Stag Brewery, Mortlake

Water Resources and Flood Risk EIA Report

For Reselton Properties

February 2018

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This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS OHSAS 18001:2007)

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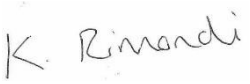

Comments

Comments

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1. Introduction

This Surface Water Drainage and Flood Risk EIA report has been prepared by Waterman Infrastructure and Environment Ltd (Waterman IE) on behalf of Reselton Properties Limited ('the Applicant') in relation to three linked planning applications for the comprehensive redevelopment of the former Stag Brewery site in Mortlake and land at Chalkers Corner ('the Site') within the London Borough of Richmond Upon Thames ('LBRuT').

This report presents the assessment of the likely significant flood risk and surface water drainage effects, together with the likely significant effects on the capacity of foul and potable water supply infrastructure, associated with the proposed demolition, alteration, refurbishment and construction works ('the Works'), and once the Development is completed and operational (see below for a definition of the Development). This report comprises the Environmental Statement (ES) Chapter and associated figures and appendices.

1.1 Report Context and Approach

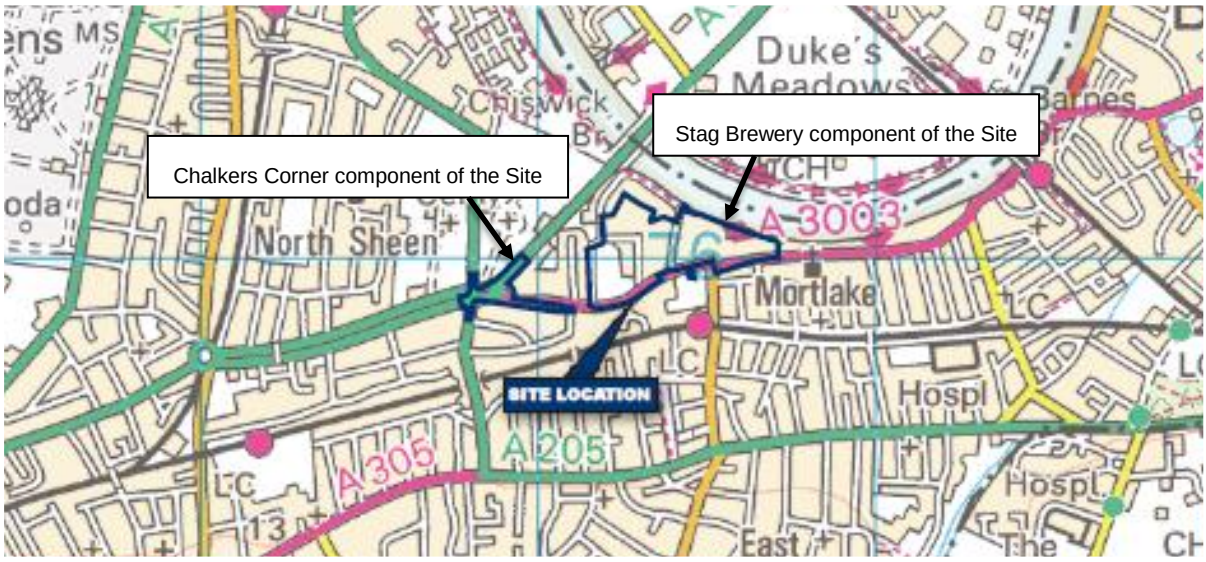
The Development is considered as EIA Development under Schedule 2, Category 10(b) (urban development projects) of the Town and Country Planning (Environmental Impact Assessment) Regulations, 2011 (as amended 2015)[1].

The ES reports the key findings of the EIA process undertaken for the Development and accompanies all three Planning Applications (as described below). At the request of the LBRuT, standalone reports have been provided, but do not differ from those contained within the ES. Justification as to the scope of the ES is summarised in ES Chapter 2: EIA Methodology. Further information on the description of the existing Site and surrounds, the proposed Development, the Works, alternatives and design evolution, and cumulative effects are provided in the ES.

1.2 Site Context and Development Proposals

The location of the Site is shown in Figure 1 below and comprises two components referred to as the 'Stag Brewery component of the Site' and the 'Chalkers Corner component of the Site'.

Figure 1: Site Location



[1] HMSO (2015) Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (as amended 2015).

The Stag Brewery component of the Site is bounded by Lower Richmond Road to the south, the river Thames and the Thames Bank to the north, Williams Lane to the east and Bulls Alley (off Mortlake High Street) to the west. The Stag Brewery component of the Site is bisected by Ship Lane. The Stag Brewery component of the Site currently comprises a mixture of large scale industrial brewing structures, large areas of hardstanding and playing fields. The Chalkers Corner component of the Site comprises highway and associated landscaping referred to as Chalkers Corner junction which includes the junction with the A316 (Clifford Avenue, A3003 (Lower Richmond Road) and A205 (South Circular). Refer to ES Chapter 3: Existing Site and land uses for further information.

The redevelopment will provide homes (including affordable homes), accommodation for an older population, complementary commercial uses, community facilities, a new secondary school alongside new open and green spaces throughout. Associated highway improvements are also proposed, which include works at Chalkers Corner junction. The proposed floorspace of the Development (made up of the three planning applications) is provided in Table 1 below. Refer to ES Chapter 5: The Proposed Development for further information on the Development. The Works would be carried out over a period of approximately 8 years, anticipated to commence in June 2019 and complete in September 2027 (as set out in ES Chapter 6: Development Programme, Demolition, Alteration, Refurbishment and Construction).

Table 1: Proposed Floorspace of the Development

Land Use and Class	Floorspace Area (m^2)	
	Gross External Area (GEA)	Gross Internal Area (GIA)
Residential (Use Class C3, excluding assisted living)	Up to 84,639 (Up to 667 units)	Up to 75,119 (Up to 667 units)
Office (Use Class B1) (including Site management office)	2,674	2,457
Cinema (Use Class D2)	2,565	2,120
Gym (Use Class D2)	912	740
Flexible Uses - Restaurant / bar / retail / community / boathouse (Use Classes A1 / A2 / A3 / A4 / B1 / D1 / Boathouse)	5,308*	4,664*
Hotel (Use Class C1)	1,858	1,668
Assisted Living (Flexible Use Class C2 / C3)	Up to 16,246	Up to 14,738
Nursing and Care Home (Use Class C2)	Up to 10,293	Up to 9,472
School (Use Class D1)	11,430	9,319
Plant and storage.	Up to 4,536 (+ Plant and storage included in school)	Up to 4,244 (+ 249 included in school)
Car parking spaces.	Up to 708 spaces	Up to 708 spaces
Cycle parking spaces.	Up to 1,611 spaces	Up to 1,611 spaces
Basement residential access / circulation	1,868	1,810
Private amenity space.	Up to 5,912	Not applicable
Public amenity space (including external and internal play space for residents and school play space).	Up to 38,943	Not applicable

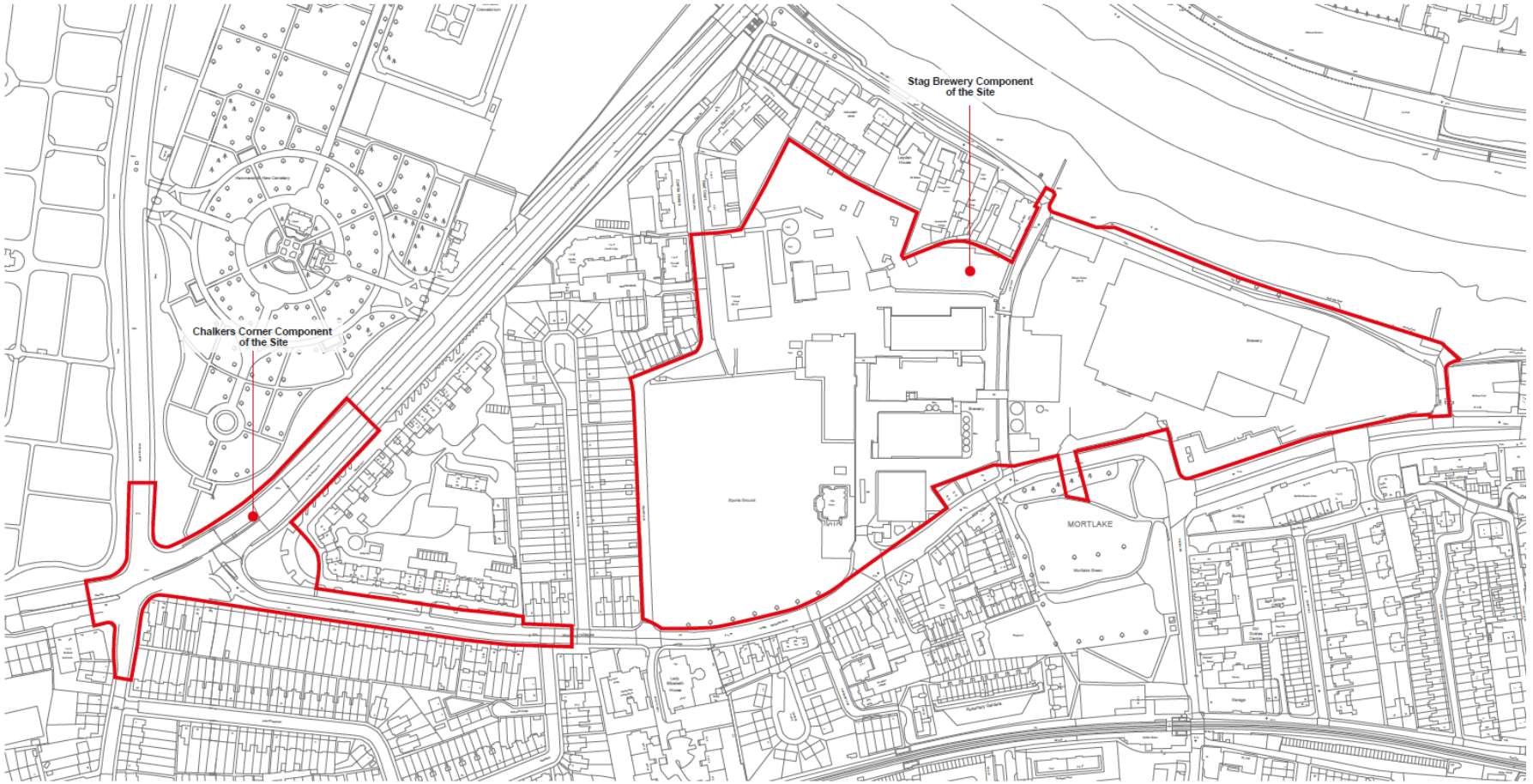
Play space (including external and internal play space for residents and school play space).	Up to 14,353	Not applicable

The three planning applications are as follows:

- Application A – hybrid planning application for comprehensive mixed use redevelopment of the Stag Brewery component of the Site consisting of:
  - Land to the east of Ship Lane applied for in detail (referred to as 'Development Area 1' throughout); and
  - Land to the west of Ship Lane (excluding the school) applied for in outline detail (referred to as 'Development Area 2' throughout).
- Application B – detailed planning application for the school (on land to the west of Ship Lane within the Stag Brewery component of the Site).
- Application C – detailed planning application for highways and landscape works at Chalkers Corner.

The three Planning Applications are separate applications, but will be linked through a S106 agreement to ensure that the Application B (school) land is handed over at an appropriate time and that the Application C (Chalkers Corner) works are carried out at an appropriate stage in conjunction with either Application A or B. For the purposes of assessment, all three Planning applications are therefore considered together as one comprehensive redevelopment proposal. As such, for the purposes of the EIA and ES, the proposals defined by the Planning Applications are collectively referred to as the 'Development'. Similarly, the collective parcels of land associated with the Planning Applications are referred to as the 'Site', as shown on Figure 2.

Figure 2: The Site for the Purposes of the EIA



2. Assessment

12. Surface Water Drainage and Flood Risk

Introduction

12.1 This Chapter, prepared by Waterman Infrastructure and Environment (Waterman IE), presents an assessment of the likely significant effects of the Development on flood risk and surface water drainage, together with the likely significant effects of the Development on the capacity of foul and potable water supply infrastructure. The likely significant effect on groundwater quality resulting from potential ground contamination is assessed separately in **Chapter 11: Ground Conditions and Contamination**.

12.2 This Chapter provides a description of the methods used in the assessment and a description of the relevant baseline conditions of the Site and surrounding area. This is followed by an assessment of the likely significant effects of the Development during demolition, alteration, refurbishment and construction (the Works), and once the Development is completed and operational. Mitigation measures are identified, where appropriate, to avoid, reduce or offset any likely significant adverse effects identified and / or enhance any likely beneficial effects. Taking account of the mitigation measures, the nature and likely significance of residual effects are described.

12.3 This Chapter is based on the findings of the Flood Risk Assessment (FRA), prepared by Hydro-Logic (refer to **Appendix 12.1**), and the Drainage Strategy prepared by Waterman IE (refer to **Appendix 12.2**).

Assessment Methodology and Significance Criteria

Assessment Methodology

12.4 The FRA and the Drainage Strategy were used to inform the baseline conditions of the Site and likely significant effects of the Development on surface water resources and flood risk. These reports were undertaken in accordance with the National Planning Policy Framework (NPPF)[1] and in consultation with statutory consultees including London Borough of Richmond Upon Thames (LBRuT), Environment Agency (EA), Port of London Authority (PLA) and Thames Water. A summary of the methodology is provided as follows. Full details are provided in **Appendix 12.1** and **Appendix 12.2**.

Baseline Data Collection and Sources

12.5 The relevant baseline conditions of the Site and surroundings were established using the following sources of information:

- the Environment Agency's (EA) online flood maps and hydraulic base modelling for the River Thames;
- Ordnance Survey (OS) maps, topographical surveys and British Geological Society (BGS) maps;
- on-Site surface water drainage records to review the existing drainage infrastructure;
- the Preliminary Environmental Risk Assessment and the Environmental Risk Assessment in relation to ground conditions and contamination prepared by Waterman IE (refer to **Appendix 11.1** and **11.2**) and the AECOM Environmental Site Assessment Reports[2,3,4];
- a visual inspection of the Site on 16th June 2016 to establish the condition of the Site including drainage;

- review of the Condition Survey of the Thames River Wall report (**Appendix 12.3**) and The Malting Wall Assessment (**Appendix 12.4**) undertaken by Waterman IE;
- consultation with the EA and Thames Water to obtain historical reports on flooding incidents and sewer records; and
- a review of LBRuT's Sequential Test Document and other relevant local planning policy documents.

Flood Risk Assessment

12.6 A FRA (refer to **Appendix 12.1**) has been undertaken by Hydro-Logic, in accordance with the requirements of the National Planning Policy Framework (NPPF)[1] and the accompanying technical guidance[5]. The purpose of the FRA is to identify all potential sources of flooding at the Site, determine the risk posed by these flooding sources to the Development and to predict the likely effect on flood risk that the Development poses to surrounding receptors. Tidal, fluvial, pluvial (surface water), sewer, groundwater and artificial, flood risks have been considered in the FRA, with allowances made for the likely effects of climate change, where relevant. In addition to breach modelling provided by the EA, Hydro-logic undertook further breach modelling, as requested by LBRuT following the FRA Scoping Level FRA (refer to **Appendix B** and **C** of **Appendix 12.1**), as part of the FRA to establish the effect that the Development may have on flood extents resulting from breach analysis.

12.7 As the Chalkers Corner Component of the Site would include highway re-modelling works and landscaping works (refer to **Chapter 5: The Proposed Development**), there would be no change of land-use or impact on ground levels in the Chalkers Corner component of the Site. There are accordingly, no flood risk implications of this part of the Site and it is not considered further in the FRA. The geographical coverage of the FRA is therefore considered to be appropriate and robust for the purposes of the assessment.

Drainage Strategy

12.8 Consideration is also given in the FRA to surface water drainage to ensure the Development does not increase the risk of flooding at off-Site locations. Accordingly, a drainage strategy for the Development has been prepared by Waterman IE. This sets out the proposed surface water runoff rates, together with the type and volume of attenuation proposed. The drainage strategy has been used to inform the FRA and the qualitative assessment presented in this Chapter, which has been based on professional judgement.

12.9 The foul water flow rates of the Development were calculated by Waterman IE. Based on the calculated foul water discharge rates of the Development a qualitative assessment has been undertaken using professional judgement to assess the likely significant effects of the Development on foul water capacity.

12.10 The Drainage Strategy has been developed for the Stag Brewery component of the Site only. The Chalkers Corner component of the Site is highway land and all drainage aspects are the responsibility of the local highway authority. The surface water run-off from the highway drainage would be discharged to the sewer as existing and would not be attenuated. As a result, Chalkers Corner is not included in the Drainage Strategy and this is considered to be appropriate and robust.

Potable Water Demand

12.11 A qualitative assessment of the likely significant effects of increased demand on the capacity of potable water supply infrastructure at the Site has been undertaken. The assessment is based upon available published information from Thames Water and calculations of the Development's likely potable water demand prepared by the Applicant's Building Services Engineers (Hoare Lea).

12.12 In respect of the assessment of the outline component of the Development (Development Area 2), the assessment set out within this Chapter has considered the maximum allowable spatial parameters sought for approval. This would give rise to the most intrusive ground works and the maximum amount of impermeable land cover so can be considered to reflect a 'worst-case' assessment for issues such as groundwater flooding and surface water flooding. That said, based on professional and expert judgement, it is unlikely that the minimum allowable spatial parameters sought for approval would give rise to materially different flood risk effects. This is because the scale of Works that would be required for both the maximum and minimum allowable parameters would be similar and the sensitive receptors likely to be affected by flooding would be the same.

Significance Criteria

12.13 In accordance with **Chapter 2: EIA Methodology**, the relative significance of the likely and residual effects considered in this Chapter are based upon the scale of significance presented in **Table 12.1**.

Table 12.1: Significance Criteria

Significance Criteria	Description of Criteria
Beneficial effect of major significance.	Significant local-scale or moderate to significant regional-scale reductions in flood risk. Major permanent reduction in demand on surface and / or foul water infrastructure. Permanent regional scale reduction in water supply demand and permanent increase in the capacity of existing infrastructure.
Beneficial effect of moderate significance.	Moderate local-scale or minor regional scale reduction in flood risk. Minor permanent reduction in demand on surface and / or foul water infrastructure. Permanent local scale reduction in water supply demand and permanent increase in the capacity of existing infrastructure.
Beneficial effect of minor significance.	Minor local-scale reduction in flood risk. Temporary local scale reduction in demand on surface and / or foul water infrastructure. Temporary local scale reduction in water supply demand and temporary increase in the capacity of existing infrastructure.
Insignificant.	No appreciable change in flood risk. No change to demand surface and/or foul water infrastructure. No change to demand on the capacity of water supply and the existing water supply infrastructure.
Adverse effect of minor significance.	Minor local-scale increases in flood risk. Increase in surface and / or foul water discharge which would require modifications to existing infrastructure. Increase in water supply which would place additional pressure on existing local supplies and existing water supply infrastructure.

Significance Criteria	Description of Criteria
Adverse effect of moderate significance.	Moderate local-scale or minor regional-scale increases in flood risk. Increase in surface and / or foul water discharge which would place undue pressure on existing infrastructure. Increase in water supply which would place undue pressure on existing local supplies and existing water supply infrastructure.
Adverse effect of major significance.	Significant local-scale or moderate to significant regional-scale increases in flood risk. Increase in surface and / or foul water discharge which would require new infrastructure. Increase in water supply which would exceed the water resource capacity of the region and therefore require new sources e.g. application of an abstraction licence.

Baseline Conditions

Topography

12.14 The Site is generally flat with no significant variations in the topographical gradient. The LiDAR map indicates that it is lowest to the east of the Stag Brewery component of the Site (4 to 6 m AOD) and highest in the north west of the Stag Brewery component of the Site (8 to 10 m AOD).

Geology

12.15 The geology beneath the Site, summarised in **Table 12.2**, was established from previous ground investigations by Dames and Moore (1995), CRA (2003) and Aecom (September 2015), BGS records and the findings of the Waterman IE Ground Investigation undertaken in the eastern part of the Stag Brewery component of the Site. Further details of the underlying geology are described in **Chapter 11: Ground Conditions and Contamination**, **Appendix 11.1** and **Appendix 11.2.**

Table 12.2: Geological Sequence Beneath the Site

Stratum	Area Covered	Estimated Thickness (m)	Typical Description
Hardstanding.	Entire Stag Brewery component of the Site (excluding the playing fields).	0.25 - 0.8	Tarmac or reinforced concrete floor slab at surface level. Encountered as two or three separate layers up to 0.5 m thick, each separated by up to 0.5 m Made Ground in eastern area.
Made Ground.	Entire Stag Brewery component of the Site.	0.4 - 2.7	Predominantly coarse sand and gravel, including pieces of brick and minor amounts of black clinker. Rare pipe fragments.
Alluvium.	Entire Stag Brewery component of the Site.	0.3 - 1.5	Soft brown grey slightly gravelly clay. Gravel is fine to coarse flint.
Kempton Park Gravel Formation.	Entire Stag Brewery component of the Site.	1.4 - 3.9	Clayey, silty sand with varying gravel content with areas of soft, brown, sandy clay. Gravel is sub-angular to rounded, fine to coarse flint.

Stratum	Area Covered	Estimated Thickness (m)	Typical Description
London Clay Formation.	Entire Stag Brewery component of the Site.	73	Stiff grey to brown clay, with occasional pockets of silt and sand.
Lambeth Group.	Entire Stag Brewery component of the Site.	15 - 20	Clay, some silty or sandy, with sands and gravels.
Thanet Formation.	Entire Stag Brewery component of the Site.	5 - 10	Fine grained sand that can be clayey and glauconitic. Flints at the base of the formation.
Chalk Group.	Entire Stag Brewery component of the Site.	Not proven.	Chalk and flints.

Hydrology and Hydrogeology

12.16 The nearest surface water to the Site is the River Thames, directly adjacent to the eastern part of the Stag Brewery component of the Site (Development Area 1) to the north.

12.17 The EA's Aquifer Designation Map[6] indicates that the Alluvium and Kempton Park Gravel Formation underlying the Stag Brewery component of the Site are classified as a Secondary A Aquifer (minor aquifer). These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. Based on available information, it is anticipated that shallow groundwater in the Alluvium and Kempton Park Gravel Formation is in hydraulic continuity with the River Thames directly adjacent to the Stag Brewery component of the Site.

12.18 The London Clay Formation is an Unproductive Stratum. The Lambeth Group and Thanet Formation are both also classed as Secondary A Aquifers, with the Chalk Formation at depth a Principal Aquifer. According to the EA, the Site is not located within a groundwater Source Protection Zone.

Groundwater Level

12.19 Previous Site Investigations by AECOM in September 2015[3] for the Stag Brewery component of the Site and subsequently Waterman IE in October 2016 for the east part of the Stag Brewery component of the Site (refer to **Appendix 11.2**) observed broadly consistent groundwater levels generally 2 m AOD in the east part of the Stag Brewery component of the Site (east of Ship Lane) and 1.3 m AOD in the west part of the Stag Brewery component of the Site (west of Ship Lane). Occasional perched levels were also observed at different locations across the Stag Brewery component of the Site. The 2015 monitoring results indicate the inferred groundwater flow direction to be to the west.

12.20 Tidal effects from the River Thames on groundwater levels were also assessed. The assessment indicates that groundwater levels of the northern boundary of the east part of the Stag Brewery component of the Site had a very subdued response to tidal variation.

Groundwater Abstractions

12.21 There are two recorded historical groundwater abstractions within the Stag Brewery component of the Site boundary. These wells were drilled circa 1830, extended to 101m and 121m below ground level and drew groundwater from the Chalk Group aquifer. A further two groundwater abstractions are recorded within a 1km radius of the Site. The closest of these is located 228m north of the Site at Dukes Meadow Golf Club, drawing groundwater from the Chalk Group aquifer. The further abstraction is located 663m north east, also at Dukes Meadow Golf Club. There are no Environmental Permits for discharges to groundwater recorded within 1km of the Site.

Tidal and Fluvial Flood Risk

12.22 The EA have provided maps of the flood zone which shows that the east and south of the Site (including the Chalkers Corner component of the Site) is located within Flood Zone 3 (high probability of tidal flooding), and the north east of the Stag Brewery component of the Site is located in Flood Zone 2 (medium probability of tidal flooding). The principal source of flood risk to the Site is from the River Thames, which is entirely from tidal flooding, with no fluvial component. As such, the risk of fluvial flooding is very low and has not been considered further within this Chapter.

12.23 Despite being located within an area at a medium to high probability of tidal flooding, the Site is protected up to the 1 in 1000-year standard by the River Thames defences. The Thames Estuary 2100 Plan (TE2100)[7], would ensure that the River Thames defences are not overtopped for the lifetime of any redevelopment on the Site. Furthermore, the Site currently benefits from tidal flood defences along the river frontage. These are formed from the Site boundary walls and the Maltings building.

12.24 Given the Site is protected by the River Thames flood defences, the risk of tidal flooding is considered to be low.

Breach

12.25 Despite the Site being defended from tidal flooding, the EA require assessment of the residual risk of flooding to the Site should the defences fail (breach).

12.26 The EA have provided their breach modelling maps and levels (refer to **Appendix 12.1**) which show that some parts of the Site could be affected if the defences were to fail. EA modelling indicates that in this scenario the Site could be subject to a future peak flood level of 6.03 m AOD by the year 2100. The further breach modelling undertaken by Hydro-logic for the Development is presented later in this Chapter.

Surface Water (Pluvial) Flood Risk

12.27 Pluvial flooding occurs when natural and engineered systems lack capacity to manage the volume of rainfall. Pluvial flooding can occur in urban areas during an extreme, high intensity, low duration summer rainfall event which overwhelms the local surface water drainage systems. This flood water would then be conveyed via overland flow routes based on the local topography.

12.28 Review of the EA's Risk of Flooding from Surface Water map indicates that most of the Site is at a 'very low' risk of surface water flooding. However, there are some areas, generally in the south of the Site, that are shown to be at a 'low' to 'high' risk of flooding.

12.29 In the low-risk scenario, greater depths of surface water flooding are predicted in Lower Richmond Road adjacent to the Watney's Sports Ground playing fields (300 to 900 mm) and in Mortlake

Green, south of Lower Richmond Road (in excess of 900 mm). Some of the surface water flooding on Lower Richmond Road may be linked to blocked gully incidents.

12.30 For the high-risk scenario, predicted surface water flooding is restricted to the carriageway of the Upper Richmond Road and the adjacent park and is of shallow depth.

12.31 Although surface water and foul sewers are laid under the Site, Thames Water have confirmed that there is no recorded history of sewer flooding at the Site (in their response to Waterman IE dated January 2016), extracts from which are shown in **Appendix E** of **Appendix 12.1**.

12.32 Given the generally 'very low' risk of surface water flooding and the lack of pluvial flooding history, it is considered that the risk of pluvial flooding from surcharged sewers or overland surface water runoff is low.

Groundwater Flood Risk

12.33 As previously described, groundwater levels are generally 2 m AOD in the east part of the Stag Brewery component of the Site (east of Ship Lane) and 1.3 m AOD in the west part of the Stag Brewery component of the Site (west of Ship Lane), with occasional perched groundwater levels.

12.34 LBRuT have confirmed that they hold no record of any flooding reports at Mortlake High Street, Lower Richmond Road, Ship Lane or Williams Lane, other than blocked gully reports.

12.35 Given that LBRuT hold no records of historical groundwater flooding within and surrounding the Site, groundwater flooding at the Site is considered to be low over the majority of the Site. However, in the far east of the Stag Brewery component of the Site, there is some uncertainty over the relative influence of the mechanisms controlling groundwater flow through the Site - either through the high permeability Kempton gravels and / or groundwater flows in the underlying minor aquifer.

Flood Risk from Artificial Sources

12.36 The Site has a potential risk of flooding from the Queen Elizabeth II reservoir and the Queen Mary reservoir in Surrey. This could occur if the reservoirs were to fail, causing water to flood over the western and southern parts of the Site. However, these reservoirs are located over 20 km upstream of the Site, and are managed and maintained by Thames Water. All large reservoirs must be inspected and supervised by reservoir panel engineers. The EA are the enforcement authority for the Reservoirs Act 1975[8] and ensure that reservoirs are inspected regularly and essential maintenance and safety work is carried out. This would ensure that the embankments are maintained to a high standard, reducing the associated flood risk.

12.37 There are no other artificial bodies of water within proximity to the Site, and the risk of flooding from artificial sources is therefore considered to be very low. Consequently, flood risk from artificial sources has not been considered further in this Chapter.

Infrastructure

Flood Defences

12.38 The formal River Thames defences within and in the vicinity of the Site are made up of a combination of walls, existing buildings and raised ground levels.

12.39 EA correspondence indicates that the present day statutory flood defence level at the Site is 5.94m AOD.

12.40 Defence record drawings confirm that the defences adjacent to the Site vary in construction. In some locations, the defences consist the remaining exterior walls of historic buildings (where the windows have been bricked up). For example, the brick wall of the Maltings Building within the Stag Brewery component of the Site behind the towpath, forms part of the flood defence wall. A Site visit confirmed that in some locations the walls themselves are considerably taller than the statutory defence height (5.94m AOD). A short section of the tidal defences is also formed in an informal basis by Ship Lane, as it rises away from the River Thames in a southerly direction. On occasion, Ship Lane and the adjacent towpath to north of the Stag Brewery component of the Site can become flooded at high tide, as noted during a previous walkover of the Site by Waterman in January 2016 (refer to **Appendix 12.1**).

12.41 Stop-logs (hydraulic engineering control elements) are located in Bull's Alley. The stop-log arrangement at Bull's Alley enables maintenance vehicles to access the river to clear debris on the foreshore. Given this regular usage, it is anticipated that this location would be regularly inspected and maintained.

12.42 The current condition of the defences is rated by the EA as 2 which is 'good' on a scale of 1 (very good) to 5 (very poor). However, a river wall condition survey (**Appendix 12.3**) undertaken by Waterman IE in September 2016 for a 368 m stretch of the River Thames wall along the northern boundary of the Stag Brewery component of the Site found the river wall to be in a poor to fair condition. Due to the nature of the existing defences it is likely that some areas would need to be replaced as part of any development proposals coming forward.

Existing Foul Drainage

12.43 Thames Water sewer records (refer to **Appendix B** of **Appendix 12.2**) indicate that several sewers are present near to and beneath the Stag Brewery component of the Site, as indicated in **Table 12.3**.

Table 12.3: Existing Sewers Associated with the Stag Brewery Component of the Site

Location	Sewer
Crossing through the north west of the Stag Brewery component of the Site.	225mm diameter Thames Water foul sewer.
Within north west of the Stag Brewery component of the Site.	Two Thames Water foul rising mains.
Along north eastern boundary of the Stag Brewery component of the along Thames towpath.	686mm diameter combined Thames Water sewer.
West of Stag Brewery component of the Site along Willams Lane.	900mm diameter Thames Water surface water sewer.
South of Stag Brewery component of the Site along Lower Richmond Road.	600mm diameter Thames Water surface water sewer.
	750mm diameter and 225mm diameter Thames Water foul water sewer.
Centre of Stag Brewery component of the Site along Ship Lane.	600mm diameter Thames Water surface water sewer.
	225mm diameter Thames Water foul water sewer.

12.44 Following review of the existing on-Site drainage records for the Stag Brewery component of the Site (refer to **Appendix C** of **Appendix 12.2**) it is understood that existing drainage scenario is as follows:

- existing foul flows discharge to the Thames Water sewer network;
- existing surface water flows from the north east of the Stag Brewery component of the Site discharge into the Thames via an existing outfall; and
- existing surface water flows from the remainder of the Stag Brewery component of the Site discharge to the Thames Water sewer network at various connection points.

12.45 The existing foul discharge rate has been calculated using the water consumption method at 14.4 l/s.

Potable Water Supply and Demand

12.46 Thames Water is responsible for public water supply within in, and in the locality of the Site. There are water distribution mains surrounding the Site including those running alongside Thames Bank (north west of the Stag Brewery component of the Site), Williams Lane (western boundary of the Stag Brewery component of the Site), Ship Lane (running north south within the centre of the Stag Brewery component of the Site) and Lower Richmond Road / Mortlake High Street (south of the Site). A trunk main also runs along Lower Richmond Road / Mortlake High Street.

12.47 As the existing Site is currently vacant, there is currently no significant on-Site demand for potable water and therefore there is no existing water demand rate for the Site.

Likely Significant Effects

The Works

Groundwater Flow and Flooding

12.48 With reference to **Chapter 5: The Proposed Development** and **Chapter 6: Development Programme, Demolition, Alteration, Refurbishment and Construction**, the bottom of the proposed basement slab within the east part of the Stag Brewery component of the Site (east of Ship Lane) would be set at 0.76 m AOD. This is around 1.25 m below the typical groundwater level of 2 m AOD. Whilst locally, some higher levels have been observed up to 3 m AOD, these are believed to be perched water tables that reflect local interventions.

12.49 The proposed foundation design for all buildings within the detailed element of the Stag Brewery component of the Site would comprise a 1 m deep piled raft, with the exception of the proposed cinema area which would be founded in 1 m deep local pile caps with 1 m deep ground beams. Below the foundations, all buildings would have an expanse of piles (3 to 5 per column) that would be 600mm in diameter and extending down 25m in length. However, as the piles would be relatively small in diameter (up to 600mm), groundwater flow would be able to continue to move around the new piles.

12.50 The maximum depth of the proposed basement within the west part of the Stag Brewery component of the Site (west of Ship Lane), would be set at 2.45m AOD. All proposed buildings in the western part of the Stag Brewery component of the Site would be above the observed groundwater levels of September 2015, therefore the Works would not impede or interfere with any groundwater flows in this part of the Site.

12.51 The new river wall would be formed within the north of the Stag Brewery component of the Site. This would comprise a sheet pile wall with an in-situ reinforced concrete capping beam. The toe level of the sheet pile wall would be set at -1 m AOD. Given the river wall piling works would be undertaken immediately next to the River Thames, and groundwater at this location is in hydraulic continuity with the river, groundwater flow would not be impeded by these works.

12.52 In view of the above, perched groundwater could be encountered during the excavation works required to construct the basement within the east part of the Stag Brewery component of the Site (east of Ship Lane). This could lead to the ingress of groundwater and potential flooding of excavated areas. The potential effect from increased flood risk from groundwater during construction, however, would be temporary and highly localised on-Site. It is therefore not considered likely that the excavation works would lead to an increase in flood risk from groundwater beyond the Site. Taking a precautionary approach, it is anticipated that during excavation of the basement within the east part of the Stag Brewery component of the Site (east of Ship Lane) in the absence of mitigation there would be a **temporary**, **short** to **medium-term**, **local**, **adverse effect** of **minor significance** in respect of groundwater flooding.

Surface Water (Pluvial) Flood Risk

12.53 Construction works, including earthworks, removal of some soft landscaping and trees, storage of waste stockpiles, sewer diversions and temporary Site drainage, would have the potential to give rise to changes in the surface water run-off regimes particularly during periods of heavy rainfall. The diversions would need to be undertaken prior to the commencement of the basement construction and would require formal liaison with Thames Water.

12.54 In the absence of mitigation, the risk of surface water flooding from overland sources could increase, as discharge rates may not be controlled, and overland surface water run-off could potentially be diverted away from the existing sewers and towards areas at higher risk of surface water flooding (such as Lower Richmond Road and Mortlake Green). A temporary change in Site conditions, and in surface water drainage regimes, could give rise to a **temporary**, **short to medium term**, **local**, **adverse effect** of **minor significance**.

River Wall

12.55 The Development does not propose any direct work to the River Thames. Nonetheless, statutory exclusion zones from the River Thames and approval of relevant consents for sewer diversion works would be agreed with the EA and other appropriate bodies in advance of the Works.

12.56 The Works, including work to the river wall and the construction compounds, would be located behind the existing river wall, within the Stag Brewery component of the Site, ensuring that access to the river wall from the towpath is maintained. This would ensure that access to the river wall for inspection and maintenance would not be hindered during the Works. As such the likely effect on access to the river wall during the Works would be **insignificant**.

12.57 As set out previously, the new flood defence walls comprise a sheet pile wall with an in-situ reinforced concrete capping beam behind the existing river wall. The existing river wall would be lowered in certain areas. However, this would be undertaken after the new flood defence wall has been built, which would be set at a minimum of 6.70 m AOD, with a 0.42 m high balustrade on top in some areas providing a crest level of 7.12 m AOD, well above the current statutory level of 5.94 m AOD. In parts, the wall would be lowered at 6.13 m AOD but would be topped by a 1.1 m high glass balustrade, with an effective crest at 7.23 m AOD. Temporary defences would also provide the required level of protection until any replacements are in place and the Works would be undertaken when there is no practical risk of tidal flooding. The alignment of the new flood defence wall would be either identical to the existing alignment, or set further into the Stag Brewery component of the Site. Accordingly, there would be no loss of flood plain storage. All such work would be undertaken in conjunction with the EA to ensure necessary approvals for design and constructional sequence through Environmental Permits (formerly Flood Defence Consents). As

such, the likely effect of remodelling the river wall on flooding during the Works would be **insignificant**.

Foul and Potable Water Infrastructure Capacity

12.58 Wastewater generation from the Works would include effluent from sanitary facilities, as well as sediment-laden water from excavations, washing down and wheel wash facilities. It is expected that foul water generated at the Site during excavation and construction would be drained via the existing Thames Water combined sewers in the surrounding area. This would result in a minor temporary increase in foul water flows to the Thames Water network, although due to the low volumes expected this is expected to be **insignificant**.

12.59 The Works may require significant volumes of water supply for sanitary facilities for staff, wheel washing and the washing down of construction areas. This is considered to have a **temporary**, **short** to **medium term**, **local**, **adverse effect** of **minor significance** on water supply and demand.

Existing Drainage Infrastructure

12.60 Vibration from piling and excavations could have the potential to lead to water main bursts or sewer collapse. However, the Development would comply with all necessary easements, and where these are not possible, appropriate diversions would occur.

12.61 The 225 mm diameter Thames Water foul sewer crossing the Stag Brewery component of the Site would be diverted as shown on the drainage plan in **Appendix I** in **Appendix 12.2**. The two rising mains only service the existing uses within the Stag Brewery component of the Site (now redundant and dis-used), and would be abandoned. An easement of 4 m is allowed for in respect of the combined sewer along the north eastern boundary of the Stag Brewery component of the Site. This would ensure there would be no physical effect to the combined sewer as it conveys off-Site flows.

12.62 Although appropriate easements and sewer diversions would be in place and agreed with Thames Water, in the absence of mitigation, vibration effects from piling and excavation works could result in a **temporary**, **short to medium term**, **local**, **adverse effect** of **moderate significance**.

Completed Development

Tidal Flood Risk

Risk to Occupants of the Development

12.63 Whilst the Site is located in a tidal flood zone, the land raising and setting of finished floor levels (FFLs) within the Development associated with the Stag Brewery component of the Site would ensure that the majority of occupiable floorspace of the Development would be at a safe level. This means that even in the event of overtopping of defences or a breach, the TE2100 levels would not encroach on the residential accommodation, all of which is set at a minimum of 7.03 m AOD, well above the reference flood level of 6.03 m AOD by 2100. The principal streets have been set at a minimum level of 6.03 m AOD in the east part of the Stag Brewery component of the Site (east of Ship Lane) and 6.30 m AOD in the west part of the Stag Brewery component of the Site (west of Ship Lane). Given this level of protection, residents would have no need for emergency egress from the Site due to flood conditions. The Development associated with the Chalkers Corner component of the Site would not be occupiable. As such, land raising would not be required at the Chalkers Corner component of the Site.

12.64 Despite the above, there are some exceptions where occupiable floorspace within the Development would be below the reference flood level of 6.03 m AOD. The exceptions would be as follows:

- **Building 1 (Cinema) & B06 (Retail):** the proposed FFL for the cinema and retail area would be set at 5.565 m AOD, however, since the proposed leisure and retail uses have a shorter design life, it is appropriate to use modelled flood levels for 2065. Interpolation for this date gives a reference flood level specific to this location of around 5.52 m AOD, which is lower than the FFL and so the risk posed by tidal flooding is deemed acceptable;
- **Building 4 (The Maltings):** the FFL for the ground floor has been constrained by the existing building which would be retained, altered and refurbished as part of the Development. The FFL for the community space on the ground floor would be set at 4.74 m AOD, well below the reference flood level. Furthermore, the exits from the residential properties on the upper floors of the Maltings would be at 5.53 m AOD, also below the reference flood level. However, a survey of the Maltings wall undertaken by Waterman IE (**Appendix 12.4**) showed the wall to have sufficient capacity to resist the increase in water level that occurs when the river rises to the 2100 flood defence levels. As such, the risk posed by tidal flooding is deemed acceptable;
- **Building 5 (Hotel lobby and bar):** the hotel lobby and bar are at a level of 5.15 m AOD, slightly below the reference flood level for this location of 5.52 m AOD. However, access to the hotel lobby and bar would be available via steps from the hotel lobby to reception, which would be set at the 2100 reference flood level of 6.03 m AOD;
- **Building 9 (Boathouse):** most of the ground floor would be at 4.25 m AOD in order to provide a facility for boat storage and access to the River. Club house facilities would also be provided at this level. Whilst the access to the river would be via 'flood-proof doors', it is accepted that these doors would not be sufficient to form part of the official tidal defences. The residential entrance lobby, deemed a 'more vulnerable' use, would be set at 6.03 m AOD and therefore be located at a safe level. However, the defences would need to be raised at this level in the future to ensure that the defences are at a sufficient height to cope with the TE2100 levels for 2100 of 6.70 m AOD. Provision has been made for additional steps from the training room to the residential exit to ensure the integrity of the defences for TE2100 levels;
- **Building 10 (Retail & substation):** some retail space along the southern elevation would have a FFL of 5.40 m AOD, lower than the reference level at this location, however there would be access via steps to levels at 6.03 m AOD at the rear of the unit. This building would also contain a sub-station, with a FFL also at 5.40 m AOD, which would need to be protected from residual risk of flooding. There would be a single point of access to the facility via a secure, flood proof door. As such, the risk posed by tidal flooding is deemed acceptable; and
- **Basement car park:** The entrance to the eastern basement from Mortlake High Street would be around 5.3 m AOD and below the reference flood level. Consequently, there would be a residual risk from any breach in the vicinity of Bull's Alley. However, it should be noted that the basement would not be for habitation and the other entry / exit ramp to the basement located along Ship Lane would be located above the reference flood level.

12.65 In summary, the Development would be designed to ensure all residential accommodation and most of the non-residential accommodation would be safe from tidal flooding. Exceptions lie with Building 9 (the Boathouse) and one entrance to the basement car park located within the east part of the Stag Brewery component of the Site (east of Ship Lane), However, the land uses within Building 9 and the basement car park that would be at risk from tidal flooding would not be intended for habitation. As such, the Development is likely to result in an **insignificant** to **long-**

term, local adverse effect of **minor significance** in respect of flood risk from tidal sources on occupants of the Development.

Off-Site Risk

12.66 It is a fundamental principle of the NPPF that redevelopment should not cause any adverse flood risk to others. The EA was consulted in 2016 as to whether any flood storage compensation would be required for Development. The response is provided in **Appendix C** of **Appendix 12.1** which states:

"*We can confirm that as the site is only at risk of tidal flooding flood storage compensation will not be required.*"

12.67 As noted in **Chapter 5: The Proposed Development**, the defences along the river frontage would be significantly upgraded. As such, the Development would reduce the risk of a breach.

12.68 The modelling undertaken as part of the FRA (refer to **Appendix D** of **Appendix 12.1**) has shown a general reduction in flood extent and depths compared with the EA modelling. Furthermore, the proposed elevated nature of the Stag Brewery component of the Site could provide a safe refuge for residents of low-lying neighbouring properties that would be at a greater risk from flooding than the Development in the highly unlikely event that the defences would be breached.

12.69 Given that the Development would improve the defences along river frontage and would provide elevated ground levels that could provide a safe refuse for surrounding residents, the Development would have a **long-term**, **local**, **beneficial effect** of **minor significance** on tidal flood risk to surrounding receptors.

Surface Water (Pluvial) Flooding

12.70 Surface water runoff from the north east of the Stag Brewery component of the Site would discharge by gravity to the River Thames (adjacent to the northern boundary of the Stag Brewery component of the Site) via three outfalls. As the River Thames is tidal at this location, direct discharge to the river would be unrestricted. Surface water runoff from the remainder of the Stag Brewery component of the Site would discharge via gravity to the Thames Water sewer network in the surrounding highways, at 50% of the existing rate (equivalent to 405.0 l/s), as per the London Plan[9]. LBRuT have confirmed that this approach is acceptable (refer to **Appendix D** of **Appendix 12.2**). The surface water run-off from the highway drainage associated with the Chalkers Corner part of the Site would discharge to the sewer as existing and would not be attenuated.

12.71 Based on a restriction to 405.0 l/s, approximately 2,655 m^3 of attenuation storage would be required, accounting for a 40% increase in rainfall intensity due to climate change. The required attenuation is provided via attenuation tanks (with the potential for lined permeable paving / sub-base storage to be considered at the detailed design stage). The location and provision of attenuation is set out in **Table 12.4**.

Table 12.4: Attenuation Provision Across the Development

Attenuation Tank	Location Within the Stag Brewery Component of the Site	Attenuation Provided (m^3)
1	South of the school building, under the Multi-Use Games Area (MUGA), West of Ship Lane.	917
2	North of the school sports pitch, west of Ship Lane (two tanks in series).	100

Attenuation Tank	Location Within the Stag Brewery Component of the Site	Attenuation Provided (m^3)
3	Western basement, underneath Building 19, west of Ship Lane (three tanks in series).	252
4	Western basement, underneath Building 18, west of Ship Lane (two tanks in series).	177
5 (offline tank)	Below tree pits, north west of Building 18, west of Ship Lane (two tanks in series).	369
6	Below tree pits, in between Buildings 13 and 14, west of Ship Lane.	499
7	In between Buildings 1 and 6, east of Ship Lane.	140
8	Below tree pits, in between Buildings 5 and 6, east of Ship Lane.	117
9	Below tree pits, in between Buildings 5 and 10, east of Ship Lane.	84
TOTAL		**2,655**

12.72 Where feasible, the attenuation tanks would be located outside of the basement extents and below the extents of the proposed tree pits. However, due to the extensive basement proposed in the north west of the Stag Brewery component of the Site, two attenuation tanks are proposed within the basement. Surface water from these tanks would be pumped into the adjacent Thames Water sewers. This would avoid the risks associated with the Thames Water sewers surcharging, which could back-up into the low-lying basement tanks and potentially cause over-flow into the basement rooms.

12.73 It is anticipated that any surface water within the proposed basements would pass through a petrol interceptor prior to being pumped into the foul network. In addition, appropriate treatment would be incorporated into the drainage system to ensure that the quality of water discharged is acceptable. This would be achieved through the incorporation of green roofs, and the potential inclusion of rainwater harvesting and permeable paving. If required, a biomat filtration system, downstream defender or other hard engineered solution could also be incorporated to ensure discharge is appropriately treated.

12.74 The above would result in a reduction in the volume and peak rate of surface runoff from the Site and hence a reduction in flood risk elsewhere compared to the current situation. Consequently, the inclusion of sustainable drainage systems (SuDS) and the management of surface water would likely result in a **long-term**, **local**, **beneficial** and of **minor significance** effect on surface water flooding.

12.75 As discussed earlier, there is a lack of pluvial flooding history in the vicinity of the Site and the existing risk of flooding to the Site from surcharged sewers or overland surface water runoff is very low. This is unlikely to change with the Development in place. Accounting for the above, including the inherent design mitigation to avoid sewer surcharging, the Development would have an **insignificant** effect on sewer surcharging flooding.

Groundwater Flow and Flooding

12.76 As described previously, the basement east of Ship Lane in the Stag Brewery component of the Site would sit within and below the typical groundwater level of 2 m AOD. However, once the Development is operational, this encroachment is unlikely to pose any groundwater flood risk, either on-Site or off-Site as the basement would be designed to be suitably waterproofed for the lifetime of the Development.

12.77 Furthermore, it was observed that the groundwater flow paths were to the west and south-west and away from the River Thames. It was inferred that the levels in the Thames, averaged over a tidal cycle of around 2 m AOD, were providing the 'source' for the associated hydraulic gradient. Any projection of the basement into this saturated area would not lead to any increase in groundwater levels off-Site. A small reduction on the southern side of the Development is the most likely response, but this would not be significant.

12.78 In view of the above, the likely effect of groundwater flooding both on-Site and off-Site would be **insignificant**.

River Wall

Access to the River Wall

12.79 The Development does not include any works to the River Thames channel or river walls. The proposal provides a minimum 4 m clear access route on the Development side for any access that may be required (as per the existing situation and as agreed with the EA via a meeting held on 26th September 2016, refer to the meeting minutes in **Appendix 12.5**), however the actual standoff is considerably more than this. Access is also available to the defences from the towpath. As such access to the river wall once the Development is completed and operational would be **insignificant**.

Change in Flood Risk from Upgrading Tidal Defences

12.80 As previously described, the crest level of the remodelled defences would be set at a minimum of 6.70 m AOD. This is the level recommended in the TE2100 Plan for 2100. It is therefore well above the current statutory level, and obviates the need for any raising to be undertaken for the foreseeable future. Furthermore, the flood wall would be topped in some places a 1.1 m high glass balustrade, with an effective crest level of 7.23 m AOD.

12.81 The risk of breach in this entire section of remodelled flood wall is effectively eliminated by the ground raising behind the defences. This provides a very robust defence, requiring only limited maintenance. The alignment is either identical to the existing alignment, or behind the existing alignment, within the Stag Brewery component of the Site. As such, there would be no loss of flood-plain storage.

12.82 Part of the defences are formed by The Maltings, as they have been for many years. The survey of the Maltings wall undertaken by Waterman IE (**Appendix 12.4**) showed the wall to have sufficient capacity to resist the increase in water level that occurs when the river rises to the 2100 flood defence levels. Furthermore, it is anticipated that the stop-logs at Bull's Alley are regularly inspected and maintained, given the regular usage to access the river to clear debris on the foreshore. As such, the risk of breach is considered unlikely at this location.

12.83 In summary, the Development is considered to result in a significant reduction in flood risk. This would be partly due to the greater integrity of the defences, and partly due to likely lower incidence of breach at the stop-logs in Bull's Alley. The modelling undertaken as part of the FRA has shown a general reduction in flood extent and depths compared with the EA modelling. As such, the likely effect of tidal flooding as a result of upgrading the tidal defences as part of the Development would be **long-term**, **local**, **beneficial** and of **minor significance**.

Change in Foul Water Drainage Capacity

12.84 The Development would introduce new land uses on the Site resulting in an increase in foul water discharges from the Site. As set out in **Appendix 11.2**, the proposed foul discharge rates have

been calculated using the water consumption method at 25.5 l/s, an increase of 11.1 l/s than existing. On-site drainage records indicate that in the existing situation some surface water flows are directed to the Thames Water foul sewer. As a result of the Development, all surface water flows into the foul sewage system would be removed.

12.85 The proposed foul drainage would be designed in accordance with BS EN 752 - Drain and Sewer Systems Outside Buildings[10], BS EN 12056 - Gravity Drainage Systems Inside Buildings[11], and Approved Document H of Building Regulations[12].

12.86 It is understood that foul flows from the existing Stag Brewery component of the Site discharge to the Thames Water foul network in the surrounding highways. It is proposed to mimic this scenario, with new connections into the sewers on Mortlake High Street, Lower Richmond Road, Ship Lane, and Williams Lane according to the proposed building layout. The indicative connection points are shown within **Appendix I** of **Appendix 11.2**.

12.87 A Pre-Development enquiry has been submitted to Thames Water to confirm that the existing public sewer network has the capacity to accommodate the foul flows.

12.88 If new connections are required, these would be made to the public sewer system through a Section 106 Agreement with Thames Water, under the Water Industry Act 1991[13] (separate from a planning S106 agreement).

12.89 Despite an outstanding response from the abovementioned Pre-Development Enquiry, it is Thames Water's statutory duty to ensure that sufficient capacity exist in the foul water drainage system (including sewage treatment and network infrastructure) to cope with the demands of existing and future population demands. Accordingly, it is considered likely that the Development would have an **insignificant** effect upon the capacity of foul water drainage infrastructure and sewage treatment works.

Change in Potable Water Demand

12.90 There are no existing uses on the Site that demand significant quantities of potable water. The Development would introduce new land uses on the Site resulting in an increase in potable water demand on the Site.

12.91 New water supplies would be required to serve cold water storage plant in each phase of the Development. Each retail unit would be provided with their own mains water supply. Commercial buildings (e.g. cinema, office, school, community centres) would also each have their own water supply. Each group of buildings (set out below) would require its own fire supply to serve sprinkler plantrooms. New water supplies would be required to serve cold water storage plant in each group of buildings. The water supply rate is based on a tank-fill rate of 4 hours, as follows:

- Buildings 1 to 4 - 2.5l/s;
- Buildings 5 to 8 and 20 - 2.8l/s;
- Buildings 9 to 11 - 2 l/s;
- Buildings 13 to 19 - 6.4 l/s; and
- Buildings 20 and 21 (townhouses) - each would be provided with their own domestic mains water supply.

12.92 Each retail unit would be provided with their own mains water supply, each with circa 0.5l/s capacity. Commercial buildings (cinema, office, school, community centres etc) would each have their own water supply, ranging from 0.5l/s to 1.5l/s depending on fit out requirements. Each group of buildings would also require its own fire supply to serve sprinkler plantrooms.

12.93 The Thames Water 'Water Resource Management Plan 2015-2040' (December, 2013)[14] indicates that over a forecast period to 2040, there is likely to be a significant demand on water supply in the London catchment (the London Water Resource Zone (WRZ) in the Thames Water supply area). To address this, Thames Water has prepared a detailed plan which aims to ensure that sufficient supply is available to meet demand during the plan period. This involves a variety of measures including the replacement of Victorian Water Mains to reduce leakage, compulsory metering and encouraging the use of water efficiency measures. Developing new water resources would also be required and schemes planned by Thames Water comprise a number of small groundwater schemes, aquifer recharge schemes, aquifer storage and recovery schemes, and water reuse schemes. In addition, in extreme periods, bulk water transfers from neighbouring water companies and further afield may be required to ensure availability of supply.

12.94 As a result of the above measures, water demand should be met within London until at least 2040. The demand supply forecast provided by Thames Water which takes into account an increase in population within the London WRZ, thus the additional demand on water resources resulting from the Development would likely be accommodated. Consequently, the likely effect of the Development on potable water demand would likely be **insignificant**.

Mitigation Measures and Likely Residual Effects

The Works

Groundwater Flow and Flooding

12.95 The construction of the basement within the east part of the Stag Brewery component of the Site (east of Ship Lane) would involve excavation to below likely groundwater levels. Appropriate dewatering and disposal, using standard techniques such as sumps and pumps would likely be required. This would mitigate the risk of groundwater flooding during excavation works and result in an **insignificant** likely residual effect.

Surface Water (Pluvial) Flood Risk

12.96 The Site-specific Construction Environmental Management Plan (CEMP) developed for the Works (refer to **Chapter 6: Development Programme, Demolition, Alteration, Refurbishment and Construction**) would include temporary measures to control surface water runoff from the Site. Such measures would include the provision of adequate drainage to manage surface water run-off. Construction of the drainage system should be designed and managed to comply with BS 6031:2009 'The British Standard Code of Practice for Earthworks'[15], which details methods that should be considered for the general control of drainage on construction sites. Discharge rates and volumes of water discharged would be agreed with the EA and Thames Water. Where appropriate, cut-off drainage would be provided around the Site during the Works when there is no on-Site drainage network in place.

12.97 As set out in **Chapter 11: Ground Conditions and Contamination**, temporary stockpiling of materials would be located away from the Thames and drains, and drums and barrels would be stored in designated bunded safe areas within the Site compound to reduce the risk of silt and pollutants entering the surface water drainage system.

12.98 Following the implementation of these measures, the anticipated likely residual effect of surface water flooding during the Works would be **insignificant**.

River Wall

12.99 Given that the river wall would still be accessible from the towpath side during the Works as all Works would be behind the existing river wall within the Stag Brewery component of the Site, no mitigation would be required and the anticipated likely residual effect on access to the river wall during the Works would remain **insignificant**.

12.100 The existing river wall would be lowered in certain areas, however, this would be undertaken after the new flood defence wall has been built, and would still be above the statutory flood defence level. Temporary defences would also provide the required level of protection until any replacements are in place and the Works would be undertaken when there is no practical risk of tidal flooding. All such work would be undertaken in conjunction with the EA to ensure necessary approvals for design and constructional sequence through Environmental Permits. As such, no mitigation would be required and the likely residual effect of remodelling the river wall on flooding during the Works would remain **insignificant**.

Foul and Potable Water Infrastructure Capacity

12.101 The likely effects of the Works upon wastewater were identified as being of insignificance. Therefore, no mitigation measures are considered necessary and the likely residual effect would remain as per the likely effect. That is, **insignificant**.

12.102 To reduce the water demand of the Development during the Works, all relevant contractors would be required to investigate opportunities to minimise and reduce the use of water in accordance with the CEMP. These would include:

- selection and specification of equipment;
- implementation of staff-based initiatives such as turning off taps, plant and equipment when not in use;
- use of recycling water systems in functions such as wheel washes and toilets;
- rainwater harvesting system for equipment and vehicle washing; and
- where possible, water from excavation would be used for dust suppression during construction.

12.103 Water consumption throughout the Works would be monitored, either through sub-metering or utility bills to allow a comparison against best practice benchmarks. With these control measures in place, the likely residual effects of the Work upon potable water supply would be **insignificant**.

Existing Drainage Infrastructure

12.104 As set previously and within **Appendix 11.2**, easements would be provided to ensure existing drainage infrastructure is not impacted upon. The CEMP would set out measures to ensure that the existing sewers are adequately protected and / or diverted in line with best practice. Requirement for asset protection measures during the Works would be confirmed with Thames Water during the future design stages. The adoption of appropriate piling methods, which would be detailed in the CEMP, would ensure vibration levels are kept to a minimum and would not affect existing below ground infrastructure.

12.105 Following the implementation of these measures, the anticipated likely residual effect on existing drainage infrastructure would be **insignificant**.

Completed Development

Tidal Flood Risk

Risk to Occupants of the Development

12.106 As previously described, the Development would be designed to ensure occupants are safe from tidal flooding. Some areas of the Development, including Building B09 (the Boathouse) and one entrance to the basement car park located in the east part of the Stag Brewery component of the Site (east of Ship Lane), would require further mitigation for residual flooding (although it should be noted that these areas would not be used for habitation). Further mitigation would be as follows:

- a self-activating flood barrier would be required for the entrance to the eastern basement car park from Mortlake High Street; and
- flood proof doors and / or demountable barriers for access from the Community Boathouse (Building B09) to the river foreshore.

12.107 In addition, a tidal flood gate would be required at Ship Lane at some point in the future to account for future flood levels and to ensure the integrity of the tidal defences (refer to later in this Chapter).

12.108 Given the level of flood protection provided by the inherent design of the Development and mitigation measures above, future residents should have no need for emergency egress from the Site due to flood conditions. However, in line with the pre-application response from LBRuT, a Flood Emergency Plan has been prepared and submitted as an appendix to the FRA (Appendix G of **Appendix 11.1**). The Plan identifies a safe route from the Stag Brewery component of the Site to land that is wholly outside Flood Zone 3.

12.109 In view of the above the likely residual risk of tidal flooding (and therefore likely residual effect) to future occupants would therefore be **insignificant**.

Off-Site Risk

12.110 As stated previously, the Development would not result in an increase in flood risk to receptors surrounding the Site and via the proposed elevated ground levels may even provide a safe place of refuge from flooding for residents of low-lying neighbouring properties. As such, the likely residual risk of off-Site tidal flooding (and therefore likely residual effect) would remain **long-term**, **local**, **beneficial effect** of **minor significance**.

Surface Water (Pluvial) Flooding

12.111 The inclusion of SuDS and the management of surface water would likely result in a **long-term**, **local**, **beneficial** effect of **minor significance** on surface water flooding, both on and off-Site by reducing the level of surface water discharge to Thames Water sewers to 50% of the existing rate. A maintenance programme of key drainage infrastructure should be put in place to ensure that these beneficial likely effects are maintained as the likely residual effect (refer to **Appendix 11.2** for further details on frequency and type of maintenance required for the SuDS).

12.112 As stated previously, the risk of flooding from surcharging sewers would be insignificant and no mitigation would be required. The likely residual effect of flooding from surcharging sewers once the Development is completed and operational would therefore be **insignificant**.

Groundwater Flows and Flooding

12.113 The completed Development is not expected to significantly alter or displace the existing groundwater flows beneath the Site and thus the risk of groundwater flooding off-Site is not expected to increase. Furthermore, given the proposed basements would be appropriately waterproofed, the basements would be unlikely to flood. No mitigation measures are therefore considered necessary. Consequently, the likely residual effects of the Development once completed and occupied would be **insignificant** in respect of groundwater flows and flooding.

River Wall

Access to the River Wall

12.114 Considering that the completed Development would have an **insignificant** effect on access to the river wall, no mitigation measures would be required and the likely residual effect would remain **insignificant**.

Change in Flood Risk from upgrading Tidal Defences

12.115 As described above, the upgrades to the river wall would improve the performance of the defences when compared to the existing situation. There is a future requirement for a tidal flood gate on Ship Lane, to ensure the integrity of the tidal defences. Without this gate, peak water levels would be able to propagate along Ship Lane. This would only be required at some point in the future. However, a suitable location has already been earmarked in the Development. Since this is a public highway, the way in which this is to be achieved would need to be discussed and agreed with LBRuT. It is likely that this would be provided using a demountable barrier, but the precise details of location and operation would need to be established in detailed design, likely as part of a suitably worded planning condition. The likely residual effect on upgrading the tidal flood defences would therefore be **long-term**, **local**, **beneficial** and of **moderate significance**.

Change in Foul Water Drainage Capacity

12.116 The Development is likely to result in an insignificant effect in respect of the capacity of foul water drainage. As such, no mitigation measures are required and the residual effect would remain as per the likely effect. That is, **insignificant**.

Change in Potable Water Demand

12.117 The Development is likely to result in an insignificant effect in respect of potable water demand. As such, no mitigation measures are required and the residual effect would remain as per the likely effect. That is, **insignificant**.

Summary

12.118 **Table 12.5** summarises the likely significant effects, mitigation measures, and likely residual effects identified within this Chapter.

Table 12.5: Summary of Likely Significant Effects, Mitigation Measures and Likely Residual Effects

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
The Works			
Groundwater flood risk from excavation works of eastern basement.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.	Dewatering of excavation activities.	**Insignificant**.
Surface water (pluvial) flood risk.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.	Implementation of CEMP to ensure appropriate adequate drainage and to manage surface water run-off.	**Insignificant**.
Access to the river wall.	**Insignificant**	None required.	**Insignificant.**
Tidal flood risk during remodelling of the river wall.	**Insignificant**.	None required, to be undertaken through an Environmental Permit.	**Insignificant**.
Foul water infrastructure capacity.	**Insignificant**.	None required.	**Insignificant**.
Increase in potable water demand.	**Temporary**, **short** to **medium-term**, **local**, **adverse effect** of **minor significance**.	Implementation of CEMP to include measures to monitor and reduce water consumption.	**Insignificant**.
Existing drainage infrastructure.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **moderate significance**.	Implementation of CEMP to ensure existing drainage is protected and appropriate piling methods are used to minimise vibration.	**Insignificant**.
Completed Development			
Tidal flood risk to future occupants of the Development.	**Insignificant** to **long-term, local adverse** and of **minor significance**.	A self-activating flood barrier would be required for the entrance to the eastern basement car park from Mortlake High Street. Flood proof doors and / or demountable barriers would be required for access from the Community Boathouse (Building B09) to the river foreshore.	**Insignificant**.

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Tidal flood risk to off-Site receptors.	**Long-term**, **local**, **beneficial effect** and of **minor significance**.	None required.	**Long-term**, **local**, **beneficial effect** of **minor significance**.
Surface water (pluvial) flood risk.	**Long-term**, **local**, **beneficial** and of **minor significance**.	None required, maintenance programme to be implemented to ensure beneficial effects are maintained.	**Long-term**, **local**, **beneficial** and of **minor significance**.
Flood risk from sewers surcharging	**Insignificant**.	None required.	**Insignificant**.
Groundwater flood risk.	**Insignificant**.	None required.	**Insignificant**.
Access to the river wall.	**Insignificant**.	None required.	**Insignificant**.
Change in tidal flood risk from upgrading the tidal defences (river wall).	**Long-term**, **local**, **beneficial** and of **minor significance**.	A flood proof gate would be required at some point in the future at Ship Lane to account for future flood levels through an appropriately worded - planning condition.	**Long-term**, **local**, **beneficial** and of **moderate significance**.
Change in foul water drainage capacity.	**Insignificant**.	None required.	**Insignificant**.
Change in potable water demand.	**Insignificant**.	None required.	**Insignificant**.

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1 Department for Communities and Local Government (2012): 'National Planning Policy Framework'. HMSO: London.

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4 AECOM (2015); 'Stag Brewery: Groundwater Sampling Point Decommissioning Report. For AB InBev UK Ltd', February 2016.

5 Department for Communities and Local Government (2015): 'Planning Practice Guidance – Flood Risk and Coastal Change'.

6 The Environment Agency's Aquifer Designation Map (accessed online April 2017), www.environment-agency.gov.uk

7 Environment Agency (2011): 'Thames Estuary 2100 Plan (TE2100)'.

8 Her Majesty's Stationery Office (1975): Reservoirs Act 1975, Her Majesty's Stationery Office, London.

9 Greater London Authority (2016); 'The London Plan: Spatial Development Strategy for Greater London consolidated with Alterations since 2011', March 2016.

10 British Standards (2008): BS EN 752:2008 'Drain and Sewer Systems Outside Buildings'.

11 British Standards (2000): BS EN 12056-4:2000 'Gravity Drainage Systems Inside Buildings'.

12 Department for Communities and Local Government (2010): 'Drainage and waste disposal: approved Document H', Approved Documents and Building regulation.

13 The Stationery Office (1991): Water Industry Act 1991, The Stationery Office, Norwich.

14 Thames Water (2013): 'Water Resources Management Plan 2015-2040, December 2013.

15 British Standards (2009): BS 6031:2009 'The British Standard Code of Practice for Earthworks', December 2009.

APPENDICES

A. Appendix 12.1: Flood Risk Assessment

APPENDIX 12.1
FLOOD RISK ASSESSMENT

Reselton Properties Ltd
(through Dartmouth Project Management Services Ltd)

Flood Risk Assessment for The redevelopment of The Former Stag Brewery Mortlake London, SW14 7ET

Report K0685/2

February 2018

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EXECUTIVE SUMMARY OF REPORT

This report documents work undertaken by Hydro-Logic Services for Reselton between June 2016 and November 2017 in relation to the proposed redevelopment of the former Stag Brewery site at Mortlake.

The purpose of the work was to:

- Provide guidance to the Project team on the issues of flood risk and drainage
- Prepare a Flood Risk Assessment suitable for submission with the Planning Applications

The key outcomes of the work are summarised in Section 5 of this Report.

The work delivered the following outputs:

- This report, including
- Flood Emergency Plan (Appendix G)
- Drainage Strategy (submitted under separate cover).

Contributors for Hydro-Logic Services:

Alan Corner	Project Director, SUDS Specialist & Reviewer
Dr Paul Webster	Project Manager & Flood Risk Specialist
Rodrigo Magno	Hydraulic modeller
Phil Cannard	Hydrologist

Document Status and Revision History:

Version	Date	Author(s)	Authorisation	Status/Comment
0	Oct 2017	P Webster	A Corner	Draft for Client review
1	Nov 2017	P Webster	A Corner	Revised site layout and following client review
2	Feb 2018	P Webster	A Corner	Final

Limitation of liability and use

TABLE OF CONTENTS

1. Introduction

1.1 Purpose of this Report

This Flood Risk Assessment has been prepared by Hydro-Logic Services on behalf of Reselton Properties Limited ('the Applicant') in support of three linked planning applications for the comprehensive redevelopment of the former Stag Brewery Site in Mortlake ('the Site') within the London Borough of Richmond Upon Thames ('LBRuT').

The former Stag Brewery Site is bounded by Lower Richmond Road to the south, the river Thames and the Thames Bank to the north, Williams Lane to the east and Bulls Alley (off Mortlake High Street) to the west. The Site is bisected by Ship Lane. The Site currently comprises a mixture of large scale industrial brewing structures, large areas of hardstanding and playing fields.

The redevelopment will provide homes (including affordable homes), complementary commercial uses, community facilities, a new secondary school alongside new open and green spaces throughout. Associated highway improvements are also proposed, which include works at Chalkers Corner junction.

The three planning applications are as follows:

- Application A – hybrid planning application for comprehensive mixed use redevelopment of the former Stag Brewery site consisting of:
    i. Land to the east of Ship Lane applied for in detail (referred to as 'Development Area 1' throughout); and
    ii. Land to the west of Ship Lane (excluding the school) applied for in outline detail (referred to as 'Development Area 2' throughout).
- Application B – detailed planning application for the school (on land to the west of Ship Lane).
- Application C – detailed planning application for highways and landscape works at Chalkers Corner.

Full details and scope of all three planning applications are described in the submitted Planning Statement, prepared by Gerald Eve LLP.

This Report presents a Flood Risk Assessment (FRA) for the proposed redevelopment of the former Stag Brewery in Mortlake. The FRA includes the development of a Drainage Strategy. The development of the Drainage Strategy has been undertaken by Waterman Infrastructure & Environment Limited ('Waterman IE'), in conjunction with Hydro-Logic Services and is summarised within this FRA.

1.2 Background

The National Planning Policy Framework (NPPF) was published on 27 March 2012 and sets out the Government's planning policies for England and how these are expected to be applied. Flooding is addressed, principally in paragraphs 100 to 104 of the NPPF. These seek to avoid inappropriate development in areas at risk of flooding by directing development away from

areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.

A site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1; all proposals for new development (including minor development and change of use) in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

A site-specific flood risk assessment must demonstrate the following:

- that the development will be safe for its lifetime taking account of the vulnerability of its users;
- it should not increase flood risk elsewhere;
- it should if possible, reduce flood risk overall.

1.3 Sources of Information and Consultation

A Scoping (Level 1) Flood Risk Assessment was prepared for the site in July 2016 (Appendix B). This was submitted to the Environment Agency and London Borough of Richmond upon Thames (LBRuT). Useful responses were obtained from both organisations, as shown in Appendix C . In particular, these have helped to Scope the requirements for this full FRA.

This Report has also been informed by:

- Product 4 flood data provided by the Environment Agency to Waterman IE in February 2016 (Ref KSL 2030);
- Product 7 flood data (The Lower Thames Model) provided to Hydro-Logic Services in January 2017 (Ref KSL 24434);
- Product 4 & 8 flood data, provided by the Environment Agency to Hydro-Logic in July 2017 (Ref KSL 52746);
- Development proposals provided by Squire and Partners throughout the project;
- Landscaping and River wall proposals provided by Gillespies LLP;
- Site visit by Dr Paul Webster on 16th June 2016.

1.4 Structure of Report

The Report has been structured in order to deal with key flood related issues of the NPPF Practice Guide, for which a checklist has been reproduced as Appendix A of this Report. The principal sections of the Report are as follows:

- Section 2 refers to spatial planning considerations by reference to the proposed land use and flood zoning;
- Section 3 presents an assessment of the existing flood risk at the application sites;
- Section 4 presents an assessment of flood risks associated with the proposed development along with any mitigation that may be required;
- Section 5 presents a summary of the main findings.

Additional Appendices are provided that deal with the following:

- Appendix B is the Scoping Level FRA submitted by Hydro-Logic Services to the Environment Agency and LBRuT;

- Appendix C provides the responses of the Environment Agency and LBRuT to the Scoping Level FRA;
- Appendix D is a Breach Analysis;
- Appendix E shows extracts from sewer maps provided by Thames Water;
- Appendix F provides the Environment Agency Climate Change Allowances (at February 2016);
- Appendix G is the Flood Emergency Plan.

2. Spatial Planning Considerations

2.1 Location Plan and Site Plan

The "Site" is the former location of the Stag Brewery, located at Mortlake in the London Borough of Richmond upon Thames (LBRuT) plus some surrounding areas, as described in this Section. It is located south west of a large meander on the River Thames which flows to the east. Its general location is shown in Figure 2-1 and an aerial photo of the site is shown in Figure 2-2. These maps show the division of the site into components; namely the Stag Brewery Component and the Chalkers Corner Component.

The **Site** comprises:

- the former Stag Brewery, an approximately 9.25 hectare (ha) parcel of land, occupied by a mix of large scale industrial brewery structures and buildings, hardstanding and a playing field in the south west known as Watney's Sports Ground, and incorporating a section of the River Thames towpath within the north of the Site (referred to as **'the Stag Brewery component of the Site'**);
- Ship Lane, a public highway bisecting the abovementioned 9.25 ha parcel of land (included within the **Stag Brewery component of the Site**);
- Bull's Alley, a public highway within the east of the abovementioned 9.25 ha parcel of land (included within the **Stag Brewery component of the Site**);
- Williams Lane, a highway within the west of the abovementioned 9.25 ha parcel of land (included within the **Stag Brewery component of the Site**);
- a section of Lower Richmond Road within the south of the abovementioned 9.25 ha parcel of land (included within the **Stag Brewery component of the Site**);
- a section of Mortlake High Street within the south of the abovementioned 9.25 ha parcel of land (included within the **Stag Brewery component of the Site**);
- a section of Sheen Lane within the south of the abovementioned 9.25 ha parcel of land (included within the **Stag Brewery component of the Site**); and
- the junction with the A316 (Clifford Avenue), A3003 (Lower Richmond Road) and A205 (South Circular) (collectively known as 'Chalkers Corner') within the west of the Site (referred to as 'the **Chalkers Corner component of the Site**').

The Chalkers Corner Component of the Site would include highway re-modelling works and landscaping works, however, there is no change of use nor impact on ground levels in this area. There are accordingly, no flood risk implications of this part of the Site and it is not considered further in this FRA.

Table 2-1 Grid reference details for the site (www.streetmap.co.uk)

Reference	Value
OS X (Eastings)	520341
OS Y (Northings)	176027
Nearest Post Code	SW14 7ET
Lat (WGS84)	N51:28:14 (51.470421)
Long (WGS84)	W0:16:08 (-0.268803)
Nat Grid	TQ203760 / TQ2034176027

Figure 2-1 General location of the proposed Development

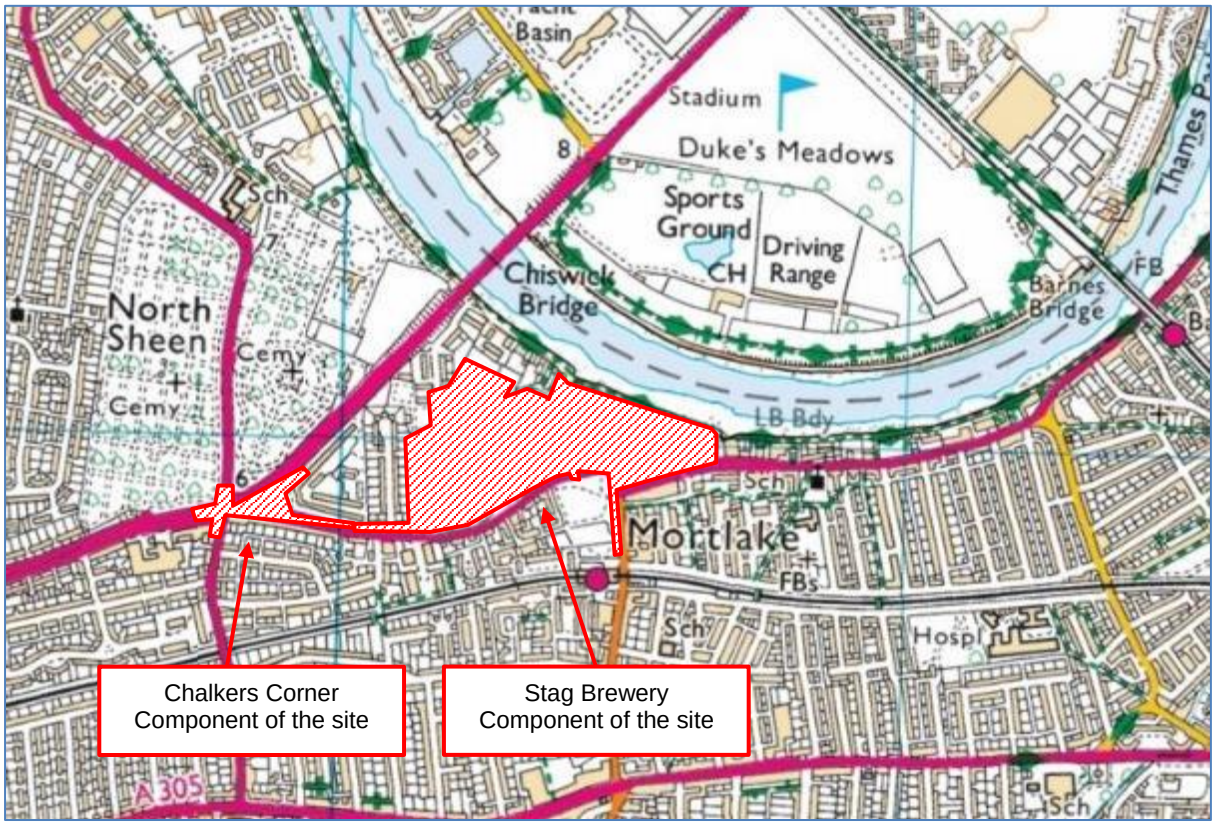

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Figure 2-2 Aerial photo of the Site

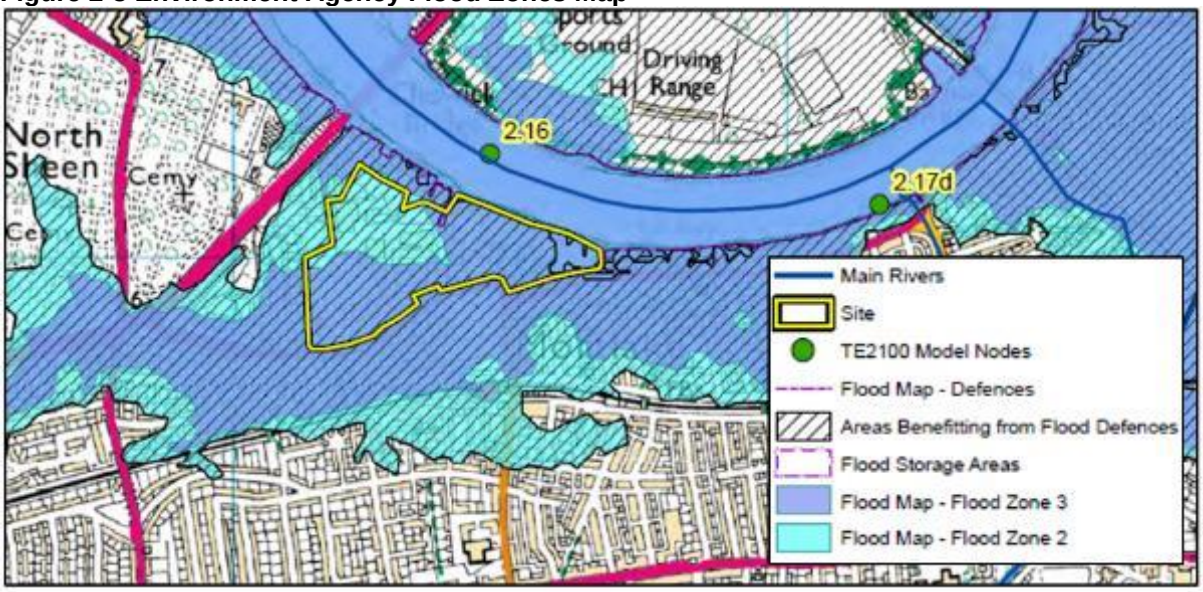
2.2 Environment Agency Flood Zone

The definitions of flood zones adopted by PPS25/NPPF are as follows:

- ***Zone 1: 'Low Probability'*** *– This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).*
- ***Zone 2: 'Medium Probability'*** *– This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5%-0.1%) in any year.*
- ***Zone 3a: 'High Probability'*** *– This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.*
- ***Zone 3b: 'The Functional Floodplain'*** *– This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the Environment* Agency, including water conveyance routes).

The Environment Agency have provided maps of the flood zones (Figure 2-3). This shows that the east and south of the Site is in flood zone 3 within the 0.5% Annual Exceedance Probability (AEP) flood event. The north east of the Site is located in flood zone 2 in the 0.1% AEP flood event.

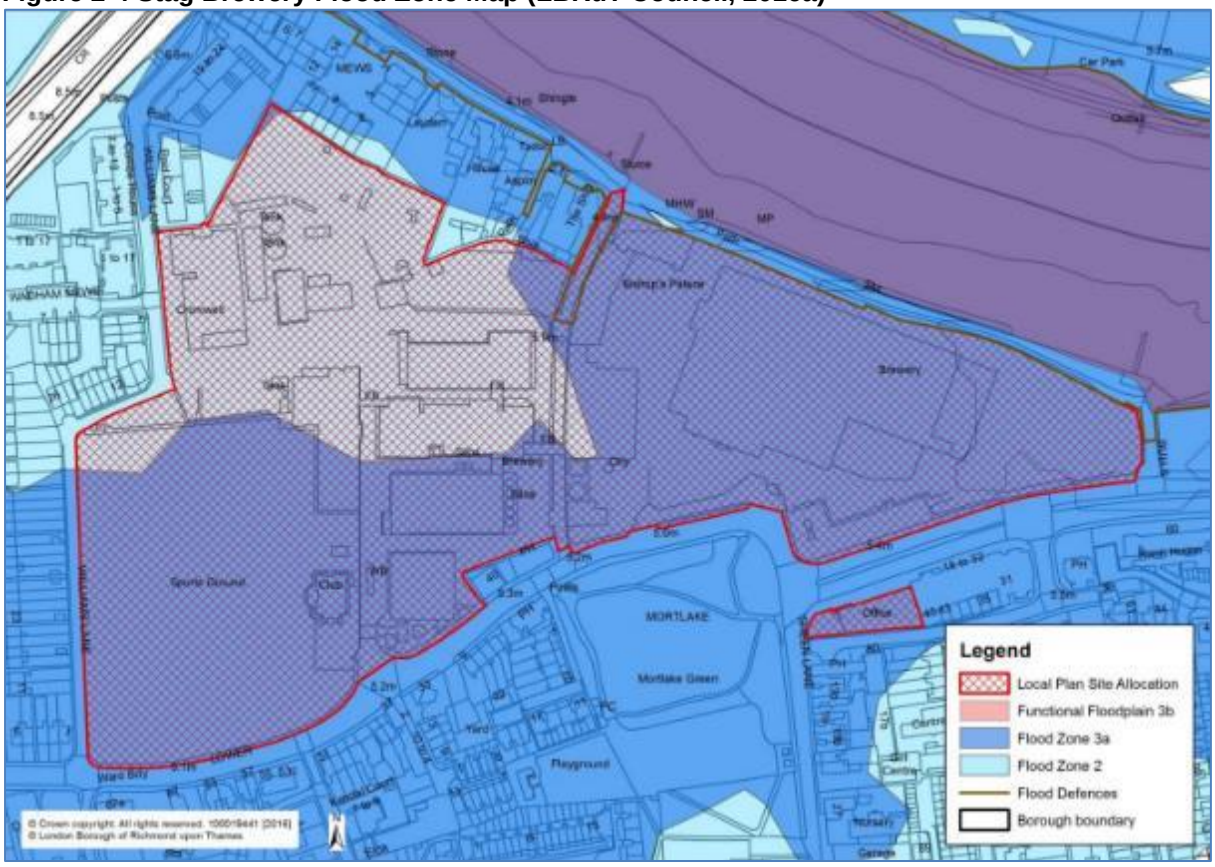
Figure 2-3 Environment Agency Flood Zones Map



Copyright Environment Agency. Note that identical maps were provided in Product 4 data sets in 2016 and 2017. This map shows a site boundary that has now been superseded.

It is also important for planning purposes, to establish if any of the site lies in the functional flood plain (termed flood zone 3b). The Flood Risk Sequential Test (LBRuT Council, 2016a) focuses on the Stag Brewery site and confirms that the site is not located in flood zone 3b (Figure 2-4).

Figure 2-4 Stag Brewery Flood Zone Map (LBRuT Council, 2016a)



This map shows a site boundary that has now been superseded.

2.3 The Strategic Flood Risk Assessment and Sequential Test

The Strategic Flood Risk Assessment (SFRA) has been prepared by the London Borough of Richmond upon Thames (LBRuT) Council (2016c). This has provided a useful source of information to guide this FRA. Mortlake is specifically mentioned as having a tidal and fluvial flood risk from the nearby River Thames. Other flood risks are also covered in this SFRA (see section 3.2).

The NPPF includes a table to highlight whether particular types of development are appropriate in each flood zone. This is reproduced as Table 2-2. The proposed development would be classed as a more vulnerable development in accordance with the classification in Table 2-2, since the **most vulnerable use classification class** is used across the development site. More vulnerable developments are considered to be appropriate in flood zone 2 but are subject to the exception test in flood zone 3a (Table 2-3).

Table 2-2 Flood risk vulnerability classification

More Vulnerable (MV)
Hospitals.
Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.
Non–residential uses for health services, nurseries and educational establishments.
Landfill and sites used for waste management facilities for hazardous waste.
Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable (LV)
Police, ambulance and fire stations which are not required to be operational during flooding
Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure.
Land and buildings used for agriculture and forestry.
Waste treatment (except landfill and hazardous waste facilities).
Minerals working and processing (except for sand and gravel working).
Water treatment works which do not need to remain operational during times of flood

Table 2 from NPPF Technical Guide (Paragraph 066)
Text in bold italics denotes all land uses proposed for the Site

Table 2-3 Flood risk vulnerability and flood zone compatibility

Flood Zone	Definition	Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
1	T>1,000	✔	✔	✔	✔	✔
2	$100<T_{fluv}<1,000$ $200<T_{tidal}<1,000$	✔	✔	Exc	✔	✔
3a	$T_{fluv}<100$ $T_{tidal}<200$	Exc.	✔	✕	Exc	✔
3b (functional floodplain)	$T_{fluv}<20$	Exc	✔	✕	✕	✕

Based on Table 3 from the NPPF Technical Guide (Paragraph 067)

Notes:

✔	development is appropriate	T	return period (fluv = fluvial)
✕	development should not be permitted	Exc	exception test should be applied

The overall aim of decision-makers should be to steer new development away from Flood Zone 3, ideally to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, then sites would be considered in Flood Zone 2 and then 3. The Sequential Test requires an assessment of available and equivalent sites in the LBRuT area to ascertain if others are available that are at lower risk of flooding. The Stag Brewery site has been commented on in the LBRuT council's Flood Risk Sequential Test (2016a) which states that:

"This is a site for major redevelopment and regeneration as the brewery has closed, and as such, it is not appropriate / possible to accommodate the proposed uses on an alternative site in the borough at lower probability of flooding. The sequential approach should be applied on the site and a site-specific FRA will be required. Flood Hazard and TE2100 levels will need to be taken into account."

The Sequential Test is therefore deemed to have been satisfied, and is confirmed in the pre-application advice from LBRuT subject to review by the Environment Agency (Appendix C.2).

The Exception Test now has two parts and the extent to which it satisfies these elements is described below:

(a) That the development supports wider sustainability benefit to the community that outweigh flood risk, informed by the SFRA.

This development meets this criterion, as confirmed from the pre-application advice from LBRuT which states:

"…the Council can confirm that development of this site in line with the draft Local Plan proposal site (SA23), as supported by the Flood Risk Sequential Test, will provide wider sustainability benefits because it is now a derelict site that is in need of regeneration, and the proposal will create a new village heart for Mortlake with a mix of uses, including enlivening the riverside frontage." (Appendix C.2)

(b) that the site can be safely developed without increasing flood risk elsewhere

This FRA provides the confirmation in Section 4 that there is no increase in flood risk elsewhere and can be made safe for residents.

Evidence is thus provided, or referred to in this FRA, to demonstrate that both the Sequential and Exception Tests have been satisfied.

2.4 Other relevant policies

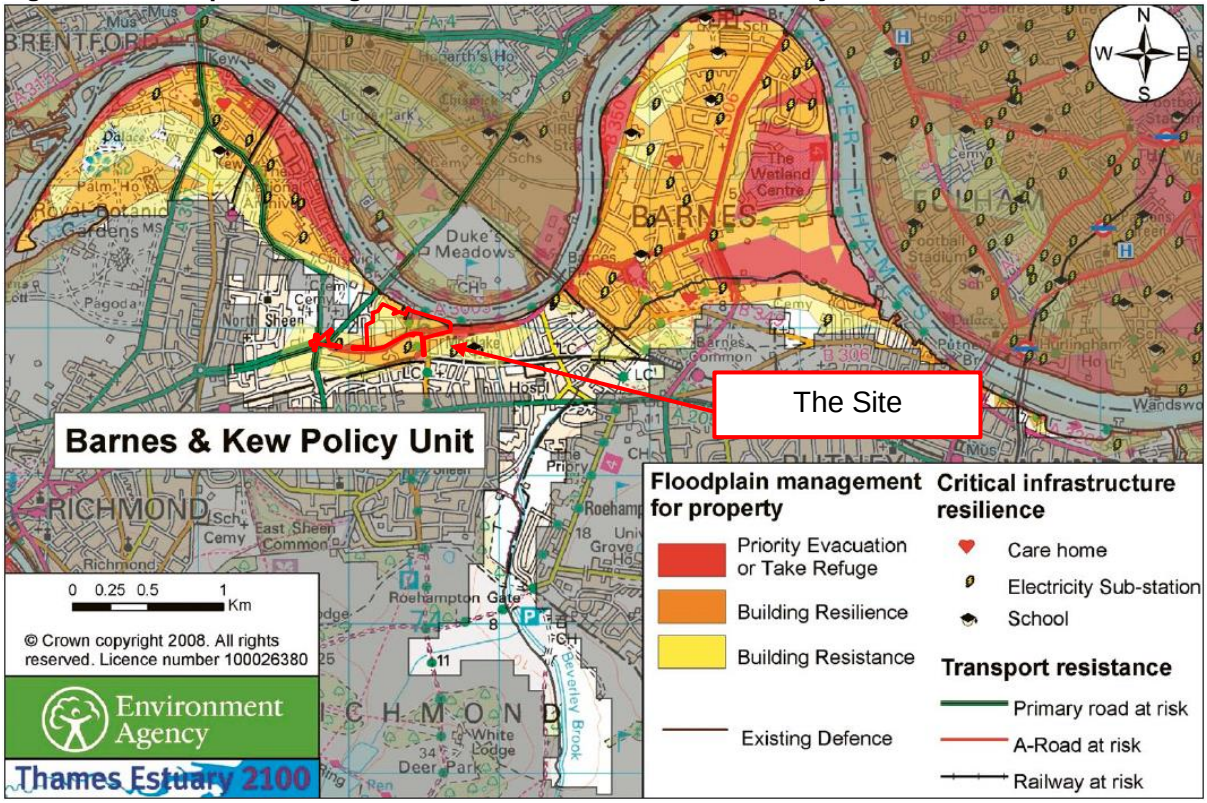
The **LBRuT Local Development Framework Core Strategy** (LBRuT, 2009) sets out the key planning policies of the borough council. Policy CP3 focusses on climate change and states that this must be accounted for within the development. This includes accounting for climate change in the drainage strategy and the flood risk posed by the River Thames.

The **Local Development Management Plan** (LBRuT, 2011) expands on the policies from the LBRuT Local Development Framework Core Strategy and includes a focus on sustainability. Policy DM SD 6 sets out the flood risk requirements which includes mitigation measures and states that a Flood Warning and Evacuation Plan would be required. Policy DM SD 7 focusses on Sustainable Drainage and states that wherever possible, Sustainable Drainage Systems (SuDS) must be used and surface water discharge from the site should be reduced to greenfield rates. Policy DM SD 8 considers flood defences and states that flood defences must be maintained and that any development within 16 m of the tidal River Thames will require consent from the Environment Agency.

The **LBRuT Local Plan** (LBRuT, 2016b) will supersede the existing policies in the two preceding documents. The new policies for flood risk and sustainable drainage are covered in policy LP 21. The independent Examination of the submission Local Plan by the Secretary of State is now underway. In the interim, this policy should be adhered to.

The tidal areas of the Thames Estuary are covered by the **Thames Estuary 2100** (TE2100) plan. This aims to manage and reduce the tidal flood risk from the estuary over the next 100 years. The site is located within action zone 1 under the Barnes and Kew policy unit. Within this area, the policy is to keep take action to reduce flood risk beyond that predicted by climate change. For the proposed development, it is indicated the floodplain management actions to be taken should be a combination of priority evacuation, and building resilience and resistance. This is illustrated for the relevant Flood Plain Management Unit (Barnes and Kew) in Figure 2-5.

Figure 2-5 Floodplain Management for the Barnes and Kew Policy Unit of the TE2100 Plan



Environment Agency (2012)

The **London Plan** was revised in 2016, consolidating a range of documents with the 2011 London Plan. Through Policy 5.12 (Flood Risk Management), the Mayor seeks to *" work with all relevant agencies including the Environment Agency to address current and future flood issues and minimise risks in a sustainable and cost-effective way."*. Through Paragraph 5.55, the Plan endorses the Thames Estuary 2100 plan. Through Paragraph 5.56, the Plan seeks to steer development away from areas of flooding. However, of greatest relevance to this FRA is Policy 5.13 (Sustainable Drainage). This states that:

> *A Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:*
>
> 1. *store rainwater for later use*
> 2. *use infiltration techniques, such as porous surfaces in non-clay areas*
> 3. *attenuate rainwater in ponds or open water features for gradual release*
> 4. *attenuate rainwater by storing in tanks or sealed water features for gradual release*
> 5. *discharge rainwater direct to a watercourse*
> 6. *discharge rainwater to a surface water sewer/drain*
> 7. *discharge rainwater to the combined sewer.*
>
> *Furthermore, drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.*

3. Flood Hazard for Existing Site

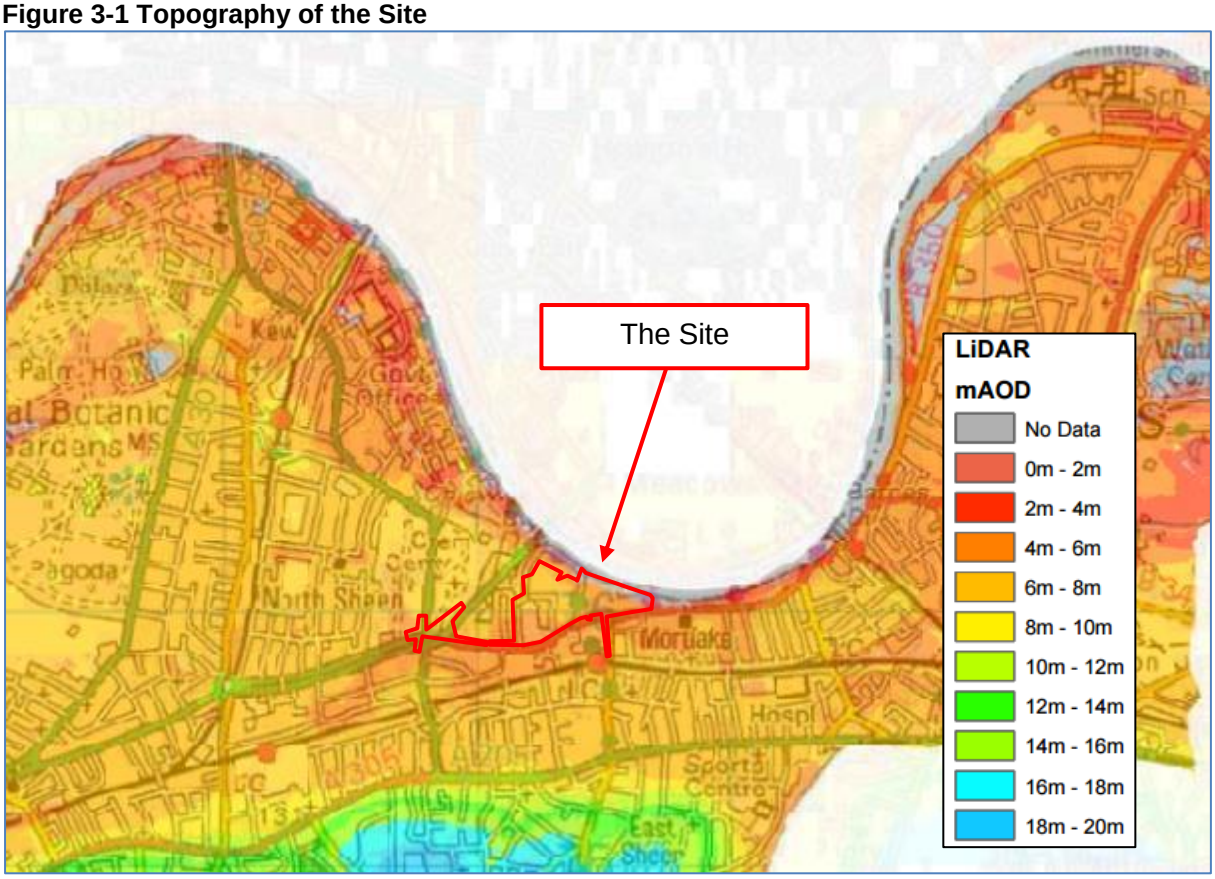
This Section reviews the characteristics of the catchment area that affect the Site. This provides the context for reviewing the sources of flooding to the site and the flood risk.

3.1 Site and Catchment Characteristics

3.1.1 Topography

The topography of the Site is relatively flat and is located on low lying land. The LiDAR map (Figure 3-1) indicates that it is lowest to the east of the Site (4 to 6 mAOD) and highest in the north west of the Site (8 to 10 mAOD).

Figure 3-1 Topography of the Site



3.1.2 Geology and soils

According to the Preliminary Environmental Risk Assessment (PERA) undertaken by Waterman IE, the geology throughout the Site is composed of Hardstanding, underlain by Made Ground, Alluvium, Kempton Park Gravel Formation, London Clay Formation, Lambeth Group, Thanet Formation and Chalk Group (Figure 3-2 shows Kempton Park Gravel as the main superficial deposit). It is anticipated shallow groundwater in the Alluvium and Kempton Park Gravel Formation is in hydraulic continuity with the River Thames directly adjacent to the Site. This presents a risk to the Site of water finding a pathway through the gravel when the River Thames is at a high water level, which could cause groundwater flooding. The Site is located on soils described as Soilscapes 6 which are "*Freely draining, slightly acid loamy soils*" (Figure 3-3). While this indicates that infiltration drainage techniques could be used, the Site's

proximity to the River Thames indicates that infiltration could be inappropriate due to a high groundwater table.

Figure 3-2 The Geology Attributes at the Site

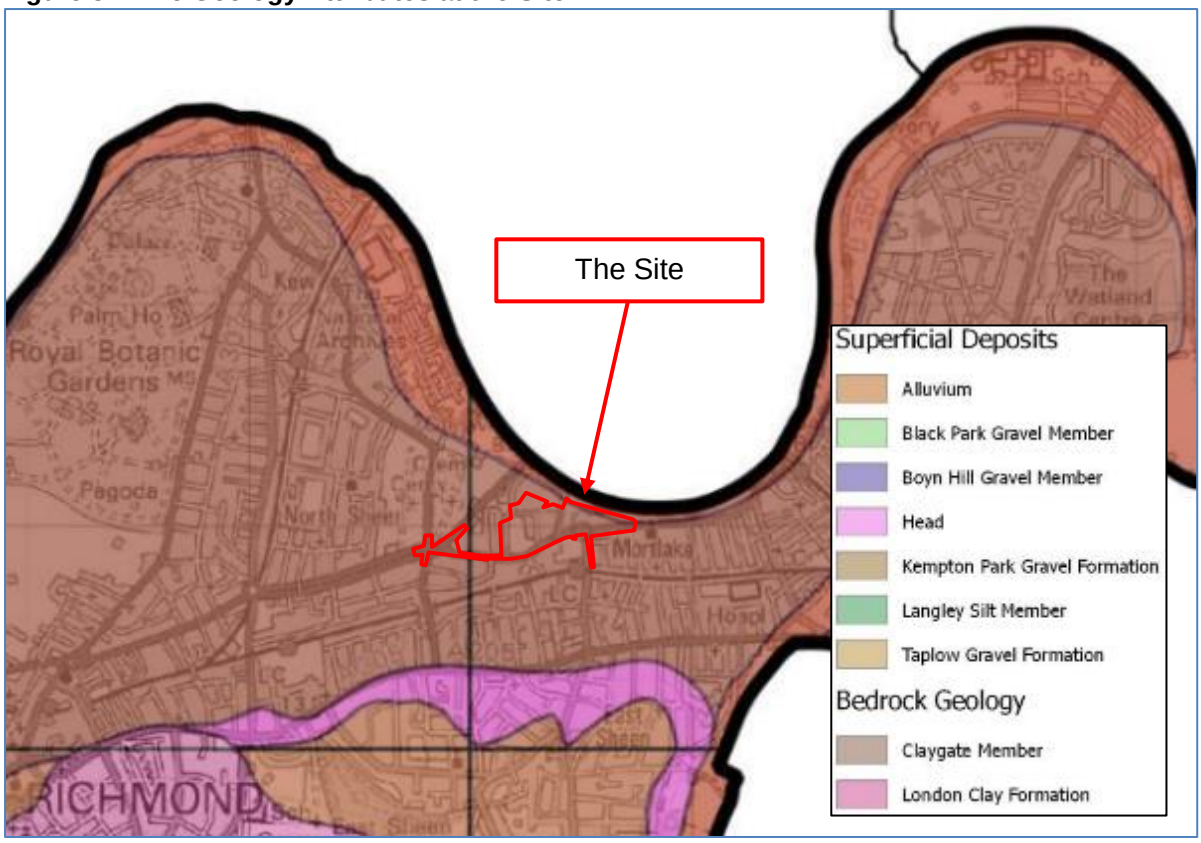
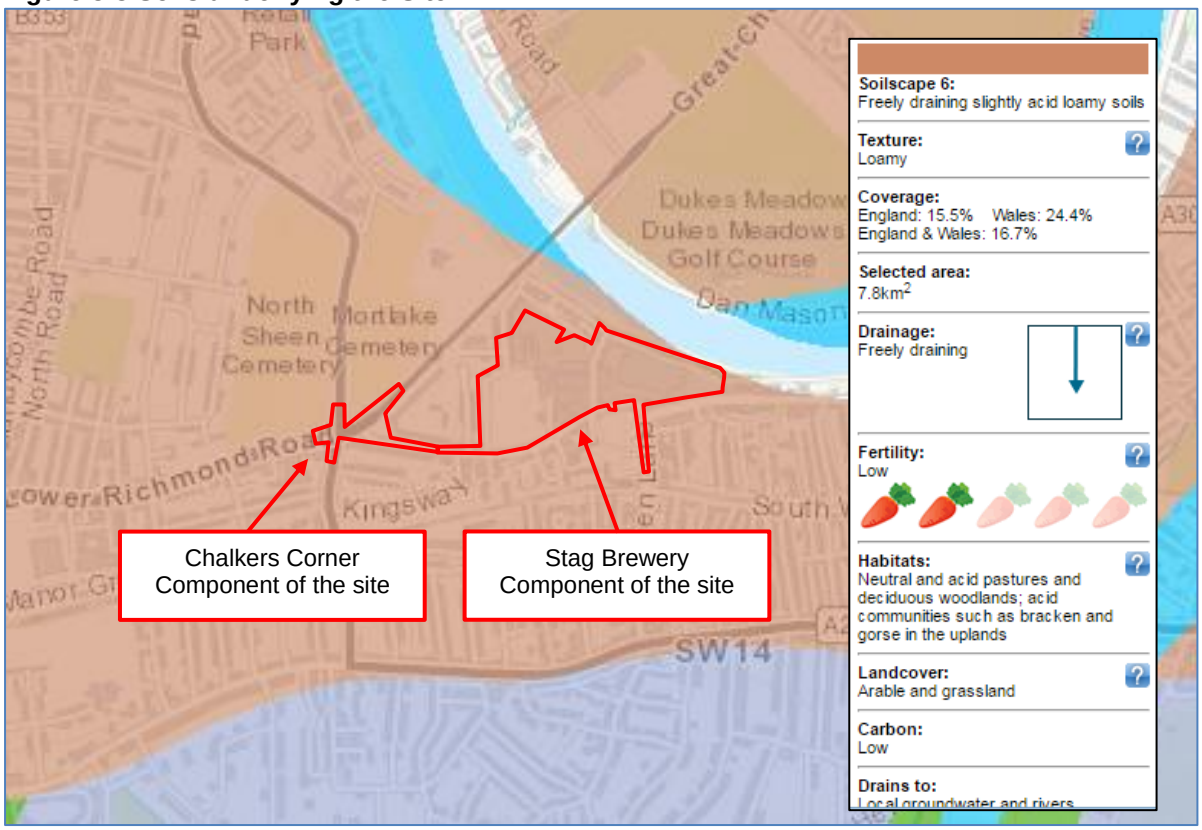


Figure 3-3 Soils underlying the Site



3.2 Sources of Flood Risk

The principal sources of flood risk are shown in Table 3-1. More detailed consideration is given in Section 3.3

Table 3-1 Possible sources of flood risk

Key sources of flooding	Possibility at Site
Fluvial (Rivers)	*Very low risk as fluvial levels would not overtop defences*
Tidal	*Moderate risk since it is located in the River Thames flood zones 3a and 2*
Groundwater	*Possible risk from its proximity to the River Thames*
Sewers	*Very low risk; No historical records*
Surface water	*Very low risk*
Infrastructure failure	*Very low risk associated with reservoirs located to west of London, namely Queen Elizabeth II and Queen Mary Reservoirs.*

Based on NPPF Practice Guide

3.3 Flood Mechanisms

3.3.1 Tidal

The dominant flood risk to the Site comes from the tides on the River Thames. This can occur from high tides combined with storm surges.

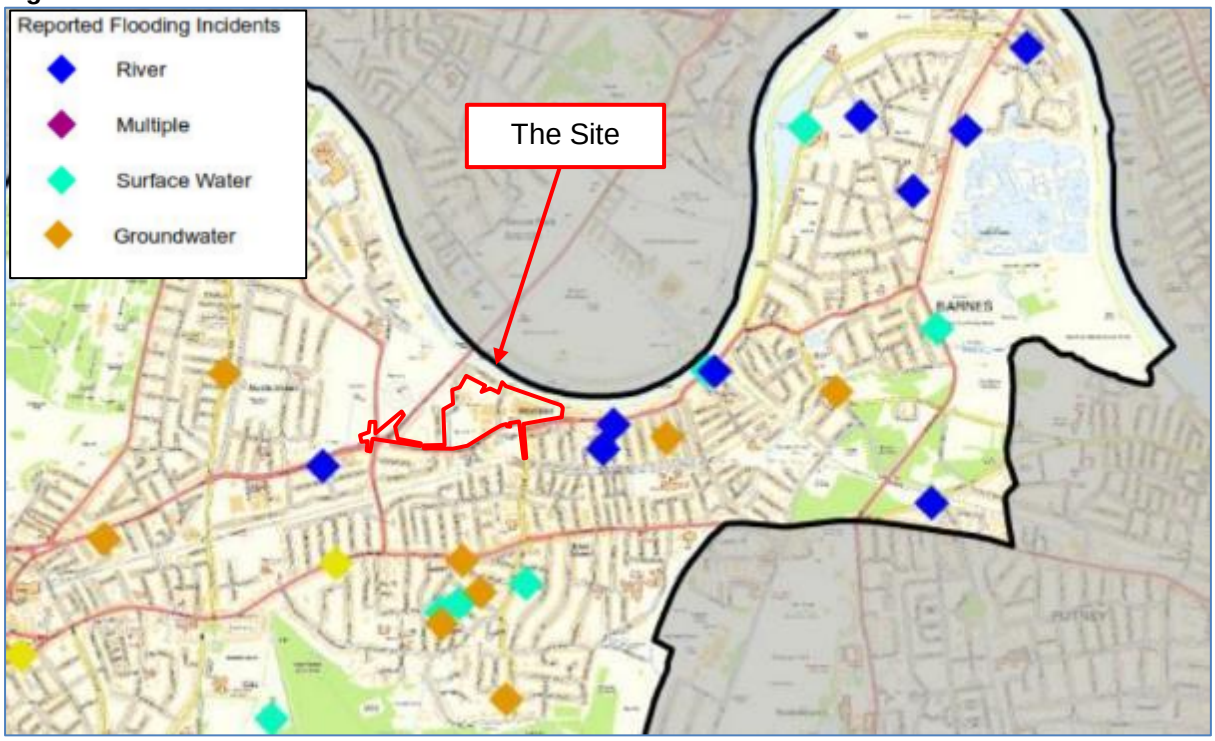
The Site is protected by formal Thames Tidal Flood defences, including the Thames Barrier. This controls the tidal water levels and, in combination with other defences, should limit flooding up to the 0.1% Annual Exceedance probability (AEP) flood event. Apart from the Thames Barrier, these defences are privately owned and it is the responsibility of the riparian owner to manage and maintain them. The boundary wall on the site of the Stag Brewery forms part of the flood defence at this location. In the cases that these defences were breached, different parts of the site would exhibit different hazards, ranging from low to extreme (see section 3.5).

The nearest tidal level station to the site is at Kew, as documented by the Port of London Authority (2016). This shows the following level information:

- Chart datum is 1.07 m below Ordnance Datum
- HAT (Highest astronomical tide) = 5.9 mACD = 4.8 mAOD
- MHWS (Mean High Water Springs) = 5.2 mACD = 4.1 mAOD
- MHWN (Mean High Water Neaps) = 4.2 mACD = 3.1 mAOD

While there are no reported historic flood incidents at the site (LBRuT, 2016a), there have been several flood incidents from the river near to the site (Figure 3-4).

Figure 3-4 Historic Flood Incidents



3.3.2 Groundwater

The BGS susceptibility to groundwater flooding map (Figure 3-5) indicates that the eastern and southern areas of the Stag Brewery Component of the Site are susceptible to groundwater flooding at the surface. The remaining areas of the Site are susceptible to groundwater flooding below the ground. While no groundwater flood incidents have been recorded at the Site, there have been several groundwater flood incidents near the Site (Figure 3-4).

The mechanism for groundwater flooding could occur from two sources and the associated pathways. The first source is from high water levels in the River Thames. Since the Site is located on Kempton Gravel Formation, this could allow water to find a pathway through the gravel into the Site.

A second mechanism is from the minor aquifer over which the Site is located (Figure 3-6). This indicates a risk from groundwater flooding that could be caused by high seasonal rainfall which increases the groundwater levels in the aquifer. Since some areas of the Site have a low elevation (Figure 3-1), this could increase its susceptibility to groundwater flooding from a high water table.

AECOM was commissioned in 2015 to undertake an Environmental Site Assessment Report in preparation for the proposed planning application (AECOM 2015a and 2015b). This included a collation of available groundwater monitoring information and a new set of observations in September 2015.

The main findings of their investigations were:

- Observed water levels vary over the site from around 2 mAOD in the east of the Site to 1.3 mAOD in the west. The hydraulic gradient is thus downwards to the west in the western part of the Site. However, in the centre, the gradient is downwards to the south-west (Figure 3-7).

Figure 3-5 BGS Groundwater Map (LBRuT, 2016c)

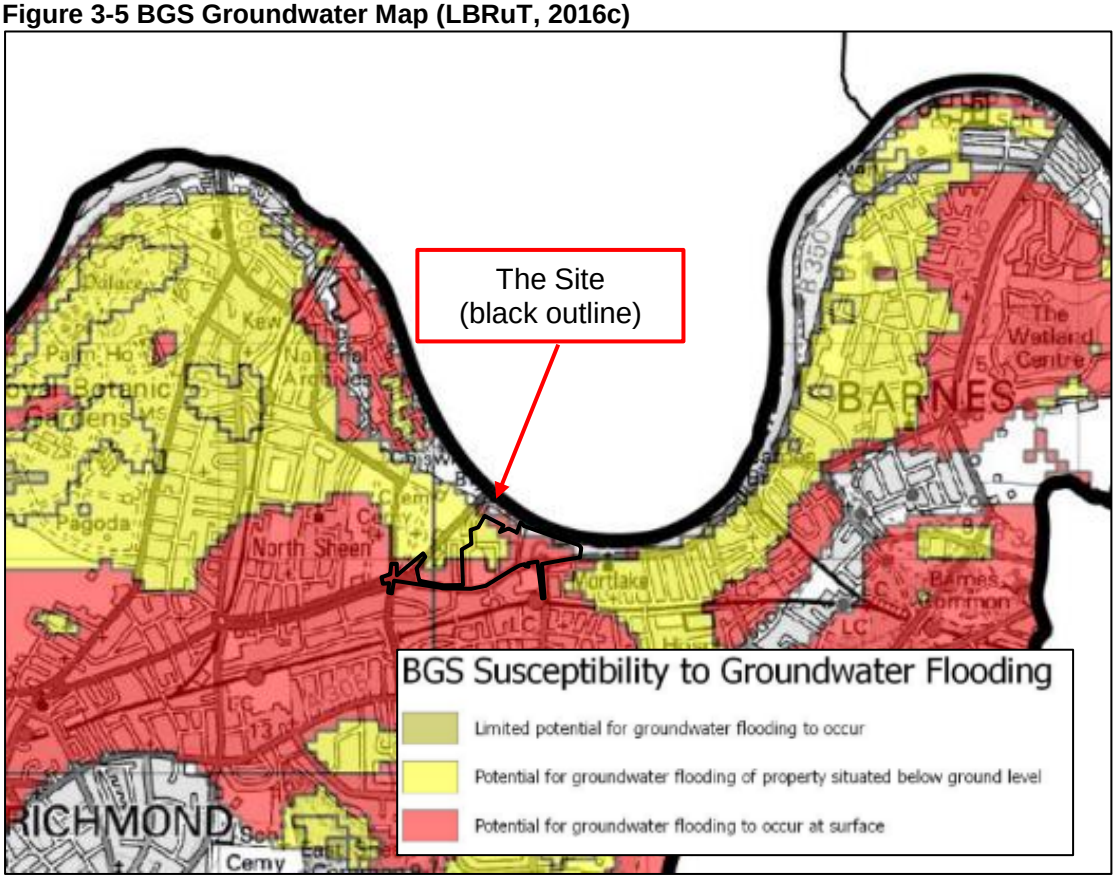
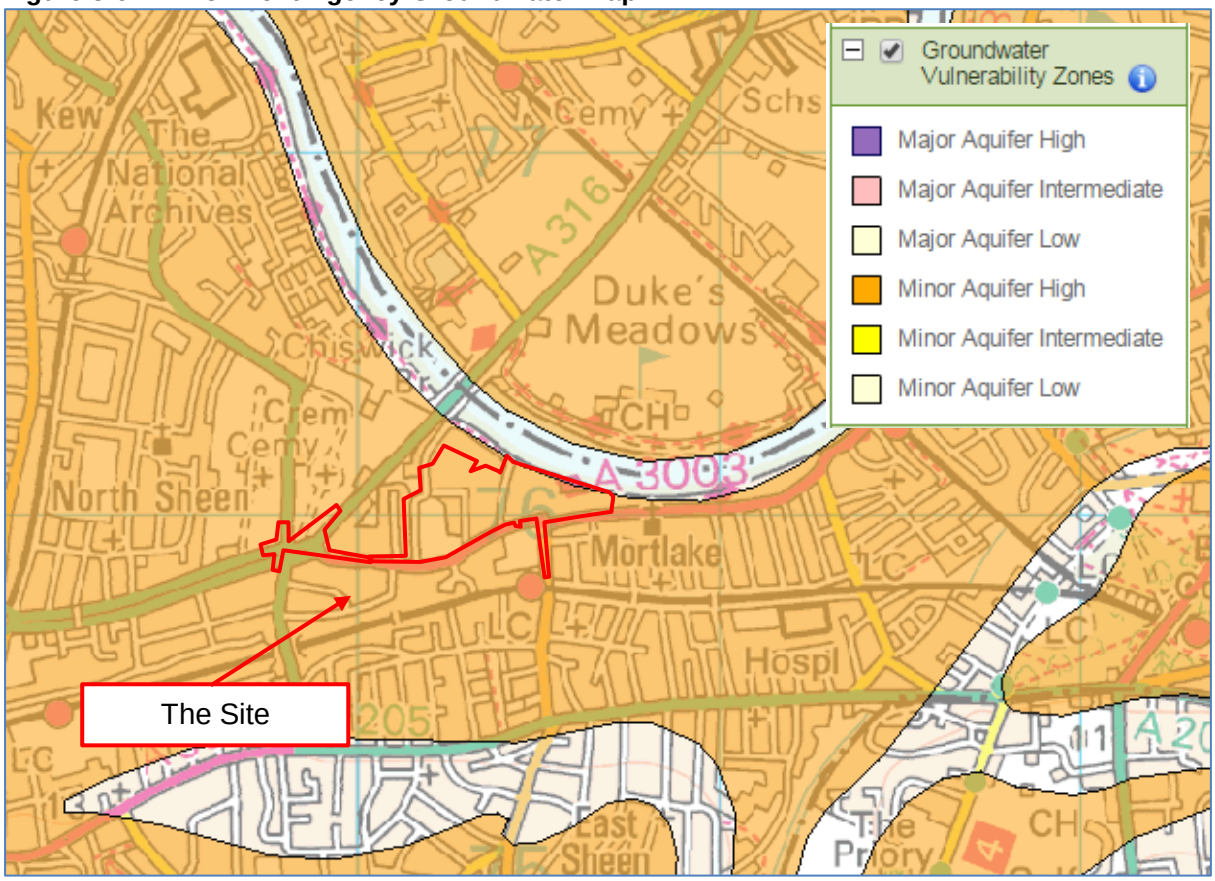


Figure 3-6 Environment Agency Groundwater Map



- The hydraulic gradient therefore contrasts with the topographic gradient which is downwards to the east across the Site.

- A review of water levels over time confirms that they vary systematically across the Site, with a typical range of about 0.5 m between the highest and lowest values (Figure 3-8).

- The influence of the tidal variation in the Thames was investigated through deployment of monitors at three of the boreholes. The closest borehole to the Thames that was monitored was BH201a, located approximately 20 m from the southern bank of the Thames. The record from BH201A shows a very subdued response to tidal variation centred around 2 mAOD over the time of observations (Figure 3-9), as expected because the borehole is located in the inter-tidal zone.

As part of their Environmental Risk Assessment in 2016 for the east part of the Stag Brewery component of the Site (east of Ship Lane), Waterman IE also made measurements of groundwater levels at a new set of boreholes. The locations of the additional boreholes are shown in Figure A.4 and the observations in Appendix D of Waterman IE (2016b). The observed water levels have been annotated in red on Figure 3-7. Based on the findings by AECOM and the observations by Waterman IE (2016b), the following hydrogeological interpretation can be made about the Site:

- Since the hydraulic gradient slopes downwards away from the river, the river appears to be acting as a "source" of groundwater flow when considered together with flows from existing surface water drainage arrangement (see Section 3.4) under wet weather conditions.

- Although the river levels are subject to tidal variation, the effects diminish with distance from the river, such that at 20 m for Borehole 201A, they are very subdued. The head boundary condition imposed by the Thames will therefore approximate to the average recorded water levels. This is logically around 2 mAOD (based on Figure 3-9) and which is consistent with the closest available water level recorders at Richmond (Figure 3-10) and Chelsea (Figure 3-11), for which average water levels are around 2.4 mAOD and 0.7 mAOD respectively.

- AECOM sought to investigate the hydrogeology of the east of the Site by drilling boreholes BH203 and BH203A. The borehole logs show that these had limited success since they encountered concrete (Figure 3-12 and Figure 3-13). The investigations by Waterman IE also sought to better understand the east of the Site through the drilling of additional boreholes, though these also encountered obstructions. These undermine any strong inferences about the hydrogeology of this part of the site.

- The general observations by Waterman IE are broadly consistent with the interpretation by AECOM. However, the picture is varied with some dry wells and other wells showing water levels within 2 to 3 m of the ground level. It seems likely that this variation reflects the complexity of the east of the Site and the numerous anthropogenic and building work interventions over a long period. It is possible (rather than probable) that the observed water levels of around 3 mAOD which were obtained in February 2016 and similar values obtained by Waterman IE in October 2016 represent a perched water table associated with the underlying Palaeogene minor aquifer. However, the relationship between the Palaeogene minor aquifer and the Kempton gravel formation does not support the assumption of a perched water table. The

presence of building work artefacts in the eastern part of the Site may be responsible for the impermeable concrete encountered at various depths through the drilling of BH203 and BH203A as recorded in their borehole logs.

It is therefore concluded that the risk to the Site and the surrounding area from groundwater is low over the majority of the Site. However, in the extreme east, there is some uncertainty over the relative influence of the mechanisms controlling groundwater flow through the Site: flows through the high permeability Kempton gravels and / or groundwater flows in the underlying minor aquifer. The possible impacts of the proposed Development on groundwater risk are reviewed in Section 4.

Figure 3-7 Groundwater Contour Map (AECOM, 2015b) supplemented by Waterman IE's observations on 27 October 2016 in red

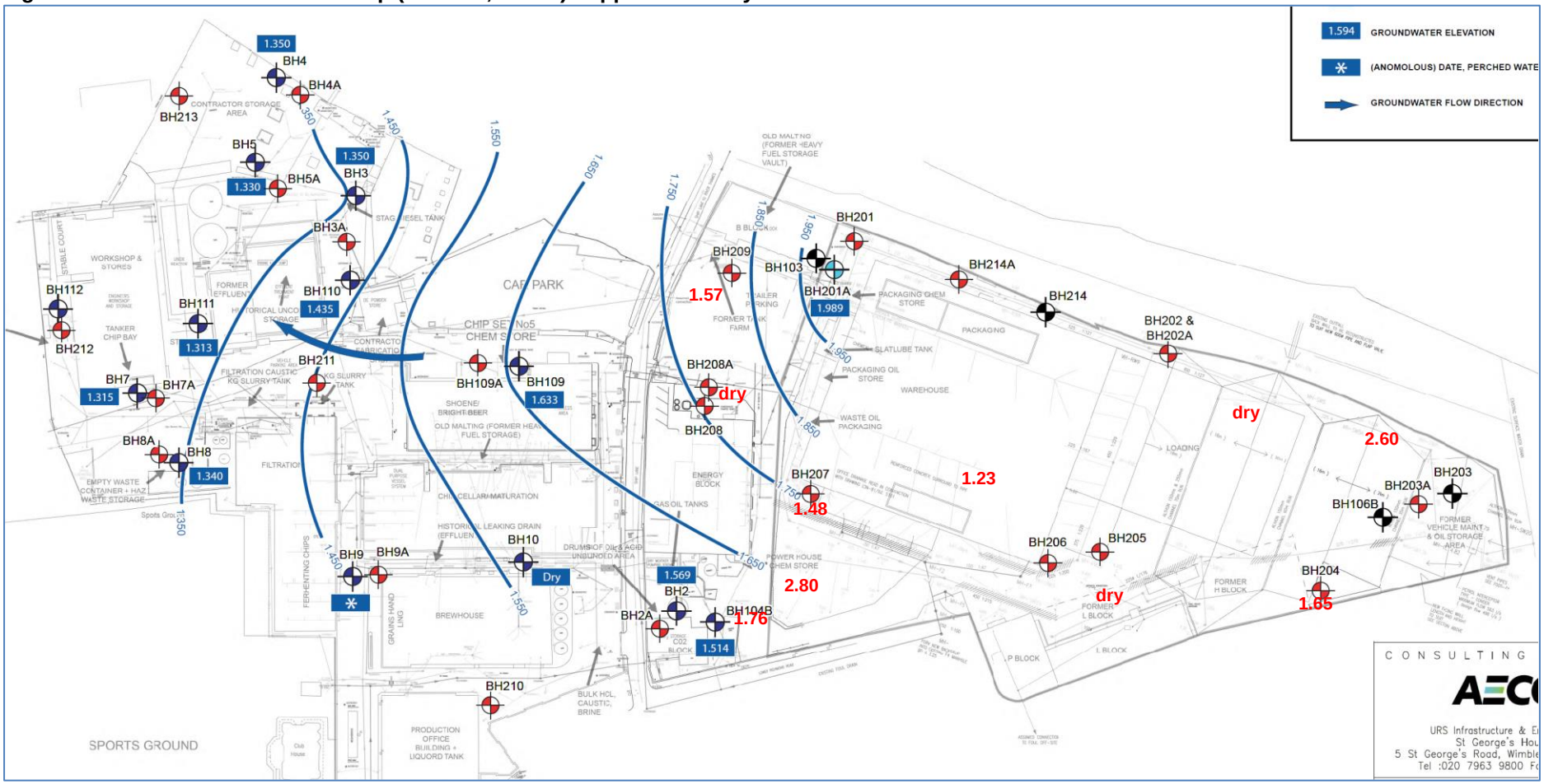


Figure 3-8 Selected Groundwater Levels over time (AECOM, 2015b)

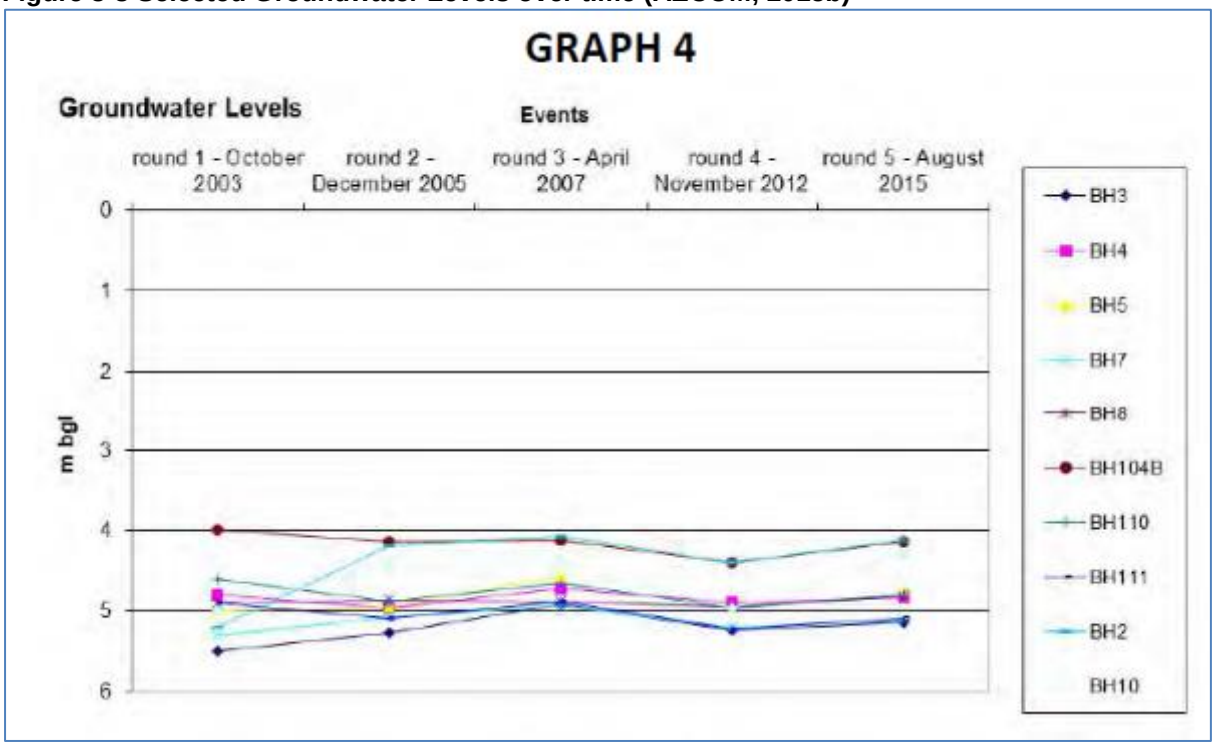


Figure 3-9 Level hydrograph for Borehole BH201A (AECOM, 2015b)

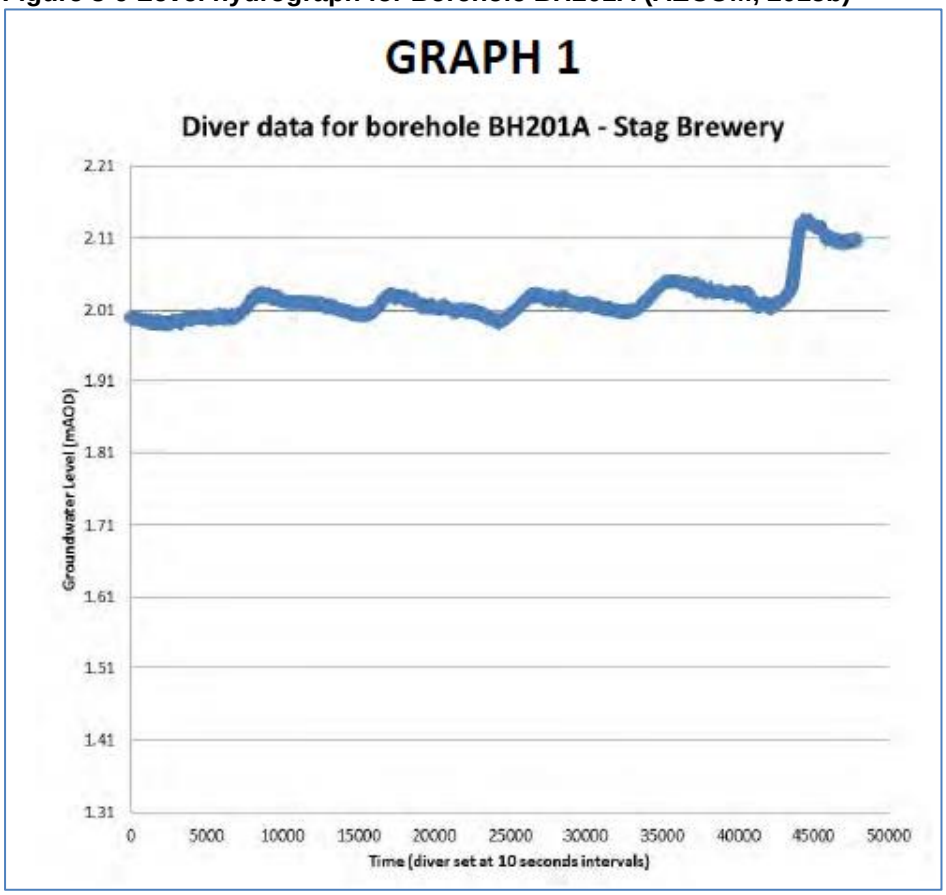


Figure 3-10 Level hydrograph for Richmond (Environment Agency)

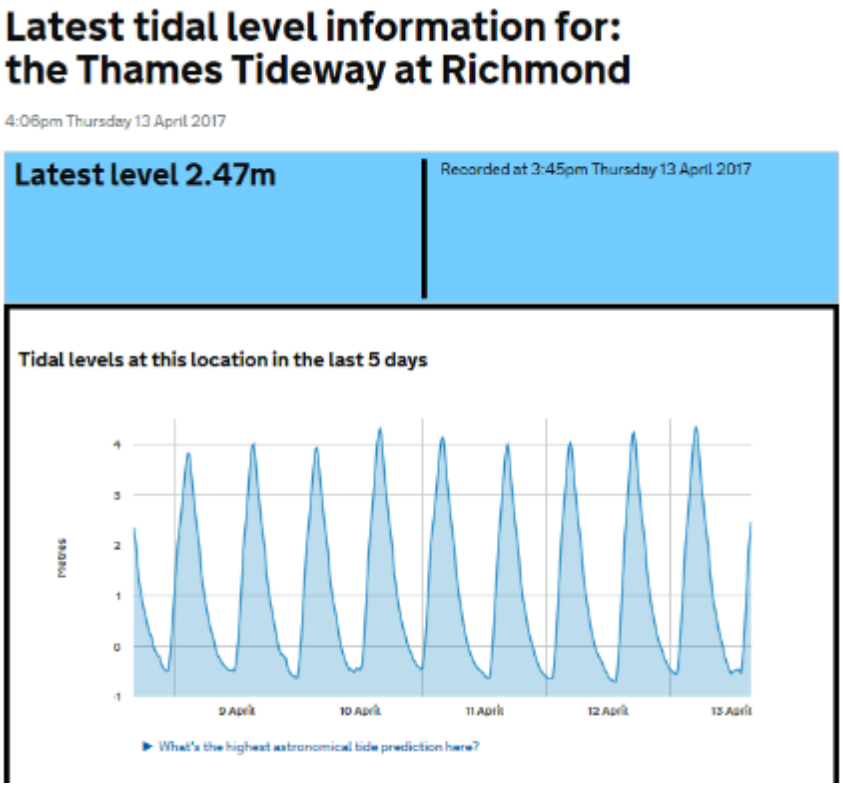


Figure 3-11 Level hydrograph for Chelsea (Environment Agency)

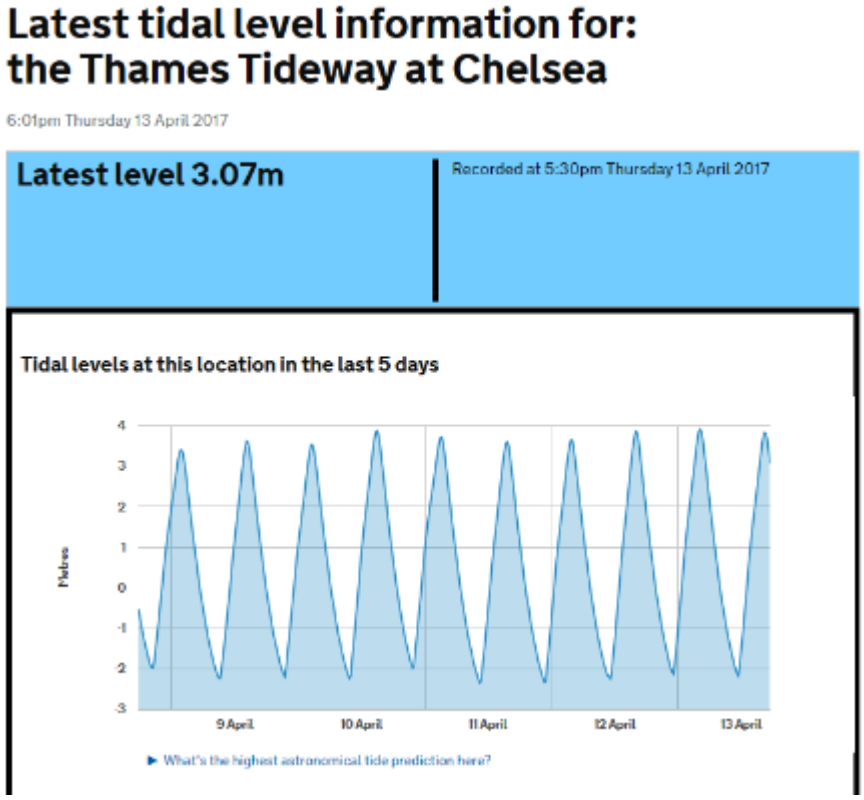
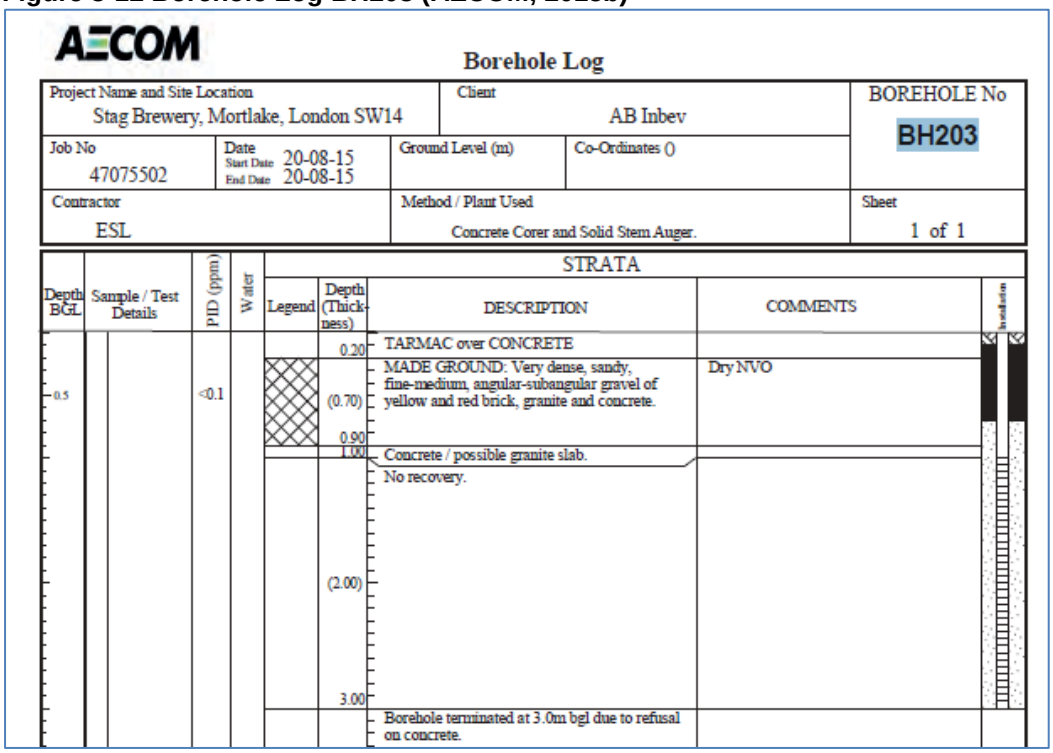


Figure 3-12 Borehole Log BH203 (AECOM, 2015b)



AECOM

Borehole Log

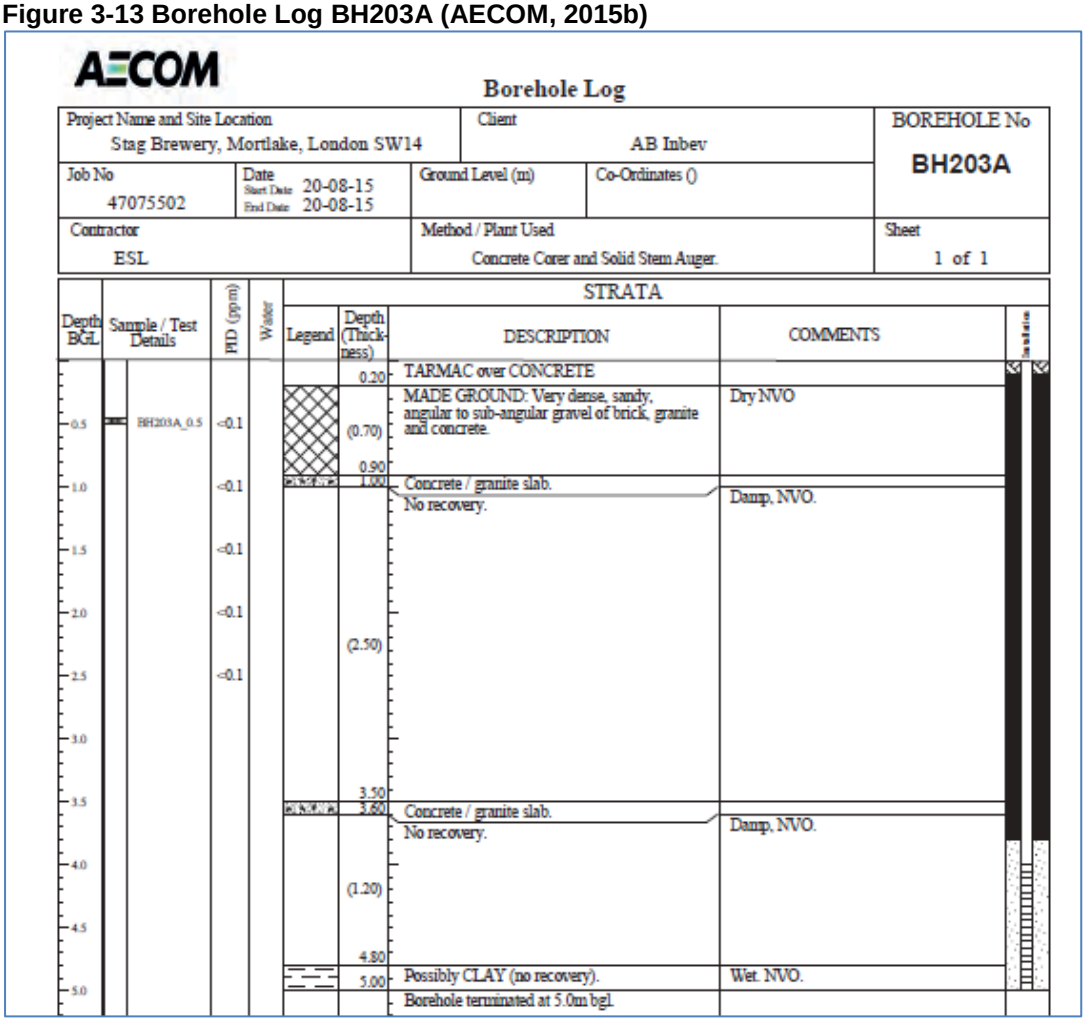
Project Name and Site Location	Client	BOREHOLE No
Stag Brewery, Mortlake, London SW14	AB Inbev	BH203

Job No	Date	Ground Level (m)	Co-Ordinates ()
47075502	Start Date 20-08-15 End Date 20-08-15		

Contractor	Method / Plant Used	Sheet
ESL	Concrete Corer and Solid Stem Auger.	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation
					0.20	TARMAC over CONCRETE		
0.5		<0.1			(0.70)	MADE GROUND: Very dense, sandy, fine-medium, angular-subangular gravel of yellow and red brick, granite and concrete.	Dry NVO	
					0.90			
					1.00	Concrete / possible granite slab.		
					(2.00)	No recovery.		
					3.00			
						Borehole terminated at 3.0m bgl due to refusal on concrete.		

Figure 3-13 Borehole Log BH203A (AECOM, 2015b)



AECOM

Borehole Log

Project Name and Site Location	Client	BOREHOLE No
Stag Brewery, Mortlake, London SW14	AB Inbev	BH203A

Job No	Date	Ground Level (m)	Co-Ordinates ()
47075502	Start Date 20-08-15 End Date 20-08-15		

Contractor	Method / Plant Used	Sheet
ESL	Concrete Corer and Solid Stem Auger.	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thickness)	DESCRIPTION	COMMENTS	Installation
					0.20	TARMAC over CONCRETE		
0.5	BH203A_0.5	<0.1			(0.70)	MADE GROUND: Very dense, sandy, angular to sub-angular gravel of brick, granite and concrete.	Dry NVO	
					0.90			
1.0		<0.1			1.00	Concrete / granite slab.		
						No recovery.	Damp, NVO.	
1.5		<0.1						
2.0		<0.1			(2.50)			
2.5		<0.1						
					3.50			
3.5					3.60	Concrete / granite slab.		
						No recovery.	Damp, NVO.	
4.0					(1.20)			
4.5					4.80			
5.0					5.00	Possibly CLAY (no recovery).	Wet. NVO.	
						Borehole terminated at 5.0m bgl.		

3.3.3 Sewers

Although surface water and foul sewers are laid under the Site, Thames Water have confirmed that there are no recorded historic sewer flooding records at the Site (Reference to their response to Waterman IE dated January 2016), extracts from which are shown in Appendix E

3.3.4 Surface Water

Surface water flooding can occur with ponding in low areas of the Site and surrounding area where the drainage is unable to deal with the incident rainfall. Surface water flood risk is available in the SFRA (LBRuT, 2016c) (Figure 3-14) and from the Environment Agency Web site (Figure 3-15). The latter shows that, for the low-risk scenario, the depths vary from 0 to about 300 mm along the Lower Richmond Road and Mortlake High Street to the east of the existing Sports Ground, as indicated on the map. Greater depths of surface water flooding are predicted in Lower Richmond Road adjacent to the Sports Ground (300 to 900 mm) and in the park, south of the Lower Richmond Road (in excess of 900 mm). Some of the surface water flooding on Lower Richmond Road may be linked to the blocked gully incidents (Figure 3-16). For the high-risk scenario, predicted surface water flooding is restricted to the carriageway of the Upper Richmond Road and the adjacent park and is of shallow depth.

Figure 3-14 Surface Water Map (LBRuT, 2016c)

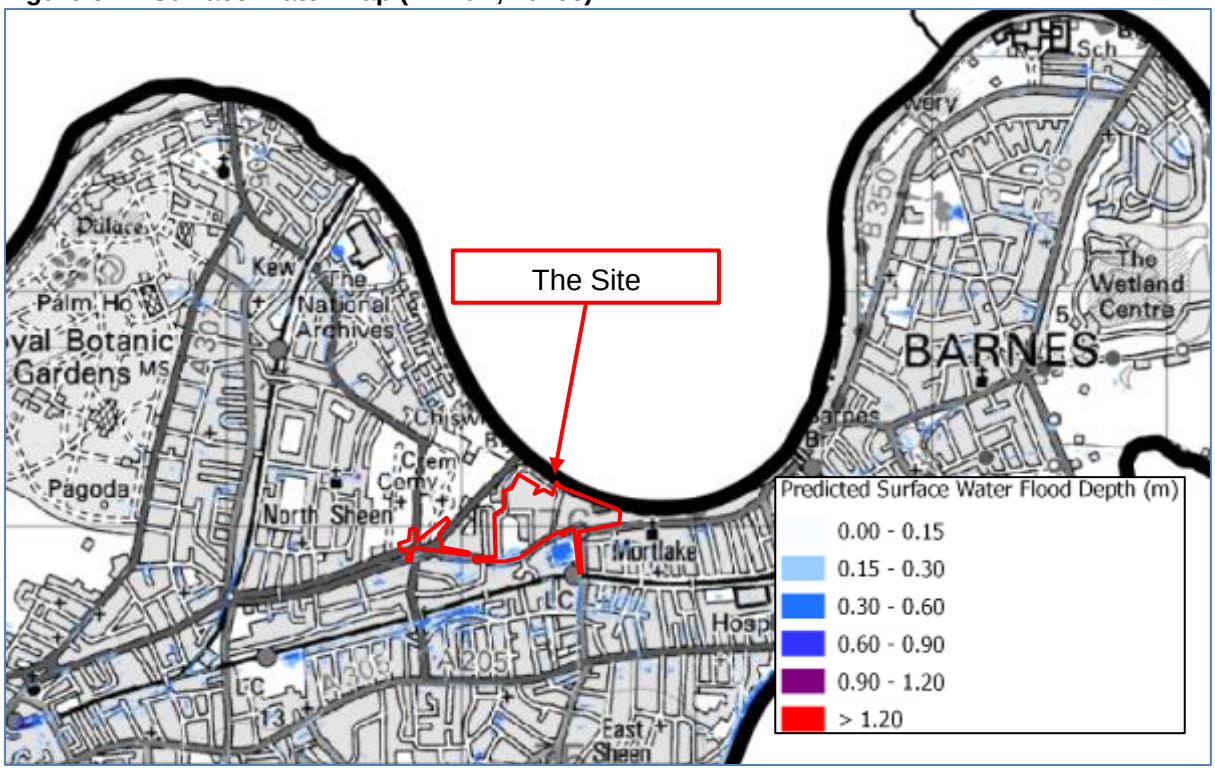
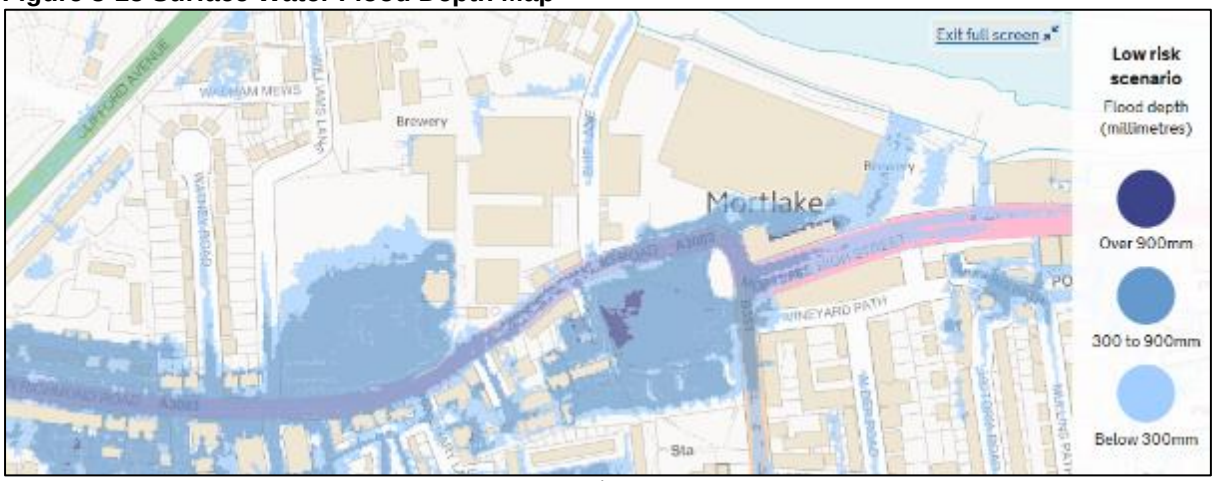
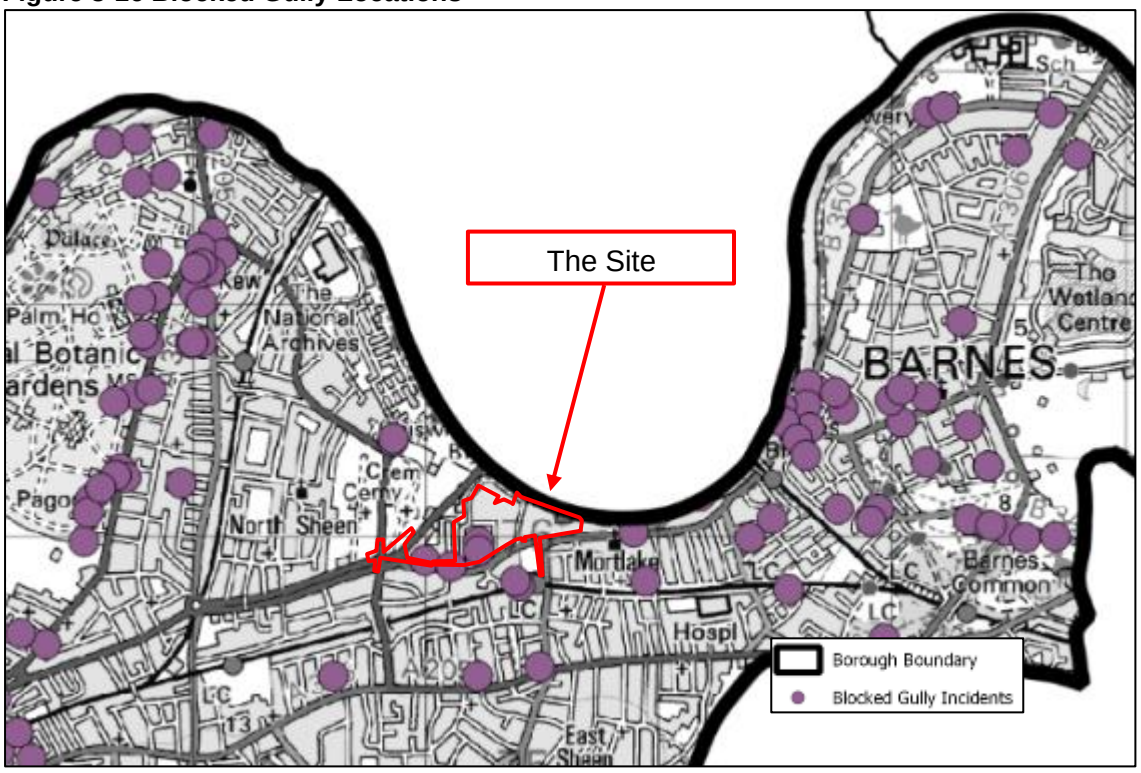


Figure 3-15 Surface Water Flood Depth Map



Environment Agency Web Site (Accessed 23rd October 2017)

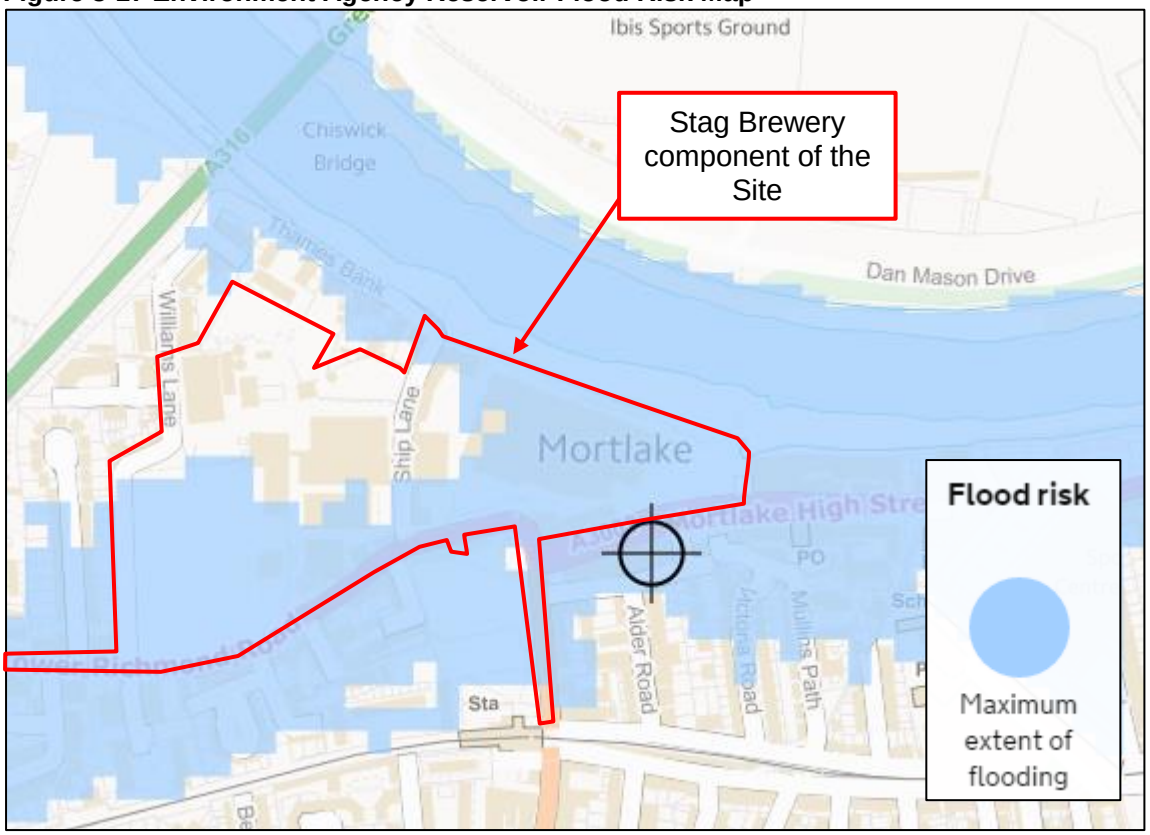
Figure 3-16 Blocked Gully Locations



3.3.5 Infrastructure

The Site has a potential risk of flooding from the Queen Elizabeth II reservoir and the Queen Mary reservoir in Surrey (Figure 3-). This could occur if the reservoirs were to fail, causing water to flood over the western and southern parts of the Site. However, these reservoirs located over 20 km upstream of the Site, they are managed and maintained by Thames Water and the risk of reservoir flooding is considered to be very low.

Figure 3-17 Environment Agency Reservoir Flood Risk Map



3.4 Existing Surface Water Drainage Arrangements

During the preliminary investigations for this Site, Waterman IE made a Developer Enquiry to Thames Water in respect of sewers and water mains. Extracts from the response in January 2016 are provided in Appendix E . These drawings show a variety of combined, surface and foul sewers around the Stag Brewery Component of the Site. Whilst sewers traverse the Stag Brewery component of the Site along both Ship Lane and Bull's Alley, none are shown on the operational area of the former brewery.

The on-site drainage measures were inspected during the site visit in 16th June 2016. Virtually the entire Site comprises either rooves or hard standing (Figure 3-18). Roof drainage was via downpipes that are believed to outfall to the Thames whilst hard standing drains (Figure 3-19). runoff calculations are presented in the Drainage Strategy (Waterman IE, 2018).

Figure 3-18 General views of the Stag Brewery component of the Site

a) West **b) East**

Figure 3-19 Examples of drainage

a) Roof **b) Hard standing**

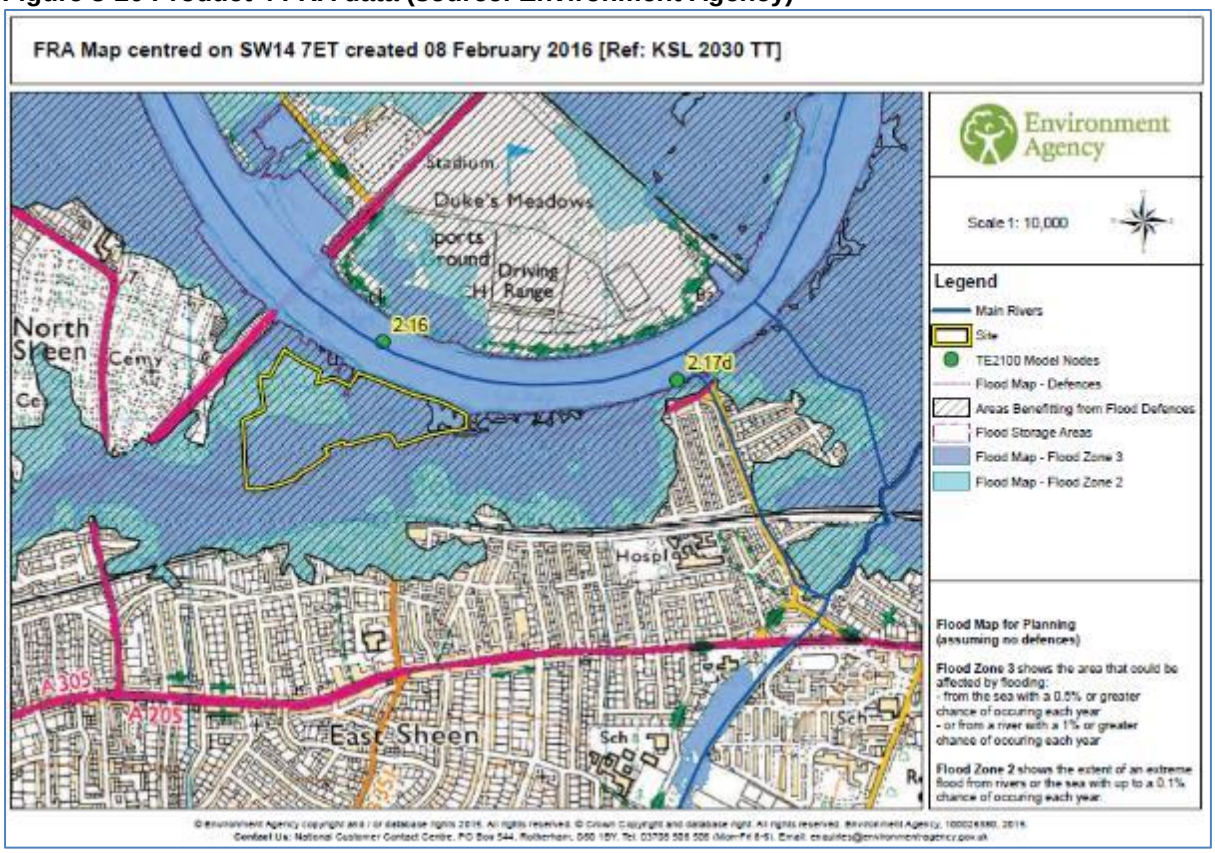
3.5 Probability of Site Flooding

The assumed tidal water levels of the River Thames are based on the TE2100 model node 2.16 (Figure 3-20) which is adjacent to the Stag Brewery component of the Site. The modelled levels for node 2.16 are assumed to apply along the entire river frontage due to the river's shallow gradient.

The probability of the Stag Brewery component of the Site flooding due to the tides is limited by the tidal defences to protect up to a 0.1% Annual Exceedance Probability (AEP) event. However, there remains a risk from flood defences failing, with the outcomes being modelled on behalf of the Environment Agency, which has been provided as Product 4 data. This

provides flood levels for the floodplain nodes in Figure 3-21 for different scenarios of flood defence failure.

Figure 3-20 Product 4 FRA data (source: Environment Agency)



An identical map was provided with the July 2017 Product 4 data set
This map shows a site boundary that has now been superseded.

The relevant levels have been provided by the Environment Agency for a range of return periods and projections. The most recent levels provided by the Environment Agency are from the following sources:

- TE2100 modelled node 2.16;
- Thames Breach Modelling; and
- Thames Tidal Upstream Inundation Modelling.

The TE2100 levels result from a large body of work commissioned by the Environment Agency in relation to flood risk management of the Thames Estuary. The operation of the Thames Barrier is critical in this strategy and the recent modelling addresses the frequency of Thames Barrier operation. The Thames Barrier manages tidal flood events up to a 0.1% AEP event. These TE2100 levels recently provided do not have return periods. The Environment Agency present them as "absolute maximum levels" and clarify this as follows:

> "*The levels upstream of the barrier are the highest levels permitted by the operation of the Thames Barrier. If levels and flows are forecast to be any higher, the Thames Barrier would shut, ensuring that the tide is blocked and the river maintained to a low level. For this reason, the probability of any given water level upstream of the Barrier is controlled and therefore any associated return period becomes irrelevant. The Thames Barrier and associated defence system has a 1 in 1000 year standard which means it ensures that flood risk is managed up to an event that has a 0.1% annual*

probability. The probability of water levels upriver is ultimately controlled by the staff at the Thames Barrier."

The modelled levels (Table 3-2) for the Stag Brewery component of the Site indicate that water levels in 2100 should reach a maximum level of 6.03 m. However, minimum bank defence levels should currently be built to 5.94 m and allow for a rise to 6.70 m.

Table 3-2 Modelled levels for TE2100 node 2.16

Year	Attribute	Level (m)
2008 levels	Extreme water level	5.23
	Right bank defence	5.94
	Allow for future defence raising to:	6.70
2065 to 2100	Design water level	5.62
	Bank defence level	6.25
2100	Design water level	6.03
	Defence level	6.70

These data are from the Product 4 data set provided in 2016. Model data for node 2.16, the most appropriate node for the site, was not provided with the Product 4 data in 2017. However, the model data for other model nodes was unchanged in the more recent product 4 data set.

Modelled levels for the nodes shown in Figure 3-21 are also provided for tidal breach modelling at the Stag Brewery component of the Site where the flood defences at the Stag Brewery component of the Site are breached. The breaches in the defences were considered to be 20 m wide for composite defences and 50 m wide for soft defences (not relevant here). The model outputs are shown in Figure 3-22 and Table 3-3. These show that a breach of the defences would cause water to flood the south-east area of the Stag Brewery Component of the Site in the present day. The flood extents would increase westwards and northwards in 2055 and 2100, with an increase in tidal breach levels up to 6.02 mAOD in the east of the site.

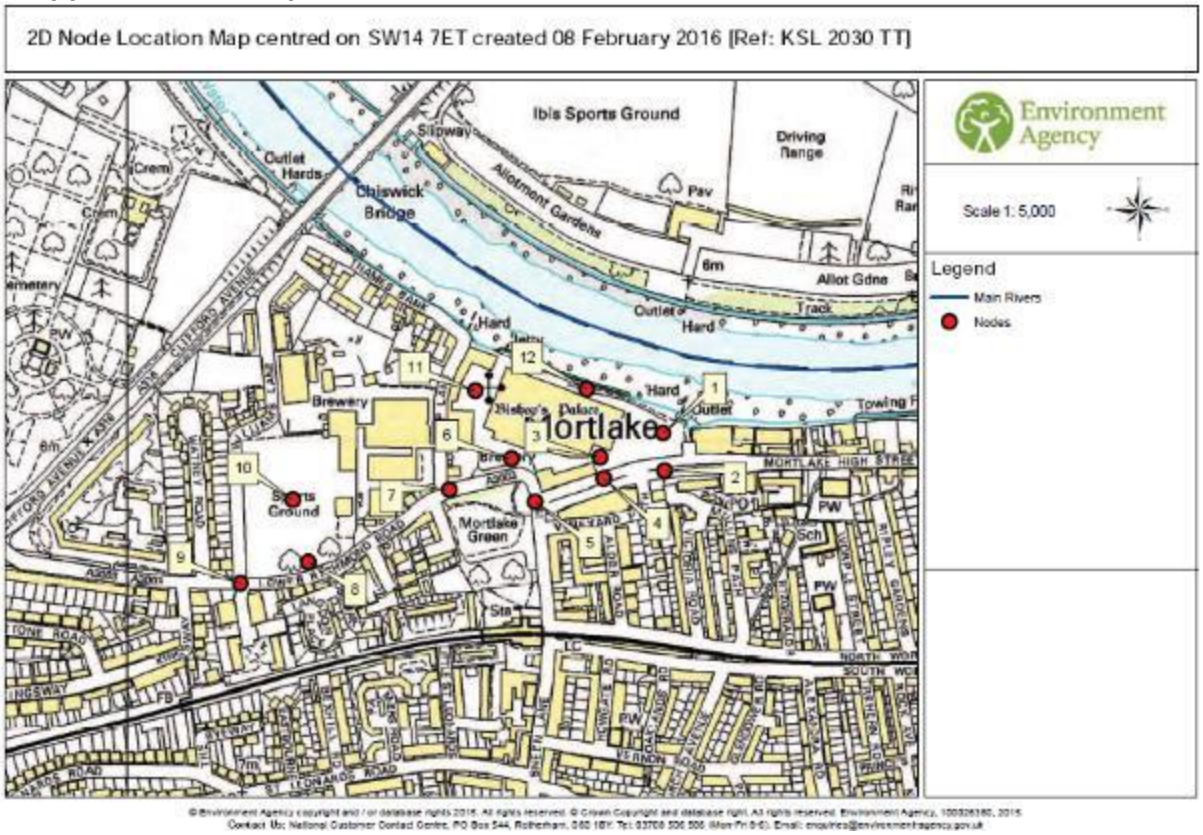
Two sets of maps are provided in the Figures and Tables:
(a) Refers to the Product 4 data provided in 2016; and
(b) Refers to Product 4 data provided in 2017.

A different set of nodes has been provided with each set of Product 4 data. However, a comparison of levels for corresponding locations has been made in Table 3-4. This shows that nodes close to the breach (i.e. towards the eastern part of the site) have lower peaks for the more recent modelling. Conversely, nodes in the western part of the site have higher levels for the more recent modelling. It has not been possible to discuss these findings with the Environment Agency modellers. However, it seems to show that the more recent modelling has enabled flood water to propagate more rapidly away from the breach. This likely reflects model assumptions about the movement of the flood wave through the urban extent. It also contributes to a larger area being affected by the breach in 2100 than was shown in the previous modelling and Product 4 data.

It should be noted that the Environment Agency modelling uses the existing site layout. The landscaping that is proposed as part of the development of the Stag Brewery component of the Site will have a profound impact on the flood extents associated with breach. It is shown in Appendix D that the development of the Stag Brewery component of the Site will lead to a general reduction in flood extents and flood levels resulting from a breach. This is partly due to the blocking of flow paths by the proposed landscaping and the reduced opportunity for breach following the development.

Figure 3-21 Environment Agency 2D Node Locations

(a) Product 4 data provided in 2016



(b) Product 4 data provided in 2017

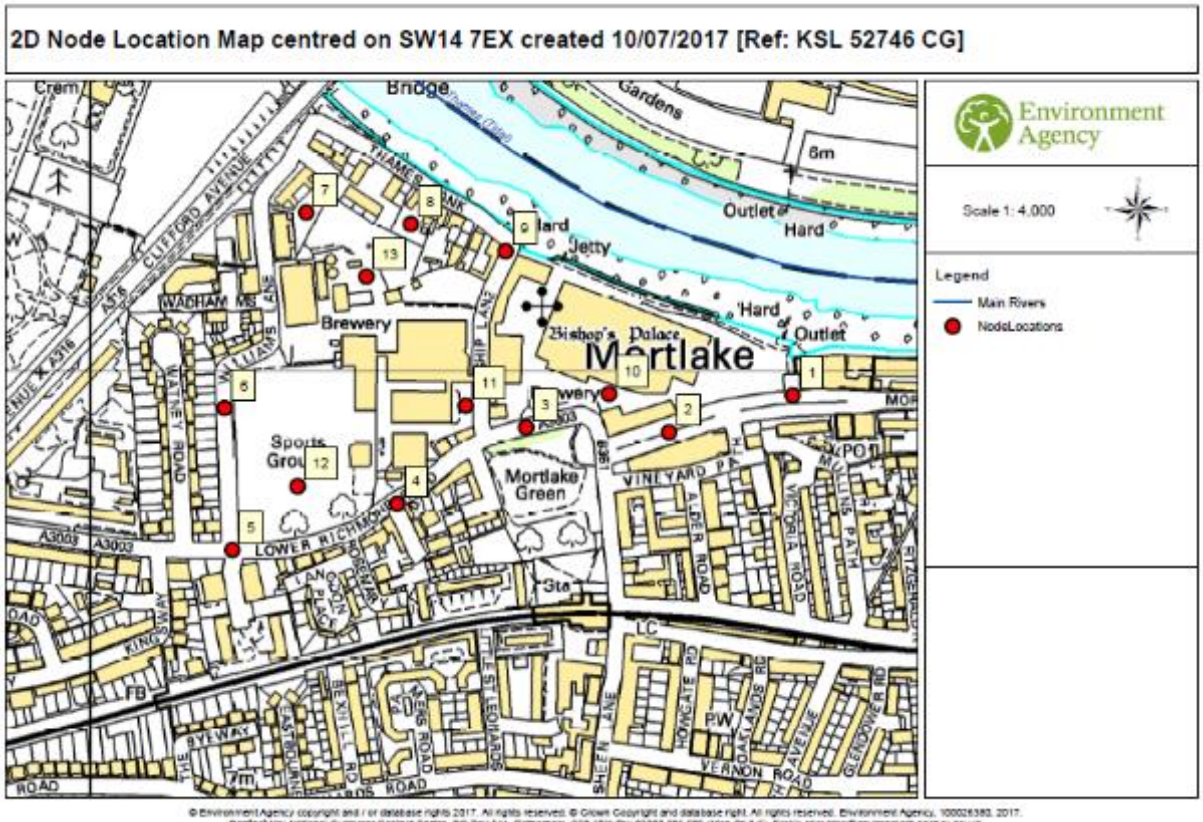
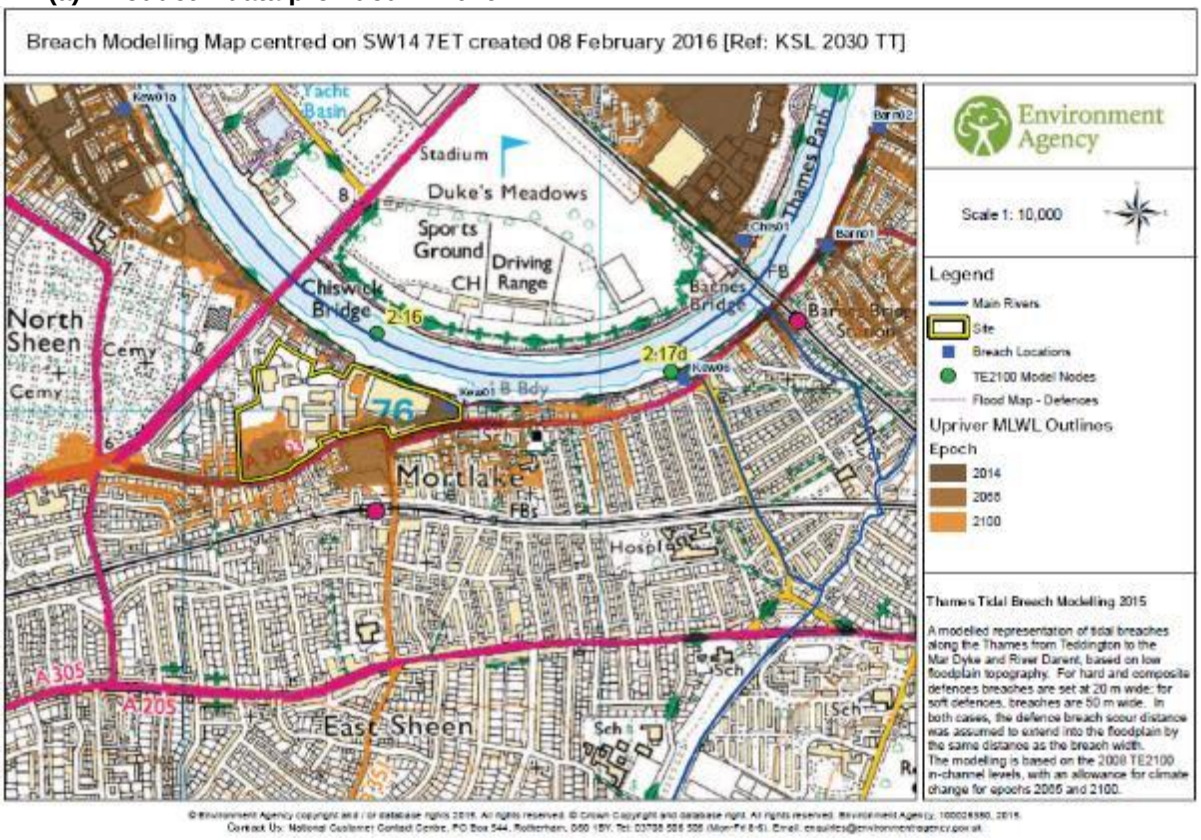


Figure 3-22 Environment Agency Breach Model Map

(a) Product 4 data provided in 2016



(b) Product 4 data provided in 2017

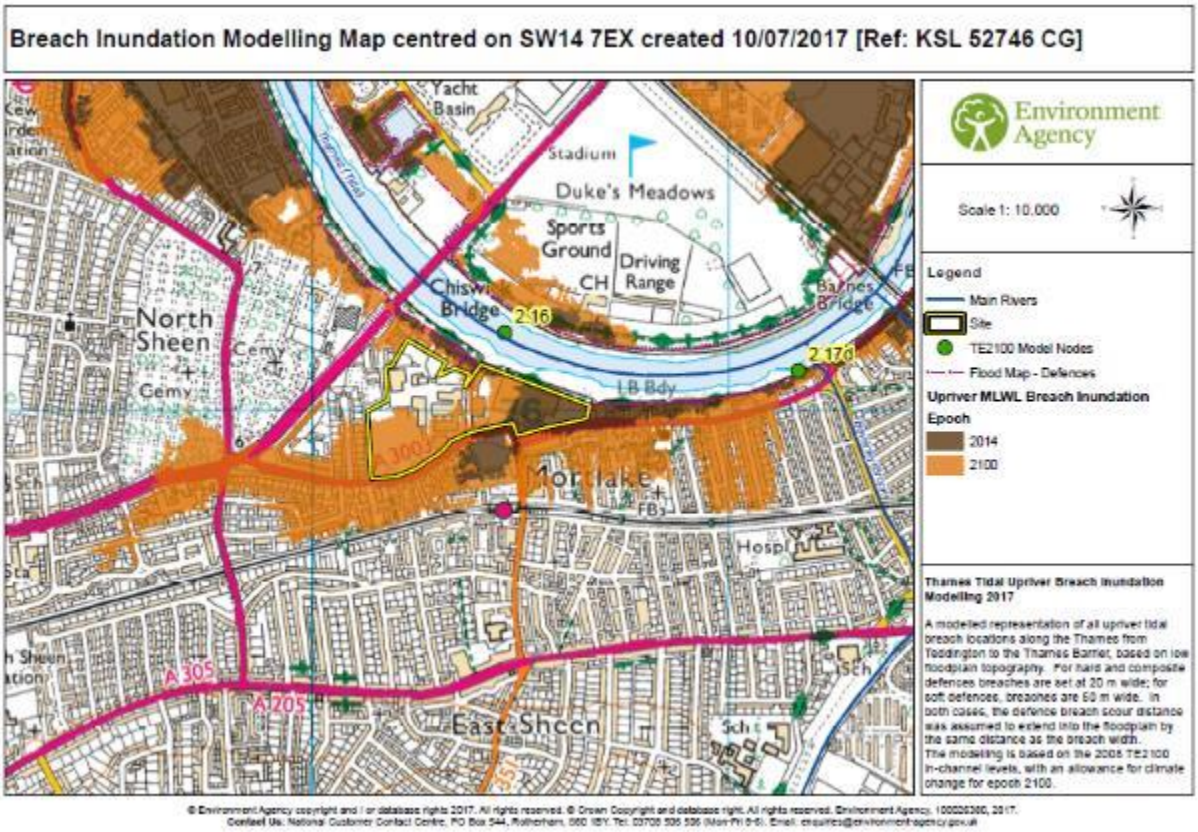


Table 3-3 Environment Agency Thames Tidal Breach Levels

(a) Product 4 data provided in 2016

			KEW01		
	National Grid Reference		Modelled levels in mAODN		
Node	Easting	Northing	2014	2065	2100
1	520639	176008	5.24	5.77	6.02
2	520641	175963	5.23	5.77	6.02
3	520564	175979	5.23	5.77	6.02
4	520568	175953	5.23	5.77	6.02
5	520486	175926	Nil Return	5.76	6.00
6	520458	175977	Nil Return	5.76	6.00
7	520384	175940	Nil Return	5.76	6.00
8	520215	175854	Nil Return	5.29	5.63
9	520134	175828	Nil Return	5.28	5.63
10	520197	175928	Nil Return	5.29	5.63
11	520415	176058	Nil Return	Nil Return	6.02
12	520548	176060	5.23	5.77	6.02

(b) Product 4 data provided in 2017

	National Grid Reference		Modelled levels in mAODN for Max Likely Water Level	
Node	Easting	Northing	2014	2100
1	520672	175977	5.20	5.99
2	520553	175941	Nil Return	5.96
3	520416	175946	5.06	5.93
4	520293	175873	-1.00	5.80
5	520135	175829	-1.00	5.79
6	520128	175964	-1.00	5.78
7	520206	176151	-1.00	6.03
8	520306	176140	Nil Return	6.03
9	520397	176115	5.27	6.03
10	520496	175978	5.13	5.95
11	520359	175967	Nil Return	5.91
12	520198	175890	-1.00	5.79
13	520264	176090	Nil Return	Nil Return

Table 3-4 Comparison Tidal Breach Levels from successive models

Node (2016)	2100 Peak (mAOD)	Node (2017)	2100 Peak (mAOD)	Change	Comment
2	6.02	1	5.99	-0.03	Mortlake Rd: Eastern part of site
4	6.02	2	5.96	-0.06	"
6	6.00	10	5.95	-0.05	"
7	6.00	3	5.93	-0.07	"
9	5.63	5	5.79	+0.16	SW corner of Sports ground
10	5.63	12	5.79	+0.16	Sports Ground
12	6.02	9	6.03	+0.01	North end of Ship Lane

Red denotes an increase in flood levels with the most recent Product 4 data in 2017; green denotes a decrease.

Further modelling conducted by the Environment Agency assessed the flood levels and flood extents if all the linear flood defence infrastructure along the River Thames is to fail while the Thames Barrier remains operational. This is a truly extreme combination of circumstances. These model results are based on data from the TE2100 in-channel levels from 2008. The outputs of this model are shown in Figure 3-23 and Table 3-5. This shows a larger flood extent than the breach model map, particularly around the eastern area of the site next to the River Thames. However, the flood levels are similar with a maximum level of 6.03 m at nodes 11

and 12. Note that identical flood extents were provided for the two sets of Product 4 Data provided in 2016 and 2017.

Figure 3-23 Environment Agency Upstream Inundation Model Map

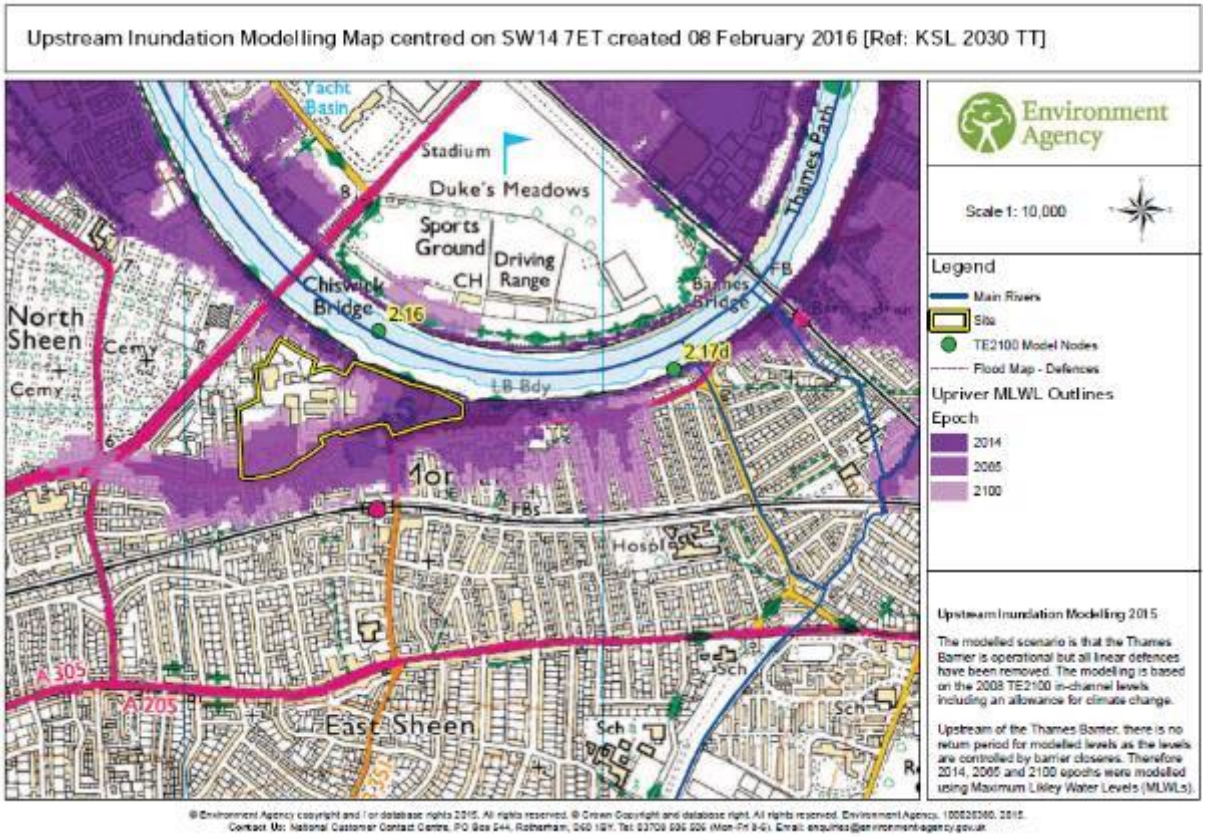


Table 3-5 Environment Agency Upstream Inundation Modelled Levels

	National Grid Reference		Modelled levels in mAODN		
Point	Easting	Northing	2014	2065	2100
1	520639	176008	5.17	5.74	6.00
2	520641	175963	5.18	5.75	6.01
3	520564	175979	5.19	5.74	6.01
4	520568	175953	5.19	5.74	6.01
5	520486	175926	5.01	5.72	5.97
6	520458	175977	Nil Return	5.72	5.97
7	520384	175940	Nil Return	5.72	5.97
8	520215	175854	Nil Return	5.33	5.63
9	520134	175828	Nil Return	5.31	5.60
10	520197	175928	Nil Return	5.33	5.63
11	520415	176058	Nil Return	Nil Return	6.03
12	520548	176060	5.23	5.78	6.03

4. Review of Development Proposals

4.1 Development Process

The location and general description of the Site has been provided in Section 2.1. In broad terms, it comprises:

- The Stag Brewery Component of the Site, being the 9.25 ha parcel of land, occupied by a mix of large scale industrial brewery structures and buildings, hardstanding and a playing field in the south west known as Watney's Sports Ground, and incorporating a section of the River Thames towpath within the north of the Site, plus sections of surrounding roads; and
- Chalkers Corner Component of the Site, being the road junction where improvements are proposed.

The boundaries of these Components are shown in Figure 4-1. This FRA is focused almost exclusively on the Stag Brewery Component of the Site, since the Chalkers Corner Component has no implications for the flood risk assessment.

The Stag Brewery Component of the Site is bisected by Ship Lane, which runs in a north-south orientation between the River Thames and the Lower Richmond Road. The section to the **east** of Ship Lane is to provide a mixed-use development including:

- residential units,
- retail use,
- community use,
- a cinema,
- gym,
- hotel,
- office space; and
- car parking.

Redevelopment of the Stag Brewery Component of the site to the **west** of Ship Lane provides residential units (including affordable housing and care home provision), car parking, and a secondary school.

The Master Plan, is shown in Figure 4-2.

Figure 4-1 Site Boundary

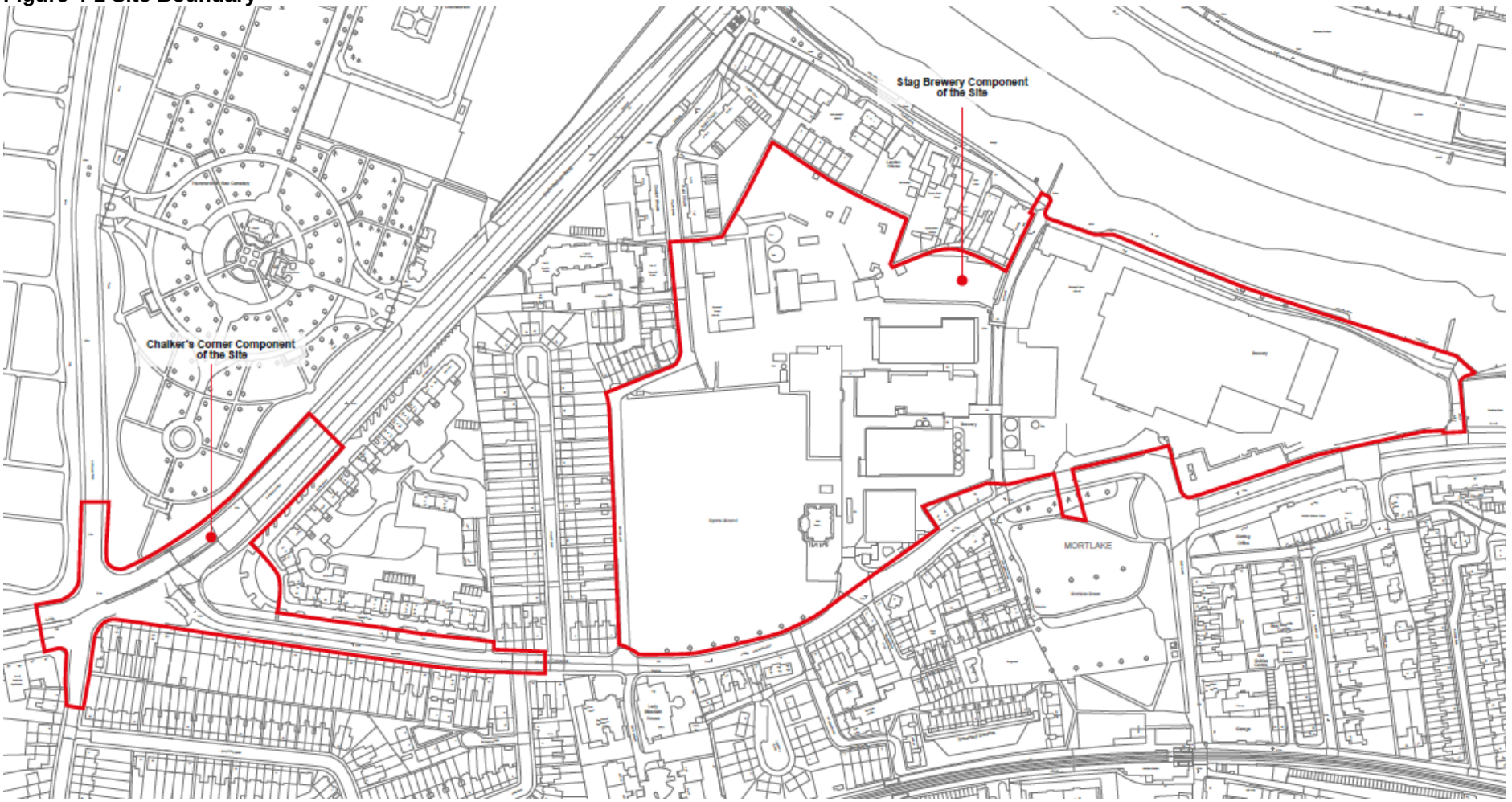
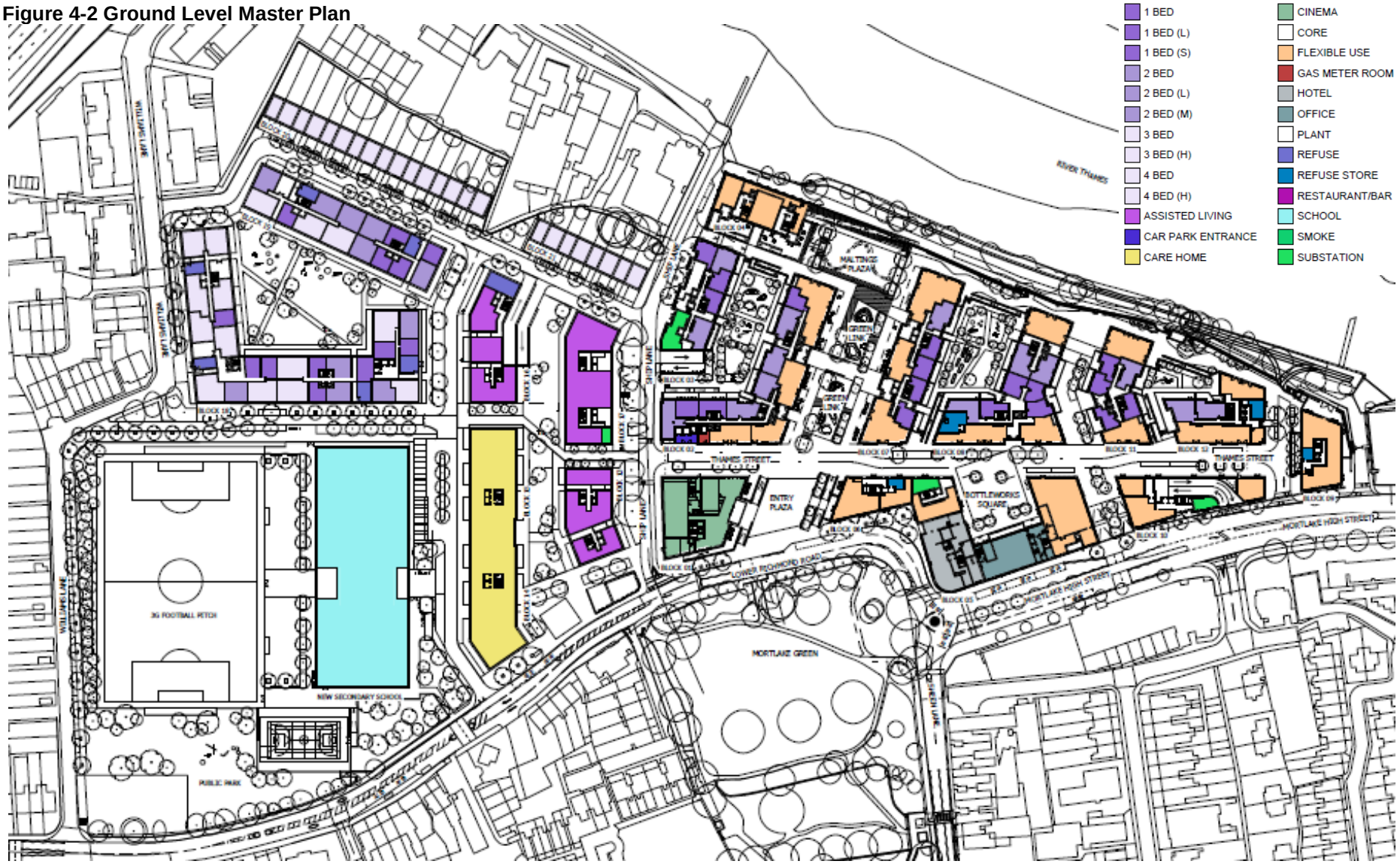


Figure 4-2 Ground Level Master Plan



Drawing C645_MP_P_00_001 by Squires & Partners, 18 January 2018

4.2 Flood Risk Management Measures

4.2.1 General

It is a requirement that any development in flood risk areas leads to a development that is safe for all users of the Site. This Section reviews the ways in which the development will be made safe from the effects of flooding.

4.2.2 Tidal Defences

The location of the existing tidal defences in shown in Figure 4-4 along with photos taken during the Site visit on 16th June 2016. For the most part, the defences comprise residual walls from buildings, the majority of which have been demolished. The major exceptions to this are where the defences are formed by the external walls of "The Maltings" and along Ship Lane. Along Ship Lane, the defences are formed for the most part by the perimeter walls of the site. Ship Lane rises away from the River, and the road surface forms part of the defence line some 50 m from the river bank (Figure 4-3).

Whilst the use of external walls of buildings is not ideal for tidal defences, this does and has provided a reasonable level of flood defence. The current condition of the defences is rated by the Environment Agency as 2 which is "good" on a scale of 1 (very good) to 5 (very poor). However, a river wall condition survey undertaken by Waterman IE in September 2016 for a 368 m stretch of the River Thames wall along the northern boundary of the Stag Brewery component of the Site found the river wall to be in a poor to fair condition (Waterman IE, 2016a). The defences are inspected twice a year by the Environment Agency. However, it is the **riparian owners' responsibility** to ensure that they are maintained to the statutory Defence Level (currently 5.94 mAOD). The towpath and river bank are under the ownership of the Port of London Authority (PLA).

The Development has provided a clear opportunity for remodelling of the tidal defences. This will improve the performance of the defences and provide benefits to the Site and surrounding area. It will also provide an opportunity for enhancement of the connection between the Site and the river, which is currently very poor. This is consistent with the pre-application response from the Environment Agency (Section C.1) "*This is a major riverside development site and an excellent opportunity to improve linkages to the River Thames and quality of the Thames Path in this area"*.

There has been extensive consultation during the development of proposals for the remodelling of the tidal wall. This included two meetings at which proposals for the defences were discussed, namely:

- With the Environment Agency on 26th September 2016;
- With PLA on 13th January 2017.

Valuable feedback was obtained at both meetings and this has informed the current proposal, the general aspects of which are shown in plan view in Figure 4-5 and sectional view in Figure 4-6. This has the following features:

- The crest level of the proposed defences is at a minimum of **6.70 mAOD**. This is the level recommended in the TE2100 Plan for 2100. It is therefore well above the current statutory level, and obviates the need for any raising to be undertaken for the foreseeable future.

- The risk of breach in this entire section of refurbished wall is effectively eliminated by the ground raising behind the defences. This provides a very robust defence, requiring only limited maintenance.
- In part, the wall, with crest at 6.13 mAOD, is topped by a 1.1 m high glass balustrade, with effective crest at 7.23 mAOD.
- The alignment is either identical to the existing alignment, or is on the "development" side. There is accordingly, no loss of flood plain storage.
- The proposal will lead to a significant improvement of the towpath; it will be more "open" (see inset images in Figure 4-4), and should provide a more pleasing aspect than is currently the case.
- The proposal provides a **minimum** 4m clear access route on the development side for any access that may be required. The actual standoff is considerably more than this as shown in Figure 4-6. Access is also available to the defences from the towpath.

The engineering detail for the walls is shown in Figure 4-7.

Part of the defences are formed by The Maltings, as they have been for many years. A survey of the Maltings wall has been undertaken by Waterman IE (*Maltings Building- Wall Assessment, Stag Brewery, August 2017*). The assessment showed the wall to have sufficient capacity to resist the increase in water level that occurs when the river rises to the 2100 flood defence levels.

A short section of the tidal defences is also formed in an informal basis by Ship Lane, as it rises away from the River Thames in a southerly direction (Figure 4-3 and upper left image in Figure 4-4).

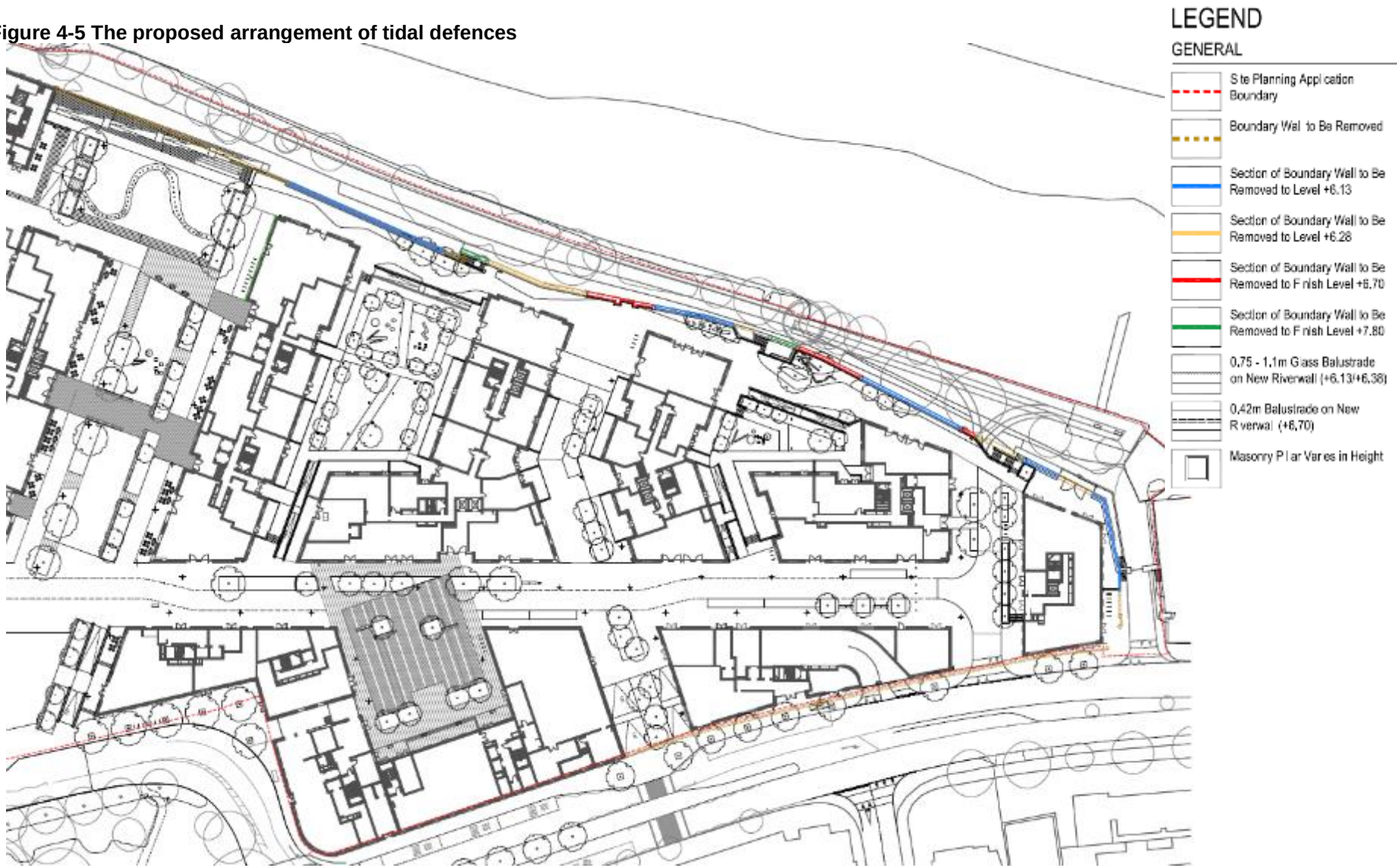
As the general crest level of defences are raised in the future, as required by the Environment Agency, it will be necessary to provide additional defences at this location. Since this is a public highway, the way in which this is to be achieved will need to be discussed with LBRuT. It is likely that this will be provided using a demountable barrier, but the precise details of location and operation will need to be established in detailed design, likely as part of a Planning Condition.

Figure 4-3 Extract from the Environment Agency's Flood Map for Planning showing tidal flood defences

https://flood-map-for-planning.service.gov.uk/summary/520505/176035

Figure 4-4 The extent of existing tidal defences

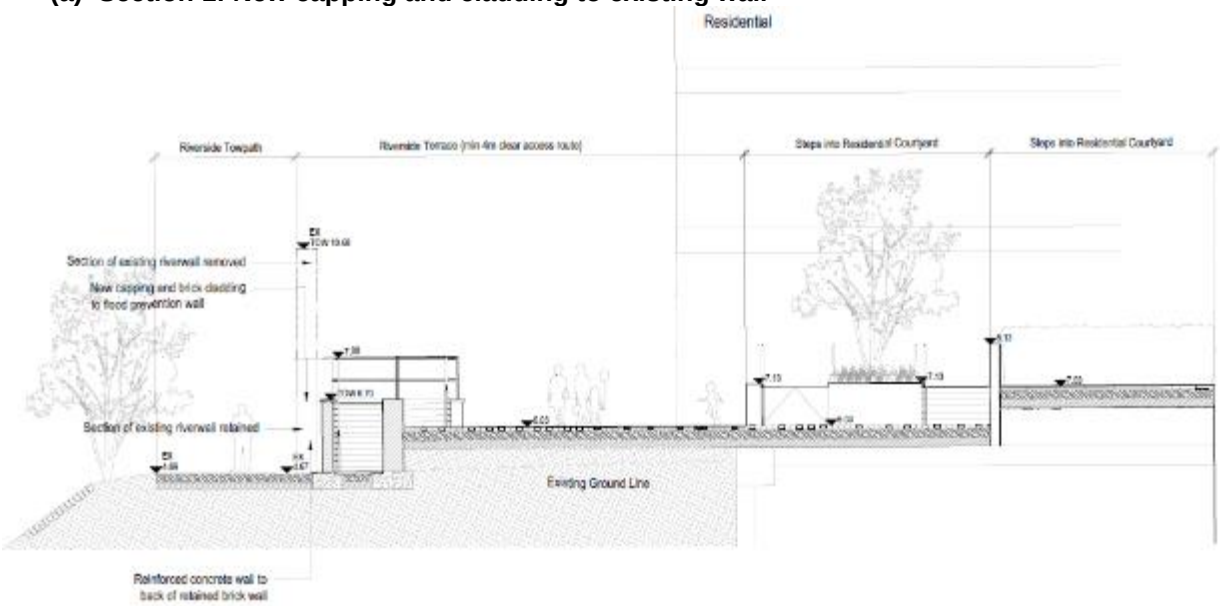
Figure 4-5 The proposed arrangement of tidal defences



Drawing by Gillespies, Ref P10736-00-001-106, Rev D08

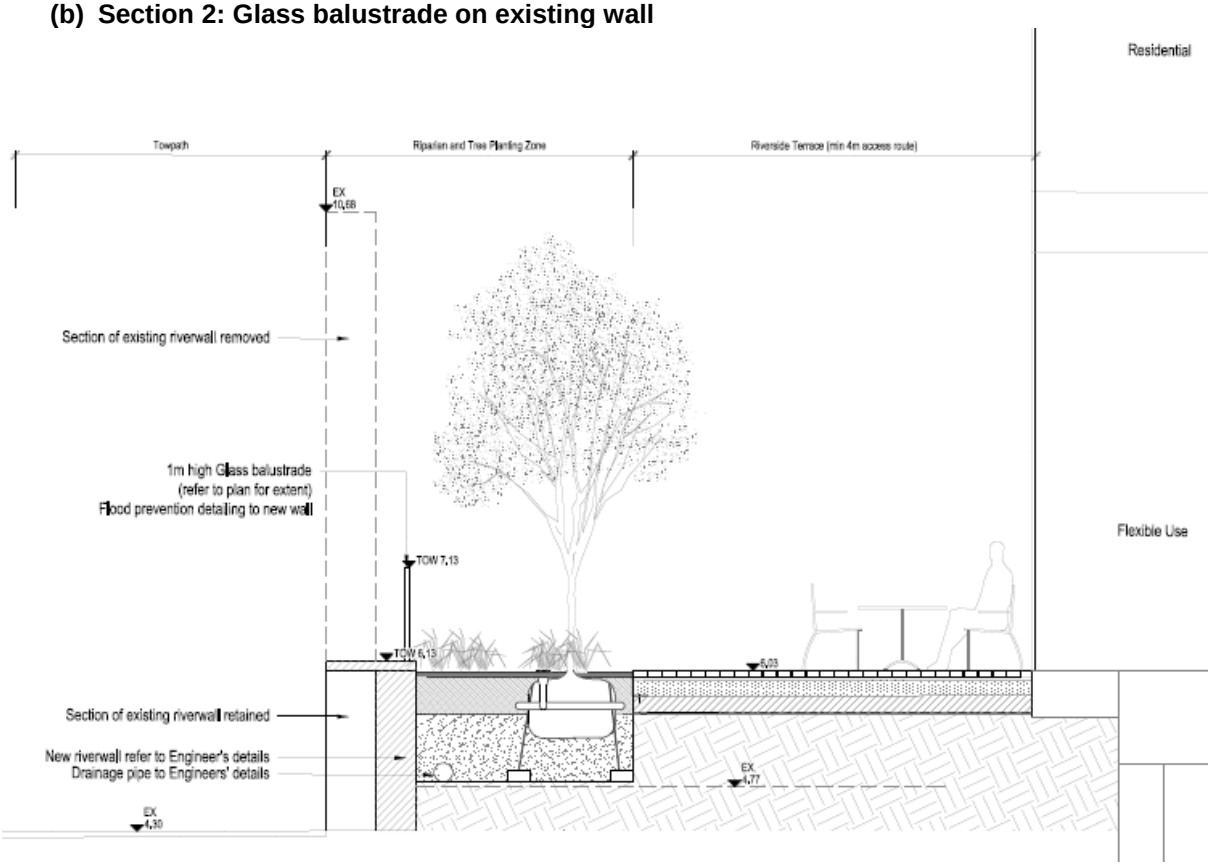
Figure 4-6 Sections of the proposed arrangement of tidal defences

(a) Section 1: New capping and cladding to existing wall



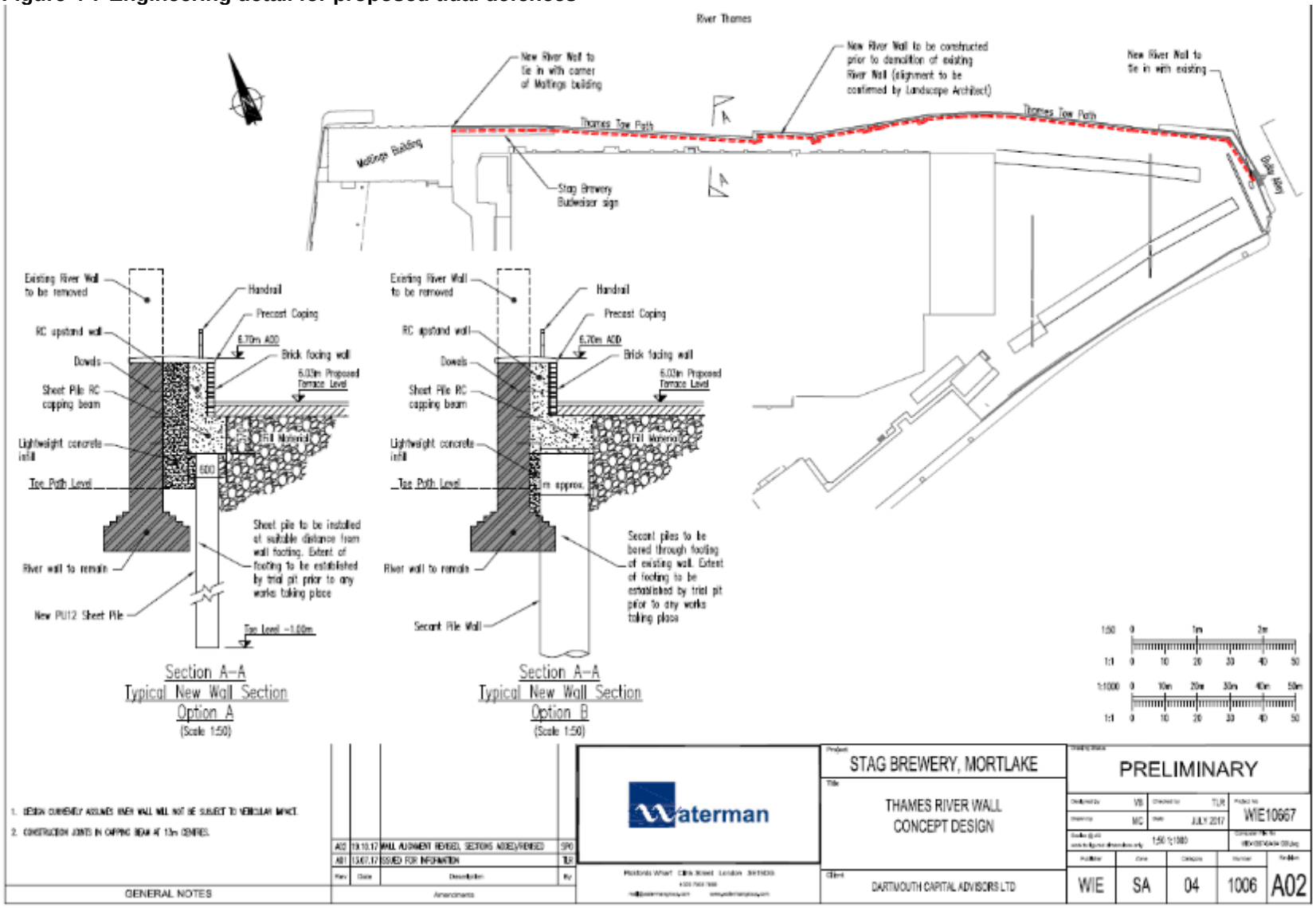
Drawing by Gillespies, Ref P10736-00-001-206

(b) Section 2: Glass balustrade on existing wall



Drawing by Gillespies, Ref P10736-00-001-207

Figure 4-7 Engineering detail for proposed tidal defences



4.2.3 Finished Floor Levels

The proposed Finished Floor Levels (FFLs) and landscaping are shown in Figure 4-8 for the Stag Brewery Component of the Site (east of Ship Lane) and in Figure 4-14 for the Stag Brewery Component of the Site (west of Ship Lane). Other than some exceptions, that are discussed later in this Section, the default **minimum ground level for the site is at 6.03 mAOD**, with the **minimum residential FFL at 7.03 mAOD**. This landscaping provides the following:

- A safe level for all residential development with a freeboard of 1 m above the reference flood level;
- A safe level for most commercial development, which will be at or above the reference flood level;
- The provision of dry access within the site with contiguous levels at, or above the reference flood level, with the sole exception of the Maltings;
- The reinforcement of defences, since virtually the entire length of tidal defence is backfilled to the reference flood level.

In summary, therefore the proposed development provides development at a safe level.

The exceptions to this general provision are described below along with relevant mitigation. The relevant buildings have been annotated on Figure 4-8.

Building B01 (Cinema) & B06 (Retail)

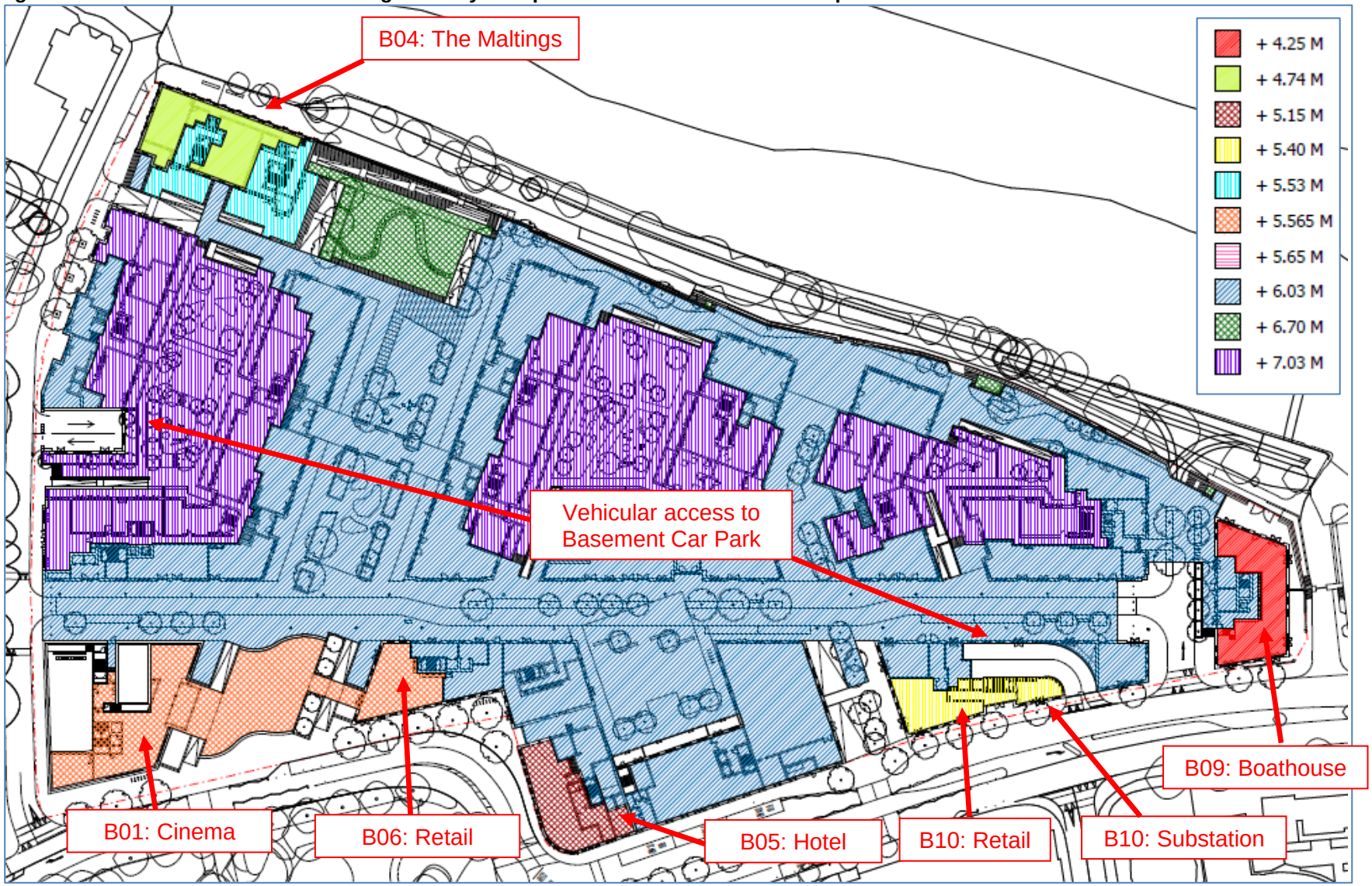
The proposed FFL for the cinema is at 5.565 mAOD, with the entrance located on the east side of the building. The FFL for the retail area is also 5.565 mAOD. Although the reference flood level for the site has been given as 6.03 mAOD, lower flood levels apply at this location, which is remoted from any potential breach. The peak level for Node 3 (Figure 3-21b) is appropriate for this location which has a 2014 peak of 5.06 mAOD and a 2100 peak of 5.93 mAOD (Table 3-3).Furthermore, since the proposed leisure use has a shorter design life, it is appropriate to use modelled flood levels for 2065. Interpolation for this date gives a reference flood level specific to this location of around 5.52 mAOD, which is lower than the FFL.

Building B04 (The Maltings)

The Maltings is an existing building, within which the FFL for the ground floor has been constrained by the historic building. The FFL for the Community Space on the ground floor is at 4.74 mAOD, well below the reference flood level. Furthermore, the exits from the residential properties on the upper floors of the Maltings is at 5.53 mAOD, also below the reference flood level (Figure 4-9). This height was set by the levels above needing to align with the existing windows. The Community use is at 4.74 m to align with the towpath and to allow for a more generous floor to ceiling than the residential entrances. The existing basement of the Maltings is in fact lower than this currently.

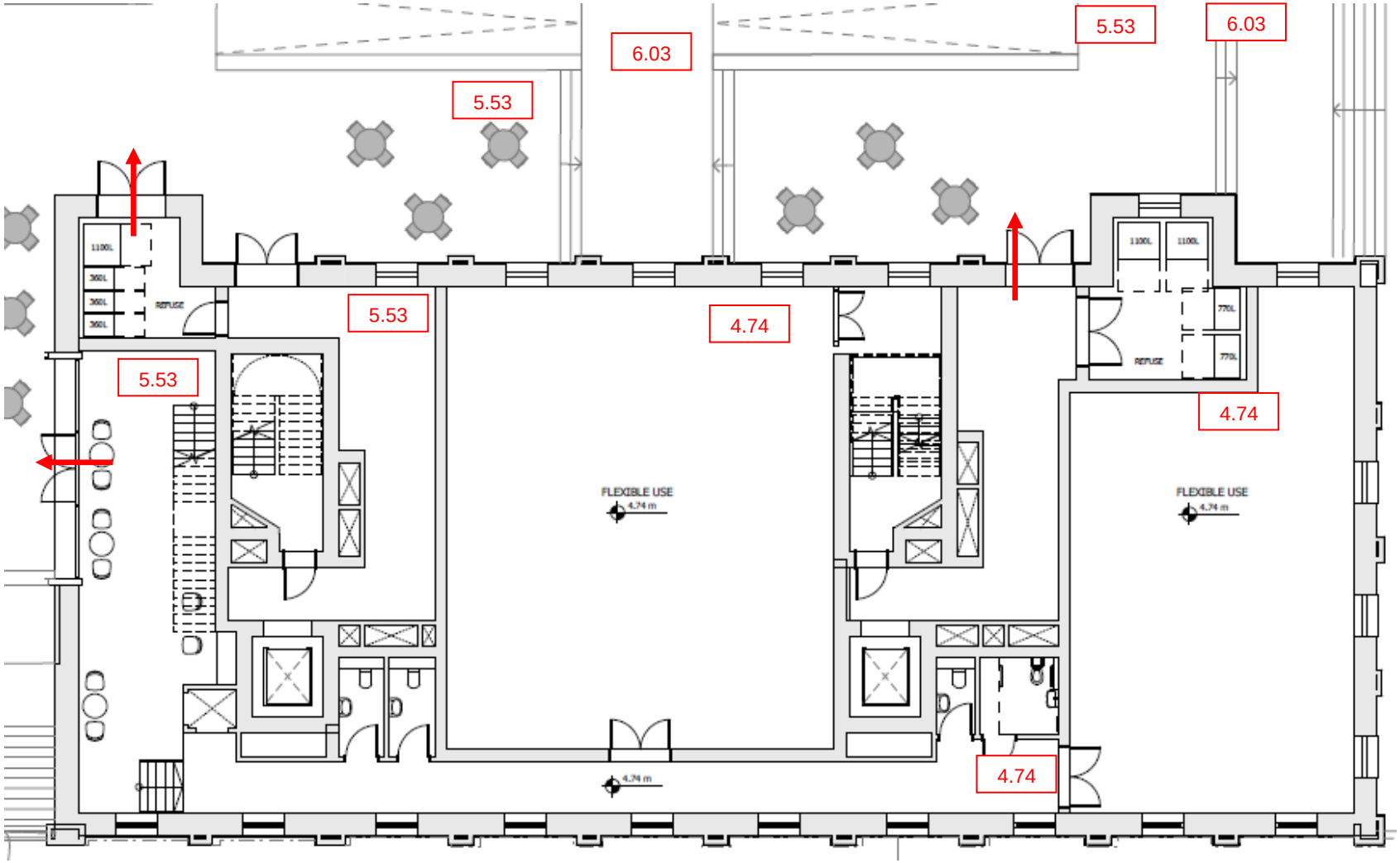
Although the ground floor of the Maltings and the courtyard to the south are technically below the reference flood level, it is difficult to see how floodwater could affect these areas. This would require a catastrophic failure of the walls of The Maltings. This appears unlikely, given the survey by Waterman IE (2017) (Section 4.2.2). There is no practical risk of a breach affecting this area, given that the relevant tidal defences are provided by landscaped areas or steps.

Figure 4-8 Ground flood FFL Plan – Stag Brewery Component of the Site – east of Ship Lane



Drawing by Squire & Partners, Ref G100_P1_P_00_003, Rev A, dated 23rd October 2017

Figure 4-9 Ground flood FFL Plan: Building B04 – The Maltings



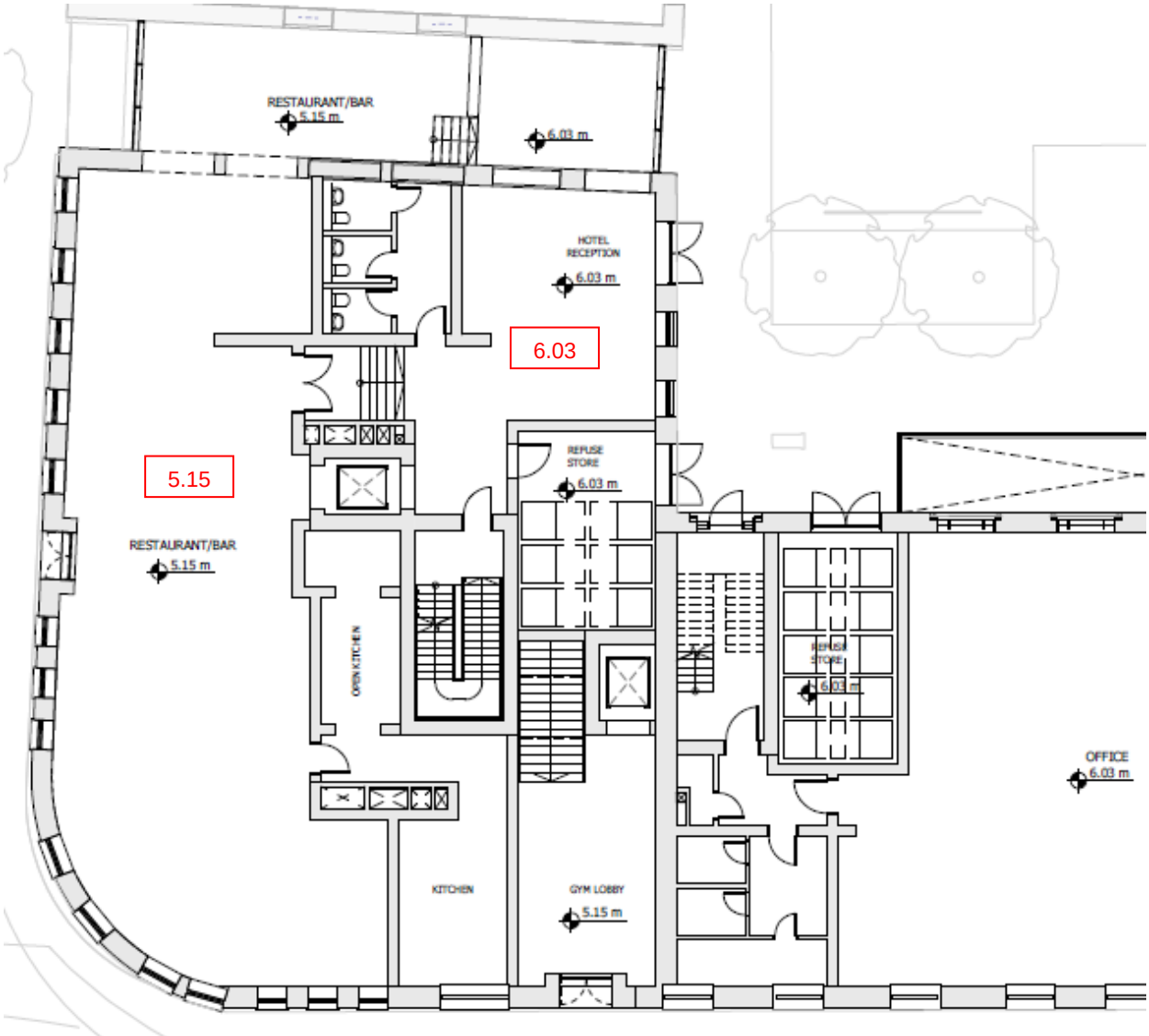
Drawing by Squire & Partners, Ref C645_B04_P_00_001, Rev E, dated 16th January 2018
Arrows show exits from the building, annotations show levels in mAOD

Notwithstanding this negligible risk of breach, safe access/egress from The Maltings to land above the reference flood level is available. This is because the maximum depth of water through which it would be necessary to wade would be 0.50 m (6.03 less 5.53 m) and it would be standing water. Strictly, this gives rise to a Hazard Rating (DEFRA & Environment Agency, 2008) of 1.25, rated as "Danger for Some" (Table G-1). However, this includes a "Debris Factor of 1. Since the risk of debris in this location is negligible, a Hazard Rating of 0.25 is more appropriate and this is classed as "Very Low Hazard – Caution".

Building B05 (Hotel lobby and bar)

The Hotel Lobby and Bar are at a level of 5.15 mAOD, slightly below the reference flood level for this location of 5.52 mAOD (i.e. the same level as for Buildings B01 and B06 described above). This very small risk has been accommodated within the proposed design. Furthermore, access is available via steps from the Hotel Lobby to reception, which is at 6.03 mAOD.

Figure 4-10 Ground flood FFL Plan: Building B05 – Hotel Lobby and Bar



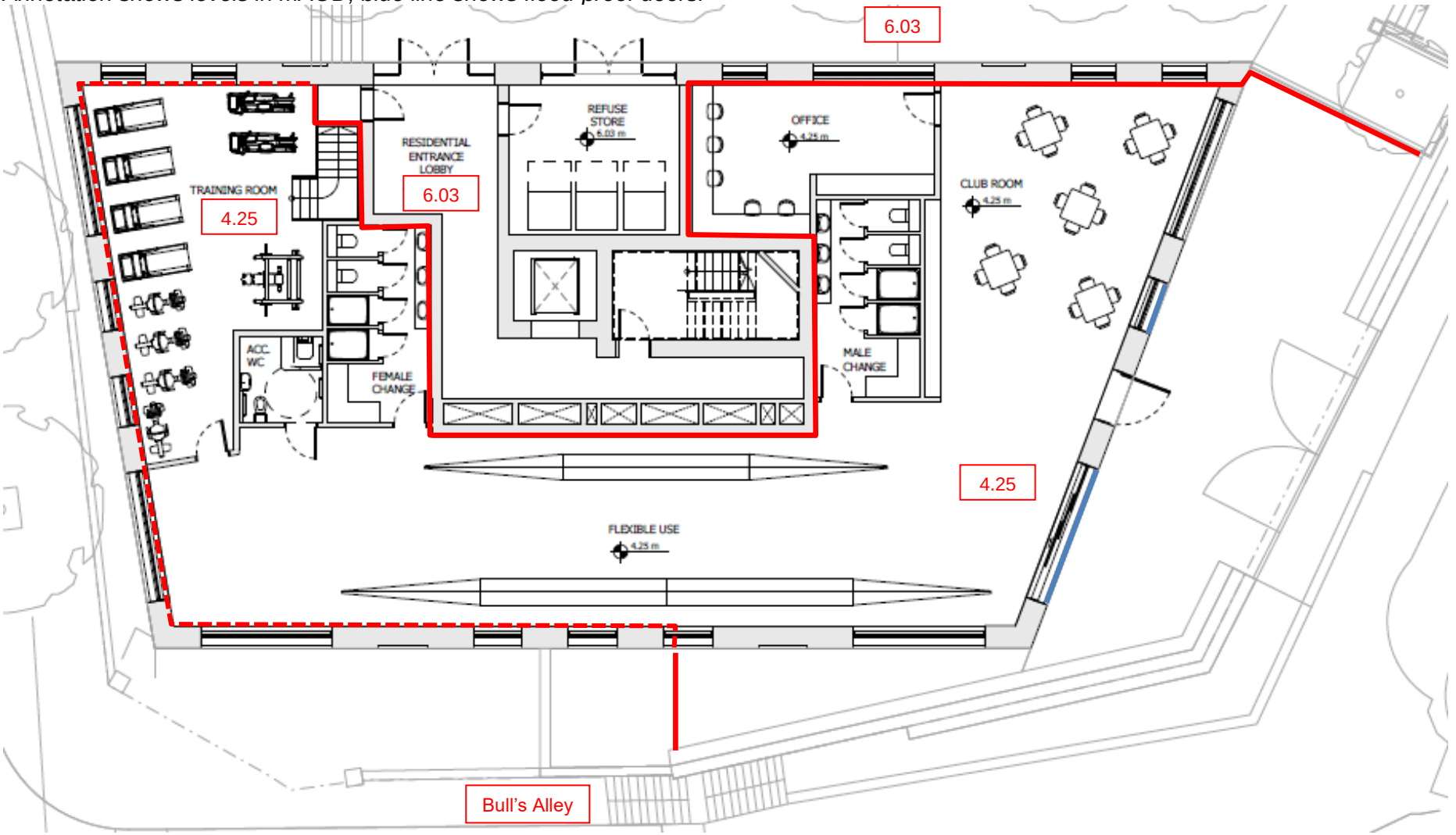
Drawing by Squire & Partners, Ref C645_B05_P_00_001, Rev B dated 17th January 2018
Annotation shows levels in mAOD

Building B09 (Boathouse)

The Boathouse is located at the eastern end of the Stag Component of the Site, adjacent to Bull's Alley. The majority of the ground floor is at 4.25 mAOD (Figure 4-11) in order to provide a facility for boat storage and access to the River. Club house facilities will also be provided at this level. Whilst the access to the river will be via "flood-proof doors", shown in blue on the Figure, it is accepted that these doors will not be sufficient to form part of the official tidal defences. The tidal defensive line is shown as a red dashed line on Figure 4-11. Where possible, it exploits the defence that is provided by the general landscaping of the site, with levels at or above 6.03 mAOD. This is shown as a solid red line on the Figure. However, where external ground levels fall below 6.03 mAOD, the defensive line follows the building wall – denoted by a dashed red line on the Figure.

Figure 4-11 Ground flood FFL Plan: Building B09 - Boathouse

Drawing by Squire & Partners, Ref C645_B09_P_00_001, dated 16th January 2018.
Annotation shows levels in mAOD; blue line shows flood-proof doors.



For the larger opening (boat access), there is a choice between flood-proof doors or a demountable barrier that can be made at a detailed design stage.

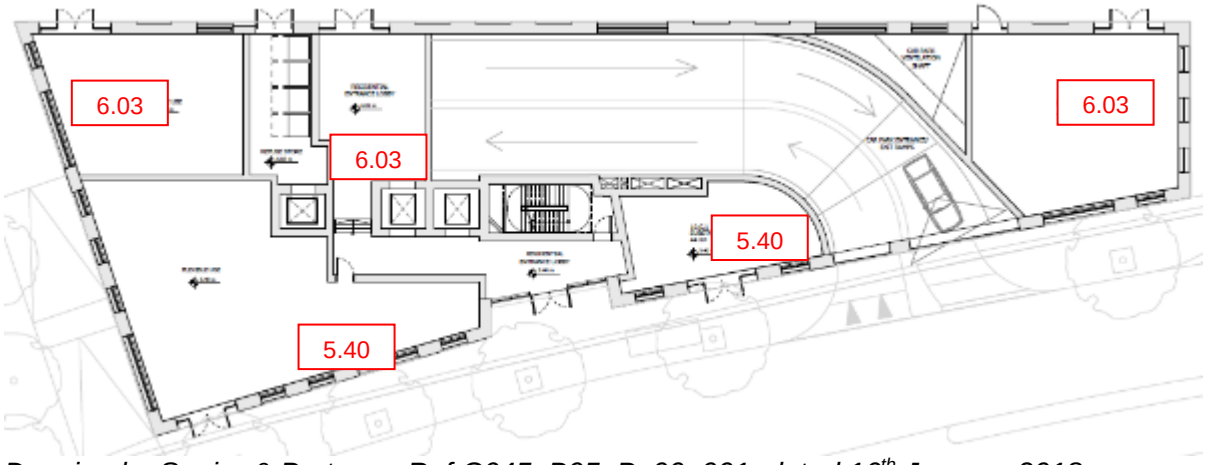
Provision will be needed at some stage in the future to ensure that the defences are at a sufficient height to cope with the TE2100 levels for 2100 of 6.70 mAOD (Table 3-2). For the most part, this will not require any further works. The one exception is at the steps from the Training Room to the Residential exit at 6.03 mAOD. Provision has been made for additional steps at this location to ensure the integrity of the defences for TE2100 levels.

Building B10 (Retail & substation)

Building 10 features some retail space along the southern elevation with FFL at 5.40 mAOD. This is lower than the reference flood level for this location. The low risk of residual flooding has been acknowledged in the design. There is access via steps to levels at 6.03 mAOD at the rear of the unit.

This building also features the sub-station, whose FFL is also at 5.40 mAOD, a facility that will need to be protected from residual risk of flooding. There will be a single point of access to the facility via a secure, flood proof door. A suitable design is available from Flood Control International (http://www.floodcontrolinternational.com/index.php) and shown in Figure 4-13.

Figure 4-12 Ground flood FFL Plan: Building B10 – Retail and sub-station

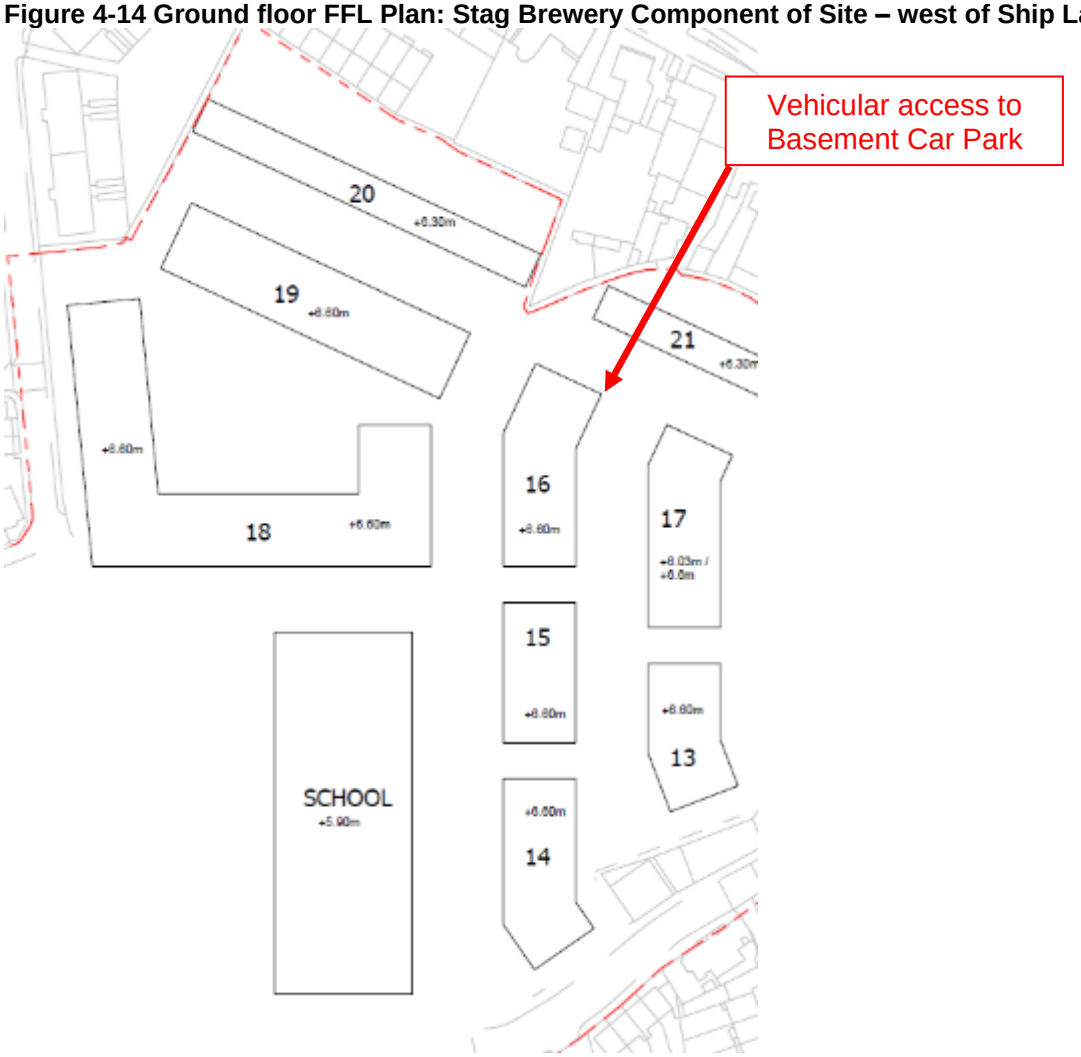


Drawing by Squire & Partners, Ref C645_B05_P_00_001, dated 16th January 2018
Annotation shows levels in mAOD

Figure 4-13 Examples of flood proof doors, suitable for sub-station facility

http://www.floodcontrolinternational.com/PRODUCTS/FLOOD-DOORS/secure-flood-doors.html

Figure 4-14 Ground floor FFL Plan: Stag Brewery Component of Site – west of Ship Lane



Drawing by Squires & Partners, Proposed Building Levels- Ground Floor

4.2.4 Basement Car Parks

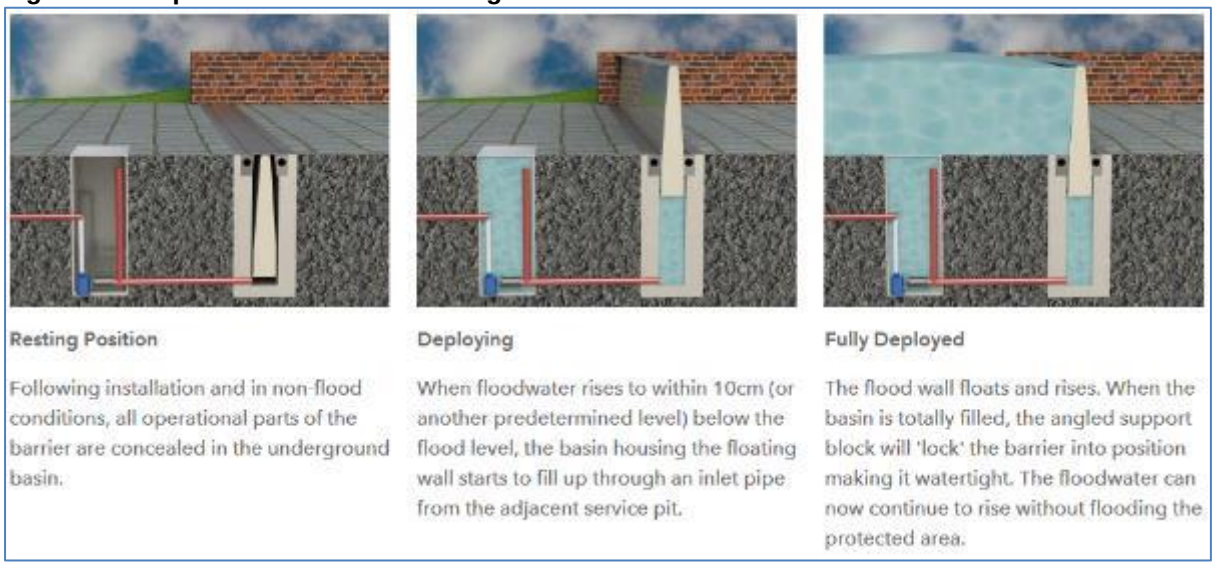
There are basement car parks under the buildings in Stag Brewery Component of the Site. The two vehicular entrances to the car park for the section **east** of Ship Lane are shown in Figure 4-8; these are from Ship Lane and from Mortlake High Street. The entrance from Ship Lane is at an elevation of around 6.1 mAOD. This is above the reference flood level for 2100 and no additional protection is required.

The entrance from Mortlake High Street is at an elevation of around 5.3 mAOD and is below the reference flood level. There is accordingly a small residual risk from any breach in the vicinity of Bull's Alley. It is proposed to install a self-activating flood barrier (SAFB) across this entrance. This is a passive system that is activated by water levels in a float chamber.

The vehicular entrance to the site (immediately to the east of the entrance to the basement car park) will be permanently manned, with the duty official located in Building B09 (Boathouse). They would be alerted to rising water levels in the float chamber via a warning system. The warning system would alert drivers to the imminent deployment of the SAFB.

Whilst the primary purpose of the SAFB would be to mitigate the residual risk due to breach, it would also be effective in preventing surface water runoff on Mortlake High Street from entering the basement car park.

Figure 4-15 Operation of Self Activating Flood Barrier



http://www.ukfbinternational.com/safb

The entrance to the car park for the Stag Brewery Component of the site **west** of Ship Lane is shown in Figure 4-14. It is within the site and is at an elevation of 6.3 mAOD, which is above the reference flood level.

The basement car park will be equipped with a drainage system for removal of any rainfall on the ramps along with that brought into the basement on vehicles.

4.2.5 Access/Egress arrangements

It is a fundamental requirement of the NPPF that any developments in flood risk areas should provide “safe” and preferably “dry” pedestrian access/egress during reference flood conditions. The reference flood in this case would be the TE2100 design water levels, for which no specific probability is assigned.

Whilst the proposed development is located in a tidal flood zone, the land raising and setting of finished floor levels within the site mean that the entire site is at a safe level. This means that even in the event of overtopping of defences or a breach, the TE2100 levels would not encroach on the residential accommodation, all of which is set at a minimum of 7.03 mAOD, well above the reference flood level. The principal streets have been set at a minimum level of 6.03 mAOD in the Stag Brewery Component of the Site east of Ship Lane (Figure 4-8) and 6.30 mAOD in the section west of Ship Lane Figure 4-14). Given this level of protection, residents should have no need for emergency egress from the site due to flood conditions. Indeed, it may well be the case that the elevated nature of the site provides a safe refuge for residents of low-lying neighbouring properties that would be at a greater risk from flooding.

However, in line with the pre-application response from LBRuT, a Flood Emergency Plan (FEP) has been prepared (Appendix G). The Plan identifies a safe route from the site to land that is wholly outside Flood Zone 3.

4.2.6 Groundwater flooding

It was noted in Section 3.3.2 that groundwater levels varied across the site from around 1.7 mAOD in the centre of the site (around Ship Lane) to around 1.35 mAOD on the western edge of the site. Levels for the eastern part of the site were difficult to obtain due to the nature of the ground. Occasional perched levels were also observed at different locations across the site as highlighted in Section 3.3.2.

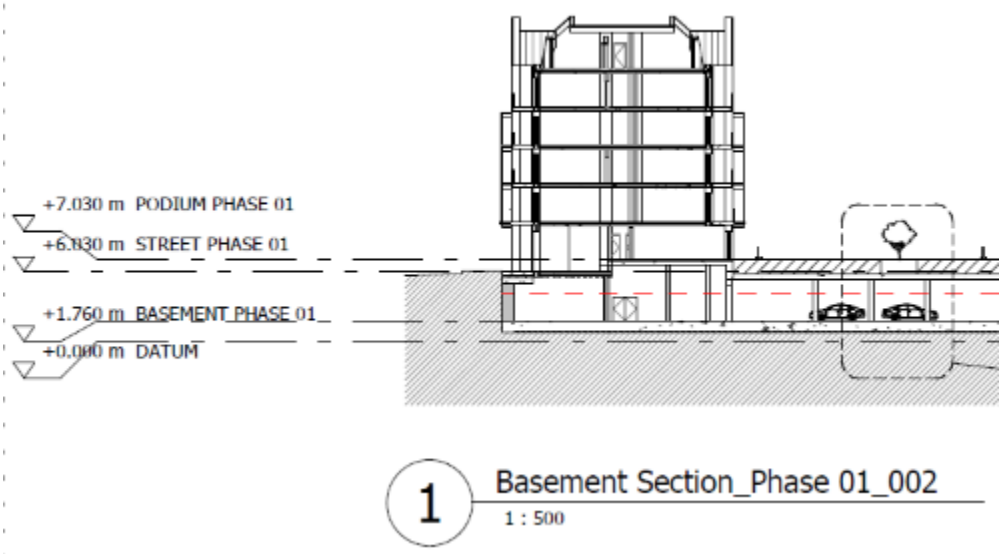
As described in Section 4.1, the proposed development will incorporate a basement car park. The proposed level of the base of the slab under the car park is shown in Figure 4-16 and Figure 4-17 for the Stag Brewery Component of the Site east and west of Ship Lane respectively. The nominal slab thickness is 1.0 m, though lower thicknesses may be viable in detailed design.

For the Stag Brewery component of the Site east of Ship Lane, the underside of the slab is shown as 0.76 mAOD. This is around 1.25 m below the typical groundwater level of 2 mAOD. Whilst locally, some higher levels have been observed up to 3 mAOD, these are believed to be perched water tables that reflect local interventions. Whilst this encroachment does not pose any groundwater flood risk, either on-site or off-site, they will need to be taken account of in design and construction of the basement. Preliminary estimates of groundwater flows associated with high transmissivity gravels (MacDonald et al., 1999) and the naturally occurring groundwaters of the underlying minor aquifer range from 0.1 to 0.5 m^3/s under wet weather conditions.

Therefore, permanent control of groundwater flows by drainage methods and temporary control of groundwater seepage during excavations (foundation dewatering) should be features of the design mitigation measures for the proposed basement car park.

For the section west of Ship Lane, the underside of the slab varies from around 1.45 mAOD to 3.1 mAOD under buildings as shown. All proposed buildings in the Stag Brewery component of the site west of Ship Lane will be above the observed groundwater levels of September 2015 and no mitigation will be required.

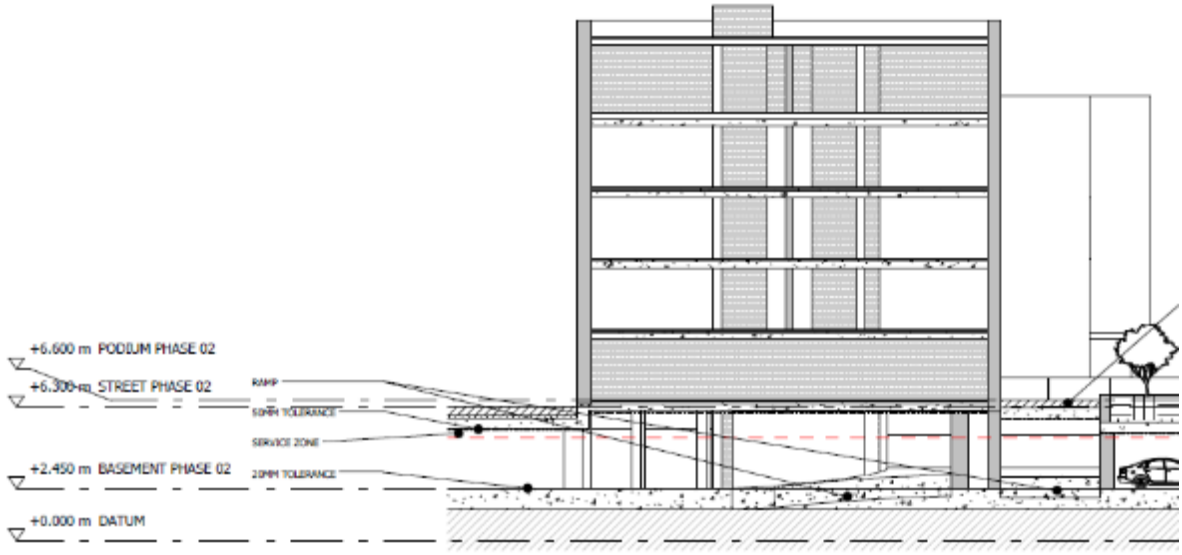
Figure 4-16 Proposed Basement levels: East of Ship Lane



Drawing by Squires, Reference G100_P1_S_002 (indicative drawing)

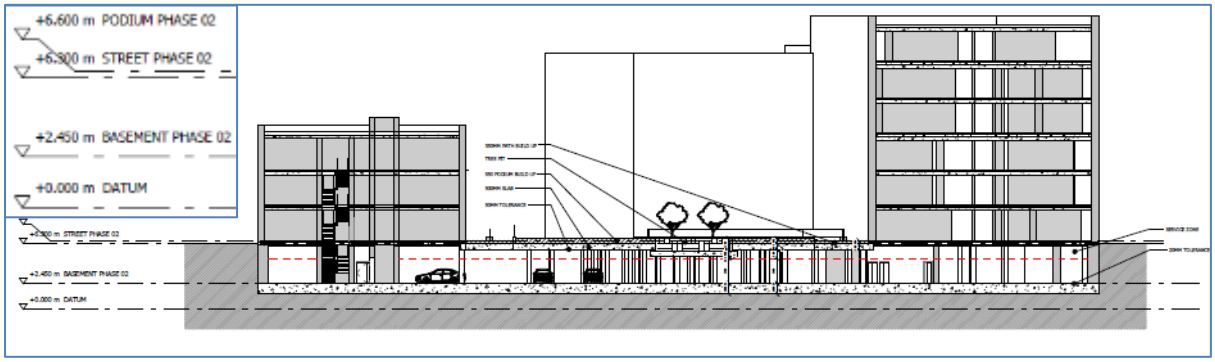
Figure 4-17 Proposed Basement levels: West of Ship Lane

a) Section 01 (Buildings 16 & 17)



Drawing by Squires, Reference G100_P2_S_001 (indicative drawing)

b) Section 02 (Buildings 18 & 19)



Drawing by Squires, Reference G100_P2_S_002 (indicative drawing)

4.3 Off Site Impacts

4.3.1 General

It is a fundamental principle of the NPPF that there should be no adverse impact of any development on others. This Section reviews the possible impacts of the development on adjacent properties and offers mitigation where this is required.

4.3.2 Flood Plain storage

The Environment Agency was consulted in 2016 as to whether any flood storage compensation would be required for this proposed development. The response is provided in Appendix C.1 and which states that *"We can confirm that as the site is only at risk of tidal flooding flood storage compensation will not be required."*

4.3.3 Drainage Strategy

The Drainage Strategy has been undertaken by Waterman IE. This is described in a report (Reference *WIE10667-101-R-9-5-1-DS*) that will be submitted under separate cover. A summary of the Drainage Strategy is provided in this Section.

Surface water runoff from the northeast of the site would discharge by gravity to the River Thames (adjacent to the northern boundary of the Site) via three outfalls. As the River Thames is tidal at this location, direct discharge to the river would be unrestricted. Surface water runoff from the remainder of the site would discharge via gravity to the Thames Water sewer network in the surrounding highways, at 50% of the existing rate (equivalent to a peak rate of 405.0 l/s). London Borough of Richmond upon Thames have confirmed that this approach is acceptable.

Based on a restriction to 405.0 l/s, approximately 2,655 m^3 of attenuation storage would be required. This has been calculated using a WinDes Quick Storage Estimate which includes for all storm durations and takes account of a 40% increase in rainfall intensity to account for climate change, in line with the NPPF requirements.

Appropriate treatment would be incorporated into the drainage system to ensure that the quality of water discharged is acceptable. This would be achieved through the incorporation of green roofs, and the potential inclusion of rainwater harvesting and permeable paving. If required, a biomat filtration system, downstream defender or other hard engineered solution could also be incorporated to ensure discharge is appropriately treated. The Drainage Strategy report sets out the principles of the SuDS scheme; however, the final proposed SuDS would be confirmed at the detailed design stage.

A Pre-Development enquiry has been submitted to Thames Water to ensure sufficient capacity is available in the foul and surface water sewer networks to accept the proposed flows.

The on-site drainage networks and Sustainable Drainage Systems would be privately managed and maintained for the lifetime of the Development, ensuring they remain fit for purpose and function appropriately. The management company/operator would be appointed post-planning.

The Drainage Strategy Report has confirmed that surface water runoff from the site can be managed sustainably to ensure that flood risk is not increased elsewhere. It is considered that the information provided within this report satisfies the requirements of the NPPF and the London Plan.

4.3.4 Breach of Tidal Defences

The breach modelling that has been undertaken by the Environment Agency is described in Section 3.5. Further modelling has been undertaken as part of this FRA to establish the impact that the proposed development may have on flood extents resulting from breach analysis. The work is described in Appendix D and the main findings are as follows:

i. The risk of breach would be substantially reduced following the proposed development due to the significant upgrading of defences along the river frontage.
ii. Following the completion of the development, the breach as modelled by the Environment Agency (with an arbitrary breach width of 20 m), could not occur due to the land raising behind the defences. The most likely location for a breach would therefore be at the stop-logs in Bull's Alley. At this point, the maximum width of breach is reduced to 6 m.

iii. The risk of a breach at this location is considered very small since the location is routinely inspected.
iv. Model runs have been undertaken to compare the flood extents resulting from a breach at Bull's Alley with those from Environment Agency modelling. These show a general reduction in flood levels and extents throughout the affected area. Whilst there are some localised increases, these reflect the finer model grid used to model the breach at Bull's Alley for the developed case. They are accordingly, not a cause for concern.

In summary, the proposed development is considered to result in a significant reduction in residual risk. This is partly due to the greater integrity of the defences, post development, and partly due to likely lower incidence of breach at the stop-logs in Bull's Alley. The modelling undertaken as part of this FRA has shown a general reduction in flood extent and depths compared with the Environment Agency modelling.

Subsequent to the modelling described in Appendix D being undertaken, the Environment Agency has updated its own modelling, the impacts of which have been discussed in Section 3.5. It should be noted that the modelling undertaken for this FRA was "relative modelling" i.e. to only compare the results of different breach scenarios. Accordingly, there seemed little benefit in repeating this substantial modelling exercise with the more recent Environment Agency model.

4.3.5 Groundwater flooding

It was noted in Section 4.2.6 that the proposed basement car park would project into the saturated area under the Stag Brewery Component of the Site east of Ship Lane, but that the basement under the section west of Ship Lane would be above typical groundwater levels. It is important that any such projection does not lead to adverse impacts on third parties. In reviewing possible impacts, it was observed that the groundwater flow paths were to the west and south-west and away from the River Thames. It was inferred that the levels in the Thames, averaged over a tidal cycle of around 2 mAOD, were providing the "source" for the associated hydraulic gradient. Any projection of the basement into this saturated area would not lead to any increase in groundwater levels off site. A small reduction on the southern side of the development is the most likely response and this would not require any mitigation.

4.4 Residual Risks

The principal residual risks for this site are associated with design exceedance, breach of the defences and maintenance of the drainage infrastructure.

In relation to design exceedance, full reference has been made in this FRA to the extreme water levels for 2100 provided by the Environment Agency. This provides appreciable contingency in the early years of the development. This also applies to the drainage strategy which has been based on the incrementing rainfalls by 40%. Even for the design conditions, it is considered that the site is well buffered against design exceedance. The FFL for residential property is at a minimum of 7.03 mAOD, which is 1 m above the reference flood level for 2100. This provision is also helpful in relation to design exceedance of the SuDS, since there will be appreciable storage at the ground surface.

The implications of breach have been modelled as part of this FRA with the results shown in Appendix D . The landscaping of the site means that it is well protected from the impacts of any breach. Furthermore, the model results presented in Appendix D show that the peak levels for a breach following the development of the site would be lower than those predicted by Environment Agency modelling.

In relation to maintenance, the key issues requiring routine maintenance will be the components of the SuDS and flood resilience measures. The maintenance of the SUDS will be the responsibility of the management company/operator. It is likely that the routine inspection and maintenance would be contracted out and that the contractor may well provide an emergency service on a call-out basis. The flood resilience measures will comprise the SAFB at the entrance to the basement car park from Mortlake High Street (Section 4.2.4), plus flood proof doors on Building B09 - Boathouse (Section 4.2.3)

4.5 Risks During Construction

The construction activities will involve demolition of existing buildings (excluding The Maltings), construction of new buildings and associated landscaping. These will involve storage of waste materials, prior to being transferred off-site and storage of building materials and plant. Construction activity may lead to wash off of silt and pollutants to the surface drainage system. Measures for interception should be put in place to minimise this risk.

The potential for impacts to occur as a result of storage of materials will be minimised by the following measures:

- Storage compounds (for the storage of construction materials or temporary stockpiling of material from demolished buildings) will be located away from the Thames and drains;
- Drums and barrels will be stored in a designated bunded safe area within a site compound; and
- All drums and barrels will be fitted with flow control taps and will be properly labelled.

The Construction Site Manager should also be in receipt of flood warnings for the Thames from the Environment Agency.

The construction of the basement will involve excavation to below likely groundwater levels. Provision will therefore be needed for dewatering and disposal. This may require an Environmental Permit from the Environment Agency.

The proposed development will also involve improvements of the existing defences. All such work would be undertaken in conjunction with the Environment Agency to ensure necessary approvals for design and constructional sequence through Environmental Permits (formerly Flood Defence Consents). In particular, it will be necessary to ensure the integrity of the existing tidal defences throughout the period of construction. This will be achieved by the use of temporary defences to provide the required level of protection until any replacements are in place and only demolishing the existing river wall once the new river wall has been built. Should there be any requirement for tying in new defences to existing alignments, this will be undertaken at times when there is no practical risk of tidal flooding.

4.6 Climate Change

NPPF requires a consideration of the impacts of climate change on the flood risk for any proposed development. A summary of the current guidelines is provided in Appendix F .

The Environment Agency has provided peak flood levels for the River Thames up to 2100 and taking account both of climate change (through its impact mainly on sea levels) and the likely operating and maintenance strategy for the Thames Barrier. As indicated above, the drainage strategy has used rainfall estimates, incremented by 40% to account for climate change over the lifetime of the scheme.

5. Summary

This Report presents an FRA for the proposed development of the Stag Brewery in Mortlake, adjacent to the River Thames.

It has been informed by discussions with the LBRuT, The Environment Agency and Thames Water, with officials from each organisation providing valuable input, relevant data and feedback. The main findings are as follows, with cross referencing to the appropriate Section of the FRA shown in square brackets.

1. The proposed development is for a mixed development featuring residential, retail and leisure use, along with a secondary school. It is located in **flood zones 2 and 3** but behind the tidal defences [Section 3.5]. Residential use has a vulnerability classification of "More Vulnerable". It is only acceptable in flood zone 3 if both the Sequential Test and the Exception Test have been satisfied.

2. The Stag Brewery site has been commented on in the LBRuT council's Flood Risk **Sequential Test** (2016a) which states that: "This is a site for major redevelopment and regeneration as the brewery has closed, and as such, it is not appropriate / possible to accommodate the proposed uses on an alternative site in the borough at lower probability of flooding. Subject to review by the Environment Agency, the Sequential Test is deemed to have been satisfied. [Section 2.3]

3. **The Exception Test** involves two components based on the sustainability credentials of the development and an acceptable FRA. Subject to this FRA being acceptable, the Exception Test is deemed to have been passed, based on pre-application advice from LBRuT which states: "…the Council can confirm that development of this site in line with the draft Local Plan proposal site (SA23), as supported by the Flood Risk Sequential Test, will provide wider sustainability benefits because it is now a derelict site" [Section 2.3].

4. **Flood levels** at the site result from a complex interaction of predominantly tidal factors and the operation of the Thames Barrier. The Environment Agency has provided the results of detailed hydraulic modelling from the TE2100 Study. The reference flood level for the site is 6.03 mAOD for 2100 [Section 3.3 and 3.5].

5. **Other sources of flooding** have been reviewed in the FRA. The risks to the site from fluvial flooding, surface water flooding and reservoir failure are considered small. However, and as guided by the LBRuT pre-application response, the risk to the site and surrounding area from groundwater flooding has been reviewed. Hydraulic gradients fall in a westerly and south-westerly direction, confirming that the River Thames acts as a boundary. It is only in the lower, eastern part of the site where groundwater was encountered close to the surface. These elevated levels are likely to reflect the historical development of the site. [Section 3.3]

6. The site currently benefits from **tidal flood defences** along the river frontage. These are formed from the residual walls from historic buildings plus The Maltings, a building which is being retained. As part of the development, the tidal defences will be remodelled. The crest will be at, or above, the Environment Agency's recommended 2100 crest level of 6.70 mAOD, so there will be no need to increase the defences over this timescale. The risk of breach of the new defences is considered negligible, due to the landscaping of the site and backfilling on the landward side of the defences. A more open river frontage will be created in line with the aspirations of the Environment Agency. A small section of the tidal defences that are currently formed by Ship Lane

will need to be raised in the future, most likely using a demountable barrier. [Section 4.2.2].

7. **Finished floor levels for the residential development** is at a minimum level of 7.03 mAOD throughout the Site. [Section 4.2.3].

8. **Finished floor levels for non-residential use** is predominantly at a level of 6.03 mAOD i.e. the reference flood level for 2100. However, the FFL for some buildings is below the reference flood level. These have been reviewed individually to ensure that the residual risk is appreciated in the design and to ensure that there is safe access to higher levels. [Section 4.2.3].

9. **The Basement** is not for habitation, but is solely for car parking with separate car parks under the parts of the Stag Brewery Component of the Site, east and west of Ship Lane. There are two entry/exit ramps for the car park to the east of Ship Lane; that in Ship Lane will be located above the reference flood level, whilst that in Mortlake High Street will be protected by a self-activating flood barrier. [Section 4.2.4]. The single entry/exit for the car park to the west of Ship Lane will be above the reference flood level.

10. It has been confirmed by the Environment Agency that, since the area is affected by tidal flooding, there is no requirement to provide **Flood Storage Compensation.** [Section C.1 and Section 4.3.2]

11. The **surface water drainage strategy** has been prepared under separate cover by Waterman IE. Part of the site would discharge on an unrestricted basis to the River Thames. The remainder would discharge to the Thames Water sewer, via attenuation storage that would lead to a 50% reduction below the existing rate of runoff. This satisfies the requirements of the NPPF and the London Plan. [Section 4.3.3]

12. The proposed development is considered to have no significant influence on groundwater levels in the surrounding area. This follows from the hydraulic gradient being away from the River Thames [Section 4.3.5].

13. **Safe access** and egress is provided within the site, where access is available to all residential property with at, or above the reference flood level for 2100 [Section 4.2.5 and Appendix G]

14. A **Flood Emergency Plan** has been prepared in line with the LBRuT requirements and is included as Appendix G . However, this is a precautionary plan, since it is not envisaged that there would be any requirement to evacuate the site.

15. Under the conditions envisaged by the Flood Emergency Plan, the development would provide **benefits to the wider community** including the provision of emergency car parking; use of the proposed emergency access and use of the site as a refuge [Appendix F]

16. The **Residual Risks** are mainly due to the risk of breach of the tidal defences. This risk is negligible for current flood levels, but will increase in line with projected increases in tidal flood levels. **Breach modelling** has been undertaken (Appendix D and Section 4.3.4). This has shown that there is a general reduction in flood extents and depths resulting from a breach following the development of the Site. Other risks have been assessed and are considered to be negligible. [Section 4.4] A maintenance programme of key drainage infrastructure should be put in place by Site Managers to ensure that residual risks are minimised.

17. Flood risks during the **period of construction** have been assessed and, with the adoption of standard site management practice, they should be of no practical consequence. It is anticipated that the construction of the basement will require dewatering of the excavation area. [Section 4.5]

18. A **statement of flood risk** should be provided to all residents that they can provide to their Insurance Company (or other organisations).

19. In summary, the proposed development will provide residential accommodation plus related activity at a safe level. The drainage strategy has demonstrated that this will lead to a reduction in peak rates of runoff from the site. The provision of elevated living accommodation with a range of access/egress routes will provide benefits to the local residents under flood conditions, as well as a refuge in times of extreme flooding. The proposed development is considered to be in accordance with the NPPF, LBRuT guidelines and the London Plan.

6. References

Author	Date	Title/Description
AECOM	July 2015a	Stag Brewery: Phase 1 Environmental Site Assessment. For AB InBev UK Ltd
AECOM	Sept 2015b	Stag Brewery: Phase 2 Environmental Site Assessment. For AB InBev UK Ltd
AECOM	February 2016	Stag Brewery: Groundwater Sampling Point Decommissioning Report. For AB InBev UK Ltd
Centre for Ecology and Hydrology.	2009	The Flood Estimation Handbook CD-ROM 3. Centre for Ecology & Hydrology, Wallingford, Oxon, UK.
CIRIA	2015	The SUDS Manual - CIRIA Report C753.
DCLG	Mar 2012a	National Planning Policy Framework.
DCLG	Mar 2012b	Technical Guidance to the National Planning Policy Framework.
DEFRA / Environment Agency	May 2008	Supplementary note on flood hazard ratings and thresholds for development planning and control purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1. Surendran et al.
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Institute of Hydrology	1999	Flood Estimation Handbook,
London Borough of Richmond upon Thames Council	2009	Local Development Framework Core Strategy. Available from: http://www.richmond.gov.uk/core_strategy-3.pdf [Accessed: 19/10/2016].
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London Borough of	2016a	Flood Risk Sequential Test. Available from:

Richmond upon Thames Council		http://www.richmond.gov.uk/local_plan_flood_risk_sequential_test_report.pdf [Accessed:19/10/2016].
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Marshall D.C.W. & Bayliss A.C	1994	Flood estimation for small catchments, IH Report No. 124, Institute of Hydrology, Wallingford and Hall, Hockin & Ellis
Port of London Authority	2016	Tide Tables and Port Information. Available from: https://pla.co.uk/assets/platidetablesmaster2016lr.pdf [Accessed: 24/10/2016]
Waterman IE	2016a	Condition Survey of the Thames River Wall, Stag Brewery, Mortlake, London. 2016. Report WIE10667-102-R-1-1-1-CS.
Waterman IE	2016b	Environmental Risk Assessment: Stag Brewery East Site, Mortlake, London. November 2016.
Waterman IE	2017	Maltings Building- Wall Assessment: Stag Brewery. Report WIE10667-102-R-2-1-3.
Waterman IE	2018	Stag Brewery, Mortlake: Drainage Strategy. Report WIE10667-101-R-9-5-1-DS.

Appendix A Flood Risk Assessment Template (Based on NPPF Practice Guide)[1]

This proforma has been completed in such a way as to identify the sections in the accompanying report where the relevant issues are addressed.

1 Development description and location
1a. What type of development is proposed and where will it be located? • A location plan at an appropriate scale should be provided with the FRA, or cross referenced to the main application when it is submitted.
Section 2.1
1b. What is its vulnerability classification? • Vulnerability classifications are provided in Table 2, NPPF Technical Guide
Section 2.1
1c. Is the proposed development consistent with the Local Development Documents?
1d. Please provide evidence that the Sequential Test or Exception Test has been applied in the selection of this site for this development type? • Evidence is required that the Sequential Test has been used in allocating the proposed land use proposed for the site and that reference has been made to the relevant Strategic Flood Risk Assessment (SFRA) in selecting development type and design (See paragraphs 100-104, NPPF and paragraphs 3-5, NPPF Technical Guide). Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue. • Where use of the Exception Test is required, evidence should be provided that all three elements of this test have been passed (see paragraphs 102, NPPF and paragraphs 4-5, NPPF Technical Guide). Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue.
Section 2.3
1e. *[Particularly relevant to minor developments (alterations & extensions) & changes of use]* Will your proposal increase overall the number of occupants and/or users of the building/land; or the nature or times of occupation or use, such that it may affect the degree of flood risk to these people?
2. Definition of the flood hazard
2a. What sources of flooding could affect the site? (see paragraph 2, NPPF Technical Guide). • This may include hazards such as the sea, reservoirs or canals, which are remote from the site itself, but which have the potential to affect flood risk (see Chapter 3 of the Practice Guide).
Section 3.2
2b. For each identified source, describe how flooding would occur, with reference to any historic records wherever these are available. • An appraisal of each identified source, the mechanisms that could lead to a flood occurring and the pathways that flood water would take to, and across, the site. • Inundation plans, and textural commentary, for historic flood events showing any information available on the mechanisms responsible for flooding, the depth to which the site was inundated, the velocity of the flood water, the routes taken by the flood water and the rate at which flooding occurred.
Section 3.3
2c. What are the existing surface water drainage arrangements for the site? • Details of any existing surface water management measures already in place, such as sewers and drains and their capacity.
Section 3.4
3. Probability
3a Which flood zone is the site within? • The flood zones are defined in Table 2, NPPF Technical Guide.

[1] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

Sections 2.2
3b If there is a Strategic Flood Risk Assessment covering this site, what does it show? • The planning authority can advise on the existence and status of the SFRA.
Section 2.3
3c What is the probability of the site flooding taking account of the contents of the SFRA and of any further site-specific assessment? This may need to include • a description of how any existing flood risk management measures affect the probability of a flood occurring at the site FRA Pro-forma • supporting evidence and calculations for the derivation of flood levels for events with a range of annual probability • inundation plans of, and cross sections through, the existing site showing flood extents and levels associated with events with a range of annual probability • a plan and description of any structures which may influence the probability of a flood occurring at the site. This may include bridges, pipes/ducts crossing a watercourse, culverts, screens, embankments or walls, overgrown or collapsing channels and their likelihood to choke with debris. • details of any modelling studies completed to define the exiting degree of flood risk (Ref Chapter 3 of the PG)
Section 3.5
3d What are the existing rates and volumes of run-off generated by the site? • This should generally be accompanied by calculations of run-off rates and volumes from the existing site for a range of annual probability events (see Section 21 of the NPPF Practice Guide).
Section 4.3
4. Climate change
4a How is flood risk at the site likely to be affected by climate change? • Paragraphs 11-15, of the NPPF Technical Guide provide guidance on how to assess the impacts of climate change.
Section 4.6
5. Detailed development proposals
Where appropriate, are you able to demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding, including providing details of the development layout? • Reference should be made to Table 2 of the NPPF Technical Guide. • Chapter 4 of the Practice Guide provide guidance on how the sequential approach can be used to inform the lay-out of new development sites.
Section 4.1
6. Flood risk management measures
How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime? • This should show that the flood risk management hierarchy has been followed and that flood defences are a necessary solution. This should include details of any proposed flood defences, access/egress arrangements, site drainage systems (including what consideration has been given to the use of sustainable drainage systems) and how these will be accessed, inspected, operated and maintained over the lifetime of the development. This may need to include details of any modelling work undertaken in order to derive design flood levels for the development, taking into account the presence of any new infrastructure proposed.
Section 4.2
7. Off site impacts
7a How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? This should be over the lifetime of the development taking climate change into account. The assessment may need to include: • Details of the design basis for any mitigation measures (for example trash screens, compensatory flood storage works and measures to improve flood conveyance). A description of how the design quality of these measures will be assured and of how the access, operation, inspection and maintenance issues will be managed over the lifetime of the development. • Evidence that the mitigation measures will work, generally in the form of a hydrological and hydraulic modelling report.

• An assessment of the potential impact of the development on the river, estuary or sea environment and fluvial/coastal geomorphology. A description of how any impacts will be mitigated and of the likely longer-term sustainability of the proposals.
Section 4.3
7b How will you prevent run-off from the completed development causing an impact elsewhere? • Evidence should be provided that drainage of the site will not result in an increase in the peak rate or in the volumes of run-off generated by the site prior to the development proceeding.
Section 4.3
8. Residual risks
8a What flood-related risks will remain after you have implemented the measures to protect the site from flooding? • Designing for event exceedence on site drainage systems is covered in Section 14 of the NPPF Practice Guide.
Section 4.4
8b How, and by whom, will these risks be managed over the lifetime of the development? • Reference should be made to flood warning and evacuation procedures, where appropriate, and to likely above ground flow routes should sewers or other conveyance systems become blocked or overloaded. This may need to include a description of the potential economic, social and environmental consequences of a flood event occurring which exceeds the design standard of the flood risk management infrastructure proposed and of how the design has sought to minimize these – including an appraisal of health and safety issues.
Section 4.4

Appendix B Scoping Level Flood Risk Assessment

Andrea Kitzberger
London Borough of Richmond upon Thames
Civic Centre
44 York Street
Twickenham
TW1 3BZ

22nd July 2016

Ref: K0685/ah

Dear Andrea

THE STAG BREWERY, MORTLAKE, SW14 7ET
FLOOD RISK ASSESSMENT – LEVEL 1 SCOPING REPORT

Hydro-Logic Services has been asked to prepare the FRA in support of the Planning Application for the above site. Given its profile, we considered it appropriate to submit a Scoping (Level 1) FRA in the form of our standard template and which is attached to this letter.

The site is located in the London Borough of Richmond upon Thames. The proposed Planning Application involves the redevelopment of the Stag Brewery complex from industrial buildings to mixed use, to include residential, retail and restaurant, office, school, assisted living, hotel, museum, car park and associated landscaping. This is likely to involve some land raising.

Located approximately 12 km downstream of the tidal limit of the River Thames at Teddington Lock, flood risk to the site is predominantly tidal. Risk from other sources of flooding is considered low. As the site is protected by the Thames Tidal Defences, maintained to a high standard, the chances of the site being flooded are extremely low. The Thames Estuary 2100 Plan (TE2100) would ensure the defences would not be overtopped for the lifetime of any redevelopment. However, there is a residual risk that these defences will be breached.

We would be grateful if the Scoping FRA could be reviewed by London Borough of Richmond upon Thames Council. This will enable us to respond to any concerns in our Level 2 FRA. In the Level 2 Report, we will review the revised layout in relation to the requirements of NPPF in terms of finished floor levels, flood storage, drainage, access and sustainability.

In particular, we seek response to clarify:

- that the development provides wider sustainability benefits to meet the Exception Test;
- that flood storage compensation is not required, due to the entirely tidal nature of flood risk;
- whether the proposed evacuation route is suitable.

I trust that this is clear and I look forward to hearing from you.

Yours sincerely,

Dr Paul Webster BSc, MSc, PhD, DIC, C.WEM, MCIWEM
Head of Flood Management

Enc.

THE STAG BREWERY, MORTLAKE, DEVELOPMENT
SCOPING FLOOD RISK ASSESSMENT FOR PRE-APPLICATION REVIEW
(BASED ON NPPF PRACTICE GUIDANCE[2])

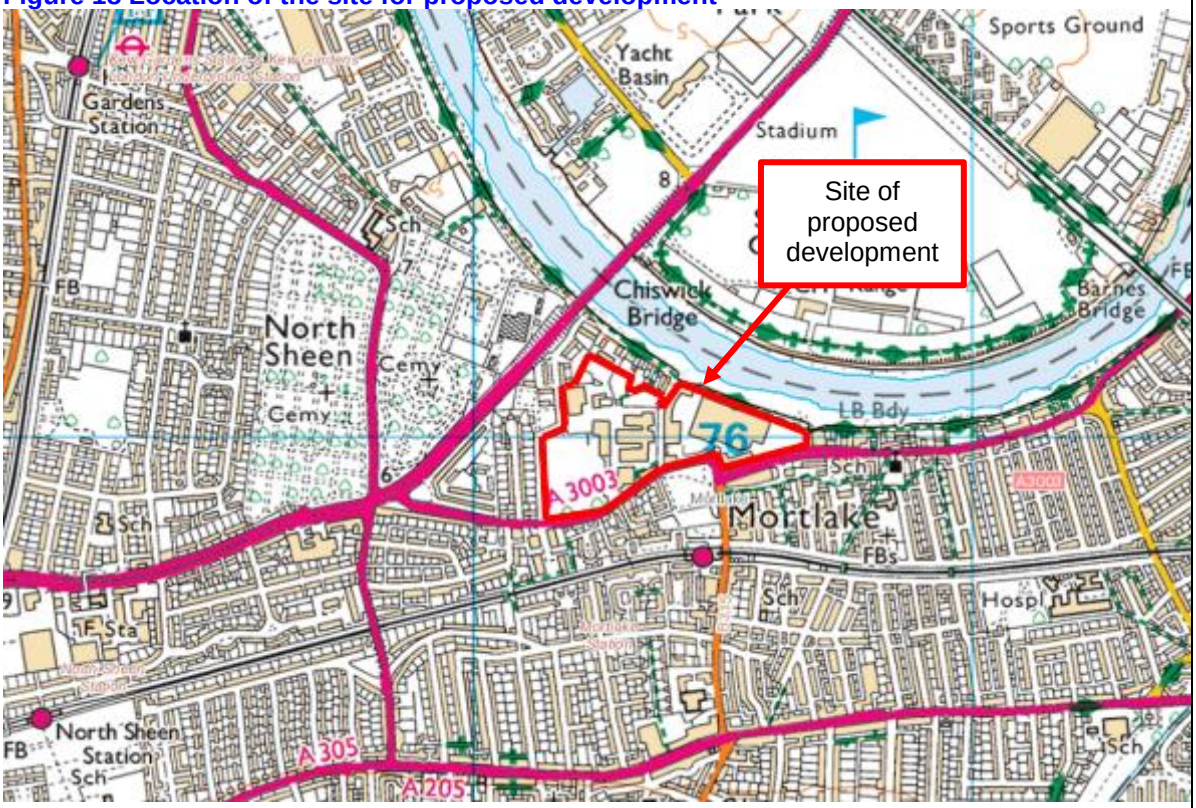
1 Development description and location

1a. What type of development is proposed and where will it be located?

- A location plan at an appropriate scale should be provided with the FRA, or cross referenced to the main application when it is submitted.

The location of the proposed development site, formerly that of the Stag Brewery, is in Mortlake, London Borough of Richmond upon Thames, (Figure 18). The area of the site is approximately 8 ha. The proposed Planning Application involves the redevelopment of the Stag Brewery complex from industrial buildings to mixed use residential and commercial. The site lies on the south bank of the River Thames, approximately 12 km downstream of the tidal limit at Teddington Lock. Vehicular access to the site is off the A3003 to the south, while there is also pedestrian access from the northwest to the A316 via a stairwell.

Figure 18 Location of the site for proposed development



1b. What is its vulnerability classification?

- Vulnerability classifications are provided in Table 2, NPPF Technical Guide

The vulnerability classification is currently 'Less Vulnerable' and will be 'More Vulnerable'.

1c. Is the proposed development consistent with the Local Development Documents?

- Where the site is allocated in an existing LDD the allocation should be referred to. Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue.

[2] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/

Formal consultation on how the development fits with the LBRuT Local Plan is in progress.

1d. Please provide evidence that the Sequential Test or Exception Test has been applied in the selection of this site for this development type?

- Evidence is required that the Sequential Test has been used in allocating the proposed land use proposed for the site and that reference has been made to the relevant Strategic Flood Risk Assessment (SFRA) in selecting development type and design (See paragraphs 100-104, NPPF and paragraphs 3-5, NPPF Technical Guide). Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue.
- Where use of the Exception Test is required, evidence should be provided that both elements of this test have been passed (see paragraphs 102, NPPF and paragraphs 4-5, NPPF Technical Guide). Your Local Planning Authority planning officer should be able to provide site-specific guidance on this issue.

The sequential test is required to review if there are equivalent sites in Borough, currently available, at a lower risk of flooding. The Stag Brewery Supplementary Planning Document (LBRuT, 2011) sets out the planning brief for potential development at the site.

The site passes the Sequential Test as carried out by LBRuT, as there are no alternative sites for the proposed use in the borough (LBRuT, 2016).

There are two requirements for the Exception Test, namely that the development supports wider sustainability benefit to the community and that it can be safely developed without increasing flood risk elsewhere. The development is on previously developed land, though sustainability benefits are yet to be fully demonstrated. The issue of flood risk will be addressed by the detailed FRA to be prepared in due course.

1e. *[Particularly relevant to minor developments (alterations & extensions) & changes of use]* Will your proposal increase overall the number of occupants and/or users of the building/land; or the nature or times of occupation or use, such that it may affect the degree of flood risk to these people?

The change of use will increase the number of occupants.

2. Definition of the flood hazard

2a. What sources of flooding could affect the site? (see paragraph 2, NPPF Technical Guide).

- This may include hazards such as the sea, reservoirs or canals, which are remote from the site itself, but which have the potential to affect flood risk (see Section 1 of the NPPF Practice Guide).

Sources of flooding are summarised in Table 6*. The principal source of flood risk to the site is from the River Thames, which is entirely from tidal flooding, with no fluvial component. The site is in a defended area protected by flood defences, namely the Thames Tidal Defences. This comprises the embankment along the south bank of the Thames plus the Thames Barrier. Hence, the chances of the site being flooded are extremely low, especially since the defences are maintained to a high standard. Flood risk from other sources is considered low.*

Table 6 Sources of flooding which could affect the site

Key sources of flooding	***Possibility at Site***
Fluvial (Rivers)	*N/A*
Tidal	*The majority of the site is located within Flood Zone 3, with area in the north west in Flood Zone 2. Therefore, the site m be at risk of flooding from the tidal River Thames. However, t site is protected by the Thames Tidal Defences, which provic a Standard of Protection up to the 1 in 1000 year flood even the year 2070. Hence the risk of tidal flooding is very low.*
Groundwater	*No record in the SFRA (LBRuT, 2008).*
Sewers	*No record in the SFRA (LBRuT, 2008), or identified consultation with the EA and LBRuT.*
Surface water	*Parts of the site are at low risk of surface water flood according to the Environment Agency surface water flood ma with an area to the southwest of the site at medium risk.*
Infrastructure failure	*There is a residual risk that the Thames Tidal Defences will breached.*

Based on NPPF Practice Guide

2b. For each identified source, describe how flooding would occur, with reference to any historic records wherever these are available.

- An appraisal of each identified source, the mechanisms that could lead to a flood occurring and the pathways that flood water would take to, and across, the site.
- Inundation plans, and textural commentary, for historic flood events showing any information available on the mechanisms responsible for flooding, the depth to which the site was inundated, the velocity of the flood water, the routes taken by the flood water and the rate at which flooding occurred.

Despite the site being defended from tidal flooding, an extreme storm surge could breach or overtop the flood defences.

Breach modelling, undertaken by the EA, shows that some parts of the site could be affected if the defences were to fail (Figure 19). Model nodes are shown in Figure 20, with the predicted levels at each node summarised in Table 7. It can be seen that the future breached flood level at the site could reach 6.03 mAOD by 2100.

Figure 19 EA Modelled Tidal Breach Flood Extents

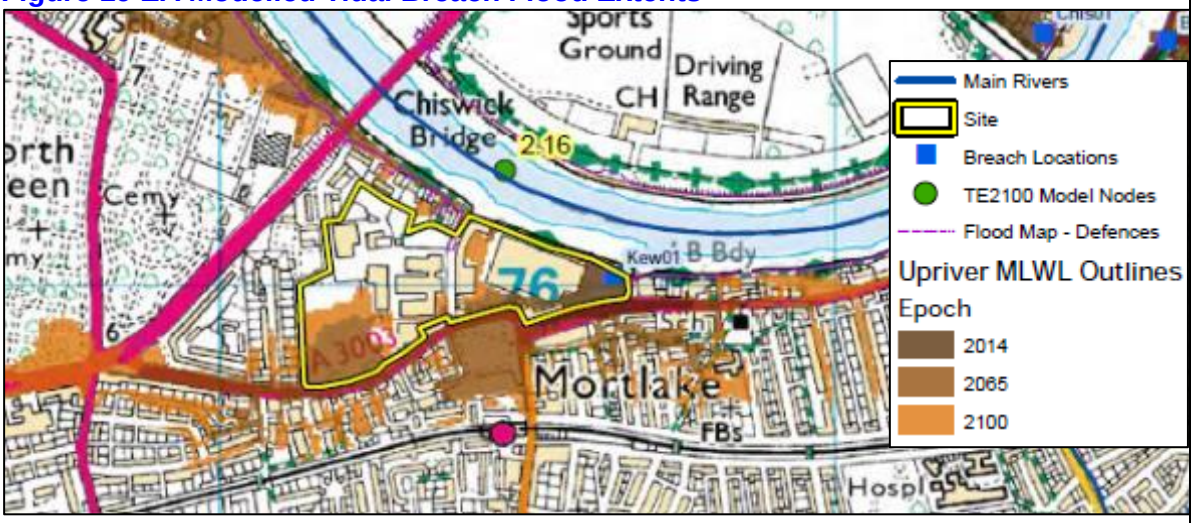


Figure 20 EA Tidal Breach Model Nodes

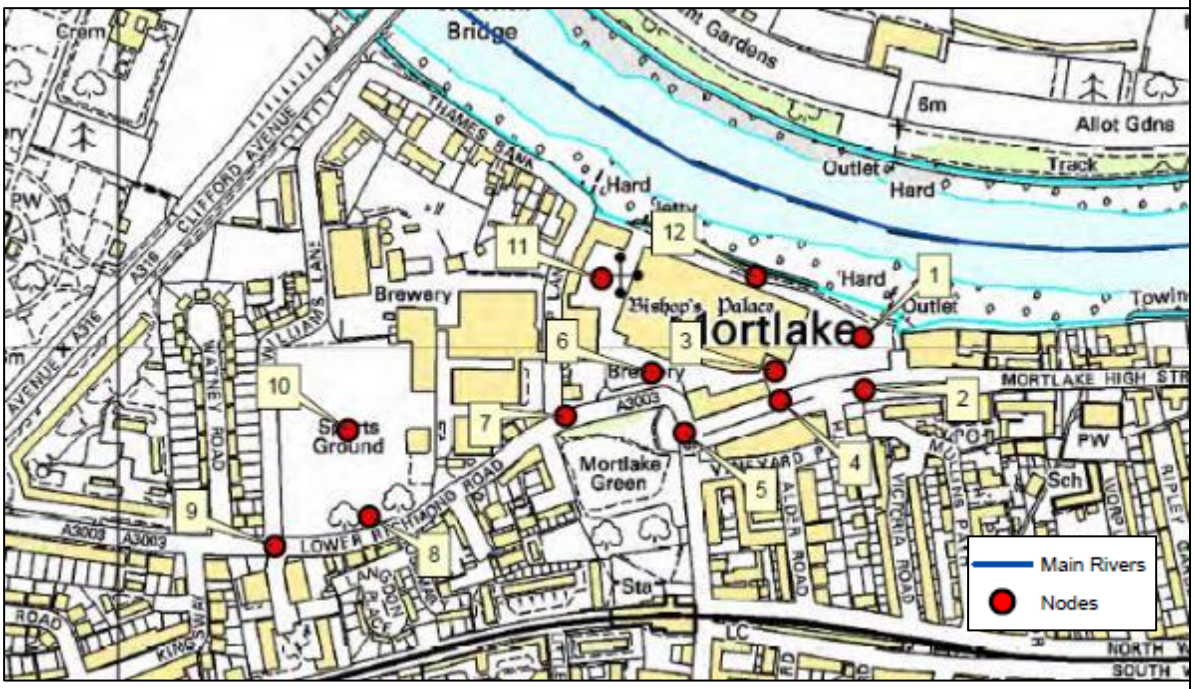
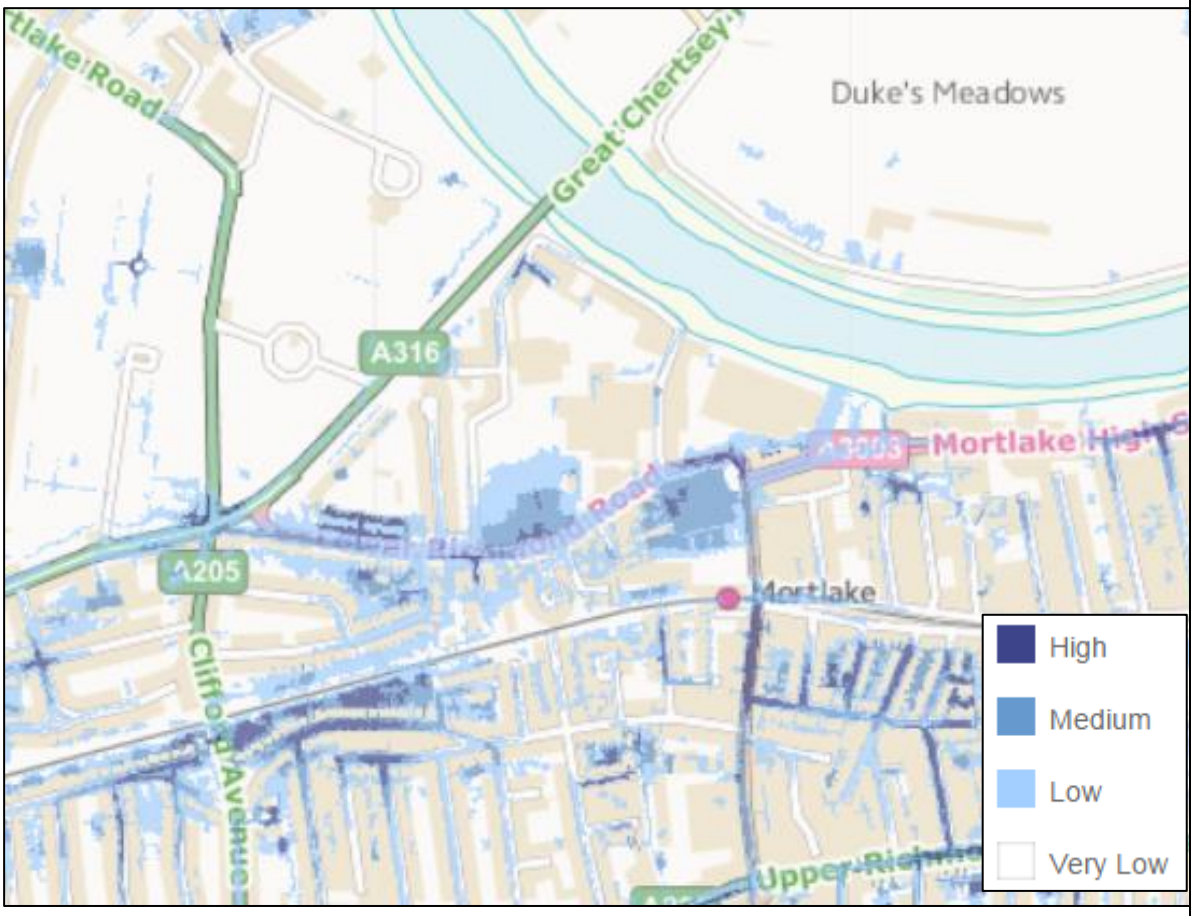


Table 7 Modelled Tidal Breach Levels for EA Model Nodes

Node	Modelled breach levels (mAOD)		
	2014	2065	2100
1	5.17	5.74	6.00
2	5.18	5.75	6.01
3	5.19	5.74	6.01
4	5.19	5.74	6.01
5	5.01	5.72	5.97
6	Nil Return	5.72	5.97
7	Nil Return	5.72	5.97
8	Nil Return	5.33	5.63
9	Nil Return	5.31	5.60
10	Nil Return	5.33	5.63
11	Nil Return	Nil Return	6.03
12	5.23	5.78	6.03

The EA's Risk of Flooding from Surface Water map (Figure 21) indicates that the majority of the site is at a 'very low' risk of surface water flooding. However, there are some areas, mostly in the south of the Site, that are shown to be at a 'low' to 'high' risk of flooding. It should be noted that this mapping is course in nature and is not appropriate for Site specific assessments.

Figure 21 EA Areas at Risk of Surface Water Flooding



2c. What are the existing surface water drainage arrangements for the site?

- Details of any existing surface water management measures already in place, such as sewers and drains and their capacity.

Existing sewers crossing the site include a 225 mm diameter foul sewer in the northwest of the site, a 686 mm diameter combined sewer along the north eastern boundary, and two foul rising mains used to discharge trade effluent from the brewery.

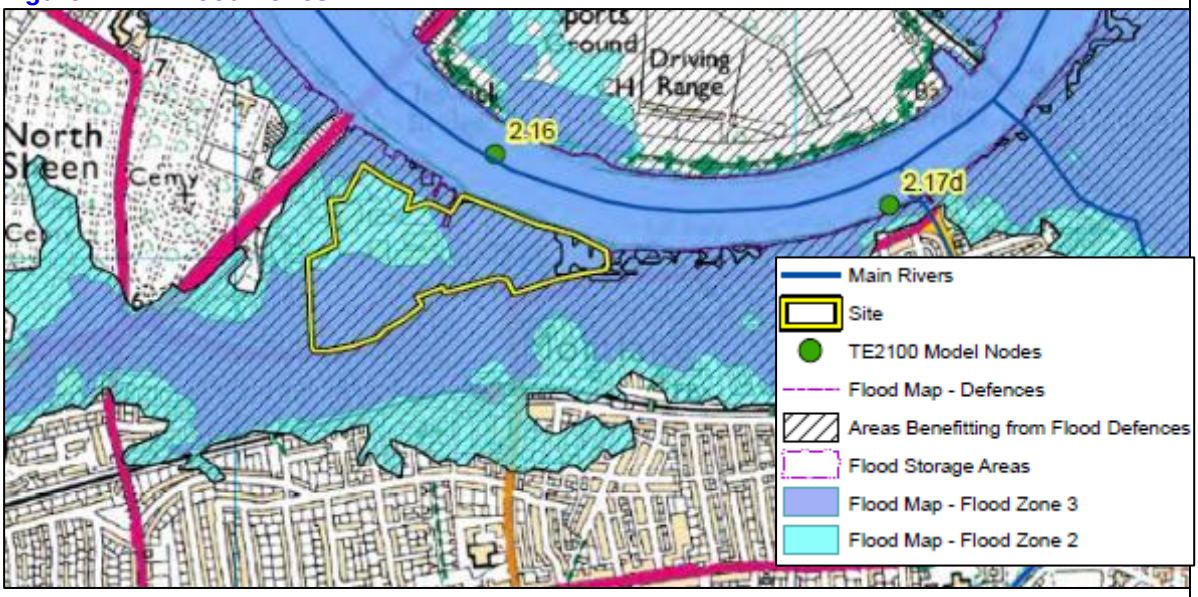
3. Probability

3a Which flood zone is the site within?

- The flood zones are defined in Table 2, NPPF Technical Guide.

The EA Flood Map for Planning shows the majority of the site is located within defended Flood Zone 3, with an area in the north west in Flood Zone 2 (Figure 22).

Figure 22 EA Flood Zones

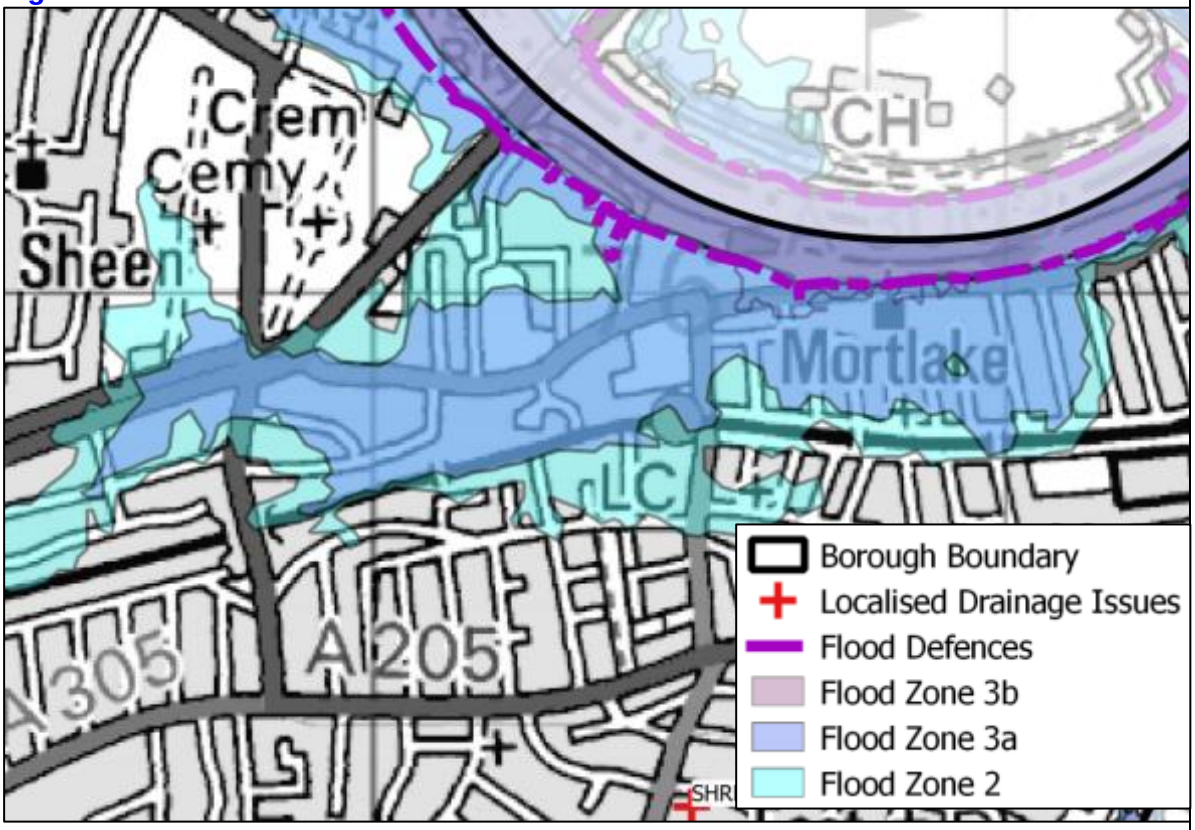


3b If there is a Strategic Flood Risk Assessment covering this site, what does it show?

- The planning authority can advise on the existence and status of the SFRA.

The SFRA confirms that the majority of site lies in Flood Zone 3, with an area in the north west in Flood Zone 2 (Figure 23).

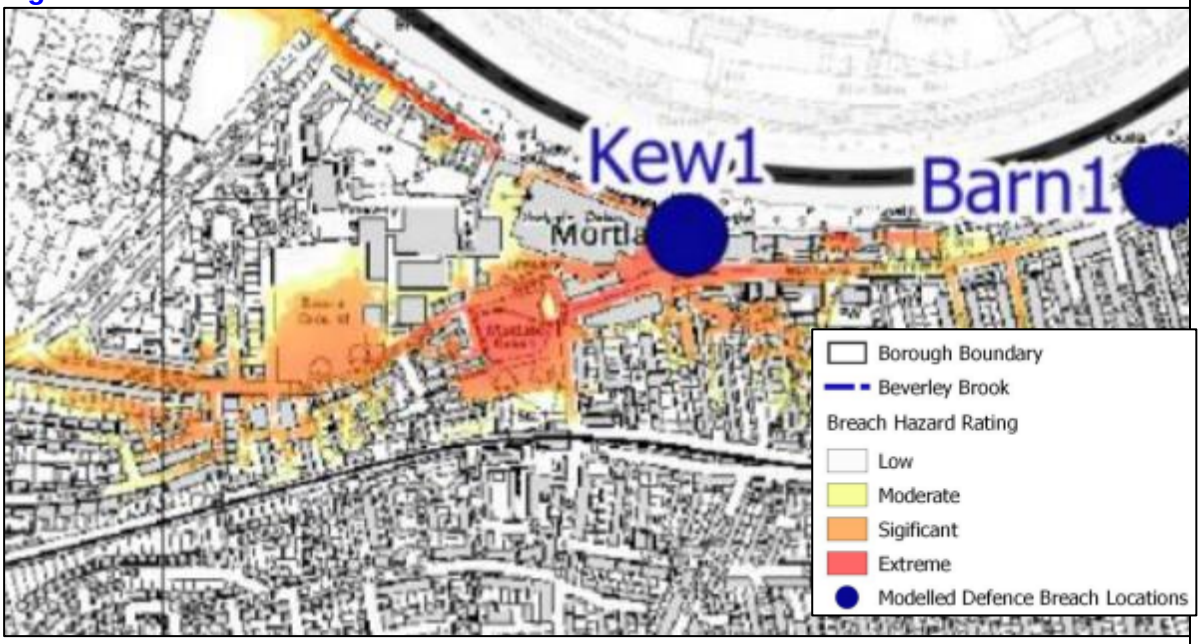
Figure 23 SFRA Flood Zones



As part of the SFRA, hydraulic modelling was carried out to consider the general velocity, depth and path of flood water should the Thames Tidal Defences fail. However, unlike the

EA breach modelling, the results do not provide detailed information of site-specific relevance in terms of these variables. Instead, flood hazard levels are provided, which show the site to encompass the range of breach hazard ratings from low to extreme. For the purposes of the FRA, the EA breach model is considered more appropriate.

Figure 24 SFRA Tidal Breach Flood Hazard



3c What is the probability of the site flooding taking account of the contents of the SFRA and of any further site-specific assessment?

This may need to include

- a description of how any existing flood risk management measures affect the probability of a flood occurring at the site FRA Pro-forma
- supporting evidence and calculations for the derivation of flood levels for events with a range of annual probability
- inundation plans of, and cross sections through, the existing site showing flood extents and levels associated with events with a range of annual probability
- a plan and description of any structures which may influence the probability of a flood occurring at the site. This may include bridges, pipes/ducts crossing a watercourse, culverts, screens, embankments or walls, overgrown or collapsing channels and their likelihood to choke with debris.
- details of any modelling studies completed to define the exiting degree of flood risk

It is considered that the probability of the site flooding is extremely low, only occurring in the event of a breach in the flood defences. In this event, and in the absence of site specific data from the SFRA, please see Section 2b for details on levels.

3d What are the existing rates and volumes of run-off generated by the site?

- This should generally be accompanied by calculations of run-off rates and volumes from the existing site for a range of annual probability events (see Section 21 of the NPPF Practice Guide).

The development concept shows a reduction in impermeable area from the existing/pre-development situation. Post-development runoff will be lower than pre-development runoff, which the FRA will quantify. Runoff rates will be compared with the SFRA target of a reduction of 50% over current levels.

4. Climate change

How is flood risk at the site likely to be affected by climate change?

- Paragraphs 11-15, of the NPPF Technical Guide provide guidance on how to assess the impacts of climate change.

Invoking the DEFRA assumptions relating to climate change will see an increase of river discharges and flood water levels. Similarly, rates of precipitation intensity are forecast to increase. Model data provided by the Environment Agency will make use of current climate change assumptions. Any drainage design work will make use of appropriate assumptions for climate change.

5. Detailed development proposals

Where appropriate, are you able to demonstrate how land uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding, including providing details of the development layout?

- Reference should be made to vulnerability classification, Table 2 of the NPPF Technical Guide.
- Section 4 of the NPPF Practice Guide provides guidance on how the sequential approach can be used to inform the lay-out of new development sites.

The proposed development is shown in Figure 25. It consists of a number of residential and commercial units, a school in the southwest of the site, and associated landscaping. The key features of the development are:

- *Remodelling of the tidal defences to improve appearance and visual impact*
- *Residential units*
- *Retail and restaurant outlets*
- *A school with the existing playing field retained*
- *A hotel*
- *A museum in the old boat house*
- *Offices*
- *A cinema and gym*
- *Assisted living*
- *Car parking*

The development concept is still being refined and will be reviewed in detail in the full FRA.

In preparing the full FRA, due consideration will be taken of:

- *Some raising of ground in the lowest part of the site (eastern boundary),*
- *The location of the existing tidal defences and the requirements for Environmental Permitting for work within 16 m of the defences. We note, for example, the extent of the defences along Ship Lane,*
- *A surface water management plan following SuDS principles (see Section 7b)*
- *Safe access and egress to and from the site (see Section 8).*

Figure 25 Proposed Development Layout

6. Flood risk management measures

How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?

- This should show that the flood risk management hierarchy has been followed and that flood defences are a necessary solution. This should include details of any proposed flood defences, access/egress arrangements, site drainage systems (including what consideration has been given to the use of sustainable drainage systems) and how these will be accessed, inspected, operated and maintained over the lifetime of the development. This may need to include details of any modelling work undertaken in order to derive design flood levels for the development, taking into account the presence of any new infrastructure proposed.

Although the development contains areas of raised land, it is anticipated there will be no requirement for flood storage compensation. This is due to the entirely tidal nature of the flood risk.

The site can be protected from flooding by setting floor levels and access/egress at appropriate level. The finished floor level will need to be at the 2100 design flood level plus a freeboard. With a freeboard of about 300 mm (0.3 m), the likely finished floor level is 6.33 mAOD.

The Thames Estuary 2100 Plan (TE2100) (EA, 2012), would seek to ensure that the defences are not overtopped for the lifetime of any redevelopment on the Site.

Modelled flood levels and associated statutory defence levels for the River Thames adjacent to the Site, both for the present day and in the future, are summarised in Table 8. The present day extreme water level in the River Thames is 5.23m AOD, rising to 6.03m AOD when the impacts of climate change up to the year 2100 are taken into account. The site will be protected up to the 1 in 1000 year standard until 2100 by the River Thames defences.

Table 8 TE2100 In-channel Design Flood Levels and Defence Levels (mAOD)

EA Flood Modelling Node	Present Day		2065 to 2100		2100	
	Design Flood Level	Defence Level	Design Flood Level	Defence Level	Design Flood Level	Defence Level
2.16	*5.23*	*5.94*	*5.59*	*6.25*	*6.03*	*6.70*

7. Off site impacts

7a How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?

This should be over the lifetime of the development taking climate change into account. The assessment may need to include:

- Details of the design basis for any mitigation measures (for example trash screens, compensatory flood storage works and measures to improve flood conveyance). A description of how the design quality of these measures will be assured and of how the access, operation, inspection and maintenance issues will be managed over the lifetime of the development.
- Evidence that the mitigation measures will work, generally in the form of a hydrological and hydraulic modelling report.
- An assessment of the potential impact of the development on the river, estuary or sea environment and fluvial/coastal geomorphology. A description of how any impacts will be mitigated and of the likely longer-term sustainability of the proposals.

There should be no requirement for flood storage compensation, as the flood risk is entirely tidal in origin. No hydraulic modelling work is deemed to be necessary in support of this FRA.

7b How will you prevent run-off from the completed development causing an impact elsewhere?

- Evidence should be provided that drainage of the site will not result in an increase in the peak rate or in the volumes of run-off generated by the site prior to the development proceeding.

A number of options will be reviewed in the FRA, following a SuDS train.

The preferred drainage solution would be to discharge surface water runoff to the ground. However, the ground conditions and likelihood of high groundwater due to the adjacent River Thames may preclude the use of infiltration techniques.

Another option would be to discharge surface water runoff directly to the River Thames. As the River Thames is tidal, surface water runoff could discharge to it unrestricted, with no formal attenuation required. Design would need to consider tide locking at the outfall.

The least preferred option would be to discharge to a Thames Water surface water sewer, ultimately connecting to the River Thames.

8. Residual risks

8a What flood-related risks will remain after you have implemented the measures to protect the site from flooding?

- Guidance on residual risks is provided in Section 14 of the NPPF Practice Guide.

There is a residual risk that the Thames Tidal Defences will be breached.

The FRA will review the following (from PPS25 Practice Guide #7.8):

1. *Flood resilience and resistance.*
2. *Flood warning and evacuation.*
3. *Sustainable drainage for extreme events.*

8b How, and by whom, will these risks be managed over the lifetime of the development?

- Reference should be made to flood warning and evacuation procedures, where appropriate, and to likely above ground flow routes should sewers or other conveyance systems become blocked or overloaded. This may need to include a description of the potential economic, social and environmental consequences of a flood event occurring which exceeds the design standard of the flood risk management infrastructure proposed and of how the design has sought to minimize these – including an appraisal of health and safety issues.

The proposed emergency evacuation route, in the event of an extreme event and breach in the defences is shown in Figure 26. This takes account of the flood hazard to the A3003.

Figure 26 Proposed Evacuation Route

The FRA will consider the following for residual risk (PPS Practice Guide #7.10):

1. *Depth of flooding on access/egress routes.*
2. *Speed of flow on access/egress routes.*
3. *Local flow paths*
4. *Speed of onset of flooding*
5. *Distance from defences*
6. *Duration of flood.*

References

Author	Date	Title/Description
Centre for Ecology and Hydrology.	2009	The Flood Estimation Handbook CD-ROM 3. Centre for Ecology & Hydrology, Wallingford, Oxon, UK.
CIRIA	2007	The SUDS Manual - CIRIA Report C697.
DCLG	Mar 2012(a)	National Planning Policy Framework.
DCLG	Mar 2012(b)	Technical Guidance to the National Planning Policy Framework.
DCLG		NPPF Practice Guide, Flood Risk. Available from: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
DEFRA / Environment Agency	2013	Rainfall Runoff Management for Development Report SC030219
Environment Agency	2012	Thames Estuary 2100 Plan: Managing flood risk through London and the Thames estuary
Institute of Hydrology	1999	Flood Estimation Handbook,
London Borough of Richmond upon Thames	2008	Strategic Flood Risk Assessment (SFRA)
London Borough of Richmond upon Thames	2011	Supplementary Planning Document: Stag Brewery, Mortlake, SW14 Planning Brief
London Borough of Richmond upon Thames	2016	Flood Risk Sequential Test to Support the Local Plan Pre-Publication version
Marshall D.C.W. & Bayliss A.C	1994	Flood estimation for small catchments, IH Report No. 124, Institute of Hydrology, Wallingford and Hall, Hockin & Ellis

Appendix C Responses to Scoping Level Report

The Scoping Level Report (Appendix B) was submitted in July 2016 for pre-application review, with responses received the following month.

C.1 Environment Agency Response

creating a better place

Environment Agency

Dr Paul Webster
HydroLogic Services
18-20 West End Road
Mortimer Common
Reading
RG7 3TF

Our ref: SL/2016/116146/01-L01
Your ref: Email 25/07/2016

Date: 25 August 2016

Dear Dr Webster,

Redevelopment of the Stag brewery complex from industrial buildings to mixed use residential and commercial at the Stag Brewery site, Mortlake, SW14 7QU

Thank you for consulting the Environment Agency for pre application advice on producing a Flood Risk Assessment at this site. Its essential flood risk and climate change issues and opportunities are integrated into the overall design and layout of this site and not considered in isolation.

There are major opportunities to create an improved riverside environment and improve connections to the river in line with London Borough of Richmond local plan policies for this site and "make space for water". The key Environment Agency issues and opportunities at this site are:

- Flood risk management, flood defences and TE2100 climate change actions – the site is located in a high risk flood zone with opportunities to improve the standard and appearance of the flood defences
- Riverside enhancements and improved biodiversity – adjacent to the River Thames and opportunities exist for new tidal terracing and 16 metre buffer zone and create a more natural riverside environment. Across the Thames Estuary only around 2% of the tidal banks are natural
- High standards of sustainable design and construction including sustainable drainage and land remediation

We have provided detailed feedback in Section 1 on the Flood Risk Assessment and improving the riverside environment as part of this redevelopment. A Water Framework Directive assessment should be completed demonstrating how the development will deliver an improved water environment.

We hope our response is helpful, if you require any additional information please contact Joe Martyn at ksiplanning@environment-agency.gov.uk

Yours sincerely

James Togher
Team Leader

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Section 1 – Detailed feedback

1.1 - Flood risk management and climate change

After reviewing the level 1 FRA for the Stag Brewery redevelopment proposal, we have several comments that we would like clarification upon. We understand that some of these queries will be addressed when a more detailed FRA is submitted and are keen to continue discussing these points during the pre application process.

- As the development will occupy a significant stretch of the Thames Tidal Defences, we would expect to see the height of the existing defences raised to the TE2100 level of 6.70 metres as part of the proposed works. Similarly it would be expected that the condition of existing defences would be improved as part of this development. In some areas the current condition is deemed 'poor' by our Asset Performance team – something that would need to improve in order for us to approve a development of this stature in such close proximity to the Thames. These actions would significantly reduce flood risk to the site for the entirety of its lifetime. You should consider opportunities to introduce an improved riverside environment at this site for example new tidal terracing and improving the Thames path as part of the redevelopment. Good practice examples of tidal terracing exist along the River Thames at other regeneration sites such as Greenwich Peninsula. (see section 1.2 below for more information on improving the riverside environment, this could be integrated with a Sustainable Drainage scheme across the site).

- We would also like detailed clarification on what appears to be two boat house/wharf structures that extend out into the Thames in Figure 8 (page 10). We encourage developers to "make space for water" and not develop into the river with new structures which can be located on land. Local plan policy supports this approach and we are likely to object to any proposed "encroachment" into the river channel. Its important the redevelopment of this key riverside introduces a 16 metre buffer zones between new development and the river edge to create an improved river corridor for people and wildlife.

- It is crucial that we know the proximity of the site in relation to the existing Thames Tidal Defences. Currently the boundary wall of the brewery along the Thames forms part of the flood defence here and would therefore have to be taken into account in the proposed design. The location of works is also likely to result in the need for an environmental permit to be issued by the Environment Agency for the site since it appears works will be carried out within 16 metre of the current defences. Information regarding the new Environmental Permitting system can be found here: (https://www.gov.uk/guidance/flood-risk-activities-environmental-permits)

- Finally as part of the detailed FRA, and in order for us to approve the application, we would require high-detail design plans including all relevant finished floor levels alongside a detailed site-specific assessment of flood risk in particularly in a breach scenario. We appreciate you have taken into account the TE2100 in-channel design flood levels when setting finished floor levels and will request that these levels are a regarded as a minimum for any properties within the development. We can confirm that as the site is only at risk of tidal flooding flood storage compensation will not be required

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In addition, we recommend that you take into account the following information regarding flood resilient measures and emergency planning throughout development of this application:

Flood resistant and resilient measures:
We recommend that consideration be given to the use of flood resistant and resilient measures – such as barriers on doors, windows and access points at the ground floor level and routing electrical services from a higher level downwards so that plug sockets are located above possible flood levels – within the proposed development, in order to reduce the impact of flooding. We further recommend consultation with the local building control department when determining whether particular flood resistant and resilient measures are appropriate and effective.

Please refer to the following resources for further guidance on flood resistant and resilient measures:
Department for Communities and Local Government (DCLG) – formerly Office for the Deputy Prime Minister (ODPM) – document 'Preparing for floods: Interim guidance for improving the flood resistance of domestic and small business properties';
Department for Communities and Local Government (DCLG) document 'Improving the flood performance of new buildings: flood resilient construction'.

Evacuation Plan
The Environment Agency does not typically comment on, or approve the adequacy of, flood emergency response procedures accompanying development proposals, because we do not carry out such roles during a flood event. Our involvement with the proposed development during an emergency will be limited to delivering flood warnings to occupants or users covered by our 'FloodLine' service.

The applicant should take advice from the emergency services when producing an emergency response plan (or evacuation plan) for the proposed development as part of the FRA, as stated in the Planning Practice Guidance[1].

We advise local planning authorities to formally consider the emergency planning and rescue implications of development proposals when making their decisions, particularly in any circumstances where warning and emergency response are fundamental to managing flood risk.

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[1] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/making-development-safe-from-flood-risk/what-are-the-important-considerations-for-flood-warning-and-evacuation-plans/

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1.2 - Improving the riverside environment and linkages to the River Thames

This is a major riverside development site and an excellent opportunity to improve linkages to the River Thames and quality of the Thames Path in this area. If the old brewery is being demolished this creates opportunities to set the new buildings 16 metres back from the river edge, create tidal terracing or tidal inlets at this location and upgrade the Thames Path.

For more information on tidal terracing and set back defences view the Estuary Edges guidance, this includes examples of good practice sites such as Greenwich Peninsula and Battersea Reach. The Estuary Edges Guidance document is a 'how to' guide on ecological design for soft natural riverbank edges to encourage wildlife on the Thames. We recommend visiting good practice sites and viewing the development from a boat in the river to see what can be achieved on riverside sites like this.
http://thamesestuarypartnership.org/our-projects/estuary-edges/

In the Thames Estuary only around 2% of the tidal banks are natural. Increasing natural riverbanks will have a significant positive ecological impact on the river and will help restore fish stocks. The development should protect and enhance the local environment and seek opportunities to deliver ecological enhancements and improve linkages to the River Thames.

We encourage developers to include a naturalised buffer zone along the river. The development should take the opportunity to naturalise and existing hard engineered river bank and set new building away from the River Thames. We seek a 16 metre buffer zone between new developments and the River Thames to "create space for water."

You will need to consider the requirements of the Water Framework Directive (WFD) which includes causing no overall deterioration in water quality or the ecological status of any waterbody. Information on WFD and the current status of water bodies can be found in the Thames River Basin Management Plan
https://www.gov.uk/government/collections/river-basin-management-plans-2015

Development close to rivers should help to deliver the objectives of the Water Framework Directive to improve riverside environments like this site. This includes applying mitigation measures (improvements to the river) identified in the river basin management plan (RBMP). This is an excellent opportunity for partnership working and funding to improve the river corridor in this area. We recommend discussing proposals for this site with local residents and river user groups such as Your Tidal Thames
http://www.thames21.org.uk/project/your-tidal-thames/

It is a requirement of WFD to deliver a significant net gain for biodiversity, and ideally this should be along the riverside, where it would deliver maximum benefits. A Water Framework Directive Assessment should be submitted with the planning application, this assessment will be expected for any extensive works within the byelaw margin.

Protection and enhancement of the River Thames is supported in the Richmond Local Plan development management policies and the Supplementary Planning Document for the Stag Brewery site http://www.richmond.gov.uk/stag_brewery_2010-2.pdf

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1.3 Sustainable design and construction

Sustainable drainage systems
The opportunities to introduce a sustainable drainage systems should be used to inform the site layout and design and included in your Flood Risk Assessment. The Environment Agency no longer comments on SuDs and you should discuss this with Richmond council as the Lead Local Flood Risk Authority. You should maximise opportunities across the site for example green roofs, walls and permeable paving / storage areas. For more information on SuDS click below:
http://www.susdrain.org/delivering-suds/using-suds/background/sustainable-drainage.html

We have produced advice with Natural England and the Forestry Commission on how new development can help improve the environment. This is in line with the national planning policy framework (NPPF).

"*the planning system should contribute to and enhance the natural and local environment*" (Para 109). https://www.gov.uk/government/publications/planning-a-guide-for-developers

Land contamination
Due to the former landuse as a brewery and industrial site there is potential for contamination at this riverside site. We recommend:

- Follow the risk management framework provided in CLR11, 'Model Procedures for the Management of Land Contamination', when dealing with land potentially affected by contamination;
- Refer to our 'Guiding Principles for Land Contamination' documents for the type of information that should be included in a Preliminary Risk Assessment (PRA;
- Refer to our 'Groundwater Protection: policy and practice (GP3)' documents
- We will require a PRA to assess if land contamination may be present at the site. This should be submitted with the planning application. The PRA needs to include information on past and current uses, if sensitive controlled waters receptors are present and if the site could pose a pollution risk. The PRA should also consider if any aspects of the proposed development could pose a pollution risk should contamination be present (i.e. deep drilling to facilitate the installation of foundation piles, site drainage). Further work such as an intrusive site investigation may be required depending on the findings of the PRA.

Please note that the view expressed in this letter by the Environment Agency is a response to a pre application enquiry only and does not represent our final view in relation to any future planning application made in relation to this site. We reserve the right to change our position in relation to any such application. You should seek your own expert advice in relation to technical matters relevant to any planning application before submission.
This opinion is based on the information submitted and current planning policy and guidance

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C.2 LBRuT Response

From: Andrea Kitzberger-Smith [mailto:Andrea.Kitzberger@richmond.gov.uk]
Sent: 28 July 2016 16:04
To: Kevin Watson KWatson@geraldeve.com
Cc: Lucy Thatcher <L.Thatcher@richmond.gov.uk>; Neil Henderson <NHenderson@geraldeve.com>; planning.se@environment-agency.gov.uk; joseph.martyn@environment-agency.gov.uk
Subject: RE: Stag Brewery - Flood Risk scoping

Hi Kevin

I've now reviewed the Level 1 Flood Risk Scoping report (Ref. K0685/ah). Below are my comments based on what has been submitted:

- Sequential Test: We have produced a Flood Risk Sequential Test report in support of the draft Local Plan: http://www.richmond.gov.uk/local_plan_flood_risk_sequential_test_report.pdf. This states in relation to Stag Brewery that *"This is a site for major redevelopment and regeneration as the brewery has closed, and as such, it is not appropriate / possible to accommodate the proposed uses on an alternative site in the borough at lower probability of flooding. The sequential approach should be applied on the site and a site-specific FRA will be required. Flood Hazard and TE2100 levels will need to be taken into account."* Therefore, the Council considers that this site has passed the Sequential Test. Note that we are awaiting comments from the Environment Agency on this report.

- Exception Test: As it has been correctly identified, this proposal will need to be subject to the Exception Test, of which there are 2 parts: (1) wider sustainability benefits and (2) a site-specific Flood Risk Assessment (FRA) to demonstrate that it can be safely developed without increasing flood risk elsewhere. In relation to the first part of the Test, the Council can confirm that development of this site in line with the draft Local Plan proposal site (SA23), as supported by the Flood Risk Sequential Test, will provide wider sustainability benefits because it is now a derelict site that is in need of regeneration, and the proposal will create a new village heart for Mortlake with a mix of uses, including enlivening the riverside frontage.

- It should be acknowledged that the proposal will increase the number of not only occupants but also users of the building/land. This will be an important aspect to address in both the FRA and Flood Emergency Plan.

- Council's updated SFRA: Attention is drawn to the recently updated and published Council Strategic Flood Risk Assessment (2016): http://www.richmond.gov.uk/flood_risk_assessment, which needs to be taken into account. (I note the reference to the 2008 version, which has been updated twice since its first publication.)

- Flood Hazard: I note the scoping paper includes hazard and breach level information. The technical data contained within this will need to be verified by the Environment Agency. Attention is drawn to the Council's SFRA (2016), which contains information on flood hazard that needs to be taken into account. The tidal breach flood hazard area shows that parts of the site are within the moderate, significant and extreme

hazard areas. This will need to be addressed in the site-specific FRA, particularly as the secondary school is proposed to be located in an area at 'significant' hazard.

- Groundwater: The SFRA (2016) contains more information on groundwater in comparison to its previous version. In particular, the BGS Susceptibility to Groundwater Flooding map shows that at the location of the Stag Brewery site, there is some potential for groundwater flooding to occur at surface as well as below ground. This will need to be considered and assessed in the FRA.

- Other sources of flooding: The updated SFRA (2016) contains more detail on other historic flooding incidents, such as blocked gulleys/drains, which should be taken into account.

- TE2100: The proposal has to take into account the requirements of the Thames Estuary 2100 (TE2100) Plan with regard to the implementation of current and future improvements to the River Thames tidal flood defences in order to effectively manage tidal flood risk. It is strongly recommended to liaise with the Environment Agency in this regard to ensure the development takes account / will be able to adapt to these requirements.

- Flood defences: I note that remodelling of flood defences forms part of the proposal. This will need to be discussed and agreed with the Environment Agency. The Council, in conjunction with the Environment Agency, will require a buffer zone of 16 metres for the tidal Thames and policies seek to set back developments from river banks and existing flood defence infrastructure where possible.

- Surface water and drainage: I note that the development concept shows a reduction in impermeable area and reference is made to the SFRA target of a reduction of 50% over current levels. Note that the SFRA has been updated and it is expected that the development proposal complies with existing policies, which seek greenfield run-off rates. If greenfield run-off rates cannot be achieved, it will need to be demonstrated by the applicant why it cannot be achieved. The minimum requirement is to achieve at least a 50% attenuation of the site's surface water runoff at peak times based on the levels existing prior to the development. I note the reference to following a SuDS train – it should be noted that there are SuDS techniques which do not require infiltration, and therefore the applicant should follow policy DM SD 7 as well as the borough-specific guidance set out in the Planning Guidance Document 'Delivering SuDS in Richmond' (2015):
http://www.richmond.gov.uk/sustainable_drainage_systems.pdf
A Statement on Sustainable Drainage Systems (SuDS) / Surface Water Drainage Strategy will have to be submitted with any planning application. The Council in its function as the Lead Local Flood Authority will be consulted on this, and their approval will be sought.

- Finished floor levels (FFL) and freeboard: I note the consultant refers to providing a freeboard of 300mm. Whilst the modelled flood levels and technical data included within the report will need to be confirmed and verified by the Environment Agency, my understanding is that the revised TE2100 tidal flood levels include an allowance for modelling uncertainty and therefore do not require the freeboard to be added. Therefore, your proposed FFL may be overly conservative and a level of 6.03 mAOD may suffice. However, this will need to be confirmed by the Environment Agency, who I understand are in the process of revising guidance on freeboard allowances.

- Climate change allowances: The Climate Change Allowance guidance has been updated and published https://www.gov.uk/guidance/flood-risk-assessments-climate-

change-allowances - please liaise with the Environment Agency as my understanding is that the revised EA guidance for climate change allowances should be applied for fluvial and surface water flooding, but they do not apply for tidal flooding as they are already accounted for in the model of the Thames Estuary 2100 plan.

- Flood Emergency Plan and proposed Evacuation Route: In line with policy DM SD 6, all proposals on sites of 10 dwellings or 1000sqm of non-residential development or more are required to submit a Flood Warning and Evacuation Plan. The Council's guidance on 'Producing a Flood Emergency Plan' (2011) should be followed: http://www.richmond.gov.uk/final_guidance_on_producing_a_flood_emergency_plan_nov_2011.pdf. Drawings showing the height of the route/road in comparison to the modelled extreme water levels will be required in this regard, including the designated safe place of refuge (which appears to be off-site). At this point, the Council is unable to confirm whether the proposed evacuation route is suitable, particularly as this is currently a non-existing route through the development site, of which the design/layout may change as a result of negotiations and discussions on the overall development scheme.

- Planning policies: The FRA and Drainage Statement will need to demonstrate compliance with existing planning policies as contained within the London Plan as well as the Council's Core Strategy (i.e. policy CP 3 in particular) and Development Management Plan (i.e. policies DM SD 6, 7 and 8 in particular). In addition, national guidance is set out in the NPPF and PPG. Also note that the Council is currently reviewing its existing policies and a draft Local Plan has been published for public consultation. Particular attention is drawn to draft policy LP 21 (Flood Risk and Sustainable Drainage). Note that in line with the NPPF, the emerging Local Plan will be given weight in the decision making process according to its stage of preparation (i.e. the more advanced the preparation, the greater the weight that may be given). Therefore, when the Local Plan reaches Publication stage, currently expected to be in late Autumn 2016, greater weight will be given to the Local Plan, including its policies and proposal sites.

- Basements and subterranean developments: Note that the updated SFRA (2016) and draft policy LP 21 contain specific guidance and requirements in relation to basements and subterranean developments. In areas of
Extreme, Significant and Moderate breach hazard (as set out in the Council's SFRA), within flood zone 3a (tidal), new basements will be restricted to Less Vulnerable / Water Compatible uses only. Therefore, basements for residential uses will not be allowed.

I note that Hydro-Logic Services are particularly seeking to clarify the following (my comments are in yellow highlight):

a. that the development provides wider sustainability benefits to meet the Exception Test – Yes, for the reasons set out above
b. that flood storage compensation is not required, due to the entirely tidal nature of flood risk – to be discussed and agreed with the Environment Agency; my understanding is that for development in a defended flood risk area, compensatory storage should not be necessary when raising ground levels due to the unlikely impact on maximum tidal levels. However, the impact on residual flood risk to other properties (i.e. off-site) needs to be considered as new development behind flood defences can increase the residual risk of flooding if the flood defences are breached by changing the conveyance of the flow paths or by displacing flood water elsewhere.
c. whether the proposed evacuation route is suitable – to be confirmed once a Flood Emergency Plan has been produced and the proposal developed further (see comments above)

Kind regards

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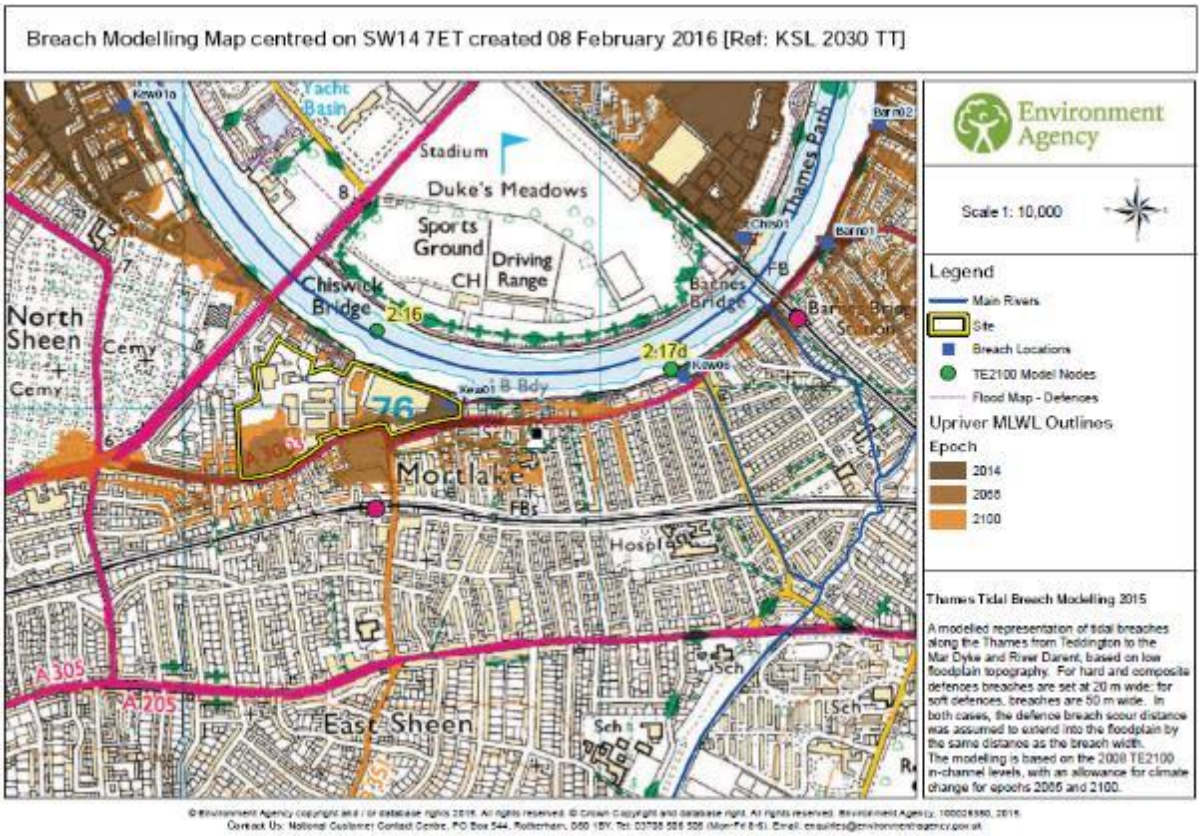
Appendix D Breach Analysis

D.1 Introduction

Breach analysis has already been undertaken by the Environment Agency for numerous locations along the tidal Thames. The results are presented for the site in Section 3.5 for a simulated breach of 20 m width at the location "Kew01" shown in Figure D-1. The breach would be within the Stag Brewery Component of the Site east of Ship Lane and would represent a catastrophic failure of the existing tidal defence that is made up of the perimeter wall of this part of the site. The areas likely to be affected by the breach are also shown in Figure D-1 for 2014, 2055 and 2100. This is based on extreme water levels provided by the Environment Agency (i.e. without reference to specific values of probability). Further, these levels are those that result from three tidal cycles, after which it is assumed that some repair to the breach would have been effected.

Although breaching of defences is regarded as a "residual risk", the LBRuT indicated in their response to the Scoping Level FRA submitted in July 2016, that further modelling would be required. Specifically, this would seek to investigate the impacts of the proposed development on flood extents during a standard breach analysis. The findings are presented in this Appendix.

Figure D-1 Thames Tidal Breach Modelling



D.2 Modelling of the breach

The location of the breach at Kew01 is entirely within the Stag Brewery Component of the site – east of Ship Lane. The location would be along the section of wall shown in Figure D-2 and which would lead to inundation of the lower parts of the site. As part of the proposed development, the Stag Brewery Component of the Site will be landscaped. Through this, ground levels adjacent to the defences will be raised to levels no lower than 6.03 mAOD – the peak TE2100 water level for 2100. Accordingly, there is effectively no risk of breach at this location – nor in fact at any location along the perimeter of this part of the site. The development of the Site therefore results in a reduced risk of breach with clear benefits for the surrounding area in reducing (residual) flood risk.

Figure D-2 Existing tidal defences (inset shows bricked up window)

In order that some effective breach analysis could be undertaken, it was assumed that a breach would occur at the stop-log arrangement at Bull's Alley, immediately to the east of the Site (Figure D-3 and C-4). The mechanism for removal of stop-logs is illustrated in Figure D-5. This stop-log arrangement enables maintenance vehicles to access the river to clear debris on the foreshore. Given this regular usage, it is anticipated that this location would be regularly inspected and maintained. The risk of breach is thus considered unlikely at this location.

A breach at this location would be much narrower than in the original Environment Agency modelling. A 6 m breach has been modelled. This in turn required that the model grid be reduced to from 5 m to 2.5 m in order that the breach could be reasonably represented in the model domain.

Figure D-3 Stop-logs at Bull's Alley (from river)

Figure D-4 Stop-Logs at Bull's Alley (towards river)

Figure D-5 Stop-logs at Bull's Alley – from above

D.3 Modelling results

The model supplied by the Environment Agency for the Lower Thames has been modified to reflect the breach at Bull's Alley. It has been run for the 2100 extreme water levels in a standard breach analysis.

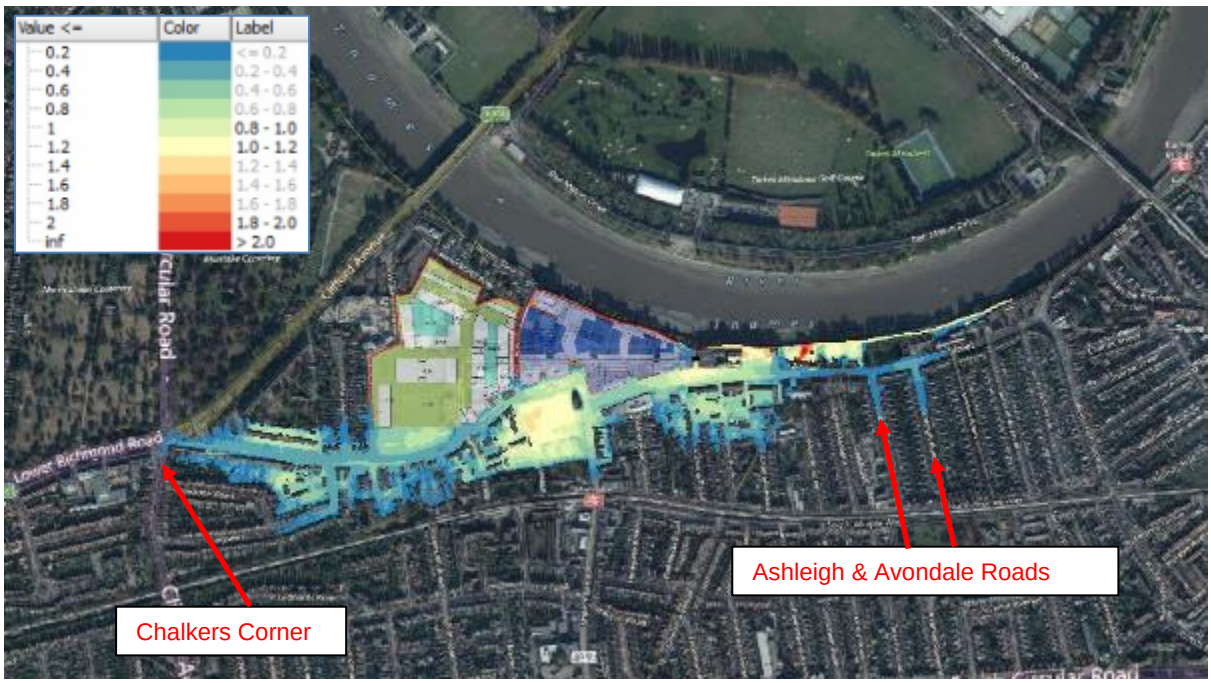
The original flood extents from the Environment Agency's model are shown in Figure D-6; these are for the 2100 levels, but for the baseline (i.e. existing site layout). The results obtained using the modified model (i.e. with the breach at Bull's Alley) and for the proposed layout are shown in Figure D-7. Finally, a comparison has been made in Figure D-8 by mapping the difference in depths across the domain.

The main observations from these Figures are as follows:

- The revised breach analysis shows a general reduction in the area affected by the breach;
- This reduction is most pronounced to the west of the site at the junction of Lower Richmond Road and Clifford Avenue at Chalkers Corner;
- There is also a reduced flood extent along Ashleigh and Avondale Roads to the east of the site;
- There is a corresponding reduction in flood depths across virtually the entire model domain;

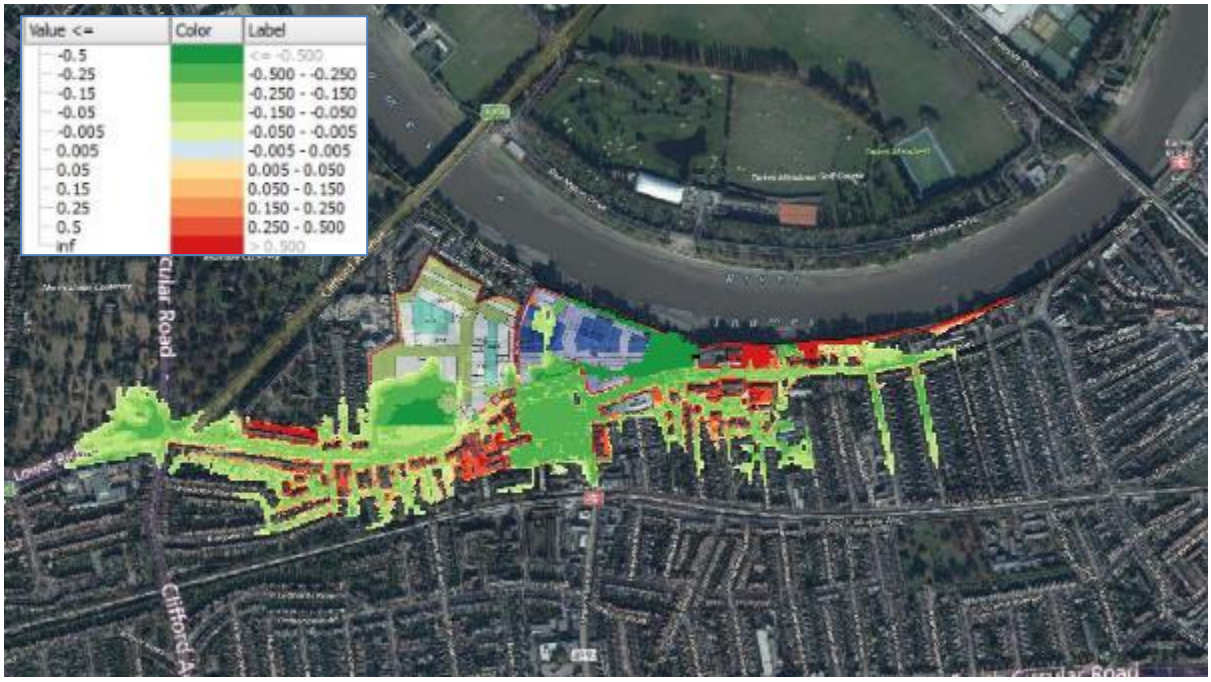
Figure D-6 Breach analysis – 2100 Baseline: EA model depths

Figure D-7 Breach analysis – 2100 Developed: HLS Model Depths (Bull's Alley Breach)



- There are localised increases, throughout the model domain; in places, these are of the order of 0.5 m. The locations showing an increase reflect the model assumptions that were required to model the breach at Bull's Alley. This required the use of a finer model grid size (2.5 m) than was used for the Environment Agency model (namely 5 m). The enhanced model has led to floodwater exploiting flow paths and areas that were not accessible in the model with the coarse grid. The areas where increases are shown are contiguous with areas showing a general reduction in flood depths. They are accordingly an artefact of the model rather than a cause for concern.

Figure D-8 Breach analysis – 2100 Baseline - Differences in depth



D.4 Summary

This Appendix describes the breach modelling that has been undertaken as part of the FRA. It has been undertaken following feedback from LBRuT and is required in order to assess the impact that the proposed development may have on flood extents resulting from breach analysis. The main findings are as follows:

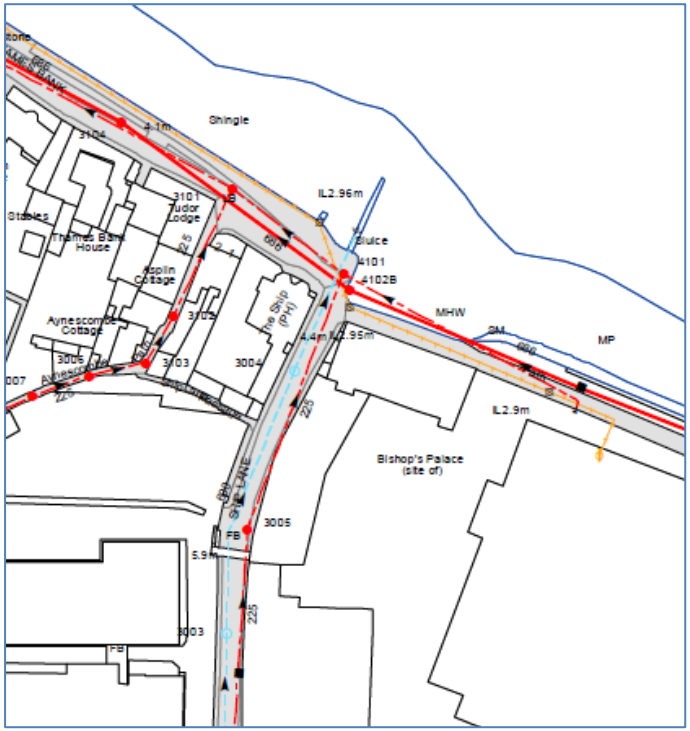
i. The risk of breach would be substantially reduced following the proposed development due to the significant upgrading of defences along the river frontage.
ii. Subsequent to development, the breach modelled by the Environment Agency with an arbitrary breach width of 20 m, could not occur due to the land raising. The most likely location for a breach would be at the stop-logs in Bull's Alley. At this point, the maximum width of breach is reduced to 6 m.
iii. The risk of a breach at this location is considered very small since the location is routinely inspected.
iv. Model runs have been undertaken to compare the flood extents resulting from a breach at Bull's Alley with those from Environment Agency modelling. These show a general reduction in flood levels and extents throughout the affected area. Whilst there are some localised increases, these are a consequence of the finer grid size used in the modelling of the breach at Bull's Alley for the developed case.

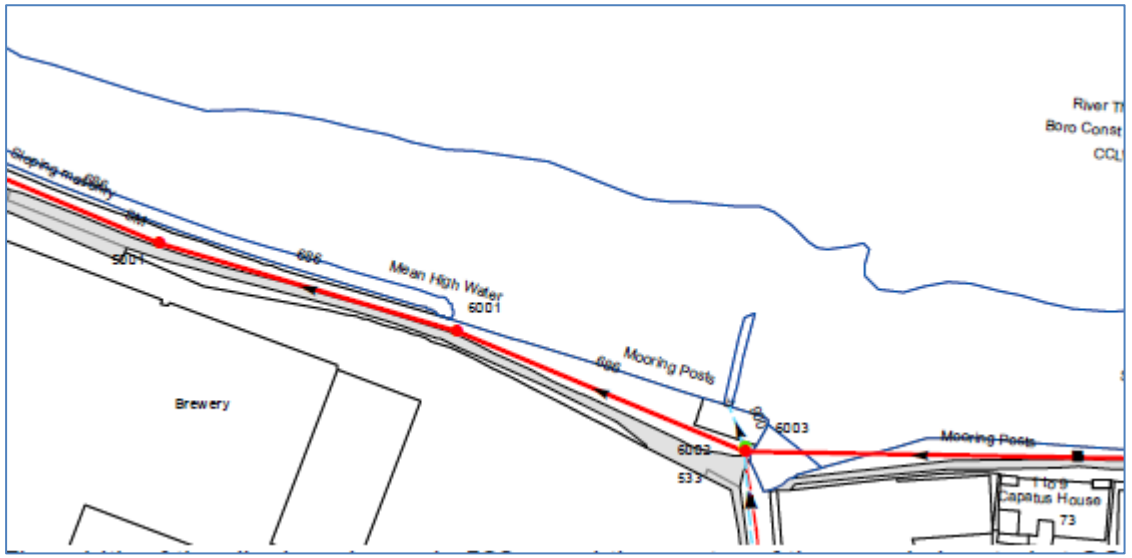
In summary, the proposed development is considered to result in a significant reduction in residual risk. This is partly due to the greater integrity of the defences, post development, and partly due to the smaller width and likely lower incidence of breach at the stop-logs in Bull's Alley. The modelling undertaken as part of this FRA has shown a general reduction in flood extent and depths compared with the Environment Agency modelling.

Appendix E Enquiry to Thames Water: Sewers

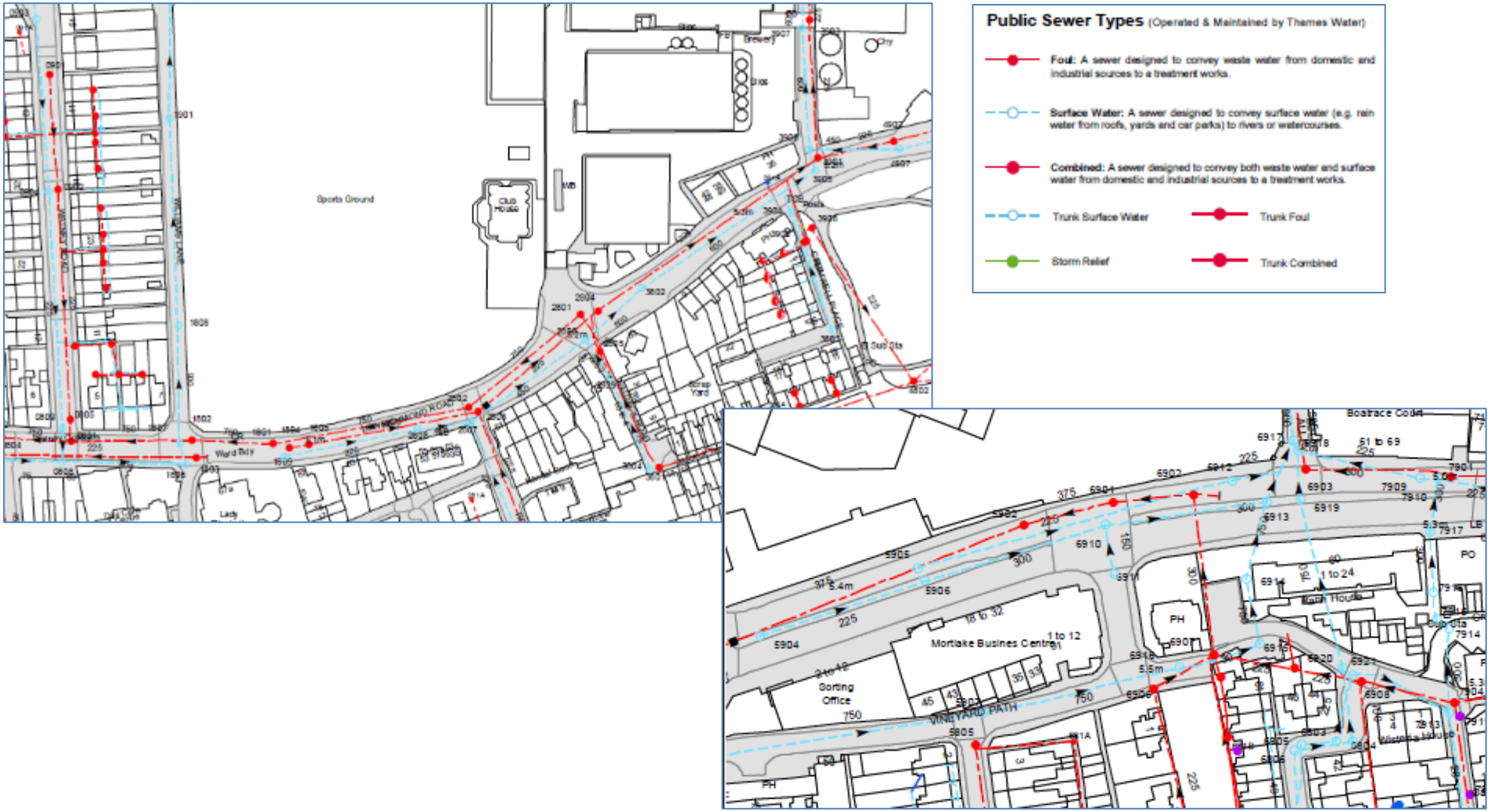
These are extracts from the Thames Water response to a developer enquiry by Waterman on 22 January 2016.

E.1 Northern part of site





E.2 Southern part of site



Appendix F Allowances for climate change in NPPF

F.1 Introduction

In February 2016, the Environment Agency updated the climate change allowances required in Flood Risk Assessments (Environment Agency, 2016); this advice updates previous climate change allowances to support NPPF (2012). Guidance has been provided for

- peak river flow by river basin district
- peak rainfall intensity
- sea level rise
- offshore wind speed and extreme wave height.

The general guidance is provided in this Appendix.
For flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact.

F.2 Peak River Flow Allowances

The peak river flow allowances for flood risk assessments should be applied by reference to the flood zone and vulnerability classification as shown below.

In flood zone 2:

- essential infrastructure – use the higher central and upper end to assess a range of allowances
- highly vulnerable – use the higher central and upper end to assess a range of allowances
- more vulnerable – use the central and higher central to assess a range of allowances
- less vulnerable – use the central allowance
- water compatible – use none of the allowances

In flood zone 3a

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – use the higher central and upper end to assess a range of allowances
- less vulnerable – use the central and higher central to assess a range of allowances
- water compatible – use the central allowance

In flood zone 3b

- essential infrastructure – use the upper end allowance
- highly vulnerable – development should not be permitted
- more vulnerable – development should not be permitted
- less vulnerable – development should not be permitted
- water compatible – use the central allowance

If (exceptionally) development is considered appropriate when not in accordance with flood zone vulnerability categories, then it would be appropriate to use the upper end allowance.

Table F-1 Total Potential Change for River flow

River basin district	Allowance category	'2020s' (2015 - 2039)	'2050s' (2040 - 2069)	'2080s' (2070 - 2115)
Northumbria	Upper end	20%	30%	50%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
Humber	Upper end	20%	30%	50%
	Higher central	15%	20%	30%
	Central	10%	15%	20%
Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%
South East	Upper end	25%	50%	105%
	Higher central	15%	30%	45%
	Central	10%	20%	35%
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%
South West	Upper end	25%	40%	85%
	Higher central	20%	30%	40%
	Central	10%	20%	30%
Severn	Upper end	25%	40%	70%
	Higher central	15%	25%	35%
	Central	10%	20%	25%
Dee	Upper end	20%	30%	45%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
North West	Upper end	20%	35%	70%
	Higher central	20%	30%	35%
	Central	15%	25%	30%
Solway	Upper end	20%	30%	60%
	Higher central	15%	25%	30%
	Central	10%	20%	25%
Tweed	Upper end	20%	25%	45%
	Higher central	15%	20%	25%
	Central	10%	15%	20%

Table 1 peak river flow allowances by river basin district (use 1961 to 1990 baseline)

F.3 Peak Rainfall Intensity Allowances

For flood risk assessments and strategic flood risk assessments, both the central and upper end allowances should be used to understand the range of impact.

Table F-2 Peak rainfall intensity allowances

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Table 2 peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

F.4 Sea Level Allowances

There is a single regional allowance for each epoch or time frame for sea level rise in the Table.

Table F-3 Sea level allowances

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cum rise 1990 to 2115
East, east midlands, London, south east	4 (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m
South West	3.5 (122.5 mm)	8 (240 mm)	11.5 (345 mm)	14.5 (435 mm)	1.14 m
North west, north east	2.5 (87.5 mm)	7 (210 mm)	10 (300 mm)	13 (390 mm)	0.99 m

Table 3 sea level allowance for each epoch in millimetres (mm) per year with cumulative sea level rise for each epoch in brackets (use 1990 baseline)

F.5 Offshore wind speed and extreme wave height Allowances

Table F-4 Wind Speed and Wave Height Allowances

Applies around all the English coast	1990 to 2055	2056 to 2115
Offshore wind speed allowance	+5%	+10%
Offshore wind speed sensitivity test	+10%	+10%
Extreme wave height allowance	+5%	+10%
Extreme wave height sensitivity test	+10%	+10%

Table 4 offshore wind speed and extreme wave height allowance (use 1990 baseline)

Appendix G Flood Emergency Plan

G.1 Introduction

This is the Flood Emergency Plan for the Stag Brewery Component of the Site. It has been prepared with help and guidance from the Environment Agency and LBRuT and informed by the Planning Advice Note for Guidance on Producing a Flood Emergency Plan (LBRuT, 2011).

G.2 General

G.2.1 Scope, Objectives and Background

The purpose of this document is to present the Plan for the proposed development. Its content is relevant to residents and users of the site in order that they understand both the risks of flooding and the actions that they will need to take to prepare for and to respond to flooding. The document is also relevant to the emergency services and LBRuT officials who will be required to manage the emergency response during flooding.

The objectives are:

- To inform residents of the risks of flooding.
- To outline proper and safe procedures to be followed before and during flooding.
- To explain the meanings of flood warnings and what action will be required and by whom.
- To provide clear advice on emergency procedures to be followed before and during a flood event.

The important aspects of this plan include:

- That the principal type of flooding that may affect the area is tidal flooding.
- That virtually the entire site, including the basement car parks, has been designed to be at a safe level throughout its planned life including an allowance for climate change. This also applies to the residual risk due to breach of the tidal defences.
- The main risks from flooding are on the towpath between the site boundary and the River Thames.
- In the unlikely event that evacuation is required, a safe (and dry) pedestrian route is available from the site to land wholly within flood zone 1.
- The emergency contacts.

G.2.2 Location and Proposal

Prior to its acquisition, the Stag Brewery Component of the Site was an operational brewery. The proposed development involves demolition of existing buildings, land raising and construction of buildings as residential accommodation, as well as retail and educational provision, as described in Section 4.1.

The accompanying FRA has shown that virtually the entire site will be protected from flooding by setting the formation level for the site at, or above the reference flood level. The reference flood level has been agreed with the Environment Agency and the LBRuT and is at 6.03 mAOD and corresponds with the TE2100 design flood level for 2100. All new residential accommodation has been set a minimum of 1 m above the reference flood level (nominally at 7.03 mAOD), and so is at an acceptably low risk of flooding.

The FRA has also noted that the development proposal will lead to a slight reduction in the flood risk to surrounding properties. This is due to the following factors:

- A surface water management plan that will see a reduction of the peak rates of runoff from their current rates;
- Landscaping of the site that will see a general reduction in flood extents and depths following breach analysis, compared with the extents modelled by the Environment Agency in their breach analysis;
- The Basement Car park may lead to a minor blocking of groundwater flow paths from the River Thames that will afford some protection for basements to the south of the proposed development; and
- The availability of the site as a refuge for residents in adjacent properties in the event of overtopping or breach of the defences.

The most important issue for users of the proposed development to note is that it will be at an acceptably low risk from flooding. The principal risks to be faced by users of the site will likely be accessing the surrounding low-lying areas of the Thames towpath.

G.2.3 Risk Assessment Summary

This being a riverside site, with a generally open access to the river, the principal risk faced by residents will be that of the proximity to a tidal river. Whilst the site itself has an open outlook to the Thames, the boundary between the Stag Brewery Component of the site and the towpath is protected by railings and glass balustrade as shown in Figure 4-6. The riverside areas will be equipped with a range of safety signs and equipment, the precise location and type to be decided at detailed design stage (Section G.3.3.)

As noted above, there is a residual risk of flooding due to a breach of the tidal defences. The buildings that may be affected have been reviewed in detail in Section 4.2.3. With current flood levels, this residual risk is negligible. However, over the lifetime of the Scheme, this residual risk will increase.

G.2.4 Assessment of potential Mitigation Measures

The Stag Brewery Component of the Site features the following mitigation measures:

- Self-Activating Flood Barrier for the entrance to the Basement Car Park from Mortlake High Street;
- Flood proof doors and/or demountable barriers for access from the Community Boathouse to the river foreshore.

There is a future requirement for tidal flood gate on Ship Lane, to ensure the integrity of the tidal defences. Without this gate, peak water levels would be able to propagate along Ship Lane. This will only be required at some point in the future. Accordingly, the description and the management procedure for the gate will likely be the subject of a suitably worded Planning Condition. However, a suitable location has already been earmarked in the scheme.

G.3 Flood Procedures

G.3.1 Lead times

The nature of the flood risk, being tidal, may be forecast with a high degree of accuracy of both the timing and the magnitude. These forecasts draw heavily on the Storm Tide Forecasting Service operated by the Met Office.

Although the tidal events may be predicted with confidence, the occurrence of breaches in the defences cannot be. The lead times associated with such breaches, should they be close to the site, is to all intents and purposes, zero. Warnings will thus be of no practical value.

G.3.2 Flood Warnings

The responsibility for issuing flood warnings in the tidal Thames lies with the Environment Agency. Their system for issuing warnings to the emergency services and to residents at risk of flooding via the Environment Agency's Floodline system, is well tested and effective.

It is not expected that any residents would need to sign up for flood warnings on account of the location of their residence being safe. Clearly, some people may wish to sign up the Floodline so as to be better appraised of flood risk in a particular area.

Those with responsibility for managing the towpath and the boat facilities should sign up to Floodline since they may need to issue warnings to users of these facilities.

G.3.3 Flood Notices & Equipment

Users of the towpath and the part of the site closest to the river will be at increased risk, especially at times of tidal flooding. It will be necessary to close the Riverside path during flooding. This will be explained to users of the path by appropriate notices. These would be deployed at the eastern end of the site (near Bull's Alley) and near Ship Lane. Furthermore, warning signs will be required within the development site where it provides access to the towpath.

G.3.4 Actions upon receiving Alerts and Warnings

(a) Residents

There is no need for residents to be in receipt of flood warnings. No action is thus required.

(b) Towpath/Boat House Managers

On receipt of warnings, managers should assess the need for and the timing of towpath closure and other facilities. The Environment Agency warnings for the tidal Thames are of good quality for both the reliability and the long lead time. It is thus most unlikely that managers would need to close paths "during" a day. In all likelihood, they could be closed at the beginning or end of a day to minimise any disruption.

Closure would be by the deployment of signage that highlighted the risk to users. Similar signage would be required within the site where it abuts the River.

The default position for flood proof doors/demountable barriers is that they will be closed and provide protection. However, Boat House Managers should check that the systems are correctly in place and able to operate effectively.

G.3.5 Safe Egress Procedures & Evacuation Routes

(a) Residents

As indicated above, the site has been designed to be safe from the effects of flooding. Accordingly, no evacuation of the site is anticipated. For completeness, a safe, pedestrian route has been identified that would enable residents to leave the site on foot, should they need to do this. This is detailed below in Section (c).

(b) Towpath and Boathouse facilities

The reliability of Environment Agency warnings, coupled with the predictability of the tidal risk is such that the public facilities can be closed in advance of any imminent flood risk. There is accordingly, no need for evacuation from the towpath or boat house. In any event, access is readily available to the Stag Brewery Component of the Site where it abuts the River.

(c) The emergency access route

The emergency access route would only need to be used in the event of breach or widespread failure of the defences. Given the scale of landscaping with raised areas located behind tidal defences, any such breach may only occur at the eastern end of the site, in the vicinity of Bull's Alley.

As indicated in the previous Section, virtually the entire site, including residential accommodation and basement car parks have been designed to be safe from flooding. All residential property is set at a minimum of 7.3 mAOD. Furthermore, there is access from all residential blocks to land at a minimum of 6.03 mAOD, with the exception of The Maltings, where the exit form residential property is at 5.53 mAOD, which is addressed separately below. This ensures "dry" access within the site and in particular to a proposed exit point at the western end of the Stag Brewery Component onto Williams Lane.

The exit from the Maltings at 5.53 mAOD is 0.50 m below the reference flood level (Figure 4-9). In practice, this may involve a walk through standing water to a depth of no more than 0.50 m. This leads to a Hazard Rating (Table G-1) of 1.25 ("Danger for Some"), or 0.25 ("Very Low Hazard") if one assumes no debris (debris factor = 0). In practical terms, it is difficult to see how water from a breach could enter this area. This assessment is thus highly precautionary.

Non-residential usage, where floor levels are below 6.03 mAOD have been reviewed in detail in Section 4.2.3 where there is a residual risk of flooding resulting from a breach of the tidal defences for the 2100 timescale. These buildings are shown in Figure 4-8 and include:

- B04 Maltings – Community Space
- B05 Hotel lobby
- B09 Community Boathouse – Boat storage and clubhouse facilities
- B10 Retail

In each case, as shown in Section 4.2.3, there is safe access to areas that are above the reference flood level. The Community Boathouse will be provided with flood-proof doors to exclude water from the facility.

Table G-1 Hazard to People Classification System

Flood Hazard Rating (HR)	Colour Code	Hazard to People Classification	Use of flood emergency plans to manage flood risk
Less than 0.75		Very low hazard – caution	Acceptable
0.75 to 1.25		Danger for some – includes children, the elderly and the infirm	Maybe acceptable
1.25 to 2.0		Danger for most – includes the general public	Unlikely to be acceptable
More than 2.0		Danger for all – includes the emergency services	Unacceptable

HR	Depth of flooding - d (m)												
	DF = 0.5				DF = 1								
Velocity - v (m/s)	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.0	0.03 + 0.5 = 0.53	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.13 + 0.5 = 0.63	0.15 + 1.0 = 1.15	0.20 + 1.0 = 1.20	0.25 + 1.0 = 1.25	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25
0.1	0.03 + 0.5 = 0.53	0.06 + 0.5 = 0.56	0.12 + 0.5 = 0.62	0.15 + 0.5 = 0.65	0.18 + 1.0 = 1.18	0.24 + 1.0 = 1.24	0.30 + 1.0 = 1.30	0.36 + 1.0 = 1.36	0.48 + 1.0 = 1.48	0.60 + 1.0 = 1.60	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.55
0.3	0.04 + 0.5 = 0.54	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.19 + 0.5 = 0.69	0.23 + 1.0 = 1.23	0.30 + 1.0 = 1.30	0.38 + 1.0 = 1.38	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	1.13 + 1.0 = 2.13	1.50 + 1.0 = 2.50	1.88 + 1.0 = 2.88
0.5	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.25 + 0.5 = 0.75	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	2.50 + 1.0 = 3.50

The offsite access route is shown in Figure G-2 by a solid red-line. This route is above the reference flood level of 6.03 mAOD and leads to the A316 (Clifford Avenue), an elevated road.

Access would then normally be in a south-westerly direction, along Clifford Avenue towards Chalkers Corner. Chalkers Corner is shown to be in the area affected by a breach in 2100 conditions according to the latest Environment Agency modelling (Figure 3-22b). However, modelling undertaken in support of this FRA and described in Appendix D has shown that following the development of the Site and with a breach location at Bull's Alley, a breach for 2100 conditions would not affect this junction.

In any case, should that route prove to be affected by a breach, then there exists an alternative route to the north-east along Clifford Avenue. This would lead over the River Thames to the Great Chertsey Road on the north bank.

Figure G-1 On-site Access Route

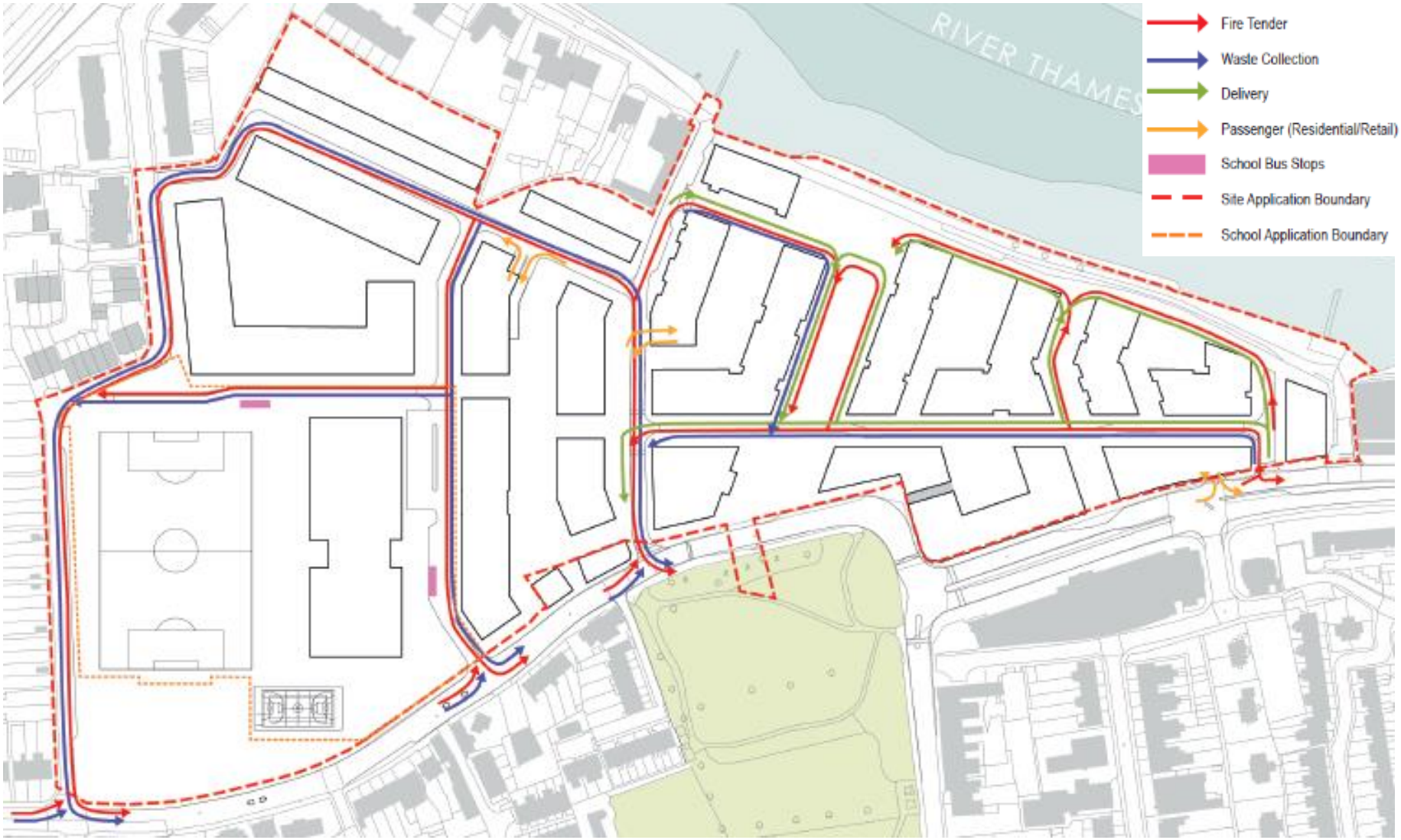


Figure G-2 Off-site Access Route

G.3.6 On-Site and/or Temporary Refuge

The site will provide a permanent refuge from flooding as it has been designed to be at a safe level. It can continue to be fully operational for the benefit of residents. Significantly, it would be available as a refuge for residents of adjacent properties, should they be affected by flooding.

G.3.7 Actions Post-Evacuation & Post Flood

It is not envisaged that the site would be evacuated, so this Section refers to actions following flooding of the towpath and possibly of the Boathouse. Prior to reopening the facilities, managers should verify that the towpath is safe to use. This may involve clearance of debris and minor repairs, where some erosion may have occurred. Should more substantial repairs be required, then the period of closure may need to be extended until such time as the repairs have been completed. The flood proof doors for the Boathouse should be checked for any signs of damage, with replacements sought if required.

G.3.8 Dangers of Flood Water

The proximity of the site to the River Thames means that residents should have some appreciation of the presence of water and associated hazard. This will be reinforced by warning notices at various locations and the provision of appropriate rescue equipment. Warnings should address not only the risk of drowning but also the risk of contact with contaminated flood water and the dangers of underwater obstacles. Such notices should be available for every property as part of the "residents' welcome pack".

G.4 Management of the Flood Emergency Plan

This is a relatively simple plan and it is not expected that it would require much updating. However, some review may be warranted following flood events under the guidance of overall site managers.

G.4.1 Business Continuity Plans

The fact that the site has been designed to be safe from flooding means that Business Continuity is not an issue due to flooding, other than in relation to the activities on the towpath and the Boathouse.

Off-site flooding may occur following a breach. This may have a minor impact on business; however, any interruptions are likely to be episodic and of a few hours' duration, consistent with the tidal cycle.

G.4.2 List of Key Contacts

A list of key contacts is given in Table G-2.

G.4.3 Plan Usage and Dissemination

The key actions that are required include:

- Provide all residents with a statement relating to flood risk. This will highlight the way that the site has been designed to be safe from flooding. This may be required by Insurers.

- The Emergency Plan would need to be retained by Site Managers and the managers of the towpath and boathouse facilities.
- Full information will also be available via the internet on warnings and actions.

G.4.4 Document Control and Monitoring

This Emergency Plan has been prepared for the scheme as envisaged at the time of Planning Application. The Plan should be updated to reflect the Scheme "as built" and to refine it so that it is suitable for a non-technical readership.

The procedure for updating this plan has been described above. The document would be "owned" by the Site Management staff, who would apply relevant control procedures to ensure key changes were communicated to all residents and updated on the web site, as required.

Table G-2 List of key Contacts

Organisation	**Service**	**Name/number**
Site office		To be advised
Environment Agency	Advice, warnings	Floodline number = 0345 988 1188
Environment Agency	Advice, warnings	http://www.environment-agency.gov.uk/default.aspx
LBRuT	Council services	08456 122 660
LBRuT	Emergency out of hours	020 8744 2442
Thames Valley Police	Non-emergency enquiries	101
Thames Water	24 hour service	0845 7200 898
Energy	Various	http://www.energynetworks.org/ Gives contacts for all energy companies

Offices at

Bromyard

Clevedon

Exeter

Reading

Sheffield

Stirling

Registered office

Hydro-Logic Services (International) Ltd
Shearwater House,
Clevedon Hall Estate,
Victoria Road,
Clevedon,
BS21 7RD

Registered in England 03036787

B. Appendix 12.2: Drainage Strategy

APPENDIX 12.2
DRAINAGE STRATEGY

Stag Brewery, Mortlake

Drainage Strategy

For Reselton Properties

February 2018

Client Name: Reselton Properties Limited
Document Reference: WIE10667-101-R-9-5-1-DS
Project Number: WIE10667

Quality Assurance – Approval Status

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

Issue	Date	Prepared by	Checked by	Approved by
First	28.09.2017	Nora Balboni	Donal O'Donovan	Harry Chetty
Comments	Draft Issue			
Second	23.10.2017	Nora Balboni	Donal O'Donovan	Harry Chetty
Comments	Draft Issue			
Third	01.11.2017	Nora Balboni	Donal O'Donovan	Harry Chetty
Comments	Draft Issue			
Fourth	26.01.2018	Nora Balboni	Donal O'Donovan	Harry Chetty
Comments	Planning Issue			
Fifth	14.02.2017	Nora Balboni	Donal O'Donovan	Harry Chetty
Comments	Final			

Disclaimer

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

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

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Executive Summary

This Drainage Strategy has been prepared by Waterman Infrastructure & Environment ('Waterman IE') on behalf of Reselton Properties Limited ('the Applicant') in support of three linked planning applications for the comprehensive redevelopment of the former Stag Brewery Site in Mortlake ('the Site') within the London Borough of Richmond Upon Thames ('LBRuT').

The former Stag Brewery Site is bounded by Lower Richmond Road to the south, the river Thames and the Thames Bank to the north, Williams Lane to the east and Bulls Alley (off Mortlake High Street) to the west. The Site is bisected by Ship Lane. The Site currently comprises a mixture of large scale industrial brewing structures, large areas of hardstanding and playing fields.

The redevelopment would provide homes (including affordable homes), complementary commercial uses, community facilities, a new secondary school alongside new open and green spaces throughout. Associated highway improvements are also proposed, which include works at Chalkers Corner junction.

The three planning applications are as follows:

- Application A – hybrid planning application for comprehensive mixed use redevelopment of the former Stag Brewery site consisting of:
    i. Land to the east of Ship Lane applied for in detail; and
    ii. Land to the west of Ship Lane (excluding the school) applied for in outline.
- Application B – detailed planning application for the school (on land to the west of Ship Lane).
- Application C – detailed planning application for highways and landscape works at Chalkers Corner.

Full details and scope of all three planning applications are described in the submitted Planning Statement, prepared by Gerald Eve LLP.

This Drainage Strategy has been produced to cover the Stag Brewery component of the Site (Applications A and B) (refer to **Figure 1).** Drainage associated with highways and surface water run-off from the highway drainage associated with the Chalkers Corner part of the Site (Application C) will be addressed as part of the wider highways drainage and would be discharged to the sewer as existing, will not be attenuated, and would continue to be managed by the local highways authority. It is therefore considered to be appropriate and robust to focus the Drainage Strategy on the Stag Brewery part of the Site herein.

Surface water runoff from the northeast of the Application A site (Stag Brewery component of the Site) would discharge by gravity to the River Thames (adjacent to the northern boundary of the Site) via three outfalls. As the River Thames is tidal in this location, direct discharge to the River would be unrestricted. Surface water runoff from the remainder of the Stag Brewery component of the Site would discharge via gravity to the Thames Water sewer network in the surrounding

highways, at 50% (or 405.0 l/s) of the existing rate. The highways team at London Borough of Richmond upon Thames have confirmed this approach to be acceptable.

Based on a restriction to 405.0 l/s, approximately 2655m^3 of attenuation would be required. This has been calculated using a WinDes Quick Storage Estimate which includes for all storm durations and takes account of a 40% increase in rainfall intensity to account for climate change.

Appropriate treatment would be incorporated into the drainage system to ensure that the quality of water discharged is acceptable. This would be achieved through the incorporation of green roofs, and the potential inclusion of rainwater harvesting and permeable paving. A biomat filtration system within the attenuation tanks and downstream defenders or similar hard engineered solution would also be incorporated to ensure discharge is appropriately treated.

Foul flows from the Stag Brewery component of the Site (Application A and B) to would discharge by gravity the Thames Water sewer network. The existing and proposed foul discharge rates have been calculated using the water consumption method at 14.4l/s and 25.5 l/s respectively.

A Pre-Development enquiry has been submitted to Thames Water to ensure sufficient capacity is available in the foul and surface water sewer networks to accept the proposed flows.

The on-Site drainage networks and Sustainable Drainage Systems would be privately managed and maintained for the lifetime of the Stag Brewery component of the Development (Applications A and B), ensuring they remain fit for purpose and function appropriately. The management company / operator would be appointed post-planning. The school drainage system (Application B) would be delivered and maintained separately from the Application A and C sites.

This report confirms that surface water runoff from the Stag Brewery component of the Site (Applications A and B) can be managed sustainably to ensure that flood risk is not increased elsewhere. It is considered that the information provided within this report satisfies the requirements of the National Planning Policy Framework (NPPF) and the London Plan.

Introduction

1.1. This Drainage Strategy has been prepared by Waterman Infrastructure & Environment ('Waterman IE') on behalf of Reselton Properties Limited ('the Applicant') in support of three linked planning applications for the comprehensive redevelopment of the former Stag Brewery Site in Mortlake ('the Site') within the London Borough of Richmond Upon Thames ('LBRuT').

1.2. The redevelopment will provide homes (including affordable homes), complementary commercial uses, community facilities, a new secondary school alongside new open and green spaces throughout. Associated highway improvements are also proposed, which include works at Chalkers Corner junction.

1.3. The three planning applications are as follows:

- Application A – hybrid planning application for comprehensive mixed use redevelopment of the former Stag Brewery site consisting of:
  - i. Land to the east of Ship Lane applied for in detail; and
  - ii. Land to the west of Ship Lane (excluding the school) applied for in outline.
- Application B – detailed planning application for the school (on land to the west of Ship Lane).
- Application C – detailed planning application for highways and landscape works at Chalkers Corner.

1.4. Full details and scope of all three planning applications are described in the submitted Planning Statement, prepared by Gerald Eve LLP.

1.5. This Drainage Strategy has been developed for Applications A and B only (hereafter referred to as 'the Stag Brewery component of the Site'). As Application C (hereafter referred to as 'the Chalkers Corner component of the Site') comprises highway land, drainage will be addressed as part of wider highways drainage design under the responsibility of the local highway authority. The surface water run-off from the highway drainage will be discharged to the sewer as existing and will not be attenuated. As a result, Chalkers Corner is not included in this Drainage Strategy. Even though a drainage strategy is provided only for the areas covered in Applications A and B, this Drainage Strategy supports all three applications as they cannot be implemented separately from one another.

Site Description

1.6. The overall Site comprises two components as follows:

- The Stag Brewery (Application A and B) – an approximately 9.25 ha parcel of land predominantly occupied by the former Stag Brewery; and
- Chalkers Corner (Application C) – an approximately 1.4 ha of highway and associated landscaping referred to as Chalkers Corner junction which includes the junction A316 (Clifford Avenue), A3003 (Lower Richmond Road) and A205 (South Circular).