Resilience and Flood Risk

127-143 Kingsway Mews, London SW14 7HN

FLOOD RISK ASSESSMENT

6th April 2016
Final Version v2.0
Ref: RAB 1003B

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Revision history

Version	Date	Amendments	Issued to
Draft 1.0	January 2015		James Lloyd
Final 1.0	January 2015		James Lloyd
Final 2.0	April 2016		James Lloyd

Quality control

Action	Signature	Date
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Disclaimer

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Resilience and Flood Risk

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Abbreviations

Abbreviation	Definition
EA	Environment Agency
FRA	Flood Risk Assessment
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
PFRA	Preliminary Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

1.0 Introduction

1.1. Terms of Reference

RAB Consultants was appointed by James Lloyd Associates Limited on behalf of Space Solutions UK Ltd to undertake this flood risk assessment (FRA) in support of a proposed demolition of 38 garages including vehicle repair garage and the erection of six residential units, incorporating two commercial units, with amenity space, off-street car parking and associated works at 127-143 Kingsway, Mortlake, London SW14 7HN.

The National Planning Policy Framework requires a Flood Risk Assessment to be carried out to ensure flood risk to the proposed development is considered as well as the impact the development will have elsewhere on people and property.

This FRA has been prepared in accordance with the Environment Agency's Flood Risk Assessment (FRA) Guidance Note 3 (All development in Flood Zones 2 and 3 where standing advice does not apply).

1.2. FRA Requirements

It is a requirement for development applications to consider the potential risk of flooding to a proposed development over its expected lifetime and any possible impacts on flood risk elsewhere, in terms of its effects on flood flows and runoff.

Where appropriate, the following aspects of flood risk should be addressed in all planning applications in flood risk areas:

- The area liable to flooding.
- The probability of flooding occurring now and over time.
- The extent and standard of existing flood defences and their effectiveness over time.
- The likely depth of flooding.
- The rates of flow likely to be involved.
- The likelihood of impacts to other areas, properties and habitats.
- The effects of climate change.
- The nature and currently expected lifetime of the development proposed and the extent to which it is designed to deal with flood risk.

This FRA follows government guidance on development and flood risk (National Planning Policy Framework) and best practices on Flood Risk Management.

1.3. Site Details

Figure 1 - Summary of site details

Site name	127-143 Kingsway Mews, Mortlake, London SW14 7HN
Site footprint	Approximately 0.14ha
Existing land-use	Residential garages and industrial
Purpose of development	Residential and commercial
Estimated lifespan	100 years
OS NGR	519823 175648
Country	England (NPPF applies)
Local planning authority	London Borough of Richmond upon Thames
Other authorities	Environment Agency Kent and South London Area

1.4. Site Description

The Site is approximately 0.14ha in size. It consists mainly of lock up garages with a combined Gross Internal Area (GIA) of approximately 539m^2. It also contains a single-storey vehicle repair garage of approximately 155m^2 GIA housed within the arches of the adjacent bridge. A metal canopy extends the coverage of the vehicle repair garage approximately 5.5m out from the bridge, with the remainder of the Site covered in hard paving.

The existing site sits approximately 860m south west of the River Thames.

1.5. Development Proposals

The proposal involves the demolition of 38 garages including vehicle repair garage and the erection of six residential units, incorporating two commercial (B1a offices) units (totaling 152m^2), with amenity space, off-street car parking and associated works.

1.6. Existing Drainage Network

The existing development actively manages surface water through gutters and rainwater pipes that drain to the public sewer.

2.0 Site Visit

2.1. Observations

The site visit was undertaken by RAB Consultants on 11th December 2014 which was a cloudy, dry day. RAB Consultants undertook a visual assessment of the existing site.

The site was accessed directly off Clifford Avenue via an access road, Figure 2 shows the access road to the development while Figure 3 shows the entrance to the actual proposed site development. The topography of the site is relatively flat, however the side road leading to the site has a gentle gradient which could potentially lead to surface water in the site as can be seen in Figure 2. During high intensity rainfall events, surface water could potentially enter the site due to the increased gradient of the access road.

Figure 4 shows the East facing view of the garages while Figure 5 shows the South-East facing view of the garages. It is proposed that these garages will be demolished and new buildings erected.

The site actively manages surface water through rainwater pipes and gullies. Figure 6 and Figure 7 show one of the rainwater pipes and gullies, respectively, located at the site.

Figure 2 - Access road to the site off Clifford Avenue

Figure 3 - Entrance to the proposed development site

Figure 4 – East facing view of the existing garages

Figure 5 – South-East facing view of the garages

Figure 6 – Existing rainwater pipes

Figure 7 – Existing surface water gully

There will not be an increase in impermeable area as a result of the development at the site, therefore the proposals will not increase surface water runoff rate or volume.

3.0 Planning Context

3.1.1. Applicable Planning Policy

National Planning Policy Framework (NPPF) was issued by the Department for Communities and Local Government in March 2012. NPPF deals specifically with development planning and flood risk using a sequential characterisation of risk based on planning zones and the Environment Agency Flood Map. The main study requirement is to identify the Flood Zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

3.1.2. Flood Zones

The Environment Agency has developed a Flood Map that shows the level of risk of flooding in England and Wales against a set of return period events. It should be noted that the Environment Agency's Flood Map is based on broad scale hydraulic modelling and is an indication of the potential flood risk to a site. The actual flood risk may therefore differ. The Flood Zone Maps (without climate change) provide the information required by NPPF for planning purposes, as described in Section 3.2. The Flood Zones do not take account of the effect of flood defences.

This site lies within Flood Zone 2 (as described in Table 1 of the Planning Practice Guidance to the National Planning Policy Framework). The proposed development is for the residential use and is categorised as a 'more vulnerable' in accordance with Table 3 of the Planning Practice Guidance to the National Planning Policy Framework.

3.1.3. Sequential and Exception Tests

The Sequential and Exception Tests should be applied when choosing the location of new development and the layout of the development site. The Sequential Test aims to promote development in areas with low flood risk. The Exception Test is used where no suitable development areas can be found in low risk areas, the risk of flooding is clearly outweighed by other sustainability factors, and the development will be safe for its lifetime, taking climate change into account.

According to the NPPF, the proposed development is classed as a new development'. This means that the Sequential Test is required (Appendix C).

3.1.4. Exception Test

Due to the nature of the development and the flood zone that the site lies in, the Exception Test is not required.

3.2. NPPF Flood Zones

Table 1 (Table 1 in this report) of the NPPF shows how the Flood Zones relate to a sequential planning process.

Table 1 - NPPF Flood Zones and Requirements

Zone 1: Low Probability	
Land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).	**Appropriate uses** All uses of land are appropriate in this zone. **FRA requirements** For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 2: Medium Probability	
Land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%) in any year.	**Appropriate uses** The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table2-2 are appropriate in this zone. Highly vulnerable uses in Table 2-2 are only appropriate in this zone if the Exception Test is passed. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to reduce the overall level of flood risk through the layout and form of the development, and the appropriate application of sustainable drainage techniques.
Zone 3a: High Probability	
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.	**Appropriate uses** The water-compatible and less vulnerable uses of land in Table 2-2 are appropriate in this zone. The highly vulnerable uses (Table 2-2) should not be permitted in this zone. The more vulnerable and essential infrastructure uses in Table 2-2 should only be permitted in this zone if the Exception Test is passed.

	FRA requirements All proposals in this zone should be accompanied by a FRA. **Policy aims** Developers and local authorities should seek opportunities to: • reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; • relocate existing development to land with a lower probability of flooding; • create space for flooding to occur by allocating and safeguarding open space for flood storage.
Zone 3b: Functional Floodplain	
Land where water has to flow or be stored in times of flood. (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 local planning authority and the Environment Agency, including water conveyance routes).	**Appropriate uses** Only the water-compatible uses and the essential infrastructure listed in Table 2-2 that has to be there should be permitted. It should be designed and constructed to: • remain operational and safe for users in times of flood; • result in no net loss of floodplain storage; • not impede water flows; • not increase flood risk elsewhere. **FRA requirements** All proposals in this zone should be accompanied by a FRA. **Policy aims** In this zone, developers and local authorities should seek opportunities to: • reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques; • relocate existing development to land with a lower probability of flooding.

Source: NPPF Planning Practice Guidance Table 1

Table 2 - Flood Risk Vulnerability Classification

Essential Infrastructure	Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations and emergency dispersal points. Basement dwellings, caravans, mobile homes and park homes intended for permanent residential use. Installations requiring hazardous substances consent.
More Vulnerable	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, hotels and sites used for holiday or short-let caravans and camping. Non–residential uses for health services, nurseries and education. Landfill and waste management facilities for hazardous waste.
Less Vulnerable	Buildings used for shops, financial, professional and other services, restaurants and cafes, offices, industry, storage and distribution, 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). Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place).
Water-compatible Development	Flood control infrastructure, water transmission infrastructure and pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel workings. Docks, marinas and wharves, navigation facilities. MOD defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard stations. Amenity open space, nature conservation and biodiversity, outdoor sports and recreation. Essential sleeping or residential accommodation for staff required by uses in this category, subject to a warning and evacuation plan.

Source: NPPF Planning Practice Guidance Table 2

Table 3 - Flood Risk Vulnerability and Flood Zone 'compatibility'

Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (Table 2)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test	✓	✓
	Zone 3a	Exception Test	✓	×	Exception Test	✓
	Zone 3b	Exception Test	✓	×	×	×

Source: NPPF Planning Practice Guidance Table 3

Key:

✓ Development is appropriate
× Development should not be permitted

4.0 Assessment of Flood Risk

4.1. History of flooding

According to the 2010 London Borough of Richmond upon Thames Council Level 1 Strategic Flood Risk Assessment (SFRA), the area of Mortlake is affected by tidal flooding from the River Thames, and falls within the Flood Zone 2 (medium probability). Large areas of Mortlake (east of the project site) are situated within Flood Zone 3 (high probability). The River Thames drains a considerable catchment area and flooding is typically a result of long duration, regional rainfall events. In this area however, the Thames is tidally dominated. Flood warnings are provided within the Borough, relating to both fluvial (river) and tidal flooding. The Environment Agency aims to provide as much forewarning as possible of a potential flood event. This provides the Council, emergency services, residents & businesses with an opportunity to prepare to minimise property damage and risk to life. In addition to the fluvial/tidal flooding from the River Thames, there are a number of localised issues that are known or perceived by the Council to pose a potential flood risk to surrounding property. It is documented that property flooding from the River Thames has occurred nine times within the past 100 years. However, these flood events are not shown to have affected the site. The 2011 London Borough of Richmond upon Thames Council Preliminary Flood Risk Assessment (PFRA) has collated all readily available historic flood data from key stakeholders within the London Borough of Richmond upon Thames, including the Richmond council and the Environment Agency. This allowed for the identification of significant historic flood events within the borough.

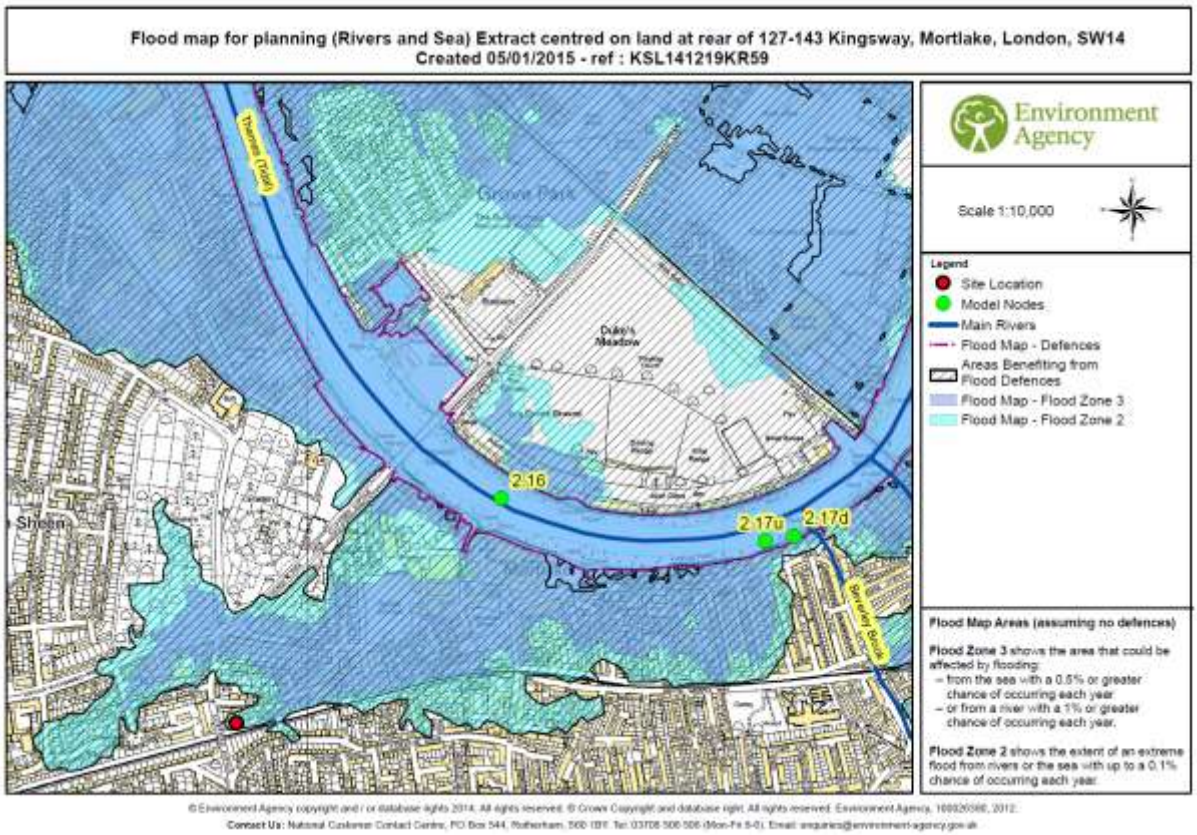
The 2011 PFRA reports surface water flooding however, no flooding incidents have been recorded for Mortlake.

4.2. Tidal Flood Risk

According to the EA flood map (Figure 8), the development site is located in Flood Zone 2, as described in the National Planning Policy Framework with annual probability (a.p.) of tidal flooding that is between 0.5% and 0.1% (1 in 200 and 1 in 1,000 year)

The site is within an area benefiting from flood defences which are estimated to protect the site up to a 0.1% a.p (1 in 1,000 year) flood event. Therefore, the threat to the site is limited to defence breaches or overtopping.

Figure 8 – Environment Agency Flood Map



4.3. Flood Defence Breach and Overtopping Risk

The in-channel flood levels for the tidal River Thames have been taken from the Thames Estuary 2100 study completed by HR Wallingford in 2008. The modelled node closest to the site is 2.16. 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 1,000 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. In addition, west London is heavily influenced from upstream flows (fluvial flows). The flood defences are built to manage tidal flood risk only. With very high fluvial flows, the river levels in west London could be above the 0.1% annual probability tidal level. Finally, the climate change levels are assessed to determine the future tidal defence levels. For this reason they only account for extreme tidal events and not extreme fluvial flow events. The present day levels include extreme flows from upstream (fluvial events) as well as extreme tidal events.

4.3.1. Overtopping Risk

The Environment Agency data (Appendix B) shows that the site is defended to a 0.1% (1 in 1,000) annual probability (a.p) standard, by a series of walls, embankments, flood gates and

barriers, with the Thames Barrier being the major protection for the study area. The statutory defence level (the level to which the defences must be maintained) for the proposed development site is 5.94m AOD. Relevant defence levels for the River Thames at node point (Figure 8) are shown in Table 4.

Table 4 - EA Records of existing and proposed flood defence levels

Node	Current Defence Levels		Allow for future defence raising (both banks) to a level of…	
	Left	Right	2065-2100	2100
2.16	5.94	5.94	6.7	6.7

Upstream of the Thames Barrier, the water levels provided by the EA are the highest levels permitted by the Barrier. The present day and future water levels for the River Thames are provided below in Table 5.

Table 5 - Environment Agency TE2100 Flood Levels

Node	Flood Levels (mAOD)		
	Present Day Water Level	Future 2065-2100 Water Level	Future 2100 Water Level
2.16	5.23	5.59	6.03

The EA data suggest that there will be an increase of water level during the design life of the proposed development. This increase is in the region of 800mm. However, the defence level is considerably higher with the current level difference between water and flood defence being 710mm. In addition, the future level difference between water and flood defences will be 670mm. Therefore, there is no risk of flooding from overtopping to the proposed development.

4.3.2. Breach Risk

The Thames Barrier is designed to be robust and reliable and the EA maintain and operate the barrier to ensure that the level of security is maintained. The barrier gates are routinely operated and there is a high degree of redundancy in terms of power supply and hydraulic systems. The Thames Barrier has been closed in response to tidal conditions over 100 times without any problems arising and thus has proved reliable in practice, according to the 2010 SFRA. However, the frequency of necessary operations of the Thames Barrier during late 2013 and early 2014 has increased considerably, and questions have been raised on what reliability guarantees can be given for increased usage over the longer term.

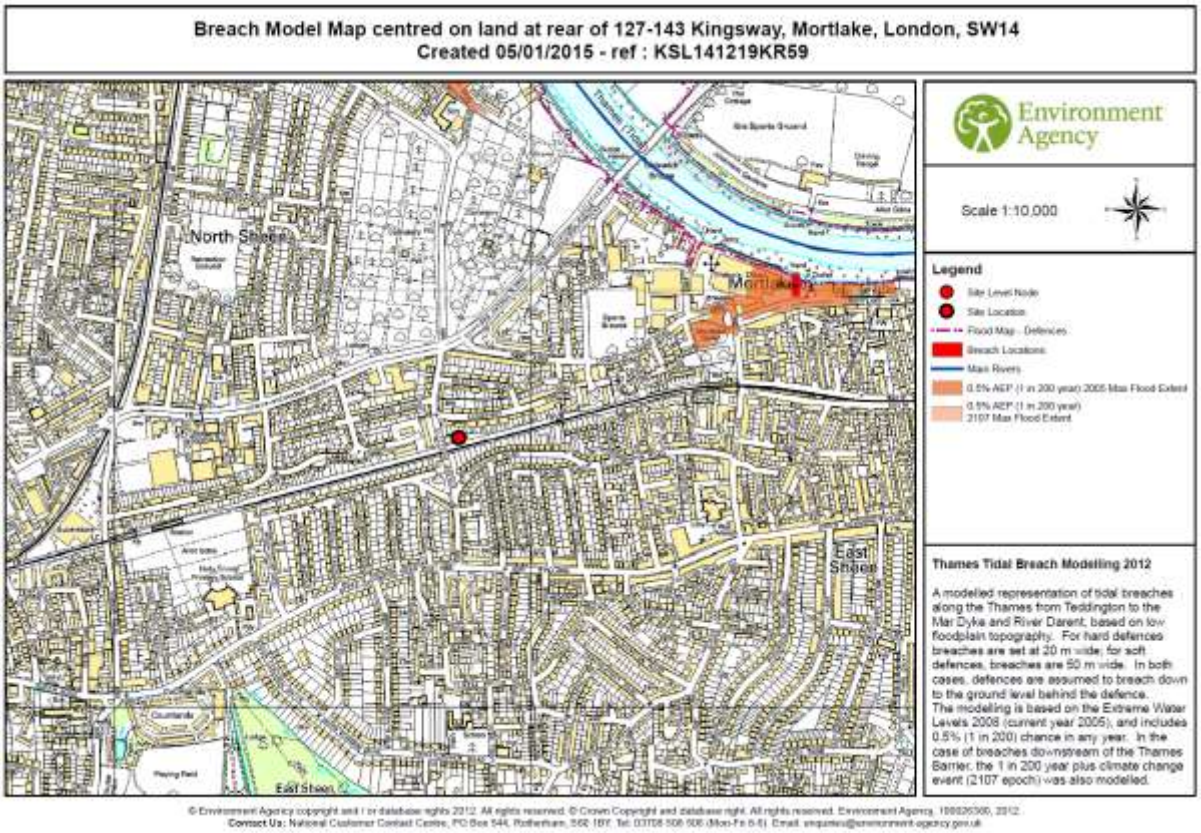
It is not possible to quantify the probability of a defence wall failure, but the probability will be greater than that of a highly engineered and managed defence, such as the Thames Defences. The design standard of protection of the flood defences in this area of the Thames is 0.1% AEP (1 in 1,000 year). The defences are all raised, man-made and privately owned. It is the riparian owners' responsibility to ensure they are maintained to a crest level of 5.94m AODN (the Flood Defence Level in this reach of the Thames). The current condition grade for defences in the area is 2 (Good). The defence condition is rated based on the National Flood and Coastal Defence Database categories (Table 7). The defence condition in the area is classified as 'Good' (see Appendix B-to be confirmed by the EA).

Table 6 - Flood Defence Condition Descriptions

Condition Rating	Condition	Condition Description
1	Very Good	Fully serviceable
2	Good	Minor defects
3	Fair	Some cause for concern. Requires careful monitoring
4	Poor	Structurally unsound now or in the future
5	Very Poor	Completely failed and derelict

A breach analysis (Figure 9) for the proposed development site has been conducted by the Environment Agency, reflecting the current status and condition of the existing flood defence wall. It was assumed for this breach analysis that the Thames Barrier will not fail but will be used more often in the future as sea levels rise. The consequence of this is that there is little change in residual risk from breaching of river walls but these remain a critical element in the tidal defence. The breach analysis demonstrates that the site will not affected by a potential breach. Therefore, there is no flood risk from this source of flooding.

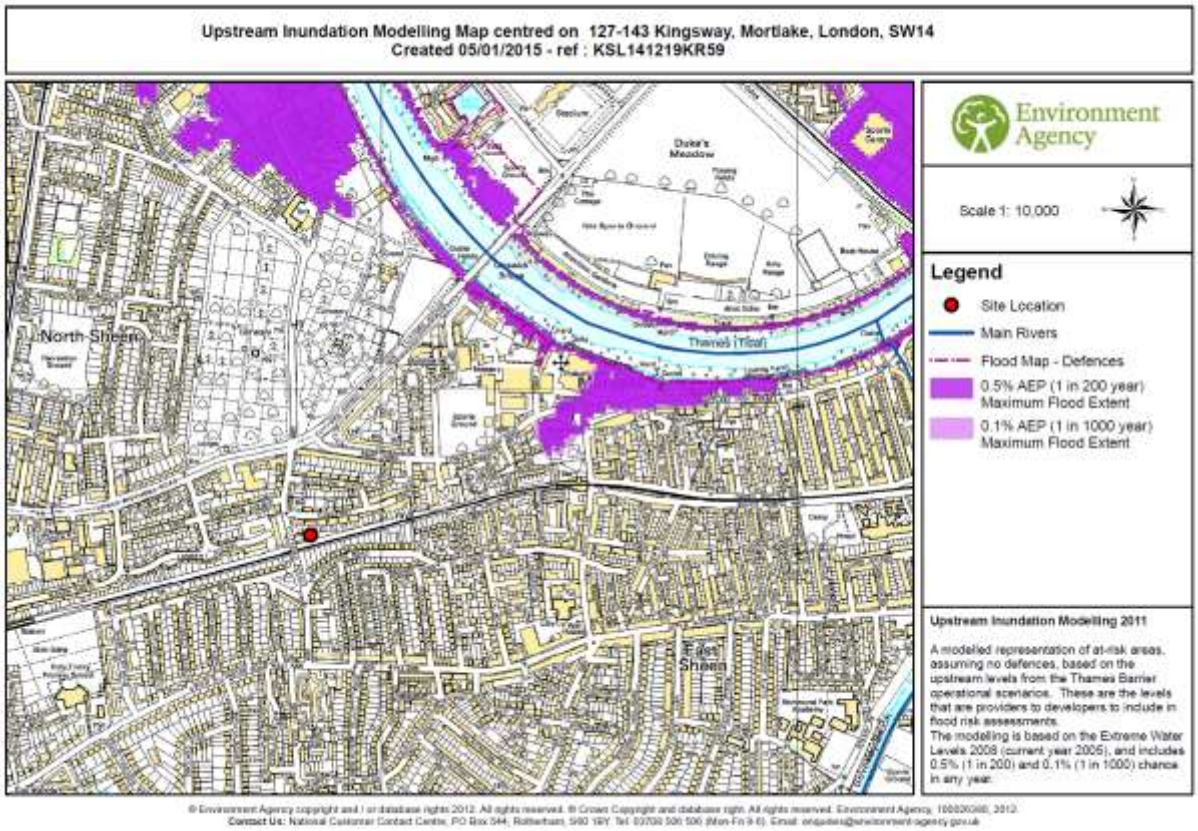
Figure 9 - Environment Agency Breach Modelling Map



4.4. Fluvial Flood Risk

In West London there is a heavy influence from Thames upstream flows (fluvial flows). As the flood defences are built to manage tidal flood risk only, if fluvial flows are very high, then river levels in Mortlake could exceed the 0.1% annual probability tidal event.

Figure 10 - Environment Agency upstream inundation modelling



The above map shows the extent of the 0.5 % AEP (1 in 200) and 0.1% AEP (1 in 1000) results for the Tidal Thames Upstream Inundation modelling study completed by Halcrow Group Ltd. in 2011. Based on the 2008 Extreme Water Level Modelling, the 0.5% and 0.1% probability of annual exceedance (1 in 200 and 1 in 1000 year joint probability respectively – Thames Barrier Operational) tidal event was modelled with a current year baseline of 2005. Using the domains created as part of the Flood Zones Improvements modelling completed by Halcrow Group Ltd. in 2006, the project generated outputs for water depths, velocity, levels and hazard. However the scenario modelled is that the Thames Barrier is operational but all linear defences have been removed. It uses the joint probability levels calculated in 2008 and only provides data for embayments upstream of the Thames Barrier. According to this information, the site will not be affected by an extreme fluvial event in respect of flooding. Consequently, the site is at no risk of fluvial flooding.

4.5. Canal Flood Risk

The proposed development is located at a considerable distance from the Grand Union Canal and consequently there is no risk of flooding from this source.

4.6. Reservoir Flood Risk

The site is identified as being at risk of reservoir flooding on the EA reservoir flood map; this is shown in Table 7 below.

Table 7 - Reservoir identified as posing a risk to the proposed development site

Name	Owner	Grid Reference	EA Area	Local Authority
Queen Mary	Thames Water Ltd	508310 169750	Hertfordshire and North London	Surrey

The reservoir flood map provided by the Environment Agency is a worst case scenario and in reality reservoir flooding is extremely unlikely with no loss of life attributed to dam failure in the UK since 1925 which was prior to reservoir safety legislation being introduced to ensure high standards in reservoir maintenance.

4.7. Groundwater/Geology

British Geological Survey records indicate that the proposed development site overlays bedrock composed of London Clay Formation – Clay and Silt. This is overlain by Alluvium – Clay, Silty, Peaty, Sandy. The superficial deposit permeability is spatially variable, but likely to permit moderate infiltration. The bedrock deposits are likely to be poorly draining.

Despite this, there is no history of groundwater flooding at the site or immediately surrounding area; as demonstrated within the 2010 SFRA and 2011 PFRA records. For this reason it is thought that the actual risk of flooding from this source is low.

4.8. Surface Water Flood Risk

When the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded, excess rainwater flows overland; this water will collect in topographic depressions and at obstructions, and can inundate development downslope. The severity of the rainfall event, the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use all contribute to and affect the severity of overland flow.

The Environment Agency's most recent flood map for surface water published in December 2013 is freely available online at their website and can be used to determine the approximate areas that would experience surface water flooding from a variety of rainfall return periods. The Environment Agency's flood map is based on the best information available to them, such as ground levels and drainage assumptions. The risk is categorised based on annual probability of occurrence. The different risk categories are displayed below in Table 8.

Table 8 - Environment Agency Surface Water Risk Categories

Environment Agency Surface Water Risk Category	Surface water flooding annual probability of occurrence
Very Low	Less than 0.1% (1 in 1,000 years)
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1,000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	Greater than 3.3% (1 in 30 years)

The surface water maps identify that the site has a low risk of surface water flooding. This type of flooding can be difficult to predict as it is hard to forecast where or how much rain will

fall in any storm. The Environment Agency's flood map is based on the best information available to them, such as ground levels and drainage assumptions.

4.9. Drainage and Sewage Infrastructure

Flooding is often caused by excess surface water entering the drainage network causing sewers to surcharge. Thames Water, who are responsible for the management of urban drainage and sewerage within the Borough, maintain a DG5 register of sites affected by sewer flood incidents on a post code basis.

For the ten years preceding production of the 2011 PFRA Thames Water have provided this data. This has been mapped within the 2011 PFRA and shows that there has been between 6 and 14 sewage incidents within the SW14 region.

It is important to note that previous sewer flood incidents or the lack thereof do not indicate the current or future risk to the site as upgrade works could have been carried out to alleviate any issues or conversely in areas that have not experienced sewer flooding the local drainage infrastructure could deteriorate leading to future flooding.

4.10. Climate Change

There is clear scientific evidence that global climate change is happening now. In the UK sea level has risen and more winter rain has fallen in intense wet spells over the past century. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

Looking ahead, greenhouse gas (GHG) levels in the atmosphere are likely to cause higher winter rainfall in future. Past GHG emissions mean some climate change is inevitable in the next 20-30 years. Lower emissions could reduce the amount of climate change further into the future, but changes are still projected at least as far ahead as the 2080s.

The Department for Environment, Food and Rural Affairs FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts (October 2006) provided information on sensitivity ranges for peak rainfall intensities and peak river flows (Table 9). This report also provides information on net sea level rise relative to 1990 (Table 10).

Table 9 – Defra recommended national precautionary sensitivity ranges for peak rainfall intensities and peak river flows

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%		

Table 10 - Defra recommended national precautionary sensitivity ranges for net sea level rises

	Net sea level rise (mm per year) relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, east midlands, London, south-east England (south of Flamborough Head)	4.0	8.5	12.0	15.0
South-west England	3.5	8.0	11.5	14.5
North-west England, north-east England (north of Flamborough Head)	2.5	7.0	10.0	13.0

On a more localised scale, if emissions follow a medium future scenario, UKCP09 projected changes by the 2050s relative to the recent past are:

- Winter precipitation increases of around 15% (very likely to be between 2 and 32%);
- Precipitation on the wettest day in winter up by around 15% (very unlikely to be more than 31%);
- Peak river flows in a typical catchment likely to increase between 8 and 18%.

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability. Wetter winters and more of this rain falling in wet spells may increase river flooding. More intense rainfall causes more surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared for the unexpected. Drainage systems in the district have been modified to manage water levels and could help in adapting locally to some impacts of future climate on flooding, but may also need to be managed differently. Rising sea or river levels may also increase local flood risk inland or away from major rivers because of interactions with drains, sewers and smaller watercourses. Even small rises in sea level could add to very high tides so as to affect places a long way inland.

According to the 2010 SFRA the site falls within a zone that will potentially be influenced by climate change in terms of flooding. The Environment Agency's modelling takes account of climate change and sea level rise and the flood defences along the tidal Thames will be raised to compensate for this as discussed above.

5.0 Mitigation Measures

5.1. Recommended Finished Floor Levels

In accordance with BS8533:2011 'Assessing and managing flood risk in development – code of practice', in order to afford a level of protection against flooding it is recommended that finished floor levels are set a nominal 300mm above either the 1 in 100 year annual probability fluvial flood (1%) or the 1 in 200 annual probability tidal flood (0.5%) in any year (including an allowance for climate change) depending on which is higher. Raising finished floor levels above ground level would also reduce the risk of flooding from other sources such as drainage infrastructure flooding.

We have demonstrated in this FRA that the site is not at risk of tidal flooding from present day and future (2100) flood levels and is not at residual risk from a breach. Therefore there is no need to raise floor levels as stated above.

5.2. Basement Protection

This FRA considers how the basement can be made safe in the event of flooding and that the risks can be mitigated.

In order to avoid flooding in the basement of the proposed development various measures can be taken. Ideally, the basement should be tanked up to the existing finished floor level; this usually includes the installation of a membrane system and basement sump tank and pump to manage water ingress. A warning device can be fitted to the pump in the event of a failure of the pump.

The key to an effective basement are moisture control (a water-managed foundation system to drain rainwater and groundwater away from foundations), airtight construction (sealing all air leaks between the conditioned space and the outside prior to insulation installation) and complete insulation coverage (properly installing the correct insulation levels, making sure the insulation coverage is continuous and complete, and aligning the insulation barrier with the air barrier).

5.3. Flood Warnings

Whilst this FRA demonstrates that the site is safe from flooding now and in the future, it would be advisable to maintain an awareness of flood conditions that may affect access in low lying areas in the locality by signing up to Floodline Warnings Direct.

5.3.1. Floodline Warnings Direct

The Environment Agency operates a free flood warning service called Floodline Warnings Direct (FWD) which can give advance notice of when flooding is likely to happen and time to prepare for a flood event. Property owners on the proposed development site will be able to sign up to FWD online using the following channels:

Table 11 - Floodline Warnings Direct

Channel	Details
Online	https://fwd.environment-agency.gov.uk/app/olr/register
Telephone	0845 988 1188
Typetalk	0845 602 6340

5.3.2. Flood Warning Service

The Environment Agency provides a Flood Warning Service throughout England and Wales in areas at risk of flooding from rivers or the sea. This is provided using up to date rainfall, river level and sea condition monitoring 24 hours a day to forecast the possibility of flooding. If flooding is forecast, the Environment Agency will issue warnings using a set of three different warning types (Table 12). Many areas of England are covered by the full four stages of the Environment Agency Flood Warning Service, including Twickenham. The Environment Agency Flood Warning target lead time; the time between a flood warning being issued and the onset of flooding is approximately 2 hours. Providing the Environment Agency can meet their target Flood Warning lead time, the occupants of the proposed development will have two hours to ensure that property is relocated to minimise risk and evacuation to safe locations can be carried out.

Table 12 - Environment Agency Flood Warning Codes

Flood Warning Code	What it Means	What To Do
	Flooding is possible. Be prepared.	Be prepared to act on your flood plan. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast on our website.
	Flooding is expected. Immediate action required.	Move family, pets and valuables to a safe place. Turn off gas, electricity and water supplies if safe to do so. Put flood protection equipment in place.
	Severe flooding. Danger to life.	Stay in a safe place with a means of escape. Be ready should you need to evacuate from your home. Co-operate with the emergency services. Call 999 if you are in immediate danger.

Warnings no longer in force	No further flooding is currently expected in your area.	Be careful. Flood water may still be around for several days. If you've been flooded, ring your insurance company as soon as possible.

5.3.3. Mortlake Flood Warning Service

Table 13 –Mortlake Flood Warning Details

Location	River Thames from Mortlake High Street East to Richmond Bridge including Mortlake, North Sheen, Kew, the Royal Botanic Gardens and Old Deer Park
Floodline	Call Floodline on 0845 988 1188, select option 1 and enter Quickdial number 174102 to get more information

5.4. Surface Water Runoff

There is no increase in impermeable surface area as a result of the development meaning there will be no impact of increased surface water. There is scope for the implementation of sustainable drainage (SuDS) techniques as part of the proposed development resulting in surface water improvement.

5.4.1. SuDS – Sustainable Drainage Systems

Paragraph 1.3.2 of the SuDS Manual (C697) discusses the SuDS 'management train' which is intended to mimic the natural catchment process as closely as possible. The hierarchy of techniques used to achieve the management train include:

Table 14 – SuDS Techniques

Technique	Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area or site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

Due to the scope of the development there is limited potential for the application of a SuDS approach. Regional and site control techniques are not considered to be applicable, however prevention and source techniques are thought to offer surface water improvement.

Table 15 – SuDS Techniques Feasibility

Technique	Issues	Feasible? Y/N
Prevention Good site design and housekeeping/rainwater harvesting/infiltration devices/education.	Water-butts could be considered for rainwater collection for use with cleaning operations or irrigation of plants.	Yes
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	A permeable surface could be considered for walkways. The use of a green roof is not feasible with this development.	Maybe No
Site and Regional Control Infiltration/detention basins/ balancing ponds/ wetlands/swales/retention ponds.	The scope of the development is too small for these techniques.	No

In summary, the proposed residential development could employ various sustainable surface water management techniques. This will decrease the impact of surface water volume downstream.

6.0 Conclusion

The site located at Kingsway Yard, Mortlake is located in Flood Zone 2 as described in Table 1 of the Planning Practice Guidance to the National Planning Policy Framework. The site benefits from flood defences that protect the site against tidal flooding to the 0.1% (1 in 1,000 year) annual probability standard. The NPPF requires a Flood Risk Assessment to be carried out to ensure flood risk to the proposed development is considered as well as the impact the development will have elsewhere on people and property.

The existing understanding of tidal flood risk at the site is based on the Environment Agency detailed flood risk data (Appendix B). The EA provided modelled flood levels along with breach modelling results in respect of the River Thames. The conclusion is that the site is not at risk of tidal flooding from the River Thames due to the presence of the defences and not at risk from a failure of the defences.

The site is at low risk from other sources of flooding including surface water, groundwater and canals.

As there is no increase in impermeable surfaces as a result of the proposed development, there will be no increase in surface water run-off rates or volume.

The site is within an Environment Agency Flood Warning Area meaning occupants will have access to flood warnings of up to two hours before onset.

It can be concluded therefore that the proposed development is appropriate for the flood risk and is not expected to increase the risk of flooding elsewhere.

7.0 Recommendations

- Flood resistant construction techniques should be employed to ensure that the proposed basement is safe from flooding and damp.
- In order to maintain awareness of flooding in the local area that may indirectly affect future residents of the property, it is recommended that they sign up to the free flood warning service offered by the Environment Agency.
- Whilst there is no increase in impermeable area and surface water run-off, it is recommended that basic SuDS techniques such as water butts/rainfall harvesting as outlined in Chapter 5.4 are employed.

Resilience and Flood Risk

Appendix A Development Proposals

To be provided by the client

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Appendix B Environment Agency Data

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Appendix C Sequential Test