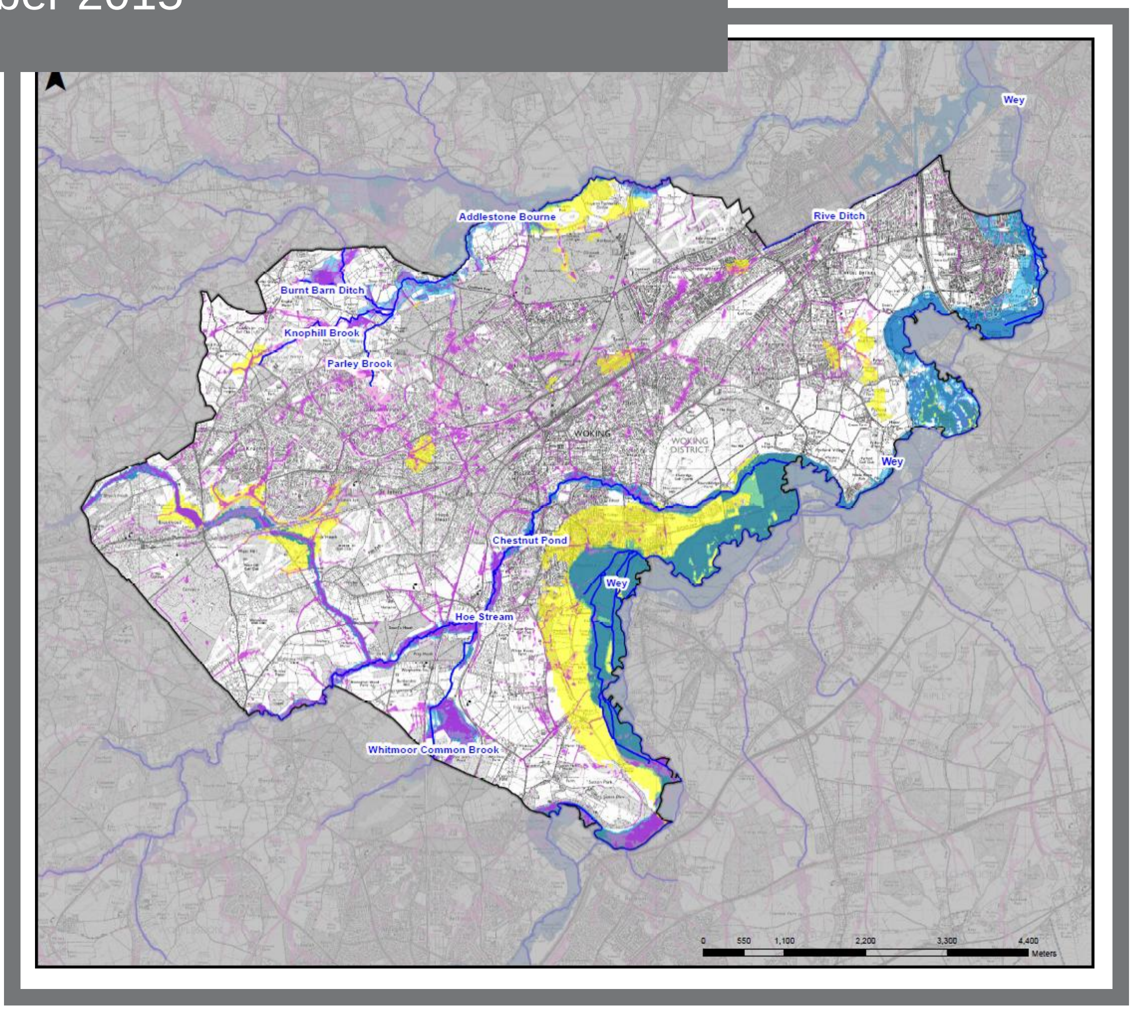
CAPITA

WOKING BOROUGH COUNCIL

Woking Borough Council
Strategic Flood risk Assessment
Volume 2
Technical Report

November 2015



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Contents

Figures

Tables

Appendices

Executive Summary

Introduction

This report is a Level 1 Strategic Flood Risk Assessment (SFRA) for Woking Borough Council (WBC). This SFRA is an update to the previous SFRAs for WBC (Bourne SFRA 2007, Wey SFRA 2008 and an overall update 2012) and has been prepared in accordance with This update has been prepared in accordance with current best practice, the National Planning Policy Framework (NPPF) and its accompanying Flood Risk and Coastal Change Planning Practice Guidance (PPG). It utilises a number of new datasets that were not available at the time of the 2009 Bourne and Wey SFRAs, including revised hydraulic modelling along the Hoe Stream (2014) and the Updated Flood Map for Surface Water and Reservoir Flood Mapping. This is Volume 2, the Technical Report, which should be read in conjunction with Volume 1 –the Decision Support Document and Volume 3 – The Catchment and Flood Risk Maps.

This updated SFRA will support the existing Evidence Base used to update the Woking Local Plan (1999) and the Core Strategy, updated in 2012. This SFRA is an update of the separate Bourne Catchment SFRA (2008) and the Wey Catchment SFRA (2009), and provides a concise document to help support the WBC evidence base, and future updates to the Core Strategy policies.

SFRA Structure

- **This is Volume 2** is the Technical Report, which is a technical analysis of the flood risk from all sources in WBC, and outlines the flood risk management measures associated with each source of flooding.

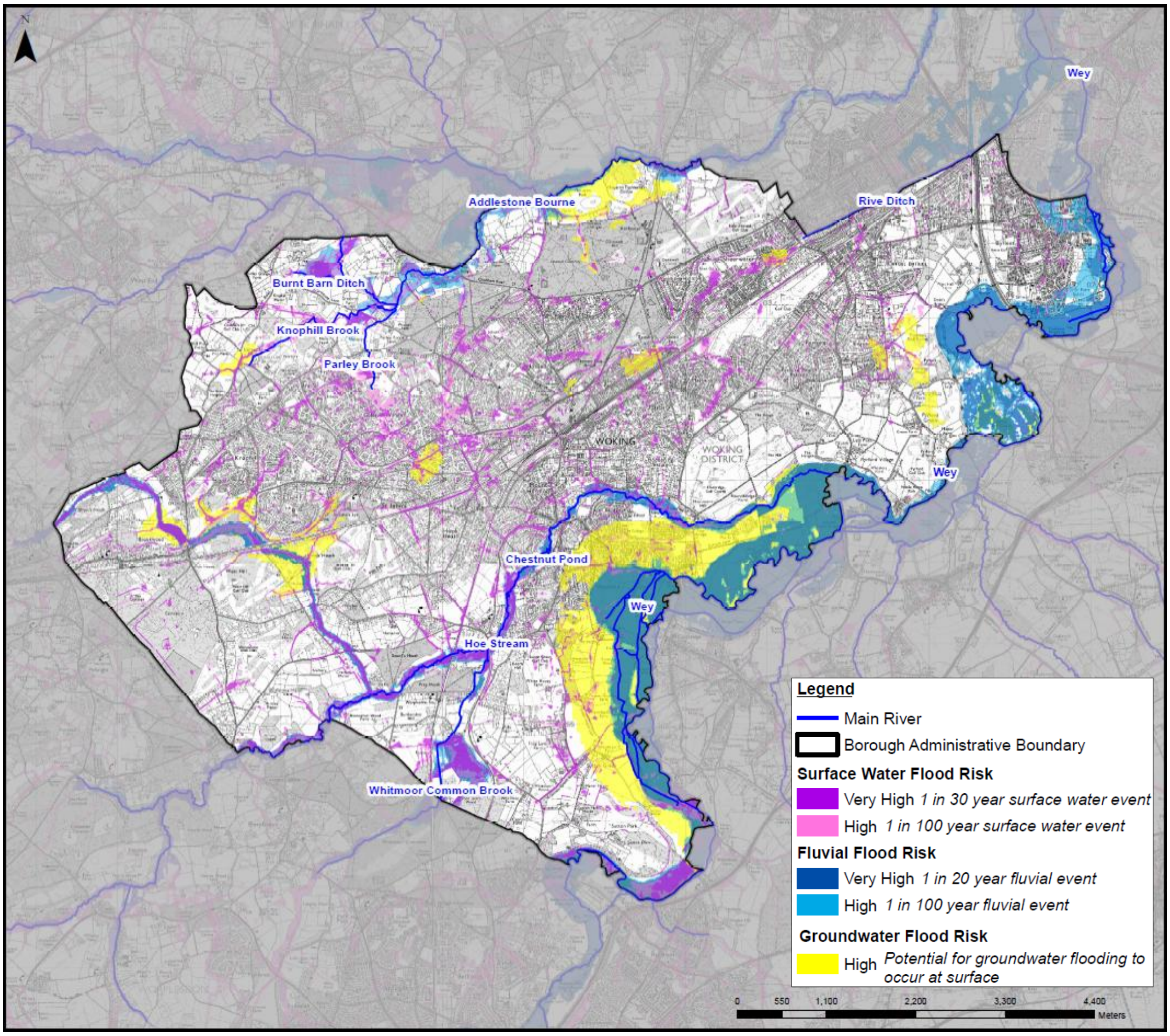
- **Volume 1,** the Decision Support Document outlines the relevant planning policies, recommendations and guidance for planners and developers. This document also sets out how to use the SFRA in carrying out the Sequential Test.

- **Volume 3** includes the flood risk maps, which represent as much of the data gathered as part of this update to visually display flood risk across the study area. The maps should be used in conjunction with this document, as well as Volume 1, and are referred to within the relevant chapters.

Flood Risk in Woking

Type of Flood Risk	Summary	Further information
Fluvial	Modelled and historic flood extents indicate higher risk along floodplains of Wey, Hoe Stream and Whitmoor Common Brook. Defences modelled along Hoe Stream have significantly reduced flood risk.	Volume 2 Section 4.3
Surface Water	Historically affected areas include Maybury, Byfleet, Old Woking and several roads (particularly Blackhorse Road), which are indicated as at higher risk. Modelling shows areas of Maybury and Sheerwater, Horsell and Goldsworth East at higher risk.	Volume 2 Section 5.3
Sewers	Highest number of historical events in Old Woking and West Byfleet. Higher risk areas are the densely populated wards of Goldsworth West, Maybury and Sheerwater and Mount Hermon.	Volume 2 Section 7.3

Groundwater	Highest groundwater flooding susceptibility in Old Woking and Pyford, where superficial river gravel deposits exist along the Wey floodplain. Parts of central Woking adjacent to Basingstoke Canal also at increased risk. No historic incidents.	Volume 2 Section 8.3
Artificial Sources	Overall low, as breaching embankments unlikely. In situation, Basingstoke Canal is the highest flood risk source in the area, potentially flooding parts of central Woking. Sutton Place lake has minimal flood extent affected several farms in southern Woking Borough.	Volume 2 Section 9.3



Areas of Woking at High Risk of Flooding

The datasets used to define high flood risk can be seen in the key. The SFRA fluvial Flood Zones, (defined in Table 4-3) have been used to show the fluvial flood risk. Very high risk has been determined using SFRA Flood Zone 3b, and high risk has been determined using SFRA Flood Zone 3. Areas shown at high risk of surface water flooding have been defined using the 1 in 30 year (3.3% AEP) outline from the Updated Flood Map for Surface Water. The high risk of groundwater flooding outline has been taken from the British Geological Susceptibility to Groundwater Flooding dataset. Areas where there is potential for groundwater flooding to occur at the surface have been defined as high risk for the purposes of this investigation.

Fluvial Flood Risk and Functional Floodplain Definition

PPG states that Local Planning Authorities (LPA's) should identify within their SFRA areas of functional floodplain (flood zone 3b) and its boundaries accordingly, in discussion with the Environment Agency (EA). The identification of functional floodplain should take into account of local circumstances. For the purpose of the Woking SFRA, Flood Zone 3b will be defined using the 5% AEP model outline from available hydraulic models. Where detailed model outlines and the definition of the 5% AEP outline is unavailable, Flood Zone 3 from the Environment Agency Flood Maps for Planning should be used to define the Functional Floodplain. A developed and undeveloped floodplain has also been defined as part of this SFRA. Flood Zone 3b - developed includes only the existing built footprint and not areas of open space within the developed areas. The extent of the Functional Floodplain is discussed further in Volume 2, Chapter 4, and is represented in the map series in Volume 3, Figure 4.

Climate Change Impacts in Woking

From the available modelling, an increase of 20% in the volume of flow in the fluvial inflows to the hydraulic model shows very minimal increase in the extent of areas at risk of fluvial flooding. It is expected that climate change is likely to increase the intensity of rainfall events; an uplift on rainfall intensities should be applied when designing to 2085 and beyond. Going forwards, climate change allowances should be considered in line with forthcoming policy; UKCIP09. These will be based on catchment projections with a range of allowances, and will depend on the vulnerability classification of the development or risk to the area. Additional details will be released by the end of 2015, but the current understanding is that climate change allowances will be going up, compared to those used currently. In the urbanised parts of the Borough, (including Woking and Byfleet) an increase in rainfall as a result of climate change is likely to increase surface water flooding due to impermeable surfaces and the current capacity of the drainage network.

1. Introduction

1.1 Background

The previous iterations of this SFRA (River Bourne SFRA 2007, River Wey SFRA 2008 and an overall update 2012) were used to inform the WBC Core Strategy in October 2012. In this document, Policy CS9: *Flooding and Water Management* specifically reflects flood risk as outlined in the previous SFRAs and with additional correspondence with the Environment Agency. WBC is now seeking to update its SFRA, as they are keen to ensure the information held on flood risk is continuously up to date.

Capita Property and Infrastructure were commissioned in January 2015 to update the WBC SFRA to include all watercourses within the study area.

This SFRA has been updated to align the document with the new National Planning Policy Framework (NPPF, March 2012) and its associated technical guidance; Flood Risk and Coastal Change, Planning Policy Guidance (PPG, March 2014). The update will also include newly available datasets, including the Hoe Stream modelling study (2014), the Updated Flood Map for Surface Water (2014), and updated historical flood incident information, including the floods of winter 2013/2014. The study area for this updated SFRA is formed of the administrative Borough boundary only (Refer to Figure 2-1), as opposed to the previous SFRA which was, divided by natural hydrological boundaries in to the Bourne Catchment and the Wey catchment, and formed a joint evidence base with Surrey Heath.

This report is a full technical report documenting the assumptions, processes and assessment undertaken in the development of the SFRA. It is intended to serve as a transparent record of the decisions and methodology that led to the outcomes of the SFRA.

1.2 WBC SFRA Structure

This updated SFRA is formed of three parts. This is Volume 2, the Technical Report, which provides a detailed technical analysis of the flood risk from all sources in WBC. Volume 1, the Decision Support Document outlines how to use the SFRA in carrying out the Sequential Test, outlines relevant planning policies and recommendations and provides guidance for planners and developers. Volume 3 includes the flood risk maps, which represent as much of the data gathered as part of this update to visually display flood risk across the study area. The maps should be used in conjunction with this document, as well as Volume 1, and are referred to within the relevant chapters.

2. Catchment Overview

The Woking SFRA covers an area of 63.41km^2 and within this the principle catchment is that of the River Wey running along the southern boundary of the borough. The Wey catchment includes the tributaries, Hoe Stream and to a lesser extent, Rive Ditch. The other major catchment included in the study area is that of the Addlestone Bourne which bounds Surrey Heath and Woking at the northern edge of the borough. Running central to the study area is an artificial watercourse, the Basingstoke Canal that passes over the River Blackwater in an aqueduct to the east of the Borough.

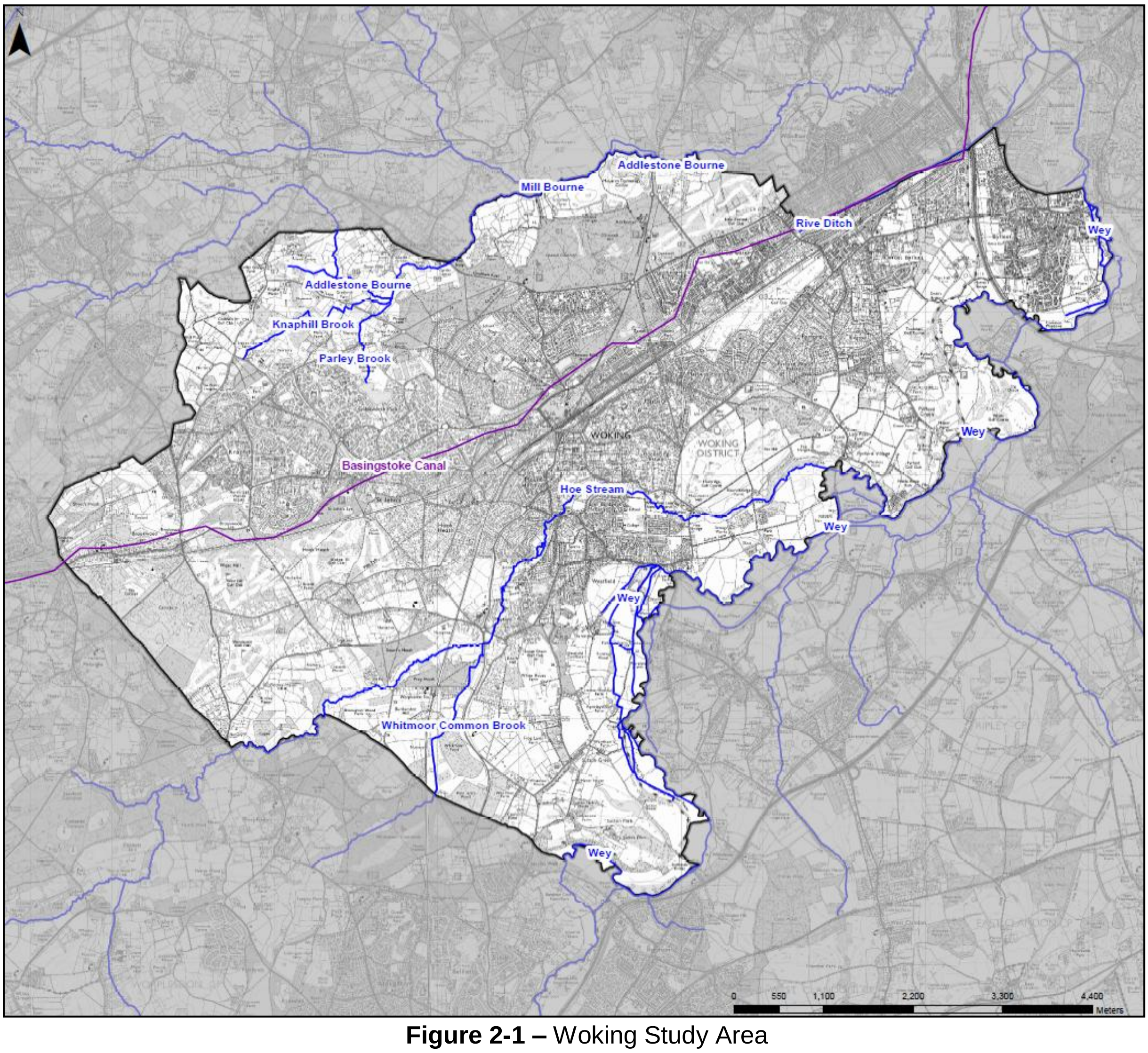


Figure 2-1 – Woking Study Area

2.1 Hydrology

2.1.1 River Wey catchment

The River Wey is a tributary of the River Thames and at its upper reaches is split into a north and south branch. The source of the north branch is at Alton, Hampshire and the south branch is at both Black Down south of Haslemere and the Devil's Punch Bowl, next to Hindhead village centre. These branches converge at Tilford, in the Waverley Borough. From the main reaches of the south Wey to the Wey confluence with the Thames, the watercourse measures 92km, with a drop in level of 190m. It is navigable for around 32km from Godalming downstream to the Thames at Weybridge, south-west of

London (see section 8.3.3). The total Wey catchment area is approximately 900km^2 and predominantly rural, although a number of urban areas are located in the lower catchment. These include Farnham, Godalming, Guildford, Weybridge and within the SFRA study area, Woking and Byfleet. There are several structures throughout the channel including mill structures, side channels and weirs.

2.1.1.1 Hoe Stream

The Hoe Stream is a tributary of the River Wey, rising at Tickners Bridge that is close to the village of Normandy, flowing in a north-easterly direction and converging with the River Wey at Newark Lock. The overall Hoe Stream catchment area is approximately 85km^2. Much of the lower Hoe Stream catchment is heavily urbanised, running through the south of the town of Woking and there subsequently exists a Flood Alleviation Scheme.

2.1.1.2 Rive Ditch

The Rive Ditch is a small tributary of the River Wey which rises in Horsell Common, flowing along the boundaries of Woking Borough and Runnymede Borough. The Rive Ditch interacts with the Basingstoke Canal (although most of the river flow goes underneath the Canal in syphons, running parallel for approximately 2.3km from Sheerwater to the M25 at Byfleet, where the Basingstoke Canal joins a minor Wey branch northwards.

2.1.2 Addlestone Bourne catchment

The Addlestone Bourne catchment is approximately 90km^2, and although it drains primarily into the Chertsey Bourne, the watercourse is also linked to the River Wey at Weybridge. Runoff routes are influenced by the Basingstoke Canal which lies south of the watercourse. Within the study area, there exist several tributaries that drain into the Addlestone Bourne, including Burnt Barn Ditch, Knaphill Brook and Parley Brook. These are located directly south of Chobham in Surrey Heath Borough, and are rural catchments.

2.2 Topography

The River Wey floodplain determines the study area topography, with floodplain hills gently grading into valley sides. The floodplain width increases downstream, towards the north, and narrows in urbanised areas. In Guildford, upstream of Woking, the floodplain is approximately 0.25km wide, increasing to 2km at the Wey confluence with the Hoe Stream.

The Lower Wey catchment is a modified river system. The River Wey does not entirely follow its original course and has been altered in places with the creation of additional man-made river channels.

2.3 Geology

The majority of the study area is underlain by the Barton and Bagshot Sands formations, with London Clay towards the south, although the dominant geology varies for each watercourse.

Upstream of the study area, the Wey catchment is dominated by highly permeable chalk whereas the lower catchment, towards Woking, the Wey is underlaid by London Clay, a highly impermeable geology. This characteristic results in the high runoff characteristics of the lower Wey catchment, and is further exacerbated by dense urbanisation. Therefore the lower Wey typically has ‘flashy’ responses to rainfall events. Superficial deposits of river terrace gravels and alluvium (clay, silt and sands) are dispersed across the bedrock along the valley floor and floodplain.

The Hoe Stream catchment is predominantly heathland, reflecting the underlying moderately impermeable sandstones and clay formations: the Barton, Bracklesham and Bagshot Sands that also overlay the London Clay. Superficial deposits include geologically recent deposited floodplain gravels.

The Addlestone Bourne catchment geology is dominated by the Barton Beds, fine-grained sands, with areas of minor aquifer of medium to high permeability downstream, east of Addlestone.

2.4 Urban Areas

The Borough's Core Strategy identifies and stratifies urban centres within the region, with the principal urban centre being Woking Town Centre, followed by the district centre of West Byfleet. Local centres varying in size and levels of amenities include Byfleet, Goldsworth Park Horsell, Kingfield, Knaphill, Sheerwater and St. John's. Neighbourhood centres include Brookwood, Mayford, Old Woking, Pyrford, Walton Road and Westfield.

The average population density of the Borough is 15.6 persons per hectare, and of the Borough's 17 wards Goldsworth West and Maybury and Sheerwater are the most densely populated.[1]

2.5 Infrastructure

Woking Borough contains the second busiest railway station in Surrey, with links to London, the South East and the South West. The line runs from the south and west to the northeast of the study area. The M25 passes through West Byfleet to the northeast of the Borough, and the A320 which links to the M25, Guildford and Chertsey striking north-south.

[1] http://www.woking.gov.uk/council/election/boroughwardboundariesreview/populationsubmission

3. Asset and Structure Data

Flood risk management measures are confined to localised flood bunds, bank protection, flood relief channels and culverts. In 2012, the Hoe Valley Scheme was completed, which was partly funded by the Environment Agency in conjunction with the Woking Borough. The scheme included the replacement of 3 flow restrictive bridges along the watercourse and the construction of flood defence/alleviation structures (Section 3.2). At the time of writing there is an ongoing assessment to explore a range of flood mitigation options for Woking Borough that would include attenuation schemes, flood bunds and storage areas to actively protect more than 90 properties.

Volume 3 Figure 3 shows the location of all defences and structures within the study area, based on information supplied by the Environment Agency from the Asset Information Management System (AIMS) database.

Within the study area it is worth noting that there are numerous small land drains, surface water courses and defences that are within private ownership and may not be recorded in the AIMS dataset. The condition and maintenance of these watercourses, and in particular the structures along them can be locally important in terms of flooding.

3.1 Flood Defences

As part of this commission, an extract from the Environment Agency Asset Information Management System (AIMS) was provided to identify the flood defences and structures within the Study Area.

Within the study area the bulk of formal flood defences included in the AIMS defence database are along the Hoe stream, included in the Hoe Stream Flood Alleviation Scheme (FAS). Additional to this scheme, are the following defences summarised in Table 3-1 , although the majority of these are not formal flood relief facilities.

Table 3-1 - Flood defences recorded in the AIMS database, that are not included in the Hoe Stream FAS

Watercourse	Type	Asset Owner	Description
Rive Ditch	Engineered Channel	Surrey County Council	Bagwork and poured concrete bank protection.
Parley Brook	Culverts	Local Authority	Concrete Box Culvert.
	Bank protection	Environment Agency	Retaining wall comprised of timber post and geotextile sections and steel sheet pile section.
Wey	Flood Relief Channel	Environment Agency	RWIS. Running through public open space.
	Bank protection (4 separate defences)	Private	Different types: in 2 cases include sheet piled retaining wall, 1 brickwork retaining wall and 1 part-concrete wall/part-concrete bagwork.
Hoe Stream	Bank Protection	Private	Concrete bagwork upstream of FAS.

The Borough maintains a good record of drainage ditches in the study area, both those owned by the Borough and private. These have been included in Volume 3 Figure 3.

3.2 Hoe Stream Flood Alleviation Scheme

The Hoe Stream Flood Alleviation Scheme (FAS), according to the AIMS database, includes earth embankments (some clay-lined), reinforced concrete flood walls and sheet pile flood walls which exist for an approximate 2km stretch of the watercourse. This starts upstream in north Mayford and extends just downstream of Elm Bridge. It is estimated almost 200 residential properties have been removed from the flood plain following the implementation of the Hoe Stream scheme[2], and according to the EA more than 80 properties protected.

This FAS consists of changes to the Hoe Stream floodplain, by the development of two new ponds, alterations to the river route, new bridge sections and several flood defences. To a lesser extent the FAS involved alteration of the river channel, such as a stretch through Elm Bridge that was re-routed and non-return valve work installed.

3.3 Other Structures along the Watercourse

There are a number of existing structures over the watercourses within the study area, as recorded in the AIMS database. These are owned and maintained by a range of stakeholders, either privately, by the Environment Agency or the Borough Council. These structures include bridges (vehicular, pedestrian, pipe and railway bridges), flood monitoring instruments (gauges and manholes) and flow control structures (sluice gates, outfall pipes and control gates that are part of the Wey Navigation). All of the hydraulically significant structures along the watercourses have been included in the hydraulic modelling studies carried out (described further in Section4.2.3).

3.4 Maintenance

The AIMS database records a total of 69km length of maintained channels within the Borough, and can refer to de-silting, cleared embankments and clearance of trees and vegetation. This includes stretches of the Wey, Hoe Stream and the Addlestone Bourne (and associated tributaries). The responsibility for maintenance of a watercourse depends on several factors described below.

The Environment Agency has permissive powers (but not a duty) to maintain and improve watercourses designated as 'Main River' and associated structures for the efficient passage of river flow and the management of water levels. The EA carry out maintenance on the Rive Ditch (which is owned by Surrey CC), Knaphill Brook, Parley Brook and Runtley Wood Ditches.

The operating authority, Woking Borough Council, has the regulatory and supervisory role for flood defences on all ordinary watercourses which are not within the area of an internal drainage board (IDB). Culverts under roads are generally the responsibility of the relevant Highways Authority.

Riparian owners have responsibilities to maintain any watercourses (all streams, ditches and river channels) that pass through their land ownership.

- Along ordinary watercourses, riparian owners need to apply for consent from Surrey County Council, guidance for which can be found at: http://new.surreycc.gov.uk/people-and-community/emergency-planning-and-community-safety/flooding-advice/more-about-flooding/ordinary-watercourse-consents

[2] http://www.woking.gov.uk/environment/hoevalleyintro/thehoevalleyafter

- Along Main Rivers, riparian owners will need to apply for flood defence consent, guidance for which can be found at: https://www.gov.uk/flood-defence-consent-england-wales

4. Flood Risk from Rivers

4.1 Overview

The Woking SFRA study area lies with the catchments of the River Wey, Hoe Stream and the Addlestone Bourne. This chapter will assess and discuss the risk of river (fluvial) flooding within the borough from these watercourses (Section 4.3), through reference to historical fluvial flooding records, Environment Agency Flood Maps and detailed hydraulic modelling studies. A background to fluvial flooding and its presentation in this SFRA has also been provided.

4.1.1 Causes and Classification

Flooding from rivers occurs when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (floodplain). The main reasons for water levels rising in rivers are:

- intense or prolonged rainfall causing runoff rates and flow to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet antecedent (the preceding time period) conditions and where there are significant contributions of groundwater;
- constrictions in the river channel causing flood water to backup;
- blockage of structures or the river channel causing flood water to backup; and
- High water levels and/or locked flood gates preventing discharge at the outlet of the river.

The consequences of river flooding depend on how hazardous the flood waters are and what the receptor of flooding is. The hazard of river flood water is related to the depth and velocity, which depends on:

- the magnitude of flood flows;
- size, shape and slope of the river channel;
- width and roughness of the floodplain; and
- types of structures that cross the channel.

Flood hazard can vary greatly throughout catchments and even across floodplain areas. The hazard posed by floodwater is proportional to the depth of exposure, the velocity of flow and the speed of onset of flooding. Hazardous river flows can pose a significant risk to exposed people, property and infrastructure. Whilst low hazard flows are less of a risk to life (shallow, tranquil water), they can disrupt communities, require significant post-flood cleanup and can cause costly and possibly structural damage to property.

4.1.2 Probability of fluvial flooding

The probability of fluvial (river) flooding is described in this SFRA using the Annual Exceedance Probability (AEP). This is sometimes known as the ‘annual probability’ of flooding. A flood event described as a 1% AEP has a 1% (or 1 in 100) chance of occurring in any given year.

The assessment of risk from fluvial sources in this SFRA is focused on four different probability flood events summarised below in Table 4-1. The flood risk extents have been based primarily on available detailed modelling (outlined in Table 4-1), and on the Environment Agency Flood Map for Planning dataset, where additional information is needed.

Table 4-1 - Fluvial flood events considered in this SFRA

Annual Exceedance Probability (AEP) of flood event	Return Period of flood event	Watercourse used in the assessment of fluvial flooding
0.1 % AEP	1 in 1000 years	• Lower Wey • Hoe Stream
1%+CC AEP	1 in 100 years plus Climate Change (see Section 4.1.3)	• Lower Wey • Addlestone Bourne • Hoe Stream
1% AEP	1 in 100 years	• Lower Wey • Addlestone Bourne • Hoe Stream
5% AEP	1 in 20 years	• Lower Wey • Addlestone Bourne • Hoe Stream

4.1.3 Climate Change Considerations

There is increasing concern about the impacts of climate change on the global environment. The nature of climate change at a regional level will vary. In the UK projections indicate that climate change will result in more frequent, short duration, high intensity rainfall and more frequent periods of long duration rainfall of the type responsible for the summer 2000 and winter 2013 floods. These changes are likely to result in the more frequent occurrence of all types of flooding, including fluvial, surface water, sewer and groundwater flooding. All of which are relevant to the Woking SFRA study area.

The Planning Practice Guidance for Flood Risk and Coastal Change states that 'A Strategic Flood Risk Assessment is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that changes or development in the area will have on flood risk'. The current guidance recommends a 20% increase in peak river flows is used to assess the impacts of climate change on rivers for time horizons between 2025 and 2115 (PPG, 2014). Climate change is currently represented by the 1 in 100 year annual probability flood event, with an additional 20% increase in peak river flow inflows. Where detailed modelling is available, the 1% AEP plus climate change outline has been mapped to show increased flood risk from climate change. These results have been acquired by adding 20% of the flow to the 1% AEP event. These are shown in the detailed models in Volume 3 Figure 4. Going forwards, a catchment based projection of climate change will be used to produce a range of climate change allowances, and will depend on the vulnerability classification of the development or the risk to the area. More details are expected by the end of 2015, in line with adoption of UKCIP 09[3]. Planners should ensure that the most up to date guidance is used.

The potential impacts of climate change are an important aspect of uncertainty relevant to flood risk estimation. Government guidance suggests that the impacts of climate change can be managed by either monitoring change in risk and adapting in the future as the need arises (Managed Adaptive Approach) or acting now to manage the eventuality (Precautionary Approach).

[3] http://www.ukcip.org.uk/

4.1.4 Definition of the Functional Flood Plain

The Functional Floodplain comprises land where water has to flow or be stored in times of flood. In line with NPPF, all new development should be kept outside of the Functional Floodplain, with the exception of certain ‘water compatible’ land uses (e.g. recreational and conservation uses), as well as essential transport/utilities infrastructure that have no viable alternative location. The Exception Test must be passed for essential infrastructure developments to take place in this zone. **For the purpose of this SFRA, where available, the 5% AEP flood outline has been used as an indication of those areas which may be acting as Functional Flood Plain. Where the 5% AEP flood outline is unavailable, the Environment Agency Flood Zone 3 outline has been used to define the Functional Flood Plain** Volume 3 Figure 5 shows the functional floodplain outline, as well as the remaining SFRA Flood Zones, as described in Section 4.2.4 and 4.3.2.

A developed and undeveloped Functional Floodplain has been defined across Woking Borough. This recognises that development has previously taken place close to the River Floodplains. Whilst development within Flood Zone 3b should be avoided where possible, this division could help planners decision making in regards to windfall developments, and in the redevelopment of Brownfield land. Flood Zone 3b – developed includes only the built footprint and not areas of open space within the developed areas including gardens.

4.1.5 Actual and residual flood risk

Actual risk provides information on flooding, when the impact of existing flood defences is considered (assuming that they operate as they are supposed to). The actual risk of river flooding is usually assessed using the 1% AEP flood event, with defences in place.

In recognition that engineered flood reduction measures cannot completely eliminate flood risk, there is a need to be aware of the residual risk generated by an event more severe than that for which the defences have been designed to provide protection. Alternatively, breach or failure of the flood defences may occur. Accordingly, this risk assessment usually considers the flooding associated with an extreme event (such as a 0.1% AEP) or flooding that may result from climate change.

4.2 Fluvial Flood Risk Datasets

4.2.1 Historic Records

Historical fluvial flooding records are represented in Volume 3 Figure 6. This map displays the EA dataset, ‘Recorded Flood Outlines’ and an approximate flood outline determined using the Surrey County Council (SCC) ‘Property Flooding Incidents’ database.

The Recorded Flood Outlines (RFO) dataset provides a comprehensive record of historical fluvial flood extents, determined from discussions, surveys and aerial photography. This is limited to the quality of data, and does not represent all past flooding. The dataset was most recently updated in August 2013, and will not include flood extents from the regional flooding that occurred during the Winter 2013/2014.

Historic flooding recorded by SCC was provided in their Wetspot flooding database, during the production of this SFRA, which identifies properties and highways that have had flood incidents reported. Property incidents with an identified fluvial source were outlined to provide approximate flood extents for the Winter 2013/2014 flood event. This includes more recent flooding than what is included in the EA RFO dataset. The SCC highway flooding database highlights roads which have experienced flooding. Roads within this dataset that intersect rivers could be assumed as having experienced fluvial source flooding, and include Carthouse Lane, Prey Heath Road, Old Woking Road, Blackhorse Road in Woking and High Road in West Byfleet.

4.2.2 Environment Agency Flood Risk Maps / Flood Maps for Planning

The Environment Agency holds dataset referred to as the EA Flood Maps for Planning. These represent different probability events and are defined in Table 4-2.The Environment Agency Flood Zones for Woking are shown in Volume 3 Figure 7 of this SFRA, and are available online on the Environment Agency website. The flood zones are primarily based on the results of their national generalised broad scale modelling (JFLOW). In some locations they are also based on historic information and more detailed hydraulic modelling. Where detailed hydraulic modelling has been carried out, results are fed into the outlines. The detailed hydraulic modelling will supersede JFLOW results where they are available and result uncertainty is low. Flood Zones are the starting point of the Sequential Test (discussed in greater detail in Volume 1 Section 5 and refer to the probability of river and sea flooding only, ignoring the presence of existing defences.

Table 4-2 – Planning Practice Guidance Flood Zone Definitions

Flood Zone	Return Period	Probability	Definition
Flood Zone 1	<0.1 % AEP	Low	Land having a less than 1 in 1,000 annual probability of river or sea flooding. *(Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)*
Flood Zone 2	0.1 % AEP	Medium	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. *(Land shown in light blue on the Flood Map)*
Flood Zone 3a	1 % AEP	High	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. *(Land shown in dark blue on the Flood Map)*
Flood Zone 3b	**See Section 4.1.4**	The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. *(Not separately distinguished from Zone 3a on the Flood Map)*

Note: See Volume 3, Figure 7 for a map of these Flood Zones within Woking Borough Council

4.2.3 Detailed Hydraulic Modelling

There are several detailed hydraulic modelling studies completed on watercourses in the study area, the Hoe Stream, the Lower Wey and the Addlestone/Hale Bourne. The fluvial flood extents from each are shown in Volume 3 Figure 4, as supplied by the EA. These studies were all commissioned by the EA, and vary in their outputs and study structures:

Hoe Stream (2014) - The Hoe Stream modelling report was completed in April 2014 by CH2M Hill. The main objective of the study was to estimate the benefit of the Hoe Stream FAS that was implemented following severe flooding in 2007. A 1D/2D linked model was developed using ISIS/TUFLOW, and consisted of twelve sub catchments that were predominantly split between the upper and lower reaches of the Hoe Stream. The study produced flood extent maps for 5%, 1% and 0.1% AEP flood events, with and without the influence of flood defences and including the PPG climate change scenario (detailed in section 4.1.2). Those 'without defences' were used to update the EA flood map. Those 'with defences' are presented in Volume 3 Figure 4.

Lower Wey (2009) - Mott MacDonald completed a study on the Lower Wey and its major tributaries in 2009. This included a hydrological model developed for input into a hydraulic model, with hydrograph inputs derived using the ReFH rainfall runoff model and design flows derived using FEH estimates. The resulting hydraulic model was run for 1 in 5 to 1000 annual probability flood events, and calibrated using 5 key historic flood events. Seven 1D hydraulic models were developed using the ISIS software package, of which 3 sub-models are included in this SFRA study area. A further five 1D-2D models were developed using ISIS and TUFLOW in conjunction, for main urban areas in the Lower Wey catchment that include Woking and Byfleet and Weybridge within this SFRA study area, Flood risk maps were produced for 5%, 1% and 0.1% AEP flood events, with and without the influence of flood defences and including the PPG climate change scenario. The flood defences included in this study comprise of a concrete flood walls along the right bank of the Wey at Byfleet and along both banks along the East Clandon Stream, the latter is external to the study area. Flood extents, represented in Volume 3 Figure 4, were provided for 5% and 1% AEP flood events, undefended, and 1% +CC and 0.1% AEP flood events, defended.

Addlestone/Hale Bourne (2007) - Mott MacDonald was initially commissioned to complete a study of the Addlestone Bourne and Hale Bourne rivers under the Strategic Flood Risk Management Framework (SFRM) Contract in July 2006. However, following a significant flood event in August 2006 that exceeded the modelling study flood risk outlines, a review and update was commissioned in November 2006. The modelling study was completed using a 1D model built in ISIS, and by splitting the overall catchment into six sub-catchments. The principal outputs included a hydrological assessment that could be used for detailed flood frequency analysis and a hydrodynamic model that could be utilised for flood and flow studies, channel and structure capacity assessment and for testing operating strategies for structures (e.g. sluices) and flood management plans. The study produced flood risk maps for 20% to 1% AEP flood events (including the climate change scenario) not considering the effect of blockages, i.e. residual risk. These are shown in Volume 3 Figure 4.

The uncertainties associated with assessing flood risk from the Environment Agency Flood Risk Maps and the detailed modelling are identified within Appendix A.

4.2.4 SFRA Fluvial Flood Risk Mapping

Table 4-3 defines the model outlines and return period definitions that have been used to produce and define each SFRA Flood Zone.

For the purpose of Woking SFRA, the functional floodplain has been divided into the developed and undeveloped flood zone 3b using MasterMap data to define the developed areas as the building footprint. A simple clipping process has been used at the extents of the flood zone 3b to define the developed areas. Flood Zone 3b - developed includes only the existing built footprint and not areas of open space within the developed areas.

Table 4-3 – Model outlines used to define SFRA Flood Zones.

SFRA Flood Zone	Lower Wey	Hoe Stream/Whitmoor	Hoe Stream tributary	Addlestone Bourne	Rive Ditch
SFRA Flood Zone 2	0.1% AEP event	0.1% AEP event	EA Flood Zone 2	EA Flood Zone 2	EA Flood Zone 2
SFRA Flood 3- Plus climate	1% AEP + CC event	1% AEP + CC event	Not defined – displays EA Flood	1% AEP + CC event	Not defined – displays EA Flood
SFRA Flood Zone 3a	1% AEP event	1% AEP event	EA Flood Zone 3	1% AEP event	EA Flood Zone 3
SFRA Flood Zone 3b	5% AEP event	5% AEP event	EA Flood Zone 3	5% AEP event	EA Flood Zone 3

4.3 Fluvial Flood Risk in WBC

4.3.1 Historical Fluvial Flooding

The EA Recorded Outlines dataset shows the following events, listed and described in Table 4-4.

Table 4-4 – Historic Fluvial Flood Events

Date	Watercourses Flooded	Areas Affected
September 1968	Addlestone Bourne, Hoe Stream, River Wey	Old Woking, Westfield and large parts of central and eastern Byfleet
February 1990	River Wey	Darntell Park Road area
December 2000	Hoe Stream	Old Woking, Kingfield, Mayford
January 2003	River Wey	Large agricultural and undeveloped areas between Byfleet and West Byfleet
August 2006	Hoe Stream	Woking
Christmas and New Year 2013/2014	River Wey	Eastern areas of Byfleet, Old Woking, Mayford

The flood extents from the September 1968, January 2003 and August 2006 events are the most extensive, although the latter appears to be isolated to the Hoe Stream flood plain. West Byfleet centre appears to have experienced the most flooding, as it is influenced by the majority of recorded flood events.

Old Woking and Byfleet were affected during the Winter 2013/2014. The High Street in Old Woking was flooded as a result of overtopping flow from the River Wey and surface water. The mapped flood extent for this event is currently being produced. The historic flood map across WBC is shown in Volume 3, Figure 6.

The implementation of flood defences and alleviation schemes, such as the Hoe Stream FAS will have a significant effect on the future recorded flood extents. Therefore, this dataset may be used to review ‘problem areas’ but should not be used to inform risk. Instead refer to sections 4.2.2 and 4.2.3.

4.3.2 Fluvial Flood Risk across Woking

For the purposes of this SFRA, this section discusses the areas at medium and high risk, indicated by the derived SFRA Flood Zones, defined in Section 4.2.4. This section also describes the areas at very high risk, that fall within the 5% AEP model outlines. These areas of risk are shown in Volume 3, Figure 5.

SFRA Flood Zone 2 – Medium Risk

- Along the Addlestone Bourne, the SFRA Flood Zone 2 extent in the west of the study area is very wide, with large areas of agricultural fields at medium flood risk. There are very few properties, houses and roads at medium risk. In the north of the Borough, the areas at medium risk are also mostly undeveloped, however, Scothchers Farm, the McClaren Park and the McClaren Technology Centre is at medium risk of fluvial flooding. This also includes the Chertsey Road.

- Along the Parley Brook, there are several properties at Littlewick, along the Goldings and The Fieldings at medium risk, including Littlewick Road.

- In Sheerwater, there are several properties along Albert Drive at medium risk of flooding from the Rive Ditch. This is also connected to flood risk from the Basingstoke Canal.

- In the north east of the study area, there are parts of Byfleet at medium risk of fluvial flooding. The SFRA Flood Zone 2 stretches west as far as Oyster Lane and Church Road, with properties and businesses along High Road at medium risk. The Park and Sanway area including Fullerton Road are at medium risk of flooding.

- To the south west of the M3, along the River Wey, the areas at medium risk are also at high and very high risk due to flat and well defined floodplains. The areas at risk are defined in the Flood Zone 3b section below.

SFRA Flood Zone 3 – High Risk

- Along the Addlestone Bourne, the areas at high risk, indicated by SFRA Flood Zone 3 are much smaller than the extent of the SFRA Flood Zone 2. There are very few properties at high risk of flooding, as the SFRA Flood Zone 3 remains much closer to the river channel.

- Eastern and southern parts of Byfleet are at high risk of flooding from the River Wey, including the A318 and Green Lane Close area. The Sanway area is also at high risk.

- Small areas of Old Woking and Westfield are at high risk of fluvial flooding from the River Wey, including properties adjacent to the A247.

SFRA Flood Zone 3b – The Functional Floodplain – Very high risk

- The areas along the Addlestone Bourne at high risk are mostly constrained to small floodplains along the channel, which are mostly undeveloped. Scotchers Farm is at very high risk of flooding.

- Along the River Wey, there are large areas at very high risk of fluvial flooding. SFRA Flood Zone 3b is extensive, with large areas of parkland and greenspace classified as the functional floodplain. To the south of Woking, much of the floodplain is undeveloped, however there are a number of farms at very high risk. The other areas at very high risk are mostly undeveloped. Wisley Golf Course and the surrounding area is at very high risk. The areas at very high risk from fluvial flooding of the River Wey at Byfleet, are currently mostly undeveloped parkland and green space, except for a few properties at Sanway and adjacent to the Wey Navigation at High Road.

- Areas along the Hoe Stream are at very high risk of fluvial flooding; however most of these remain as parkland areas, with few properties at very high risk. Many of the residential and developed areas are protected by the Hoe Stream FAS. Where the Hoe Stream crosses the A247, there is potential for flooding to properties and infrastructure, and properties (mainly external areas) on the south side of White Rose Lane are at very high risk of flooding.

4.3.3 Climate Change Considerations

Volume 3, Figure 4 shows that there is little increase in the extent of fluvial flooding in response to climate change along the Addlestone Bourne. There is a small area of land along the Knaphill Brook at the Nursery which become a high risk area in response to climate change. Due to the well defined channels along the River Wey, there is also a minimal increase in the area of land at high risk, however depths across the floodplain are likely to increase. Through Byfleet, there are an increased number of properties that become high risk in response to climate change. There are very few areas along the Hoe Stream expected to be at high risk of flooding as a result of climate change that are not currently at high or very high risk. The EA are undertaking a project currently which investigates looking at flood alleviation options in a number of areas across the Wey catchment, including Woking and Byfleet.

4.4 Management of Fluvial Flood Risk in WBC

4.4.1 Messages from the Thames Catchment Flood Management Plan (December 2009)

The Environment Agency have prepared a Catchment Flood Management Plan (CFMP) for the River Thames catchment within which the River Wey and Hoe Stream are specifically considered. The Thames CFMP considers on a broad scale how flood risk can be expected to change on a 50 – 100 year timescale taking into account climate and land use change and will be used to set EA policy and to target investment in flood risk management. It is important that the policies WBC develop as a result of the SFRA are consistent with the policy framework outlined in the Thames CFMP. It is also worth considering that the Thames CFMP is due to be updated in 2016, and therefore the WBC should source this for new policies.

The Rural Wey and Addlestone Bourne sub-areas

Policy Option 2:
Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions.

Vision and preferred policy:

- Maintain, and where possible maximise, the flow of water in the rivers through the towns.
- In the undeveloped areas, maintenance will be reduced to allow the flood plain to flood more frequently, allowing efforts to be focused where it is most beneficial.
- To ensure that high risk areas can prepare and respond accordingly, work will be complimented with increased flood warning and awareness measures.
- New habitat generation will aid increased biodiversity in the sub area.
- Where possible, opportunities for recreation and navigation will be improved also, through the relationship between the EA and the National Trust.

The proposed actions to implement the preferred policy:

- Maintenance of the capacity of watercourses in towns and villages through ongoing annual EA maintenance programme. Levels of maintenance elsewhere will be reduced.
- Safeguarding of the natural floodplain from inappropriate development by working with Local Authority partners. This will provide local social and economic benefits (by reducing flood risk) and environmental benefits (by allowing flooding)
- Working with Local Authority partners to ensure that plans are prepared to respond to flooding. This will help communities to work with local organisations and produce community flood plans.

The Hoe Stream sub-area

CFMP Policy Option 5:
Areas of moderate to high flood risk where we can generally take further action to reduce flood risk. We recognise the challenge of this policy and that we will not be able to reduce the risks everywhere.

Vision and preferred CFMP policy:

- There are major technical obstacles which mean any solutions will be expensive, provide different levels of protection and not benefit everyone in the affected communities. The EA are confident of being able to bring forward proposals that will reduce the risk to many people.
- Where major flood defences are not a realistic option in the foreseeable future, the most sustainable way of reducing flood risk will be through floodplain management.
- In areas of redevelopment; resilience and resistance measures can be incorporated into new buildings.
- The partnership between the EA and Woking Borough Council can be used to develop and achieve sustainable and flood compatible floodplain use. Flood awareness and emergency response will have an important role to play in all areas.

The proposed actions to implement the preferred CFMP policy:

- In the short-term, partners will be encouraged to develop policies, strategies and initiatives to increase the resistance and resilience of all new development at risk of flooding. The EA will look at protecting land that may be needed to manage flood risk in the future, and work with partners to identify opportunities for this and to recreate river corridors in urban areas.
- In the longer-term, land and property owners need to adapt the urban environment to be more flood resilient. This includes the refurbishment of existing buildings to increase resilience and resistance to flooding. Management of flood consequences will be promoted by working with EA partners to improve public awareness and local emergency planning, for example identifying critical infrastructure at risk and producing community flood plans.

4.4.2 Messages from the Surrey Local Flood Risk Management Strategy

This report is still currently in draft form and is available on the Surrey County Council Website. It was produced in response to legislation required by The Flood and Water Management Act 2010. The final strategy will be endorsed by the Surrey Flood Risk partnership Board and will become a statutory document which Surrey's local authorities, water companies and internal drainage board must have regard to. The intent of the strategy is to increase awareness of local flood issues, identify ongoing activities and propose actions to manage flood risk, and clarify the roles and responsibilities of organisations involved in flood risk management. As part of the strategy, under the EU directive, a strategic environment assessment has been conducted that outlines the plans and programmes being prepared, adopted and implemented by public authorities in regards to flood management. These findings are available to review in the Environmental Report on the Surrey County Council website.

4.4.3 River Wey Flood Risk Management Strategy

In 2010 the EA developed a draft strategy to set out a long term approach to managing the flood risk in the River Wey catchment. During the production of the strategy it was identified that the flood defences within the River Wey Improvement Scheme (RWIS), currently provide little flood risk value and require high maintenance costs. The EA has decided to investigate a more sustainable solution and will consider the RWIS assets separately from the River Wey Flood Risk Management Strategy.

Following this, the EA is still continuing to act on reducing flood risk along the Wey through improvement of environmental aspects and the recently awarded £1m to restore the Wey channel capacity following recent storms. Further ongoing work by the EA and its partners, to raise public awareness and improving flood warning services and response is contributing towards reducing the consequences of flooding in this area.

4.4.4 Flood Warnings in WBC

The Environment Agency operate a flood warning service in areas at risk of flooding from rivers or the sea. Rainfall and river levels are monitored in these areas to forecast the probability of flooding, and warnings are issued if flooding is forecast. Flood warning and evacuation procedures can reduce the risk of people being exposed to flood water and minimise the consequences of flooding. According to the AIMS database, there are seventeen monitoring instruments in the Woking SFRA study area, of which two are active gauging stations positioned along the Hoe Stream at the Hoe Bridge and at Mayford.

The EA provide a flood warning service for the Addlestone Bourne, Mill Bourne, River Wey and the Hoe Stream, which are within the Woking SFRA study area. There are flood alert areas within the SFRA study area for these watercourses and these would be used when water levels along the river are forecast to overtop the banks.

A Flood Warning is issued when the Environment Agency anticipates flooding to property. Flood warnings are issued for specific flood warning areas within a river catchment. There are eight flood warning areas within the SFRA study area including:

- Hale Bourne and Addlestone Bourne at Chobham;
- Mill Bourne at Emmetts Mill;
- River Wey at Wisley and Byfleet;
- River Wey properties between Walsham meadow and Byfleet town;
- Hoe Stream at Woking;
- Area at Woking benefitting from the Hoe Stream FAS;
- River Wey at Old Woking; and
- River Wey at Guildford.

4.4.5 Flood Alleviation Schemes in WBC

The Hoe Stream Flood Alleviation Scheme, completed in 2012 has effectively managed fluvial flood risk for a stretch of around 2km along the Hoe Stream, as detailed in Section 3.2.

4.4.6 Surrey Local Flood Risk Management Strategy

Surrey County Council, as the Lead Local Flood Authority, have a responsibility to manage flood risk from surface water, groundwater and ordinary water courses. Whilst the management of main rivers is the responsibility of the EA, SCC are responsible for the smaller river, streams and ditches across Woking Borough. A coordinated approach with the Woking drainage engineers is also necessary to manage fluvial flood risk. Management practices include channel and defence maintenance, as detailed in Table 3-1. Management of the channel and flood defences will impact the level of flood risk within Woking.

5. Flood Risk from Surface Water

5.1 Overview

The Woking SFRA study area includes the major developed urban areas of Woking and Byfleet, which have large areas of impermeable surfaces such as roads, pavements and driveways. This is likely to contribute to surface water runoff and subsequently present a significant risk of surface water flooding. This chapter will provide a brief background to the definition and causes of surface water flooding (Section 5.1.1), impacts (Section 5.1.2) and assess the flood risk in the study area using historic records and the Environment Agency Updated Flood Map for Surface Water (Section 5.3).

5.1.1 Causes and Classifications

Surface Water is classified several ways, as:

- Rainfall that infiltrates into the soil but resurfaces further down the hill;
- The water in lakes, marshes and reservoirs; and
- Water flowing over the ground surface that has not entered a natural channel or artificial drainage system is classified as surface water runoff or overland flow.

The latter, surface water runoff/overland flow occurs when intense, often short duration rainfall is unable to soak into the ground or enter drainage systems. The volume of surface runoff will usually depend on catchment size and shape, geology, slope, climate, rainfall, saturation, soil type and vegetation. Poorly drained material that is saturated has a higher runoff potential and is more likely to cause flooding.

The excess water then ponds in low points, overflows or concentrates in minor drainage lines that are usually dry. This type of surface water flooding is usually short lived and associated with heavy downpours of rain. Often there is limited warning before this type of localised flooding occurs. Surface water runoff can cause localised flooding in natural valleys as normally dry areas become inundated and in natural low spots where water may collect.

Drainage basins or catchments vary in size and shape, which has a direct effect on the amount of surface runoff. The amount of runoff is also a function of geology, slope, climate, rainfall, saturation, soil type and vegetation. Geological considerations include rock and soil types and characteristics, as well as degree of weathering. Porous material (sand, gravel, and soluble rock) absorbs water more readily than fine-grained, dense clay or unfractured rock and has a lower runoff potential. Poorly drained material has a higher runoff potential and is more likely to cause flooding. Urban settlements often have large areas of impermeable surfaces, such as roads, pavements and driveways, which behave similarly to poorly drained materials.

Surface water flooding can occur in rural and urban areas, but usually causes more damage in the latter. Urban areas can be inundated by flow from adjacent farmlands. Flood pathways include the land and water features over which floodwater flows. These pathways include drainage channels, rail and road cuttings. Flood management infrastructure can also serve as a flood pathway. Developments that include significant impermeable surfaces, such as roads and car parks may increase the occurrence of surface water runoff. Urban areas usually have extensive drainage or sewer systems. Blockage or constraints to these sewer systems can exacerbate surface water flooding. Developments which are close to artificial drainage systems, or located at the bottom of hillslopes, in valley bottoms and hollows, may be more prone to flooding. This may especially be the case in areas that are downslope of land that has a high runoff potential including agricultural land, impermeable areas and compacted ground.

Flooding from land can also occur when structures used to manage flooding fail. For example, flooding would be worse if a culvert were to collapse or block. Note: these are culverts to manage surface water runoff, not urban drainage systems or rivers.

5.1.2 Impacts of Surface Water Flooding

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

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

Often surface water flooding can be short-lived, lasting only as long as the rainfall event. However flooding may persist in low-lying areas where ponding occurs. Flooding may occur as sheet flow or as rills and gullies causing increased erosion of agricultural land. This can result in ‘muddy floods’ where soil and other material are washed onto roads and properties, requiring extensive clean-up.

Both rural and urban land use changes are likely to alter the amount of surface water in the future. Future development is also likely to change the position and numbers of people and/or developments exposed to flooding.

5.2 Pluvial Flood Risk Datasets

5.2.1 Historic Records

Historical surface water flooding records for the Woking Borough have been provided through a variety of sources including: the SCC Wetspot database, previous discussions during the 2009 Woking SFRA and WBC flood investigation reports.

The SCC Wetspot Database describes the location of reported flood incidents and typically includes details about the incident including the supposed source. It includes information from a range of sources including the borough councils, EA, Thames Water and internal departments such as the Highways Department. It was provided for this SFRA, although many of the flood source information within the Woking Borough is missing, and few surface water events can be identified.

Woking Borough Council provided flood investigation reports for incidents that occurred during the Winter of 2013/14. Nationwide flooding occurred over this period, as the UK was affected by a series of winter storms. In December 2013, effective rainfall for the West Thames area was twice its monthly average and the soil moisture deficit was recorded as zero within the Woking Borough Council[4] indicating ground saturation that caused significant surface water runoff. Many of the incidents within the flood investigation reports were the result of blocked drainage systems, surcharging of the drainage systems and backflow of flood water during overloading of systems.

Historical surface water flooding records have not been represented in Volume 3 of this SFRA, due to an absence of available data, although the reported problem areas have been discussed in Section 5.3.1.

5.2.2 Updated Flood Map for Surface Water

The Updated Flood Map for Surface Water (uFMfSW) GIS data has been provided by the Environment Agency. The dataset contains information for predicted surface water flooding extents, which are shown in Volume 3 Figure 8. These maps are more detailed than the second generation flood map for surface

[4] Flood Incident reports

water (known as the Flood Map for Surface Water FMfSW), and have been generated based on a JFLOW model using a 5m grid size and detailed hydrology. The updated flood map model includes representation of buildings, structures and road networks. The dataset shows areas that are at risk of surface water flooding for the 3.3% AEP, 1% AEP and 0.1% AEP event outlines. It is important to note that quantifying surface water flood risk depends on many other factors, including antecedent conditions and drainage maintenance conditions. Historic records of surface water flooding may indicate an increased risk; however, attention to the problems in these areas may change the associated risk through time.

5.2.3 Woking and Byfleet Surface Water Management Plan (SWMP)

Woking and Byfleet Surface Water Management Plan (SWMP) commenced in September 2010 and followed the revised Surface Water Management Plan Technical Guidance[5]. There are four organisations involved including Surrey County Council (which is the Lead Local Flood Authority for the Borough), Woking Borough Council, Environment Agency and Thames Water. The aim of the SWMP is: *To identify viable options to manage the risks of surface water flooding, for the benefit of Woking and Byfleet and its people, both now and in the future.*

During production of this SFRA, the draft report of the Woking and Byfleet SWMP Preliminary Risk Assessment was provided. This report identifies areas which have historically flooded as well as existing flood risk management plans and locations where further assessment should be warranted. Several sites were determined as having elevated risk of surface water flooding during the assessment, and are discussed in Section 5.3.3.

5.3 Surface Water Flood Risk in WBC

5.3.1 Historic Pluvial Flooding

Historic flooding recorded by the SCC in their Wetspot database indicated no property flooding incidents with an identified surface water source in the study area. However, a review of the dataset shows several incidents which occur with unknown sources distal from the watercourses. These occur within Sutton Green, Knaphill and Horsell villages. Within Sutton Green the flooding incidents are described as having been exacerbated by cars travelling at speed through flood water. The SCC Wetspot database also highlights roads which have experienced flooding. Roads within this dataset that do not intersect rivers may be assumed as having experienced surface water related flooding. These include French’s Wells, and Hartshill Walk in Woking, as well as New Lane in Sutton Green and Moor Lane in Old Woking. These roads have not been represented in Volume 3.

During the production of the 2009 Woking Borough Council SFRA, discussions between Capita and the Environment Agency identified locations affected by surface water flooding relating to the July 2007 flood event. These were:

- Walton terrace, Maybury;
- Princess Road, Maybury;
- Rectory Lane, Byfleet;
- Station Road, Byfleet;
- Morton Close;
- Boundary Road, Maybury;
- Sopwith Drive, Byfleet;

[5] Defra (2010) Surface Water Management Plan Technical Guidance. March 2010. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

- Blackhorse Road;
- Lockfield Drive; and
- West Byfleet.

The Rive Ditch, which flows from Horsell Common to the River Wey, was reported as being a problem area during this flood event. A blockage in the grill located just before the ditch passes under the canal resulted in the area near the ditch becoming flooded.

The WBC-provided flood investigation reports (for the Winter of 2013/14) included several locations where the source of flooding could be attributed to surface water, or a combination of fluvial and surface water. Many of these problems stemmed from drainage problems, and lack of ditch maintenance. Reference to Volume 3 Figure 3, shows the locations of drainage ditches in the study area and the maintenance responsibility is described in this document in Section 3.4. The surface water flooding incidents reported occurred around the following locations:

- Old Woking Road, Woking;
- New Lane, Sutton Green, Woking;
- Blackhorse Road, Woking;
- Sutton Avenue, Woking;
- Kirby Road, Woking;
- Saunders Lane, Woking; and
- Smarts Heath Road, Woking.

These areas can be subsequently identified as areas at moderate or higher risk from surface water flooding, although following reporting of these flood incidents, the relevant authorities have been contacted and actions to address the issues made. Often where the cause was blocked drainage systems, jetting has occurred. Therefore, surface water flood risk should not be interpreted using only historical information, as the probability of areas affected will change with maintenance and development of the drainage system and the introduction of new developments that will change surface flow paths.

5.3.2 Updated Flood Map for Surface Water

The Environment Agency Updated Flood Map for Surface Water (uFMfSW) shown in Volume 3 Figure 8, show multiple isolated areas within the Woking SFRA study area which are at moderate to high risk from surface water flooding, based on the 1% AEP event and 3.3% AEP event outlines respectively. The common areas with increased surface water flood risk are along roads, depressions, and land adjacent to watercourses. Where drainage river networks are shown to be particularly dense, the surface water flooding risk is typically higher, such as in Horsell, at the confluence of the Addlestone Bourne and Burnt Barn Ditch, where several minor watercourses also rise. This discussion of flood risk will therefore be focused around identifying areas that are not immediately influenced by the local drainage network.

Within Woking the Wards with the largest percentage of areas at moderate or high risk of surface water flooding can be identified as Horsell, Goldsworth East and Maybury and Sheerwater. Within these boroughs particularly, are concentrated areas at increased risk that are not adjacent to watercourses, and are summarised in Table 5-1.

Table 5-1 – Summary of areas at moderate to high surface water flood risk

Ward	Affected Property/Infrastructure
Maybury and Sheerwater	Recreation Ground, residential properties (including those in Maybury estate),schools (Bishop David Brown School, Broadmere Community Primary School), Sheerwater community centre, the Woking/Kingsley Business park, Monument Road and Arnold Road
Horsell	Residential properties (concentrated along South Road and Hammond road), Woking and Horsell Cricket Club, Well Lane, High Street and South Road
Goldsworth East	Goldsworth Park recreation ground, parts of Wolsley shopping centre, residential properties (concentrated along Merrivale Gardens and Holyoake Avenue), Goldsworth House car park, retail properties along Vale Farm Road, schools (Goldsworth primary school), Parley Drive, Lockfield Drive and Synthwood

Review of the neighbourhood and district centres, shows that whilst the majority are shown as having limited surface water flood risk, the centres for West Byfleet, Goldsworth Park, Horsell, Kingfield, Woking and Sheerwater have slight ponding and coverage of properties with varied uses that include religious, education, retail and business. These centres should be reviewed individually for risk.

Much of the surface water runoff is indicated as occurring along roads and other infrastructure in Woking Borough. Review of uFMfSW highlights that the railway within Woking is affected at several locations, between St John's and Hook Heath residential areas, and for a stretch north of the Worpleston station. Roads in the study area that can be identified as at moderate or greater surface water flood risk include (but are not exclusive to):

- Triggs Lane, Parley Drive, Synthwood, Kirkland Avenue in Goldsworth East;
- High Street, South Road in Horsell;
- Chobham Road, Barrs Lane and the High Street in Knaphill;
- A247/Westfield Road in Old Woking;
- White Rose Lane in Mount Hermon East;
- Albert Drive in Sheerwater;
- Rectory Lane and Brewery Lane in Byfleet; and
- Pyford Road, Hollybank road and Floyds Lane in West Byfleet.

5.3.3 Woking and Byfleet SWMP

Historical areas that are identified within the SWMP, since the 2009 SFRA, as having experienced surface water flooding includes Brewery Road, Horsell and the A320 between Woking and Chertsey, both events having occurred during 2011. Sites selected for Preliminary Flood Risk Assessments (PFRAs) within the SWMP report were chosen by reviewing historic and modelled flood risk maps. Those which fell within the Woking Borough and considered as at moderate or higher risk from surface water flooding from the PFRA were:

- Forge End/Vale Farm Road, Woking;
- Wheatshead Close, Horsell;
- Woking High School, Horsell;
- Lakeview Recreation Ground, Horsell;
- Abbey Road/Arthur's Bridge Road, Horsell;
- Stockwood Bridge;
- Blackhorse Road, Worplesdon Hill;
- Saunders Lane, Hook Heath;

- Walton terrace / Princess Road, Great Wood / Maybury;
- Sheerwater;
- Knaphill; and
- Moor Lane.

The SWMP draft report indicates that the main risk factors in the borough come from combined effect of surface water and fluvial flood risk to areas adjacent to watercourses, with steep flow paths from surrounding catchments, obstruction of natural drainage paths and depressions causing ponding of water.

5.3.4 Climate Change Considerations

Future climate change projections indicate that more frequent short- duration, high intensity rainfall and more frequent periods of long duration rainfall are to be expected (See Table 6-1). Studies into the impact of climate change on surface water are ongoing. Research from the Living with Environmental Change study led by NERC (2013) may feed into UK Flood Risk and Coastal Erosion Risk Management Strategy. Indirect impacts of climate change on land use and land management may also change future flood risk.

As our understanding of the impacts of climate change improves, these guidelines are likely to be revised. New guidance on climate change allowances is expected to be released by the end of 2015, in line with the adoption of UKCIP 09. A catchment based approach is expected; planners should endure the appropriate guidance is considered.

5.4 Management of Pluvial Flood Risk

5.4.1 Messages from the drainage reports

The majority of surface water flooding incidents within the flood investigation reports were caused by surcharging of highway gullies, ditches and drainage pipes, after significant rainfall during the winter of 2013/14 had resulted in higher than average river flows and ground saturation. This indicates that the drainage network in the report areas, is unable to cope with (what was) a lower frequency, higher intensity storm events. In response to the flooding events, in areas where surcharging occurred the Borough Council is investigating flap valves in large pipes to prevent the backflow of flood water. In other areas, such as along the High Street in Old Woking a new flood defence scheme is being considered.

Other causes included blocked drainage ditches and pipe failures from root egress. These issues are addressed through routine maintenance, which often requires consulting with the riparian owner, as responsibility for this depends on the ditch/watercourse (see Section 3.4).Other considered drainage solutions include installing trash screens, the re-organisation of drainage outfalls, and considering flood storage potential in places such as Worplesdon Golf course.

The recommended actions for each flood incident typically are analysed depending on the severity and a view towards a sustainable reduction of flood risk. They are broken into several categories depending on this analysis:

- *Delivery of Quick win schemes - a solution that can be implemented quickly by the Risk Management Authorities or Local Authority at relatively low cost;*
- *Further investigation/research - Further investigations such as catchment studies and hydrological/hydraulic assessments to understand the flow rates and directional paths and evaluate the extent of flooding. These would provide evidence for future capital investment.*
- *Development of Future schemes - Where immediate action is not financially viable or a solution not readily available then a larger scale flood alleviation scheme may be required. In such cases national funding would need to be secured together with additional contributions from others, such as local levy, local authorities and other third parties.*

- *Land owner action - Members of the public who own land adjacent to watercourses have riparian responsibilities and therefore have a duty to maintain their section of watercourse to ensure there is no impediment of flow. Other works to protect their property may also need to be funded by themselves to ensure delivery within their timescales.*
- *Community action - In some cases it may be prudent for community groups to join forces and deliver and maintain their own local schemes. In some cases this may generate further contributions from local levy or the LLFA.*

5.4.2 Messages from the Woking and Byfleet SWMP Report

The report identified that drainage paths have been historically obstructed or diverted in areas of urban development. In response, it recommends that future development avoid natural drainage routes to manage surface water flood risk. Furthermore, issues with maintenance of drainage systems or insufficient capacity have contributed to flood incidents and should be considered for improving the surface water flood risk. Due to the local geology in the Woking Borough area, the report recognises that urban drainage should be non-infiltration based and consider of utilising open spaces along surface water flow routes for the attenuation of surface water flow.

5.4.3 Messages from the Surrey Local Flood Risk Management Strategy

Within the strategy, Surrey County Council identifies Woking and Byfleet as the area at second highest risk from surface water flooding in Surrey. The SCC has subsequently produced a detailed surface water management plan to identify mitigation measures.

5.4.4 Sustainable Drainage Systems

Sustainable Drainage Systems are recognised as an essential management strategy for surface water. As of 6th April 2015, Local Planning Authorities will be responsible for the delivery of SuDS across Woking Borough. Volume 1, Chapter 8 provides further information on the policy surrounding SuDS, and Appendix B of this document outlines more detailed information on SuDS techniques, and how they can be used to manage surface water flood risk, how to incorporate them into the planning process and alongside other environmental benefits including water quality. The following sections outline where different SuDS techniques are suitable for different regions of the study area.

5.4.4.1 Available Datasets

The British Geological Society (BGS) produce a range of datasets which provide information surrounding the suitability of the ground for infiltration SuDs, The selection and design of an appropriate system depends on the properties of the ground and in particular the following four factors:

- the presence of severe constraints that must be considered prior to planning infiltration
- the drainage potential of the ground
- the potential for ground instability when water is infiltrated
- the protection of groundwater quality

The Infiltration SuDS Map is based on 15 nationally derived subsurface property datasets, some of which are a result of direct observations, whilst others rely on modelled data.

The dataset is structured using the above four factors, and allows consideration of the subsurface permeability, the depth to groundwater, the presence of geological floodplain deposits, the presence of artificial ground, ground stability (soluble rocks, collapsible ground, compressible ground, running sand, shallow mining, landslide and shrink swell clays), potential for pollutant attenuation and the Environment Agency's source protection zones. The maps show data at 1:50,000 scale and was provided during the production of this SFRA by the SCC, as was already purchased.

5.4.4.2 Infiltration SuDs Map: Detailed

The detailed map provides the data layers described above, along with a further 20 individual, bespoke data layers. These data layers provide information on the properties of the ground, which can be used to guide local SuDS planning and design.

The data can be used to determine the likely limitations present at a site and make preliminary decisions on the type of infiltration SuDS that may be appropriate. We anticipate that this map will be used by planners, developers, consultants and SuDS Approval Bodies.

5.4.4.3 Infiltration SuDs Map: Drainage Summary

The summary map comprises four summary layers whose classifications are shown in Table 5-2, and provide an indication of the suitability of the ground for infiltration SuDS. The layers summarise: the presence of severe constraints; the drainage potential of the ground; the potential for ground instability as a result of infiltration and the susceptibility of the groundwater to contamination. The layer is derived from the following datasets:

- Infiltration constraints summary
- Superficial deposit permeability
- Superficial deposit thickness
- Bedrock permeability
- Depth to water level
- Geological indicators of flooding

This map is anticipated to be of use in strategic planning and not for local assessment. It does not provide specific subsurface data or state the limitations of the subsurface with respect to infiltration.

Table 5-2 – Drainage Summary Map classifications

Score	Description	Typical Storage Capacity
1	Highly compatible for infiltration SuDS	The subsurface is likely to be suitable for free-draining infiltration SuDS
2	Probably compatible for infiltration SuDS	The subsurface is probably suitable for infiltration SuDS although the design may be influenced by the ground conditions
3	Opportunities for bespoke infiltration SuDS	The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions
4	Very significant constraints are indicated	There is a very significant potential for one or more geohazards associated with infiltration

5.4.5 SuDS Suitability Assessment

The Drainage Summary (also referred to as infiltration constraints) layer provides an indication of the extent to which the ground will be suitable for infiltration SuDS, with respect to drainage, based on the geology and hydrogeology of the subsurface. This BGS dataset is shown for the study area in Volume 3 Figure 9 and should be used to advise the methods and location of SuDS across Woking Borough. However, the detailed SuDS Map dataset should be referred to at the detailed FRA stage to highlight any further or site specific constraints on SuDS and relevant applications for surface water management.
The urban areas which are encompassed by each infiltration category in the drainage summary map are detailed in Table 5-3. The smaller areas and parts which are not urban have not been described although

it is worth noting that the dataset shows many of the golf courses within the area to be highly compatible for infiltration SuDS. This includes Westhill, Woking, Worplesdon, Chobham, New Zealand and Hoebridge golf clubs. Additionally, some open areas in Woking Borough are considered to have significant SuDS constraints such as the Goldsworth Park Recreation ground, Traditions Golf Course, Pyford Golf Club and Wisley Golf Course.

Table 5-3 – Summary of infiltration constraints for urban areas within the Woking Borough

Score	Description	Areas within WBC
1	Highly compatible for infiltration SuDS	• Most of Knaphill area, except for the southern part of Lower Guildford Road • A band extending from Fisher's Hill, stretching to central Woking and including the Wolseley Place Shopping centre (includes St John's, Hook Heath, parts of Maybury and Mount Hermon, and Hockering Estate) • Parts of Horsell • Most of Pyrford area, including Pyrford Wood Estate • Small isolated sections of West Byfleet • Along the A245/B385 in Sheerwater
2	Probably compatible for infiltration SuDS	These areas outline those in category 1, particularly in Knaphill, West Byfleet, Hook heath and Mayford
3	Opportunities for bespoke infiltration SuDS	Most of the Woking Borough falls within this category but several urban areas can be determined: • The entire of Byfleet centre included in the borough • Goldsworth East, area bordered by Lockfield Drive and Littlewick East • Parts of Horsell ,Maybury (including part of Maybury Estate), West Byfleet, Ridgway and Elm Bridge (including Elm Bridge Estate) • Most of Sheerwater • Most of Brookwood, north of the railway • Eastern Horsell
4	Very significant constraints are indicated	• Parts of the railway and areas adjacent, which include stretches from Brookwood to Hook Heath, in Mount Hermon and Byfleet • Most of the Wey floodplain, encompassing urban areas of Westfield and Old Woking • Isolated areas within Goldsworth (recreation ground, along Kestrel Way and adjacent to Winnington Way) • Isolated area within Maybury along Walton road • Isolated area within Sheerwater along Albert Drive • Isolated areas within Pyrford including along Pyford Road

5.5 Adoption and Maintenance of SuDS

To ensure approval of a proposed SuDS scheme it is critical that developers consult with WBC, the Highways Agency, Thames Water and any other applicable parties to discuss the adoption and maintenance of SuDS techniques and associated drainage infrastructure. WBC will now offer adoption for SuDS that are in public open spaces and serve more than one property. Developers interested in WBC adoption need to have discussions with WBC Drainage and Flood Risk Engineer before hand and systems designed in accordance with the WBC SuDS Design and Adoption Guide.

Sewerage undertakers are responsible for surface water and foul drainage from developments, where this is adopted via adopted sewers. Thames Water is the sewerage undertakers within the study area.

The Flood and Water Management Act 2010 outlined plans to establish SuDS Approval Bodies (SABs) within County, County Borough or Unitary Local Authorities. However, the Department for Communities and Local Government (DCLG), following consultations with the Department for Environment, Food and Rural Affairs, has dropped the development of SuDS Approval Bodies (SABs) as the primary mechanism for SuDS review.

All Major planning applications will need to set out who will be responsible for maintaining and inspecting the drainage system for the lifetime of the development and include a detailed SuDS maintenance plan. Developers will need to consult with the WBC drainage and flood risk engineer to ensure that proposals are compliant with NPPF, the non-statutory technical standards for sustainable drainage, WBC Core Strategy policy CS9 and the WBC SuDS Design and Adoption guide. All Major Planning application will need to be accompanied by the information in the SuDS validation list and include a completed and signed Pro-Forma. This should also include a maintenance plan for the lifetime of the development and set out who will be responsible for the lifetime of the development.

6. Identifying Preliminary Drainage Areas

As part of this SFRA, analysis has been undertaken in order to identify areas where development may increase flood risk. This has been done by identifying preliminary drainage areas (PDAs) based on identifying hydrological catchments. Where several PDAs exist along the same Main River reach, these should be addressed by river reach with regard to a potential cumulative impact. This should be done in collaboration between the LLFA, LPA and EA.

6.1 Defining Preliminary Drainage Areas

These areas have been defined using the Water Framework Directive Main River Catchments. These have been compared to hydrological catchment boundaries using the Flood Estimation Handbook software, to validate the catchment boundaries. The UFMfSW has also been used to validate the catchments and indicative surface water flow paths.

The catchments have been classified as preliminary drainage areas, based on potential future risk, as new development could create additional runoff in the downstream part of the catchment. The PDAs are a starting point for considering potential downstream flood risk areas and the cumulative impact of development.

6.2 PDAs within Woking Borough

Volume 3, Figure 10 shows the identified PDAs within Woking.

The developed areas of Woking fall across three PDAs.

- The main PDA follows the Basingstoke canal, the upstream areas are more rural becoming increasingly urbanised downstream;
- The PDAs in the south of the borough help identify that increased development within the upper, more rural reaches of these catchments could increase surface water flood risk in the urban downstream extents of the PDAs;
- The cumulative impact of development within these PDAs could further increase surface water flood risk, and it is therefore imperative that surface water is maintained at Greenfield runoff rate or below; and
- The Water Framework Directive Layers show that the watershed boundaries do not follow the political boundaries, and highlight the importance of considering the downstream effects of developments in other neighbouring Boroughs. This also highlights the need for liaison between Boroughs and larger scale management by the LLFA.

6.3 Policy recommendations

In addition to the existing flooding policy, adopted as part of the Woking core Strategy, it is recommended that WBC consider developing a surface water management policy for the forthcoming Development Management Policies DPD such that development within the identified PDAs must reduce surface water run-off following any development of the site. This is in line with NPPF and correspondence with the EA that future development should look to not only mitigate but reduce surface water runoff from all developments, reducing future flood risk across the Borough. Greenfield developments should maintain the predevelopment runoff rate; brownfield sites should attempt to reduce runoff rates to Greenfield rates.

By identifying specific locations where additional development is expected to exacerbate flood risk, Woking Borough Council can create specific policies. SuDS techniques are important in achieving these objectives.

The identification of the PDA regions within Woking can also be used as a starting point for identifying the potential need for Surface Water Management Plans across the Borough. It is recommended that SWMPs are developed for the PDAs showing significant risk – in terms of existing impact and potential future risk. The benefits of developing these smaller scale SWMPs include:

- Detailed understanding of local flood risk and improved evidence base (this may result in a reduction of predicted risk and an increase in available developable land or vice versa)
- Ability to define robust, defendable policies that are effective at a catchment scale
- Increased ability to defend policy decisions and enforce planning conditions

7. Flood Risk from Sewers

7.1 Overview

There are areas of high population density within the Woking Borough, which place stress on the capacity of sewer networks and can result in an increased risk of sewer surcharging and flooding. This chapter will provide a brief background to the causes (Section 7.1.1) and impacts (Section 7.1.2) of sewer flooding, and assess the flood risk in the study area using historic records provided by Thames Water, the Water Company responsible for Woking Borough (Section 7.3).

7.1.1 Causes and Classifications

Flooding from sewers occurs when rainfall exceeds the capacity of networks or when there is an infrastructure failure. Flooding from foul and surface water sewers (combined sewers) occurs when rainfall exceeds the capacity of networks or when there is an infrastructure failure.

The main causes of sewer flooding are:

- Lack of capacity in sewer drainage networks due to original under-design.
- Lack of capacity in sewer drainage networks due to an increase in demand (such as climate change and/or new developments).
- Lack of capacity in sewer drainage networks due to events larger than the system designed event.
- Lack of capacity in sewer drainage networks when a watercourse is fully culverted (lost watercourses), thus removing floodplain capacity.
- Lack of maintenance of sewer networks which leads to a reduction in capacity and can sometime lead to total sewer blockage.
- Water mains bursting/leaking due to lack of maintenance or as a result of damage.
- Groundwater infiltration into poorly maintained or damaged pipe networks.
- Restricted outflow from the sewer systems due to high water levels in receiving watercourses.

Drainage systems often rely on gravity assisted dendritic systems, which convey water in trunk sewers located at the lower end of the catchment. Failure of these trunk sewers can have serious consequences, which are often exacerbated by topography, as water from surcharged manholes will flow into low-lying land which may already be suffering from other types of flooding.

The modification of watercourses into culverted or piped structures can result in a reduced capacity. Excess water may be sent along unexpected routes as its original channel is no longer present and the new system cannot absorb it.

7.1.2 Impacts of Sewer flooding

Whilst the impact of sewer flooding is usually confined to relatively small localised areas, when flooding is associated with blockage or failure of the sewer network, flooding can be rapid and unpredictable. Flood waters from this source are often contaminated with raw sewage and pose a health risk. The spreading of illness and disease can be a concern to the local population if this form of flooding occurs on a regular basis.

Sewer flooding is likely to have a high concentration of solid, soluble and insoluble contaminants. This can lead to a reduction in the environmental quality of receiving watercourse, and may also enter properties near to the watercourses (particularly in the example of flooding of combined sewers).

Flooding of contaminated land (such as landfills, motorways, and petrol station forecourts) will transport contaminants such as organics and metals to vulnerable receptors if the respective drainage systems are not designed to treat the water.

Sewer flooding will impact on river and ground water quality and will cause implications on achieving objectives within the River Basin Management plans which in turn feed in to the Water Framework Directive legislation.

7.2 Sewer Flood Risk Datasets

7.2.1 The DG5 Register

All Water Companies have a statutory obligation to maintain a register of properties/areas which have reported flooding from the public sewerage system. This is shown on the DG5 Flood Register, provided for the SFRA by Thames Water, which is the sewerage undertaker and Water Company that covers Woking Borough. The DG5 register includes records of flooding from foul sewers, combined sewers and surface water sewers which are deemed to be public (and therefore maintained by the Water Company) for the past 20 years.

The aim of the DG5 levels of service indicators is to measure the frequency of actual flooding of properties and external areas from the public sewerage system by foul water, surface water or combined sewage. It should be noted that flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register. In addition, the records do not account for the effect of any capital works designed to alleviate flooding.

As the DG5 register relies on reports from home owners, there are incidents which have not been reported and will not be shown.

7.2.2 SFRA Sewer Flood Risk Mapping

The data from the supplied DG5 register has been represented in Volume 3 Figure 11. This shows the number of flooding incidents within each postcode district, defined by just the postcode outward code. Where no data was provided or no incidents recorded the area is left blank. In total property flooding incidents were reported for the last 20 years in 17 postcode sectors that are within the Woking Borough.

7.3 Sewer Flood Risk in WBC

7.3.1 Historical Sewer Flooding

The data provided by Thames Water for use in this SFRA shows postcodes where properties are known to have experienced sewer flooding prior to January 2015. The DG5 register holds records of 51 flood incidents resulting in internal property flooding, and 75 external flooding incidents, as shown in Figure 6-1 and Figure 6-2. The records do not indicate a trend in property flooding with scale of flood events (AEP), although the most internal and external property flooding incident reports are for the medium scale flooding events (10% AEP).

Figure 6-1 – Total Internal property flooding from Sewers within Woking Borough

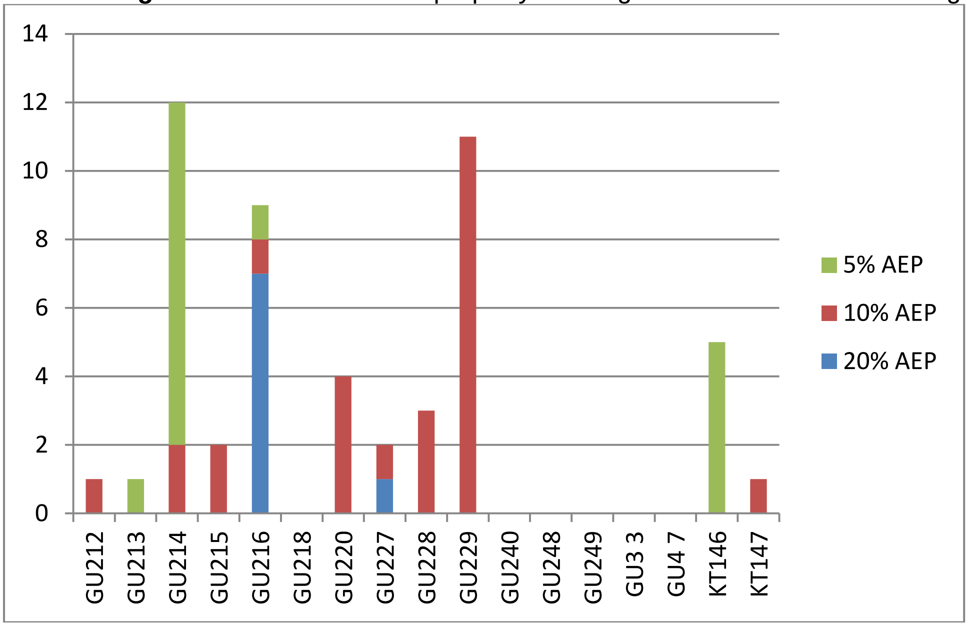
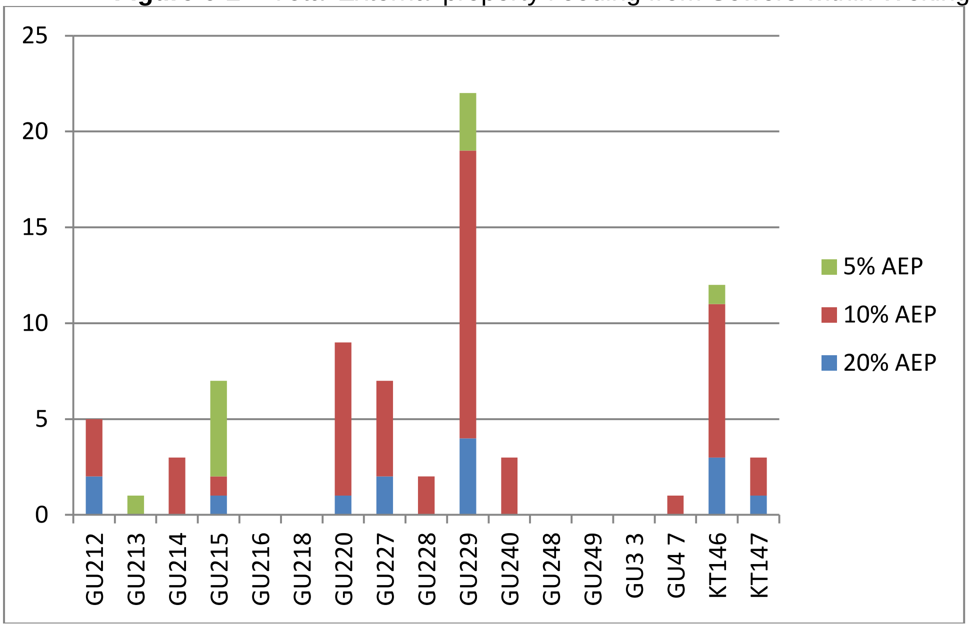


Figure 6-2 – Total External property flooding from Sewers within Woking Borough



Sewer flooding is a particularly damaging source of flooding because of the after affects associated with this type of flooding. Sewer flooding is often combined with surface water flooding when combined sewerage and drainage systems surcharge. In the study area this type of flooding is more likely to occur in the densely populated wards which according to the 2011 Census[6] are Goldsworth West, Maybury and Sheerwater, Mount Hermon West and Knaphill South. Volume 3 Figure 11 provides a broad overview map that indicates the densest number of reported flood incidents has occurred in the relatively low population density wards of Old Woking and West Byfleet. In comparison, the densely populated urban areas of Goldsworth and Knaphill show less than 10 reported flooding incidents.

[6] http://www.woking.gov.uk/woking/people/wokingsvitalstatistics/demographicprofile

The use of historic data to estimate the probability of sewer flooding is the most practical approach, however it does not take account of possible future changes due to climate or future development. Historic results should also be viewed with caution as the sewer network is constantly being maintained, upgraded and improved. Thus flooding issues may be relatively short lived (<10 years). If identified by the Environment Agency or the water company as a major risk, sewer flooding will need to be assessed in greater detail in individual flood risk assessments.

7.3.2 Climate Change Considerations

Climate change is expected to impact sewer flooding by increases in rainfall intensity. This may require new infrastructure to be designed with greater capacities and existing infrastructure may require upgrading to maintain the same level of service. The relevant climate change predictions contained with NPPF are reproduced in Table 6-7-1.

Table 6-7-1 – Predicted increase in rainfall intensity with climate change

	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	5%	10%	20%	30%

Going forwards, updated guidance relating to climate change is expected to be adopted. UKCIP 09 guidance is expected to be released by the end of 2015, which will detail guidance going forwards. Rainfall intensities and peak river flows are still expected to increase.

7.4 Management of Sewer Flood Risk in WBC

Flooding from sewers or urban areas can theoretically be managed with engineering works for any size event. However such works are not always economically or environmentally sustainable. Improvements to urban drainage can also lead to rapid rainfall runoff into rivers, increasing flood risk downstream and potentially transporting contaminants.

The National Planning Policy Framework recommends that Sustainable Urban Drainage Systems (SuDS) are used to decrease the probability of flooding by limiting the peak demand on urban drainage infrastructure. All new developments, and wherever possible existing networks, are also advised to separate out foul drainage from surface water drainage to ensure that any flooding that does occur is not contaminated.

As part of WBC role in delivering SuDS, policy and guidance should promote the adoption of sustainable drainage techniques on all new developments where they are appropriate following consultation with the WBC drainage engineer.

8. Flood Risk from Groundwater

8.1 Overview

The Woking SFRA area is predominantly underlain by the Bagshot Beds, consisting of clay and marl (a type of mudstone) and the Bracklesham beds consisting of clay and sandstone. These deposits are generally impermeable and limit the likelihood of groundwater flooding. Parts of the borough, particularly along the floodplains, are underlain by superficial river alluvium that has the potential to hold locally perched water tables and cause localised groundwater flooding. This chapter will discuss the causes (Section 8.1.1) and impacts (Section 8.1.2) of groundwater flooding, and assess the groundwater flooding risk posed to the study area through historic records and the BGS dataset 'Susceptibility to Groundwater flooding' (Section 8.3).

8.1.1 Causes and Classifications

Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Groundwater floods may emerge from either point or diffuse locations. They tend to be long in duration developing over weeks or months and prevailing for days or weeks.

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

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

Groundwater levels rise and fall in response to rainfall patterns and distribution, with a time scale of months rather than days. The significance of this rise and fall for flooding, depends largely on the type of rock it occurs in, i.e. how permeable to water the rock is, and whether the water level comes close to or meets the ground surface.

Groundwater flood events have been recorded in various aquifer units (including Cretaceous Chalk, Limestones, river terrace gravels). Compared to other aquifer units, Chalk is more vulnerable to groundwater flooding because of its geological formation. It contains many pores and fissures which can result in rapid rises in groundwater levels, which take a long time to recede.

The primary controls on the distribution and timing of groundwater flooding include:

- Spatial and temporal distribution of rainfall;
- Spatial distribution of aquifer properties;
- Recharge mechanisms;
- Spatial distribution of geological structures (drift deposits, stratigraphy); and
- Efficiency of the surface drainage network.

The likelihood of an area experiencing groundwater flooding can largely be determined on a broad scale through an analysis of the previous meteorological conditions and geological knowledge. This can be helped by the analysis of groundwater boreholes and historic information.

High groundwater levels can result from the combination of geological, hydrogeological, topographic and recharge phenomena and can mostly be associated with the seven mechanisms described in Table 8-1. Each has been described using the source-pathway- receptor model.

Table 8-1 – Causes of high groundwater levels

Flooding phenomenon	Sources	Pathways	Receptors	Hazard	Characteristics
Rising groundwater levels in response to prolonged extreme rainfall (often near or beyond the head of ephemeral streams)	Long duration rainfall	Permeable geology, mainly chalk	People, properties, environment	Basement flooding/rural ponding	Responsible for the large majority of groundwater flooding. May occur a few days after the rainfall or up to several weeks after. Usually lasts for a number of weeks. An increase in the baseflow of channels, which drain aquifers, is often associated with elevated groundwater levels and may lead to an exceedance of the carrying capacity of these channels. Floodwaters are most often clear and so this form of groundwater flooding may be referred to as 'clear water flooding'. High groundwater levels may also inundate sewer and storm water drainage networks, exceed capacity and lead to flooding in locations, which would otherwise be unaffected. This flooding can be associated with pollution.
Rising groundwater levels due to leaking sewers, drains and water supply mains	Water in water mains, drainage and sewerage networks	Cracks in pipes/permeable strata	People, properties, environment	Basement flooding/water quality issues	Leakage from sewer, storm water and water supply networks can lead to a highly localised elevation in groundwater levels, particularly where the leak is closely associated with chalk bedrock.
Groundwater rebound owing to rising water table and failed or ceased pumping	Groundwater	Permeable geology and artificial pathways e.g. adits	Property, commercial	Basement flooding / flooding of underground infrastructure	Where historic heavy abstraction of groundwater for industrial purposes has ceased, a return of groundwater levels to their natural state can lead to groundwater flooding. This process can potentially cover large areas or maybe associated
Upward leakage of groundwater driven by artesian head	Groundwater emerging from boreholes or through permeable geology	Artesian aquifer and connection to surface	*Property*	Basement flooding / flooding at surface	Mainly associated with short duration and localised events this process can lead to significant volumes of discharge. It can occur in locations where boreholes have been drilled through a confining layer of clay to reach the underlying aquifer.
Inundation of trenches intercepting high groundwater levels	Groundwater	Permeable geology	Property	Routing of floodwaters	The excavation and fill of engineering works with permeable material can create groundwater flow paths. High groundwater levels maybe intercepted, resulting in flooding of trenches and land to which they drain.
Other – alluvial aquifers, aquifer, sea level rise	Rivers, rainfall, sea	Floodplain gravels, permeable geology	Property, environment	Basement flooding / flooding at surface/saline intrusion.	Other mechanisms of groundwater flooding include leakage of fluvial flood waters through river gravels to surrounding floodplains e.g. behind flood defences; and a rise in groundwater levels as a result of adjacent sea level rise as a result of the discharge boundary rising.

8.1.2 Impacts of Groundwater Flooding

The main impacts of groundwater flooding are:

- Flooding of basements of buildings below ground level – in the mildest case this may involve seepage of small volumes through walls, temporary loss of services etc. In more extreme cases larger volumes may lead to the catastrophic loss of stored items and failure of structural integrity.
- Overflowing of sewers and drains – surcharging of drainage networks can lead to overland flows causing significant but localised damage to property. Sewer surcharging can lead to inundation of property by polluted water. Note: it is complex to separate this flooding from other sources, notably surface water or sewer flooding.
- Flooding of buried services or other assets below ground level – prolonged inundation of buried services can lead to interruption and disruption of supply.
- Inundation of farmland, roads, commercial, residential and amenity areas – inundation of grassed areas can be inconvenient; however the inundation of hard-standing areas can lead to structural damage and the disruption of commercial activity. Inundation of agricultural land for long durations can have financial consequences.
- Flooding of ground floors of buildings above ground level – can be disruptive, and may result in structural damage the long duration of flooding can outweigh the lead time which would otherwise reduce the overall level of damages.

Additionally groundwater flooding can cause a change in the structural properties of clay overlying chalk aquifers. This may cause costly damage to structures in the ground and the buildings that they support. In general terms groundwater flooding rarely poses a risk to life although it can be associated with significant damage to property.

Groundwater flooding generally occurs more slowly than river flooding and in specific locations. The rarity of groundwater flooding combined with the mobility of the population means that people often do not know there is a groundwater flood risk.

New developments are particularly at risk because little consideration is given to groundwater as a source of flooding in the planning process. The sparse frequency of groundwater flood events can contribute to poor decision-making. The economic and social costs of groundwater flooding are compounded by the relative long duration of events.

The nature and occurrence of groundwater flooding in England is highly variable. 1.7 million properties are vulnerable to groundwater flooding in England (Jacobs 2006). The occurrence of groundwater flooding is very local and often results from the interaction of very site specific factors, e.g. aquifer properties, topography, man-made structures etc.

In general terms groundwater flooding rarely poses a risk to life. However groundwater flooding can be associated with significant damage to property.

However, the predominantly sandstone bedrock across most of the WBC study area, means that much of the Borough has a very low susceptibility to groundwater flooding.

8.2 Groundwater Flood Risk Datasets

8.2.1 Historic Records

There are very few records of historical groundwater flooding across the Woking Borough. The Surrey County Council Wetspot database does not attribute any property or highways flooding incidents to groundwater sources.

The 2009 SFRA identified six historic groundwater flooding incidents through discussion with the Environment Agency that occurred in the spring seasons of 2001, 2003 and 2004. The EA indicated that the underlying geology of sandy Bagshot Formation could hold a relevant water table which may have been associated with these flooding events.

The lack of incidents recorded may not be reflective of the actual occurrence of groundwater flooding, as they may not be reported or may occur following prolonged rainfall events simultaneously with other types of flooding.

8.2.2 BGS Susceptibility to Groundwater Flooding Dataset

The BGS susceptibility to groundwater flooding dataset has been analysed to identify areas within the Borough which are susceptible to groundwater flooding and is shown in Volume 3 Figure 12. The Susceptibility to Groundwater Flooding dataset is a national dataset produced by the BGS following the particularly wet winter of 2000/2001.

The dataset is based on geological and hydrogeological information and can be used to identify areas where geological conditions could increase the likelihood of groundwater flooding and the depth at which this would occur relative to the surface. It is important to note that it is a susceptibility set, and does not indicate hazard or risk and does not provide any information on the depth to which groundwater flooding occurs, or the likelihood of the occurrence of an event of a particular magnitude.

The Environment Agency also produce an ‘Areas susceptible to groundwater flooding map’, which is based on some of the information from the BGS maps and information on superficial deposits, although this is not assessed in this SFRA. Again the dataset identifies susceptibility and not risk.

The British Geological Society groundwater susceptibility Maps are considered to be more detailed and accurate and have a finer resolution to the Environment Agency maps, and therefore identifying groundwater susceptibility in the borough of Woking has been done based on this dataset. The dataset is classified into four subgroups described in Table 8-2.

Table 8-2 – BGS susceptibility to groundwater flooding classifications

Classification	Description
A	**Limited potential for groundwater flooding to occur:** based on rock type and estimated groundwater level during periods of extended intense rainfall.
B	**Potential for groundwater flooding of property situated below ground level:** based on rock type and estimated groundwater level during periods of extended intense rainfall. Where this may have an impact, you are advised to check that this has not been a problem in the past at this location and/or that measures are in place to sufficiently reduce the impact of the flooding.
C	**Potential for groundwater flooding to occur at surface:** based on rock type and estimated groundwater level during periods of extended intense rainfall. You are advised to check that this has not been a problem in the past at this location and/or that measures are in place to sufficiently reduce the impact of the flooding.
Elsewhere	Not considered to be prone to groundwater flooding: based on rock type.

8.3 Groundwater Flood Risk

8.3.1 BGS Susceptibility to GW Flooding Maps

The BGS Susceptibility to Groundwater Flooding dataset shown in Volume 3 Figure 12, indicate the potential for groundwater flooding to occur and the depth at which this could occur relative to the surface. This potential depends significantly on the underlying geology. The majority of the Woking Borough is shown to have a limited potential for groundwater flooding at any depth, reflecting the impermeable geology of the Barton, Bracklesham and Bagshot beds.

Along the Lower Wey floodplain, in the south east of the borough, encompassing old Woking and Westfield, and east of Pyford, there is a higher potential of groundwater flooding (potential for groundwater to occur at the surface). Likewise areas within the north of the borough, along the Addlestone Bourne floodplain, are shown as having a medium potential for groundwater flooding (potential for groundwater flooding to occur at depth/surface). These areas are all located on superficial river gravel deposits, alluvium, which are more permeable than the bedrock clays and have the ability to develop locally perched water tables. As these areas coincide with the fluvial flooding zones described in Section 4.3), Flood Risk Assessments should examine the potential for groundwater flooding on a local site scale in these areas.

There is increased groundwater flooding potential is patches adjacent to the Basingstoke Canal route including the areas south of Knaphill, parts of Goldsworth West, Maybury and an area of Sheerwater. The geology does not have an obvious variation in these areas that would influence the groundwater flooding potential.

8.3.2 Climate Change Considerations

There is currently no research specifically considering the impact of climate change on groundwater flooding. The mechanisms of flooding from aquifers are unlikely to be affected by climate change, however if winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers.

8.4 Management of Groundwater Flood Risk

As the Lead Local Flood Authority, Surrey County Council is responsible for managing flood risk from groundwater within Woking, in conjunction with Woking Borough Council. The SCC Local Flood Risk Management Strategy does not detail any specific management measures for groundwater flooding within Surrey; however it is recommended that along with other sources of flooding, WBC should endeavour to record and investigate any groundwater flood incidents to enhance the historic record and understanding of the groundwater flooding mechanism across WBC.

Groundwater flooding is often highly localised and complex; management is highly dependent on the characteristics of the specific situation. The costs associated with the management of groundwater flooding are highly vulnerable. The implications of groundwater flooding should be considered and managed through development control and building design. Whilst groundwater flood risk across most of the borough is most likely very low, possible management measures could include:

- Improved conveyance of floodwater through and away from flood prone areas;
- Raising property ground or flood levels;
- Providing local specific problem areas specific flood proofing;
- Replacement and renewal of leaking sewers, underground drains and water supply reservoirs; and
- The management of SuDS techniques should also be considered in relation to groundwater levels.

Although groundwater flood risk across most of the Borough is very low, it is important it is still considered in all levels of Flood Risk Assessments (FRAs), and is included in the detailed FRA stage. Developers should consider the following indicators that a site may be at risk of groundwater flooding.

- If the development site is near to the junction between geological strata of differing permeability.
- If the development site is located at a similar level to nearby springs, or stream headwaters.
- If the development proposals include basements or excavation into the ground.
- If the vegetation on the site suggests periodic waterlogging due to high groundwater levels.
- If nearby recorded borehole levels reach those of the site ground levels.

9. Artificial Sources

9.1 Overview

There are multiple structures that present artificial flood risk in Woking Borough, which according to the NPPF includes reservoirs, canals and lakes where water is retained above natural ground level. These embanked water bodies exist in Woking Borough as the Sutton Place Lake, the Basingstoke Canal, which runs across the centre of the borough, and the Wey Navigation which includes separate engineered channels to the Wey. This section goes on to discuss the classification of artificial sources (Section 9.1.2), the background of those within Woking Borough (Section 9.1.4 and 9) and assesses the flood risk presented using historical data, topography and the EA Reservoir Inundation maps (Section 9).

9.1.1 Causes and Classifications

NPPF describes non-natural or artificial sources of flooding such as reservoirs, canals and lakes where water is retained above natural ground level. NPPF also includes operational and redundant industrial processes including mining, quarrying, and sand and gravel extraction as they may increase water depths and velocities in adjacent areas. In addition to this the impacts of flood management infrastructure and other structures need to be considered. Flooding may result from a facility being overwhelmed or from failure of a structure. Failure of structures can result in rapid, deep flowing water which poses a serious hazard, threatening life and potentially causing major property damage. Failure of pumps may also result in flooding.

For the purpose of the SFRA, flooding from artificial sources has been defined as that arising from failure of man-made infrastructure or human intervention that causes flooding. This includes failure of canals or reservoir embankments, as well as activities such as ground water pumping. To understand flooding from artificial sources the whole hydrological and drainage system must be considered, along with the potential for interaction with other sources of flooding.

The spatial and temporal extent of flooding from artificial sources is highly variable. For example the likelihood of a new reservoir failing is very low compared to that of a canal embankment that is more than one hundred years old. However the consequences of a reservoir failing is potentially catastrophic in comparison to a local canal embankment breaching.

Increased urbanisation, aging infrastructure and the impacts of climate change all result in the requirement for consideration of flooding from artificial sources within the development process
Reservoirs are defined as artificial lakes, used to store water for various uses. They can be either modified natural structures or completely man-made. An 'attenuation' or 'impoundment' reservoir is used to prevent flooding to lower lying lands or regulate flows for abstraction and irrigation purposes. Control reservoirs collect water at times of excess (or unseasonably high rainfall), then release it slowly on demand or over the course of the following weeks or months.

Managed or un-managed reservoir release may increase floodwater depths and velocities in adjacent areas. Reservoir flooding may occur as a result of failure of a reservoir’s civil structure due to the system being overwhelmed; or malfunction of the water level control system.

9.1.2 Reservoirs Act

Reservoirs with an impounded volume in excess of 25,000 cubic metres (measured above natural ground level) are governed by the Reservoirs Act 1975 and the Flood and Water Management Act 2010. The Reservoir Act makes owners (undertakers) responsible for the safety of their reservoirs and they are obliged to ensure assessments are undertaken by appropriately qualified engineers on a routine basis.

As Enforcement Authority the Environment Agency have the following key roles:

- Surveillance - maintaining a register of reservoirs for England and Wales.
- Enforcement - achieving compliance.

For reservoirs below the threshold of 25,000 cubic metres above ground volume, regulation is managed by the Health and Safety Executive and they carry out inspections in accordance with the Health and Safety at Work Act. The Environment Agency has a register of reservoirs and undertakers, as well as a set of risk maps for all reservoirs greater than 25,000 cubic meters.

9.1.3 Reservoirs, Lakes and Ponds in Woking Borough

Within the Woking Borough, there is only one identified reservoir which has raised embankments and presents artificial flood risk. This is Sutton Place Lake, which covers an area of approximately 47, 000 m^2 and located at the southernmost area of the Borough. It is within English Heritage land and associated with the Tudor mansion, Sutton Place. The EA reservoir inundation map also identifies a minor risk from the Clandon Park Lake, located in West Clandon.

9.1.4 The Basingstoke Canal

The Basingstoke Canal stretches between the villages of Greywell in Hampshire and Woodham in Surrey. The canal stretches for a distance of 32 miles (51km) incorporating 29 locks to raise the canal from the River Wey up to the plateau in Hampshire which was 245ft (75m) above sea level. The Basingstoke Canal is what is known as a contour canal. This means that as far as possible the canal is built around the side of the hills on a contour maybe 5m above the normal ground level. The system of following contours eventually brings the canal to the same level as the Wey Navigation at New Haw near Byfleet in Surrey. The canal is now fully navigable, and connects to the River Wey Navigation, which in turn joins the River Thames. Hampshire County Council and Surrey County Council originally managed the canal, but management and maintenance is coordinated in partnership with the Basingstoke Canal Authority. This Partnership also comprises six local funding borough and district councils: Hart, Rushmoor, Guildford, Surrey Heath, Woking and Runnymede. Hart District is further comprised of local Parishes and Fleet Town Council who contribute revenue funding to maintain the canal.

As shown in Volume 3 Figure 13, the Basingstoke Canal passes through the study area, entering to the west of the study area at Brookwood, and following a meandering course through central Woking, sub-parallel to the railway. The canal exits the study area to the north east, where it interacts with Rive Ditch, and meets the Wey Navigation at the border of the study area, where the Rive Ditch crosses the M25 in West Byfleet.

9.1.5 The Wey Navigation

The Wey Navigation is managed by the National Trust and forms a continuous waterway of 22miles (32km), making a navigable route from the River Thames between Weybridge and Godalming in Waverley. The navigation is a combination of engineered channels separate from the river, and sections of navigable river and follows the path of the Wey along the boundary of the Woking Borough. The navigation enters the study area towards the south at Sutton Green, exits at Westfield and re-enters, separate from the main river at Pyrford Green until uniting with the Basingstoke Canal at the northern boundary of the borough. The trace of the Wey Navigation shown in Volume 3 Figure 13 has been determined from OS mapping.

9.2 Flood Risk from Artificial Sources Datasets

9.2.1 Historic Records

On September 15th 1968, maintenance neglect and a period of exceptionally heavy rain caused the canal to burst its banks in two places, an event which led to the restoration of the Basingstoke Canal. No further documented historic records of flooding from artificial water bodies have been identified during the production of the SFRA.

9.2.2 Basingstoke Canal Authority Correspondence

As part of this SFRA update, there was correspondence with the Basingstoke Canal Authority, a voluntary organisation that seeks to restore the canal. Previous data from the 2010 SFRA completed by Capita has been used, and was procured through prior consultation with the trust. Further information regarding the canal has been inferred from available online sources. However, information regarding weir protocols, areas which have breached in the past, maintenance regimes, and embanked reaches (which therefore may pose a risk in the event of a breach) is not available.

9.2.3 Environment Agency Reservoir Inundation Maps

The Environment Agency Reservoir Flood Map Maximum Flood Outline dataset, presented in Volume 3 Figure 13, represents the maximum extent of flooding, should the unlikely event of a reservoir embankment breach occur and all the . This flood map only considers embanked "large" reservoirs, and combines the flood extents from several potential breach locations.

9.2.4 SFRA Flood Risk from Artificial Sources Mapping

Areas that are subject to residual flood risk from the Basingstoke Canal have been mapped in Volume 3 Figure 13, and given there are no recent variations in topography or the canal course, were taken from the 2009 SFRA. These highlight the lower lying areas relative to canal, which would be liable to flooding in the event of embankment breach. These were identified using OS mapping contour lines and information on the elevation of the Canal. The canal corridor has also been provided by the WBC as an area recognised as susceptible to occasional flooding.

9.3 Flood Risk from Artificial Sources

9.3.1 Flood Risk from Reservoirs

Volume 3 Figure 13 shows that the only reservoir-related artificial flood risk within the Woking Borough study area is from Sutton Place Lake. In the low probability event of the embankments becoming breached, flooding may occur along the Wey floodplain north towards Westfield. The EA dataset, Reservoir Flood Map Maximum Outline, shows this flooding to only affect a couple properties such as Moorland and Fisher's Farm, which are along the floodplain.

9.3.2 Flood Risk from the Basingstoke Canal

No information on Historic flood incidents from the Basingstoke Canal within Woking was provided by Surrey County Council or Woking Borough Council. Information presented in the previous SFRA highlighted that a breach had occurred external to the study area, and flooding did not influence the

Woking Borough. Correspondence with the Basingstoke Canal Authority also highlighted that there have been very few / no known incidents within the last 20 years[7].

The Basingstoke canal is a contour canal, and its construction requires that a ledge be excavated around the hill, for which the spoil is then placed on the downhill side of the excavation to form a bank to retain water. Whilst this is considered a low risk form of construction, with drainage and compacted material, there is an inherent residual risk of failure of the canal embankments, as in 1968, which would cause surcharging or backing-up of surrounding drains and may cause water logging and flood surrounding areas. Alternatively embankment breach could result in ground slip / movement and cause further issues.

Within the Study Area, the Basingstoke Canal passes through low-lying land, which at some sites was originally marshland and has been historically drained for development. Consequently the land particularly to the south of the canal has extensive drainage ditch networks in place. In the event of the canal breaching its banks, these drainage ditches could back-up or may have a surcharge effect and waterlog the surrounding areas causing flooding. This will affect drainage and possibly result in flooding remote from the canal. A breach at sites 1 to 7 in Volume 3 Figure 13 would possibly result in a discharge of very large volumes of water into the Rive Ditch.

Increased water level within the canal as a direct effect of excessive rainfall has been increased over recent years as a result of increased surface water runoff from diverted road drains and railways drainage. It should be noted however, that the Canal can also reduce flood risk in other areas by carrying surface water runoff away from main river channels and developed areas.

There are many culverts under the Basingstoke Canal within the Study Area which increase flooding probability. These culverts enable the canal to pass over minor watercourses. A blockage or collapse (resulting in a blockage) of any of these culverts could result in extensive flooding and could also surcharge the land drainage system. The sites at risk of culvert failure include sites 5, 7 and 10 in Volume 3 Figure 13.

9.3.3 Flood Risk from the Wey Navigation

The sections of the Wey Navigation that correspond with the navigable river will flood with the river naturally, and therefore the extent of flooding is indicated by the modelled fluvial flood extents. The engineered sections should not flood, and are controlled by various weirs and gates. However some of the engineered sections are on perched embankments and therefore there is a small risk of breach or failure. Should there be a failure the gates controlling water flow through the engineered section of the navigation could be operated to isolate the breached section. Although a specific breach analysis has not been done as part of this SFRA it is likely that as the Wey Navigation is located in the valley bottom, parallel to the river, the flooding resulting from a breach would be within the extents of flooding indicated on the fluvial flood maps.

9.3.4 Climate Change Considerations

Based on information collated as part of the UK Climate Change Projections 2009 (UKCP09)[8], there is likely to be an increased vulnerability of reservoir flooding in response to climate change. This is most likely due to changes in yields, flood flows, water quality and source waters, based in changes in demand, river flows and rainfall events. The UKCcP09 document provides guidance on responding and adapting to climate change for reservoir management.

[7] Surrey County Council, 17th March 2015
[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/399993/RFI7086_DG09_Guidance_Final.pdf

9.4 Management of Flood Risk from Artificial Sources

Summer Weir Protocols ensures that the adjustable sections of weirs in the Surrey section of the canal will be restored to their normal working heights to maintain full water levels in the canal. *Winter Weir Protocols* require the adjustable sections of weirs on the Surrey section of the canal to be reduced in height by 100mm to establish a flow on the canal towards the weirs. In the event of extreme rainfall or a canal emergency, the protocol states that the canal should be isolated into discrete sections, which can then be controlled via the use of sluices. In the case of a dire emergency it is advised in the protocol that the sluices are fully drawn to allow canal water to drain quickly. Although this would result in an immediate relief of flood risk to the area, it is likely that this action could cause flooding problems elsewhere in the vicinity. In such an event the Environment Agency would be informed of this magnitude of weir movement.

It is recommended that WBC consider the flood risk from canal breach when identifying development sites.

The flood risk from reservoirs within the study area is very low, as the probability of occurrence is very low but the potential consequences are high. WBC should attempt to avoid development within the areas that are at potential risk of inundation from reservoirs. However these generally follow well defined river channels and are similar to the areas at risk of fluvial flooding, and should be avoided where possible.

10. Conclusions

The SFRA has identified that the significant sources of flood risk within the Woking Borough Council are fluvial and surface water flooding. A summary of flood risk across the Borough from all sources is shown in Table 10-1.

Table 10-1 – Summary of flood risk from all sources of flooding

Type of Flood Risk	Summary	Further information
Fluvial	Modelled and historic flood extents indicate higher risk along floodplains of Wey, Hoe Stream and Whitmoor Common Brook. Defences modelled along Hoe Stream have significantly reduced flood risk.	Volume 2 Section 4.3
Surface Water	Historically affected areas include Maybury, Byfleet, Old Woking and several roads (particularly Blackhorse Road), which are indicated as at higher risk. Modelling shows areas of Maybury and Sheerwater, Horsell and Goldsworth East at higher risk.	Volume 2 Section 5.3
Sewers	Highest number of historical events in Old Woking and West Byfleet. Higher risk areas are the densely populated wards of Goldsworth West, Maybury and Sheerwater and Mount Hermon.	Volume 2 Section 7.3
Groundwater	Highest groundwater flooding susceptibility in Old Woking and Pyford, where superficial river gravel deposits exist along the Wey floodplain. Parts of central Woking adjacent to Basingstoke Canal also at increased risk. No historic incidents.	Volume 2 Section 8.3
Artificial Sources	Overall low, as breaching embankments unlikely. In situation, Basingstoke Canal is the highest flood risk source in the area, potentially flooding parts of central Woking. Sutton Place lake has minimal flood extent affected several farms in southern Woking Borough.	Volume 2 Section 9.3

Fluvial and surface water flooding are particularly problematic, with the Borough experiencing significant problems historically, particularly during Winter 2013 / 2014. Volume 3, Figure 5 and Figure 8 provides an overview of fluvial and surface water flood risk in the Borough. It is recognised that most of the large scale flooding occurs in undeveloped rural land along the floodplains. There are many areas within the urbanised parts of Woking where properties and infrastructure are at risk of surface water flooding, including Merrivale Gardens, Holyoake Avenue, Sheerwater Community Centre, Rectory Lane, Pryford Road and the mainline Railway at West Byfleet and Hook Heath.

There are few developed areas at risk of combined surface water and fluvial flooding, except at Brookwood and parts of the Hoe Stream. Parts of Old Woking are at elevated groundwater flood risk, however generally flood risk from groundwater across the study area is mostly very low.

It is recommended that WBC liaises with SCC to embrace new policy and guidelines surrounding surface water management practices. This should be supported through the results of the final Surface Water Management Plan, which is presently at draft stage.

There is a high risk of fluvial flooding along the main river corridors of the River Wey, the Hoe Stream and the Addelstone Bourne. Channel and defence maintenance along the channels will ensure fluvial flood risk is reduced, now and in the future. Maintenance of the Hoe Stream FAS will ensure future flood risk is minimised.

Future climate change predictions imply that surface water, sewer and groundwater flooding will become more frequent; therefore the Council needs to plan for future emergencies, become proactive in mitigating against the risk, and provide guidance to residents on how they too can mitigate against the impacts of this type of flooding.

Guidance has been given to the LPA on what types of development are suitable in each of these Flood Zones according to the NPPF. As set out in the current Core Strategy (CS9), all new development proposed within Flood Zone 2 or 3 needs to pass the sequential test prior to development.

It is essential that Flood Risk Assessments are submitted with development proposals to take into account the findings of this, and assess flood risk from all sources. Proposals should also demonstrate that safe access and egress to the development can be maintained during an extreme flood event and that development is set at an appropriate level so that the residual risks are managed to acceptable levels.

Where the site falls within an area which is classified as being at High or Medium Residual Risk, the detailed FRA should include a detailed assessment of the residual risks posed by the existing defences being breached or overtopped in an extreme event (usually the 0.1% AEP plus climate change if available). Developers should seek advice from the Council, the Environment Agency and Thames Water as to the specific requirements for assessment.

11. References

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12. Glossary

Term	Definition
Alluvium	Sediments deposited by fluvial processes / flowing water.
Annual Exceedance Probability (AEP)	The probability of an event occurring within any one given year.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Breach	An opening – For example in the sea defences.
Brownfield	Previously developed land, usually of industrial land use within inner city areas.
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.
Culvert/culverted	A channel or pipe that carries water below the level of the ground.
Drift Geology	Sediments deposited by the action of ice and glacial processes.
EA Flood Zone 1	Low probability of flooding.
EA Flood Zone 2	Medium probability of flooding. Probability of fluvial flooding is 0.1 – 1%. Probability of tidal flooding is 0.1 – 0.5 %.
EA Flood Zone 3a	High probability of flooding. Probability of fluvial flooding is 1% (1 in 100 years) or greater. Probability of tidal flooding is 0.5% (1 in 200 years).
EA Flood Zone 3b	Functional floodplain.
Estuary	A tidal basin, where a river meets the sea, characterised by wide inlets.
Exception Test	The exception test should be applied following the application of the Sequential Test. Conditions need to be met before the exception test can be applied.
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).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Resilience	Resistance strategies aimed at flood protection.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Risk Assessment	Considerations of the flood risks inherent in a project, leading to the development actions to control, mitigate or accept them.
Flood storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone	The extent of how far flood waters are expected to reach.
Fluvial	Relating to the actions, processes and behaviour of a water course (river or stream).
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level.
Functional Floodplain	Land where water has to flow or be stored in times of flood.

Freeboard	Height of the flood defence crest level (or building level) above designed water level.
GIS	Geographic Information System – A mapping system that uses computers to store, manipulate, analyse and display data.
Greenfield	Previously undeveloped land.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Highly Vulnerable Developments	Developments that are at highest risk of flooding.
Hydraulic Modelling	A computerised model of a watercourse and floodplain to simulate water flows in rivers too estimate water levels and flood extents.
Hydrodynamic Modelling	The behaviour of water in terms of its velocity, depth and hazard that it presents. Infiltration The penetration of water through the grounds surface.
Infrastructure	Physical structures that form the foundation for development. Inundation Flooding.
LiDAR	Light Detection And Ranging – uses airborne scanning laser to map the terrain of the land.
Local Development Framework (LDF)	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map.
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by DEFRA. The environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Overtopping	Water carried over the top of a defence structure due to the wave height exceeding the crest height of the defence.
Reach/ Upper reach	A river or stream segment of specific length. The upper reach refers to the upstream section of a river.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	The probability or likelihood of an event occurring.
River Catchment	The areas drained by a river.
SAR	Synthetic Aperture Radar - a high resolution ground mapping technique, which uses reflected radar pulses.
Sequential Test	Aims to steer development to areas of lowest flood risk.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Solid Geology	Solid rock that underlies loose material and superficial deposits on the earth's surface.
Source Protection	Defined areas in which certain types of development are restricted to

Zone	ensure that groundwater sources remain free from contaminants.
Standard of Protection	The flood event return period above which significant damage and possible failure of the flood defences could occur.
Storm surge	A high rise in sea level due to the winds of the storm and low atmospheric pressure.
Sustainability	To preserve /maintain a state or process for future generations.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
Tidal	Relating to the actions or processes caused by tides.
Topographic survey	A survey of ground levels.
Tributary	A body of water, flowing into a larger body of water, such as a smaller stream joining a larger stream.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

Appendix A – Uncertainties in Flood Risk Assessment

When assessing risk, the impact of uncertainties associated with the predictions of the hazard and the consequences should be recognised and appreciated so informed decisions can be made.

This SFRA update addresses the inherent uncertainties and where necessary seeks to institute measures for their reduction.

The strategy for risk management requires that all phases of the planning and implementation process are fully co-ordinated. The level of detail on flood risk assigned to particular proposals will be limited by the information available at the time of the submission of respective planning applications. It should be noted that the outputs of the SFRA are only as good as the data inputs.

The Woking SFRA is owned by Woking Borough Council and should be kept as a live document, reviewed and updated as necessary as the best available information is improved or the inherent uncertainties identified are reduced. Ownership of the SFRA document and maps within WBC will be established by the SFRA Steering Group. The implementation of measures or strategic options may change the Actual Risk, Residual Risk and Flood Hazard.

Other future uncertainties that will affect the estimate of flood risk in the Woking SFRA study area include (but are not limited to):

- Updated hydrological and hydraulic modelling studies
- Changes to the upstream catchment and river channel
- Changes in land use within and upstream of the study area,
- Revision of climate change predictions

It is probable that development proposals will be a focus for the collection of better data in the future and the catalyst for commissioning studies that lead to a reduction in the uncertainty in the magnitude or frequency of influential parameters, i.e. the improvement of hydrometric data, or completion of new hydraulic models on previously unmodelled reaches. A prudent response is to use the best available data at each stage of the planning process and prepare proposals that are respectively precautionary in accordance with the advice in PPG and flexible with respect to uncertainty. The need to prepare stand alone Flood Risk Assessments in support of the submission of particular planning applications will serve to highlight information that would be the trigger for a review of the Woking SFRA.

The Woking SFRA is based on information that will inevitably be amended by better data, changes in the baseline condition due to development and changing institutional and policy conditions. To be robust and able to withstand challenge in the planning process there is a need to ensure the Woking SFRA reflects conditions at the time particular evaluations are made. Failure to maintain the SFRA may reduce the effectiveness of flood risk management measures; delay plan making and development processes; and potentially lead to the neglect of flood risk considerations and the failure to capture strategic responses and interventions.

The Planning Policy Team at WBC will have the prime responsibility for managing and maintaining this SFRA. The SFRA will be monitored annually as part of the annual monitoring report.

Flood Risk from Rivers

The following section summarises the uncertainties and assumptions associated with the hydraulic modelling completed on the watercourses in the area:

- The flows predicted using the hydrological analyses for the Bourne catchment rely on data from a system of gauges that are generally not accurate at high flow magnitudes;

- Topographic data that is used to determine flood extents in the modelling are of limited accuracy due to the techniques used for its production. This has a significant bearing on the uncertainty and accuracy of the flood mapping produced;
- Not all flood defences may have been considered/more may have been constructed following the modelling studies; and
- Not all watercourses in the study area have been specifically hydraulically modelled for this SFRA. Quantification of flood risk on these watercourses is subject to greater uncertainty.

It is also worth noting when considering flood risk that the historic record of flooding is not complete and could be supplemented in future updates of the SFRA. Furthermore when considering the climate change scenario, the additional 20% in magnitude peak flow added to the 1% AEP flood event is not definitive and peak flows could in actuality be more or less.

Flood Risk from Surface Water

The supporting guidance document to the uFMfSW highlights the limitations inherent to the dataset. The following uncertainties therefore apply to the flood risk from surface water:

Although the uFMfSW is a significant improvement on past nationally produced surface water flood mapping, it is important not to lose sight of the limitations which remain. These include the following:

- The methodology assumed a single drainage rate for all urban areas within the nationally produced modelling unless LLFAs were able to provide better local data. Modelled flood extents are particularly sensitive to the way drainage is taken into account. Omitting large subsurface drainage elements such as flood relief culverts and flood storage can also significantly affect the modelled pattern of flooding.
- The nationally produced modelling assumes a free outfall and so does not take into account tide locking or high river levels which may prevent surface water from draining away freely.
- Limited recorded surface water flood data exists for LLFAs, so in many places LLFAs have not yet been able to validate the nationally produced modelling.
- As with many other flood models:
    - The input information, model performance and modelling that was used to create the nationally produced modelling varies for different areas. For example, in many areas, the ground level data is based on detailed LIDAR information, but where this is not available ground levels are much less accurate. Similarly, models of this type tend to perform better in steeper rural areas than in flat urban areas. These variations affect the reliability of the mapped flood extents and, in turn, the suitability for different applications.
    - UFMfSW does not take individual property threshold heights into account so the map shows areas that may potentially flood but cannot accurately predict the impacts on individual properties.
    - The flood extents show predicted patterns of flooding based on modelled rainfall. The patterns of flooding from two similar storm events can vary due to many local circumstances.

Consequently these maps cannot definitively show that an area of land or property is, or is not, at risk of flooding, and the maps are not suitable for use at an individual property level.

Flood Risk from Sewers

Assessing the risk of sewer flooding over a wide area is limited by the lack of data and the quality of data that is available. Furthermore, flood events may be a combination of surface water, groundwater and sewer flooding.

An integrated modelling approach is required to assess and identify the potential for sewer flooding but these models are complex and require detailed information. Obtaining this information can be problematic as datasets held by stakeholders are often confidential, contain varying levels of detail and may not be complete. Sewer flood models require a greater number of parameters to be input and this increases the uncertainty of the model predictions.

Existing sewer models are generally not capable of predicting flood routing (flood pathways and receptors) in the above ground network of flow routes (for example, streams, dry valleys, and highways).

Use of historic data to estimate the probability of sewer flooding is the most practical approach; however it does not take account for improvements to the network, including clearance of blockages, which may have occurred. Nor does it account of possible future changes due to climate change or future development.

UKCP09 (UK Climate Projections) provides future climate projections for land and marine regions as well as observed (past) climate data for the UK. UKCP09 was produced in 2009, funded by a number of agencies led by Defra. It is based on sophisticated scientific methods provided by the Met Office, with input from over 30 contributing organisations. UKCP09 can be used to help organisations assess potential impacts of the projected future climate and to explore adaptation options to address those impacts.

Flood Risk from Groundwater

The supporting document to the British Geological Society outlines the limitations of the dataset and highlights the importance of using the information in conjunction with other flood risk data. The following is taken from the supporting document.

The susceptibility data is suitable for use for regional or national planning purposes where the groundwater flooding information will be used along with a range of other relevant information to inform land-use planning decisions. It might also be used in conjunction with a large number of other factors, e.g. records of previous incidence of groundwater flooding, rainfall, property type, and land drainage information, to establish relative, but not absolute, risk of groundwater flooding at a resolution of greater than a few hundred metres. The susceptibility data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. The susceptibility data cannot be used on its own to indicate risk of groundwater flooding.

Flood Risk from Artificial Sources

The reservoir flood map outline shows the largest area that might be flooded if the reservoir fails and releases all of the water it holds, which is extremely unlikely, and is a prediction of worst case scenario. Actual flood risk is considered to be much lower than these outlines show. The flood map does not include smaller reservoirs of reservoirs commissioned after spring 2009 (when mapping began).

Flood risk from the Basingstoke Canal has been assessed based on areas susceptible to breach, failure and overtopping during the 2010 SFRA. Degradation as well as maintenance of embankments will affect the risk of failure, which has not been considered in the assessment.

Appendix B - Managing Surface Water with SuDS

What is the SuDS Approach?

The SuDS approach is centred on mimicking natural drainage. SuDS encourages the management of water as close to its source as possible, using features that collect, filter, store and/or infiltrate water using mechanisms similar to that found in nature. SuDS practices should be designed taking the following criteria into consideration:

- water quantity;
- water quality; and
- amenity/biodiversity.

By considering all three functions adequate and well designed systems should be provided. SuDS components work in several ways: infiltration (soak) into the ground, conveyance (flow) into a watercourse (or if necessary a sewer), and attenuation (slow down). When selecting SUDS components the site opportunities and constraints need to be fully considered, it is sometimes schemes that provide a combination of approaches that provide the best results.

There is an economic benefit of installing SuDS for the developer. Defra commissioned a detailed study to provide an evidence base for drainage design and operational costs (WT1505), which was published in July 2013. The study looked at the cost implications of a SUDS design on a small site (8 dwellings), a medium site (32 dwellings) and a large site (210 dwellings) compared to a traditional scheme.

The cost of installing SUDS measures on all sites were dependent on ground conditions. Where the ground was not contaminated and therefore SUDS systems did not need lining and additional features for treatment, the costs were lower than the installation of traditional systems. Where the ground required systems to be lined, cost of installation was lower on medium and large sites but slightly higher on small sites.

Water Quantity

SuDS practices can play a key role in managing surface water through two mechanisms: runoff rate and storage volumes. As SuDS features often utilize pervious surfaces, they reduce runoff rates from the site compared to conventional development comprised primarily of impervious surfaces. SuDS can also help supplement the volume of water that must be stored on-site (attenuation volume) to achieve the desired runoff rate from the site. SuDS practices can store and/or infiltrate surface water into the surrounding soil, providing the necessary for attenuation storage for frequent rainfall events.

Water Quality

SuDS techniques help to improve surface water quality through the use of a ‘Management Train,’ which recommends incorporating a chain of techniques throughout a development, (as outlined in CIRIA C697 (Woods Ballard *et al*, 2007), where each component adds to the performance of the whole system. The Management Train approach consists of four stages:

- **Prevention** — good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping)
- **Source control** — runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements)

- **Site control** water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site)
- **Regional control** integrate runoff management from a number of sites (e.g. into a wetland).

Amenity/Biodiversity

As SuDS techniques can be integrated within the fabric of a site they provide opportunities to create amenity areas and improve the site's biodiversity. Many SuDS techniques are landscaped with grasses and/or plantings that help to create green streets, neighbourhoods and commercial/industrial properties. SuDS can also be implemented as part of multi-functional places, enabling both the management of surface water and other uses like recreation within the same space.

SuDS Techniques

There are a wide range of SuDS techniques available for use throughout the four stages of the Management Train. Techniques available to manage the quantity of surface water typically operate in combination or solely on the basis of the following two main principles:

- Infiltration
- Attenuation

The effectiveness of techniques in achieving the goals of attenuating discharges, reducing pollution and providing amenity benefit will depend on a number of other factors such as filtration, settlement and oxidation.

The SuDS Manual (C697)[9] provides a summary of SuDS techniques and their suitability to meet the three goals of sustainable drainage systems (water quantity, water quality and amenity biodiversity) and their suitability within the stages of the Management Train. Table B-12-1 presents a summary of a variety of SuDS techniques along with their suitability in achieving the goals of sustainability and their place within the Management Train.

[9] CIRIA, The SUDS Manual (C697), March 2007

Table B-12-1: Summary of SuDS Techniques and their Suitability to meet the three goals of sustainable drainage systems

Management Train	SuDS Technique	Description	SuDS Principle	Water Quantity	Water Quality	Amenity Biodiversity
Source, Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	Attenuation	●	●	●
Source, Prevention	Rainwater harvesting	Capturing and reusing rainwater for domestic or irrigation uses.	Attenuation	●	○	○
Source, Prevention	Arboriculture	Planting of trees / hedgerows to intercept surface water runoff and increase infiltration	Attenuation /Infiltration	●	●	●
Source, Prevention	Permeable pavements	Infiltration through the surface into underlying layer.	Infiltration	●	●	○
Source	Filter drains	Drain filled with permeable material with a perforated pipe along the base.	Infiltration	●	●	X
Source	Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	Infiltration	●	●	X
Source	Soakaway	Underground structure used for store and infiltration.	Attenuation	●	●	X
Source	Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	Attenuation	●	●	●
Site, Source	Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	Attenuation	●	●	○
Site	Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	Infiltration	●	●	X
Regional, Site	Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	Attenuation	●	●	○
Regional, Site	Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	Attenuation	●	●	●
Regional, Site	Wetlands	Similar to ponds, but are designed to provide continuous flow through vegetation.	Attenuation	●	●	●

Key: ● – highly suitable, ○ - suitable depending on design, X – unsuitable

Design of SuDS techniques

Detailed guidance for the design of SuDS, including specific guidance for individual SuDS techniques is available in the CIRIA SuDS Manual C697, and the associated document 'Site Handbook for the Construction of SuDS, C698 (Woods Ballard *et al*, 2007a). These publications provide best practice guidance on the planning, design, construction, operation and maintenance of SuDS to ensure effective implementation within developments.

The design of SuDS measures should be undertaken as part of a drainage strategy and design for a development site. A ground investigation should form part of the SuDS assessment to determine ground conditions and the most appropriate SuDS technique(s). Hydrological analysis should be undertaken using industry approved procedures to ensure an appropriate design is developed. This should account for the effects of climate change over the lifetime of the proposed system/development and based on an agreed permitted rate of discharge from the site.

It is a Material Planning consideration that detailed SuDS designs accompany major planning applications. The information submitted must demonstrate the system works and is viable for the critical storm durations. A simulation model will need to be submitted as part of the application demonstrating the proposal does not surcharge the system for the 1 in 1 year event, flood in the 30 year event and if flooding occurs in the 100 year and the 100 year plus climate change event that it is contained safely on site, does not flood buildings and does not leave the site by overland flow routes. It is no longer acceptable to leave the design of SuDS to a later stage to be dealt with by planning condition.

Incorporating SuDS into a site plan

The flexibility of SuDS to be placed throughout a site, to meet a variety of criteria and be integrated within the urban fabric means that it is suitable for a wide range of land use types, site topographies and geology. Often a successful SuDS solution will utilise a number of techniques in combination, providing flood risk, pollution and landscape/wildlife benefits to the site and surrounding area. This section provides some guidance on how to incorporate SuDS techniques as part of the master planning and outline planning stages. It has been adapted from C687 Planning for SuDS.

To assist developers and their design teams on how to properly plan for SuDS, Surrey County Council working in partnership with the other Lead Local Flood Authorities in the South East, have prepared the guidance document, Water, People, Places. This is a guide to master planning sustainable drainage into developments.

Examine site topography and geology

During this stage, characterize the existing site topography to determine natural flow paths. Bedrock and superficial geology can be used as an initial tool to determine locations where SuDS techniques should be located to maximize their infiltration potential. More in-depth analysis of soil conditions, including borehole testing and soakage testing are required to confirm the suitability of SuDS techniques and their ideal placement upon the site.

Create a spatial framework for SuDS

The next step in the planning process is to develop an estimate of impermeable (paved roadway and buildings) and permeable surface across the site. This information is used to assess pre- and post-development runoff rates and volume, from which attenuation storage/infiltration targets can be set. The number, type(s) and size of SuDS practices can then be determined as part of the surface water management scheme at the site.

Look for multi-functional spaces
look for areas of the site where SuDS practices could be integrated within the urban fabric, for instance locating SuDS in planned green space, within a play area.

Integrate the street network with SuDS
The street network is one of the most important areas to incorporate SuDS. Swales can be located along the road network to accept street runoff, tree planters can be configured to accept runoff from roads and car parks and the use of rain gardens and bioretention techniques can be used to create ‘green streets’ that improve the amenity of a property. Large below-ground storage/infiltration practices can also be located beneath the street network or car parks. Pervious pavement materials are ideal for car parks and parking lay-bys.

A common concern with incorporating SuDS in developments is the belief that all SuDS are ‘land hungry’ and significantly impact on the developable area of sites. By applying the principles discussed above, SuDS can be considered at the earliest opportunity, ensuring that they are integrated within the site using as little land as possible, whilst creating multi-functional spaces that improve the amenity value of the property. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS, however, each development site must offset its own increase in runoff; attenuation cannot be “traded” between developments.

SuDS Constraints

The underlying ground conditions of a development site will often influence the type(s) of SuDS technique suitable at an individual site. While this will need to be determined through ground investigations carried out on-site, an initial assessment of the site’s suitability to the use of SuDS can be obtained from a review of the available soils/geological survey of the area.

Much of Woking Borough is located on the Sandstone Beds which is mostly suitable geology for the use of infiltration based SuDS. In the areas where infiltration SuDS are less suitable, sustainable drainage can be achieved by the use of ponds, swales, wetlands and other such methods which do not rely on infiltration into the ground. There are a no identified groundwater abstractions around Woking and none of the Borough lies within a Source Protection Zone which does not limit the use of infiltration based SuDS. It is recommended that for all sites where infiltration drainage is proposed on site test are carried out to determine specific infiltration rates.

It is recommended that developers should consult WBC, the Environment Agency, and relevant service authorities and Utility Companies at the earliest stage of the development process to establish the best solution for a particular site.

During the design process, in addition to considering the properties of the underlying soils and strata it is necessary to also consider the sensitivity of the receiving water body and any previous uses of the site.

The use of SuDS can be limited based on a number of constraints, which include:

- Groundwater vulnerability and potential contamination of an aquifer;
- Current or target water quality of a receiving watercourse;
- The presence of groundwater Source Protection Zones and potential contamination of a potable water source;
- Restrictions on infiltration on contaminated land to prevent the spread of contamination; and,
- Restricted area on development sites where housing densities are high.

Groundwater Vulnerability

Groundwater resources can be vulnerable to contamination from both direct sources (e.g. into groundwater) or indirect sources (e.g. infiltration of discharges onto land). Groundwater vulnerability within the study area has been determined by the Environment Agency based on a review of aquifer characteristics, local geology and the leachability of overlying soils.

The vulnerability of the groundwater is important when advising on the suitability of SuDS. The Environment Agency is the responsible drainage authority for any discharges to groundwater and should be consulted on proposals to discharge to ground. Groundwater vulnerability for the study area can be assessed by reviewing the most up-to-date maps on the Environment Agency's website.

Groundwater Source Protection Zones

In addition to groundwater vulnerability, the Environment Agency also defines groundwater Source Protection Zones (SPZs) around groundwater abstraction points. Source Protection Zones are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks.

SPZs are defined based on the time it takes for pollutants to reach an abstraction point. Depending on the nature of the proposed development and the location of the development site with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas.

Any restrictions imposed on the discharge of site generated runoff by the Environment Agency will be determined on a site by site basis using a risk based approach. SPZ for the study area can be assessed by reviewing the most up-to-date maps on the Environment Agency's website.

Water Quality

Under the Water Framework Directive all member states are required to take steps to achieve good ecological and chemical status of water bodies by 2027. To achieve this, discharges to watercourses draining development areas will require pre-treatment to remove oils and contaminants. Appropriately designed SuDS can assist developments improve water quality discharges through passive treatment, whilst additionally providing ecological benefit to a development or local area. Developments should be connected to the public sewer network, unless proven unreasonable, to help protect water quality.

Contaminated Land

Previous site uses can leave a legacy of contamination that if inappropriately managed can cause damage to local water bodies. During the design of SuDS it is essential to have regard to the nature of potential ground contamination.

Particular restrictions may be placed on infiltration based SuDS, forcing consideration of attenuation based systems. Early discussion with the authority responsible for the receiving water body should be undertaken to establish the requirements of SuDS on contaminated sites.

High Development Densities

Where developments are required to achieve high development densities it is essential that the requirement for SuDS and their constraints are identified early in the site master planning process. High development densities can restrict the land area available for SuDS, which if mandatory can affect the ability of a site to gain planning permission.

Early consideration of SuDS enables the drainage requirements to be integrated with the design, limiting the impact they have on developable area and development densities.

Further Guidance on SuDS

- CIRIA C635 Designing for Exceedance in Urban Drainage – Good Practice (2006)
- CIRIA C687 Planning for SuDS – Making it Happen (2010)
- CIRIA C697 The SUDS Manual (2007)
- CIRIA C698 Site Handbook for the Construction of SuDS (2007)
- CIRIA C753 The SUDS Manual (To be published)
- Communities and Local Government – Guidance on the Permeable Surfacing of Front Gardens (2008)
- London Borough of Islington - Promoting Sustainable Drainage Systems (2013)
- CIRIA C609 Sustainable Drainage Systems – Hydraulic, structural and water quality advise (2004)

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