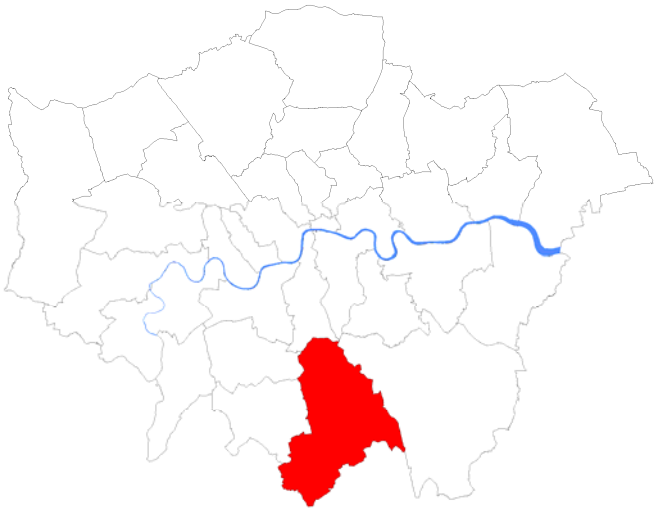
SURFACE WATER MANAGEMENT PLAN



DRAIN LONDON

LONDON
BOROUGH OF
CROYDON

GREATER LONDON AUTHORITY

Thames Water

LONDON COUNCILS

Environment Agency

CROYDON COUNCIL

Executive Summary

This document forms the Surface Water Management Plan (SWMP) for the London Borough of Croydon which has been delivered as part of the Tier 2 package of works of the Drain London Project. This document is a plan which outlines the preferred surface water management strategy for London Borough of Croydon and includes consideration of flooding from sewers, drains, groundwater and runoff from land, ordinary watercourses and ditches that occurs as a result of heavy rainfall.

The SWMP builds upon previous work undertaken with the Borough and has been undertaken following 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 upon work formerly undertaken during Tier 1 of the Drain London Project (as well as the Phase 1 Scoping SWMP prepared in 2009) to collect and review surface water data from key stakeholders and build partnerships between stakeholders responsible for local flood risk management. As part of this work, London Borough of Croydon has continued to partner with the Environment Agency and have begun to establish a broader partnership with neighbouring London Boroughs in south west London in order for these local authorities to pool best practice and resources to enable each local authority to discharge their responsibilities as Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (FWMA) 2010.

Phase 2 Risk Assessment

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

Figure 1 – Critical Drainage Area Index Map & Surface Water Flood Depth (1% AEP)

Within the London Borough of Croydon, sixteen (16) CDAs have been identified; these are shown in Figure 1. The chief mechanisms for flooding can be broadly divided into two categories;

Scattered Flooding Incidents - geographically dispersed and relatively isolated flooding of individual properties or small groups of properties (e.g. Chipstead Valley Road, Woodside, South Norwood);

More Severe Pluvial Flooding – more significant pluvial flooding with interlinked sources of flooding, multiple asset owners and typically affecting a significantly greater number of properties (e.g., Brighton Road, Purley Cross and South and Central Croydon).

Analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a 1 in 100 annual chance of occurring in any given year (1% AEP). A review of these statistics coupled with local knowledge of the study area identifies that the following CDAs are at greatest risk of flooding in terms of the number of receptors at risk:

Table 1 Critical Drainage Areas at greatest risk in London Borough of Croydon

CDA ID & Name	No. of infrastructure / properties at risk of flooding during 1% AEP event rainfall event.						
	Infrastructure (PPS25 Categories)			Households		Commercial	
	Essential	Highly Vulnerable	More Vulnerable	Non-Deprived	Non-Deprived (Basements)	All	Basements
Group8_042 South & Central Croydon	14	1	28	3450	431	830	464
Group8_041 Brighton Road	1	0	18	2357	86	373	41
Group8_040 Purley Cross	1	1	22	2316	1	83	0
Group8_036 Old Lodge Lane	1	0	5	1342	0	16	0
Group8_038 A22 Godstone Road	0	0	4	1205	0	35	0
Group8_039 Chipstead Valley Road	0	0	7	1177	0	193	0

CDA_043 South and Central Croydon, CDA_041 Brighton Road and CDA_040 Purley have the greatest number of receptors at risk of flooding, in proportion to the size of the CDA. The CDA for South and Central Croydon is also identified to have the greatest amount of Essential Infrastructure at risk and the highest number of commercial properties.

Across the Borough as a whole, 25 electricity substations, 3 police stations, 2 hospitals, 11 residential care homes and 53 educational establishments are identified to be at risk of flooding from surface water during the 1% AEP event.

CDA_047 South Norwood and CDA_045 Forestdale/Addington in the east of the Borough cross into the administrative areas of London Borough of Bromley, and CDA_049 associated with the Norbury Brook crosses into the London Borough of Merton. These CDAs will need to be jointly managed to implement the potential options and manage surface water flood risk in these areas.

Phase 3 Options Assessment

There are a number of opportunities for measures to be implemented across the Borough to tackle surface water flood risk. Ongoing maintenance of the drainage network and small scale improvements are already undertaken as part of the operations of the Borough. In addition, opportunities to raise community awareness of the risks and responsibilities for residents should be sought, and London Borough of Croydon may wish to consider the implementation of a Communication Plan to assist with this.

Two Policy Areas have been delineated for the Borough; Policy Area North and Policy Area South. Within these Policy Areas there are opportunities for generic measures to be implemented through the establishment of a policy position on issues including the widespread use of water conservation measures such as water butts and rainwater harvesting technology and use of SuDS. In addition, there are Borough-wide opportunities to raise community awareness, look at opportunities to increase resilience to flooding and improve targeted drainage network maintenance.

For each of the CDAs identified within the Borough, site-specific measures have been identified that could be considered to help alleviate surface water flooding. These measures were subsequently shortlisted to identify a potential preferred option for each CDA.

For the purposes of this SWMP, CDAs in which the predominant source of flooding is Main Rivers have not been taken forward for consideration of capital schemes, given that flooding from fluvial sources is not the focus of a SWMP and the primary responsibility for Main River flooding is that of the Environment Agency. This includes the CDA for Norbury. In this area it is essential that London

Borough of Croydon continue to work with the Environment Agency as they (the Environment Agency) seek to lead on flood risk management from Main Rivers.

The area of chief concern within London Borough of Croydon is that covered by the following three CDAs, CDA_040 Purley Cross, CDA_042 Brighton Road and CDA_042 South and Central Croydon. These CDAs delineate the pathway of former river channel for a tributary of the River Wandle. During heavy rainfall, surface water follows its natural course along the A23 Brighton Road towards the Purley Cross Junction, resulting in flooding to significant depths. The preferred option for these three CDAs will require collaboration with Thames Water and the completion of a Drainage Capacity Study to determine the existing capacity of the drainage system, and works that could be undertaken to make improvements to the system. A potential option could be to construct a deep interceptor sewer along, or parallel to, the route of the Brighton Road, to provide adequate capacity. Due to the highly urbanised nature of this part of Croydon, opportunities for above ground flood storage are scarce, however it is recommended that a feasibility study is undertaken into the potential to use a number of parks and playing fields along the Brighton Road corridor for additional temporary flood storage, including the Whitgift House playing fields, South Croydon playing fields and the recreation grounds off Christchurch Road.

Details of the preferred options for each of the CDAs are outlined in Chapter 4: Phase 2 Options Assessment.

Phase 4 Implementation & Review

Phase 4 establishes a long-term Action Plan for London Borough of Croydon to assist in their role under the FWMA to lead in the management of surface water flood risk across the Borough. The purpose of the Action Plan is to;

- Outline the actions required to implement the preferred options identified in Phase 3;
- Identify the partners or stakeholders responsible for implementing the action;
- Provide an indication of the priority of the actions and a timescale for delivery; and,
- Outline actions required to meet the requirements for London Borough of Croydon as LLFA under the FWMA.

As part of this phase, it is recommended that London Borough of Croydon build upon the work of the Purley Cross Community Flood Plan to engage with residents regarding the flood risk in the Borough, to make them aware of their responsibilities for property drainage (especially in the south of the Borough) and steps that can be taken to improve flood resilience. It is also recommended that London Borough of Croydon prepare a Communication Plan to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public.

The draft Action Plan (included in Appendix I), is a ‘living’ document, and as such, should be reviewed and updated regularly, particularly following the occurrence of a surface water flood event, when additional data or modelling becomes available, following the outcome of investment decisions by partners and following any additional major development or changes in the catchment which may affect the surface water flood risk.

Glossary

Term	Definition
AEP	Annual Exceedance Probability
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
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 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
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.
FMfSW	Flood Map for Surface Water
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Hazard	The derivation of flood hazard is based on the methodology in Flood Risks to people FD2320 using and is a function of flood depth, flow velocity and a debris factor.
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 water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRR2009	Flood Risk Regulations 2009
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
LB	London Borough
LDF	Local Development Framework

Term	Definition
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 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 has responsibilities and powers
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 from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
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
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
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
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
WaSC	Water and Sewerage Company

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Figures

1. Introduction

1.1 What is a Surface Water Management Plan?

1.1.1 A Surface Water Management Plan (SWMP) 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, ordinary watercourses 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[1] in consultation with key local partners who are responsible for surface water management and drainage in the London area. These include the Greater London Authority, Thames Water, the Environment Agency and Transport for London. The Partners have worked together to understand the causes and effects of surface water flooding so that they can agree the most cost effective way of managing surface water flood risk for the long term.

1.1.3 This document also establishes a starting point for 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 Boroughs and other organisations such as Transport for London, London Underground, Network Rail and the Environment Agency and Thames Water. Relationships between surface water flooding and other sources of flood risk were also found to be 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 delivered through 3 'Tiers' as shown in Figure 1-1 and Table 1-1. This SWMP is part of the Tier 2 package of works.

[1] Further information on the Drain London Project can be found here http://www.london.gov.uk/drain-london

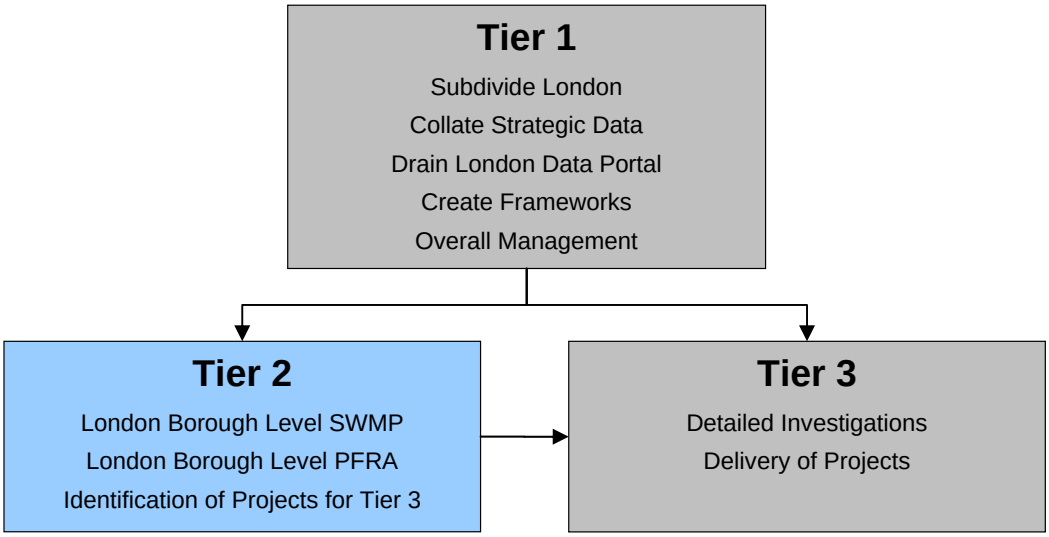

Figure 1-1 Drain London Project 'Tier' Structure

1.2.4 Table 1-1 further describes the activities undertaken in each of the Tiers. The management groups for Tier 2 of the Drain London Project are shown in Figure 1-2; the London Borough of Croydon is within Group 8 of the Drain London management group, and is grouped with the London Borough of Sutton, London Borough of Richmond upon Thames and Royal Borough of Kingston upon Thames.

Table 1-1 Drain London Project '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 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 2 community flood plans in local communities at risk from flooding

1.2.5 As described in Table 1-1, Tier 2 of the Drain London project involves the preparation of SWMPs for each London Borough. Through the subsequent enactment of the Flood Risk Regulations 2009 (FRR2009), Boroughs are also required to produce Preliminary Flood Risk Assessments (PFRA). The Drain London project has therefore been adjusted to deliver both a PFRA and an SWMP for each London Borough. The PFRA for London Borough of Croydon was completed in June 2011. These documents will form an evidence base and provide 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 Local Risk Authorities. Drain London assists this by creating sub-regional partnerships as set out in Figure 1-2.

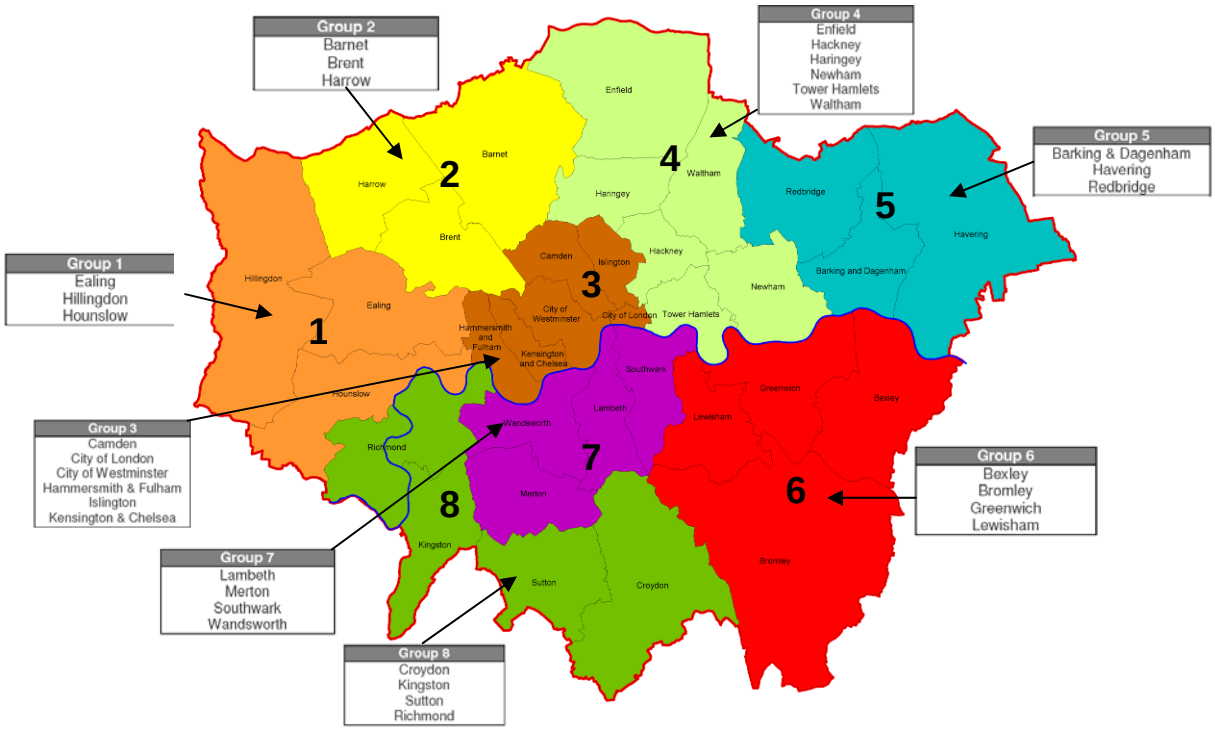

Figure 1-2 Drain London Borough Partnerships

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 study area, taking into account the challenges of climate change, population and demographic change and increasing urbanisation in London;
- Identify, define and prioritise Critical Drainage Areas (CDAs), including further definition of existing local flood risk zones (LFRZ) and mapping new areas of potential flood risk;
- 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 Borough specific objectives as recorded at the outset of the development of the SWMP (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 Borough specific aims and objectives were discussed at the various meetings held throughout the development of the SWMP. These are summarised below:

- As a priority, establish roles, structures and lines of communication internally within London Borough of Croydon to enable the Council to discharge responsibilities as Lead Local Flood Authority (LLFA);
- Establish links with other LLFAs in Group 8 to draw on collective resources to deliver duties under the FWMA.
- Build upon the Phase 1 and 2 SWMP prepared for London Borough of Croydon in 2010 to provide hazard mapping across the Borough;
- Identify any potential locations for strategic improvements and upgrades to the existing drainage systems;
- Provide guidance on mitigation options and associated outline costs;
- Provide guidance on London Borough of Croydon's responsibilities as LLFA under the FWMA.

1.4 STUDY AREA

TOPOGRAPHY & LAND USE

1.4.1 London Borough of Croydon is one of the largest of the London Boroughs. It is located in south London and covers an area of approximately 86km2; it is bounded to the north by London Boroughs of Merton and Lambeth, to the east by London Borough of Bromley, to the west by London Borough of Sutton and to the south by Surrey County. The A235 Brighton Road is a TfL red route that runs from south to north through the Borough connecting it to central London. Key rail links follow the same route from south to north to the Selhurst junction and Network Rail depot.

1.4.2 The topography is characterised by steep slopes in Coulsdon in the south of the Borough which then level off to flatter land in the north as shown in Figure 1.4.1. The Brighton Road is located in the natural valley of the topography, which is the flow path of the former River Wandle, now entirely culverted until it emerges at Wandle Park in South Croydon.

1.4.3 The majority of the Borough drains into the catchment of the River Wandle, which passes into London Borough of Sutton. The northern part of the Borough drains into the Norbury Brook which feeds into the River Wandle further downstream. The south eastern part of the Borough including the settlements of Forestdale and Addington is characterised by steeper topography and more rural land which drains into the tributaries of the River Ravensbourne which flows eastwards into London Borough of Bromley.

1.4.4 As shown in Figure 1.4.2, the Borough is highly urbanised; with increasing distance from the Croydon Metropolitan Centre and the Brighton Road corridor, development begins to open out and there is more park land and rural land in the south of the Borough around Coulsdon and New Addington.

Figure 1.4.1 – LiDAR Topographic Survey
Figure 1.4.2 – Land Use Areas

HISTORIC FLOODING

1.4.5 According to national research undertaken by Defra[2], Croydon is ranked the 4th settlement in England most susceptible to surface water flooding, with as many as 21,100 properties estimated to be at risk.

1.4.6 London Borough of Croydon has historically suffered significant surface water flooding. During the flood event of summer 2007 intense rainfall exceeded the capacity of the existing highways drainage systems, and led to substantial overland flow and ponding of surface water in low lying areas. Approximately 320 properties and 26 schools reported surface water flooding to the Council during the July 2007 floods. Drainage systems were overwhelmed in several locations across the Borough in 2007, 2008, 2009 and 2010 most notably in Purley Cross, the Brighton Road and Norbury.

[2] National Rank Order of Settlements Susceptible to Surface Water Flooding, Defra 2009

1.4.7 Media and meteorological research carried out as part of the Local Climate Impact Profile (LCIP) for London Borough of Croydon[3] identified eight reports of severe heavy rain and flooding in the Borough between July 2006 and November 2009. The most significant events were in July 2007 when a month's worth of rain fell in 2-4 hours and overwhelmed the existing drainage infrastructure, and in July 2008 when 1.25 inches of rainfall fell in 24 hours resulting in widespread flash flooding around the Borough. During the 2007 event there were over 300 reports of flooding of residential properties, businesses and playing fields and the Wellesley Road underpass and the Purley Cross junction between the A22 and A23 were impassable due to floodwaters.

1.4.8 Under UKCIP02, predictions for future rainfall for the Croydon area up to 2050 are for up to 15% more winter precipitation. Heavier winter precipitation is expected to become more frequent with 0.25-0.75 more days of 'intense' rainfall (i.e. over 20mm). The risk of exceedance of the urban drainage system and surface water flooding in the Borough is therefore likely to increase into the future unless steps are taken to manage and mitigate this form of flooding.

CROSS BOUNDARY INTERACTIONS WITH NEIGHBOURING LOCAL AUTHORITIES

1.4.9 As shown in Figure 1-2, London Borough of Croydon shares boundaries with LLFAs within Group 6, Group 7, Group 8 as well as Surrey County Council which lies outside of the Greater London Authority study area. A summary of the cross-boundary interactions with these LLFAs is provided below.

Interactions with Group 8 – London Borough of Sutton

1.4.10 The boundary between London Boroughs of Croydon and Sutton largely follows the topographical highpoint and there are few significant cross boundary flows with the exception of the path of the River Wandle, a designated Environment Agency Main River. This fluvial watercourse is culverted throughout London Borough of Croydon, coming out of culvert briefly at Wandle Park before passing west into London Borough of Sutton.

1.4.11 Ongoing work relating to the maintenance and management of this watercourse will be led by the Environment Agency and will require buy-in from both Boroughs.

Interactions with Group 7 – London Borough of Merton

1.4.12 The catchment of the Norbury Brook, designated Environment Agency Main River, drains the northern part of London Borough of Croydon and feeds into London Borough of Merton. Proposals underway to create use open spaces along the corridor of the Norbury Brook for temporary flood storage, are likely to result in benefits for the downstream catchment which lies within London Borough of Merton.

1.4.13 Modelling shows predicted pluvial flooding within Upper Norwood and Norwood New Town that affects both London Borough of Merton and London Borough of Croydon. Any works to manage this flooding at the source will require collaborative working between these two Boroughs.

Interactions with Group 6 – London Borough of Bromley

1.4.14 Surface water flow in the location of Monks Orchard and South Norwood Country Park feed the catchment that continues into London Borough of Bromley.

[3] Scott Wilson (March 2010) Local Climate Impact Profile (LCLIP) for London Borough of Croydon

1.4.15 In addition, significant flows are modelled to flow into London Borough of Bromley from the area surrounding Forestdale and Addington. The steep catchment drains a large area and feeds the ordinary watercourses that subsequently drain to the Ravensbourne catchment in London Borough of Bromley.

Interactions with Surrey County Council

1.4.16 London Borough of Croydon adjoins the administrative area of Surrey County Council to the south of the Borough. Significant flows of surface water from Surrey County Council into London Borough of Croydon have been identified around the edge of the Borough, most notably at Chipstead Valley Road, Woodplace Lane in Coulsdon, Kenley, Hamsey Green and Court Wood Lane adjacent to Selsdon Wood. The topography at the boundary between these areas is steep and runoff generated further up the catchment in Surrey has the potential to result in flooding of significant depths in London Borough of Croydon. Any source control and attenuation measures to manage the flood risk in these areas will require collaborative working between London Borough of Croydon and Surrey County Council (or the relevant District Council, where responsibilities have been delegated from Surrey County Council).

FUTURE URBANISATION & DEVELOPMENT

1.4.17 London Borough of Croydon's growth strategy, which is set out in policy CS1 and CS2 of the Core Strategy provides an increase of approximately 21,510 new homes and many new jobs over the lifetime of the plan (2031). Future growth is planned for the A23 corridor and the Croydon Metropolitan Centre (CMC) which is reported to be capable of taking nearly 8,000 new homes and several thousand new jobs[4].

Table 1-2 Proposed Number of New Homes by Area of the Borough[5]

Spatial Management Area	Proposed Number of New Homes
Croydon Metropolitan Centre (CMC) & Environs	14,400 (of which CMC 8,000)
North	3,600
East	900
South	2,600

1.4.18 The London Plan[6] currently classifies Croydon Metropolitan Centre as a Strategic Office Location and an Opportunity Area. The Draft Replacement London Plan maintains these designations as well as highlighting it as a Strategic Outer London Development Centre, having potential for higher education, strategic office economic development functions, and a night time economy cluster of regional/sub-regional significance. The Mayor's strategies confirm the London Borough of Croydon's intentions for the CMC to continue as the major retail, office and regional transport interchange centre in South London.

1.4.19 These plans for urbanisation and redevelopment within London Borough of Croydon present a significant challenge to the existing drainage systems. However, it is also affords a crucial opportunity to address long-standing issues and problems relating to surface water flooding and pressure points on the drainage system through strategic improvements and upgrades to the drainage system.

[4] Croydon Council, (September 2010) Infrastructure Delivery Plan, Draft for Public Consultation
[5] Croydon Council, (September 2010) Towards a preferred Core Strategy for Croydon – Supplement, for consultation
[6] Greater London Authority (October 2009) London Plan

1.4.20 The SWMP for London Borough of Croydon should afford a particular focus on these areas allocated for further development and urbanisation and identify any potential locations for strategic improvements and upgrades to the existing drainage systems.

1.5 Interactions Between Sources of Flooding

1.5.1 In the context of SWMPs, surface water flooding incorporates flooding from sewers, drains, groundwater, and runoff from land, small water courses (often referred to as ordinary watercourses) and ditches occurring as a result of heavy rainfall. These sources may operate independently or through a more complex interaction of several sources.

1.5.2 An initial overview of the flooding issues in the London Borough of Croydon reveals areas that are affected by multiple sources of flood risk. These include complex interactions between urban watercourses, direct surface water ponding, overland flow paths and the surface water sewer system. One such example is the Marlpit Lane Critical Drainage Area (CDA) which is susceptible to surcharge of the foul and surface water drainage system as well as direct surface water flooding from rainfall that contributes to overland flow-paths.

1.5.3 In order for these flooding mechanisms to be adequately assessed, a holistic approach to surface water management is required. The SWMP approach will seek to ensure that all sources and mechanisms of surface water flood risk are assessed and that solutions are considered in a holistic manner so that measures are not adopted that reduce the risk of flooding from one source to the detriment of another.

1.6 Linkages with Other Plans

1.6.1 The increased focus on flood risk over recent years is an important element of adaptation to climate change. It is important that the SWMP is not viewed as an isolated document, but one that connects with other strategic and local plans. Drain London links into a number of regional and local plans which are discussed in more detail below.

Regional Flood Risk Appraisal (RFRA)

1.6.2 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. The London Plan 2011 was produced in July 2011 and includes a number of policies generated by the RFRA which is being prepared alongside the London Plan 2011. A summary of the policies from the London Plan of relevance to London Borough of Croydon with respect to flood and water management is provided in Table 1-3.

Table 1-3 London Plan 2011 – Policies relevant to surface water management

Policy 5.11 Green roofs and development site environs Planning decisions A) Major development proposals should be designed to include roof, wall and site planting, especially green roofs and walls where feasible, to deliver as many of the following objectives as possible: • Adaptation to climate change (i.e. aiding cooling) • Sustainable urban drainage • Mitigation of climate change (i.e. aiding energy efficiency) • Enhancement of biodiversity • Accessible roof space

- Improvements to appearance and resilience of the building
- Growing food.

LDF preparation

B) Within LDFs boroughs may wish to develop more detailed policies and proposals to support the development of green roofs and the greening of development sites.

Boroughs should also promote the use of green roofs in smaller developments, renovations and extensions where feasible.

Policy 5.12 Flood risk management

Strategic

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

Planning decisions

B) Development proposals must comply with the flood risk assessment and management requirements set out in PPS25 over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 (TE2100 – see paragraph 5.55) and Catchment Flood Management Plans.

C) Developments which are required to pass the PPS25 Exceptions Test will need to address flood resilient design and emergency planning by demonstrating that:

- The development will remain safe and operational under flood conditions;
- A strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions;
- Key services including electricity, water etc will continue to be provided during a flood;
- Buildings are designed for quick recovery following a flood.

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

LDF preparation

E) In line with PPS25, boroughs should, when preparing LDFs, utilise Strategic Flood Risk Appraisals to identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks, particularly through redevelopment of sites at risk of flooding and identifying specific opportunities for flood risk management measures.

Policy 5.13 Sustainable drainage

Planning decisions

A) Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

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

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

LDF preparation

B) Within LDFs boroughs should, in line with the Flood and Water Management Act 2010, utilise Surface Water Management Plans to identify areas where there are particular surface water management issues and develop actions and policy approaches aimed at reducing these risks.

THAMES CATCHMENT FLOOD MANAGEMENT PLAN (CFMP)

1.6.3 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.

1.6.4 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.

1.6.5 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 1-4 CFMP Policy Unit

River Wandle Policy Unit

The River Wandle Policy Unit comprises generally urban areas, with some river flood defences. The preferred policy is Policy 4 – accept the risk – but in the long term take action to ensure that risk does not increase from current level. Key messages for this Policy Unit as follows:

- Redevelopment rates in some areas are very high and offer the opportunity to reduce the risk and the current reliance on flood defences. This includes making the urban environment more resilient and with a layout that offers more options for managing future flood risk and the impacts of climate change.
- Generally the existing river corridors in these areas provide an opportunity to be able to adapt to the impacts of climate change and we are seeking to safeguard them from inappropriate development. We are seeking to maintain existing assets at least until redevelopment takes place.
- Climate change will mean that we need to adapt the existing defences over time. Rather than replacing them like for like, we will be seeking a different combination of flood storage, river defences and floodplain attenuation.
- Some of these areas are susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important.

River Ravensbourne Policy Unit

The River Ravensbourne Policy Unit comprises highly developed floodplains with little open space and modified river channels. The preferred policy is Policy 4 – accept the risk – but in the long term take action to ensure that risk does not increase from current level. Key messages for this Policy Unit as follows:

- We need long-term adaptation of the urban environment. There are massive opportunities to reduce flood risk through redevelopment. In most areas we need to change the character of the urban area in the floodplain through re-development. It must be resilient and resistant to flooding and result in a layout that recreates river corridors
- We are seeking to re-create river corridors through redevelopment so that there is space for the river to flow more naturally and space in the floodplain for water to be attenuated
- We will be seeking to build flood defences as redevelopment occurs and as part of an overall catchment plan. This is because more attenuation and more space in the river corridors are needed for defences to be sustainable. This is more complex but represents better value for society in the long-run even if it is more costly for the Environment Agency today
- These areas are very susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important.

PRELIMINARY FLOOD RISK ASSESSMENT (PFRA)

1.6.6 These are required as part of the FRR2009 which implement the requirements of the European Floods Directive. Drain London has produced a PFRA 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 6 years.

SURFACE WATER MANAGEMENT PLANS (SWMP)

1.6.7 Drain London is producing a SWMP for each London Borough. 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 the Borough and relevant other Risk Management Authorities. This data and actions and associated policy interventions will need to feed directly into the operational level of the Borough across many departments, in particular into spatial and emergency planning policies and designations and into the management of local authority controlled land.

STRATEGIC FLOOD RISK ASSESSMENTS (SFRA)

1.6.8 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. The information from Drain London will improve this understanding and the Council may wish to use information within the SWMP to update the Level 1 (Scott Wilson December 2008) and Level 2 (Scott Wilson July 2009) SFRA where necessary.

LOCAL DEVELOPMENT DOCUMENTS (LDD)

1.6.9 LDDs including the Core Strategy 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 of Boroughs, 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. The updated SFRA 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.

LOCAL FLOOD RISK MANAGEMENT STRATEGIES

1.6.10 The Flood and Water Management Act 2010 (FWMA) requires each LLFA to produce one of these by December 2012. 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.

1.6.11 Figure 1-3 illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a LFRMS.

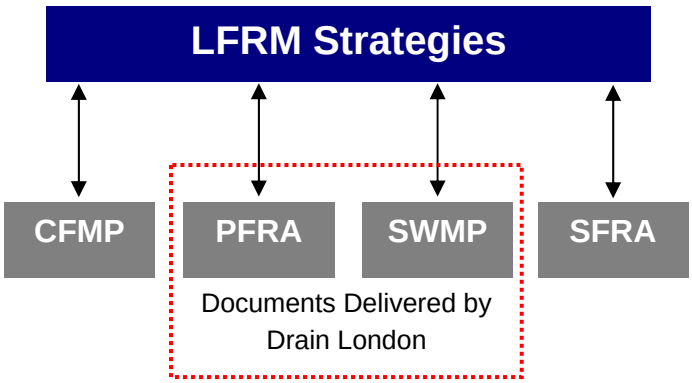

Figure 1-3 Linkages between Flood Risk Management Documents

1.7 EXISTING LEGISLATION

1.7.1 The 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 have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater.

1.7.2 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.

1.7.3 The FWMA must also be considered in the context of the EU Floods Directive, which was transposed into law by the FRR2009 on 10 December 2009. The FRR2009 requires three main types of assessment / plan:

1) Preliminary Flood Risk Assessments (PFRAs)
    i. This process involves collecting information on past and future (potential) floods, assembling the information into a PFRA report and spreadsheet, and identifying Flood Risk Areas.
    ii. LLFAs are only required to undertake a PFRA for local sources of flooding, which principally includes surface water, groundwater and ordinary watercourses.
    iii. It is the responsibility of the Environment Agency to assess the flood risk from the following sources; main rivers, the sea and reservoirs
    iv. The PFRA reports and spreadsheets must be completed by 22nd December 2011.
2) Flood Hazard Maps and Flood Risk Maps: Following the identification of Flood Risk Areas, the Environment Agency and LLFAs are required to produce Hazard and Risk maps by 22nd December 2013.
3) Flood Risk Management Plans. The Environment Agency and LLFAs are required to produce Flood Risk Management Plans by 22nd December 2015. It is likely that the

SWMP will contribute significantly to the preparation of a Flood Risk Management Plan by London Borough of Croydon.

1.7.4 Figure 1-4 illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

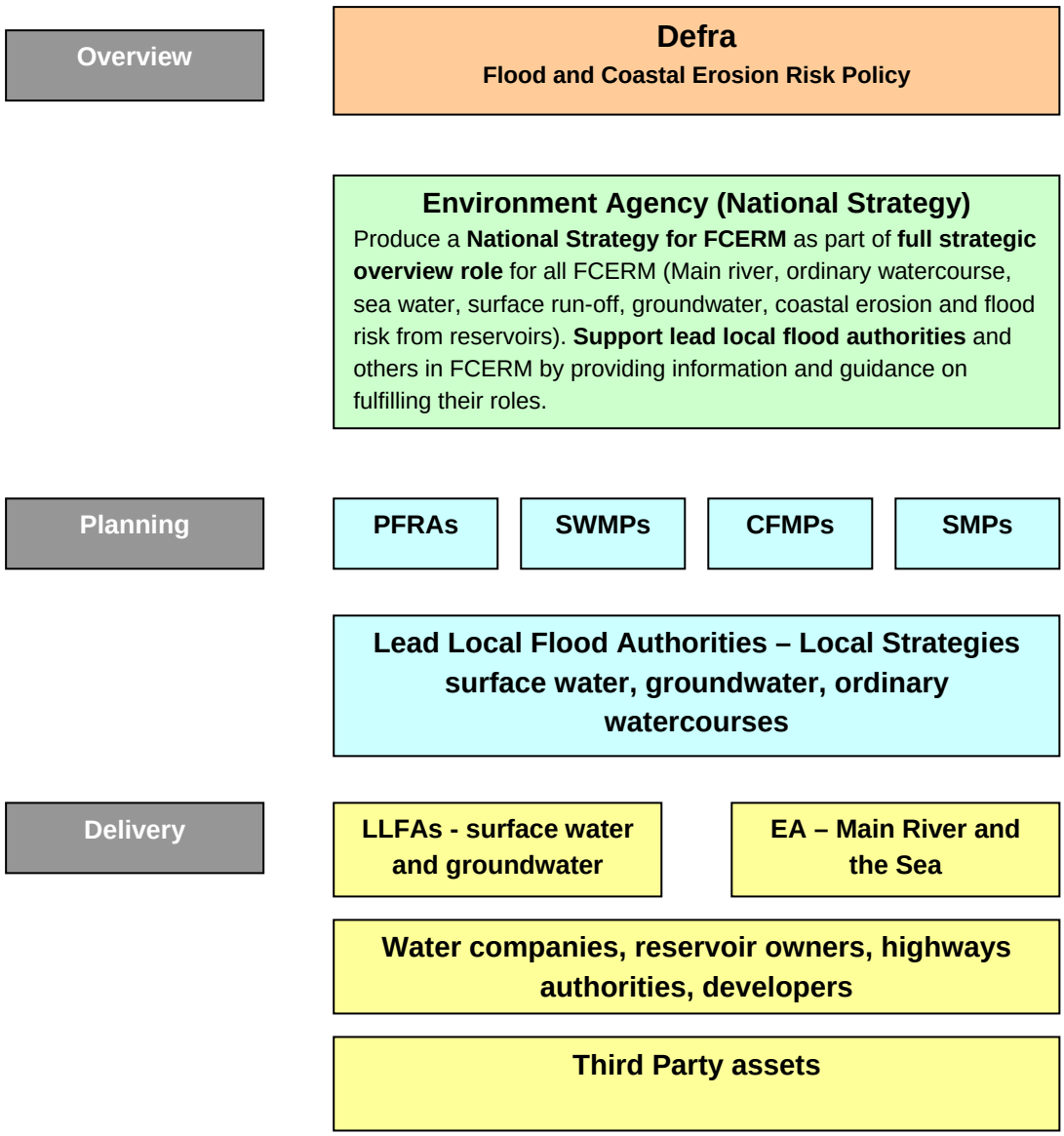

Figure 1-4 Local Flood & Coastal Management: Reports & Responsibilities

1.7.5 Aside from forming 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 FRR2009. The preparation of the SWMP and PFRA for London Borough of Croydon as part of the Drain London Project will enable the Council to strengthen its understanding of these responsibilities and how they can be fulfilled by the Borough. These responsibilities include:

- **Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done

or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.

- **Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have a significant effect on flood risk, including details on ownership and condition as a minimum. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.
- **SuDS Approving Body** – LLFAs are designated the Sustainable Drain age Systems (SuDS) Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new SuDS within their area. This responsibility is anticipated to commence from April 2012.
- **Local Flood Risk Management (LFRM) strategies** – LLFAs are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area. The LFRM strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.
- **Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the LFRM strategy for the area.
- **Designation powers** – LLFAs, as well as District Councils and the Environment Agency have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it.

1.8 PEER REVIEW

1.8.1 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).

1.8.2 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. Phase 1: Preparation

2.1 PARTNERSHIP

2.1.1 Under the FWMA and the FRR2009, all Unitary Authorities including the London Borough of Croydon are designated 'Local Lead Flood Authority' (LLFA). As such, the London Borough of Croydon is responsible for leading local flood risk management, including establishing effective partnerships within their local authority as well as with external stakeholders such as the Environment Agency, Thames Water Utilities Ltd, Transport for London and Network Rail as well as others.

2.1.2 In areas of multiple sources of flood risk and complicated interactions between different sources of flooding, there are often multiple water or drainage regulators, owners and maintainers. It is essential that all relevant partners with responsibility for making decisions and taking actions are involved in plans for flood risk management from the outset. One of the aims of the SWMP for London Borough of Croydon is to strengthen the partnership between these organisations and ensure inclusivity through all phases of this study and future flood risk management in the Borough.

LOCAL STRATEGIC PARTNERSHIP CLIMATE CHANGE GROUP

2.1.3 London Borough of Croydon has an existing Strategic Partnership Group dedicated to climate change, the aim of which is to ensure that long-term climate change adaptation is considered in all areas of relevant work across the Council. Current objectives include the delivery of the GLA Community Flood Plan pilot in Purley, as part of the Drain London project. The Group meets every 6 to 8 weeks.

2.1.4 This group is currently being reformed, however, up until now, members have included representatives from Council departments such as Business Continuity, Street Services, Regeneration and Asset Management, Planning, Highways, Planning, Risk and Insurance, as well as the Environment Agency, Natural England, Thames Water, NHS Croydon, Primary Care Trust, and the Greater London Authority.

STRUCTURES AND DRAINAGE MEETINGS

2.1.5 Officers from the structures and drainage teams at London Borough of Croydon attend meetings such as the Association of Thames Drainage Authorities (ATDA), and have semi regular meetings with Surrey County Council and neighbouring Local Authorities to discuss cross border issues with respect to highway drainage and flooding issues when required. They also meet with representatives from Thames Water to discuss flooding issues when required. Officers are engaged in the Communities@local.gov.co.uk discussion forum and are involved in ongoing discussions with schools and residents affected by flooding issues.

SOUTH WEST LONDON STRATEGIC FLOOD GROUP

2.1.6 At the moment the responsibility for flood risk management at Croydon is shared across the following four departments:

- Planning and Building Control;

- Economy and Environment;
- Street Services; and,
- Civil Contingencies.

2.1.7 However discussions are currently underway to determine future governance arrangements for local flood risk management in London Borough of Croydon.

2.1.8 As part of the Drain London Project, London Borough of Croydon have been working closely with neighbouring Boroughs to forge partnerships with respect to local flood risk management as part of the preparation of SWMPs for all 33 London Boroughs.

2.1.9 As part of this work, suggestions have been put forward for a South West London Strategic Flood Group that would report to the Regional Flood Defence Committee through Councillor Osborne at Royal Borough of Kingston. A potential structure may look something like that shown in Figure 2-1.

Figure 2-1 Organogram of Potential South West London Flood Partnership

PUBLIC ENGAGEMENT

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

2.1.11 However, it is also recognised that it is crucial to plan the level and timing of engagement with communities predicted to be at risk of flooding from surface water, groundwater and ordinary watercourses. This is to ensure that the potential for future management options and actions is adequately understood and costed without raising expectations before solutions can reasonably be implemented.

2.1.12 It will be important to undertake some public engagement when formulating local flood risk management plans (including the upcoming LFRMS) as this will help to inform future levels of public engagement. It is recommended that the London Borough of Croydon follow the guidelines outlined in the Environment Agency's "Building Trust with Communities" which 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.

Recommendation 1: Continue to establish partnerships and governance arrangements for the London Borough of Croydon to take forward local flood risk management actions.
Recommendation 2: Formalise governance structure and terms of reference for South West London Strategic Flood Group.
Recommendation 3: Ensure required skills and resources are in place within (or between) LLFA(s) to deliver FWMA and Local Flood Risk Management requirements.
Recommendation 4: Actively engage with members of the public regarding local flood risk management and formulation of the LFRM Strategy.

2.2 DATA COLLECTION

2.2.1 The collection and collation of strategic level data across London 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 Croydon
- British Airports Authority
- British Geological Survey
- British Waterways
- Environment Agency
- Greater London Authority
- Highways Agency
- London Underground
- Network Rail
- Thames Water
- Transport for London

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

2.3 DATA REVIEW

2.3.1 Table 2-1 provides a brief summary of key datasets used in the preparation of the SWMP. Further details regarding the datasets used as part of this SWMP are included in Appendix A.

Table 2-1 Data Review

Data Supplier	Dataset	Description
London Borough of Croydon	Strategic Flood Risk Assessment (SFRA)	The London Borough of Croydon Level 1 and Level 2 SFRA contain useful information on historic flooding, including local sources of flooding from surface water and groundwater.
	Historical flooding records	Historical records of flooding from surface water, groundwater and ordinary watercourses.
	Anecdotal information relating to local flood history and flood risk areas	Anecdotal information from authority members regarding areas known to be susceptible to flooding from excessive surface water, groundwater or flooding from watercourses.
	Local Climate Impacts Profile (LCLIP) for London Borough of Croydon	The LCLIP Report prepared by Scott Wilson identifies weather-related impacts and their associated consequences on infrastructure and services across the London Borough of Croydon.
	Maintenance Regime	Details of the maintenance regimes undertaken by London Borough of Croydon Council.
	Site Visit Notes	Details of site visits undertaken with Bob Hucks, London Borough of Croydon.
	Phase 1 Scoping SWMP	Phase 1 report providing descriptions of available datasets and known flooding mechanisms in the Borough.
Environment Agency	Environment Agency Flood Map (Fluvial)	Shows the extent of flooding from rivers with a catchment of more than 3km^2 and from the sea.
	Areas Susceptible to Surface Water Flooding	A national outline of surface water flooding held by the Environment Agency and developed in response to Pitt recommendations.
	Flood Map for Surface Water	A second generation of surface water flood mapping which was released at the end of 2010.
	National Receptors Dataset (v1.0)	A nationally consistent dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations.
	Indicative Flood Risk Areas	National mapping highlighting key flood risk areas, based on the definition of 'significant' flood risk agreed with the Defra.
	Historic Flood Map	Attributed spatial flood extent data for flooding from all sources.
	Groundwater Flooding Database	Database of groundwater flooding incidents recorded in the last 10 years.
	Thames Estuary 2100 (TE2100) Groundwater Hazard Maps	Environment Agency / Jacobs dataset of the Thames Estuary 2100 (TE2100) Groundwater Hazard Maps
Thames Water Utilities Limited	DG5 Register for Thames Water Utilities areas	DG5 Register logs and records of properties at risk of flooding from sewers. The dataset supplied provides those properties at risk at end of June 2010.
	Thames Water Sewer Network and Asset Location	The Thames Water Sewer network shows the location and size of the foul, combined, surface water and storm relief sewers across the Greater London area along with the locations for Sewage Treatment Works,

Data Supplier	Dataset	Description
		Pumping Stations and Combined Sewer Overflows.
Greater London Authority	Ordnance Survey Mapping (1:10k, 1:50k, Mastermap)	Ordnance Survey Mapping for the Greater London Area for the 1:10k and 1:50k scale and Mastermap dataset.
London Fire Brigade	Historical flooding call-out records	Records of all London Fire Brigade callouts for 'flooding' events since 2000. However, no flooding source is provided, so could be a result of water mains bursting as well as heavy rainfall / surface water flooding.
Network Rail	Areas Prone To Flooding	A list of areas prone to flooding across their South East Territory.
Transport for London (TfL)	TfL Red Routes	Pdf of the TfL Red Routes for the Greater London area
	TfL Gullies	GIS dataset of the TfL owned / managed gullies along the Red Routes for the Greater London area
	TfL Pumps	Location and pump regimes for TfL owned / managed gullies in the Greater London area
London Underground	Flooding records – July 2007	Records relating to station closures (location and duration) on 20th July 2007 due to heavy rainfall.
British Geological Survey	Groundwater Flooding Susceptibility Map	GIS dataset of areas susceptible to groundwater flooding
Jacobs / JBA	Groundwater Emergence Maps (GEMs)	GIS dataset of areas of groundwater emergence (GEMs)
	Groundwater Flood Map	GIS dataset of groundwater flood map
	Increased Potential for Elevated Groundwater (iPEG)	GIS dataset of areas of increased potential for elevated groundwater (iPEG), produced using existing Environment Agency, BGS and Jacobs / JBA datasets, produced for the Greater London area for the purpose of assessing groundwater flood risk as part of the Drain London project.

Security, Licensing and Use Restrictions

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

2.3.3 The following national datasets provided by the Environment Agency are available to local authorities and their consultants for emergency planning and strategic planning purposes:

- Flood Map for Rivers and the Sea
- Areas Susceptible to Surface Water Flooding
- Flood Map for Surface Water
- National Receptor Database

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

- Strategic Flood Risk Assessment
- Catchment Flood Management Plan

2.3.5 The use of some of the datasets made available for the SWMP has been restricted and is time limited, licensed to London Borough of Croydon via the Greater London Authority for use under the Drain London Project, which includes the production of a SWMP for the London Borough of Croydon. The restricted datasets include records of property flooding held by the Council and by Thames Water Utilities Ltd, and data licensed by the Environment Agency. Necessary precautions must be taken to ensure that all information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the agreement. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

2.4 ASSET REGISTER

2.4.1 Section 21 of the FWMA 2010 sets a duty on LLFAs 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 6th 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 Legal Characteristics of Asset Register & Records

	Register	Record
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.	

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

2.4.3 Populating and ensuring the ongoing maintenance of 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 will utilise a risk-based approach to populate the register and record with those structures or features considered the most significant first. It is also important to note that the register will be a 'living' asset register and grow over time, as more structures and features are identified and added, and asset information is updated through further information, for example through surveys of the structures, being made available.

2.4.4 Appendix B provides a summary of the current status of the asset register for London Borough of Croydon as well as recommendations for future actions.

Recommendation 5: Establish and populate a standardised Asset Register for London Borough of Croydon, as required under the FWMA 2010.

2.5 PHASE 1 – SUMMARY

2.5.1 Phase 1 of the SWMP has achieved the following:

- Built upon the partnerships established between the Environment Agency, Thames Water, and the London Boroughs of Croydon;
- Established a sub-regional flood risk partnership structure for the London Boroughs of Sutton, Wandsworth, Merton, Kingston and Richmond (along with other key stakeholders), through the 'South West London Strategic Flood Group', to take forward and manage flood risk in the future;
- Collected and reviewed flood risk data and knowledge from key stakeholders and partner organisations;
- Set out recommendations for the London Borough of Croydon's Asset Register, as required under the FWMA; and
- Set out the objectives and governance for the Phase 2 – Risk Assessment, Phase 3 – Options Assessment, and Phase 4 – Action Plan of the Croydon SWMP.

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3. 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 will be achieved through an intermediate assessment of pluvial flooding, sewer flooding, groundwater flooding and flooding from ordinary watercourses along with the interactions with main rivers. The modelling outputs have then been 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 the 'Borough' scale and fulfils the objectives of a second level 'Intermediate Assessment'.

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. Used 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, the intermediate assessment is applicable across a large town, city or Borough. In the light of extensive and severe historical flooding and the results from the Environment Agency national pluvial modelling suggesting that there are 21,100 properties at risk across the Borough (for a rainfall event with a 1 in 200 probability of occurrence in any given year), it is appropriate to adopt this level of assessment to further quantify the risks.

3.1.4 The purpose of this intermediate assessment will be 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.

- 2-Dimensional pluvial modelling (using TuFLOW software) has been undertaken following a Direct Rainfall Approach. Rainfall events of known probability are applied directly to the ground surface and water is routed overland to provide an indication of potential flow path directions and velocities and areas where surface water will pond.

- The 2-Dimensional pluvial modelling has been supported by field visits and visual surveys with the London Borough of Croydon and Environment Agency staff.
- The outputs from the pluvial modelling are verified (where possible) against historic surface water flood records.

3.2 Risk Overview

Surface Water Flood Risk Mapping – Limitations

3.2.1 The mapping shown within this report is intended to identify broad areas which are more likely to be vulnerable to surface water flooding. This allows the London Borough of Croydon and its partners to undertake more detailed analysis in areas which are most vulnerable to surface water flooding.

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

3.2.3 It should be noted that the mapping only shows the predicted likelihood of surface water flooding (this includes flooding from drains, ordinary watercourses and ditches that occurs in heavy rainfall in urban areas) for defined areas. Due to the coarse nature of the source data used, the maps are not detailed enough to define risk for individual addresses. Individual properties therefore may not always face the same chance of flooding as the areas that surround them.

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 suitable and relevant data provided and have been produced using expert knowledge to create conclusions that are as reliable as possible. However, it is essential that users of these maps understand the complexity of the data and modelling utilised in their production and are also aware of the associated limitations and uncertainties in the mapping. The maps are not intended to be used in isolation.

3.2.5 The Council 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 if they are misused or misunderstood despite our warnings. For this reason we are not able to guarantee that the maps will always be completely accurate or up to date.

Summary of Definitions

3.2.6 Figure 3-1 provides a summary of the terminology used throughout this SWMP; the following sections provide a definition of each area. To avoid confusion and ensure clarity of scale, the hierarchy of definitions is summarised as follows, from smallest to largest:

1. Local Flood Risk Zone (LFRZ, managed at the local scale);
2. Critical Drainage Area (CDA, containing one or more Local Flood Risk Zones – managed at the local scale);
3. Policy Areas (PA, containing one or more Critical Drainage Areas and covering the entire Borough);

4. Flood Risk Area (as defined by the EA / Defra Indicative Flood Risk Areas – an area approximately covering the entire Greater London Area and managed at a strategic scale).

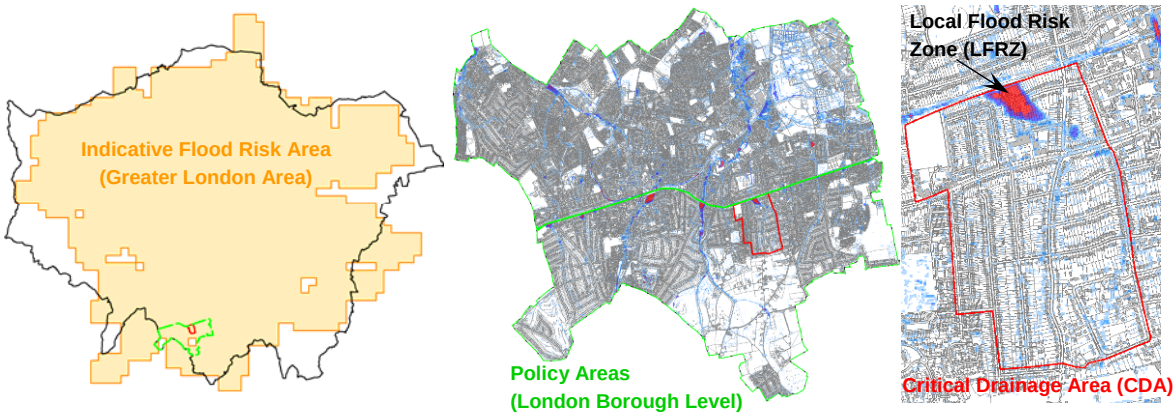


Figure 3-1 Example of Flood Risk Area, Policy Area, CDA and LFRZ (Example taken for CDA within neighbouring London Borough of Sutton)

Local Flood Risk Zones

3.2.7 For the purpose of the SWMP, a Local Flood Risk Zone (LFRZ) is defined as:

"A discrete area of flooding that affects houses, businesses or infrastructure".

3.2.8 The LFRZ is defined as the actual spatial extent of predicted flooding in a single location. Related LFRZs can be grouped together as a Critical Drainage Area or left in isolation and considered within the larger Policy Areas.

Critical Drainage Areas

3.2.9 A Critical Drainage Area (CDA) is defined as:

"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."

3.2.10 CDA units are larger than Local Flood Risk Zones and denote an area or catchment where mitigation measures may be implemented to reduce flooding experienced in the flood risk zone. CDA units should be used for site specific detailed planning and capital works schemes and may contain one or more Local Flood Risk Zones.

Policy Areas

3.2.11 A Policy Area is defined as:

'A discrete area within an administrative area where appropriate planning policy can be applied to manage flood risk.'

3.2.12 Policy Areas contain one or more CDAs and cover the entire study area. Policy Areas are primarily based on hydrological catchments but may also accommodate geological concerns and other factors as appropriate. Policy areas may be used to provide guidance on general policy across the study area e.g. the use of soakaways in new development.

Indicative Flood Risk Areas

3.2.13 Indicative Flood Risk Areas are defined by the Environment Agency / Defra definition primarily for the purposes of the preparation of Preliminary Flood Risk Assessments. The Indicative Flood Risk Area covers the entire Greater London Areas and is managed at a strategic scale.

3.3 SURFACE WATER FLOODING

MECHANISM OF FLOODING

3.3.1 Surface water or pluvial flooding occurs when high intensity rainfall, often short duration summer storms such as those experienced in London Borough of Croydon in July 2007, generates runoff which flows over the surface of the ground and ponds in low lying areas. It often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with the additional flow.

3.3.2 No single organisation has overall responsibility for surface water flooding with different aspects of the drainage system falling to either The Highway Authority (in this case London Borough of Croydon Council), Thames Water, riparian owners and Transport for London (red routes including the A23, A24 and A232).

PLUVIAL MODELLING

3.3.3 The Environment Agency commissioned national scale surface water modelling, resulting in the preparation of the Flood Map for Surface Water (FMfSW) which identified areas at risk of flooding during the 1 in 30 year and 1 in 200 year rainfall events.

Figure D1 – EA Flood Map for Surface Water

3.3.4 In order to continue developing an understanding of the causes and consequences of surface water flooding in the study area, intermediate level hydraulic modelling has been undertaken for a suite of five rainfall event probabilities. This hydraulic modelling has been designed to provide additional information where local knowledge is lacking and forms a basis for future detailed assessments in areas identified as high risk.

3.3.5 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. A full methodology of the hydraulic modelling undertaken is included in Appendix C.

3.3.6 Figures 3.3.1 and 3.3.2 show the modelling results for London Borough of Croydon for the rainfall event with a 1 in 100 annual chance of occurring in any year. Figures for the other modelled return periods are included in Appendix D.

Figure 3.3.1 – Surface Water Flood Depth (1 in 100 annual chance 1% AEP)
Figure 3.3.2 – Surface Water Flood Hazard (1 in 100 annual chance 1% AEP)

Figure D6 – Surface Water Flood Depth (1 in 30 annual chance 3.3% AEP)
Figure D7 – Surface Water Flood Hazard (1 in 30 annual chance 3.3% AEP)
Figure D8 – Surface Water Flood Depth (1 in 75 annual chance 1.3% AEP)
Figure D9 – Surface Water Flood Hazard (1 in 75 annual chance 1.3% AEP)
Figure D10 – Surface Water Flood Depth (1% AEP plus climate change)
Figure D11 – Surface Water Flood Hazard (1% AEP plus climate change)
Figure D12 – Surface Water Flood Depth (1 in 200 annual chance 0.5% AEP)
Figure D13 – Surface Water Flood Hazard (1 in 200 annual chance 0.5% AEP)

3.3.7 A summary of the suggested use for each mapped output is provided in Table 3-2.

Table 3-2 Modelled Return Periods and Suggested Use

Modelled Return Period	Suggested use
1 in 30 chance of rainfall event occurring in any given year (3.3%)	Current standards require Thames Water sewers to be designed to accommodate rainfall event with a 1 in 30 year return period, however the capacity of existing sewers is likely to be lower. This layer will identify areas that are prone to regular flooding and could be used by highway teams to inform maintenance regimes.
1 in 75 chance of rainfall event occurring in any given year (1.3%)	In areas where the likelihood of flooding is 1 in 75 years or greater insurers will not guarantee to provide cover to property should it be affected by flooding. This GIS layer should be used to inform spatial planning; if property can not be guaranteed insurance, the development may not be viable.
1 in 100 chance of rainfall event occurring in any given year (1%)	Can be overlaid with Environment Agency Flood Zone 3 GIS layer to show areas at risk under the same event from both sources. Can be used to advise planning teams.
1 in 100 chance of rainfall event occurring in any given year (1%) plus climate change	PPS25 requires that the impact of climate change is fully assessed. Reference should be made to this flood outline by the spatial planning teams to assess the sustainability of developments.
1 in 200 chance of rainfall event occurring in any given year (0.5%)	To be used by emergency planning teams when formulating emergency evacuation plans from areas at risk of flooding.

HISTORICAL SURFACE WATER FLOODING

3.3.8 London Borough of Croydon has provided records of properties, roads and broad locations which experienced flooding during the July 2007 floods. Approximately 320 properties and 26 schools reported flooding to the Council during this event. However, the total number of actual properties affected during the 20th July flood event in Croydon is likely to be under-reported with the actual figure likely to be much greater. These incidents have been geo-referenced and mapped over the modelling results in Figure D2 (Appendix D).

Figure D2 – Surface Water Flood Depth (1% AEP) & Recorded Surface Water Flood Incidents

3.3.9 Network Rail has records of flooding at Caterham Station which has subsequently been

resolved by refurbishment of the pumping system. Specific details regarding areas affecting and mechanisms of surface water flooding are included in the descriptions of Critical Drainage Areas and Local Flood Risk Zones in Section 3.8.

3.3.10 Rainfall data from the Purley Oaks gauging station for the summer 2007 flood events is shown in Figure 3-2. The statistical likelihood of this storm, calculated using the Bilham Formula is thought to be 1 in 130 years (Hucks 2008).

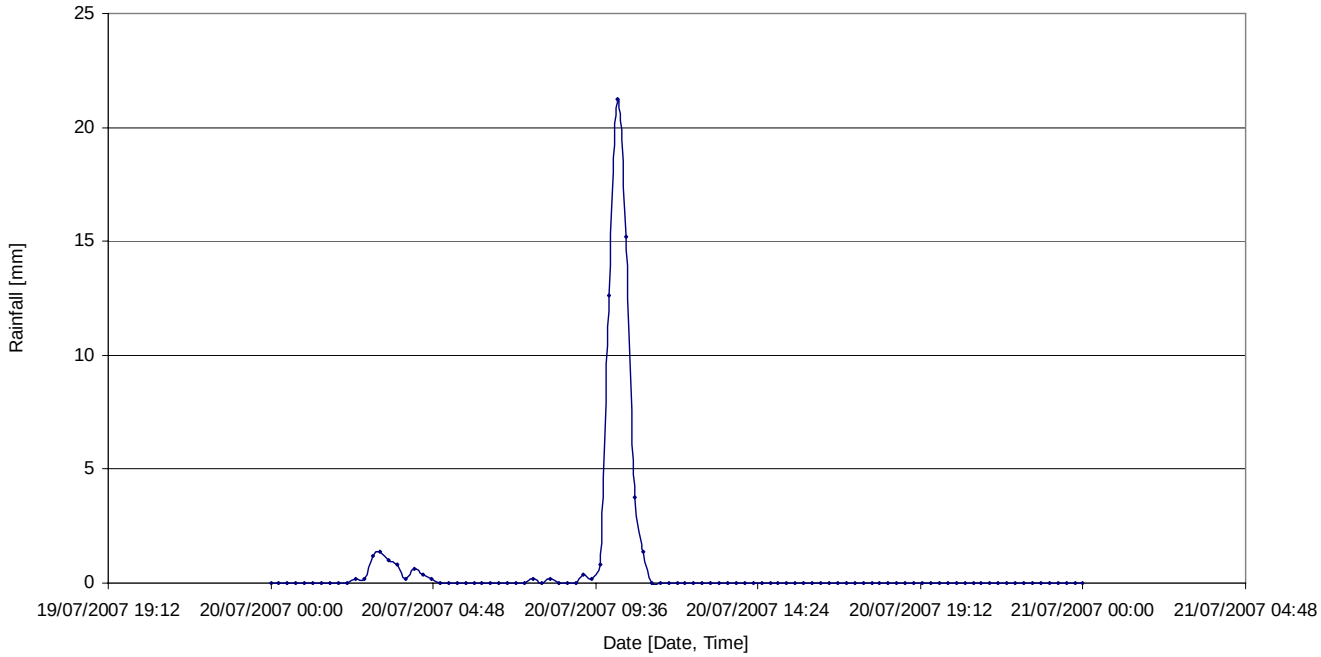


Figure 3-2 Rainfall Data: Purley Oaks Rainfall Gauging Station Croydon, 20th July 2007

Recommendation 6: Establish and populate a standardised Flood Incident Log to record and investigate future flooding incidents within London Borough of Croydon as required by the FWMA.

3.4 ORDINARY WATERCOURSE FLOODING

MECHANISM OF FLOODING

3.4.1 Ordinary watercourse flooding includes flooding from small open channels and culverted urban watercourses. These small channels often receive most of their flow from inside the urban area and perform an urban drainage function.

3.4.2 A number of other watercourses and ditches are present in the Borough, which are summarised in Table 3-3 along with the primary owner and maintaining organisation.

3.4.3 As part of the pluvial modelling, inclusion has been made for an assessment of flooding from ordinary watercourses. The presence of ordinary watercourses has been defined using the DNR dataset provided by the Environment Agency and the ground levels have been determined using the LiDAR topographic data. It is therefore considered that the pluvial flooding maps include an indication of the extent of flooding from ordinary watercourses.

Table 3-3 Watercourses in London Borough of Croydon

Watercourse	Classification	Owner / Maintainer
Norbury Brook, tributary of River Graveney	Main River	Fragmented ownership/maintainer: Environment Agency, LBC, riparian
River Wandle	Main River	Environment Agency, riparian.
Caterham Bourne, tributary of the River Wandle	Main River	Fragmented ownership; Network Rail owned at My Old China, but maintained by LBC. Cricket Club owned at Roke Close. Residents & Parks Dept owned at Valley View Gardens (Bourne Park).
Chaffinch Brook (West Branch), tributary of Ravensbourne	Main River	Environment Agency, riparian.
Shirley Heath Ditch & Outlet	Ordinary watercourse	Parks Dept owned at Palace View
Norwood Grove Ditch	Ordinary watercourse	Parks Dept owned at Covington Way
Shirley Oaks Ditch	Ordinary watercourse	Land owner at Poppy Lane. Residents at Woodmere Avenue.
Stoneleigh Park Ave Ditch	Ordinary watercourse	Residents / riparian owners.
Glenthorne Ave Ditch	Ordinary watercourse	Shirley Allotments
The Beck (tributary of the Ravensbourne Catchment)	Ordinary watercourse	Land owner
Featherbed Lane	Ordinary watercourse	LBC and riparian.
Old Lodge Lane	Ordinary watercourse	LBC and riparian.
Waddon Ponds inlet	Ordinary watercourse	Parks Dept.
Oaks Road	Ordinary watercourse	Parks Dept.
Pinewood Close	Ordinary watercourse	LBC
Pinewood	Ordinary watercourse	Scouts
Springhurst	Ordinary watercourse	Residents
Palace View	Ordinary watercourse	Residents
Woodside Brickworks	Ordinary watercourse	Parks Dept.
South Norwood Country Park	Ordinary watercourse	Parks Dept.
Kenley Lane	Ordinary watercourse	Network Rail (pipework & ditch on BR land) Seeboard (but LBC maintain as it drains highway runoff) Land owner (LBC maintain at present, land sold by Network Rail for development & piping of ditches will be required).
Hayes Lane	Ordinary watercourse	Network Rail owned. LBC maintained as this drains highway gully.

RESPONSIBLE ORGANISATIONS

3.4.4 The responsibility for maintenance of small open channels and culverted urban watercourses which are not designated as 'main river' falls to the London Borough of Croydon and riparian owners who own land on either bank i.e. London Borough of Croydon is only responsible for ordinary watercourses where land on either bank is in Council ownership, or where historical agreements have been made.

3.4.5 Responsibilities as riparian owner are to:

- Pass flow on without obstruction, pollution or diversion affecting the rights of others;
- To accept flows through your land even if caused by inadequate capacity downstream;
- Maintain the bed and banks of the watercourse (including trees and shrubs growing on the banks) and for clearing any debris, natural or otherwise even if it did not originate from your land;
- Watercourses and their banks must not be used for the disposal of any form of garden or other waste;
- Failure in carrying out these responsibilities could result in possible civil action;
- Local Authorities have certain permissive powers to undertake flood defence works and powers for enforcement under the Land Drainage Act 1991 and Public Health Act on watercourses which have not been designated as main rivers.

3.4.6 The fragmentation of assets in the Borough has been acknowledged by the SWMP partnership and needs to be addressed. The fragmentation of assets along the Caterham Bourne and Norbury Brook, calls for greater discussion and engagement between Thames Water, London Borough of Croydon and the Environment Agency to resolve issues of ownership and designation and clarify partners responsible for maintenance to ensure greater co-ordination on maintenance activities.

3.4.7 In addition, the mixed ownership of the Purley Oaks Pond and Pumping Station requires careful management to ensure coordinated use of these systems. Thames Water is responsible for the sewers, including the surface water sewer that contributes inflows to the pond from Purley Cross. London Borough of Croydon owns the pond and associated pumping station.

3.4.8 Under the FWMA, London Borough of Croydon has a duty to compile an asset register of all features with a flood risk management function which should include records of the presence, condition and performance of Council-managed ordinary watercourses.

HISTORICAL FLOODING FROM ORDINARY WATERCOURSES

3.4.9 Network Rail has provided details of flooding at Park Hill Park associated with a small watercourse. During heavy rainfall, water in the ditch along the boundary line is recorded to have overtopped down into the railway cutting resulting in land slipping and washouts.

Figure 3-3 Watercourse, Park Hill Park

3.4.10 It was reported that the roots of trees were partially blocking flow in this watercourse, but the ditch needs re-profiling and connection to an outfall. As an ordinary watercourse on Council owned land, this is the responsibility of London Borough of Croydon to maintain.

Figure 3-4 Landslip, July 2007

Figure 3-5 Landslip, January 2009

3.4.11 In December 2000 and January 2001, flooding associated with the Caterham Bourne was experienced, posing a threat to residential properties and a Sutton and East Surrey Water treatment works. This watercourse, shown in Figure 3-6, is reported to flow approximately every 7 years and passes westwards, out falling into a large Council owned pond at Purley Oaks.

3.4.12 Following the 2000-01 floods, a bund was subsequently created adjacent to the Bourne View allotment gardens to protect against future flooding, as shown in Figure 3-7 and 3-8. This flood storage area is also known as the Kenley Flood Storage Area.

Figure 3-6 Caterham Bourne

Figure 3-7 Bourne View Flood Meadow

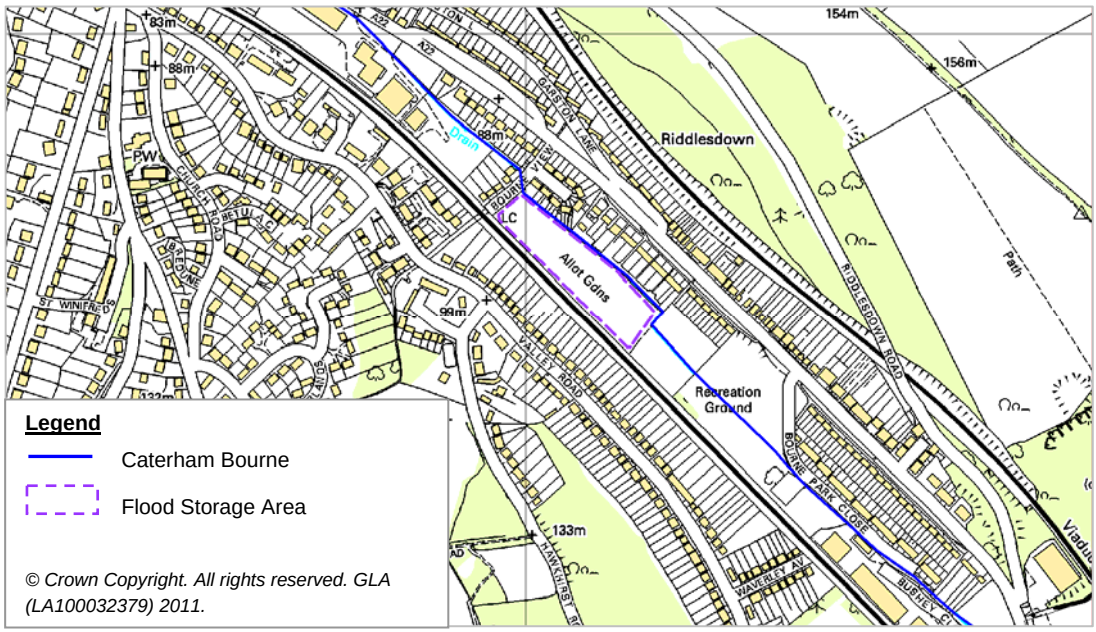


Figure 3-8 Bourne View / Kenley Flood Storage Area

Recommendation 7: Identify and map in GIS, all ordinary watercourses within London Borough of Croydon, including their condition, function and ownership, where known.

3.5 GROUNDWATER FLOODING

MECHANISM OF FLOODING

3.5.1 Groundwater flooding occurs as a result of water rising up from the underlying aquifer or from water flowing from springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by principal aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

3.5.2 Groundwater flooding tends to occur sporadically in both location and time, and tends to last longer than fluvial, pluvial or sewer flooding. Basements and tunnels can flood, buried services may be damaged, and storm sewers may become ineffective, exacerbating the risk of surface water flooding. Groundwater flooding can also lead to the inundation of farmland, roads, commercial, residential and amenity areas.

3.5.3 It is also important to consider the impact of groundwater level conditions on other types of flooding e.g. fluvial, pluvial and sewer. High groundwater level conditions may not lead to widespread groundwater flooding. However, they have the potential to exacerbate the risk of pluvial and fluvial flooding by reducing rainfall infiltration capacity, and to increase the risk of sewer flooding through sewer / groundwater interactions.

3.5.4 The need to improve the management of groundwater flood risk in the UK was identified through Defra's Making Space for Water strategy. The review of the July 2007 floods undertaken by Sir Michael Pitt highlighted that at the time no organisation had responsibility for groundwater flooding. The FWMA identified new statutory responsibilities for managing groundwater flood risk, in addition to other sources of flooding and has a significant component which addresses groundwater flooding.

3.5.5 Based on the hydrogeological conceptual understanding of the London Borough of Croydon study area, the potential groundwater flooding mechanisms that may exist are:

- **Chalk catchments in the southern half of London Borough Croydon:** Groundwater flooding is often associated with Chalk catchments, which allow groundwater levels to rise to the near surface through permeable subsoil following long periods of wet weather and / or reductions in historic abstractions. The London Basin has historically been heavily abstracted, lowering groundwater levels in both the Chalk and the 'Basal Sands'. However, since the '*mid 1960's, declining abstraction has resulted in the water level in the Chalk / Basal Sands aquifer rising at a rate of up to 3 m per year*' (Allen *et al.,* 1997). Therefore, depending on abstraction regimes and the presence and thickness of the London Clay Formation aquiclude, there may be a risk of groundwater flooding at basement level or ground level if Chalk groundwater levels rise. Developed areas within a valley setting will be the most vulnerable to flooding.
- **River Terrace Deposits in hydraulic continuity with the River Wandle and its tributaries:** Groundwater flooding can also be associated with substantial River Terrace and Head deposits, where they are in hydraulic continuity with surface water courses. Stream levels may rise following high rainfall events but still remain 'in-bank', and this can trigger a rise in groundwater levels in the associated superficial deposits. The properties at risk from this type of groundwater flooding are probably limited to those with basements, which have been constructed within the superficial deposits.

- **River Terrace Deposits in various locations:** A third mechanism for groundwater flooding is also associated with substantial superficial deposits, but occurs where they are not hydraulically connected to surface water courses. Perched groundwater tables can exist within these deposits, developed through a combination of natural rainfall recharge and artificial recharge e.g. leaking water mains.
- **Made ground in various locations:** a fourth mechanism for groundwater flooding may occur where the ground has been artificially modified to a significant degree. If this artificial ground is of substantial thickness and permeability, then a shallow perched water table may exist. This could potentially result in groundwater flooding at properties with basements, or may equally be considered a drainage issue. Areas mapped by the BGS as containing artificial ground are shown in Figures 1 and 2 in Appendix C.
- **Impermeable (silt and clay) areas down slope of aquifers in various locations:** a fifth mechanism for groundwater flooding may occur where groundwater springs / seepages form minor flows and pond over impermeable strata where there is poor drainage (artificial or natural).

EVIDENCE OF GROUNDWATER FLOODING

Figure 3.5.1 – Increased Potential for Elevated Groundwater (iPEG) Dataset & Historic Groundwater Flood Incidents

3.5.6 Figure 3.5.1 shows the locations of a number of groundwater flooding incidents between 2000 and 2010 within the study area that have been reported to the Environment Agency and London Borough of Croydon. Further details are presented in Table 3-4.

3.5.7 It should be noted that there has not been a statutory obligation to record incidences of groundwater flooding in the past. It is therefore likely that this list of groundwater flooding incidents is not exhaustive.

Table 3-4 Available Groundwater Flooding Records

Bedrock Geological Unit*	Overlying Superficial Deposits*	Location	NGR	Incident N°**	Reported Incident	Year
Harwich Formation	None	Croydon	537387 165738	1	House continually damp, even in dry summers. Garden unusually green	2005
London Clay Formation	Lynch Hill Gravel Member	Croydon	532300 167300	2	Water below floor	2000
Edge of Harwich Formation	None	Croydon	536042 166135	3	Waterlogged Garden	2000
Chalk	Hackney Gravel Member	Croydon	532400 164500	4	Flooded basement	2000
London Clay Formation	Lynch Hill Gravel Member	Croydon	532076 166598	5	Water in cellar	2000
London Clay Formation	Hackney Gravel Member	Croydon	531400 165400	6	Basement flooded	2000
London Clay Formation	Hackney Gravel Member	Croydon	532000 165500	7	Flooded basement	2001
London Clay Formation	Lynch Hill Gravel Member	Croydon	531947 166487	8	Flooding	2001
Thanet Sand Formation	None	Croydon	535477 163031	9	Flooded Garden	2001
Edge of Harwich Formation	None	Croydon	536500 166000	10	Garden flooding	2001

Bedrock Geological Unit*	Overlying Superficial Deposits*	Location	NGR	Incident N°**	Reported Incident	Year
London Clay Formation	Lynch Hill Gravel Member	Croydon	532824 166932	11	Water in Cellar	2002
Harwich Formation	None	Croydon	536024 167388	12	High water table	2002
London Clay Formation	None	Croydon	535054 166360	13	Flooded Garden, water entering house	2002
Harwich Formation	None	Croydon	533987 166298	14	Flooded Cellar	2003
London Clay Formation	Artificial Ground	Croydon	533777 166784	15	Water under floorboards	2003
Chalk	Head deposits	Kenley	532100 160400	16	Leak through retaining wall below property	2000
Chalk	Hackney Gravel Member	Purley	531430 161330	17	Water in basement	2001
Chalk	None	Redhill	536500 163600	18	Flooding at Addington	2001
Chalk	Hackney Gravel Member	S. Croydon	532307 162667	19	Water in basement	2001
London Clay Formation	None	SE19	532933 169451	20		2003
London Clay Formation	None	SE19	532466 170335	21	Basement Flooding	2003
London Clay Formation	Lynch Hill Gravel Member	Thornton Heath	531823 168084	22	Flooding of Cellar regularly in winter	2004
London Clay Formation	Lynch Hill Gravel Member	Thornton Heath	531755 168742	23	Watelogged garden, also neighbours	2001
London Clay Formation	Lynch Hill Gravel Member	Thornton Heath	530902 167711	24	Flooded Cellar	2002
London Clay Formation	Lynch Hill Gravel Member	Thornton Heath, Croydon	531850 168226	25	Water in basement	2000
Edge of Harwich Formation	None	Thornton Heath, Croydon	532900 168100	26	Water in basement	2001
London Clay Formation	Lynch Hill Gravel Member	Thornton Heath, Croydon	531921 168260	27	basement flooded	2001
Chalk	Head deposits	Whyteleafe, Croydon	531633 161079	28	Flooded basement	2000
London Clay Formation	None	Norbury	531587 170202	29	Spring in garden	2001
Chalk	Head deposits	Dagnall Park, 46.	533002 167448	30	Recorded as GW flooding	-

Note: * Geology of incident based on plotted location (Figures 1 and 2) and Environment Agency record
** Incident reference number as shown on Figures 1 and 2.

3.5.8 Table 3-4 demonstrates that the majority of reported incidents occurred during late 2000 / early 2001; a particularly wet period that resulted in both surface and groundwater flooding incidents in a number of locations across the country.

3.5.9 Each recorded incident has been appraised based on the underlying geology and the potential groundwater flooding mechanisms identified in Section 3.5.1. Incident numbers 13, 20, 21 and 29 are located over the London Clay Formation and have no known overlying superficial deposits. The London Clay Formation is an aquiclude and does not permit groundwater flow. Based on current available information, it can be suggested that these incidents are probably related to poor drainage over clayey soils following heavy rainfall and are therefore not groundwater flooding incidents.

3.5.10 Flood incidents 2, 5, 6, 7, 8, 11, 22, 23, 24, 25 and 27 are reported to be underlain by superficial deposits on London Clay Formation. A water table is often present in these superficial deposits, perched over the London Clay Formation aquiclude. It is therefore likely that these are true groundwater flooding incidents.

3.5.11 Incidents 4, 16 to 19, 28 and 30 are underlain by Chalk bedrock (often with thin superficial deposits), within a valley setting. Water levels within the Chalk aquifer are expected to be near or at ground surface in these areas during exceptionally wet periods. Therefore, these incidents are believed to be true groundwater flooding incidents.

3.5.12 Flood incident 9 is located on the Thanet Sand Formation outcrop. The incident is recorded as a flooded garden. It is possible this is due to groundwater emergence at surface, but without water level information it is difficult to confirm if this is a true groundwater flooding event.

3.5.13 Flood incidents 1, 3, 10, 12, 14 and 26 are located on the Harwich Formation outcrop. Some of the incidents are recorded as high water table, or flooding within basements. The Harwich Formation is defined as a secondary aquifer and so these incidents are likely to be true groundwater flood events. However, groundwater level data is required to confirm this.

3.5.14 Finally, incident 15 is located on an area of artificial ground overlying the London Clay Formation aquiclude. The incident is recorded as ‘water under floorboards’. It is possible that if the artificial ground is permeable (behaves as an aquifer) a perched groundwater table could form on top of the London Clay Formation.

POTENTIAL FOR ELEVATED GROUNDWATER

3.5.15 Areas where there is increased potential for groundwater levels to rise within 2 m of ground surface, following periods of higher than average recharge, are shown in Figure 3.5.1. These are separated into permeable superficial deposits and bedrock (consolidated) aquifers. The data set was produced for the whole of the Drain London project area, derived from four individual data sources:

- British Geological Survey (BGS). Groundwater Flood Susceptibility maps;
- Environment Agency (EA). Thames Estuary, 2100 groundwater hazard maps;
- DEFRA. Groundwater emergence maps; and
- JBA. Groundwater flood maps.

3.5.16 Figure 4 (Appendix C) shows that within the London Borough of Croydon area, increased potential for elevated groundwater is associated with both permeable superficial deposits and bedrock (consolidated) aquifers. This is in broad agreement with the groundwater flooding mechanisms identified in Section 3.5.1. The permeable superficial deposits that have been identified as having an increased potential for elevated groundwater are the Head and River Terrace Deposits, where they overlie the London Clay Formation aquiclude and ground elevations are low. With respect to bedrock (consolidated) aquifers, the Chalk valleys are shown to have an increased potential for elevated groundwater, as expected.

3.5.17 A reasonable correlation exists between groundwater flooding incidents and areas mapped as having an increased potential for elevated groundwater. The main discrepancies are:

- The increased potential for elevated groundwater data set does not appear to consider the Harwich Formation. However, a number of the groundwater flooding incidents seem to be associated with this aquifer. Either these are not true groundwater flooding incidents, or the increased potential for elevated groundwater data set may need to be refined at these locations;
- A number of reported groundwater flooding incidents are located where permeable superficial deposits exist, although not within areas defined as having an increased potential for elevated groundwater. Either these are not true groundwater flooding incidents, or the increased potential for elevated groundwater data set may need to be refined at these locations; and
- There are reported groundwater flooding incidents located on the London Clay Formation aquiclude, where superficial deposits are absent. As discussed in Section 3.5.2, it is likely that these incidents are not related to groundwater flooding.

3.5.18 In general, it is thought that the approximate areas identified by Figure 4 (Appendix C) as having increased potential for elevated groundwater are sensible. However, some areas that may have increased potential have been identified as having no potential for elevated groundwater, probably due to limited water level data being available. The Environment Agency does not monitor groundwater levels in the superficial deposits within the Croydon BC area and groundwater level data for bedrock aquifers is sparse.

3.5.19 Finally, it is important to note that the data set presented in Figure 4 (Appendix C) does not consider groundwater rebound following a reduction of groundwater abstraction. As there are numerous public water supply abstractions in the Borough, they have the potential to influence groundwater levels and therefore groundwater flood risk. A groundwater model would be useful for exploring scenarios where certain abstractions are switched off.

SUMMARY OF POTENTIAL FOR ELEVATED GROUNDWATER – CURRENT SUSCEPTIBILITY

Locations where Lambeth Group, Harwich Formation and Thanet Sand Formation (Basal Sands) outcrop at surface

3.5.20 The Lambeth Group, Harwich Formation and Thanet Sand Formation are all secondary aquifers and therefore water bearing. However, the Drain London mapping suggests there is a low potential for elevated groundwater where these units outcrop. This could be owing to a limited availability of data; the Environment Agency does not monitor groundwater levels in these aquifers.

3.5.21 There are a number of groundwater flooding incidents that appear to be associated with the Harwich Formation, in the vicinity of Spring Park, Addiscombe and Monks Orchard. This suggests that the increased potential for elevated groundwater data set needs to be refined.

3.5.22 It is likely that groundwater levels in the Lambeth Group, Harwich Formation and Thanet Sand Formation will depend on the degree of hydraulic continuity with the Chalk aquifer and the presence of clay horizons. Site specific investigations should therefore be carried out to confirm the depth to groundwater and monitor seasonal fluctuations before development takes place.

Locations in a Chalk valley setting in the southern half of the London Borough of Croydon area

3.5.23 The Upper Chalk is a principal aquifer and therefore water bearing. The mapping (Figure 4, Appendix C) suggests there is increased potential for elevated groundwater within the valleys of the unconfined Chalk aquifer, including Addington to the east, Waddon and South Croydon in the west and Purley in the south.

Locations where London Clay Formation is overlain by permeable superficial deposits in the north west of the London Borough of Croydon area

3.5.24 The superficial deposits in the Borough are defined as water bearing and the mapping (Figure 4, Appendix C) suggests that there is increased potential for elevated groundwater in the north west. The location of groundwater flooding incidents suggests that the increased potential for elevated groundwater data set may need to be refined, particularly in the area around Broad Green.

3.5.25 It should be noted that there is no groundwater level data to confirm the depth to water within the superficial deposits. The deposits are likely to be variable in composition across the London Borough of Croydon area. Site investigation will be important for any proposed development sites, to understand the local groundwater conditions, particularly those areas located in topographic lows near to surface water courses.

Locations where London Clay Formation outcrops at surface in the north of the Borough

3.5.26 The London Clay Formation is an aquiclude and does not permit groundwater flow. In areas where there are no overlying superficial deposits and the London Clay Formation is of an appreciable thickness, the potential for elevated groundwater is considered to be negligible.

3.5.27 It is possible that minor groundwater springs could emerge from nearby aquifer units and then flow onto the London Clay Formation. However, groundwater will not be a key source of flooding in areas underlain by this geology.

Recommendation 8: Work with the Environment Agency to record and investigate groundwater flooding incidents and mechanisms.

3.6 SEWER FLOODING

FLOODING MECHANISM

3.6.1 During heavy rainfall, flooding from sewer system may occur if:

1. The rainfall event exceeds the capacity of the sewer system / drainage system

3.6.2 Sewer systems are typically designed and constructed to accommodate rainfall events with a 1 in 30 year return period or less. Therefore, rainfall events with a return period of frequency greater than 1 in 30 years would be expected to result in surcharging of some of the sewer system. While Thames Water is concerned about the frequency of extreme events, it is not economically viable to build sewers that could cope with every extreme.

2. The system becomes blocked by debris or sediment

3.6.3 Over time there is potential that road gullies can become blocked from fallen leaves, build up of sediment and debris (e.g. litter).

3. The system surcharges due to high water levels in receiving watercourses

3.6.4 Within the Borough there is potential for river outlets to become submerged at high tide. When this happens, water is unable to escape into the river and flows back along the sewer. Once storage capacity within the sewer itself is exceeded, the water will overflow into streets and houses.

3.6.5 Within the pluvial modelling methodology, the sewer system has been assumed to have a capacity of 6.5mm/hour. This has been represented by removing 6.5mm/hour from the inflow hyetograph for urban areas, and, in accordance with the specification, no connectivity between the sewer system and the above ground surface has been modelled. More detailed analysis of the interactions through the use of a combined surface water and sewer model could be undertaken in the future if thought beneficial.

RESPONSIBLE ORGANISATIONS

3.6.6 The Highway Authority (London Borough of Croydon and TfL) are responsible for the effectual drainage of roads in so far as ensuring that drains, including kerbs, road gullies and the pipe network which connects to the trunk sewers are maintained.

3.6.7 Thames Water are responsible for surface water drainage from development via adopted sewers and are responsible for maintaining trunk sewers into which much of Croydon's highway drainage connects.

3.6.8 Riparian owners are responsible for private drainage networks and receiving watercourses where they are small open channels and culverted urban watercourses (see Section 3.4 below).

3.6.9 In addition to the Thames Water network, there are also some sewers and drains which are in private ownership. Most of these private systems connect to the Thames Water public sewerage system for treatment; however private owners can also connect foul water to septic tanks and storm water to soakaways.

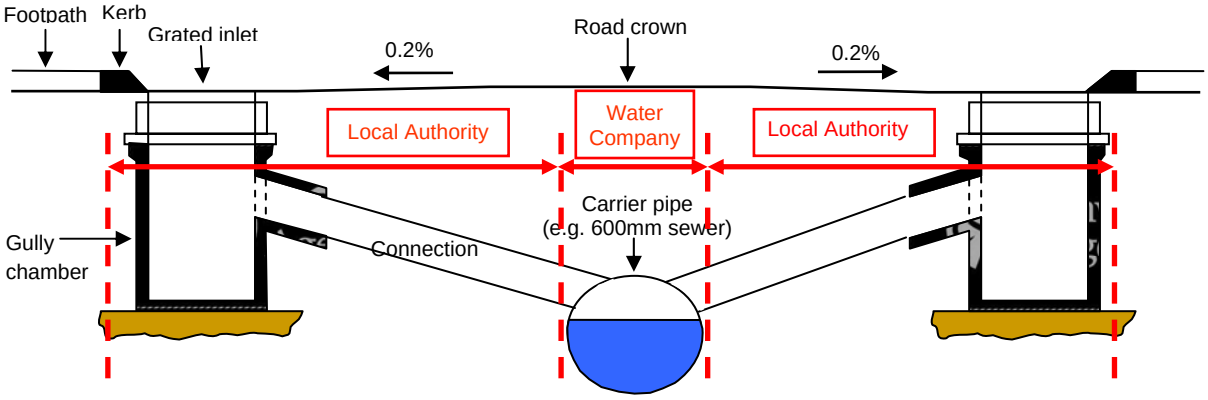


Figure 3-9 Surface Water Drainage Responsibility

3.6.10 The southern part of the Borough is underlain by chalk and is not served by a Thames Water surface water drainage system. Drainage is provided for the highways by way of soakaways and linked systems of soakaways which are maintained by London Borough of Croydon as the highways authority. Properties are also served by soakaways and it is the responsibility of the property owner to maintain these systems.

THAMES WATER DATASETS

3.6.11 Thames Water has provided their DG5 database which details the total number of sewer flood incidents that have affected properties both externally and internally over the last 10 years. The DG5 dataset is provided on a five-digit postcode area, which makes it difficult to determine more precisely where sewer flooding problems may have occurred. In addition, Thames Water focus their efforts on removing properties from the DG5 register, and therefore this dataset may no longer accurately represent those properties which are currently at risk.

3.6.12 Thames Water has also provided details of their utility infrastructure including sewers, pumping stations and outfalls. This information has been overlaid onto critical drainage areas to inform on potential mitigation options for each location. Thames Water is keen to work with Councils in order to mitigate flood risk issues. Where required in order to further inform detailed design of mitigation options, Thames Water have agreed to make network models available. Figure D-4 shows the Thames Water sewer network.

Figure D4 – Thames Water Sewer Network
Figure D5 – Historic Sewer Flooding Incidents

HISTORIC SEWER FLOODING

3.6.13 A review of Figure D-5 shows that there are records of sewer flooding in the majority of the Borough. The sewer flooding records highlight the following areas as being at a higher risk of sewer flooding (numbers in brackets indicate number of records of sewer flooding incidents):

- Thornton Heath CR7 7 (73 incidents of sewer flooding)
- Croydon CR0 6 (32 incidents of sewer flooding)
- Croydon CR0 7 (32 incidents of sewer flooding)

- South Croydon CR2 6 (23 incidents of sewer flooding)

3.6.14 London Borough of Croydon is also aware of a number of locations that are susceptible to sewer flooding. Site inspections of the following key sewer flooding sites have been undertaken and further details are provided in Section 3.8.

3.6.15 Properties on Caterham Drive are known to be affected by a combination of foul sewer and surface water sewer flooding. Figure 3-10 shows an example of a property in this location with a brick constructed flood wall to prevent the ingress of water into the driveway of the property.

Figure 3-10 Properties on Caterham Drive

3.6.16 The section of Marlpit Lane between the railway bridge and the road bridge is known to flood once to twice a year. Reportedly the Thames Water sewer surcharges from manholes and a combination of sewage and surface water ponds on the highway and surrounding area. Marlpit Lane is located in Coulsdon where surface water is drained into linked soakaways into the underlying chalk and therefore there is also potential for contamination of groundwater.

Recommendation 9: Work with Thames Water Utilities to identify areas where sewer flooding impacts on surface water flooding.

3.7 OTHER INFLUENCES

3.7.1 The Environment Agency has responsibility over flooding from designated Main Rivers and flooding from this source has been further assessed as part of the previously completed Level 1 and 2 Strategic Flood Risk Assessments for the London Borough of Croydon.

3.7.2 The River Wandle rises from natural springs at Waddon Ponds in London Borough of Croydon and Carshalton Ponds in London Borough of Sutton. It has two tributaries; the River Graveney which rises from springs in Addiscombe and the Caterham Bourne which is an ephemeral chalk stream in the upper catchment which drains into the Wandle at Waddon, Croydon (Environment Agency 2007). The Caterham Bourne is recorded to flow approximately every 7 years in the upper catchment in Coulsdon.

3.7.3 Figure D3 in Appendix D shows the Main Rivers and Flood Zones covering the London Borough of Croydon, using the Environment Agency Flood Map. The effects of Main River flooding have not been assessed as part of this study.

Figure 3.7.1 – EA Main Rivers, Flood Zones & Fluvial Flood Incidents
Figure D3 – EA Main Rivers and Flood Zones

Recommendation 10: Work with the Environment Agency to incorporate any findings from the SWMP into SFRAs and other river modelling projects.

3.8 Critical Drainage Areas

3.8.1 As shown in Figure 3.2.1, 16 Critical Drainage Areas (CDAs) have been identified within or crossing the administrative boundary of London Borough of Croydon. Croydon Council has been identified as the 'lead' authority in terms of managing flood risk within these CDAs, though it will be necessary to work in partnership with other Boroughs to manage flood risk within several of the CDAs.

3.8.2 The remainder of this Chapter provides a description of each Critical Drainage Area including details of the flooding mechanisms and interaction between flooding locations within the CDA, the level of validation, any specific assumptions made, and the number and types of receptors identified to be at risk.

Figures 3.8.1 – 3.8.16 show the modelling results for each CDA; two maps for each CDA have been included which show the surface water depth and surface water flood hazard rating during the rainfall event with a 1 in 100 chance of occurring in any given year (1% AEP).

Property Counts

3.8.3 Pluvial modelling completed as part of Phase 2 of the Drain London Project affords an improved understanding of the level of flood risk facing the London Borough of Croydon. In order to provide a quantitative indication of potential risks, a property count for all return periods modelled as part of the Drain London project for the entire London Borough of Croydon has been undertaken and is shown in Table 3-5. This has been undertaken using the Environment Agency's National Receptors Dataset (NRD) and follows the methodology defined in the Drain London Data and Modelling Framework.

Table 3-5 Drain London Tier 2 Pluvial Modelling Property Count for the modelled event with a 1 in 100 annual chance of occurrence (1% AEP)

Property Type	Sub Category*	No. of properties flooded >0.03m**	No. of properties flooded >0.5m***
Infrastructure	Essential Infrastructure	77	6
	Highly Vulnerable	12	2
	More Vulnerable	228	18
	Other Infrastructure	162	10
Households	Deprived (All)	7,290	23
	Deprived (Basements)	451	3
	Non-Deprived (All)	57,012	1,215
	Non-Deprived (Basements)	1,731	61
Commercial / Industrial	Commercial/Industrial (All)	3,600	230
	Commercial/Industrial (Basements)	779	25
Other		47	3
	TOTAL	**68,428**	**1,507**

* A full description of the sub-categories is included in Table 3-7 at the end of this Chapter.

** Building thresholds have been represented in the modelling as 'stubs' raised 100mm above the average ground level within the building footprint. A depth of >0.03m will result in a water level 0.03m above the property threshold, which is therefore considered to flood.

*** Buildings where the average depth of flooding across the building footprint is greater than 0.5m.

3.8.4 To provide an indication of the spatial flood risk across the Borough, a property count has been undertaken within each of the CDAs in the London Borough of Croydon for the 1 in 100 year (1% AEP) event. These values are included in the following sections for each CDA and a full summary is included in Table 3-7 at the end of this Chapter.

3.8.5 It is important to note that the counts have been undertaken on a CDA basis, and therefore, for those cross boundary CDAs, not all flooded properties will lie within the London Borough of Croydon administrative area.

CDA 034 WOODPLACE LANE

3.8.6 Pluvial modelling of this area shows that surface water will tend to flow off the land surrounding Woodplace Farm and the Farthing Downs and pond in the topographical low points surrounding Woodplace Lane. Ponding is modelled to occur along the eastern edge of the CDA in the open land surrounding Hooley Farm. Surface water is also modelled to pond either side of Woodplace Lane and build up adjacent to the railway line. Depths of approximately 0.5m are modelled to occur on Ashbourne Close, Charlton Close and Woodplace Lane, leading to a risk of property flooding. This CDA is defined as an area of iPEG in the underlying consolidated aquifer which gives rise to the potential for flood incidents of multiple or combined sources.

Group8_034 Woodplace Lane		
LLFA	London Borough of Croydon and Surrey County Council	
Flood Risk Categorisation:	Surface Water	
Property Count	Approximately 196 Non-deprived households flood to a depth > 0.03m.	Approximately 14 Non-deprived households flood to a depth of > 0.5m.
Critical Infrastructure	Railway Line	
Validation	There are two recorded incidents of pluvial flooding within the CDA along Woodplace Lane and Ashbourne Close. There are no recorded incidents of sewer or groundwater flooding within the CDA.	
Assumptions	The modelling assumes no culverts underneath the railway line, or pumping infrastructure to alleviate the build up of surface water at this location.	
Figures	Figure 3.8.1a – Surface Water Depth (1% AEP) Figure 3.8.1b – Surface Water Flood Hazard (1% AEP)	

CDA 035 MARLPIT LANE

3.8.7 The section of Marlpit Lane between the railway bridge and the road bridge is modelled to be at risk of surface water ponding and is recorded to flood once to twice a year from a combination of pluvial and sewer flooding. The Thames Water sewer reportedly surcharges from manholes and a combination of sewage and surface water ponds in this area. This has led to deep ponding causing disruption to the local transport infrastructure.

3.8.8 Marlpit Lane is located in Coulsdon where surface water is drained into linked soakaways in the underlying chalk. Given these circumstances, there is potential for contamination of groundwater. Although it has been reported that Thames Water has undertaken maintenance in this area to remove a blockage, there have been reports of surcharging sewers in recent months.

3.8.9 Modelling also shows Ullswater Crescent and the Industrial Estate, which is located in a former quarry, to be at risk of pluvial flooding due to the local topography. Further up in the CDA, surface water is modelled to pond along Chaldon Way and Mead Way causing risk to properties.

Figure 3-11 Marlpit Lane, Coulsdon

Group8_035 Marlpit Lane		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation	Sewer Flooding & Surface Water	
Property Count	Approximately 895 Non-deprived households and 65 commercial properties flood to a depth of greater than 0.03m.	Approximately 2 Non-deprived households and 1 commercial property flood to a depth of greater than 0.5m.
Critical Infrastructure	Police Station Rail Station Fire Station	
Validation	London Borough of Croydon holds records of pluvial and sewer flooding along Chaldon Way, Bradmore Way and the bottom of Marlpit Lane.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.2a – Surface Water Depth Figure 3.8.2b – Surface Water Flood Hazard	

CDA 036 OLD LODGE LANE

3.8.10 This CDA is located in Coulsdon which is a steeper part of the Borough of Croydon. The catchment that has been defined for this CDA falls from 155m AOD in the south to 80m AOD where Old Lodge Lane passes beneath the railway line in the northern part of the CDA.

3.8.11 Following the topography, surface water is modelled to flow off the grounds of Coulsdon Manor and down the highway routes to pond in the surrounding predominantly residential area. Significant ponding is identified along Old Lodge Lane, Whitefield Avenue, Colscroft Hill, Somerton Close, Hartley Hill, Highland Road and Burcott Road.

3.8.12 Surface water flows down Reedham Drive and the surrounding area and builds up in the Sports Ground behind the railway line. This area acts as a flood storage area during periods of heavy rainfall.

Figure 3-12 Sports Ground, Old Lodge Lane

Group8_036 Old Lodge Lane		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation	Surface Water	
Property Count	Approximately 1342 Non-deprived households and 16 commercial properties flood to a depth of greater than 0.03m.	Approximately 14 Non-deprived households flood to a depth of greater than 0.5m.
Critical Infrastructure	Electrical substation, Hartley Down Schools	
Validation	There are 18 records of pluvial flooding within this CDA; 15 incidents along Old Lodge Lane, 2 incidents on Hartley Way and 1 incident on Holmes Close off Reedham Drive.	
Assumptions / Comments	It is assumed that there is no flow path for water to pass from the Sports Ground underneath the railway line.	
Figures	Figure 3.8.3a – Surface Water Depth Figure 3.8.3b – Surface Water Flood Hazard	

CDA 037 KENLEY STATION

3.8.13 The EDF electrical substation on Kenley Lane, the Kenley railway station and adjacent properties have historically experienced flooding associated with overland flow and insufficient highway drainage and this area is identified as a flooding hotspot by London Borough of Croydon.

3.8.14 The source of the floodwater is overland flow which runs off the land at the top of Welcomes Road. Water flows down Welcomes Road, which is a private road without a positive drainage system, and ponds at the junction with Kenley Lane resulting in flooding of the Kenley Lane EDF electrical substation and several adjacent properties.

3.8.15 Pre-cast concrete drainage blocks have been placed along the road gully and entrance to the substation to improve the management of localised surface water. Residents of the adjacent property have also installed a small pre-cast metal grated linear drainage pipe (ACO drain) along the front of their drive.

3.8.16 Driven by the topography, overland flooding affects these properties where it continues downhill and it reportedly ponds affecting the railway line which runs along the bottom of the valley.

Figure 3-13 Pluvial flowpaths and receptors at risk on Kenley Lane, Kenley

Group8_037 Kenley Station		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation	Surface Water. Caterham Bourne.	
Property Count	Approximately 826 Non-deprived households and 21 commercial properties flood to a depth of greater than 0.03m.	Approximately 43 Non-deprived households and 12 commercial properties flood to a depth of greater than 0.5m.
Critical Infrastructure	EDF Electricity Substation Kenley Rail Station 3 Residential Homes	
Validation	LB Croydon has records of pluvial flooding affecting Kenley Station and properties on Kenley Way.	
Assumptions / Comments	The modelling does not take account of additional drainage recently installed on Kenley Lane by London Borough of Croydon. A standard loss to the drainage system is assumed across the whole study area.	
Figures	Figure 3.8.4a – Surface Water Depth Figure 3.8.4b – Surface Water Flood Hazard	

CDA 038 A22 GODSTONE ROAD

3.8.17 Pluvial modelling identifies large parts of this CDA to be at risk of surface water flooding. The catchment is steep with Downs Court Road and Godstone Road located at the topographic low point resulting in surface water ponding along these road routes. Areas identified to be at particular risk within this CDA including Purley Vale, Roke Lodge Road, Lower Road, Cross Road, Godstone Road, Friends Road, Foxley Hill Road, Approach Road and Warren Road.

3.8.18 This CDA contributes to flooding at Purley Cross (CDA 040) however the majority of flow from further up in the Downs Court Road CDA is restricted by the railway embankments and results in flooding in Foxley Hill Road.

Group8_038 A22 Godstone Road		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation	Surface Water	
Property Count	Approximately 1205 Non-deprived households and 35 commercial properties flood to a depth of greater than 0.03m.	Approximately 34 Non-deprived households and 5 commercial properties flood to a depth of greater than 0.5m.
Critical Infrastructure	Purley Station A22 (TfL Red Route) London Concrete Works Residential Home Health Surgery	
Validation	There are seven records of pluvial flooding in this CDA, including Lower Road, Little Roke Avenue, Godstone Road and Foxley Hill Road.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.5a – Surface Water Depth Figure 3.8.5b – Surface Water Flood Hazard	

CDA 039 CHIPSTEAD VALLEY ROAD

3.8.19 Surface water flow paths in Coulsdon are driven by the local topography. During the heavy rainfall of July 2007, surface water flowed north along Rickman Hill, west along Westleigh Avenue, and flooding properties on the northern side of the road. Surface water passed through the properties on Westleigh Avenue and down Gidd Hill towards Chipstead Valley Road which lies in a topographic depression.

3.8.20 As identified in the pluvial modelling, properties on the north side of Chipstead Valley Road and Westleigh Avenue, including those shown in the photographs below, are affected by surface water flooding during heavy rainfall events, such as that of July 2007. These properties are located as much as 1.5m below the road level and are therefore have no protection against surface water flowing off the roads and through the properties.

Figure 3-14 Properties on Chipstead Valley Road

3.8.21 Along Chipstead Valley Road, surface water also collects where there are depressions in the road level. In order to alleviate surface water ponding lateral pipes have been installed to pipe water from depressions in the road to the other side of the rise.

3.8.22 Surface water flowpaths continue north eastwards across the CDA and back up behind the railway line causing significant depths of flooding along the Brighton Road and adjacent side roads. There is a significantly sized soakaway underneath the junction at this location, however even with the presence of this soakaway there are still regular episodes of flooding in this area.

Group8_039 Chipstead Valley Road		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation	Surface Water	
Property Count	Approximately 1177 Non-deprived households and 193 commercial properties flood to a depth of greater than 0.03m.	Approximately 129 Non-deprived households and 73 commercial properties flood to a depth of greater than 0.5m.
Critical Infrastructure	Schools Community Centres	
Validation	There are 11 records of pluvial flooding in this CDA including locations along Chipstead Valley Road, Gidd Hill, Westleigh Avenue, Lion Green, Brighton Road and Malcolm Road.	

	There are also 3 records of sewer flooding on Chipstead Valley Road, Marlpit Lane/Chaldon Way and Hayes Lane/Park Road.
Assumptions / Comments	The modelling assumes a standard loss to the drainage network but does not take account for the presence of the oversized soakaway present at this location.
Figures	Figure 3.8.6a – Surface Water Depth Figure 3.8.6b – Surface Water Flood Hazard

CDA 040 PURLEY CROSS

3.8.23 This CDA covers the section of Brighton Road from Smitham Rail Station northwards to the Purley Cross junction. Brighton Road is located in a natural depression along the former pathway of the River Wandle. During periods of heavy rainfall, surface water flows down the side roads and ponds along Brighton Road resulting in highway flooding and flooding of properties on either side of the highway. Accordingly, reported incidents of flooding are concentrated along Brighton Road.

3.8.24 The A22, A23 and A235 trunk roads that serve Croydon meet at a large junction in Purley known as Purley Cross. A pedestrian subway passes through the centre of this junction in the form of a gyratory system below road level.

3.8.25 Due to its location in a topographic depression, the pluvial modelling identifies this area to be susceptible to significant depths of flooding. The Purley Cross junction has historically experienced severe flooding, most notably in July 2007 when TfL issued a flood warning for the area, and the gyratory system including the surface water pumping system was completely submerged beneath 2 to 3 metres of flood water. The area has been affected by flooding historically, including 1961 (McQueeny 2007), as shown in the photograph below.

Figure 3-15 Purley Cross, 1961 (Croydon Local Studies Library & Archive Service)

3.8.26 Purley Cross is located within a topographic depression and forms a 'bowl' where floodwaters pond. The flooding mechanisms at Purley Cross are complex with interlinked sources of flooding, including flooding from Transport for London drainage assets from the A22 and A23 and the pedestrian subway.

3.8.27 The Caterham Bourne is an Environment Agency designated Main River with an open channel section and trash screen located at the rear of the Tesco's car park. This watercourse reportedly contributed to the flooding at Purley in the 20th July 2007 flood event.

3.8.28 In addition to these sources, the Purley Cross area receives overland flow contributions from the adjacent Council maintained roadways.

Group8_040 Purley Cross		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation:	Surface Water and Ordinary Watercourse	
Property Count	Approximately 2316 Non-deprived households and 83 commercial properties flood to a depth of greater than 0.03m.	Approximately 101 Non-deprived households and 20 commercial properties flood to a depth of greater than 0.5m.
Critical Infrastructure	A23 TfL red route from London to Brighton 2 Fire Stations Electrical substation Schools Community Centres Residential Homes	
Validation	There are 16 records of flooding within this CDA. There are 12 records of pluvial flooding at Purley Cross, Brighton Road, Woodcote High School, Russell Hill Road, Smitham Bottom Lane, The Chase, The Horseshoe and Old Lodge Lane. In addition there are records of sewer flooding at Brighton Road, Old Lodge Lane, Reedham Drive, Foxley Lane and Purley Cross.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.7a – Surface Water Depth Figure 3.8.7b – Surface Water Flood Hazard	

CDA 041 BRIGHTON ROAD

3.8.29 Brighton Road is located along the former pathway of the River Wandle. During periods of heavy rainfall, surface water is channelled from higher land in Kenley and Sanderstead towards Purley and ponds along the length of Brighton Road. Accordingly, reported incidents of flooding are concentrated along Brighton Road.

3.8.30 During the 20th of July 2007 flood event, reportedly more than 50 properties reported to be affected by surface water flooding along the Brighton Road corridor. The capacity of the surface water drainage system was overwhelmed and the residual surface water resulted in roadway and property flooding. Flooding extended beyond the Brighton Road frontage to adjacent roads and properties.

3.8.31 The Brighton Road is defined as Environment Agency Flood Zone 3a however the watercourse is entirely culverted along this section and joins the River Wandle in neighbouring London Borough of Sutton.

Group8_041 Brighton Road		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation:	Surface Water, Culverted Ordinary Watercourse	
Property Count	Approximately 2357 Non-deprived households and 373 commercial properties flood to a depth of greater than 0.03m.	Approximately 163 Non-deprived households and 26 commercial properties flood to a depth of greater than 0.5m.
Critical Infrastructure	TfL Red Route (A23) Hospital Fire Station, Brighton Road Bus Depot Electrical substation	
Validation	London Borough of Croydon has records of flooding at more than 8 locations along this section of Brighton Road.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.8a – Surface Water Depth Figure 3.8.8b – Surface Water Flood Hazard	

CDA 042 SOUTH & CENTRAL CROYDON

3.8.32 This CDA covers the upper extent of Brighton Road extending from Haling Park to Wandle Park. The pluvial modelling outputs demonstrate how surface water flows into the channel of the former River Wandle in the area designated as Environment Agency Flood Zone 3a and ponds to significant depths. Surface water is shown to pond beneath the Croydon flyover and the subways beneath Mitcham Road including Booth Road and Bourne Street shown in the following photographs.

3.8.33 The majority of this CDA is located within an iPEG area. There are two records of groundwater flooding within this CDA and there are approximately 50 records of sewer flooding within the post code areas that fall within the CDA.


Figure 3-16 Booth Road and Bourne Street

Group8_042 South & Central Croydon		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation:	Surface Water, Culverted Ordinary Watercourse	
Property Count	Approximately 3450 Non-deprived households of which 431 are basements; 327 Deprived households, of which 17 are basements; and 830 commercial properties, of which 464 are basements, flood to a depth of greater than 0.03m.	Approximately 349 Non-deprived households of which 25 are basements; 5 Deprived households, or which 3 are basements; and 49 commercial properties, of which 11 are basements, flood to a depth of greater than 0.5m.
Critical Infrastructure	A23 TfL Red Route Fire Station, Duppas Hill Terrace Sewage Treatment Works 14 Electrical substations Police Station, Wellesley Road Croydon Hospital Tram network (Reeves Corner and Central stations)	
Validation	London Borough of Croydon has records of pluvial flooding at 33 locations within this CDA including Wellesley Road (Croydon underpass), Brighton Road, Haling Park Road, Church Street, Cliffe Road, Howard Primary School, Duppas Hill Terrace, North End, Park Lane, Parker Road, Queen Street, Southbridge Place, Waddon Road, Warham Road, Warrington Road, Barlett Street, Selsdon Road, Incidents of sewer flooding have been recorded at Purley Road, Miller Road and North End. Incidents of groundwater flooding have been recorded at Barham Road, Brighton Road and Church Road.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.9a – Surface Water Depth Figure 3.8.9b – Surface Water Flood Hazard	

CDA 043 CARLTON ROAD & BUSINESS ESTATE

3.8.34 The LFRZ within this CDA is primarily the Business Estate off Carlton Road. The modelling for this area identifies that this area is located in a topographic depression between the railway lines and is at risk of flooding to significant depths.

3.8.35 Surface water is modelled to flow off the residential area around Hook's Hill School and to pond in the following highways; Ellenbridge Way Elmfield Way, West Hill, Sandhurst Way, Essenden Road, Carlton Road.

3.8.36 This area is susceptible to combined sources of flooding. The Business Centre and the north western part of the CDA are located in an area of iPEG. There are records (1-5 incidents) of sewer flooding within the post code areas that fall within the CDA.

Group8_043 Carlton Road & Business Estate		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation:	Surface Water	
Property Count	Approximately 630 Non-deprived households and 68 commercial properties flood to a depth of greater than 0.03m.	Approximately 14 commercial properties flood to a depth of greater than 0.5m.
Critical Infrastructure	Railway Line Rail Station	
Validation	There are records of pluvial flooding on Beechwood Road, Capital Business Centre on Carlton Road and Eddenden Road within the CDA. There are records (1-5 incidents) of sewer flooding within the post code areas that fall within the CDA.	
Assumptions	N/A	
Figures	Figure 3.8.10a – Surface Water Depth Figure 3.8.10b – Surface Water Flood Hazard	

CDA 044 CROHAM ROAD

3.8.37 Within this CDA, pluvial modelling shows that surface water may runoff the Croham Golf Course and the surrounding residential area resulting in ponding in gardens and highways on Croham Valley Road, Croham Road, Winchelsey Rise, Croham Manor Road, Normanton Road and the lower part of Birdhurst Road. The Sports Ground off Manor Way provides an area for storage of some of the overland flow.

3.8.38 The western part of the CDA is located within an area of increased potential for elevated groundwater but there are no reported incidents of groundwater flooding in this location.

3.8.39 Records of sewer flooding provided by Thames Water identify 1-5 properties affected by sewer flooding within the post code areas with the CDA.

Group8_044 Croham Road		
Lead Borough	London Borough of Croydon	
Flood Risk Categorisation:	Surface Water	
Property Count	Approximately 1176 Non-deprived households, of which 23 are basements; and 15 commercial properties flood to a depth of greater than 0.03m.	Approximately 13 Non-deprived households flood to a depth of greater than 0.5m.
Critical Infrastructure	South Croydon Rail Station	
Validation	There are six records of pluvial flooding along The Ruffetts and Croham Valley Road in this CDA. Thames Water has records of 1-5 incidents of sewer flooding within the post code areas that fall within the CDA.	
Assumptions	N/A	
Figures	Figure 3.8.11a – Surface Water Depth Figure 3.8.11b – Surface Water Flood Hazard	

CDA 045 FORESTDALE / ADDINGTON

3.8.40 This CDA is characterised by steep topography which falls from approximately 120mAOD in the west and 150m AOD in the south to 65mAOD in the north west close to the border with London Borough of Bromley. As a result, the CDA is defined by surface water flows that follow the natural topography and which form the upper catchment of tributaries that feed the Ravensbourne River.

3.8.41 During heavy rainfall, the topography channels surface water flows off Selsdon Wood and Addington Golf Course towards the built up area of Selsdon, particularly affecting Albatross Gardens, Goldfinch Road and the main highway Kent Gate Way and Addington Road. Surface water is modelled to pond along this highway and flow eastwards towards London Borough of Bromley where the watercourse becomes a culverted Main River tributary of the River Ravensbourne.

3.8.42 The areas of Sorrel Bank and Hancroft within Forestdale are shown to be affected by depths of over 0.5m. The junction of the A212 Gravel Hill and the A2022 Kent Gate Way and the route of the tramlink are also shown to be at risk of flooding.

3.8.43 The northern part of the CDA is located within an area of increased potential for elevated groundwater (iPEG). Thames Water have records of 1-5 properties affected by sewer flooding in the post code areas in which this CDA is located.

Group8_045 Forestdale / Addington		
LLFA	London Borough of Croydon (Lead) London Borough of Bromley	
Flood Risk Categorisation	Surface Water	
Property Count	Approximately 3115 Non-deprived households, of which 10 are basements; 1602 Deprived households, of which 22 are basements; and 56 commercial properties, of which 1 is a basement, flood to a depth of greater than 0.03m.	Approximately 164 Non-deprived households, of which 1 is a basement; 3 Deprived households; and 15 commercial properties, of which 1 is a basement, flood to a depth of greater than 0.5m.
Critical Infrastructure	Tramlink 9 Electrical Substations Junction of A212 and A2022 Addington Police Station Community Centres Health Care Surgeries	
Validation	17 records of pluvial flooding; Selsdon Community Hall, Ambleside Gardens, Applegarth Junior School, Cowley Close, Elmside, Gravel Hill Roundabout, Pixton Way, Fairleigh Rd South, Southviews, Sundale Avenue, Kent Gate Way, North Walk, Lodge Lane, Old Fairleigh Way. Sewer flooding along Kent Gate Way, Old Fairleigh Road and Cowley Close.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.12a – Surface Water Depth Figure 3.8.12b – Surface Water Flood Hazard	

CDA 046 WOODSIDE

3.8.44 There are several LFRZ within the Woodside CDA which have been considered together. Railway embankments pass through the CDA and surface water is modelled to pond behind the railway line at Teevan Road and Dalmally Road reaching depths of between 0.5 - 1m.

3.8.45 The low lying nature of this part of the Borough leads to ponding of surface water in low lying gardens leading to property flooding along Davidson Road, Rees Gardens, Lindfield Road, Northway Road, Aschurch Road, Jesmond Road, Morland Road and Amberley Road, Adams Way, Goodhew Road and Davies Road.

3.8.46 The CDA is shown to be located in an area of increased potential for elevated groundwater which may indicate the potential for combined sources of flooding in these locations. There are 2 records of groundwater flooding in the CDA, in Bredon Road and Inglis Road.

3.8.47 Thames Water have records of 21-50 properties affected by sewer flooding in the post code areas in which this CDA is located.

Group8_046 Woodside		
LLFA	London Borough of Croydon	
Flood Risk Categorisation	Surface Water Groundwater	
Property Count	Approximately 1631 Non-deprived households, of which 25 are basements; 199 Deprived households, of which 7 are basements; and 46 commercial properties, of which 7 are basements, flood to a depth of greater than 0.03m.	Approximately 33 Non-deprived households, of which 2 are basements and 7 Deprived households, flood to a depth of greater than 0.5m.
Critical Infrastructure	Tramlink Railway line Blackhorse Lane Station Addiscombe Station Electrical Substation	
Validation	London Borough of Croydon hold records of surface water flooding within this CDA at the following locations; Dickenson's Lane, Grant Road, Stanley Technical High School on Davidson Road, 27 Inglis Road, Lower Addiscombe Road, Morland Road, 2 Northway Road, Rees Gardens, Teevan Road, Beckford Road, Lower Addiscombe Road/Woodside Court Road.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.13a – Surface Water Depth Figure 3.8.13b – Surface Water Flood Hazard	

CDA 047 SOUTH NORWOOD

3.8.48 This CDA is located between South Norwood Country Park and the railway line passing through Norwood Junction. Modelling identifies surface water flow paths along Holland Road, Albert Road and Westgate Road, resulting in significant ponding on Portland Road, Notson Road, Aylett Road and the end of Westgate Road. Ponding is also shown to occur on Addison Road and Cresswell Road and ponds behind the railway embankment in the north of the CDA affecting properties along Cromer Road. The area within the CDA is highly urbanised and includes residential properties, several primary schools and a small portion of the South Norwood Country Park.

3.8.49 There are no records of groundwater flooding in the area; however the eastern part of the CDA is located within an area of increased potential for elevated groundwater (iPEG). Thames Water have records of 6-10 properties affected by sewer flooding in the post code areas in which this CDA is located.

Group8_047 South Norwood		
LLFA	London Borough of Croydon	
Flood Risk Categorisation	Surface Water	
Property Count	Approximately 924 Non-deprived households, of which 53 are basements; 65 Deprived households, of which 10 are basements; and 41 commercial properties, of which 10 are basements, flood to a depth of greater than 0.03m.	Approximately 17 Non-deprived households, of which 2 are basements, flood to a depth of greater than 0.5m.
Critical Infrastructure	Tramlink Railway line Harrington Tram Station Norwood Junction Rail Station Electrical substation	
Validation	London Borough of Croydon holds records of surface water flooding at St Mark's Primary School, 101 Albert Road.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.14a – Surface Water Depth Figure 3.8.14b – Surface Water Flood Hazard	

CDA 048 SOUTH NORWOOD HILL

3.8.50 Within this CDA, pluvial modelling identifies a LRFZ adjacent to the railway embankment affecting properties in Grosvenor Road and Norwood Junction Rail Station. The key flowpaths leading to this LFRZ are along South Norwood Hill, High Street, Selhurst Road and St Dunstan's Road.

3.8.51 Surface water is also shown to pond along Nugent Road, Elm Park Road and Broster Gardens leading to property and highway flooding in these locations. London Borough of Croydon has records of flooding along Selhurst Road, Station Road, South Norwood Hill and Portland Road within this CDA.

3.8.52 Thames Water has records of 1-5 properties affected by sewer flooding in the post code area in which this CDA is located. The CDA is not identified to lie within an area of increased potential for elevated groundwater (iPEG).

Group8_048 South Norwood Hill		
LLFA	London Borough of Croydon	
Flood Risk Categorisation	Surface Water	
Property Count	Approximately 105 Non-deprived households, of which 1 is a basement; 279 Deprived households, of which 76 are basements; and 36 commercial properties, of which 20 are basements, flood to a depth of greater than 0.03m.	Approximately 8 Deprived households flood to a depth of greater than 0.5m.
Critical Infrastructure	Police Station Residential Home Community Hall Health Care Surgery Norwood Junction Rail Station	
Validation	London Borough of Croydon has records of pluvial and sewer flooding along Oliver Ave, Portland Rd, Selhurst Rd, Station Rd and South Norwood Hill.	
Assumptions / Comments	N/A	
Figures	Figure 3.8.15a – Surface Water Depth Figure 3.8.15b – Surface Water Flood Hazard	

CDA 049 NORBURY

3.8.53 The primary flood source in this CDA is fluvial flooding associated with the Norbury Brook. A large part of the CDA is located within Flood Zone 3a defined as having a High Probability (1% AEP) of flooding from fluvial sources and London Borough of Croydon holds historic records of flooding from the Norbury Brook within this CDA.

3.8.54 However, whilst the primary flood source affecting the area is fluvial, there are some surface water flow paths within the CDA that contribute to the flood risk area. Surface water flowpaths and areas of ponding generally follow the highways, which slope downwards towards the Norbury Brook. Modelling shows that the following roads are affected by surface water ponding, Marion Road, Swain Road, Brook Road, Warlingham Road, Linden Avenue, Beechwood Avenue, Norbury Crescent, Kynaston Avenue, Zermatt Road and on the eastern side of the railway, Beulah Road, Westminster Avenue, Kensington Avenue, Willowtree Way, Northwood Road and St Oswold's Road.

3.8.55 The CDA is shown to be located in an area of increased potential for elevated groundwater which may indicate the potential for combined sources of flooding in these locations. There are 4 records of groundwater flooding in the CDA. In addition, Thames Water have records of between 50 – 100 properties affected by sewer flooding in the post code areas in which this CDA is located.

Group8_049 Norbury		
LLFA	London Borough of Croydon (Lead) London Borough of Lambeth	
Flood Risk Categorisation	Fluvial Surface Water Sewer Groundwater	
Property Count	Approximately 3922 Non-deprived households, of which 122 are basements; 638 Deprived households, of which 8 are basements; and 242 commercial properties, of which 49 are basements, flood to a depth of greater than 0.03m.	Approximately 109 Non-deprived households; and 14 commercial properties, of which 9 are basements, flood to a depth of greater than 0.5m.
Critical Infrastructure	10 Electrical substations Sewage Treatment Works 2 Police Stations Community Centres	Health Surgeries Schools Railway line 2 Rail Stations
Validation	London Borough of Croydon has 17 records of pluvial flooding in the CDA including Boswell Rd, Brigstock Rd, Winterbourne Rd, Goston Gardens, Granville Gardens, Green Lane, Highbury Avenue, Kilmartin Ave, London Rd, Norbury Ave, Parchmore Rd, Strathyre Ave, Windsor Rd, Zermatt Rd, Kensington Ave, and Oaklands Ave. The Council also hold records of sewer flooding on Brigstock Rd, Parchmore Rd, Norbury Ave, Zermatt Rd and Highbury Avenue. There are 4 records of groundwater flooding in this CDA.	
Assumptions	N/A	
Figures	Figure 3.8.16a – Surface Water Depth Figure 3.8.16b – Surface Water Flood Hazard	

ADDITIONAL LOCAL FLOOD RISK ZONES

3.8.56 A number of Local Flood Risk Zones (LFRZs) have also been identified in the Borough which have not been identified within Critical Drainage Areas. As stated in Section 3.2.1, a LFRZ is defined as *"a discrete area of flooding that affect houses, businesses or infrastructure".* The following sections describe additional Local Flood Risk Zones within the Borough.

Local Flood Risk Zone – Caterham Drive, Austin Close, Coulsdon

3.8.57 Properties 1, 3, 5 Caterham Drive are known by the Council to be affected by a combination of foul sewer flooding and surface water flooding. These properties reported flooding during the 20th of July 2007 flood event as well as subsequent heavy rainfall events. Reportedly the source of flooding in this area was due to the exceedance of the Thames Water sewer network which was further exacerbated by local surface water and overland flow paths originating from the adjacent steep slopes and Caterham Drive.

3.8.58 It is possible that land at the end of Caterham Drive owned by the City of London known as 'Dollypers Hill' could be further enhanced to mitigate flooding in this area. This should be considered in conjunction with the incorporation of a brow ditch or interceptor drain to intercept runoff from the adjacent steep slopes thereby reducing the volume of overland flooding in this area.

3.8.59 It is worth noting that sewer systems are typically designed and constructed to accommodate rainfall events with a 1 in 30 year return period or less. Therefore, rainfall events with a return period of frequency greater than 1 in 30 years would be expected to result in surcharging of some of the sewer system.

3.8.60 In this case, it is likely that the combined system becomes overwhelmed during heavy rainfall and therefore surcharges foul and surface water which ponds along the end of Caterham Drive. Figure 3-17 shows an example of a property with a brick constructed flood wall to prevent the ingress of water into the driveway and thus the doorway threshold of the property.

Figure 3-17 Raised Property Entrance, Caterham Drive, Coulsdon (Site Visit Oct 2009)

Local Flood Risk Zone – Hamsey Green, Coulsdon

3.8.61 Properties on Kingswood Way, Audley Drive, Kingswood Avenue and Harewood Gardens in Hamsey Green experienced surface water flooding during the July 2007 floods, and historically (Hucks 2008).

3.8.62 An investigation into the causes of flooding in this area was undertaken by the Bob Hucks of London Borough of Croydon. In this report, it was concluded that the main cause of flooding is surface water runoff from the field south of Kingswood Lane which is directed along a natural gully between Kingswood Lane and Harewood Gardens.

3.8.63 It is likely that the capacity of the highway drainage system, which is designed solely to manage runoff from the highways, was exceeded, thereby contributing further to the flooding. Hucks (2008) recommended the construction of a bund along the edge of the field to alleviate flooding in Hamsey Green.

Figure 3-18 Audley Drive, 1993

Figure 3-19 Audley Drive, 2007

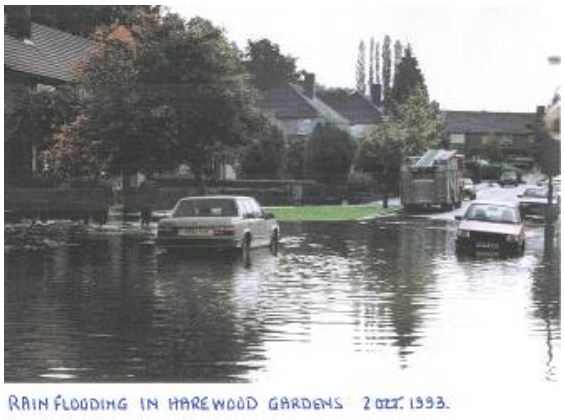


Figure 3-20 Harewood Gdns, 2nd Oct 1993

Figure 3-21 Kingswood Ln/Meadway 2001

3.8.64 In Hamsey Green, and South Croydon more generally, the highway drainage system comprises road gullies connected to a system of linked soakaways in the underlying chalk strata. As a result, any siltation of these soakaways will exacerbate the flooding in this area.

3.8.65 London Borough of Croydon has recently installed a new soakaway in Hamsey Green to provide additional capacity to the highway drainage. The soakaway was 8m deep, 2.5 diameter and was costed at approximately £10,000.

Local Flood Risk Zone – Asmar Close, Coulsdon

3.8.66 Asmar Close comprises residential development dating to the 1980s which experiences regular surface water flooding during heavy rainfall. The pathway for surface water flooding is along Greenfield Link and Hillars Heath Road, into Asmar Close.

Figure 3-22 Flow paths along Hillars Heath Road & Asmar Close

3.8.67 The drainage provision onsite comprises a series of soakaways that drain into the underlying chalk. It is understood that Croydon's current design standard for highway drainage systems is for soakaways to accommodate a 50mm rainfall depth over the contributing impermeable area. However, when the housing estate at Asmar Close was built the design standard was 38mm. The system at Asmar Close was designed solely for the development area and not the runoff generated from adjoining roads at that drain towards Asmar Close, and therefore the capacity is often exceeded.

3.8.68 Surface water collects in the topographic depression at the end of the Close, severely affecting four properties and causing disruption to all the properties in the road. As an alleviation measure, an extra gully has recently been put in at the entrance of Asmar Close, in an attempt to intercept some of the runoff.

3.8.69 The pluvial flooding experienced at Asmar Close highlights the importance of strategic drainage provision as part of new developments; in this case, for example, a dry ephemeral channel could have been designed into the development as an overland flow path to alleviate surface water flooding during storm events and provide improved local protection for these properties.

3.9 SUMMARY OF RISK

3.9.1 The following conclusions have been drawn from our Phase 2 Risk Assessment:

3.9.2 Pluvial flooding incidents are widely dispersed across Croydon;

- There are multiple centres of pluvial flooding which leads to technical challenges regarding the long term operational management of flood risk as well as future investment in drainage schemes;

- Pluvial flooding appears to be driven chiefly by the local topography and relatively steep slopes in Coulsdon and Kenley and Upper Norwood channelling water south to Purley, South Croydon and Thornton Heath.

3.9.3 In broad terms, we have identified two major categories of pluvial flooding within the London Borough of Croydon, as follows:

3.9.4 **Scattered Flooding Incidents** - geographically dispersed and relatively isolated flooding of individual properties or small groups of properties (e.g. Chipstead Valley Road and Asmar Close);

3.9.5 **More Severe Pluvial Flooding** – more significant pluvial flooding with interlinked sources of flooding and multiple asset owners, typically affecting 15 or greater properties (e.g., Brighton Road and Purley Cross).

3.9.6 The geology of the Borough has a significant influence on the rapid response of the northern part of the catchment due to the presence of impermeable London Clay and highly developed areas which reduce the infiltration of storm water.

3.9.7 There are several known groundwater flooding areas within the Borough with the most significant area being the Bourne View area of Kenley where approximately 7 residential properties were affected in 2000.

RISK TO EXISTING PROPERTIES & INFRASTRUCTURE

3.9.8 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 this assessment, as specified in the Drain London Data and Modelling Framework.

3.9.9 A full summary of the results of the property count are included in Table 3-7 at the end of this Chapter.

3.9.10 The values in Table 3-7 coupled with local understanding of the areas identify that CDA_043 South and Central Croydon, CDA_041 Brighton Road and CDA_040 Purley have the greatest number of receptors at risk of flooding, in proportion to the size of the CDA.

3.9.11 CDA_042 ‘South and Central Croydon’ is also identified to have the greatest amount of Essential Infrastructure at risk and the highest number of commercial properties.

3.9.12 It should also be noted that in the event of an extreme rainfall event across the Borough, there is a cumulative threat of multiple pieces of key infrastructure being affected by flooding. Across the CDAs within London Borough of Croydon, the following pieces of essential, highly vulnerable and more vulnerable infrastructure are identified to be at risk of flooding during the 1% AEP event.

- 3 Fire/Ambulance Stations.
- 9 Police Stations.
- 3 Hospitals.
- 21 Residential Care Homes.
- 72 Electricity Substations.

- 106 Educational Establishments.

3.9.13 This cumulative affect should be considered by the LLFA when considering emergency planning provisions across the Borough and in collaboration with neighbouring authorities.

RISK TO FUTURE PROPERTIES & INFRASTRUCTURE

3.9.14 As described in Section 1.4, London Borough of Croydon's growth strategy provides for an increase of approximately 21,510 new homes and many new jobs throughout the Borough over the lifetime of the plan (2031). Future growth is planned for the A23 corridor and the Croydon Metropolitan Centre (CMC) which is reported to be capable of taking nearly 8,000 new homes and several thousand new jobs[7].

Table 3-6 Proposed Number of New Homes by Area of the Borough[8]

Spatial Management Area	Proposed Number of New Homes
Croydon Metropolitan Centre (CMC) & Environs	14,400 (of which CMC 8,000)
North	3,600
East	900
South	2,600

3.9.15 Land available for development is scarce within the Borough and is being put under increasing pressure due to the demand for new housing.

3.9.16 As shown in Table 3-6, the majority of future growth and redevelopment for the Borough is being proposed in the area at greatest risk of surface water flooding; the A23 corridor and the Croydon Metropolitan Centre (CMC).

3.9.17 It will be essential that decisions are made through the spatial planning process which can guarantee that land is used efficiently and that the impact of future development on existing infrastructure, including the drainage systems, is assessed and adequately managed. However, proposals for large scale development within these areas of high risk also present a key opportunity for options to be considered to tackle the significant posed by surface water flooding, and to consider the potential for large scale capital works to the urban drainage systems in this area.

COMMUNICATE RISK

Professional Stakeholders

3.9.18 There are various professional stakeholders which are in interested in increasing their knowledge of risks from surface water flooding. It is essential that the SWMP partnership actively engages with these groups, where appropriate, to share the findings of this report. This will ensure that emerging plans and policies are informed by the latest and improved understanding of surface water flood risk issues.

3.9.19 Appendix G – Spatial Planning Information Pack and Appendix H – Resilience Forum and Emergency Planner Information Pack provide guidance on how the SWMP outputs should be used in updating existing planning documents, such as Strategic Flood Risk Assessments

[7] Croydon Council, (September 2010) Infrastructure Delivery Plan, Draft for Public Consultation
[8] Croydon Council, (September 2010) Towards a preferred Core Strategy for Croydon – Supplement, for consultation

(SFRAs) and Multi-Agency Flood Plans (MAFPs), and informing emerging planning policy and spatial planning decisions.

Local Resilience Forums

3.9.20 In line with the SWMP Technical Guidance it is strongly recommended that the information provided in the SWMP is issued to the Local Resilience Forum. Surface water flood maps and knowledge of historic flood events should be used to update Incident Management Plans and Community Risk Registers for the area. In addition, maps showing the depth of pluvial flooding during a range of return period rainfall events can be used to inform operations undertaken by emergency response teams especially near public buildings and major routes through the Borough. This information can be used in parallel with Extreme Rainfall Alert (ERA) service provided by the Flood Forecasting Centre[9]. In addition, maps showing the depth of pluvial flooding during a range of return period rainfall events can be used to inform operations undertaken by emergency response teams especially near public buildings and major routes through the Borough.

Communication and Engagement Plan

3.9.21 It is recommended that a Communication and Engagement Plan should be produced for the London Borough of Croydon to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public.

3.9.22 The Plan should:

- Develop clear key messages from the SWMP (and PFRA) relating to local surface water flood risk and management;
- Create simplified maps and meaningful data for communications materials,
- Clearly define a structure for multi-agency partnership working (based on the partnership structure identified in Phase 1 of the SWMP) and formalise through a Memorandum of Understanding;
- Provide a strategy for communicating the SWMP findings to political stakeholders, local resilience forum members, Regional Flood and Coastal Defence Committee members and the general public and engaging these parties in future local flood risk management actions.

Recommendation 11: Actively engage with professional stakeholders to communicate findings of SWMP and local flood risk management.
Recommendation 12: Issue the SWMP to the Local Resilience Forum and use the SWMP to inform emergency response operations and update Incident Management Plans and Community Risk Registers.
Recommendation 13: Design and gain buy-in to a Communication and Engagement Plan to identify how to effectively communicate and raise awareness of local flood risk to different audiences.

[9] The Flood Forecasting Centre was set up in 2008 by the Met Office and the Environment Agency to provide services to emergency and professional partners.

Table 3-7 Phase 2 Summary of Risk

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	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	
Group8_034	Woodplace Lane	None	None	0	0	0	0	0	196	14	0	0	0	0	0	0	0	0	0	0	Validated
Group8_035	Marlpit Lane	None	None	0	0	1	0	0	895	2	0	0	0	0	0	0	65	1	0	0	Validated
Group8_036	Old Lodge Lane	None	None	1	0	0	0	5	1342	10	0	0	0	0	0	0	16	0	0	0	Validated
Group8_037	Kenley Station	Regionally important infrastructure	None	2	2	1	0	6	826	43	0	0	0	0	0	0	21	12	0	0	Validated
Group8_038	A22 Godstone Rd	Regionally important infrastructure	None	0	0	0	0	4	1205	34	0	0	0	0	0	0	35	5	0	0	Validated
Group8_039	Chipstead Valley Rd	None	None	0	0	0	0	7	1177	129	0	0	0	0	0	0	193	73	0	0	Validated
Group8_040	Purley Cross	Regionally important infrastructure	None	1	0	1	0	22	2316	101	1	0	0	0	0	0	83	20	0	0	Validated
Group8_041	Brighton Rd	Regionally important infrastructure	None	1	0	0	0	18	2357	163	86	1	0	0	0	0	373	26	41	4	Validated
Group8_042	South & Central Croydon	Regionally important infrastructure	None	14	1	1	0	28	3450	349	431	25	327	5	17	3	830	49	464	11	Validated
Group8_043	Carlton Road & Industrial Estate	None	None	0	0	0	0	2	630	0	0	0	0	0	0	0	68	14	0	0	Validated
Group8_044	Croham Road	Regionally important infrastructure	None	1	0	0	0	3	1176	13	23	0	0	0	0	0	15	0	0	0	Validated
Group8_045	Forestdale/Addington	None	None	9	1	1	1	13	3115	164	10	1	1602	3	22	0	56	14	1	1	Validated
Group8_046	Woodside	None	None	1	0	0	0	1	1631	33	25	2	199	7	7	0	46	0	7	0	Validated
Group8_047	South Norwood	None	None	1	0	0	0	2	924	17	53	2	65	0	10	0	41	0	10	0	Validated
Group8_048	South Norwood Hill	None	None	0	0	1	0	3	105	0	1	0	279	8	76	0	36	0	20	0	Validated
Group8_049	Norbury	None	None	11	2	2	1	20	3922	109	122	0	638	0	8	0	242	14	49	9	Validated

Notes

The Summary of Risk table is populated by calculating the total number of units from each sub-category that are affected by surface water flooding in the modelled scenario for the rainfall event with a 1 in 100 chance of occurring in any given year (1% AEP). In accordance with the Drain London Data and Modelling Framework, the Environment Agency National Receptor Database (NRD) Version 1.0 has been used to identify receptors at risk of flooding within each CDA. The type of receptor has been identified based on definitions (MCM Codes) within Appendix 3.1 of the Multi-Coloured Manual[10] and divided into sub-categories consistent with those within Planning Policy Statement 25: Development and Flood Risk[11]. A summary is provided in the following tables:

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

Household & Basement Sub-Categories	
Category	**Description**
Households	• All residential dwellings • Caravans, mobile homes and park homes intended for permanent residential use • Student halls of residence, residential care homes, children's homes, social services homes and hostels
Deprived Households	• Those households falling into the lowest 20% of ranks by the Office of National Statistics' Indices of Multiple Deprivation.
Non-Deprived Households	• Those households not falling into the lowest 20% of ranks by the Office of National Statistics' Indices of Multiple Deprivation
Basements	• All basement properties, dwellings and vulnerable below ground structures (where identified in existing dataset including those provided by Thames Water and the Environment Agency's National Receptor Database).

[10] Flood Hazard Research Centre, 2010, Multi-Coloured Manual – 2010

[11] DCLG (Revised 2010) Planning Policy Statement 25: Development & Flood Risk

4. 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.

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 London-wide Prioritisation Matrix within the next Tier (Tier 3) of the Drain London project.

4.2 METHODOLOGY

IDENTIFY MEASURES

4.2.1 This stage aims to identify a number of measures that have the potential to alleviate surface water flooding in the London Borough of Croydon. It has been informed by the knowledge gained as part of the Phase 1 and Phase 2 work. Where possible options will be identified that have multiple benefits, for example to alleviate flooding from more than one source, or provide environmental benefits such as water quality, biodiversity and amenity benefits. At this stage the option identification pays no attention to constraints such as funding or delivery mechanisms to enable a robust assessment.

4.2.2 As detailed in the Defra SWMP Guidance, measures have been identified regardless of the potential mechanism or funding. A standard set of structural and non-structural measures have been specified by the Drain London Forum for consideration within each CDA (Table 4-1) and follow the source-pathway-receptor model. Structural measures are considered to be those which require fixed or permanent assets to mitigate flood risks. Non-structural measures are those which are responses to urban flood risk that may not involve fixed or permanent facilities, and whose positive contribution to the reduction of flood risk is most likely through a process of influencing behaviour.

Table 4-1 Drain London Structural and Non-Structural Measures for Consideration

Source	Pathway	Receptor
Green roof	Increasing capacity in drainage systems	Improved weather warning
Soakaways	Separation of foul and surface water sewers	Planning policies to influence development
Swales	Improved maintenance regimes	Temporary or demountable flood defences
Permeable Paving	Managing overland flows	Social change, education and awareness
Rainwater Harvesting	Land management practices	Improved resilience and resistance measures
Detention Basins		

4.2.3 An opportunity assessment was undertaken for each CDA to evaluate where there were opportunities for the implementation of structural and non-structural measures identified by the Drain London Forum and through consultation with relevant stakeholders. The results from the Opportunity Assessment for each CDA are summarised in Table 4-2. Full details are included in Appendix E.

Table 4-2 Measures Opportunity Assessment

CDA ID	CDA Name	Source								Pathway								Receptor					
		Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flow paths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures
Group8_034	Woodplace Lane	×	✓	✓	✓	✓	✓	×		✓		✓	×	✓	✓			✓	✓	✓	✓	✓	
Group8_035	Marlpit Lane	×	✓	✓	✓	✓	✓	×		✓		✓	×	✓	✓			✓	✓	✓	✓	✓	
Group8_036	Old Lodge Lane	×	✓	✓	✓	✓	✓	×		✓		✓	×	✓	✓			✓	✓	✓	✓	✓	
Group8_037	Kenley Station	×	✓	✓	✓	✓	✓	×		✓		✓	×	✓	✓	×		✓	✓	✓	✓	✓	
Group8_038	Downs Court Rd	×	✓	✓	✓	✓	✓	×		✓		✓	×	✓	✓			✓	✓	✓	✓	✓	
Group8_039	Chipstead Valley Rd	×	✓	✓	✓	✓	×	×		✓		✓	✓	✓	×			✓	✓	✓	✓	✓	
Group8_040	Purley Cross	✓	✓	✓	✓	✓	×	×		✓		✓	✓	✓	×	×		✓	✓	✓	✓	✓	
Group8_041	Brighton Rd	✓	✓	✓	✓	✓	✓	×		✓		✓	✓	✓	×	×		✓	✓	✓	✓	✓	
Group8_042	Sth & Central Croydon	✓	✓	✓	✓	✓	✓	×		✓		✓	✓	✓	×	×		✓	✓	✓	✓	✓	
Group8_043	Carlton Rd & Business Centre	×	✓	✓	×	×	✓	×		✓		✓	✓	✓	×			✓	✓	✓	✓	✓	
Group8_044	Croham Rd	×	✓	✓	✓	✓	✓	×		✓		✓	✓	✓	×			✓	✓	✓	✓	✓	
Group8_045	Forestdale/Addington	×	✓	✓	×	×	✓	×		✓		✓	×	✓	×	×		✓	✓	✓	✓	✓	
Group8_046	Woodside	×	×	✓	✓	✓	✓	×		✓		✓	✓	✓	×			✓	✓	✓	✓	✓	
Group8_047	South Norwood	×	×	✓	✓	✓	✓	✓		✓		✓	✓	✓	×			✓	✓	✓	✓	✓	
Group8_048	South Norwood Hill	×	×	✓	✓	✓	×	×		✓		✓	✓	✓	×			✓	✓	✓	✓	✓	
Group8_049	Norbury	×	×	✓	✓	✓	✓	✓		✓		✓	✓	✓	×	×		✓	✓	✓	✓	✓	

Measures Opportunity Assessment Criteria	
✓	There are opportunities for implementation of this mitigation measure within the CDA. Measure should be considered in the Options Assessment.
✓	There may be some, but limited opportunities for implementation of this mitigation measure within the CDA. Measures should be considered in the Options Assessment but would likely be limited in effectiveness or be subject to site-specific investigations prior to consideration.
×	There are no opportunities for implementation of measure within CDA. The measure it not suitable or required to address the surface water flood risk within the CDA.
	Not Applicable

Table 4-3 Identification of Potential Options

Description		Standard Measures Considered
Do Nothing	Make no intervention / maintenance	• None
Do Minimum	Continue existing maintenance regime	• None
Improved Maintenance	Improve existing maintenance regimes e.g. target improved maintenance to critical points in the system.	• Improved Maintenance Regimes
Planning Policy	Use forthcoming development control policies to direct development away from areas of surface water flood risk or implement flood risk reduction measures.	• Planning Policies to Influence Development
Source Control, Attenuation and SuDS	Source control methods aimed to reduce the rate and volume of surface water runoff through infiltration or storage, and therefore reduce the impact on receiving drainage systems.	• Green Roof • Soakaways • Swales • Permeable paving • Rainwater harvesting • Detention Basins • Ponds and Wetlands • Land Management Practices
Flood Storage / Permeability	Large-scale SuDS that have the potential to control the volume of surface water runoff entering the urban area, typically making use of large areas of green space. Upstream flood storage areas can reduce flows along major overland flow paths by attenuating excess water upstream.	• Detention Basins • Ponds and Wetlands • Managing Overland Flows (Online Storage) • Land Management Practices
Separate Surface Water and Foul Water Sewer Systems	Where the CDA is served by a combined drainage network separation of the surface water from the combined system should be considered. In growth areas separation creates capacity for new connections.	• Separation of Foul and Surface Water Sewers
De-culvert / Increase Conveyance	De-culverting of watercourses and improving in-stream conveyance of water.	• Deculverting Watercourse(s)
Preferential / Designated Overland Flow Routes	Managing overland flow routes through the urban environment to improve conveyance and routing water to watercourses or storage locations.	• Managing Overland Flows (Preferential Flowpaths) • Temporary or Demountable Flood Defences
Community Resilience	Improve community resilience and resistance of existing and new buildings to reduce damages from flooding, through, predominantly, non-structural measures.	• Improved Weather Warning • Temporary or Demountable Flood Defences • Social Change, Education and Awareness • Improved Resilience and Resistance Measures
Infrastructure Resilience	Improve resilience of critical infrastructure in the CDA that is likely to be impacted by surface water flooding e.g. electricity substations, pump houses.	• Improved Resilience and Resistance Measures
Other - Improvement to Drainage Infrastructure	Add storage to, or increase the capacity of, underground sewers and drains and improving the efficiency or number of road gullies.	• Increasing Capacity in Drainage Systems
Other or Combination of Above	Any alternative options that do not fit into above categories and any combination of the above options where it is considered that multiple options would be required to address the surface water flooding issues.	

IDENTIFY & SHORT LIST OPTIONS

4.2.4 Following the identification of measures that should be considered within the Borough, options have been identified and short listed for each CDA. As a detailed appraisal of cost and benefits of each of the measures is not deemed to be practical, a high-level scoring system for each of the options has been developed. The approach to short-listing the measures is based on the guidance in FCERM[12] and Defra's SWMP technical guidance[13]. The scoring criteria are provided in Table 4-4.

Table 4-4 Options Assessment Short-Listing Criteria

Criteria	Description	Score
Technical	• Is it technically possible and buildable? • Will it be robust and reliable? • Would it require the development of a new technique for its implementation?	U: Unacceptable (measure eliminated from further consideration) -2: Severe negative outcome -1: Moderate negative outcome 0: Neutral +1: Moderate positive outcome +2: High positive outcome
Economic	• Will benefits exceed costs? • Is the measure within the available budget? • Estimate the whole life costs of the option including asset replacement, operation and maintenance. The scoring of this measure will depend on the budget available from the local authority although it should be remembered that alternative routes of funding could be available such as Thames Region Flood Defence Committee.	
Social	• Will the community benefit or suffer from implementation of the measure? • Does the option promote social cohesion or provide an improved access to recreation/open space? • Does the option result in opposition from local communities for example if an option involves the displacement of houses?	
Environmental	• Will the environment benefit or suffer from implementation of the measure? • Would the option have a positive or negative effect on the environment for example, water quality and biodiversity?	
Objectives	• Will it help to achieve the objectives of the SWMP partnership? • Does the option meet the overall objective of alleviating flood risk?	

4.2.5 Meetings were held with London Borough of Croydon in March 2011 to discuss and agree short-listed options identified for each CDA and to discuss any works currently in progress.

4.2.6 The process aimed to ensure that inappropriate measures are eliminated early in the process to avoid investigation of options that are not acceptable to stakeholders. The agreed shortlisted options have been progressed to the Preferred Options stage where they will be costed and further developed.

[12] Environment Agency (March 2010) *'Flood and Coastal Erosion Flood Risk Management Appraisal Guidance'*, Environment Agency: Bristol.
[13] Defra (March 2010) *'Surface water management plan technical guidance'*, Defra: London

4.3 PREFERRED OPTIONS

BOROUGH-WIDE – PREFERRED OPTIONS

4.3.1 A number Borough-wide options and policies have been identified that the Council and relevant stakeholders may consider adopting as part of their responsibility as LLFA for local flood risk management.

4.3.2 The preferred Borough-wide are listed below and described in more detail in the following sections.

- Raising Community Awareness
- Improving Resilience to Flooding
- Ongoing improvements to Maintenance of Drainage Network.
- Planning and Development Policies.
- Water Conservation.

Borough Wide Options: Raising Community Awareness

4.3.3 A 'quick win' action that could be implemented in the short-term is to increase awareness of flooding within communities at risk, and across both Policy Areas. This could be achieved through a number of measures including:

- Newsletters;
- Drop-in surgeries;
- Promotion on Croydon Council's website (see Figure 4-1); and
- Community Flood Plans, such as that being undertaken in Purley Cross.

4.3.4 The aim of these actions is to raise awareness and improve understanding of the risks and consequences of surface water flooding amongst local communities and, through this, encourage residents to take up measures to combat flooding. Such measures may include installation of water butts to capture roof runoff and consideration of the extent and materials used when replacing permeable areas within hard standing areas within their property e.g. through the installation of driveways and patios.

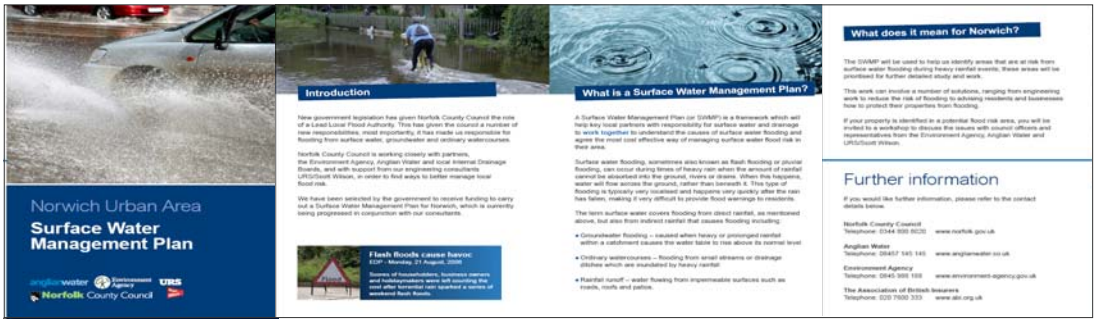


Figure 4-1 – Example Newsletter (URS Scott Wilson, 2011)

Recommendation 14: Consider and implement options for raising community awareness including letter drop, public meetings, and/or preparation of Community Flood Plans.	
Option A	Undertake a letter drop to highlight the improvement works that have been implemented as well as works that are planned for the future.
Option B	A public meeting could be held following the letter drop where residents can highlight any issues. This could include a talk from the key partner organisations – Environment Agency, Thames Water and London Borough of Croydon – on the work that is being undertaken and who is responsible. Such a meeting could also outline how residents can help themselves and highlight their responsibility for maintaining private drainage, soakaways, driveway drainage etc.
Option C	Consider preparing a Community Flood Plan for those communities identified to be at high risk (such as that already identified for Purley Cross).

Borough Wide Options: Improving Property Level Resilience to Flooding

4.3.5 One method to reduce the risk of surface water flooding to properties is raising property thresholds. Raising the thresholds of entrances to property land, i.e. where there are currently gates adjacent to paved walls, may offer flood resilience benefits. Property level thresholds could also be increased where possible to improve resilience to surface water flooding, and especially where roads are predicted to flood and the properties contain no front gardens.

Figure 4-2 Raised Driveway, Croydon

Figure 4-3 Raised threshold, Coulsdon

4.3.6 Thresholds as shown in Figures 4-2 and 4-3 are a useful and an accepted method of defending property against flooding. However, this can conflict with possible accessibility issues within Part M, Section 6 of the Building Regulations 2004 and the requirements of the Disability Discrimination Act 1996 (DDA). In Figure 4-3 a brick wall has been constructed across the property driveway in order to protect the property from flooding. Until such time as national guidance or best practice is available London Borough of Croydon will, when required, work with residents to realise suitable, sensible and cost effective solutions which allow access and deliver mitigation against possible flooding.

Recommendation 15: Consider opportunities to promote awareness of property level thresholds, particularly in areas of higher flood risk.	
Option A	It is recommended that the Council aim to raise the awareness of the options for increasing property thresholds to protect against flooding.
Option B	It is recommended that the Council work with residents to realise suitable, sensible and cost effective property level resilience to potential flooding (through, for example raising property thresholds to 100mm).

Borough Wide Options: Ongoing Improvements to Maintenance of Drainage Network

4.3.7 The management and maintenance of the urban drainage network in London Borough of Croydon is the responsibility of a number of organisations:

- London Borough of Croydon – highway drainage including gully pots and soakaway system in the south of the Borough;
- Thames Water – main sewers, lateral sewers;
- Transport for London – highway drainage along the A22 and A23;
- Environment Agency – culverts, raised defences, trash screens, Main River channel;
- Network Rail – railway drainage and culverts beneath raised rail embankments

4.3.8 Community Services "Streetscene" undertake the responsibility for gully cleansing in the Borough. Maintenance is for all gullies to be cleared once to twice a year generally. Priority areas are tackled more often than this. Problems with gaining access to gullies have been identified during liaison with London Borough of Croydon as part of this study. Issues raised included the presence of cars parked over gullies, or timings of visits by the maintenance team coinciding with school opening and closing times which prevent gullies being attended to.

4.3.9 In the south of the Borough a major cleaning programme for the soakaways is currently underway. Historically this was done by a rolling programme of soakaway cleansing however this ceased and cleansing was undertaken on a reactive basis of isolated soakaways. Now a more holistic approach is being applied whereby all soakaways are undergoing cleansing and maintenance on a rolling programme. Cleansing is not being limited to the flooding hotspots, but is targeted across the whole of the wider catchment to maximise the drainage capacity further up the local catchments prior to build up at known flooding hotspots.

4.3.10 The procedure for soakaway cleansing is time consuming and costly, especially with the increasing costs for waste disposal which requires a licence for tipping, but this work is essential for the continued maintenance of the drainage system in the south of the Borough and must be a priority for local flood risk management.

4.3.11 Effective cleansing of gully pots is fundamental to the drainage across the Borough and London Borough of Croydon operates a regular maintenance regime for gully cleansing as well as soakaway maintenance in the south of the Borough. Fallen leaves and build up of silt are the main causes of blockages in the highway drainage network.

4.3.12 London Borough of Croydon Drainage department have provided details of their maintenance regime for road gullies which is coordinated with severe weather warnings and is undertaken by the Streetscene Department.

4.3.13 The maintenance routine during severe weather warnings has been summarised below.

- Head of Streetscene and Refuse and Cleansing Manager alerted to a Severe Weather Warning.
- Volunteers requested for out of normal office hours working.
- Upon receipt of such a warning, the Head of Streetscene and the Refuse and Cleansing Manager will decide what action should be taken. The action should include the following:

- Whether Borough-wide or selective sweeping should be suspended and street cleansing operatives deployed to ensure gullies in priority street areas are clear of debris.
- The Highways DSO will decide whether sandbags should be distributed to selected properties on the priority list of locations.
- Whether gully sucker machines should be mobilised to clear gullies in priority streets.

- Gully clearance requests raised via the Contact Centre will be responded to by Veolia Environmental Services after streets on the priority street listing have received attention.
- Veolia Environmental Services will provide a list to the Head of Streetscene of locations requiring their attention every hour.
- The list of gully clearance addresses will be passed to Streetscene Officers by the Head of Streetscene for a visit by them thereafter.
- Where a subsequent visit by the Streetscene Officer confirms that water ingress into property is likely, the Streetscene Officer will discuss with the Highways DSO the need for sandbag delivery and further action by the DSO.
- The Head of Streetscene will receive regular updates from Veolia and the Highways DSO in respect of progress with gully clearance and the provision of sandbags.
- Ensure information is communicated promptly to the Contact Centre and the Press Office to enable good communication with the public and members.

4.3.14 In order for this maintenance regime to be successfully implemented, it is essential that contact details for client staff (Streetscene Officers, Team Managers) and contractor staff (Veolia Environmental Services and Highways DSO staff), are kept up-to-date.

4.3.15 Additional options that could be considered by London Borough of Croydon with respect to highway drainage maintenance include:

Recommendation 16: Consider opportunities for ongoing improvements to the maintenance of the drainage network.	
Option A	Gullies that are known to flood could be painted yellow to encourage residents to check if they are blocked and to avoid parking directly over them thereby preventing access for gully clearing team.
Option B	Encourage gully cleansing contractors to use powers to enforce movement of parked cars to ensure all gullies are regularly cleared.
Option C	Coordinate timing of gully cleansing rounds to ensure that they do not coincide with school opening and closing times and other peak times that would prevent gaining access to gullies.
Option D	Focus attention on the maintenance of gully pots in the identified Critical Drainage Areas (CDAs) which are considered to be high risk.
Option E	Develop a GIS database of all Council-owned flood / drainage assets (in line with FWMA requirements).
Option F	As LLFA, the Council must record and investigate incidents of flooding. It is recommended that the source of flooding be recorded, e.g. gully surcharging, to inform maintenance priorities.

Borough Wide Options: Planning & Development Policies

4.3.16 As part of this phase of work Policy Areas have been defined across the Borough within which appropriate planning policies should be applied to manage flood risk. These Policy Areas cover the entire Borough and are not limited to CDA extents.

4.3.17 The reason for the inclusion of these areas is to highlight the fact that even if an area does not fall within a CDA it does not mean that surface water discharge from these areas can be uncontrolled, merely that the need for considering direct options for the area are not so critical. Two Policy Areas have been identified for London Borough of Croydon (Figure 4-4).

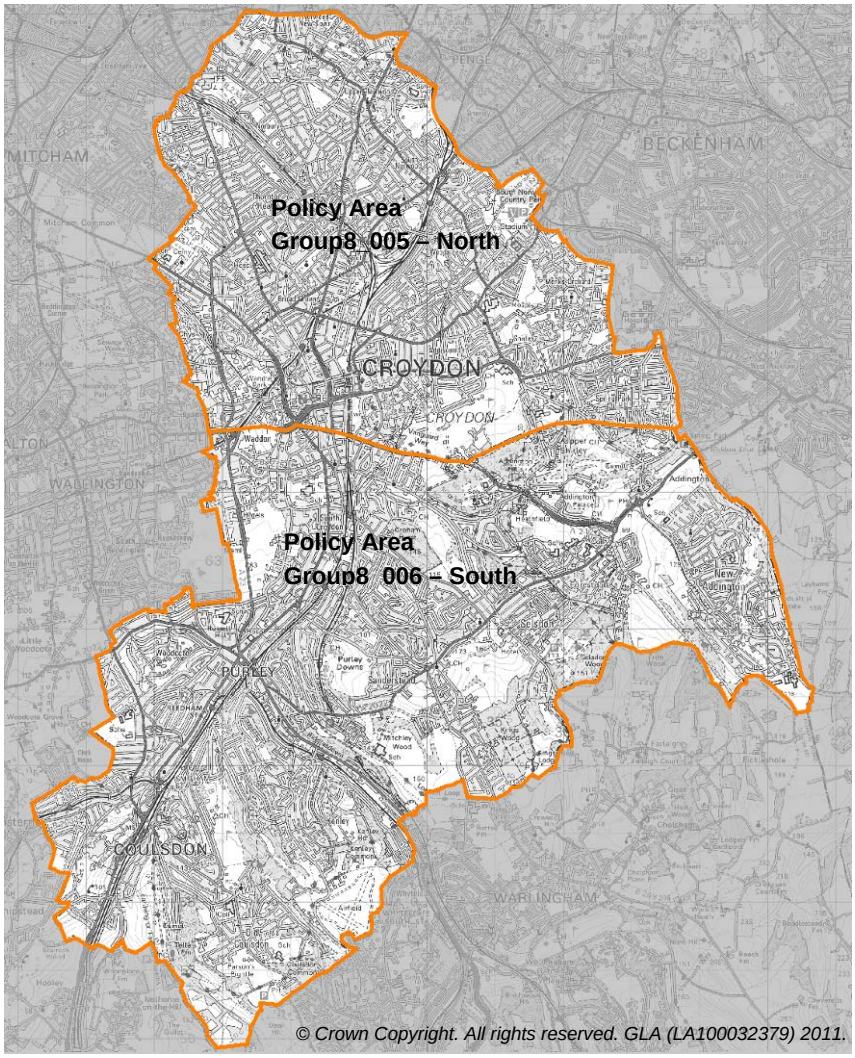


Figure 4-4 London Borough of Croydon

4.3.18 The North Policy Area comprises the highly urbanised areas of Croydon Centre, Norwood and Thornton Heath. This PA is characterised by relatively gentle slopes and an underlying geology of impermeable London Clay. This PA contains areas of Environment Agency Flood Zone 3a associated with the Norbury Brook and River Wandle. Future proposed development is concentrated within the Croydon Metropolitan Area within this PA.

4.3.19 The South Policy Area is marked by two key transport routes, the A23 Brighton Road and the A22 Godstone Road, along which much of the urbanisation is concentrated. The South PA also comprises a number of larger green spaces, parkland and golf courses. The topography is marked by steep valleys feeding into the former valley of the River Wandle which is now culverted and runs parallel with the A23. The predominant geology in this PA is permeable Chalk, a principal aquifer which may afford increased potential for elevated groundwater within the valleys of unconfined chalk.

4.3.20 A number of options and policies have been identified for these Policy Areas that the Council and relevant stakeholders may consider adopting as part of their responsibility as LLFA for local flood risk management. The majority of the following options are common to both Policy Areas; however the way in which they are implemented may vary.

Paved Gardens

4.3.21 Impermeable paving in gardens can significantly increase surface water runoff entering the local drainage network. From the 1st October 2008 the permitted development rights that allow householders to pave their front garden with hard standing without planning permission was removed. It is recommended that residents should be encouraged to design their gardens in a way that optimises drainage and reduces runoff. The Council should publicise this issue and refer to standard guidance on the surfacing of front gardens provided by the CLG and Environment Agency in September 2008[14].

Figure 4-5 Permeable front gardens allowing for parking

Source CLG/EA Guidance on the permeable surfacing of front gardens 2008 and Richmond Scrutiny Report 2008

4.3.22 During options workshops it was identified that London Borough of Croydon have produced a leaflet outlining the requirements for residents choosing to pave a driveway and whether planning permission or consent for kerb lowering is required. It was suggested that a policy could be established for driveway paving in the Borough and a similar method could be used to convey to residents the requirements in relation to surface water drainage from the driveway and property as a whole.

4.3.23 This measure could also be used to raise awareness, particularly in the south of the Borough, about the responsibilities for property surface water drainage and highway surface water drainage.

[14] Department for Communities and Local Government, 2008, Guidance on the Permeable Surfacing of Front Gardens http://www.communities.gov.uk/documents/planningandbuilding/pdf/pavingfrontgardens.pdf

Recommendation 17: Ensure appropriate Development Control Policy for repaving of gardens or driveways and explore education / awareness opportunities for general public regarding SuDS guidance and 'best practice'.	
Option A	The Council could encourage residents to ensure that paved areas in front gardens drain onto flower beds rather than running onto the highway.
Option B	The Council could aim to raise awareness of the options for installation and maintenance of permeable surfaces within property grounds.
Option C	The Council could aim to provide an information portal that residents can consult for further information on permeable paving and other SuDS measures, including links to other organisations (e.g. Environment Agency) who can provide 'best practice' guidance and examples
Option D	The Council could aim to educate/train their staff to ensure that planning officers: • are aware of the existing planning permissions, guidance and best practice; • are in a position to educate the public if enquiries are made regarding planning permission to change their drive/garden; and, • can identify/enforce for non-compliance or non permitted conversion (in particular in CDAs where it exacerbates the problem).

Sustainable Drainage Systems (SuDS)

4.3.24 A number of policies have already been implemented within London Borough of Croydon to ensure that new development incorporates Sustainable Drainage Systems (SuDS) wherever possible. It is recommended that these are reviewed and updated where necessary in the light of the Groundwater Assessment (Appendix C2) and the SuDS Suitability Map shown in Figure 4.3.1. A summary of the type of SuDS that could be utilised is provided below.

Figure 4.3.1 – Infiltration SuDS Suitability Map

4.3.25 SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc). Various SuDS techniques are available and operate on two main principles; attenuation and infiltration. All systems generally fall into one of these two categories, or a combination of the two.

Infiltration SuDS

4.3.26 This type of Sustainable Drainage System relies on discharges to ground, where ground conditions are suitable. Therefore, infiltration SuDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as a potable resource) for their successful operation.

4.3.27 Development pressures and maximisation of the developable area may reduce the area available for infiltration systems. This can be overcome through the use of a combined approach with both attenuation and infiltration techniques e.g. attenuation storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway or as a pond/water feature.

4.3.28 Permeable surfaces are designed to intercept rainfall and allow water to drain through to a sub-base. The use of a permeable sub-base can be used to temporarily store infiltrated run-off underneath the surface and allows the water to percolate into the underlying soils. Alternatively, stored water within the sub-base may be collected at a low point and discharged from the site at an agreed rate.

4.3.29 Permeable paving prevents runoff during low intensity rainfall, however, during intense rainfall events some runoff may occur from these surfaces.

4.3.30 Programmes should be implemented to ensure that permeable surfaces are kept well maintained to ensure the performance of these systems is not reduced. The use of grit and salt during winter months may adversely affect the drainage potential of certain permeable surfaces.

4.3.31 Types of permeable surfaces include:

- Grass/landscaped areas
- Gravel
- Solid Paving with Void Spaces
- Permeable Pavements

4.3.32 Where permeable surfaces are not a practical option more defined infiltration systems are available. In order to infiltrate the generated run-off to ground, a storage system is provided that allows the infiltration of the stored water into the surrounding ground through both the sides and base of the storage. These systems are constructed below ground and therefore may be advantageous with regards to the developable area of the site. Consideration needs to be given to construction methods, maintenance access and depth to the water table. The provision of large volumes of infiltration/sub-surface storage has potential cost implications. In addition, these systems should not be built within 5m of buildings, beneath roads or in soil that may dissolve or erode.

4.3.33 Various methods for providing infiltration below the ground include:

- Geocellular Systems
- Filter Drain
- Soakaway (Chamber)
- Soakaway (Trench)
- Soakaway (Granular Soakaway)

4.3.34 The infiltration SuDS suitability assessment shown on Figure 4.3.1 is based on minimum permeability data obtained from the BGS. There also exist maximum permeability data, however, only the minimum permeability is used, as this is understood to be more representative of the bulk permeability.

4.3.35 Three permeability zones have been identified:

1) **Infiltration SuDS potentially suitable:** Minimum permeability is high or very high for bedrock (and superficial deposits if they exist).
2) **Infiltration SuDS potentially unsuitable:** Minimum permeability is low or very low for bedrock (and superficial deposits if they exist).
3) **Infiltration SuDS suitability uncertain:** Minimum permeability is low or very low for bedrock and high or very high for superficial deposits OR minimum permeability is low or very low for superficial deposits and high or very high for bedrock.

4.3.36 Figure 4.3.1 shows that much of South Policy Area is potentially suitable for infiltration SuDS; this is where the unconfined Chalk and Thanet Sand Formation exist. The north west quarter of the London Borough of Croydon area is potentially unsuitable for infiltration SuDS, owing to the outcrop of London Clay Formation. The north east quarter of the Borough requires further investigation, as the ability of the River Terrace Deposits to store and

transmit groundwater without causing flooding / drainage issues is uncertain.

4.3.37 It is noted that this is a high level assessment and only forms an approximate guide to infiltration SuDS suitability; a site investigation is required to confirm local conditions.

Attenuation SuDS

4.3.38 If ground conditions are not suitable for infiltration techniques then management of surface water runoff prior to discharge should be undertaken using attenuation techniques. This technique attenuates discharge from a site to reduce flood risk both within and to the surrounding area. It is important to assess the volume of water required to be stored prior to discharge to ensure adequate provision is made for storage. The amount of storage required should be calculated prior to detailed design of the development to ensure that surface water flooding issues are not created within the site.

4.3.39 The rate of discharge from the site should be agreed with the Local Planning Authority and the Environment Agency. If surface water cannot be discharged to a local watercourse then liaison with the Sewer Undertaker should be undertaken to agree rates of discharge and the adoption of the SuDS system.

4.3.40 Large volumes of water may be required to be stored on site. Storage areas may be constructed above or below ground. Depending on the attenuation/storage systems implemented, appropriate maintenance procedures should be implemented to ensure continued performance of the system. On-site storage measures include basins, ponds, and other engineered forms consisting of underground storage.

4.3.41 Basins are areas that have been contoured (or alternatively embanked) to allow for the temporary storage of run-off from a developed site. Basins are designed to drain free of water and remain waterless in dry weather. These may form areas of public open space or recreational areas. Basins also provide areas for treatment of water by settlement of solids in ponded water and the absorption of pollutants by aquatic vegetation or biological activity. The construction of basins uses relatively simple techniques. Local varieties of vegetation should be used wherever possible and should be fully established before the basins are used. Access to the basin should be provided so that inspection and maintenance is not restricted. This may include inspections, regular cutting of grass, annual clearance of aquatic vegetation and silt removal as required.

4.3.42 Ponds are designed to hold the additional surface water run-off generated by the site during rainfall events. The ponds are designed to control discharge rates by storing the collected run-off and releasing it slowly once the risk of flooding has passed. Ponds can provide wildlife habitats, water features to enhance the urban landscape and, where water quality and flooding risks are acceptable, they can be used for recreation. It may be possible to integrate ponds and wetlands into public areas to create new community ponds. Ponds and wetlands trap silt that may need to be removed periodically. Ideally, the contaminants should be removed at source to prevent silt from reaching the pond or wetland in the first place. In situations where this is not possible, consideration should be given to a small detention basin placed at the inlet to the pond in order to trap and subsequently remove the silt.

4.3.43 Depending on the setting of a pond, health and safety issues may be important issues that need to be taken into consideration. The design of the pond can help to minimise any health and safety issues (i.e. shallower margins to the pond reduce the danger of falling in, fenced margins).

4.3.44 Various types of ponds are available for utilising as SuDS measures. These include:

- Balancing/Attenuating Ponds
- Flood Storage Reservoirs
- Lagoons
- Retention Ponds
- Wetlands

4.3.45 Site constraints and limitations such as developable area, economic viability and contamination may require engineered solutions to be implemented. These methods predominantly require the provision of storage beneath the ground surface, which may be advantageous with regards to the developable area of the site but should be used only if methods in the previous section cannot be used. When implementing such approaches, consideration needs to be given to construction methods, maintenance access and to any development that takes place over the storage facility. The provision of large volumes of storage underground also has potential cost implications.

4.3.46 Methods for providing alternative attenuation include:

- Deep Shafts
- Geocellular Systems
- Oversized Pipes
- Rainwater Harvesting
- Tanks
- Green and brown biodiverse roofs

4.3.47 In some situations it may be preferable to combine infiltration and attenuation systems to maximise the management of surface water runoff, developable area and green open space.

Water Conservation

4.3.48 Water conservation is a key option for reducing peak discharges and in turn downstream flood risk. This can be applied using a number of options including planning led encouragement of the use of rainfall in rainwater harvesting systems and property level use of water butts. Both are described in more detail below.

Rainwater Harvesting

4.3.49 The potential for the use of rainwater harvesting should be jointly led by Thames Water (for the North Policy Area) and the Council. Promotion of the benefits of such schemes could be rolled out across multiple Boroughs to reduce costs. The principle of rainwater harvesting in both domestic and commercial property is the same. Rainwater from roof areas is passed through a filter and stored within large underground tanks. When water is required, it is delivered from the storage tank to toilets, washing machines and garden taps for use. If the tank becomes low on stored water, demand is topped up from the mains supply. Any excess water can be discharged via an overflow to a soakaway or local drainage network.

4.3.50 Rainwater harvesting systems could be retrofitted to local schools within the Borough. A case study for Southampton University Student Services Building is described below, with an example layout of a system illustrated in Figure 4-6 below[15]:

- Roof Area: 1000m^2

[15] *Source: Rainwaterharvesting systems UK*

- Underground storage tank: 15,000 litres
- Building occupancy: 150 people
- Planned usage: 21 WCs and 3 urinals
- Expected annual rainwater collection: 410,000 litres
- Capital cost: £4,325
- Expected payback time 5.3 years (based on Southern Water 2006 tariff)

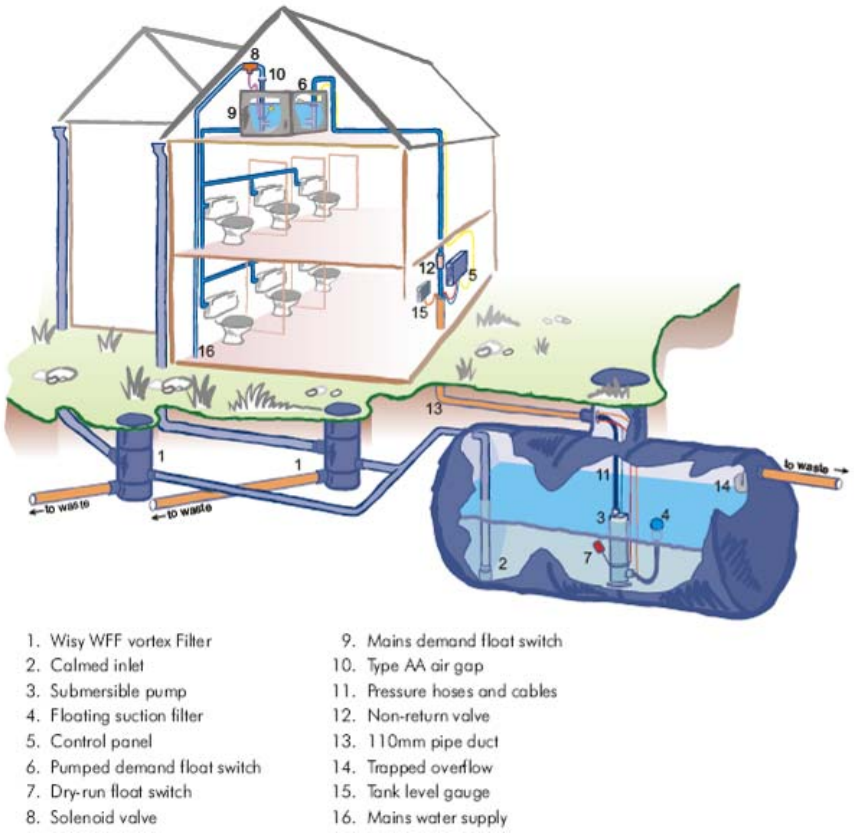


Figure 4-6 Example Rainwater Harvesting system in a Commercial Property

Recommendation 18: Consider opportunities to promote rainwater harvesting in both new and existing development throughout the London Borough of Croydon	
Option A	The Council could consider providing an incentive scheme for the use of rainwater harvesting systems across the Borough. This may be linked to the Council's sustainability checklist.
Option B	The Council could consider retrofitting rainwater harvesting systems on Council owned properties, such as schools, for example, which offer educational opportunities as well as local surface water flood mitigation.
Option C	The Council could explore potential opportunities for the installation of rainwater harvesting systems on new or regenerated development areas (in particular where there is high footfall / potential for use).

Water Butts

4.3.51 One of the preferred measures to reduce peak discharges and downstream flood risk, is the robust implementation of water butts on all new development within the Borough, and where possible and higher surface water flooding risk has been identified, retrofitting these to existing properties. Given the constraints associated with infiltration in the north of the Borough, the wholesale implementation of water butts can significantly reduce peak discharges.

4.3.52 Water butts often have limited storage capacity given that when a catchment is in flood, water butts are often full, however it is still considered that they have a role to play in the sustainable use of water and there is potential to provide overflow devices to soakaways or landscaped areas to ensure that there is always a volume of storage available.

4.3.53 Whether to construct formal spill pipes to soakaways, or to allow simple overspill to the adjacent ground are detailed decisions that will need to be based on a site-by-site basis. Such a decision will have only minor significance on the proposals with respect to the surface water drainage.

Rainwater Harvesting – Water Butts		
Description	**Benefits**	**Impacts**
Installation of water butts for all new development within Opportunity Areas	Ties in with SuDS hierarchy and reduces peak discharges to surface water	Positive impacts to sustainability and water re-use.
Retrofit water butts on all existing development (as shown on Figure 4-7)	Supplementary benefits beyond regeneration and redevelopment sites (volumetric reduction with opportunity for complimentary water quality improvements)	Currently no available incentives to encourage homeowners to install water butts.

Figure 4-7 Example of a 100L Water Butt retrofitted to existing development

Recommendation 19: Consider opportunities to promote use of water butts in both new and existing development throughout the London Borough of Croydon	
Option A	Consider installation of water butts for all new development. This ties in with the SuDS hierarchy and reduces peak discharges to surface water and is likely to have positive impacts to sustainability and water re-use
Option B	Consider retrofitting water butts on all existing development. This provides supplementary benefits beyond regeneration and redevelopment sites (volumetric reduction with opportunity for complementary water quality improvements). However there are currently no available incentives to encourage homeowners to install water butts.
Option C	It is recommended that the Council promote the use of water butts across the Borough and provide information on costs, suppliers, installation and benefits.
Option D	Consider installation of water butts for all new development. This ties in with the SuDS hierarchy and reduces peak discharges to surface water and is likely to have positive impacts to sustainability and water re-use

CDA Level Potential Preferred Options

4.3.54 Following the Options Workshop and consultation with relevant stakeholders, potential preferred options (combination of measures) for each CDA have been identified and further assessment to:

- Estimate the benefits; and
- Estimate the approximate implementation costs.

4.3.55 For most CDAs, a range of options have been identified that could be further explored to alleviate flooding. These have been included within the Borough Action Plan as short, medium or long-term actions with an associated priority. However where there is a potential preferred capital scheme for a CDA, this has been identified and the estimated benefits and approximate costs have been assessed for inclusion in a London wide Prioritisation Matrix for consideration by the GLA. A summary of the preferred options is provided within Table 4-5 and further described in the following sections.

Benefits

4.3.56 For the purpose of the Drain London Prioritisation Matrix, it is necessary to determine the benefits of each preferred option. The potential benefits of the scheme are measured using an estimated percentage of units removed from the predicted floodplain (eliminated) or where flood frequency is reduced (mitigated). This percentage has been determined by calculating the number of units within the Local Flood Risk Zone that the particular scheme has been designed to mitigate, as a percentage of the number of units within the CDA as a whole. The input is restricted to multiples of five percent. It should be noted that the information within this table is purely for input into the Drain London Prioritisation Matrix and should be treated as such. Further modelling would be required to determine more accurately the potential benefits of the suggested schemes.

Costs

4.3.57 An estimated cost for the preferred flood mitigation option for each identified CDA has been calculated based on standard unit costs provided as part of Tier 1 of the Drain London Project to mitigate the 1 in 75 year (3.3% AEP) event. No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been

applied, as determined in the Drain London Prioritisation Matrix Guidance:

- The costs are the capital costs for implementation of the scheme only.
- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

4.3.58 As a result, costs have been provided as cost bands[16], reflecting the strategic nature of the SWMP study and options identification.

4.3.59 The following sections provide a summary of potential preferred options for each CDA; full details regarding the justification for preferred and eliminated options is provided in Appendix E.

[16] As defined by Drain London Prioritisation Matrix Guidance, the cost bands to be used are: <£25k, £26k - £50k, £51k - £100k, £101k - £250k, £251k - £500k, £501k - £1m, £1m - £10m and >£10m.

CDA: Group8_034 (Woodplace Lane)

Preferred Option: Combined Measure:

- **Flood Storage / Permeability – Woodplace Farm and Hooley Farm**
- **SuDS – Woodplace Lane / Ashbourne Close**

Pluvial modelling identifies overland flowpaths across rural areas which results in flooding of residential properties in Woodplace Lane and Ashbourne Close. The preferred option involves a combination of measures designed to address the main flow routes as well as the actual LFRZs.

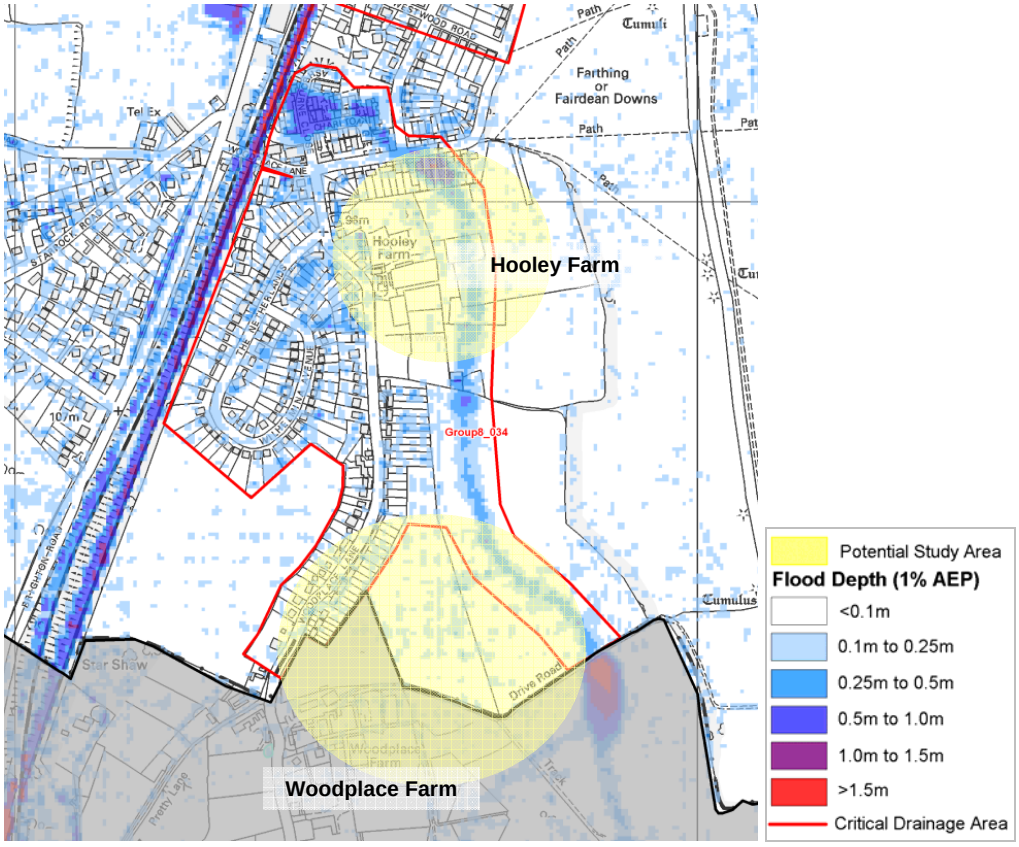
Flood Storage / Permeability – Woodplace Farm and Hooley Farm

As part of the preferred option for this CDA, it is recommended that further investigation is undertaken to assess the feasibility of using infiltration trench (indicative length 80m) and a length of connecting swale (approximate length 200m) around the edge of Woodplace Farm land to reduce overland flow into the residential area.

A similar infiltration trench (indicative length 100m) at the edge of Hooley Farm land could also be used to reduce overland flow into the rear gardens of properties on Woodplace Lane.

SuDS – Woodplace Lane / Ashbourne Close

Installation of two additional soakaways and gullies on residential highways, such as Woodplace Lane and Ashbourne Close would reduce the levels of surface water ponding in the LFRZ within this CDA.



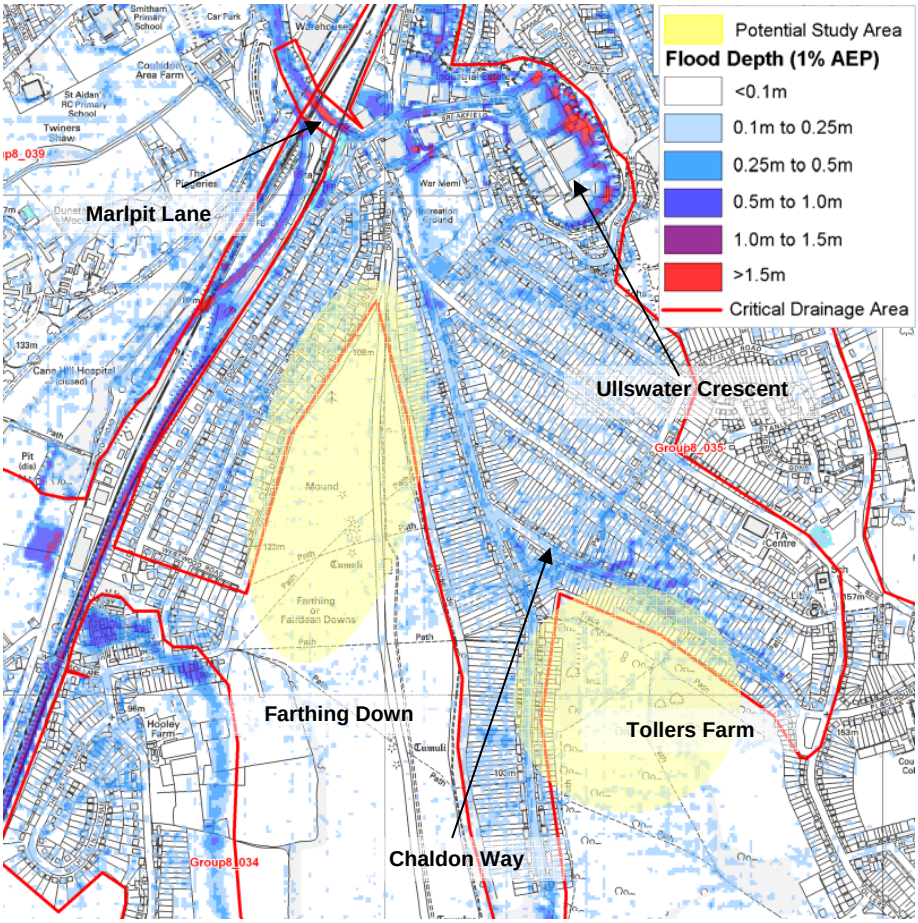
Approximate Cost	£26K-50K
Potential Benefits	• This option is estimated to mitigate the flood risk for an estimated 40% of households identified to be at risk within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).

CDA: Group8_035 (Marlpit Lane)

Preferred Option: Combined Measures:

- **Flood Storage / Permeability – Farthing Down**
- **SuDS – Chaldon Way, Marlpit Lane, Ullswater Crescent**
- **Drainage Capacity Study – Marlpit Lane**

Marlpit Lane is the predominant LFRZ within this CDA. Overland flow runs off towards the topographic low point from Farthing Down and the surrounding residential area and local highways. The sewer network at this location is often overloaded leading to the closure of the road.



Flood Storage / Permeability – Farthing Down

The preferred option for this CDA includes land management along the edge of rural land associated with Farthing Down and Tollers Farm to reduce the overland flow onto the highways which contributes to flows further down the CDA. Potential measures could include swales (approximate length 1700m) and infiltration trenches (approximate length 300m) located at the edge of Farthing Down and Tollers Farm.

SuDS – Chaldon Way, Marlpit Lane, Ullswater Crescent

In addition, the preferred option includes the installation of additional soakaways to improve the highway drainage on Chaldon Way, Marlpit Lane and Ullswater Crescent Business Park and reduce the volume of water that reaches the LFRZ at the lower end of Malpit Lane.

Drainage Capacity Study – Marlpit Lane

It is also recommended that a drainage capacity study is undertaken with Thames Water within this area to more accurately assess the capacity of the existing combined sewer network.

<table>
<tr><th colspan="3">CDA: Group8_035 (Marlpit Lane)</th></tr>
<tr><td>Approximate Cost</td><td colspan="2">£101K-500K (Capital Works)
<£25K (Investigations)</td></tr>
<tr><td>Potential Benefits</td><td colspan="2">• This option is estimated to mitigate the flood risk for an estimated 30% of the residential properties and 35% of the commercial properties on Marlpit Lane and Ullswater Crescent currently at risk within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).
• Improved understanding of capacity and issues with local drainage network at Marlpit Lane to enable prioritisation for maintenance and upgrade works.</td></tr>
<tr><td colspan="3">Additional ‘Quick Win’ Measures</td></tr>
<tr><td>Option A</td><td>Rainwater Harvesting</td><td>The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.</td></tr>
<tr><td>Option B</td><td>Drainage Maintenance</td><td>The Council could continue to target highways in this CDA, e.g. Downs Road, Chaldon Way, for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system. The following images provide an example of the creation of “cut-ins” and additional gully pots used in neighbouring London Borough of Sutton to slow overland flow on steeper highways and increase the volume that enters the drainage network.
   </td></tr>
</table>

CDA: Group8_036 (Old Lodge Lane)		
Preferred Option: Combined Measures: • **Flood Storage / Permeability – Coulsdon Manor** • **SuDS – Old Lodge Lane**		
Surface water is modelled to flow down the valley slopes and north westwards towards the railway line. Floodwater ponds adjacent to the railway line and is modelled to reach significant depths in the Sports Ground off Old Lodge Lane. **Flood Storage / Permeability – Coulsdon Manor** A potential preferred option for this CDA includes the creation of an infiltration trench (approximate length 200m) and a length of connecting swale (approximate length 1100m) around the edge of Coulsdon Manor to encourage infiltration and reduce overland flow onto highways, thereby reducing the pressure on the highway drainage. **SuDS – Old Lodge Lane** In combination with measures to encourage infiltration and retention of overland flow higher up in the CDA, two additional soakaways and additional gullies could be installed on Old Lodge Lane to further increase the volume of surface water removed from the CDA by infiltration. This may reduce the ponding of floodwater on the highways and contributing to flooding further down the catchment.		
Approximate Cost	£51K-100K	
Potential Benefits	• This option is estimated to mitigate the flood risk for an estimated 20% of the residential properties and 20% of the commercial properties currently at risk within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_037 (Kenley Station)

Schemes already implemented: SuDS – Kenley Lane

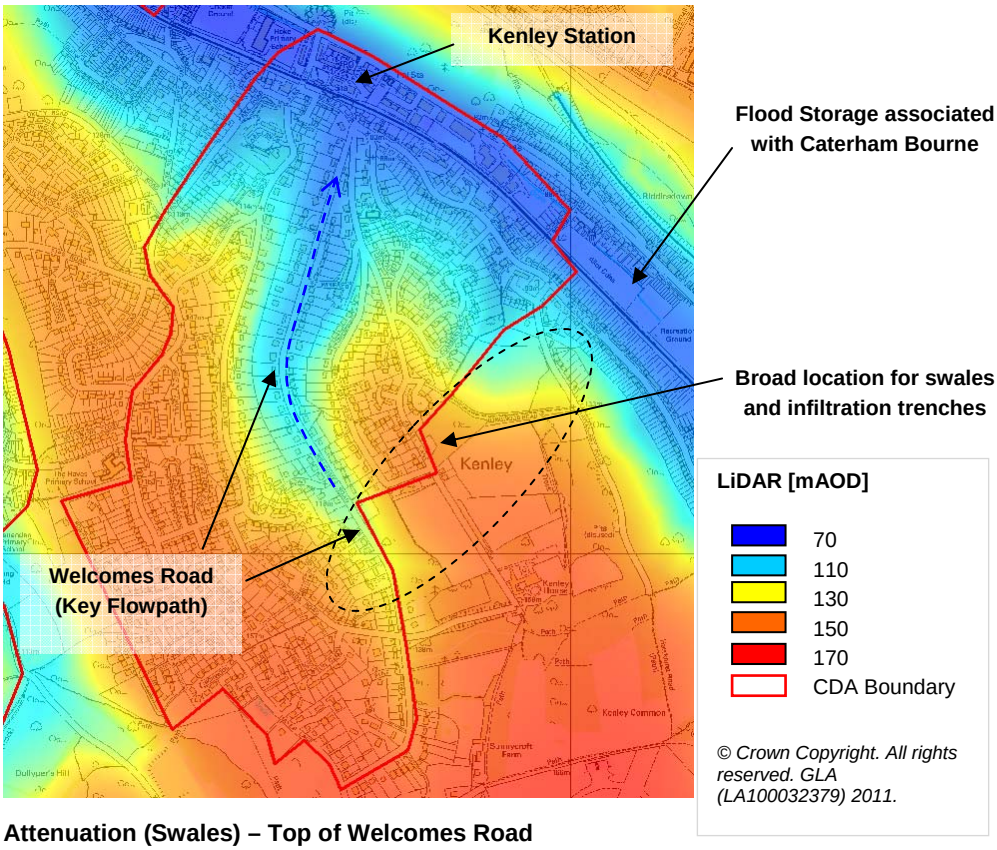
London Borough of Croydon has already implemented measures to alleviate flooding at the LFRZ of Kenley Station and substation on Kenley Lane. The works including the installation of new soakaways in Kenley Lane and pre-cast concrete drainage blocks placed along the road gully and entrance to the substation to improve the management of localised surface water. Residents of the adjacent property have also installed a small pre-cast metal grated linear drainage pipe (ACO drain) along the front of their drive.

There is also potential for interactions with flooding from the Caterham Bourne at this location. This watercourse is an ephemeral chalk stream which feeds into the Wandle at Waddon and is recorded to flow approximately every 7 years in the upper catchment in Coulsdon. Following flooding in 2001, the Environment Agency and East Surrey Water created a flood storage area to the east of Kenley Station to provide additional storage during times of peak flow.

Preferred Option: Combined Measures:

- **Attenuation (Swales) – Top of Welcomes Road**
- **Flood Storage / Permeability – Top of Welcomes Road**

Due to the steep topography characterising this CDA, the preferred option for this area involves two measures to reduce the amount of overland flow generated from the open land at the top of Welcomes Road.



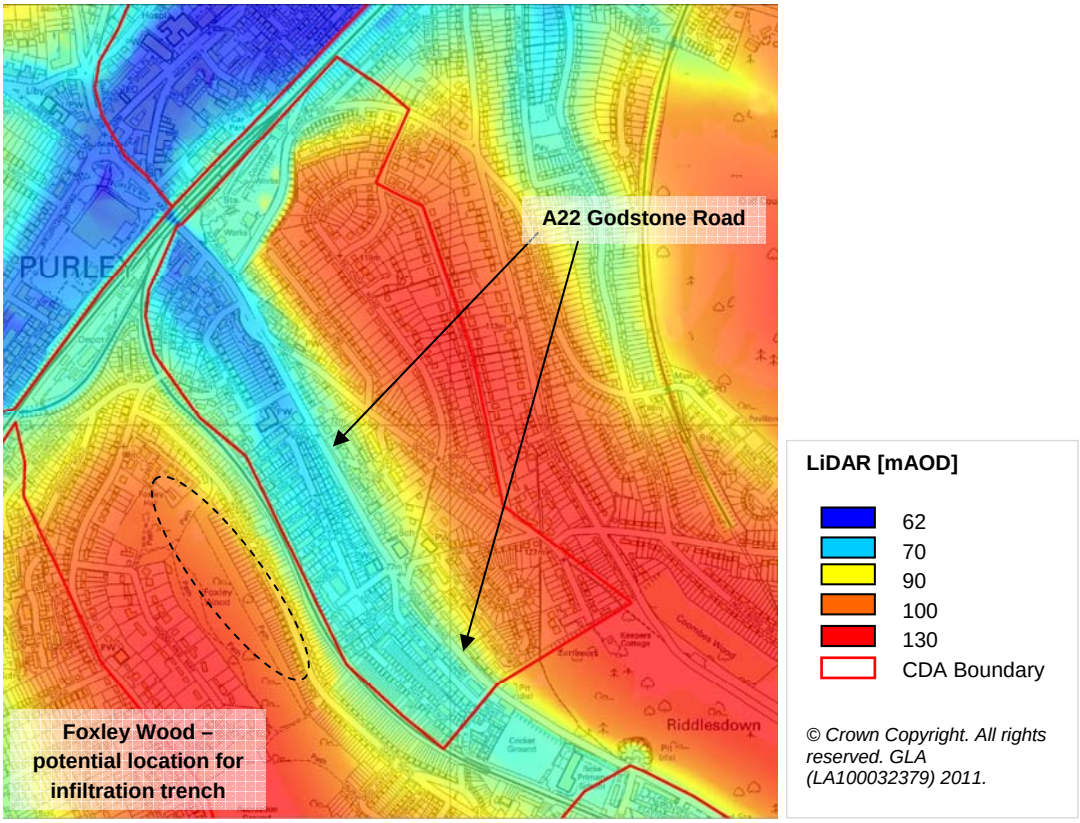
Attenuation (Swales) – Top of Welcomes Road

The Council may wish to consider the creation of swales on the edge of the rural land at the top of Welcomes Road to attenuate surface water runoff. Approximately 1280m length of swales could be created in this area to limit the runoff received by the local highways.

Flood Storage / Permeability – Top of Welcomes Road

The other element of the preferred option entails the creation of 120m length of infiltration trench to intercept overland flow and encourage some infiltration. Similarly, this would reduce the amount of surface water runoff received further down in the CDA catchment.

CDA: Group8_037 (Kenley Station)		
Approximate Cost	<£25K	
Potential Benefits	• This option is estimated to mitigate the flood risk for an estimated 35% of More Vulnerable infrastructure, 25% of residential households, and 10% of commercial properties currently at risk within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_038 (A22 Godstone Road)	
Preferred Option: Combined Measures: • **Flood Storage / Permeability – Coulsdon Manor** • **SuDS – Purley Vale, Foxley Hill Road, Warren Road** • **Drainage Infrastructure Investigation**	
Flood Storage / Permeability – Coulsdon Manor The preferred option for this CDA includes the creation of an infiltration trench (of approximate length 200m) and a length of connecting swale (approximate length 1100m) along the lower edge of Foxley Wood to encourage infiltration and reduce overland flow into properties on Northwood Avenue. **SuDS – Purley Vale, Foxley Hill Road, Warren Road** In addition, the installation of three additional soakaways and gullies on Purley Vale, Foxley Hill Road and Warren Road would increase the capacity of the local drainage network (which is a linked soakaway system in this part of the Borough).  **Drainage Infrastructure Investigation** It is also recommended that an inspection is undertaken in conjunction with TfL of the soakaways on Godstone Road (A22) to check the capacity and current condition of these drainage assets. Following this inspection there may be a case to consider improved maintenance, future upgrades, or the installation of additional soakaways to improve drainage on Godstone Road.	
Approximate Cost	£51K-100K
Potential Benefits	• This option is estimated to mitigate the flood risk for an estimated 30% of residential households and 35% commercial properties currently at risk of flooding within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP). It is anticipated that the scheme would alleviate highway flooding and benefit properties currently experiencing flows from the highways along Northwood Avenue, Foxley Hill Lane, Warren Lane, Purley Vale and

CDA: Group8_037 (Kenley Station)		
		Godstone Road. • Improved understanding of the capacity and condition of the local drainage network to enable prioritisation for maintenance and upgrades.
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

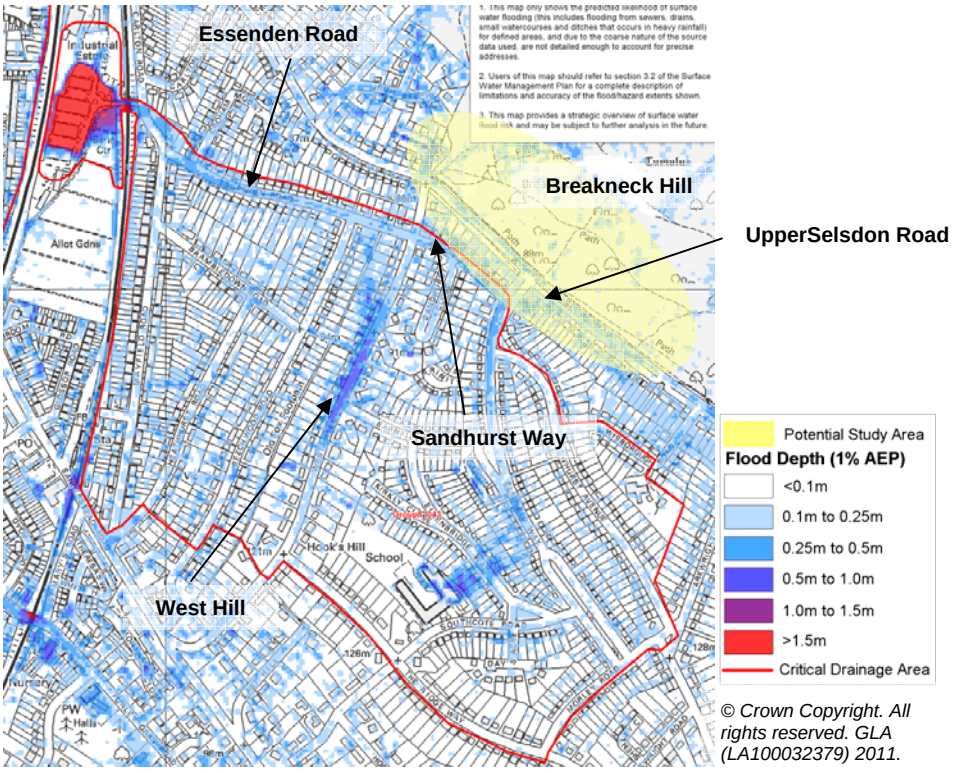
CDA: Group8_039 (Chipstead Valley Road)		
Preferred Option: Combined Measures: • **Property Level Resilience** • **Drainage Infrastructure Improvements** • **Drainage Capacity Investigation**		
Property Level Resilience One of the measures recommended for this CDA is the use of property level flood defences such as flood gates or alterations to property entrances (driveways) on 40 'at risk' properties along Chipstead Valley Road and Westleigh Avenue. These measures will prevent floodwaters flowing from the highways into properties. **Drainage Infrastructure Improvements** In addition, it is recommended that additional gullies are installed at approximately 20 locations along the key flowpaths in this CDA (Chipstead Valley Road) in order to catch surface water runoff on the steeper highways and increase the amount that is discharged to the soakaway system. **Drainage Capacity Investigation** It is also recommended that the capacity and maintenance of the oversized soakaway located at the junction between the B2032 and the A23 Brighton Road is checked to ensure that it is providing adequate storage. The findings of this investigation will help inform any further remedial works that may be necessary.		
Approximate Cost	£101K-250K	
Potential Benefits	• Improved understanding of the capacity of the oversized soakaway system, to enable prioritisation for maintenance and upgrades. • This option is estimated to mitigate the flood risk to the 40 and the highways in the areas in which the additional gullies are located.	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_040 (Purley Cross)		
Schemes under Implementation: Community Flood Plan		
The need for a Community Flood Plan in Purley Cross has already been identified and the Greater London Authority is working with London Borough of Croydon and residents of Purley to prepare a plan. The work is currently in the initial stages and meetings with the Chair of the Neighbourhood Partnership have been held. The aim of the Community Flood Plan is to empower communities to increase their resilience to flood risk.		
Preferred Option: Improvements to the Drainage Infrastructure Capacity – Brighton Road ***To be considered in conjunction with CDA Group8_041 (Brighton Rd) & Group8_042 (Sth/Ctrl Croydon)***		
Purley Cross was initially identified within the Growth Areas under the Core Strategy Issues and Options report (London Borough of Croydon 2009). Studies have been undertaken to identify the potential options for road realignment, the removal of the gyratory system and freeing up of land for Council or private development. Due to the highly urbanised nature of the CDA the preferred option for this CDA is the construction of a deep interceptor sewer of approximate length 2250m, along, or parallel to the Brighton Road from Smitham (Coulsdon Town) Rail Station to the Purley Cross Junction. This could provide in the region of 2700m^3 of online storage in the drainage network. It should be noted that CDA_040, CDA_041 and CDA_042 are one continual catchment. Three CDAs have been defined in order to consider the options along the entire length of the catchment in a more manageable manner; however options will need to be selected in using a joined-up approach. Any options to reduce the flooding in CDA_040 (Purley Cross) will help to alleviate flooding further "downstream" in the catchment.		
Approximate Cost	£5M-10M	
Potential Benefits	• This option is estimated to mitigate the flood risk to the A23 Brighton Road, Purley Cross Junction, and properties adjacent to the Brighton Road. It is anticipated that this scheme would mitigate flood risk for an estimated 100% of Essential Infrastructure, 100% of Highly Vulnerable infrastructure, 50% of More Vulnerable infrastructure, 25% of households and 45% of commercial properties that are currently at risk of flooding within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Resolve ownership of the Caterham Bourne	In order to effectively manage surface water flood risk within this area, the issues surrounding the unknown ownership of the Caterham Bourne watercourse/sewer need to be resolved. Thames Water, the Environment Agency and London Borough of Croydon should be involved in the clarification of this issue in order to identify the lead partners for future maintenance and management of this system. This is likely to be a necessary precursor to future flood alleviation measures in the CDA.
Option B	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option C	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_041 (Brighton Road)		
Preferred Option: Combined Measures: • **Flood Storage – Recreation Ground** • **Improvements to Drainage Infrastructure Capacity – Brighton Road** ***To be considered in conjunction with CDA Group8_040 (Purley Cross) & Group8_042 (Sth/Ctrl Croydon)***		
This CDA encompasses part of the path of a former watercourse that has been culverted along its entire length. Brighton Road is located in the valley bottom, and overland flows are modelled to run down the valleys and flow along this highway. **Flood Storage – Recreation Ground** Part of the preferred option for this CDA is to investigate the potential benefit of creating a temporary flood storage area (of approximately 5000m^3) in the recreation grounds off Christchurch Road parallel to the Brighton Road. **Improvements to Drainage Infrastructure Capacity – Brighton Road** Due to the highly urbanised nature of this CDA, the chief measure within the preferred option is to consider the construction of a deep interceptor sewer from the Purley Cross junction to Whitgift School, to provide circa. 3000m^3 additional online storage in the drainage network and alleviate flooding on Brighton Road. It should be noted that CDA_040, CDA_041 and CDA_042 are one continual catchment. Three CDAs have been defined in order to consider the options along the entire length of the catchment in a more manageable manner; however options will need to be selected in using a joined-up approach. Any options to reduce the flooding in CDA_041 (Brighton Road) will help to alleviate flooding further "downstream" in CDA_42 (Sth and Ctrl Croydon). Similarly, any options implemented further upstream in CDA_040 Purley Cross, may help to alleviate flooding in CDA_041 Brighton Road.		
Approximate Cost	£5M-10M	
Potential Benefits	• This option would be expected to deliver significant benefit to the Brighton Road corridor, properties adjacent to the Brighton Road as well as the 'downstream' are within South Croydon immediately to the north of the CDA. Of the properties currently at risk within the CDA during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP), the scheme is estimated to mitigate the risk for 70% of the More Vulnerable infrastructure, 50% of households and 90% of commercial properties.	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_042 (South and Central Croydon)		
Preferred Option: Combined Measures: • **Flood Storage – South Croydon Playing Fields** • **Improvements to Drainage Infrastructure Capacity – Brighton Road** ***To be considered in conjunction with CDA Group8_040 (Purley Cross) & Group8_041 (Brighton Rd)***		
Flood Storage – South Croydon Playing Fields Part of the preferred option for this CDA is to investigate the potential of creating approximately 16000m^3 of temporary flood storage in the South Croydon playing fields and 3500m^3 in Whitgift House playing fields. Measures such as these may help to alleviate highway flooding along the A23 Brighton Road. **Improvements to Drainage Infrastructure Capacity – Brighton Road** The chief measure within the preferred option is to consider the construction of a deep interceptor sewer along the Brighton Road from the Whitgift School to Wandle Park, to provide approximately 3000m^3 of additional online storage in the drainage network. It should be noted that CDA_040, CDA_041 and CDA_042 are one continual catchment. Three CDAs have been defined in order to consider the options along the entire length of the catchment in a more manageable manner; however options will need to be selected in using a joined-up approach. Any options to reduce the flooding further up the catchment in CDA_040 (Purley Cross) and CDA_041 (Brighton Road) will help to alleviate flooding in CDA_42 (Sth and Ctrl Croydon).		
Approximate Cost	£5M-10M	
Potential Benefits	• This option would be expected to deliver significant benefit to the Brighton Road corridor, properties adjacent to the Brighton Road and a large portion of the Croydon Metropolitan area. It is anticipated that the scheme would mitigate the flood risk for 35% of Essential Infrastructure, 35% of More Vulnerable infrastructure, 40% of non-deprived households, 65% of deprived households and 30% of the commercial properties within the CDA that are currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_043 (Carlton Road and Business Estate)		
Preferred Option: Combined Measures: • **SuDS – Essenden Road, Sandhurst Way, West Hill** • **Flood Storage / Permeability – Breakneck Hill**		
The primary LFRZ within this CDA is the Business Estate located off Carlton Road which is located within a topographic depression and is at risk of flooding to significant depths. The pluvial modelling for this area shows that surface water flows off the surrounding residential area around Hook's Hill School and ponds on the local highways. The preferred option for this CDA includes a combination of measures as described below: **SuDS – Essenden Road, Sandhurst Way, West Hill** The preferred option includes the potential installation of additional soakaways and gullies along Essenden Road and Sandhurst Way and West Hill to reduce the amount of surface water ponding on these highways. **Flood Storage / Permeability – Breakneck Hill** In addition, the creation of an infiltration trench (approximate length 110m) and connecting swale (approximate length 760m) at bottom of Breakneck Hill could be considered, in order to limit runoff onto Upper Selsdon Road.		



Approximate Cost	£51K-100K
Potential Benefits	• This option would be expected to mitigate the risk of flooding to properties adjacent to Sandhurst Way, West Hill, Essenden Road, 'downstream' of the proposed capital works. It is anticipated that this option would mitigate the risk of flooding for 20% of households and 90% of commercial properties within the CDA that are currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).

Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_044 (Croham Road)		
Preferred Option: Combined Measures: • **Flood Storage – Sports Ground, Manor Way** • **Swales – Ballards Plantation** • **SuDS – Croham Valley Road, Croham Road**		
Within this CDA, pluvial modelling shows that surface water may runoff the Croham Golf Course and the surrounding residential area resulting in ponding in gardens and highways on Croham Valley Road, Croham Road, Winchelsey Rise, Croham Manor Road, Normanton Road and the lower part of Birdhurst Road. The Sports Ground off Manor Way provides an area for storage of some of the overland flow. **Flood Storage – Sports Ground, Manor Way** As part of the preferred option for this CDA, modifications could be made to the ground levels in the Sports Ground off Manor Way to maximise its function to accommodate surface water flow paths and act as a flood storage area, providing circa. 11000m^3 of storage; **Swales – Ballards Plantation** In addition, the creation of swales (of approximate length 600m) along the lower edge of Ballards Plantation could be used to limit runoff from this area. **SuDS – Croham Valley Road, Croham Road** The installation of two soakaways on Croham Valley Road and Croham Road would also help to reduce the amount of surface water ponding on these highways.		
Approximate Cost	£251K-500K	
Potential Benefits	• This option would be expected to alleviate the risk of flooding currently posed to properties along Ballards Way, Croham Valley Road and Croham Road. It is anticipated that the scheme would mitigate flood risk for 100% of the Essential Infrastructure, 35% of the More Vulnerable Infrastructure and 10% of the households within the CDA that are currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_045 (Forestdale / Addington)		
Preferred Option: Combined Measures: • **Flood Storage / Permeability – Selsdon Wood** • **Attenuation – Gravel Hill Road and Kent Gate Way** • **Attenuation – Falconwood Road**		
Pluvial modelling of this area demonstrates how the topography channels surface water off Selsdon Wood and Addington Golf Course towards the built up area of Selsdon, particularly affecting Albatross Gardens, Goldfinch Road and the main highway Kent Gate Way and Addington Road. Surface water is modelled to pond along this highway and flow eastwards towards London Borough of Bromley where the watercourse becomes a culverted Main River tributary of the River Ravensbourne. A combination of measures is suggested for the CDA. **Flood Storage / Permeability – Selsdon Wood** There may be scope to create an infiltration trench, of approximate length 900m along the edge of Selsdon Wood to encourage infiltration of surface water and reduce the volume that runoffs towards the built up area. **Attenuation –Gravel Hill Road and Kent Gate Way** In addition, the creation of up to 620m length of swales around the junction between Gravel Hill Road and Kent Gate Way could be used to attenuate surface water. Similarly, the creation of a swale (approximately 260m length) along the edge of Kent Gate Way close to Threehalfpenny Wood, could be used to alleviate flooding on the highway. **Attenuation – Falconwood Road** In order to help alleviate flooding of properties on Falconwood Road, there may be potential to create in the region of 560m length of swales to help attenuate floodwater and reduce runoff into the rear of the properties.		
Approximate Cost	£101K-250K	
Potential Benefits	• This option is estimated to alleviate overland flows and flooding of properties along the edge of Selsdon Wood, properties on Falconwood Road as well as providing benefits to the highways and transport networks, in particular Kent Gate Way, Police Station. Kent Gate Way / Gravel Hill junction and tram link. • It is anticipated that this combined scheme would mitigate flooding for 10% of the More Vulnerable Infrastructure, 10% of the households and 5% of the commercial properties within the CDA that are currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_046 (Woodside)		
Preferred Option: Combined Measures: • **Improvements to Drainage Infrastructure – Rees Gardens** • **Improvements to Drainage Infrastructure – Teevan Road**		
There are several LFRZs within the Woodside CDA. Railway embankments pass through the CDA and surface water is modelled to pond behind the railway line at Teevan Road and Dalmally Road reaching depths of between 0.5 - 1m. The low lying nature of this part of the Borough leads to ponding of surface water in low lying gardens leading to property flooding, for example along Davidson Road and Rees Gardens. **Improvements to Drainage Infrastructure – Rees Gardens** The preferred option includes considering improvements to the drainage network along Rees Gardens through installation of a 260m length of new surface water sewer to provide additional capacity. **Improvements to Drainage Infrastructure – Teevan Road** In addition, consideration of improvements to drainage network is recommended for Teevan Road, through the installation of a 270m length of new surface water sewer.		
Approximate Cost	£51K-100K	
Potential Benefits	• This option is estimated to alleviate flooding to properties located on Rees Gardens and Teevan Road. The scheme is estimated to alleviate flooding for 15% of the households within the CDA that are currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_047 (South Norwood)

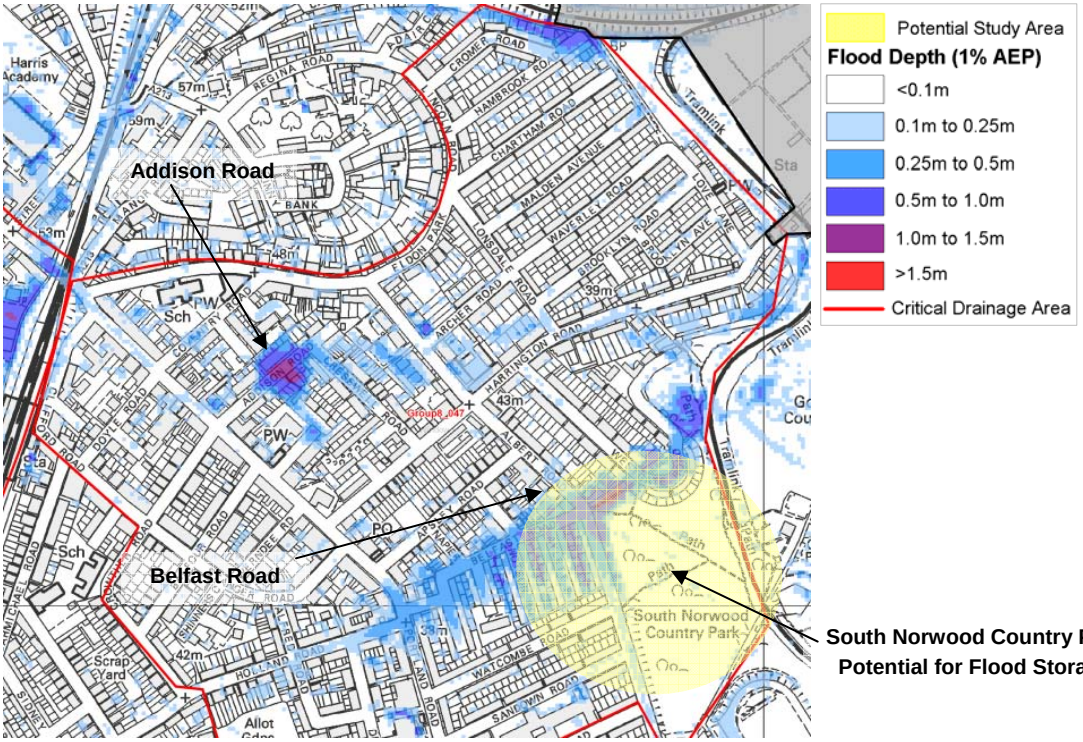
Preferred Option: Combined Measures:

- **Investigate Flood Storage – South Norwood Country Park**
- **Community Resilience – Belfast Road and Addison Road**

This CDA is highly urbanised and includes residential properties, several primary schools and a small portion of the South Norwood Country Park. Modelling shows how surface water ponds behind railway embankments and residential roads located in topographic low points.

Investigate Flood Storage – South Norwood Country Park

There may be potential to create a temporary flood storage area in the South Norwood Country Park, providing circa. 11700m^3 of temporary storage for surface water flows. Further work to investigate the viability and potential benefit of such a scheme would be required.



Community Resilience – Belfast Road and Addison Road

In addition, due to the localised nature of flooding in this area, the preferred option includes consideration of property level resilience measures for 20 properties along Addison Road and 20 properties along Belfast Road. Measures could include alterations to kerb heights to divert surface water flowpaths away from entranceways, or door guards and air brick covers to prevent water entry.

Approximate Cost	£251K-500K
Potential Benefits	• It is anticipated that a combined scheme such as this could mitigate the flood risk within the CDA for 100% of the More Vulnerable Infrastructure, 20% of the households and 10% of the commercial properties within the CDA that are

CDA: Group8_047 (South Norwood)		
		currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP), including those located on Addison Road and Belfast Road. • Potential for improved amenity / multi functional space in South Norwood Park
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_048 (South Norwood Hill)		
Preferred Option: Combined Measures: • **Preferential Flow Routes – South Norwood Hill, St Dunstan's Road** • **Community Resilience - Property Level Defences**		
Within this CDA, pluvial modelling identifies a LRFZ adjacent to the railway embankment affecting properties in Grosvenor Road and Norwood Junction Rail Station. The key flowpaths leading to this LFRZ are along South Norwood Hill, High Street, Selhurst Road and St Dunstan's Road. Surface water is also shown to pond along Nugent Road, Elm Park Road and Broster Gardens leading to property and highway flooding in these locations. London Borough of Croydon has records of flooding along Selhurst Road, Station Road, South Norwood Hill and Portland Road within this CDA. **Community Resilience - Property Level Defences** Part of the preferred option for this CDA is the installation of property level flood resistance measures for 20 properties currently at risk within the CDA, including providing protection for the station on Grosvenor Road. Measures could include alterations to kerb heights to divert surface water flowpaths away from entranceways, or door guards and air brick covers to prevent water entry. **Preferential Flow Routes – South Norwood Hill, St Dunstan's Road** In addition, the preferred option for this CDA could include the consideration of creating preferential flowpaths along South Norwood Hill and St Dunstan's Road. Raising kerb heights to keep the surface water on the highway and prevent the flooding of properties could be a viable and effective method for managing surface water flooding in this area.  **Figure 4-8 Pre-cast concrete drainage units (Beany Block), Purley Oaks**		
Approximate Cost	£26K-50K	
Potential Benefits	• It is estimated that this option could mitigate the flood risk within the CDA for 20% of the deprived households within the CDA that are currently at risk of flooding during the rainfall event with a 1 in 100 annual chance of occurring (1% AEP).	
Additional 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

CDA: Group8_049 (Norbury)		
Schemes under implementation: Flood Storage		
The primary flood source in this area is fluvial flooding from the Norbury Brook. This watercourse is designated Main River and as such options are primarily the responsibility of the Environment Agency and are not within the scope of this SWMP. As a result, no options have been provided for to put forward for the Prioritisation Matrix for this CDA. It is noted that a feasibility study has been undertaken to assess the potential for creating flood storage within the parks and sports grounds along the river corridor to help alleviate fluvial flooding in this CDA.		
Preferred Option: 'Quick Win' Measures		
Option A	Rainwater Harvesting	The widespread installation of water butts for properties within this CDA could provide a significant volume of rainwater storage. This option would be particularly beneficial for events of a lower magnitude rather than the high order events.
Option B	Drainage Maintenance	The Council could continue to target highways in this CDA for high priority gully cleansing and consider the potential for additional works to increase the volume of water entering the highway drainage system.

4.4 Preferred Options Summary

4.4.1 A summary of the preferred options (capital schemes) discussed above is presented in Table 4-5.

4.5 Recommendations for Next Steps and Quick Wins

4.5.1 Taking into account the nature of the surface water flooding in the London Borough of Croydon, the options identified through the Phase 3 Options Assessment, and requirements under the FWMA and FRR2009, it is considered that the London Borough of Croydon should prioritise the following actions in the short to medium-term:

Recommendation 20: Identify and record surface water assets as part of the London Borough of Croydon Asset Register, prioritising those areas that are known to regularly flood and are therefore likely to require maintenance or upgrading in the short-term.

Recommendation 21: Consider the development of an 'Information Portal' via the London Borough of Croydon website, including links to the relevant Environment Agency and National Flood Forum web pages that provide advice on measures that can be taken by residents to mitigate surface water flooding to / around their property. This could be developed in conjunction with the South West London Strategic Flood Group and include:

- A list of appropriate property-level flood risk resilience measures that could be installed in a property;
- A link to websites / information sources providing further information, such as the Environment Agency and National Flood Forum; and
- An update on work being undertaken in the Borough by the Council and/or other Stakeholders to address surface water flood risk.

Recommendation 22: Prepare a Communication Plan to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public.

Recommendation 23: Build upon the work of the Purley Cross Community Flood Plan to engage with residents regarding the flood risk in the Borough, to make them aware of their responsibilities for property drainage (especially in the south of the Borough) and steps that can be taken to improve flood resilience.
Recommendation 24: In conjunction with Thames Water, determine the capacity of the existing sewer network along Rees Gardens and Teevan Road (CDA_046 Woodside) and investigate options for increasing the surface water sewer capacity at this location.
Recommendation 25: Undertake a Drainage Capacity Study for the three CDAs that cover the Purley Cross Junction and Brighton Road corridor (CDA_040, CDA_41 and CDA_042) to determine the drainage capacity and potential for future improvements such as the construction of a deep interceptor sewer or online storage tank. The Study could consider the following: • Identifying and recording surface water assets, including type, location and condition, as required for preparation of the Asset Register; • Determining the condition and capacity of gullies and carrier pipes; • Determining the connections to Thames Water surface sewers and assets; • Undertaking CCTV surveys of those areas which experience regular surcharging and flooding; • Clearing those gullies or pipes identified as blocked during investigations (as part of annual maintenance routine); and, • Determining upgrade requirements and costs for the local drainage infrastructure and seek funding opportunities to implement these.
Recommendation 26: It is also recommended that the capacity and maintenance of the oversized soakaway located at the junction between the B2032 and the A23 Brighton Road is checked to ensure that it is providing adequate storage. The findings of this investigation will help inform any further remedial works that may be necessary.
Recommendation 27: Consider undertaking a feasibility study to assess the potential for flood storage in South Norwood Country Park (CDA_047 South Norwood).
Recommendation 28: Consider undertaking a feasibility study to assess the potential for flood storage in the South Croydon playing fields and the Whitgift House playing fields (CDA_042 South and Central Croydon).
Recommendation 29: Consider undertaking a feasibility study to assess the potential for flood storage in the recreation grounds off Christchurch Road parallel to the Brighton Road (CDA_041 Brighton Road).
Recommendation 30: Use the findings of the SWMP to review the priority areas that are currently targeted for gully cleansing and maintenance and amend if necessary.
Recommendation 31: Collate and review information on Ordinary Watercourses in the Borough to gain an improved understanding of surface water flooding in the vicinity of these watercourses as well as ownership and maintenance responsibility for each watercourse.

Table 4-5 Phase 3 Summary of Preferred Options

CDA_ID	CDA Name	Option Category	Option Description	Combination Scheme?	Indicative Dimensions & Costs (See Notes below)										
					Measures	Cost (£) per unit	Unit Description	Unit	Length	Area	Depth	Volume	Number	Drain London Cost Band	Cost Band for Combination of Measures
Group8_034	Woodplace Lane	Source Control, Attenuation and SuDS	Swale along edge of Woodplace Farm	✓	Swales	16	m^2 of swale area	m^2		645	1	645		<£25k	£26k - 50k
		Flood Storage / Permeability	Infiltration Trench at edge of Woodplace Farm	✓	Other 'Source' Measures	95	m length of infiltration trench	m	80					<£25k	
		Flood Storage / Permeability	Infiltration Trench at edge of Hooley Farm land to reduce overland flow into the rear gardens of properties on Woodplace Lane.	✓	Other 'Source' Measures	95	m length of infiltration trench	m	100					<£25k	
		Source Control, Attenuation and SuDS	Soakaway at Woodplace Lane	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway at Ashbourne Close	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Other - Improvement to Drainage Infrastructure	4 more gullies; 2 on Woodplace Lane and 2 on Ashbourne Close.	✓	Increase the number or size of gullies to collect runoff and discharge to sewer	215	per Gully	per gully					4	<£25k	
Group8_035	Marlpit Lane	Source Control, Attenuation and SuDS	Swale along the edge of rural land associated with Farthing Down and Tollers Farm	✓	Swales	16	m^2 of swale area	m^2		2550	1	2550		£26k - 50k	£51k - 100k
		Flood Storage / Permeability	Infiltration Trench along the edge of rural land associated with Farthing Down and Tollers Farm	✓	Other 'Source' Measures	95	m length of infiltration trench	m	300					£26k - 50k	
		Source Control, Attenuation and SuDS	Soakaway on Chaldon Way	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Marlpit Lane	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Ullswater Crescent	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Other - Improvement to Drainage Infrastructure	6 more gullies on Chaldon Way, Marlpit Lane, and Ullswater Crescent.	✓	Increase the number or size of gullies to collect runoff and discharge to sewer	215	per Gully	per gully					6	<£25k	
Group8_036	Old Lodge Lane	Source Control, Attenuation and SuDS	Swale around the edge of Coulsdon Manor	✓	Swales	16	m^2 of swale area	m^2		1650	1	1650		£26k - 50k	£51k - 100k
		Flood Storage / Permeability	Infiltration Trench around the edge of Coulsdon Manor	✓	Other 'Source' Measures	95	m length of infiltration trench	m	200					<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Old Lodge Lane	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Old Lodge Lane	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
Group8_037	Kenley Station	Source Control, Attenuation and SuDS	Swale along the edge of the rural land at the top of Welcomes Road	✓	Swales	16	m^2 of swale area	m^2		1920	1	1920		£26k - 50k	£26k - 50k
		Flood Storage / Permeability	Infiltration Trench along the edge of the rural land at the top of Welcomes Road	✓	Other 'Source' Measures	95	m length of infiltration trench	m	120					<£25k	
Group8_038	A22 Godstone Rd	Source Control, Attenuation and SuDS	Swale along the lower edge of Foxley Wood	✓	Swales	16	m^2 of swale area	m^2		1650	1	1650		£26k - 50k	£51k - 100k
		Flood Storage / Permeability	Infiltration Trench along the lower edge of Foxley Wood	✓	Other 'Source' Measures	95	m length of infiltration trench	m	200					<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Purley Vale	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Foxley Hill Road	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Warren Road	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
Group8_039	Chipstead Valley Rd	Community Resilience	Flood level protection measures such as flood barriers for property doors, air bricks, non-return valves, for 40 properties	✓	Temporary or Demountable Flood Defences	2500	per property protected	per property					40	£51k - 100k	£101k - 250k
		Other - Improvement to Drainage Infrastructure	20 Gullies plus creation of cut-ins	✓	Increase the number or size of gullies to collect runoff and discharge to sewer	215	per gully	per gully					20	<£25k	
Group8_040	Purley Cross	Other - Improvement to Drainage Infrastructure	2250m length of deep interceptor sewer (based on 3m deep, 2250 length, 45 manholes).	✓	Increasing Capacity in Drainage Systems	173 4190	m of culvert dia.1200mm per manhole	m per manhole	2250 -				- 45	£5m – 10m	
Group8_041	Brighton Rd	Flood Storage / Permeability	Storage Area in Recreation Ground off Christchurch Rd	✓	Detention Basins	33	m^3 of detention volume	m^3				8500		£251k - 500k	£5m - 10m
		Other - Improvement to Drainage Infrastructure	2600 length of deep interceptor sewer (based on 2m deep, 2600 length, 50 manholes).	✓	Increasing Capacity in Drainage Systems	173 4190	m of culvert dia.1200mm per manhole	m per manhole	2600 -				- 50	£5m - 10m	

Group8_042	South & Central Croydon	Flood Storage / Permeability	Storage Area in South Croydon Playing Fields	✓	Detention Basins	33	m^3 of detention volume	m^3				160000		£1m - 10m	£5m - 10m
		Flood Storage / Permeability	Storage Area in Whitgift House Playing Fields	✓	Detention Basins	33	m^3 of detention volume	m^3				3350		£101k - 250k	
		Other - Improvement to Drainage Infrastructure	2600 length of deep interceptor sewer (based on 2m deep, 2600 length, 50 manholes).	✓	Increasing Capacity in Drainage Systems	173 4190	m of culvert dia.1200mm per manhole	m	2600 -				- 50	£5m - 10m	
Group8_043	Carlton Rd & Business Est.	Source Control, Attenuation and SuDS	Swale at the bottom of Breakneck Hill	✓	Swales	16	m^2 of swale area	m^2		1140	1	1140		<£25k	£51k - 100k
		Flood Storage / Permeability	Infiltration Trench at bottom of Breakneck Hill	✓	Other 'Source' Measures	95	m length of infiltration trench	m	110					<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Essenden Road	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Sandhurst Way	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on West Hill	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Other - Improvement to Drainage Infrastructure	6 additional gullies	✓	Increase the number or size of gullies to collect runoff and discharge to sewer	215	per gully	per gully					6	<£25k	
Group8_044	Croham Rd	Flood Storage / Permeability	Provision of additional storage in Sports Ground off Manor Way	✓	Detention Basins	33	m^3 of detention volume	m^3				11000		£251k - 500k	£251k - 500k
		Source Control, Attenuation and SuDS	Land management through creation of a swale along Ballards Plantation	✓	Swales	16	m^2 of swale area	m^2		900	1	900		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Croham Valley Road	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
		Source Control, Attenuation and SuDS	Soakaway on Croham Road	✓	Soakaways	219	m^3 of stored volume	m^3		7	6	42		<£25k	
Group8_045	Forestdale / Addington	Flood Storage / Permeability	Infiltration trench along the edge of Selsdon Wood	✓	Other 'Source' Measures	95	m length of infiltration trench	m	900					£51k - 100k	£101k - 250k
		Source Control, Attenuation and SuDS	Swale around the rear of properties on Falconwood Road	✓	Swales	16	m^2 of swale area	m^2		840	1	840		<£25k	
		Source Control, Attenuation and SuDS	Creation of three swales around the junction between Gravel Hill Road and Kent Gate Way.	✓	Swales	16	m^2 of swale area	m^2		930	1	930		<£25k	
		Source Control, Attenuation and SuDS	Swale along the edge of Kent Gate Way close to ThreehalfPenny wood, to alleviate flooding on the highway.	✓	Swales	16	m^2 of swale area	m^2		390	1	390		<£25k	
Group8_046	Woodside	Other - Improvement to Drainage Infrastructure	260m length of new sewer along Rees Gardens	✓	Increasing Capacity in Drainage Systems	118 1710	m of pipe dia.900mm per manhole	m	260 -				- 5	£26k - 50k	£51k - 100k
		Other - Improvement to Drainage Infrastructure	270m length of new sewer along Teevan Road	✓	Increasing Capacity in Drainage Systems	118 1710	m of pipe dia.900mm per manhole	m	270				- 5	£26k - 50k	
Group8_047	South Norwood	Flood Storage / Permeability	Storage Area in South Norwood Country Park	✓	Detention Basins	33	m^3 of detention volume	m^3				11700		£251k - 500k	£251k - 500k
		Community Resilience	Property level flood defences at 20 properties on Addison Road	✓	Temporary or Demountable Flood Defences	2500	per property protected	per property					20	£26k - 50k	
		Community Resilience	Property level flood defences at 20 properties on Belfast Road	✓	Temporary or Demountable Flood Defences	2500	per property protected	per property					20	£26k - 50k	
Group8_048	South Norwood Hill	Preferential / Designated Overland Flow Routes	Kerb raising along South Norwood Hill and St Dunstan's Road	✓	Managing Overland Flows (Preferential Flowpaths)		m of kerb raised	m						<£25k	£26k - 50k
		Community Resilience	Property level flood defences at 20 properties	✓	Temporary or Demountable Flood Defences	2500	per property protected	per property					20	£26k - 50k	
Group8_049	Norbury	Do Nothing	None	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: This table has been produced to assist with the preliminary cost estimates as part of the SWMP for London Borough of Croydon dimensions and costs are indicative and should only be used for preliminary estimates due to the generalised nature of the information used to compile it. An estimated cost for the preferred flood mitigation option for each identified CDA has been calculated based on standard unit costs provided as part of Tier 1 of the Drain London Project. No monetised damages have been calculated, and flood mitigation costs have been determined using engineering judgement, but have not undergone detailed analysis. The following standard assumptions have been applied, as determined in the Drain London Prioritisation Matrix Guidance:

- The costs are the capital costs for implementation of the scheme only.
- Costs do not include provisions for consultancy, design, supervision, planning process, permits, environmental assessment or optimum bias.
- No provision is made for weather (e.g. winter working).
- No provision is made for access constraints
- Where required, it will be stated if costs include approximate land acquisition components.
- No operational or maintenance costs are included.
- No provision is made for disposal of materials (e.g. for flood storage or soakaway clearance).

As a result, costs have been provided as cost bands, reflecting the strategic nature of the SWMP study and options identification.

4.6 Option Prioritisation

4.6.1 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.

4.6.2 The information within Table 4-6 will used by the Drain London Programme Board to populate the Drain London Prioritisation Matrix and identify schemes to be taken forward under the Tier 3 package of works.

Table 4-6 Phase 3 Summary of Preferred Options – *For input into Drain London Prioritisation Matrix*

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 (%)	
Group8_034	Woodplace Lane	1,2,3	N/A	N/A	N/A	N/A	N/A	N/A	0	40%	N/A	N/A	0	N/A	£26K-50K
Group8_035	Marlpit Lane	1,2,3	N/A	N/A	0	0	N/A	N/A	0	30%	N/A	N/A	0	35%	£51K-100K
Group8_036	Old Lodge Lane	1,2	0	0	N/A	N/A	0	0	0	20%	N/A	N/A	0	20%	£51K-100K
Group8_037	Kenley Station	1,2	0	0	0	0	0	35%	0	25%	N/A	N/A	0	10%	£26K-50K
Group8_038	A22 Godstone Rd	1,2	N/A	N/A	N/A	N/A	0	0	0	30%	N/A	N/A	0	35%	£51K-100K
Group8_039	Chipstead Valley Rd	3,4	0	0	0	0	0	0	0	5%	N/A	N/A	0	0	£101K-250K
Group8_040	Purley Cross	3	0	100%	0	100%	0	50%	0	25%	N/A	N/A	0	45%	£501K-1M
Group8_041	Brighton Rd	2,3	0	0	N/A	N/A	0	70%	0	50%	N/A	N/A	0	90%	£501K-1M
Group8_042	South & Central Croydon	2,3	0	35%	0	0	0	35%	0	40%	0	65%	0	30%	£1M-10M
Group8_043	Carlton Rd & Business Centre	1,2,3	N/A	N/A	N/A	N/A	0	0	0	20%	N/A	N/A	0	90%	£51K-100K
Group8_044	Croham Rd	1,2	0	100%	N/A	N/A	0	35%	0	10%	N/A	N/A	0	0	£251K-500K
Group8_045	Forestdale/Addington	1,2	0	0	0	0	0	10%	0	10%	0	0	0	5%	£101K-250K
Group8_046	Woodside	3	0	0	N/A	N/A	0	0	0	15%	0	0	0	0	£51K-100K
Group8_047	South Norwood	2,4	0	0	N/A	N/A	0	100%	0	20%	0	0	0	10%	£251K-500K
Group8_048	South Norwood Hill	4,5	N/A	N/A	0	0	0	0	0	0	0	20%	0	20%	
Group8_049	Norbury	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

*__Scheme Categories__ 1 - Source Control, Attenuation & SuDS; 2 - Flood Storage / Permeability; 3 - Improvements to Drainage Infrastructure

Note: The Drain London Prioritisation Matrix requires an estimation of the percentage of total number of units that have the potential to benefit from the proposed scheme. This has been determined by calculating the number of units within the Local Flood Risk Zone that the scheme has been designed to mitigate, as a percentage of the number of units within the CDA as a whole. The input is restricted to multiples of five percent. It should be noted that the information within this table is purely for input into the Drain London Prioritisation Matrix and should be treated as such.

5. Phase 4: Implementation and Review

5.1 Action Plan

5.1.1 The purpose of Phase 4 of the SWMP is to clearly identify actions and responsibilities for the ongoing management of surface water flood risk within the London Borough of Croydon that have been identified throughout the work undertaken in Phases 1 to 3.

5.1.2 A draft Action Plan has been prepared for London Borough of Croydon and is included within Appendix I. The purpose of the Action Plan is to:

- Outline the actions required to implement the preferred options identified in Phase 3;
- Identify the partners or stakeholders responsible for implementing the action;
- Provide an indication of the priority of the actions and a timescale for delivery;
- Outline actions required to meet the requirements for London Borough of Croydon as LLFA under the FWMA 2010.

5.1.3 Actions within the Action Plan (Appendix I) have been categorised as summarised in Table 5-1 and a summary of the key actions falling within each category is provided in the following sections.

Table 5-1 Types of Action within the London Borough of Croydon Action Plan

Definition	Action Type Abbreviation	Description
Flood and Water Management Act / Flood Risk Regulations 2009	FWMA / FRR	Duties and actions as required under 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.
Policy Action	Policy	Spatial planning or development control actions.
Communication / Partnerships	C+M	Actions to communicate risk internally or externally to LLFA or create / improve flood risk related partnerships.
Financial / Resourcing	F+R	Actions to secure funding internally / externally to support works or additional resources to deliver actions.
Investigation / Feasibility / Design	I/F/D	Further investigation / feasibility study / Design of mitigation.
Flooding Mitigation Action	FMA	Maintenance or capital works undertaken to mitigate flood risk.

5.1.4 As part of the preparation of the draft Action Plan and the SWMP, the requirement for a Strategic Environmental Assessment (SEA), an Appropriate Assessment (required by the Habitats Directive) or an Article 4.7 assessment (under the Water Framework Directive) was considered. A 'screening decision' was made which suggested that the SWMP alone does not require any of the environmental assessments described above. However, it is possible that any actions which are taken forward will require such assessments and it is envisaged that the requirement for this will form part of feasibility studies for individual schemes.

Key Actions – FWMA 2010 / FRR 2009

5.1.5 As identified in Table 5-1, a number of the key actions for London Borough of Croydon relate to duties and responsibilities under the FWMA and the FRR2009 outlined in Section 1.7.

5.1.6 The actions required are contained in the Action Plan however of chief importance and immediacy are those listed below:

- Implement a standardised Flood Incident Log and investigate flooding incidents.
- Implement and populate a standardised Asset Register.
- Establish a Flood Risk Management Group for London Borough of Croydon.
- Formalise Terms of Reference for the South West London Strategic Flood Group.

5.1.7 It is likely that these actions may require consideration of internal Borough functions, roles of specific personnel, and adopting new systems of data collection and asset management.

Key Actions – Policy

5.1.8 Actions that will need to be delivered through policy include policies or strategies for influencing the use of rainwater harvesting techniques, managing driveway resurfacing and associated drainage, and the use of SuDS. These may be delivered across the Borough or for specific Policy Areas within the Borough. Key actions from the draft Action Plan include:

- Ensure Development Control policies incorporate consideration of surface water flood risk.
- Establish Development Control policy on Driveway and Garden repaving.

Key Actions – Communications / Partnerships

5.1.9 As our understanding about surface water flood risk improves and more information is made available, it becomes increasingly important to be able to communicate the risk effectively both within the London Borough of Croydon and to other stakeholders and members of the public. To this end a number of actions relate to the future communication of flood risk and the London Borough of Croydon may wish to consider the implementation of a Communication Plan to deliver this action.

5.1.10 Building on the steps made as part of Phase 1 of this work, and continuing to forge partnerships with neighbouring London Boroughs through the establishment of the South West London Flood Group will be essential to the continued management of surface water across this area in a joined-up manner. Collaboration with neighbouring London Boroughs is also likely to aid each local authority in meeting the requirements of the FRR2009 and taking on new roles and responsibilities under the FWMA.

5.1.11 Key actions from the draft Action Plan under this category include:

- Establish a Communication and Engagement Plan.
- Increase community awareness of local flood risk through letter drops and Community Flood Plans (such as that for Purley Cross).
- Actively engage political stakeholders in local flood risk management.
- Establish a Flood Risk Management Group for London Borough of Croydon.
- Formalise Terms of Reference for the South West London Strategic Flood Group.

Key Actions – Financial / Resourcing

5.1.12 In order to deliver the requirements of the FWMA 2010 and, to a lesser extent, the FRR 2009, alongside the local flood risk management actions identified in this SWMP, London Borough of Croydon is likely to require additional resources and funding over the long-term. Key actions from the draft Action Plan under this category include:

- Ensure required skills and technical capability is in place to deliver FWMA 2010 / FRR 2009 requirements.
- Identify local flood risk management funding opportunities through internal and external, existing and future, funding initiatives and mechanisms.

Key Actions – Investigation / Feasibility / Design

5.1.13 As well as these Borough-wide actions, a large number of actions have been identified for specific CDAs based upon the preferred options identified for each CDA. Within London Borough of Croydon, these are predominantly either capital works in the form of improvements to the drainage infrastructure, installation of additional soakaways in the south of the Borough, or further investigation through more detailed modelling and initial surveys, or where appropriate feasibility studies for example for the creation of flood storage areas and use of land management techniques.

5.1.14 Key actions from the draft Action Plan under this category include:

- Undertake a Drainage Capacity Study for the three CDAs that cover the Purley Cross junction and Brighton Road corridor and consider the potential for future improvements such as the construction of a deep interceptor sewer or online storage tank.
- Investigate feasibility of using playing fields and open spaces along the Brighton Road corridor for flood storage.
- Resolve issues over the ownership of the Caterham Bourne system.
- Investigate feasibility of using land management and source control techniques on rural land at the top of Welcomes Road to mitigate flood risk in Kenley (CDA Group8_037).

Key Actions – Flooding Mitigation Action

5.1.15 Flooding mitigation actions include maintenance or capital works which can be can be progressed without any further investigation to mitigate flood risk. The following actions have been extracted from the draft Action Plan as examples of key actions for consideration under this category:

- Continue to undertake drainage maintenance that prioritises LFRZs.
- Encourage gully cleansing contractors to use powers to enforce movements of parked cars to ensure all gullies are regularly maintained.
- Identify, map and maintain ordinary watercourses in the Borough.

5.2 Ongoing Monitoring

5.2.1 The partnership arrangements established as part of the SWMP process (e.g., the South West London Strategic Partnership, Environment Agency and Thames Water 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.

5.2.2 The SWMP Action Plan should be reviewed and updated once every six years as a minimum, but there may be circumstances which might 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;**
- If the outcome of an investment decision 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.

Recommendation 32: Develop, maintain and update the draft Action Plan to meet London Borough of Croydon's local flood risk management priorities.

5.3 Updating SWMP Reports and Figures

5.3.1 In recognition that the SWMP will be updated in the future, the report has been structured in chapters according to the SWMP guidance provided by Defra. By structuring the report in this way, it is possible to undertake further analyses on a particular source of flooding and only have to supersede the relevant chapter, whilst keeping the remaining chapters unaffected.

5.3.2 In keeping with this principle, the following tasks should be undertaken when updating SWMP reports and figures:

- Undertake further analyses as required after SWMP review;
- Document all new technical analyses by rewriting and replacing relevant chapter(s) and appendices;
- Amend and replace relevant SWMP Maps; and,
- Reissue to departments within the London Borough of Croydon and other stakeholders.

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Site visits with Bob Hucks, 5th October 2009

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Limitations

URS Scott Wilson Ltd ("URS Scott Wilson"), acting solely in its capacity as sub-consultant to Capita Symonds Ltd, has prepared this Report for the sole use of the Greater London Authority ("Client") in accordance with the Agreement under which our services were performed (Drain London Tier 2 Quotation of Services 13 September 2010)]. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by URS Scott Wilson. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of URS Scott Wilson.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by URS Scott Wilson has not been independently verified by URS Scott Wilson, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by URS Scott Wilson in providing its services are outlined in this Report. The work described in this Report was undertaken between September 2010 and June 2011 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

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Where field investigations are carried out, these have been restricted to a level of detail required to meet the stated objectives of the services.

Costs may vary outside the ranges quoted. Whilst cost estimates are provided for individual issues in this Report these are based upon information at the time which can be incomplete. Cost estimates for such issues may therefore vary from those provided. Where costs are supplied, these estimates should be considered in aggregate only. No reliance should be made in relation to any division of aggregate costs, including in relation to any issue, site or other subdivision.

No allowance has been made for changes in prices or exchange rates or changes in any other conditions which may result in price fluctuations in the future. Where assessments of works or costs necessary to achieve compliance have been made, these are based upon measures which, in URS Scott Wilson's experience, could normally be negotiated with the relevant authorities under present legislation and enforcement practice, assuming a pro-active and reasonable approach by site management.

Forecast cost estimates do not include such costs associated with any negotiations, appeals or other non-technical actions associated with the agreement on measures to meet the requirements of the authorities, nor are potential business loss and interruption costs considered that may be incurred as part of any technical measures.

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Appendix A - Data Review

A review of the data provided as part of Drain London Tier 1 package of works and that used within this SWMP has been undertaken. An assessment of the quality of the data has been completed, using the criteria set out in the Defra SWMP Guidance, which is summarised in Table A-1 of Appendix A.

DLT2-GP8-Croydon-AppendixA-DataReview_v1pt0.xls

Appendix B - Asset Register Recommendation

A review of the existing Council-held asset information and systems and recommendations for compliance with the Flood and Water Management Act 2010 Asset Register requirements has been undertaken for the London Borough of Croydon and is provided electronically alongside this report.

DLT2-GP8-Croydon-AppendixB-AssetRegister_V0pt3.pdf

Appendix C - Risk Assessment: Technical Details

Appendix C1 – Pluvial Modelling Methodology

DLT2-GP8-Croydon-AppendixC1-ModellingMethod_V0pt2.pdf

Appendix C2 – Intermediate Assessment of Groundwater Flooding Susceptibility

DLT2-GP8-Croydon-AppendixC2-GroundwaterAssessment.pdf

Appendix D - Maps

The following supporting figures have been supplied electronically alongside this report.

D1	Environment Agency Flood Map for Surface Water
D2	1% AEP Maximum Flood Depth & Recorded Surface Water Flooding Incidents
D3	Environment Agency Flood Map and Fluvial Flooding Incidents
D4	Thames Water Sewer Network
D5	Recorded Incidents of Sewer Flooding
D6	3.3% AEP Rainfall Event: Maximum Flood Depth + CDA
D7	3.3% AEP Rainfall Event: Hazard Rating + CDA
D8	1.3% AEP Rainfall Event: Maximum Flood Depth + CDA
D9	1.3% AEP Rainfall Event: Hazard Rating + CDA
D10	1% AEP Rainfall Event plus Climate Change: Maximum Flood Depth + CDA
D11	1% AEP Rainfall Event plus Climate Change: Hazard Rating + CDA
D12	0.5% AEP Rainfall Event: Maximum Flood Depth + CDA
D13	0.5% AEP Rainfall Event: Hazard Rating + CDA

Appendix E - Options Assessment Details

The **draft** Options Assessments for each CDA have been undertaken in Excel Worksheets. These are provided electronically alongside as part of this report.

DLT2-GP8-Croydon-AppendixE-Options_V0pt2.zip

Appendix F - Peer Review

The Peer Review undertaken as part of this SWMP is provided electronically alongside this report.

DLT2-GP8-Croydon-AppendixF-PeerReview_V0pt1.pdf

Appendix G - Spatial Planner Information Pack

A Spatial Planning Information Pack has been produced as part of the SWMP and is provided electronically alongside this report.

DLT2-GP8-Croydon-AppendixG-SpatialPlanning_V0pt2.pdf

Appendix H - Resilience Forum and Emergency Planner Information Pack

A Resilience Forum and Emergency Planner Information Pack has been produced as part of the SWMP and is provided electronically alongside this report.

DLT2-GP8-Croydon-AppendixG-EmergencyPlanning_V0pt2.pdf

Appendix I - Action Plan

The **draft** Action Plan for the London Borough of Croydon has been provided as an Excel Worksheet alongside this report.

DLT2-GP8-Croydon-AppendixI-DraftActionPlan-V0pt2.xls