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Flood Risk Management

THE ROYAL BOROUGH OF
KENSINGTON
AND CHELSEA

Royal Borough of Kensington and Chelsea Strategic Flood Risk Assessment
Final
March 2014

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Executive Summary

Introduction

This report is a Strategic Flood Risk Assessment (SFRA) for Royal Borough of Kensington and Chelsea (RBKC). This SFRA has been prepared in accordance with current best practice, National Planning Policy Framework (NPPF) and its accompanying Technical Guidance.

The SFRA is a planning tool that enables a council to select and develop sustainable site allocations away from vulnerable flood risk areas. The assessment focuses on the existing site allocations within the Borough but also sets out the procedure to be followed when assessing additional sites for development in the future. The SFRA will assist RBKC to make the spatial planning decisions required to inform the Local Development Framework (LDF).

High level planning, policy and guidance documents have been identified which have to be taken into account in preparing this SFRA. The documents which have been reviewed include national, regional and local planning legislation (including the London Plan), together with Environment Agency policy guidance.

Why this update was required

The August 2009 Strategic Flood Risk Assessment was completed on behalf of the Royal Borough of Kensington and Chelsea (RBKC) and the London Borough of Hammersmith and Fulham (LBHF). The SFRA was developed in line with the now superseded Planning Policy Statement 25 – Development and Flood Risk (PPS25) (DCLG, 2006)[1]. Capita were commissioned in 2013 to update the SFRA and to produce a separate SFRA document for each Borough. This is the SFRA draft report for RBKC and contains analysis of flood risks and planning implications and recommended policies for the Borough. It utilises a number of new datasets that weren't available at the time of the 2008 SFRA, including the 2014 Surface Water Management Plan (SWMP), Areas Susceptible to Groundwater flooding (AStGWF) and revised breach analysis using the Environment Agency breach mapping exercise completed in 2012 as part of the Thames Tidal Hazard Mapping Study and an update to the breach locations identified within the 2009 SFRA based on TE2100 tidal information.

Methodology and Results

A thorough review of existing information, and additional modelling work, was used to identify the level of flood risk at present within the Borough from tidal and other sources. The SFRA identified that the significant sources of flood risk within Royal Borough of Kensington and Chelsea (RBKC) are surface water and sewer flooding, and the risk which arises from a failure in the Thames tidal defences.

Tidal Flood Risk

There is no fluvial flood risk within RBKC, the tidal flood risk predicted within RBKC (with the presence of the Thames tidal defences) was determined by the Environment Agency Flood Zone Maps and was delineated into four flood zones in line with NPPF:

- Zone 1: Low Probability. This zone comprises land assessed as having a less than 1 in 1000 annual probability of flooding in any year (<0.1% Annual Exceedance Probability (AEP). The percentage coverage of this flood zone within RBKC Borough is 92%.
- Zone 2: Medium Probability. This zone comprises land assessed as having between a 1 in 200 and 1 in 1000 annual probability of flooding (0.5% - 0.1% AEP) in any year. The percentage coverage of this flood zone within RBKC is 2%.

[1] Planning Policy Statement 25: Development and Flood Risk, March 2010.

- Zone 3a: High Probability. This zone comprises land assessed as having a 1 in 200 or greater annual probability of flooding (>0.5% AEP) in any year. The percentage coverage of this flood zone within RBKC is approximately 6%.
- Zone 3b: The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood.

Residual Flood Risk

Tidal flood risk is extensive, but at present the RBKC is defended against predicted events up to and including the 0.1% AEP tide level. Nevertheless, the areas benefiting from these tidal defences have the potential to experience high hazard from a breach or during an overtopping scenario if the climate change predictions are correct and the defences aren't raised.

Surface Water and Sewer Flood Risk

Sewer and surface water flooding is particularly problematic, within RBKC experiencing significant problems historically and during the recent heavy rainfall events of July 2007.

A surface water management plan (SWMP) was completed in January 2014. The report outlines the predicted risk and preferred surface water management strategy for the Royal Borough. Maps 3 and 4 (within Appendix B) show the results of the surface water modelling for the Borough.

Thames Water provided details of sewer flooding on a postal area basis. Map 8 (In Appendix B) shows the spatial distribution of sewer flooding events for the Borough. Thames Water have stated that the areas which have in the past been affected by such flooding should not be seen as areas to avoid future development and that the reverse is also true, that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure discharge capacity exists and that flood risk is not increased.

As sewer and surface water flooding is significant, it is recommended that the Royal Borough of Kensington and Chelsea take an active role in future strategic surface water management plans for London, plan for future emergencies, and provide some guidance to residents on how they to mitigate against the impacts of this type of flooding.

Future Planning and Development Control

The SFRA is the basis upon which initial planning decisions with regard to flooding are made. The Council will be required to prioritise the allocation of land for development in ascending order from Flood Risk Zones 1 to 3. However, as development becomes necessary because of lack of suitable zone 1 space, or for socioeconomic reasons, then it will become necessary to consider development allocations in higher risk zones. Where development is allocated within medium flood risk zone (Zone 2) or high flood risk zone (Zone 3) NPPF requires the Council to demonstrate that there are no reasonable alternative development sites in lower flood risk zones. Once the Sequential Test has been satisfied it may be necessary to apply the Exception Test. The situations where it is necessary and appropriate to apply the Exception Test are outlined in Table 3 of NPPF, and in Section 2 Table 2.2 of this report. The table indicates where developments could be allowed, rejected or subject to the Exception Test.

What does that mean for Sites within Zone 1?

From a flood risk perspective all land uses are acceptable within Flood Zone 1. Flood risk is not considered to be a significant constraint to development and all land uses listed below are appropriate in this zone:

- Essential infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable

- Water compatible development.

Due to their potential impact on the local flood risk, a Flood Risk Assessment will be required for all developments greater than 1 ha in size. This will include further consideration of surface water drainage, the recommendation of approach to control surface water discharge, and onsite mitigation measures that may be required, particularly where the capacity of the surface water sewer or receiving watercourse is limited.

A Flood Risk Assessment will not usually be required for development less than 1 ha in size in this zone unless there are, for example, historical records of localised flooding or site-specific considerations such as surface water issues that necessitate further investigation and identification of onsite mitigation measures.

A Flood Risk Assessment will be undertaken by the potential developer of the site. The Environment Agency will be able to advise potential developers as to their specific requirements on a site by site basis.

What does that mean for Sites within Zone 2?

Subject to the application of the Sequential Flood Risk Test, NPPF specifies suitable types of development in Zone 2 as:

- Essential infrastructure
- More vulnerable
- Less vulnerable
- Water compatible development.

Highly vulnerable development is subject to the Exception Test.

A Flood Risk Assessment will be required for all development in this zone. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

A further level of analysis of the affects of a breach in or overtopping of the defences in an extreme event (usually the 0.5% AEP plus climate change) may be required if the site falls within an area which is classified as being at High or Medium Residual Risk in order to test the sustainability and robustness of the mitigation measures. Other flood risk constraints, such as incidents of localised flooding and other site specific considerations will need to be addressed. Site-specific Flood Risk Assessments will be undertaken by the developer of the site and the Environment Agency, who will be able to advise developers as to their specific requirements on a site by site basis.

What does that mean for Sites within Zone 3a?

Subject to the application of the Sequential Flood Risk Test, NPPF specifies suitable types of development in Zone 3a as:

- Less vulnerable
- Water compatible development.

Essential Infrastructure and more vulnerable development are subject to the Exception Test. Highly vulnerable development should not be permitted in this zone.

Any proposals for development within Flood Zone 3 will require developers to undertake a detailed site specific Flood Risk Assessment. The Flood Risk Assessment will need to assess the current level of flood risk as well as the level of flood risk following development. Development plans for the site will need to demonstrate that flood risk can be effectively and safely managed without increasing flood risk elsewhere.

Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

Where the site falls within an area which is classified as being at High or Medium Residual Risk the detailed FRA should include a detailed assessment of the residual risks posed by the existing defences being breached or overtopped in an extreme event (usually the 0.5% AEP plus climate change). It should be noted that constraints to development are likely to be significant and developers should seek advice from the Environment Agency as to the specific requirements for assessment.

The SFRA also contains:

- An initial review of flood risk at each of the Borough's preferred future development sites, to allow the councils to apply the Sequential Test;
- Recommended policies to aid the councils in managing the flood risk within their Boroughs;
- An outline of requirements for detailed Flood Risk Assessments (FRAs); and
- Advice on Sustainable Drainage Systems (SuDS) and mitigation measures to consider as part of a development proposal.

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Glossary

Term	Definition
AEP	Annual Exceedance Probability
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act 2004	The Civil Contingencies Act 2004, the bulk of which was enacted in 2005, imposed duties on local bodies to assess the risk of an emergency occurring and to maintain plans for the purposes of responding to emergencies. Emergency includes acts that would have engaged previous civil defence legislation, terrorism and events which threaten serious damage to human welfare or to the environment.
CLG	Communities and Local Government: The Government department responsible for the National Planning Policy Framework (NPPF) and the Technical Guidance to the National Planning Policy Framework4
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Consequence	Impact that the flood event would cause if it occurred
De facto flood defence	A structure, such as a road embankment, rail embankment or wall that was not designed to provide a flood risk management function but which provides a level of protection to a vulnerable receptor
DEFRA	Department for Environment, Food and Rural Affairs: The Government department responsible for environmental protection, agriculture, food production and food standards as well as fisheries and rural communities.
DG5 Register	A water-company held register of properties that have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DPD	Development Plan Document
Drift Geology	The name for all material of glacial origin found anywhere on land or at sea. Typically refers to deposits of Quaternary age (up to 2.6M years).
EA	Environment Agency: A non-departmental Agency reporting to DEFRA charged with protecting or enhancing the Environment and managing flood risk and pollution in England.
Exception Test	The Exception Test should be applied following the application of the Sequential Test. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, , the development is safe and will not increase flood risk elsewhere.
Flood defence	Natural or man-made infrastructure used to prevent flooding
Flood Map for Surface Water (FMfSW)	National scale surface water flood modelling published in 2009. Two bandings are provided, 'Surface Water Flooding' and 'Deeper Surface Water Flooding', which indicate surface water flooding greater than 0.1m and greater than 0.3m respectively. There are outputs available for events with a 1 in 30 and 1 in 200 chance of occurring in any given year.
Updated Flood Map for Surface Water (UFMfSW)	National scale surface water flood modelling published in 2012. Three bandings are provided, 'High', 'Medium' and 'Low'.
Flood risk	Flood risk is a combination of two components: the chance (or probability) of a particular flood event and the impact (or consequence) that the event would cause if it occurred.
Flood risk management	Flood risk management can reduce the probability of occurrence through the management of land, river systems and flood defences, and reduce the impact through influencing development in flood risk areas, flood warning and emergency response.

Term	Definition
Flood Risk Vulnerability	Classifications presented within the Technical Guidance to the National Planning Policy Framework, which indicates the vulnerability of a specific land-use to flood risk.
Flood Zones	This refers to the Flood Zones in accordance with Table 1 of the Technical Guidance to the National Planning Policy Framework3. For the purpose of the SFRA, where the 'actual risk' is referred to this reflects the vulnerability of land to flooding taking into account the presence of flood defences.
Floodplain	Area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow but for the presence of flood defences where they exist.
Flood and Water Management Act (FWMA)	An Act of Parliament which forms part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods. The Act takes forward some of the proposals in three previous strategy documents published by the UK Government – Future Water [1], Making Space for Water and the UK Government's response to the Sir Michael Pitt's Review of the Summer 2007 floods. The Act also takes forward parts of the draft Flood and Water Management Bill and takes into account pre-legislative scrutiny of the draft Bill by the Environment, Food and Rural Affairs Committee. The Act was passed in 2010 and is currently being enacted.
Fluvial	Relating to a watercourse (rivers or streams)
FRA	Flood Risk Assessment
Freeboard	The height of the top of a bank, floodwall or other flood defence structure, above the design water level (normally the water level that would occur disregarding any effects from wave action).
FRR	Flood Risk Regulations Transposition of the EU Floods Directive [5] into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
FRSA	Flood Risk Standing Advice. The Environment Agency's website providing development and flood risk advice for Local Planning Authorities, applicants and agents.
FZM	Flood Zone Map. The term used to refer to the Environment Agency's maps that present the currently defined Flood Zones.
Groundwater	Groundwater is the term used to describe the water stored underground in areas of permeable rocks, known as aquifers. Consistently high levels of groundwater can lead to groundwater flooding.
Groundwater Rebound	Groundwater rebound is the term given to local or regional groundwater levels that rise back to natural levels as a result of the cessation of activities that had artificially lowered the groundwater level, such as groundwater pumping associated with mining or abstraction of water for use in industrial processes. Because groundwater levels have often been artificially controlled for long periods of time there is risk to vulnerable sub-surface infrastructure built in the intervening time period.
ISIS	Hydraulic modelling software developed by Halcrow to simulate the hydraulics of waterways in 1D and 2D.
LPA	Local Planning Authority
LDD	Local Development Documents: Documents describing a Local Planning Authority's strategy for development and use of land within their area of authority. These include Local Plans, Supplementary Planning documents, and Neighbourhood Plans
LDF	Local Development Framework: The spatial planning strategy introduced in England and Wales by the Planning and Compulsory Purchase Act 2004. These documents typically set out a framework for future development and redevelopment within a local planning authority. Annex 2 of the NPPF refers to these documents as the Local Plan.

Term	Definition
LFRMS	Local Flood Risk Management Strategy. Under the Flood & Water Management Act 20105, a Lead Local Flood Authority (LLFA) must produce a strategy for managing local flood risk from surface run off, ordinary water courses and ground water.
LiDAR	Light Detection and Ranging, a technique to measure ground and building levels remotely from the air, LiDAR data is used to develop DTMs and DEMs (see definitions above).
LLFA	Lead Local Flood Authority: Local Authority responsible for taking the lead on local flood risk management. The duties of LLFAs are set out in the Floods and Water Management Act5.
Local Plan	The plan for the future development of the local area drawn up by the local planning authority in consultation with the community.
Local Sources of Flooding	The flood risk posed from ordinary watercourses, surface water, groundwater, canals and small reservoirs. Any source of flooding other than main rivers, the sea and large reservoirs.
LPA	Local Planning Authority
MAFP	Multi-Agency Flood Plan. An emergency plan focussed specifically on the complex issues associated with flooding that can be prepared by a Local Resilience Forum and/or a Local Planning Authority.
Main River	Main rivers are a statutory type of watercourse in England and Wales and are usually larger streams and rivers, but may also include some smaller watercourses. A main river is defined as a watercourse marked as such on a main river map. It can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only.
NFCDD	National Flood and Coastal Defence Database. The data held in NFCDD consists of mapping data showing the areas at risk of flooding and data about the defences themselves (their type, location and condition) and the areas that benefit from those defences.
NGR	National Grid Reference
NPPF	National Planning Policy Framework (March 2012): the document and its supporting Technical Guidance that sets out the Government's planning policies for England and how these are expected to be applied, providing a framework within which local and neighbourhood plans can be produced to reflect local needs and priorities.
Ordinary Watercourse	All watercourses that are not designated main river, and which are the responsibility of Local Authorities or, where they exist, IDBs are termed Ordinary Watercourses.
PAR	Preliminary Appraisal Report. The reporting element of the Preliminary Flood Risk Assessment (PFRA) process
PFRA	Preliminary Flood Risk Assessment: A statutory requirement of the Flood Risk Regulations35, which implement the requirements of the European Floods Directive36. The Floods Directive required PFRAs to be published by 22 December 2011.
Policy Unit	A defined area in which the Environment Agency's CFMP policies are applied. .
PPS25	Planning Policy Statement 25: Development and Flood Risk (December 2006). Now replaced, by the National Planning Policy Framework (March 2012) although the supporting Practice Guide has not been revoked and is therefore still applicable.
Probability of Consequence	The probability of a flood event being met or exceeded in any one year. For example, a probability of 1 in 100 corresponds to a 1 per cent or 100:1 chance of an event occurring in any one year.

Term	Definition
RBMP	River Basin Management Plan. A strategic document that sets out measures to protect and improve the water environment. They have been developed in consultation with organisations and individuals and they identify the main issues for the water environment and the actions that are needed to deal with them.
Receptor	A property, business or land-use that is at risk from flooding.
Residual risk	Flood risks resulting from an event more severe than for which particular flood defences have been designed to provide protection.
RIZ	Rapid Inundation Zone
RPB	Regional Planning Body
SAB	SuDS Approval Body. A body that will be set up on the commencement of the National Standards for Sustainable Drainage (likely to be the lead local flood authority) that will be responsible for approving, adopting and maintaining drainage plans and SuDS schemes that meet the National Standards for sustainable drainage systems serving two or more properties.
Sequential risk-based assessment	Priority in allocating or permitting sites for development, in descending order to the Flood Zones set out in Table 1 of the Technical Guidance to the National Planning Policy Framework, including the sub divisions in Zone 3. Those responsible for land development plans or deciding applications for development would be expected to demonstrate that there are no reasonable options available in a lower- risk category.
Sequential Test	Test to determine if there are other reasonable available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
Sewer flooding	Sewer flooding occurs when surface water or foul sewage escapes from the sewerage system due to either hydraulic inadequacy or other causes (blockage, collapse or equipment failure).
SFRA	Strategic Flood Risk Assessment
SIRS	Sewer Incident Reporting System. A now superseded database of historical incidents associated with United Utilities sewer network. Replaced in 2008 by the Water incident Reporting System (WIRS)
Solid Geology	The bedrock geology underlying soil or drift geology.
SoP	Standard of Protection. The actual or design standard of protection afforded by a flood defence, whether formal or informal.
SuDS	Sustainable Drainage Systems
Surface water	Any body of water that is not groundwater (for example rivers, estuaries, ponds etc) as well as temporary waters resulting from flooding, run-off etc.
SWMP	Surface Water Management Plan
TUFLOW	Hydraulic modelling software developed by WBM to simulate the hydraulics of waterways in 2D.
WFD	The Water Framework Directive (2000/60/EC) came into force in 2000. It was transposed into UK law in 2003 and it establishes a strategic framework for the management of the water environment with the aim of enhancing aquatic ecosystems, promoting the sustainable use of water and reducing water pollution.
Windfall Sites	Sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan
WIRS	Water Incident Reporting System. A database of incidents associated with United Utilities sewer network. Replaced the Sewer incident Reporting System (SIRS) in 2008.

1. Introduction

1.1 Overview

The August 2009 Strategic Flood Risk Assessment was completed on behalf of the Royal Borough of Kensington and Chelsea (RBKC) and the London Borough of Hammersmith and Fulham (LBHF). The SFRA was developed in line with the now superseded Planning Policy Statement 25 – Development and Flood Risk (PPS25) (DCLG, 2006)[2]. The SFRA was developed to assist RBKC to inform their Local Development Framework (LDF).

Capita URS were commissioned in 2013 to update the SFRA and to produce a separate SFRA document for each Borough. This is the SFRA report for RBKC and contains analysis of flood risks and planning implications and recommended policies for the Borough.

The 2009 SFRA was largely retained however several updates and reviews were carried out. The following summaries the scope of works for this updated document:-

- Identify policy updates since 2009 in particular the introduction of National Planning Policy Framework (NPPF) and its Technical Guidance;
- Identify updates related to new information available from the RBKC Surface Water Management Plan (SWMP);
- Review and update new data sources; and
- Review of policy and guidance.

The release of Planning Policy Statement 25: Development and Flood Risk in December 2006 (PPS25) (DCLG, 2006) emphasised the responsibility that Local Planning Authorities (LPAs) have to ensure that flood risk is understood and managed effectively using a risk-based approach as an integral part of the strategic planning process. PPS25 encouraged LPAs to undertake SFRAs and to use their findings and those of other studies to inform strategic land use planning. The National Planning Policy Framework (NPPF) document replaced the suite of Planning Policy Statements, including PPS25, on 27 March 2012.

NPPF states *"A Strategic Flood Risk Assessment is a study carried out by one or more planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of climate change, and to assess the impact that changes or development in the area will have on flood risk".*

The NPPF and its accompanying Technical Guidance maintain the requirement to apply a risk-based, sequential approach to the location of development in order to avoid flood risk to people and property. The key difference for flood risk policy compared to PPS25 is that the NPPF gives local authorities a wider remit to interpret and implement local policies. This makes the SFRA process all the more important in establishing suitable, reasonable and practical local development policies to manage local flood risk.

1.2 SFRA Objectives

In keeping with guidance presented in the NPPF and its accompanying Technical Guide, the objectives of this SFRA update are:

1. Identify the extent of all Flood Zones;
2. Determine the actual flood risk in Zone 3 given the presence of defences.
3. Identify the rapid inundation zone (RIZ) resulting from defence failure.
4. Identify the effect of flood defence failure, including extent, depth and velocity of flooding.
5. Assess the potential increase in flood risk resulting from climate change.

[2] Planning Policy Statement 25: Development and Flood Risk, March 2010.

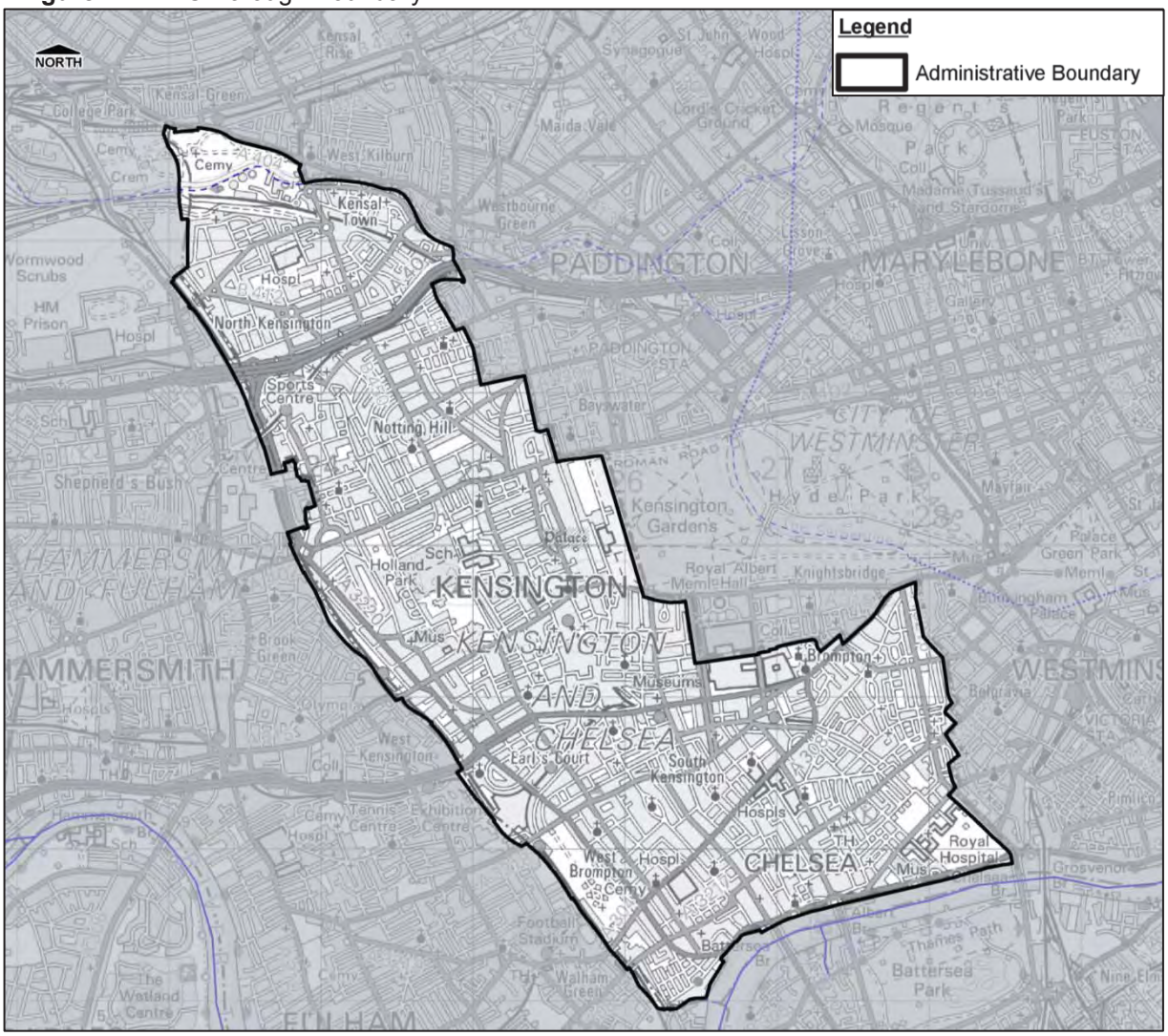
6. To establish the flood risk to proposed development sites included in the emerging LDF documents within the delineated NPPF zones.
7. To determine the effect of an increase in surface water drainage as a result of the proposed development sites and highlight any areas where the drainage system is known to be inadequate.
8. To supplement current policy guidelines and to provide a straightforward risk based approach to development control in the local area.
9. To provide a reference document to which all parties involved in planning and flood risk can reliably turn to for initial advice.

Note that the above objectives have not changed and remain the same (with the exception of updating to account for policy changes) as the 2009 SFRA. The potential impact of growth on future flood risk is a key driver for development of the SFRA and to provide a consistent and robust evidence base for assessment of new development.

1.3 Study Area

The study area (refer to Figure1) comprises of the London Borough of Kensington and Chelsea.

Figure 1: RBKC Borough Boundary



1.3.1 The Tidal Thames

The River Thames, through central London, is primarily a tidally dominated river and the most severe flood risks come from tidal surges. Teddington is the normal tidal limit although high fluvial flows can affect parts of west London and extreme surges can impact areas upstream of Teddington. The Tidal Thames floodplain is currently defended through a combination of raised banks and barriers, the most important being the Thames Barrier at Woolwich. There are also eight other major barriers, 36 major industrial floodgates, 400 minor moveable structures and 337 km of tidal walls and embankments[3]. These defences provide protection against tidal flooding to an estimated 1 in 1000 year standard for 2030 (as estimated when the defences were originally designed), which equals a less than 0.1% chance of flooding each year. So far the rate of sea level rise has not exceeded that expected and the defences are thus currently providing a greater level of protection than originally projected 2030 (1 in 1000 year event).

The Thames Barrier does not eliminate normal tidal movements and thus high water levels can be reached in the river that, without the river walls and banks, would flood lower lying parts of Kensington and Chelsea. These are similar to the areas shown on the Environment Agency's Flood Zone maps, which represent a scenario where the area is undefended.

The Environment Agency released the Thames Estuary 2100 (TE2100) Plan in November 2012. The document sets out the Environment Agency's recommendations for flood risk management for London and the Thames Estuary through to the end of century and beyond. The plan puts the need for climate change adaptation at its core. It primarily looks at tidal flooding though other sources of flooding including high river flows as a result of heavy rainfall and surface water flooding are also considered.

The River Thames, along the RBKC boundary, is strongly influenced by tides, for any given tide the peak river levels are also influenced by fluvial flows, although this influence is often small in comparison.

1.3.2 Flood Risks

The RBKC faces flood risks from a number of sources, the nature of which differs significantly. Flood risk can be considered in terms of probability of occurrence and consequence.

The probability of flooding from the Tidal Thames is small, but the consequences are potentially high due to the high flows causing rapid inundation of low lying areas and therefore increasing the potential threat to life. The last major flood from the Thames in the area occurred in 1928 and resulted in a number of people being killed in basement properties. Flood protection with RBKC has improved, but the area under threat is considered further in the study.

The two possibilities for flooding from the River Thames are:

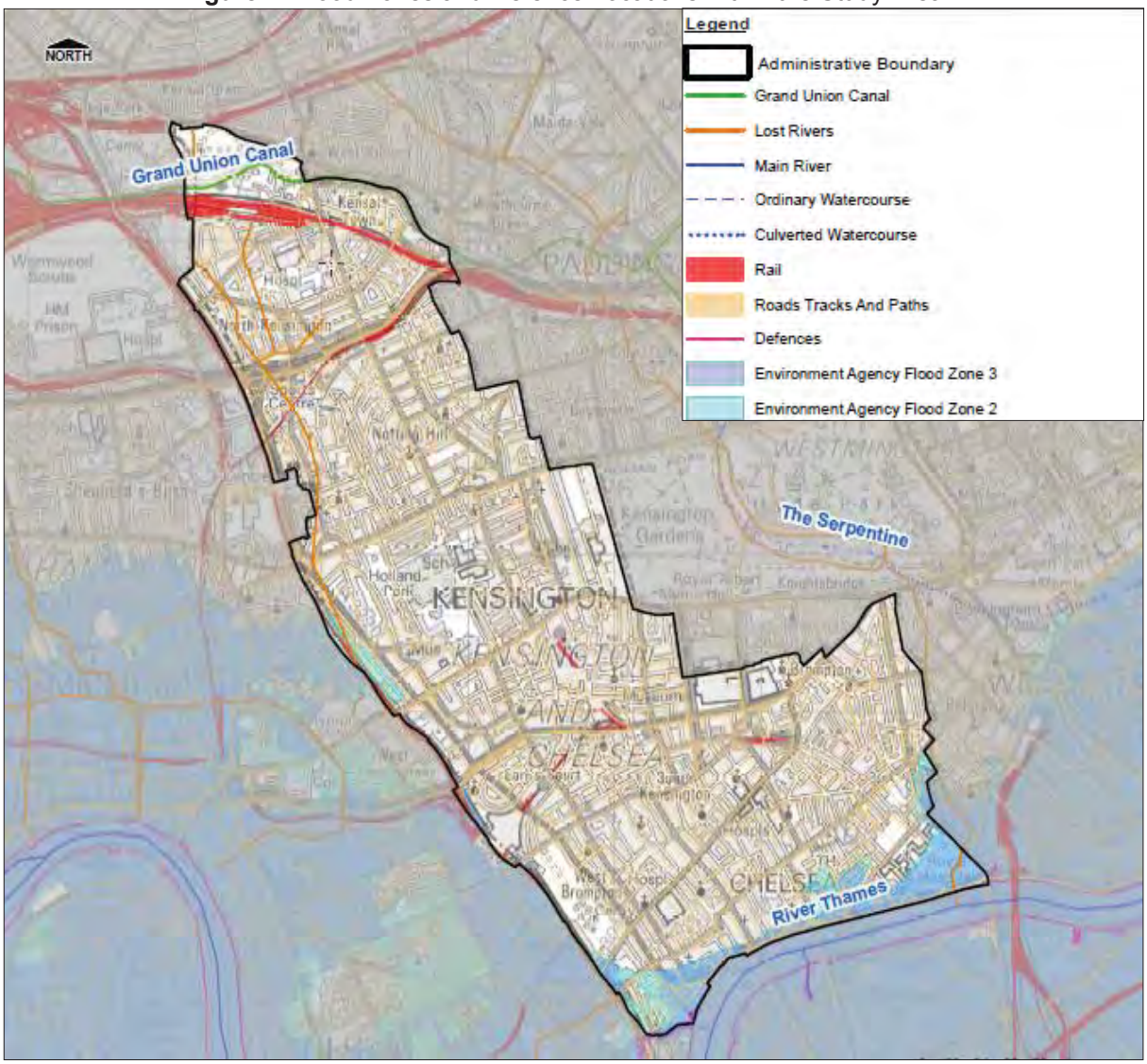
- A major failure of a defence wall due to breaching; and
- Failure of the Thames Barrier and consequent overtopping (subject to climate change)

Surface water flooding due to intense rainfall overwhelming the capacity of the sewer system is much more likely, but would have localised impacts and a less severe threat to life. Failure of water mains or small temporary defences is also more likely though has less impact. Other possible sources of flood risk within the Borough include the Grand Union Canal and the Serpentine in Hyde Park.

[3] Lavery, S and Donovan, B (2005) Flood Risk Management in the Thames Estuary looking ahead 100 years. Phil Trans. R. Soc, 1455-1474

Figure 2 (below) displays the Flood Risk Zones and identifies the areas benefiting from defences.

Figure 2: Flood Zones and Defence Locations within the Study Area



2. Strategic Flood Risk Assessment Overview and Approach

2.1 Overview of the SFRA Process

The SFRA is a planning tool that can be used to inform the spatial planning process. The SFRA process is outlined in Figure 2.1. The SFRA should be used to refine the information relating to the areas within RBKC which may flood, taking into account all sources of flooding and climate change. This information should form the basis of RBKC's future flood risk management policies. In addition the SFRA will inform the LDF, and provide the information to enable the sequential and exception tests to be applied during the site allocation and development control process.

In line with NPPF guidelines, allocations should be made outside of the flood risk areas (i.e. located within Zone 1) wherever possible. If there are no reasonably appropriate Flood Zone 1 sites, allocations should be made in Zone 2 first, considering flood risk vulnerability of land uses. Only where there are no reasonably available sites in Flood Zone 1 or 2 should Zone 3 allocations be made. In order to demonstrate that there are no lower risk sites available the Sequential Test needs to be carried out. The information provided in the SFRA should allow the LPA to carry out the Sequential Test. Only on completion of the Sequential Test should the Exception Test be used, where allowed, to justify allocations or developments in high risk areas where the need to develop is considered exceptional.

An SFRA is a project with defined start and end point. The deliverables are a report and suite of maps to allow the sequential testing to be undertaken within the LDF. It should be noted that the SFRA itself cannot determine where additional replacement sites in low- risk areas can be found.

RBKC have the information and options to sequentially test and provide more detailed evidence to support the Exception Test within this SFRA. The SFRA will recommend removal of allocations at the extreme of flood risk policy, e.g. site is in the functional floodplain or rapid inundation zone.

The SFRA provides some indication of deliverability, and hence whether the site should be considered in more detail. Risk is defined as a function of both probability of an event occurring and the consequence should that event take place. When considering the residual risk associated with the failure of a flood defence, consideration must be given to both overtopping (subject to climate change) and the structural integrity of the defence.

To assess residual risk, it will be necessary to model the consequence of a breach in, or the overtopping of, the flood defences in an event with a 0.5% chance of occurring each year (1 in 200 year event). Generally, the worst case scenario will coincide with a failure of the defences at the peak of the flood event. A two dimensional inundation model (which has the ability to predict depth, velocity and hazard) of the defended area will be required to examine the impact of either a breach failure or overtopping during the design event. The extent of inundation behind the defence should be identified, and the depth and velocity of flow (within the inundated area) monitored over time throughout the duration of the event.

2.1.1 Sequential Test

NPPF provides the basis for the sequential approach, it recommends that LPAs use a risk based approach to development planning and specifies the need, for undertaking SFRAs.

When allocating or approving land for development in flood risk areas, those responsible for making development decisions are expected to demonstrate that there are no suitable alternative development sites located in lower flood risk areas.

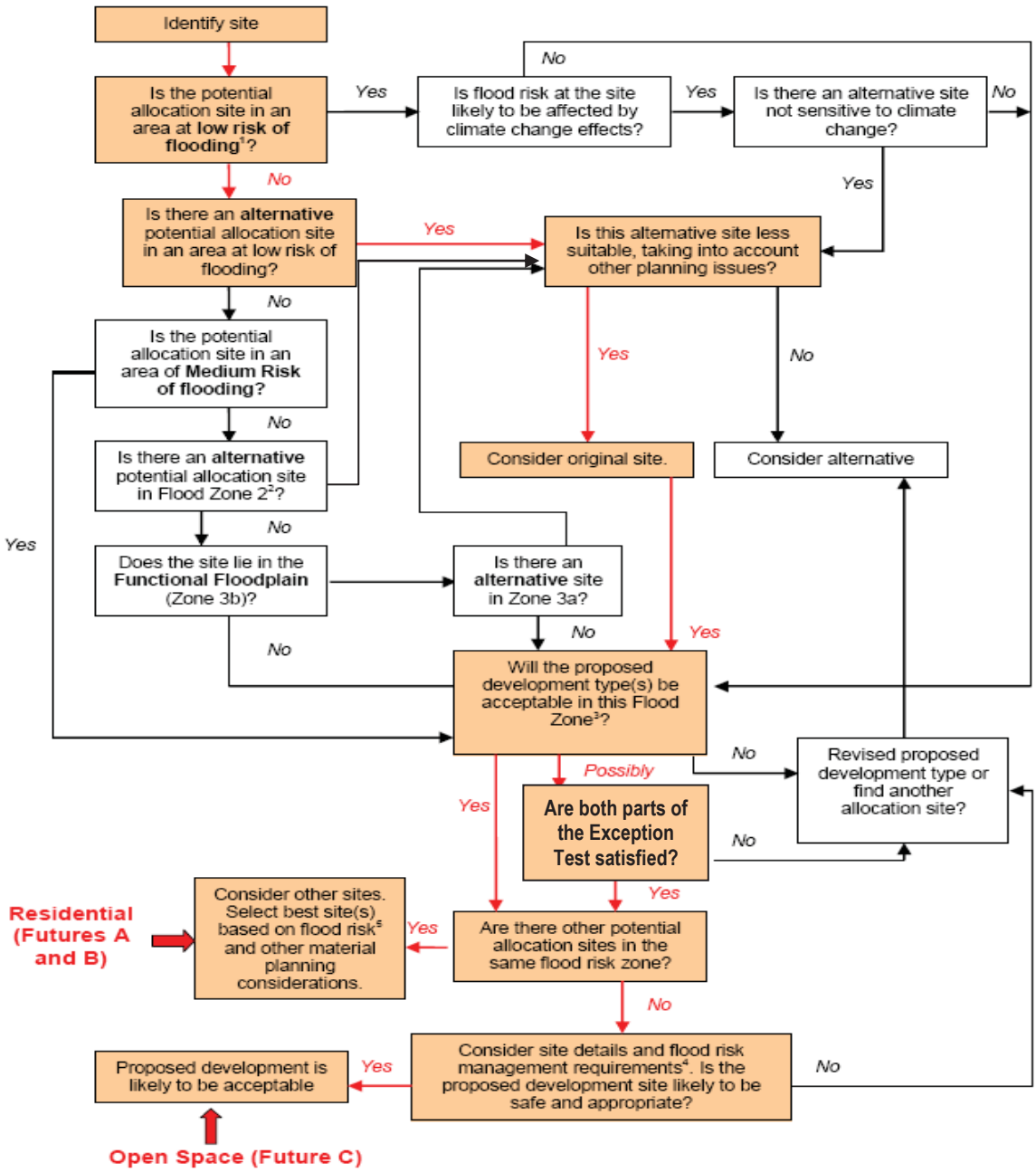
The methodology introduces a Sequential Test that is core to the SFRA process. The Sequential Test is the key driver for the SFRA. The Environment Agency Flood Zone Map provides the basis of the test, which will be undertaken a number of times, considering a greater resolution and understanding of flood risk at each stage taking into account flooding from other sources. At each step, sites of lower flood risk are identified and prioritised in order of vulnerability to flood risk and their safety in terms of allocation for development.

A further level of analysis may be required where development is planned behind or adjacent to existing defences in order to test the sustainability and robustness of the mitigation measures.

This SFRA provides RBKC with flood zone classifications for all present locations identified for development as well as the information required to classify future allocations. The information provided by the SFRA will assist the Council in developing their LDFs and prioritise allocations.

The Council will be required to prioritise the allocation of land for development in ascending order from Flood Risk Zone 1 to 3, including the subdivisions of Flood Risk Zone 3, if necessary. The Environment Agency has statutory responsibility and must be consulted on all development applications allocated with medium and high risk zones, including those in areas with critical drainage problems and for any development on land exceeding 1 hectare outside flood risk areas. In these circumstances, the Environment Agency will require the Council to demonstrate that there are no reasonable alternatives, in lower flood risk categories, available for development. Where appropriate, the Exception Test is to be applied.

Figure 3: Application of the Sequential Test adapted from the PPS 25 Practice Guide (June 2008).



[1] Flood Zone 1 for fluvial and tidal flooding and with a low risk of flooding from other sources.
[2] Flood Zone 2 for fluvial and tidal flooding and with a medium risk of flooding from other sources.
[3] As defined by the Sequential Test.
[4] Development to be safe and to not increase flood risk elsewhere. Required to pass part c) of the Exception Test, where applicable.
[5] including susceptibility to future climate change and residual flood risk.

2.1.2 Exception Test

Once the Sequential Test has been satisfied, it may be necessary to apply the Exception Test. It is acknowledged that flood risk is one of many issues (including transport, housing, economic growth, natural resources, regeneration and the management of other hazards) which need to be considered in spatial planning.

NPPF explains where and for what type of development the Exception Test needs to be applied. In some situations, for certain types of development, it is not appropriate to use the Exception Test to justify development, for example, development which is highly vulnerable to flooding (e.g. hospital) cannot be justified within the high risk zone through the use of the Exception Test. The situations where it is necessary and appropriate to apply the Exception Test are outlined below.

Where the Exception Test is required, it should be applied as soon as possible to all Local Development Framework (LDF) allocations for development and all planning applications other than for minor development. Both elements of the Exception Test have to be passed before development is allocated or permitted. For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- A site specific flood risk assessment must be demonstrated that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible will reduce flood risk overall.

Compliance "*with each part of the Exception Test should be demonstrated in an open and transparent way*".

2.1.3 Flood Risk Vulnerability

In NPPF different types of development are divided into five flood risk vulnerability classifications (refer to Table 2.1):

- Essential infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable
- Water compatible development.

Subject to the application of the Sequential Test, NPPF specifies which of these types of development are suitable within each zone:

Zone 1: All the uses of land listed above are appropriate in this zone.

Zone 2: The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure are appropriate in this Zone. The highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.

Zone 3a: The water-compatible and less vulnerable uses of land are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable and essential infrastructure uses should only be permitted in this zone if the Exception Test is passed.

Zone 3b: Only water-compatible uses and the essential infrastructure that has to be there should be permitted in this zone. Essential infrastructure in this zone should pass the Exception Test and be designed and constructed to meet a number of flood risk related targets. The less vulnerable, more vulnerable and highly vulnerable uses should not be permitted in this zone.

Table 2.1 provides a description of the flood risk vulnerability classification for various development types, whilst Table 2.2 summarises the applicability of the Exception Test for different development sites.

Table 2-1: Flood risk vulnerability classification

Essential Infrastructure	• Essential transport infrastructure and strategic utility infrastructure, including electricity generating power stations and grid and primary substations
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding • Emergency dispersal points • Basement dwellings • Caravans, mobile homes and park homes intended for permanent residential use[4] • Installations requiring hazardous substances consent[5] (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure")[6]
More Vulnerable	• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels • Non–residential uses for health services, nurseries and educational establishments • Landfill and sites used for waste management facilities for hazardous waste[7] • Sites used for holiday or short-let caravans and camping, *subject to a specific warning and evacuation plan*[8]

[4] For any proposal involving a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site, the Sequential and Exception Tests should be applied.

[5] 4 See Circular 04/00: Planning controls for hazardous substances (paragraph 18) at: www.communities.gov.uk/publications/planningandbuilding/circularplanningcontrols

[6] In considering any development proposal for such an installation, local planning authorities should have regard to planning policy on pollution in the National Planning Policy Framework

[7] For definition, see Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10 at www.communities.gov.uk/publications/planningandbuilding/planningsustainable

[8] See footnote 2

Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding • Buildings used for shops, financial, professional and other services restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working) • Water treatment works which do not need to remain operational during times of flood • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place)
Water compatible development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, *subject to a specific warning and evacuation plan.*

Notes to table 2: a. This classification is based partly on Department for Environment, Food and Rural Affairs and Environment Agency research on Flood Risks to People (FD2321/TR2)[9]and also on the need of some uses to keep functioning during flooding.

b. Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

c. The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

[9] See website for further details.
www.defra.gov.uk/science/Project_Data/DocumentLibrary/FD2320_3364_TRP.pdf

Table 2-2: Flood Risk vulnerability and flood zone 'compatibility'

Flood Risk Vulnerability classification	Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test Required	✓	✓
Zone 3a	Exception Test Required	✓	✗	Exception Test Required	✗
Zone 3b	Exception Test Required	✓	✗	✗	✗

2.2 SFRA Approach

This SFRA was undertaken in two stages, the approach to each stage of the SFRA is as follows:

2.2.1 Stage 1

Data Collection

A critical phase in the project delivery is the collection and review of existing information. A summary of data sources used in this assessment is provided below:

- Sites likely to be developed in the Local Development Framework (LDF)
- Historical records of flooding including cause and extent
- Known and perceived flood risk areas, including Flood Zone Maps and details of flood risk areas associated with groundwater and surface water drainage issues. Catchment topography (LiDAR (Light Detection and Ranging) data and Ordnance Survey (OS) Mapping)
- Existing investigations for the River Thames
- Current flood risk management strategies including details of flood defence assets
- Hydrometric data
- Sewer Map and surface water modelling results from the Surface Water Management Plan
- DG5 Sewer Flooding Records

Assessment of Flood Risk

The primary objective is to assess and categorise, in accordance with Table 1 of NPPF, flood risk within the developing areas. In general, the following considerations have been addressed as part of the flood risk assessment process:

- Identification of known and/or perceived flood risk areas, including the nature of the flooding problem (e.g. river, canal, sewer, groundwater flooding; surface water flooding and local under-capacity drainage; culvert blockage), providing the initial 'filter' for key flood risk issue areas within the district.

- Review of current Environment Agency Flood Zone Map to provide an initial definition of High Risk Zone 3.
- Identification of critical floodplain areas
- Identification of significant structures (bridges, culverts, embankments, outfalls etc) that will influence local hydraulics
- Identification of formal and informal flood defences that reduce flooding to developing and regeneration areas
- Definition of areas subject to development pressure and/or regeneration.
- The hazard associated with rapid inundation following failure of existing defences, breaching and overtopping will be identified (where relevant) and modelled (where possible).

Review of Climate Change and Land Use Impacts

Consideration has been given to the implications of wider land management practices on flood risk in the area. The delineation of Flood Zones 2 and 3, coinciding with the 1 in 1000 year event (0.1% AEP) and 1 in 200 year (0.5% AEP events respectively, has been used as an indication of how flood risk may alter laterally as a result of climate change. Where existing river models were available, further interrogation of modelling results has been used to determine more accurately the potential impact of climate change and land use change on design levels.

2.2.2 Stage 2

This involves identifying those areas in the Borough that fall within Flood Risk Zones 1, 2 and 3. RBKC have forwarded six potential key development areas to be considered in the LDF. The individual sites are overlain onto the defined flood risk zones and reviewed with respect to the degree of flood risk predicted to impact them. The filtering process used to categorise these sites is summarised below.

Table 2-3: Flood Zones and Development

Sites within Flood Zone 1: Sites located outside the 'medium' and 'high' Flood Risk Zones 2 and 3, respectively. NPPF considers areas within 'Flood Risk Zone 1 to be at little or no risk of fluvial flooding. Flood risk zones are defined by the Environment Agency's Flood Zone Maps.	 Preferred location for development (least risk and greater range of compatible land use
Sites within Flood Zone 2: Sites located outside the high flood risk zone 3 but wholly or partially located within the medium Flood Risk Zone 2.	
Sites within Flood Zone 3a: Previously developed or undeveloped areas wholly or partially located within high Flood Risk Zone 3a	
Sites within Flood Zone 3b: Sites located wholly or partially within the functional floodplain. These are areas where water has to flow or be stored in times of flood.	Development less/not acceptable (highest risk and least range of compatible land use

Planning Review Sites within Flood Risk Zones 1 and 2

Recommendations for the future management of development and redevelopment sites in 'low' to 'medium' Flood Risk Zones are provided to meet the requirements of national planning guidance and regional and local flood risk policy.

Planning Review of Sites within High Risk Zone 3

Consideration has been given to the actual risk posed to individual sites in 'high' (Flood Risk Zone 3) and recommendations for development allocations have been made. Development constraints within these areas are dependent on the strategic importance and requirement for development (within a planning context). Recommendations for the future management of development within the 'high' Flood Risk Zone have been provided on a site-by-site basis to meet the requirements of NPPF, as well as regional and local flood risk policy.

Detailed Assessment Requirements and Exception Test

In order to assist the RBKC in determining whether housing and employment requirements can be met, without affecting existing areas of medium to high flood risk, detailed assessment has been carried out at a number of sites. At these sites the potential impact and feasibility of generic mitigation measures has been considered. Where necessary sites are assessed to determine what is required to pass part b of the Exception Test.

Establishment of Guidance for LPA and Developers at Planning Application Stage

Concise and pragmatic guidance has been developed to assist the council and developers to ensure that the outcomes and recommendations of the SFRA are followed through to the planning application and implementation stage.

It is imperative to ensure that the requirements placed upon developers at the planning application stage are robust and fit for purpose. Similarly, the ownership, roles and responsibilities of the LPA and Environment Agency as appraisal bodies must also be clearly understood to ensure that the intent of the SFRA and planning process are not lost.

RBKC as a lead local flood authority is only responsible for the management of Local Flood Risk. Local flood risk is defined as surface water flooding, ordinary watercourse flooding and groundwater flooding. This area of responsibility is defined by the Flood and Water Management Act.

3. The Planning Framework

3.1 Introduction

The purpose of this section of the report is to identify and outline those high level documents which have to be taken into account in preparing this SFRA. The documents which have been reviewed include the London Plan together with national planning legislation and policy guidance.

3.2 National Planning Guidance

Flood and Water Management Act

The Flood and Water Management Act 2010 places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues. The Act and Regulations together set out the requirements and targets Local Authorities need to meet, including:

- Taking an active role leading flood risk management as Lead Local Flood Authorities (LLFAs)
- Cooperating with other relevant authorities to manage local flood risk
- Duty to investigate flood incidents and report upon them
- Maintain an 'Asset Register' of assets that have a significant influence on local flood risk
- Designate 'features' that have a significant influence on local flood risk
- Regulation of works on 'ordinary watercourses'
- Development and implementation of Local Flood Risk Management Strategies (LFRMS)
- Responsibility for first approval, then adoption, management and maintenance of Sustainable Urban Drainage System (SuDS) where they service more than one property (not currently enacted – expected to be enacted in 2014)

The Flood and Water Management Act also clarifies three key areas that influence development:

- Sustainable drainage (SuDS) - the Act makes provision for a national standard to be prepared on SuDS. Developers will be required to obtain local authority approval for the SuDS in accordance with the standards, likely with conditions. When they are designed and constructed robustly, local authorities will be required to adopt and maintain the SuDS that serve more than one property.
- Flood risk management structures - the Act enables the Environment Agency (EA) and local authorities to designate structures such as flood defences or embankments owned by third parties for protection if they affect flooding or coastal erosion. A developer or landowner will not be able to alter, remove or replace a designated structure or feature without first obtaining consent.
- Permitted flooding of third party land - The EA and local authorities have the power to carry out work which may cause flooding to third party land where the works are deemed to be in the interest of nature conservation, the preservation of cultural heritage or people's enjoyment of the environment or of cultural heritage.

National Planning Policy Framework (NPPF)

The NPPF replaced the suite of Planning Policy Statements (PPS), including PPS25, on 27 March 2012. It should be noted however that the PPS25 Practice Guide is still current and a useful reference tool for technical guidance. The NPPF sets out the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

In the context of flood risk, the NPPF is supported by a Technical Guidance to the National Planning Policy Framework (the 'Technical Guidance'). The Technical Guidance provides further background to policies relating to flood risk and minerals. The Technical Guidance retains the majority of requirements of PPS25 for Strategic Flood Risk Assessment (SFRA), site specific flood risk assessment and the overall processes for sequential and exception tests.

The NPPF and Technical Guidance maintain the requirement to apply a risk-based, sequential approach to the location of development in order to avoid flood risk to people and property. The key difference for flood risk policy compared to PPS25 is that the NPPF gives local authorities a wider remit to interpret and implement local policies. This makes the SFRA process all the more important in establishing suitable, reasonable and practical local development policies to manage local flood risk.

The essence of NPPF is that:

- Local Plans should be supported by a Strategic Flood Risk Assessment and develop policies to manage flood risk from all sources, taking advice from the Environment Agency and other relevant flood risk management bodies, such as lead local flood authorities and internal drainage boards.
- Polices in development plans should outline the consideration, which will be given to flood issues, recognising the uncertainties that are inherent in the prediction of flooding and that flood risk is expected to increase as a result of climate change.
- Planning authorities should apply the precautionary principle to the issue of flood risk, using a risk based search sequence to avoid such risk where possible and managing it elsewhere.
- The vulnerability of a proposed land use should be considered when assessing flood risk.
- Use opportunities offered by new developments to reduce the causes and impacts of flooding.
- Planning authorities should recognise the importance of functional floodplains, where water flows or is held at times of flood, and avoid inappropriate development on undeveloped and undefended floodplains.
- The concept of Flood Risk Reduction, particularly in circumstances where development has been sanctioned on the basis of the "Exception Test".

3.3 Regional Policy Drivers

The London Plan

The London Plan is the overall strategic plan for London, setting out an integrated economic, environment, transport and social framework for the development of London over the next 20-25 years. The London Plan was adopted in 2004, there have since been several revisions to the Plan, with the most recent revisions published in October 2013 when the Revised Early Minor Alterations (REMA) to the London Plan was published. The London Plan contains a series of objectives identified by the Mayor of London. The overarching objective of the plan is to promote sustainable development. The London Plan indentifies five sub regions (Central London, North, East South and West). RBKC is identified as being within the Central London sub region. The London Plan also has a number of polices, some of the policies have recently been revised in the REMA document. The policies relevant to this SFRA include;

Policy 5.11 Green Roofs—Major development proposals should be designed to include roof and site planting, especially green roofs and walls where feasible, to deliver as many of the following objectives as possible:

- Adaption to climate change
- Sustainable urban drainage
- Mitigation of climate change
- Enhancement of biodiversity
- Accessible roof space
- Improvements to appearance and resilience of the building
- Growing food

Policy 5.12 Flood Risk Management

Strategic —The Mayor will work with all relevant agencies including the Environment Agency to address current and future flood issues and minimise risks in a sustainable and cost effective way.

Planning decisions — Development proposals must comply with the flood risk assessment and management requirements set in the NPPF and the associated Technical Guidance on flood risk over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 and Catchment Flood Management Plans.

Developments which are required to pass the Exception Test set out in the NPPF and the Technical Guidance will need to address flood resilient design and emergency planning by demonstrating that:

a) The development will remain safe and operational under flood conditions.

b) A strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions.

c) Key services including electricity, water etc will continue to the provided under flood conditions.

d) Buildings are designed for quick recovery following a flood.

Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourse and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way.

Policy 5.13 Sustainable Drainage

Planning decisions—Development should utilise Sustainable Urban Drainage Systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve Greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

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

Drainage should be designed and implemented in ways that deliver other policy objectives of the Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

Draft Sustainable Design and Construction: The London Plan Supplementary Planning Guidance

The Draft Supplementary Planning Guidance (SPG) was published in July 2013 and remained open for consultation until October 2013. At the timing of writing this SFRA, the Greater London Authority (GLA) were reviewing the consultation responses with a view to finalising and adopting the SPG. The document seeks to provide additional information to support the implementation of the London Plan. The guide seeks to identify a series of standards and measures to promote sustainable development around the themes of resource management, adapting to climate change and pollution management, principally land, air, noise, light and water.

With regard to water pollution and flooding the SPG identifies the following essential standards:

- Developments are expected to achieve at least 50% attenuation of the undeveloped sites surface water runoff at peak times.
- Incorporate sustainable drainage into all developments.
- Assess a range of return periods up to and including the 1 in 100 year plus climate change critical storms (an additional 20-30%).

The guidance provides a helpful introduction to the various methods of SuDS which can be applied and adopted as part of a development proposal.

3.4 Local Planning Policy

Local Development Framework and the Core Strategy Adopted 8th December 2010

The Local Development Framework is the collection of local development documents produced by RBKC which collectively delivers the spatial planning for the Borough. The Core Strategy is the key plan within the Local Development Framework and sets out the future development within Kensington and Chelsea over the next 20 years. It looks ahead to 2028 and identifies where the main developments will take place, and how places within RBKC will change.

The Core Strategy highlights there is a requirement to have a policy to ensure that development considers potential flood risk from all sources and incorporates measures to mitigate this risk especially the risk of surface water and sewer flooding.

Policy CE2 Flooding
The Council will require development to adapt to fluvial flooding and mitigate the effects of, and adapt to, surface water and sewer flooding. To deliver this the Council will:

- Resist vulnerable development, including self contained basement dwellings in Flood Zone 3 as defined in the Strategic Flood Risk Assessment;
- Require a site specific Flood Risk Assessment, including an 'Exception Test' for all development in Flood Risk Zone 2 and 3 as defined in the Strategic Flood Risk Assessment, for sites in areas with critical drainage problems and for all sites greater than 1 hectare;
- Where required undertake the 'Sequential Test' for planning applications within Flood Risk Zones 2 and 3, and for sites in areas with critical drainage problems;
- Require development at risk from flooding in Flood Risk Zones 2 and 3, in areas with critical drainage problems, or sites greater than 1ha to incorporate suitable flood defence or flood mitigation measures in accordance with the recommendations of the site specific Flood Risk Assessment;
- Require Sustainable Urban Drainage Systems (SuDS), or other measures, to reduce both the volume and the speed of water run-off to the drainage system ensuring that surface water run-off is managed as close to its source as possible in line with the hierarchy in the London Plan. In particular, major development must make a significant reduction in the current volume and speed of water run-off to the drainage system;
- Resist impermeable surfaces in front gardens;
- Require development adjacent to the Thames to be set back from the Thames flood defence to enable the sustainable and cost-effective upgrade of flood defences over the next 50 to 100 years;
- Require works associated with the construction of the Thames Tideway Tunnel to:
    - preserve or enhance the character or appearance of the Cheyne, Royal Hospital and Thames Conservation areas;
    - preserve listed buildings and their settings, and Parks and Gardens of Special Historic Interest (i.e. the Royal Hospital grounds);
    - not adversely impact on amenity; and
    - not compromise the future of Cremorne Wharf which is a Safeguarded Wharf.

The Environment Agency's Thames Estuary 2100 Project

The Thames Estuary 2100 Project was established by the Environment Agency in 2002 with the aim of developing a strategic flood risk management plan for London and the Thames estuary through to the end of the century. The project primarily looks at tidal flooding, though other sources of flooding (including high river flows as a result of heavy rainfall and surface water flooding) are considered.

The key driver for the project was to consider how tidal flood risk was likely to change in response to future changes in climate and people and property in the floodplain. Additional to this there was an understanding that many of the existing flood walls, embankments and barriers were getting older and would need to be raised or replaced to manage rising water levels.

The plan divided the estuary into 23 geographical areas, known as policy units. Each policy unit has been assessed to determine the appropriate level of flood risk management.

It confirms that the source of flooding is:-

- Tidal from the Thames upriver of the Thames Barrier (probability 0.1% per annum or less frequent, barrier controlled), flood depths up to 3 meters if the Thames Barrier failed.
- Risk from pluvial and urban drainage sources.

RBKC is within Action plan Zone 2 "Central London", and is in Policy Unit London City. The Policy is *P5: to take further action to reduce flood risk beyond that required to keep pace with climate change".*

This will be provided by the Thames Barrier for tidal flood risk for the foreseeable future. Fluvial flooding from the Thames is unlikely to be a problem for this area because fluvial flood levels would not overtop the defences – although there may be fluvial/pluvial flood risk from behind the tidal defences.

Surface Water Management Plan (SWMP)

On behalf of RBKC, a Surface Water Management Plan (SWMP) was completed in February 2014. The report outlines the predicted risk and preferred surface water management strategy for the Royal Borough. Within the study area four Critical Drainage Areas (CDAs) were identified, the dominant mechanisms for flooding can be broadly divided into, topographical low lying areas and low points, sewer flood risk and fluvial / tidal flood risk.

An analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a1% AEP event. A review of the results predicts that over 20,000 properties in the study area could be at risk of surface water flooding of a depth greater than 0.1m during a 100 year rainfall event. A number of recommendations for the short and medium term were included in the SWMP and include the following;-

- Basement properties include suitable pumping devices to protect them from sewer flooding.
- Promote the use of SuDS features within council assets (roads, parks, footpaths) and private property (car parking areas, private parks, etc).
- Improve maintenance regimes to target those areas identified to flood regularly or known to have blocked gullies or are prone to damage.

The SWMP Action Plan, which is a major output of the SMWP, recommends that the following policies are implemented within the boundaries of the catchment to reduce the flood risk therein:

***Policy 1**: Proposed 'brownfield' redevelopments of more than one property or area greater than 0.1 hectare are required to reduce post-development runoff rates for events up to and including the 1 in 100 year return period event with an allowance for climate change (in line with NPPF and UKCIP guidance) to that of a Greenfield condition (calculated in accordance with IoH124[10]).*

***Policy 2:** Developments located in Critical Drainage Areas (CDAs) and for redevelopments of more than one property or area greater than 0.1 hectare should seek betterment to a Greenfield runoff rate (calculated in accordance with IoH124). It is recommended that a SuDS treatment train is utilised to assist in this reduction.*

The Councils may also wish to consider the inclusion of the following policy to manage the pollutant loads generated from proposed development applications:

***Policy 3:** Best Management Practices (BMP) are required for development applications greater than 0.1 hectare within the catchment. The following load-reduction targets must be achieved when assessing the post-developed sites SuDS treatment train (comparison of unmitigated developed scenario versus developed mitigated scenario):*

- 80% reduction in Total Suspended Sediment (TSS);

- 45% reduction in Total Nitrogen (TN);

- 60% reduction in Total Phosphorus (TP); and

- 90% reduction in litter (sized 5mm or greater).

Preliminary Flood Risk Assessment

A Preliminary Flood Risk Assessment (PFRA) was completed in July 2011 as part of the wider Drain London project which involved the delivery of a Surface Water Management Plans (SWMP) – modelled at an intermediate level – and PFRA for each of the 32 London Borough and the Corporation of the City of London. The PFRA has been undertaken to assist RBKC to meet its duties as a Lead Local Flood Authority, with the delivery of the first stage of the Flood Risk Regulations (2009).

The PFRA is a high level screening exercise that compiles information on significant local flood risk from past and future floods, based on readily available and derivable information. The study has not identified any past floods that are considered to have had significant harmful consequences. Future flood risk from extreme events is estimated to be high in RBKC.

[10] Defra/Environment Agency, September 2005, Flood and Coastal Defence R&D Programme: Preliminary Rainfall Runoff Management for Developments (R&D Technical Report W5-074/A/TR/1 Revision D)

4. Data Collection

4.1 Flood Zone Maps

The Environment Agency Flood Zone Maps show the 1 in 200 year (tidal) return period event (an event with a 0.5% chance of occurring each year) and 1 in 1000 year tidal period event (an event with a 0.1% chance of occurring each year). They were prepared using a methodology based on modelling of the estuary and two dimensional (2D) flood routing using ground data based on LiDAR.

The Environment Agency Flood Zone Maps do not take account of flood defences and, therefore, represent a theoretical maximum extent of tidal flooding. The actual extent of flooding is mitigated by flood defences. Therefore, the Environment Agency Flood Zone Maps provide a worst case assessment of the extent of flooding and are consistent with NPPF, which categorises flood risk ignoring the effects of defences. Figure 1 shows the extent of Flood Zones 2 and 3 across the Borough.

4.2 Flood Defences

As discussed above, the Environment Agency Flood Zone Maps do not take account of the presence of flood defences. NPPF states that defended areas (i.e. those areas that are protected to some degree against flooding by the presence of a formalised flood defence) are still at risk of flooding, and therefore sites within these areas must be assessed with respect to the adequacy of the defences.

The Tidal Thames is defended to a 1 in 1000 year standard (protection against an event with a 0.1% chance of occurring each year), by a series of walls, embankments, flood gates and barriers, with the Thames Barrier being the major protection for the study area. The statutory defence level (the level to which the defences must be maintained) within the study area is 5.41m downstream of Putney Bridge, and 5.54m upstream.

The location and condition of all flood defences within the Borough has been provided by the Environment Agency via the National Fluvial and Coastal Defence Database (NFCDD). Table 4.1 shows how condition is rated by the Environment Agency.

Table 4-1: NFCDD condition Ratings

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

4.3 Hydraulic Modelling

An Environment Agency Thames Tidal Joint Probability Extreme Water Level Model (2008) covers the study area. The model uses in channel water levels in the Thames and are based on three main factors, the astronomical tide, the surge tide and the flow coming from the non-tidal Thames. The study modelled water levels to various annual probabilities (10%, 5%, 1%, 0.5% 0.2% and 0.1%). Each of the probabilities have been modelled for present day (2005) and future years (2055 and 2107) taking into account DEFRA's climate change allowances as set out in the now superseded planning document PPS25. Refer to Table 4-2 for the modelled flood levels as supplied by the Environment Agency in April 2013. Table 4-3 shows the TE2100 Extreme Water Levels (m AOD) for the Tidal Thames.

Table 4-2: Modelled Water Levels (mAOD) for the Tidal Thames

Year	Annual Probability of Exceedance for node 2.27 Battersea Bridge						
	10%	5%	2%	1%	0.5%	0.2%	0.1%
2005	4.93	4.97	5.01	5.04	5.06	5.08	5.09
2055	4.98	4.99	5.01	5.01	5.02	5.03	5.04
2107	5.00	5.01	5.01	5.02	5.02	5.03	5.04
Year	Annual Probability of Occurrence for node 2.28 Albert Bridge						
	10%	5%	2%	1%	0.5%	0.2%	0.1%
2005	4.92	4.96	5.00	5.02	5.04	5.06	5.08
2055	4.97	4.98	4.99	5.00	5.01	5.02	5.03
2107	4.99	5.00	5.00	5.01	5.01	5.02	5.04
Year	Annual Probability of Occurrence for node 2.29 Chelsea Bridge						
	10%	5%	2%	1%	0.5%	0.2%	0.1%
2005	4.91	4.95	4.99	5.01	5.03	5.05	5.07
2055	4.96	4.97	4.98	4.99	5.00	5.01	5.02
2107	4.98	4.99	4.99	5.00	5.00	5.01	5.02

Table 4-3: TE2100 Extreme Water Levels (m AOD) for the Tidal Thames

Scenario	0.5% Annual Probability of Exceedance for node 2.24
Present Day	4.92
Future (up to 2100 including climate change)	5.85

4.4 Topography

Remotely sensed ground level data (LiDAR) have been made available for use in the SFRA by the Environment Agency. This information is in the form of a land surface level grid with a 1m grid resolution. The nominal vertical accuracy of LiDAR data is typically ± 0.25 m. LiDAR data are available for most of the Borough areas and have been utilised. Figure 2 (Appendix B) shows the topography of the study area.

4.5 Lost Rivers

Lost Rivers where once tributaries of the River Thames before they became culverted over or converted into sewers. There are two Lost Rivers within the RBKC; the Westbourne River and Counters Creek. Figure 1 (Appendix B) shows the location of these lost rivers.

The Westbourne rose in West Hampstead, flowed southwest where it crossed the Bayswater Road and entered Hyde Park, from here the Westbourne was conveyed under Knightsbridge, and then meandered southwards through the grounds of the Royal Hospital Chelsea to meet the Thames[11]. The part of the Westbourne through Hyde Park was dammed in 1730 to form the Serpentine[12]. In 1856-7 the Westbourne was completely covered and is now the Ranelagh Sewer, although it is carried above ground at Sloane Square tube station.

Counter's Creek rose near Kensal Green cemetery and flowed roughly straight in a south-south-east direction passing close to the present sites of Olympia, Earl's Court, and Stamford Bridge, it would have passed under the bridge carrying the King's Road and continued to the Thames as Chelsea Creek (which is still visible). In early the 19th century Counter's Creek, south of the Olympia, was converted to the Kensington Canal, but was later bought and drained by the West London Railway Company to build a line extension, the stream now runs underneath the railway line in Counter's Creek Sewer.

4.6 Historical Flooding

Historical flooding events and issues have been identified and assessed utilising a number of information sources. These include the Environment Agency, RBKC, Thames Water, London Fire Brigade, Transport for London and Network Rail.

Surface Water Flooding

RBKC has historically suffered basement flooding and surface water ponding following heavy rainfall events. Water ponding in roads is mainly due to blocked or collapsed highways drains that are regularly checked, maintained and replaced as necessary and blocked drainage gullies.

In October 2006 the Notting Hill and Sloane Square London Underground stations were affected by surface water flooding due to heavy rainfall and sewer surcharge. During the heavy rainfall on 20 July 2007, 511 properties across three areas were flooded as a result of a combination of surface water and sewer flooding. This was caused by the following:

- The insufficient capacity of the drainage network leading to exceedance flows bypassing gulley inlets which results in ponding within topographic low areas; and
- Surcharging of the sewer drainage network, leading to the flooding or basements property which have a direct connection to the combined sewer network.

The areas affected were the Holland Road and Elsham Road areas along the boundary with the London Borough of Hammersmith and Fulham, Sloane Street and Sloane Square area as well as the Gloucester Road and South Kensington area where both London Underground stations were flooded.

A summary of key historic events which were provided for this report have been geo-referenced and mapped in Figure 7 Appendix B.

[11] Barton, N (2000) The Lost Rivers of London. Historical Publications Limited, chpt 4, p.43-48.
[12] Barton, N (2000) The Lost Rivers of London. Historical Publications Limited, chpt 9, p.112. Barton, N

Groundwater Historic Records

There are several groundwater flooding records identified within the RBKC boundary. Below is a summary of potential areas.

- Flooding from rising groundwater may pose a problem to underground infrastructure at various underground stations across the Royal Borough as indicated, although there was only one record of groundwater flooding in the vicinity of Gloucester Road tube station; and
- Refer to Figure 6 which indicates the Environment Agency records of groundwater flooding. The majority of the incidents recorded are located within Notting Hill and South Kensington areas of the Borough.

Historic Tidal Flooding Records

The Environment Agency does not have a record of flood extents within RBKC. Table 4-3 indicates the levels recorded during extremely high tides in London.

Table 4-4: Observed water levels (mAOD) at Chelsea Bridge during high tides

	7 Jan 1928	13 Feb 1938	1 Mar 1949	1 Feb 1953	10 Dec 1965	19 Jan 1975	12 Jan 1978	31 Dec 1978
Chelsea Bridge	5.17	5.15	5.16	5.39	4.9	5.03	5.15	5.29

The following are some reports of how RBKC was affected by the 1928 and 1953 flood events in London.

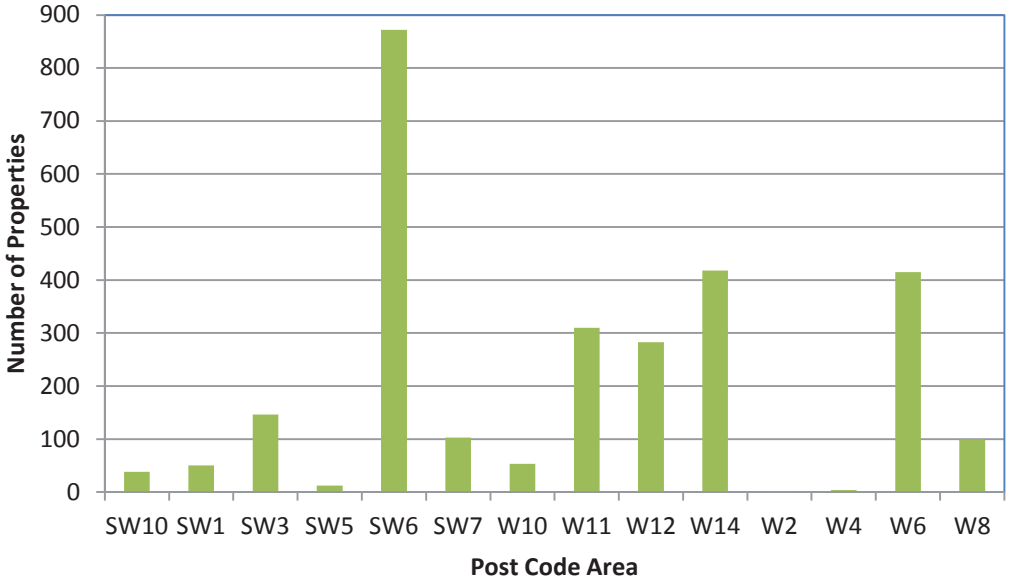
- In 1928 "the flooding at Hammersmith Bridge reached a depth of five feet (approximately 1.5 metres). There was widespread dislocation; phones were cut off, cars damaged and stranded, roads blocked by fallen debris. In all fourteen people died in the 1928 floods, most of them in their beds, including young female servants in the downstairs quarters of wealthy property owners in the Westminster and Chelsea areas."[13]
- In 1953 "the water came dead level with the Chelsea Embankment."[14]
- There has been no major flooding from the Thames within RBKC since the 1930 Flood Act when, following the 1928 flood event the level of the defences were raised.

Sewer Flooding

Thames Water was able to provide information regarding sewer flooding events over the past ten years on a broad scale. The information was provided on postal area basis, no specific information was provided as this went against the data protection of Thames Water's customers. Figure 4 shows the number of properties flooded by overloaded sewers, within RBKC and nearby Borough over the past ten years.

[13] Milne, A (1982) London's drowning. Thames Methuen, chpt 1, p17.
[14] Milne, A (1982) London's drowning. Thames Methuen, chpt 1, p7.

Figure 4: Number of properties flooded by overloaded sewers over the last 10 years



4.7 Flooding from other sources

In addition to tidal flood risk, alternative sources of flooding including groundwater, overland flow and drainage systems also need to be considered when planning development. Although explicit consideration of these sources of flooding is not a requirement for flood zone allocation, local drainage issues have the potential to cause substantial damage and distress. When considering development proposals, known drainage and surface water problems need to be taken into account.

RBKC and Thames Water have provided some information with regards location and type of historical flooding events from other sources.. Flooding from reservoirs has been assessed using the Environment Agency's reservoir inundation map. Unfortunately there is no further information available on the possibility of a breach in the canal.

5. Flood Risk in the Royal Borough of Kensington and Chelsea

5.1 Introduction

The guidance detailed below has been developed to provide a clear, concise and consistent means of assessing the feasibility and sustainability of sites and to determine appropriate flood risk mitigation measures where required. The framework will aid RBKC and others to assess flood risk associated with allocations and potential development sites. It will also allow policies on flood risk to be included in the LDF's, which draw upon national guidance for consistency, but provide the local detail and interpretation of these national policies.

NPPF aims to direct development to lower flood risk sites wherever possible. “Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere”[15].Only when the Sequential Test has been employed and new development is, necessary and no other lower risk sites have been shown to be available should the Exception Test be applied.

NPPF states that "residual risks are those remaining after applying the sequential approach and taking mitigating actions. It is the responsibly of those planning development to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed. Flood resistance and resilience measures should not be used to justify development in inappropriate locations"[15].

The Practice Guide was issued in February 2007 as a 'living draft' to accompany PPS25. Although now replaced by NPPF, the PPS25 Practice Guide still contains useful guidance and examples of flood risk management which can be used to manage flooding within RBKC. However, it should be noted that defences don't eliminate the risk, only reduce the frequency of flooding.

It must be made clear that this SFRA does not preclude the need for site specific flood risk assessments. Table 2.2, Chapter 2, highlights the type of development considered appropriate for each Flood Zone. This table highlights if a development not permitted in a specific Flood Zone, if the development is permitted but only when the Exception Test is passed, and whether a site specific Flood Risk Assessment is required to support a planning application.

This chapter will present the guidance for Flood Zone 3b; Flood Zone 3a (including defended, public safety and rapid inundation, and the feasibility of flood risk mitigation); Flood Zone 2; and Flood Zone 1. It will then discuss issues relating to flood risk from other sources.

5.2 Delineation of NPPF Flood Zones

The extent of the Flood Zone within RBKC can be seen within Section 1 Figure 2 and at a larger A3 scale within Appendix B, Figure 1.

Flood Zone 1 – Low Probability

[15] Technical Guidance to the National Planning Policy Framework. March 2012

Flood Zone 1 is the area outside Flood Zone 2 and 3 - for RBKC this is the majority of the Borough. It includes the area north of Kings Road and a large portion of the area to the south.

Flood Zone 1 equates to a flood event with less than a 0.1% chance of occurring each year (1 in 1000 year event).

In accordance with NPPF Table 1, all development (essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water-compatible development) is permitted in Flood Zone 1. All development proposals should consider the following about the sites:

- Their vulnerability to flooding from other sources as well as from river and sea flooding.
- Their potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff.

Flood Zone 2 – Medium Probability

Flood Zone 2 is similar in extent to Flood Zone 3 (discussed overleaf) with a few areas where its extents are slightly larger. These areas include Westfield Park, Chelsea Manor Street and Christchurch Street.

Flood Zone 2 equates to a flood event which has a between a 0.1% and 0.5% chance of each year (between a 1 in 1000 and 1 in 200 year event).

Flood Zone 2 is considered suitable for water-compatible, less vulnerable, more vulnerable and essential infrastructure. Highly vulnerable development is only allowed where the Exception Test is passed.

All development proposals must consider the following information about the sites:

- Their vulnerability to flooding from other sources as well as from river and sea flooding.
- Their vulnerability to flooding over the lifetime of the development.
- Their potential to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water run-off, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property.
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account, including flood defences, flood resilient and resistant design, escape / evacuation (access and egress), effective flood warning and emergency planning) are acceptable.

Flood Zone 3a – High Probability

Flood Zone 3 covers a small portion of the Borough. Flood Zone 3 mainly consists of the areas adjacent to Cheyne Walk and the Chelsea Embankment with wider extents around The Royal Hospital and Gardens, Ashburnham Road, Cremorne Road, Chelsea Manor Street and Christchurch Street.

Flood Zone 3 equates to a flood event with a greater than a 0.5% chance of occurring each year (1 in 200 year event).

NPPF Table 1 (reproduced within Section 2 Table 2-1) states that the water-compatible uses and less vulnerable development are allowed in this Flood Zone, following testing within the sequential process. According to NPPF Table 1, highly vulnerable development is not permitted, with essential infrastructure and more vulnerable development required to pass the Exception Test. Essential infrastructure should be designed and constructed to remain operational and safe for users in times of flood.

According to NPPF Table 1, developers and local authorities should implement the following policy aims:

- Reduce the overall level of flood risk through the layout and form of the development and the appropriate application of sustainable drainage techniques.
- Relocate existing development to land in zones with a lower probability of flooding.
- Create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Regeneration of land or change in land use behind existing defended areas in the High Risk Zone will continue to require a more detailed assessment of the flood risk (i.e. whether the scale of risk is worth taking), and how sustainable and effective the mitigation measures would be (i.e. whether the risk could be managed).

Where, due to wider sustainable development reasons, there are no other suitable sites available in lower risk zones then an assessment of the actual risk within Flood Zone 3 is required. For developments to proceed it must also be shown that the development will not increase flood risk elsewhere.

Flood Zone 3b (Functional Floodplain) – High Probability

No areas of functional floodplain are identified within the Borough due to the presence of the defences. Although not strictly 'floodplain', the tidal foreshore exposed each tide should be protected as this plays an important role in the functioning of the Tidal Thames.

5.3 Assessment of Residual Risk

The Technical Guidance to NPPF deals with managing residual flood risk.

Paragraph 16 of NPPF states that “residual risks are those remaining after applying the sequential approach and taking mitigating actions."It states that:

> "It is the responsibility of those planning development to fully assess flood risk, propose measures to mitigate it and demonstrate that any residual risks can be safely managed”.

It is the developer’s responsibility to demonstrate how (in planning terms) this can be achieved and how the residual risks will be managed. A clear distinction between commercial flood standards of protection and management of loss of life should be explored in the Flood Risk Assessment (FRA). A greater reliance on flood warning may be required, which is not always a tangible alternative to accepting a lower standard of protection.

The study area is a defended area, and is considered to be an area of floodplain where the defences substantially (but not necessarily completely) mitigate the flood risk associated with the event which has a 0.5% chance of occurring each year (1 in 200 year return period).

Within defended areas flood risk is primarily associated with overtopping and breach of defences (and localised flooding associated with drainage systems in some locations). These risks are related to the likelihood (standard of protection and structural integrity of defences) and consequences of flooding (depth, speed and duration of flooding, and land use within defended area).

The consequences of defence overtopping or breach failure can be estimated using flood inundation modelling and mapping.

5.4 Breach Analysis

The Thames Barrier is designed to be robust and reliable and the Environment Agency maintains and operates the barrier to ensure that the level of protection is maintained. The barrier gates are routinely operated and there is a high degree of redundancy in terms of power supply and hydraulic systems. The Thames Barrier has been closed in response to tidal conditions over 150 times without any problems arising and thus has proved reliable in practice. The Thames Barrier is only closed in response to high surges (though it has also on occasion been used to reduce high level levels in Teddington and Richmond during fluvial flood events) and thus even with the barrier operating as intended, the predicted peak tide levels can be significantly above the ground level in RBKC. The river walls therefore provide an important defence and a source of residual risk arises from a breach in the flood defence wall.

Possible locations of a defence breach were obtained by reviewing the flood defence condition data held within the National Flood and Coastal Defence Database (NFCDD). It should be noted that this is only an indication as it fails to account for the possibility of human interference with the defence. Examples of human interference include vehicle impact, ship impact and excavation behind defences. The effects of these events on the defence are not always noticed immediately, and the defence may appear fine but later collapse under the pressure of a rising tide. It is not possible to quantify the probability of a defence wall failure, but the probability will be greater than that of a highly engineered and managed defence such as the Thames Barrier.

For the breach analysis it is assumed that the Thames Barrier will not fail but will be used more often in the future as sea levels rise and other actions being studied by the TE2100 are brought into effect.

5.4.1 Approach to Breach Analysis

TUFLOW modelling software was used to model flood defence breaches for three locations along the Thames. Environment Agency TE2100 tidal data was used in the breach modelling. The stage-time hydrograph (tidal curve) for a 1 in 200 year tidal event was extracted for node 2.24, located at NGR 525111 175429. The section of the hydrograph corresponding to the largest tidal peak was applied as an inflow boundary to the model. The defence breach was modelled for one tide cycle as it was assumed that the defence walls in this area would be temporarily repaired within this time period. A digital terrain model (DTM) based on Environment Agency 1m LiDAR (Light Detection and Ranging) data was used to represent the topography within RBKC, with land use types derived from OS MasterMap (these were used to define ground roughness / resistance to flow). A bank full scenario was assumed for the river channel, meaning that flow would not be able to re-enter the river.

5.4.2 Breach Locations

The locations of the breaches were based on those used in the original RBKC SFRA (2009), which were selected based on defence condition and ground level behind the defence wall. Only breach locations within the RBKC boundary were considered. A site visit was undertaken as part of the 2009 SFRA to check the plausibility of a breach actually occurring at these locations. The breaches remain open for one tide cycle before being closed. This assumes that (temporary or permanent) repairs would be carried out within hours of the breach occurring. The breaches are represented by a drop from the statutory defence level to the level of the land behind the defence based on 1m LiDAR data provided by the Environment Agency. The breaches are 20m wide, a standard width for hard defences. Table 5-4 indicates the breach locations and elevations and the crest level of the existing defences, based on Environment Agency NFCDD data.

Table 5-1: Breach Dimensions

Breach	Location	Width (m)	Defence Crest Level (mAOD)	Breach Sill Level (mAOD)
B2	NGR 526611, 177202	20	5.85	4.7
B3	NGR 527626, 177700	20	5.41	4.6
B4	NGR 528244, 177848	20	5.41	4.7

5.4.3 Overtopping Analysis

Overtopping of the defence walls is unlikely given the operation of the Thames Barrier. However, in the unlikely event of non closure of the barrier overtopping could occur. The likelihood of overtopping can be estimated by comparison of modelled water levels and defence crest levels. The TE2100 present day extreme water level for node 2.24 is 4.92mAOD, which is below the crest level of all defences in RBKC, indicating that overtopping of the defences is highly unlikely.

The TE2100 future dataset takes into account the effects of climate change. The future (up to 2100) extreme water level for node 2.24 is 5.85mAOD, which is equal to the current defence crest level of breach B2 and exceeds the current defence crest level of breaches B3 and B4, indicating that overtopping could occur at this tidal level for B3 and B4. Review of the TE2100 study information provided the Environment Agency indicates that the defences at the three breach locations may be raised to 6.35mAOD, which would mean that overtopping does not occur at the extreme tidal level currently predicted. Based on this assumption no overtopping scenarios have been modelled for RBKC.

5.5 Climate Change

A comparison between the TE2100 present day and future (up to 2100 including climate change) extreme water levels for a 1 in 200 year tidal event indicate a significant increase in Thames tidal peak in the region of RBKC. At node 2.24, used in the breach model, the extreme water level is estimated to increase from the present day level of 4.92mAOD to a level of 5.85mAOD by 2100. The breach model has been run for the TE2100 future scenario (up to 2100 including climate change) by increasing the tidal levels in the input hydrograph such that the peak water level matches that provided by the TE2100 future dataset. The results from this analysis can be seen within Appendix B.

5.6 Residual Risk Classification

For allocations where a development site is close to a defence consideration must be given to the risk to public safety (risk to life). Development should not be sited where risk unduly threaten public safety and/or the structural integrity of buildings and infrastructure. Consideration of the depth of flooding, rate of inundation and safe access/egress is required to assess these risks. This assessment is applicable to areas at risk from both breach and overtopping. Environment Agency guidance suggests that all development should have a dry access and egress in the 1 in 200 year event (the event with a 0.5% chance of occurring each year). Greater depths may be permitted where elevated access/egress to safe ground is provided.

A simplified residual risk classification to delineate risk within Flood Zone 3a was derived (Table 5.3) taking account of DEFRA's work on Flooding Hazards to People (DEFRA/ Environment Agency Flood Risk to People FD2320/TR2, Dated 2008) which gives consideration to both the depth of water and speed of flow that can affect people (Table 5-2, overleaf) and the possible impact the proximity of a site to the river during a sudden surge of water resulting from the failure of a defence.

Table 5-2: Residual Flood Risk Classification within Flood Zone 3

Classification	Criteria
HH: High	Areas within the RIZ of 500m with a water depth greater than of 0.25m. Areas outside the RIZ with a water depth of greater than 0.6m. Areas within the RIZ with no safe (dry) access or egress.
MH: Medium	Areas within RIZ of 500m and with a water depth of less than of 0.25m. Areas outside the RIZ with a water depth less than 0.6m.
LH: Low	Areas which has not been classified as medium or high risk but are still within the Environment Agencies Flood Zone 3.

DEFRA have produced a classification to determine the Flood Hazard to People as a function of depth and velocity (

Table 5-3). The following text explains how the Flood Hazard rating has been incorporated into the Residual Risk Classification.

Table 5-3: FD2320 Flood Hazard to People as a function of Depth and Velocity

d × (*v*+0.5) + *DF*	Degree of Flood Hazard	Description
< 0.75	**Low**	Caution *"Flood zone with shallow flowing or deep standing water"*
0.75 - 1.25	**Moderate**	Dangerous for some (e.g. 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"*
DF is a debris factor. For urban areas it is recommended that DF=0 for depth <0.25m and DF=1 for depth > 0.25m		

The location of high velocities is dependent on the location of the breach. The modelled velocities for the limited number of simulated breaches cannot therefore give a full picture of Flood Hazard. In reality high velocities can be generated due to local features not picked up in the LiDAR or the grid used for flood modelling. For example, flow into a basement may be a high hazard if it occurs rapidly without warning.

The Rapid Inundation Zone (RIZ) can be defined as the area that a flood will cover within half an hour of a breach occurring. The RIZ is often the area which suffers the highest depths and velocities. For allocations where a development site is close to a defence, consideration must be given to the risk to public safety associated with access and egress from properties. Examining the simulated progression of a number of breaches, it was found that, in line with a number of other studies, within 30 minutes the extent of a breaching could reach an area of approximately 80m - 180m from where the failure occurs and increases to 275m – 325m when the predicted climate change impacts are included within the breach models. This area in proximity to the river is thus potentially at high risk and is classed as a RIZ.

The Hazard Classification takes account of a debris factor and it is believed that this can increase significantly above a depth of 0.25m. The high residual risk classification is thus chosen to indicate the areas that could be dangerous to people and incorporates the RIZ and FD2320 Hazard categories equivalent to moderate, significant and extreme flood hazard.

The medium residual risk classification is equivalent to low to moderate flood hazard incorporating areas within the RIZ and with water depths of less than 0.25m. Outside the RIZ velocities were generally lower than 0.75m/s therefore depths with less than 0.6m are seen as low or medium hazard.

The low residual risk part of Flood Zone 3 is that area that is not predicted to be affected by the breaching considered but could potentially be affected if breaches were not closed within the time assumed.

5.7 Other Sources of Flood Risk

Sewer Flooding

Based on customer privacy and legal issues, there was not enough detailed data available from Thames Water to provide a detailed map for sewer flooding within RBKC. Thames Water have provided details of sewer flooding on a postal area basis. Figure 8 (Appendix B) utilises this data and provides an overview of the spatial distribution of sewer flooding events in the Borough. Thames Water have stated that the areas which have in the past been affected by sewer flooding should not be seen as areas to avoid future development and that the reverse is also true, that areas with no known flooding incidents should not always be viewed as the best place to accommodate new development. What is essential is that all development locations are assessed to ensure capacity exists within both the on and off site network.

Surface Water Flooding

A surface water management plan (SWMP) was completed in February 2014. The report outlines the predicted risk and preferred surface water management strategy for the Royal Borough of Kensington and Chelsea. The report defines surface water as flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches[17] that occurs as a result of heavy rainfall.

Analysis of the number of properties at risk of flooding was undertaken for the rainfall event with a 1% AEP A review of these results predicts that over 20,000 properties in RBKC could be at risk of surface water flooding of a depth greater than 0.1m during a 100 year rainfall event (above an assumed 0.1m building threshold), refer to Table 5-1 below and refer to Figure 3 and 4 in Appendix B for the depth and hazard result for the 1 in 100 year plus climate change results.

Table 5-4: Predicted Flooded Properties Summary – 1 in 100 Year Flood Event. Depths > 0.1m

Administration Boundary	Infrastructure	Households		Commercial / Industrial	Other (Unclassified Landuse)	Total
		Non-Deprived	Deprived			
The Royal Borough of Kensington and Chelsea	145	15,820	2,441	1,266	1,281	**20,953**

Within the study area, four (4) CDAs were identified and are presented in Figure 5.

Critical Drainage Area 01—North Kensington Area

This CDA is located in the North Kensington area of the Royal Borough.

Surface water is predicted to flow generally from east to west towards the A3220. The pluvial modelling indicates predicted surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads and within lowered basements). Surface water runoff flows from the upper catchment in a westerly direction (predominantly via the road network). The CDA is located within Flood Zone 1 as it is not at risk of fluvial and tidal flooding.

[17] Please note: There are no small watercourses or ditches within The Royal Borough of Kensington and Chelsea.

Critical Drainage Area 02—Holland Park Area

This CDA is located in the Notting Hill and Holland Park area of the Royal Borough. Surface water is predicted to flow generally from east to southwest towards the A3220 and London Underground line. The pluvial modelling indicates predicted surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads and within lowered basements). Surface water runoff flows from the upper catchment in a west – south-westerly direction (predominantly via the road network). The majority of areas predicted to be at risk are basement properties. The majority of the CDA is located within Flood Zone 1. However, the south western boundary (west of the A3220) is at risk of tidal flooding, but currently benefits from flood defence infrastructure that protects the area.

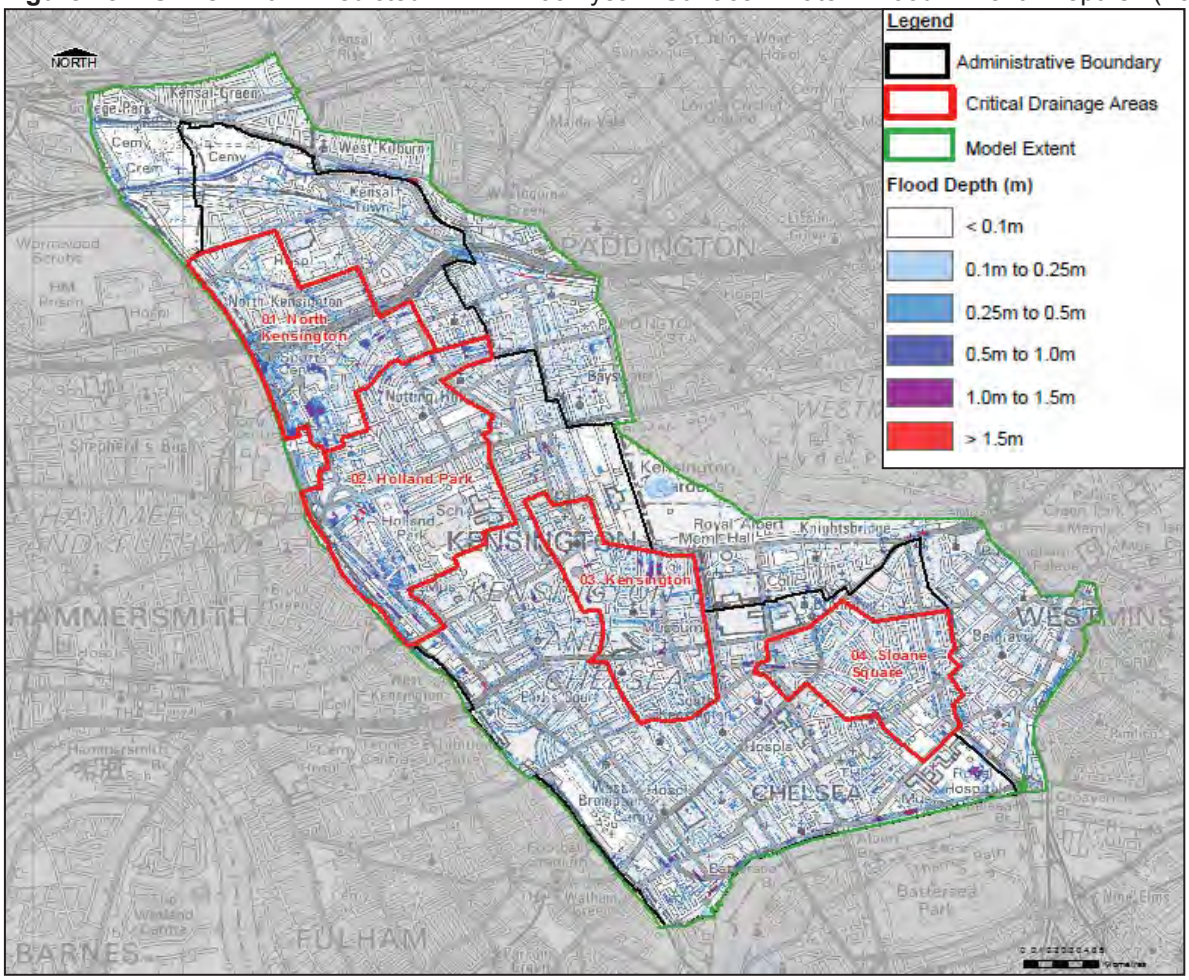
CDA 03 – Kensington Area

This CDA is located around the Kensington area of the Royal Borough. Surface water is predicted to flow generally from north to south. The pluvial modelling indicates predicted surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads and within lowered basements). The majority of areas predicted to be at risk are basement properties. The majority of the CDA is located within Flood Zone 1.

CDA 04 – Sloane Square Area

This CDA is located in the Sloane Square area of the Royal Borough. The topography in the area is generally flat with overland flow being conveyed in a north-east to south-west direction. The pluvial modelling indicates predicted surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads and within lowered basements). The majority of areas predicted to be at risk are basement properties. The majority of the CDA is located within Flood Zone 1, although there is a small area of FZ2 and FZ3 to the South.

Figure 5: CDAs with Predicted 1 in 100 year Surface Water Flood Event Depths (>0.1m)



5.8 Groundwater Flooding

Groundwater flooding is water originating from sub-surface permeable strata which emerges from the ground, either at a specific point (such as a spring) or over a wide diffuse location, and inundates low lying areas. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land.

The actual flooding can occur some distance from the emergence zone, with increased flows in local streams resulting in flooding at downstream constrictions / obstructions. This can make groundwater flooding difficult to categorise. Flooding from groundwater tends to be long in duration, developing over weeks or months and continuing for days or weeks.

There are many mechanisms associated with groundwater flooding, which are linked to high groundwater levels, and can be broadly classified as:

- Direct contribution to channel flow.
- Springs emerging at the surface.
- Inundation of drainage infrastructure.
- Inundation of low-lying property (basements).

Geology

A geological map for the study area is provided in Appendix B (Figure 13, reproduced from the British Geological Survey (BGS) 1:50,000 scale geological series. The RBKC sits primarily over the London Clay Formation in the north from Harrow Road (A404) to just north of Holland Park Secondary School, with an intrusion from the west of the Langley Silt Member from St Quintin Gardens along St Quintin Avenue to the junction with St Marks Road and down to the junction of Abbotsbury Road and Holland Park in the south.

In the immediate vicinity of Holland Park Secondary School there is an outcropping of the Boyn Hill Gravel Member, before giving way to the Lynch Hill Gravel Member to the east, and the Taplow Gravel Formation to the south. The Taplow Gravel formation extends from Abbotsbury Road to Elvaston Place. South of the Taplow Gravel Formation the remainder of the Royal Borough (South Kensington, West Brompton, Brompton and Chelsea) is underlain by the Kempton Park Gravel Formation.

Groundwater Flooding Risk Assessment

The data sources listed below have been reviewed to produce an overall interpretation of groundwater flood risk in the study area.

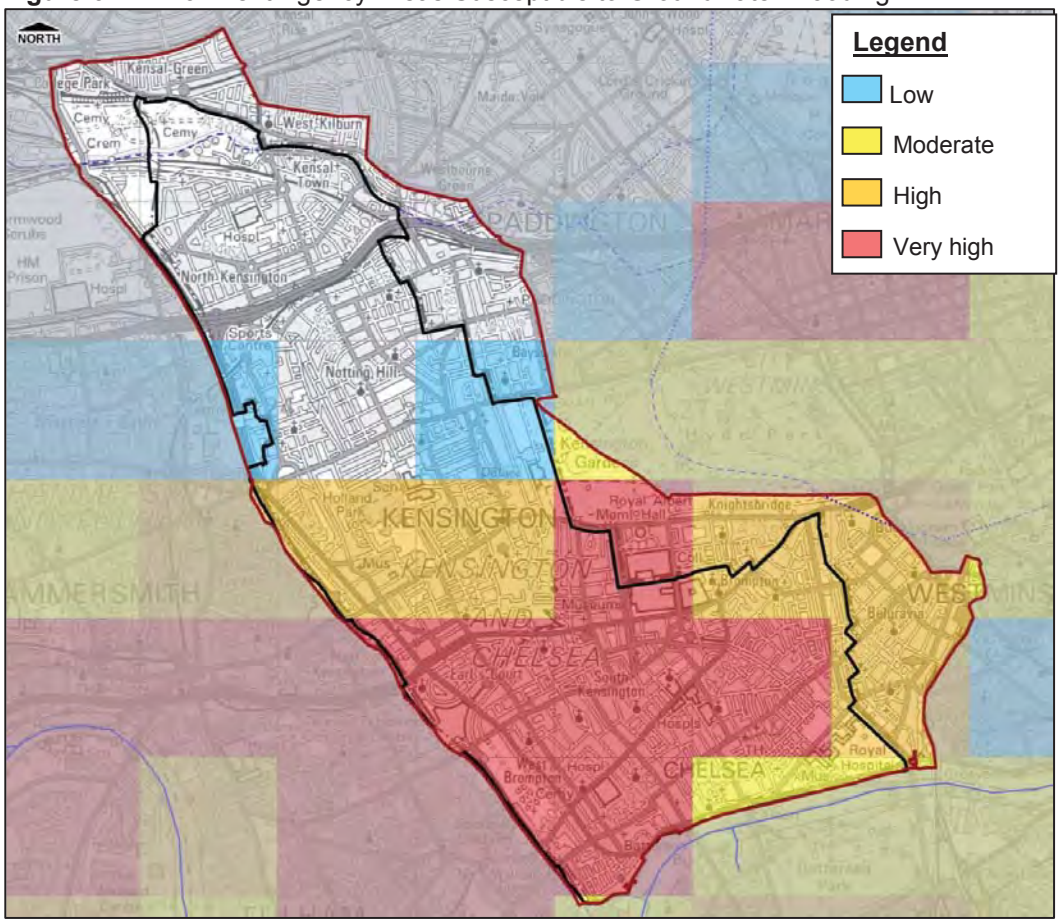
- Increased Potential for Elevated Groundwater Maps (GLA 2011).
- EA Areas Susceptible to Groundwater Flooding Map (EA 2012).

The information sources listed above were reviewed as part of this study. Table 5-5 summarises the content of each source and how it has been used within the risk assessment.

Table 5-5: Review of Available Groundwater Information

Source	Summary	Risk Assessment Application
EA Areas Susceptible to Groundwater Flooding (AStGWF) Map	This data has used the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge.	This provides an overview of proportional area that is at high or very high risk of groundwater flooding. The categories are as follows: <25% (low) ≥25%<50%(moderate) ≥ 50% <75% (high) >=75% (very high)
EA Groundwater Flooding Database	Use of records provided within the Draft Tier 2 SWMP (2011).	Review of predicted and known groundwater risk locations

Figure 6: Environment Agency Areas Susceptible to Groundwater Flooding



A review of the Environment Agency Areas Susceptible to Groundwater Flooding (AStGWF) map highlights that the southern half of the study are highly susceptible to groundwater flooding. This 'very high' – 'high' area of risk correlates well with the known areas that have experienced groundwater flooding (refer to Figure 7) for the groundwater flooding records provided for the Drain London Tier 2 SWMP).

The latest dataset for assessing groundwater flood risk in the study is predominantly the Environment Agency Areas Susceptible to Groundwater Flooding map. This map uses underlying geological information to infer groundwater flood susceptibility. If more detailed data relating to the risk of groundwater flooding is required, it is recommended that the reader contact the British Geological Society in order to obtain the Groundwater Flooding Susceptibility Maps. This data covers consolidated aquifers (chalk, sandstone etc., termed 'clearwater' in the data attributes) and superficial deposits. It does not take account of the chance of flooding from groundwater rebound and classify the susceptibility into the following categories; very low, low, moderate, high and very high and is not restricted to identifying the risk with 1km square grids.

Potential for Elevated Groundwater

Large areas within the Drain London area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface. The mapping technique used aims to identify only those areas in which there is the greatest potential for this to happen and in which there is the highest possible confidence in the assessment.

The following four data sources have been utilised to produce the increased Potential for Elevated Groundwater map which was created as part of the Drain London Tier 2 project (reproduced within Figure 7 overleaf)

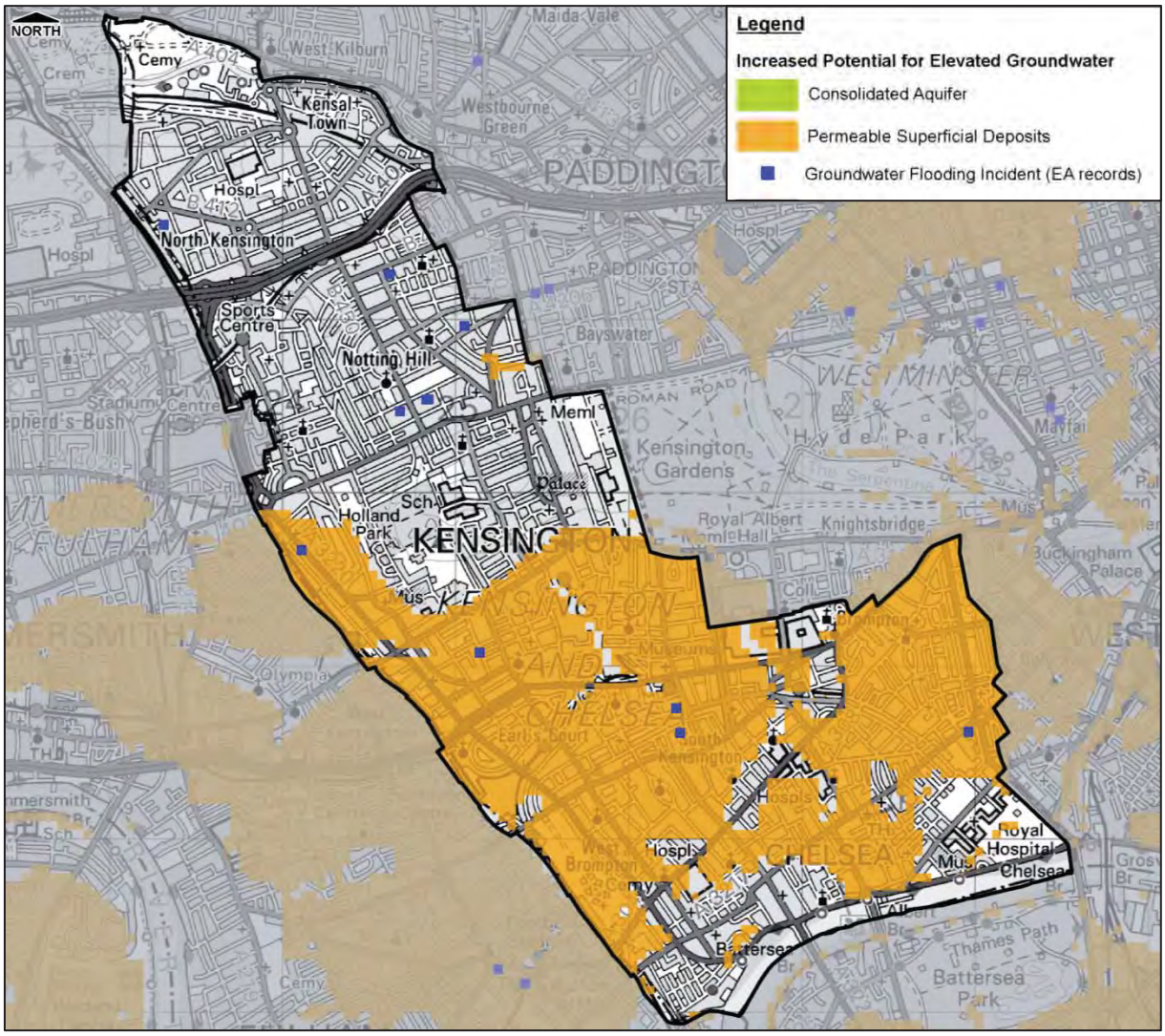
- British Geological Survey (BGS) Groundwater Flood Susceptibility Map.
- Jacobs Groundwater Emergence Maps (GEMs).
- Jeremy Benn Associates (JBA) Groundwater Flood Map.
- Environment Agency/Jacobs Thames Estuary 2100 (TE2100) groundwater hazard maps.

The increased Potential for Elevated Groundwater map shows those areas within the Royal Borough where there is an increased potential for groundwater to rise sufficiently to interact with the ground surface or be within 2m of the ground surface.

This mapping indicates that elevated groundwater from permeable superficial soils are located from the northern end of the A3220 (Holland Road) to the boundary with Hammersmith and Fulham in the west and Addison Road to the east. Proceeding south until Addison Road meets Kensington High Street the area affected extends across the entire Borough from West Brompton to Brompton and down into Chelsea. The area south of West Brompton surrounding Battersea is not affected and neither is the area around the Royal Hospital (Chelsea).

In areas with an increased potential for groundwater, basements of buildings below ground level, buried surfaces and other assets held below ground level are vulnerable to flooding from groundwater. This can also lead to inundation of roads, commercial, residential and amenity areas as well as flooding of ground floors of buildings above ground level and overflowing of sewers and drain.

Figure 7: Increased Potential for Elevated Groundwater



Infiltration SuDS

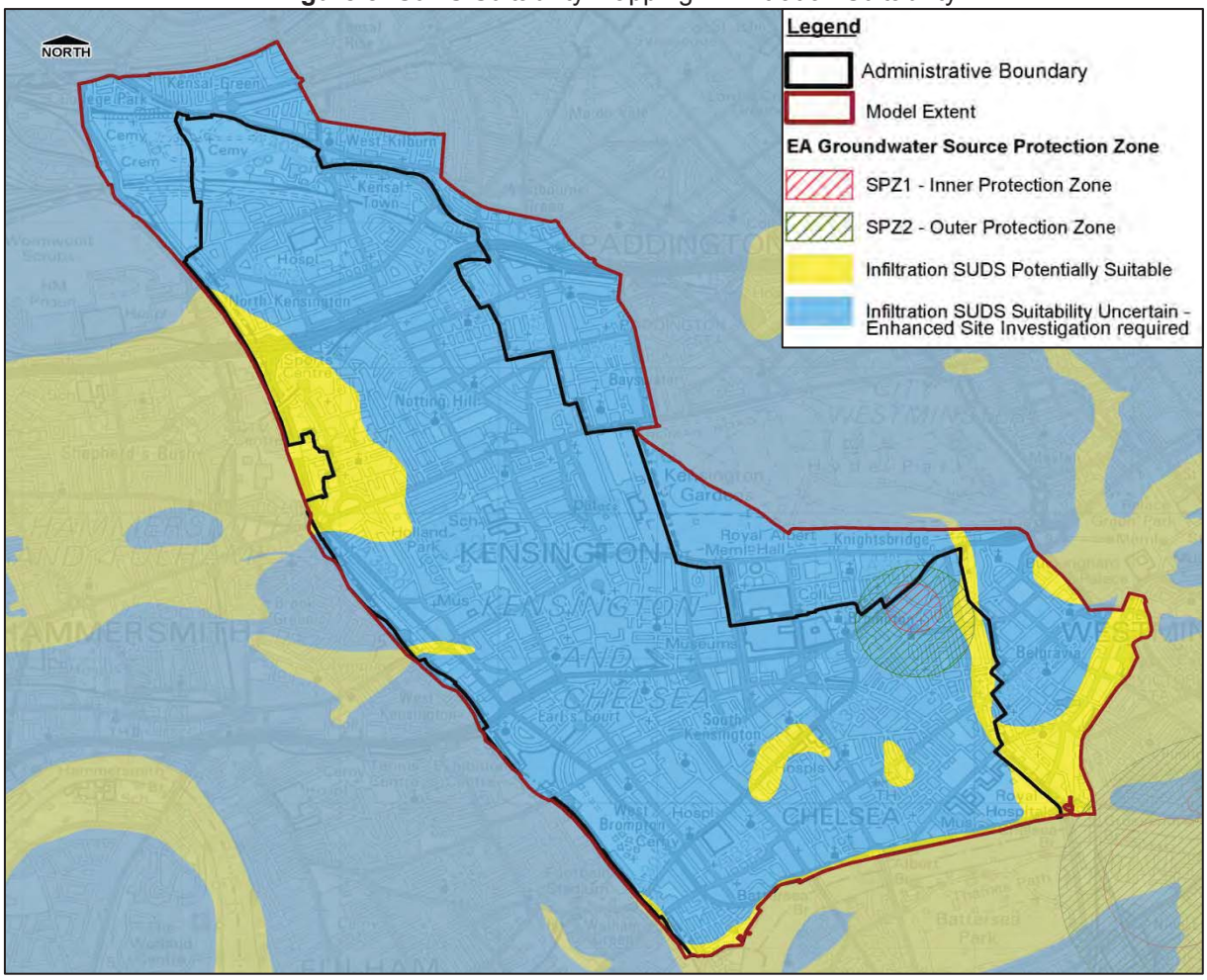
Improper use of infiltration SuDS could lead to contamination of the superficial deposit or bedrock aquifers, leading to deterioration in aquifer quality status or groundwater flooding / drainage issues. However, correct use of infiltration SuDS is likely to help improve aquifer quality status and reduce overall flood risk.

The Environment Agency provides guidance on infiltration SuDS at the following website: http://www.environment-agency.gov.uk/business/sectors/36998.aspx. These documents should be considered by developers and their contractors, and by the Councils when approving or rejecting planning applications. Other reference materials for the UK can be located on the CIRIA website http://www.ciria.org, www.wsud.co.uk and the professional community website http://www.susdrain.org/resources/ which provides resource links and SuDS case studies.

RBKC also has a tool for assisting small developments (up to a maximum of 10 dwellings or 1,000m² of non-residential property) with determining suitable SuDS measures that can assist with managing runoff volumes discharging from the site. The website for accessing this toolkit is http://www.rbkc.gov.uk/planningandconservation/planningpolicy/sudstool-smalldevelopment.aspx.

The areas that may be suitable for infiltration SuDS exist where there is a combination of high ground and permeable geology. However, consideration should be given to the impact of increased infiltration SuDS on properties further down gradient. An increase in infiltration and groundwater recharge will lead to an increase in groundwater levels, thereby increasing the susceptibility to groundwater flooding at a down gradient location. This type of analysis is beyond the scope of the current report, but it could be as significant problem where there is potential for perched water tables to develop. Figure 8 provides the summary outputs of the Infiltration SuDS Map across the Borough.

Figure 8: SuDS Suitability Mapping – Infiltration Suitability



Due to the underlying geology the suitability for incorporating infiltration SuDS measures is largely uncertain and developers will need to undertake infiltration tests to confirm the suitability of utilising these SuDS measures.

Source protection zones (SPZs) should be considered when applying mitigation measures, such as SuDS, which have the potential to contaminate the underlying aquifer if this is not considered adequately in the design. Generally, it will not be acceptable to use infiltrating SuDS in an SPZ 1 if the drainage catchment comprises trafficked surfaces or other areas with a high risk of contamination. Restrictions on the use of infiltration SuDS apply to those areas within an SPZ. Developers must ensure that their proposed drainage designs comply with the available Environment Agency guidance.

Grand Union Canal

The Grand Union Canal travels across the north of the Borough, along its length there are a few embanked (raised above local ground level) parts, however most of the canal follows the land contour and thus there are very few places where failure of the canal bank is a risk to the Borough. Figure 1 (Appendix B) shows the location of the canal within the Borough. It is more likely that the canal will act as a conveyor of flow in an extreme event, and it is likely to convey flow out of the Borough due to the topography.

Unfortunately there is no further information available on the probability of canal breach. Without this information and adequate ground data we are unable to make further investigation into the few places where the canal could fail.

The Serpentine

The Serpentine Lake in Hyde Park in the Borough of Westminster was created by damming the River Westbourne in 1730. Subsequently, there is a potential risk of dam failure for the Serpentine dam at the east end of the impoundment. Large raised dams containing more than 25,000m3 are subject however to stringent safety measures under the Reservoirs Act and the probability of the dam overtopping and breaching may be seen as unlikely and with less than a 1:10,000 chance of occurring.

Unfortunately, there is no further information available to assess risk from the Serpentine therefore it could not be further investigated. Appendix B (Figure 1) shows the location of the Serpentine.

Flood Risk from areas outside the Borough

There is a possible flood risk from Hammersmith and Fulham as a result of flood waters travelling along the tube network into Earls Court Station and from there entering the tube network within the Borough. It is unlikely the waters would be deep enough to emerge from the tube network to the streets of the Borough; nevertheless the disruption of the tube network within the Borough would be significant.

The possible flood risk arising from the City of Westminster is the Serpentine as mentioned above. Failures of the defences along the Thames at its frontage in Westminster are unlikely to travel into the Borough.

Due to the topography of the area the Borough is also at risk of receiving surface runoff from the neighbouring Borough of Hammersmith and Fulham, Brent and Westminster.

Flood Risk to areas outside the Borough

Failures of the defences along the Thames at its frontage with Kensington and Chelsea are unlikely to be conveyed into the neighbouring Borough. However, surface water runoff from Kensington and Chelsea could cross the border with Hammersmith and Fulham, and the border with the City of Westminster.

5.9 Critical Infrastructure at Risk of Flooding

Critical infrastructure is infrastructure which would be critical in the event of an emergency. Figure 6 (Appendix B) highlights the location of the critical infrastructure at risk of flooding within the Borough. Critical Infrastructure at flood risk includes tube stations and main roads (including the A3212).

6. Proposed Development Sites

The following section provides a summary of the flood risk to seven strategic development sites as defined with The RBKC Core Strategy (2010). The assessment considers flood risk from all sources based on the strategic scale information collated for this SFRA. The types of measures potentially required to manage flood risk on each site are also identified.

This assessment does not remove the need for planning applications to be supported by a detailed flood risk assessment. The flood risk management measures identified are a guide only. As stated in Chapter 2, it is recommended that developers consult with the Environment Agency, RBKC, Thames Water and the Rivers and Canal Trust (where required) early in the development of site proposals to agree appropriate measures, informed by more detailed analysis where necessary.

Table **6-1** provides a summary of the seven strategic sites included in the assessment and the site locations are shown in Figure 9. The assessment of each site identifies:

The site location and broad development proposals;

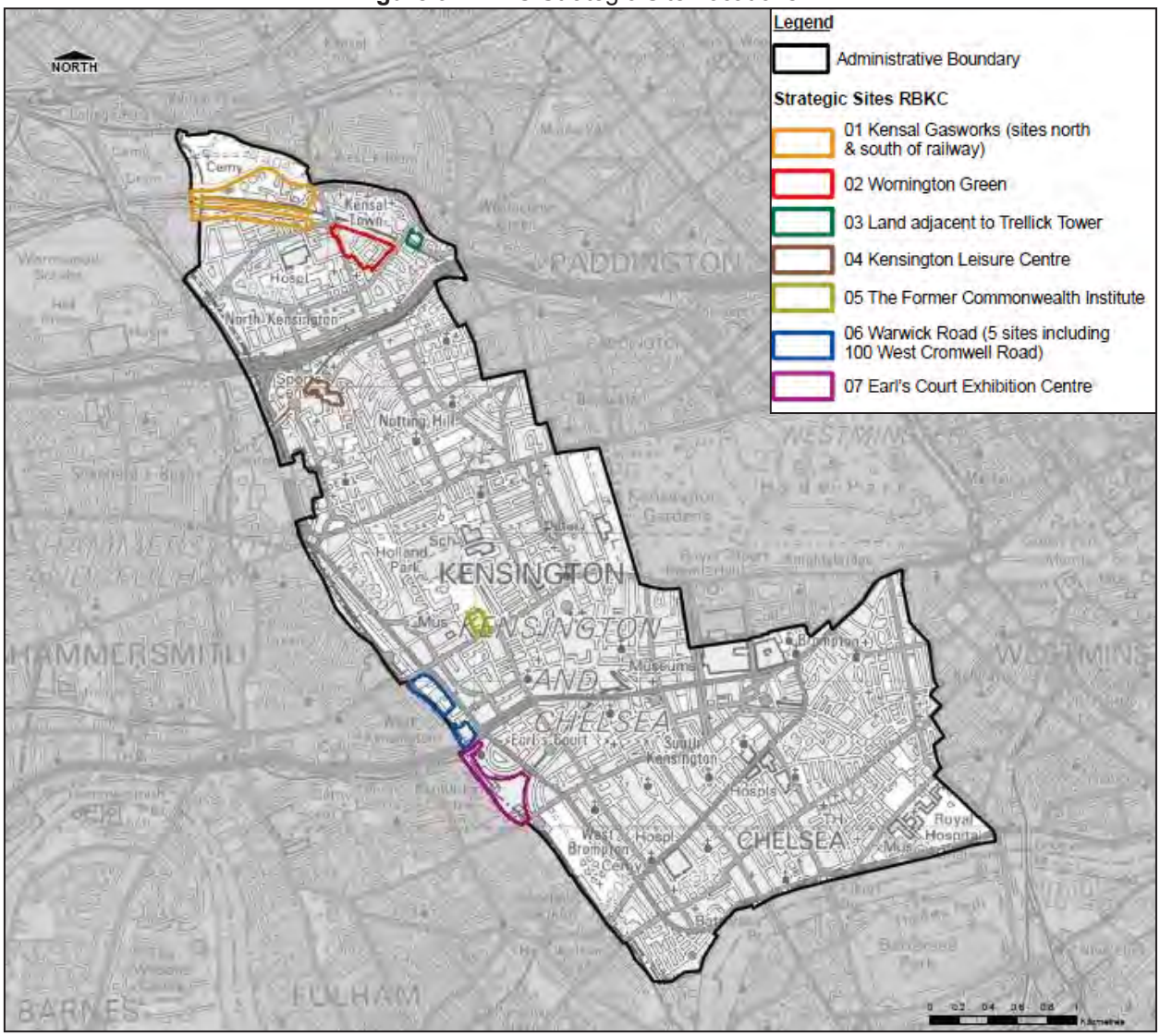
- The site location and broad development proposals.
- Risk Assessment – an assessment of flood risk from all sources, for the lifetime of the development.
- Risk Management – an identification of the potential measures to manage flood risk on site.
- Exception Test Summary – will development increase flood risk, and can it reduce flood risk overall?

Table 6-1: Categorisation of RBKC Sites in Accordance with NPPF

Site Reference	Development Site	Area (ha)	Flood Zone	Residual Risk	FRA Required
01	Kensal Gasworks (sites north & south of railway)	18	1	Low	Yes
02	Wornington Green	6.4	1	Low	Yes
03	Land adjacent to Trellick Tower	0.8	1	Low	Recommended to consider surface water flooding at the site and the management of surface water.
04	Kensington Leisure Centre	2.1	1	Low	Yes
05	The Former Commonwealth Institute	1.4	1	Low	Yes
06	Warwick Road (5 sites including 100 West Cromwell Road)	5.6	1	Low	Yes
07	Earl's Court Exhibition Centre	7.9	3	Low	Yes

Detailed site analysis is located within Appendix C.

Figure 9: RBKC Strategic Site Locations



7. Conclusion and Recommendations

The SFRA has identified that the significant sources of flood risk within Royal Borough of Kensington and Chelsea (RBKC) are surface water and sewer flooding, and the residual risk which arises from a possible failure in the Thames tidal defences.

Tidal flood risk is limited to the southern portion of the Borough, but at present Kensington and Chelsea is fully defended against the 0.1% annual probability extreme tide level. Nevertheless, the areas benefiting from these tidal defences have the potential to experience high hazard should a breach occur. Although a breach in the defences is not expected this is a possibility that needs to be taken into account in planning and areas of higher risk have been defined and mapped.

The Environment Agency released the Thames Estuary 2100 (TE2100) Plan in November 2012. The document sets out the Environment Agency's recommendations for flood risk management for London and the Thames Estuary through to the end of century and beyond. The Plan puts the need for climate change adaptation at its core. It primarily looks at tidal flooding though other sources of flooding including high river flows as a result of heavy rainfall and surface water flooding are also considered.

It is thought most unlikely that the Thames Barrier should fail to close during a significant tidal surge in the North Sea, but should this occur then the impacts of overtopping have been discussed and the risks have been concluded to be low based on the information provided by the Environment Agency (TE2100 information) relating to the necessary increase in flood defence elevations being identified. If these defences are not raised to the identified levels, then there is a sever risk of overtopping flooding to RBKC.

In the future, with sea level rise and climate change, the Environment Agency studies predict an increase in levels within the Borough. These impacts will be limited based on the works proposed as part of TE2100, but an analysis of the impact of these breaches has been undertaken within the Borough. These results indicate a significant increase in residual risk within (both depth and hazard) as a result of the predicated climate change levels and should be considered within any future development applications.

The SFRA has fully assessed the extent and variation of the residual risk remaining behind defences within the Borough. Maps and GIS layers have been provided with the report showing the areas suffering residual risk and their classification.

Sewer and surface water flooding is particularly problematic, with the Borough experiencing significant problems historically and during the heavy rainfall events of 20th July 2007. It is recognised that this is a larger scale issue and it is recommended that RBKC Council continues it an active role in future strategic surface water management plans for London in liaison with the Greater London Authority and Thames Water. This can now be supported by the results of the SWMP. The historic surface water and sewer flooding highlight the risk posed to the Borough. Future climate change predictions imply that this type of flooding is/will be becoming more frequent, therefore the Council needs to plan for future emergencies, become proactive in mitigating against the risk, and provide guidance to residents on how they too can mitigate against the impacts of this type of flooding.

Guidance has been given for the LPA on what types of development are suitable in each of these Flood Zones according to NPPF. The proposed development sites in the Borough has been categorised in order to allow the council to apply the Sequential Test.