LBR 2.61.2

LONDON BOROUGH OF REDBRIDGE

STRATEGIC FLOOD RISK ASSESSMENT

LEVEL 2

DRAFT V1.2 – APRIL 2016

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EXECUTIVE SUMMARY

BACKGROUND

A Strategic Flood Risk Assessment (SFRA) is a study carried to assess the risk to an area from flooding from all sources, now and in the future. It takes into account the impacts of climate change, assesses the impact that land use changes and development in the area will have on flood risk. The Level 1 SFRA for the London Borough of Redbridge (LBR) was completed in early 2015. It identified that that land outside flood risk areas could not appropriately accommodate all the necessary development and a Level 2 SFRA was required.

A Level 2 SFRA (this document) considers the detailed nature of the flood characteristics within a Flood Zone, assesses existing flood defence infrastructure and the impacts of climate change with respect to specifically selected potential development sites. This study delivers detailed assessments of two major potential development sites at Oakfields and Goodmayes and higher level assessments of 22 other sites throughout LBR. This Level 2 document has been developed in line with the National Planning Policy Framework (NPPF), the accompanying National Planning Practice Guidance (NPPG) and the LBR's own knowledge and policies.

KEY CHALLENGES – FLOODING IN REDBRIDGE

Fluvial and Tidal

The River Roding, the Cran Brook and the Seven Kings Water are the main sources of fluvial flood risk in the LBR. The River Roding is also affected by the tidal influence from the River Thames downstream from Ilford. Fluvial flood risk is relatively well confined to remain alongside the channels. Areas affected by the predicted fluvial flood extent include Woodford, Wanstead, Redbridge, Cranbrook, Ilford, Little Heath, Seven Kings and Loxford.

Surface Water and Ordinary Watercourses

Surface water flood risk is caused by overland flow which cannot drain away through drainage systems or soak into the ground and therefore lies on or flows over the ground instead. As surface water flooding is most affected by topography, geology and urban development, it can be variable in extent. The surface water flood risk in the LBR is mostly located in close proximity to the watercourses as this is where land is the lowest and natural drainage causes overland flows to reach these areas.

Sewer

Sewer flood risk is usually caused by blockages or capacity exceedance in the sewers which results in water being unable to enter the system or it surcharges from the sewers back onto the surface. Thames Water Utilities Ltd (TWUL) are responsible for maintenance and operation public sewers in the LBR. TWUL records show that sewer flooding has occurred at some point in most areas within the borough.

Groundwater

Groundwater is water which is found underground, held in the soil or in pores and crevices in rock. Groundwater flooding occurs when water levels in the ground rise above surface levels or into subterranean property such as basements. Areas susceptible to groundwater flooding in LBR are generally associated with alluvial geological deposits along the river corridors.

Artificial

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. Should a large reservoir fail, small areas of the LBR alongside watercourses would be affected, such as Wanstead, Ilford and Fairlop.

KEY SITE ASSESSMENTS

Oakfields

Flood Risk Assessment:

Source	Risk Level	Source	Risk Level
Fluvial / Tidal	Very low	**Groundwater**	Uncertain but potential
Surface water	Low to medium	**Artificial**	Very low
Sewer	Low	**Residual**	Very low

Planning Considerations:

- Sequential and Exception Tests are not required as site is located within Flood Zone 1
- Site layout must accommodate overland flow paths
- Sufficient SuDS infrastructure must be provided to achieve better than Greenfield runoff rates
- Better than Greenfield rates must be achieved in order to mitigate existing downstream flood risk along the Cran Brook

Goodmayes

Flood Risk Assessment:

Source	Flood Risk	Source	Flood Risk
Fluvial / Tidal	Medium to Very High	**Groundwater**	Uncertain but potential risk
Surface water	Medium to High	**Artificial**	Medium
Sewer	Medium to High	**Residual**	Very low

Planning Considerations:

- Sequential and Exception Tests will be required if vulnerable developments are proposed within Flood Zones 2, 3a and 3b (these are generally only within a 150m to 200m wide corridor through the centre of the site)
- Site layout must accommodate overland flow paths
- Sufficient SuDS infrastructure must be provided to achieve better than Greenfield runoff rates
- A Flood Storage Area should be considered to alleviate on-site and downstream flood risk

NON-KEY SITE ASSESSMENTS

22 non key sites were assessed to analyse their level of flood risk and potential for future development. The sites are situated along Seven Kings Water, Cran Brook and the River Roding (middle and lower reaches). The high level assessment:

- Identifies and assesses flood risk sources
- Spatially defines developable areas
- Identifies possible site access and egress routes for emergency planning purposes
- Proposes potential flood mitigation measures
- Defines site specific flood risk assessment requirements
- Identifies key planning considerations and if the site has a reasonable prospect of compliance with flood risk aspects of the Exception Test

All of the sites assessed have the potential to pass the Exception Test through effective site master planning and practical risk mitigation approaches. However, none of the sites are fully suitable for sole residential use and development will need to be generally directed towards less vulnerable land uses. Several of the sites are only partially impacted by flood risk and have potential to be used for mixed residential and commercial development.

ABBREVIATIONS

Abbreviation	Definition
AIMS	Asset Information Management System
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
Defra	Department of Environment, Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
FSA	Flood Storage Area
GLA	Greater London Authority
LA	Local Authority
LBR	London Borough of Redbridge
LPA	Local Planning Authority
NAFRA	National Flood Risk Assessment
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
RRFRMS	River Roding Flood Risk Management Strategy
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SuDS	Sustainable Drainage System
TE2100	Thames Estuary 2100 Flood Risk Management Plan
TWUL	Thames Water Utilities Ltd
WFD	Water Framework Directive
WSP	WSP UK Ltd

GLOSSARY

Term	Definition
Climate Change	This refers to any change in climate over time. On Earth, the temperatures are rising causing an increase in sea levels and rainfall. This is usually accounted for in models by applying a potential change percentage to the current 1 in 100 year return period rainfall.
Environment Agency	The Environment Agency is a non-departmental public body, established in 1996 and sponsored by the government's Department for Environment, Food and Rural Affairs (Defra). Its responsibilities relate to the protection and enhancement of the environment in England.
Exception Test	This is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactory, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.
Flood Map for Planning (Rivers and Sea)	This map shows the assessment of the likelihood of flooding from rivers and the sea at any location. It takes into account the presence and effect of all flood defences, predicted flood levels, and ground levels.
Floodplain	A floodplain is the area that would naturally be affected by flooding if a river rises above its banks.
Flood Resilience	Flood resilience, or wet-proofing, accepts that water will enter the building, but through careful design will minimise damage and allow the re-occupancy of the building quickly.
Flood Resistant	Flood resistance, or dry-proofing. This stops water from entering a building.
Flood Risk	For the purpose of applying the National Planning Policy Framework (NPPF), 'flood risk' is a combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals, lakes and other artificial sources.
Flood Risk Vulnerability Classification	This classification categorises different types of property uses and development according to their vulnerability to flood risk.
Flood Storage Area	These are natural or man-made basins which temporarily fill with water during periods of high river levels.
Flood Zones	These show areas of land that could flood from rivers and/or the sea. They identify the extents over which flooding could occur, if the flooding is not constrained by flood defences.
Flood Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Flood 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.
Flood Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding or land having a 1 in 200 or greater annual probability of sea flooding.
Flood Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.
Fluvial	Of a river. For example, fluvial flooding is caused by river water.
Lead Local Flood Authority	The unitary authorities or county councils responsible for managing local flood risk, including from surface water, ground water and ordinary watercourses, and for preparing the local flood risk management strategy.
Local Flood Risk	Flood risk from surface runoff, groundwater and Ordinary Watercourses.
Main River	As marked on a main river map, these are larger watercourses which the EA have powers to carry out flood defence work on.
Ordinary Watercourse	This refers to every watercourse through which water flows and which does not form part of a Main River.

Term	Definition
Residual Risk	Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigation actions.
Sequential Approach	The sequential, risk-based approach to the location of development is a general approach designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. Application of the sequential approach in the plan-making process, in particular application of the Sequential Test, will help ensure that development can be safely and sustainably delivered.
Sequential Test	This method ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new development to Flood Zone 1 (areas with the lowest probability of flooding) and only considering sites outside of this zone when there are no reasonably available sites. If this is the case, Flood Zone 2 should be considered ahead of Flood Zone 3. Local Planning Authorities should take account of flood vulnerability of land uses when considering locations outside of Flood Zone 1, applying the Exception Test if required.
Site-Specific Flood Risk Assessment	This is to be carried out by (or on behalf of) a developer to assess the flood risk to and from a development site. Where necessary, the assessment should accompany a planning application submitted to the Local Planning Authority. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users.
SFRA	This is a study carried out by one or more Local Planning Authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that land use changes and development in the area will have on a flood risk.
SuDS	Sustainable Drainage Systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. They also provide opportunities to reduce the causes and impacts of flooding, remove pollutants from urban run-off at source and combine water management with green space with benefits for amenity, recreation and wildlife.
Surface Water	This refers to the water which ponds or flows on the surface following rainfall whereby water cannot drain away or soak into the ground fast enough.
Surface Water Flood Extent	The name given to the layer generated using the 1 in 100 year event layer from the Flood Map for Surface Water to represent the areas at risk of flooding due to surface water.
Tidal	Relating to the tide. For example, tidal flooding refers to a flood caused by unusually high tides.
Unitary Authority	Unitary authorities in England are Local Authorities who are responsible for an administrative division of local government established in place of, or as an alternative to, a two-tier system of local councils.

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1. INTRODUCTION

1.1. AIMS AND OBJECTIVES

A Strategic Flood Risk Assessment (SFRA) is a study carried out by one or more Local Planning Authorities (LPA) to assess the risk to an area from flooding from all sources, now and in the future. It is to take account of the impacts of climate change and to assess the impact that land use changes and development in the area will have on flood risk.

In order to construct properties that are sustainable, the National Planning Policy Framework (NPPF) (DCLG, 2012) requires that a Level 1 SFRA is carried out to provide the evidence so that development can be planned in areas that are least at risk from flooding. The Sequential and Exception Tests are methods used to achieve this. The document is to be used strategically by the council's planning department, as well as used by developers as a tool to better understand the flood risk and to ensure that the requirements set out by a LPA are met when applying for planning permission.

Where a Level 1 SFRA shows that land outside flood risk areas cannot appropriately accommodate all the necessary development, it may be necessary to increase the scope of the assessment to a Level 2. This is to provide the information necessary for application of the Exception Test where appropriate. A Level 2 SFRA should consider the detailed nature of the flood characteristics within a Flood Zone including:

- Flood probability
- Flood depth
- Flood velocity
- Duration of flood
- Rate of onset of flooding

The Level 2 SFRA also needs to assess existing flood defence infrastructure (for example flood barriers). The assessment should state where the infrastructure is and what condition it is in. The risk of flood defence infrastructure failing during the lifetime of the development also needs to be assessed, including in the assessment an allowance for climate change. The assessment should consider what the consequences of failed flood defences would be for the area.

If there is anything specific planning applicants need to do to meet the requirements of the Exception Test, they must be stated. This should include any requirements based around the Flood Zones and other sources of flooding such as surface water and groundwater. A Level 2 SFRA should reduce burdens on developers, in particular, at windfall sites, in the preparation of site-specific flood risk assessments.

Following on from the London Borough of Redbridge's (LBR) Level 1 SFRA, produced in March 2015, this Level 2 document has been developed in line with the NPPF, the accompanying National Planning Practice Guidance (NPPG) (DCLG, 2012) and the LBR's own knowledge and policies.

1.2. BACKGROUND – LEVEL 1 SFRA

The Level 1 SFRA (2015) was developed to achieve the following:

- Collate borough-wide information to determine the variations in risk from all sources of flooding.
- Provide highly vulnerable areas further protection from unsuitable development by delineating the Flood Zone 3b using information from the Environment Agency and LBR knowledge.
- A tool to be used to inform the sustainability appraisal of the Local Plan and in the preparation of planning policies with regards to fully consider flood risk.
- Provides the information required to apply the Sequential Test and where necessary, the Exception Test when determining land use allocations.
- To provide assistance to planners/developers looking to produce or review a site-specific flood risk assessment.

The Level 1 SFRA was set out in a way which clearly displays the various flood risk sources identified within the borough along with the policies and recommendations associated with each one. In order to avoid duplication, *Table 1-1* below signposts the key aspects of the Level 1 document, including where the maps and recommendations can be found.

Table 1-1. Signpost to the key aspects of the Level 1 SFRA.

Key information from Level 1 SFRA	Description	Location
Associated policy and guidance	An overview of the national, regional and local policy and guidance documents which support or feed into the SFRA.	Section 2. Pages 6-12.
Flood risk sources in the LBR	A borough wide overview of the various flood risk sources with the LBR:	Section 4. Pages 19-26.
	- River and sea flood risk	Section 4.1. Pages 19-21. Figure 4.1 and Figure A4.1.
	- Sewer flood risk	Section 4.2. Pages 21-22. Figure 4.2.
	- Surface water flood risk	Section 4.3. Pages 22-23. Figure 4.3 and Figure A4.3.
	- Groundwater flood risk	Section 4.4. Pages 24-25. Figure 4.4 and Figure A4.4.
	- Reservoir flood risk	Section 4.5. Pages 25-26.
	- Additional flood risk	Section 4.6. Page 26.
Flood risk application to planning	This section outlines how each source of flood risk identified in Section 4 should be dealt with in terms of planning applications:	Section 5. Pages 27-36.
	- River and sea flood risk	Section 5.2. Pages 27-32.
	- Sewer flood risk	Section 5.3. Pages 32-33.
	- Surface water flood risk	Section 5.4. Page 33.
	- Groundwater flood risk	Section 5.5. Pages 33-34.
	- Reservoir flood risk	Section 5.6. Page 34.
	- Combination of flood risk sources	Section 5.7. Page 34.
	- Recommendation summary (Local Plan preparation)	Section 5.8.1. Page 35.
	- Recommendation summary (individual planning applications)	Section 5.8.2. Page 36.
Site-specific flood risk assessments	A site-specific flood risk assessment is carried out by, or on behalf of, a developer to assess the flood risk to and from a development site. The LBR requirements have been developed using the NPPG checklist as shown in the Level 1 SFRA.	Section 6. Pages 37-38. Table 6.
LBR area breakdown	Maps have been produced which split the borough into nine geographic areas allowing for a reduced scale and therefore better detail of the river and sea and surface water flood risk. These should be used in producing and reviewing site-specific flood risk assessments.	Section 7. Page 40. Appendix C, Figures C1A to C9B.
Development practice	This section describes the national and local policy relating to sustainable drainage, additional building guidance and flood warning systems.	Section 8. Pages 41-42.

2. GUIDANCE

2.1. LOCAL PLANNING AUTHORITIES

Where a Level 1 SFRA shows that land outside flood risk areas cannot appropriately accommodate all the necessary development, the scope of the assessment should be increased to a Level 2. The main objective of the Level 2 SFRA is to facilitate the application of the Sequential and Exception Tests.

In developing the Level 2 SFRA, the LPA have put forward a number of potential development sites which would benefit from a site-specific flood risk assessment. These have been selected based upon their susceptibility to predicted flood risk, historic flood records or due to the size of the site.

The outcome of this study provides detailed information on the predicted flood risk for two main opportunity sites (Oakfields and Goodmayes) and 22 other potential development sites. Alongside this, there are recommendations and development requirements which set out ways to ensure that development does not increase flood risk whilst constructing sustainable new developments.

The LPA should use this Level 2 SFRA to better understand flood risk and to prioritise sites for development accordingly. Due to the detailed nature of the flood risk, taking account of the presence of flood risk management measures such as flood defences, a sequential approach to site allocation can be adopted. The sites identified as being more suitable for development should be chosen over those that are not. Where recommendations have been made for sustainable development, the LPA should encourage these from the beginning of the planning process. The report will also allow the development of policies to ensure that development in such areas satisfy the requirements of the Exception Test.

When assessing planning applications, the LPA should cross-reference the designs with the Level 2 SFRA outputs to ensure that the proposed developments are suitable for the site in questions. This may include information on the layout of the development and the use of Sustainable Drainage Systems (SuDS). The LPA should steer the developers towards this document and emphasis the recommendations. Where the Exception Test is required, this report should outline the data required by the developer to ensure that it has been passed.

2.2. DEVELOPERS

Developers should use the Level 1 SFRA to familiarise themselves with the development requirements of the LPA and to identify the flood risk within the borough. If the site in question has been put forward for assessment in the Level 2 SFRA, developers should utilise this report at the earliest stage possible. This would prevent time being wasted designing a development which would be unsuitable or generally unacceptable to the LPA.

The Level 2 SFRA provides the developer with a detailed assessment of the flood risk which could be exist at the assessed sites. There is information on which areas within the development would be suitable for the varying vulnerable developments. For example, an area in Flood Zone 3a should not contain any highly vulnerable buildings such as a basement dwelling, but instead could be located in Flood Zone 1 or in Flood Zone 2 if the Exception Test has been passed. There is guidance on suggested SuDS and alleviation measures which should be incorporated into development designs to increase the sustainability and prevent flood risk from increasing.

The Level 2 SFRA contains information on anything specific that planning applicants need to do to do to meet the requirements of the Exception Test. Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall. When producing site-specific Flood Risk Assessments (FRA), the Level 2 SFRA will provide some of the evidence to inform these.

3. SEQUENTIAL AND EXCEPTION TESTS

3.1. POLICY SUMMARY

Chapter 10 of the NPPF (*Meeting the challenge of climate change, flooding and coastal change*) outlines the sequential, risk based approach to the location of development. This is in place to avoid, where possible, flood risk to people and property and manage any residual risk taking account of the impacts of climate change. The Floods Zones form the baseline information used when carrying out the sequential approach to the location of development and they represent the probability of river and sea flooding, ignoring the presence of defences They include the Flood Zones 1, 2 and 3 delineated in the Environment Agency's (EA) Flood Map for Planning (Rivers and Sea) and Flood Zone 3b outlined by the LBR (see *Figure 4.1 and A4.1* in the 2015 Level 1 SFRA). The Flood Zone definitions are explained in Table 1 of the NPPG and in Table 5.1 f the Level 1 SFRA (2015).

Application of the sequential approach in the plan-making process will help ensure that development can be safely and sustainably delivered and developers do not spend abortive time promoting proposals which are inappropriate on flood risk grounds. Within each Flood Zone, surface water and other sources of flooding also need to be taken into account in applying the sequential approach to the location of development.

There are two stages of the sequential approach, the Sequential Test and when required, the Exception Test. These are summarised in the following sections.

3.1.1. SEQUENTIAL TEST

The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, LPAs, in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required.

Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered. This process must take into account the flood risk vulnerability of land uses and apply the Exception Test if required.

Table 2 in the NPPG (Table 5.2 in the 2015 Level 1 SFRA) categorises different types of uses and development according to their vulnerability to flood risk. Table 3 in the NPPG (Table 5.3 in the 2015 Level 1 SFRA) links these vulnerability classes against the Flood Zones.

3.1.2. EXCEPTION TEST

The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. As noted in *Section 2*, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

3.2. LEVEL 1 SFRA REQUIREMENTS

The Level 1 SFRA (2015) reinforces the policies set out in the NPPF and NPPG. It also sets out the LBR's application to planning requirements to ensure that land susceptible to all sources of flooding in addition to those from the river and sea are also adequately assessed to prevent inappropriate development. Section 5 of the Level 1 SFRA explains these requirements fully and a summary is provided in *Table 3-1*.

Table 3-1. Summary of the Flood Risk Application to Planning (SFRA Level 1, 2015)

Flood Risk	Planning Application Requirements
River and Sea	• Use the Sequential Test to try and place proposed developments within Flood Zone 1. If this is not possible, take account of the flood risk vulnerability of the land use and consider reasonable available sites in Flood Zone 2, applying the exception test when required. Only when there are no reasonable available sites in Flood Zones 1 and 2 should the suitability of sites within Flood Zone 3 be considered, taking account of the flood risk vulnerability of the land use and applying the Exception Test when required. • Use Table 1 of the NPPG (Table 5.1 in the Level 1 SFRA) and the Flood Maps available (EA website, Figure 4.1 or Figure A4.1 in the Level 1 SFRA) for delineation of the Flood Zones. • Use Table 2 of the NPPG (Table 5.2 in the Level 1 SFRA) for classification of flood risk vulnerability. • Use Table 3 of the NPPG (Table 5.3 in the Level 1 SFRA) for clarification on flood risk vulnerability and Flood Zone 'compatibility' and to see when an Exception Test is required. • All developments within 8m of a Main River must obtain consent from the EA. This also applies to culverted channels. Although not a Main River, development within 8m of the culverted Mayes Brook will also require additional consideration but this will be handled by the LBR rather than the EA. • Development located alongside the tidal section of the Lower Roding should ensure that flood defences maintain a minimum height of 5.6mOD. The TE2100 strategy should also be considered. • Footnote 20 in the NPPF outlies that a site-specific FRA is required for the following proposals: - 1 hectare or greater in Flood Zone 1; - All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3; - In an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the EA); and - Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.
Sewer	A site-specific flood risk investigation should consider sewer flood risk but a FRA is not required solely due to sewer flood risk.
Surface water	The surface water flood extent as defined by the Level 1 SFRA should be treated in the same way as Flood Zone 3a. Therefore the NPPG Table 2 and 3 apply. Any advice and additional data required relating to surface water flood risk should be obtained from the LBR and NOT the EA. Where a development is to be located within the surface water flood extent, SuDS should be used to ensure that surface water runoff is not increased. Developers should refer to national and local SuDS guidance for clarification on the standards required.
Groundwater	Should a site-specific FRA be carried out, then the groundwater flood risk should be considered.
Reservoir	Reservoir flood risk should be considered depending on the type of development proposed. Where this is the case, a site-specific FRA will be required.
Combination of above	Should a development site be subjected to a number of flood risks, all of the relevant planning application requirements should be followed and the worse-case scenario FRA findings should be used when developers design the buildings and SuDS, as well as when the LPA considers the application.

4. KEY CHALLENGES – FLOODING IN REDBRIDGE

4.1. FLUVIAL AND TIDAL

Fluvial flood risk describes the risk from Main Rivers. During heavy or prolonged rainfall events, rivers can encounter large flows which can result in them exceeding their capacity. When a river has a tidal influence, high tides and storm surges can result in tidal flooding (independently or in parallel with fluvial flooding).

Figure 4.1 (and Figure A4.1 in Appendix A) of the Level 1 SFRA shows the fluvial flood risk extent along with the Main Rivers in the LBR. The Main Rivers include the Seven Kings Water, the River Roding and the Cran Brook (tributary of the River Roding).

The EA's Flood Map for Planning (Rivers and Sea) shows that the River Roding, the Cran Brook and the Seven Kings Water are the main sources of fluvial flood risk in the LBR. The River Roding is also affected by the tidal influence from the River Thames downstream from Ilford. Fluvial flood risk is relatively well confined to remain alongside the channels. Areas affected by the predicted fluvial flood extent include Woodford, Wanstead, Redbridge, Cranbrook, Ilford, Little Heath, Seven Kings and Loxford.

Other large bodies of water which have been delineated as Flood Zone 3b include the waterbodies in and around Wanstead Park, the waterbody in Goodmayes Park and the three flood storage areas (FSA). FSA's are natural or man-made basins which temporarily fill with water during periods of high river levels. There are 3 FSA's in the LBR - Fairlop Waters, Valentine Park and Winn Brook.

The London Borough Environmental Fact Sheet (EA, 2011) states that fluvial flooding occurred in the LBR in 1974, 1987, 1993, 2000 and 2009. Flooding occurred in 2000 from the River Roding, which extended along the majority of the length of the river through the borough. The most recent event occurred in February 2009. The overall cause of this event was heavy rainfall that caused rapid snowmelt.

4.2. SURFACE WATER & ORDINARY WATERCOURSES

Surface water flood risk is caused by overland flow which cannot drain away through drainage systems or soak into the ground and therefore lies on or flows over the ground instead. It also includes flooding from Ordinary Watercourses. Ordinary Watercourses within LBR include the Mayes Brook, small Main River tributaries along with numerous land drains.

Figure 4.3 (and Figure A4.3 in Appendix A) of the Level 1 SFRA shows the surface water flood risk within the LBR. As surface water flooding is most affected by topography, geology and urban development, it can be variable in extent. The surface water flood risk in the LBR is mostly located in close proximity to the watercourses as this is where land is the lowest and natural drainage causes overland flows to reach these areas. The surface water flood risk has been modelled to reach depths greater than 1.20m in places within LBR. The areas most at risk are Hainault Forest Country Park, land to the east of Fairlop Waters, Broadmead Playing Fields (Winn Brook FSA), areas in Clayhall and areas in Wanstead.

Part of the flood risk mapping carried out by the EA combines the predicted depth and velocity of surface water to produce hazard maps. This categories areas as having either a low risk, a moderate risk, a significant risk or an extreme risk (Defra 2006). This is outlined in more detail in *Table 4.*1 below. There are areas within the LBR associated with all of the different hazard ratings. These follow the same general pattern as the depth maps.

Table 4-1. Hazard rating classifications and descriptions.

Hazard Rating	Associated risk	Risk Description
<0.75	Low	Caution. Flood zone with shallow flowing water or deep standing water
0.75-1.25	Moderate	Dangerous for some (i.e. children). Danger: flood zone with deep or fast flowing water
1.25-2.5	Significant	Dangerous for most people. Danger: flood zone with deep fast flowing water
>2.5	Extreme	Dangerous for all. Extreme danger: flood zone with deep fast flowing water

4.3. SEWER

Sewer flood risk is usually caused by blockages or capacity exceedance in the sewers which results in water being unable to enter the system or it surcharges from the sewers back onto the surface. Figure 4.2 in the Level 1 SFRA maps data obtained from Thames Water Utilities Ltd (TWUL). TWUL are responsible for the public water supply and waste water treatment in the LBR. TWUL keep a record of the number of properties that have experienced sewer flooding and they work to resolve any problems which do occur. The records show that sewer flooding has occurred at some point in most post-code areas within the borough.

4.4. GROUNDWATER

Groundwater is water which is found underground, held in the soil or in pores and crevices in rock. Groundwater flooding occurs when water levels in the ground rise above surface levels or into subterranean property such as basements.

The Level 1 SFRA utilises the EA's Aquifer Maps to better understand the risk the LBR may face. The Aquifer Maps show the locations of aquifers based on geological mapping provided by the British Geological Survey (BGS). It has been assumed that areas above aquifers are more susceptible to groundwater flooding, especially those areas above Principle Aquifers (formally major aquifers). Principle Aquifers have a high intergranular and/or fracture permeability and usually provide a high level of water storage and may support water supply and/or base flow on a strategic scale. The Aquifers Map shows that the LBR does not contain any principle aquifers, as seen in *Figure 4.4* (and *Figure A4.4* in Appendix A) of the 2015 Level 1 SFRA, although large areas are located above secondary superficial and bedrock aquifers.

4.5. ARTIFICIAL

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. Planners and developers should refer to the EA's Risk of Flooding from Reservoirs map which shows the maximum extent of flooding should a large reservoir fail. Should a large reservoir fail, small areas of the LBR alongside watercourses would be affected, such as Wanstead, Ilford and Fairlop.

4.6. IMPACTS OF CLIMATE CHANGE

The EA's website states that there is clear evidence to show that climate change is happening (EA, 2014). Measurements show that the average temperature at the Earth's surface has risen by about 0.8°C over the last century. In Britain, the average temperature is now 1°C higher than it was 100 years ago and 0.5°C higher than it was in the 1970s. Along with warming at the Earth's surface, other changes in the climate include:

- Warming oceans
- Melting polar ice and glacier
- Rising sea levels
- More extreme weather events

In term of flood risk, rising sea levels are putting our coastal establishments at a higher risk and more extreme weather events have seen more intense, heavy rainfall events occur. Our drainage networks are not designed to be able to cope with the increasing amount of water associated with a rainfall event and watercourses and groundwater sources are experiencing an increase in levels. Water is also reaching downstream areas at an increasing speed. These result in an increase in flood risk.

In order to suitably prepare for the future, climate change should be considered when assessing flood risk. It is usually accounted for in flood risk modelling by applying a potential change percentage to the current 1 in 100 year return period rainfall. At the time of writing this SFRA, percentages such as 20% or 30% depending on the type and lifetime of the development being assessed were used. This may change following updates to EA guidance in Autumn 2015 and so checks should be made on the current recommendations should additional assessment be carried out. Challenges occur due to the unpredictability of climate change and therefore our inability to confidently model the risk and therefore mitigate against it.

In the Level 1 SFRA, climate change was accounted for whenever possible. The 1 in 100 year event was used to assess the surface water flood risk extent rather than the 1 in 30 year event. For fluvial flood risk, the EA's modelling of Main Rivers generally accounts for climate change and so this can only be considered where modelling has been done. In the LBR, modelling on the Middle and Lower River Roding has been carried out and there is associated climate change modelling.

The result of acknowledging climate change in flood risk modelling has led to an increase in the number of properties considered to be at risk of flooding. The depth and velocity of flood water tends to be greater and it is estimated that flooding will last for longer.

The Environment Agency has recently (February 2016) published revised guidance on climate change allowances for flood risk assessment. The guidance provides allowances for a range of time periods specifically related to river basin districts for river flows, rainfall intensities for urban catchments and sea level rise. Allowances are split into upper end, higher central and central bands. This issued guidance provides detailed direction on how these should be applied to development scenarios.

For more information, please refer to 'Flood risk assessments: climate change allowances - https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Note that modelled climate change scenarios for flooding in line with new guidance were not available at time of writing and the user should consult with EA to determine when new data will be available.

The EA has also provided an updated version of 'Adapting to Climate Change: Advice for Flood & Coastal Erosion Risk Management Authorities'. It has been updated in line with best available scientific evidence to help ensure flood and coastal erosion risk management schemes and plans take into account the most up to date scientific evidence.

For more information, please refer to 'Adapting to climate change: guidance for risk management authorities - https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities

5. FLOOD DEFENCE INFRASTRUCTURE

5.1. LOCATION AND CONDITION

A flood defence is a structure which withholds water to prevent it from inundating the surrounding area. They have an associated Standard of Protection (SoP) which describes the maximum flood probability occurrence at which the defence will remain effective, for example to a 1 in 100 year event.

In order to assess flood risk in detail, the borough's flood defence infrastructure has been reviewed. The information for this has been obtained from the EA's Asset Information Management System (AIMS) as at July 2015. This is an inventory of all assets relevant for flood risk management from main rivers, estuaries and the coast. It is advised that when completing Flood Risk Assessments and detailed site investigations, the SoP and condition of the defences should be verified with the Environment Agency. The SoP of a defence can change over time based on the level of maintenance and potential impacts of climate change.

Flood defences are considered as either natural, such as high-ground, or artificial, such as FSAs, embankments, walls. Out of river artificial defences have been displayed below in *Figure 5.*1 (and *Figure A1* in *Appendix A*), based upon the SoP, ranging from the 1 in 5 year to the 1 in 1000 year events. The locations of the three FSAs within Redbridge are also shown. The SoP provided by these FSAs should be obtained from the Environment Agency as they can vary based on current operational conditions. Approximately half of the flood defences with the LBR have a SoP of 20 years or less and only the short reaches of the River Roding within LBR are defended to a standard that exceeds 1 in 100 years.

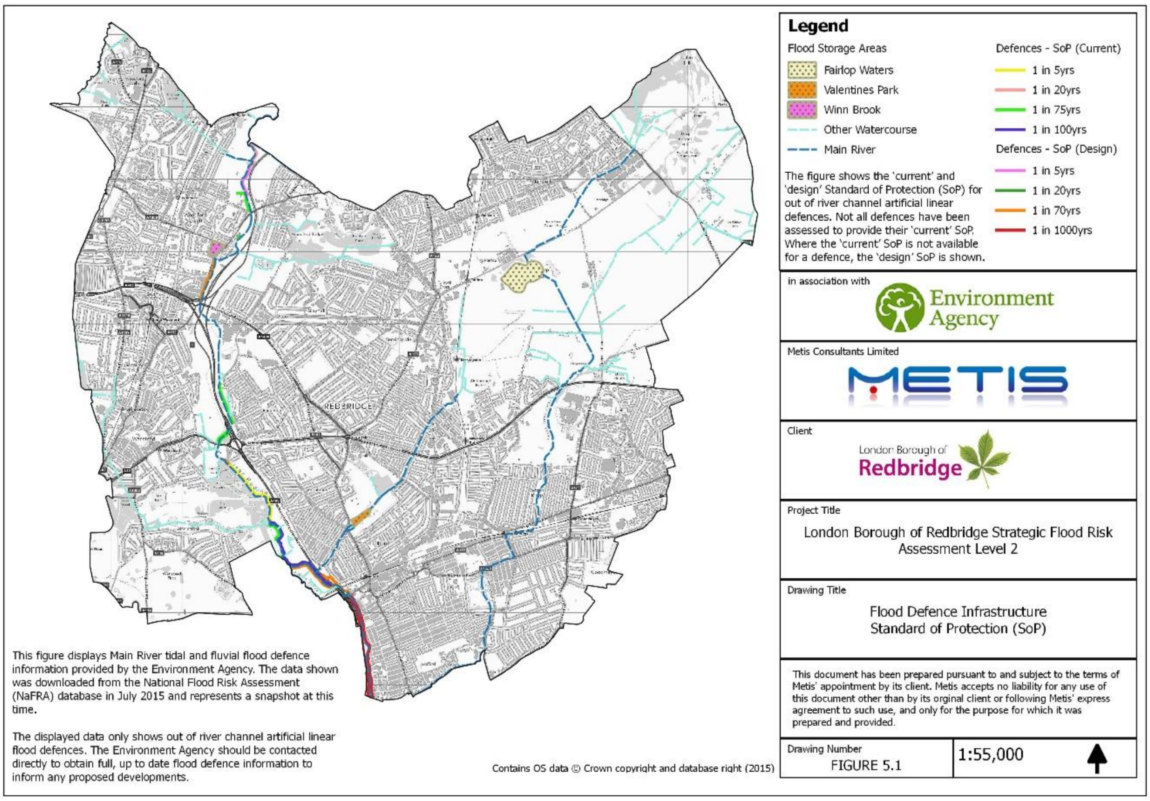

Figure 5-1. Flood defence infrastructure (SoP)

Flood defences are maintained in order to remain effective. Defences within the LBR are maintained by either the EA, the Local Authority (LA) or privately. The conditions are also monitored and recorded. They are rated using the EA's *Managing Flood Risk: Condition Assessment Manual* (EA, 2006), as defined in *Table 5.1*.

Table 5-1. Condition rating as per the EA's Condition Assessment Manual.

Grade	Rating	Description
1	Very good	Cosmetic defects that will have no effect of performance.
2	Good	Minor defect that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very poor	Severe defects resulting in complete performance failure.

The majority of the flood defences within the LBR are graded as 3 (fair) or better. Most of these are either 2 (good) or 3 (fair), as shown in *Figure 5.2* (and *Figure A2* in *Appendix A*).

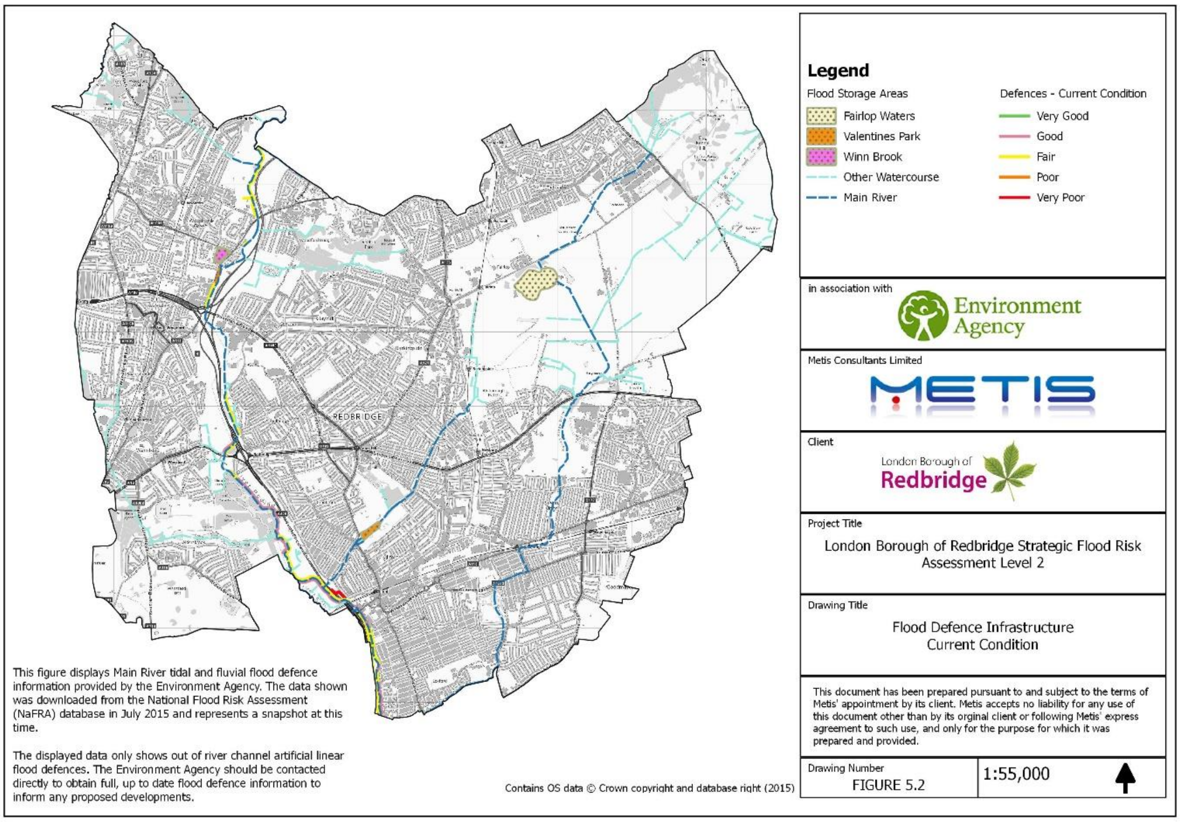

Figure 5-2. Flood defence infrastructure (condition grades)

The EA's Flood Map for Planning (rivers and the sea) delineates areas which benefit from flood defences against river floods with 1% (1 in 100) chance of happening each year and floods from the sea with a 0.5% (1 in 200) chance of happening each year. There are no areas within the LBR which benefit from defences that provide this standard of protection from fluvial and tidal sources. Some reaches of defences within the southern areas of LBR provide a SoP that exceeds 1 in 200 chance of happening in each year for tidal flooding, but do not provide this level of protection for fluvial flooding. This means that no areas within LBR are classified as 'areas benefitting from defences'.

A small section of the River Roding within the LBR is tidal. The tidal extent begins in Ilford and continues downstream to where the river joins the River Thames. The Barking Barrier located at Barking Creek delivers tidal flood protection on the River Roding.

5.2. FUTURE STRATEGY AND MAINTENANCE

There are a number of EA strategies which, when implemented, could affect the defences within the LBR. These include the Thames Catchment Flood Management Plan (Thames CFMP) (EA, 2009), the River Roding Flood Risk Management Strategy (RRFRMS) (EA, 2012) and the Thames Estuary 2100 Flood Risk Management Plan (TE2100) (EA, 2012). Further details of these can be found in Section 2.2 of the Level 1 SFRA.

The Thames CFMP sets out the preferred plan for sustainable flood risk management over the next 50 to 100 years, considering climate change. The LBR is partly covered by Sub-Area 9 of the plan which contains the following proposed action with respect to flood defences:

> 'We want to continue to maintain the existing flood defences and when redevelopment takes place, replace and improve them so that they are more effective against the impacts of climate change. We will be looking to remove culverts and other structures that cause significant conveyance problems.'

The floodplain surrounding the River Roding within the LBR is an area of moderate to high fluvial flood risk. The EA have identified the need for further action which has been explored and will be implemented via the RRFRMS. This strategy gives options for improving the management of flood risk on the River Roding, from its source near Stansted to where it becomes tidal in Ilford, for the next 100 years. Since the 2006 consultation, there have been some changes made to the draft strategy, including the following:

> 'Withdrawal of maintenance where the cost of maintaining existing defences to their current standard outweighs the benefits provided.'

The TE2100 is an adaptive plan developed by the EA with recommendations for flood risk management for London and the Thames estuary through to the end of the 21st century and beyond. One of the key requirements set out in the TE2100 centres around the need to carry out significant improvements to the current tidal defence system. This is reflected in the recommendations. The Plans reads as follows:

> '…significant improvements to the current tidal defence system will be needed before 2070 including raising the crest level of most of the flood defences and replacement of a large proportion of the defence structures as they reach the end of their lives.'

It is essential that all parties who are responsible for the maintenance of flood defences continue to do so. This includes the EA, the LA and private riparian owners. Any development in an area that benefits from flood defence at any SoP should consider the condition and future maintenance of those defences in their site-specific FRA.

5.3. RISK OF FAILURE/OVERTOPPING

5.3.1. FAILURE MECHANISMS

Flood defences fail when they no longer hold back water and flooding occurs in areas which would usually be protected. The EA emphasis that flood defences do not completely remove the chance of flooding and can be overtopped or fail in extreme weather conditions.

Overtopping occurs when the river levels are greater than the defence height and water spills over into the surrounding area which would usually be protected. This would happen when the storm event exceeds the flood defences SoP. A flood defence with a lower SoP is more likely to overtop compared to one with a higher SoP.

A breach in a flood defence occurs when the structure is damaged or fails due to a lack of maintenance leaving a hole for water to flow through. This could occur in any type of raised defence.

Damage can occur due to a particularly fast and turbulent flow. Additionally, when the river flow is deeper and has a greater velocity, the ability for debris transportation is increased. Not only can the flow carry larger sediment, but vegetation and debris can also be moved. This can damage defences when it crashes into the structures.

5.3.2. EFFECT OF FAILURE

As explained in Section 5.1, the EA map the areas benefitting from flood defences at a specified SoP, although there are no areas shown to be in the LBR. They have also carried out breach modelling on large sections of the River Thames, but this does not fully extend into its upper tributaries such as the River Roding. There is no defence failure modelling available for any of the Main Rivers within the LBR.

Flood Zones 2 and 3a, which outline the risk of flooding from Main Rivers, do not consider defences and is therefore a good place to start when analysing which areas would be inundated if a defence was to fail. Information on time to inundation and duration of inundation would have to be carried out at a local scale if required. This may be necessary if a development is proposed to be within close proximity of a flood defence.

5.4. IMPACTS OF CLIMATE CHANGE

As the strategies and plans described in the previous section acknowledge, the consideration of climate change in flood risk management is essential (refer to section 4.6: Impacts of Climate Change). The increasing occurrence of previously rare storm events is resulting in our defences being relied on more frequently. It is possible that the SoP is altered in response to the frequency of which more extreme weather conditions could occur.

The heavier river flows associated with storm evens can damage flood defences. Subsequent debris caught up within the channel, such as vegetation and trash, can harm structures. Additionally, as river flows and depths increase, defences with a lower SoP will not be able to contain the water resulting in overtopping. The impacts of climate change on flood defences should be considered when assessing the suitability of development.

6. KEY SITE ASSESSMENT – OAKFIELDS

6.1. SUMMARY

Flood Risk Assessment:

Source	Risk Level	Source	Risk Level
Fluvial	Very low	**Groundwater**	Uncertain but potential
Surface water	Low to medium	**Artificial**	Very low
Sewer	Low	**Residual**	Very low

Additional Considerations:

Consideration	Implication to Flood Risk
Climate change	Probable increase in surface water and sewer flood risk
Historic flooding	None recorded on site. Site contributes to the Cran Brook and Seven Kings Water. There are records of historic flooding noted on these Main Rivers and tributaries

Planning Considerations:

- Sequential and Exception Tests are not required as site is located within Flood Zone 1.
- Site layout must accommodate overland flow paths.
- Sufficient SuDS infrastructure must be provided to achieve better than Greenfield runoff rates.
- Better than Greenfield rates must be achieved in order to mitigate existing downstream flood risk along the Cran Brook.

6.2. SITE DESCRIPTION

The proposed Oakfields development site is approximately 25 hectares in area. It is located to the north of the borough in Barkingside as shown in *Figure 6*.

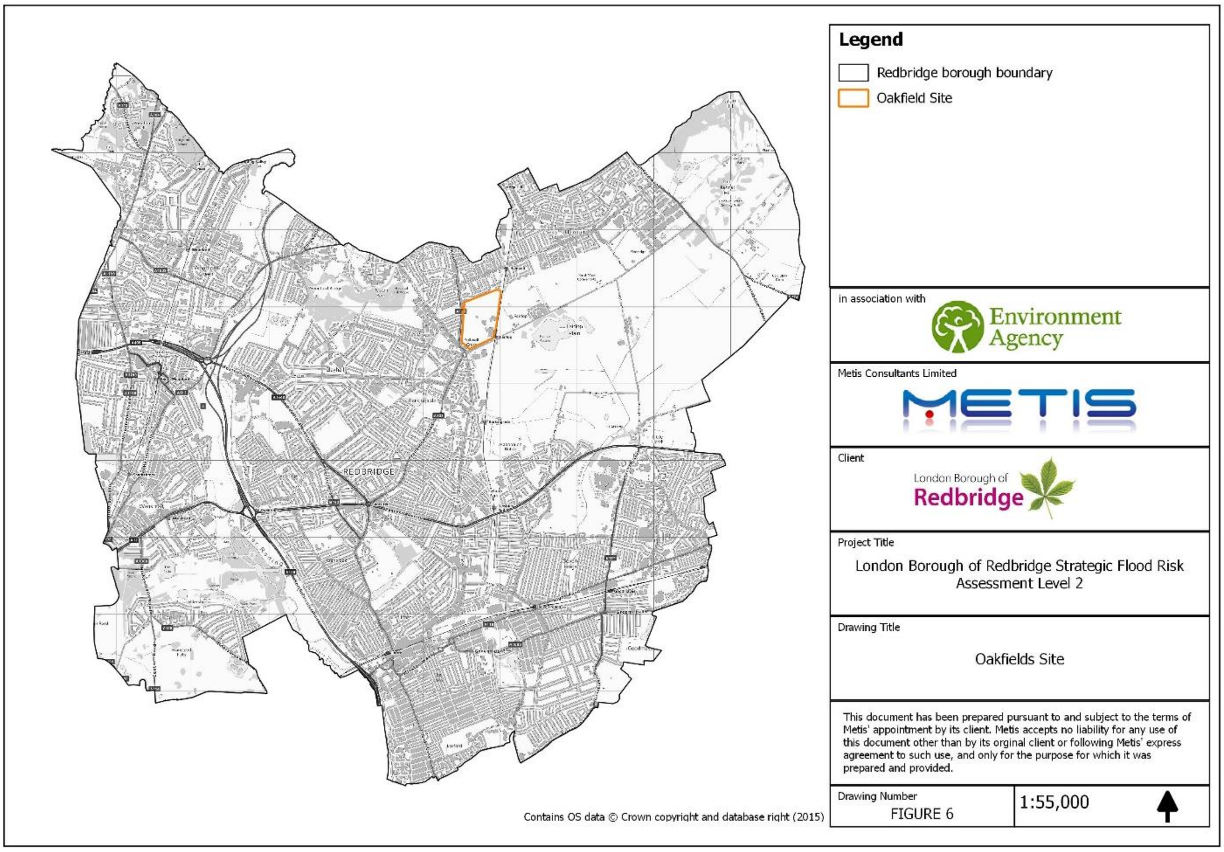

Figure 6. The proposed Oakfields development site within the London Borough of Redbridge.

The Oakfields site is surrounded by suburban houses on three sides and a raised railway embankment on the other. The change in elevation over the site is low and there is a small gradient sloping north to south. Fairlop tube station lies adjacent to the south-east corner of the site and a bus routes run along Fencepiece Road to the west.

Currently the Oakfields sites includes Redbridge Sports and Leisure Centre which is located at the eastern end of site, Frenford sports pitches towards the north of site and Old Parkonians sports pitches to the south of the site. The leisure centre has been open since 1972 and provides the facilities for indoor, outdoor and racket sports, as well as kids activities. The Old Parkonians sports pitches house both a cricket and a football team.

6.3. PLANNING CONTEXT

A Green Belt review was undertaken by LBR in 2010. It concluded that whilst most Green Belt land in Redbridge continues to fulfil a Green Belt purpose under national planning policy to prevent urban sprawl and encroachment into the countryside, a number of parcels did not because of changes (in both physical and national policy terms) that have occurred since they were designated in the 1950s. Oakfields was one of the sites and so the emerging Local Plan does not include it in the Green Belt.

6.4. RISK ASSESSMENT

6.4.1. FLUVIAL AND TIDAL

EA and LBR mapping shows that the Oakfields site is not at risk of fluvial or tidal flooding. Fairlop Waters, a FSA and therefore a designated Flood Zone 3b area, is approximately 500m to the east of the site and is not considered a risk to the site. As the site is not at risk of fluvial flooding, there is no requirement to pass the Sequential or Exception Tests.

6.4.2. SURFACE WATER AND ORDINARY WATERCOURSES

The Level 1 SFRA (2015) outlines the boroughs surface water flood extent, taken from the EA's Updated Flood Map for Surface Water. It shows that the Oakfields site is susceptible to patchy surface water flooding towards the centre, to the north east and southern part of the site. The predicted depths of these sit within the 0.15-0.3m and 0.3-0.6m ranges, as shown in *Figure 6.1 (*and *Figure B1* in *Appendix B*). The velocity of this surface water ranges from 0-1m/s in the north east and 0-0.25m/s in the central and southern parts of the site. For context, typical walking speed is approximately 1.5m/s.

The combination of depth and velocity is used to calculate the hazard. The surface water flood hazard towards the north of the site ranges from 0.5 to 2 (low to significant hazard) and the central and southern parts are 0.5-0.75 (low hazard) with a very small area in the 0.75-1.25 (medium hazard) category. This is shown in *Figure 6.2 (*and *Figure B2* in *Appendix B*).

The nearest Ordinary Watercourse is approximately 160m to the south of the south-east corner of Oakfields and flows away from the site. The site is not at risk of flooding from Ordinary Watercourses.

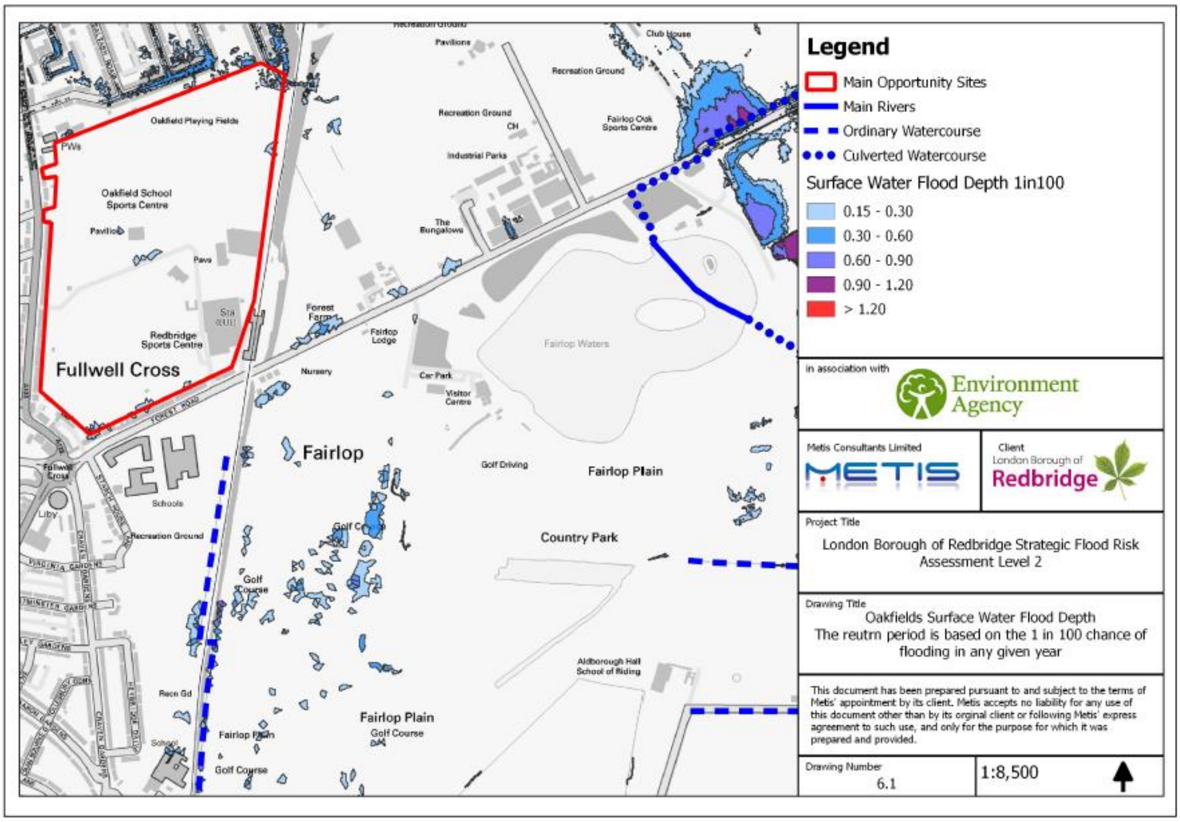

Figure 6-1. Oakfields surface water flood map (depth)

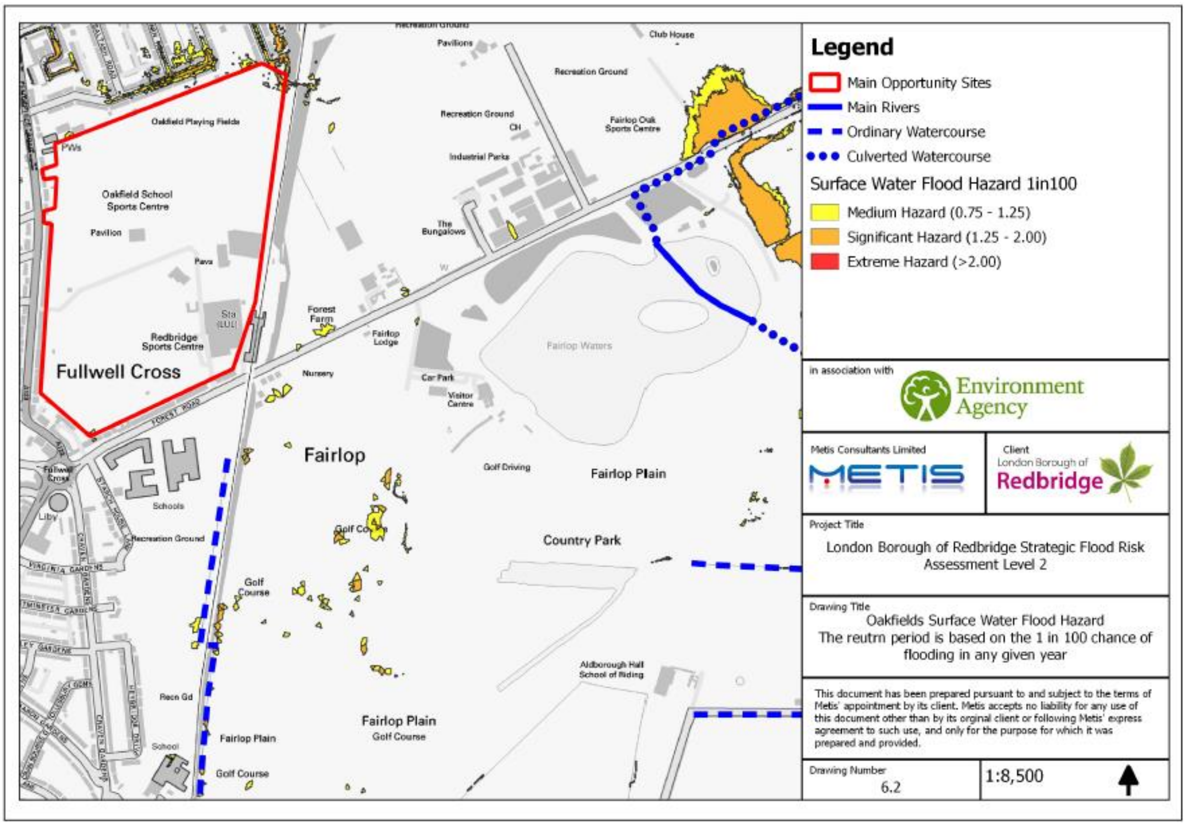

Figure 6-2. Oakfields surface water flood map (hazard)

6.4.3. SEWER

The Oakfields site falls within two postcode areas, IG6 3 and IG6 2. TWULs DG5 register shows that one property within the IG6 2 area has experienced sewer flooding. There were no records of sewer flooding occurring in the IG6 3 area. There is no information on the time to inundation and duration of flood available.

There are surface water sewers which run along the three sides of the site which are surrounded by suburban houses, although none of these run though the Oakfields Site. There is a foul sewer which runs the length of the site down the eastern side. The risk of flooding to the Oakfields site from sewers is assessed to be low.

6.4.4. GROUNDWATER

Groundwater flooding is most likely to occur in areas underlain by permeable rocks, areas known as aquifers. The Oakfields site is located above a superficial secondary aquifer. These have permeable layers capable of supporting water supplies at a local level and in some cases they form an important source of base flow to rivers. In comparison to an area not situated above an aquifer, Oakfields has an increased level of groundwater flood risk.

The Boyn Hill Gravel Member superficial deposit overlays London Clay Formation bedrock throughout the Oakfield site. There is an increased potential for elevated groundwater in areas overlain by permeable superficial deposits.

*Figures 6.3A and 6.3B (*and *Figures B3a and B3b* in *Appendix B*) display the groundwater flood risk associated with the Oakfields site.

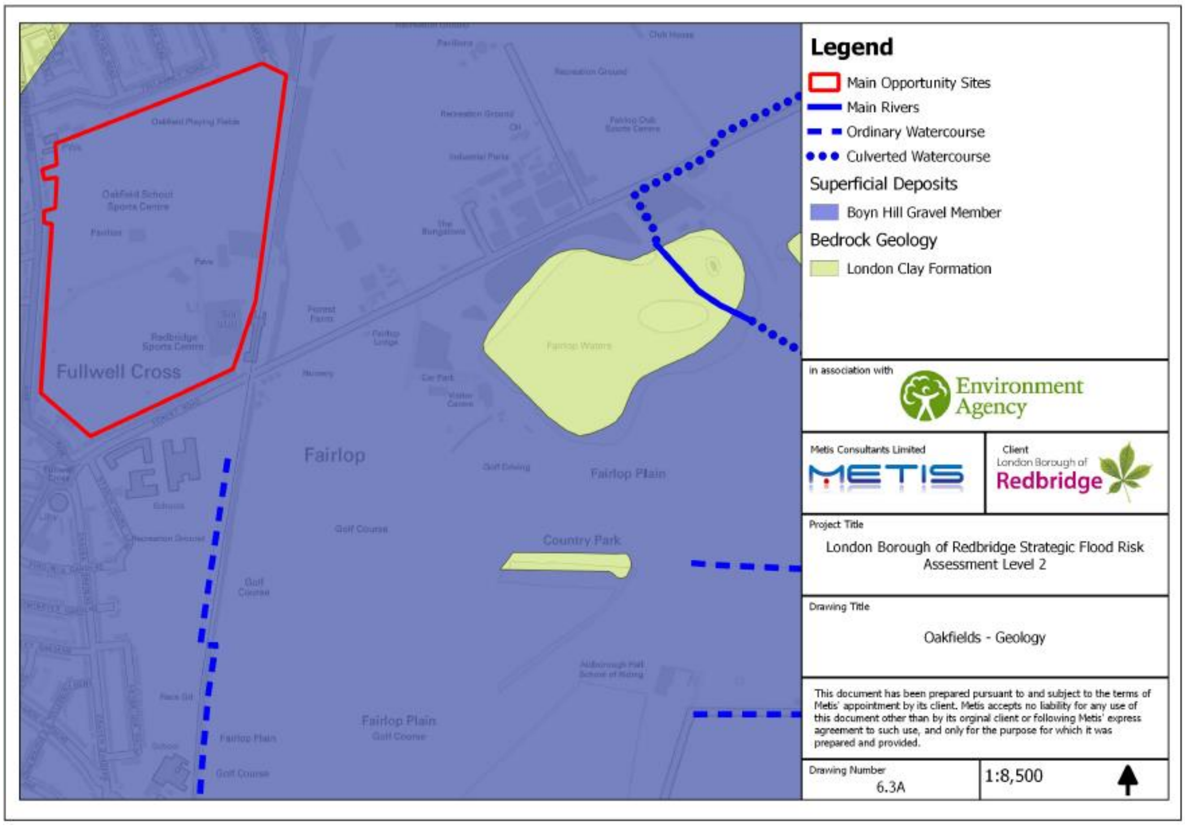

Figure 6-3A. Oakfields groundwater flood risk (geology).

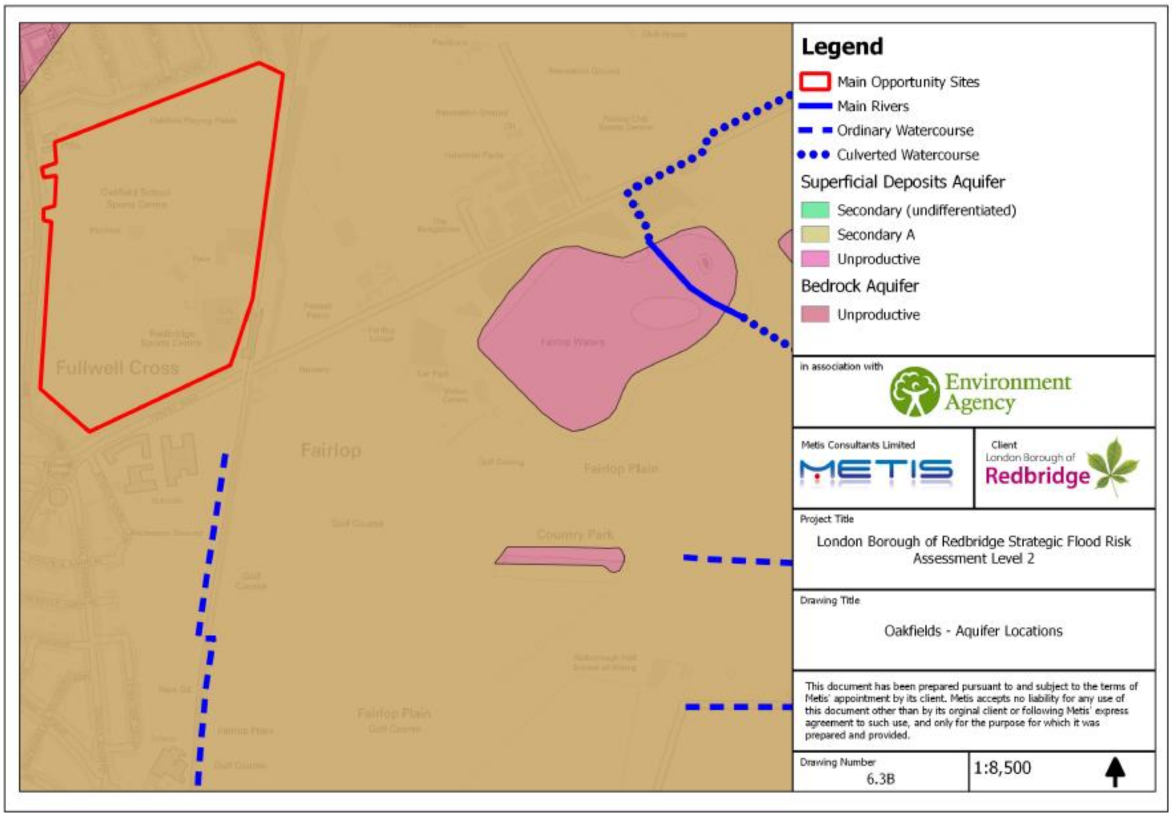

Figure 6.3B. Oakfields groundwater flood risk (aquifers).

Due to the fact that there has been little groundwater flood risk modelling in this area, information on flood extent, level of risk, time to inundation and duration of flood is not available. The evidence available indicates that there may be a risk of groundwater flooding and it should be investigated further by the site developer and the outcomes considered in development designs.

6.4.5. ARTIFICIAL

The EA's Risk of Flooding from Reservoirs mapping indicates the Oakfields site is not at potential risk from flooding due to a reservoir failure. There are no lakes or canals which could impose a risk of flooding to the site.

6.4.6. RESIDUAL (DEFENCE FAILURE/OVERTOPPING)

By EA definition, an area benefits from a flood defence if it has a SoP against the 1 in 100 year event. There are no areas with the LBR which benefit from defences under this definition. There are also no formal flood defences within the Oakfields site. The nearest defences are the natural banks around Fairlop Waters approximately 500m away. These have a stated SoP of 5 years but do not influence flood risk on the Oakfields site. In light of this information, there is no residual risk due to defence failure or overtopping.

6.4.7. IMPACTS OF CLIMATE CHANGE

Climate change could result in an increase of flood risk (refer to section 4.6: Impacts of Climate Change). The following paragraphs outline how climate change may impact the Oakfields site.

FLUVIAL AND TIDAL FLOOD RISK

It is understood that climate change may result in more extreme weather occurrences which could include increased rainfall. This may cause river levels to increase at times and for downstream areas to be inundated with water at an increased speed. The current Flood Zones could expand and more areas could be at risk. Given the local topography, it is unlikely that fluvial or tidal flood risk could impact the site under current climate change scenarios.

SURFACE WATER AND ORDINARY WATERCOURSE FLOOD RISK

An increase in the occurrence of heavy rainfall events may increase surface water and ordinary watercourse flood risk. Water may not be able to drain away quickly enough resulting in overland flow. Additionally, shallower ditches and channels may flood.

The LBR decided to map surface water flood risk as when water is deeper than 150mm and caused by a rain event with an annual probability of 1% (1 in 100). The 1 in 100year event was selected to account for climate change impacts on the 1 in 30year event. The difference in spatial extent between the two return periods can be seen in *Figure 6.4 (*and *Figure B4* in *Appendix B*).

The Updated Flood Map for Surface Water shows that for an event with an annual probability of 0.33% (1 in 30 year) very marginal sections to the north east and south west of the Oakfields site are at risk of surface water with depths ranging from 0.15-0.6mm. The 1 in 100 year event by comparison is predicted cause similar depths of flooding, but to a slightly larger extent.

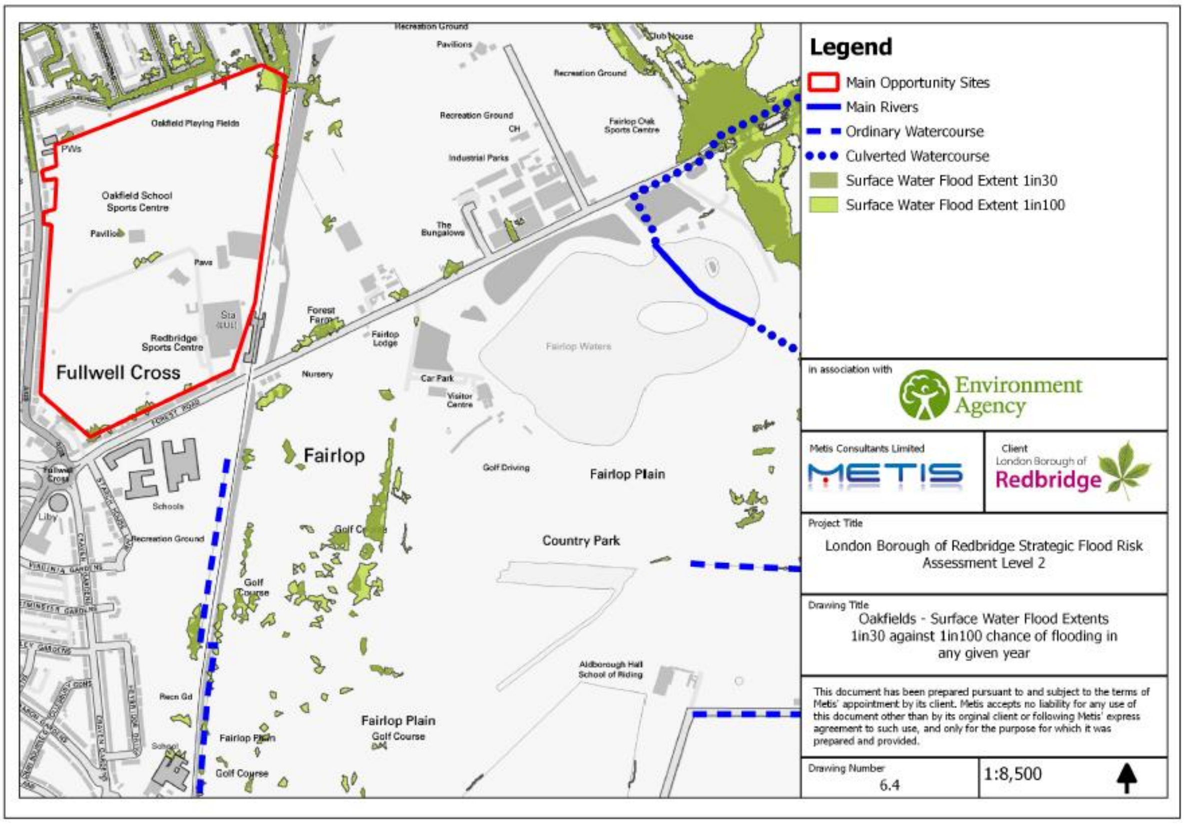

Figure 6-4. Oakfields surface water flood risk comparison (1 in 30 year compared to the 1 in 100 year event)

Due to the increase in groundwater levels and surface water runoff associated with climate change, intermittent watercourses can be found to contain a flow or an increased flow which increases the risk of flooding. As there are no Ordinary Watercourses with the Oakfields site, it would not be at risk from flooding due to these.

SEWER FLOOD RISK

It is expected that climate change will result in an increase in the frequency and intensity of rainfall events. This will decrease the level of service provided by the sewer system over time and sewer flooding will increase where capacity is not increased in line with these changes.

GROUNDWATER FLOOD RISK

It is predicted that the effects of climate change may increase groundwater flood risk. An increase in rainfall can result in aquifers becoming fully recharged more frequently resulting in excess water rising back to the surface in the form of springs. Subsequently, intermittent watercourses can be found to contain a more frequent or permanent flow. These effects can also be caused by higher sea levels which can cause an increase in the water table resulting in groundwater being found closer to the surface. Although there are no Ordinary Watercourses within the site area, it should be noted that due to the aquifer located below the Oakfields site, groundwater flood risk can be expected to increase due to climate change and any development should consider the impacts of this.

ARTIFICIAL FLOOD RISK

The increased rate and volume of rainfall associated with climate change could increase reservoir flood risk in a similar way in which climate change could affect flood defences. Although this has not been modelled, the frequency in which overtopping occurs could increase, as could the risk of subsequent breaches. An increase in water volume could extend the reservoir breach flood risk extent.

6.4.8. HISTORIC FLOOD ISSUES

The previous SFRA (2009) showed significant flooding of the Oakfield site but modelling has since been refined to what appears to be more accurate with respect to flooding actually experienced. In 2012, WSP UK Ltd (WSP) carried out integrated modelling of the Cran Brook and its contributing catchment. The model represents the Oakfields site as an open space. Surface water is shown to travel south and potentially flood properties along Forest Road. LBR officers are content that this is representative of actual flooding at the site. There are no known flood issues to the north of the site. There are known historic flooding issues further downstream of the Cran Brook. Retaining surface water on the Oakfields site to delay water entering the channel would be beneficial.

The EA's historic flood map shows flooding along the River Roding. This does not impact the upper part of the Cran Brook or the Oakfields site.

6.5. POTENTIAL MANAGEMENT MEASURES

6.5.1. FLUVIAL AND TIDAL

The Oakfields site is not directly at risk of flooding from any rivers or the sea. However, the site is located within the Cran Brook catchment. The Cran Brook has been known to flood historically and if surface water runoff can be reduced from the Oakfields site, downstream fluvial flooding issues could be mitigated.

If the surface water runoff is increased through development, there is a chance that flood risk would be increased downstream as a result. SuDS should be utilised to achieve better than Greenfield runoff rates post-development and provide a potential reduction in flood risk downstream. Attenuation methods should be used to delay water from leaving the site and increase the time it takes for it to reach the watercourse. More details on these can be found below in *Section 6.5.6*.

6.5.2. SURFACE WATER AND SEWER

The Oakfields site has a low to medium risk of surface water flooding. When developing the site masterplan, 'highly vulnerable' developments should not be located within the surface water flood extent. The sequential approach should be utilised to locate any 'essential infrastructure' or 'more vulnerable' developments outside the predicted surface water flood extent. Finished floor levels must be set at least 150mm above the predicted 1 in 100 year surface water flood level or the adjacent ground level – whichever is the greater.

SuDS features should be used on-site to mitigate the surface water flood risk and to reduce runoff to aid in mitigating flood risk elsewhere. Attenuation methods should be used to delay surface water from leaving the site. The London Plan (GLA, 2015) states that developments should aim to achieve Greenfield runoff rates as a minimum. For the Oakfields site, the LBR will be seeking better than Greenfield runoff rates to mitigate downstream flood risk on the Cran Brook. Site ground conditions should be tested to determine the potential for disposal of surface water via infiltration. This approach will also mitigate the impact of the development on sewer flooding.

6.5.3. GROUNDWATER

The risk of flooding from groundwater is uncertain and should be investigated by the developer. If investigations show that there is a groundwater flood risk, basements should not be permitted and the use of infiltration based SuDS will need to be reviewed.

6.5.4. ARTIFICIAL

The Oakfields site has a very low risk of flooding from artificial sources. There are no associated management measures proposed.

6.5.5. EMERGENCY PLANNING

Access and egress routes should be designed so that should a flood event occur, residents can safely leave the area and emergency services are able to navigate as required. When planning these routes, developers should consider the 1 in 100 year surface water flood risk and be mindful of the risk along the north-east and southern areas of the site boundary. These areas should be avoided. Routes adjoining Fencepiece Road, western Trelawney Road and eastern Forest Road would be most appropriate.

6.5.6. USE OF SUDS

VOLUMES AND RATES

The use of SuDS maintains natural drainage flows and contributes to reduction of flood risk elsewhere. To provide an approximation of the surface water runoff rates and volumes expected at the Oakfields site, HR Wallingford's UK Sustainable Drainage Guidance and Tools website has been used. The 'Greenfield runoff estimate' and the 'Stormwater storage analysis' tools have been utilised. Information on how these tools work can be found on the website (HR Wallingford, 2015).

A summary of the estimated Greenfield runoff rates are in *Table 6.1* and estimated storage volumes in *Table 6.2.* The full reports generated by the SuDS tool can be found in *Appendix B (Figures B6* and *B7)*. Estimates have been made based on two different percentages of impermeable area to provide a range of how this changes depending on the density of the development.

Table 6-1. Predicted Greenfield runoff rates for the Oakfields site

Return Period	Peak Runoff Rate
Qbar*	99.4 l/s
1 in 1 year	84.49 l/s
1 in 30 years	228.63 l/s
1 in 100 years	317.10 l/s

*the mean annual flood

Table 6-2. Predicted surface water storage requirements for the Oakfields site

Storage Type	50% impermeable area	66.6% impermeable area
	Storage Volume	
Interception storage	500 m^3	700 m^3
Attenuation storage	8,800 m^3	12,200 m^3
Long term storage	0	1,000 m^3
Treatment storage	1,500 m^3	2,000 m^3
Total storage	**10,800 m^3**	**15,900 m^3**

As noted in Sections 6.5.1 and 6.5.2, the LBR expects surface water runoff from the Oakfields site to reduce as part of the development. The values in the above tables should be treated as the minimum targets and a higher retention volume is expected. A minimum 5 l/s peak discharge rate should remain to prevent the blocking of any channels or culverts.

CHOICE OF SUDS

There is a wide range of different types of SuDS and not all techniques will be suitable for all sites. There will be opportunities and constraints with each development location and SuDS should be chosen accordingly.

The SuDS Selection chapter of The SuDS Manual (CIRIA C697, 2007) contains a Design Information Checklist and a step-by-step approach to selecting SuDS. It uses a SuDS selection criteria which assesses SuDS features based upon the following headings:

- Land use characteristics
- Site characteristics
- Catchment characteristics
- Quantity and quality performance requirements
- Amenity and environmental requirements

An assessment for the Oakfields site has been made using the SuDS selection criteria. This can be seen below in *Table 6.*3. A number of assumptions have been made for this high level assessment. The site developer should satisfy themselves that they are appropriate or propose alternatives if needed. The following assumptions have been made:

- Land use: Based upon a potential development comprising of residential, commercial and local roads.
- Site characteristics: Based on the site investigations, the soil is permeable; the area draining to a single SuDS component could be either 0-2 ha or >2 ha; the minimum depth to the water table is greater than 1m and the site slope is less than 5%.

Table 6-3. Initial SuDS assessment for the Oakfields site.

SuDS Group	Technique	Land use			Site characteristics						
		Residential	Commercial	Local Roads	Permeable soil	0-2 ha draining to a single SuDS	>2ha draining to a single SuDS	Min depth to water table >1m	Site slope 0-5%	Available head 0-1m	Low available space
Retention	Retention pond	Y	Y[2]	Y[1]	Y[3]	Y	Y[5]	Y	Y	Y	N
	Subsurface storage	Y	Y	Y	Y	Y	Y[5]	Y	Y	Y	Y
Wetland	Shallow wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N
	Extended detention wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N
	Pond/wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N
	Pocket wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	N	Y[7]	Y	Y	Y
	Submerged gravel wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N
	Wetland channel	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N
Infiltration	Infiltration trench	Y	Y[2]	Y[1]	Y	Y	N	Y	Y	Y	Y
	Infiltration basin	Y	Y[2]	Y[1]	Y	Y	Y[5]	Y	Y	Y	N
	Soakaway	Y	Y[2]	Y[1]	Y	Y	N	Y	Y	Y	Y
Filtration	Surface sand filter	Y	Y[2]	Y[1]	Y	Y	Y[5]	Y	Y	N	N
	Sub-surface sand filter	Y	Y[2]	Y[1]	Y	Y	N	Y	Y	N	Y
	Perimeter sand filter	N	Y[2]	Y[1]	Y	Y	N	Y	Y	Y	Y
	Bioretention/filter strip	Y	Y[2]	Y[1]	Y	Y	N	Y	Y	Y	N
	Filter trench	Y	Y[2]	Y[1]	Y[3]	Y	N	Y	Y	Y	Y
Detention	Detention basin	Y	Y[2]	Y[1]	Y[3]	Y	Y[5]	Y	Y	N	N
Open channels	Conveyance swale	Y	Y[2]	Y[1]	Y	Y	N	Y	Y	Y	N
	Enhanced dry swale	Y	Y[2]	Y[1]	Y	Y	N	Y	Y	Y	N
	Enhanced wet swale	Y	Y[2]	Y[1]	Y[4]	Y	N	Y	Y	Y	N
Source control	Green roof	Y	Y[2]	N	Y	Y	N	Y	Y	Y	Y
	Rain water harvesting	Y	Y[2]	N	Y	Y	N	Y	Y	Y	
	Pervious pavements	Y	Y[2]	N	Y	Y	Y	Y	Y	Y	Y

Y = Yes
N = No
[1] = may require two treatment train stages depending on type and intensity of road use and receiving water sensitivity.
[2] = may require three treatment trains depending on receiving watercourse sensitivity
[3] = with liner
[4] = with liner and constant surface baseflow, or high ground water table
[5] = possible but not recommended (implies appropriate management train not in place)
[6] = where high flows are diverted around SuDS component
[7] = with surface baseflow

The catchment characteristics assessment section helps to determine how many components of the SuDS treatment train is required to lower the risk of poor water quality and whether these are any regulatory criteria which may restrict or preclude the use of a SuDS technique. For example, the downstream water body that will receive the discharge or the pollutant removal required. As the receiving water sensitivity increases, the number of treatment train components increase. The following questions should be asked and answered as part of a full assessment of the Oakfields site:

- Are aquifers used for public water supply?
- Is the Cran Brook used as formal recreational/amenity facilities?
- Are there any local habitat requirements?
- Would any of the water discharge into the sewerage network?

Once the sensitivity of the receiving water is established and the required number of components required in the SuDS train is identified, the quantity and quality performance section should be used. This outlines which components have a high, medium or low potential to deal with water quality treatment or hydraulic control. With respect to the Oakfields site, the receiving waterbody is ultimately the Cran Brook.

In line with the Water Framework Directive (WFD), rivers within the European Union should be striving to improve water quality. Therefore, the sensitivity should be high requiring the use of more SuDS components within the treatment train. This will help to ensure clean water leaves the site.

SuDS which are to collect water from the residential roads and commercial areas should be made up of three components and those collecting water from roofs should be made up of one. Ideally, SuDS techniques with a high potential to produce better quality water should be used. To account for the flood risk associated with the Cran Brook, techniques with high potential for runoff volume reduction and with high potential of hydraulic control for the 1 in 100 year event should be used.

Part of the SuDS section process should focus on the community and environment requirements at the site. In order to maximise the benefits from SuDS, they need to be maintained. Some techniques require more maintenance than others. It is important that the adopter of the proposed drainage system is involved in the planning process in the early stages so that the most appropriate SuDS are chosen based upon the initial cost and the available maintenance commitment.

SuDS techniques should also be chosen based on how acceptable they are to the community. A resident may not want a swale in their garden although a feature in a recreation ground would be acceptable. Equally, they need to be safe and the public should not be concerned. Lastly, SuDS can also improve wildlife habitat and in turn have ecological benefits.

The following SuDS techniques are recommended for the Oakfields site (although, as mentioned, a number of site investigations would need to be carried out to confirm this):

- Retention pond / wetland - where space is available
- Infiltration trench - where less than 2 ha is being drained
- Infiltration basin - where space is available
- Soakaway - where less than 2ha is being drained
- All swale types - where less than 2ha is being drained
- Green roof - not roads and only where less than 2ha is being drained
- Rainwater harvesting - not roads and only where less than 2ha is being drained
- Pervious pavements - Roads , parking and paved outside areas where less than 2ha is drained

MAINTENANCE REQUIREMENTS

The document *Cost estimation for SuDS – summary of evidence* (EA 2015), which provides indicative costs and maintenance guidance for SuDS and other drainage infrastructure. *Table 6.4* below describes the typical works and frequencies for the SuDS most suitable for the Oakfields site.

Table 6-4. Typical works and frequencies for the SuDS most suitable for the Oakfields site

SuDS Technique	Annual or sub annual maintenance	Intermittent	Design life estimates
Retention pond	No information available		20-50 years
Infiltration trench	Monthly - litter and debris removal. Annual - weed/root management. Removal & washing of exposed stones. Removal or sediment from pre-treatment devices.	Replacement of filter material (20-25 years)	Unlimited design life. 10-15 years before replacement of filter material.
Infiltration basin	Monthly - litter & debris removal, grass cutting of landscaped areas. Half yearly - grass cutting of meadow grass and around basin. Annual - manage vegetation & remove nuisance plants.	Re-seed areas of poor vegetation growth. Prune % trim trees. Remove sediment when 50% full. Repair of erosion or other damage. Repair/ rehabilitation of inlets, outlets & overflows. Re-level uneven surfaces & reinstate design levels.	Unlimited design life. 10-15 years before tilling required & replacement of infiltration surface.
Soakaway	Remove sediment and debris. Clean gutters and filters. Trim roots that cause blockage.		No information available.
Swales	Monthly - litter and debris removal, grass cutting. Annual - manage vegetation and remove nuisance plants. Checks for poor vegetation growth and re-seed.	Repair erosion or damage, re-level uneven surfaces. Remove sediment and/or oils.	Unlimited design life. 5-10 years before tilling required & replacement of infiltration surface.
Green roof	6 monthly - remove debris and litter. Remove weeds. Mow grass (if applicable)		Unlimited design life.
Rainwater harvesting	**Simple:** Annual - cleaning inlets, outlets, gutters & tanks. **Advanced:** 3-6 monthly - self-cleaning & coarse filter checks & clean. 6-12 monthly - check & clean roof & gutters. UV unit operation checks. Annual - pump operation checks.		Unlimited design life.
Pervious pavements	4 monthly - brushing and vacuuming	Stabilise & mow contributing areas, removal of weeds. Remedial work to any depressions or broken blocks. Rehabilitation of surface & upper sub-structure where significant clogging occurs. Replacement of filter material (20-25 years).	Unlimited design life. 20-25 years before replacement of filter material.

INDICATIVE CAPITAL AND MAINTENANCE COSTS

The EA document *Cost estimation for SuDS – summary of evidence* contains information on calculating whole life costs, which include the following:

- Procurement and design costs
- Capital construction costs
- Operation and maintenance costs
- Monitoring costs
- Replacement or decommissioning costs

Using this information, *Table 6.5* provides an initial estimations of the costs associated with the most suitable SuDS components for the Oakfields site as identified in the above section. Note that there are a number of factors which may affect the costs outlined below and a site-specific estimate should be compiled by the developer to demonstrate that the recommended SuDS approach is cost effective (or to demonstrate an alternative approach provides a more cost effective solution).

Table 6-5. Indicative prices for the most suitable SuDS components for the Oakfields site.

SuDS Technique	Indicative Capital Costs	Annual Maintenance Costs
Retention pond	£15-£25/m^3 treated volume (CIRIA 2007) £80,000/5000m^3 pond (£16/m^3) (SNIFFER, 2007)	£0.5 - £1.5/m^2 of pond surface area (HR Wallingford, 2004) £0.1 - £2/m^3 of pond volume (Ellis, 2003)
Infiltration trench	£55-£65/m^3 stored volume (CIRIA, 2007) £74-£99/m length (Stovin & Swan 2007) £60/m^2 (EA, 2007)	£0.2 - £1/m^2 of filter surface area (HR Wallingford, 2004)
Infiltration basin	£10-£15/m^3 stored volume (CIRIA, 2007)	£0.1 - £0.3/m^2 of basin area £0.25 - £1/m^3 of detention volume (HR Wallingford, 2004)
Soakaway	>£100/m^3 stored volume (CIRIA, 2007) £454 -£552/soakaway (Stovin & Swan 2007)	£0.1/m^2 of treated area (HR Wallingford, 2004)
Swales	£10-£15/m^2 swale area (CIRIA, 2007) £18-£20/m length using an excavator (Stovin & Swan 2007) £12.5/m^2 (EA, 2007)	£0.1/m^2 of swale surface area (HR Wallingford, 2004) £350/year (Ellis, 2003)
Green roof	£90/m^2 - covered roof with sedum mat (Bamfield, 2005) £80/m^2 - biodiverse roof (varied covering of plants, growing medium & aggregates) (Bamfield, 2005)	£2,500/year for first 2 years for covered roof with sedum mat, £600/ year after (Bamfield, 2005) £1,250/year for first 2 years for covered roof with biodiverse roof, £150/year after (Bamfield, 2005)
Rainwater harvesting	**Simple:** £100 - £243/property (includes installation & connection pipe) (Stovin & Swan 2007) **Advanced:** £2,100 - £2,400/residential property (Woking Borough Council) £2,500 - £6,000/residential property (EA, 2007) £2,600 - £3,700/residential property (RainCycle, 2005) £6,300 - £21,000/ commercial/industrial property (RainCycle, 2005) £45/m^2 for residential properties (EA, 2007) £9/m^2 for non-residential properties (EA, 2007)	**Simple:** Negligible **Advanced:** £250 per year/property for external maintenance contract (RainCycle)
Pervious pavements	£30-£40/m^2 of permeable Surface (CIRIA, 2007) £27/m^2 of replacement surface (Stovin & Swan 2007) £54/m^2 (EA, 2007)	£0.5 - £1/m^3 of storage volume (HR Wallingford, 2004)

6.6. DEVELOPABLE AREA

From analysing the various sources of flood risk, the development site can be split into areas determined by what type of development would be suitable. This is based upon the vulnerability classifications. *Figure 6.5 (*and *Figure B5* in *Appendix B*) displays this information. It shows that the majority of the Oakfields site is considered to be at a low risk and any type of development would be acceptable. There are very small areas of land considered to be at a moderate risk and so more vulnerable development types should not be placed within these areas (or the flood risk investigated further and possibly eliminated). Emergency access and egress routes should avoid using routes considered to be moderate risk areas.

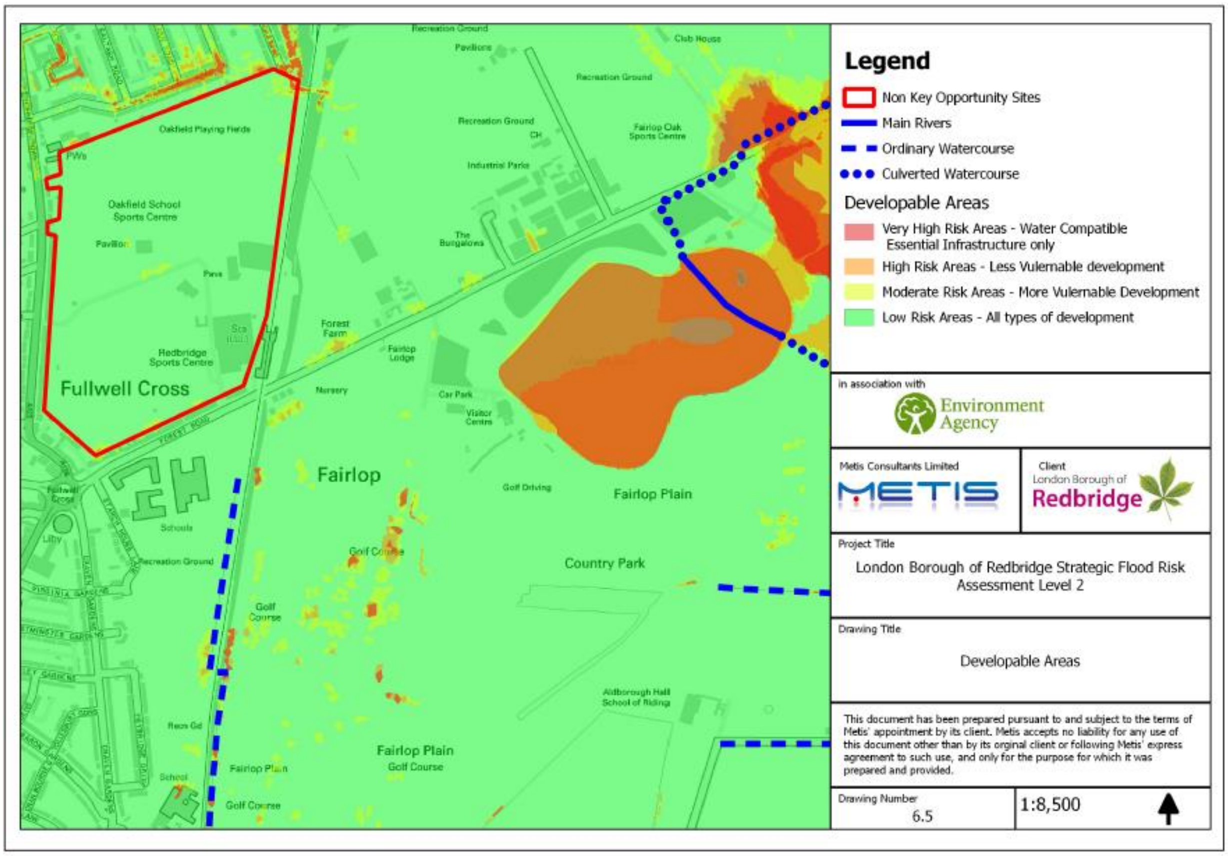

Figure 6-5. Developable area within the Oakfields site based upon flood risk and development vulnerability.

6.7. SITE SPECIFIC FLOOD RISK ASSESSMENT REQUIREMENTS

The assessment of groundwater flood risk showed the location of an aquifer below the Oakfields site along with a permeable superficial deposit layer. These could result in an increased risk of groundwater flooding. A site-specific FRA should investigate this further. It should investigate water table level and potential soil permeability. The outcome of these investigations will outline whether basement developments are suitable and whether infiltration SuDS would be appropriate to mitigate against surface water flood risk on-site and fluvial flood risk downstream at the Cran Brook.

Where the FRA shows there to be surface water flood risk, finished floor levels must be set at least 150mm above the predicted 1 in 100 year surface water flood level or above the adjacent ground level – whichever is the higher.

6.8. DRAINAGE STRATGEY REQUIREMENTS

The drainage strategy must demonstrate that surface water runoff can be managed on site with an overall reduction in peak flow and volume compared to Greenfield rates. If this is not reasonably practical to achieve, then a clear justification must be provided along with an alternative approach that shows Greenfield runoff can be maintained as a minimum.

The strategy should outline which SuDS will be utilised within the development and how the selection process has taken place. This decision should have used the London Plan drainage hierarchy. A justification must be provided where options further down the hierarchy have been chosen over those higher up.

London Plan Policy 5.13 drainage hierarchy:
1. Store rainwater for later use
2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer

It should be clear whether the SuDS will attenuate surface water and, if so, how much. This would provide an indication as to whether there will be a positive effect of flood risk downstream of the catchment at the Cran Brook.

Where SuDS are to be utilised, the drainage strategy should outline who the future owners of the assets will be, who will be responsible for their maintenance and how this will be paid for. There should also be an accompanying maintenance strategy to cover the life of the development.

6.9. PLANNING CONSIDERATIONS

Would the development be at risk of flooding?
Flood risk assessment shows that main potential flood risk sources are surface water, groundwater and sewer flooding. Practical measures are available to mitigate these risks to an appropriate level.

Will the development increase flood risk elsewhere?
Potentially – the LBR should enforce a clear policy requiring the site to deliver better than Greenfield runoff rates post-development.

How can the development reduce flood risk overall?
The site has potential to retain surface water and mitigate existing flood risk further downstream in the Cran Brook catchment.

How can the development be made safe?
Design safe access and egress routes and ensure that finished floor levels are above any predicted flood depths. Do not develop basements where there is groundwater flood risk and do not locate vulnerable land uses within described flood risk areas.

Is there a reasonable prospect of compliance with flood risk aspects of the Exception Test?
Yes – the site is located in Flood Zone 1 and at low to medium risk of surface water flooding that is practically manageable within the development footprint.

6.10. CONCLUSIONS

An assessment of flood risk identifies that the Oakfields site is at a low to medium risk of surface water flooding. There is also the potential of groundwater flooding although further investigation will need to be carried out. Due to the fact that the site is not at risk of fluvial flooding (Flood Zone 1), the Exception Test is not required.

The site layout must accommodate overland flow paths and vulnerable land uses should not be located in any areas at risk. Sufficient SuDS infrastructure will be required to achieve better than Greenfield runoff rates in order to mitigate flood risk downstream in the Cran Brook.

7. KEY SITE ASSESSMENT – GOODMAYES

7.1. SUMMARY

Flood Risk Assessment:

Source	Flood Risk	Source	Flood Risk
Fluvial	Medium to Very High	**Groundwater**	Uncertain but potential risk
Surface water	Medium to High	**Artificial**	Medium
Sewer	Medium to High	**Residual**	Very low

Additional considerations:

Consideration	Implication to Flood Risk
Climate change	Probable increase in surface water and sewer flood risk
Historic flooding	Northern and southern sections of site due to out of bank flooding from Seven Kings Water

Planning Considerations:

- Sequential and Exception Tests will be required if vulnerable developments are proposed within Flood Zones 2, 3a and 3b.
- Site layout must accommodate overland flow paths.
- Sufficient SuDS infrastructure must be provided to achieve better than Greenfield runoff rates.
- A FSA should be considered to alleviate both on-site and downstream flood risk.

7.2. SITE DESCRIPTION

The Goodmayes site is approximately 90 hectares in area and is located to the east of the borough in Ilford (see *Figure 7*). It is surrounded on most sides by residential developments with back gardens. It is bordered on the north by the Eastern Avenue (A12) and Fairlop Plain.

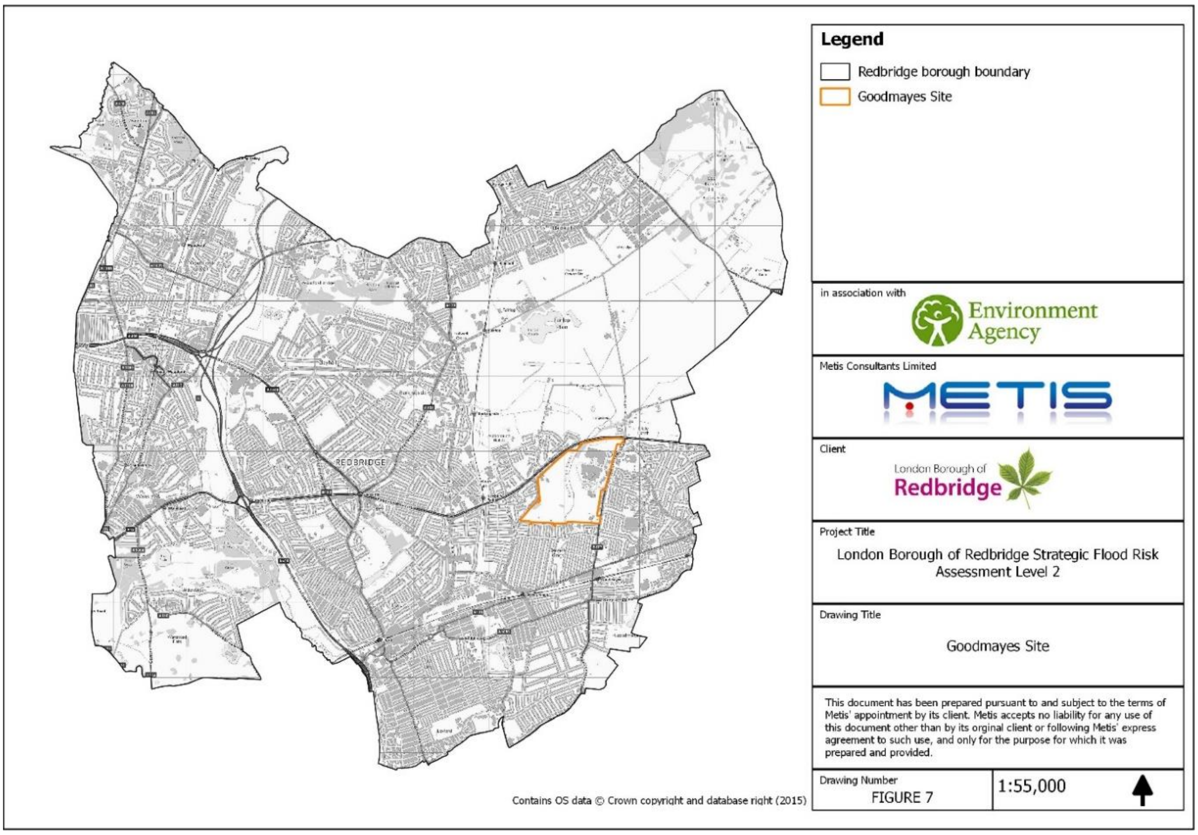

Figure 7. The Goodmayes site.

Two hospitals are situated in the eastern section of the site with Farnham Green Primary School and Barley Lane allotments are located in the south. In the western section of the site, there is the Ilford ambulance station, the Ford Sports and Social Club pavilion with playing fields and the Seven Kings Park. The Seven Kings Water runs through the centre of the site in a north to south direction. The change in elevation from north to south results in a slight downhill gradient, with the watercourse providing a clear flow route for water through the middle of the site.

7.3. PLANNING CONTEXT

Like the Oakfields site, the Goodmayes site was included in the Green Belt review undertaken in 2010. The Goodmayes site was also found not to be meeting the purposes of Green belt policy to prevent urban sprawl and so the emerging Local Plan no longer includes it in the Green Belt.

Due to the Seven Kings Water which runs through the middle of the site, parts of the site are designated Flood Zones 2, 3a and 3b. Therefore, there are development restrictions and if development cannot be located elsewhere, as outlined by the Sequential Test, the Exception Test must be passed. In order to do this, it must be illustrated that the development will provide wider sustainability benefits to the community that outweigh the flood risk and that it will be safe over its lifetime without increasing flood risk elsewhere and where possible, reduce flood risk overall.

7.4. RISK ASSESSMENT

7.4.1. FLUVIAL AND TIDAL

The Seven Kings Water has been designated as a Main River since 2004. Where it runs through the middle of the site, there is a small section of Flood Zone 3b, a large section of Flood Zone 3a and a marginal section of Flood Zone 2. These run the length of the site from north to south generally parallel to the Seven Kings Water in a 100m-200m wide corridor, as shown below in *Figure 7.1* (and *Figure C1* in *Appendix C*).

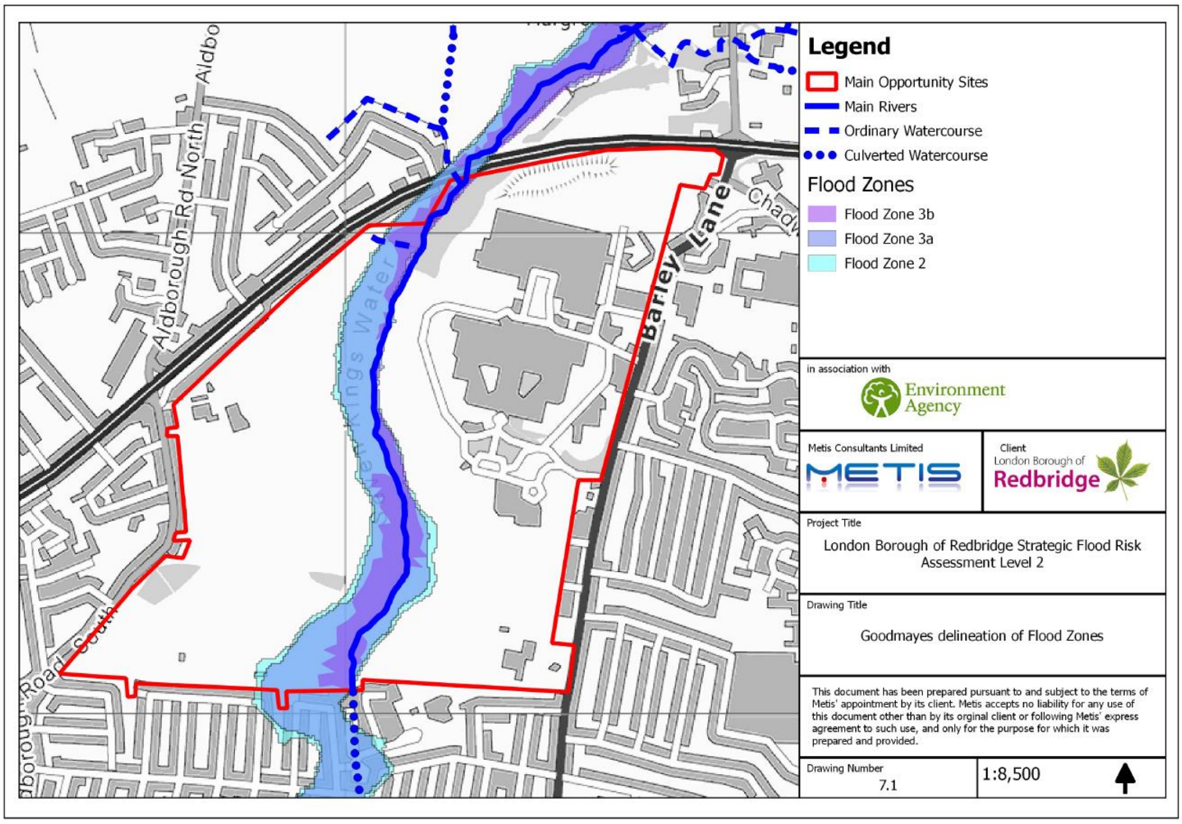

Figure 7-1. Goodmayes fluvial flood risk outlined by the Flood Zones.

7.4.2. SURFACE WATER AND ORDINARY WATERCOURSES

The surface water flood extent shows that the majority of the risk surrounds the Seven Kings Water watercourse where the land is lower. It is very similar to the Flood Zone 3b extent discussed in the previous section. The land surrounding the northern and southern extents of the watercourse within the site is predicted to experience depths up to 0.9m (as per the 1 in 100 year event), whereas the middle section could reach up to 0.6m. There are other small areas of surface water flood risk reaching possible depths of 0.6m to the west of the site and around the hospital buildings to the east. This is shown in *Figure 7.2* (and *Figure C2* in *Appendix C*).

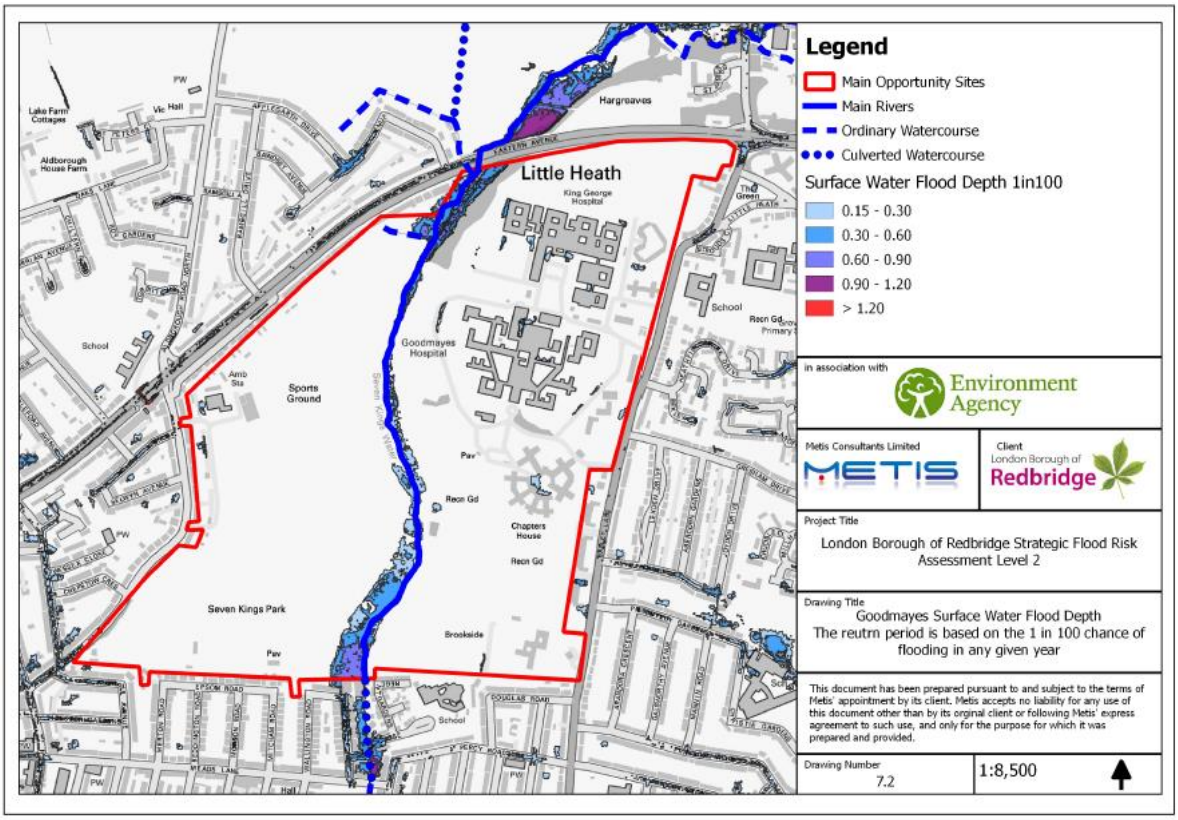

Figure 7-2. Goodmayes surface water flood map (depth)

The predicted velocities differ from the depths in that the greatest rates are predicted to be around the middle reaches of the watercourse. These are estimated to reach 1m/s whereas the land surrounding the northern and southern extents could reach up to 0.5m/s. The patchy areas to the west and east of the site could reach rates of 0.25m/s.

The hazard modelling predicts that the most hazardous areas are around the northern and southern extents of the watercourse. These have a rating that ranges from 0.5-2 (low to significant hazard), with the land surrounding the middle section of the watercourse reaching a rate of 1 (medium risk). The smaller, patchy areas around the site range from 0.5-1.25 (low to medium hazard), as shown in *Figure 7.3* (and *Figure C3* in *Appendix C*).

Since the designation of the Seven Kings Water as a Main River in 2004, there are no Ordinary Watercourses within the site area. There is an Ordinary Watercourse which joins the Seven Kings Water on the northern site boundary and a drain which also joins approximately 450m to the north of the site boundary.

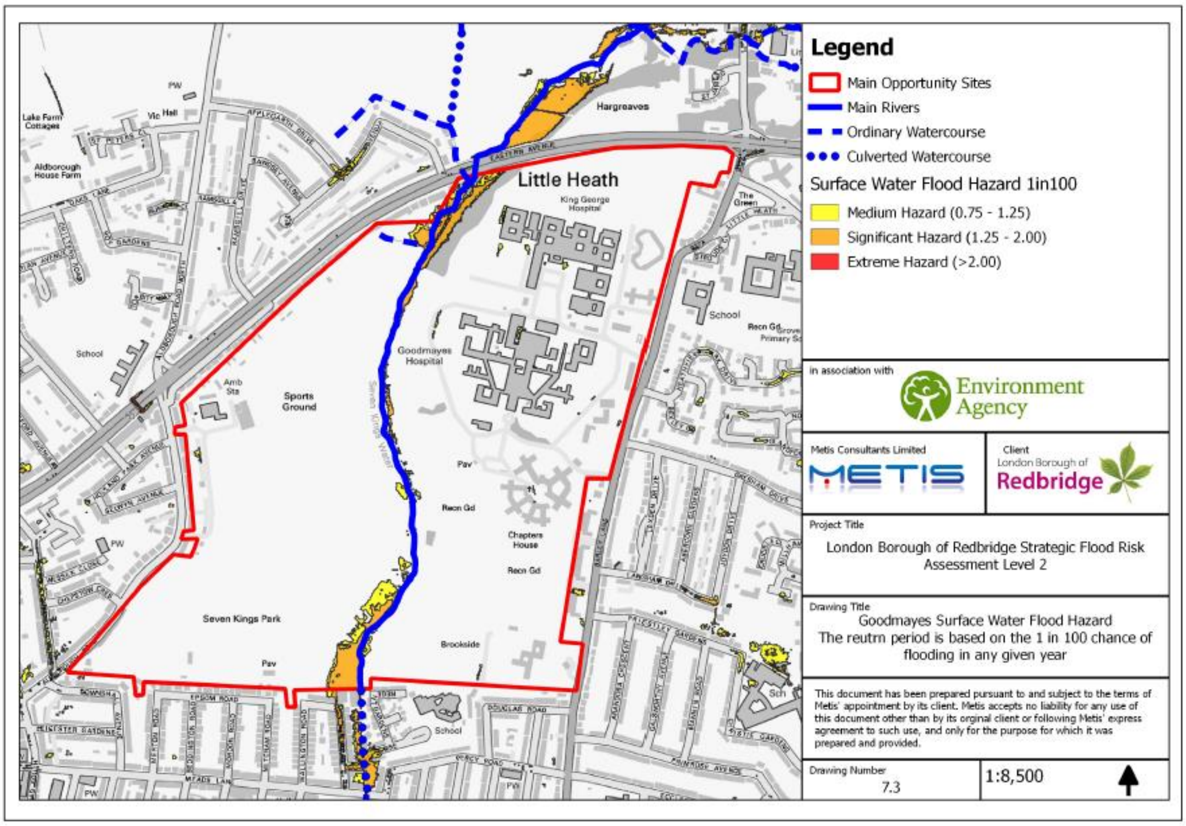

Figure 7-3. Goodmayes surface water flood map (hazard)

7.4.3. SEWER

The Oakfields site falls within the IG3 8 postcode. The Thames Water DG5 register reveals that there are 27 properties at risk of sewer flooding within this area. This is the second highest area at risk within the LBR. There is no information on the time to inundation and duration of flood available.

The roads surrounding the Goodmayes site are served by surface water and foul sewers. There is a foul sewer running the length of the site, from north to south. There is also a short surface water sewer and a foul sewer which looks to serve a small section of the existing highway around the hospital. The sewer flood risk would need to be assessed in detail should any development design progress.

7.4.4. GROUNDWATER

Groundwater flooding is most likely to occur in areas underlain by permeable rocks, areas known as aquifers. The Goodmayes site is located above a superficial secondary aquifer. These have permeable layers capable of supporting water supplies at a local level and in some cases they form an important source of base flow to rivers. In comparison to an area not situated above an aquifer, the Goodmayes site has an increased level of groundwater flood risk.

The bedrock geology is London Clay. There are areas of this overlain by superficial deposits (Boyn Hill Gravel Formation, Head and Ilford Salt Member). There is an increased potential for elevated groundwater in areas underlain by permeable superficial deposits. Information on flood extent, level of risk, time to inundation and duration of potential flooding is not available.

Figures 7.4A and *7.4B* below (and *Figures C4a* and *C4b* in *Appendix C*) show the groundwater flood risk associated with the Goodmayes site.

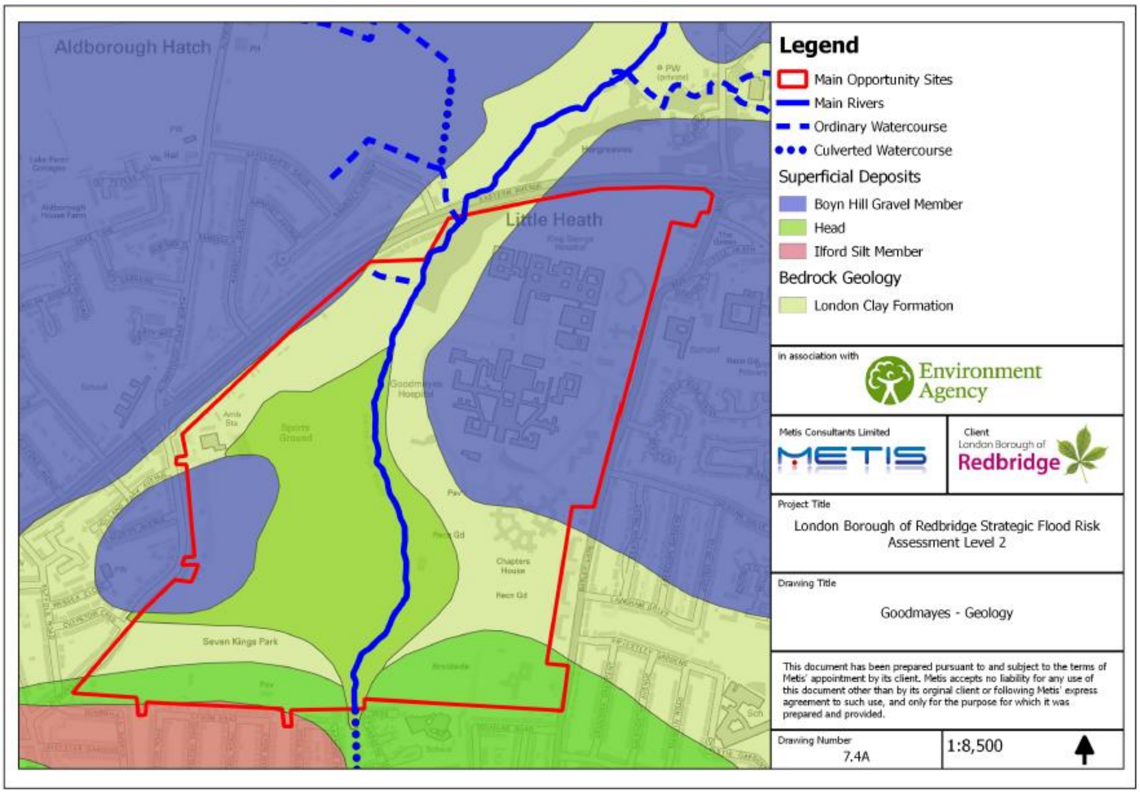

Figure 7-4A. Goodmayes groundwater flood risk (geology)

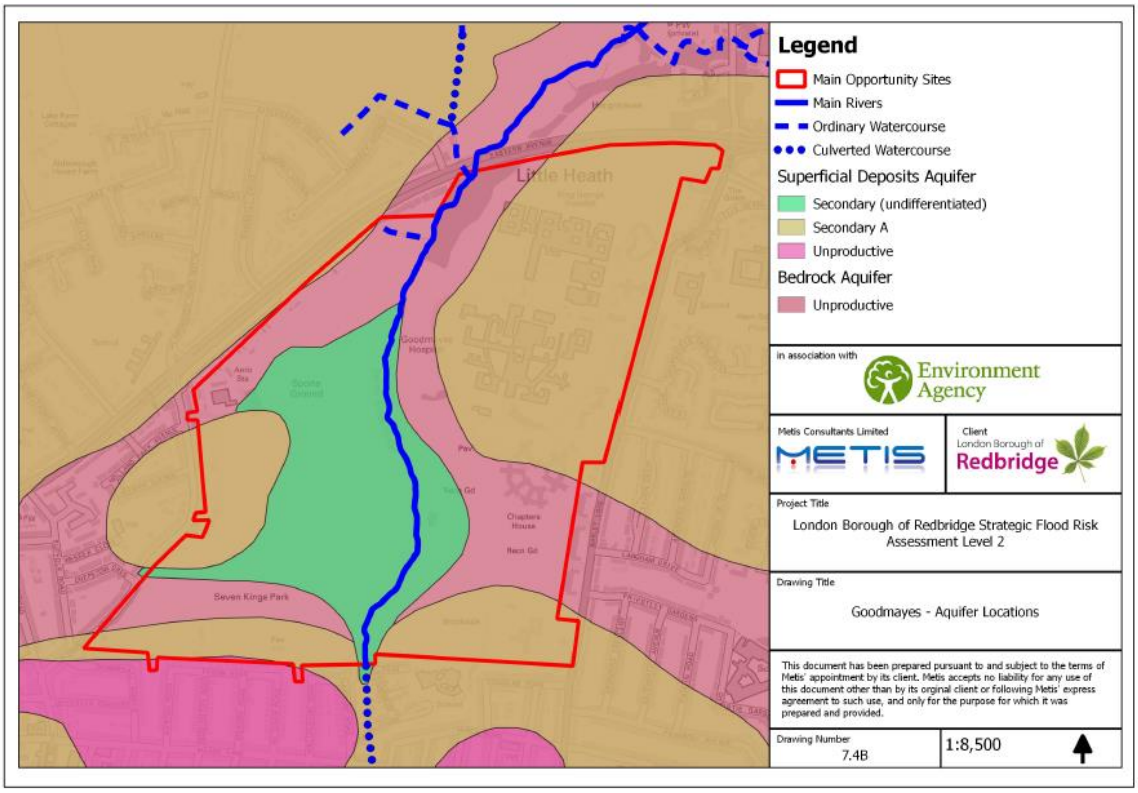

Figure 7.4B. Goodmayes groundwater flood risk (aquifers)

7.4.5. ARTIFICIAL

The EA's mapping indicates that part of the Goodmayes site is at risk of flooding due to a reservoir breach. Should this happen, water from the Hainault Forest Lake (to the north of the site) is predicted to follow the route of the Seven Kings Water which flows through the site. The risk of flooding remains confined to the land immediately alongside the watercourse.

The EA's website states that reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the EA ensure that reservoirs are inspected regularly and essential safety work is carried out.

7.4.6. RESIDUAL (DEFENCE FAILURE/OVERTOPPING)

By EA definition, an area benefits from a flood defence if it has a SoP against the 1 in 100 year event. There are no areas within the LBR which benefit from defences under this definition. There are also no formal flood defences within the Goodmayes site beyond the natural river banks. The river banks are estimated to provide a 1 in 5 year SoP. In light of this information, there is no residual risk due to defence failure or overtopping as this occurs as part for the normal flood mechanism.

7.4.7. IMPACTS OF CLIMATE CHANGE

Climate change could result in an increase of flood risk (refer to section 4.6: Impacts of Climate Change). The following paragraphs outline how climate change may impact the Goodmayes site.

FLUVIAL FLOOD RISK

The potential increase in river levels and time to inundation caused by an increase in rainfall as a result of climate change may result in the current Flood Zones expanding. This could mean that more land within the Goodmayes site may be at risk of fluvial flooding. Those areas already delineated by the Flood Zones could experience an increased risk. Additional modelling would be required to better understand this potential increase in flood risk.

SURFACE WATER AND ORDINARY WATERCOURSE FLOOD RISK

As previously mentioned, the LBR decided to map surface water flood risk as a result of rainfall with an annual probability of 1% (1 in 100) to account for climate change. The Updated Flood Map for Surface Water shows that for an event with an annual probability of 0.33% (1 in 30 year), the surface water flooding predicted to occur around the Seven Kings affects less land and has a shallower depth compared to that estimated for the 1 in 100 year event. There are also less areas at risk around the rest of the site, with patches of land around the hospital buildings affected. The difference in flood extents can be seen in *Figure 7.5* (and *Figure C5* in *Appendix C*).

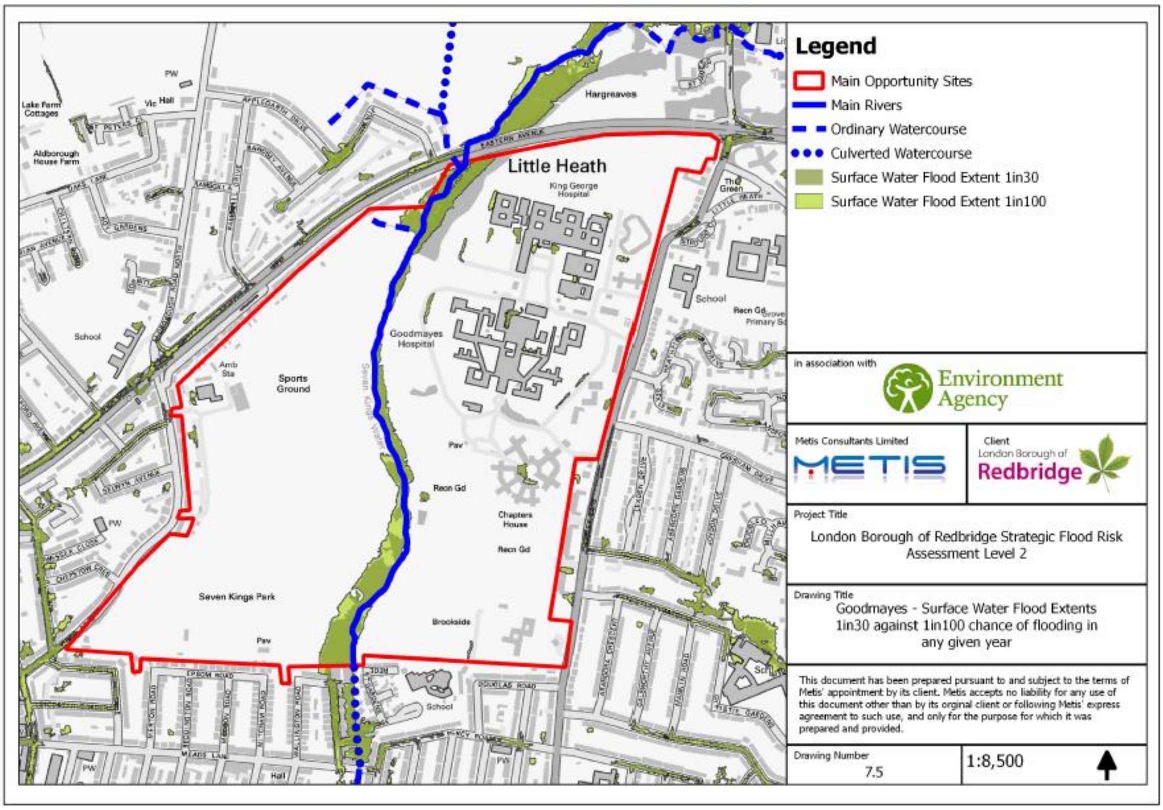

Figure 7-5. Goodmayes surface water flood risk comparison (1 in 30 year vs 1 in 100 year events)

Due to the increase in groundwater levels and surface water runoff associated with climate change, intermittent watercourses can be found to contain a flow or an increased flow which heightens the flood risk. Ordinary Watercourses which feed into the Seven Kings Water may experience an increase in flow resulting in increased Seven Kings Water river levels, increasing the fluvial flood risk. Although there is no modelling to support this, the risk of the Ordinary Watercourses bursting their banks and flooding the northern sections of the site should be investigated.

SEWER FLOOD RISK

Climate change is expected to increase the frequency and intensity of rainfall events. This will decrease the level of service provided by the sewer system over time and the risk of sewer flooding will increase where capacity is not increased in line with these changes.

GROUNDWATER FLOOD RISK

It is predicted that the effects of climate change may increase groundwater flood risk. An increase in rainfall can result in aquifers becoming fully recharged more frequently resulting in excess water rising back to the surface in the form of springs. Subsequently, intermittent watercourses can be found to contain a permanent flow. These effects can also be caused by higher sea levels which can cause an increase in the water table resulting in groundwater being found closer to the surface. Both the Ordinary Watercourses to the north of the site and the aquifers located below the Goodmayes site could experience an increase in water levels and therefore the groundwater flood risk can be expected to increase. Any potential development should consider the impacts of this.

ARTIFICIAL FLOOD RISK

The increased rate and volume of rainfall associated with climate change could increase reservoir flood risk in a similar way in which climate change could affect flood defences. Although this has not been modelled, the frequency in which overtopping occurs could increase, as could the risk of subsequent breaches. An increase in water volume could extend the reservoir flood risk extent resulting in more of the Goodmayes site being at risk.

7.4.8. HISTORIC FLOOD ISSUES

The EA's historic flood map does not show that any flood events having occurred in the Goodmayes site. Anecdotal evidence provided by LBR officer's shows that the wooded area of land in between the A12 and the small watercourse to the north of the site experiences regular flooding. The residential land reaches the river banks where sheds and other structures have been constructed and likely restrict watercourse capacity. The playing fields and other recreational areas in the southern section of the site were flooded in 2000.

7.5. POTENTIAL MANAGEMENT MEASURES

7.5.1. FLUVIAL AND TIDAL

Where the Seven Kings Water runs through the middle of the Goodmayes site, there is a small section of Flood Zone 3b, a large section of Flood Zone 3a and a marginal section of Flood Zone 2. These run the length of the site from north to south generally parallel to the Seven Kings Water in a 100m-200m wide corridor. Initial fluvial flood risk management should utilise the sequential approach guidance set out within the NPPF and NPPG to locate development within area with a low flood risk. If it is not possible to locate all buildings outside of the Flood Zones, then the Exception Test may be required. Information on how to pass the Exception Test can be found in *Section 7.7*. Additionally, development should not result in a reduction of the capacity of the Seven Kings Water.

The Goodmayes site is approximately 90ha and sufficient green space may be available to create a Flood Storage Area (FSA). As noted in *Section 4.1*, FSA's are natural or man-made basins which temporarily fill with water during periods of high river levels. A FSA could be constructed to contain flood water from the Seven Kings Water during high river levels to prevent it from flooding adjoining and downstream areas.

In order to mitigate flood risk downstream of the Goodmayes site, a FSA could attenuate fluvial water to reduce the speed at which large volumes of water reach downstream sections. A high-level assessment of the site indicates that there could be approximately 8 ha of green space surrounding the Seven Kings Water which could be landscaped to contain a FSA, providing the capacity for an estimated 80,000m^3 of flood water. An additional benefit of attenuating fluvial flood water on site could result in the reduction of risk for potential development sites further downstream.

Development of the Goodmayes site could increase the surface water runoff and increase the risk of fluvial flooding downstream. SuDS should be utilised to achieve better than Greenfield runoff rates post-development and attenuation methods should be used to delay water from leaving the site and increase the time it takes for it to reach the watercourse. Some of the surface water could be directed into the FSA. More details on potential SuDS can be found below in *Section 7.5.6*.

As noted in *Section 7.4.8*, fluvial flooding has been experienced in northern areas of the Goodmayes site where residential land backs on to the watercourse. The construction of sheds and other structures are likely to be restricting the watercourse capacity, resulting in flooding. A potential mitigation measure could be to inform residents and land owners on the role of a riparian owner.

As per the *Living on the Edge* document (EA, 2014), if you own land or property next to a river, stream or ditch you are a 'riparian landowner'. There are a number of responsibilities associated with this which include allowing water to flow through land without any obstruction and keeping banks clear of anything that could cause obstruction and increase flood risk. EA National Flood Risk Assessment (NAFRA) data shows that the right banks of the Seven Kings Water within the Goodmayes site are privately maintained and so should be managed accordingly.

7.5.2. SURFACE WATER AND SEWER

The Goodmayes site has a low to medium risk of surface water flooding. The majority of the areas at risk of surface water flooding are also within the fluvial Flood Zones and so development recommendations already apply in accordance with the NPPF and NPPG. When developing the site masterplan, 'highly vulnerable' developments should not be located within the surface water flood extent. The sequential approach should be utilised to locate any 'essential infrastructure' or 'more vulnerable' developments outside the predicted surface water flood extent. Finished floor levels must be set at least 150mm above the predicted 1 in 100 year surface water flood level or the adjacent ground level – whichever is the greater.

SuDS features should be used on-site to mitigate the surface water flood risk and to reduce runoff to aid in mitigating flood risk elsewhere. Attenuation methods should be used to delay surface water from leaving the site. A potential FSA could also attenuate surface water flow. The London Plan states that developments should aim to achieve Greenfield runoff rates as a minimum. The use of SuDS is investigated further in *Section 7.5.6.* For the Goodmayes site, LBR will be seeking better than Greenfield runoff rates to mitigate downstream flood risk on the Seven Kings Water. Site ground conditions should be tested to determine the potential for disposal of surface water via infiltration. This approach will also mitigate the impact of the development on sewer flooding.

7.5.3. GROUNDWATER

The risk of flooding from groundwater is uncertain and should be investigated by the developer. If investigations show that there is a groundwater flood risk, basements should not be permitted and the use of infiltration based SuDS will need to be reviewed.

7.5.4. ARTIFICIAL

A small section of the Goodmayes site is at risk of flooding should the Hainault Forest Lake breach. This area is already covered by Flood Zone 3a, so vulnerable properties should not be located there.

Reservoir flooding is extremely unlikely, but in the event that a reservoir dam does fail, a large volume of water would escape at once and flooding could happen with little or no warning. Any development within an area at risk should have plans in advance outlining what to do in an emergency. It may be that an immediate evacuation is required. Considerations should be made as to where people should go to safety, ready to follow the advice of the emergency services.

7.5.5. EMERGENCY PLANNING

The NPPG's Flood Risk Vulnerability Classification alongside the Flood Zones is set out to avoid vulnerable people and properties being at avoidable risk should a flood occur. This should prevent emergency planners having to consider where additional help may be required. Access and egress routes should be designed so that should a flood event occur, residents can safely leave the area and emergency services are able to navigate as required. When planning these routes, developers should consider the Flood Zones and the 1 in 100 year surface water flood risk. The areas around the Seven Kings Water should be avoided.

7.5.6. USE OF SUDS

VOLUMES AND RATES

The use of SuDS maintains natural drainage flows and contributes to reduction of flood risk elsewhere. To provide an approximation of the surface water runoff rates and volumes expected at the Oakfields site, HR Wallingford's UK Sustainable Drainage Guidance and Tools website has been used. The 'Greenfield runoff estimate' and the 'Stormwater storage analysis' tools have been utilised. Information on how these tools work can be found on the website.

A summary of the estimated Greenfield runoff rates are in *Table 7.1* and estimated storage volumes in *Table 7.2.* The full reports generated by the SuDS tool can be found in *Appendix* C (*Figures C7* and *C8*). Estimates have been made based on two different percentages of impermeable area to provide a range of how this changes depending on the density of the development.

Table 7-1. Predicted Greenfield runoff rates for the Goodmayes site

Return Period	Peak Runoff Rate
Qbar*	326.86 l/s
1 in 1 year	277.83 l/s
1 in 30 years	751.78 l/s
1 in 100 years	1,042.69 l/s

*the mean annual flood

Table 7-2. Predicted surface water storage requirements for the Goodmayes site

Storage Type	50% impermeable area	66.6% impermeable area
	Storage Volume	
Interception storage	1,800 m^3	2,400 m^3
Attenuation storage	32,700 m^3	45,400 m^3
Long term storage	0	3,600 m^3
Treatment storage	5,400 m^3	7,200 m^3
Total storage	**34,500 m^3**	**51,400 m^3**

As noted in *Sections 7.5.1* and *7.5.2*, the LBR expects surface water runoff from the Goodmayes site to reduce as part of the development. The values in the above tables should be treated as the minimum targets and a higher retention volume is expected. A minimum 5 l/s peak discharge rate should remain to prevent the blocking of any channels or culverts.

CHOICE OF SUDS

There is a wide range of different types of SuDS and not all techniques will be suitable for all sites. There will be opportunities and constraints with each development location and SuDS should be chosen accordingly.

The SuDS Selection chapter of The SuDS Manual (CIRIA C697, 2007) contains a Design Information Checklist and a step-by-step approach to selecting SuDS. It uses a SuDS selection criteria which assesses SuDS features based upon the following headings:

- Land use characteristics
- Site characteristics
- Catchment characteristics
- Quantity and quality performance requirements
- Amenity and environmental requirements

An assessment for the Goodmayes site has been made using the SuDS selection criteria. This can be seen below in *Table 7*.3. A number of assumptions have been made for this high level assessment. The site developer should satisfy themselves that they are appropriate or propose alternatives if needed. The following assumptions have been made:

- Land use: Based upon the potential development comprising of the existing hospital, health facilities, ambulance depot and bowls and social club along with new low density residential, commercial, local roads and open space areas.
- Site characteristics: Based on the sites geology, both the areas underlain and not underlain by superficial deposits are permeable; the area draining to a single SuDS component could be either 0-2 ha or >2 ha; the minimum depth to the water table is less than 1m due to the close proximity of the Seven Kings Water, the site slope is less than 5% and the available space could be both high or low depending on the density decision.

Table 7-3. Initial SuDS assessment for the Goodmayes site.

SuDS Group	Technique	Land use			Site characteristics							
		Residential	Commercial	Local Roads	Permeable soil	0-2 ha draining to a single SuDS	>2ha draining to a single SuDS	Min depth to water table 0-1m	Site slope 0-5%	Available head 0-1m	Low available space	High available space
Retention	Retention pond	Y	Y[2]	Y[1]	Y[3]	Y	Y[5]	Y	Y	Y	N	Y
	Subsurface storage	Y	Y	Y	Y	Y	Y[5]	Y	Y	Y	Y	Y
Wetland	Shallow wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Extended detention wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Pond/wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Pocket wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	N	Y[7]	Y	Y	Y	Y
	Submerged gravel wetland	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Wetland channel	Y	Y[2]	Y[1]	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
Infiltration	Infiltration trench	Y	Y[2]	Y[1]	Y	Y	N	N	Y	Y	Y	Y
	Infiltration basin	Y	Y[2]	Y[1]	Y	Y	Y[5]	N	Y	Y	N	Y
	Soakaway	Y	Y[2]	Y[1]	Y	Y	N	N	Y	Y	Y	Y
Filtration	Surface sand filter	Y	Y[2]	Y[1]	Y	Y	Y[5]	N	Y	N	N	Y
	Sub-surface sand filter	Y	Y[2]	Y[1]	Y	Y	N	N	Y	N	Y	Y
	Perimeter sand filter	N	Y[2]	Y[1]	Y	Y	N	N	Y	Y	Y	Y
	Bioretention/filter strip	Y	Y[2]	Y[1]	Y	Y	N	N	Y	Y	N	Y
	Filter trench	Y	Y[2]	Y[1]	Y[3]	Y	N	N	Y	Y	Y	Y
Detention	Detention basin	Y	Y[2]	Y[1]	Y[3]	Y	Y[5]	N	Y	N	N	Y
Open channels	Conveyance swale	Y	Y[2]	Y[1]	Y	Y	N	N	Y	Y	N	Y
	Enhanced dry swale	Y	Y[2]	Y[1]	Y	Y	N	N	Y	Y	N	Y
	Enhanced wet swale	Y	Y[2]	Y[1]	Y[4]	Y	N	Y	Y	Y	N	Y
Source control	Green roof	Y	Y[2]	N	Y	Y	N	Y	Y	Y	Y	Y
	Rain water harvesting	Y	Y[2]	N	Y	Y	N	Y	Y	Y		
	Pervious pavements	Y	Y[2]	N	Y	Y	Y	N	Y	Y	Y	Y

Y = Yes
N = No
[1] = may require two treatment train stages depending on type and intensity of road use and receiving water sensitivity.
[2] = may require three treatment trains depending on receiving watercourse sensitivity
[3] = with liner
[4] = with liner and constant surface baseflow, or high ground water table
[5] = possible but not recommended (implies appropriate management train not in place)
[6] = where high flows are diverted around SuDS component
[7] = with surface baseflow

The catchment characteristics assessment section helps to determine how many components of the SuDS treatment train is required to lower the risk of poor water quality and whether these are any regulatory criteria which may restrict or preclude the use of a SuDS technique. For example, the downstream water body that will receive the discharge or the pollutant removal required. As the receiving water sensitivity increases, the number of treatment train components increase. This is particularly relevant to the Goodmayes site as under the WFD, the Seven Kings Water currently has a moderate ecological status. Action should be taken to firstly prevent the deterioration of water quality and then to improve it. The following questions should be asked and answered as part of a full assessment of the Goodmayes site:

- Are aquifers used for public water supply?
- Is the Seven Kings Water used as formal recreational/amenity facilities?
- Are there any local habitat requirements?
- Would any of the water discharge into the sewerage network?
- Are there opportunities to improve the ecological status of the Seven Kings Water?

Once the sensitivity of the receiving water is established and the required number of components required in the SuDS train is identified, the quantity and quality performance section should be used. This outlines which components have a high, medium or low potential to deal with water quality treatment or hydraulic control. With respect to the Goodmayes site, the receiving waterbody is the Seven Kings Water.

SuDS which are going to collect water from the residential roads and commercial areas should be made up of three components and those collecting water from roofs should be made up of one. Ideally, SuDS techniques with a high potential to produce better quality water should be used. To account for the flood risk associated with the Seven Kings Water, techniques with high potential for runoff volume reduction and with high potential of hydraulic control for the 1 in 100 year event should be used.

Part of the SuDS selection process should focus on the community and environment requirements at the site. In order to maximise the benefits from SuDS, they need to be maintained. Some techniques require more maintenance than others. It is important that the adopter of the proposed drainage system is involved in the planning process in the early stages so that the most appropriate SuDS are chosen based upon the initial cost and the available maintenance commitment.

SuDS techniques should also be chosen based on how acceptable they are to the community. A resident may not want a swale in their garden although a feature in a recreation ground would be acceptable. Equally, they need to be safe and the public should not be concerned. Lastly, SuDS can also improve wildlife habitat and in turn have ecological benefits.

The following SuDS techniques are recommended for the Goodmayes site (although, as mentioned, a number of site investigations would need to be carried out to confirm this):

- Retention pond / wetland - where space is available
- Infiltration methods (trench/basin/soakaway) – where the water table is deeper than 1m
- All swale types - where less than 2ha is being drained and the water table is deeper than 1m
- Green roof - not roads and only where less than 2ha is being drained
- Rainwater harvesting - not roads and only where less than 2ha is being drained
- Pervious pavements - roads, parking and paved outside areas where less than 2ha is drained

MAINTENANCE

The EA document *Cost estimation for SuDS – summary of evidence*, provides indicative costs and maintenance guidance for SuDS and other drainage infrastructure. *Table* 7.4 below describes the typical works and frequencies for the SuDS most suitable for the Goodmayes site.

Table 7-4. Typical works and frequencies for the SuDS most suitable for the Goodmayes site

SuDS Technique	Annual or sub annual maintenance	Intermittent	Design life estimates
Retention pond	No information available		20-50 years
Infiltration trench	Monthly - litter and debris removal. Annual - weed/root management. Removal & washing of exposed stones. Removal or sediment from pre-treatment devices.	Replacement of filter material (20-25 years)	Unlimited design life. 10-15 years before replacement of filter material.
Infiltration basin	Monthly - litter & debris removal, grass cutting of landscaped areas. Half yearly - grass cutting of meadow grass and around basin. Annual - manage vegetation & remove nuisance plants.	Re-seed areas of poor vegetation growth. Prune % trim trees. Remove sediment when 50% full. Repair of erosion or other damage. Repair/ rehabilitation of inlets, outlets & overflows. Re-level uneven surfaces & reinstate design levels.	Unlimited design life. 10-15 years before tilling required & replacement of infiltration surface.
Soakaway	Remove sediment and debris. Clean gutters and filters. Trim roots that cause blockage.		No information available.
Swales	Monthly - litter and debris removal, grass cutting. Annual - manage vegetation and remove nuisance plants. Checks for poor vegetation growth and re-seed.	Repair erosion or damage, re-level uneven surfaces. Remove sediment and/or oils.	Unlimited design life. 5-10 years before tilling required & replacement of infiltration surface.
Green roof	6 monthly - remove debris and litter. Remove weeds. Mow grass (if applicable)		Unlimited design life.
Rainwater harvesting	**Simple:** Annual - cleaning inlets, outlets, gutters & tanks. **Advanced:** 3-6 monthly - self-cleaning & coarse filter checks & clean. 6-12 monthly - check & clean roof & gutters. UV unit operation checks. Annual - pump operation checks.		Unlimited design life.
Pervious pavements	4 monthly - brushing and vacuuming	Stabilise & mow contributing areas, removal of weeds. Remedial work to any depressions or broken blocks. Rehabilitation of surface & upper sub-structure where significant clogging occurs. Replacement of filter material (20-25 years).	Unlimited design life. 20-25 years before replacement of filter material.

INDICATIVE COSTS

The EA document *Cost estimation for SuDS – summary of evidence* contains information on calculating whole life costs, which include the following:

- Procurement and design costs
- Capital construction costs
- Operation and maintenance costs
- Monitoring costs
- Replacement or decommissioning costs

Using this information, *Table 7.5* provides an initial estimations of the costs associated with the most suitable SuDS components for the Goodmayes site as identified in the above section. Note that there are a number of factors which may affect the costs outlined below and a site-specific estimate should be compiled by the developer to demonstrate that the recommended SuDS approach is cost effective (or to demonstrate an alternative approach provides a more cost effective solution).

Table 7-5. Indicative prices for the most suitable SuDS components for the Goodmayes site.

SuDS Technique	Capital Indicative Costs	Annual Maintenance Costs
Retention pond	£15-£25/m^3 treated volume (CIRIA 2007) £80,000/5000m^3 pond (£16/m^3) (SNIFFER, 2007)	£0.5 - £1.5/m^2 of pond surface area (HR Wallingford, 2004) £0.1 - £2/m^3 of pond volume (Ellis, 2003)
Infiltration trench	£55-£65/m^3 stored volume (CIRIA, 2007) £74-£99/m length (Stovin & Swan 2007) £60/m^2 (EA, 2007)	£0.2 - £1/m^2 of filter surface area (HR Wallingford, 2004)
Infiltration basin	£10-£15/m^3 stored volume (CIRIA, 2007)	£0.1 - £0.3/m^2 of basin area £0.25 - £1/m^3 of detention volume (HR Wallingford, 2004)
Soakaway	>£100/m^3 stored volume (CIRIA, 2007) £454 -£552/soakaway (Stovin & Swan 2007)	£0.1/m^2 of treated area (HR Wallingford, 2004)
Swales	£10-£15/m^2 swale area (CIRIA, 2007) £18-£20/m length using an excavator (Stovin & Swan 2007) £12.5/m^2 (EA, 2007)	£0.1/m^2 of swale surface area (HR Wallingford, 2004) £350/year (Ellis, 2003)
Green roof	£90/m^2 - covered roof with sedum mat (Bamfield, 2005) £80/m^2 - biodiverse roof (varied covering of plants, growing medium & aggregates) (Bamfield, 2005)	£2,500/year for first 2 years for covered roof with sedum mat, £600/ year after (Bamfield, 2005) £1,250/year for first 2 years for covered roof with biodiverse roof, £150/year after (Bamfield, 2005)
Rainwater harvesting	**Simple:** £100 - £243/property (includes installation & connection pipe) (Stovin & Swan 2007) **Advanced:** £2,100 - £2,400/residential property (Woking Borough Council) £2,500 - £6,000/residential property (EA, 2007) £2,600 - £3,700/residential property (RainCycle, 2005) £6,300 - £21,000/ commercial/industrial property (RainCycle, 2005) £45/m^2 for residential properties (EA, 2007) £9/m^2 for non-residential properties (EA, 2007)	**Simple:** Negligible **Advanced:** £250 per year/property for external maintenance contract (RainCycle)
Pervious pavements	£30-£40/m^2 of permeable Surface (CIRIA, 2007) £27/m^2 of replacement surface (Stovin & Swan 2007) £54/m^2 (EA, 2007)	£0.5 - £1/m^3 of storage volume (HR Wallingford, 2004)

7.6. DEVELOPABLE AREA

From analysing the various sources of flood risk, the development site can be split into areas determined by what type of development would be suitable. This is based upon the vulnerability classifications. *Figure 7.6* (and *Figure C6* in *Appendix C*) displays this information. It shows that the majority of the Goodmayes site is considered to be at a low risk and any type of development would be acceptable.

The land parallel to the Seven Kings Water is considered to vary between moderate and very high risk. Highly vulnerable developments should not be developed within moderate areas. Only less vulnerable or water compatible developments should be developed within high risks areas, with more vulnerable and essential infrastructure only permitted is the Exception Test is passed. The areas considered to be at a very high risk should only contain water compatible developments and essential infrastructure when the Exception Test is passed.

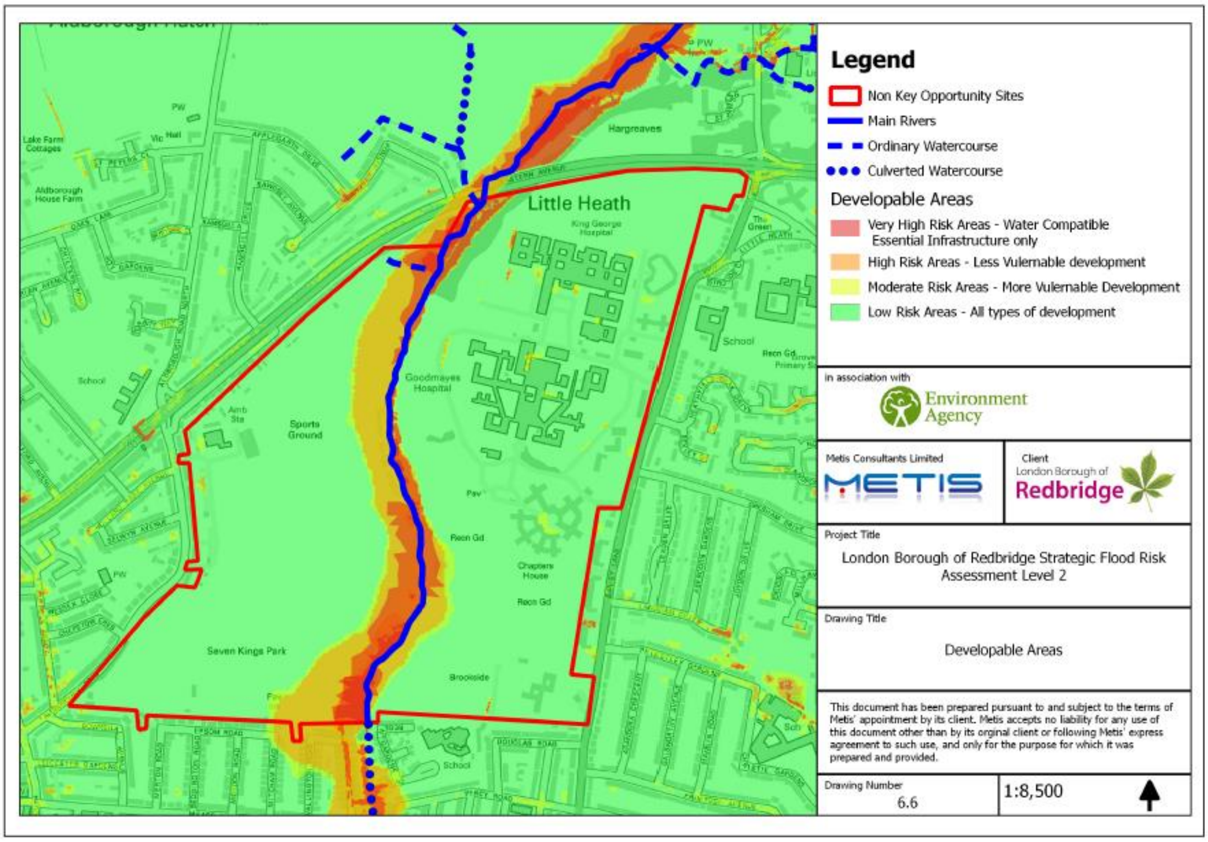

Figure 7-6. Developable area within the Goodmayes site based upon flood risk and development vulnerability

7.7. SITE SPECIFIC FLOOD RISK ASSESSMENT REQUIREMENTS

The site-specific FRA must investigate all sources of flood risk at a local level. Where data has not been available for the assessment within this SFRA, additional investigations should be carried out to either verify decisions made or to justify where alternative options have been utilised. Ultimately, the FRA must demonstrate that flooding can be managed on site with no increase in flood risk elsewhere.

If a development is required to pass the Exception Test, the FRA must show that the development will provide wider sustainability benefits to the community that outweigh the flood risk and that it will be safe for its lifetime without increasing flood risk elsewhere and where possible, reduce flood risk overall.

Where development is located alongside the river banks, the FRA must include riparian ownership information and clarification on who owns any defences or structures and how these should be maintained in order to prevent flooding. Consultation with the EA will be required at an early stage to establish Flood Defence Consent requirements of any works within the 8m buffer zone along the Main River.

The assessment of groundwater flood risk showed that the Goodmayes site is situated above secondary aquifers along with large sections overlain by a permeable superficial deposit layer. This could result in an increased risk of groundwater flooding. A site-specific FRA should investigate this further. It should investigate water table level and potential soil permeability. The outcome of these investigations will outline whether basement developments are suitable and whether infiltration SuDS would be appropriate to mitigate against surface water flood risk on-site and fluvial flood risk downstream at the Seven Kings.

Where the FRA shows there to be surface water flood risk, finished floor levels must be set at least 150mm above the predicted 1 in 100 year surface water flood level or above the adjacent ground level – whichever is the higher. Where it is proposed that surface water flows into the Seven Kings Water, evidence should be provided that sufficient water treatment has taken place (in the form of multiple SuDS components) in line with the objectives of the WFD.

7.8. DRAINAGE STRATEGY REQUIREMENTS

The drainage strategy must demonstrate that surface water runoff can be managed on site with an overall reduction in peak flow and volume compared to Greenfield rates. If this is not reasonably practical to achieve, then a clear justification must be provided along with an alternative approach that shows Greenfield runoff can be maintained as a minimum.

The strategy should outline which SuDS will be utilised within the development and how the selection process has taken place. This decision should have used the London Plan drainage hierarchy. A justification must be provided where options further down the hierarchy have been chosen over those higher up.

London Plan Policy 5.13 drainage hierarchy:
1. Store rainwater for later use
2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer

It should be clear whether the SuDS will attenuate surface water and, if so, how much. This would provide an indication as to whether there will be a positive effect of flood risk downstream of the catchment at the Seven Kings Water. There should also be sufficient treatment trains in place to ensure that water discharging from the site to the Seen Kings Water is clean and will not be having a negative effect of the water quality and therefore the ecological status under the WFD.

Where SuDS are to be utilised, the drainage strategy should outline who the future owners of the assets will be, who will be responsible for their maintenance and how this will be paid for. There should also be an accompanying maintenance strategy to cover the life of the development.

7.9. PLANNING CONSIDERATIONS

<u>Would the development be at risk of flooding?</u>
Flood risk assessment shows that main potential flood risk sources are fluvial, surface water, groundwater and sewer flooding. There is also a risk of artificial flooding from the Hainault Forest Lake. Practical measures are available to mitigate these risks to an appropriate level.

<u>Will the development increase flood risk elsewhere?</u>
Potentially – the LBR should ensure that development does not reduce the capacity of the Seven Kings Water and should enforce a clear policy requiring the site to deliver better than Greenfield runoff rates post-development.

<u>How can the development reduce flood risk overall?</u>
The site has potential to retain surface water and mitigate flood risk further downstream in the Seven Kings Water catchment. The construction of a FSA within the site could help to alleviate fluvial flood risk downstream and potentially reduce risk to development areas further downstream.

How can the development be made safe?

Design safe access and egress routes and ensure that finished floor levels are above any predicted flood depths. Do not develop basements where there is groundwater flood risk and do not locate vulnerable land uses within described flood risk areas.

Is there a reasonable prospect of compliance with flood risk aspects of the Exception Test?

A detailed site-specific FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test. The combined risk as a result of fluvial and surface water flooding, along with reservoir flood risk in an extreme situation will need to be thoroughly assessed when analysing the benefits associated with the development.

Is there a requirement for a Flood Evacuation Plan?

Where an Exception Test has been required or a development is proposed to be within areas at risk of flooding due to a reservoir breach, a Flood Evacuation Plan must demonstrate that the site can be used safely for its lifetime. It should outline the safe access and egress routes and indicate the expected time to inundation and flood duration. There are currently no flood warning or flood alert services which cover the Goodmayes site.

Are there any additional benefits that could be achieved through effective development planning?

The Seven Kings Water currently has a moderate ecological status. Treatment of surface water through SuDS and attenuation methods could help to improve the water quality feeding into the watercourse. Additionally, the development of wetlands and FSA's could result in biodiversity and amenity benefits.

7.10. CONCLUSIONS

An assessment of flood risk identifies that the Goodmayes site contains areas of Flood Zone 2, 3a and 3b, but these are located within a 150m – 200m wide corridor through the centre of the site. The site is at a low to medium risk of surface water flooding. There is also the potential of groundwater flooding although further investigation will need to be carried out confirm the level of risk associated with this source. Due to the fluvial flood risk, the Exception Test will be required if vulnerable developments are to be located within the areas at risk of flooding.

If a development is required to pass the Exception Test, the site-specific FRA must show that the development will provide wider sustainability benefits to the community that outweigh the flood risk and that it will be safe for its lifetime without increasing flood risk elsewhere and where possible, reduce flood risk overall. A Flood Evacuation Plan would be required addressing the safety and management of the site. It must also be demonstrated that the development would not increase the risk of flooding to others.

The site layout must accommodate overland flow paths and vulnerable land uses should not be located in any areas at risk. Sufficient SuDS infrastructure will be required to achieve better than Greenfield runoff rates in order to mitigate flood risk downstream in the Seven Kings Water. A FSA should be considered to alleviate fluvial flood risk both on site and downstream.

8. OTHER SITE ALLOCATIONS – ASSESSMENT

8.1. OVERVIEW

22 non-key sites were assessed to analysis their level of flood risk and potential for future development. The sites are situated along Seven Kings Water, Cran Brook and the River Roding (middle and lower course) as shown in *Table 8.1*.

Table 8-1. Number of sites assessed per Main River

Main River	Number of sites
Seven Kings Water	12
Cran Brook	1
River Roding (middle course)	6
River Roding (lower course)	3

The purpose of the assessment was to:

- Identify and assess flood risk sources
- Spatially define developable areas
- Identify possible site access and egress routes for emergency planning purposes
- Propose potential mitigation measures based on the flood risk sources associated with the site
- Define site specific flood risk assessment requirements
- Recommend planning considerations and if the site has a reasonable prospect of compliance with flood risk aspects of the Exception Test.

The approach for assessment is described in the following sections with a summary of the assessment for all sites presented in Section 8.5. Full site assessment details and associated mapping are provided in Appendix D.

8.2. MAPPING

Mapping is provided for each non-key site in Appendix D to illustrate flood risk as follows:

- Flood Zones 1, 2, 3a and 3b
- 100 year fluvial flood outline and the 100 year fluvial flood outline plus climate change
- Surface water flood hazard (1 in 100 year)
- Surface water flood depth (1 in 100 year)

Each map is identified with a drawing number in the format 'XX_YYYYY_No' where:

- XX = the River Reach ("SKW" is Seven Kings Water, "CB" is the Crab Brook, "MR" is the Middle Roding and "LR" is the Lower Roding)
- YYYYY = the Site ID (site ID can be found on figure 8.1 and section 8.4
- No. = 1 - 4(Represents the mapping listed above)
- The Seven Kings Water maps have clusters of sites. The clusters are defined by the letter A or B followed by the No. There is no site ID (YYYY) within the drawing Number.

8.3. DEVELOPABLE AREAS

A plan is provided within each key site and non-key site (Appendix D) that identifies the general areas within the site that can be developed for different land use types and flood risk vulnerability. The areas defined are as follows:

- Very High Risk Areas – Water Compatible / Essential Infrastructure only
- High Risk Areas – Less Vulnerable development

- Moderate Risk Areas – More Vulnerable development
- Low Risk Areas – All types of development

Each of the classes are based on the following data with the following basis:

- Very High Risk Areas
  - Flood Zone 3b (where available from detailed modelling) – On the basis that this is Functional Floodplain
  - Areas of Significant Hazard (where available from detailed modelling – fluvial and surface water) – On the basis that the EA will object to development in areas shown to have a Significant – Hazard to Most classification.
- High Risk Areas
  - Flood Zone 3a (where there is no detailed modelling available) – This defines the area of High Risk over the anticipated lifetime of a development
  - Areas shown to flood to depths of greater than 0.3m by the Flood Map for Surface Water dataset (100yr) – On the basis that the EA's guidance considers this area to be a hazard to people and the probability of flooding and consequences in this area are equivalent to a High Risk from other sources
- Moderate Risk Areas
  - Flood Zone 2– On the basis that this is the only available information on areas at Moderate Risk
  - Areas shown to flood to depths of between 0.15m and 0.3m by the Flood Map for Surface Water dataset (100yr)
- Low Risk Areas
  - All areas outside of the above within the development sites

8.4. FORMAT OF NON-KEY ASSESSMENT

Non-key site assessments were completed using a tabular format. An example table that describes the assessment is provided below in *Table 8.2*.

Table 8-2. Format of non-key assessment

<table>
<tr><th colspan="2">Site Assessment – Location X</th><th>Site ID: YYYY</th></tr>
<tr><td>Site Area:</td><td>Area in hectares</td><td rowspan="3">Site Access / Egress:

Outline access / egress issues to the site and whether safe refuge should be available within the development should fluvial flooding occur rapidly</td></tr>
<tr><td>Existing Use / Vulnerability:</td><td>Land use identified via aerial photography/ Vulnerability Classification from the NPPG table 2</td></tr>
<tr><td>Geology:</td><td>Based on BGS data</td></tr>
<tr><td colspan="2" rowspan="2">Risk Assessment:
<u>Fluvial / Tidal</u>
• Defines the proportion of the site identified under the various Flood Zones 1, 2, 3a and 3b
<u>Surface Water + Sewers</u>
• Identifies surface water risks within the site and the surrounding areas.
• Identifies historic sewer flooding occurrences
<u>Groundwater</u>
• Identifies potential risk of groundwater flooding based on the bedrock geology and the superficial deposits.
<u>Artificial</u>
• Identifies potential reservoir flooding based on EA breach mapping</td><td>Potential Mitigation Measures:
• SUDS / defences / emergency planning etc.</td></tr>
<tr><td>Site Specific FRA Requirements
• Outlines FRA requirements</td></tr>
<tr><td colspan="2">Developable Site Area

[Map of developable site area]</td><td>Planning Considerations
<u>Will development increase flood risk elsewhere?</u>

<u>How can development reduce flood risk overall?</u>

<u>How can the development be made safe?</u>

<u>Is there a reasonable prospect of compliance with flood risk aspects of the Exception Test?</u></td></tr>
</table>

8.5. SUMMARY OF NON-KEY SITE ASSESSMENT

A summary of the non-key site assessments can be found below. The full assessments are located within *Appendix D*.

Site ID	Site Name	Current Land Use	Current Vulnerability	Risk Assessment	Development Opportunities / Constraints	FRA Requirements
CCOS03b	Former Ilford Swimming Pool, 468 High Road, Ilford	Multi surface, sports facilities and school	More vulnerable	• Fluvial flood risk: Flood Zone 3a and 2 (50%), Flood Zone 1 (50%) • Surface water flood risk: medium/high risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: Low	• Highly vulnerable land use not permitted within flood zone 2 or 3a • Only less vulnerable and water compatible development permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No Basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Development proposals should achieve Greenfield runoff rates • Flood plain compensation for any development in the Flood Zone 2/3a • Through surface water management strategy integrated within the site masterplan
CCOS06	573-603 High Road, Ilford	Commercial Units	Less vulnerable	• Fluvial flood risk: mainly Flood Zone 1 and parts Flood Zone 2 • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Highly vulnerable land uses should not be located in Flood Zone 2 • No significant ground level changes within flood zone 2 • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• The majority of the site could be developed without overlap with Flood Zone 2 • No significant modifications of ground levels in the Flood Zone 2 area • Thorough surface water management strategy integrated within the site masterplan • Development proposals should achieve Greenfield runoff rates • Recommended that all finished floor levels are set 150mm above predicted surface water flood levels
CCOS07	The Joker Public House, Cameron Road, Seven Kings	Hard standing sports and activities area	Less vulnerable	• Fluvial flood risk: mainly Flood Zone 1 and parts Flood Zone 2 • Surface water flood risk: high risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Use the sequential approach to develop site masterplan • Highly vulnerable landuse not permitted within Flood Zone 2 • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• The majority of the site could be developed without overlap with Flood Zone 2 • No significant modifications of ground levels in the Flood Zone 2 area • Thorough surface water management strategy integrated within the site masterplan • Development proposals should achieve Greenfield runoff rates • Recommended that all finished floor levels are set 150mm above predicted surface water flood levels
CCOS08	Seven Kings Health Centre, 1 Salisbury Road, Seven Kings	Health Centre	More vulnerable	• Fluvial flood risk: Flood Zone 3a • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low/medium risk	• Only less vulnerable or water compatible development permitted • Use flood resistant and/or resilient technique • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Future development should be restricted to less vulnerable land uses • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels • Develop appropriate reservoir breach warning and risk mitigation processes.
CCOS09	Seven Kings Methodist Church and Hall, Balmoral Gardens, Seven Kings	Place of worship (Methodist Church)	More vulnerable	• Fluvial flood risk: mainly Flood Zone 3a and parts Flood Zone 2 • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Only less vulnerable or water compatible development should be permitted • Use flood resistant and/ or resilient techniques in developments • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Future development should be restricted to less vulnerable land uses • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
CCOS10	706 - 720 (Homebase) High Road, Seven Kings	Car parking facility and commercial use (Homebase)	Less vulnerable	• Fluvial flood risk: mainly Flood Zone 1 and parts Flood Zone 2 and 3a • Surface water flood risk: medium/high risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff. • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Majority of site lies outside of Flood Zone 2/3a and can be developed with minimal restriction in relation to flood risk • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates
CR1.3	Ashton Playing Fields, Chigwell Road, Woodford Bridge	Open playing field	Water compatible	• Fluvial flood risk: Flood Zone 3b (50%) and 3a (50%) • Surface water flood risk: high risk, 27 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Undeveloped Flood Zone 3b should be protected for flood storage purposes. • Future development restricted to water compatible within 3b • Only less vulnerable or water compatible land use should be located within 3a. • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Future development should be restricted to less vulnerable land uses • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels. • Flood plain compensation for any development in the Flood Zone 2/3a
CR1.7	Woodford Town Football Club, r/o 243-265 Snakes Lane East, Woodford Green	Football club	Less vulnerable	• Fluvial flood risk: mainly Flood Zone 3a and parts Flood Zone 2 • Surface water flood risk: medium/high risk, 27 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Only less vulnerable or water compatible development permitted within Flood Zone 3a • Buildings should be flood resistant and/or resilient • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Future development should be restricted to less vulnerable land uses • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels

Site ID	Site Name	Current Land Use	Current Vulnerability	Risk Assessment	Development Opportunities / Constraints	FRA Requirements
CW20	225-227 Green Lane, Ilford	Commercial	Less vulnerable	• Fluvial flood risk: Flood Zone 3a • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Only less vulnerable or water compatible development should be permitted. • Buildings should be flood resistant and/or resilient. • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Future development should be restricted to less vulnerable land uses • Flood plain compensation for any development in the Flood Zone 3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
GM08	83-85 Highbury Gardens, Goodmayes	Hardstanding commercial facility (Car Wash)	Less vulnerable	• Fluvial flood risk: Flood Zone 3a • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Only less vulnerable or water compatible development should be permitted. • Buildings should be flood resistant and/or resilient • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Future development should be restricted to less vulnerable land uses • Flood plain compensation for any development in the Flood Zone 3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
IASW7	Raven Road Industrial Estate, South Woodford	Mixed Commercial and industrial units	Less vulnerable	• Fluvial flood risk: Flood Zone 1 (10%), 2(40%) and 3a (50%). • Surface water flood risk: low risk, 4 historic sewer flooding incidents • Groundwater flood risk: high risk • Artificial flood risk: low risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
IASW9	Southend Road Industrial Estate, Woodford Green	Mixed commercial and industrial units	Less vulnerable	• Fluvial flood risk: Flood Zone 1 (60%), 2 (20%), 3a (20%0 • Surface water flood risk: high risk, 4 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Sequential approach should be used to develop the site masterplan • Highly vulnerable land use should not be located in Flood Zone 2 or 3a. • Only water less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels.
ITCOS1	Land between Mill Road & the Railway Line, Ilford	Car parking	Less vulnerable	• Fluvial flood risk: Flood Zone 1 (80%), 2 (10%), 3a (10%) • Surface water flood risk: low risk, 86 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: medium/high risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • Only water less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • A significant portion of the site could be developed without overlap with Flood Zone 2, 3a or 3b • No significant modification of ground levels in the Flood Zone 2/3a/3b area • A thorough surface water management strategy • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels • Develop appropriate reservoir breach warning and risk mitigation processes
RO05	Maybank Road & Chigwell Road, Woodford	Commercial units	Less vulnerable	• Fluvial flood risk: Flood Zone 1 (20%), 2 (60%) and 3a (20%) • Surface water flood risk: low risk, 4 historic sewer flooding incidents • Groundwater flood risk: low risk • Artificial flood risk: low risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • Only water less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • Basements may be considered with suitable site investigations • Basements for residential uses are not permitted within Flood Zone 2 and 3a	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test. • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
RO09	120, 120a and other land at Chigwell Road, South Woodford	Mixed commercial and industrial units	Less vulnerable	• Fluvial flood risk: Flood Zone 1 (30%), 2 (20%), and 3a (50%) • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • Only water less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • Basements may be considered with suitable site investigations. • Basements for residential uses are not permitted within Flood Zone 2	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
SHLAA12	4-32B Cameron Road and 625-643, High Road	Mixed use of residential and commercial units	Less and highly vulnerable	• Fluvial flood risk: Flood Zone 1 (50%), 2 and 3a (50%) • Surface water flood risk: medium risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • Only water less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels

Site ID	Site Name	Current Land Use	Current Vulnerability	Risk Assessment	Development Opportunities / Constraints	FRA Requirements
SHLAA13	645 – 861 High Road, Seven Kings	Commercial Units	Less vulnerable	• Fluvial flood risk: Flood Zone 1 (30%), 2 (10%), 3a (60%) • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: medium/high risk	• Sequential approach should be used to develop the site masterplan. • Highly vulnerable land use should not be located in Flood Zone 2 or 3a. • Only water less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test. • Flood plain compensation for any development in the Flood Zone 2/3a • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels • A thorough surface water management strategy • Develop appropriate reservoir breach warning and risk mitigation processes.
SHLAA15	245-275 Cranbrook Road, Ilford	Mixed use commercial units	Less vulnerable	• Fluvial flood risk: majority Flood Zone 1 with parts Flood Zone 2 and 3a • Surface water flood risk: low risk, 5 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: Low/medium risk	• Use the sequential approach to develop site masterplan • Highly vulnerable land use not permitted within Flood Zone 2 or 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements • Develop appropriate reservoir breach warning and risk mitigation processes	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • A significant portion of the site could be developed without overlap with Flood Zone 2 or 3a • No significant modification of ground levels in the Flood Zone 2/3a area • A thorough surface water management strategy • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
SHLAA18	61-63 & rear of 59-91 Wanstead Park Road, IG1 3TQ	Open space and informal commercial storage	Less vulnerable	• Fluvial flood risk: Flood Zone 2 (25%) and 3a (75%) • Surface water flood risk: medium/high risk, 86 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: medium/high risk	• Use the sequential approach to develop site masterplan • Highly vulnerable land use not permitted within Flood Zone 2 or 3a • More vulnerable land uses may be considered with Flood Zone 2 • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements • Develop appropriate reservoir breach warning and risk mitigation processes.	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • A thorough surface water management strategy • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels
SK02	674-700 High Road, Seven Kings	Commercial units	Less vulnerable	• Fluvial flood risk: Flood Zone 3a with parts Flood Zone 2 • Surface water flood risk: medium/high risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low/medium risk	• Only less vulnerable or water compatible development permitted within Flood Zone 3a. • Buildings should be flood resistant and/or resilient • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • A thorough surface water management strategy • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels • Develop appropriate reservoir breach warning and risk mitigation processes
SK06	Seven Kings Car Park & Lorry Park, High Road, Seven Kings	Hardstanding car park facility	Less vulnerable	• Fluvial flood risk: Flood Zone 3a • Surface water flood risk: low risk, 2 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: low/medium risk	• Only less vulnerable or water compatible development should be permitted • Buildings should be flood resistant and/or resilient • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • No basements	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 3a • A thorough surface water management strategy • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels • Develop appropriate reservoir breach warning and risk mitigation processes
VA06	Land r/o 41-57 Wanstead Park Road, Ilford	Commercial (car wrecking yard)	Less vulnerable	• Fluvial flood risk: Flood Zone 2 (75%) and 3a (25%) • Surface water flood risk: low risk, 86 historic sewer flooding incidents • Groundwater flood risk: medium/high risk • Artificial flood risk: medium/high risk	• Sequential approach should be used to develop the site masterplan • Highly vulnerable land use should not be located in Flood Zone 2 or 3a • Only less vulnerable or water compatible land uses should be permitted within Flood Zone 3a • SuDS should be applied on site to minimise the amount of runoff, then attenuate the maximum practical volume of surface water runoff • Basements may be considered with suitable site investigations • Basements for residential uses are not permitted within Flood Zone 2 and 3a	• A detailed FRA will be required to demonstrate compliance with flood risk aspects associated with the Exception Test • Flood plain compensation for any development in the Flood Zone 2/3a • A thorough surface water management strategy • Development proposals should achieve Greenfield runoff rates • All finished floor levels are set above the predicted flood levels • Develop appropriate reservoir breach warning and risk mitigation processes

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APPENDICES

Appendix A – Figures: Flood Defence Infrastructure

Appendix B – Figures: Key Development Site - Oakfields

Appendix C – Figures: Key Development Site - Goodmayes

Appendix D – Non-Key Site Assessments and Figures

Appendices are provided as separate PDF documents.