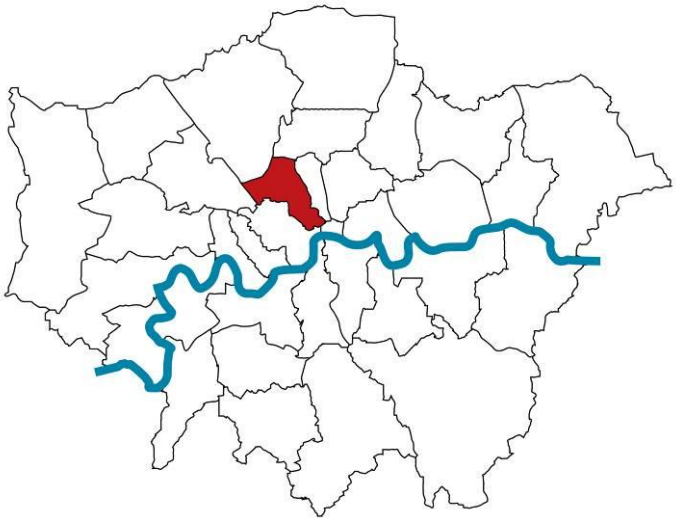
SURFACE WATER MANAGEMENT PLAN



DRAIN LONDON

LONDON BOROUGH OF CAMDEN

GREATERLONDONAUTHORITY

Thames Water

LONDON COUNCILS

Environment Agency

Camden

Quality Management

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RELATED DOCUMENTS

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PFRA	Preliminary Flood Risk Assessment for London Borough of Camden	Bruno Venturini/ Laura Markeson	18/04/2011	0.3

SWMP Document Status **June 2013**

This document has been produced to present the outputs of the London Borough of Camden. This document was used as the basis for the Local Flood Risk Management Strategy. It provides important information and is a useful reference. However it has been superseded by the strategy and at any point where there is a contradiction between the two documents, the strategy should take precedence. The strategy was informed by more detailed modelling of the flood risk and should be considered a better guide to the risk in the borough. Similarly its action plan should be considered to override the SWMP whenever there are discrepancies.

The Surface Water Management Plan was originally designed to be a 'living document' which would be reviewed but the statutory requirement to have a strategy has made this a redundant step and it will not be reviewed in the future.

Executive Summary

This report is the Surface Water Management Plan (SWMP) for the London Borough of Camden. The study forms part of the wider Drain London Tier 2 project, which involves the delivery of Surface Water Management Plans and Preliminary Flood Risk Assessments for each of the thirty two London Boroughs and the Corporation of City of London.

The SWMP builds on previous studies undertaken by the Borough and has been delivered using a four phase approach; Phase 1 – Preparation; Phase 2 – Risk Assessment; Phase 3 – Options; and Phase 4 – Implementation and Review.

Phase 1 Preparation

Phase 1 builds on the work undertaken in the previous stage (Tier 1) of the Drain London project that collected and reviewed data from key stakeholders and partners. In addition to this Tier 1 established partnerships with adjacent LLFAs and the Environment Agency as well as other stakeholders responsible for local flood risk management, for example Thames Water and London Underground. The London Borough of Camden continues 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

Drain London Tier 2 modelling was designed to analyse the impact of heavy rainfall events across each London Borough by assessing flow paths, velocities and catchment response. A direct rainfall method was used in the modelling approach that incorporated conservative allowance for the drainage network and infiltration. The dominant surface water flood mechanism in the Borough is pluvial flooding where water from the extreme rainfall event is not able to drain into the ground due to the heavy urban development in the Borough.

The results of the modelling have been used to identify seven Local Flood Risk Zones (LFRZs) in the Borough where flooding affects houses, businesses and infrastructure. From this three Critical Drainage Areas (CDAs) have been identified (**Figure 0 – CDA index Map**) where interlinked sources of flood risk (surface water, groundwater, sewer, main river) cause flooding in LFRZs during severe weather.

Phase 3 Options Assessment

This SWMP outlines a surface water management strategy and long term action plan for the management of local surface water flood risk. This should be used to influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments. In addition to specific actions to manage issues identified in the CDAs there are a number of generic actions that should be implemented Borough wide to ensure the long term and sustainable management of water that will also assist in managing surface water flooding and reducing the impact of flooding should it occur.

Details of the preferred options for each of the CDAs are outlined in **Chapter 4** of this report.

In addition to the CDAs identified it is recognised that London Borough of Camden falls within the Counters Creek hydraulic catchment. It is known that several Boroughs within this area experience basement flooding as a result of sewer surcharge following heavy rainfall. The basement flooding is caused by the sewer network in the Counters Creek catchment being filled from the connections in the upstream Boroughs.

Phase 4 Implementation and Review

The action plan for the London Borough of Camden is set out in phase 4 and identifies actions to implement the preferred options identified for the CDAs in the Borough as set out in Phase 3. In addition to this, the action plan identifies actions that will assist the Borough to deliver its responsibilities as LLFA under the FWMA.

Glossary

Term	Definition
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan
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.
AStSWF	Areas Susceptible to Surface Water Flooding
BGS	British Geological Survey
Catchment Flood Management Plan	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
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
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums must 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 or sewage at or below the level of the ground.
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
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.
DTM	Digital Terrain Model
EA	Environment Agency
FCERM	National Strategy for Flood and Coastal Erosion Risk Management
FMfSW	Flood Map for Surface Water
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).

Term	Definition
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG.
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.
Floods and Water Management Act	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 and groundwater flood risk in England.
FLIPS	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.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR	Flood Risk Regulations
IDB	Internal Drainage Board
Indicative Flood Risk Areas	Areas determined by the Environment Agency as indicatively 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
LB	London Borough
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone
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
Lead Local Flood Authority	Local Authority as defined in the FWMA responsible for taking the lead on local flood risk management
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
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.
LPA	Local Planning Authority
LRF	Local Resilience Forum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency have duties and powers
MSfW	Making Space for Water

Term	Definition
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment
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 generated from a rainfall event and 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 in sufficient capacity to cope with additional flow.
PPS25	Planning and Policy Statement 25: Development and Flood Risk
PA	Policy Area
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
Receptor	In flood risk management, receptor is defined as anything that is affected by flooding such as people, property, transport links and habitats.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	As defined by the Floods and Water Management Act; (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
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment

Term	Definition
Significant Harmful Consequences	Memorable past floods or otherwise registered on a national scale (such as the summer 2007 event) even if only occurring over a relatively small area
SMP	Shoreline Management Plan
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.
SuDS	Sustainable Drainage Systems
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.
Surface Water	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
TfL	Transport for London
TWUL	Thames Water Utilities Ltd
WAG	Welsh Assembly Government
WaSC	Water and Sewerage Company

Contents

Appendices

Figures

The following figures are included in the body of the report. Additional figures are included in Appendix D

1.0 Introduction

1.1 What is a Surface Water Management Plan?

1.1.1 A Surface Water Management Plan (SWMP) is a plan 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 water courses and ditches that occurs as a result of heavy rainfall.

1.1.2 This SWMP study has been undertaken as part of the Drain London Project in consultation with key local partners who are responsible for surface water management and drainage in the London area – including Thames Water, the Environment Agency and Transport for London. 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.

1.1.3 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

1.2.1 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 is split between the local planning authorities and other organisations such as Transport for London, London Underground, Network Rail and relationships with the Environment Agency and Thames Water and other sources of flood risk were unclear. To give the issue even greater urgency it is widely expected that heavy storms will increase in frequency with climate change.

1.2.2 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).

1.2.3 Defra recognized the importance of addressing surface water flooding in London and fully funded the Drain London project. The Drain London project is broken down using a 'tier' based approach as shown below in **Figure 1.1**.

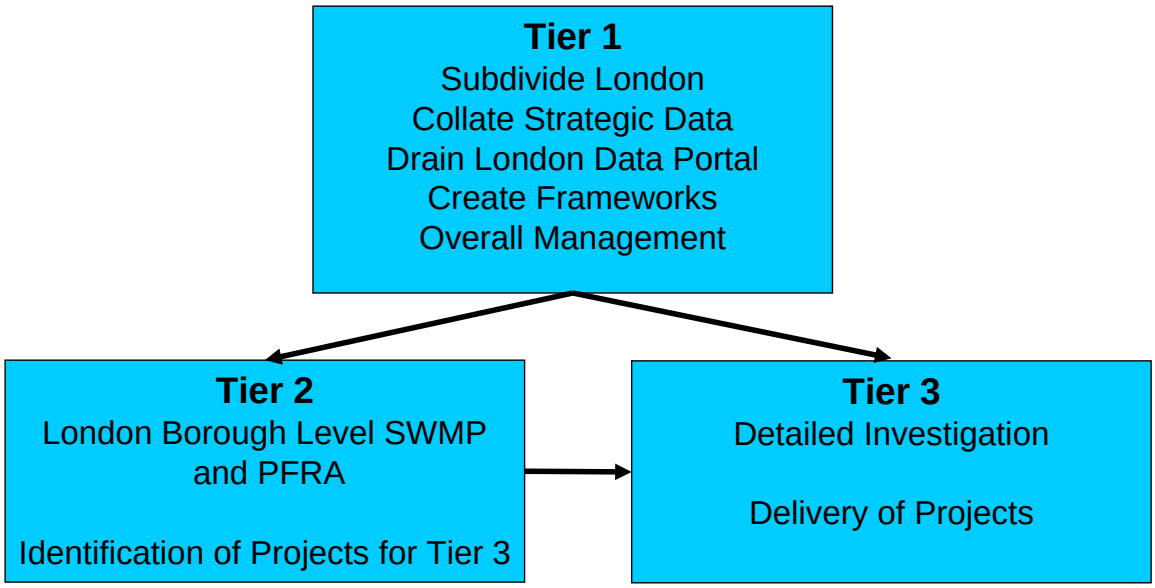


Figure 1.1: Drain London Project 'Tier' Structure

1.2.4 **Table 1.1** below further describes the activities undertaken in each of the Tiers. The management groups are shown in **Figure 1.2**. This SWMP report is a direct output from Tier 2.

Table 1.1: Summary of 'Tier' Activities

Tier	Summary
Tier 1	a) A high level strategic investigation to group the 33 separate boroughs into a smaller number of more manageable units for further study under Tiers 2 and 3. b) Collection and collation of relevant information across all London Boroughs and strategic stakeholders including the Environment Agency, Thames Water and Transport for London. c) Development of a web based 'Portal' to provide data management, data storage and access to the various data sets and information across the 'Drain London Forum' (DLF) participants and to consultants engaged to deliver Tiers 2 and 3. d) Develop technical framework documents and prioritisation tools to guide delivery of Tiers 2 and 3.

Tier	Summary
Tier 2	a) Delivery of 33 Borough-level intermediate Surface Water Management Plans (SWMPs) within the management groups to define and map Local Flood Risk Zones, Critical Drainage Areas and flood policy areas and produce an Action Plan for each borough. b) Delivery of 33 Borough-level Preliminary Flood Risk Assessments to comply with the Flood Risk Regulations 2009 requirements for Lead Local Flood Authorities (LLFAs). c) Define a list of prioritised Critical Drainage Areas for potential further study or capital works in Tier 3, using the prioritisation tool developed in Tier 1.
Tier 3	a) Further investigations into high priority Local Flood Risk Zones/Critical Drainage Areas to further develop and prioritise mitigation options. b) Delivery of demonstration projects of surface water flood mitigation solutions identified in Tier 2 SWMPs. c) Funding or co-funding within the London area for green roofs and other types of sustainable urban drainage (SUDS). d) Set up of at least two community flood plans in local communities at risk from flooding

1.2.5 The objective of the Drain London Tier 2 is to produce draft Surface Water Management Plans (SWMPs) for each London Borough. Through the subsequent enactment of the FWMA, boroughs are required to produce Preliminary Flood Risk Assessments (PFRA). The Drain London project has been adjusted to deliver both a PFRA and an SWMP for each London Borough. This will be a major step in meeting borough requirements as set out in the FWMA. Another key aspect of the Act is to ensure that boroughs work in partnership with other Lead Local Flood Authorities and agencies. Drain London assists this by organising London Boroughs into different groups creating sub-regional partnerships that encourage partnership working as set out in **Figure 1.2**.

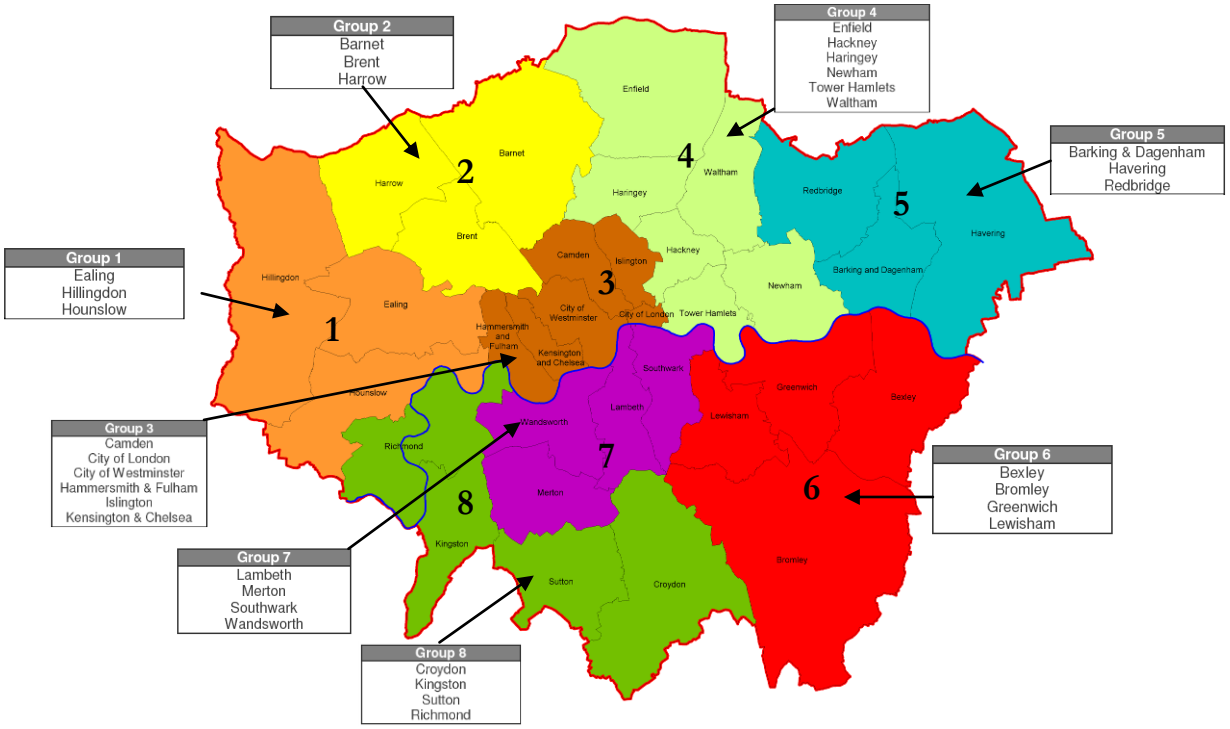


Figure 1.2: Drain London Sub-regional Partnerships

1.3 Objectives

1.3.1 The objectives of the SWMP are to:

- Develop a robust understanding of surface water flood risk in and around the London Borough of Camden, taking into account the challenges of climate change, population and demographic change and increasing urbanisation in London;
- Identify, define and prioritise Critical Drainage Areas, including further definition of existing local flood risk zones and mapping new areas of potential flood risk (see definitions in Section 3.8);
- Make holistic and multifunctional recommendations for surface water management which improve emergency and land use planning, and enable better flood risk and drainage infrastructure investments;
- Establish and consolidate partnerships between key drainage stakeholders to facilitate a collaborative culture of data, skills, resource and learning sharing and exchange, and closer coordination to utilise cross boundary working opportunities;
- Undertake engagement with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions;
- Deliver outputs to enable a real change on the ground rather than just reports and models, whereby partners and stakeholders take ownership of

their flood risk and commit to delivery and maintenance of the recommended measures and actions;

- Meet the London Borough of Camden's specific objectives as recorded during the development of the SWMP (see further details below);
- Facilitate discussions and report implications relating to wider issues falling outside the remit of this Tier 2 work, but deemed important by partners and stakeholders for effectively fulfilling their responsibilities and delivering future aspects of flood risk management.

1.3.2 Specific aims and objectives were discussed at the various meetings held throughout the development of the SWMP. These are summarised below:

- Ensure where possible the SWMP is consistent with the North London Strategic Flood Risk Assessment (SFRA) undertaken by the London Borough of Camden and neighbouring boroughs.
- Develop a SWMP action plan that is specific to the London Borough of Camden and which builds on Group 3 stakeholder workshops.
- Ensure the SWMP action plan promotes the integration and ownership of the relevant departments within the London Borough of Camden (those departments that deal with highways, parks, development control, emergency planning, etc).
- Investigate if the SUDS Approval Authority role (as required by the FWMA next year) could be led at Group 3 level.

1.4 Study Area

1.4.1 Topography and Land Use

The study area covers the administrative boundary of the London Borough of Camden (see **Figure 1.3**). It is located in the north of London and covers an area of approximately 21.8km^2. The London Borough of Camden sits between the London Boroughs of Barnet and Haringey to the north, London Borough of Islington to the east, the City of London and City of Westminster to the south and the London Borough of Brent to the west. The national A1 travels through the Borough and three of the fourteen central London's railway terminals are located in the borough; Euston, St. Pancras International and Kings Cross. In addition the London Underground Circle, Hammersmith and City, Jubilee, Metropolitan, Northern, Piccadilly and Victoria lines run throughout the Borough.

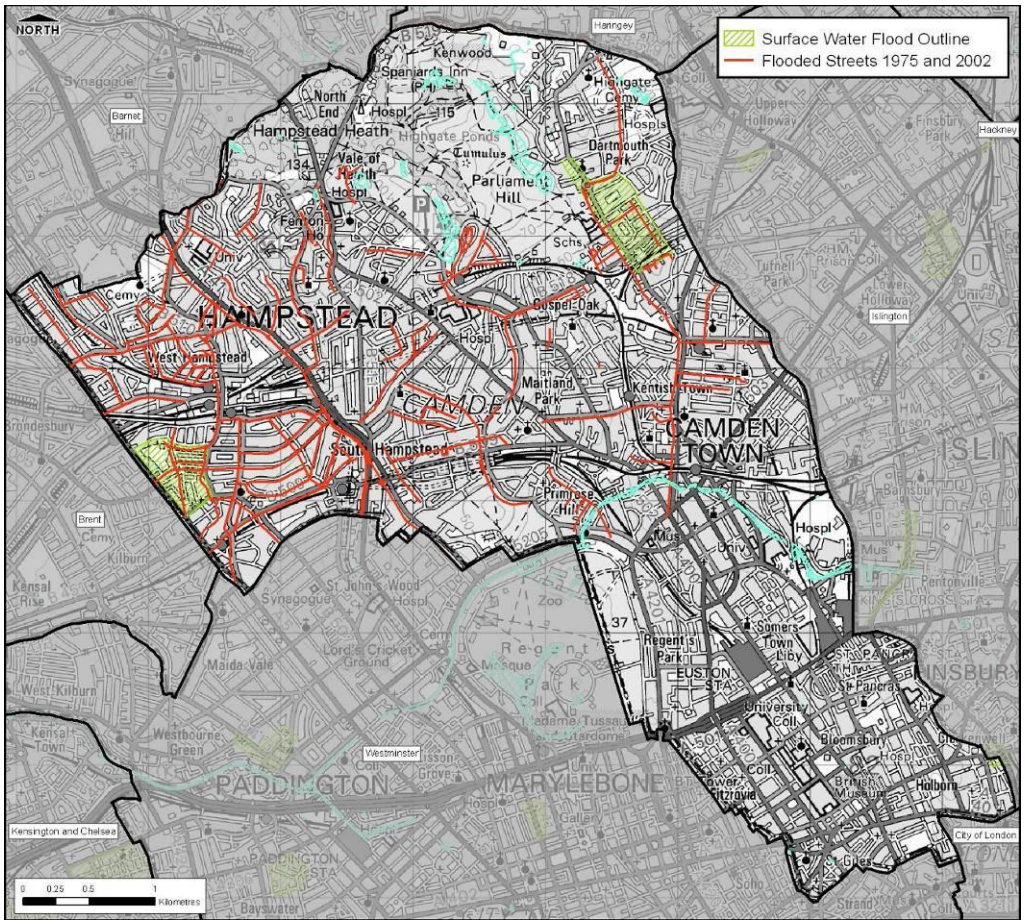


Figure 1.3 - Study Area and Locations of Past Floods

1.4.2 The **LiDAR Topographic Survey Map (Figure 1.4.1, Appendix D)** shows that the north of the Borough falls from a high point of 137m AOD either side of a ridge line between Hampstead Heath and South Hampstead, towards Camden Town in the east and Kilburn in the west. From Camden Town the general terrain continues to fall towards Somerstown, St Pancras and Holborn to the south which is around 10m AOD.

1.4.3 The predominant land uses within the London Borough of Camden are shown in the **Land Use Areas Map (Figure 1.4.2, Appendix D)**. There is a varied mix of land-uses in the Borough including a number of entertainment and tourist attractions such as theatres and Camden Market. The borough stretches from Hampstead Heath (one of the largest open spaces in the capital) through Camden Town, Euston and Kings Cross to central London. Parts of central London such as Holborn, St Giles and Covent Garden are amongst the capital's most built-up areas.

1.4.4 The Regents Canal runs from west to east and bisects Camden borough. The River Fleet, which is formed from two springs on Hampstead Heath, is the largest of London's subterranean rivers and historically drained the Camden area. The Fleet has long since been incorporated into the London sewer

network although the traditional route of the Fleet and the large sewer in its place can still be traced in the south of the Borough as it passes into the City of London. Highgate and Hampstead Ponds were constructed to increase London's water supply. They are fed by the Fleet and are now used by the public for leisure activities.

1.4.5 Camden contains important national and local infrastructure. This includes four main-line railway stations (Kings Cross, St Pancras, Euston, and the new St Pancras International terminal) and an extensive bus and tube network. Camden also contains a wide range of commercial activities and houses a large proportion of the University of London's activities, including University College London (UCL). Camden is also home to major teaching hospitals including University College Hospital (UCH) and the Royal Free Hospital, as well as much of the country's legal centre.

1.4.6 Camden has a rich heritage of historic buildings and open spaces. Conservation areas cover over 50% of the borough and there are more than 5600 listed buildings. Camden also contains one designated monument, Boadicea's mound on Hampstead Heath which is managed by the Corporation of London.

1.4.7 Most of the significant development proposals identified in Camden's Site Allocations Issues and Options document are based around transport interchanges where increased capacity is planned. These include: a) King's Cross and surrounds (the borough's largest development area), b) Euston Station and surrounds, c) High Holborn Area, d) Tottenham Court Road Area, e) West Hampstead Interchange, f) Swiss Cottage Area and g) Camden Town.

1.5 Historic Flooding

1.5.1 Camden had a major flood event in 1975 and more recently suffered widespread surface water flooding in the summer of 2002 due to a high intensity rainfall event.

1.5.2 Areas north of the Regents Canal, including Hampstead were particularly badly hit in the 2002 events. The flooding inflicted considerable damage to properties and public services and facilities. The flood event was caused by excessive rainfall causing the main sewer system to become completely inundated. The surcharge pressure forced the water to back onto the streets through manholes and gully gratings and into residents' homes at basement and ground floor level. Thames Water's evidence confirmed that the flooding was caused by its sewer system reaching maximum capacity very quickly so that surface water could not be drained at the rate the rain fell.

1.5.3 **Interactions with Neighbouring Local Authorities**

1.5.4 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.

1.5.5 As outlined in **Figure 1.3** the Borough shares boundaries with the London Boroughs of Barnet, Haringey (North), Islington (East), Brent (West) and the City of London and City of Westminster (South). Modelling and mapping of surface water flow routes for extreme events demonstrates that the London Borough of Camden has only a few minor flow routes that do not extend far into and out of the Borough. These routes are observed in locations outlined below (see **Figure D8b**, **Figure D9b**, **Figure D10b** and **Figure D11b** in **Appendix D**).

- West into London Borough of Brent from the Hampstead area.
- From London Borough of Islington into Camden along the A5203 into St Pancras.

1.5.6 The Thames Water drainage system conveys foul flow together with surface runoff that enters the system through drain pipes and road gulleys. North of the River Thames, a series of deep east – west interceptor sewers collect high level sewers draining south towards the river, transporting all flows to Becton sewage treatment works in east London. Through this underground system (**Figure 1.4**), the London Borough of Camden receives flows from Westminster and Brent (in the west). It transfers flow towards Islington in the east.

Figure 1.4: The Beckton Sewer Catchment

1.5.7 **Future Urbanisation and Development**

1.5.8 The London Borough of Camden's growth strategy is set out in policy CS6 of the borough's Core Strategy (adopted November 2010). This outlines an increase in housing by 8,925 properties over the lifetime of the plan (2028)

with a target set in the London plan of 5,950 houses to 2016/17, annualised to 595 a year.

1.5.9 Future growth is planned primarily for the areas of King's Cross, Euston, Tottenham Court Road, Holborn and West Hampstead Interchange. Appropriate development is also planned at other highly accessible locations, in particular Central London and the town centres of Camden Town, Finchley Road/Swiss Cottage, Kentish Town, Kilburn High Road and West Hampstead.

1.5.10 Future flood risk has been considered as part of the London Regional Flood Risk Assessment and redevelopment in the Borough's growth areas will need to improve surface water management and reduce flood risk.

1.5.11 Plans for further urbanisation and change of land use within the Borough 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.

1.5.12 The SWMP for London Borough of Camden provides guidance and recommendations for the sustainable long term management of surface water flood risk in the Borough.

1.6 Flooding Interactions

1.6.1 Interactions with sewer flooding have been observed in Camden. Surface water flooding mainly occurs when high intensity rainfall is not able to enter into the combined sewers. This mechanism of flooding can be combined with overflows from the combined sewers (out of gullies or blown out manhole covers) as a result of the storm event.

1.6.2 Whilst there is not considered to be any risk from fluvial sources, The River Fleet is one of London's "Lost Rivers" which historically originates from springs on Hampstead Heath and drains to the Thames approximately via Kentish Town, Camden Town and Holborn. Through Camden and the City of London The Fleet is entirely incorporated within the sewer network, owned and maintained by Thames Water. The Fleet would have been the main drainage body for the Camden area and any future development activities in Camden could have significant impacts on flood risk within the City of London if they are not adequately managed (Strategic Flood Risk Assessment for North London, August 2008).

1.6.3 Other sources of flood risk include the Regent's Canal, which flows east across the Borough and the Hampstead Ponds to the North.

1.6.4 **Regents Canal**

Regents Canal was constructed in 1820 to form the London arm of the Grand Union Canal. It stretches from Limehouse basin in Docklands to Paddington passing through Mile End, Hackney, Islington, King's Cross, Camden, Regents Park and Little Venice. Currently, the Camden lock system apparently holds a head of water of some 25 miles. The water levels within the Regents Canal are controlled by British Waterways and for this reason they are considered to pose a minimal risk of flooding.

1.6.5 **Hampstead Ponds**

The interaction between Hampstead ponds and a large pluvial event which may result in overtopping in Hampstead Heath has been considered as part of the modelling work undertaken in the SWMP study. The SWMP has not, however, considered the consequences of a breach, emergency draw down (where the reservoirs have the facility to be emptied at a faster than normal rate) or the works the City of London are planning to carry on the dams because it is outside of the scope of this study.

1.6.6 **Thames Water Combined Sewer Network**

Most of the London Borough of Camden is drained by combined sewer which receives foul flow together with surface runoff from roofs, roads and other areas of hard standing. The sewerage network was designed in the 1860s and has served London well. Over time the area connected to the sewer network has increased progressively reducing its capacity to accommodate heavy rainfall.

1.7 Linkages to Other Plans

1.7.1 The increased focus on flood risk over recent years is an important element of adaptation to climate change. The SWMP is a live document that should complement and coordinate with existing strategic and local plans. How Drain London links into these documents is set out below:

1.7.2 **Regional Flood Risk Appraisal (RFRA)**

This is produced by the Greater London Authority and gives a regional overview of flooding from all sources. The RFRA will be updated in 2012 to reflect the additional information on local sources of flood risk (surface water, groundwater and ordinary watercourses) from Drain London. This may also generate new policies that would be incorporated into the London Plan when it is reviewed.

Table 1.2: RFRA Strategic recommendations relevant to the London Borough of Camden

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 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.

1.7.3 **Thames Catchment Flood Management Plan (CFMP)**

The Thames Catchment Flood Management Plan 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 1.3: CFMP Policy Unit

TE2100 Policy Unit

The TE2100 Policy Unit covers the whole of Group 3 including the London Borough of Camden.

The preferred policy is Policy 4; Areas of low, moderate or high risk where the Environment Agency are 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.

1.7.4 **Preliminary Flood Risk Assessment (PFRA)**

These are required as part of the Flood Risk Regulations (see details in **Section 1.7**), which implement the requirements of the European Floods Directive. Drain London is producing one of these for each London Borough (LLFA), to give an overview of all local sources of flood risk. In London PFRAs will benefit from an increased level of information relating to surface water from the Drain London SWMPs. Boroughs will need to review these PFRAs every six years.

1.7.5 **Surface Water Management Plans (SWMP)**

Drain London is producing a draft SWMP for each London Borough (this document). They provide much improved probabilistic 2-dimensional modelling and data on what has been made available at a national scale by the Environment Agency. In addition they contain an Action Plan that has been developed in conjunction with both London Borough of Camden and relevant other Risk Management Authorities. This data, the actions and the associated policy interventions will need 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. This action plan will be consulted upon with residents and relevant agencies.

1.7.6 **Strategic Flood Risk Assessments (SFRA)**

Each local planning authority is required to produce a SFRA under Planning Policy Statement 25 (PPS25). This 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 relatively weak in evaluating flooding from other local sources including surface water, groundwater and ordinary watercourses.

1.7.7 **Local Development Documents (LDD)**

LDDs including the Core Strategy (adopted on 8 November 2010) and relevant Area Action Plans (AAPs) will need to reflect the results from Drain London. This may include policies for the whole Borough or for specific parts, for example Critical Drainage Areas. There may also be a need to review Area Action Plans where surface water flood risk is a particular issue. A future SFRA update will assist with this as will the reviewed RFRA and any updated London Plan policies. In producing Opportunity Area Planning Frameworks, the GLA and boroughs will also examine surface water flood risk more closely.

1.7.8 **Local Flood Risk Management Strategies**

The Flood and Water Management Act 2010 (FWMA) requires each LLFA to produce a LFRMS. The Flood Risk Regulations 2009 also require a Flood Risk Management Plan (FRMP) of Flood Risk Areas by December 2015. Whilst Drain London will not actually produce these, the SWMPs, PFRAs and their associated risk maps will provide the necessary evidence base to support

the development of LFRMS. No new modelling is anticipated to produce these strategies.

Figure 1.5 below illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.

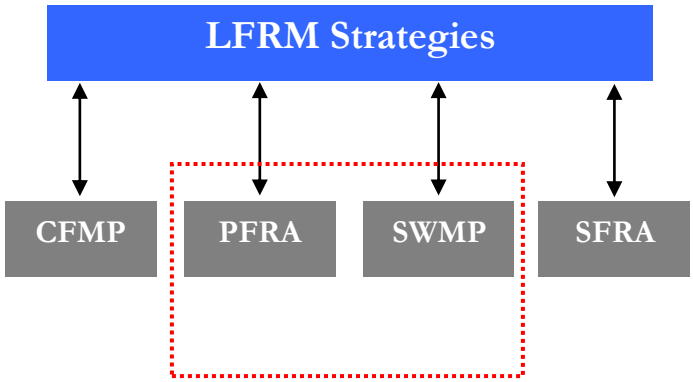


Figure 1.5 Linkages between Flood Risk Management Documents

1.7.9 **Strategic Environmental Assessment**

The Strategic Environmental Assessment (SEA) Directive (2001/42/EC) is implemented in the UK by 'The Environmental Assessment of Plans and Programmes Regulations 2004 (Statutory Instrument No.1633)'. Its objective is 'to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development'.

The flood risk management plans required under the Flood Risk Regulations 2009 fall under the scope of the SEA Directive.

1.8 Existing Legislation

1.8.1 The Flood and Water Management Act 2010 (FWMA) 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 (Lead Local Flood Authorities – LLFA) have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater.

1.8.2 The FWMA 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.

1.8.3 The FWMA 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:

1) Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) to be completed by Lead Local Flood Authorities and the Environment Agency by the 22 December 2011. Flood Risk Areas, at potentially significant risk of flooding, will also be identified. Maps and management plans will be developed on the basis of these flood risk areas.

2) Flood Hazard Maps and Flood Risk Maps. The Environment Agency and Lead Local Flood Authorities 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.

3) Flood Risk Management Plans. The Environment Agency and Lead Local Flood Authorities 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.

Figure 1.6 illustrates how this SWMP fits into the delivery of local flood and coastal erosion risk management (FCERM), and where the responsibilities for this lie.

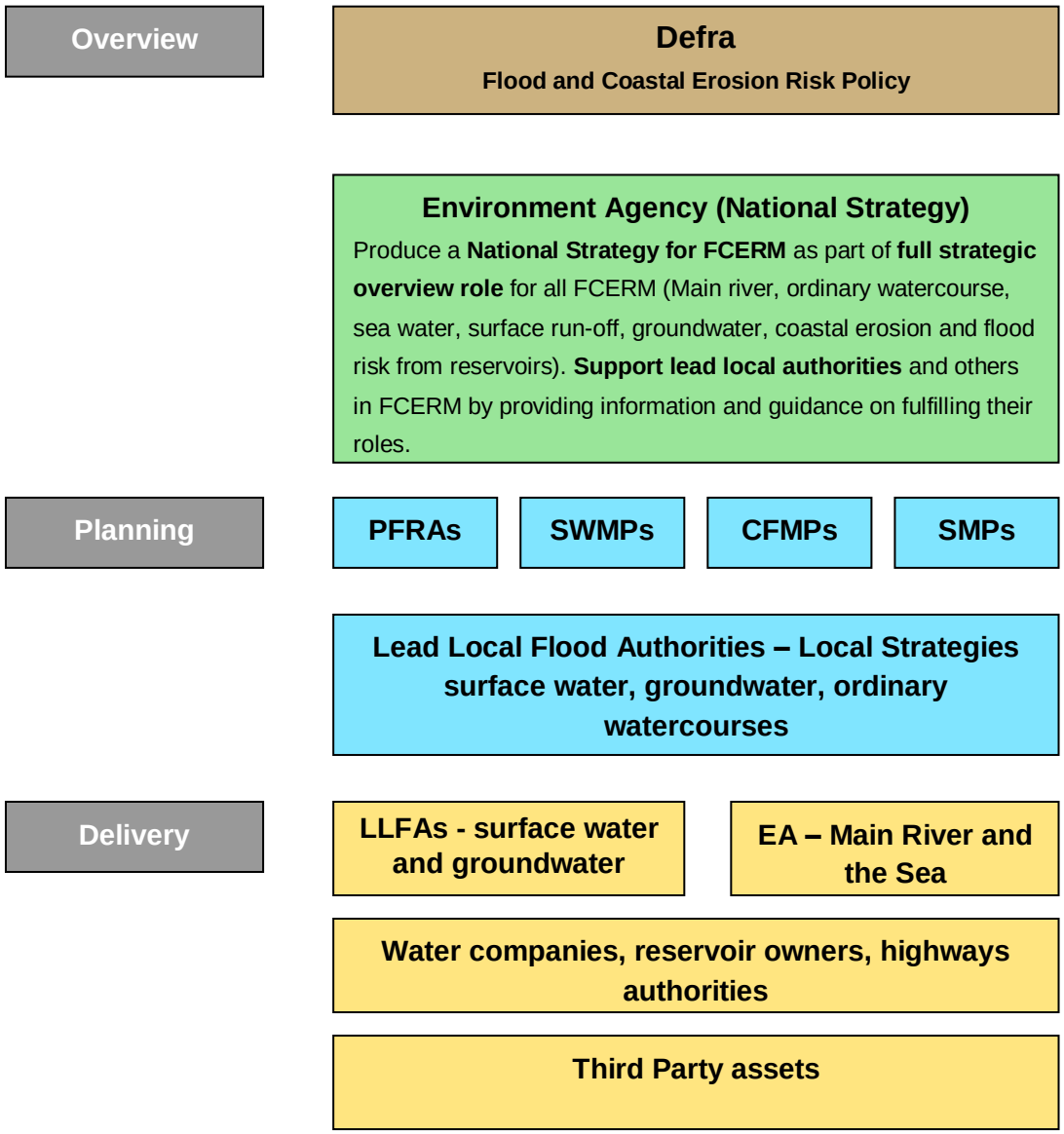


Figure 1.6 - Delivery of Local FCERM

1.9 Peer Review

1.9.1 It is essential for the Drain London Project that SWMPs are consistent and comparable across Greater London. This is to facilitate:

- Fair, transparent and rapid allocation of funds to identified high priority flood risk areas within London;
- Collaborative working practices between stakeholders; and
- Building of local capability (Council officers and consultants doing work in the future will be able to make use of outputs regardless of who produced them for each Borough).

1.9.2 To ensure consistency and comparability between London Borough SWMPs produced, a Peer Review process has been used. The process involved the four consultant teams working on the Drain London SWMPs independently reviewing each others work. This has ensured that all outputs result from a

consistent technical approach, are of a high technical quality and are communicated in the specified formats. The peer review report for this SWMP is included in **Appendix F**.

2.0 Phase 1 – Preparation

2.1 Leadership and Partnership

2.1.1 As Lead Local Flood Authority, it is the role of the London Borough of Camden to forge effective partnerships with the adjacent LLFA and the Environment Agency (this is currently the case with the Drain London project) as well as other key stakeholders – Thames Water, Network Rail, Transport for London and the Highways Agency. Some progress has been made toward establishing these partnerships already, although Network Rail and the Highways Agency have not yet fully engaged with the process. Ideally working arrangements should now be formalised by the LLFA 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).

Figure 2.1 provides a schematic of the recommended partnership and stakeholder arrangements:

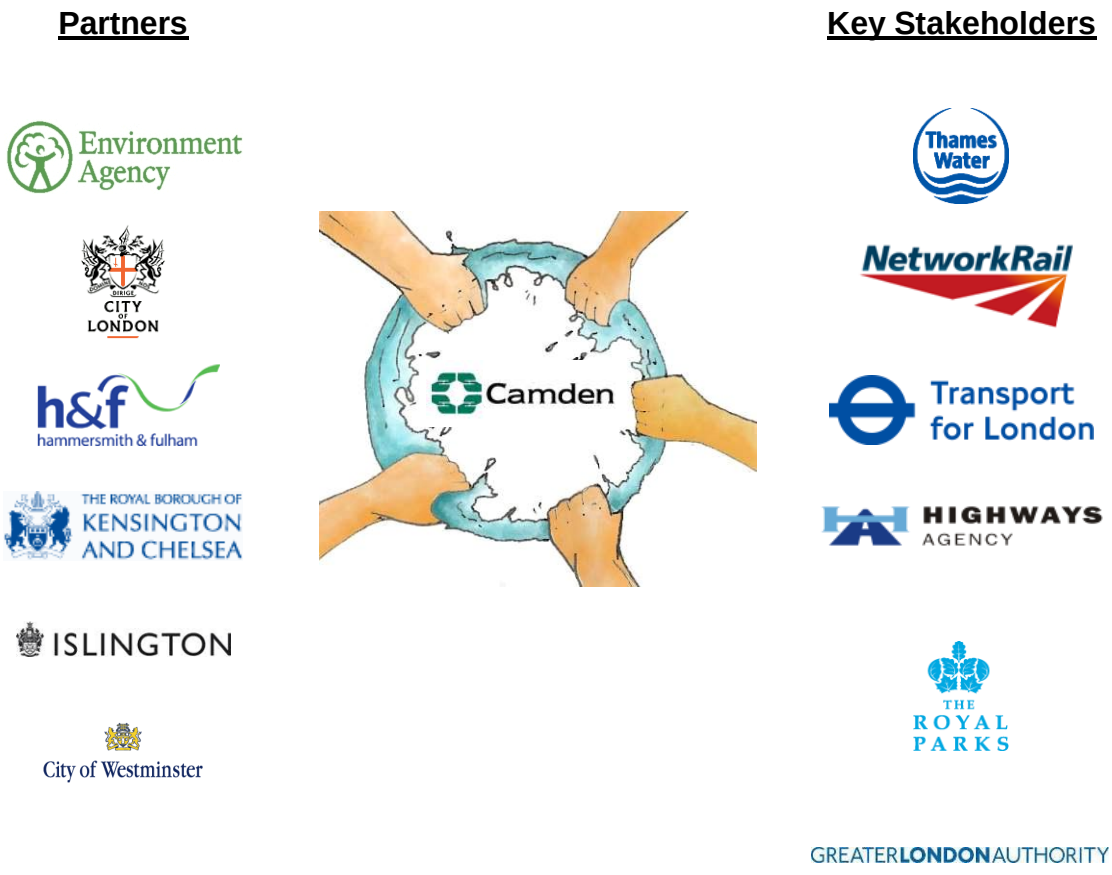


Figure 2.1 - Partnership and Main Stakeholder Schematic Diagram

2.1.2 **Public Engagement**

It is recommended that the best vehicle for engaging the public is by integrating the management of local flood risk with other Borough initiatives, such as integrating with emerging development proposals and improving the amenity of parks and open spaces. This approach will require a sustained and coordinated approach within the Borough.

2.1.3 It is recognised that members of the public may also have valuable information to contribute to the SWMP. Stakeholder engagement can be of significant benefit 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 in future flood risk management plans.

2.1.4 It is important to undertake some public engagement when formulating local flood risk management plans as this will help to inform future levels of public engagement. It is recommended that London Borough of Camden follow the guidelines outlined in the Environment Agency's 'Building Trust with Communities' document that provides a useful process of how to communicate risk including the causes, probability and consequences to the general public and professional forums such as local resilience forums.

2.2 Data Collection

The collection and collation of strategic level data was undertaken as part of the Tier 1 work and disseminated to Tier 2 consultants by the GLA. Data was collected from each of the following organisations:

- London Borough of Camden
- British Airports Authority
- British Geological Survey
- British Waterways
- Environment Agency
- Greater London Authority
- Highways Agency
- London Underground
- Network Rail
- Thames Water
- Transport for London

2.2.1 A comprehensive data set was passed onto Tier 2 consultants and in some cases additional supplementary data was provided by individual organisations.

2.3 Data Review

2.3.1 The key information that was obtained is listed in **Table 2.1** below. A full list of the information is included in the Data Gap and Licensing Report issued by Tier 1 Consultants in October 2010.

Table 2.1 – Summary of Key Drain London Tier 1 Data

Source	Data/Studies
Environment Agency	Environment Agency Asset Data; Water Studies (including Thames Catchment Flood Management Plan, Thames Catchment Abstraction Management Strategy and Thames River Basin management Plan); Historic flood data (GIS flood event outlines extracted from NFCDD); Geostore data including Main River details, flood data for areas vulnerable to surface water flooding and Digital River Network (DRN) data for London; Numerous fluvial and surface water models located in the Greater London area; London hydrometric data including groundwater level data, rainfall data and river flow data; and Details of Flood Warning Areas in London
The London Borough of Camden	North London Strategic Flood Risk Assessment and mapping (includes SW mapping); West Hampstead flood relief scheme overview; Flooded streets 1975 and 2002 event; Multi-Agency Flood Plan For London Borough of Camden Floods in Camden Scrutiny Panel Report (December 2002 and May 2003) Camden pilot retrofit SUDS schemes
Thames Water	Foul water and surface water sewer network models in GIS format; Pumping station and manhole locations.
Other (Highways Agency, Transport for London, Network Rail, Local flood groups, fire brigade, etc)	Various assets; Flood records; GIS layers for land use types; BGS Susceptibility to Groundwater Flooding

2.3.2 Additional information has been obtained from the London Borough of Camden through an initial site visit followed by a more detailed virtual site visit/workshop of areas at risk of flooding.

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

a) the SFRA for the Borough is relatively recent (completed in November 2009),

b) it has been thoroughly reviewed more than once by the Borough and the Environment Agency,

c) it has been formally approved by the Borough through the LDF planning process and

d) it has gathered relevant information from relevant local previous studies (Level 2 SFRA, FRAs, etc).

2.3.4 Virtual site visits/workshops were undertaken with staff from the Environment Agency, London Borough of Camden and Halcrow to identify local flood risk areas. This involved 'virtual walks using a GIS environment and the use of Google Street View for 3D images.

2.3.5 The key GIS datasets used for the main stages of the SWMP and the virtual site visits are:

a) OS maps,

b) the Thames Water pipe network system,

c) the river networks,

d) the flood zones and the historic flood map from the Environment Agency,

e) flood incident records,

f) local flood risk data from strategic data providers (for example the fire brigade),

g) the Environment Agency national Flood Map for Surface Water (FMfSW),

h) the Drain London surface water hazard and flood depth maps produced by Halcrow for the Borough,

i) a digital terrain model from LiDAR data to identify catchment boundaries and terrain gradients,

j) Thames Water postcode records of flooding,

k) the National Receptor Database and

l) the potential for elevated groundwater maps.

Appendix A provides further details of this data and their quality score

2.4 Other Responsibilities

2.4.1 Aside from forging partnerships and coordinating and leading on local flood management there are a number of other key responsibilities that have arisen for LLFAs from the FWMA and the FRR. These responsibilities include:

2.4.2 **Investigating Flood Incidents**

Section 12 of the FRR 2009 outlines that LLFAs have a duty to investigate and record details of significant flood events within their area.

2.4.3 **Asset Register**

Section 21 of the FWMA 2010 sets a duty on each London Borough (LLFA) to maintain a register of structures or features, and a record of information about each of those structures or features, which, in the opinion of the authority, are likely to have a significant effect on flood risk in its area. From the 6 of April 2011 all LLFAs have a duty to maintain a register. The legal characteristics of the register and record are outlined below:

Table 2.2 – Main characteristics of the Asset Register

	Register	Record (includes details of ownership and condition)
a.	Must be made available for inspection at all reasonable times.	Up to the LLFA to decide if they wish to make it available for inspection
b.	Must contain a list of structures or features which in the opinion of the authority, are likely to have a significant effect on a local flood risk.	For each structure or feature listed on the register, the record must contain information about its ownership and state of repair.
c.	s.21 (2) of the Act allows for further regulations to be made about the content of the register and record. There is currently no plan to provide such regulations therefore their content should be decided on by the LLFA depending on what information will be useful to them.	
d.	There is no legal requirement to have a separate register and record although as indicated above, only the register needs to be made available for public inspection.	

2.4.4 Defra have provided each LLFA with templates to demonstrate what information should be contained in the asset register. Although these templates are not intended as a working tool, they provide a good example of how an asset register might be structured.

2.4.5 Populating the asset register is outside the scope of the Drain London project and is the responsibility of each London Borough. The expectation from Defra is that LLFAs (London Boroughs) will utilise a risk-based approach to populate the register and record which of those structures or features are considered the most significant first.

2.4.6 The London Borough of Camden has included the population of the asset register in its SWMP action plan. The Borough aims to start populating this register during this financial year (2011-2012) focussing on the most significant assets to begin with.

Appendix B provides a summary of the current status of the asset register for London Borough of Camden as well as recommendation for suggested actions.

2.4.7 **SuDS Approval Body (SAB)**

The FWMA 2010 establishes a SuDS Approval Body (SAB) at county or unitary local authority level (within London at Drain London Group level) to ensure national standards of sustainable drainage are enforced. Developers will be required to gain approval of their proposed drainage systems before they can begin construction. The SAB will be responsible for adopting and maintaining SuDS that serve more than one property, other than on public roads which are the responsibility of the Highways authority.

2.4.8 **Local Flood Risk Management (LFRM) Strategies**

LLFAs are required to develop, maintain, apply and monitor a local strategy for flood risk 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.

2.4.9 **Works Powers**

LLFAs have powers to undertake works to manage local flood risk, consistent with the local flood risk management strategy for the area.

2.4.10 **Designation Powers**

LLFAs, as well as the Environment Agency have powers to designate structures and features that affect flooding or coastal erosion in order to safeguard assets that are relied upon for flood or coastal erosion risk management.

3.0 Phase 2 – Risk Assessment

3.1 Intermediate Assessment

3.1.1 The aim of the Phase 2 Intermediate Risk Assessment is to identify the sources and mechanisms of surface water flooding across the study area which are achieved through an intermediate assessment of pluvial flooding, sewer flooding, groundwater flooding and flooding from ordinary watercourses along with the interactions with main rivers and the sea. The modelling outputs are then mapped using GIS software.

3.1.2 SWMPs can function at different geographical scales and therefore necessarily at differing scales of detail. **Table 3.1** defines the potential levels of assessment within a SWMP. This SWMP has been prepared at a 'Borough' scale, fulfilling the objectives of a second level 'Intermediate Assessment', highlighted in green below.

Table 3.1: SWMP Study Levels of Assessment [Defra 2010]

Level of Assessment	Appropriate Scale	Outputs
1. Strategic Assessment	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.
2. Intermediate Assessment	Borough wide	Identify flood hotspots which might require further analysis through detailed assessment. Identify immediate mitigation measures which can be implemented. Inform spatial and emergency planning.
3. Detailed Assessment	Known flooding hotspots	Detailed assessment of cause and consequences of flooding. Use to understand the mechanisms and test mitigation measures, through modelling of surface and sub-surface drainage systems.

3.1.3 As shown in **Table 3.1** above, the intermediate assessment is applicable across a large town, city or borough. In the light of repeated historical flooding and the results from the over-arching national pluvial modelling (FMfSW 1:200yr event) suggesting that there are 19,100 properties at risk across the Borough, it has been considered appropriate to adopt this level of assessment to further quantify the risks.

3.1.4 The purpose of this intermediate assessment is to further identify those parts of the Borough that are likely to be at greater risk of surface water flooding and require more detailed assessment. The methodology used for this SWMP is summarised below. Further detail of the methodology is provided in **Appendix C**.

- A Direct Rainfall approach using TuFLOW software has been selected whereby rainfall events of known probability are applied directly to the ground surface and is routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond.
- The outputs of the 2-dimensional pluvial modelling were reviewed at a large scale and compared against the SFRA pluvial modelling outputs, via the virtual site visits undertaken with key London Borough of Camden staff and the Environment Agency.

3.1.5 The outputs from the pluvial modelling are verified (where possible) against the historic surface water flood records.

3.2 Risk Overview

3.2.1 **Mapping of Surface Water Flood Risk**

The mapping shown within this report (**Figure 3.2.1a, Figure 3.2.1b** and **Appendix D**) is suitable to identify broad areas which are more likely to be vulnerable to surface water flooding. This will allow the London Borough of Camden and its partners to undertake more detailed analysis in areas which are most vulnerable to surface water flooding.

3.2.2 In addition, the map can also be used as an evidence base to support spatial planning process to ensure that surface water flooding is appropriately considered when allocating land for housing development. The map can be used to assist emergency planners in preparing their Multi-Agency response plans.

3.2.3 The Drain London maps show the predicted likelihood and extent of surface water flooding across all boroughs. They are good at predicting overland flow paths and areas where surface water flooding might occur in local depressions. They are adequate at representing the flooding from drains, small watercourses and ditches (known as ordinary watercourses). They do not represent the mechanisms that cause sewer flooding although sewer

flooding can be more likely to occur in low lying areas with flat gradients; the same locations where surface water ponds. Due to the coarse nature of the source data used, these are not detailed or accurate enough to reliably predict flooding at individual properties.

3.2.4 There may also be particular occasions when flooding occurs and the observed pattern of flooding does not in reality match the predicted patterns shown on these maps. The maps reflect all the data provided and have been produced using expert knowledge to create conclusions that are as reliable as possible. It is essential that the users of the maps understand the complexity of the data utilised in their production and are also aware of the limitations and uncertainties in the mapping and modelling (see **Section 3.3** and **Appendix C**). The maps are not intended to be used in isolation.

3.2.5 The London Borough of Camden and the Drain London Tier 1 and Tier 2 Consultants will not be liable if the maps by their nature are not as accurate as might be desired or are misused or misunderstood despite warning.

3.2.6 **Mapping of Fluvial/Tidal Flood Risk**

The London Borough of Camden does not fall within the Environment Agency's Fluvial flood zones and therefore is not at significant risk from fluvial or tidal flooding. For this reason, **Figure 3.2.2 – Environment Agency Flood Map** has been omitted from this report.

3.2.7 **Summary of Definitions**

The following terminology is used throughout the SWMP. The spatial scale of these areas follows a hierarchy and is presented below from the smallest to largest:

1. **Local Flood Risk Zone (LFRZ)** is a discrete area of flooding that does not exceed the national criteria for a Flood Risk Area but affects houses, businesses and/or local infrastructure. The boundary is defined as the actual spatial extent of predicted flooding in a single location.
2. **Critical Drainage Area (CDA)** is a discrete geographic area where multiple and interlinked sources of flood risk cause flooding in one of more LFRZs during severe weather affecting people, property and/or local infrastructure.
3. **Policy Area (PA)** is one or more CDAs 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.
4. **Indicative Flood Risk Area (iFRA)** defined by Defra and the Environment Agency for the purposes of the PFRA. Greater London is covered by an Indicative Flood Risk Area.

3.3 Surface Water Flooding

3.3.1 Mechanism of Flooding

Surface water flooding or pluvial flooding occurs in the London Borough of Camden when intense rainfall is unable to soak sufficiently into the ground (this is normally the case along the large relatively impermeable paved and roof areas in the area) and when the road gulleys have insufficient capacity to allow all surface water to enter the sewer drainage network.

3.3.2 In these conditions surface water builds up locally if the ground terrain is flat or travels following prevailing terrain gradients. Surface water flooding then occurs at locations where surface water flow paths converge, at local dips in the ground and/or due to overland obstructions. In particular, basement properties are vulnerable.

3.3.3 It is important to note that the mechanism of surface water flooding can be combined with surcharge from the combined sewer network (see Section 3.6). Surface water may not be able to enter the combined system because it is already full or overflowing as a result of the same storm event or a previous storm event.

3.3.4 The LLFA is responsible for the management of surface water flooding and flooding from highway drainage. Flooding from the highway drainage infrastructure occurs as a result of limited inflow capacity of the road drains and may be worsened by gully blockages.

3.3.5 The London Borough of Camden's drainage infrastructure is currently in good working order and is regularly cleaned and maintained. Only 2.7% of the 9015 gullies do not function although any non functioning gullies in critical risk locations are prioritised and repaired. This is not to say that Camden's network or any Local Authority is capable of dealing with a 1 in 200 flood risk, therefore a potential solution is to investigate the volume of water which may possibly wash down from the highest risk areas such as Hampstead Heath and ponds and perhaps design measures on the heath in partnership with the Corporation of London to hold or slow the flow onto the public highway network. In conjunction with this additional capacity of the gully network around the South End Green area could be improved although this would require Thames Water's network being able to take this or also being upgraded.

3.3.6 Surface Water Flood Modelling

Surface water flood risk is assessed through hydraulic modelling. The Environment Agency has undertaken national scale surface water modelling that has delivered the Flood Map for Surface Water (FMfSW). The outputs identify areas at risk of surface water flooding resulting from the 1 in 30 year and 1 in 200 year rainfall events (see **Figure D2a** and **b**, **Appendix D**).

3.3.7 To support the SWMP for London Borough of Camden, strategic level and refined modelling was undertaken. A Direct Rainfall approach using TUFLOW software has been used whereby rainfall events of known probability are applied directly to the ground surface and generated flows are routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond. The following scenarios were modelled:

- Surface Water Flood Depth 1 in 30 annual chance 3.3% AEP (**Figure D8a**)
- Surface Water Flood Hazard 1 in 30 annual chance 3.3% AEP (**Figure D8b**)
- Surface Water Flood Depth 1 in 75 annual chance 1.3% AEP (**Figure D9a**)
- Surface Water Flood Hazard 1 in 75 annual chance 1.3% AEP (**Figure D9b**)
- Surface Water Flood Depth 1 in 100 annual chance 1% AEP (**Figure 3.2.1a**)
- Surface Water Flood Hazard 1 in 100 annual chance 1% AEP (**Figure 3.2.1b**)
- Surface Water Flood Hazard 1 in 100 annual chance 1% AEP plus climate change (**Figure D10a**)
- Surface Water Flood Depth 1 in 100 annual chance 1% AEP plus climate change (**Figure D10b**)
- Surface Water Flood Depth 1 in 200 annual chance 0.5% AEP plus climate change (**Figure D11a**)
- Surface Water Flood Hazard 1 in 200 annual chance 0.5% AEP plus climate change (**Figure D11b**)

3.3.8 **Model Output Limitations**

The modelling undertaken has limitations which should be taken into account when interpreting potential surface water flooding (see further modelling details in **Appendix C**). The main limitations are described below:

a) The combined sewers have not been modelled and therefore their variable capacity has not been taken into account (instead some of the rainfall has been removed at a constant rate of 6.5mm/hour everywhere).

b) The modelled topography uses a 5m resolution grid based upon 1m resolution LiDAR data with a 200mm vertical accuracy. Any features at a resolution smaller than 5m have not been modeled.

c) Obstructions such as railway embankments have been modelled however culvert crossings beneath them (unless clearly seen on OS maps) have not been modelled.

d) Infiltration has been modelled through the use of variable runoff rates depending on land use however this is limited to the land use defined in OS Mastermap.

e) The capacity of the watercourses has been modelled as bankfull and therefore there is a tendency for surface water build up along the river floodplain.

3.3.9 **Historical Surface Water Flooding**

The outputs of the surface water modelling have been validated against the historical flood records provided by the Drain London Tier 1 Consultants and the London Borough of Camden (see **Figure D1**).

3.3.10 The model outputs have identified and correlated with the locations of the properties flooded during the 2002 flood event, particularly, Gospel Oak and West Hampstead. The localised areas of ponding shown by the modelling are indicative of areas which may be more susceptible to problems such as roads or risk of flooding to ground floors and basements.

3.4 Ordinary Watercourse Flooding

Ordinary watercourses flow through The London Borough of Camden in the following locations:

- **Parliament Hill** – The interaction between Parliament Hill ponds and a large pluvial event which may result in overtopping has been considered as part of the modelling work undertaken in the SWMP study.
- **Regents Canal** - The risk of overtopping and breach of the Regents Canal has not been considered in detail as part of this SWMP study. Any locations of raised canal embankments should be considered in more detail in close partnership with British Waterways. The water levels within the Regents Canal are controlled by British Waterways and they are considered to pose a minimal risk of flooding.
- **Hampstead Heath** - The interaction between Hampstead ponds and a large pluvial event which may result in overtopping in Hampstead Heath has been considered as part of the modelling work undertaken in the SWMP study.

3.5 Groundwater Flooding

3.5.1 **Mechanism of Flooding**

Groundwater flows from the ground at the point where the water table meets the surface. Groundwater flooding is likely to occur in low-lying areas which are underlain by permeable rock (aquifers).

3.5.2 The London Borough of Camden sits primarily over the London Clay Formation with Hampstead Heath atop the Bagshot Formation/Claygate Member. To the south of the Borough from Euston Station to St Giles the Lynch Hill Gravel Member overlies the London Clay Formation with small

intrusions of the Langley Silt member to the north of Euston Station and a slightly larger occurrence of the Hackney Gravel Member towards Holborn.

3.5.3 The groundwater level in London is being addressed by the General Aquifer Research Development and Investigation Team (GARDIT) an informal group of interested parties, and through increased abstraction of groundwater, notably by Thames Water. Thames Water is opening 20 or more new pumping stations to extract groundwater to ensure the stability of water levels.

3.5.4 As part of the Drain London project, Jacobs/JBA combined a number of groundwater datasets to produce Increased Potential for Elevated Groundwater Maps. **Figure 3.2.3** 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.

3.5.5 Groundwater may become elevated by a number of means: a) above average rainfall for a number of months in Chalk outcrop areas; b) shorter period of above average rainfall in permeable superficial deposits, c) permeable superficial deposits in hydraulic continuity with high water levels in the river, d) interruption of groundwater flow paths; and e) cessation of groundwater abstraction causing groundwater rebound.

Groundwater flooding is under the responsibility of the LLFA.

3.5.6 **Groundwater Flood Assessment**

Groundwater flood risk is assessed through susceptibility mapping and any historical data. As part of the Drain London Project, Increased Potential for Elevated Groundwater Maps have been developed to identify where groundwater could be at, or near ground surface (see **Figure 3.2.3**).

3.5.7 **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.

3.5.8 The following four data sources have been utilised to produce the increased Potential for Elevated Groundwater map (**Map 3.2.3**):

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

3.5.9 The increased Potential for Elevated Groundwater map shows those areas within the 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.

3.5.10 This mapping indicates that elevated groundwater from permeable superficial soils are located at the southern end of the Borough and in particular from the adjacent Marylebone area to Euston Station, University College, St Pancras, and Bloomsbury with a pocket along the southern boundary with Westminster to the west of St Giles.

3.5.11 **Historical Groundwater Flooding**

3.5.12 There are no actual records of groundwater flooding provided from the Borough in those locations however the groundwater flood incident records from the Environment Agency shows a number of incidents across the Borough. Overall Groundwater flooding is considered to be a relatively low risk in the London Borough of Camden.

3.6 Sewers

Mechanism of Flooding

As outlined in **Section 1.5.3**, the Thames Water drainage system conveys foul flow together with surface runoff that enters the system through drain pipes and road gulleys. North of the River Thames, a series of deep east – west interceptor sewers collect high level sewers draining south towards the river, transporting all flows to Becton sewage treatment works in east London. Through this underground system (**Figure 1.4**), the London Borough of Camden receives flows from Westminster and Brent (in the west). It transfers flow towards Islington in the east.

3.6.1 During intense rainfall sewer flooding occurs as a result of:

- Surcharge within the sewer drainage network causing flooding in property basements with direct connections to the sewer.
- Surcharge within the sewer drainage network, causing flooding at the surface through manholes or through road gullies.
- Sewer flooding can also occur at other times due to blockages, but this mechanism is not considered in the SWMP.

3.6.2 Thames Water is responsible for the removal of frequent sewer flooding. Property flooding incidents that once every ten years (or more frequently) are placed on the 'DG5' register and protected through investment in new sewerage through the water company's asset investment programmes, subject to a cost benefit justification. Sewer flooding resulting from extreme events in severe weather is excluded from the DG5 register. Exceedance flow that results is the responsibility of the LLFA to manage. In special

circumstances a business case can be made to provide a higher level of protection from sewer flooding.

3.6.3 **Thames Water Datasets**

Thames Water has provided their DG5 data which shows the number of properties (sewer flood incidents) affected both externally and internally over the past decade. The data includes sever weather events which are normally excluded from Thames Water's official DG5 reporting. The dataset provided is based on the postcode envelopes and does not give exact locations of where flood incidents have occurred, only the numbers affected in that area. This data is shown in **Figure D5** in **Appendix D**.

3.6.4 Thames Water also provided their network infrastructure, showing assets including sewers, pumping stations, sewage works and outfalls. This data was considered when looking at options for areas identified at risk. **Figure D4** in **Appendix D** shows the Thames Water network in the Borough.

3.6.5 **Historic Sewer Flooding**

The DG5 records show a significant number of past sewer flooding incidents in Camden Town and the Hampstead Area. The areas at highest risk (greater than 51 recorded sewer incidents) are shown to be:

- NW6 1 (104 properties affected in past decade)
- NW6 3 (101 properties affected in past decade)
- NW1 0 (91 properties affected in past decade)
- NW1 8 (190 properties affected in past decade)
- NW1 9 (70 properties affected in past decade)
- NW5 1 (328 properties affected in past decade)
- NW5 2 (86 properties affected in past decade)

3.7 Other Influences

As mentioned in **Section 1.5**, there is limited interaction from the surface water with other sources of flooding other than with the combined sewer system.

3.7.1 The risk of overtopping and breach of the Regents Canal which runs from west to east and bisects the borough of Camden have not been considered in detail as part of this SWMP study. Any locations of raised canal embankments should be considered in more detail in close partnership with British Waterways.

3.8 Critical Drainage Areas

A critical drainage area (CDA) is a discrete geographic area and 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. Local Flood Risk Zones (LFRZs) are discrete areas/extents of predicted surface water flooding; these are in general shown as dark blue areas of deep flooding in the in 1 in 100 year Rainfall Event Flood Depth Map or the dark orange areas in the corresponding Hazard Map (see **Figures 3.2.1a** and **3.2.1b in Appendix D**).

3.8.1 The critical drainage areas (CDA) and Local Flood Risk Zones (LFRZs) identified for the borough are shown in **Figure 3.1**.

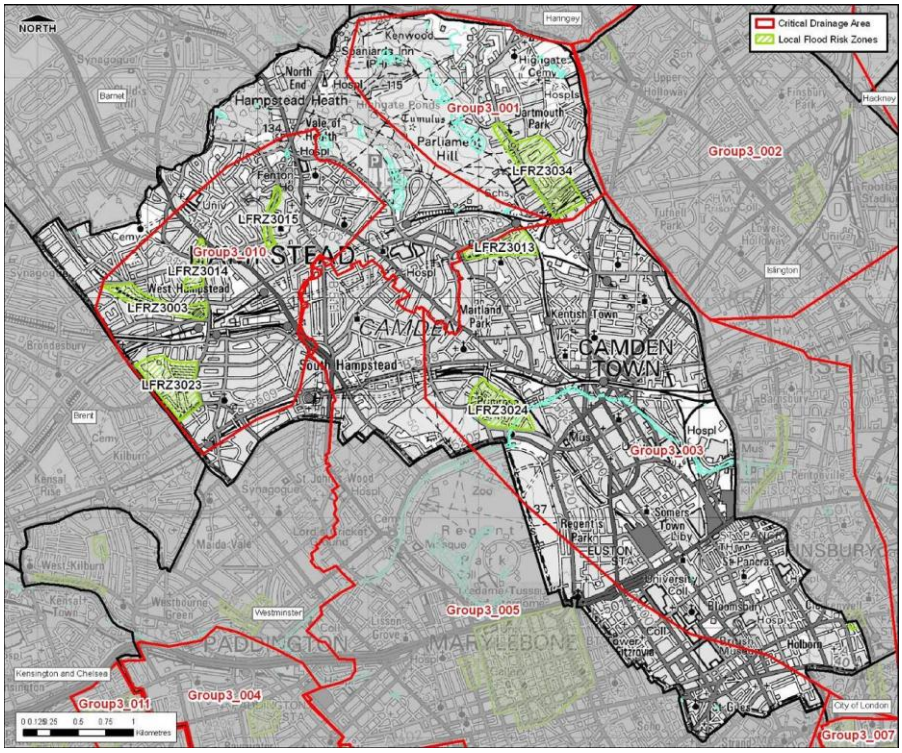


Figure 3.1 – Critical Drainage Areas and key Local Flood Risk Zones

3.8.2 Surface water modelling indicates a widespread vulnerability to surface water flooding across the Borough and most of central London. This is in part due to the flat gradient and 'noisy' digital terrain data. In consultation with the London Borough of Camden, seven LFRZs have been identified, corroborated by modelling data (to a degree), local knowledge and records of historical incidents. **Table 3.4** below summarises the LFRZs and associated CDAs.

Table 3.4 – Critical Drainage Areas and Local Flood Risk Zones

Grey cells relate to LFRZs outside of London Borough of Camden that fall within the CDA.

CDA	LFRZ	Site ID	Source of Flooding	Verified?
3_001	3034	York Rise	Surface water flooding and residual risk from reservoir inundation from an extreme pluvial flooding event.	Yes
3_003	3013	Gospel Oak	Surface water and sewer flooding	Yes
	3024	Primrose Hill	Surface water and sewer flooding	Yes
	3004	Caledonian Road (LB Islington)		
	3005	Clerkenwell Road (LB Islington)		
	3020	Historic river valley of the River Fleet Farringdon Street - City Thameslink (City of London)		
Group3_010	3003	Sumatra Road	Surface water flooding and sewer capacity problem (partly resolved through the Sumatra Scheme) causes water to collect behind the railway cutting. Creates overland flow compounded by urban creep.	Yes
	3014	Cannon Hill/West End Lane		Yes
	3015	Frognal		Yes
	3023	Kings Gate Road		Yes

3.8.3 **CDA Group 3_001 – LFRZ3034 – Parliament Hill**

This CDA is located in the North Eastern corner of the borough and is characterised by steep topography with high ground to the north and lower flatter ground to the south. This steep gradient causes relatively fast flows down York Rise towards the railway line.

3.8.4 Historic records show that this road, and the surrounding area, experienced flooding during the 2002 heavy rainfall event.

Summary of CDA Group 3_001 – Parliament Hill		
LLFA(s)	London Borough of Camden	
Flood Source	Pluvial	
Property Count	Approximately 558 non-deprived households (128 of which with basements) and 57 commercial/industrial properties (four of which with basements) are at risk of flooding to a depth of greater than 0.03m	Approximately 75 non-deprived households (21 of which with basements) and three commercial/industrial properties are at risk of flooding to a depth of greater than 0.5m
Critical Infrastructure	Five 'essential', one 'highly vulnerable' and one 'more vulnerable' infrastructure are at risk of flooding to a depth of greater than 0.03m.	Two 'essential' infrastructure are at risk of flooding to a depth of greater than 0.5m.
	These include schools and an underground station.	
Validation	Consultation with borough and historic records	
Assumptions	N/A	
Associated Figures	**Figure 3.8.1a** – Group3_001: Parliament Hill Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	
	Figure 3.8.1b - Group3_001: Parliament Hill Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	

3.8.5 **CDA Group 3_003 – River Fleet Catchment**

This CDA incorporates LFRZs from both London Borough of Camden and neighbouring Islington and City of London. The topography creates a catchment with Camden Town in the north coming down to Finsbury at the bottom.

3.8.6 The LFRZs identified in Camden are Gospal Oak (LFRZ3013) and Primrose Hill (3024). Both LFRZs have records of flooding in the past.

3.8.7 The surface water modelling shows deep flooding at Gospel Park, affecting Oak Village, Lamble Street, Grafton Road and Kiln Place. This appears to be caused by the railway embankments creating a 'basin' into which surface water collects.

3.8.8 Primrose Hill displays surface water ponding along properties which may indicate vulnerability to basement flooding.

3.8.9 The property figures reported in the table below are for all LFRZs in the CDA, including those in the London Borough of Islington and City of London

Summary of CDA Group 3_003 – River Fleet Catchment		
LLFA(s)	London Borough of Camden, London Borough of Islington and City of London	
Flood Source	Pluvial	
Property Count	Approximately 140 non-deprived households (33 of which with basements), 57 deprived households and 84 commercial/industrial properties (15 of which with basements) are at risk of flooding to a depth of greater than 0.03m	Approximately 40 non-deprived households (15 of which with basements), 14 deprived households and 15 commercial/industrial properties are at risk of flooding to a depth of greater than 0.5m
Critical Infrastructure	One 'essential' and two 'highly vulnerable' infrastructure are at risk of flooding to a depth of greater than 0.03m. These include schools, underground main line railways stations.	
Validation	Consultation with borough and historic records. Both Gospel Oak and Primrose Hill experienced flooding in the summer 2002 event.	
Assumptions	N/A	
Associated Figures	**Figure 3.8.1a** – Group3_003: Camden Town Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	
	Figure 3.8.1b - Group3_003: Camden Town Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	

3.8.10 **CDA Group 3_010 – West Hampstead**

This CDA includes LFRZs identified at Sumatra Road (LFRZ3003), Cannon Hill/West End Lane (LFRZ3014), Frognal (LFRZ3015) and Kings Gate Road (LFRZ3023) where the modelling shows deep flooding.

3.8.11 Problems in this area may have been partly resolved by the Sumatra Road Scheme implemented by Thames Water. This scheme provides underground storage of storm water which is held before delayed discharge into the combined sewer network.

3.8.12 The West Hampstead area was extensively flooded in the 2002 flood event and the modelling reflects this.

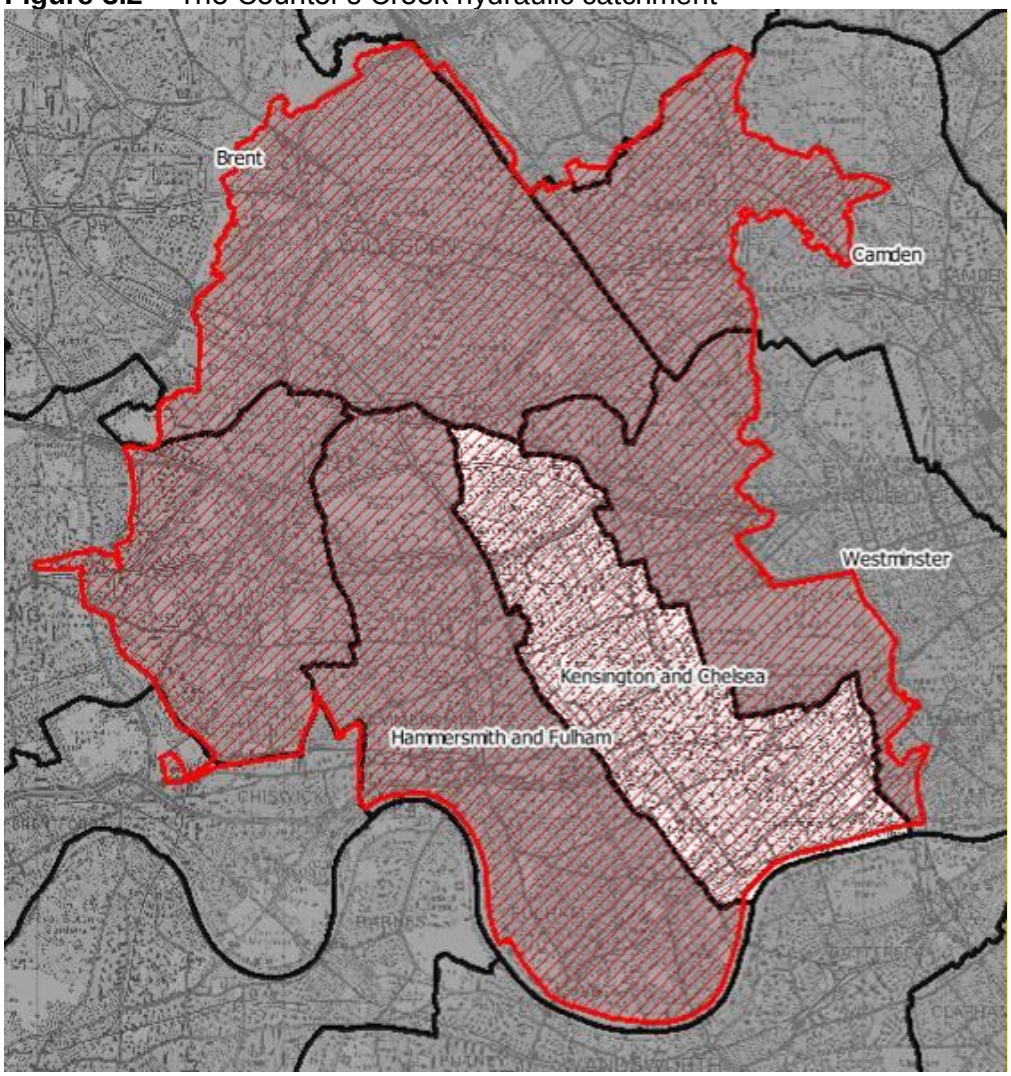
Summary of CDA Group 3_010 – West Hampstead		
LLFA(s)	London Borough of Camden	
Flood Source	Pluvial/sewer capacity issue	
Property Count	Approximately 631 non-deprived households (183 of which with basements), 271 deprived households (97 of which with basements) and 62 commercial/industrial properties (16 of which with basements) are at risk of flooding to a depth of greater than 0.03m	Approximately 80 non-deprived households (26 of which with basements), 123 deprived households (52 of which with basements) and 11 commercial/industrial properties are at risk of flooding to a depth of greater than 0.5m
Critical Infrastructure	Three 'essential', two 'highly vulnerable' and two 'more vulnerable' infrastructure are at risk of flooding to a depth of greater than 0.03m.	One 'essential', one 'highly vulnerable' and one 'more vulnerable' infrastructure are at risk of flooding to a depth of greater than 0.5m.
Validation	Consultation with borough and historic records.	
Assumptions	N/A	
Associated Figures	**Figure 3.8.1a** – Group3_010: West Hampstead Surface Water Depth (m) 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	
	Figure 3.8.1b - Group3_010: West Hampstead Surface Water Flood Hazard Rating 1 in 100 chance of rainfall event occurring in any given year (1% AEP)	

3.8.13 **Policy Area: PA Group3_008 - Counter's Creek Catchment**

The Counter's Creek catchment (see **Figure 3.2**) is a large sewer drainage system that spans the London boroughs of Brent, Ealing, Hounslow, Camden, Hammersmith and Fulham, Kensington and Chelsea and the City of Westminster. A Policy Area (Group3_008) has been drawn to match this catchment as almost all flooding issues spanning this area are interlinked due to the sewer network. Over the last 20 years, changes in land use, planning and population have meant an increase in the volume of water entering the system and the speed at which it gets there have increased.

The extent of the CDA and the LFRZ have been validated against sewer flooding data from TWUL as well as historical flood data and other information gained from meetings with the boroughs within the catchment.

Figure 3.2 - The Counter's Creek hydraulic catchment



3.9 Summary of Risk

Pluvial modelling and historical records of flooding have identified three Critical Drainage areas The risk in these areas are attributed to pluvial sources and has been validated by the LLFA.

3.9.1 As with most Group 3 Boroughs the modelling displays scattered and localised flood risk in the London Borough of Camden. Deep flooding occurs in 'basins' created either by the natural topography or by railway and road embankments. The widespread flooding reflects the vulnerability of basement properties in the Borough.

3.9.2 As part of the Phase 2 assessment, a quantitative assessment of the number of properties at risk of flooding has been undertaken for each CDA. The rainfall event with a 1 in 100 chance of occurring in any given year has been used to inform the assessment, as specified in the Drain London Data and Modelling Framework. A full summary of the results of the property count are included in **Table 3.6**.

3.9.3 The London Borough of Camden contains nationally and locally significant infrastructure, including main line railway terminus Euston, Kings Cross and St Pancras.

3.9.4 For the London Borough of Camden approximately 361 properties are at risk of flooding to a depth of 0.5m or more, 32% of which are basement properties.

3.9.5 The surface water modelling also identifies 16 units of infrastructure at risk from flooding. This includes nine 'Essential', four 'Highly Vulnerable' and three 'More Vulnerable' infrastructure. The definition of infrastructure is given in **Section 3.9.3** below.

3.9.6 **Infrastructure**

The definition of the "Infrastructure" category is an adaptation of the "Flood Vulnerability Categories" from PPS25 guidance. Following that guidance the main category is subdivided into three subcategories "Essential Infrastructure", "Highly Vulnerable" and "More Vulnerable". The definition of the subcategories is shown in T**able 3.5** below.

Table 3.5 - Infrastructure Category Description

Essential Infrastructure	Highly Vulnerable	More Vulnerable
Essential transport infrastructure which has to cross the area at risk	Police stations, Ambulance stations, Fire stations, Command Centres and telecommunications installations	Hospitals
Mass evacuation routes	Emergency dispersal points	Health services
Tube stations and entrances	Installations requiring hazardous substances consent	Educational establishments, nurseries
Essential utility infrastructure which has to be located in a flood risk area for operational reasons		Landfill, waste treatment and waste management facilities for hazardous waste
Electricity generating power stations and grid and primary substations		Sewage treatment works
Water treatment works		Prisons

Table 3.5 – Prioritisation Matrix – Summary Table for Phase 2

CDA ID	Scheme Location	Moderation		Infrastructure						Households								Commercial/Industrial				Validation
		Primary	Secondary	Essential		Highly Vulnerable		More Vulnerable		Non-Deprived (All)		Non-Deprived (Basements)		Deprived (All)		Deprived (Basements)		All		Basements Only		
				All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	
Group3_001	North Camden – Parliament Hill	Health and Safety	N/A	5	2	1	0	1	0	558	75	128	21	0	0	0	0	57	3	4	0	Yes
Group3_003	River Fleet Catchment	Health and Safety	N/A	1	0	2	0	0	0	140	40	33	15	57	14	0	0	84	15	15	0	Yes
Group3_010	West Hampstead	Health and Safety	N/A	3	1	2	1	2	1	631	80	183	26	271	123	97	52	62	11	16	0	Yes

NOTE: The numbers of properties for each CDA are calculated based upon those properties at risk in the local flood risk zones within the CDA

4.0 Phase 3 – Options

4.1 Objectives

4.1.1 The purpose of Phase 3 is to identify a range of structural and non-structural measures for alleviating flood risk and assess them to eliminate those that are not feasible or cost beneficial. The remaining options are then developed and tested against their relative effectiveness, benefits and costs. The target level of flood protection has been set at 1 in 75 years to align solutions with the likely level of insurance cover available to the general public.

4.1.2 To maintain continuity within the report and to reflect the flooding mechanisms within the Borough the option identification has taken place on an area-by-area (site-by-site) basis following the process established in Phase 2. Therefore, the options assessment undertaken as part of the SWMP assesses and short-lists the measures for each CDA and identifies any non-standard measures available.

4.1.3 Phase 3 delivers a high level option assessment for each of the Critical Drainage Areas (CDAs) identified in Phase 2. No monetised damages have been calculated and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. Costs should be treated at an order of magnitude level of accuracy. The options assessment presented here follows that described in the Defra SWMP Guidance but is focussed on highlighting areas for further detailed analysis and immediate 'quick win' actions. Further detailed analysis may occur for high priority Critical Drainage Areas as defined by the Prioritisation Matrix in the next Tier (Tier 3) of the Drain London project.

4.1.4 The main goal when investigating options is to focus the mitigations at the three locations (identified in **section 3.8**) where flooding has been verified and where damages will be the greatest.

4.1.5 Any mitigation solutions at these locations need to address basement flooding as well as critical infrastructure flooding.

4.2 Measures

The measures available are summarised in the following **Table 4.1**:

Table 4.1 – Source, Pathway and Receptor Options Available

Source Control Measures	Green roofs
	Soakaways
	Swales
	Permeable paving
	Rainwater harvesting
	Detention basins
	Ponds and wetlands
	Partial or full disconnection of roof runoff from sewer system (combined with rainwater harvesting, garden flooding, infiltration or filling of ponds)
	Other 'Source' measures
Pathway	Increased capacity in drainage systems
	Separation of foul and surface water sewers
	Improved maintenance regimes
	Land management practices
	Managing overland flows (in particular sacrificial flooding of car parks, open spaces and other water compatible land uses) to detain and slow down surface water
	Managing overland flows (in particular new pipes through embankments to avoid deep flooding)
	Other 'Pathway' measures
Receptor	Improved weather warning
	Planning policies to influence development
	Temporary or demountable flood defences
	Social change, education and awareness
	Improved resilience measures
	Improved resistance measures
	Evacuation plans
	Emergency Planning
	Other 'Receptor' measures

4.3 Preferred Options

Modelling and observed data show three distinct areas of surface water ponding in London Borough of Camden.

4.3.1 The nature of flooding from local sources within London is widespread and without a significant investment of money it will be impossible to solve all of them in one attempt. Preferred options have been chosen based upon those areas that are worst affected and for which historical flood information exists. Selection of these options has been supplemented by the outputs of the Drain London modelling. Even within these areas, the scale of flooding is too diverse, to be solved universally and cost-effectively. As a result, several options rely on the proposal of pilot schemes that aim to alleviate flooding for the worst affected properties and demonstrate the effectiveness of the proposed measures for future work.

4.3.2 All options identified will require further investigation through a feasibility study to establish which will bring maximum benefit for managing surface water flood risk in the London Borough of Camden.

4.3.3 Measures in each CDA were discussed and agreed in virtual site visits and workshops with the Borough and other stakeholders.

The full options assessment is given in **Appendix E.**

4.3.4 **CDA Group3_001 – Parliament Hill**

4.3.5 **Pilot project proposal: York Rise (Source Control)**

York Rise is proposed as a pilot project as the street flooded during the 2002 event and the location was also identified as at risk of surface water flooding from the modelling. The primary flooding hazards on York Rise relate to surface water flooding and the residual risk from reservoir inundation from an extreme pluvial flooding event.

4.3.6 Source control measures of permeable paving and rainwater harvesting have been selected to increase the time it takes for run off generated by impermeable areas to get into the existing sewer network. To achieve this infiltration, water re-use, and disconnecting new and existing development from the combined sewer network will be implemented at a cost of £875,000.

4.3.7 These costings are based on all properties in the affected area implementing the measures. There is potential to incentivise developers and residents to retrofit sustainable drainage options, and permeable paving as a result of the pilot projects using them to publicise what can be achieved.

4.3.8 **Pilot Project: York Rise (Pathway/Receptor Management)**

4.3.9 Pathway and receptor management measures are proposed in this location to focus on the route of the flood water and the point at which this surface flow will collect (the receptor).

4.3.10 A pre-feasibility study is required to identify which roads will benefit from the measures and designate them as flood channels in flood events and determine a diversion system.

4.3.11 To ensure that the surface water runoff is retained within the road cross section it will be necessary to provide raised kerb levels at a cost of £504,000. This will enable a managed approach to the channelling of the water on road network.

4.3.12 These costings are based on kerb levels being raised on both sides of the road affected by flooding in 2002.

4.3.13 **CDA Group3_003 – Camden Town (River Fleet Catchment)**

Further investigation in to the surface water flood risk around Gospel Oak area at a cost of £15,000. This study should include detailed modelling to understand the flood mechanisms, flow routes and consequences of flooding in the area. A feasibility study should be undertaken to establish which flood risk management measures deliver maximum benefit for managing surface water flood risk that results in ponding in Farringdon Street in the City of London.

4.3.14 **CDA Group3_010 – West Hampstead**

4.3.15 **Pilot Project Proposal: Hampstead Area – Willow Road (Source Control)**

Willow Road is proposed as a pilot project as the street flooded during the 2002 event and the location was also identified as at risk of surface water flooding from the modelling.

4.3.16 The surface water flooding and sewer capacity problem (which was partially resolved through the Sumatra Road Scheme) causes water to collect behind the railway cutting, and creates overland flow which is further compounded by urban creep.

4.3.17 Source control measures of permeable paving and rainwater harvesting have been selected to increase the time it takes for run off generated by impermeable areas to get into the existing sewer network. To achieve this infiltration, water re-use, and disconnecting new and existing development from the combined sewer network will be implemented at a cost of £330,000.

4.3.18 These costings are based on all properties in the affected area implementing the measures. There is potential to incentivise developers and residents to retrofit sustainable drainage options, and permeable paving as a result of the pilot projects using them to publicise what can be achieved.

4.3.19 **Policy Area Group3_008 – Counter's Creek Catchment**

Basement sewer flooding associated with the Counters Creek sewer in West London is the principal local flooding concern for residents, officials and elected members of the Boroughs. Flooding occurs regularly (many times per year) and is due to hydraulic incapacity in the sewerage network and the fact that many basements have low level connections to the sewer system. Basement flooding occurs when no flooding appears on the surface.

4.3.20 The proposed interventions are to be implemented both local to the flooding and across the wider contributing catchment which extends beyond RBKC to neighbouring Boroughs which are also connected to the same sewerage system.

4.3.21 **Preferred options**

The preferred option is already being implemented or planned by Thames Water. It has three elements:

- Property resistance through FLIP (flooding local improvements project) devices which provide a one-way connection between the basement and the sewers. This 'quick win' intervention enables the discharge of wastewater from the property but prevents reverse flows from the sewer to the basement. FLIPS are financed by Thames Water but installed within properties. 1000 FLIP devices are being fitted across the Counters Creek catchment (including RBKC) within LFRZ 3016 at £9000 each. The £9 million programme will eliminate this source of flooding for 1000 properties. It is, however, a temporary and unsustainable intervention.

- SuDS Pilot Program is being implemented to assess the potential reduction in surface water to sewer in the long term the use of SUDs measures including driveway cutoff drains, drainpipe diversion, water butt/rainwater tanks and permeable paving.
- The pilot schemes will assess:
    - The reduction in surface water to sewer from each measure and how this varies with relevant parameters
    - Assessment of uptake and feasibility of install and development of practical solutions that are accessible for customers
    - What is possible through legislation and incentivisation, for example design standards for SUDS measures, retrospective enforcement of legislation.
- A major sewerage scheme which will remove local hydraulic incapacity through a series of new shafts and tunnel connections; flows are passed downstream. The estimated cost of this scheme is £440million and will protect at least 7500 properties from the risk of regular basement sewer flooding providing a level of protection of at least 1 in 30 years.

4.3.22 **Generic Measures**

As a forthcoming SuDS Approval Body, London Borough of Camden will have new powers to ensure that any new of re-development scheme implements source control and only discharges to sewer at limited run off rates in accordance with new SuDS standards. Discharge to sewer can only be made once all other options have been ruled out. London Borough of Camden should enforce these new rules vigorously to reduce the risk of basement sewer flooding in the future.

4.3.23 London Borough of Camden should promote and enable (through the Planning system) the use of SuDS retrofit measures in properties, highways and paved areas of public open space. This is most easily done when refurbishment or repair is occurring and via marketing to encourage the installation of property storm water storage devices. The latter can be attractive when combined with rainwater harvesting which will also reduce the demand of and cost for potable water for businesses and householders.

4.4 Preferred Options Summary

Table 4.2 below give a summary of the preferred options as discussed above and outlines the benefits of implementing the preferred scheme in the Borough.

Table 4.2 - Prioritisation Matrix – Summary Table for Phase 3

CDA ID	Scheme Location	Scheme Category	Infrastructure						Households				Commercial/ Industrial		Capital Cost Band
			Essential		Highly Vulnerable		More Vulnerable		Non-Deprived (All)		Deprived (All)		All		
			Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	Eliminated (%)	Mitigated (%)	
Group3_001	York Rise – Parliament Hill area	Preferential/designated overland flow routes	50	50	50	50	100	100	10	25	10	25	10	25	£1m - £10m
Group3_003	Camden Town – River Fleet Catchment	Preferential/designated overland flow routes	100	100	100	100	100	100	5	5	5	5	25	25	£251k - £500k
Group3_010	Hampstead Area	Other or combination of above.	30	0	100	100	100	100	25	5	25	5	25	5	£501k - £1m

4.5 Option Prioritisation

The Prioritisation Matrix was developed out of the need for a robust, simple and transparent methodology to prioritise the allocation of funding for surface water management schemes across the 33 London Boroughs by the Drain London Programme Board. As such, the prioritisation should be understood in the high-level decision-making context it was designed for. It is not intended to constitute a detailed cost-benefit analysis of individual surface water flood alleviation schemes.

4.5.1 The information in **table 4.2** will be used by the Drain London Programme Board to populate the Drain London Prioritisation Matrix and identify schemes to be taken forward under Tier 3.

4.5.2 Inputs to the Prioritisation Matrix have been submitted to the Board. They will provide feedback to all London Boroughs to influence the Action Plan prepared as part of Phase 4.

4.5.3 The Board's feedback will be included in the Final SWMP Report.

5.0 Phase 4 – Implementation and Review

5.1 Action Plan

5.1.1 The purpose of Phase 4 of the SWMP is to identify actions and responsibilities for the ongoing management of surface water flood risk identified in Phases 1 to 3.

5.1.2 A draft action plan has been developed in consultation with the London Borough of Islington separately and as part of a Group 3 workshop, which has been useful in identifying common tasks between LLFAs.

5.1.3 The objectives of the action plan are to:

1. outline the actions required to implement the preferred options identified in Phase 3 (**Section 4**);
2. Identify the partners or stakeholders responsible for the implementation of the actions;
3. Provide an indications of the priority of the actions and timescales for delivery;
4. Outline actions required to meet the requirements for the London Borough of Islington as LLFA under the FWMA 2010.

5.1.4 The action plan is subdivided in generic actions, investigation/feasibility/design and flood mitigation actions.

5.1.5 The generic actions are management tasks that the LLFA needs to undertake to fulfil its obligations as an LLFA. The flood mitigation actions relate to the actual implementation of investigations/feasibility studies/designs.

5.1.6 The generic actions have been grouped as follows:

- **Communications/Partnerships** Actions to communicate risk internally or externally to LLFA or create/improve flood risk related partnerships
- **Flood and Water Management Act/Flood Risk Regulations** Duties and actions as required by the FRR and FWMA – Refer to Appendix A of the LGG 'Preliminary Framework to assist the development of the Local Strategy for Flood Risk Management' (February 2011) for minimum requirements.
- **Financial/Resourcing/Capacity Building** Actions to secure funding internally/externally to support works or additional resources to deliver actions.
- **Policy Action** Spatial planning or development control actions.

Table 5.1 below provides a full summary of the action plan.

Table 5.1 – Summary of Action Plan

Action Type	ID	Action		Priority Ranking	Timing		
		What?	How?		Timeframe	Start Date	Approx. Duration
Communications and partnership	1	Prepare for public and media enquires	Alert Communications Team and ensure they have created a list of key facts and messages for dealing with any Media Enquiries	High	Short	Apr-11	Ongoing
	2	Set up a Flood Risk Management Working Group	LB of Camden to Identify stakeholders and set up internal working group (to meet 2-4 times per year) to agree actions, resourcing and responsibilities, and to monitor progress. Outcomes to be reported at Director level via Corporate Sustainability Board and reports to Scrutiny on the sustainability plan, Green Action for Change.	Medium	Short	May-11	Ongoing
	3	Engage Network Rail, Highways Agency and critical Infrastructure stakeholders	• Alert these stakeholders to mapping findings through Multi-Agency Flood Plan and related flood response work • EF will provide additional Network Rail and TFL contacts to TK • Find out if we are responsible for TFL roads	Medium	Medium	Aug-11	Ongoing
	4	Meet with Thames Water to: • Discuss maintenance concerns and observations • Discuss opportunities for further infrastructure projects • Discuss other support/issues identified through PFRA and SWMP • Discuss how we can obtain their records for our flood incident log • Ask for models for relevant locations	Engage with Thames Water	Medium	Short	Aug-11	Ongoing

		• Discuss City of London Hampstead Heath works					
	5	Develop public awareness plan	• Comprehensive information already on Camden website - ensure is up to date • Planning have published guidance and flooded streets. • PL to liaise with EF to discuss any additional information of the Planning pages.	Medium	Medium	Aug-11	Two weeks
	6	Quality Plan: Ensure processes and activities are recorded for Quality Plan in case of future audit.	• Everyone to ensure information is properly recorded and sent to PL. • PL to maintain central record (based around this Action Plan)	Medium	Medium	May-11	Ongoing

Action Type	ID	Action		Priority Ranking	Timing		
		What?	How?		Timeframe	Start Date	Approx. Duration
Flood and Water Management Act/ Flood Risk Regulations	7	PFRA: Contribute to and consider draft Preliminary Flood Risk Assessment (PFRA)	Finalise PFRA document and maps received and gain approval by all internal stakeholders	High	Short	Apr-11	two weeks
	8	PFRA: Finalise PFRA and obtain Scrutiny Committee sign off on final documents.	• Scrutiny scheduled for 6 June. LB of Camden to write report. • LB of Camden to submit PFRA to Environment Agency	High	Short	Jun-11	One month
	9	Maintain a local flood risk asset register	LB of Camden to start mapping and registering significant assets/features. This must consist of two documents, a Register of Assets which must be ready for viewing by the public if requested, and a Record of Assets which must contain information on the condition of assets and is not a public document.	High	Short	Apr-11	Nine months

	10	Discuss and approve the Surface Water Management Plan. This is a non-statutory document, and should remain as a "living document".	• Initial consultation on Action Plan undertaken 6 May. • LB of Camden to develop revised Action Plan by 13 May. • All stakeholders to review documents when received from consultants (May/June 2011)	Medium	Short	May-11	Ongoing
	11	Local Flood Risk Management Strategy: develop strategy using SWMP as basis.	• Stakeholder mapping required by September 2011 • Consider and outline work needed to turn SWMP into LFRMS	Medium	Medium	Jun-11	Seven months
	12	Flood Event Management: Investigate and report how a flood event is managed within and/or outside council (i.e. which risk management authorities share relevant functions and whether they are proposing to exercise these in the event of a flood)	• Discuss with Stakeholders through Multi-Agency Flood Plan work • Obtain agreement and process for the reporting of information about floods for the Flood Incident Log (Action 16) • Note findings, feedback and discuss further actions if required	Medium	Short	Aug-11	Ongoing
	13	Flood Incident Log: Develop and agree process for collecting data on future floods.	• Drain London have provided a template register. • Highways have provided a questionnaire to Contact Centre (MR to provide a copy to PL). • Highways have a call out report form (MR to provide a copy to PL) • TK to provide feedback on outcome of work in Action 10 re other stakeholders recording flood information. • Meeting with Thames Water (Action 13) should provide further information. • Once above is received, PL to draft Process Note.	Medium	Short	Jun-11	Ongoing

Action Type	ID	Action		Priority Ranking	Timing		
		What?	How?		Timeframe	Start Date	Approx. Duration
Flood and Water Management Act/ Flood Risk Regulations	14	Plan for next year SUDS Approving Body (SAB) role	• Discuss with Head of Development Management (Frances Wheat). PL to contact June 2011	Medium	Short	Jun-11	Ongoing
	15	Designate third party assets/features	The exact meaning of this is currently unclear. TBC	-	-	-	-
	16	Prepare Flood Hazard and Flood Risk Maps: by for the flood risk areas and in relation to local flood risk	Suitable maps will be provided by the consultants through the work to develop the SWMP.	Medium	Medium	-	Submit on 22 June 2013
	17	Finalise Surface Water Management Plan: for the EU	Can use Surface Water Management Strategy as the basis	Medium	Medium	May-11	Deadline 22 June 2015
Financial/ Resourcing/Capacity Building	18	Develop funding strategy including allocation of budget	• Ensure Defra funding is ring-fenced and establish with Finance that it can be rolled over to next year if necessary. • Work with EA to identify all streams and develop strategy.	Medium	Short	Defra funding May 2011 Funding strategy December 2011	one week
Policy	19	Ensure Policy Group are aware that Surface Water Flooding is captured in Corporate Risk Register and other Council teams (CSF and HASC) are aware of risk areas	• LB of Camden to advise Policy Group and incorporation into Risk Register. • LB of Camden to send a summary of SWMP findings to CSF and HASC Stakeholders	-	-	-	-
	20	Planning and Development Control Policies: • Review all Policies as a result of SWMP maps (including LDF and North London Strategic Flood Risk Assessment) • Basement policy (Policy and Guidance for new developments in place, further guidance for existing basements to be developed) • If possible add flood mitigation to	LB of Camden to develop any additional guidance outlined in the ”what” section			Jun-11	Ongoing

		Community Infrastructure Levy List.					
Investigation/ Feasibility/Design	21	Review the Multi-Agency Flood Plan in the context of the SWMP outputs	• Compare PFRA and SWMP findings with current Multi-agency flood plan and feed in any new information/revisions	Medium	Short	Aug-11	one month
	22	Risk based maintenance: Ensure priority maintenance areas are updated and maintained in line with SWMP.	• Maintenance already undertaken on a risk-based model (high risk areas gullies cleaned four times per year). • Once SWMP maps received, MR will check to ensure their designated risk areas align with mapping outputs.	Medium	Medium	June/July-11	3 weeks
	23	Identify multiple benefits with Green Grid projects	Consultant to possibly assist in identifying these	Medium	Medium	2011/2012	Ongoing

Action Type	ID	Action		Priority Ranking	Timing		
		What?	How?		Timeframe	Start Date	Approx. Duration
Flood Mitigation Action	24	Analyse, develop and implement flood mitigation schemes	To include analysis of retrofitting potential within the borough, and possible development of the pilot schemes identified in the SWMP	Medium	Medium	Jun-11	Ongoing
	25	Source control options - need to reduce the run off coefficient to reclaim permeability and disconnect new and existing development from the combined sewer network. Potential to incentivise developers and residents, retrofit sustainable drainage options, permeable paving etc.	Pilot 'Proof of concept' Study	Medium	Medium		

	26	Source control options - need to reduce the run off coefficient to reclaim permeability and disconnect new and existing development from the combined sewer network and the Sumatra Road scheme. Potential to incentivise developers and residents, retrofit sustainable drainage options, permeable paving etc.	Pilot 'Proof of concept' Study	Medium	Medium		
	27	Pathway/receptor management - identify which roads are pathways and receptors, designate roads as flood channels in flood events and identify a diversion system (See CIRIA - designing for exceedance).	Feasibility Study	Medium	Medium		

5.2 Implementation Programme

The implementation programme showing actions, responsibilities and timeframes is shown in **Figure 5.1**. The complete Action Plan is given in **Appendix I**.

ID	Task	Responsibility	Financial Year 2011/12			Financial Year 2012/2013			
			Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Prepare for public and media enquires	London Borough of Camden	■	■	■	■	■	■	■
2	Set up a Flood Risk Management Working Group	London Borough of Camden	■	■	■	■	■	■	■
3	Engage Network Rail, Highways Agency and critical Infrastructure stakeholders	London Borough of Camden	■	■	■	■	■	■	■
4	Meet with Thames Water	London Borough of Camden	■	■	■	■	■	■	■
5	Develop public awareness plan	London Borough of Camden	■						
6	Develop and Implement Quality Plan	London Borough of Camden	■	■	■	■	■	■	■
7	Finalise and submit PFRA	London Borough of Camden	■						
9	Maintain a local flood risk asset register	London Borough of Camden	■	■	■				
10	Discuss and approve the Surface Water Management Plan.	London Borough of Camden	■	■	■	■	■	■	■
11	Local Flood Risk Management Strategy	London Borough of Camden	■	■					
12	Flood Event Management:/Investigation	London Borough of Camden		■	■	■	■	■	■
13	Flood Incident Log	London Borough of Camden	■	■	■	■	■	■	■
14	Plan for next year SUDS Approving Body (SAB) role	London Borough of Camden	■	■	■	■	■	■	■
15	Designate third party assets/features	London Borough of Camden				■	■	■	■
16	Flood Hazard and Flood Risk Maps	London Borough of Camden				■	■	■	■
17	Finalise Surface Water Management Plan	London Borough of Camden	■	■					
18	Develop funding strategy	London Borough of Camden	■						
19	Ensure Policy Group and other Council teams are aware of risk areas	London Borough of Camden		■					
20	Review all Planning and Development Control Policies	London Borough of Camden	■	■					
21	Review the Multi-Agency Flood Plan	London Borough of Camden	■						
22	Risk based maintenance	London Borough of Camden			■	■	■	■	■
23	Identify multiple benefits with Green Grid projects	London Borough of Camden			■	■	■	■	■
24	Analyse, develop and implement flood mitigation schemes	London Borough of Camden			■	■	■	■	■

Figure 5.1 – Implementation Programme

5.3 Review Timeframe and Responsibilities

The actions within the action plan fall into short, medium and long term categories. The short term actions have been identified as urgent and will be reviewed within two months of implementation. Medium term actions will be reviewed at the end of the financial year and Long term actions, with lower priority, will be reviewed beyond the first year.

5.3.1 Immediate actions from the Act (required by Defra from April 2011) include (actions 7-12):

- Maintain a local flood risk asset register
- Use its power to request relevant information to exercise its functions
- Investigate and report how a flood event is managed (within and/or outside the LLFA)
- Produce quality plan (to demonstrate that LLFA is implementing its duties)
- Plan for next year SUDS Approving Body (SAB) role
- Delivery of local Flood Risk Management Strategy through the LDF

5.3.2 The London Borough of Camden has identified Lead Departments who will take responsibility for implementing the plan. This is summarised in **Table 5.2**.

Table 5.2 – Lead Departments and their Responsibilities

ID	Responsibility			Other Stakeholders
	Lead Organisation	LLFA Dept.	Primary Support	
1	LB of Camden	1. Communications (Lead) 2. CST	-	-
2	LB of Camden	1. CST 2. Highway Engineering 3. Emergency Planning 4. Transport Strategy 5. Planning	-	-
3	LB of Camden	1. Emergency Planning	-	TWUL, TfL, Network Rail
4	LB of Camden	1. CST 2. Highways Engineering 3. Emergency Planning	-	TWUL
5	LB of Camden	1.Planning 2.CST	-	TWUL, TfL, Network Rail
6	LB of Camden	1. CST 2. Highway Engineering 3. Emergency Planning 4. Transport Strategy 5. Planning	-	-
7	LB of Camden	1. Corporate Sustainability Team (CST) (Lead) 2. Highway Engineering 3. Emergency Planning 4. Transport Strategy 5. Planning	-	-
8	LB of Camden	1. CST 2. Cabinet/Cllr Mason	-	-
9	LB of Camden	1. Asset Team (Highways) 2. CST 3. GIS Team	-	-
10	LB of Camden	1. CST (Lead) 2. Highway Engineering 3. Emergency Planning 4. Transport Strategy 5. Planning	-	-
11	LB of Camden	1. CST (Lead) 2. Highway Engineering 3. Emergency Planning 4. Transport Strategy 5. Planning	-	All Stakeholders
12	LB of Camden	1. Emergency Planning	-	-

13	LB of Camden	1. CST 2. Emergency Planning 3. Highway Engineering 4. Contact Centre	-	-

ID	Responsibility			Other Stakeholders
	Lead Organisation	LLFA Dept.	Primary Support	
14	LB of Camden	1. Planning and Development Control (Lead) 2. CST 3. Other Boroughs (work in partnership?)	-	-
15	-	-	-	-
16	LB of Camden	1. CST	-	Thames Water
17	LB of Camden	1. CST 2. Highway Engineering 3. Emergency Planning. 4. Transport Strategy	-	-
18	LB of Camden	1. CST	-	EA
19	LB of Camden	1. CST	-	-
20	LB of Camden	1. Planning	-	-
21	LB of Camden	1. Emergency Planning	-	Blue services
22	LB of Camden	1. Highways Engineering	Parks/ Recreation	-
23	LB of Camden	1. CST 2. Biodiversity and Parks	Spatial planning	Green Grid Initiative
24	LB of Camden	1. Highway Engineering 2. Transport Strategy 3. CST		Environment Agency; Thames Water
25	LB of Camden		TWUL	-
26	LB of Camden		TWUL	-
27	LB of Camden		TWUL	-

5.4 Ongoing Monitoring

5.4.1 The partnership arrangements established as part of the SWMP process (e.g., the London Borough of Camden, EA and TWUL working in collaboration) should continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

5.4.2 The SWMP Action Plan should be reviewed and updated once every six years as a minimum, but there may be circumstances which could trigger a review and/or an update of the action plan in the interim, for example:

- Occurrence of a surface water flood event;
- Additional data or modelling becoming available, which may alter the understanding of risk within the study area;
- Outcome of investment decisions by partners is different to the preferred option, which may require a revision to the action plan, and;
- Additional (major) development or other changes in the catchment which may affect the surface water flood risk.

6.0 References

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The Pitt Review (2008) Learning lessons from the 2007 floods

Appendix A – Data Review

Appendix B – Asset Register Recommendation

Appendix C – Risk Assessment Technical Details

Appendix D – Maps

Appendix E – Options Assessment Details

Appendix F – Peer Review

Appendix G – Spatial Planner Information Pack

Appendix H – Resilience Forum and Emergency Planner Information Pack

Appendix I – Action Plan