

TFL_PSF_9131 SITE INVESTIGATIONS: SMALL SITES INITIATIVE LAND AT BRIDGE VIEW ROAD, LONDON BOROUGH OF HAMMERSMITH AND FULHAM, W6 9DD

Site Ref. 310


Flood Risk Review

OCTOBER 2017

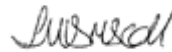
Land at Bridge View Road, London Borough of Hammersmith and Fulham, W6 9DD

Flood Risk Review

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1 INTRODUCTION

1.1 Background

Arcadis Consulting (UK) Limited ('Arcadis') has been commissioned by Transport for London (TfL) 'the Client' to undertake a number of technical surveys for a site known as Land at Bridge View Road in the London Borough of Hammersmith and Fulham ('the Site').

TfL is aiming to divest a number of small sites to enable positive regeneration. The objective of the Small Sites Initiative is to provide robust and pragmatic advice that sensibly de-risks each of the sites such that unreasonable 'abnormal' development costs are not included by developers.

The aim of this flood risk review is to assess the flood risk status of the Site and confirm the suitability for various forms of development on the Site as based on the findings of this desk study.

1.2 Scope of Works

Specific objectives of the flood risk review are to:

- Collect and review Environment Agency (EA) and Lead Local Flood Authority (Hammersmith and Fulham London Borough Council (HFLBC)) flood maps and published datasets (Strategic Flood Risk Assessments, Surface Water Management Plan and Local Flood Risk Management Strategy);
- Assess flood risk from all relevant sources (coastal and tidal, rivers, groundwater, surface water, sewers and artificial sources) and assign a risk value for each form of flooding (high, medium or low);
- Confirm the EA Flood Zone and confirm the acceptability of accommodating residential or other forms of development in accordance with the National Planning Policy Framework (NPPF) requirements;
- Confirm the need for application of the NPPF Sequential and Exception Tests; and
- Provide recommendations for further study or necessary flood risk mitigation measures to facilitate development.

1.3 Limitations

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This report has been compiled from a number of sources, which Arcadis believes to be trustworthy. However, Arcadis is unable to guarantee the accuracy of information provided by others. The report is based on information available at the time. Consequently, there is a potential for further information to become available, which may change this report's conclusion and for which Arcadis cannot be responsible.

2 SITE OVERVIEW

The Site covers 0.05 hectares and is located at the northern end of Bridge View Road adjacent to the Hammersmith Flyover (A4), centred at national grid reference 523025 178350.

The Site is located at the end of a terrace plot and consists of vacant, grassed land. The Site is located within a generally urban setting and is surrounded by residential, commercial and public buildings as well as some green open spaces. The Site is bounded by Bridge View Road to the east, residential properties to the south and west and by the Hammersmith Flyover (A4) and Hammersmith Bridge Road (A4 slip road) to the north, as shown in Figure 1.

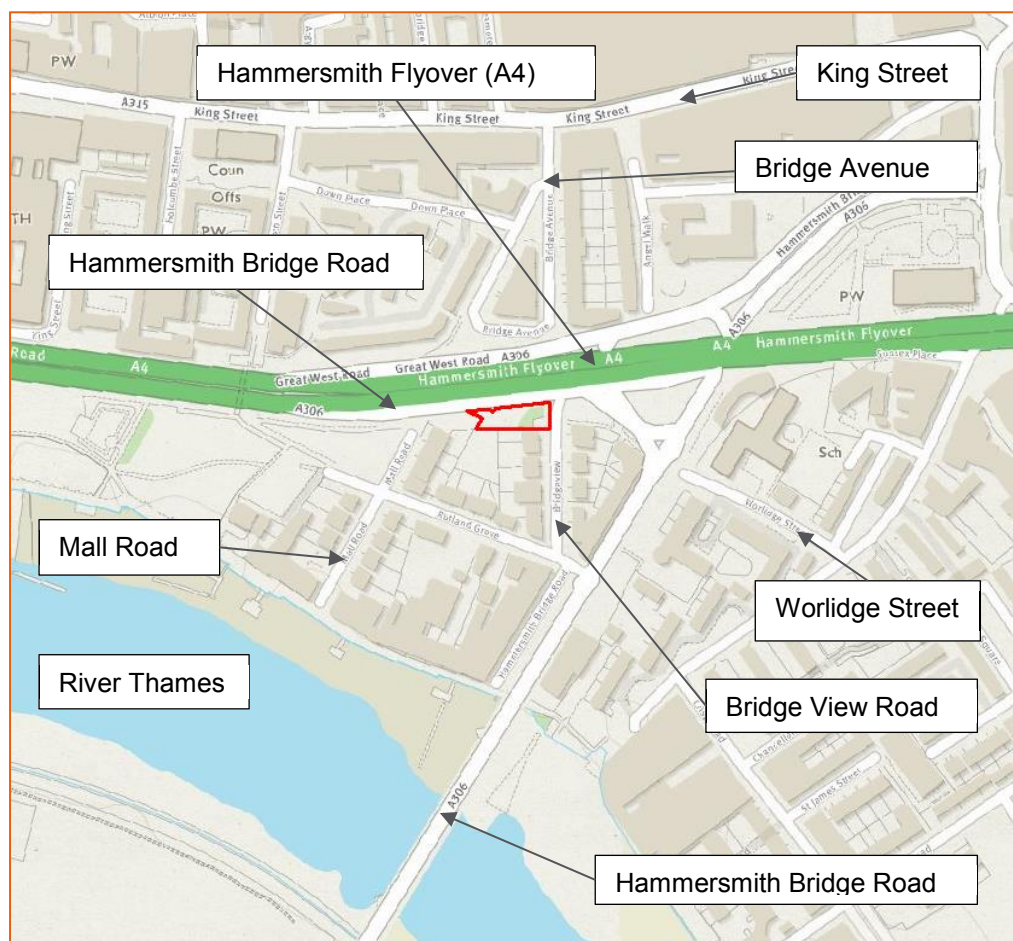


Figure 1: Site Location. Site Boundary Outlined in Red.
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Topographical information for the Site has been identified from data collected from a survey commissioned by TfL and completed by 40Seven in May 2017, verified against EA Opensource Government License 2m LiDAR digital terrain mapping (DTM) datasets (Ref. 1). The Site is generally flat, with ground levels between 4.90m above ordnance datum (mAOD) and 5.40mAOD, with slight gradients from west to east and from south to north. The landform in the wider area generally slopes down towards the River Thames in the south (Figure 2).

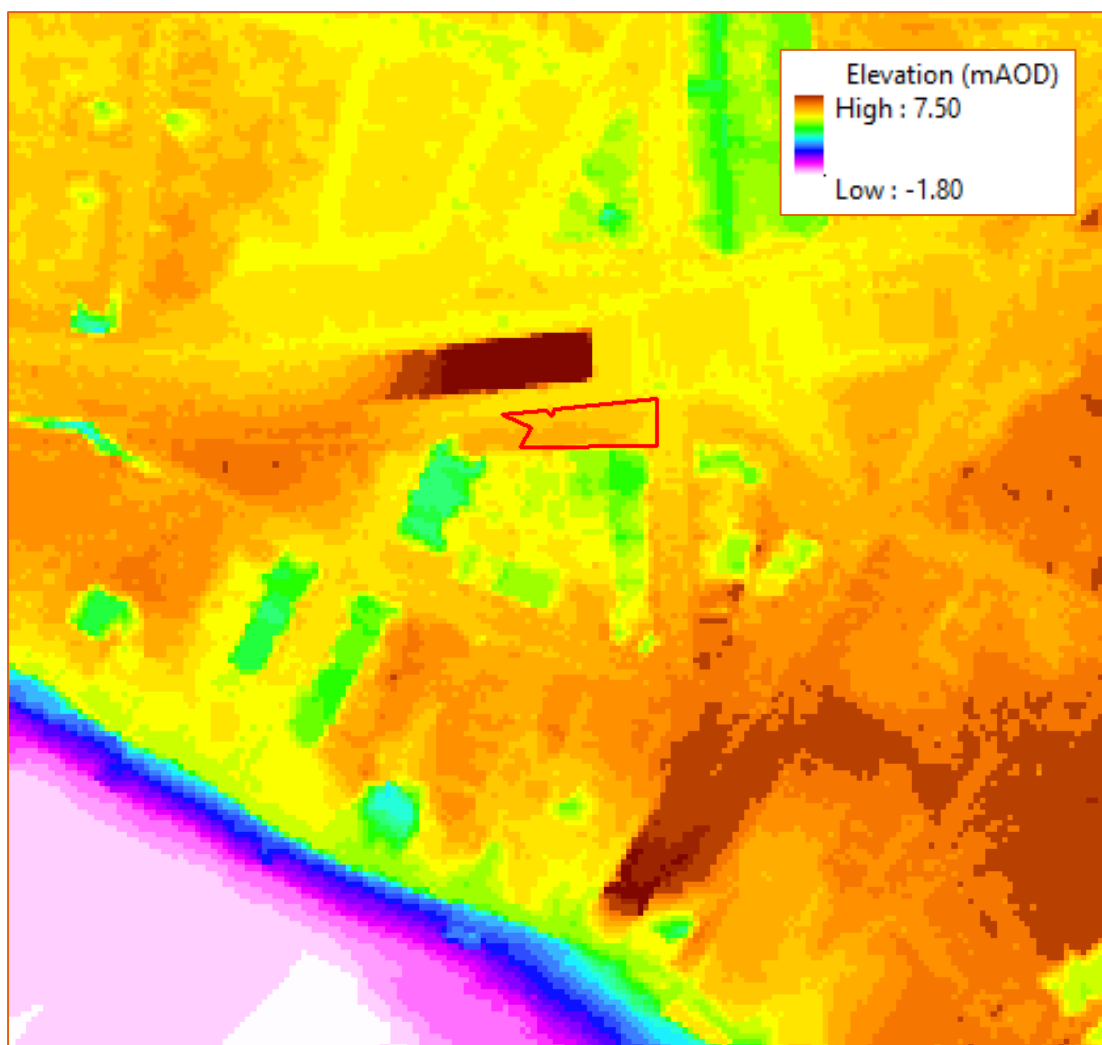


Figure 2: Site Topography. Site Boundary Outlined in Red.
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2.1 Catchment Description

The Site is located within the catchment of the River Thames, an EA designated Main River. The River Thames flows in a south easterly direction approximately 200m southwest of the Site and to this point drains a catchment of over 10,000km². The River Thames is tidally influenced to Teddington, approximately 15km upstream of the Site. The catchment local to the Site receives an average annual rainfall of 690mm (Ref. 2).

The HFLBC Strategic Flood Risk Assessment (SFRA) 2016 Update (Ref. 3) identifies two lost rivers in proximity of the Site, consisting of unnamed ordinary watercourses and minor tributaries of the River Thames that were built over and culverted during the growth of London (Figure 3). The rivers are located, at their closest, 350m west and 500m southeast of the Site and drain catchments of 1.1km² and 8.4km² respectively.

2.2 Ground Conditions and Aquifers

Soils underlying the Site are described as freely draining slightly acidic loamy soils (Ref. 4). The superficial geology consists of Kempton Park Gravel Formation – sand and gravel (Ref. 5), supporting a Secondary A aquifer (Ref. 6). Such aquifers are defined by rock layers or drift deposits with a wide range of permeability and storage that can support water supplies at a local scale. The bedrock

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geology underlying the Site consists of the London Clay Formation – clay and silt, which has no aquifer designation.

3 DATA SOURCES

Information has been drawn from web-based and published sources, outlined below, as well as having been collected through consultation with the EA who provided Flood Product 4 and Flood Product 8 data packs, reproduced in Appendix A (Ref. 7).

Web-bases sources:

- Flood Estimation Handbook (FEH) Web-Service;
- EA What's In Your Backyard? Interactive Maps;
- EA Long Term Flood Risk Interactive Maps (Ref. 8);
- EA Flood Map for Planning (Ref. 9);
- Cranfield Soil and AgriFood Institute, Soilscales Viewer;
- British Geological Survey, Geology of Britain Viewer.

Published documents:

- HFLBC SFRA 2016 Update;
- HFLBC Level 1 SFRA 2010 (Ref. 10);
- HFLBC Local Flood Risk Management Strategy (LFRMS) (Ref. 11);
- Surface Water Management Plan for HFLBC (SWMP) (Ref. 12);
- Thames Estuary 2100 (TE2100) Plan (Ref. 13).

4 RELEVANT PLANNING POLICES & DESIGNATIONS

4.1 NPPF and Flood Risk

The NPPF (Ref. 14) and accompanying flood risk and coastal change planning practice guidance (PPG) (Ref. 15) set out the Government's planning policy for England and advises on '*how to take account of and address the risks associated with flooding and coastal change in the planning process*'. The principal aim of the NPPF is to achieve sustainable development by accounting for flooding at all stages of the planning process, avoiding inappropriate development in areas at risk of flooding and directing development away from areas where risks are highest. Where development is necessary in areas at risk of flooding, the NPPF aims to ensure it is safe, without increasing flood risk to third parties.

Early adoption of, and adherence to, the principles set out in the NPPF and its PPG, with respect to flood risk, ensures that detailed designs and plans for development take due account of flood risk and the need for appropriate mitigation, if required.

4.2 The Sequential and Exception Tests

The NPPF identifies four Flood Zone classifications, detailed in Table 1 below.

Table 1: Flood Zones (Source: PPG, Table 1)

Flood Zone	Definition
Zone 1 – Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Zone 2 – Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Zone 3a – High Probability	Land having a greater than 1 in 100 annual probability of river flooding; or land having a greater than 1 in 200 annual probability of sea flooding.
Zone 3b – The Functional Floodplain	Land where water flows or is stored in times of flood.

The NPPF specifies that the suitability of all new development in relation to flood risk should be assessed by applying the Sequential Test to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development proposed. The NPPF provides guidance on the compatibility of each land use classification in relation to each of the Flood Zones, as summarised in Table 2.

Table 2: Flood Risk Vulnerability and Flood Zone Compatibility (Source: PPG, Table 3)

Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test required	✓	✓

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Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 3a	Exception Test required	✓	X	Exception Test required	✓
Zone 3b	Exception Test required	✓	X	X	X
Key: ✓ Development is appropriate X Development should not be permitted					

When the Exception Test is triggered, this requires the development proposals to demonstrate wider sustainability benefits to the community that outweigh flood risk, and that the development will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce overall flood risk.

The Site has been assessed against the NPPF planning tests in Section 6 of this report.

5 FLOOD RISK SOURCES AND FLOODING HISTORY

5.1 Overview

In line with best practice, flood risk from the range of possible sources listed in Table 3 has been considered.

Table 3: Potential Sources of Flooding

Source of Flooding	Description
1. Flooding from the sea (Coastal and Tidal)	Flooding originating from nearby sea or connected waterbody when seawater overflows onto land through extreme tidal conditions, storm surge or breach.
2. Flooding from rivers (Fluvial)	Floodwater originating from a nearby watercourse when the amount of water exceeds the channel capacity of that watercourse.
3. Flooding from land (Surface Water)	Flooding caused by intense rainfall exceeding the available infiltration and/or drainage capacity of the ground.
4. Flooding from groundwater	Flooding caused when groundwater levels rise above ground level following prolonged rainfall.
5. Flooding from reservoirs, canals and other artificial sources and sewers	Failure of infrastructure that retains or transmits water or controls its flow.

5.2 Historical Flooding

Historical flood records provided by the EA identify one flood incident in proximity to the Site, where the Site is located approximately 20m north of the 1928 River Thames Flood outline.

The HFLBC SFRA 2016 Update *Historical Flooding Overview* map shows more than 10 flooding incidences recorded by the HFLBC within 500m of the Site (the closest of which are located on Bridge Avenue, between 50 and 100m north of the Site; on King Street, approximately 200m north of the Site; on Hammersmith Bridge Road, approximately 200m south of the Site; and on Worlidge Street, 250m east of the Site). Six surface water flooding incidences affecting the A4 have also been recorded (with one incident located less than 50m northwest of the Site on the A4 slip road and the remainder over 200m west or east of the Site).

The HFLBC SFRA 2016 Update *Recorded Incidents of Sewer Flooding* map identifies 415 flooding incidences within the W6 postal code, however no specific location information is available. These incidences primarily relate to exceedance of the sewer network during heavy rainfall, in particular during the July 2007 storm.

5.3 Flood Defences

The River Thames is tidally dominated through London, with the most severe risks associated with tidal surges. The River Thames' catchment is defended through London via a combination of raised banks, river walls and tidal barriers, most notably the Thames Barrier.

The Thames Barrier and associated defence system protect to the 1 in 1000 year standard. In addition, the EA Flood Product 4 and 8 data packs state that '*if levels and flows are forecast to be any higher [than the 1 in 1,000 year standard] 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 upriver of the Barrier [beyond the 1 in 1,000 year standard] is controlled and therefore any associated return period becomes irrelevant.*'

In addition to the Thames Barrier, the River Thames is contained by river walls and raised banks that, in proximity to the Site, are raised to a height of 5.54mAOD. EA data describes the condition of these defences as 'Good', denoting defences with some 'minor defects'.

Through the combination of the Thames Barrier, river walls and other structures, the HFLBC LFRMS states that 'Hammersmith and Fulham is fully defended against the 0.1% annual probability extreme tide level'.

The TE2100 Plan, which sets out the EA recommendations for flood risk management for London and the River Thames to 2100, states that the river walls on the River Thames in the proximity of the Site (Node 2.20, Figure 3), should allow for future raising to a minimum level of 6.40mAOD by 2100.

5.4 Flooding from the Sea

The EA *Flood Map for Planning*, identifies the Site within an area designated as 'benefitting from flood defences'. This designation identifies areas that benefit from formal flood defences that protect to a minimum of a 1 in 200 (0.5%) standard from the sea. The EA *Flood Map for Planning* (which does not account for the presence of defences) identifies the Site as in Flood Zone 3, high flood risk (land having a greater than 1 in 200 (0.5%) annual probability of flooding from the sea). This denotes the high residual flood risk to the Site from the River Thames in the unlikely event of a failure/breach of the defences.

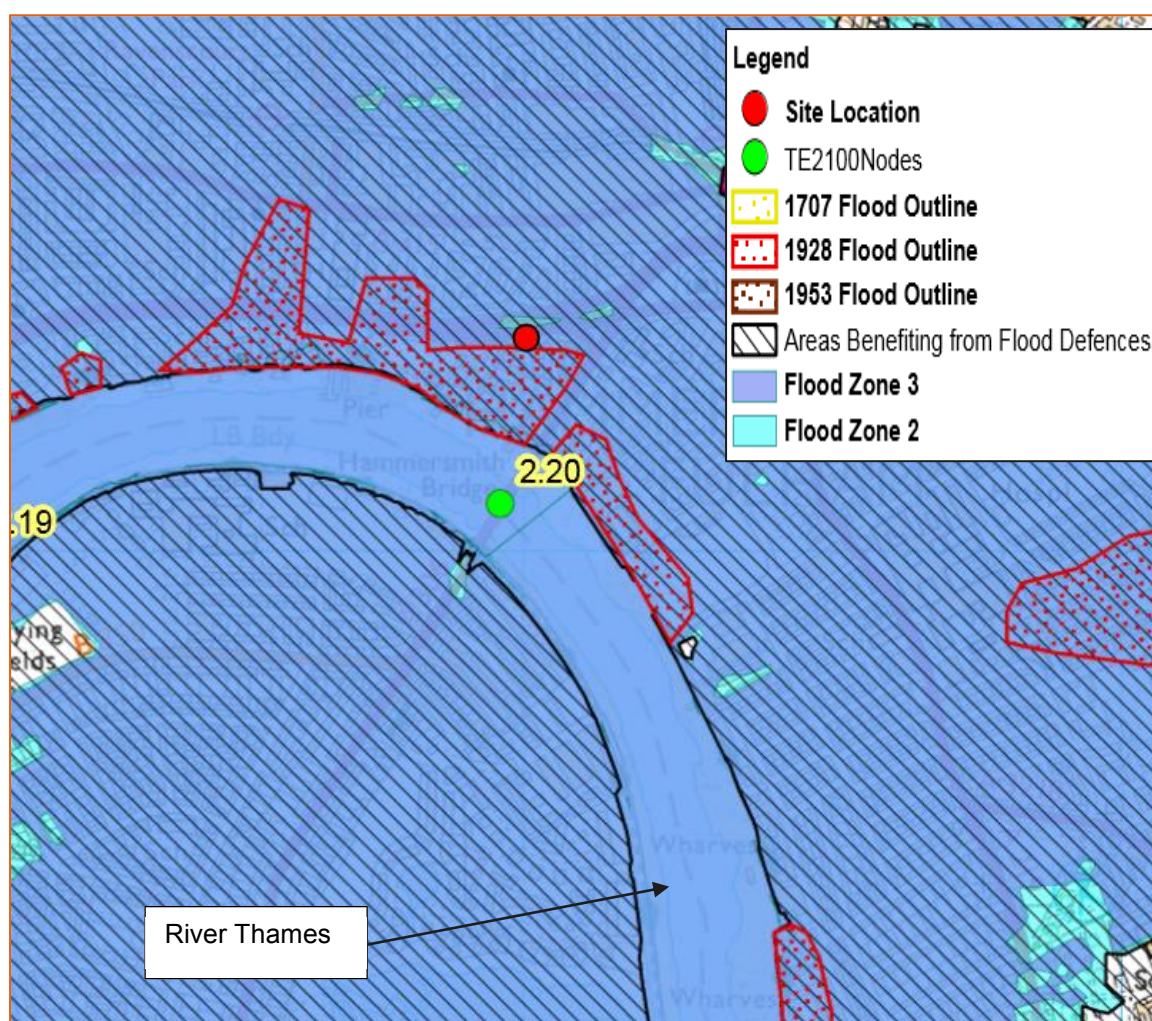


Figure 3 EA Flood Map for Planning. Site Location Indicated by the Red Dot.

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Modelled water levels applicable to the Site have been supplied by the EA, extracted from the TE2100 Plan. The TE2100 Plan provides extreme water levels (1 in 200 year annual exceedance events) in the River Thames for the present day and two future scenarios, incorporating an allowance for climate change. The TE2100 Plan estimates extreme water levels of 5.01mAOD (present day, 2012) and design water levels of 5.48mAOD (future, 2065) and 5.92mAOD (future, 2100) for a model node at Hammersmith Bridge (Node 2.20, Figure 3). These flood levels would result in overtopping of the current installed defences in the future (post 2065) due to the predicted effects of climate change. However, the TE2100 Plan provides recommendations for the improvement of the installed defences along the River Thames, including their raising and repair, in line with predicted climate change impacts. It is therefore anticipated that the Thames flood defences will be maintained to provide a 0.1% standard of protection over the lifetime of any proposed development at the Site.

It is therefore considered highly unlikely that the installed defences will be overtopped, instead the greatest tidal flood risk from the River Thames corresponds to a failure (breach) of the defences.

The EA *Thames Tidal Breach Modelling* map identifies the Site within the 1 in 200 (0.5%) annual probability flood event outline for the 2065 and 2100 modelled scenarios, from a breach at the southern extent of Mall Road (see Figure 1), with predicted flood levels at the Site of 5.361mAOD and 5.695mAOD. Compared with the Site's elevation, this results in a maximum flood depth of approximately 0.8m. In addition, the HFLBC SFRA 2016 Update *Tidal Breach Hazard (Maximum) 1 in 200yr event* map identifies the Site as having a Moderate (Danger to Some) to Significant (Danger for Most) flood hazard in the event of defence breach.

The River Thames defences are interspersed with demountable structures that allow boating access to the river and provide a more likely flood scenario if the defences are not replaced. The HFLBC Level 1 SFRA 2010 *Boat Access Point Failure* map shows the extent of flooding if the demountable flood defences are left open and estimates a flood depth of up to 0.6m on the Site, from a breach from the structure at the southern extent of Mall Road (see Figure 1).

Overall, it is considered that the Site is at a low risk of tidal flooding, due to the protection afforded by flood defences, but has a high residual risk of flooding from this source in the unlikely event of defence failure/breach.

5.5 Flooding from Rivers

The HFLBC SFRA 2016 Update does not identify fluvial flooding as a significant risk in the Borough. The Site is identified in Flood Zone 3, high flood risk, however this is associated with tidal flooding from the River Thames, rather than fluvial sources. It is considered that, given the standard of installed defences, there is a low risk of fluvial flooding to the Site from the River Thames.

The EA *Flood Map for Planning* and EA Flood Zone classifications do not illustrate flood risk from non-Main River sources (ordinary watercourses). There are two ordinary watercourses in proximity to the Site, however these watercourses are culverted and drain small catchments, therefore the flood risk from these watercourses is considered minor.

Overall, it is considered that the Site is at a low risk of fluvial flooding.

5.6 Flooding from Surface Water and Sewers

The EA *Risk of Flooding from Surface Water* map (Figure 4) identifies most of the Site as having a very low risk (less than 1 in 1,000 (0.1%) annual probability) of surface water flooding. A small proportion of the eastern extent of the Site, neighbouring Bridge View Road, is mapped at low risk (between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability) of flooding from this source. There are no records of surface water flooding within the Site boundary and the Site is not located in proximity to any flooding hotspots in the Hammersmith Broadway ward, as identified in the HFLBC SWMP.

However, the HFLBC SWMP identifies the Site within an area assigned with a moderate flood hazard rating (Danger to Some) and the Site is neighboured by areas designated with medium risk (between a 1 in 30 (3.3%) and 1 in 100 (1%) annual probability) and high risk (greater than 1 in 30 (3.3%) annual probability) of surface water flooding. Development of the site should seek to contribute towards reducing this risk.

Overall, it is considered that the Site is at a medium risk of surface water flooding.

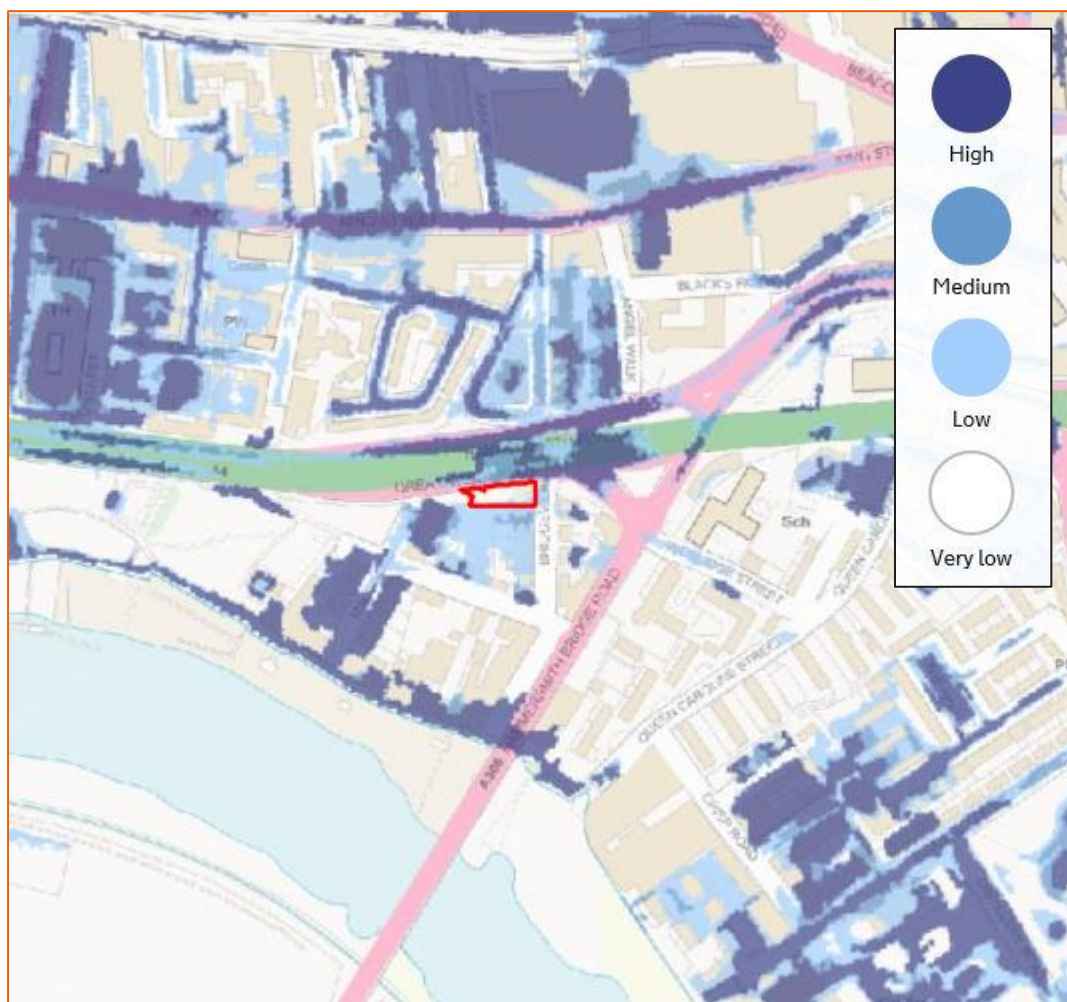


Figure 4: EA Risk of Flooding from Surface Water, Site Boundary Outlined in Red.
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The sewer network mainly consists of combined sewers and sewer flood risk is therefore intrinsically linked to surface water flood risk.

The HFLBC SFRA 2016 Update states that the HFLB is known to experience sewer flooding, particularly during heavy rainfall, and a significant number of sewer flooding incidences have been recorded within the local area. No specific location data is available for these occurrences, however the HFLBC SWMP states that '*areas which have in the past been affect by sewer flooding should not be seen as areas to avoid future development... [and] areas with no known flooding incidents should not always be viewed as the best place to accommodate new development.*' Instead, development locations should be assessed on an individual basis to ensure the sewer capacity exists, in the local and wider networks, to accommodate the proposals.

Overall, it is considered that the Site is at a medium risk of sewer flooding and it is recommended that consultation with Thames Water should be undertaken to understand the capacity of the local network serving the site.

5.7 Flooding from Groundwater

The HFLBC SFRA 2016 Update *Susceptibility to Groundwater Flooding Map* identifies the Site within an area having a Very High ($\geq 75\%$) susceptibility to groundwater flooding, which is linked to the high permeability of the superficial deposits and high permeability overlying soils. Water levels in the underlying soils may have connectivity with the River Thames, which could cause groundwater to rise to the surface if river levels were high for prolonged periods.

However, groundwater flooding generally only poses a risk to basements, ground floor properties and assets held below ground level and subsequently has an overall risk to life that is considered low. The HFLBC SFRA 2016 Update *Increase Potential for Elevated Groundwater* map does not include the Site within a risk area and there are no records of groundwater flooding affecting the Site.

Overall, it is considered that the Site is at a medium risk of groundwater flooding.

5.8 Flooding from Artificial Sources

The EA *Risk of Flooding from Reservoirs* map indicates that the Site is located within the maximum extent of flooding should large reservoirs fail and release the water that they hold. This risk is associated with numerous reservoirs upstream of the Site, but notably the Island Barn, Queen Elizabeth II, Knight, Bessborough, Queen Mary, Staines, King George VI, Wraysbury and Queen Mother Reservoirs. The consequence of reservoir breach can be very high, however continuing management of reservoirs under the Reservoirs Act 1975 serves to greatly reduce the likelihood of reservoir flooding.

Overall, it is considered that the Site is at a low risk of flooding from artificial sources.

6 RISK RATING & RECOMMENDATIONS FOR FURTHER INVESTIGATION

Following an assessment of flood risk to the Site from all likely sources, it is considered that there is a **Medium** risk of flooding from surface water, groundwater and sewers and a **Low** risk of flooding from rivers and artificial sources. The degree of tidal flood risk is dependent on the installed defences on the River Thames, which protect the Site up to the 0.1% tidal flood event.

Table 4: Flood Risk Sources

Source of Flooding	Flood Risk
1. Flooding from the Sea (Coastal and Tidal)	Low (High Residual)
2. Flooding from rivers (Fluvial)	Low
3. Flooding from land (Surface Water)	Medium
4. Flooding from groundwater	Medium
5. Flooding from reservoirs, canals and other artificial sources	Low
6. Flooding from sewers	Medium

The EA *Flood Map for Planning* identifies the Site as benefitting from the protection of defences, however the EA *Flood Map for Planning (ignoring the presence of defences)* identifies the Site in Flood Zone 3. Following the NPPF guidance, the Site would not be appropriate for ‘*Highly Vulnerable*’ development types (which includes emergency services stations and command centres; basement dwellings; caravans, mobile homes and park homes intended for permanent use; and installations requiring hazardous substance consent).

The Site would be suitable for ‘*Water Compatible*’ and ‘*Less Vulnerable*’ development types, but would trigger application of the Exception Test for ‘*More Vulnerable*’ (which includes residential land uses) and ‘*Essential Infrastructure*’ uses.

To satisfy the Exception Test, a Flood Risk Assessment (FRA) would need to be prepared and this report would be a key requirement in support of a planning application for development on the Site. The FRA would be a more detailed assessment than is presented in this Flood Risk Review and would need to be specific to the type and layout/configuration of development that is proposed.

The FRA should demonstrate that any proposed development would not be subject to an unreasonable risk of flooding and that developing the Site would not subsequently increase flood risk to third parties. The EA *Thames Tidal Breach Modelling* map identifies the Site within the likely flood extent following defence breach, with maximum flood depths of up to 0.8m during the extreme tidal flood events. Further investigation, via the FRA, would therefore be required to demonstrate how the Site can be developed safely, identifying necessary design measures to provide adequate protection in these flood scenarios, without increasing flood risk to third parties.

It is considered that there is a medium risk of surface water flooding and sewer flooding and there is a known history of sewer and surface water flooding in areas local to the Site. Surface water drainage and runoff from the Site, including available connections with the sewer network, should be further investigated and it should be ensured that drainage is managed to a high standard. Further investigation should include the calculation of current rainfall-runoff rates and volumes, greenfield runoff rates for the Site and confirmation of the available capacity of the local and wider sewer networks.

The Site is considered to have a medium risk of groundwater flooding and the HFLBC SFRA 2016 Update states that '*it is essential that groundwater flood risk is assessed in relation to any development*' and '*groundwater flood risk must be considered when designing Sustainable Drainage Systems [SuDS], in particular the potential impact of increased infiltration SuDS on properties further down gradient*'.

A Drainage Strategy should be developed, detailing methods to manage runoff from the Site, which would ideally be controlled to match greenfield rates. The HFLBC SFRA 2016 Update identifies the Site as in an area unsuitable for infiltration SuDS.

Overall, it is considered that the Site is inappropriate for Highly Vulnerable development types (residential use is not classified within this category). However, following the production of an FRA and Drainage Strategy it is considered likely that flood risk would not limit any other development types on the Site, including residential development.

7 REFERENCES

1. Her Majesty's Stationary Office, 2017. Open Government License, LiDAR Composite Digital Terrain Model (DTM) 2m spatial resolution. Accessed May 2017, via <http://environment.data.gov.uk/ds/survey/>
2. Centre for Ecology and Hydrology, 2017. Flood Estimation Handbook (FEH) Web-Service. Accessed May 2017 via: <https://fehweb.ceh.ac.uk/GB/map>
3. Capita AECOM, 2016. London Borough of Hammersmith and Fulham Strategic Flood Risk Assessment Update
4. Cranfield Soil and Agrifood Institute, 2017. Soilscales Viewer. <http://www.landis.org.uk/soilscales/>
5. British Geological Survey, 2017. Geology of Britain Viewer. Accessed May 2017 via: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>
6. Environment Agency, 2017. What's In Your Backyard? Groundwater map. Accessed May 2017 via: http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683&y=355134&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=groundwater
7. Environment Agency, 2017. Provision of Product 4 and 8 for FRA Bridge View, Hammersmith and Fulham, W6 9LQ.
8. Environment Agency, 2017. Long term flood risk information. Accessed May 2017 via <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>
9. Environment Agency, 2017. Flood Map for Planning. Accessed May 2017 via <https://flood-map-for-planning.service.gov.uk/>
10. JBA Entec, 2010. Kensington, Chelsea, Hammersmith and Fulham Level 1 Strategic Flood Risk Assessment.
11. Hammersmith and Fulham London Borough Council, 2017. London Borough of Hammersmith and Fulham, Local Flood Risk Management Strategy
12. Capita URS, 2015. London Borough of Hammersmith and Fulham, Updated Surface Water Management Plan.
13. Environment Agency, 2011. Thames Estuary 2100 (TE2100) Plan.
14. Department for Communities and Local Government, 2012. National Planning Policy Framework
15. Department for Communities and Local Government, 2014. Planning Practice Guide: Flood Risk and Coastal Change

APPENDIX A

EA Flood Data Packs 4 and 8

Product 4 (Detailed Flood Risk) for: W6 9LQ (523007, 178355)

Reference: HNL49192JH

Date: 12/06/2017

Contents

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- Thames Tidal Breach Modelling
- Thames Tidal Breach Modelling Map
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- Thames Tidal Upstream Inundation Modelling Map
- Site Node Locations Map
- Defence Details
- Recorded Flood Events Data
- Recorded Flood Events Outlines Map
- Additional Information
- Environment Agency Standard Notice

The information provided is based on the best data available as of the date of this letter.

You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements to the data for this location have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

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

Flood Map for Planning (Rivers and Sea)

The Flood Map:

Our Flood Map shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences. Although flood defences reduce the risk of flooding they cannot completely remove that risk as they may be over topped or breached during a flood event.

The Flood Map indicates areas with a 1% (0.5% in tidal areas), Annual Exceedance Probability (AEP) - the probability of a flood of a particular magnitude, or greater, occurring in any given year, and a 0.1% AEP of flooding from rivers and/or the sea in any given year. In addition, the map also shows the location of some flood defences and the areas that benefit from them.

The Flood Map is intended to act as a guide to indicate the potential risk of flooding. When producing it we use the best data available to us at the time and also take into account historic flooding and local knowledge. The Flood Map is updated on a quarterly basis to account for any amendments required. These amendments are then displayed on the internet at

<https://www.gov.uk/government/organisations/environment-agency>.

At this Site:

The Flood Map shows that this site lies within Flood Zone 3 - with a 0.5% chance of flooding from the sea (tidal flooding) in any given year

Enclosed is an extract of our Flood Map which shows this information for your area.

Method of production

The Flood Map at this location has been derived using detailed modelling of the tidal River Thames through the Thames Tidal Defences Study completed in 2006 by Halcrow Ltd.

Thames Estuary 2100 (TE2100)

You have requested in-channel flood levels for the tidal river Thames. These have been taken from the Thames Estuary 2100 study completed by HR Wallingford in 2008. The modelled node closest to your site is **2.20**; the locations of nearby nodes are also shown on the enclosed map.

Details about the TE2100 plan

The TE2100 plan is now live and within it are a set of levels on which the flood risk management strategy is based. The plan is the overarching flood management strategy for the Thames Estuary and therefore any development planning should be based on the same underlying data.

Details about the TE2100 in-channel levels

The TE2100 in-channel levels take into account operation of the Thames Barrier when considering future levels. The Thames Barrier requires regular maintenance and with additional closures the opportunity for maintenance will be reduced. When this happens, river levels – for which the Barrier would normally shut for the 2008 epoch – will have to be allowed through to ensure that the barrier is not shut too often. For this reason, levels upriver of the barrier will increase and the tidal walls will need to be heightened to match.

Why is there no return period for levels upriver of the barrier?

The levels upriver 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 upriver 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.

TE2100 2008 levels:

Levels downriver of the Thames Barrier are 0.1% AEP (1 in 1000) and levels upriver are the highest levels permitted by the Thames Barrier, described as the Maximum Likely Water Levels (MLWLs). The defence levels (left defence, right defence) are the minimum levels to which the defences should be built.

Location	Node	Easting	Northing	Extreme water level (m)	Left defence (m)	Right defence (m)	Allow for future defence raising to a level of...	
							Left Bank (m)	Right Bank (m)
Barnes	2.19	522080	177994	5.03	5.54	5.94	6.40	6.40
	2.2	522963	178079	5.01	5.54	5.94	6.40	6.40
	2.21	523388	177068	4.96	5.54	5.94	6.40	6.40

TE2100 climate change levels:

Location	Node	Easting	Northing	2065 to 2100		2100	
				Design water level	Defence level (both banks)	Design water level	Defence level (both banks)
Barnes	2.19	522080	177994	5.49	5.95	5.93	6.40
	2.2	522963	178079	5.48	5.95	5.92	6.40
	2.21	523388	177068	5.45	5.95	5.89	6.40

Thames Tidal Breach Modelling

The table below displays site-specific modelled flood levels at your site. These have been taken from the Thames Tidal Breach Modelling Study 2015 completed by CH2M HILL in March 2015. The exact location of the given site-specific levels and the extent of the breach are shown on the enclosed map.

This modelling simulates tidal breaches along the Thames from Teddington to the Mar Dyke and River Darent. A series of 113 tidal models were developed for the Environment Agency at pre-determined breach locations. These were chosen using a risk-based approach by examining critical locations based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width.

Based on the 2008 TE2100 in-channel levels, the 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) annual probability of exceedance tidal events were modelled for all breach locations downriver of the Thames Barrier. These were modelled for the 2065 year epoch, as well as the 2100 epoch which include allowances for climate change.

For breaches upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. The levels used are referred to as Maximum Likely Water Levels (MLWLs). Therefore 2065 and 2100 epochs were modelled on that basis.

Please note that we have produced only a finite number of breach models for the Tidal Thames, based on a number of key locations. Although these modelled levels are site-specific levels at your site, they may not have captured the most critical breach location for this site. Therefore you may need to consider carrying out additional modelling to simulate the breaching of defences in an alternative location.

The modelled levels shown assume that the Thames defences have been breached at location 'Ham02 (TQ2252978312) and Ham03 (TQ2289378222).

Ham 02

Node	National Grid Reference		Modelled levels in mAODN for Max Likely Water Level	
	Easting	Northing	2065	2100
0	523042	178363	No Flood	5.292
1	523041	178350	No Flood	5.292
2	523026	178350	No Flood	No Flood
3	523011	178350	No Flood	No Flood
4	522996	178350	No Flood	No Flood
5	522993	178357	No Flood	5.292
6	523004	178358	No Flood	5.292
7	523019	178359	No Flood	5.292
8	523034	178361	No Flood	5.292
9	523031	178355	No Flood	5.292
10	523011	178355	No Flood	5.195

Ham 03

Node	National Grid Reference		Modelled levels in mAODN for Max Likely Water Level	
	Easting	Northing	2065	2100
0	523042	178363	5.333	5.695
1	523041	178350	5.334	5.695
2	523026	178350	No Flood	5.694
3	523011	178350	5.017	5.694
4	522996	178350	5.089	5.694
5	522993	178357	5.361	5.694
6	523004	178358	5.333	5.694
7	523019	178359	5.333	5.694
8	523034	178361	5.333	5.695
9	523031	178355	5.334	5.695
10	523011	178355	5.225	5.694

Thames Tidal Upstream Inundation Modelling

The enclosed map shows results for the Thames Tidal Upstream Inundation Modelling Study 2015 completed by CH2M HILL in March 2015.

Upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2065 and 2100 epochs were modelled on that basis.

Using the domains updated as part of the Thames Tidal Breach Modelling Study 2015 completed by CH2M HILL in March 2015, 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 TE2100 in-channel levels calculated in 2008 and only provides data for embayments upriver of the Thames Barrier.

Point	National Grid Reference		Modelled levels in mAODN	
	Easting	Northing	2065	2100
0	523042	178363	5.143	5.608
1	523041	178350	5.272	5.635
2	523026	178350	5.399	5.684
3	523011	178350	5.446	5.716
4	522996	178350	5.447	5.719
5	522993	178357	5.407	5.704
6	523004	178358	5.401	5.698
7	523019	178359	5.386	5.682
8	523034	178361	5.179	5.61
9	523031	178355	5.224	5.62
10	523011	178355	5.43	5.707

Defence Details

The design standard of protection of the flood defences in this area of the Thames is 0.1% AEP; they are designed to defend London up to a 1 in 1000 year **tidal** flood event. The defences are all raised, man-made and privately owned. It is the riparian owners' responsibility to ensure that they are maintained to a crest level of **5.54m** AODN (the Statutory Flood Defence Level in this reach of the Thames). We inspect them twice a year to ensure that they remain fit for purpose. The current condition grade for defences in the area is **2 (good)**, on a scale of 1 (very good) to 5 (very poor). For more information on your rights and responsibilities as a riparian owner, please see our document 'Living on the edge' found on our website at:

<https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities>

There are no planned improvements in this area. Please see the 'Thames Estuary 2100' document on our website for the short, medium and long term Flood Risk Management strategy for London:

<https://www.gov.uk/government/publications/flooding-thames-estuary-2100-te2100-plan>

Areas Benefiting from Flood Defences

This site is within an area benefiting from flood defences, as shown on the enclosed extract of our Flood Map. Areas benefiting from flood defences are defined as those areas which benefit from formal flood defences specifically in the event of flooding from rivers with a 1% (1 in 100) chance in any given year, or flooding from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there, these areas would be flooded. An area of land may benefit from the presence of a flood defence even if the defence has overtopped, if the presence of the defence means that the flood water does not extend as far as it would if the defence were not there.

Recorded Flood Events Data

We hold records of historic flood events from rivers and the sea. Information on the floods that may have affected the area local to your site are provided in the enclosed map.

Due to the fact that our records are not comprehensive, we would advise that you make further enquiries locally with specific reference to flooding at this location. You should consider contacting the relevant Local Planning Authority and/or water/sewerage undertaker for the area.

We map flooding to land, not individual properties. Our historic flood event record outlines are an indication of the geographical extent of an observed flood event. Our historic flood event outlines do not give any indication of flood levels for individual properties. They also do not imply that any property within the outline has flooded internally.

Please be aware that flooding can come from different sources. Examples of these are:

- from rivers or the sea;
- surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system);
- overflowing or backing up of sewer or drainage systems which have been overwhelmed,
- groundwater rising up from underground aquifers

Currently the Environment Agency can only supply flood risk data relating to the chance of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding and drainage systems that have been overwhelmed.

Other Sources of Flood Risk

The Lead Local Flood Authority for your area are responsible for local flood risk (i.e. surface runoff, ground water and ordinary watercourse) and may hold further information .

You may also wish to consider contacting the appropriate relevant Local Planning Authority and/or water/sewerage undertaker for the area. They may be able to provide some knowledge on the risk of flooding from other sources.

Additional Information

Use of Environment Agency Information for Flood Risk / Flood Consequence Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In **England**, you should refer to the Environment Agency's Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

<https://www.gov.uk/flood-risk-standing-advice-frsa-for-local-planning-authorities>

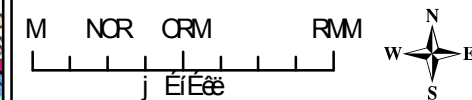
<https://www.gov.uk/government/publications/national-planning-policy-framework-technical-guidance>

<https://www.gov.uk/government/publications/development-and-flood-risk-practice-guide-planning-policy-statement-25>

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.



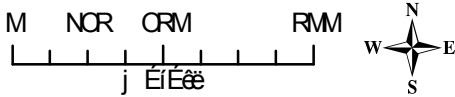
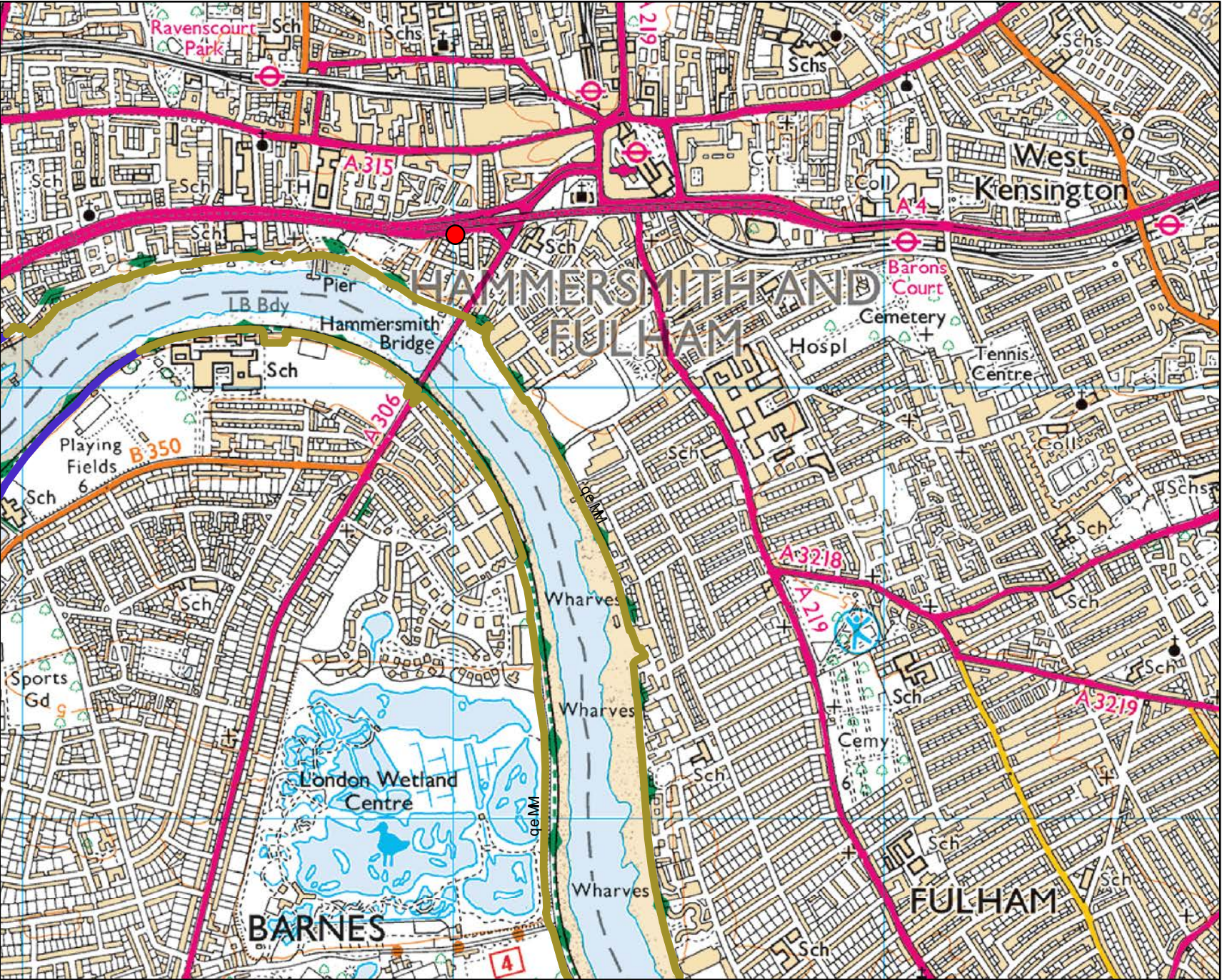
Legend

- Site Location**
- qbONMkçQĖĖ
- 1707 Flood Outline**
- 1928 Flood Outline**
- 1953 Flood Outline**
- Flood Zone 3**
- Flood Zone 2**

Flood Map for Planning (assuming no defences)

Flood Zone 3 = U C U E = E = U = A C A E
 ~ N E A E C A = N C A O W
 = N C A = U E = E = A U = M R B = E O E = I E e
 = A U = A E = N A A E O E = A U = E = e
 = C E N A = E E E A U = N B = C O E = I E e
 = A U = A E = N A A E O E = A U = E = A K

Flood Zone 2 Üçüncü Derece Tehlike Alanıdır. Bu alanda bulunan yapılar için özel önlemler alınmalıdır.

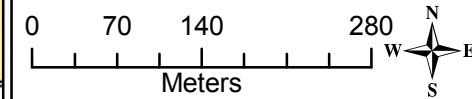


- Legend**
- Site Location
 - TTD Defences SDL (mAODN)
 - SDL
 - R/RQ
 - R/VQ

Flood Map for Planning (assuming no defences)

Flood Zone 3 - Areas at high risk of flooding from the sea, including areas that are currently used for agriculture, forestry, or other land uses that are not suitable for residential or commercial development.

Flood Zone 2 - Areas at medium risk of flooding from the sea, including areas that are currently used for residential or commercial development.



Legend

● Site Location

■ Breach Locations

Upriver MLWL Outlines

Epoch

■ 2014

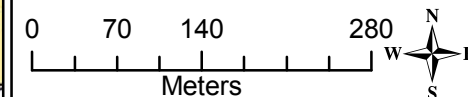
■ 2065

■ 2100

Thames Tidal Breach Modelling 2015

A modelled representation of tidal breaches along the Thames from Teddington to the Mar Dyke and River Darent, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epochs 2065 and 2100.

Upstream Inundation Modelling Map for: 523007, 178355 - 12/06/2017 - HNL/49192/JH



Legend

● Site Location

Upriver MLWL Outlines

Epoch

2014

2065

2100

Upstream Inundation Modelling 2015

The modelled scenario is that the Thames Barrier is operational but all linear defences have been removed. The modelling is based on the 2008 TE2100 in-channel levels including an allowance for climate change.

Upstream of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2014, 2065 and 2100 epochs were modelled using Maximum Likely Water Levels (MLWLs).

Modelled Flood Levels For: 523007, 178355 - 12/06/2017 - HNL/49192/JH



0 2 4 8
Meters



Legend

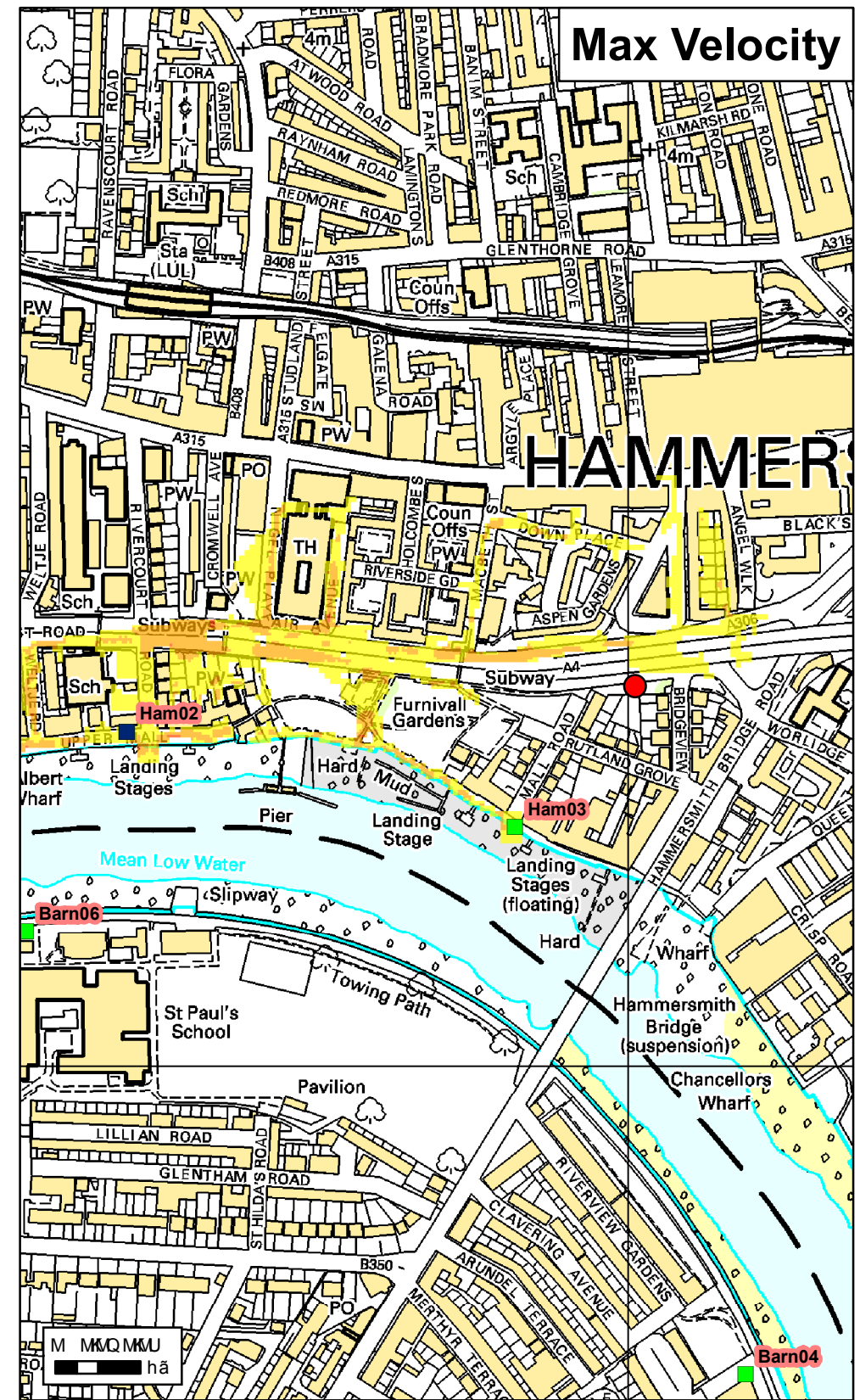
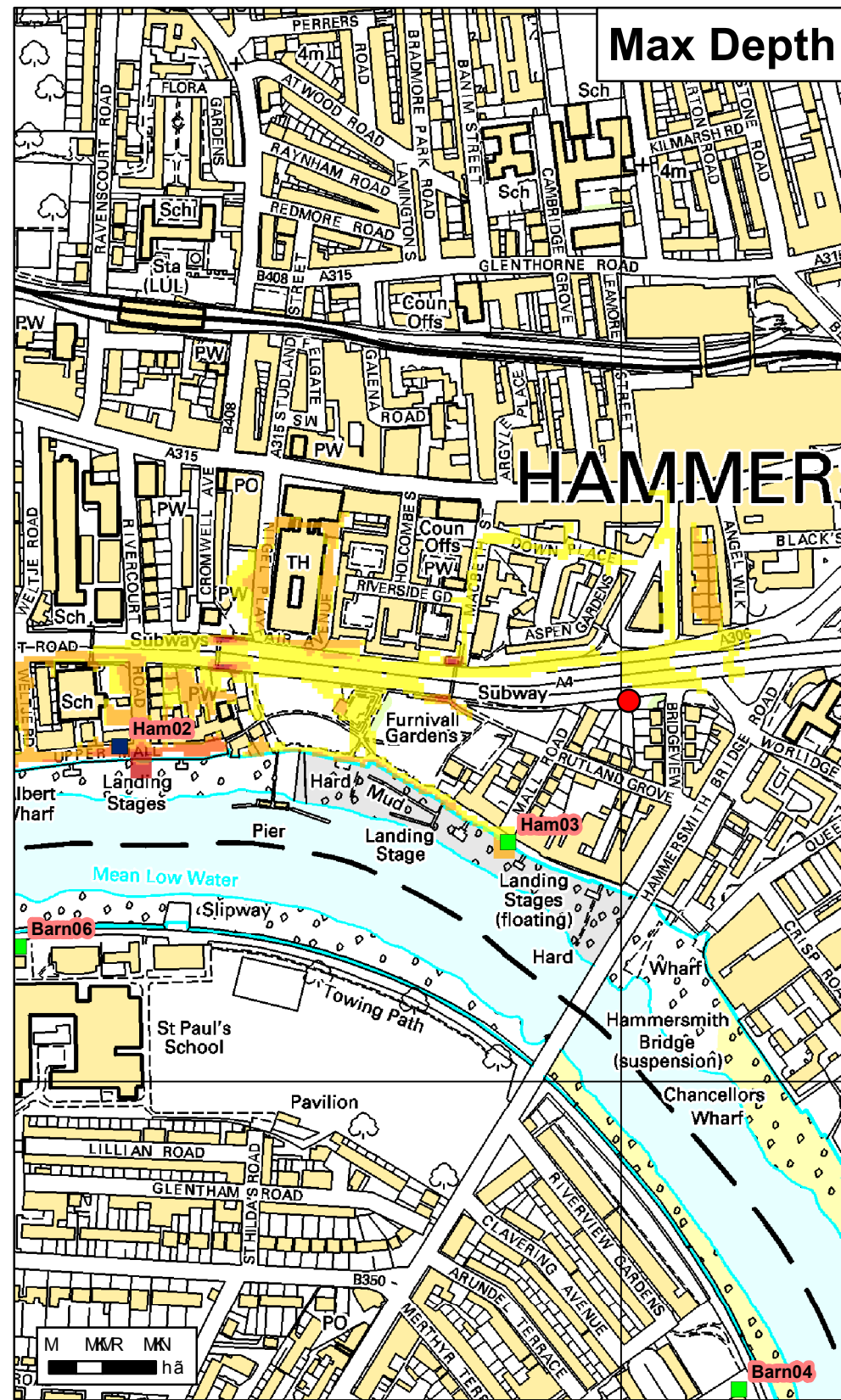
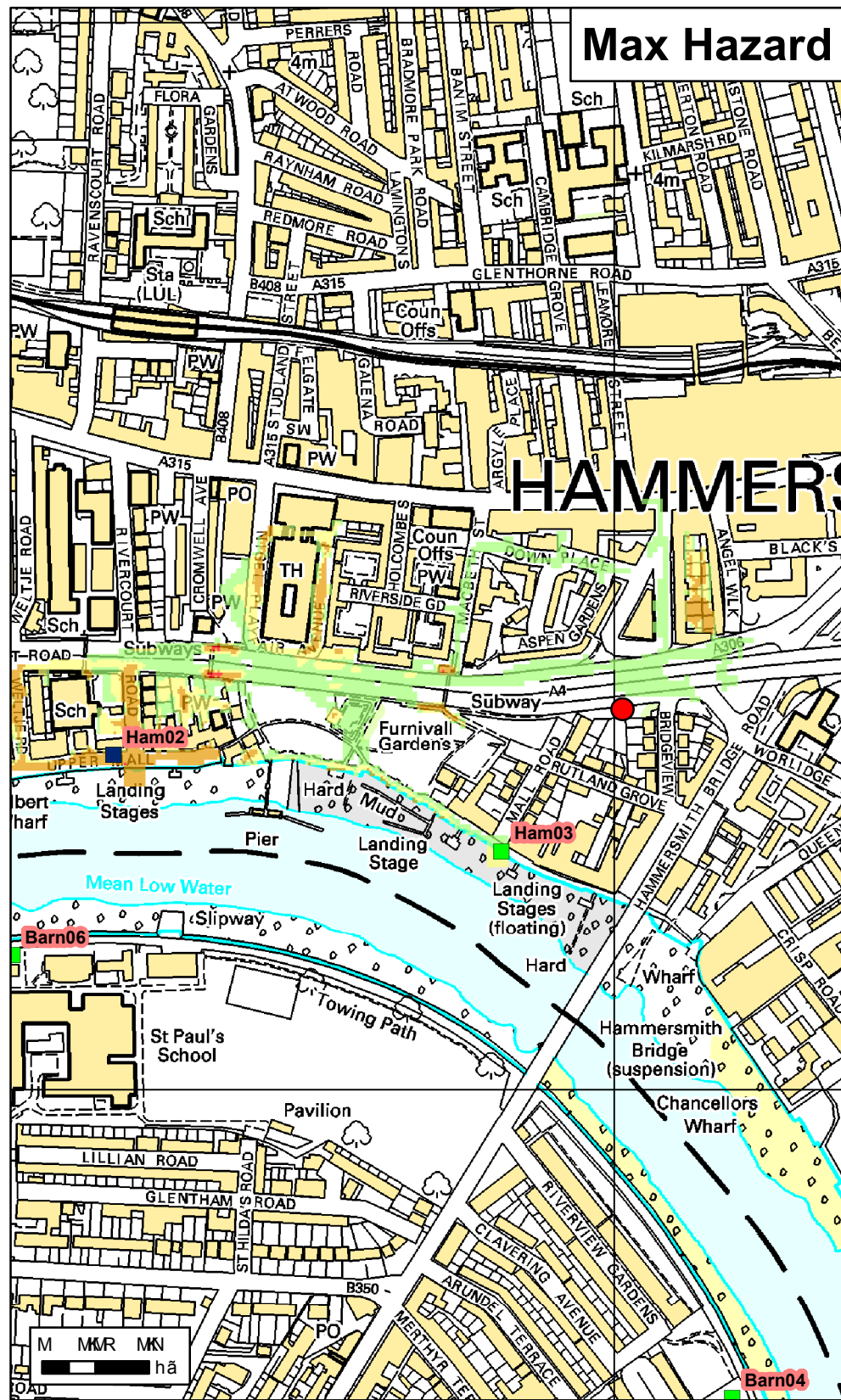
- Site Location
- Points

Thames Tidal Breach Modelling 2015

A modelled representation of tidal breaches along the Thames from Teddington to the Mar Dyke and River Darent, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epochs 2065 and 2100.

Upstream Inundation Modelling 2015

The modelled scenario is that the Thames Barrier is operational but all linear defences have been removed. The modelling is based on the 2008 TE2100 in-channel levels including an allowance for climate change. Upstream of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. Therefore 2014, 2065 and 2100 epochs were modelled using Maximum Likely Water Levels (MLWLs).



Max Hazard		Max Depth (m)		Max Velocity (m/s)	
	Low		M=1MCR		M=1MCR
	Medium		MCR=1MCR		MP=1MCR
	High		NM=1MCR		NM=1MCR
	Very High		NR=1MCR		NR=1MCR
	Extreme		[=0MCR]		[=0MCR]
Date Printed	NOLMSLOWT	Scenario year	QMSR e~ã ~VO	Scenario Annual Chance	MRB ENã ~OMF

The maps show the maximum hazard, depth, and velocity of the Thames tidal breach. The hazard levels are based on the potential impact of the breach on the surrounding area. The depth levels are based on the maximum water level that could be reached. The velocity levels are based on the maximum speed of the water flow.

The maps are based on the following assumptions:

- The breach is assumed to be a straight line across the river.
- The water level is assumed to be at the mean low water level.
- The water flow is assumed to be uniform across the river.
- The surrounding area is assumed to be flat.

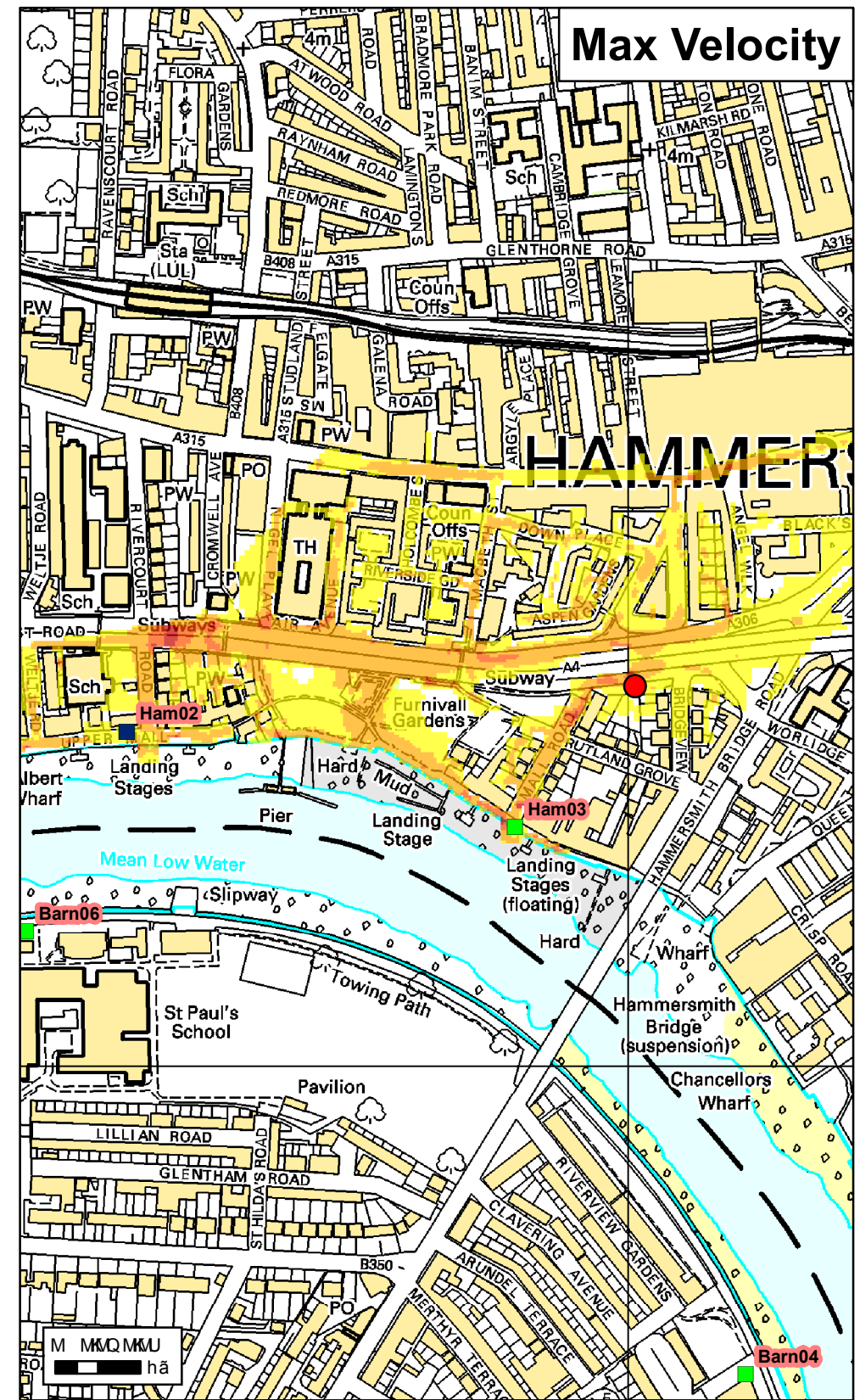
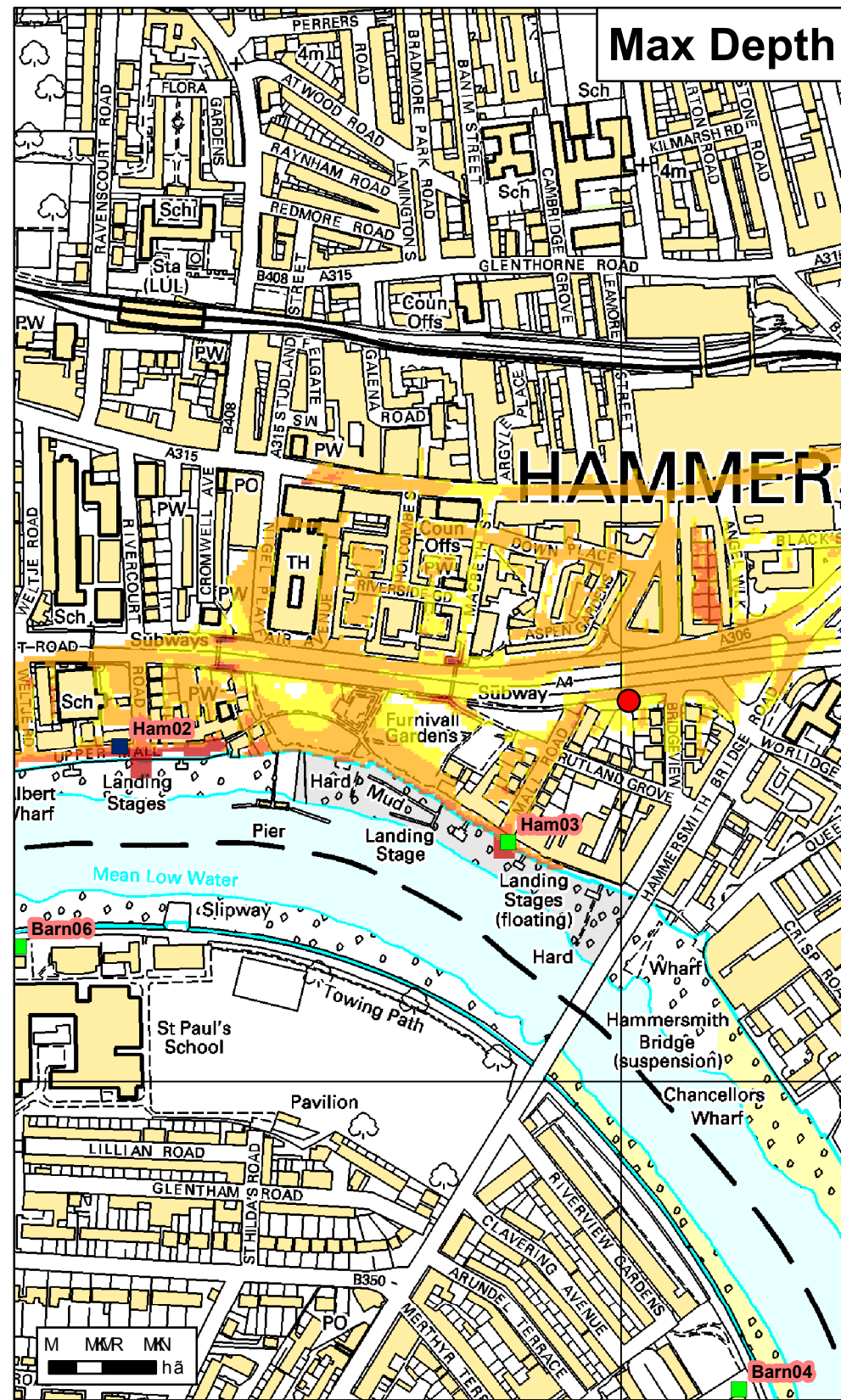
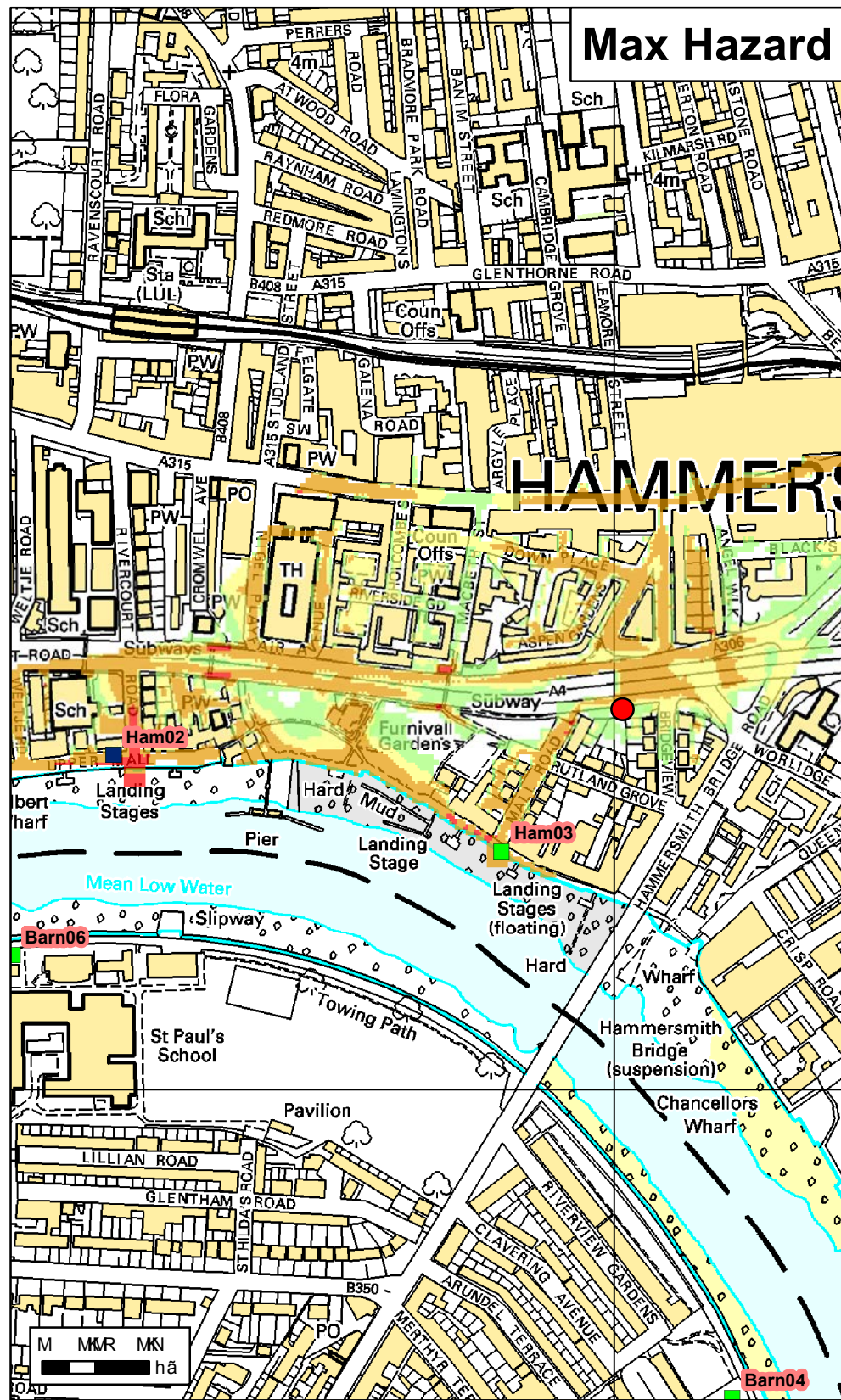
The maps are intended to provide a general overview of the potential impact of the breach. They are not intended to be used for detailed planning or design purposes.



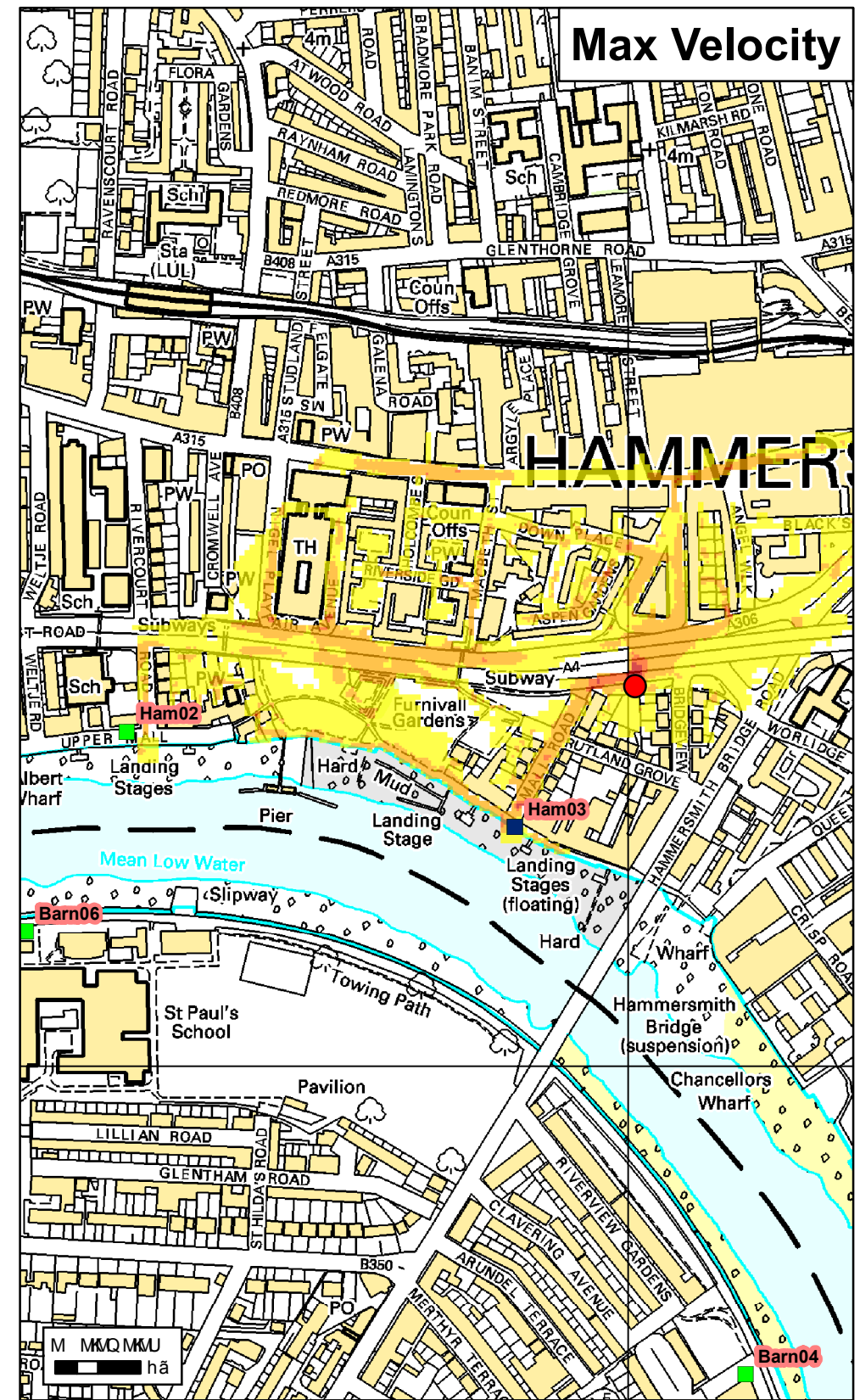
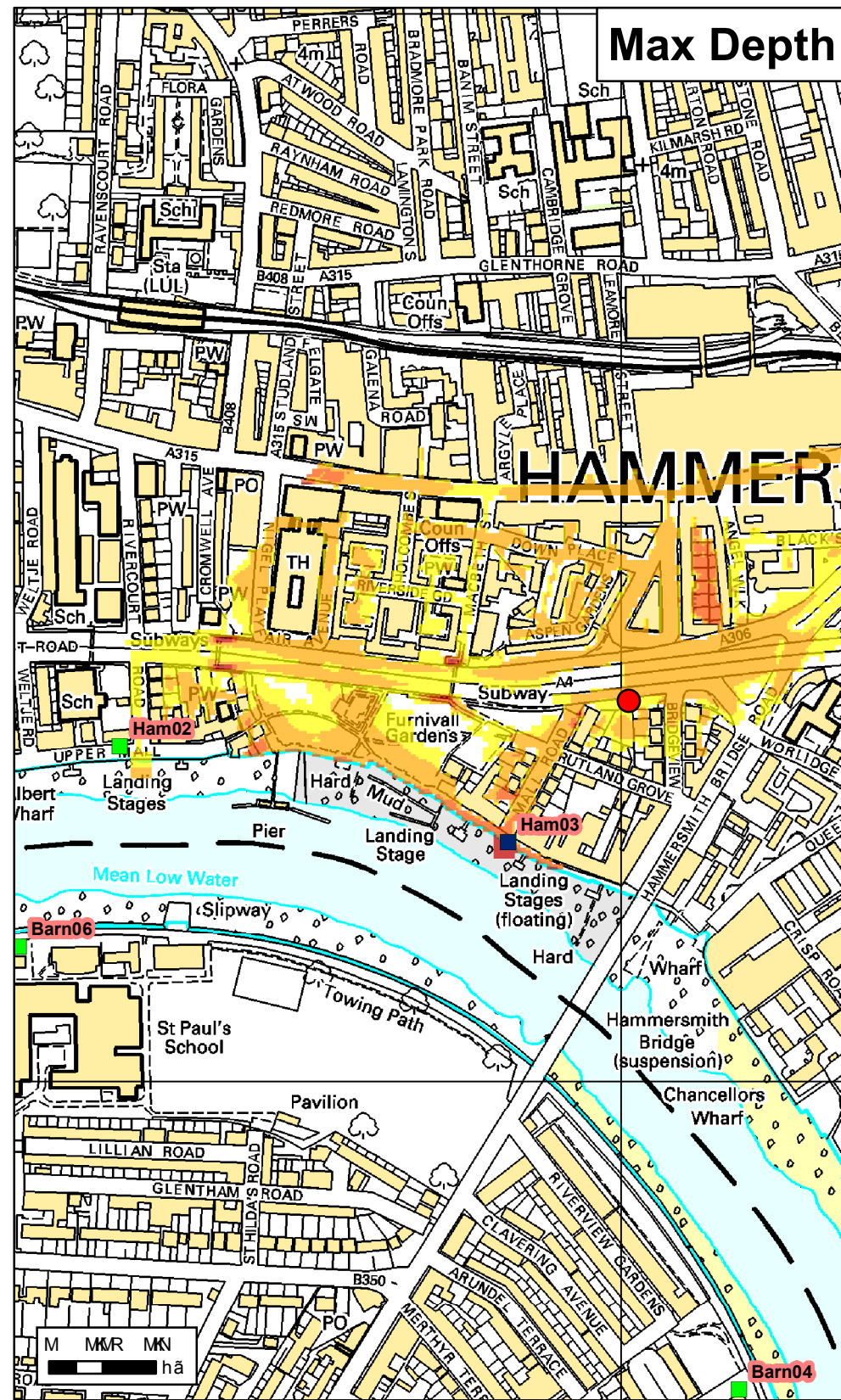
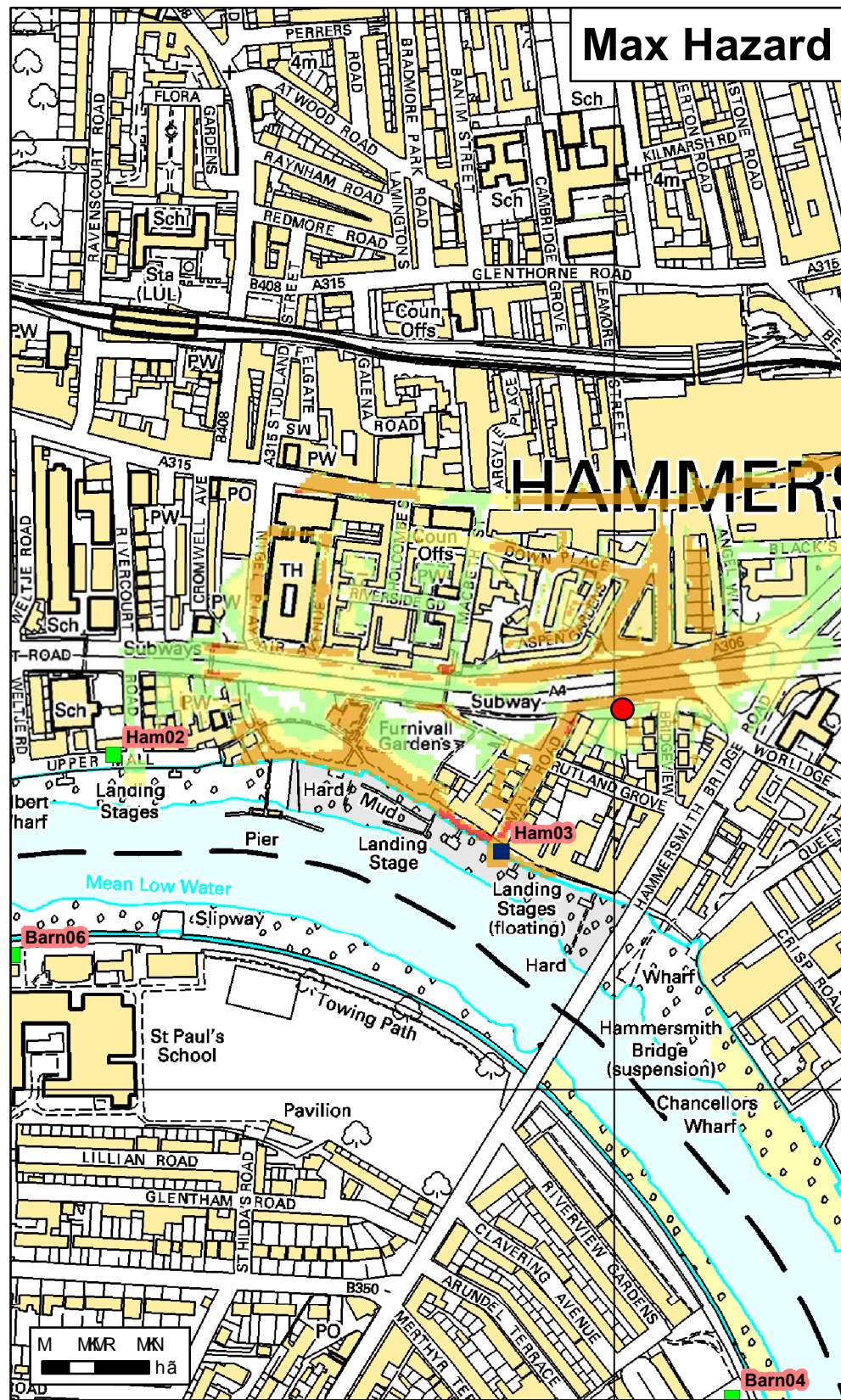
Thames Tidal Breach Hazard Mapping

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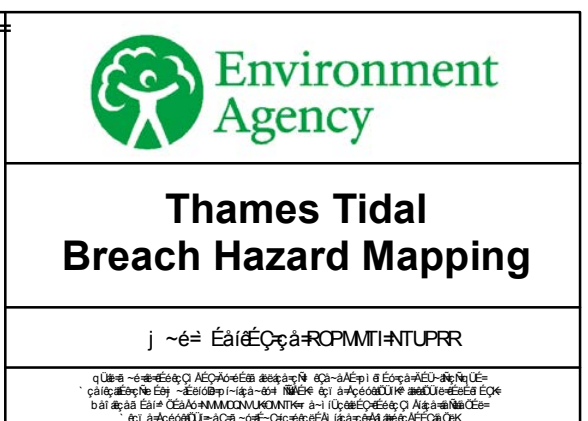
The maps show the maximum hazard, depth, and velocity of the Thames tidal breach. The hazard levels are based on the potential impact of the breach on the surrounding area. The depth levels are based on the maximum water level that could be reached. The velocity levels are based on the maximum speed of the water flow.



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Max Hazard		Max Depth (m)		Max Velocity (m/s)	
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