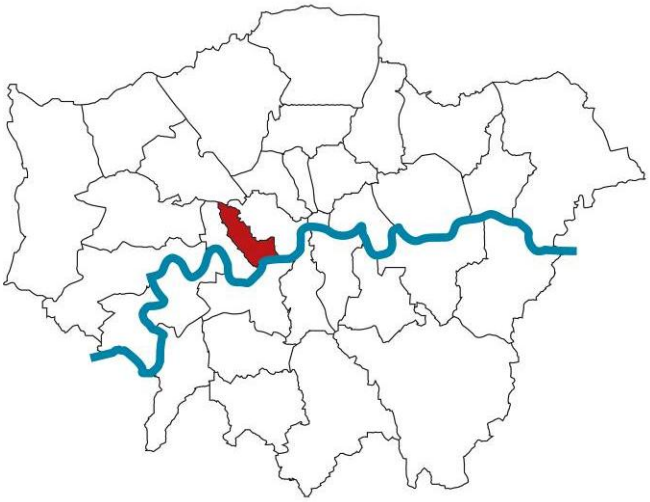
The Royal Borough of Kensington and Chelsea Surface Water Management Plan



Final Draft Report
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Prepared for

THE ROYAL BOROUGH OF
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APPROVALS

Name	Title	Signature	Date

RELATED DOCUMENTS

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	Preliminary Flood Risk Assessment for the Royal Borough of Kensington & Chelsea	Halcrow	2011	0.6
	Surface Water Management Plan for Royal Borough of Kensington & Chelsea	Halcrow	2011	0.10

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- Environment Agency;
- Thames Water;
- British Geological Survey;
- Transport for London; and
- Network Rail.

Executive Summary

This document forms the Surface Water Management Plan (SWMP) for the Royal Borough of Kensington and Chelsea (RBKC). The study is an update to the Drain London Tier 2 SWMP, completed in 2011. The report outlines the predicted risk and preferred surface water management strategy for the Royal Borough. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches[1] that occurs as a result of heavy rainfall.

A four phase approach has been undertaken in line with Defra's SWMP technical guidance documentation (2010). These are:

Phase 1 – Preparation;
Phase 2 – Risk Assessment;
Phase 3 – Options; and
Phase 4 – Implementation and Review.

Phase 1: Preparation

Phase 1 work involved the collection and review of surface water information and the building of partnerships between key stakeholders responsible for local flood risk management. RBKC continue to work with these partners and stakeholders to share best practice and resources to deliver their responsibilities as Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (FWMA) 2010.

Phase 2: Risk Assessment

As part of the Phase 2 Risk Assessment, direct rainfall modelling was undertaken across the study area for nine rainfall event return periods. The results of this modelling have been used to identify Local Flood Risk Zones (LFRZs) where surface water flooding affects properties, businesses and/or infrastructure. Those areas identified to be at more significant risk have been delineated into Critical Drainage Areas (CDAs) representing one or more LFRZs as well as the contributing catchment area and features that influence the predicted flood extent.

Within the study area, four (4) CDAs have been identified and are presented in the figure overleaf. The dominant mechanisms for flooding can be broadly divided into the following categories:

- Topographical low lying areas - are more susceptible to surface water flooding particularly where obstructions impede flow;
- Topographical low points – areas which are at topographical low points throughout the Royal Borough (predominantly from basement properties) which result in small, discrete areas of deep surface water ponding;
- Sewer flood risk – areas where extensive and deep surface water flooding is likely to be the influence of sewer flooding mechanisms alongside pluvial and groundwater sources; and
- Fluvial / tidal flood risk - areas where extensive and deep surface water flooding is likely to be the influence of fluvial and tidal flooding mechanisms (alongside pluvial, groundwater and sewer flooding sources).

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

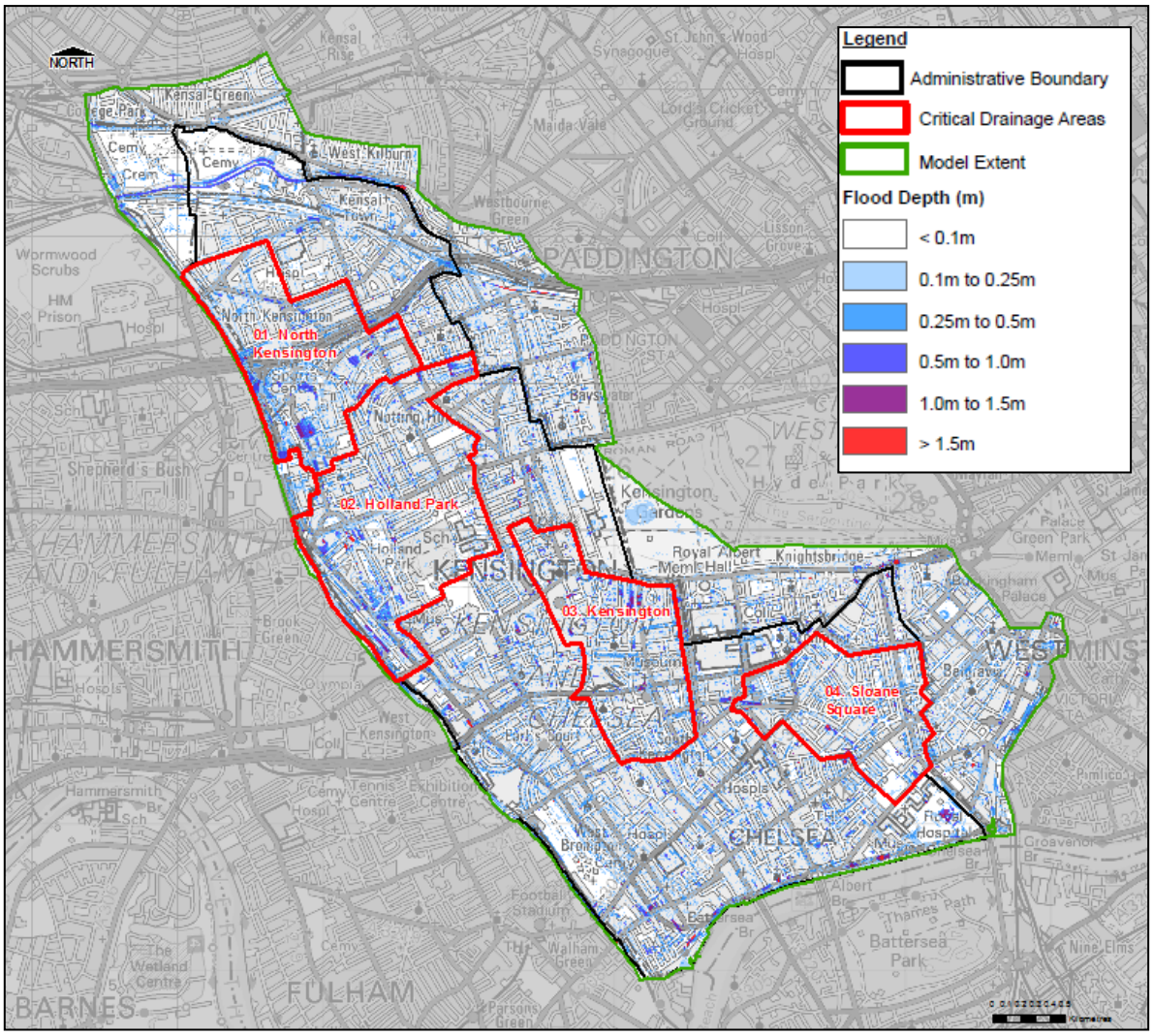


Figure i: Critical Drainage Areas with Predicted 1 in 100 year Surface Water Flood Event Depths (>0.1m)

Analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a 1 in 100 probability of occurrence in any given year. 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 (above an assumed 0.1m building threshold), refer to Table i below.

Table i. 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**

Phase 3: Options Assessment

There are a number of opportunities across the catchment to reduce the impact of surface water flooding. Ongoing maintenance of the drainage network and small scale improvements are already undertaken as part of normal operation within the study area.

It is important to recognise that flooding within the catchment is not confined to the CDAs. There are opportunities for generic measures to be implemented through the establishment of a policy position on issues including the widespread use of water conservation measures such as water butts and rainwater harvesting technology, use of swales, permeable paving, bioretention car park pods and green roofs. In addition, there are study area wide opportunities to raise community awareness.

For each of the CDAs within the study area, site-specific measures have been identified that could be considered to help reduce the risk of surface water flooding. These measures are subsequently short listed to identify a potential preferred option for each CDA.

Pluvial modelling undertaken as part of the SWMP has identified that flooding is heavily influenced by the generally flat topography. The extensive coverage of basement developments increases flood risk in the area. It is recommended that in the short to medium term RBKC take the following actions:

- Basement properties include suitable pumping devices to protect them from sewer flooding;
- A Flooding Steering Group was set up in 2011. The Council should continue to engage with residents regarding the flood risk in their areas, to make them aware of their responsibilities for property drainage (especially in the CDAs) and steps that can be taken to improve flood resilience;
- Continue providing information to residents to inform them of measures that can be taken to mitigate surface water flooding to/around their property. Information can be accessed through the following webpage: http://www.rbkc.gov.uk/planningandconservation/planningpolicy/floodingissues.aspx;
- Prepare and implement a communication strategy to raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public;
- Promote the use of SuDS features within council assets (roads, parks, footpaths) and private property (car parking areas, private parks, etc.); and
- Improve maintenance regimes to target those areas identified to flood regularly or known to have blocked gullies or are prone to damage.

Phase 4 Implementation & Review

Phase 4 establishes a long-term Action Plan for RBKC and other Risk Management Authorities to assist in their roles under the Flood and Water Management Act 2010 (FWMA 2010) to lead in the management of surface water flood risk across the catchment. The purpose of the Action Plan is to:

- Outline the actions required to implement the preferred options identified in Phase 3;
- Identify the partners or stakeholders responsible for implementing the action;
- Provide an indication of the priority of the actions and a timescale for delivery; and
- Outline actions required to meet the requirements of RBKC and other Risk Management Authorities under the FWMA 2010.

The SWMP Action Plan is a 'living' document, and as such, should be reviewed and updated regularly, particularly following the occurrence of a surface water flood event, when additional data or modelling becomes available, following the outcome of investment decisions by partners and following any additional major development or changes in the catchment which may influence the surface water flood risk within the Borough.

Glossary

Term	Definition
AEP	Annual Exceedance Probability: the probability of a flood of a given size occurring in any one year, expressed as a percentage. For example, a flood with a return period of 100 years has an AEP of 1%, which means that there is a 1% probability (i.e. a 1 in 100 probability) of a storm of that magnitude occurring in any one year.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan, see below
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStGWF	Areas Susceptible to Groundwater Flooding. A national data set held by the Environment Agency identifying the risk of groundwater emergence within an area.
AStSWF	Areas Susceptible to Surface Water Flooding. A national data set held by the Environment Agency and based on high level modelling which shows areas potentially at risk of surface water flooding.
Bank Full	The flow stage of a watercourse in which the stream completely fills its channel and the elevation of the water surface coincides with the top of the watercourses banks.
Catchment Flood Management Plan (CFMP)	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CDA	Critical Drainage Area, see below.
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan, see entry above
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This UK Parliamentary Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums have a duty to put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Government Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model: a topographic model consisting of terrain elevations for ground positions at regularly spaced horizontal intervals. DEM is often used as a global term to describe DSMs (Digital Surface Model) and DTMs (Digital Terrain Models).
Dendritic	Irregular stream branching, with tributaries joining the main stream at all angles e.g. drainage networks converge into larger trunk sewers and finally one outfall.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are ‘at risk’ of sewer flooding more frequently than once in 20 years.
DSM	Digital Surface Model: a topographic model of the bare earth/underlying terrain of the earth’s surface including objects such as vegetation and buildings.

Term	Definition
DTM	Digital Terrain Model: a topographic model of the bare earth/underlying terrain of the earth's surface excluding objects such as vegetation and buildings. DTMs are usually derived from DSMs.
EA	Environment Agency, Government Agency reporting to Defra charged with protecting the Environment and managing flood risk in England.
RBKC	The Royal Borough of Kensington and Chelsea. The Lead Local Flood Authority in the area.
FCERM	Flood and Coastal Erosion Risk Management Strategy. Prepared by the Environment Agency in partnership with Defra. The strategy is required under the Flood and Water Management Act 2010 and will describe what needs to be done by all involved in flood and coastal risk management to reduce the risk of flooding and coastal erosion, and to manage its consequences.
FLIP	Flooding Local Improvement Projects. Non-return valves and pump devices installed to prevent sewage 'back-surging' into basements in times of heavy rain and allow the property's sewage to flow properly into the sewer network.
Flood defence	Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	See entry under Indicative Flood Risk Areas.
Flood Risk Regulations	Transposition of the EU Floods Directive 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.
Flood and Water Management Act	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 aim of which is to clarify the legislative framework for managing surface water flood risk in England. The Act was passed in 2010 and is currently being enacted.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a watercourse (river or stream). In this report the term Fluvial Flooding generally refers to flooding from Main Rivers (see later definition).
FMfSW	Flood Map for Surface Water. A national data set held by the Environment Agency showing areas where surface water would be expected to flow or pond, as a result of two different chances of rainfall event, the 1 in 30yr and 1 in 200yr events.
FRR	Flood Risk Regulations, see above.
Hyetograph	A graphical representation of the variation of rainfall depth or intensity with time.
IDB	Internal Drainage Board, see below.
Internal Drainage Boards	Internal Drainage Board. An independent body with powers and duties for land drainage and flood control within a specific geographical area, usually an area reliant on active pumping of water for its drainage.
Indicative Flood Risk Areas	Areas determined by the Environment Agency as potentially having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
IUD	Integrated Urban Drainage, a concept which aims to integrate different methods and techniques, including sustainable drainage, to effectively manage surface water within the urban environment.
LDF	Local Development Framework is the spatial planning strategy introduced in England and Wales by the Planning and Compulsory Purchase Act 2004 and given detail in Planning Policy Statements 12. These documents typically set out a framework for future development and redevelopment within a local planning authority.

Term	Definition
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 Act.
LFRZ	Local Flood Risk Zone, see below.
Local Flood Risk Zone	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location
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, see above.
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner and respond in an emergency. Roles and Responsibilities are defined under the Civil Contingencies Act.
LPA	Local Planning Authority, see below.
Local Planning Authority	The local authority or Council that is empowered by law to exercise planning functions for a particular area. This is typically the local borough or district Council.
LRF	Local Resilience Forum, see above.
Main River	Main rivers are a statutory type of watercourse in England and Wales, usually larger streams and rivers, but also include some smaller watercourses. A main river is defined as a watercourse marked as such on a main river map, and 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.
NPPF	National Planning Policy Framework (replaces PPS25)
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency. A receptor could include essential infrastructure such as power infrastructure and vulnerable property such as schools and health clinics.
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.
PA	Policy Area, see below.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment, see below.
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
NPPF	National Planning Policy Framework
Preliminary Flood Risk Assessment	Assessment required by the EU Floods Directive which summarises flood risk in a geographical area. Led by LLFAs.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.

Term	Definition
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Return Period	The return period is defined as the average period of time expected to elapse between occurrences of events at a certain location. This measure is used to define the magnitude of rainfall events. The longer the return period, the greater the magnitude of the rainfall event.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, combined with the consequence of the flood.
Risk Management Authority	As defined by the Floods and Water Management Act. These can be (a) the Environment Agency, (b) a lead local flood authority, (c) a district council for an area for which there is no unitary authority, (d) an internal drainage board, (e) a water company, and (f) a highway authority.
RMA	Risk Management Authority, see above
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment, see below
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
Strategic Flood Risk Assessment	SFRAs (SFCAs in Wales) are prepared by local planning authorities (in consultation with the Environment Agency) to help guide local planning. They allow them to understand the local risk of flooding from all sources (including surface water and groundwater). They include analysis and maps of the impact of climate change on the extent of future floods. You can find these documents on the website of your local planning authority.
SuDS	Sustainable Drainage Systems, see below.
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques. Includes swales, wetlands, bioretention devices and ponds.
Surface water runoff	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
Thames Water	Thames Water Utilities Ltd: the water company providing clean water and sewerage services for this area.
UKCIP	The UK Climate Impacts Programme. Established in 1997 to assist in the co-ordination of research into the impacts of climate change. UKCIP publishes climate change information on behalf of the UK Government and is largely funded by Defra.
WaSC	Water and Sewerage Company
Water Cycle Strategy / Study	A method for determining what sustainable water infrastructure is required and where and when it is needed; based on a risk based approach ensuring that town and country planning makes best use of environmental capacity and opportunities, and adapts to environmental constraints.
WCS	Water Cycle Strategy or Study (see above)

Abbreviations

Term	Definition
AEP	Annual Exceedance Probability
AMP	Asset Management Plan
AStGWF	Areas Susceptible to Ground Water Flooding
AStSWF	Areas Susceptible to Surface Water Flooding
BGS	British Geological Survey
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
CLG	Government Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EA	Environment Agency
FGS	Flood Guidance Statement
FLIP	Flooding Local Improvement Projects
FMfSW	Flood Map for Surface Water
FRR	Flood Risk Regulations
FWMA	Flood and Water Management Act 2010
IUD	Integrated Urban Drainage
LFRZ	Local Flood Risk Zone
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
NPPF	National Planning Policy Framework
NRD	National Receptor Dataset
PFRA	Preliminary Flood Risk Assessment
NPPF	National Planning Policy Framework
RBKC	The Royal Borough of Kensington and Chelsea
RMA	Risk Management Authority (as defined by the Flood and Water Management Act)
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TfL	Transport for London

Table of Contents

1 Introduction

Capita has been commissioned by the Royal Borough of Kensington and Chelsea (hereinafter referred to as the Royal Borough or RBKC) to prepare an updated Surface Water Management Plan (SWMP) which covers Phases 1, 2, 3 and 4 of the Defra guidance.

1.1 What is a Surface Water Management Plan?

A Surface Water Management Plan (SWMP) is a plan produced by the Lead Local Flood Authority (LLFA), in this case the Royal Borough, which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches[2] that occurs as a result of heavy rainfall.

This SWMP study has been undertaken in partnership with key local stakeholders who are responsible for surface water management and drainage in the Royal Borough – including Thames Water (TW) and the Environment Agency (EA). The Partners have worked together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.

This document also establishes a long-term action plan to manage surface water and will influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments

1.2 Background

In May 2007 the Mayor of London consulted on a draft Regional Flood Risk Appraisal (RFRA). One of the key conclusions was that the threat of surface water flooding in London was poorly understood. This was primarily because there were relatively few records of surface water flooding and those that did exist were neither comprehensive nor consistent. Furthermore the responsibility for managing flood risk was split between the local planning authorities and other organisations such as Transport for London, London Underground and Network Rail. Relationships with the Environment Agency and Thames Water and other flood risk management agencies were unclear. To give the issue even greater urgency it is widely expected that heavy storms will increase in frequency with climate change.

The Greater London Authority, London Councils, Environment Agency and Thames Water commissioned a scoping study to test these findings and found that this was an accurate reflection of the situation. The conclusions were brought into sharp focus later in the summer of 2007 when heavy rainfall resulted in extensive surface water flooding in parts of the UK such as Gloucestershire, Sheffield and Hull causing considerable damage and disruption. It was clear that a similar rainfall event in London would have resulted in major disruption. The Pitt Review examined the flooding of 2007 and made a range of recommendations for future flood management, most of these have been enacted through the Flood and Water Management Act 2010 (FWMA). Defra recognised the importance of addressing surface water flooding in London and fully funded the Drain London project. A draft SWMP was prepared for RBKC as part of Drain London Tier 2 in 2011. This report aims to update the previous Drain London Tier 2 SWMP with more detailed hydraulic modelling results and review the surface water flood risk to RBKC.

[2] [2] Please note: There are no small watercourses or ditches within The Royal Borough of Kensington and Chelsea.

As part of the duties created by the Flood and Water Management Act 2010, local authorities are responsible for the management of local flood risk – including surface water and groundwater. RBKC is a second tier local authority responsible for delivering the Lead Local Flood Authority (LLFA) requirements of the FWMA in the Royal Borough.

As it has been previously identified that the Royal Borough is susceptible to surface water flooding, this updated SWMP will provide a basis for more effective management of surface water within it and the risk of flooding from it.

1.3 SWMP Process

The Defra SWMP Technical Guidance (2010) provides the framework for preparing SWMPs. This report has been prepared to reflect the four principal stages identified by the guidance (refer overleaf):

1. Preparation: Identify the need for a SWMP, establish a partnership with the relevant stakeholders and scope SWMP (refer to Section 2);
2. Risk Assessment: Select an appropriate level risk assessment and complete it – a Level 2 Intermediate assessment was selected for this study (refer to Sections 3 and 4);
3. Options: Identify options/measures (with stakeholder engagement) which seek to alleviate the surface water flood risk within the study area (refer to Section 5); and
4. Implementation and Review: Prepare Action Plan and implement the monitoring and review process for these actions (refer to Section 8).

The scope of this study includes elements of all phases of the process. These phases and their key components are illustrated in Figure 1-1 and summarised in Figure 1-2.

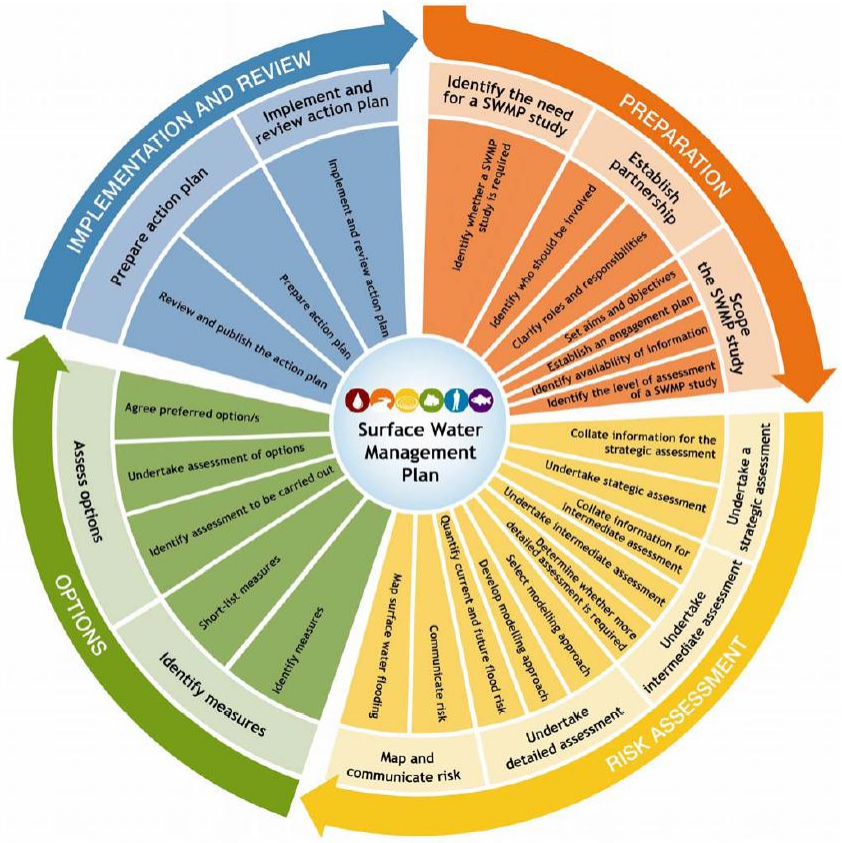


Figure 1-1 Recommended Defra SWMP Process (Defra 2010)

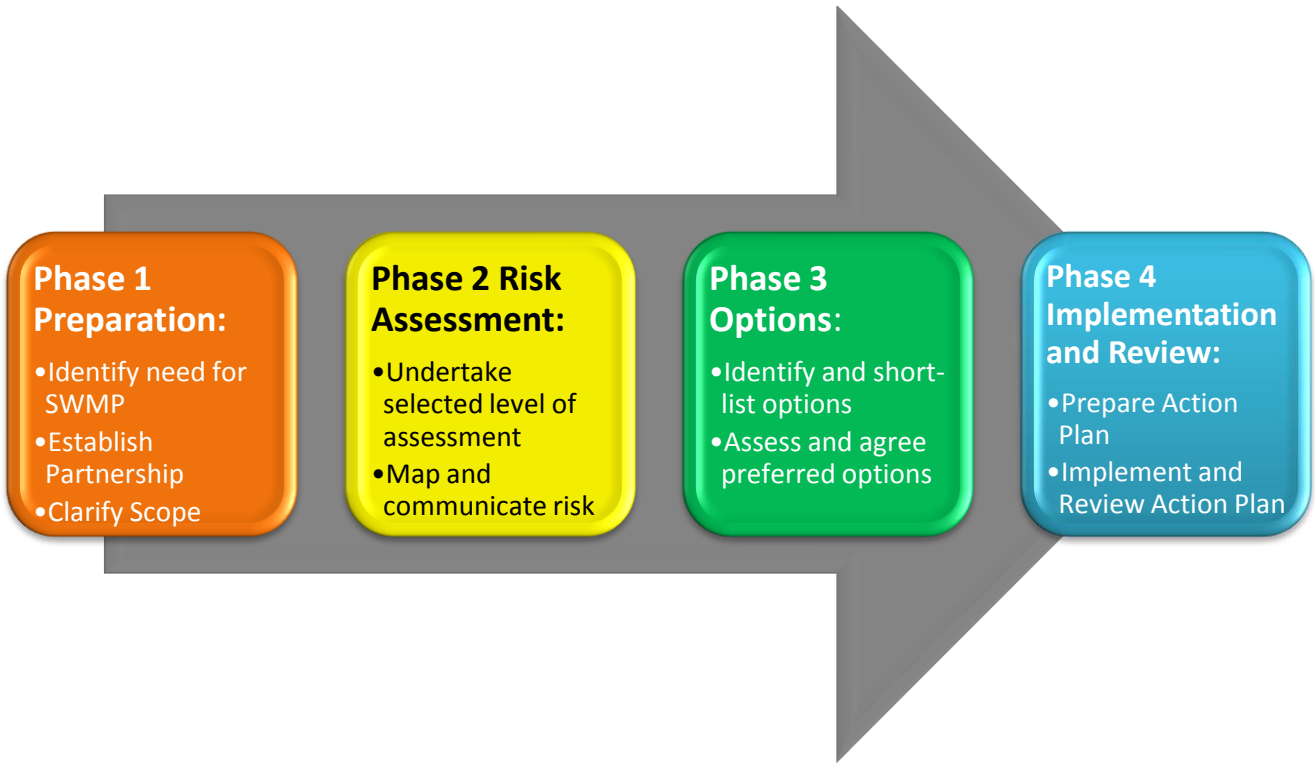


Figure 1-2 Summary of the Defra SWMP Phases

1.4 Objectives

The objectives of the SWMP are to:

- Review the Drain London Tier 2 SWMP and develop a thorough understanding of the surface water flood risk in and around the study area, taking into account the implications of climate change, population and demographic change and increasing urbanisation in and around RBKC;
- Identify, define and prioritise Critical Drainage Areas, including further definition of existing local flood risk zones and mapping new areas of potential flood risk;
- Make recommendations for holistic and integrated management of surface water management which improve emergency and land use planning, and support better flood risk and drainage infrastructure investments;
- Establish and consolidate partnerships between key stakeholders to facilitate a collaborative culture, promoting openness and sharing of data, skills, resource and learning, and encouraging improved coordination and collaborative working;
- Engage with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions; and
- Deliver outputs to enable practical improvements or change where partners and stakeholders take ownership of their flood risk and commit to delivering and maintaining the recommended measures and actions.

1.5 Study Area

The Royal Borough of Kensington and Chelsea is located in the west of London and covers an area of approximately 12.15km^2.The spatial extent of the study area within this SWMP is illustrated in Figure 1-3. The Royal Borough sits between the London Borough of Brent to the north, City of Westminster to the east, the River Thames to the south and the London Borough of Hammersmith and Fulham to the west. The A40 Westway, A315 Kensington Road and A4 Cromwell Road run east to west through the Royal Borough connecting it to central London. The Central, Circle, District and Piccadilly London Underground lines run through the Royal Borough.

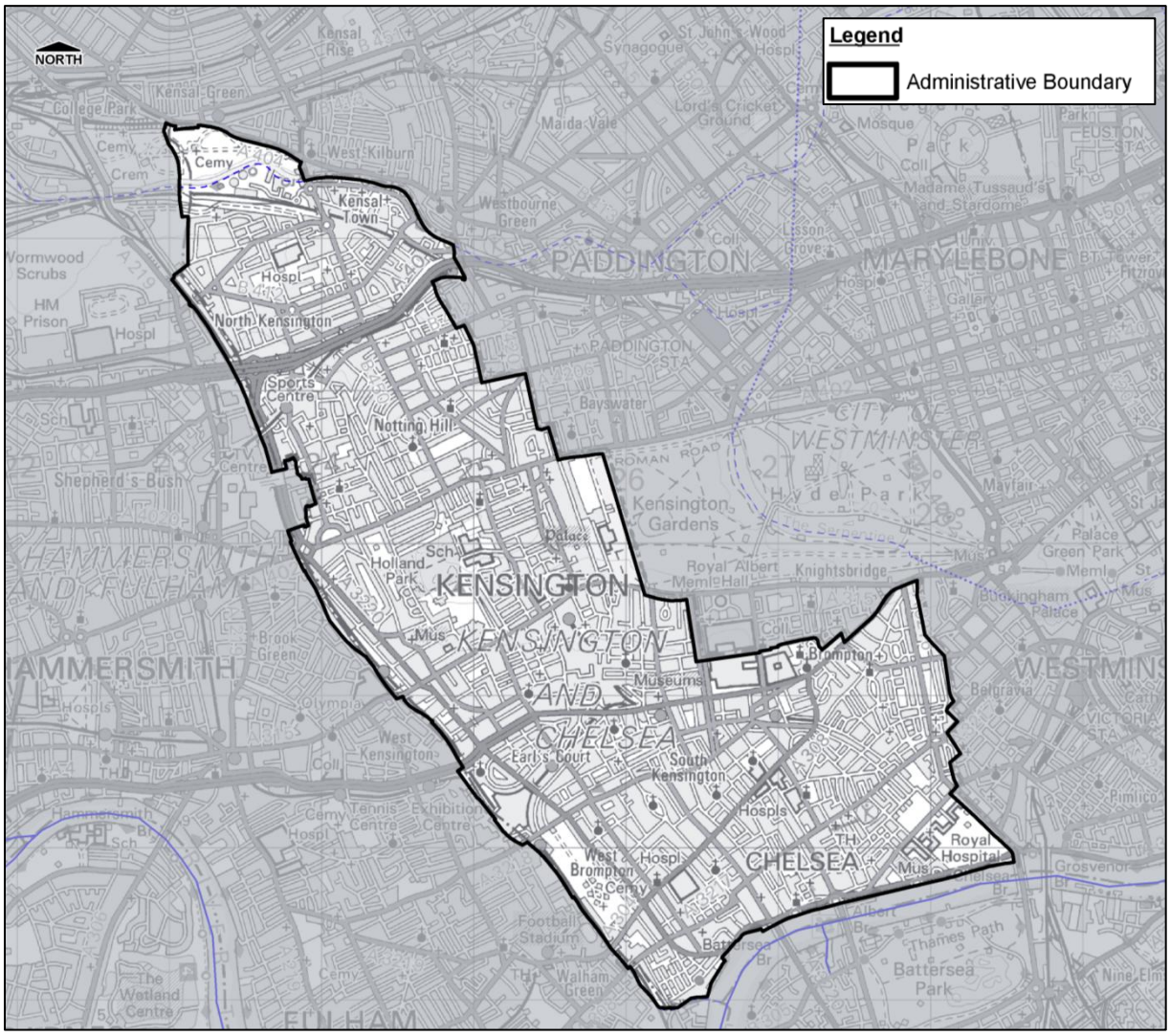


Figure 1-3 RBKC Borough Boundary

1.5.1 Location and Characteristics

Figure 1-4 (and Figures 2.0 – 2.5 within Appendix C) provides an overview of the land uses within the study area. The Royal Borough is heavily urbanised but has 32 parks in addition to garden parks and community gardens, nine of which are classified as primary parks in RBKC's biodiversity action plan.

The Royal Borough has 13 parks or gardens that have been classified as Sites of Importance for Nature Conservation (SINC), of which five are classified as of Local importance, six of Borough importance, and two of Metropolitan importance.

RBKC also contains important national and local infrastructure, as detailed below:

- Transport: Twelve London Underground stations and three Overground railway stations;
- Emergency services: three police stations, four fire stations and one ambulance station; and
- Education establishments: forty six schools (primary and secondary); and three universities.

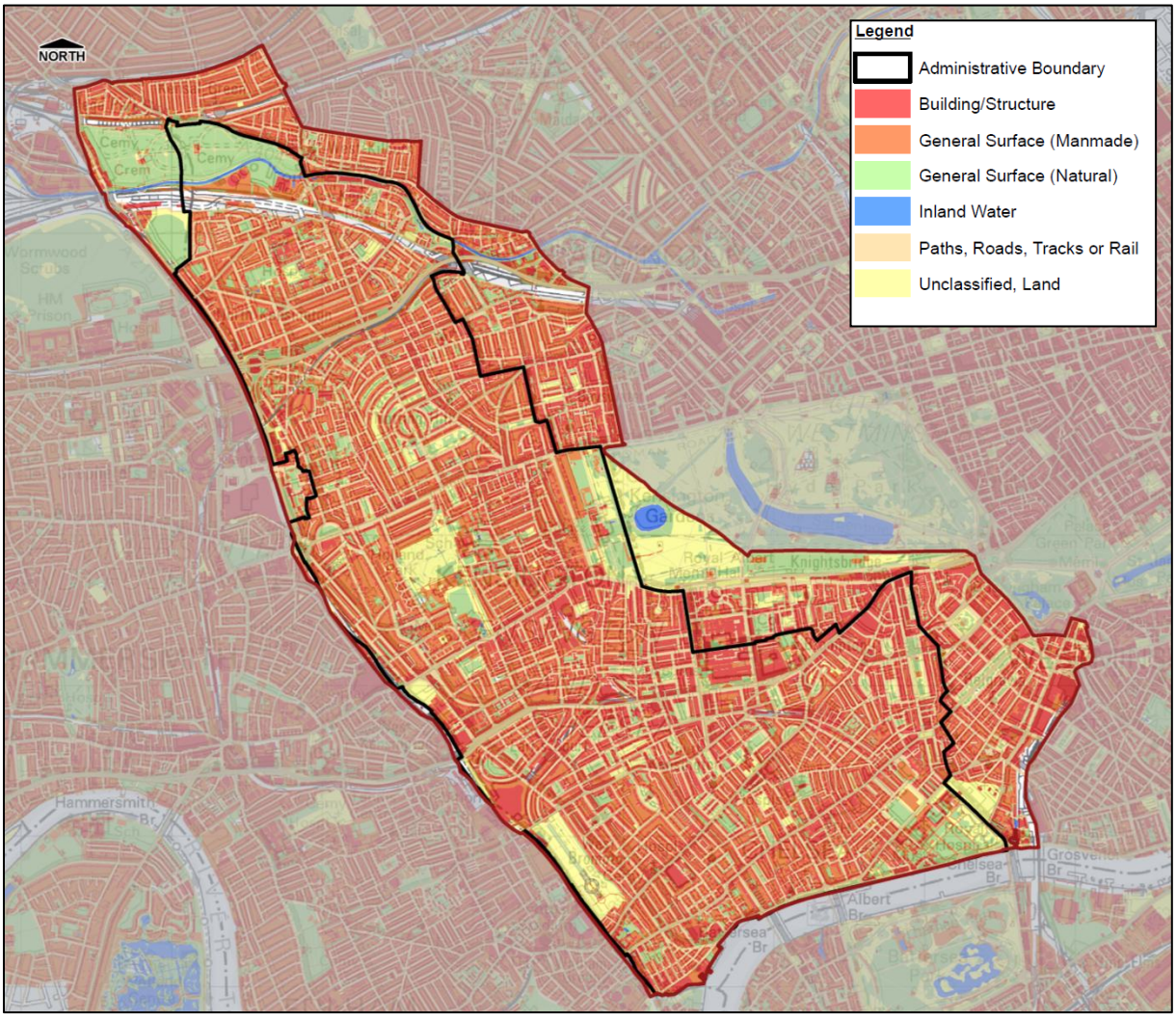


Figure 1-4 Land Uses within RBKC

1.5.2 Major Rivers and Waterways within RBKC

The River Thames forms the southern boundary of the Royal Borough, along which flood defences provide a high standard of protection (1:1000 year for 2030, as estimated when the defences were designed).

There are two 'lost rivers' in the Royal Borough, the Westbourne River and Counters Creek. These rivers have been culverted and turned into sewers. The main method for removing surface runoff is by the Thames Water combined sewer system, which does not interact with the River Thames in normal flow conditions.

The Grand Union Canal runs along the north of the Royal Borough and follows the land contour. The Serpentine, in Hyde Park, sits just outside the Royal Borough boundary to the east, within the administrative boundary of the City of Westminster. The Serpentine was created by damming in 1730 and falls under the Reservoirs Act 1975.

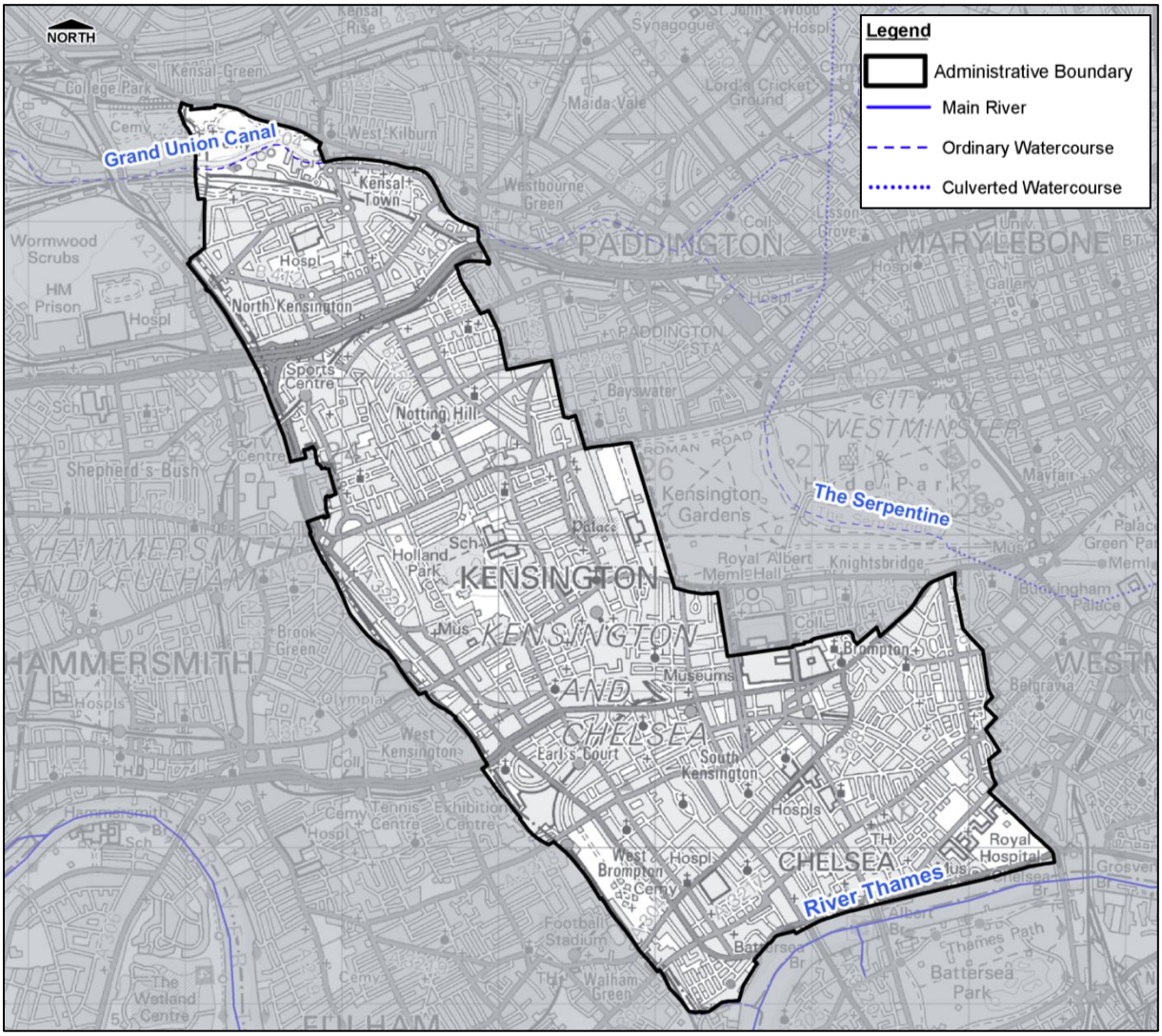


Figure 1-5 Borough Boundary and Watercourse Locations

1.5.3 Topography and Geology

Figure 1-6, below, identifies the general topography of the study area. The LiDAR Topographic Survey Map (Figure 1.4.1, Appendix D) demonstrates topographic high points at Kensal, Holland Park Secondary School and on Ladbroke Grove between Lansdowne Crescent and Stanley Crescent.

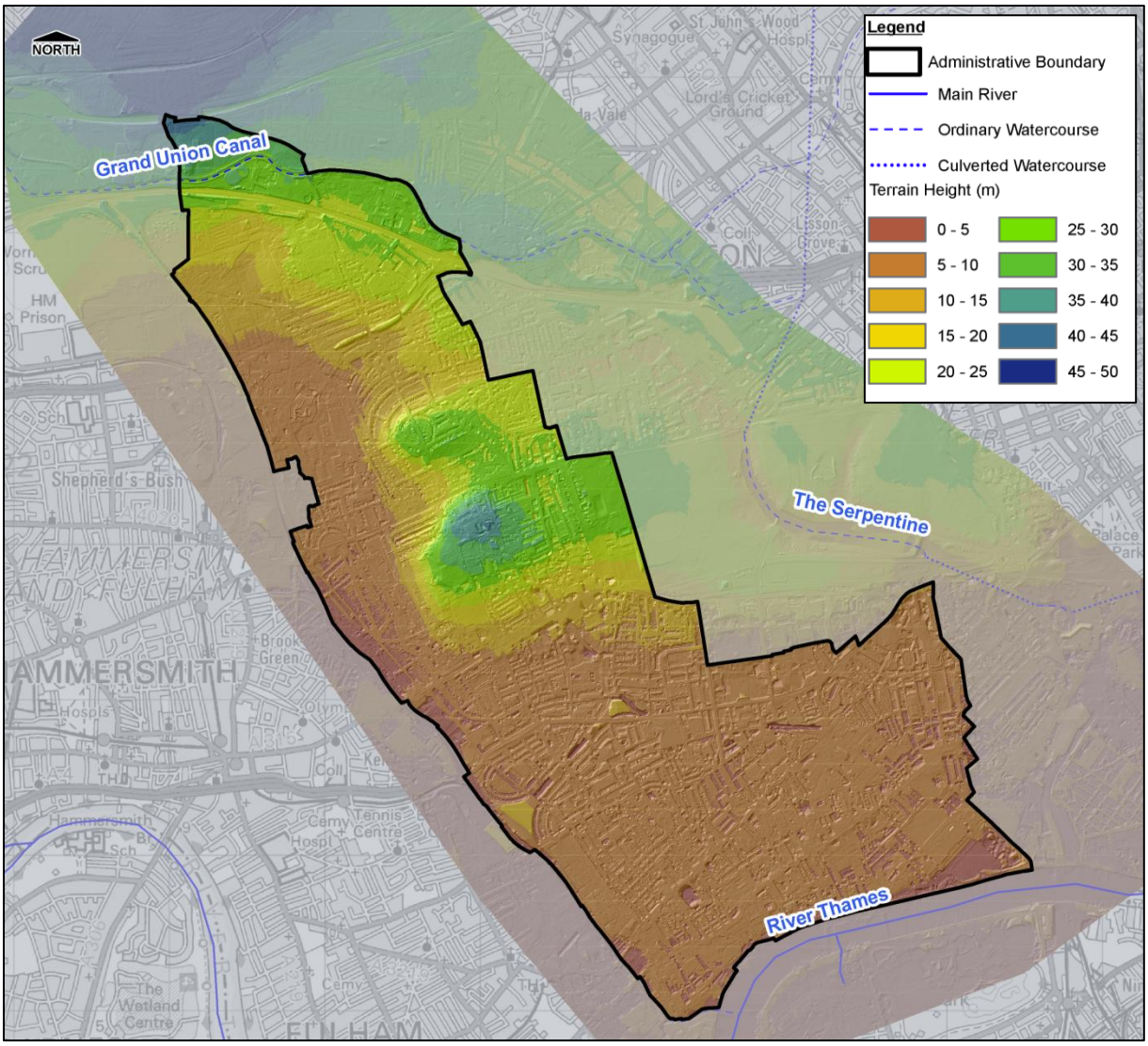


Figure 1-6 DTM Representation of the Topography within the Royal Borough

The highest point in RBKC is situated at Holland Park Secondary School (40m AOD) which falls away to the west and south reasonably steeply with a gentler gradient towards Notting Hill to the north and Kensington Gardens to the east. In the north of RBKC Kensal is the high point falling towards North Kensington. From North Kensington heading south and skirting to the west of Holland Park Secondary School the area is relatively flat at around 2m AOD which continues down to West Brompton and east to Chelsea Bridge.

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.

1.6 Partnership

The Flood and Water Management Act 2010 defines the Lead Local Flood Authority (LLFA) for an area as the unitary authority for the area, or if there is no unitary authority, the county council for the area.

As such RBKC (the unitary authority) are responsible for leading local flood risk management including establishing effective partnerships with stakeholders such as the Environment Agency, Thames Water and Transport for London as well as others.

Ideally these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU). It is recommended that the partnerships created as part of the SWMP work are maintained into perpetuity.

Members of the public may also have valuable information to contribute to the SWMP and to an improved understanding and management of local flood risk within the study area. Public engagement can afford significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options, and decisions proposed in future flood risk management plans.

1.7 Stakeholder Engagement

In order to provide an integrated approach to surface water management, it is important that key stakeholders with responsibility for different flood mechanisms are able to work together in a coordinated effort. To this end, key stakeholders have been engaged throughout the duration of this study through the establishment of a Steering Group, which contains representatives from the organisations illustrated in Figure 1-7. These groups have been consulted throughout the SWMP process and have provided key input at a number of stages of the study.

Figure 1-7: Key stakeholders engaged in the SWMP process

1.7.1 Key Stakeholders / Study Area Governance

RBKC is the LLFA for the Royal Borough of Kensington and Chelsea (as defined by the FWMA 2010) and is part of the Thames Regional Flood and Coastal Committee (RFCC).

The EA is responsible for flood risk and water quality management of the River Thames (refer to Figure 1-5). The River Thames receives a large proportion of the surface water runoff in this study area and the EA are an essential partner for flood risk management.

Thames Water is the sewerage undertaker within the Royal Borough.

1.8 Interactions with Neighbouring Local Authorities

Evaluation of surface water flood risk needs to take into account interactions with adjacent LLFAs, local planning authorities, pipe network systems, catchment contributions and other sources of flood risk that are not constrained by administrative boundaries. The RBKC shares boundaries with the London Boroughs of Brent (North), Westminster (East) and Hammersmith and Fulham (West). The original Drain London Tier 2 SWMP modelling and mapping of surface water flow routes for extreme events demonstrated that RBKC has several minor flow routes that do not extend far beyond the Royal Borough boundaries. These routes are observed in several locations as outlined below:

- From London Borough of Brent in to RBKC towards the Grand Union Canal through the Kensal Green area.
- From City of Westminster in to RBKC along Kensington Gore at the south west boundary of Hyde Park toward Gloucester Road.

The Thames Water drainage system conveys foul flow together with surface runoff that enters the system through drain pipes and road gulleys. This sewerage network was designed in the 1860s. Over time the area connected to the sewer network has increased progressively reducing its capacity to accommodate heavy rainfall.

North of the River Thames, a series of deep west to east interceptor sewers collect high level sewers draining south towards the river, transporting all flows to Beckton sewage treatment works in east London. Through this underground system (Figure 1-8), RBKC receives flows from Hammersmith and Fulham (in the west) and Brent (in the north). It transfers flow towards Westminster in the east.

Figure 1-8 The London Sewer Catchment

The catchment served by the sewer network indicates that development in the upstream Borough of Brent could have a significant impact on flood risk within the central London if surface water run-off were not adequately managed.

1.9 Significant future development plans

The Royal Borough of Kensington and Chelsea's growth strategy is set out in policy CP1 of the Royal Borough's Core Strategy (adopted December 2010). This outlines an increase in housing by 6000 properties over the lifetime of the plan (2028) with a target set in the London plan of 600 net additional dwellings a year.

The Core Strategy Proposals Map identified eight strategic sites which will be the areas where significant change will be focussed for future development/redevelopment. The strategic sites allocated for development in the core strategy are:

- Kensal (residential, offices, and retail);
- Wornington Green (residential);
- Land adjacent to Trellick Tower (residential);
- North Kensington Sports Centre (school and possibly leisure);
- Commonwealth Institute (exhibition space/leisure);
- Warwick Road (five sites – various uses);
- Earl's Court (various uses); and
- Lots Road Power Station (various uses).

Some of the sites have already had planning permission granted which is being implemented by the relevant developers. Plans for further urbanisation and change of land use within RBKC will present a challenge to the current drainage system but also the opportunity to address and manage surface water flood risk associated with the drainage network.

1.10 Sources of Flooding

The SWMP technical guidance (Defra 2010) identifies four primary sources of surface water flooding that should be considered within a SWMP as described below:

- **Pluvial flooding**: High intensity storms (often with a short duration) are sometimes unable to infiltrate into the ground or be drained by formal drainage systems since the capacity of the collection systems is not large enough to convey runoff to the underground pipe systems (which in turn might already be surcharging). The pathway for surface water flooding can include blockage, restriction of flows (elevated grounds), overflows of the drainage system and failure of sluice outfalls and pump systems.
- **Sewer flooding**: Flooding which occurs when the capacity of the underground drainage network is exceeded, resulting in the surcharging of water into the nearby environment (or within internal and external building drainage networks). The discharge of the drainage network into waterways and rivers can also be affected if high water levels in receiving waters obstruct the drainage network outfalls.
- **Ordinary Watercourses**: Flooding from small open channels and culverted urban watercourses (which receive most of their flow from the urban areas) can either exceed their capacity and cause localised flooding of an area or can be obstructed (through debris or illegal obstruction) and cause localised out of bank flooding of nearby low lying areas.
- **Groundwater flooding:** Flooding occurs when the water level within the groundwater aquifer rises to the surface. In very wet winters these rising water levels may lead to flooding of areas that are normally dry. This can also lead to streams that only flow for part of the year being reactivated. These intermittent streams are typically known as 'bournes'. Water levels below the ground can rise during winter (dependant on rainfall) and fall during drier summer months as water discharges from the saturated ground into nearby watercourses.

Figure 1-9 provides an illustration of these flood sources. Each of these sources of flood risk are further explained within Section 3 of this report.

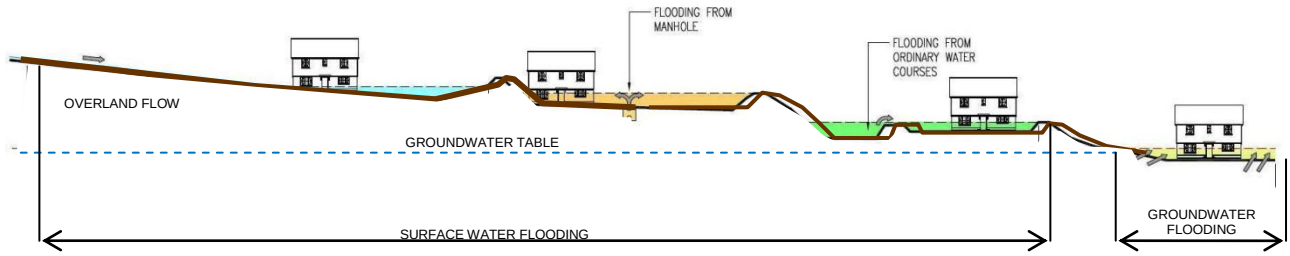


Figure 1-9 Illustration of Flood Sources[3]

[3] Adapted from Thatcham Surface Water Management Plan Volume One

1.11 Links with Other Studies

It is important that the SWMP is not viewed as an isolated document, but one that connects with other strategic and local plans. It is also important that it fits in with other studies and plans and does not duplicate existing work.

Figure 1-10, shows an interpretation of the drivers behind the RBKC SWMP, the evidence base and how the SWMP supports the delivery of other key planning and investment processes.

Figure 1-10 Where SWMPs fit in with Policy and Other Strategic Documents

Figure 1–9, highlights reports compiling evidence on flood risk (CFMP, SFRA, PFRA and WCS) and strategy documents (SWMP and LFRMS). The number of these reports and their nature running parallel to each other has primarily been driven by the timings of their production and data availability; however, the creation and existence of numerous different documents can be confusing. Some key details for these different studies and plans and how they are relevant to the study area are included below:

Regional Flood Risk Appraisal (RFRA)

The London RFRA was produced in 2009 by the Greater London Authority (GLA). The RFRA provides a regional overview of flooding from all sources with the aim of informing Strategic Flood Risk Assessments (SFRAs) and other local development plans. With the introduction of the new National Planning Policy Framework replacing the current Planning Policy Statements, the RFRA is unlikely to be revised in future. Table 1-1, overleaf, highlights the strategic recommendations that are relevant to RBKC.

Table 1-1 RFRA Strategic Recommendations Relevant to the Royal Borough of Kensington and Chelsea

Thames and tidal tributaries to enable sustainable and cost effective upgrade of river wall/embankments, in line with policy 5.12, CFMPs and TE2100.

Recommendation 5: Developments all across London should reduce surface water discharge in line with the Sustainable Drainage Hierarchy set out in Policy 5.13 of the draft replacement London Plan.

Recommendation 6: Regeneration and redevelopment of London's fluvial river corridors offer a crucial opportunity to reduce flood risk. SFRAs and policies should focus on making the most of this opportunity through appropriate location, layout and design of development as set out in PPS25 and the Thames CFMP. In particular opportunities should be sought to:

- Set back of development from the river edge to enable sustainable and cost effective flood risk management options
- Ensure that the buildings with residual flood risk are designed to be flood compatible or flood resilient
- Use open spaces within developments which have a residual flood risk to act as flood storage areas

Recommendation 8: Organisations responsible for development with large roof areas should investigate providing additional surface water run-off storage.

Recommendation 9: Thames Water to continue the programme of addressing foul sewer flooding.

Recommendation 10: The groundwater flood risk is kept under review.

Recommendation 11: Network Rail should examine the London Rail infrastructure for potential flooding locations and flood risk reduction measures. For large stations, solutions should be sought to store or disperse rainwater from heavy storms; this may involve the need for off site storage.

Recommendation 12: London Underground and DLR should keep potential flood risks to their infrastructure and flood risk reduction measures under review and up to date.

Recommendation 13: TfL, Highways Agency and London boroughs should continue to monitor the flood risk and flood risk reduction measures at these locations and any others with a potential flood risk.

Recommendation 18: Operators of London's emergency services should ensure that emergency plans for flooding incidents are kept up to date and suitable cover arrangements are in place in the event of a flood affecting operational locations.

Recommendation 19: Operators of electricity, gas, water and sewerage utility sites should maintain an up to date assessment of the flood risk to their installations and considering the likely impacts of failure, programme any necessary protection measures, this may include secondary flood defences.

Thames Catchment Flood Management Plan (CFMP)

The Thames Catchment Flood Management Plan (Thames CFMP) was published in 2008 by the Environment Agency and sets out policies for the sustainable management of flood risk across the whole of the Thames catchment over the long-term (50 to 100 years) taking climate change into account. More detailed flood risk management strategies for individual rivers or sections of river may sit under these.

The Plan emphasises the role of the floodplain as an important asset for the management of flood risk, the crucial opportunities provided by new development and regeneration to manage risk, and the need to re-create river corridors so that rivers can flow and flood more naturally.

This Plan will be periodically reviewed, approximately five years from when it was published, to ensure that it continues to reflect any changes in the catchment. There are links to Drain London where there are known interactions between surface water and fluvial flooding.

Table 1-2 CFMP Policy Unit

TE2100 Policy Unit

The TE2100 Policy Unit covers the whole of Group 3 including the Royal Borough of Kensington and Chelsea.

The preferred policy is Policy 4; Areas of low, moderate or high risk where the Environment Agency is already managing the flood risk effectively but where further action may need to be taken to keep pace with climate change.

Key messages are:

- The most sustainable approach to managing future flood risk will be to bring about adaptation of the urban environment. There are some major opportunities to reduce flood risk through the appropriate location, layout and design of redevelopment. This will make properties more resilient or resistant to flood water, therefore reducing the consequences of flooding.
- The Environment Agency will continue to maintain existing defences where appropriate to do so. Where this is not possible flood defences will be replaced in conjunction with redevelopment and as part of an overall catchment scale plan.
- Strategic scale planning is key to achieving the needs of the community and managing flood risk in a more sustainable way.

Emergency planning is integral to the approach to managing extreme flood events. Although flood risk may be low in places there is limited time for warning and action. It is important for local communities to be aware and prepared for a flood. The Environment Agency will work with other organisations and the communities at risk to focus on these issues.

Strategic Flood Risk Assessment (SFRA)

Each local planning authority is required to produce a SFRA under Planning Policy Statement 25 (PPS25) and the new National Planning Policy Framework (NPPF). This document provides an important tool to guide planning policies and land use decisions. Current SFRAs have a strong emphasis on flooding from main rivers and the sea and are less focussed on evaluating flooding from local sources such as surface water, groundwater and ordinary watercourses; the information from this study will improve this understanding. This is not the case in the RBKC SFRA (2009), as detailed investigations were undertaken for surface water as part of the SFRA.

Particular care has been taken by using the SFRA for the Royal Borough as the primary document from which local flood risk information has been obtained. The reasoning behind this is that:

- The SFRA for the Royal Borough is relatively recent (completed in August 2009) – this is in the process of being updated by the Council;
- It has been thoroughly reviewed more than once by the Council and the Environment Agency;

- It informed the LDF planning process; and
- It has gathered relevant local information.

RBKC is in the process of updating the SFRA and it is recommended that future updates to this document take into account the findings of the SWMP study.

Preliminary Flood Risk Assessment (PFRA)

A Preliminary Flood Risk Assessment for the Royal Borough of Kensington and Chelsea, as Lead Local Flood Authority, has been prepared as part of the Flood Risk Regulations. The PFRA process provides a consistent high level overview of the potential risk of flooding from local sources such as surface water, groundwater and ordinary water courses. The outputs from this SWMP will be able to inform future PFRA cycles, which will benefit from an increased level of information and understanding relating to surface water flood risk in RBKC. RBKC will need to review the PFRA every six years.

Draft RBKC Surface Water Management Plan

Drain London produced a draft SWMP for each London Borough, including RBKC. This provided much improved probabilistic 2-dimensional modelling and data, compared with what has been made available at a national scale by the Environment Agency. In addition, the draft SWMP contained an Action Plan that was developed in conjunction with both RBKC and relevant other Risk Management Authorities. This data, the actions and the associated policy interventions were created to feed directly into the operational level of the Royal Borough across many departments, in particular into spatial and emergency planning policies and designations and into the management of local authority controlled land.

Local Plans

LDDs including the Core Strategy and relevant Area Action Plans (AAPs) will need to reflect the results from this study. This may include policies for the whole study area (Policy Areas) or for specific parts of the study area (Critical Drainage Areas). There may also be a need to review Area Action Plans where surface water flood risk is a particular issue.

National Flood and Coastal Erosion Risk Management Strategy (National FCERM Strategy)

The FWMA 2010 requires the EA to produce a national strategy to inform and guide local flood risk management strategies. This NFRMS document was consulted upon in early 2011 and became law on 19 July 2011. The strategy's overall aim is to ensure that flooding and coastal erosion risks are well-managed and co-ordinated, so that their impacts are minimised.

The National FCERM Strategy for England stresses the need for risk to be managed in a co-ordinated way across river catchments and along the coast, embracing the full range of practical options and helping local decision-making.

Local Flood Risk Management Strategy (LFRMS)

The Flood and Water Management Act (2010) requires each LLFA to produce a Local Flood Risk Management Strategy. The Flood Risk Regulations 2009 also require a Flood Risk Management Plan (FRMP) of Flood Risk Areas by December 2015. This SWMP will provide a strong evidence base to support the development of the RBKC LFRMS and FRMP.

Summary of Documents

The schematic diagram (Figure 1-11) illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.

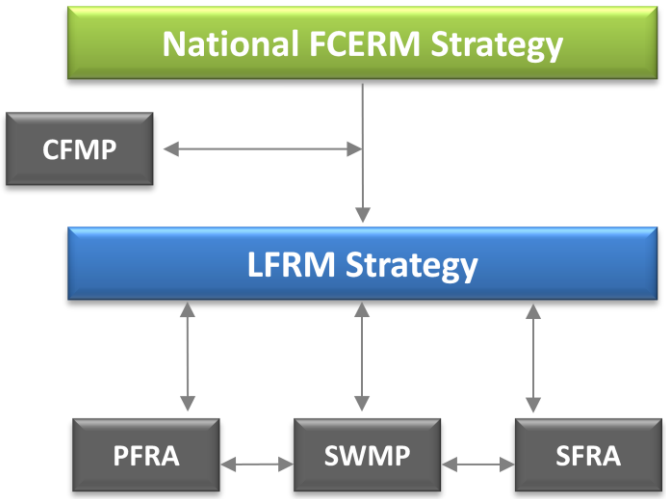


Figure 1-11 Links to local strategies

1.12 Existing Legislation

The FWMA 2010 presents a number of challenges for policy makers and the flood and coastal risk management authorities identified to co-ordinate and deliver local flood risk management (surface water, groundwater and flooding from ordinary water courses). 'Upper Tier' local authorities have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater.

The FWMA 2010 reinforces the need to manage flooding holistically and in a sustainable manner. This has grown from the key principles within Making Space for Water (Defra, 2005) and was further reinforced by the summer 2007 floods and the Pitt Review (Cabinet Office, 2008). It implements several key recommendations of Sir Michael Pitt's Review of the summer 2007 floods, whilst also protecting water supplies to consumers and protecting community groups from excessive charges for surface water drainage.

The FWMA 2010 must also be considered in the context of the EU Floods Directive, which was transposed into law by the Flood Risk Regulations 2009 (the Regulations) on 10 December 2009. The Regulations requires three main types of assessment / plan to be produced:

a) Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) to be completed by LLFA and the Environment Agency by the 22 December 2011. Flood Risk Areas, at potentially significant risk of flooding, must also be identified. Maps and management plans will be developed on the basis of these flood risk areas. Within the PFRA the LLFA address the local flood risk whilst the Environment Agency provides advice on strategic flood risk.

b) Flood Hazard Maps and Flood Risk Maps. The Environment Agency and LLFA are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2013.

c) Flood Risk Management Plans. The Environment Agency and LLFA are required to produce Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2015.

It should be noted that only (a) above is compulsory for all LLFAs. Where an LLFA is not located within a nationally defined 'Flood Risk Area', then (b) and (c) above are not required. Figure 1-12, below, illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

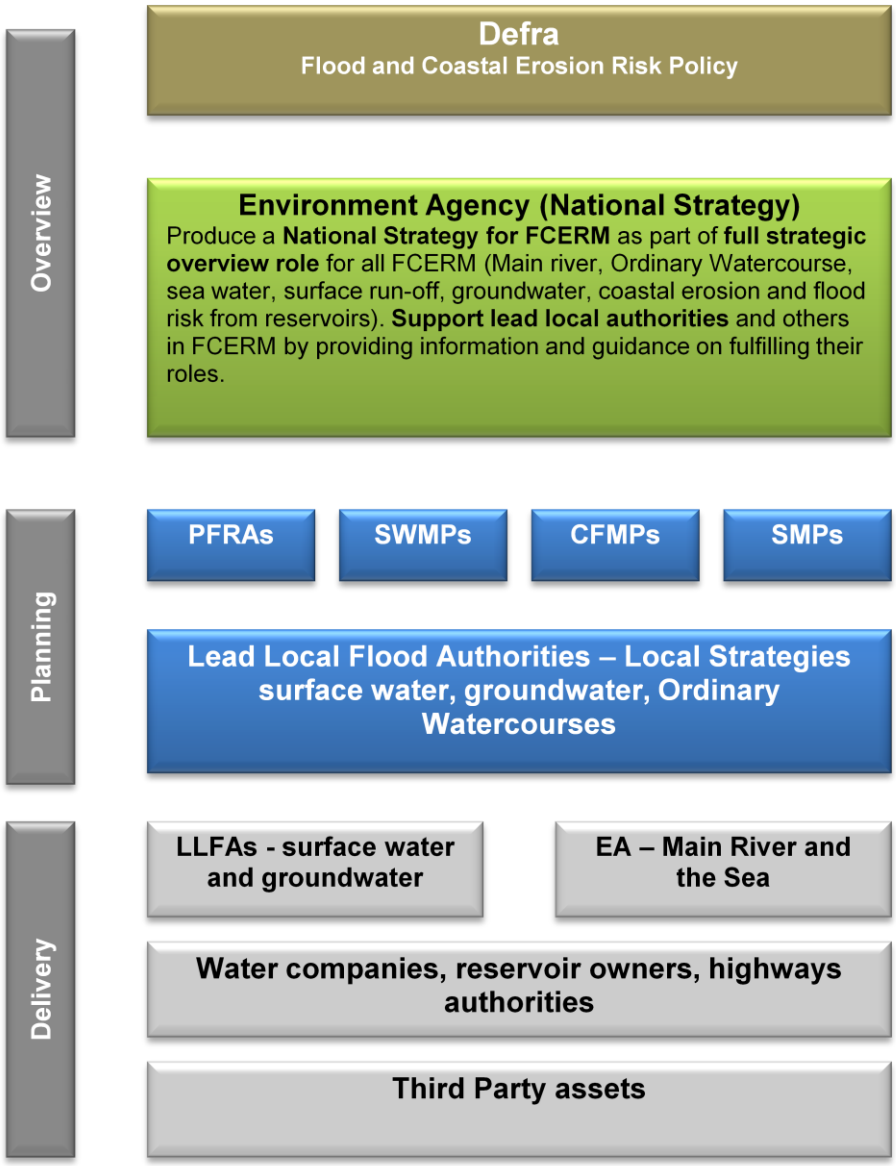


Figure 1-12 Where the SWMP is located within the Delivery of Local Flood and Coastal Risk Management

1.13 LLFA Responsibilities

In addition to forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the Flood & Water Management Act 2010, and the Flood Risk Regulations 2009. These responsibilities include:

1. **Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.

2. **Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have a significant effect on flood risk, including as a minimum details of ownership and condition.

3. **SuDS Approving Body** – LLFAs are designated the SuDS Approving Bodies (SABs) for any new drainage system, and therefore must approve, adopt and maintain new sustainable drainage systems (SuDS) within their area. This responsibility is anticipated to commence in April 2014 and will affect first those SuDS serving large developments. It should be noted that the Environment Agency is a statutory consultee and currently has the responsibility of providing comments to the Local Planning Authority (LPA) relating to the surface water management of new developments.

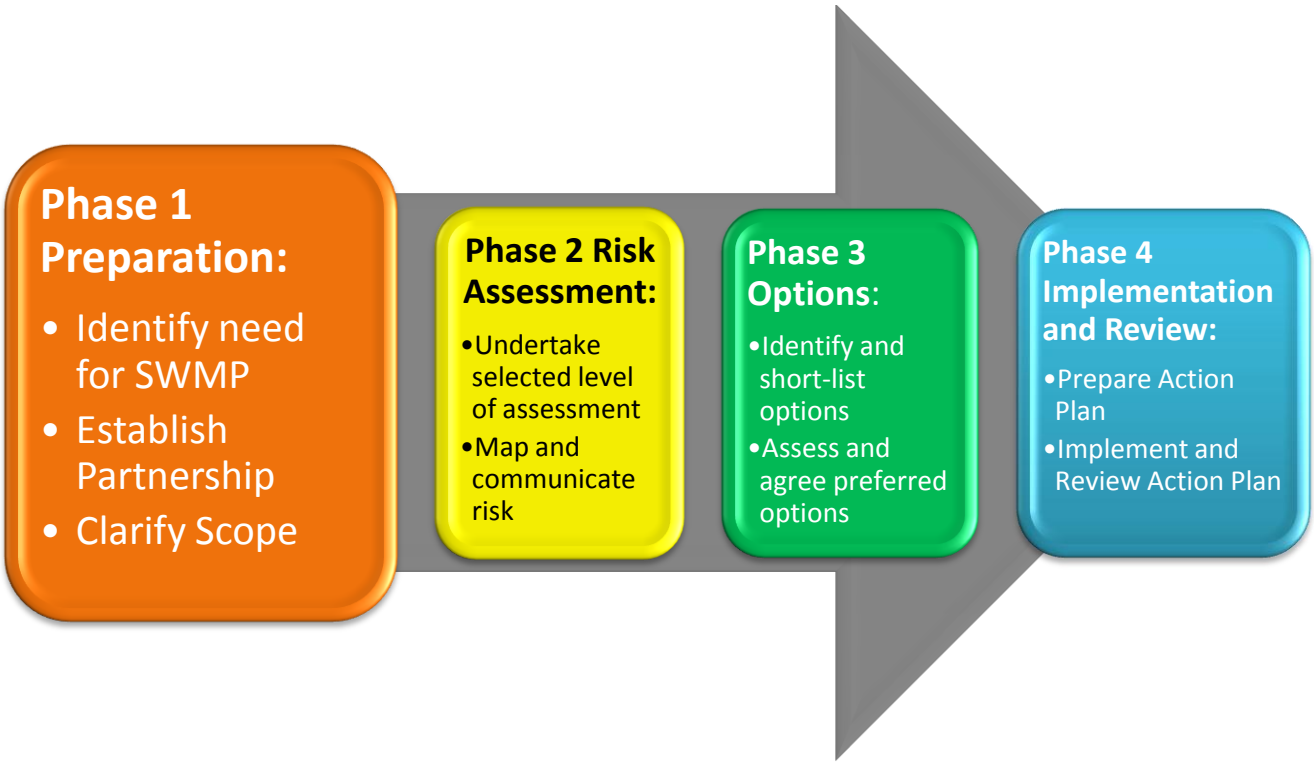
4. **Local flood risk management strategies** – LLFAs are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area. The local strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.

5. **Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.

6. **Designation powers** – LLFAs and the Environment Agency, have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management.

These LLFA requirements have been considered in the production of this document. The SWMP will assist the LLFA in providing evidence for points 1, 2, 3 and 4.

PHASE 1: PREPARATION



2 Phase 1: Preparation

2.1 Partnership

The FWMA 2010 defines the LLFA for an area as the unitary authority or upper tier authority for the area. As such, RBKC is responsible for leading local flood risk management including establishing effective partnerships with stakeholders such as the Environment Agency and Thames Water Utilities Ltd as well as others. Ideally these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memoranda of Understanding (MoU). An initial MoU has been formally established between the parties noted above as part of the original Drain London Tier 2 SWMP study.

As mentioned in Section 1.7, the study area falls within the Thames Regional Flood and Coastal Committee (RFCC). RBKC is part of the Drain London Group 3 and has a Councillor who represents the group at the Thames RFCC. The representative is elected annually. Currently Councillor Coleridge, who is the Planning Policy Cabinet Member for RBKC, is the FRCC representative.

Members of the public may also have valuable information to contribute to the SWMP and to an improved understanding and management of local flood risk within the study area. Public engagement can afford significant benefits to local flood risk management including building trust, gaining access to additional local knowledge and increasing the chances of stakeholder acceptance of options and decisions proposed in future flood risk management plans.

2.2 Data Collection

Data was collected from each of the following organisations:

- The Royal Borough of Kensington and Chelsea;
- British Geological Survey;
- Environment Agency;
- Transport for London.
- Thames Water;
- London Fire Brigade;
- Network Rail; and

Table 2-1 provides a summary of the data sources held by the organisations listed above and provides a description of each dataset, and how the data was used in preparing the SWMP.

Table 2-1 Data Sources and Use

Source	Dataset	Description	Use in this SWMP
Environment Agency	Main River centre line	GIS dataset identifying the location of Main Rivers across they study area	To define waterway locations within the study area.
	Environment Agency Flood Map (Flood Zones)	Shows extent of flooding from rivers during a 1 in 100yr flood and 1 in 1000yr return period flood. Shows extent of flooding from the sea during 1 in 200yr and 1 in 1000yr flood events. Ignores the presence of defences.	To identify the fluvial and tidal flood risk within RBKC and areas benefiting from fluvial and tidal defences.
	Areas Susceptible to Surface Water Flooding	A national outline of surface water flooding held by the EA and developed in response to Pitt Review recommendations.	To assist with the verification of the pluvial modelling.
	Flood Map for Surface Water	A second generation of surface water flood mapping which was released at the end of 2010.	To assist with the verification of the pluvial modelling.
	Groundwater Flooding Incidents	Records of historic incidents of groundwater flooding as recorded by the Environment Agency.	To identify recorded groundwater flood risk – assist with verifying groundwater flood risk.
	LiDAR topographic data	2m, 1m, 50cm and 25cm resolution terrain model compiled from aerial surveys in 2002, 2004 and 2006	Creation of terrain model for pluvial modelling.
	Historic Flood Outline	Attributed spatial flood extent data for flooding from all sources.	Used to assist with the verification of modelling results and CDA locations (where available.
	Areas Susceptible to Groundwater Flooding	Mapping showing areas susceptible to groundwater flooding	To assess groundwater flood risk.
	National Receptors Dataset	A nationally consistent dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations.	Utilised for property/infrastructure flood counts and to determine CDAs.
Royal Borough of Kensington and Chelsea	Anecdotal information relating to local flood history and flood risk areas	Records of flooding from surface water, groundwater and ordinary watercourses.	Where available used to assist with the verification of modelling results and CDA locations.
	OS Mapping / MasterMap / Aerial Photography	Topographic maps of the study area	Used to derive modelling parameters.
	Core Strategy	Identification of broad locations for growth in RBKC.	Understanding of areas of future development.
	Flood Alleviation Schemes	Location and description of existing flood alleviation schemes within the study area.	Used in Phase 3: Options Assessment to determine options of each CDA.
	Historic Flood Records	Locations of historic flooding	Assists with the verification of modelling and risk.

Source	Dataset	Description	Use in this SWMP
Thames Water	DG5 Register	DG5 Register logs and records of sewer flooding incidents in each area.	Mapping sewer flooding incidents.
	Sewer pipe network	GIS dataset providing the geo-referenced location of surface water, foul and combined sewers across the study area. Includes pipe size and some information on invert levels.	Verifying CDA locations and Phase 3:Options Assessment
British Geological Society	Geological datasets	Licensed GIS datasets including: Geological indicators of flooding; Permeability; Bedrock and superficial geology;	Understanding the geology of the study
London Fire Brigade	Historic flooding records	Locations of historic flooding	Validation of hydraulic modelling results

2.3 Data Review

Historic Records of Local Flooding

The most significant data gap across the study area relates to records of past 'local' flooding incidents. This is a common issue across the UK as record keeping of past floods has historically focussed on flooding from rivers or the sea, or has incorrectly attributed flooding to these sources. Records of past incidents of surface water, sewer, groundwater or ordinary watercourse flooding have been sporadic. RBKC has provided all available historic records that were accessible at the time of request. Where possible, these have been digitised into GIS from, however there is very little information on the probability, hazard or consequence of flooding.

Thames Water has provided postcode linked data on records of sewer flooding, known as the DG5 register. However, more detailed data on the location and cause of sewer flooding is not currently available.

Similarly, the London Fire Brigade has recorded incidents of call outs related to flooding, however there is no information on the source of flooding (e.g. pipe bursts or rainfall) or probability, hazard or consequence of the flooding.

Groundwater Flooding

Groundwater flooding is dependent on local variations in topography, geology and soils. The causes of groundwater flooding are generally understood; however it is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets.

There is a lack of reliable measured datasets to undertake flood frequency analysis and even with datasets, this analysis is complicated due to the non-independence of groundwater level data. Surface water flooding incidents are sometimes mistaken for groundwater flooding incidents, such as where runoff via infiltration seeps from an embankment, rather than locally high groundwater levels.

Flooding Consequences

The National Receptors Database (NRD), version 1.1 data set, was provided by the EA allow property counts to be undertaken for this SWMP.

Topographic / Elevation Data

The EA LiDAR data provided for the catchment has a resolution of 1m

Main River Information

Information on the River Thames has been provided by the EA. This data provides a good basis for understanding the impacts on flooding within RBKC.

2.4 Security, Licensing and Use Restrictions

A number of datasets used in the preparation of this SWMP are subject to licensing agreements and use restrictions.

The following national datasets provided by the Environment Agency are available to LLFA for local decision making:

- EA Flood Zone Map (including historic mapping);
- Areas Susceptible to Surface Water Flooding;
- Areas Susceptible to Groundwater Flooding
- Flood Map for Surface Water; and
- National Receptor Database.

A number of the data sources used are publicly available documents, such as:

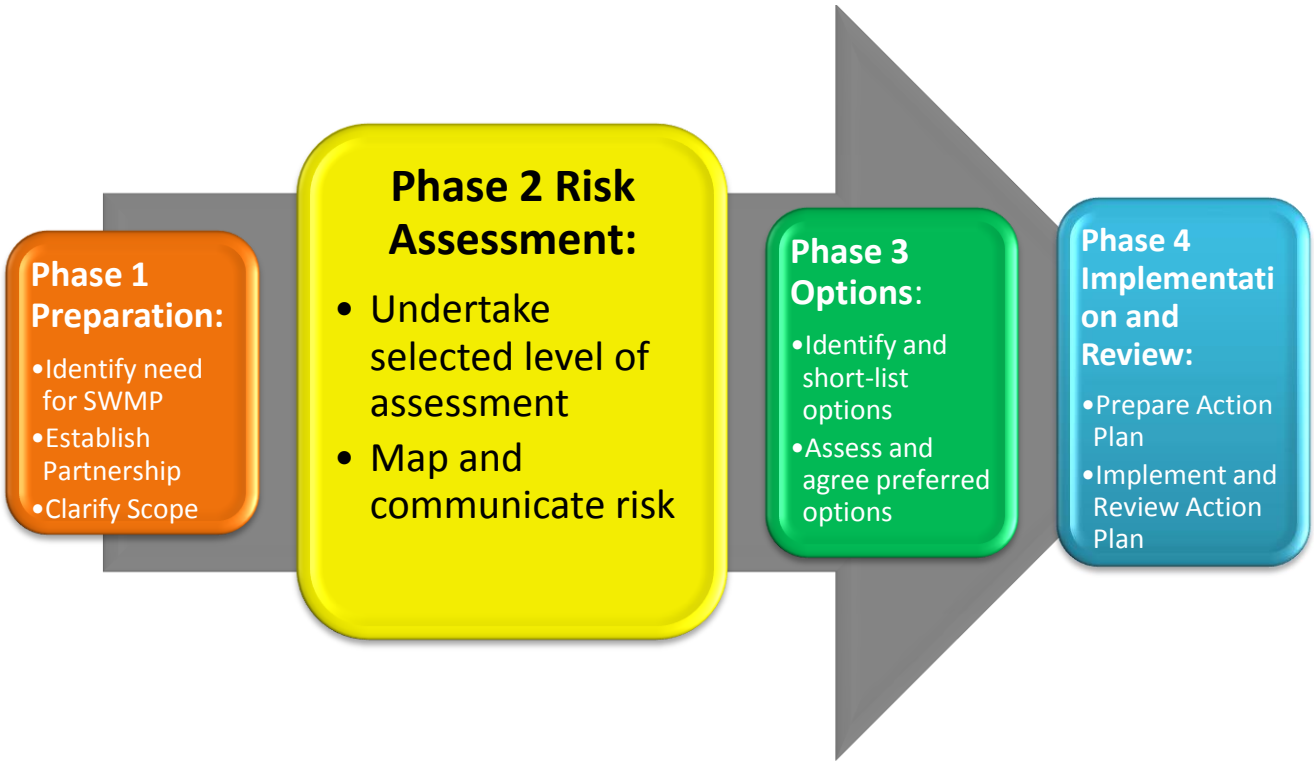
- Strategic Flood Risk Assessment;
- Catchment Flood Management Plan;
- Preliminary Flood Risk Assessment; and
- Index of Multiple Deprivation.

The use of some of the datasets made available for this SWMP has been restricted. These include:

- Records of property flooding held by the RBKC and by Thames Water Utilities Ltd; and
- British Geological Society geological datasets.

Necessary precautions must be taken to ensure that all restricted information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the terms and conditions of use accompanying the data. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

PHASE 2: RISK ASSESSMENT



3 Surface Water Flooding

3.1 Overview

Surface water flooding, also known as pluvial flooding or flash flooding, occurs when high intensity rainfall generates runoff which flows over the surface of the ground and ponds in low lying areas. It is usually associated with high intensity rainfall events and can be exacerbated when the ground is saturated (or baked hard) and the drainage network has insufficient capacity to manage the additional flow.

3.2 Historic Flooding

Various flood records were utilised within the collected from a range of sources including:

- Royal Borough of Kensington and Chelsea;
- Environment Agency
- London Fire Brigade;
- Transport for London; and
- Network Rail.

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.

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 Holland Road and Elsham Road area 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 3-1.

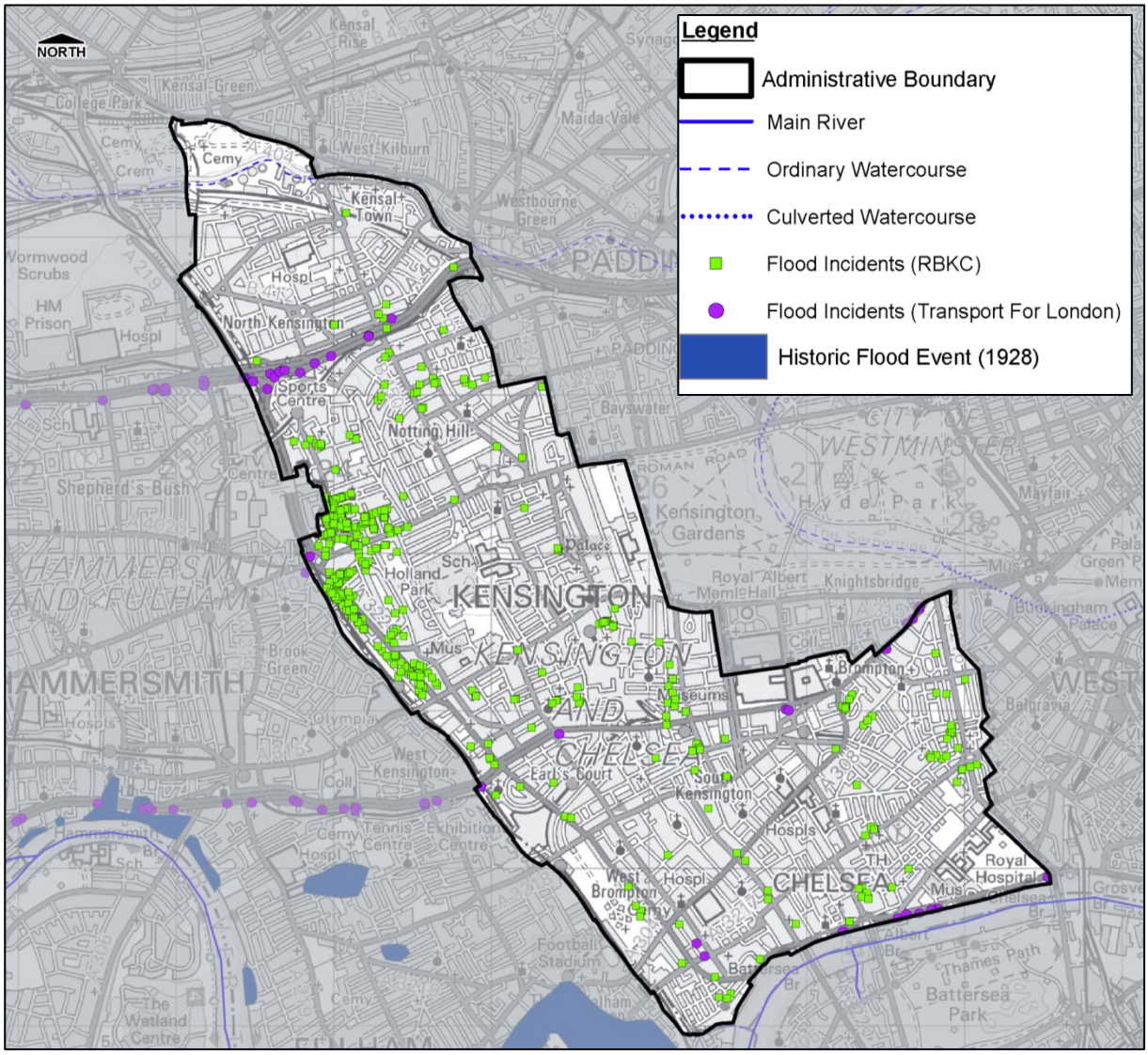


Figure 3-1 Historic Flood Events within the Royal Borough

3.3 Level of Assessment

SWMPs can function at different geographical scales and as a result of this differing levels of detail may be necessary. Table 3-1, overleaf, defines the levels of assessment that can be used within a SWMP.

Table 3-1 Level of assessment (adapted from Defra SWMP Guidance, March 2010)

Level of Assessment	Appropriate Scale	Outputs
Strategic Assessment	County or large conurbation (e.g. Greater London)	• Broad understanding of locations that are more vulnerable to surface water flooding. • Prioritised list for further assessment. • Outline maps to inform spatial and emergency planning.
Intermediate Assessment	Large town or city (e.g. Drain London Tier 2 RBKC model)	• Identify flood hotspots which might require further analysis through detailed assessment. • Identify immediate mitigation measures which can be implemented. • Inform spatial and emergency planning.
Detailed Assessment	Known flooding hotspots (e.g. Critical Drainage Areas) or defining the risk within a area in greater detail	• Detailed assessment of cause and consequences of flooding. • Use to understand the mechanisms and test potential mitigation measures.

3.3.1 Detailed Assessment

As shown in Table 3-1, an intermediate assessment is applicable across a large town or city and was completed as part of the Drain London Tier 2 project. Discussions with the Council, Thames Water and local residents concluded that further confidence in the predicted modelling results was required and as such a detailed assessment was considered to be the appropriate level of assessment to further quantify the risks within RBKC. The detailed modelling improvements included refining the rainfall for the area, a review of the critical storm duration, refined grid model cell size and inclusion of the gulley and drainage network within the Royal Borough.

The outputs from this assessment should be used to inform spatial and emergency planning. The outputs can also be used to identify potential mitigation measures which can be implemented immediately in order to reduce surface water flood risk. These may include quick win measures such as improving maintenance and clearing blockages/obstruction to the drainage infrastructure.

3.4 Risk Overview

The following sources of flooding have been assessed and are discussed in detail in the following sections of this report:

- Pluvial flooding: runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or a watercourse.
- Flooding from ordinary watercourses: flooding which occurs as a result of the capacity of the watercourse being exceeded resulting in out of bank flow (water coming back out of rivers and streams).
- Sewer flooding: Flooding which occurs when the capacity of the underground drainage system is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters as a result of wet weather conditions.

- Flooding from groundwater sources: Occurs when the water level within the groundwater aquifer rises to the surface.

The identification of areas at risk of flooding has been dominated by the assessment of surface water and ordinary watercourse flooding as these sources are expected to result in the greater consequence (risk to life and damage to property), as well as by the quality of the information available for informing the assessment.

3.5 Pluvial Flooding

3.5.1 Description

Pluvial flooding is the term used to describe flooding which occurs when intense, often short duration rainfall is unable to soak into the ground or to enter drainage systems and therefore runs over the land surface causing flooding. It is most likely to occur when soils are saturated (or baked hard) so that they cannot infiltrate any additional water or in urban areas where buildings tarmac and concrete prevent water soaking into the ground. The excess water can pond (collect) in low points and result in the development of flow pathways often along roads but also through built up areas and open spaces. This type of flooding is usually short lived and associated with heavy downpours of rain.

The potential volume of surface runoff in catchments is directly related to the size and shape of the catchment to that point. The amount of runoff is also a function of geology, slope, climate, rainfall, saturation, soil type, urbanisation and vegetation.

3.5.2 Causes and classifications

Pluvial flooding can occur in rural and urban areas, but usually causes more damage and disruption in the latter. Flood pathways include the land and water features over which floodwater flows. These pathways can include drainage channels, rail and road cuttings. Developments that include significant impermeable surfaces, such as roads and car parks may increase the volume and rate of surface water runoff.

Urban areas which are close to artificial drainage systems, or located at the bottom of hill slopes, or in valley bottoms and hollows, may be more prone to pluvial flooding. This may be the case in areas that are down slope of land that has a high runoff potential including impermeable areas and compacted ground.

3.5.3 Impacts of pluvial flooding

Pluvial flooding can affect all forms of the built environment, including:

- Residential, commercial and industrial properties;
- Amenity and recreation facilities; and
- Infrastructure, such as roads and railways, electrical infrastructure, telecommunication systems and sewer systems.

This type of flooding is usually short-lived and may only last as long as the rainfall event. However occasionally flooding may persist in low-lying areas where ponding occurs. Due to the typically short duration, this type of flooding tends not to have consequences as serious as other forms of flooding, such as flooding from rivers; however it can still cause significant damage and disruption on a local scale.