 (Combinations 1 and 2)

b] Factor on shaft resistance, γ_s = 1.6 (Combination 2)

c] Factor on base resistance, γ_b = 2.0 (Combination 2)

When designing to EC7, the engineer must ensure that the correct comparisons are made between the Design Actions and Design Resistances. Whilst the partial factors address ULS design, serviceability checks should also be carried out.

We recommend that a specialist piling contactor is consulted at an early stage to advise on the most appropriate pile type and to ultimately provide the final pile design. If pile testing is undertaken it is probable that a lower overall factor of safety could be adopted.

6.4 Foundation concrete

Concentrations of soluble sulphates were measured in selected soil and groundwater samples as follows:

- SCL (10no samples): water soluble sulphate range <10 to 251mg/kg and pH 7.4 to 9.3
- Waterman IE (5no samples): water soluble sulphate range 23 to 472mg/kg and pH 8.5 to 11.2
- AECOM (14no groundwater samples): soluble sulphate <2 to 457mg/kg and pH of 7.1 to 8.1

The older results from the previous investigations have not been included in this assessment as there is no reliance on these results.

The above values result in an overall Site Design Class DS-1/AC-1, as provided in BRE Special Digest 1 (2005), Table C2 for cases where soil oxidation is not anticipated (for example for piling). However, the results suggest that the London Clay is probably pyritic at this site, with many of the oxidisable sulphide levels significantly exceeding 0.3%. Our preliminary recommendation is that that buried concrete which is in contact with soils that have been disturbed/potentially oxidised is designed in accordance with ACEC Site Class AC-4.

Further testing (on both water and soil samples) is being undertaken by WIE as part of the environmental assessment which must be reviewed for final design.

6.5 Further geotechnical investigations

Further comprehensive ground investigations and monitoring of water levels will be required prior to final scheme design.

The current preliminary exploratory work was restricted to Phase 1 and 2 (the eastern half of the global site) and within this area there are significant distances of up to 100m between exploratory positions. In addition contractual reliance may not be available upon some information we have reviewed; particularly the Ground Explorations report of 1980; this information will certainly be outside any warranty period. The BGS Borehole data similarly is provided publicly for information purposes only. The majority of the dynamic sampler boreholes are also of insufficient depth to provide much useful geotechnical design information. Therefore, further investigations should comprise a series of deep boreholes to confirm the levels of the various strata and the groundwater regime, in order to provide sufficient pile and basement design information.

In the Phase 3 (western half of the global site) there are very little data which can be relied upon. Presumably the Client can obtain reliance on the data in the SCL 2004 report; we would have no objection to this but again the information will be outside any warranty period. The BGS information should be used for general background information only. Therefore, in this phase a comprehensive geotechnical investigation will be required, essentially across the whole of the area, again comprising a series of deep boreholes to confirm the levels of the various strata and groundwater regime to provide pile and basement construction design information.

Of course these additional investigations can be undertaken in tandem with WIE to efficiently provide the necessary environmental coverage.

As we have discussed above, a detailed ground movement analysis will be required to assess the performance of the proposed raft. In addition, a hydrogeological assessment is likely to be required for final scheme design.

GENERAL INFORMATION, LIMITATIONS AND EXCEPTIONS

Unless otherwise stated, our Report should be construed as being a Ground Investigation Report (GIR) as defined in BS EN1997-2. Our Report is not intended to be and should not be viewed or treated as a Geotechnical Design Report (GDR) as defined in EN1997-2. Any 'design' recommendations which are provided are for guidance only and are intended to allow the designer to assess the results and implications of our investigation/testing and to permit preliminary design of relevant elements of the proposed scheme.

The methods of investigation used have been chosen taking into account the constraints of the site including but not limited to access and space limitations. Where it has not been possible to reasonably use an EC7 compliant investigation technique we have adopted a practical technique to obtain indicative soil parameters and any interpretation is based upon our engineering experience and relevant published information.

The Report is issued on the condition that Soil Consultants Ltd will under no circumstances be liable for any loss arising directly or indirectly from ground conditions between the exploratory points which differ from those identified during our investigation. In addition Soil Consultants Ltd will not be liable for any loss arising directly or indirectly from any opinion given on the possible configuration of strata both between the exploratory points and/or below the maximum depth of the investigation; such opinions, where given, are for guidance only and no liability can be accepted as to their accuracy. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant delay in using this Report.

Comments made relating to ground-water or ground-gas are based upon observations made during our investigation unless otherwise stated. Ground-water and ground-gas conditions may vary with time from those reported due to factors such as seasonal effects, atmospheric effects and and/or tidal conditions. We recommend that if monitoring installations have been included as part of our investigation, continued monitoring should be carried out to maximise the information gained.

Specific geotechnical features/hazards such as (but not limited to) areas of root-related desiccation and dissolution features in chalk/soluble rock can exist in discrete localised areas - there can be no certainty that any or all of such features/hazards have been located, sampled or identified. Where a risk is identified the designer should provide appropriate contingencies to mitigate the risk through additional exploratory work and/or an engineered solution.

Where a specific risk of ground dissolution features has been identified in our Report (anything above a 'low' risk rating), reference should be made to the local building control to establish whether there are any specific local requirements for foundation design and appropriate allowances should be incorporated into the design. If such a risk assessment was not within the scope of our investigation and where it is deemed that the ground sequence may give rise to such a risk (for example near-surface chalk strata) it is recommended that an appropriate assessment should be undertaken prior to design of foundations.

Where spread foundations are used, we recommend that all excavations are inspected and approved by suitably experienced personnel; appropriate inspection records should be kept. This should also apply to any structures which are in direct contact with the soil where the soil could have a detrimental effect on performance or integrity of the structure.

Ground contamination often exists in small discrete areas - there can be no certainty that any or all such areas have been located, sampled or identified.

The findings and opinions conveyed in this Report may be based on information from a variety of sources such as previous desk studies, investigations or chemical analyses. Soil Consultants Limited cannot and does not provide any guarantee as to the authenticity, accuracy or reliability of such information from third parties; such information has not been independently verified unless stated in our Report.

Our Report is written in the context of an agreed scope of work between Soil Consultants Ltd and the Client and should not be used in any different context. In light of additional information becoming available, improved practices and changes in legislation, amendment or re-interpretation of the assessment or the Report in part or in whole may be necessary after its original publication.

Unless otherwise stated our investigation does not include an arboricultural survey, asbestos survey, ecological survey or flood risk assessment and these should be deemed to be outside the scope of our investigation.

APPENDIX

Fieldwork, in-situ testing

- Cable percussion borehole records
- Dynamic sample borehole records
- Standard Penetration Test (SPT) results
- SPT hammer energy certificates

Laboratory testing and monitoring

- Summary of classification test results
- Plasticity charts
- Particle size distribution results
- Summary of undrained shear strength test results
- Soluble Sulphate/pH results (QTS Environmental)

Ground model/summary plots

- SPT and c_u vs depth
- Depth to top – River Terrace Deposits
- Depth to top – London Clay Formation
- Schematic geological cross sections

Plans & drawings

- Architectural drawings
- Topographical survey drawings
- Site Plan
- Location Maps

FOREWORD/GUIDANCE NOTES - CABLE PERCUSSION BORING

GENERAL

The Borehole Records are compiled from the driller's description of the strata encountered, an examination of the samples by our Geotechnical Engineer and the results of in-situ and laboratory tests. Based on this data, the report presents an opinion on the configuration of strata within the site. However, such reasonable assumptions are given for guidance only and no liability can be accepted for changes in conditions not revealed by the boreholes.

BORING METHODS

The Cable Percussion technique of boring is normally employed and allows the ground conditions to be reasonably well established. However, some disturbance of the ground is inevitable, particularly some "softening" of the upper zone of clay immediately beneath a granular soil. The presence of thin layers of different soils within a stratum may not always be detected.

GROUND WATER

The depth at which ground water was struck is entered on the Borehole Records. However, this observation may not indicate the true water level at that period. Due to the speed of boring and the relatively small diameter of the borehole, natural ground water may be present at a depth slightly higher than the water strike. Moreover, ground water levels are subject to variations caused by changes in the local drainage conditions and by seasonal effects. When a moderate inflow of water does take place, boring is suspended for at least 10 minutes to enable a more accurate short term water level to be achieved. An estimate of the rate of inflow is also given. This is a relative term and serves only as a guide to the probable flow of water into an excavation.

Further observations of the water level made during the progress of the borehole are shown including end of shift and overnight readings and the depth at which water was sealed off by the borehole casing, if applicable.

Whilst drilling through granular soils, it is usually necessary to introduce water into the borehole to permit their extraction. When additional water has been used a remark is made on the Borehole Record and the implications are discussed in the text.

SAMPLES

Undisturbed samples of the predominantly cohesive soils are obtained using a 100mm diameter open-drive sampler. In granular soils, disturbed bulk samples are taken and placed in polythene bags. Small jar samples are taken at frequent intervals in all soils for subsequent visual examination. Where ground water is encountered in sufficient quantity, a sample of the ground water is also taken.

IN-SITU STANDARD PENETRATION TESTS

This test is performed in accordance with the procedure given in B.S.1377: 1990. The individual blow count record for each test is given on a separate table. The 'N' value is normally the number of blows to achieve a penetration of 0.3m following a seating distance of 0.15m and is quoted at the mid-depth of the test zone. However if a change of stratum occurs within the test zone then a revised 'N' value is calculated to assess one layer in particular. In hard strata full penetration may not be obtained. In such cases the suffix + indicates that the result has been extrapolated from the limited penetration achieved. Where ground water has affected the measured values, the resultant 'N' value has been placed in brackets since it is unlikely to represent the true in-situ density of the soil.

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH1**
Client:	**Reselton Properties Ltd**	Coordinates: 520384E, 175949N	Sheet 1 of 3
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.15mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced: 04/10/2016 BH/casing dia: 150mm BH casing depth: 5.0m							MADE GROUND: concrete [250mm] over compact concrete and brick - driller's decription	
	ES	0.50						
	PID	0.50	0.5					
	ES	1.00						
	PID	1.00	0.7					
Hand excavated inspection pit to 1.20m	D	1.30		1.20	3.95		Soft brown mottled sandy CLAY - driller's description	
	ES	1.50						
	PID	1.50	0.1					
	U	1.55						
				1.85	3.30		Light brown slightly silty gravelly fine to medium SAND. Gravel is subangular to rounded, fine to coarse flint	
Water added between 2.0m and 4.50m to assist drilling	ES	2.00						
	ES	2.50						
	PID	2.50	0.3				*at 2.55m; becoming dense*	
	B	2.55						
	SPT/C	2.55	N=39 N_{60}=43					
				3.15	2.00		Dense light brown slightly silty very sandy GRAVEL. Gravel is subangular to rounded, fine to coarse flint	
	ES	3.50						
	PID	3.50	0.3				*at 3.55m; becoming medium dense*	
	B	3.55						
	SPT/C	3.55	N=25 N_{60}=28					
Groundwater strike at 4.30m [fast flow]; sealed out at 5.0m								
	ES	4.50						
	PID	4.50	0.4					
	D	4.70		4.70	0.45			
	D	4.90		4.90	0.25		Firm dark brown, locally mottled dark grey and reddish brown, CLAY with rare subangular to rounded, fine to medium flint gravel	
	D	5.05		5.05	0.10			
	SPT/S	5.05	N=15 N_{60}=16				Firm dark brown, fissured, CLAY. Occasional light grey staining on fissured surfaces	
	PID	5.50	0.4				Stiff, fissured, dark greyish brown CLAY	
	D	6.00					*at 6.0m; with rare foram fossils*	
	U	6.55					*at 6.55m; locally firm*	
End of shift 04/10/2016 BH depth: 7.0m Groundwater depth: dry								
	D	7.50		7.50	-2.35		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	
	D	8.05						
	SPT/S	8.05	N=24 N_{60}=26					
	D	9.00						
	U	9.55						
				10.00	-4.85		Continued on next sheet	

Backfill / Installation: 1 2 3 4 5 6 7 8 9 10

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm ID standpipe installed to 6.0m

Borehole No: **BH1**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH1**
Client:	**Reselton Properties Ltd**	Coordinates: 520384E, 175949N	Sheet 2 of 3
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.15mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
	D	10.50					Very 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	
	D SPT/S	11.05 11.05	N=34 N_{60}=37	11.05	-5.90		Very stiff, fissured, dark greyish brown CLAY	11
	D	12.00					*at 12.0m; with rare foram fossils and grey silt infilled burrows*	12
	U	12.55					*at 12.55m; locally stiff*	
	D	13.50		13.50	-8.35		Very stiff dark greyish brown slightly sandy silty CLAY. Occasional foram fossils and grey silt infilled burrows *between 13.70m and 13.80m; claystone*	13
	D SPT/S	14.05 14.05	N=35 N_{60}=38					14
	D	15.00						15
	U	15.55						16
	D	16.50		16.50	-11.35		Very stiff dark greyish brown silty CLAY. Occasional foram fossils and grey silt infilled burrows	
	D SPT/S	17.05 17.05	N=41 N_{60}=45					17
	D	18.00						18
	U	18.55						19
	D	19.50		19.50	-14.35		Very stiff dark greyish brown slightly sandy silty CLAY. Occasional foram fossils and grey silt infilled burrows	
				20.00	-14.85		Continued on next sheet	20

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm ID standpipe installed to 6.0m

Borehole No: **BH1**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH1**
Client:	**Reselton Properties Ltd**	Coordinates: 520384E, 175949N	Sheet 3 of 3
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.15mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
	D	20.05					Very stiff dark greyish brown slightly sandy silty CLAY. Occasional foram fossils and grey silt infilled burrows	
	SPT/S	20.05	N=46 N_{60}=51					
	D	21.00						21
	U	21.55						
End of shift 05/10/2016 BH depth: 22.0m Groundwater depth: dry							*between 22.20m and 22.35m; claystone*	22
0.5hr chiselling between 22.20m and 22.35m [claystone]	D	22.55						
	D	23.05						23
	SPT/S	23.05	N=46 N_{60}=51					
	D	24.00						24
	U	24.55						
								25
	D	25.50						
	D	26.05		26.00	-20.85			26
	SPT/S	26.05	N=51 N_{60}=56				Very stiff dark greyish brown CLAY with occasional white shell fragments	
	D	27.00						27
0.5hr chiselling between 27.40m and 27.60m [claystone]	U	27.55					*between 27.40m and 27.60m; claystone*	
								28
	D	28.75					*at 28.75m; locally silty clay with occasional grey silt infilled burrows*	
								29
	D	29.55						
BH completed: 06/10/2016 Groundwater depth on removal of casing: 3.90m	SPT/S	29.55	N=46 N_{60}=51					
				30.00	-24.85		End of hole at 30.00m	30

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm ID standpipe installed to 6.0m

Borehole No: **BH1**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH2**
Client:	**Reselton Properties Ltd**	Coordinates: 520410E, 175962N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.81mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced: 03/10/2016 BH/casing dia: 150mm BH casing depth: 3.45m							MADE GROUND: asphalt (300mm) over crushed concrete with brick, steel and concrete boulders - driller's description	
	ES	0.50						
	PID	0.50	0.7					
	ES	1.00						
	PID	1.00	0.9					
Hand excavated inspection pit to 1.20m	D	1.25						
	SPT/S	1.25	N=71					
	ES	1.50	N_{60}=78					
	PID	1.50	0.8					
1.5hr chiselling at 1.80m [possible concrete slab]								
	ES	2.00						
	PID	2.00	0.6					
1.5hr chiselling at 2.25m [concrete boulder]	D	2.25						
	SPT/C	2.25	N>50*					
Groundwater strike at 2.30m [fast inflow]; not sealed out	ES	2.50						
	PID	2.50	1.0					
	ES	3.00						
	PID	3.00	5.5					
2hr chiselling between 3.40m and 3.60m [possible concrete slab]				3.60	1.21		End of hole at 3.60m	
Borehole terminated on impenetrable concrete slab at 3.60m								

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: BH backfilled upon completion

Borehole No: **BH2**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH2A**
Client:	**Reselton Properties Ltd**	Coordinates: 520651E, 176003N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.80mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced 06/10/2016 BH/casing dia: 150mm BH casing depth: 2.0m							MADE GROUND: asphalt (250mm) over pea shingle, plastic pipe fragments and crushed concrete - driller's description	
Hand excavated inspection pit to 1.20m								
				2.00	2.80		MADE GROUND: pea shingle and crushed concrete - driller's description	
Groundwater strike at 2.30m [fast inflow]; not sealed out								
2hr chiselling between 3.45m and 3.50m [possible concrete slab]				3.45 3.50	1.35 1.30		MADE GROUND: concrete slab - driller's description End of hole at 3.50m	

1 2 3 4 5 6 7 8 9 10

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: BH backfilled upon completion

Borehole No: **BH2A**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**		Borehole No: **BH2B**
Client:	**Reselton Properties Ltd**	Coordinates: 520598E, 175976N	Sheet 1 of 3
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.96mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH commenced: 07/10/2016 BH/casing dia: 150mm BH casing depth: 4.15m							MADE GROUND: asphalt [200mm] over compact crushed concrete and brick	
Hand excavated inspection pit to 1.20m				1.25	3.71			
	ES	1.50					Firm orangish brown, mottled dark brown, sandy CLAY with frequent black flecks and rare rounded, fine to medium flint gravel	
	PID	1.50	0.1					
				1.80	3.16			
	B	2.00					Dense orangish brown slightly silty very gravelly SAND. Gravel is subangular to rounded, fine to coarse flint	
	ES	2.00						
	SPT/C	2.00	N=36 N_{60}=40					
	PID	2.00	0.1					
	B	3.00					*at 3.0m; becoming medium dense slightly silty very sandy gravel*	
	ES	3.00						
Groundwater strike at 3.20m [fast flow]; sealed out at 4.15m	SPT/C	3.00	N=14 N_{60}=15					
	PID	3.00	0.1					
				3.75	1.21			
	D	3.90					Soft to firm dark greyish brown CLAY with occasional subrounded, fine to medium gravel	
	D	4.05		4.05	0.91			
	SPT/S	4.05	N=15 N_{60}=16				Stiff, fissured, dark greyish brown CLAY. Rare grey silt infilled burrows	
End of shift 07/10/2016 BH depth: 4.50m Groundwater level: dry	D	4.75						
	U	5.05						
	D	6.00		6.00	-1.04		Stiff, fissured, dark greyish brown CLAY with occasional pockets and partings of dark grey fine sand. Rare foram fossils and grey silt infilled burrows	
	D	6.55						
	SPT/S	6.55	N=23 N_{60}=25					
	D	7.50						
	U	8.05						
0.5hr chiselling between 8.60m and 8.75m [claystone]							*between 8.60m and 8.75m; claystone*	
	D	9.00						
	D	9.55						
	SPT/S	9.55	N=25 N_{60}=28					
				10.00	-5.04		Continued on next sheet	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm ID standpipe installed to 5.0m

Borehole No: **BH2B**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH2B**
Client:	**Reselton Properties Ltd**	Coordinates: 520598E, 175976N	Sheet 2 of 3
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.96mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
				10.20	-5.24		Stiff, fissured, dark greyish brown CLAY with occasional pockets and partings of dark grey fine sand. Rare foram fossils and grey silt infilled burrows	
	D	10.50					Very stiff dark greyish brown slightly sandy silty CLAY with occasional to frequent foram fossils and grey silt infilled lenses. Occasional pockets and partings of fine dark grey sand	11
	U	11.50						
	D	12.00						12
	D SPT/S	12.55 12.55	N=34 N_{60}=37				*between 12.55m and 13.55m; locally silty clay*	13
	D	13.50		13.50	-8.54		Very stiff dark greyish brown slightly sandy silty CLAY. Occasional foram fossils and grey silt infilled burrows	
	U	14.05						14
	D	15.00					*at 15.0m; with rare fossil shell debris and frequent foram fossils*	15
	D SPT/S	15.55 15.55	N=35 N_{60}=38					16
	D	16.50		16.50	-11.54		Very stiff dark greyish brown silty CLAY. Occasional foram fossils and grey silt infilled burrows	
	U	17.05						17
	D	18.00					*at 18.0m; pocket of pyrite/pyritic sand*	18
0.5hr chiselling between 18.20m and 18.35m [claystone]							*between 18.20m and 18.35m; claystone*	
	D SPT/S	18.55 18.55	N=39 N_{60}=43					19
	D	19.50		19.50	-14.54		Very stiff dark greyish brown slightly sandy silty CLAY. Frequent foram fossils and grey silt infilled burrows	
				20.00	-15.04		Continued on next sheet	20

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm ID standpipe installed to 5.0m

Borehole No: **BH2B**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**BH2B**
Client:	**Reselton Properties Ltd**	Coordinates: 520598E, 175976N	Sheet 3 of 3
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.96mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation	
	U	20.05					Very stiff dark greyish brown slightly sandy silty CLAY. Frequent foram fossils and grey silt infilled burrows		
	D	21.00							21
	D SPT/S	21.55 21.55	N=44 N_{60}=48						
	D	22.50							22
	U	23.05							23
	D	24.00							24
	D SPT/S	24.55 24.55	N=47 N_{60}=52						
End of shift 10/10/2016 BH depth: 25.0m Groundwater depth: dry									25
	D	25.50							
	U	26.05		26.00	-21.04		Very stiff dark greyish brown CLAY with occasional white shell fragments		26
	D	27.00							27
	D SPT/S	27.55 27.55	N=49 N_{60}=54						
0.5hr chiselling between 28.00m and 28.15m [claystone]							*between 28.0m and 28.15m; claystone*		28
	D	28.75					*at 28.75m; locally silty clay with occasional grey silt infilled burrows*		29
	U	29.55							
BH completed: 11/10/2016 Groundwater depth on removal of casing: 3.50m				30.00	-25.04		End of hole at 30.00m		30

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Cable Percussion

Remarks: 50mm ID standpipe installed to 5.0m

Borehole No: **BH2B**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS1**
Client:	**Reselton Properties Ltd**	Coordinates: 520396E, 176074N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +6.12mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions
BH constructed: 04/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: reinforced concrete
	ES PID	0.50 0.50	0.3	0.50 0.60	5.62 5.52		MADE GROUND: orangish brown very clayey gravel. Gravel is fine to coarse flint
	ES PID	1.00 1.00	0.3				MADE GROUND: dark brown and reddish brown very clayey sandy gravel. Gravel is fine to coarse brick, flint, clinker. Rare pipe fragments
	ES PID	1.50 1.50	0.3				
				2.00	4.12		Orangish brown silty very gravelly SAND. Gravel is subangular to rounded, fine to coarse flint
	D	2.20					
	ES PID	2.50 2.50	0.3				
	D SPT/S	3.00 3.00	N=28 N_{60}=37				*at 3.0m; becoming dense fine to medium sand*
	ES PID	3.50 3.50	0.3				
	D	3.80		3.80	2.32		Dense dark brown, becoming orangish brown, very sandy GRAVEL. Gravel is subangular to rounded, fine to coarse flint
	SPT/S	4.00	N=35 N_{60}=46				
Groundwater strike at about 4.50m	ES PID D	4.50 4.50 4.70	0.2				*at 4.50m; becoming greyish brown slightly gravelly sand*
	SPT/S	5.00	N=21 N_{60}=28				*at 5.0m; becoming medium dense*
				5.50	0.62		End of hole at 5.50m

Backfill / Installation

1 2 3 4 5 6 7

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 5.0m

Borehole No: **WS1**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS2**
Client:	**Reselton Properties Ltd**	Coordinates: 520408E, 176037N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +6.08mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed: 04/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: asphalt (150mm) over reinforced concrete	
				0.40	5.68			
	ES PID	0.50 0.50	0.4				MADE GROUND: light greyish brown very gravelly sand. Gravel is fine to coarse concrete and flint	
				0.70	5.38			
							MADE GROUND: orangish brown slightly clayey sandy gravel. Gravel is fine to coarse flint and occasional concrete	
	ES PID	1.00 1.00	0.4					
							at 1.40m; concrete cobble	
	ES PID	1.50 1.50	0.3					
							between 1.65m and 1.80m; locally dark grey	
							at 1.80m; becoming dark greyish brown sand	
	D SPT/S	2.00 2.00	N=28 N_{60}=37	2.00	4.08		Dense orangish brown slightly to very sandy GRAVEL. Gravel is subangular to angular, fine to coarse flint. Locally clayey to very clayey	
	ES PID	2.50 2.50	0.2					
	SPT/S	3.00	N=34 N_{60}=45					
	ES PID	3.50 3.50	0.3				*at 3.50m; becoming very sandy gravel*	
	D SPT/S	4.00 4.00	N=44 N_{60}=58				*at 4.0m; becoming very dense*	
	ES PID	4.50 4.50	1.5					
BH dry upon completion							*at 4.90m; becoming dark grey. Medium dense at 5.0m*	
	ES SPT/S	5.00 5.00	N=22 N_{60}=29					
	PID	5.00	0.8					
				5.50	0.58		End of hole at 5.50m	

Backfill / Installation: 1 2 3 4 5 6 7

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 2.0m

Borehole No: **WS2**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS3**
Client:	**Reselton Properties Ltd**	Coordinates: 520447E, 176074N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.67mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed: 04/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: asphalt (150mm) over dark greyish brown slightly silty very gravelly sand. Gravel is fine to coarer limestone, flint and concrete	
	ES PID	0.50 0.50	0.4	0.50	5.17		MADE GROUND: dark brown gravelly clay. Gravel is fine to coarse brick, flint and chalk	
							at 0.80m; becoming orangish brown clayey gravelly sand. Gravel is brick and flint	
				1.00	4.67		Orangish brown silty slightly gravelly, locally gravelly to very gravelly, SAND. Gravel is subangular to rounded, fine to coarse flint	1
	ES PID D	1.50 1.50 1.60	0.3					
	SPT/S	2.00	N=23 N_{60}=30				*at 2.0m; becoming dense*	2
	ES PID D	2.50 2.50 2.70	1.8					
	SPT/S	3.00	N=32 N_{60}=42					3
	ES PID D	3.50 3.50 3.70	8.8					
	SPT/S	4.00	N=9 N_{60}=12	4.00	1.67		Medium dense dark brownish grey slightly gravelly SAND. Gravel is subangular to rounded, fine to medium flint	4
							at 4.20m; becoming dark grey with rare flint	
	ES PID D	4.50 4.50 4.70	1.3					
BH dry upon completion	SPT/S	5.00	N=35 N_{60}=46				*at 5.0m; becoming dense*	5
				5.50	0.17		End of hole at 5.50m	6
								7

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS3**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS4**
Client:	**Reselton Properties Ltd**	Coordinates: 520431E, 176031N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.85mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed: 04/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: asphalt (200mm) over dark brown silty very sandy gravel. Gravel is limestone, brick and rare flint	
	ES PID	0.50 0.50	0.8					
				0.80	5.05		MADE GROUND: dark brown and black slightly sandy slightly gravelly clay. Gravel is fine to coarse clinker, brick and flint *at 0.90m; becoming light greyish brown*	
	ES PID	1.00 1.00	0.3					
	ES PID	1.50 1.50	0.3					
				1.70	4.15		MADE GROUND: dark brown grey slightly sandy slightly gravelly clay. Gravel is fine to medium clinker, brick and rare concrete fragments	
	ES PID	2.00 2.00	0.5	2.00	3.85		Light brown slightly, locally very, gravelly SAND. Gravel is subangular to angular, fine to coarse flint	
	D	2.30						
	ES PID	2.60 2.60	1.3				*at 2.60m; locally stained black*	
	D SPT/S	3.00 3.00	N=38 N_{60}=50				*at 3.0m; becoming very dense*	
	ES PID	3.50 3.50	4.2					
	SPT/S	4.00	N=17 N_{60}=22				*at 4.0m; becoming medium dense*	
	ES PID D	4.50 4.50 4.70	3.4					
	SPT/S	5.00	N=9 N_{60}=12	5.00	0.85		Firm dark brown CLAY	
BH dry upon completion	D	5.50		5.50	0.35		End of hole at 5.50m	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 5.0m

Borehole No: **WS4**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS5**
Client:	**Reselton Properties Ltd**	Coordinates: 520429E, 175972N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.76mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed: 03/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: asphalt (100mm) over greyish brown sandy gravel of concrete	
	ES PID	0.50 0.50	2.0	0.50	5.26		MADE GROUND: light grey and pinkish grey clayey sandy gravel. Gravel is fine to coarse limestone and occasional brick	
	ES PID	1.00 1.00	0.4	1.20	4.56		MADE GROUND: dark brown slightly sandy slightly gravelly clay. Gravel is fine to coarse brick	1
	ES PID	1.50 1.50	0.5					
	ES PID	2.00 2.00	0.5	2.20	3.56		Firm brownish grey slightly gravelly slightly sandy CLAY. Gravel is subangular to rounded, fine to coarse flint. Occasional root traces	2
	D	2.30						
	ES PID	2.50 2.50	0.8	2.80	2.96			
	SPT/S D	3.00 3.10	N=16 N_{60}=21				Medium dense orangish brown, becoming yellowish brown, slightly silty SAND with rare subangular to rounded, fine to coarse flint gravel	3
	ES PID	3.50 3.50	1.1					
	SPT/S	4.00	N=40 N_{60}=53				*at 4.0m; becoming very dense*	4
Groundwater strike at about 4.50m	ES PID D	4.50 4.50 4.60	16.3				*at 4.50m; becoming slightly silty very gravelly sand*	
				5.00	0.76		End of hole at 5.00m	5
								6
								7

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 5.0m

Borehole No: **WS5**

Soil Consultants

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS6**
Client:	**Reselton Properties Ltd**	Coordinates: 520477E, 176066N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.22mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 05/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: concrete	
BH refused at 0.50m				0.50	4.72		End of hole at 0.50m	

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Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS6**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS7**
Client:	**Reselton Properties Ltd**	Coordinates: 520486E, 176003N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.23mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 05/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: reinforced concrete slab	
	ES	0.70		0.60	4.63		MADE GROUND: dark greyish brown very sandy gravel. Gravel is fine to coarse brick and flint. Locally clayey to very clayey	
BH refused at 0.80m	PID	0.70	0.1	0.80	4.43		End of hole at 0.80m	

1 2 3 4 5 6 7

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS7**

Soil Consultants

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS7A**
Client:	**Reselton Properties Ltd**	Coordinates: 520486E, 176003N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.23mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 05/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth				0.25	4.98		MADE GROUND: concrete	
	ES PID	1.00 1.00	0.3				MADE GROUND: dark grey clayey sandy gravel. Gravel is fine to coarse concrete, metal and clinker	
BH refused at 1.40m				1.40	3.83		End of hole at 1.40m	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 1.40m

Borehole No: **WS7A**

Soil Consultants

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS8**
Client:	**Reselton Properties Ltd**	Coordinates: 520583E, 176026N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.15mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 03/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: concrete	
				0.70	4.45		MADE GROUND: orangish brown slightly silty sandy gravel. Gravel is fine to coarse flint	
Bh refused at 1.0m	ES SPT/S PID	1.00 1.00 1.00	 N>50* 0.7	1.00	4.15		End of hole at 1.00m	

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Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS8**

Soil Consultants

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS8A**
Client:	**Reselton Properties Ltd**	Coordinates: 520583E, 176026N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +5.15mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 12/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: concrete	
				0.70	4.45		MADE GROUND: brown silty sandy gravel. Gravel is fine to coarse concrete and rare flint	
				1.00	4.15		MADE GROUND: brown and orangish brown sandy gravel. Gravel is fine to coarse flint and occasional concrete	
	ES PID	1.50 1.50	0.4					
	ES PID	2.00 2.00	0.2				*at 2.0m; becoming brownish grey very clayey sandy gravel*	
							at 2.30m: recovered as fine to coarse brick fragments - possible buried structure	
				2.40	2.75		Orangish brown sandy GRAVEL. Gracvel is subangular to subrounded, fine to coarse flint	
BH refused at 2.50m	ES PID	2.50 2.50	0.3	2.50	2.65		End of hole at 2.50m	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 2.50m

Borehole No: **WS8A**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS9**
Client:	**Reselton Properties Ltd**	Coordinates: 520517E, 175966N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.89mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 03/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: asphalt (200mm) over concrete	
BH refused at 0.50m				0.50	4.39		End of hole at 0.50m	

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Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

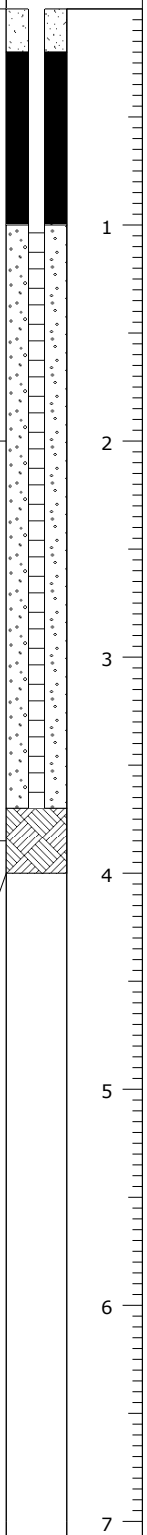
Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS9**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS9A**
Client:	**Reselton Properties Ltd**	Coordinates: 520517E, 175966N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.89mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 12/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: dark brown clayey very sandy gravel. Gravel is fine to coarse flint, brick and clinker	
							at 1.60m; becoming orangish brown, grey, brown mottled slightly sandy slightly gravelly clay. Gravel is fine to coarse flint and rare brick	
	ES	2.00		2.00	2.89		Medium dense light brown silty slightly gravelly, locally very clayey, SAND. Gravel is subrounded to rounded, fine to coarse flint	
	SPT/S	2.00	N=10 N_{60}=13					
	PID	2.00	0.4					
	D	2.50						
Groundwater standing at about 2.90m upon completion							*at 2.90m; becoming orangish brown sandy gravel*	
	ES	3.00					*at 3.0m; becoming dense*	
	SPT/S	3.00	N=34 N_{60}=45					
	PID	3.00	2.9					
	D	3.50						
	HV	3.80	70	3.85	1.04		Firm dark grey, orangish grey and reddish grey mottled CLAY	
	D	3.90					*at 3.90m; becoming dark grey clay*	
	HV	3.90	60	4.00	0.89		End of hole at 4.00m	



Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 3.70m

Borehole No: **WS9A**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS10**
Client:	**Reselton Properties Ltd**	Coordinates: 520615E, 176024N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.92mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 03/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth				0.25	4.67		MADE GROUND: reinforced concrete	
	ES PID	0.50 0.50	1.1				MADE GROUND: dark grey sandy gravel. Gravel is fine to coarse concrete, brick and flint. Locally slightly clayey	
	ES PID	1.00 1.00	0.5					
BH refused at 1.60m	ES PID	1.50 1.50	0.5	1.60	3.32		End of hole at 1.60m	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS10**

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS10A**
Client:	**Reselton Properties Ltd**	Coordinates: 520615E, 176024N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.92mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests Type	Samples & Tests Depth (m)	Field Test Results	Strata Depth (m)	Strata Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 12/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: grey sandy gravel. Gravel is fine to coarse concrete and rare brick	
	ES PID	2.50 2.50	 0.3	2.50	2.42		Light brown silty SAND and GRAVEL. Gravel is subangular to rounded, fine to coarse flint	
	D SPT/S	3.00 3.00	 N=37 N_{60}=49				*at 3.0m; becoming dense*	
	ES PID	3.50 3.50	 3.5	3.70	1.22		Stiff, locally firm, dark brownish grey CLAY	
	D HV HV	3.80 3.80 3.90	 75 70					
Groundwater standing at about 4.50m upon completion	D HV HV	4.50 4.50 4.70	 75 88					
	HV D	4.90 5.00	94 	5.00	-0.08		End of hole at 5.00m	

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: 50mm ID standpipe installed to 4.0m

Borehole No: **WS10A**

Soil Consultants

Site & Location:	**Stag Brewery,** **Lower Richmond Road, Mortlake, London SW14 7ET**	Borehole No:	**WS11**
Client:	**Reselton Properties Ltd**	Coordinates: 520598E, 175976N	Sheet 1 of 1
Engineer:	**Waterman Structures Ltd**	Ground Level: +4.96mOD	Report No: 10022/OT

Progress & Observations	Samples & Tests: Type	Samples & Tests: Depth (m)	Field Test Results	Strata: Depth (m)	Strata: Level (m)	Legend	Strata Descriptions	Backfill / Installation
BH constructed 03/10/2016 BH dia: 100mm from GL to 1.0m, reducing with depth							MADE GROUND: asphalt (300mm) over dark greyish brown sandy gravel. Gravel is fine to coarse concrete, and rare brick and clinker	
	ES PID	0.50 0.50	0.3					
BH refused at 0.70m				0.70	4.26		End of hole at 0.70m	

1
2
3
4
5
6
7

Key: U = Undisturbed B = Bulk D = Small disturbed W = Water ES = glass jar & plastic tub E = glass jar SPT/S = split spoon SPT/C = solid cone PP = Pocket Penetrometer [kg/cm²] HV = Hand Vane [kPa] PID = Photo Ionisation Detector [ppm - Isobutylene Equivalent, PhoCheck Tiger, 10.6eV lamp] * = full SPT penetration not achieved - see summary sheet

Borehole type: Dynamic Sampler

Remarks: BH backfilled upon completion

Borehole No: **WS11**

Soil Consultants

SPT Calibration Report

EQUIPE GROUP
www.equipegroup.com

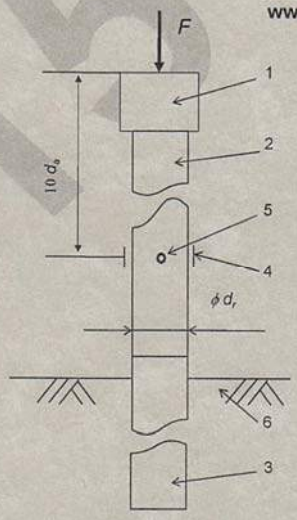
Hammer Energy Measurement Report

Type of Hammer	SPT HAMMER
Client	GEH GROUNDWORKS
Test No	EQU1367_5
Test Depth (m)	7.59
Date of Test	16 October 2015
Valid until	15 October 2016
Hammer ID	GEH2

Mass of the hammer	m =	63.5kg
Falling height	h =	0.76m
E_{theor} =	$m \times g \times h$ =	473J

Characteristics of the instrumented rod

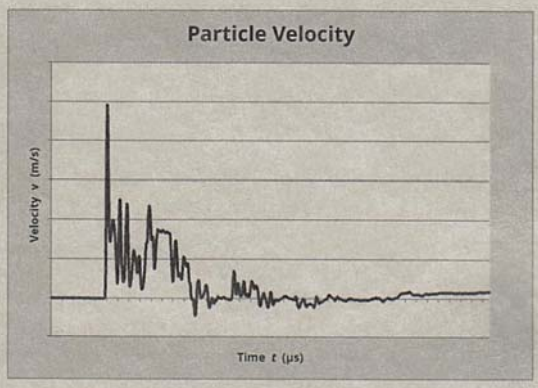
Diameter	d_r =	0.052 m
Length of the instrumented rod		0.558 m
Area	A =	11.61 cm^2
Modulus	E_a =	206843 MPa

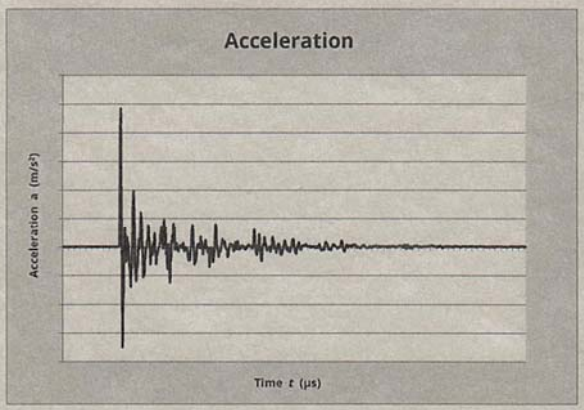


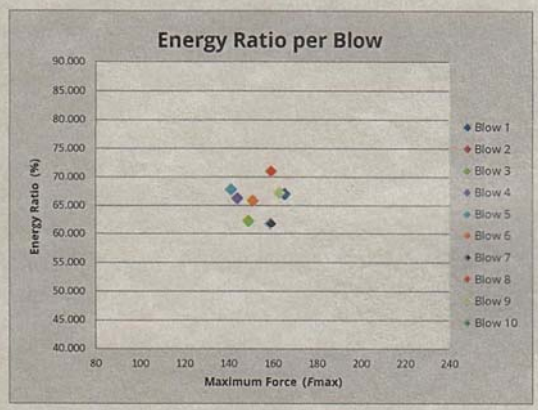
Key
1 Anvil
2 Part of instrumented rod
3 Drive Rod
4 Strain Gauge
5 Accelerometer
6 Ground

F Force
d_r Diameter of rod

Fig. B.1 and B.2 BS EN ISO 22476-3 : 2005 + A1 : 2011







Observations:
1.

E_{meas} = **0.312** kN-m

E_{theor} = **0.473** kN-m

Energy Ratio (E_r) = $\frac{E_{meas}}{E_{theor}}$ = **65.96%**

Equipe SPT Analyzer Operators: MH

Prepared by: **Checked by:** **Date** 21/10/2015

 Equipe Group, The Paddocks, Home Farm Offices, The Upton Estate, Banbury, Oxfordshire, OX15 6HU
Tel: +44 (0)1295 670990 Fax: +44 (0)1295 678232 Email: info@equipegroup.com

Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Dynamic sampling uk ltd
6-8 victory parkway
victory road
Derby
DE24 8ZF

Hammer Ref:	SS01
Test Date:	27/06/2016
Report Date:	
File Name:	SS01.spt
Test Operator:	TP

Instrumented Rod Data

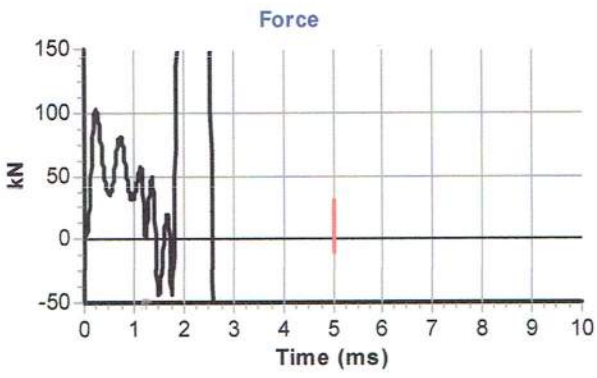
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.9
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	6455
Accelerometer No.2:	6457

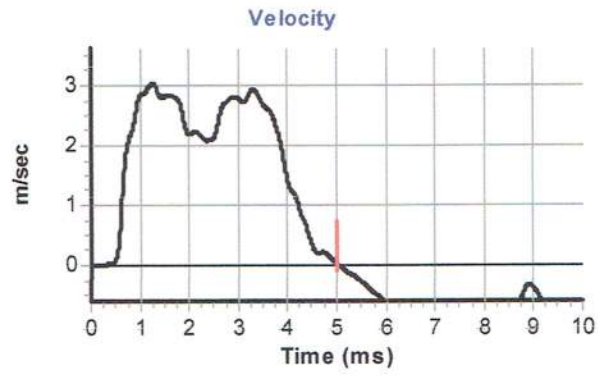
Hammer Information

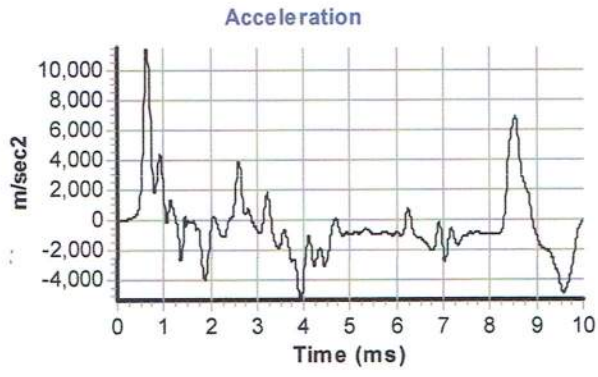
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
String Length L (m):	15.0

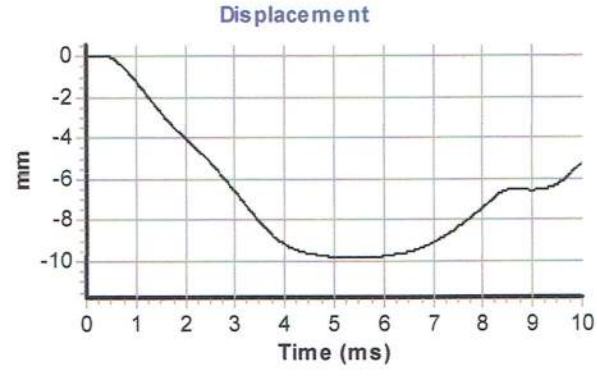
Comments / Location

Hammer tested at Dynamic samplins yard.





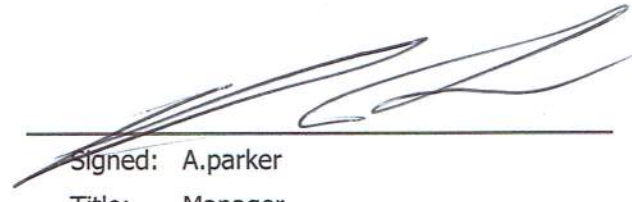




Calculations

Area of Rod A (mm2):	1021
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	374

Energy Ratio E_r (%): **79**



Signed: A.parker

Title: Manager

The recommended calibration interval is 12 months

Site & Location	**Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**	Report No:	**10022/OT**

STANDARD PENETRATION TEST SUMMARY

BH ID	Depth [m]	Test type	'N' value and blow-counts [Seating blows/Test blows]	N_{60}	Casing depth [m]	Water depth [m]	Remarks
BH1	2.55	C	N = 39 :5 5/ 8 10 10 11	44	2.55	DRY	
	3.55	C	N = 25 :4 4/ 6 6 6 7	28	3.55	DRY	
	5.05	S	N = 15 :2 3/ 3 4 4 4	17	5.00	DRY	
	8.05	S	N = 24 :3 3/ 5 6 6 7	27	5.00	DRY	
	11.05	S	N = 34 :4 4/ 7 9 9 9	38	5.00	DRY	
	14.05	S	N = 35 :3 4/ 7 8 10 10	39	5.00	DRY	
	17.05	S	N = 41 :4 4/ 8 10 11 12	46	5.00	DRY	
	20.05	S	N = 46 :5 5/ 9 11 13 13	51	5.00	DRY	
	23.05	S	N = 46 :5 5/ 9 12 12 13	51	5.00	DRY	
	26.05	S	N = 51 :5 6/ 10 13 13 15	57	5.00	DRY	
	29.55	S	N = 46 :5 5/ 8 11 13 14	51	5.00	DRY	
BH2	1.25	S	N = 71 :15 15/ 13 14 20 24	79	1.25	DRY	
	2.25	C	50 :50 /	>56*	0.00	DRY	Refusal
BH2B	2.00	C	N = 36 :4 5/ 7 9 10 10	40	2.00	DRY	
	3.00	C	N = 14 :3 3/ 3 3 4 4	16	3.00	DRY	
	4.05	S	N = 15 :2 3/ 3 4 4 4	17	4.05	DRY	
	6.55	S	N = 23 :3 3/ 5 6 6 6	26	4.15	DRY	
	9.55	S	N = 25 :3 3/ 5 6 7 7	28	4.15	DRY	
	12.55	S	N = 34 :4 4/ 8 8 9 9	38	4.15	DRY	
	15.55	S	N = 35 :5 5/ 7 9 9 10	39	4.15	DRY	
	18.55	S	N = 39 :5 5/ 8 10 10 11	44	4.15	DRY	
	21.55	S	N = 44 :5 5/ 9 10 12 13	49	4.15	DRY	
	24.55	S	N = 47 :5 5/ 9 12 13 13	52	4.15	DRY	
	27.55	S	N = 49 :6 7/ 11 12 13 13	55	4.15	DRY	
WS1	3.00	S	N = 28 :3 4/ 7 7 8 6	37	0.00	DRY	
	4.00	S	N = 35 :9 10/ 11 9 8 7	46	0.00	DRY	
	5.00	S	N = 21 :3 5/ 6 7 4 4	28	0.00	DRY	
WS10A	3.00	S	N = 37 :9 11/ 10 10 10 7	49	0.00	DRY	
WS2	2.00	S	N = 28 :7 6/ 7 7 7 7	37	0.00	DRY	
	3.00	S	N = 34 :8 8/ 7 9 8 10	45	0.00	DRY	
	4.00	S	N = 44 :9 12/ 12 11 11 10	58	0.00	DRY	
	5.00	S	N = 22 :2 3/ 4 6 7 5	29	0.00	DRY	
WS3	2.00	S	N = 23 :3 5/ 5 6 6 6	30	0.00	DRY	
	3.00	S	N = 32 :7 8/ 8 8 8 8	42	0.00	DRY	
	4.00	S	N = 9 :1 1/ 1 2 3 3	12	0.00	DRY	
	5.00	S	N = 35 :4 8/ 7 8 10 10	46	0.00	DRY	
WS4	3.00	S	N = 38 :10 9/ 8 10 10 10	50	0.00	DRY	
	4.00	S	N = 17 :7 6/ 5 5 3 4	22	0.00	DRY	
	5.00	S	N = 9 :3 2/ 2 2 2 3	12	0.00	DRY	
WS5	3.00	S	N = 16 :3 3/ 4 4 4 4	21	0.00	DRY	
	4.00	S	N = 40 :7 7/ 8 12 10 10	53	0.00	DRY	
WS8	1.00	S	50 :25 / 50	>66*	0.00	DRY	
WS9A	2.00	S	N = 10 :3 2/ 2 3 2 3	13	0.00	DRY	

Standard Penetration Test : BS EN ISO 22476:2005 Part 3 Hammer Energy Ratio, Er = 66% [CP boreholes] 79% [WS boreholes]

* where full penetration not achieved, the reported N_{60} is based on maximum uncorrected blow-counts of 50

** extrapolated N_{60} value where full penetration not achieved - this is indicative only and should be used with caution

Soil Consultants

Site & Location	**Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**	Report No:	**10022/OT**

STANDARD PENETRATION TEST SUMMARY

BH ID	Depth [m]	Test type	'N' value and blow-counts [Seating blows/Test blows]	N_{60}	Casing depth [m]	Water depth [m]	Remarks
WS9A	3.00	S	N = 34 :7 7/ 7 8 10 9	45	0.00	DRY	

Standard Penetration Test : BS EN ISO 22476:2005 Part 3 Hammer Energy Ratio, Er = 66% [CP boreholes] 79% [WS boreholes]

* where full penetration not achieved, the reported N_{60} is based on maximum uncorrected blow-counts of 50

** extrapolated N_{60} value where full penetration not achieved - this is indicative only and should be used with caution

Site & Location: **Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**

Report No: **10022/OT**

SUMMARY OF CLASSIFICATION TEST RESULTS

BH ID	Depth (m)	Type	w (%)	wL (%)	wP (%)	Pass 425 (%)	IP (%)	Mod IP (%)	IL (%)	LOI (%)	Description
BH1	1.55	U	10	38	19	>95	19		-0.48		Brown sandy CLAY
	4.90	D	33	79	32	>95	47		0.03		Dark brown CLAY
	6.55	U	27								Dark greyish brown CLAY
	9.55	U	26	73	31	>95	42		-0.14		Dark greyish brown CLAY
	12.55	U	26	78	30	>95	48		-0.09		Dark greyish brown CLAY
	15.55	U	20								Dark greyish brown slightly sandy silty CLAY
	18.55	U	26								Dark greyish brown silty CLAY
	21.55	U	25	77	33	>95	44		-0.18		Dark greyish brown slightly sandy silty CLAY
	24.55	U	25	81	33	>95	48		-0.18		Dark greyish brown slightly sandy silty CLAY
	27.55	U	20								CLAYSTONE
BH2B	5.05	U	28	76	32	>95	44		-0.09		Dark greyish brown CLAY
	8.05	U	26								Dark greyish brown CLAY
	11.50	U	25	79	30	>95	49		-0.11		Dark greyish brown slightly sandy silty CLAY
	14.05	U	27								Dark greyish brown slightly sandy silty CLAY
	17.05	U	26	82	31	>95	51		-0.10		Dark greyish brown silty CLAY
	20.05	U	25								Dark greyish brown slightly sandy silty CLAY
	23.05	U	23	79	33	>95	46		-0.23		Dark greyish brown slightly sandy silty CLAY
	26.05	U	25								Dark greyish brown CLAY
	29.55	U	25	78	32	>95	46		-0.16		Dark greyish brown CLAY

Testing in accordance with BS EN ISO 17892 unless specified otherwise

Date: 01 Nov 16

Modified Plasticity Index calculated in accordance with NHBC Standards Chapter 4.2 (reported if %passing 425mm <95%)

Percent passing 425μm: by estimation, by hand* or by sieving**

Soil Consultants

Site & Location: **Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**

Report No: **10022/OT**

SUMMARY OF CLASSIFICATION TEST RESULTS

BH ID	Depth (m)	Type	w (%)	wL (%)	wP (%)	Pass 425 (%)	IP (%)	Mod IP (%)	IL (%)	LOI (%)	Description
WS10A	3.80	D	31	75	32	>95	43		-0.03		Dark brownish grey CLAY
	5.00	D	28	77	32	>95	45		-0.09		Dark brownish grey CLAY
WS5	2.30	D	20	33	18	93	15	14	0.11		Brownish grey slightly gravelly slightly sandy CLAY
WS9A	3.90	D	32	75	33	>95	42		-0.02		Dark grey, orangish grey and reddish grey mottled CLAY

Testing in accordance with BS EN ISO 17892 unless specified otherwise

Date: 01 Nov 16

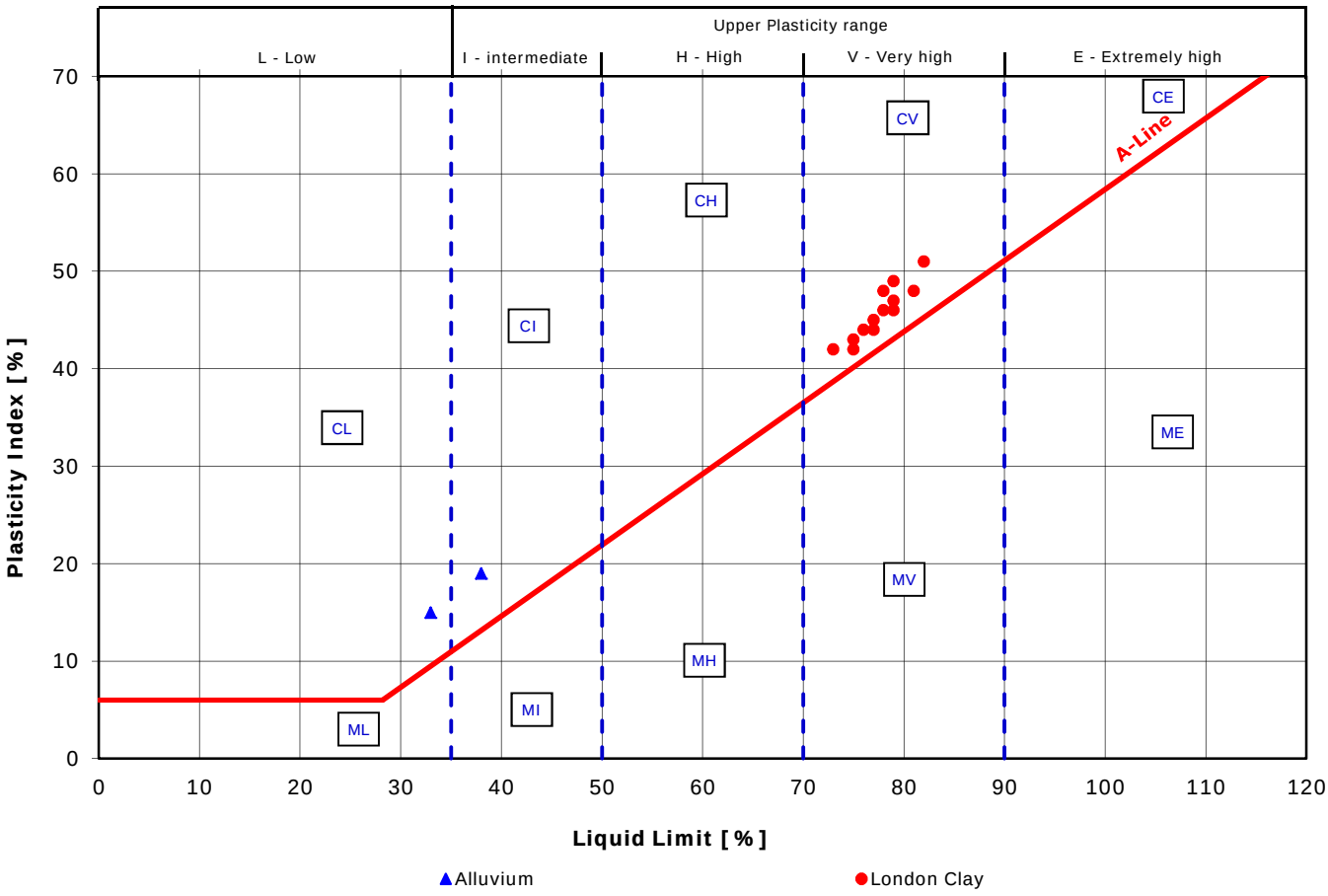
Modified Plasticity Index calculated in accordance with NHBC Standards Chapter 4.2 (reported if %passing 425mm <95%)

Percent passing 425μm: by estimation, by hand* or by sieving**

Soil Consultants

Site & Location	**Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**	Report No:	**10022/OT**

Plasticity Chart



M - SILT [plots below the A-Line]

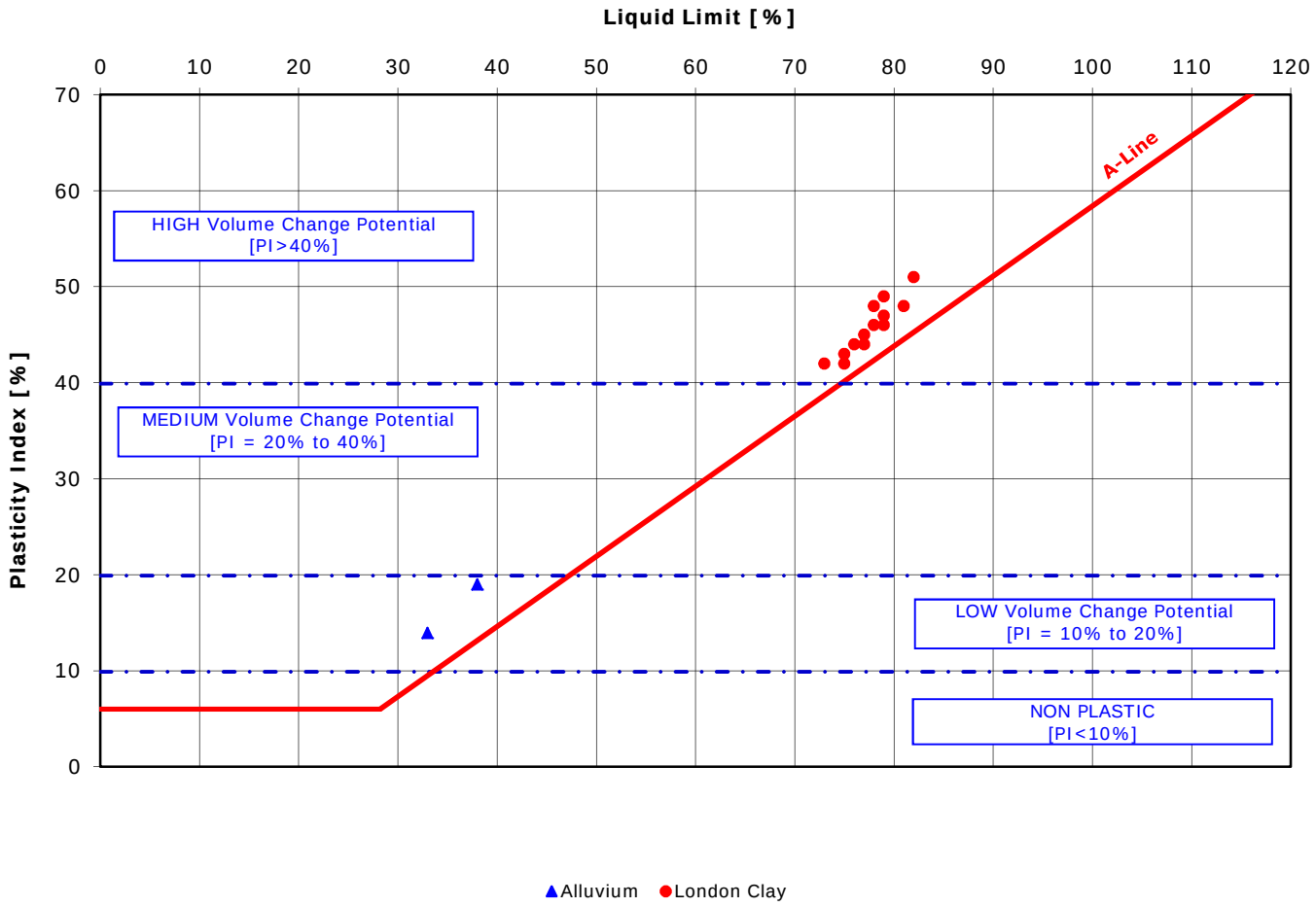
C - CLAY [plots above the A-Line]

Classification in accordance with BS5930:1999+A2:2010 "Code of practice for site investigations"

Soil Consultants

Site & Location	**Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**	Report No:	**10022/OT**

Plasticity Chart



Modified Plasticity Index, I'p:

$$I'p = \frac{Ip \times (\%\ \text{passing 425mm})}{100\%}$$

[where Ip = Plasticity Index]

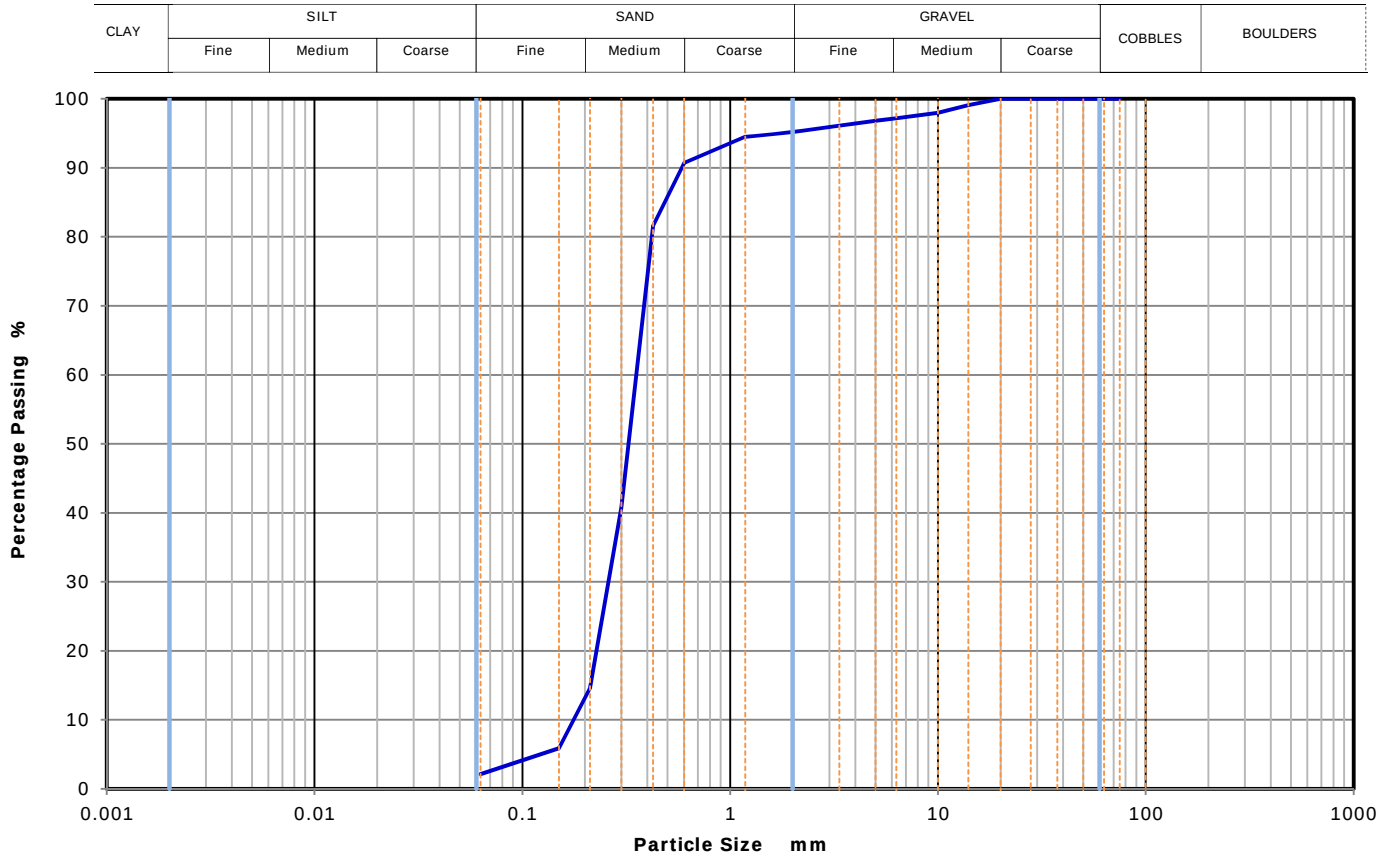
Classification in accordance with NHBC Standards, Part 4 'Foundations', Chapter 4.2 'Building near trees'

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **BH1**	Description: **Light brown slightly silty gravelly SAND**
Depth [m]: **2.55**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	100
20	100
14	99.1
10	98
6.3	97.2
5	96.8
3.35	96.1
2	95.2
1.18	94.5
0.6	90.7
0.425	81.6
0.3	40.8
0.212	14.6
0.15	5.9
0.063	2.1

Sample proportions	%
Cobbles	0
Gravel	5
Sand	93
Fines <0.063mm	2

Grading analysis		
D60	mm	0.4
D30	mm	0.3
D10	mm	0.2
Uniformity Coefficient		2.0
Curvature Coefficient		1.1

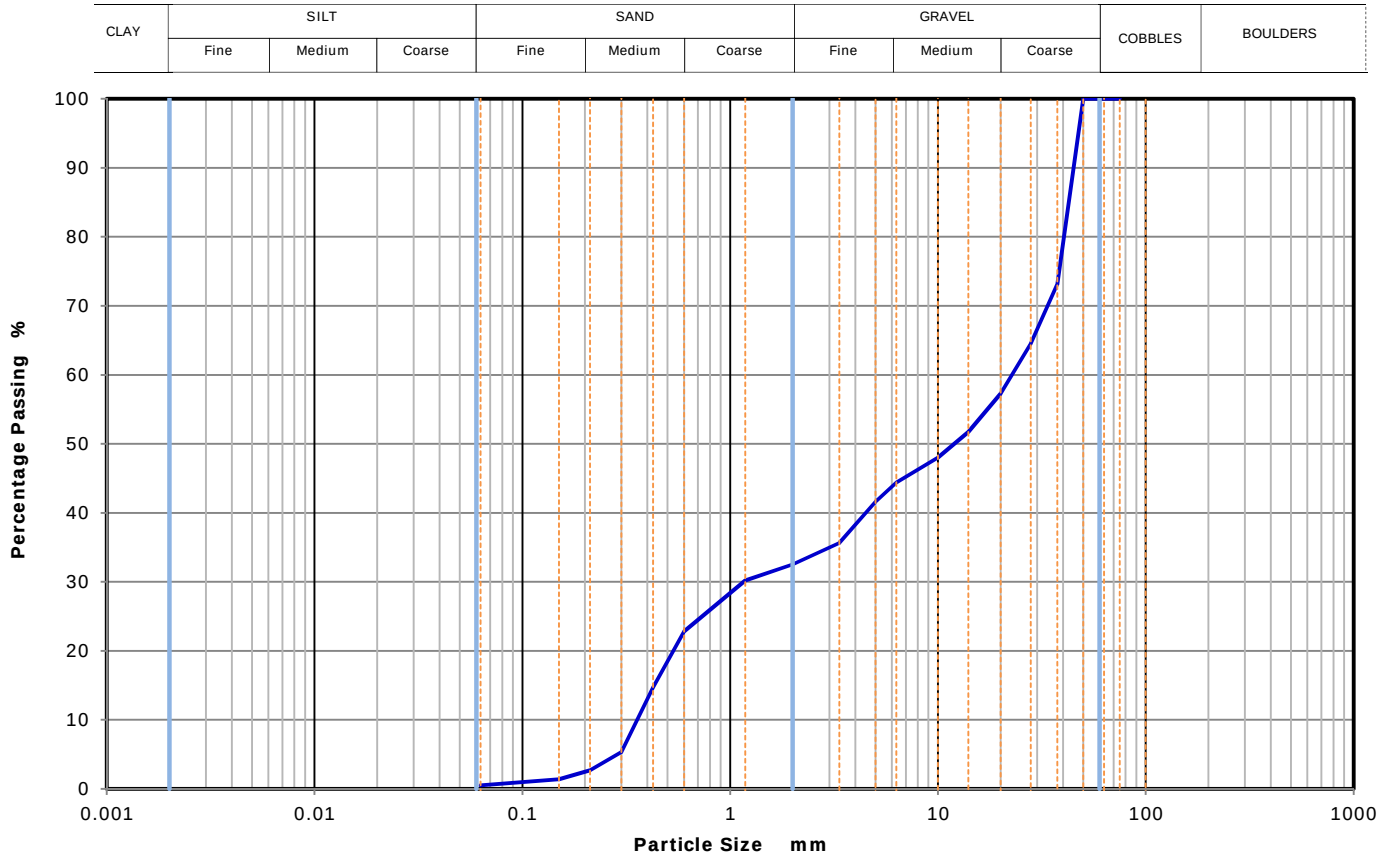
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **BH1** Depth [m]: **3.55**	Description: **Light brown slightly silty very sandy GRAVEL**



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	73.1
28	64.5
20	57.3
14	51.7
10	48
6.3	44.4
5	41.6
3.35	35.6
2	32.5
1.18	30.2
0.6	22.8
0.425	14.7
0.3	5.3
0.212	2.7
0.15	1.4
0.063	0.5

Sample proportions	%
Cobbles	0
Gravel	68
Sand	32
Fines <0.063mm	1

Grading analysis		
D60	mm	22.7
D30	mm	1.2
D10	mm	0.4
Uniformity Coefficient		63.5
Curvature Coefficient		0.2

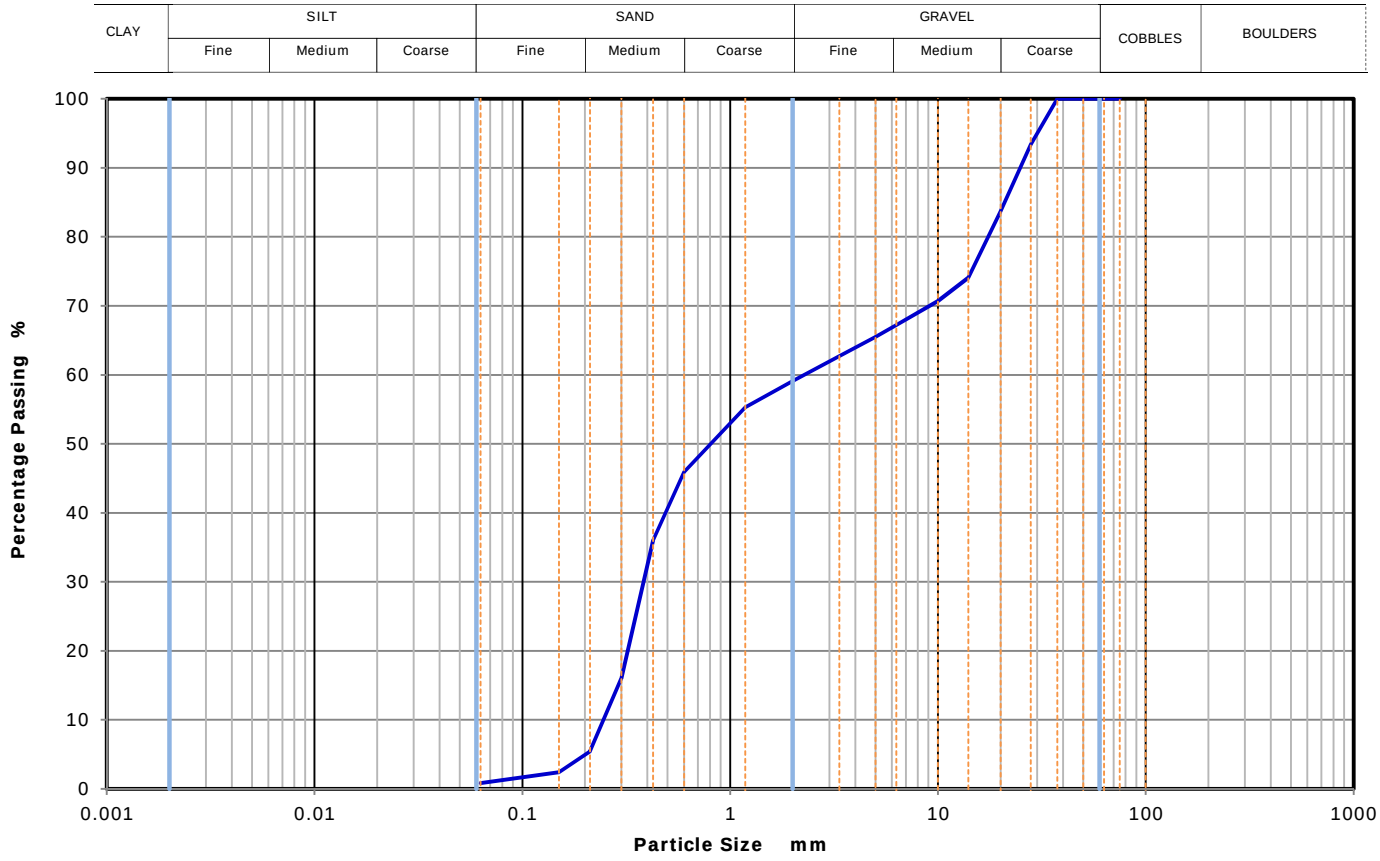
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **BH2B**	Description: **Orangish brown slightly silty very gravelly SAND**
Depth [m]: **2.00**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	93.4
20	83.7
14	74.1
10	70.7
6.3	67.2
5	65.5
3.35	62.7
2	59.1
1.18	55.3
0.6	45.9
0.425	36
0.3	16
0.212	5.4
0.15	2.4
0.063	0.8

Sample proportions	%
Cobbles	0
Gravel	41
Sand	58
Fines <0.063mm	1

Grading analysis		
D60	mm	2.3
D30	mm	0.4
D10	mm	0.2
Uniformity Coefficient		9.2
Curvature Coefficient		0.3

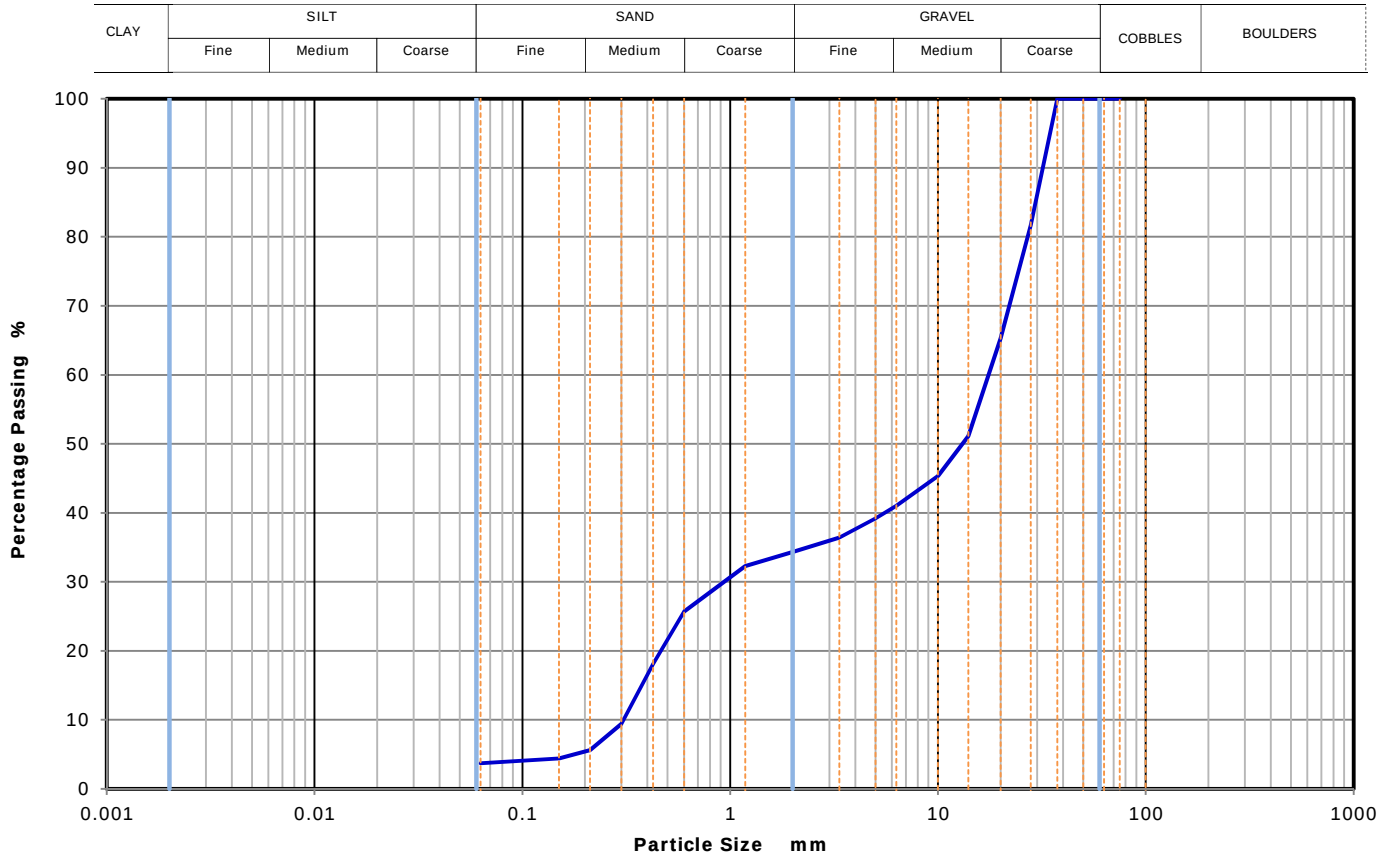
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **BH2B**	Description: **Orangish brown slightly silty very sandy GRAVEL**
Depth [m]: **3.00**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	81.7
20	65.3
14	51.1
10	45.3
6.3	41
5	39.2
3.35	36.4
2	34.3
1.18	32.3
0.6	25.7
0.425	18.1
0.3	9.4
0.212	5.6
0.15	4.4
0.063	3.7

Sample proportions	%
Cobbles	0
Gravel	66
Sand	31
Fines <0.063mm	4

Grading analysis		
D60	mm	17.5
D30	mm	0.9
D10	mm	0.3
Uniformity Coefficient		57.0
Curvature Coefficient		0.2

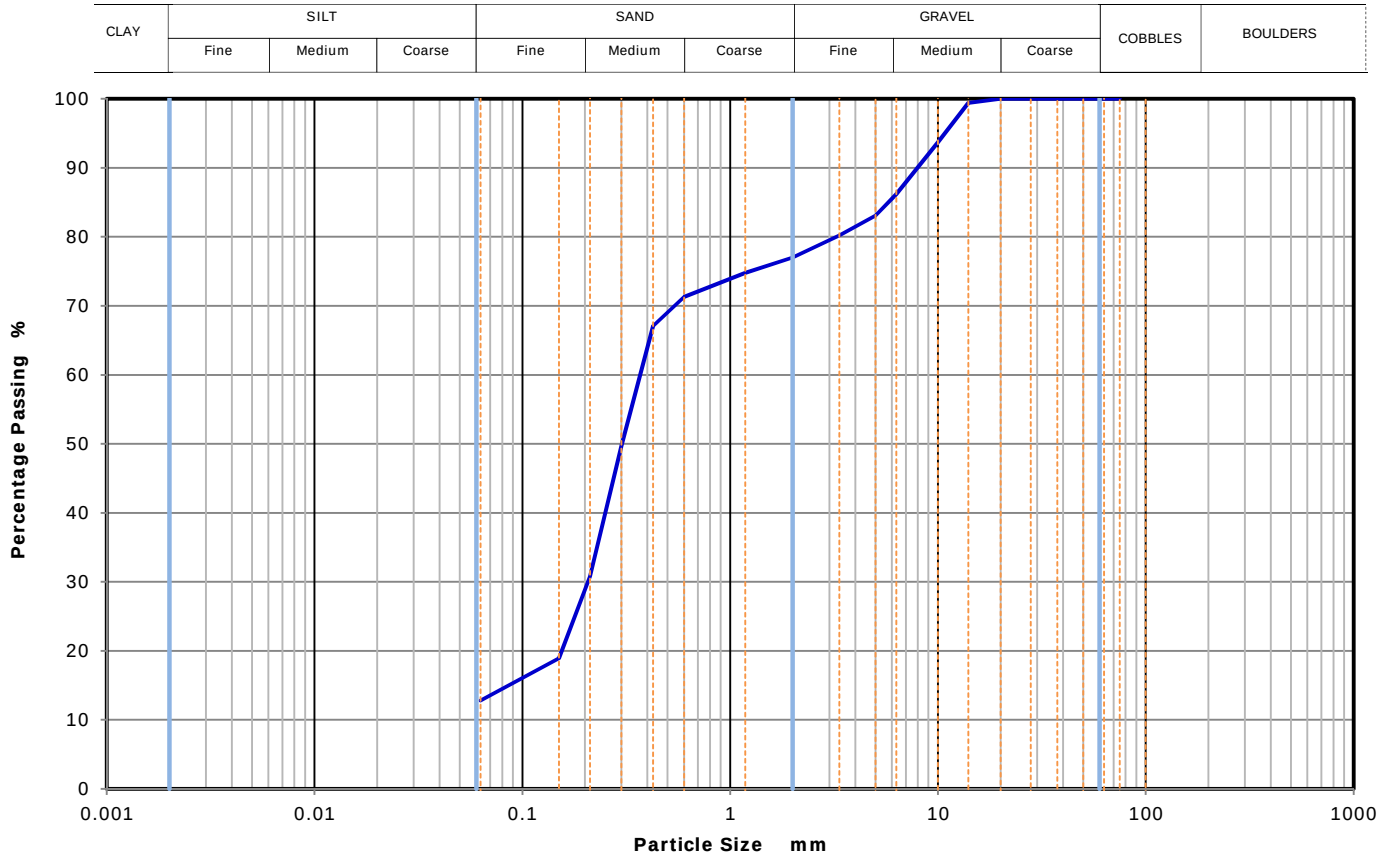
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **WS1** Depth [m]: **3.00**	Description: **Orangish brown silty very gravelly SAND**



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	100
20	100
14	99.4
10	93.7
6.3	86.2
5	83.1
3.35	80.2
2	77
1.18	74.8
0.6	71.3
0.425	67.1
0.3	49.7
0.212	30.8
0.15	18.9
0.063	12.8

Sample proportions	%
Cobbles	0
Gravel	23
Sand	64
Fines <0.063mm	13

Grading analysis		
D60	mm	0.4
D30	mm	0.2
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

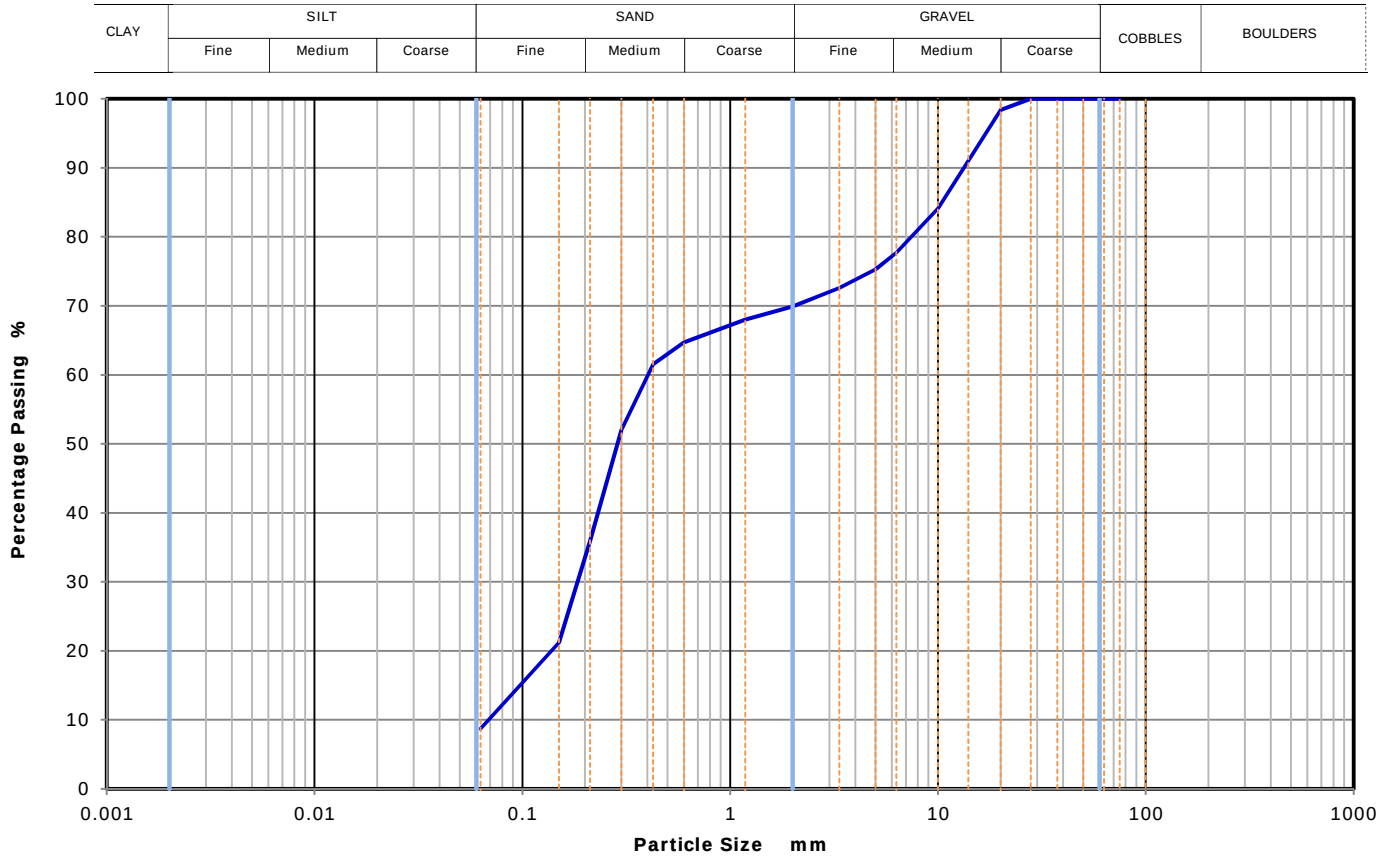
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **WS3**	Description: **Orangish brown silty very gravelly SAND**
Depth [m]: **1.60**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	100
20	98.4
14	91
10	84.1
6.3	77.7
5	75.3
3.35	72.6
2	69.9
1.18	68
0.6	64.7
0.425	61.5
0.3	52
0.212	35.9
0.15	21.2
0.063	8.7

Sample proportions	%
Cobbles	0
Gravel	30
Sand	61
Fines <0.063mm	9

Grading analysis		
D60	mm	0.4
D30	mm	0.2
D10	mm	0.1
Uniformity Coefficient		5.8
Curvature Coefficient		1.2

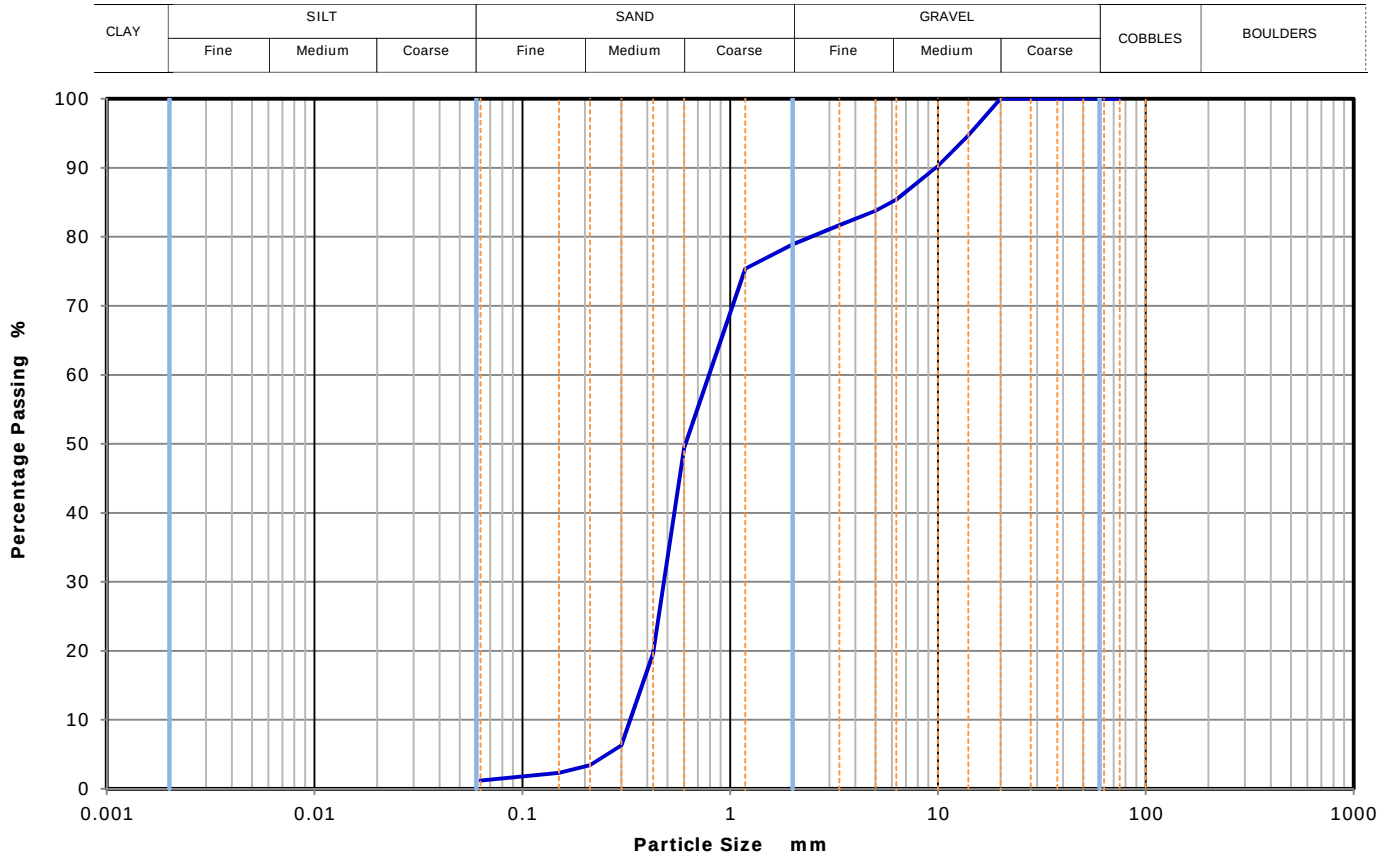
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **WS5**	Description: **Orangish brown slightly silty very sandy GRAVEL**
Depth [m]: **4.60**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	100
20	100
14	94.7
10	90.3
6.3	85.4
5	83.8
3.35	81.7
2	78.9
1.18	75.4
0.6	49.4
0.425	19.6
0.3	6.3
0.212	3.4
0.15	2.3
0.063	1.2

Sample proportions	%
Cobbles	0
Gravel	21
Sand	78
Fines <0.063mm	1

Grading analysis		
D60	mm	0.8
D30	mm	0.5
D10	mm	0.3
Uniformity Coefficient		2.4
Curvature Coefficient		0.9

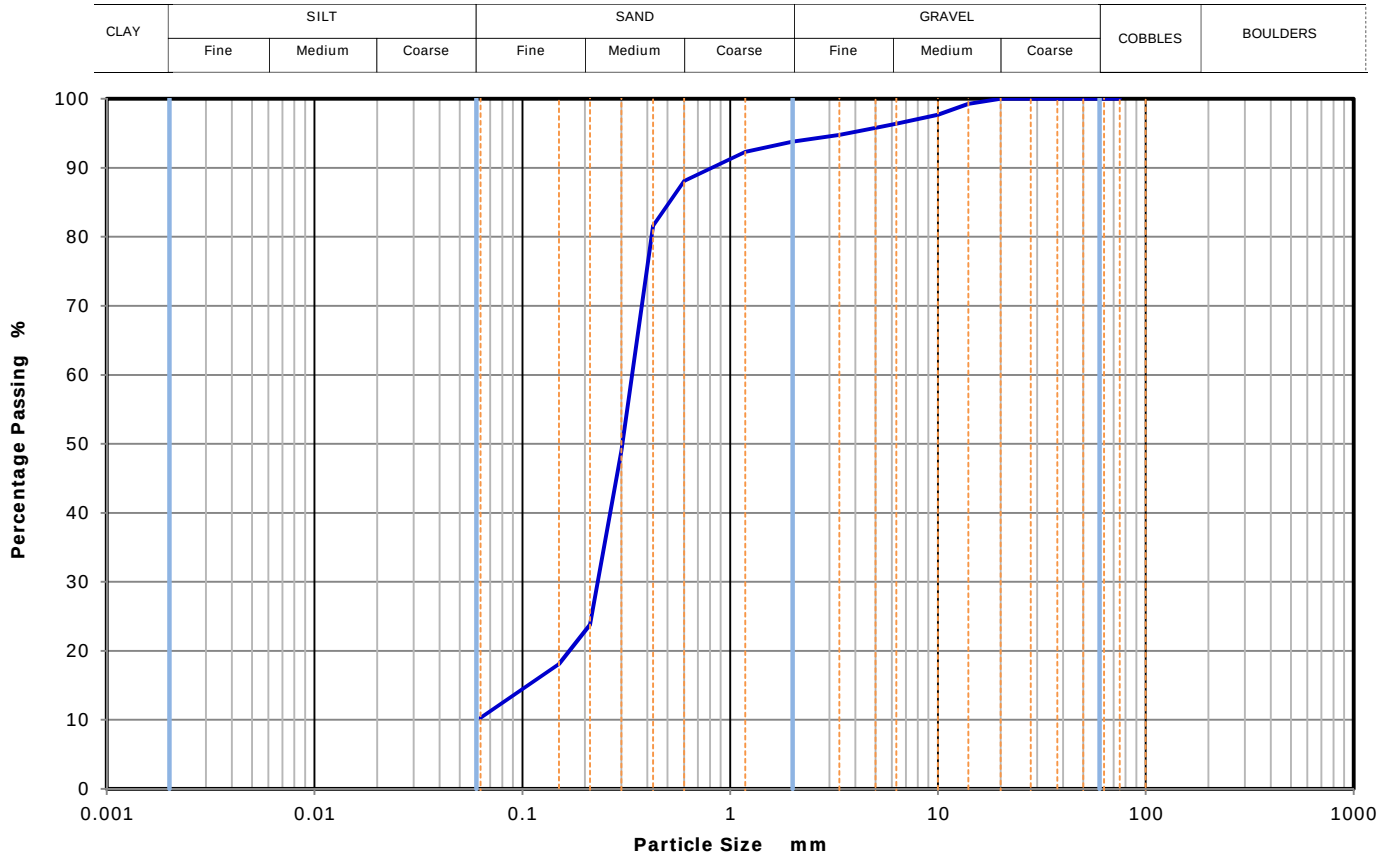
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **WS9A**	Description: **Light brown silty gravelly SAND**
Depth [m]: **2.50**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	100
20	100
14	99.3
10	97.7
6.3	96.4
5	95.8
3.35	94.8
2	93.8
1.18	92.3
0.6	88.1
0.425	81.6
0.3	49
0.212	23.8
0.15	18.1
0.063	10.3

Sample proportions	%
Cobbles	0
Gravel	6
Sand	84
Fines <0.063mm	10

Grading analysis		
D60	mm	0.3
D30	mm	0.2
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

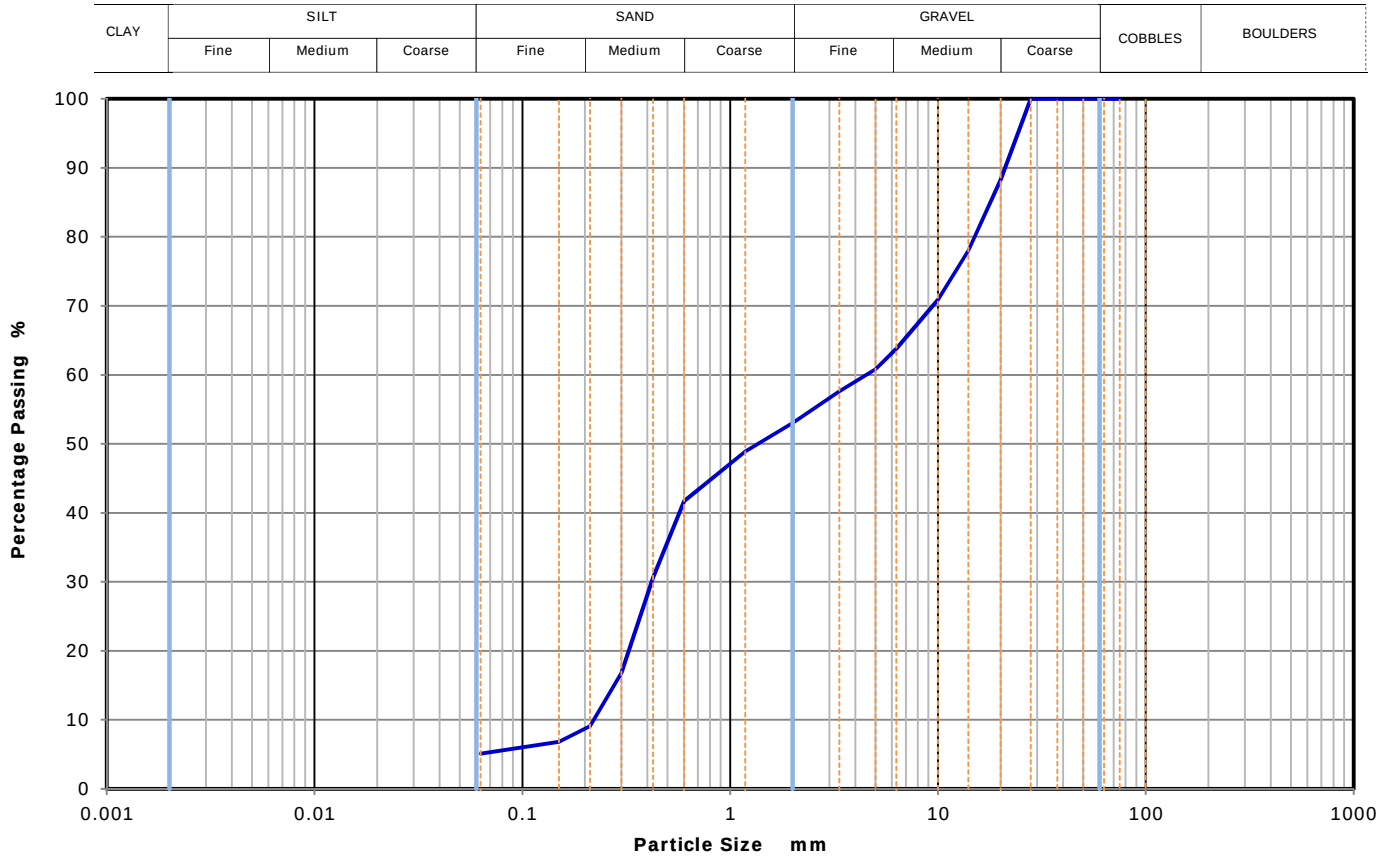
Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report No:	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**		

PARTICLE SIZE DISTRIBUTION

Hole ID: **WS10A**	Description: **Light brown silty SAND and GRAVEL**
Depth [m]: **3.00**	



Sieving	
Size [mm]	% passing
75	100
63	100
50	100
37.5	100
28	100
20	88.3
14	78
10	70.9
6.3	63.8
5	60.8
3.35	57.6
2	53
1.18	48.9
0.6	41.7
0.425	30.6
0.3	16.8
0.212	9.1
0.15	6.8
0.063	5.1

Sample proportions	%
Cobbles	0
Gravel	47
Sand	48
Fines <0.063mm	5

Grading analysis		
D60	mm	4.5
D30	mm	0.4
D10	mm	0.2
Uniformity Coefficient		20.5
Curvature Coefficient		0.2

Test method and date	
Testing in accordance with BS EN ISO 17892:	
Wet sieving method	
Reporting date:	08 Nov 16

Soil Consultants

Site	**Stag Brewery,**	Report	**10022/OT**
Location	**Lower Richmond Road, Mortlake, London SW14 7ET**	No:	

SUMMARY OF UNDRAINED SHEAR STRENGTH TEST RESULTS

BH ID	Depth [m]	Moisture content [%]	Bulk density [Mg/m^3]	Dry density [Mg/m^3]	Cell pressure [kPa]	$(\sigma_1-\sigma_3)_f$ [kPa]	Failure strain [%]	Failure mode	Undrained cohesion [kPa]	Remarks
BH1	1.55	10	1.98	1.80	70	94	7.00	B	47	
	6.55	27	1.91	1.50	130	142	4.00	B	71	
	9.55	26	2.00	1.59	190	427	5.00	B	214	
	12.55	26	1.97	1.56	250	295	5.00	P	148	
	15.55	20	2.05	1.71	310	429	5.00	B	215	
	18.55	26	2.00	1.58	370	445	4.00	P	223	
	21.55	25	1.98	1.58	430	576	8.00	B	288	
	24.55	25	2.01	1.61	490	421	7.00	B	211	
BH2B	5.05	28	1.95	1.52	100	151	5.00	P	76	
	8.05	26	1.97	1.56	160	187	5.00	P	94	
	11.50	25	1.99	1.59	220	386	8.00	B	193	
	14.05	27	1.95	1.54	280	377	7.00	P	189	
	17.05	26	1.96	1.55	340	349	4.00	B	175	
	20.05	25	1.96	1.57	400	423	4.00	B	212	
	23.05	23	2.04	1.66	460	706	8.00	B	353	
	26.05	25	2.03	1.62	520	459	6.00	B	230	
	29.55	25	2.07	1.66	590	825	6.00	B	413	

Testing in accordance with BS EN ISO 17892 UU = unconsolidated, undrained; MUU = multistage, unconsolidated, ur Date: 01 November 16

Unless stated otherwise: Rate of strain = 2mm/min, Standard latex membrame used with thickness = 0.5mm

Failure modes: B = brittle, I = intermediate, P = plastic

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russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 16-50918

Site Reference:	Stag Brewery, Lower Richmond Road, Mortlake, London
Project / Job Ref:	10022/JW
Order No:	None Supplied
Sample Receipt Date:	26/10/2016
Sample Scheduled Date:	26/10/2016
Report Issue Number:	1
Reporting Date:	01/11/2016

Authorised by:

Russell Jarvis
Associate Director of Client Services

Authorised by:

Ela Mysiara
Inorganics & ICP Section Head

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Tel : 01622 850410

Soil Analysis Certificate						
QTS Environmental Report No: 16-50918	**Date Sampled**	15/10/16	15/10/16	15/10/16	15/10/16	15/10/16
Soil Consultants Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Stag Brewery, Lower Richmond Road, Mortlake, London	**TP / BH No**	WS2	WS4	WS9A	WS10A	BH1
Project / Job Ref: 10022/JW	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	**Depth (m)**	2.00	4.70	3.90	4.50	1.55
Reporting Date: 01/11/2016	**QTSE Sample No**	235212	235213	235214	235215	235216

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	8.6	7.4	7.7	8.3	8.2
Total Sulphate as SO_4	mg/kg	< 200	NONE	< 200	< 200	1002	856	206
Total Sulphate as SO_4	%	< 0.02	NONE	< 0.02	< 0.02	0.10	0.09	0.02
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	23	< 10	166	161	26
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.02	< 0.01	0.17	0.16	0.03
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02	1.19	0.42	0.02

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

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Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate						
QTS Environmental Report No: 16-50918	**Date Sampled**	15/10/16	15/10/16	15/10/16	15/10/16	15/10/16
Soil Consultants Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Stag Brewery, Lower Richmond Road, Mortlake, London	**TP / BH No**	BH1	BH1	BH2B	BH2B	BH2B
Project / Job Ref: 10022/JW	**Additional Refs**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Order No: None Supplied	**Depth (m)**	6.55	12.55	17.05	23.05	29.55
Reporting Date: 01/11/2016	**QTSE Sample No**	235217	235218	235219	235220	235221

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	8.1	8.8	9.1	8.9	9.3
Total Sulphate as SO_4	mg/kg	< 200	NONE	971	1737	952	685	670
Total Sulphate as SO_4	%	< 0.02	NONE	0.10	0.17	0.10	0.07	0.07
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	197	251	178	105	90
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.20	0.25	0.18	0.11	0.09
Total Sulphur	%	< 0.02	NONE	0.57	2.56	0.63	0.72	0.61

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

QTS Environmental Ltd
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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 16-50918	
Soil Consultants Ltd	
Site Reference: Stag Brewery, Lower Richmond Road, Mortlake, London	
Project / Job Ref: 10022/JW	
Order No: None Supplied	
Reporting Date: 01/11/2016	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 235212	WS2	None Supplied	2.00	7.1	Light brown sand
$ 235213	WS4	None Supplied	4.70	12.4	Light brown sand
$ 235214	WS9A	None Supplied	3.90	21.9	Brown clay
$ 235215	WS10A	None Supplied	4.50	21.7	Brown clay
$ 235216	BH1	None Supplied	1.55	8.5	Light brown sandy clay with stones
$ 235217	BH1	None Supplied	6.55	19.1	Brown clay
$ 235218	BH1	None Supplied	12.55	16.1	Light grey clay
$ 235219	BH2B	None Supplied	17.05	17	Brown clay
$ 235220	BH2B	None Supplied	23.05	16.7	Brown clay
$ 235221	BH2B	None Supplied	29.55	16.9	Brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

$ samples exceeded recommended holding times

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4480

Soil Analysis Certificate - Methodology & Miscellaneous Information

QTS Environmental Report No: 16-50918

Soil Consultants Ltd

Site Reference: Stag Brewery, Lower Richmond Road, Mortlake, London

Project / Job Ref: 10022/JW

Order No: None Supplied

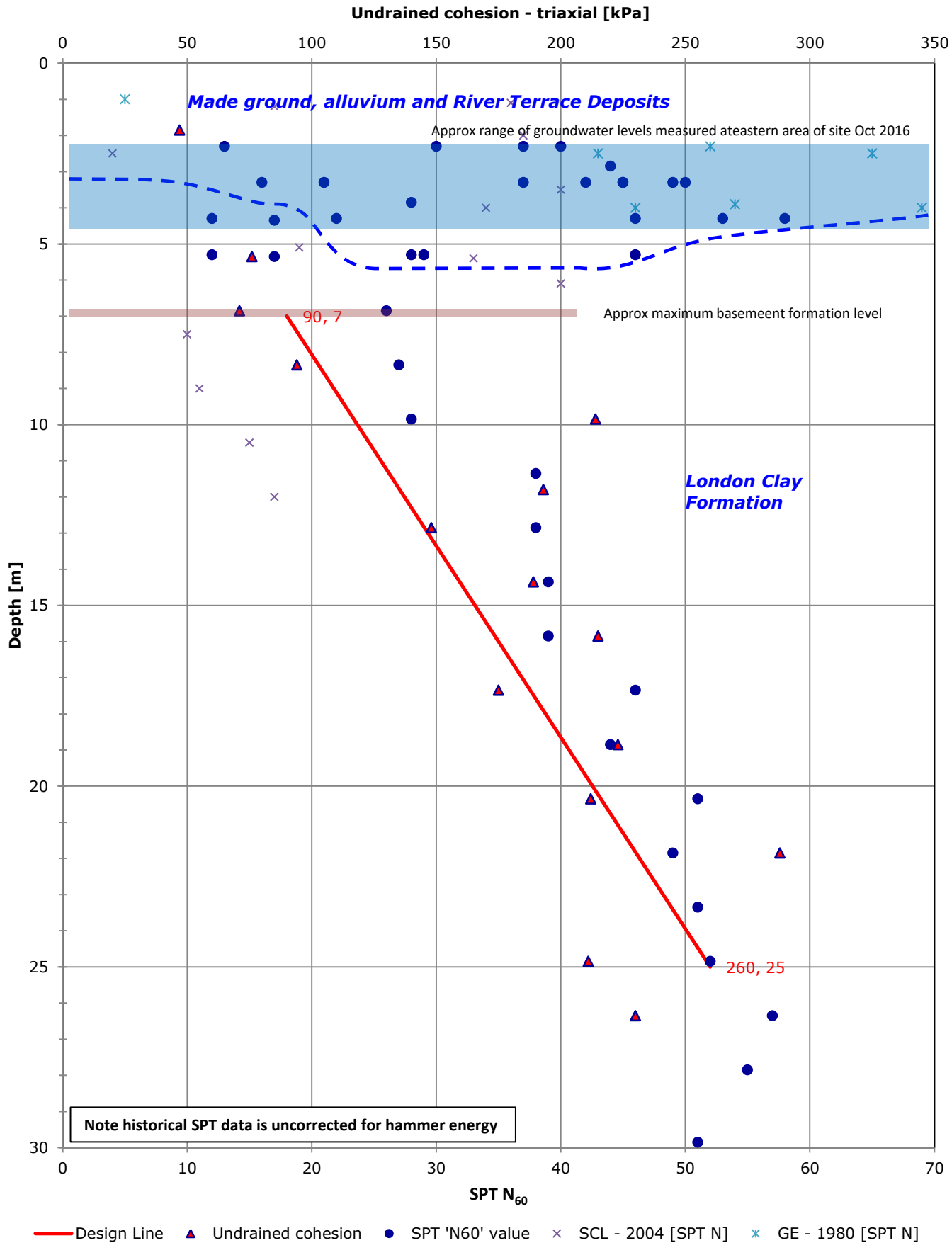
Reporting Date: 01/11/2016

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Site & Location	**Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET**	Report No:	**10022/OT**

Undrained cohesion and SPT [N60] vs depth



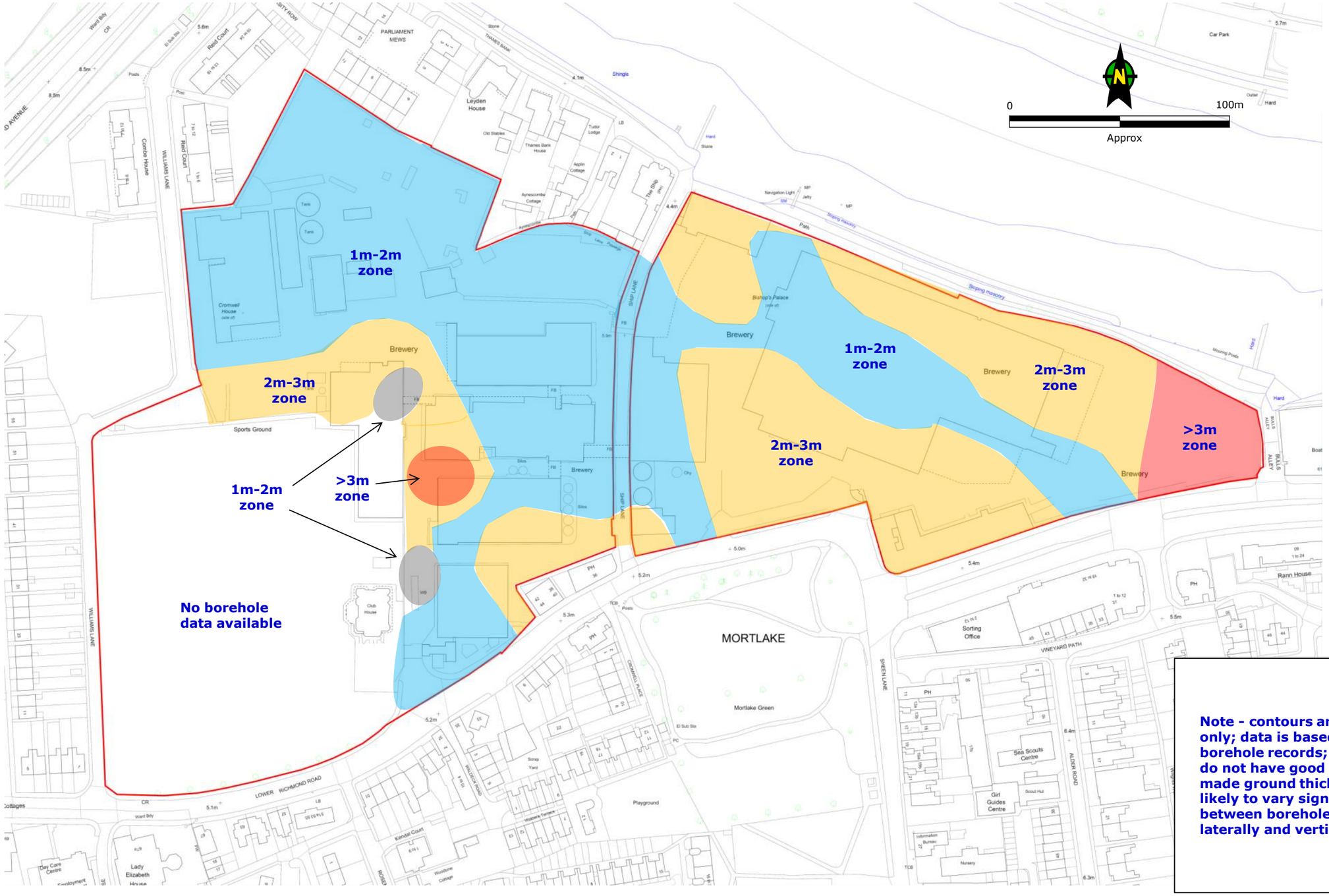
Design Line Δcu = 9.44kPa/m

Note: this plot may incorporate extrapolated results, generally where 'N' >50 - these are indicative only and should be used with caution

Soil Consultants

Site Location	Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET	Report No: 10022/OT

Depth to top - River Terrace Deposits



Note - contours are indicative only; data is based on available borehole records; some areas do not have good coverage and made ground thicknesses are likely to vary significantly between boreholes, both laterally and vertically

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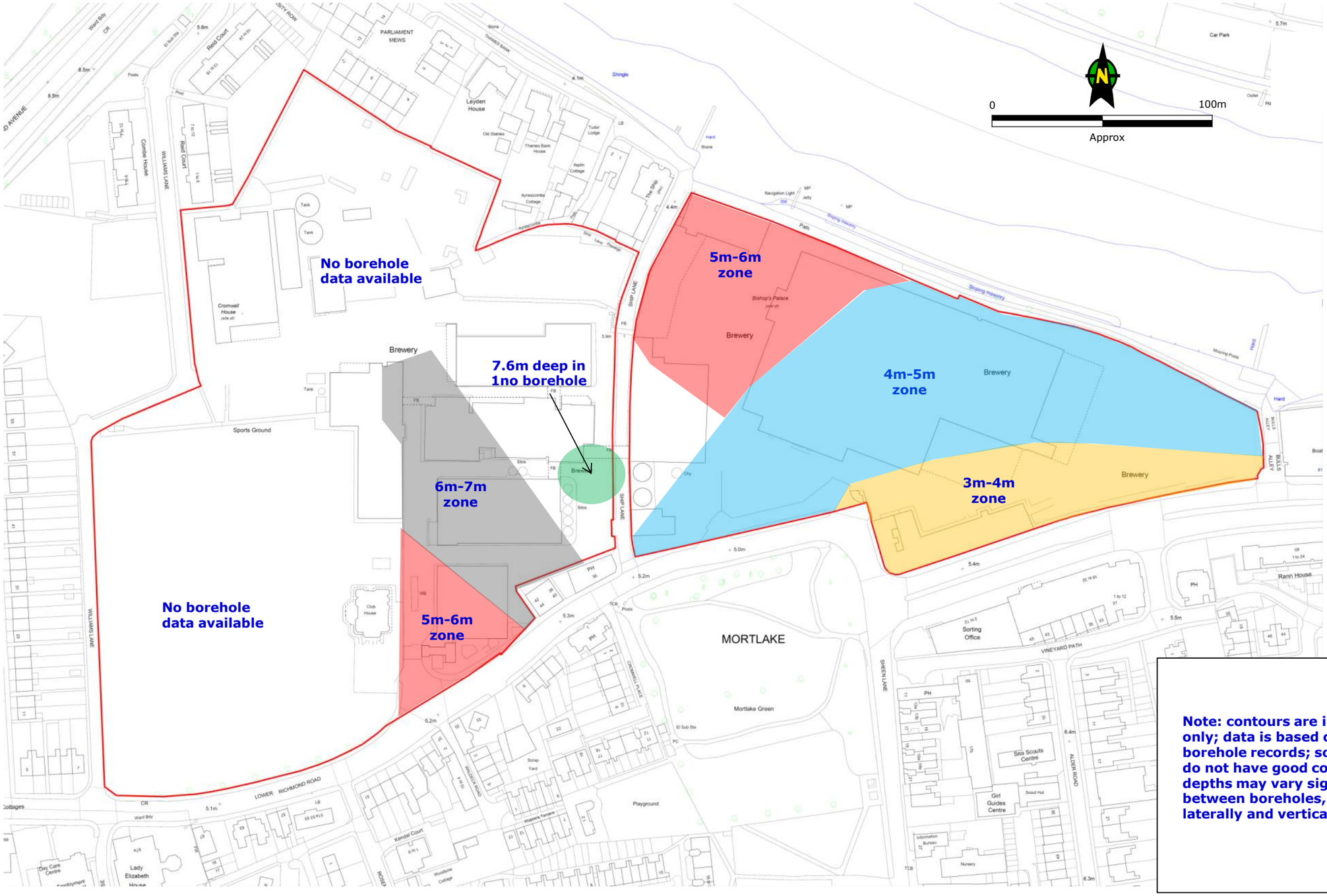
Site Location	Stag Brewery, Lower Richmond Road, Mortlake, London SW14 7ET	Report No: 10022/OT

Depth to top – London Clay Formation



Note: contours are indicative only; data is based on available borehole records; some areas do not have good coverage and depths may vary significantly between boreholes, both laterally and vertically

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