

TFL_PSF_9131 SITE INVESTIGATIONS: SMALL SITES INITIATIVE 46 BRENTMEAD PLACE, BARNET, NW11 9LJ

Site Ref. 1633

Flood Risk Review

OCTOBER 2017

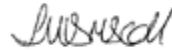
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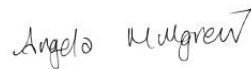
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CONTENTS

1 INTRODUCTION.....	1
1.1 Background	1
1.2 Scope of Works	1
1.3 Limitations	1
2 SITE OVERVIEW.....	2
2.1 Catchment Description.....	3
2.2 Ground Conditions and Aquifers	3
3 DATA SOURCES.....	4
4 RELEVANT PLANNING POLICES & DESIGNATIONS.....	5
4.1 NPPF and Flood Risk.....	5
4.2 The Sequential and Exception Tests	5
5 FLOOD RISK SOURCES AND FLOODING HISTORY	7
5.1 Overview	7
5.2 Historical Flooding.....	7
5.3 Flooding from Rivers	7
5.4 Flooding from Surface Water	9
5.5 Flooding from Groundwater	10
5.6 Flooding from Artificial Sources and Sewers	10
6 RISK RATING & RECOMMENDATIONS FOR FURTHER INVESTIGATION.....	11
7 REFERENCES.....	13

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 at 46 Brentmead Place in the London Borough of Barnet ('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 (Barnet London Borough Council (BLBC)) flood maps and published datasets (Strategic Flood Risk Assessments, Preliminary Flood Risk Assessment and Local Flood Risk Management Strategy);
- Assess flood risk from all relevant sources (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 0.03 hectares and is located at 46 Brentmead Place, Barnet, centred at national grid reference 523830 188206.

The Site consists of an infill plot on the North Circular Road (A406) in Brent Cross at the centre of a row of detached houses. 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 the North Circular Road to the east, the River Brent to the west and residential properties to the north and south, as shown in Figure 1.

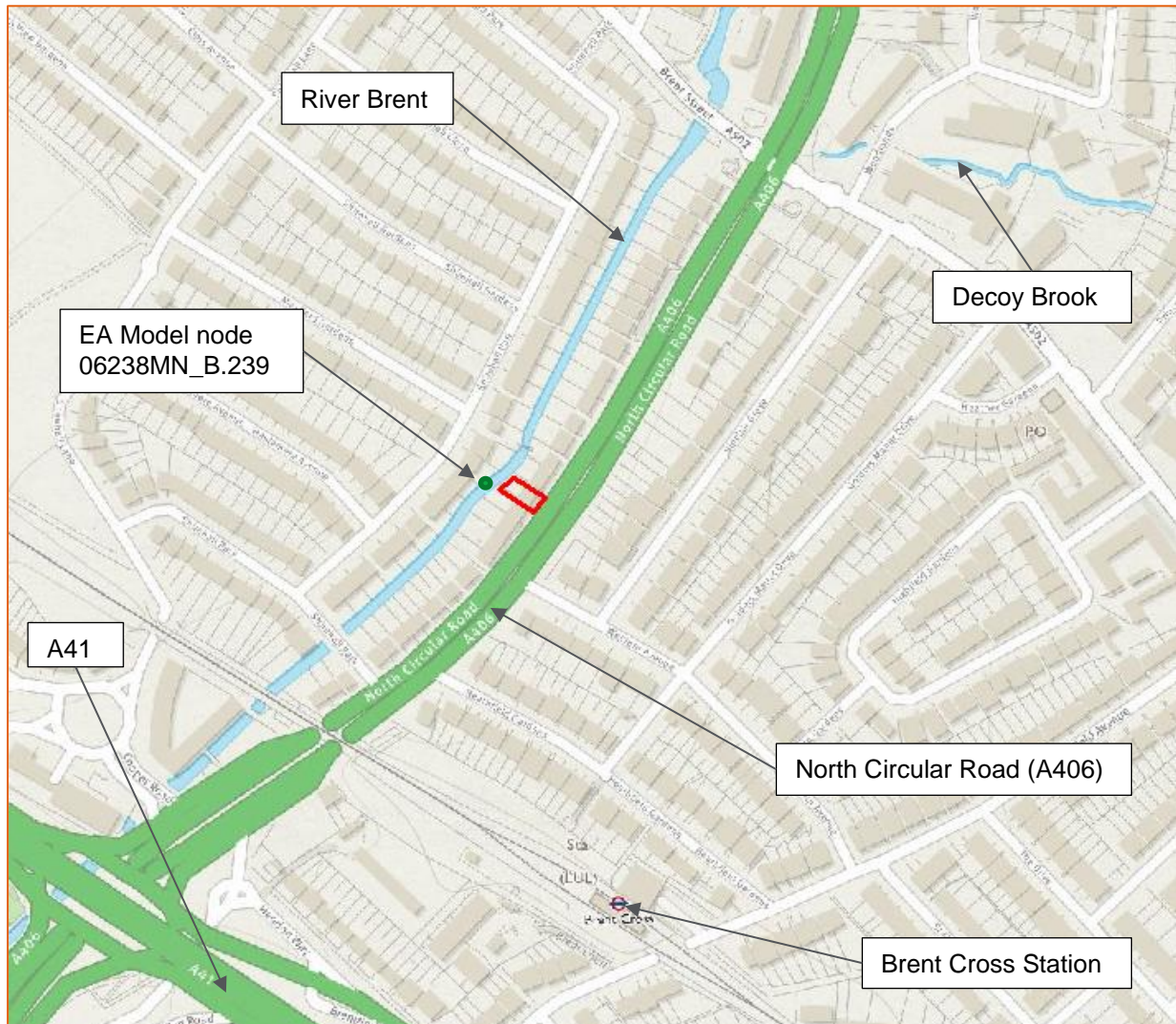


Figure 1: Site Location. Site Boundary Outlined in Red.
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Topographical information for the Site has been identified from EA Opensource Government License 2m LiDAR digital terrain mapping (DTM) datasets (Ref. 1). The Site is relatively steep, with ground levels between 39.7m above ordnance datum (mAOD) and 43.0mAOD, with a slope down towards the River Brent in the west. The landform in the wider area generally also slopes down towards the River Brent (Figure 2).

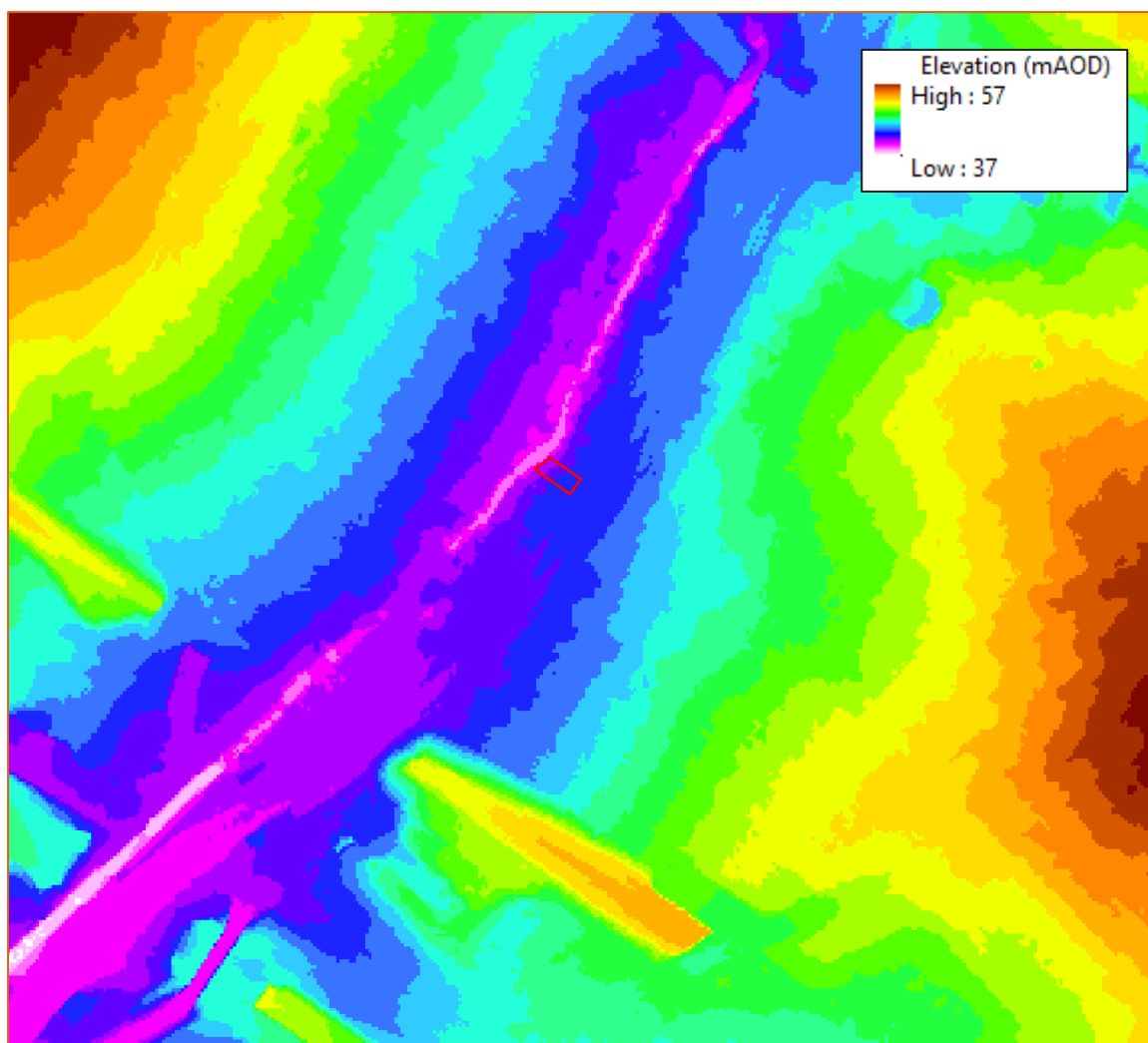


Figure 2: Site Topography. Site Boundary Outlined in Red
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2.1 Catchment Description

The Site is located within the catchment of the River Brent, an EA designated Main River and tributary of the River Thames. The River Brent flows in a southerly direction along the western boundary of the Site and to this point drains a catchment of approximately 36km². The catchment receives an average annual rainfall of 684mm (Ref. 2).

The Decoy Brook, which is an ordinary watercourse and minor tributary of the River Brent, conflues with the River Brent approximately 300m upstream and north of the Site. To this point, the Decoy Brook drains a catchment of approximately 3.5km².

2.2 Ground Conditions and Aquifers

Soils underlying the Site are described as slowly permeable seasonally wet slightly acidic, but base-rich loamy and clayey soils with impeded drainage (Ref. 3). The superficial geology consists of Alluvium – clay, silt, sand and gravel (Ref. 4), supporting a Secondary B aquifer (Ref. 5). Such aquifers are defined by rock layers or drift deposits with a wide range of permeability and storage that are capable of supporting water supplies at a local scale. The bedrock 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 a Flood Product 4 data pack (Ref. 6).

Web-based sources:

- Flood Estimation Handbook (FEH) Web-Service;
- EA What's In Your Backyard? Interactive Maps;
- EA Long Term Flood Risk Interactive Maps (Ref. 7);
- EA Flood Map for Planning (Ref. 8);
- Cranfield Soil and AgriFood Institute, Soilscales Viewer;
- British Geological Survey, Geology of Britain Viewer.

Published documents:

- North London Strategic Flood Risk Assessment (SFRA) (Ref. 9);
- BLBC Preliminary Flood Risk Assessment (PFRA) (Ref. 10);
- BLBC Local Flood Risk Management Strategy (LFRMS) (Ref. 11);
- BLBC Surface Water Management Plan (SWMP) (Ref. 12).

4 RELEVANT PLANNING POLICES & DESIGNATIONS

4.1 NPPF and Flood Risk

The NPPF (Ref. 13) and accompanying flood risk and coastal change planning practice guidance (PPG) (Ref. 14) 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	✓	✓

Flood Risk Review

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 flood risk overall.

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 rivers (Fluvial)	Floodwater originating from a nearby watercourse when the amount of water exceeds the channel capacity of that watercourse.
2. Flooding from land (Surface Water)	Flooding caused by intense rainfall exceeding the available infiltration and/or drainage capacity of the ground.
3. Flooding from groundwater	Flooding caused when groundwater levels rise above ground level following prolonged rainfall.
4. Flooding from reservoirs, canals and other artificial sources	Failure of infrastructure that retains or transmits water or controls its flow.

5.2 Historical Flooding

The EA *Surface Water Historic Flood Incidents* map, EA *Historic Fluvial Flood Incidents* map and EA *Historic Ground Water Flood Incidents* map, included in the BLBC PFRA, identify no records of historic flooding affecting the Site.

The BLBC PFRA *Historic Sewer Flood Incidents* map, which breaks down sewer flooding by postal code, identifies 4 incidences of sewer flooding in the NW11 9 area, however no further specific location data is available for these occurrences.

The BLBC LFRMS identifies three flooding incidences linked to the Decoy Brook, in 2007, 2009 and 2012, with flooding around the confluence between the Decoy Brook and the River Brent. These incidences were in response to heavy rainfall events combined with blockage of a 1.2m culvert at the confluence. However, during these events floodwaters did not reach the Site.

The Site does not benefit from any installed flood defences. However, the steep change in ground elevation on the west of the Site is recognised by the EA as providing a 1 in 10 year standard of protection, with a topographic crest level of approximately 42.3mAOD.

5.3 Flooding from Rivers

The EA *Flood Map for Planning* (Figure 3) identifies the eastern two-thirds of the Site in Flood Zone 1, low flood risk (land having a less than 1 in 1,000 (0.1%) annual probability of flooding) from rivers. However, the western third of the Site, in proximity to the River Brent, is in Flood Zone 3, high flood risk (land having a greater than 1 in 100 (1%) annual probability of flooding) from rivers. The high flood risk area is associated with flooding from the River Brent and the limit of the flood zone is defined by the location of the topographical crest described above.

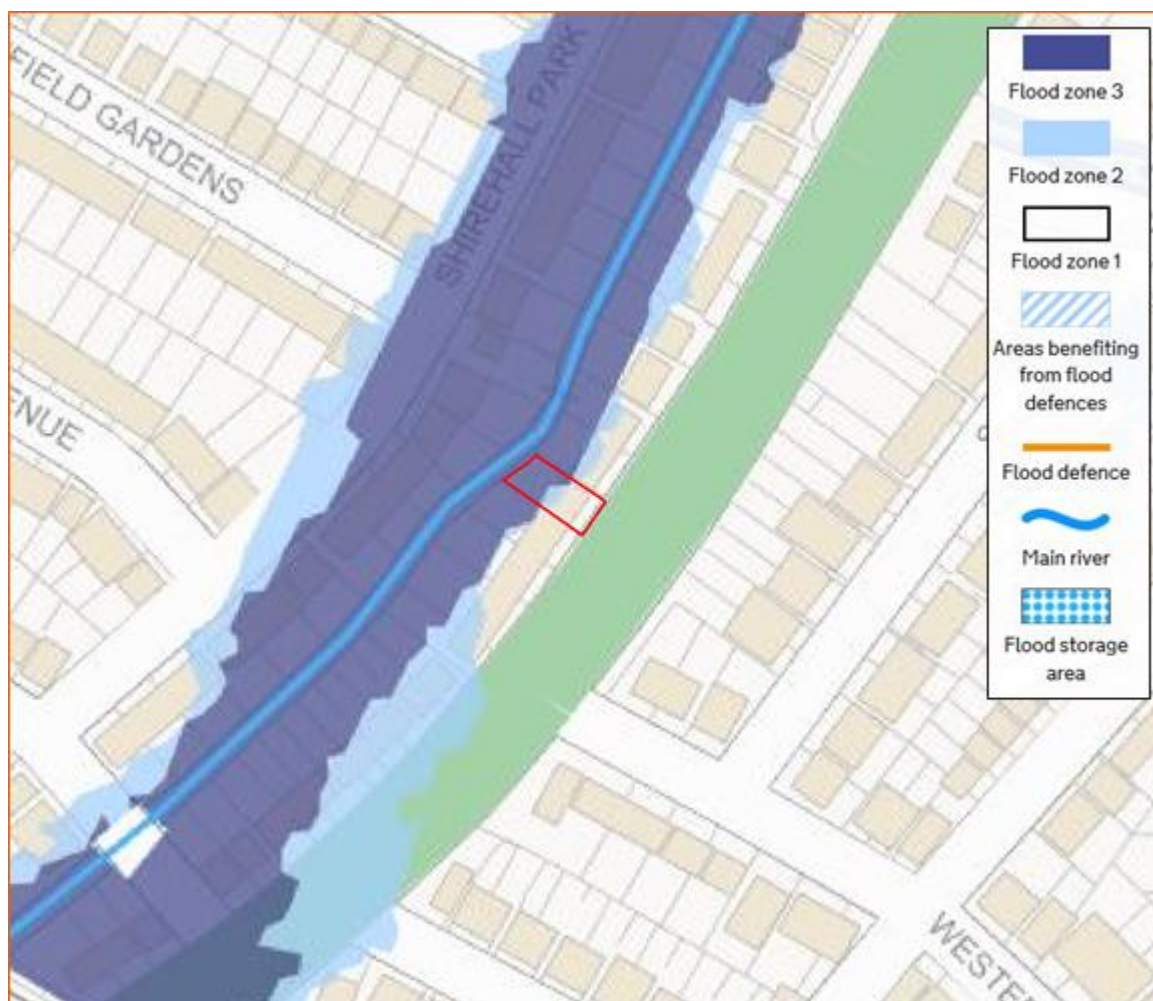


Figure 3: EA Flood Map for Planning. Site Boundary Outlined in Red
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The EA provided flood levels for the River Brent at node 06238MN_B.239, located immediately west of the Site (see Figure 1). Flood levels were supplied for a range of return period events, between 1 in 5 year (20% annual probability) and 1 in 1000 year (0.01% annual probability). The data is presented in Table 4.

Table 4: EA Modelled Flood Levels for the River Brent (mAOD)

Modelled Flood Levels	Return Period										
	5yr	10yr	20yr	30yr	50yr	70yr	75yr	100yr	100yr +CC	250yr	1000yr
River Brent node: 06238MN_B.239	41.16	41.56	41.74	41.80	41.92	41.99	42.00	42.07	42.22	42.26	42.58

Compared to the Site elevation, ranging between 39.7mAOD and 43.0mAOD, the data indicates that the eastern two-thirds of the Site would be free from inundation during the extreme 1 in 1000 year flood event. The modelled flood levels also confirm the flood risk to the western third of the Site that is at a lower elevation. The westernmost areas of the Site are vulnerable to flooding during the 1 in 20 year, 1 in 30 year and 1 in 50 year flood events, with flood depths of up to 1.22m, which suggests these areas of the Site are in the functional floodplain (Flood Zone 3b).

The EA *Flood Map for Planning*, does not illustrate flood risk from non-Main River sources (ordinary watercourses). The Decoy Brook is located 300m upstream of the Site and there is a history of flooding at the confluence, however there are no records of flooding from the Decoy Brook affecting the Site.

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

5.4 Flooding from Surface Water

The EA *Risk of Flooding from Surface Water* map (Figure 4) identifies the eastern two-thirds of the Site as having a very low risk (less than 1 in 1,000 (0.1%) annual probability) of surface water flooding. However, the western third of the Site, neighbouring the River Brent, has a high risk (greater than 1 in 30 (3.3%) annual probability) of flooding from this source. The EA *Areas Susceptible to Surface Water Flooding* map identifies the high risk flood area, with predicted flood depths of greater than 1.0m.

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

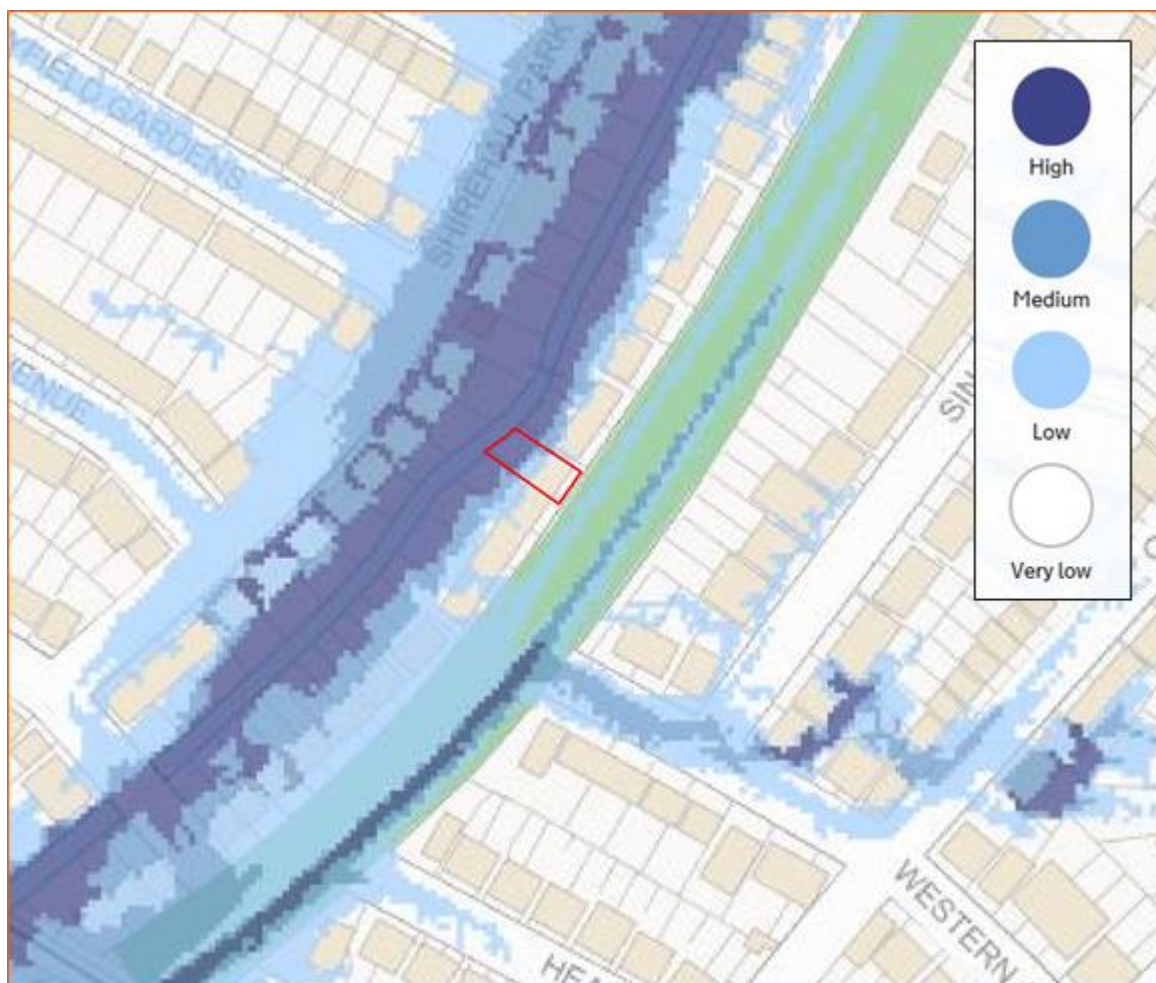


Figure 4: EA Risk of Flooding from Surface Water. Site Boundary Outlined in Red.
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5.5 Flooding from Groundwater

The BLBC PFRA *Groundwater Susceptibility* map identifies the Site as having a very low susceptibility to groundwater flooding and the BLBC PFRA *Increased Potential for Elevated Groundwater* map does not identify the Site in an at-risk area. Water levels in the underlying soils may have connectivity with the River Brent, which could cause groundwater to rise to the surface if river levels were high for prolonged periods. However, there are no records of groundwater flooding in proximity to the Site.

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

5.6 Flooding from Artificial Sources and Sewers

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 the Highgate Reservoir, located approximately 4.5km upstream of the Site. 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 flooding from breach.

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

The London Borough of Barnet is primarily served by separate sewer systems for foul water and surface water, which were designed and built to a standard that allowed for increases in population but not surface water runoff. However, the BLBC SFRA states that sewer flooding in Barnet presents a low risk and there are limited recorded incidences of sewer flooding in proximity to the Site.

It is considered that the overall flood risk to the Site from sewers is low.

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 **High** risk of flooding from rivers and surface water and a **Low** risk of flooding from groundwater and artificial sources, including sewers, as summarised in Table 5. However, the degree of risk varies across the Site, with approximately two thirds of the site (to the east) having a low risk of flooding from all sources.

Table 5: Flood Risk Sources

Source of Flooding	Flood Risk
1. Flooding from rivers (Fluvial)	High
2. Flooding from land (Surface Water)	High
3. Flooding from groundwater	Low
4. Flooding from reservoirs, canals, sewers and other artificial sources	Low

The EA *Flood Map for Planning* identifies the Site as being divided between Flood Zone 1 in the east and Flood Zone 3 in the west, in proximity to the River Brent. More detailed data provided by the EA indicates that the westernmost areas of the Site are vulnerable to inundation during more frequent flood events and may therefore be classified as in Flood Zone 3b (the functional floodplain). However further consultation with the EA is required to confirm the Flood Zone classification.

If areas are classified in Flood Zone 3b, following the NPPF Guidance, these areas would be suitable for 'Water Compatible' development types only and would trigger the application of the Exception Test for 'Essential Infrastructure' uses. These areas would not be appropriate for any other form of development, including residential.

However, the remainder of the Site (in Flood Zone 1) would be suitable for all forms of development, including residential. Should the current boundary of the Site continue to include the area of Flood Zone 3, which is potentially Zone3b (the functional floodplain), a Flood Risk Assessment (FRA) would need to be prepared in support of a planning application for any 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 the proposed development would not be subject to an unreasonable risk of flooding and would not increase flood risk to third parties. 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 high risk of surface water flooding, however there are no records of surface water flooding in areas local to the Site. The BLBC SWMP states that '*it is essential that the impact of future development on existing infrastructure, including the drainage systems, is assessed*'. Surface water drainage and runoff from the Site, should be further investigated and it should be ensured that drainage is managed to a high standard, which should include the calculation of current rainfall-runoff rates and volumes and greenfield runoff rates for the Site.

A Drainage Strategy should be developed, detailing methods to manage runoff from the Site, which would ideally be controlled to match greenfield rates.

Comparison of modelled flood levels with the Site elevation suggests that the westernmost areas of the Site may be in Flood Zone 3b. Further consultation with the EA is required to confirm this Flood Zone, however this classification would preclude these areas from all but Water Compatible and Essential Infrastructure development types.

It is considered that the remainder of the Site (located in Flood Zone 2) is appropriate for all forms of development, including residential.

It is advised that the Site boundary be altered to exclude land within Flood Zone 3, particularly if a Flood Zone3b designation is confirmed. This would avoid the need for any further assessment of flood risk at the planning application stage, with the exception of producing a Surface Water Drainage Strategy.

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