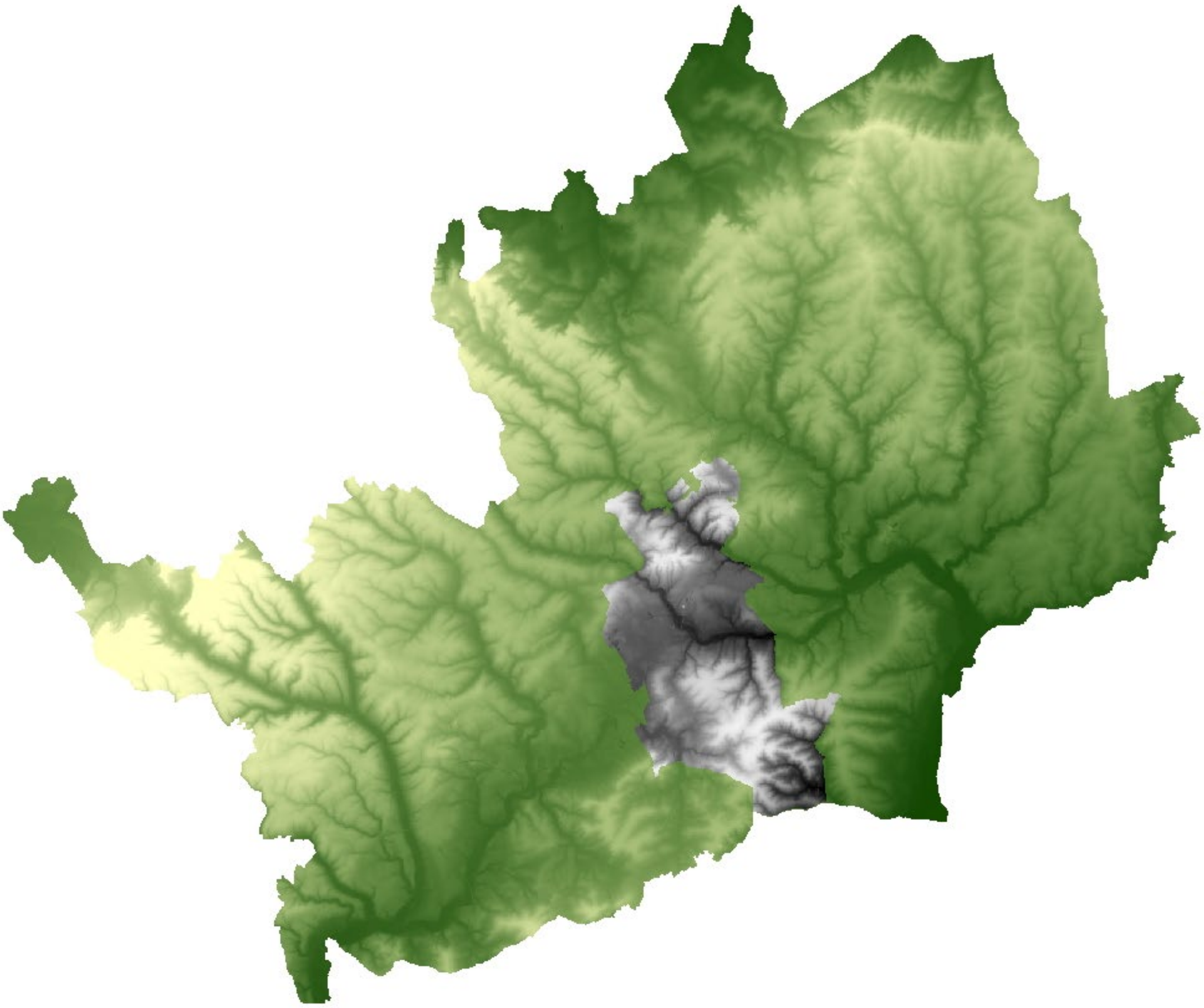

Welwyn-Hatfield Borough Surface Water Management Plan

Final Report

March 2021

Hertfordshire County Council
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Revision history

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Contract

This report describes work commissioned by Hertfordshire County Council, by a letter dated 2nd August 2017. Emily Jones, Cheryl Briars and Alistair Clark of JBA Consulting carried out this work.

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Purpose

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Executive summary

The Local Flood Risk Management Strategy (LFRMS) for Hertfordshire 2013 – 2016 identified the need for district scale Surface Water Management Plans (SWMPs) for each of the 10 local authority areas in the county. The Welwyn-Hatfield Surface Water Management Plan (SWMP) has been prepared alongside parallel studies for Three Rivers District, Stevenage Borough and Hertsmere Borough. Together, these four studies will complete coverage of SWMPs for the county.

A SWMP is a framework to improve the understand of surface water flood risk in an area. The study has been led by Hertfordshire County Council as Lead Local Flood Authority (LLFA), in partnership with key stakeholders; Welwyn-Hatfield Borough Council, the Environment Agency and Thames Water Utilities Limited to improve the understanding of risk and work together to find the most cost-effective way to manage the risk.

The SWMP includes an intermediate scale assessment of surface water flood risk across the district to identify key surface water flood risk hotspots, which is then further analysed through detailed catchment scale assessments of the hotspots.

Welwyn-Hatfield is a borough in Hertfordshire, England. The area is a mix of urban and rural areas that is surrounded by Green Belt. Major towns include Hatfield in the centre of the borough, and Welwyn Garden City in the north which are all included in the study area. Several main rivers flow through the borough including the Lee, the Upper Colne, Mimmshall Brook and the Mimram. In addition to the fluvial flood sources, the county is at risk of surface water flooding, which is the dominant risk to all the identified hotspots. The risk from sewer flooding is also considered as part of the SWMP.

Using the Hertfordshire County Council flood incident record, a Source-Pathway-Receptor model was applied. The application of the model facilitates flood risk management by potentially addressing the source (often very difficult), blocking or altering the pathway and even removing the receptor e.g. finding an alternative location for development. Mapping these flood incidents across the borough, by source, provides a visual aid for understanding the cause of flooding in the identified hotspots.

To better understand flood risk in Welwyn-Hatfield, and identify potential solutions, the SWMP was based around a series of detailed integrated models, each focussing upon a hotspot. All models represented the varying landscape across each hotspot, and incorporated surface water sewer networks and watercourses to understand flood risk to the area. The following areas were identified as highest risk, and therefore modelled:

- WHBC3: Hyde Valley;
- WHBC6: Digswell Water.

Using the outputs from the detailed modelling, potential interventions to alleviate flood risk have been identified, and detailed within the hotspot shortlisting. The implementation of the action plan will be undertaken locally, and it is expected that partners will take forward actions independently and convene as and when appropriate.

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Abbreviations

ASTGWF ....Areas Susceptible to Groundwater Flooding
AStSWF ....Areas Susceptible to Surface Water Flooding
BGS..........................British Geological Survey
DRN ....Detailed River Network
EA ....Environment Agency
GIS ....Geographic Information System
HCC ....Hertfordshire County Council
IUDS.........................Integrated Urban Drainage Study
JBA...........................Jeremy Benn Associates
LFRMS ....Local Flood Risk Management Strategy
LLFA.........................Lead Local Flood Authority
LNR ....Local Nature Reserve
LPA ....Local Planning Authority
NFM ....Natural Flood Management
OS ....Ordnance Survey
PFR ....Property Flood Resilience
RMA ....Risk Management Authority
RoFSW.....................Risk of Flooding from Surface Water
SAC ....Special Area of Conservation
SFHD ....Sewer Flooding History Database
SSSI ....Site of Special Scientific Interest
SuDS........................Sustainable Drainage Systems
SWMP ....Surface Water Management Plan
TWUL ....Thames Water Utilities Limited
WFD ....Water Framework Directive
WwNP ....Working with Natural Processes

1 Introduction

1.1 Background

The Local Flood Risk Management Strategy (LFRMS) for Hertfordshire 2013 – 2016 identified the need for district scale Surface Water Management Plans (SWMPs) for each of the 10 district authority areas in the county. This document aims to improve the understanding of surface water flood risk in Welwyn-Hatfield Borough.

This report has been developed using the Defra Surface Water Management Plan Guidance[1] published in 2010 and details of the SWMP process are set out in Chapter 1.4.

1.2 Study area

The Borough of Welwyn-Hatfield is situated 25km to the north of London, covering an area of approximately 129km^2. It is bordered by the local authorities of North Hertfordshire, St Albans, Broxbourne, Hertsmere, and East Hertfordshire. The main urban areas in the borough are Hatfield, in the centre, and Welwyn Garden City to the north. Other urban settlements include Brookmans Park, Welham Green, Welwyn, Oaklands, Mardley Heath and Cuffley. Outside of these urban areas there are large tracts of countryside, Green Belt land and smaller settlements and villages.

The study area has a number of watercourses that predominately drain from north west to south east as shown in Figure 1-1. The principal watercourses are the River Lee, the Upper Colne, Mimmshall Brook and River Mimram. Parts of the borough have relatively steep topography, including the land around Cuffley, east Hatfield, Ayot St Lawrence and north Welwyn Garden City.

1 Defra Surface Water Management Plan Technical Guidance, March 2010. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

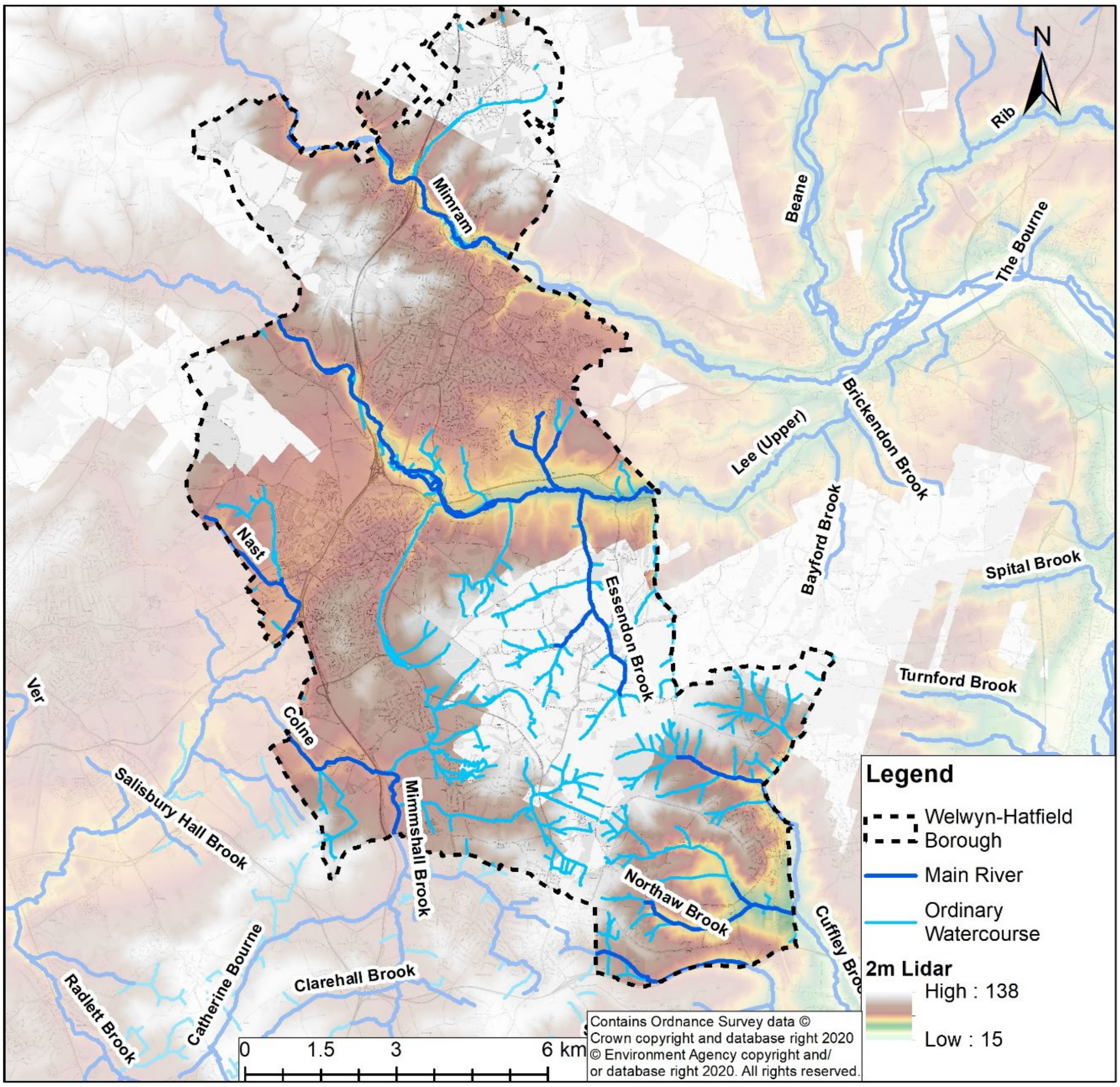

Figure 1-1: Location plan of the SWMP study area and topography of Welwyn-Hatfield Borough

1.2.1 Geology

The bedrock geology of Welwyn-Hatfield Borough consists of Upper Chalk in the north with the Lambeth Group in the centre of the borough, and outcrops of London Clay to the south. The superficial geology consists of predominately River Terrace Deposits, Alluvium and Till. There are also a number of depressions within the borough, which are most notably to the south of Welham Green at Water End. These are depressions in the ground of various sizes that capture overland flow. They are normally found in chalk or limestone landscapes and are connected to underlying aquifers. A simplified map of the bedrock and superficial geology of the borough is shown Figure 1-2.

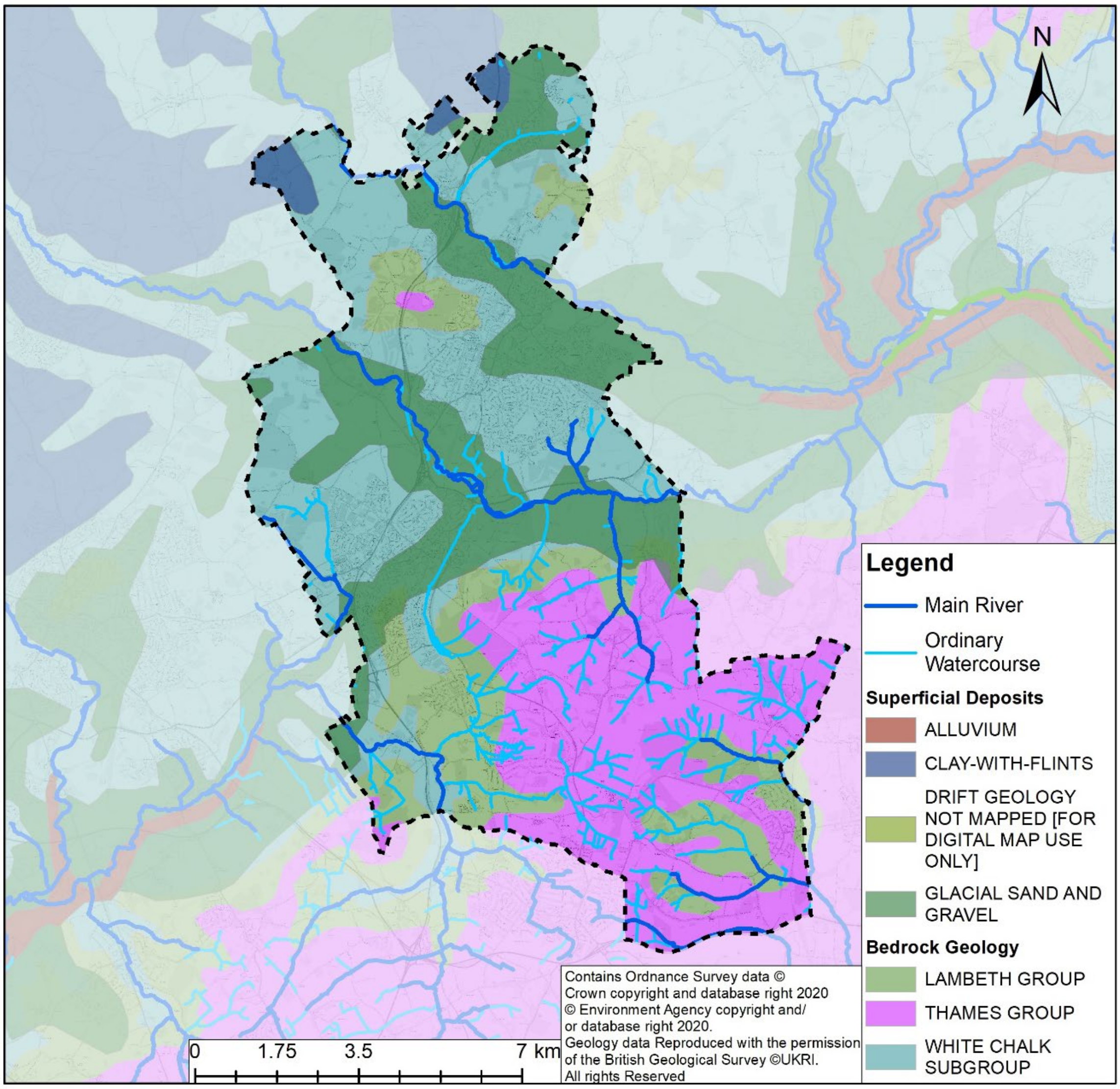

Figure 1-2: Bedrock and superficial geology underlying Welwyn-Hatfield Borough

1.2.2 Watercourses

Main river

A Main River is any watercourse which is designated as such on the Environment Agency Main River map, and for which the Environment Agency has responsibilities and powers. Main Rivers are generally larger arterial watercourses, but smaller watercourses can be designated if the watercourse poses a significant flood risk. Where fluvial or tidal flooding from main rivers is the sole source of flooding, it is the role of the Environment Agency to manage the flood risk. Fluvial flooding from Main Rivers is outside the scope of a SWMP and is addressed in the Catchment Flood Management Plan and Flood Risk Management Plan, or other local more detailed studies. However, interactions between a watercourse and the local drainage network and surface water flows, may impact on the surface water flood risk in certain areas.

There are several Main Rivers, which run predominately from north west to south east through the Borough including theLee, Upper Colne, Mimmshall Brook and the Mimram. The ee enters the borough boundary in the west near to Warren Farm and flows in a south easterly direction towards Welwyn Garden City. It flows adjacent to Stanborough Park and south of Welwyn Garden City where there are flow control structures on the watercourse. The Hatfield Hyde Brook and Essendon Brook converge with the Middle Lee before it flows out of the study area. The Mimram catchment covers the north of the borough including the areas of Welwyn Garden City, Welwyn and Oaklands, covering an area of approximately 8km. The Upper Colne is located in the south west of the study area and flows westerly through North Mymms park. The Mimmshall Brook is another Main River classified by the Environment Agency that rises to the southwest of the borough near Borehamwood and flows through isolated and rural areas. Other main rivers identified in Figure 1-3 include Turkey Brook, and Cuffley Brook.

Ordinary watercourses

In England and Wales, the term ordinary watercourse refers to rivers, streams, ditches and drains which do not form part of a Main River. Hertfordshire County Council (HCC) as a LLFA, has permissive powers to regulate works on ordinary watercourses within Hertfordshire.

There are several unnamed ordinary watercourses that run through the central band of Welwyn-Hatfield Borough that are identified by the light blue line in Figure 1-3.

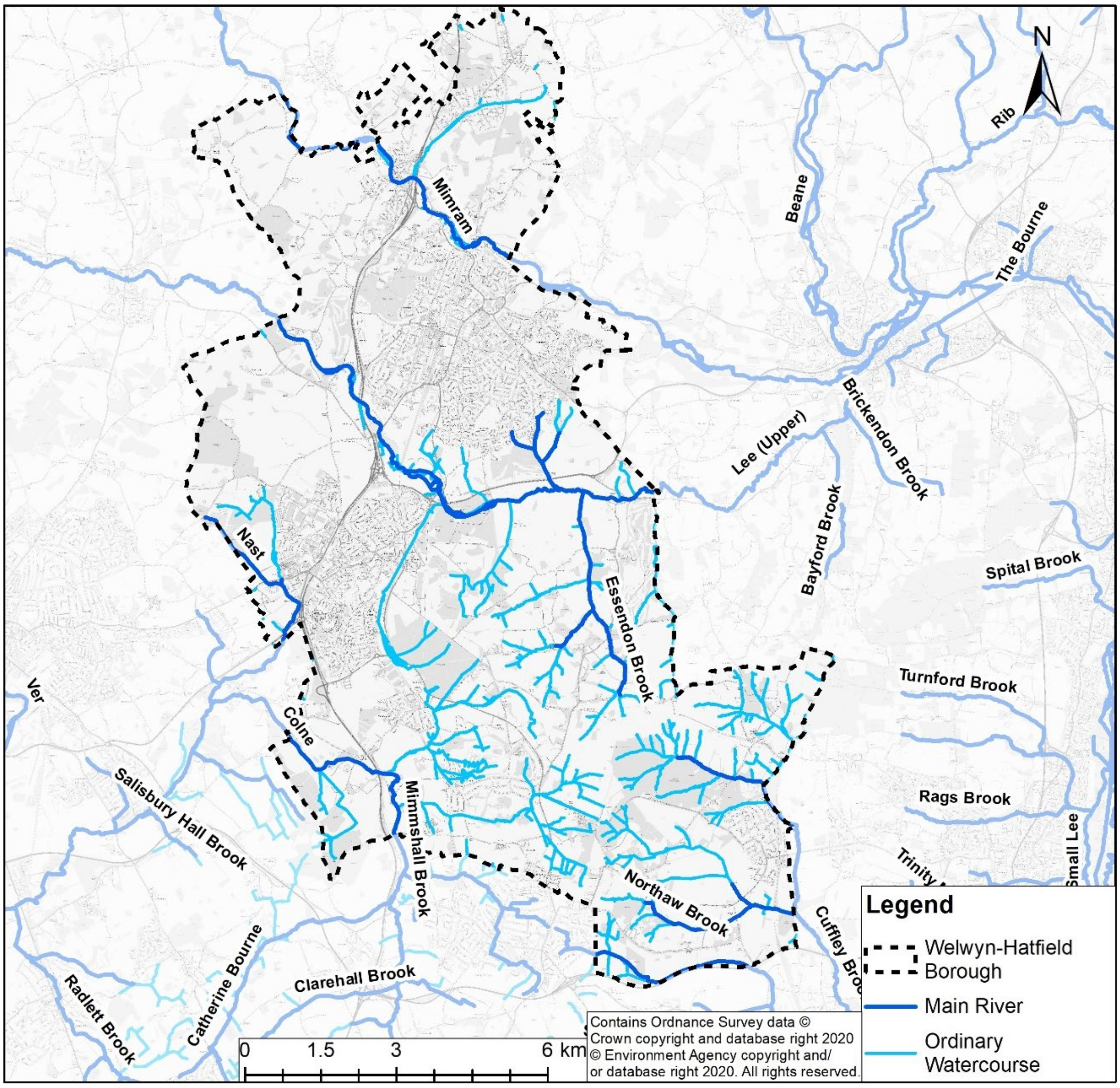

Figure 1-3: Location of main rivers and ordinary watercourses in Welwyn-Hatfield Borough

1.2.3 Sewers

Sewers describe infrastructure generally below ground, for the conveyance of wastewater. Sewers are categorised by the type of wastewater removed and include:

- Foul sewer;
- Surface water sewer;
- Combined sewer.

Foul sewers convey sewage from houses and commercial properties to treatment works. Surface water sewers take runoff from domestic premises, yards and roofs, also (under agreement) highway drainage. Combined sewers convey a mix of both foul water and surface water.

Thames Water Utilities Limited (TWUL) is responsible for the public sewer network in this area. As a partner of the SWMP process, TWUL has provided records of its assets in Welwyn-Hatfield. This SWMP will concentrate mainly on surface water and combined sewer networks. The performance of these drainage networks relates directly to the proportion of rainfall which forms pluvial runoff and the inflow into ordinary watercourses from the surface water drainage network.

Sewer flooding from the foul and surface water sewer network is the responsibility of TWUL. Foul sewer flooding has been considered in the SWMP to examine interactions between foul sewer surcharge and other, local flood sources such as infiltration of groundwater into the sewer network.

Overloaded foul and combined sewer networks can result in sewer outflows which can present potential water quality and public health issues. Although water quality is not the principal driver for this project, a SWMP should provide a framework for improving the quality of water within the area. As a result, some actions resulting from the SWMP may also improve the water quality in the borough.

1.2.4 Surface water

Surface water flooding occurs when rainfall fails to infiltrate into the ground or enter the drainage system. Ponding generally occurs at low points in the topography. The likelihood of flooding is dependent on not only the permeability of the surface, but also saturation of the receiving soils, the groundwater levels and the capacity and condition of the surface water drainage system (i.e. surface water sewers, highway authority drains and gullies, open channels, ordinary watercourses and SuDS).

The Environment Agency Risk of Flooding from Surface Water (RoFSW) mapping will be used to assess the potential areas/valleys that may act as a flow path for surface water, identifying areas of ponding that could occur in areas of lower lying topographic floodplains within the borough.

1.2.5 Climate change

There is still considerable uncertainty regarding the localised impact of climate change, but it is likely that the risk of flooding will increase under any climate change scenario. This increased risk could manifest itself as more frequent flooding, increase in flood extent and an increase in flood depth.

Climate change is predicted to increase rainfall intensity in the future by up to 40%[2] under the new range of allowances published by the EA.

This will increase the likelihood and frequency of surface water flooding, with the greatest impact experienced in impermeable urban areas such as Welwyn Garden City. Fluvial flood risk to watercourses such as Essendon Brook, Ray Brook and Cuffley Brook will increase with the impact of climate change, which is likely to impact the fluvial flood risk exposed to Welwyn-Hatfield Borough, and flooding from surface water drainage systems restricted by higher river levels.

1.3 Integrated flood risk

Where relevant this SWMP has considered the integrated flood risk that is created by the interaction between sewer exceedance, fluvial flooding, pluvial runoff, restricted outfall and groundwater flooding.

1.4 Surface Water Management Plans

A SWMP outlines the preferred surface water management strategy for a specified location. Defra defines surface water flooding as "flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall".

This SWMP was undertaken to explore the local flood risks in the borough. It was carried out to provide a strategy for managing surface water in the area.

At the heart of the SWMP process there is recognition that surface water is managed by a complex patchwork of organisations and responsibilities, and therefore requires a partnership approach in order to deliver joined-up solutions.

This SWMP has been developed in line with the Defra guidance for the preparation of SWMPs[3], which follows a four-stage "wheel" of preparation, risk assessment, options and implementation shown in Figure 1-4.

2 Environment Agency (2016) Flood Risk Assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
3 Surface Water Management Plan Technical Guidance, 2010. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf. Accessed on 26/09/2017.

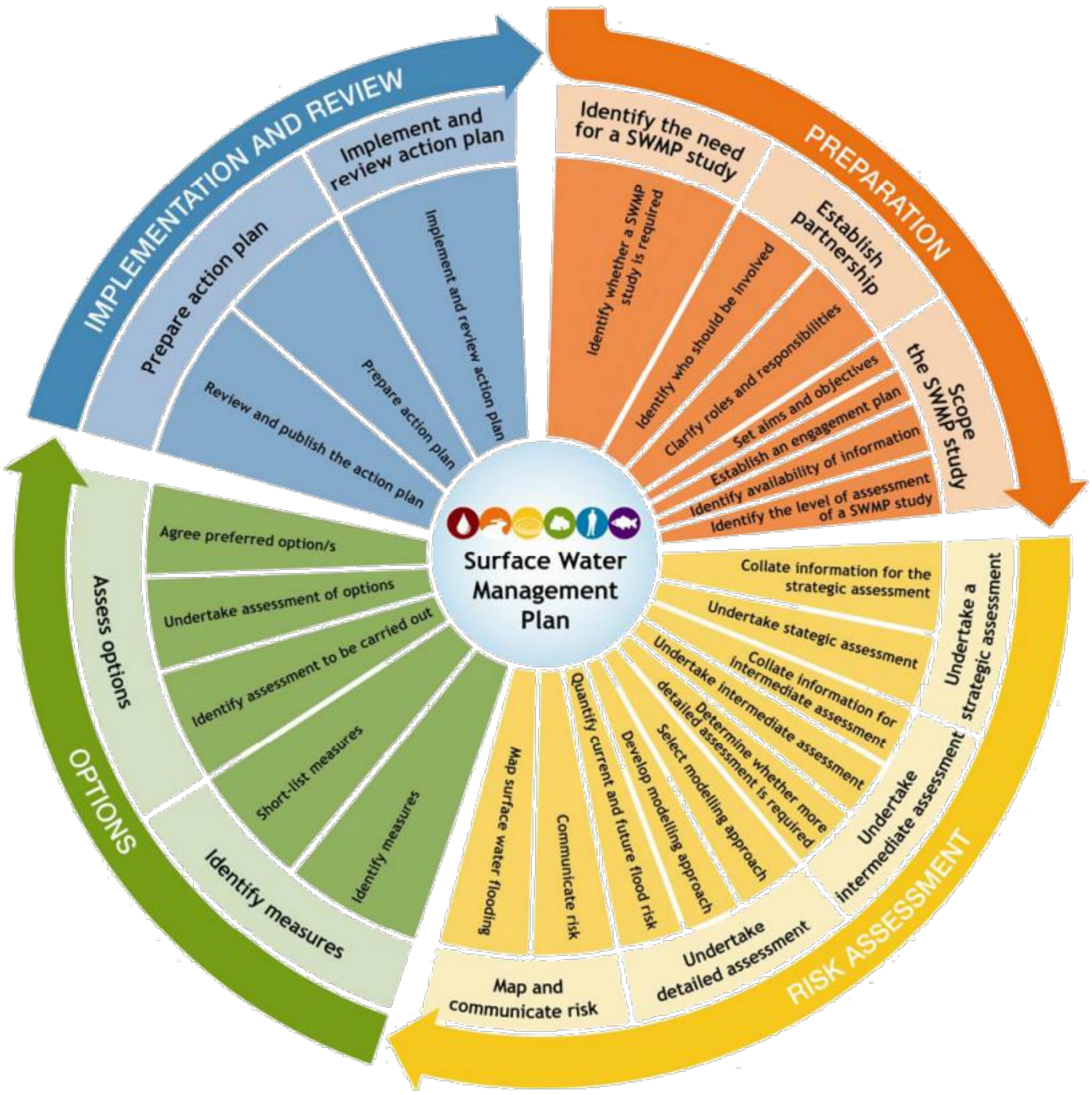

Figure 1-4: Defra Surface Water Management Plan "Wheel"

1.5 Stages of a SWMP

The four phases to be completed as part of a SWMP study as set out by the Defra guidance are as follows:

- **Preparation** – The first phase of SWMP study focuses on preparing and scoping the requirements of the study. Once the need for a SWMP study has been identified the LLFA and the key stakeholders should identify how they will work together to deliver the SWMP study. The aims and objectives of the study should be established, as well as details of how all parties should be engaged throughout the SWMP study. An assessment should subsequently be undertaken to identify the availability of information. Based on the defined objectives, current knowledge of surface water flooding, and the availability of information, an agreement is made regarding the level of assessment at which the SWMP study should start.
- **Risk assessment** – The outputs from the preparation phase will identify which level of risk assessment will form the first stage of the SWMP study. The first stage is likely to be the strategic assessment where little is known about the local flood risks. The strategic assessment focuses on identifying areas more vulnerable to surface water flooding for further study. The

intermediate assessment, where required, will identify flood hotspots in the chosen study area, and identify quick win mitigation measures, and scope out any requirements for a detailed assessment. A detailed assessment of surface water flood risk may be required to enhance the understanding of the probability and consequences of surface water flooding and to test potential mitigation measures in high risk locations. Guidance is provided on undertaking modelling to support a detailed assessment of surface water flood risk and mitigation measures. The outputs from the strategic, intermediate and/or detailed assessment should be mapped and communicated to all stakeholders including spatial planners, local resilience forums, and the public.

- **Options** – In this phase a range of options are identified, through stakeholder engagement, which seeks to alleviate the risk from surface water flooding in the study area. The options identified should go through a short-listing process to eliminate those that are unfeasible. The remaining options should be developed and tested using a consideration of their relative effectiveness, benefits and costs. The purpose of this assessment is to identify the most appropriate mitigation measures which can be agreed and taken forward to the implementation phase.
- **Implementation and Review** – Phase 4 is about preparing an implementation strategy (i.e. an action plan), delivering the agreed actions and monitoring implementation of these actions. The first step is to develop a coordinated delivery programme. Once the options have been implemented, they should be monitored to assess the outcomes and benefits, and the SWMP should be periodically reviewed and updated, where required.

2 Preparation

2.1 Identify the need for a SWMP

Action 8.2.4 of the first LFRMS for Hertfordshire4 identified a need to develop 10 SWMPs across the county based on the boundaries of the district / borough authorities. As the LLFA, HCC is seeking to gain an improved understanding of local flood risk. SWMPs within Hertfordshire are being prepared at the district/borough scale in order to:

- Ensure a complete coverage of SWMPs across the county;
- Reinforce the linkage between surface water management and the Local Planning Authorities (LPAs);
- Align with the role of district and borough councils as Risk Management Authorities (RMAs).

This SWMP was prepared alongside parallel studies covering Hertsmere, Stevenage and Three Rivers. Together, these four studies complete the coverage of SWMPs for the whole county. This SWMP commenced at the intermediate scale, moving on to detailed scale assessments covering hotspots.

2.2 Establish a partnership

A SWMP is a framework to improve the understand of surface water flood risk in an area and enable key stakeholders with responsibility for surface water and drainage to work together to find the most cost-effective way to manage the risk.

Organisations managing flood risk in Welwyn-Hatfield, include:

- Hertfordshire County Council;
- Welwyn-Hatfield Borough Council;
- Thames Water Utilities Limited; and
- The Environment Agency.

The borough council has powers for managing flood risk from ordinary watercourses. Often, urban flooding is caused by multiple mechanisms, which are the responsibility of different organisations. Therefore, a holistic approach is required to manage a flooding issue. As such, partnership working is key to the SWMP process.

To make the best of the opportunity to work with partners afforded by a SWMP, a series of engagements were undertaken as set out in Table 2-1.

[4] Local Flood Risk Management Strategy for Hertfordshire, 2011, https://www.hertsmere.gov.uk/Documents/09-Planning--Building-Control/Planning-Policy/Local-Plan/SADMS-EB05-Local-Flood-Risk-Management-Strategy-13-16-full.pdf

Table 2-1: Planned meetings, workshops and site visits

Meeting	Attendees	Purpose
Monthly progress (teleconference)	HCC, JBA	Monitor progress, budget, programme, risks.
Inception meeting (1no.)	HCC, JBA, EA, TWUL, LAs	Agree stage 1 methodology, agree data provision
Hotspot selection site visit (4 no.)	HCC, JBA, EA, TWUL, LAs	Select hotspots, gather additional information on hotspots.
Hotspot selection workshop (1no.)	HCC, JBA, EA, TWUL, LAs	Select hotspots
Options workshop (2no.)	HCC, JBA, EA, TWUL, LAs	Discuss draft options, costings etc.

2.2.1 The communications and engagement plan

A Stakeholder Communications and Engagement Plan was drafted at the project inception and maintained as a live document through the project. This is included in Appendix B.

2.3 Scoping of the study

HCC have undertaken a series of SWMPs across the county to improve the understanding of local flood risk following an initial assessment of risk in the first LFRMS published in 2013.

The key aims and objectives of the SWMP, are as followed:

- **Objective 1:** To identify areas within the district or borough that are linked by significant flood risk from surface water runoff and its interactions with sewers, drains, groundwater, ordinary watercourses, ditches, and Main Rivers.
- **Objective 2:** To deliver a list of potential hotspot sites; these hotspot sites will likely be a combination of hotspots identified through GIS and Multi-Criteria Analysis, as well as hotspots identified by key stakeholders (desk-based identified hotspots and stakeholder identified hotspots), though the two may often coincide. Selection of the hotspot sites must be via a robust methodology for prioritisation.
- **Objective 3:** To identify up to five hotspots from each district / borough for detailed hydraulic modelling.
- **Objective 4:** To propose potential options to reduce the flood risk to the hotspot sites identified for hydraulic modelling, and recommend a preferred option per site, which is community focused and feasible in terms of funding and sustainability.
- **Objective 5:** To produce user friendly SWMPs, which are well written, clear, concise and understandable.

3 Strategic and intermediate risk assessment

3.1 Introduction

The main purpose of the Strategic Assessment is to identify broad areas that may be susceptible to surface water flooding and considers available flood risk mapping and historical flood events.

The Intermediate assessment develops on the initial assessment to improve the understanding of the sources of flood risk and identify key flooding hotspots for more detail investigation as set out below.

3.2 Overview of the hotspot selection process

Figure 3-1 provides an overview of the activities followed to select hotspots. These are explained in detail in the following sections.

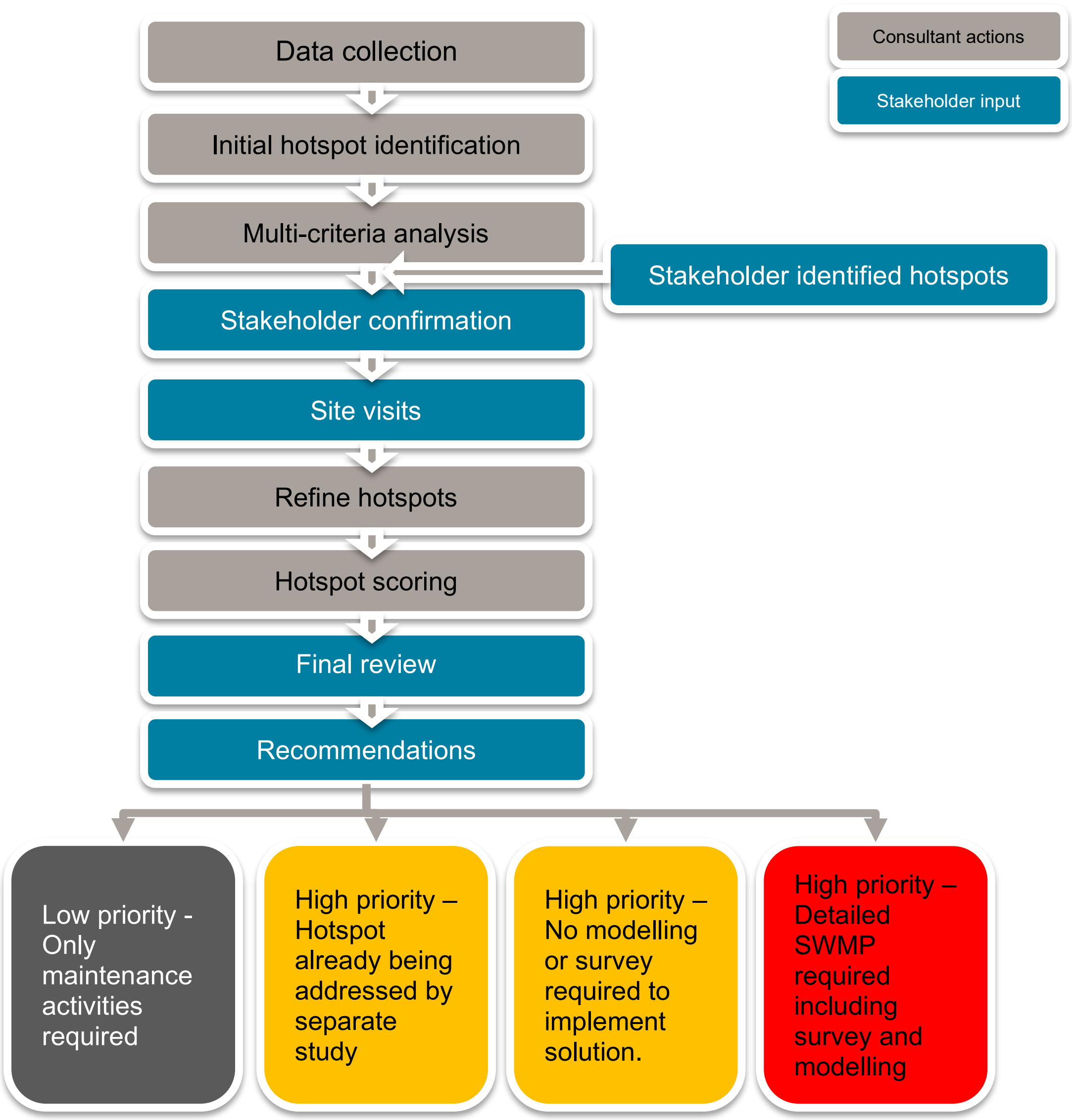

Figure 3-1: Hotspot selection process flow chart

3.3 Data collection

Relevant data was collected and analysed for Welwyn-Hatfield, from Welwyn-Hatfield Borough Council (WHBC), HCC, TWUL, the EA and from Open Data

Sources online, for the purpose of identifying surface water flood risk. These are summarised in Table 3-1.

Table 3-1: Summary of data received for the intermediate-scale assessment

Source	Description / Title
BGS Website	British Geological Survey Geology - bedrock and surface
BGS Website	British Geological Survey Hydrogeology
Welwyn-Hatfield Borough Council	Evidence of flood history
Welwyn-Hatfield Borough Council	Strategic Flood Risk Assessment
EA Data Catalogue	1m and 2m LiDAR DTM
EA Data Catalogue	EA Chalk River dataset
EA Data Catalogue	EA Main River Network
EA Data Catalogue	Flood Zones 2 & 3
EA Data Catalogue	Historic Flood Map
EA Data Catalogue	Water Framework Directive data
Environment Agency	History of flooding
Environment Agency	River model coverage polygons
Environment Agency	Obstructions to fish passages
Hertfordshire County Council	Detailed River Network (DRN)
Hertfordshire County Council	Environment Agency Risk of Flooding from Surface Water maps
Hertfordshire County Council	Highways gully and grip locations
Hertfordshire County Council	HCC Highways incident data
Hertfordshire County Council	HCC Highways Inspection reports of culverts
Hertfordshire County Council	Section 19 reports and reports of other studies
Hertfordshire County Council	Hertfordshire County Council Flood Incident Database
Hertfordshire County Council	National Receptor Database
Hertfordshire County Council	Ordinary watercourses
Hertfordshire County Council	Polygons of committed development (allocations, windfall sites etc.)
Hertfordshire County Council	SWMPs for other boroughs within Hertfordshire
Ordnance Survey	OS Open Greenspace
Thames Water Utilities Limited	Sewer flooding history database (SFHD) report of incidents at the postcode sector level.
Thames Water Utilities Limited	Sewerage models
Thames Water Utilities Limited	Thames Water sewer network in GIS format

3.4 Initial hotspot identification

All incoming data was reviewed and, where appropriate, loaded into ArcGIS, in order to identify potential hotspot locations. Some new GIS layers were created, for example the locations of Section 19 flooding investigation reports were digitised.

The initial identification of hotspots was carried out by visual identification of locations with modelled and / or reported flood risk to -residential properties, businesses or other receptors. The Defra definition of surface water flooding; *"flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall."* Was used to identify areas where surface water was the key source of flood risk. Flooding from main rivers (identified using Flood Zone 2 and 3 outlines and the Main River layer) was discounted, unless a secondary surface water issue was also thought to be present. The EA's national RoFSW map was the primary source of modelled risk. The HCC flooding history register, along with accompanying Section 19 flood investigation[5] and other technical reports were the primary sources of Hertfordshire's flood history.

TWUL provided numbers of properties at risk of internal and external sewer flooding on their Sewer Flooding History Database (SFHD). In order to anonymise this data, they were summarised by postcode sectors by TWUL. Postcode sectors (e.g. "SG1 2") cover relatively large areas, and therefore cannot be used to pinpoint sewer flooding risk to specific streets. Consequently, this information has not been used in the hotspot selection process, except where other information, for example in Section 19 reports, could be used to point to sewer flooding issues.

Boundaries were drawn to designate hotspot areas, guided by the existing RoFSW mapping, the LiDAR and sewer mapping to define hydraulically discrete areas. Not all hotspots were hydraulically discrete; consideration was also given to land use, for example defining an industrial estate as a hotspot even if it had two or more hydraulic flow pathways.

Note that the hotspot areas digitised do not necessarily contain the whole upstream catchment contributing surface water, but rather they define areas of concentrated flood risk. Upstream catchment areas and the extents of modelling were defined later in the hotspot selection process alongside the modelling methodology.

Available information relating to the character, flooding history and flood risk for each hotspot were summarised in a hotspot selection report, included in Appendix C.

A total of 8 draft hotspots were identified within WHBC and the hotspots were given unique identification codes, for example WHBC1, as shown in Table 3-2 and Figure 3-2 below.

[5] Lead Local Flood Authorities are required, under Section 19 of the Floods and Water Management Act 2010, to carry out investigations into flooding within their boundaries, in order to identify which Risk Management Authorities (RMAs) have relevant flood management functions and whether these have been or are proposed to be exercised. HCC has set out its criteria for triggering a Section 19 investigation, and published draft and final investigations here: https://www.hertfordshire.gov.uk/services/recycling-waste-and-environment/water/flood-investigations.aspx#

Table 3-2: Welwyn-Hatfield draft hotspots

Hotspot Reference	Location
WHBC1	Travellers Lane, Hatfield
WHBC2	Robbery Bottom Lane, Oaklands
WHBC3	Hyde Valley, Cole Green Lane and Beehive Green (in Woodhall), Welwyn Garden City
WHBC4	Great Ganet, Little Gannet, Thistle Grove, Desborough Close, and Autumn Grove, Welwyn Garden City
WHBC5	Swallowfields, Swiftfields, Knella Road, Welwyn Garden City
WHBC6	Rosedale, Digswell Water, Harwood Close, Sewells, Hertford Road, Welwyn Garden City
WHBC7	Heay fields, Wren Wood, Westly Wood, Welwyn Garden City
WHBC8	Hatfield and Roe Green (French Horn Lane, Link Drive, Oaklands Wood, Vigors Croft, Hill Ley, Worcester Road and Lemsford Road)

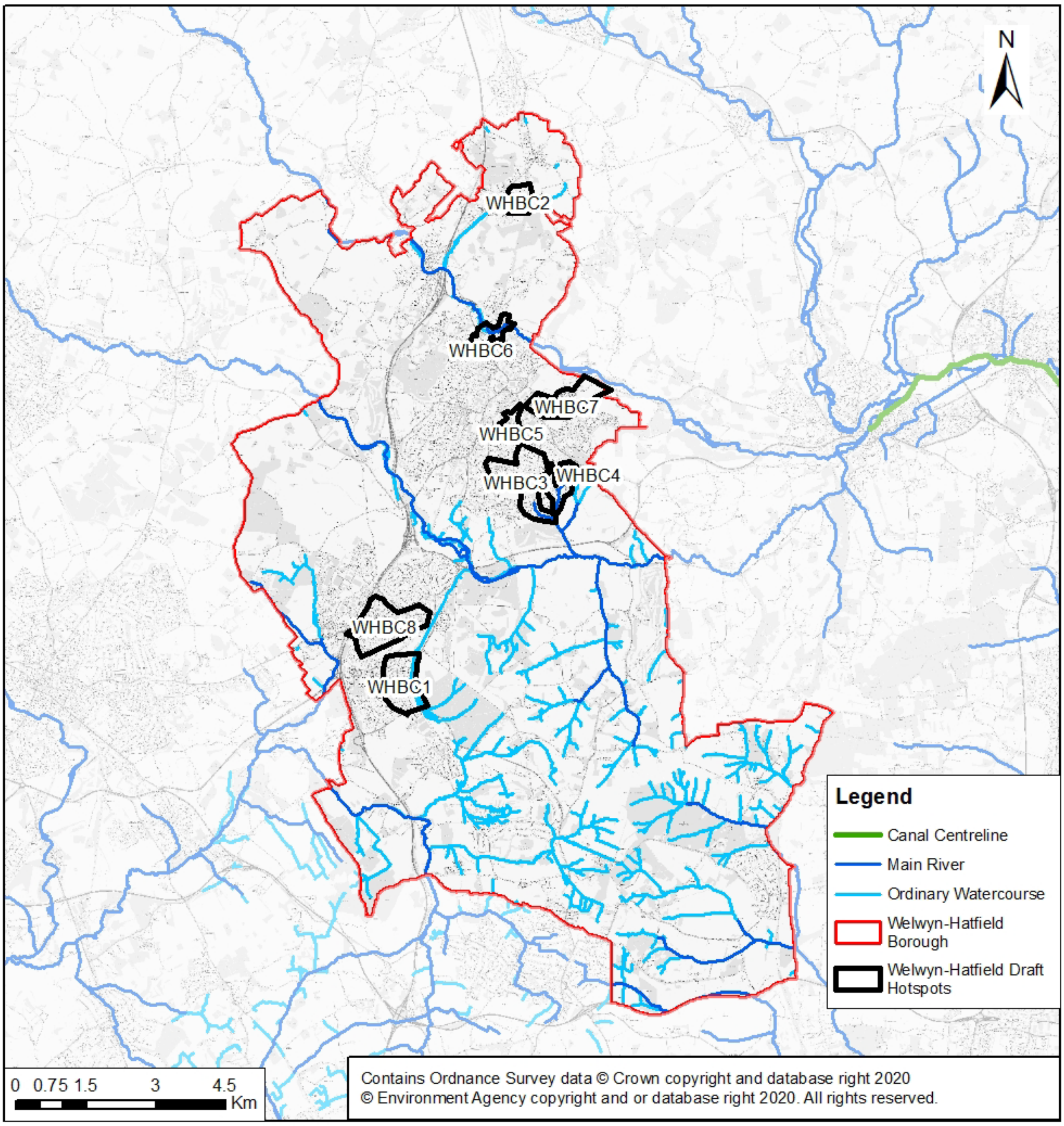

Figure 3-2: Welwyn-Hatfield draft hotspots

3.5 Multi-criteria analysis

Experience in Hertfordshire and elsewhere indicates that it is rare that Flood and Coastal Erosion Risk Management (FCERM) funding will cover all or even most of the cost of surface water management schemes. Therefore, it is common practice for other sources of funding (Partnership Funding) to be sought in order to implement surface water schemes.

The benefits of Sustainable Drainage Systems (SuDS) extend beyond flood risk management, and may include, depending upon the type of SuDS implemented, water quality, amenity, biodiversity and air quality benefits.

Given the above, HCC is seeking to identify, at an early stage, what additional opportunities and funding sources may be available within each hotspot.

The following sources of information were reviewed, within and around each hotspot:

- **Committed development:** Boundaries of committed developments were provided by HCC who collated the information from the Local Planning Authority. Significant development within a hotspot may represent opportunities for improving the management of surface water at source, redeveloping brownfield sites in ways that eliminate or reduce flood risk, and as a potential additional source of funding.
- **Green spaces:** These were identified using the new Ordnance Survey Greenspace layer, which identifies green spaces open to the public (though not necessarily publicly owned), including allotments, sports and play facilities, public parks and religious grounds. The presence of green spaces within or near to hotspots may present opportunities for storing and controlling surface water runoff.
- **Environmental designations:** These include international, national and local designations including Special Areas of Conservation (SACs), Sites of Special Scientific Interest (SSSI), Local Nature Reserves (LNR). These can represent both opportunities for improved surface water management to enhance or prevent deterioration of designated areas, but also may represent constraints. For example limiting use of these areas for flood storage where this is not compatible with the conservation objectives.
- **Working with Natural Processes (WwNP):** The EA published a set of online maps in October 2017 identifying areas where WwNP type interventions could be applied to manage flood risk.[6] The primary focus of the WwNP mapping is for flood risk reduction, however WwNP measures may also have benefits to water quality and bio-diversity. The mapping identifies areas of potential opportunity for runoff attenuation features, floodplain reconnection, woodland in riparian zones and floodplains and the wider catchment. The term NFM (Natural Flood Management) is generally used interchangeably with WwNP.
- **Water quality and the Water Framework Directive (WFD):** It is a requirement of the WFD that deterioration of waterbodies as a result of human activities should be prevented, and an objective for all waterbodies to reach Good Ecological Status (GES) or, where the waterbody is already highly modified, Good Ecological Potential (GEP). Flood risk management activities should, therefore, be designed to protect waterbodies and where possible assist towards improving their status. At this initial stage, the 2016 overall classification of waterbodies within or downstream of each hotspot was identified. In all cases where a waterbody was present and had a current status, the 2016 classification was “Moderate”, with an objective of achieving “Good” status by 2021.

This first stage of identification of other opportunities will be developed in more detail for those hotspots which progress to the detailed SWMP stage.

3.6 Stakeholder confirmation of hotspots and site visits

Draft hotspot assessment sheets were provided to HCC, WHBC, EA and TWUL for review. Subsequently, a one-day site visit was carried out to visit all the draft hotspots within the Borough. The site visits were attended by representatives of JBA, HCC, WHBC and the EA. The site visits provided an opportunity to discuss the various RMA’s experience of flood history in each hotspot, to identify potential flood routes and receptors and, where flood mechanisms were clearly identifiable, to consider the types of interventions which could reduce risk. The site visits were also an opportunity to review the hotspot boundaries, and to ensure that no known hotspots of risk had been missed in the initial selection.

3.7 Refining the hotspots

Following this first stakeholder review and site visit, hotspots WHBC3 and WHBC4 were merged and subsequently referred to as WHBC3, to form one larger hotspot which better represented the hydrological catchment and captured the flow paths in the hotspot more effectively. This resulted in the number of hotspots within WHBC being reduced to 7. Minor alterations to some of the other hotspot boundaries were made and taken forward to the final assessment. No additional hotspots were identified by stakeholders.

The hotspot assessment sheets (Appendix C) were updated with further information gained from the site visits and from additional information provided by the partners. The coverage of existing river and sewerage models was identified at each hotspot.

Within Welwyn-Hatfield, none of the hotspots are covered by existing river models. All hotspots, with the exception of WHBC1 and WHBC8, are covered by TWUL's Rye Meads model, a relatively detailed model of foul and combined sewerage, but which does not include surface water sewerage systems. WHBC1 and the eastern half of WHBC8 are covered by TWUL's Maple Lodge model, however this is a relatively coarse "macro" model and does not include surface water sewerage systems. The western half of WHBC8 is covered by the detailed Welwyn (Mill Green) model, but this also does not model surface water sewerage. The TWUL modelled coverage for the borough is displayed in Figure 3-3.

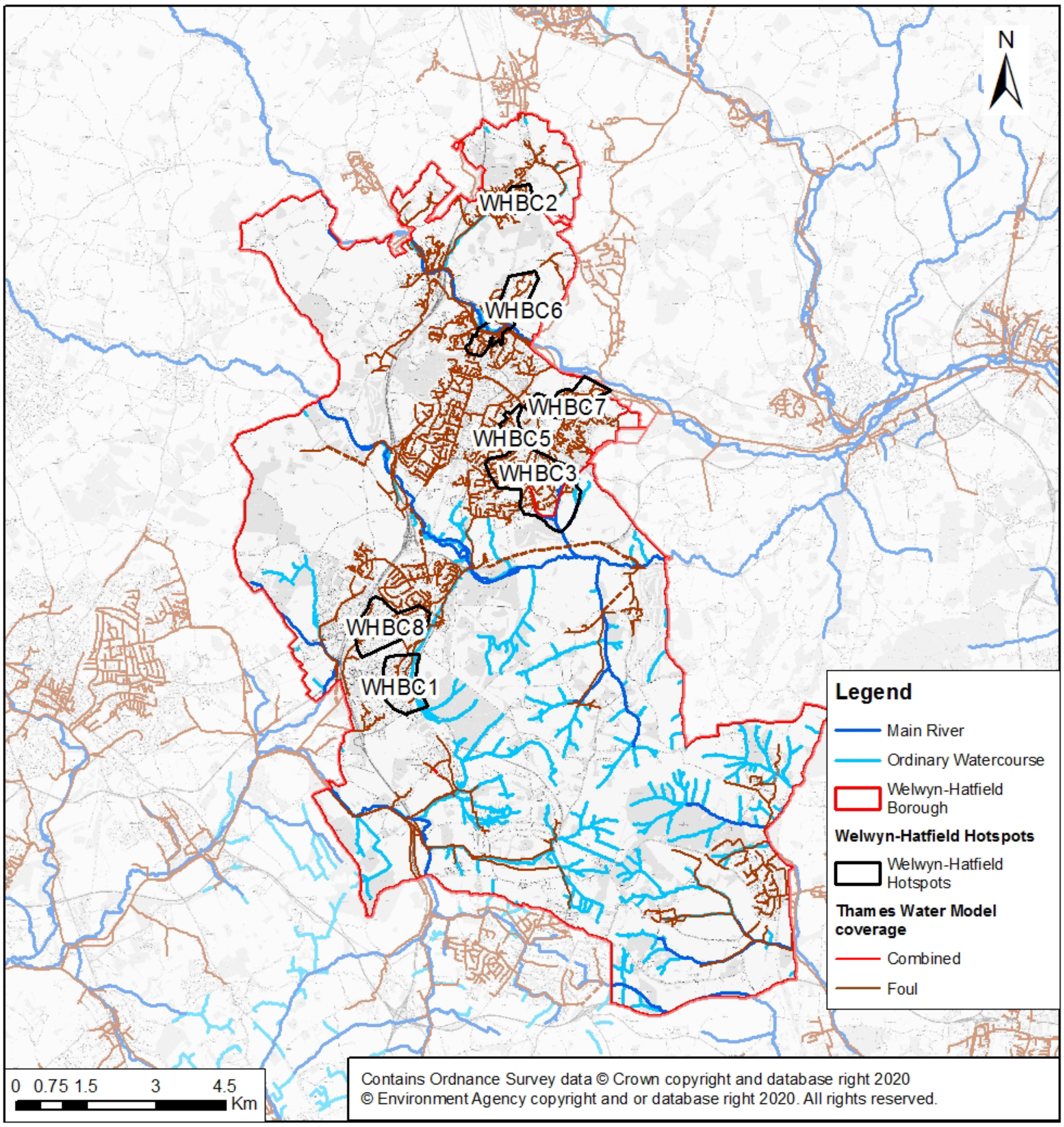

Figure 3-3: Map displaying TWUL model coverage for Welwyn-Hatfield

3.8 Hotspot scoring

A scoring system was used to help assess whether hotspots should progress to detailed SWMPs. The scoring was based on the following weighting and set out in Table 3-3:

- Count of properties at risk in the RoFSW mapping “medium risk” (1 in 100 year) event - 40%;
- Count of properties on the HCC flooding records - 40%;
- A qualitative assessment of the other needs and opportunities within the hotspot - 20%.

Scores were applied as follows and the results are shown in Table 3-4.

Table 3-3: Hotspot scoring system

Score given	RoFSW score (receptor count)	Historic flooding score (property count)	Other needs and opportunities score
40%	> 20	> 20	Not used
30%	11 - 20	11 - 20	Not used
20%	6 - 10	6 - 10	High
10%	1 - 5	1 - 5	Medium
0%	0	0	Low

Table 3-4: Hotspot scoring results

Hotspot code	Scoring - RoFSW Medium (%)	Scoring - LA properties (%)	Scoring - Other Needs / Opportunities (%)	Overall score (%)
WHBC1	40	40	10	90
WHBC2	10	30	10	50
WHBC3	40	40	10	90
WHBC5	0	20	0	20
WHBC6	10	20	10	40
WHBC7	30	20	0	50
WHBC8	30	40	10	80

The scoring was not normalised by size or number of receptors at this stage, and therefore there was some bias towards larger hotspots getting higher scores, where they contain high numbers of reported or modelled flooding receptors.

The hotspot scoring was used as a tool to inform the selection of sites for further analysis in detailed SWMP's alongside judgement based on experience and the history of flood risk in each hotspot.

3.9 Summary of hotspots

The hotspots identified are shown in Figure 3-4, and the recommended way-forward is summarised in Table 3-5. See Appendix C for the full hotspot assessment sheets.

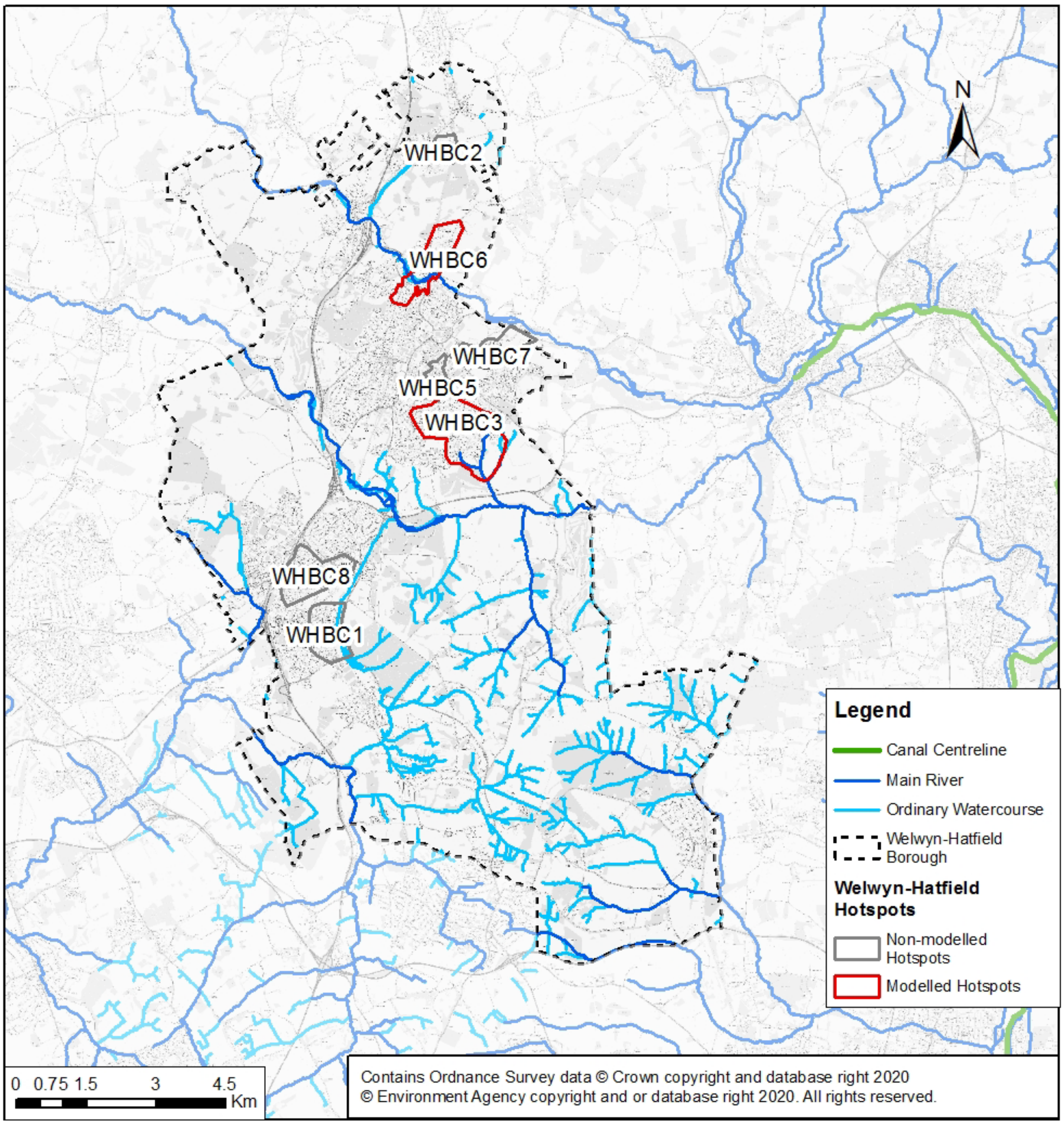

Figure 3-4: Map of modelled hotspots for Welwyn-Hatfield

Hertfordshire

JBA consulting

Table 3-5: Summary of Hotspot assessment

Hotspot code	Recommended way forward	Decision Significant risk identified and further modelling required	Decision Non-modelled hotspot	Decision No further actions
WHBC1 - Travellers Lane, Hatfield	A reactive study has been carried out by HCC. It has been decided that recommendations from the HCC study that is being carried out at this hotspot will be taken forward for this hotspot. A follow up meeting regarding this site should be arranged, which will include review of the model that has been developed for this area and whether any changes need to be made to it. Discussions on the site visit noted that funding for further work in the future could potentially come from a flood defence grant. There is potential for the area to include an environmental enhancement scheme (e.g. landscape a swale).		✓	
WHBC2 - Robbery Bottom Lane, Oaklands	Two studies have recently been commissioned by HCC for this area, so it is recommended that this hotspot is not taken forward to the next phase of the SWMP project as highlighted flood risk will be considered in due course. As part of the HCC study, the upstream options were assessed but nothing was implemented, and the workshop on 16/01/2018 concluded that modelling this hotspot further would not lead to any cost beneficial direction. HCC will continue to identify and explore whether there are any recommendations that can be implemented here.			✓
WHBC3 - Hyde Valley, Cole Green Lane and Beehive Green	Take forward to phase 2 of the SWMP process and model this hotspot. There is potential for floodwater storage and so it is worthwhile to investigate feasibility options. Along Thistle Grove the clusters of previous surface water flooding demonstrated that distributed schemes would need to be implemented. The area of the Commons Nature Reserve is alongside where the main river runs. This area would require a cross section survey to be carried out. Potential to model the channel (high roughness).	✓		

Hotspot code	Recommended way forward	Decision Significant risk identified and further modelling required	Decision Non-modelled hotspot	Decision No further actions
WHBC5 - Swallowfield, Swiftfields, Knella Road	The hotspot has been identified as one that is of lower priority, however it is recommended to survey this hotspot and carry out PFR work. There would be very limited funding to implement any SuDS opportunities that would be identified through a model due to the industrial nature of the area. This area is limited to PFR or minor works, particularly along Swiftfields.		✓	
WHBC6 - Rosedale, Digswell Water, Harwood Close, Sewells, Hertford Road	This hotspot would not benefit from detailed modelling however it is recommended to be taken forward as a small modelled hotspot. It is also recommended that a levelling survey is carried out. The modelling would look at how the surface water can be kept on the road rather than affect the nearby properties, particularly along Sewells Road. Sending out a questionnaire to Sewells Road is also recommended to improve the reporting and better understand the flood risk. The site visit and later discussion around this hotspot revealed the extended risk around Harmer Green and St Ives Close. These areas have now been included within the hotspot area and the modelled boundary has been extended. It was reported that runoff collets by the roundabout and flows through the properties.	✓		
WHBC7 - Heay fields, Wren Wood, Westly Wood	The flood events that have been recorded in this hotspot area are dispersed and therefore additional modelling would be unlikely to increase the understanding on flood risk. The level of predicted modelled flood risk is relatively low and the flood events recorded are in a largely flat area, which suggests the flooding is localised.		✓	

Hotspot code	Recommended way forward	Decision Significant risk identified and further modelling required	Decision Non-modelled hotspot	Decision No further actions
WHBC8 - Hatfield and Roe Green	The flood risk that has been identified in this area has been shown to be dispersed and there is no defined flow path evident by the site visit or from the RoFSW mapping. The flood history that has been evident is dispersed in the area is relatively flat, which suggests the flooding is localised and therefore means it is unlikely this hotspot would benefit from being modelled. The area is already undergoing development in the town centre, which has the potential to reduce the flood risk to the area. As a result, this hotspot is not being carried forward to the next phase.			✓

In summary, within Welwyn-Hatfield Borough, two hotspots are recommended for a detailed SWMP investigation, three as non-modelled hotspots and two for no further action.

Hotspots recommended for detailed SWMP investigation:

- WHCB3 – Hyde Valley, Cole Green Lane and Beehive Green;
- WHBC6 – Rosedale, Digswell Water, Harwood Close, Sewells, Hertford Road.

3.10 Hotspot selection workshop

A hotspot selection workshop was carried out on 16 January 2018, attended by representatives of HCC, WHBC, EA and TWUL. The workshop confirmed the decisions regarding which ones to take forward to the modelling phase, which ones to take forward as non-modelled hotspots and which ones that do not require any further action.

3.11 Recommendations

The recommendations are outlined in Table 3-5 and are attached in Appendix C with the full hotspot assessment sheet, outlining the details of each hotspot area, images from the site visits and the recommended way forward.

4 Detailed Risk Assessment - Approach

4.1 Introduction

The intermediate assessment identified two hotspots for a detailed assessment of the surface water flood risk using hydraulic modelling in line with the Defra guidance. The modelling has been developed to be outcome-focused and provide an improved understanding of the surface water flood risk within the hotspots.

4.2 Data collection and surveys

The models have been developed using a range of topographic and asset data as outlined below.

4.2.1 Topography

EA LiDAR data was used as the basis of the Digital Terrain Model (DTM) for all hotspots. The data was provided at a composite 1m resolution for the study.

4.2.2 Topographic Survey

Survey data was collected for key open channel watercourses in the hotspot areas and included major structures such as bridges, weirs and culvert inlets.

This data was also used to ground truth the LiDAR data provided by the EA.

4.2.3 Drainage infrastructure

No detailed TWUL models of the public surface water network were available for the borough; therefore, the GIS sewer network information was made available to support the study.

4.2.4 Survey

Manhole surveys of the surface water network were undertaken to support the model development in WHBC3 and WHBC6 and targeted areas where information such as pipe dimensions or sewer invert levels was missing within the TWUL GIS sewer data, or where the sewer network required validation checking.

In addition, manholes were identified on culverted watercourses, which may interact with the public surface water sewer network or combined sewer network via Combined Sewer Overflows (CSOs).

4.3 Model build and validation

Using the data and surveys described above, integrated models were constructed to represent all the key components of the drainage systems within each hotspot, including the catchment surfaces from which rainfall-runoff is generated, the sewers and minor watercourses. This type of model allows the interactions between different parts of the drainage system to be investigated – for example, runoff from a field can run down a road, enter a sewer, cause this to become overloaded and to flood back onto the surface further downstream.

The model was run using a set of design rainfall events with a range of annual event probabilities (50%, 20%, 5%, 3.3%, 1.3%, 1% and 0.1%). The model results include a two-dimensional representation of flood extents, depths, velocities and hazard (a measure of how dangerous the flooding is to people). The models were also run for future scenarios to represent the impacts of climate change resulting in increased river flows and rainfall.

The hydraulic model outputs form an assessment of flood hazard. To assess flood risk, these were combined with mapping of flood receptors (residential properties, businesses, public buildings etc) to calculate a range of flood risk metrics including the number of properties at risk of the direct economic damages as a result of internal flooding.

Details of flood risk metric analysis, information about the survey specification, general schematisation of the models, modelling approach and model review process used in the development of the models for Welwyn-Hatfield Borough are included in Appendix D.

4.4 Options development

A long list of potential options to help better manage and mitigate flood risk within the Welwyn-Hatfield hotspots was compiled and the feasibility of their implementation, including consideration of their advantages and constraints was assessed in each area using the criteria set out below.

The long list of options was developed using the outputs of the updated detailed surface water modelling, previous studies and local guidance as well as publicly available information such as EA LiDAR data, British Geological Survey (BGS) maps and online mapping, as well as notes from the site walkovers and other data provided by HCC such as TWUL asset maps.

The viability of each longlisted option has been subjectively assessed using engineering judgement considering the buildability, possible benefits and likely reasonableness of costs.

4.4.1 Assessment Criteria:

- **Disruption for construction and maintenance are minimised**: An ideal scheme would have little disruption to the public during its construction and future maintenance. For example, a scheme including upsizing of sewers would have large disruption when digging to the pipes.
- **Number of properties protected from flooding by surface water runoff:** This is crucial when considering the cost-benefit of the scheme.
- **Level of additional environmental benefit provided:** A proposed scheme should aim to enhance the environment. For example, retrofitting of SuDS can involve conversion to green space, which would potentially create habitat space.
- **Risk to maintenance operatives is minimised:** Any future maintenance scheme would require planning ahead of construction. Any design should ensure that maintenance operatives can complete their job safely.
- **Overall acceptability of the scheme to the public:** This is crucial to a scheme being accepted and taken aboard by the public. Consultation with people within the surrounding area would aid understanding of what would be accepted/rejected.
- **No adverse ecological effect on flora and fauna:** Any negative impact upon the existing ecology should be avoided when considering schemes.
- **Scheme minimises visual impact on surrounding area:** A scheme to manage flood risk should aim to work with its setting. For example, construction of artificial surfaces (e.g. concrete and brick) would be detrimental within an existing green environment.

- **Design can be easily adapted to accommodate climate change impacts:** The changing climate means that a scheme built today may not be suited within the future. It is advised that climate change is considered when schemes are constructed, however it would be preferred if the scheme could easily be updated.
- **Low capital investment required:** costs associated with the proposed scheme are considered against properties that would likely benefit. Where there are only few properties at risk, a low-cost scheme would be more cost-effective.
- **Low maintenance costs:** it is key to consider any costs that are incurred following completion of the construction and who is responsible for these.

The scoring of the options is included within the longlist for each hotspot. The total score was used to understand which of the suggested options would be most beneficial. These were then taken to the final shortlist of proposed actions.

4.5 Economic assessment

Damage estimates have been derived from direct tangible flood damages, emergency costs and vehicle damages. The approach to assess the damages was undertaken in accordance with FCERM-AG (EA, 2010), the MCM (FHRC, 2013), the MCM Handbook (FHRC, 2016) and The Green Book (HM Treasury, 2011).

4.6 Methodology

This application of the MCM has been undertaken using JBA Consulting's in-house Flood Risk Metrics (FRISM) software.

FRISM is a GIS based impact analysis software that computes a range of metrics, including property damages, in accordance with the techniques outlined in the MCM. FRISM computes these metrics by combining flood modelling results together with receptor data. The metrics that can be calculated depend on the geometry type of the receptor data and the type of modelling results used. As depths grids were produced for this project, detailed property level analysis was computed, which includes minimum, maximum and mean depths and damages at each property. Property level analysis was then summed across the study area to determine the total impact (e.g. the total damages for a particular flood event). As multiple events were modelled, the Annual Average Damages (AADs) were computed for each metric. FRISM has also been used to provide property counts for each event. These figures can be used to determine the potential economic viability of any proposed works.

4.7 Available data

The following datasets were used to calculate the damages estimates and property counts:

- RoFSW mapping – Flood extents from the national scale RoFSW mapping were used as a baseline.
- Hydraulic modelling results – Depths grids generated by the modelling give the flood depths across the study area for each flood event for each scenario.
- National Receptor Data (NRD; 2014) – The property point dataset contains information such as building type, class description, floor area, floor level, and MCM code.

- Office for National Statistics Consumer Price Inflation (d; 2018) – Provides the CPI to enable uplift of values to present-day.
- Ordnance Survey (OS) MasterMap – The building footprint polygon layer was extracted from the OS MasterMap and used to determine whether a property would be flooded or not. For this assessment, if any part of the building footprint is within the flood extent, then the building is considered flooded.

4.7.1 Property data

All property data is based upon the NRD. The NRD was processed to remove property points which should be excluded from the assessment, in accordance with FCERM-AG (EA, 2010). The full property exclusion list is taken from the NRD2014 guidance as non-reportable property points. These include, but are not limited to, street records, PO boxes, property shells and advertising hoarding. All the remaining properties within the study have been included within the analysis.

The following assumptions were made:

- Only properties which had an associated OS MasterMap building footprint were included within the analysis.
- Property floor areas used were taken directly from the NRD opposed to the associated OS MasterMap building footprint.
- All upper floor properties were removed from the analysis as direct flood damages are unlikely to impact upon first floor properties and above.

4.7.2 Property types

The MCM code and class description were used to categorise the NRD points into:

- Residential – All properties with an MCM code of '1' or a class description of residential.
- Non-residential – All properties which are not categorised as above, therefore included retail and office spaces, places of worship and workshops.

4.7.3 Property footprints

Property areas were taken directly from the NRD data. However, only properties with an associated OS MasterMap footprint were included within the calculations for a more accurate representation of properties.

4.7.4 Property values

4.7.5 Due to the flood levels estimated by the modelling which would not result in extensive damage to properties, none of the properties were assigned a property value as investigation of the results indicates that non-residential damages are low compared to property values and so capping of damages based on property values would not be implemented.Present value damages threshold survey

A floor level threshold of 100mm was applied to all properties within the study area. This average threshold was determined from site visit observations of the study area. This 100mm was applied directly within the damage assessment.

4.8 Direct damage estimation methodology

This section outlines the damage calculations undertaken. In assessing the damages, it has been assumed that the flood duration is less than 12 hours, with no warnings prior to the damages occurring.

4.8.1 Property damages

Damages were calculated at the property level in accordance with the MCM (FHRC, 2013). For this economic appraisal, the flooding scenario is taken to be fluvial water with a short duration (i.e. less than 12 hours) and no flood warning, and the associated MCM 2013 depth-damage curves were used. The depth-damage curves, were uplifted to August 2018 values using the CPI, as recommended in the MCM (FHRC 2013; p86). Within the FRISM code, the 2013 MCM depth-damages curves have been uplifted and calibrated to January 2017, with an additional manual uplift to account for changes in CPI up to 2018. The CPI value was taken from the Office of National Statistics on 26 September 2018 for August 2018 as the most recently published data at the time.

The MCM code field within the NRD dataset was used to assign an appropriate MCM curve to each property to calculate the AAD. Damages were not calculated for upper floor properties or those assigned an MCM code of '999'.

4.8.2 Capping

4.8.3 As the predicted damages to properties is unlikely to exceed the market value the Present Value damages (PVd) of individual residential properties have not been capped at the market value of the property, nor have non-residential properties been capped. Investigation of the results indicate that capping of properties would not impact upon the outcome of this economic appraisal as the non-residential damages are low compared to property values and so capping would not be implemented.Write-off

A property can be written-off within the economic assessment if it is considered to flood in a 33.33% AEP event, or more frequent, as stated in the MCM (FHRC, 2013; p82). This is based on the assumption provided by the EA that three years is required for a property to be repaired and return to full use after the impact of flood event. Write-off has not been applied for this economic assessment due to the low flood depths within this study area which are not likely to result in the property needing to be abandoned, and hence written off.

4.8.4 Indirect and intangible damages

In addition to the direct tangible property damages calculated using depth-damage curves, emergency costs, vehicle damages, indirect property damages and intangible property damages have also been calculated in accordance with the MCM (FHRC, 2013). Emergency costs have been included as an uplift of 5.6% on property damages as appropriate for urban areas. Vehicle damages have been calculated at £3,600 per residential property where flood depths are greater than 0.35m.

5 Detailed risk assessment – Results

5.1 Introduction

The modelled outputs have been reviewed for each hotspot and a detailed Source-Pathway-Receptor assessment of the key flooding mechanisms and flood risk areas have been identified. Possible flood mitigation measures have been considered for each hotspot and the details of the options considered and preferred short listed options are set out below.

5.2 WHBC3 – Hyde Valley

The Hyde Valley hotspot, shown in Figure 5-1, includes the area around Cole Green Lane and Beehive Green (in Woodhall) in the east, and Great Gannet, Little Gannet, Thistle Grove, Desborough Close and Autumn Grove in the west. This hotspot was identified as one to take forward for modelling after undertaking the multi-criteria analysis on the hotspot. The model incorporated the surface water sewer system and the watercourses in the south.

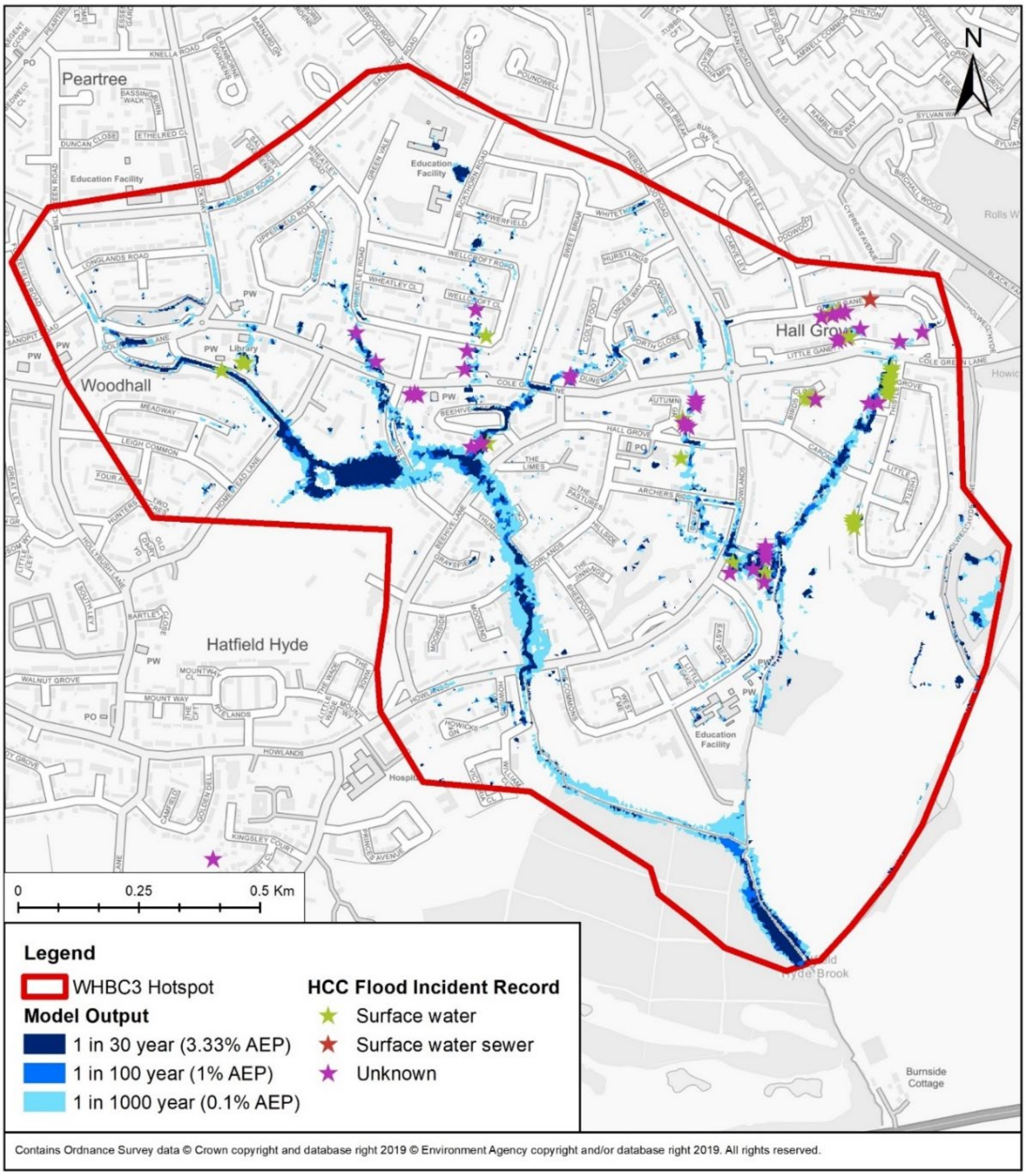

Figure 5-1: Detailed model outputs for WHBC3

5.2.1 Assessment of flood mechanisms - Source-Pathway-Receptor

According to the flood incident record, there are many incidents that have an unknown cause. However, from the modelling it is safe to assume that these have also been caused through surface water flooding. The main flow paths are closely associated with the route of the surface water network whereby culverted watercourses exist. In the west, a large area of ponding forms in the King George V recreation grounds, which then flows south to join the ordinary watercourse. Other areas of surface water flow are largely associated with the topography, resulting in localised flow. Surface water flow paths exist in during the 1 in 30-year event and the modelled flood results correspond with previous flood events that have been recorded in the hotspot.

Maps showing flood depths in the 1 in 30, 100 and 1,000 year return periods are included within Appendix E.

Table 5-1 shows a comparison of the number of properties at risk in the EA RoFSW mapping and based on the detailed flood modelling, respectively. Generally, the surface water flooding aligns between the RoFSW mapping and the modelled outputs, with the dominant flow paths appearing. The main difference between the two outputs is flow paths along most roads within the RoFSW mapping resulting in much higher numbers of properties expected to flood during the 1 in 100- and 1000-year events. Additionally, the dominant flow paths also have larger extents within the RoFSW mapping, increasing the numbers shown to be at risk.

Table 5-1: WHBC3 Properties at risk from surface water flooding

Number of residential properties at risk	1 in 20 year	1 in 30 year	1 in 75 year	1 in 100 year	1 in 200 year	1 in 1,000 year
RoFSW	N/A	154	N/A	399	N/A	947
WHBC3 detailed modelling	158	200	240	267	310	461
Number of non-residential properties at risk	**1 in 20 year**	**1 in 30 year**	**1 in 75 year**	**1 in 100 year**	**1 in 200 year**	**1 in 1,000 year**
RoFSW	N/A	27	N/A	33	N/A	53
WHBC3 detailed modelling	24	27	31	32	36	44

Across the hotspot, there have been 71 previously reported flood incidents. The majority of the reports occurred in June 2016, with many reporting both internal and external flooding. This internal flooding occurred in several locations including Thistle Grove and Desborough Close. These with internal flooding have either identified the flood source as surface water or it remains unknown. Several of the reports highlight the intense rainfall which exceeded the drains ability to contain runoff.

5.2.2 WHBC3 Mitigation Options Considered

The detailed modelling was used to understand the flood mechanisms that impact the at-risk areas within the hotspot and as part of the longlisting process, several methods were considered to alleviate the flood risk within the hotspot. These options are summarised in Table 5-2 and further information about the options considered and the locations for options is included in Appendix F and Appendix G respectively.

Table 5-2: Summary of options for WHBC3

Option Number	Option Type	Description	Areas Applicable	Shortlisted?
Option 1	Allocation of Land within Local Planning	Land designation based upon at-risk areas	Not applicable within hotspot	✘
Option 2	Flow restriction from new development	Recommending greenfield runoff rates for new developments within hotspot	Hotspot-wide application	✘
Option 3	Property flood resilience	Protection for individual properties	Hall Grove, Desborough Close	✓
Option 4	Increased conveyance and temporary storage within the highway	Providing increased highway capacity through raising of kerbs to limit volumes of water reaching property	Thistle Grove Cole Green Lane, Hyde Valley	✓
Option 5	Retrofitting of SuDS	Disconnection of surface water from public sewer via SuDS	Area-wide application – e.g. King George V recreation ground, Great Ganett and Cole Green Lane	✓

The reported flooding across the hotspot is not isolated to one area, with reported incidents widespread. The modelling also shows that there are numerous surface water flow pathways within this hotspot. Consequently, to address flood risk, multiple actions across the hotspot will be required.

Option 1 and Option 2 considered possible measures that WHBC could put into place in its role as the LPA, with the support of HCC. These included the allocation of land at higher risk of surface water flooding for less vulnerable uses as part of the Local Plan process. For example, where land at higher surface water flood risk becomes available for redevelopment consider allocating as recreational space or for water compatible development (Option 1). The model results highlight the importance of runoff generated within the hotspot on local flood risk therefore to address this, a hotspot-wide policy to limit any additional flows from new developments could be implemented (Option 2). It is noted that, while some small-scale urban creep may occur, at the time of writing there are no known largescale developments within the hotspot where this policy is most likely to be beneficial. Therefore, it is considered that this option will provide no overall enhancement to the hotspot if it were to be shortlisted.

The area around Desborough Close includes a number of properties which have reported flood incidents in the past. The detailed modelling has identified that this is associated with a flow path from Howlands (Figure 5-2). The area has limited opportunity for the construction of surface water management techniques; however based on site observations and a desk-based review of the area, it is understood that the properties have very low thresholds, resulting in flooding from even shallow flood depths. Option 3 therefore considered the suitability of this area for the installation of property flood resilience measures. This would likely involve the installation of flood doors which would be a permanent fixture, not requiring any temporary installation during the time of flood. This would be most suited to the surface water flood risk as there is often little warning that surface water flooding is going to occur. Other points of potential ingress, for example airbricks, would also need to be considered and fitted with resilience devices.

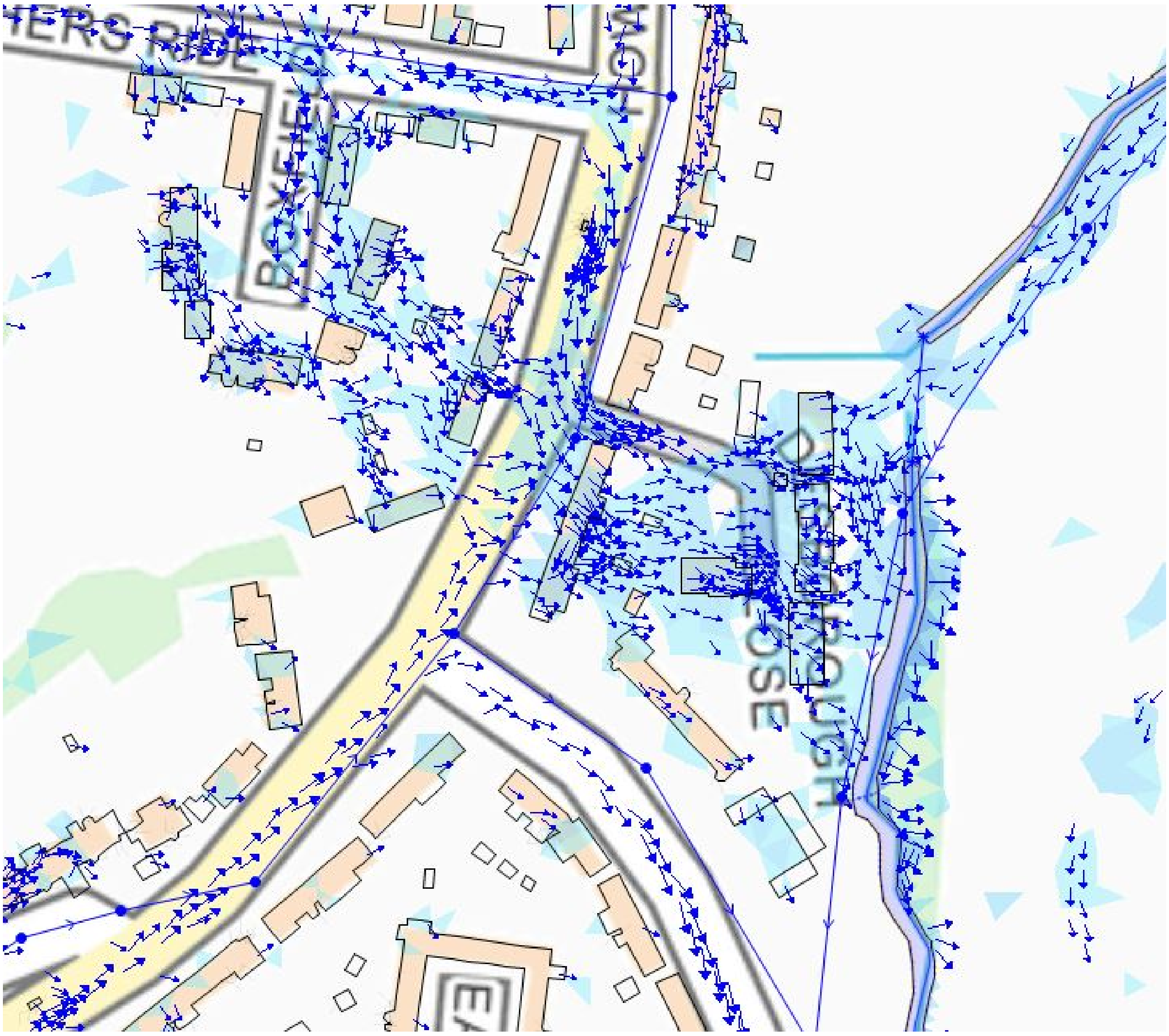

Figure 5-2: Flooding around Desborough Close from Howlands

In areas with little space available for the capture of flood volumes through SuDS, Option 4 considered the potential use of the highway to provide improved conveyance of shallow surface water flow and increased temporary storage flood water to prevent property flooding. At the southern end of Thistle Grove, there is a cluster of reported flood incidents. The modelling shows that surface water accumulates along this road and flows towards the properties (Figure 5-3). Increasing the kerb height could reduce the possibility of flood waters reaching properties and, as they have no driveway access, a dropped kerb is not required. It is likely that during more extreme events with a return period of greater the 1 in 75-years, the kerb would continue to be overtopped, and property flooding may occur. The construction of raised kerbs would create disruption but would be localised to this area which is not a main traffic route. This method of preventing flooding is relatively expensive and has no environmental benefits (equally it will not result in environmental degradation) and would have no negative visual impact for the area.

Figure 5-3: Surface water leaving the highway and flooding property along Thistle Grove

The nature of the garden city means there are many areas of greenspace across the site which could potentially be utilised as areas to intercept flow paths. To be effective, this would be a hotspot-wide policy of retrofitting SuDS features to help manage flood risk. Option 5 considered where there may be opportunities to install SuDS features and identified that there are limited opportunities to excavate large areas with significant volumes. It is therefore important to make the best use of the many small green spaces across the hotspot to provide a larger combined storage volume. Various SuDS techniques could be considered including rain gardens or infiltration basins, which could utilise infiltration to dispose of captured surface water where the geology allows, or alternatively discharge it to the existing highway or surface water sewer network at a more controlled rate if geology does not permit infiltration. Across the area, SuDS should be designed to work with the existing environment and enhance the natural environment.

One area where larger scale SuDS techniques could be considered is in the west of the hotspot, where the King George V recreation ground provides a large green space. This area already retains a large volume of water associated with a flow path from the west (see Figure 5-4). A desk-based assessment shows that there is a small bund feature running parallel with Marley Road which acts to trap water before it can reach the road. To the east of Marley Road, the green space here could be adopted to capture the flow path from the north (Figure 5-4). As the area is so large, a small lowering of ground levels could provide a significant amount of additional storage without resulting in dangerously deep standing water. It is also suggested that a bund be constructed (using excavated materials) in the south (along Beehive Lane) to further obstruct the flow path.

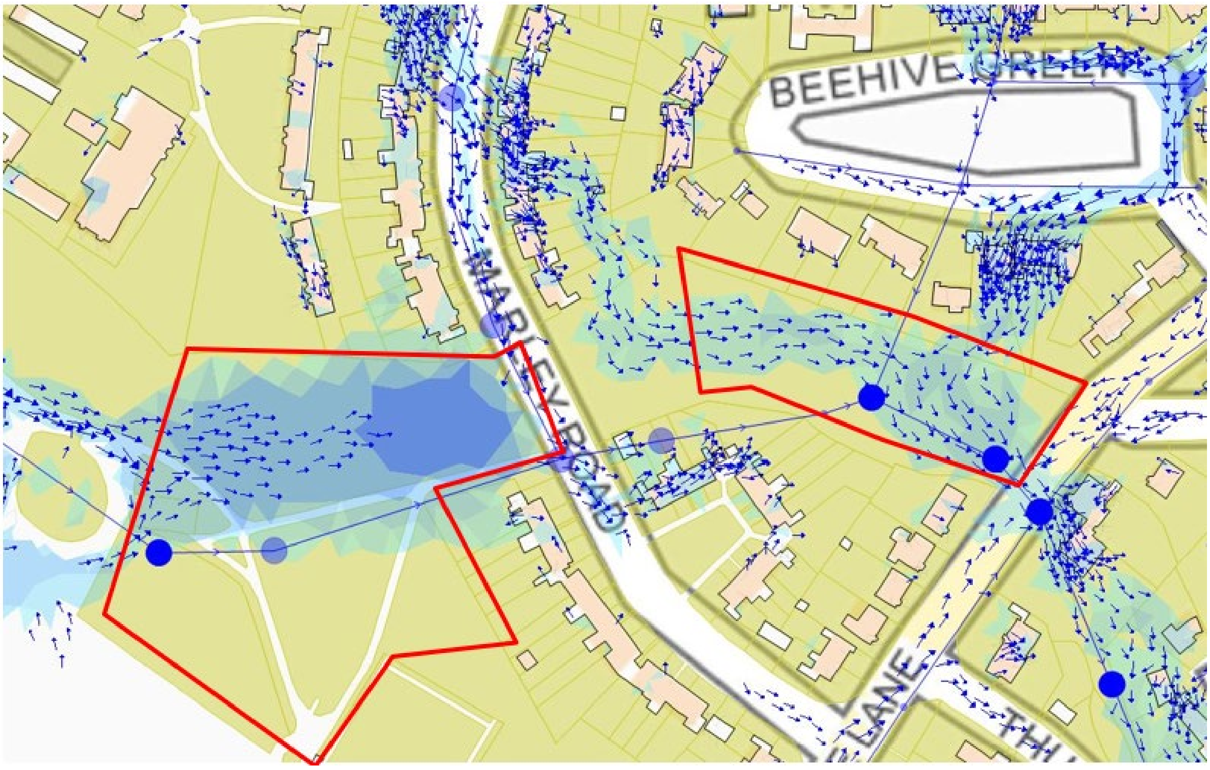

Figure 5-4: Storage of flows within King George V recreation ground (highlighted in red)

In the north east, there is a large concentration of reported incidents which could be addressed through the diversion of flow paths into existing green spaces. There are opportunities for the construction of swales along Great Ganett and Little Ganett (Figure 5-5) and a small detention area along Cole Green Lane.

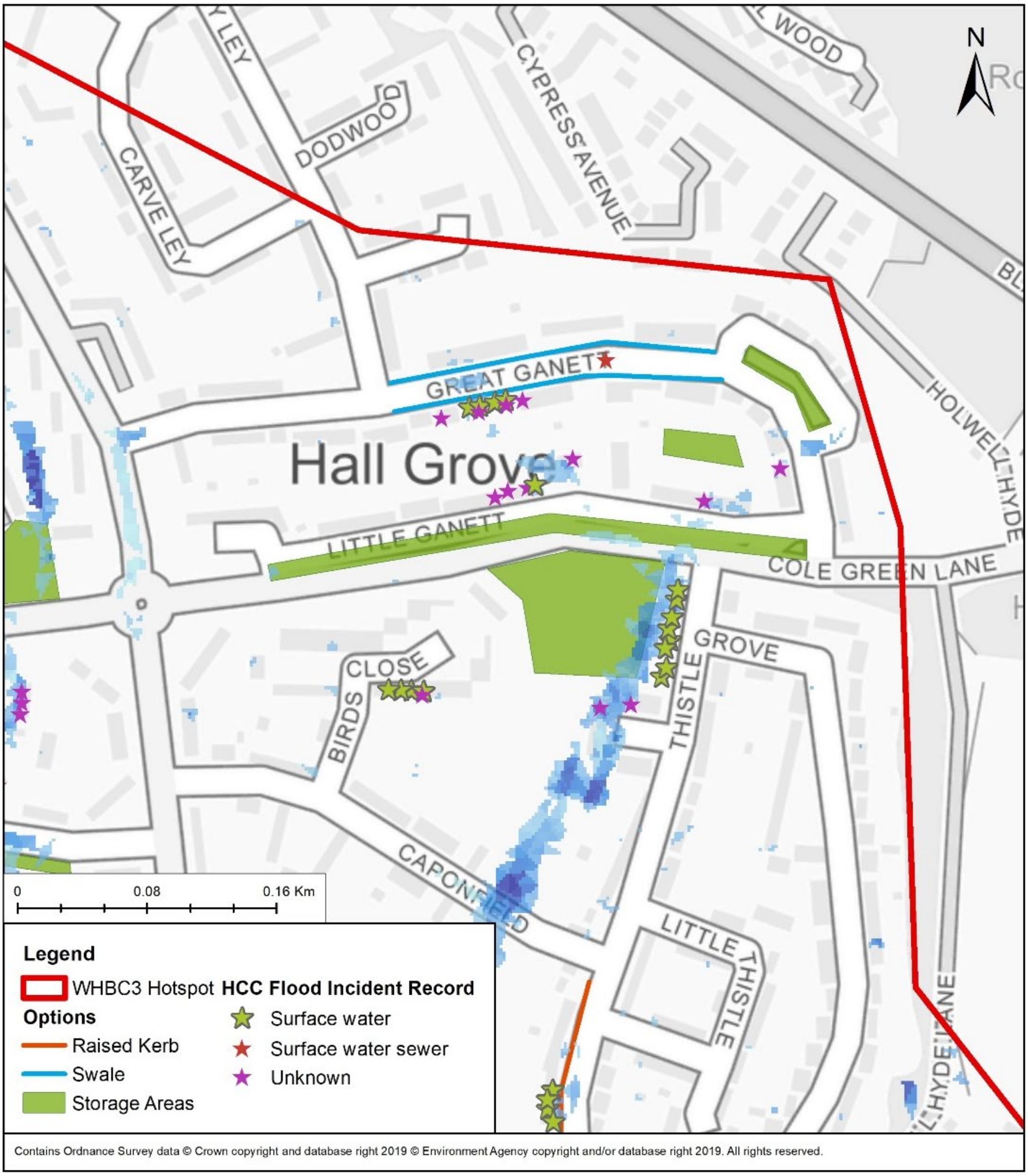

Figure 5-5: Examples of SuDS along Great Ganett and Little Ganett

The retrofitting of SuDS across this area is largely associated with adopting existing green spaces. These schemes will have little associated future maintenance and is likely to only include grass cutting to ensure no volume loss. Furthermore, there will be little disruption during the excavation of the areas and no detrimental visual impact for the area. Design would need to consider the amenity impact on green spaces, ensuring that water would drain away after an event so that the green spaces do not become waterlogged and unusable for extended periods of time.

The options chosen as the preferred methods for the hotspot are:

- Option 3 – Property flood resilience;
- Option 4 – Increased conveyance and temporary storage of water within the highway;
- Option 5 – Retrofitting of SuDS.

It is unlikely that one option alone would not provide protection for the affected properties and the options above should be combined for an effective response to the flood risk.

5.3 WHBC6 – Digswell Water

The Digswell Valley hotspot includes the area around Rosedale, Digswell Water, Harwood Close, Sewells, Hertford Road as shown in Figure 5-6. This hotspot was identified as one to take forward for modelling after undertaking the multi-criteria analysis on the hotspot. The model incorporated the surface water sewer system and the River Mimram which flows in a westerly direction through the centre of the hotspot.

5.3.1 Assessment of flood mechanisms - Source-Pathway-Receptor

The primary source of flood risk within the hotspot is surface water and the dominant surface water flow path moves in a southerly direction from the residential area in Digswell and is associated with the natural topography, as shown in Figure 5-6. The flow path moves onto New Road and predominantly flows within the highway, however some front gardens of properties along New Road are also shown to be at risk in all return periods, including the 1 in 5-year event. Surface water ultimately drains towards the River Mimram, which runs through the centre of the hotspot.

In the south of the hotspot, there is a separate cluster of reported flood incidents located around Sewells and Harwood Close which occurs as a result of localised ponding.

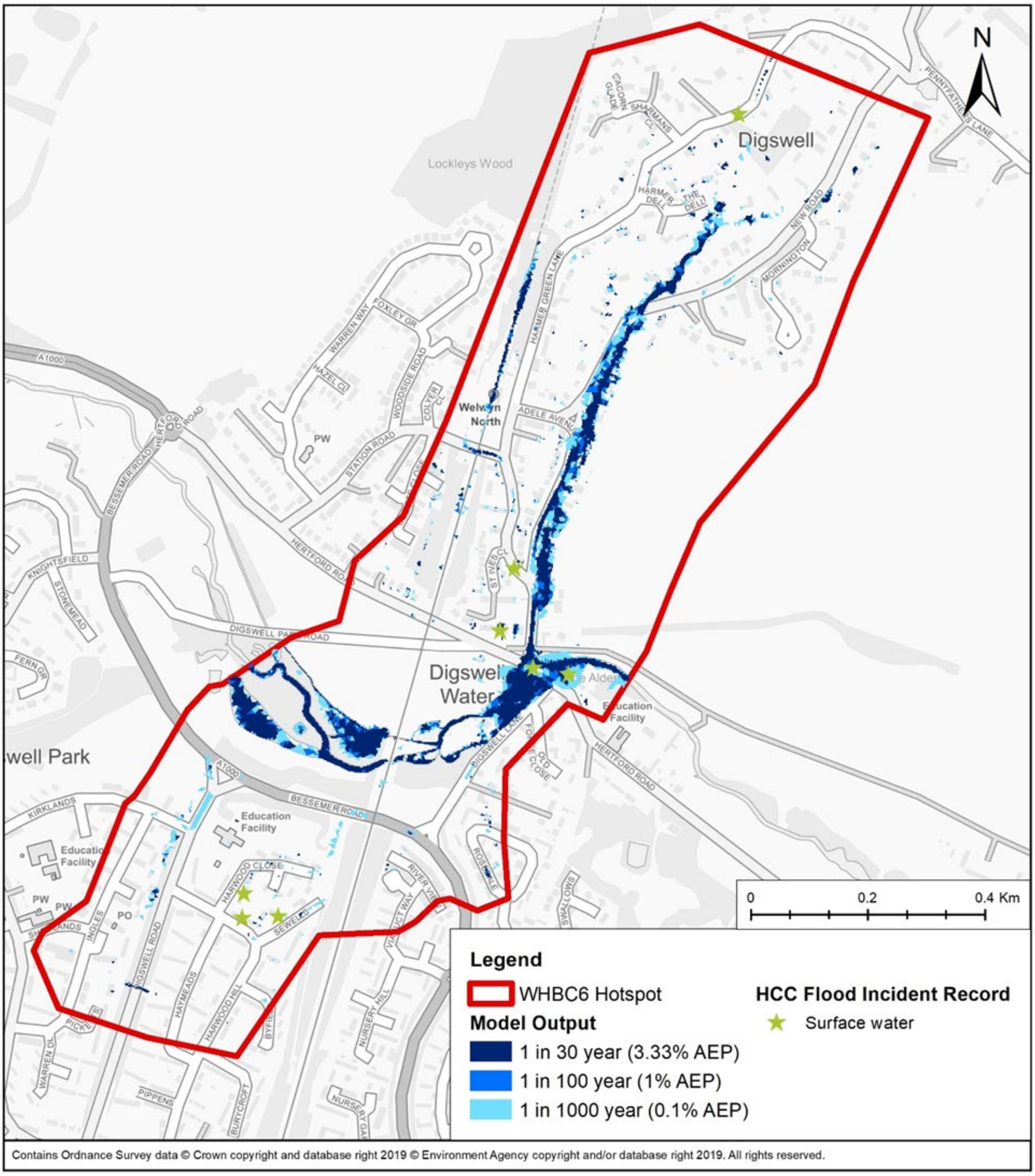

Figure 5-6: Detailed model outputs for WHBC6

Table 5-3 shows a comparison of the number of properties to be at risk of surface water flooding in the EA RoFSW mapping and the detailed flood modelling for WHBC6. For the 1 in 30-year event, the numbers of properties affected is greater for the detailed modelled as opposed to the EA RoFSW mapping. This is as a result of the positioning of the flow path along New Road. For the detailed modelling, it is shown to be less concentrated to the highway and intercepts properties on the east of the road. For the 1 in 100- and 1,000-year events, it is the detailed modelling which predicts fewer impacted property. This is not concentrated to one area, but a general decrease in flood extent.

Table 5-3: WHBC6 Properties at risk from surface water flooding

Number of residential properties at risk	1 in 20 year	1 in 30 year	1 in 75 year	1 in 100 year	1 in 200 year	1 in 1,000 year
RoFSW	N/A	15	N/A	62	N/A	192
WHBC6 detailed modelling	30	29	33	36	40	64
Number of non-residential properties at risk	**1 in 20 year**	**1 in 30 year**	**1 in 75 year**	**1 in 100 year**	**1 in 200 year**	**1 in 1,000 year**
RoFSW	N/A	13	N/A	21	N/A	33
WHBC6 detailed modelling	13	13	13	13	17	22

The reported flood incidents closely correspond with the modelled flood outputs, with locally sourced runoff impacting properties outside the main flow path. The flood incidents around Hertford Road, which occurred in July 2017 all reported the cause as intense rainfall. The flooding around Sewells and Harwood Close occurred at the same time and is also reported to be as a result of surface water.

5.3.2 WHBC6 Mitigation Options Considered

The detailed modelling was used to understand the flood mechanisms that impact the at-risk areas within the hotspot and as part of the longlisting process, several methods were considered to alleviate the flood risk within the hotspot. These options are summarised in Table 5-4 and further information about the options considered and the locations for options is included in Appendix F and Appendix G respectively.

Table 5-4: Summary of mitigation options for WHBC6

Option Number	Option Type	Description	Areas Applicable	Shortlisted?
Option 1	Increased conveyance and temporary storage within the highway	Providing increased conveyance and temporary storage capacity within the highway through raising of kerbs to limit volumes of water reaching properties	New Road, Sewells, Harwood Close	✓
Option 2	Retrofitting of SuDS	Disconnection of surface water from public sewer via SuDS	New Road	✓
Option 3	Property flood resilience	Protection to individual properties	St Ives Close, The Alders, Hertford Road / Digswell Lane	✓
Option 4	Catchment management	Upstream management of the Mimram River to manage flood risk downstream	Mimram River catchment	✗

Flood risk in this area is largely associated with a surface water flow path from the north. There is also a fluvial aspect in the centre of the hotspot from the Mimram River.

To address the surface water flood risk, actions should be implemented in the north of the hotspot, surrounding New Road. Figure 5-7 shows the flow path and how it moves to the highway. The water originates in the gardens of private properties and is associated with the natural topography. Management of the water here would be difficult to enforce.

Option 1 considered the potential for improving the conveyance of flows and providing temporary storage of surface water within the highway. This could be achieved through increasing of kerb height or lowering of the road surface. Along New Road, this would act to ensure the flow path remains within the highway and not affect properties. However, there are several properties along the road that have driveway access and therefore changes to the kerb height would limit access and would not be suitable in this location. An increase in kerb height is also considered in the south of the hotspot, where flooding has previously been experienced along Sewells. Here, there is limited green space that could be utilised to capture water before it reaches properties and there are less dropped kerbs. The disruption caused by kerb alteration could, however, still be high with the requirement for road closures. Furthermore, it provides no additional benefits for amenity space or environmental enhancement. It should also be considered that this option would only protect against low order events.

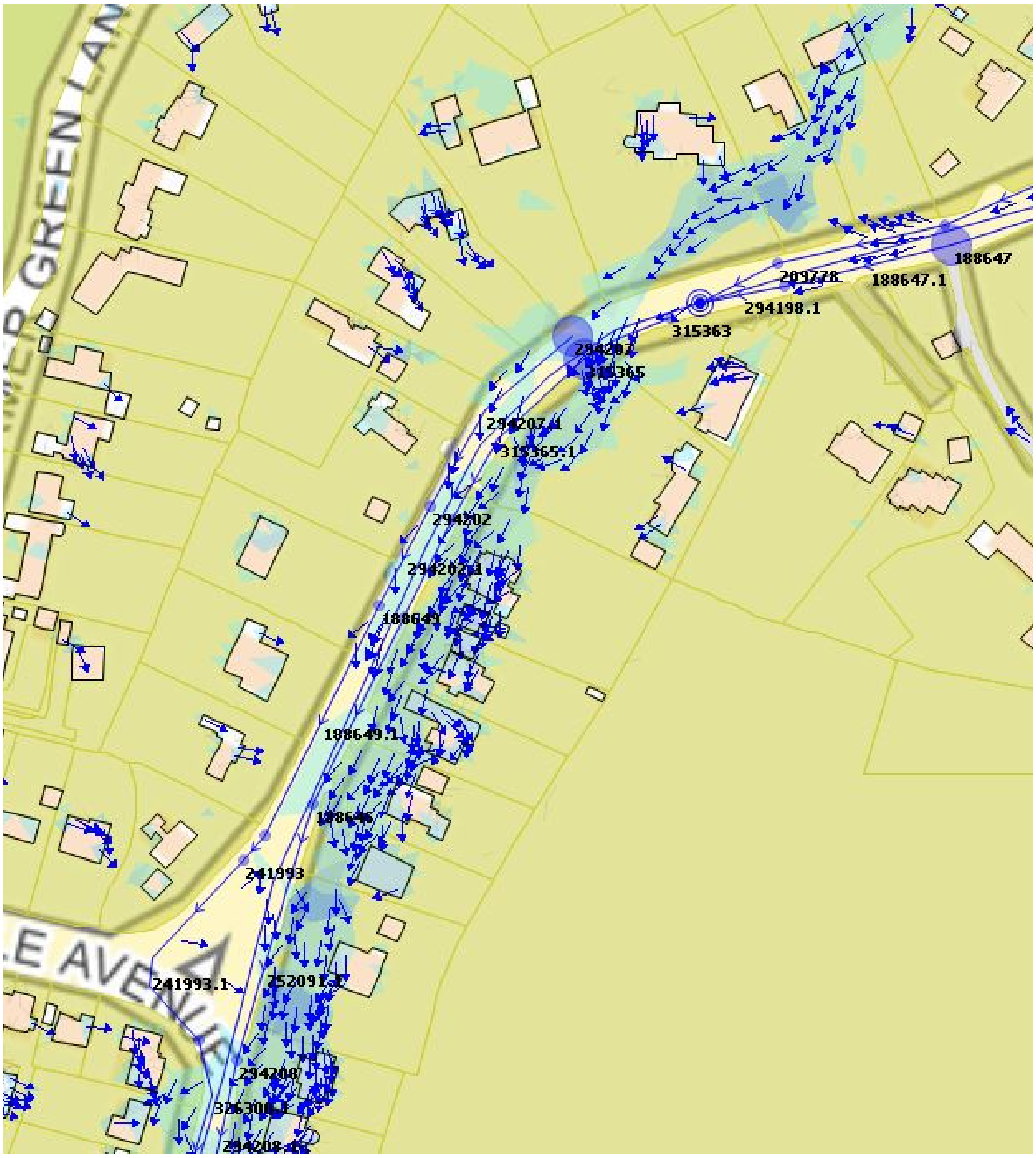

Figure 5-7: Flow path from residential areas onto New Road

Option 2 considered the retrofitting of SuDS to alleviate the flood risk posed by the flow path. Small grass verges are present adjacent to the footpath of New Road that may provide opportunities for the construction of SuDS including swales or rain gardens as shown in Figure 5-8 and Appendix G. These would act to intercept the flows, reducing the volumes that move along New Road. Utilising these areas would result in little disruption to the area. The incorporation of rain gardens could visually enhance the area and improve the existing environmental opportunity of the grass verges.

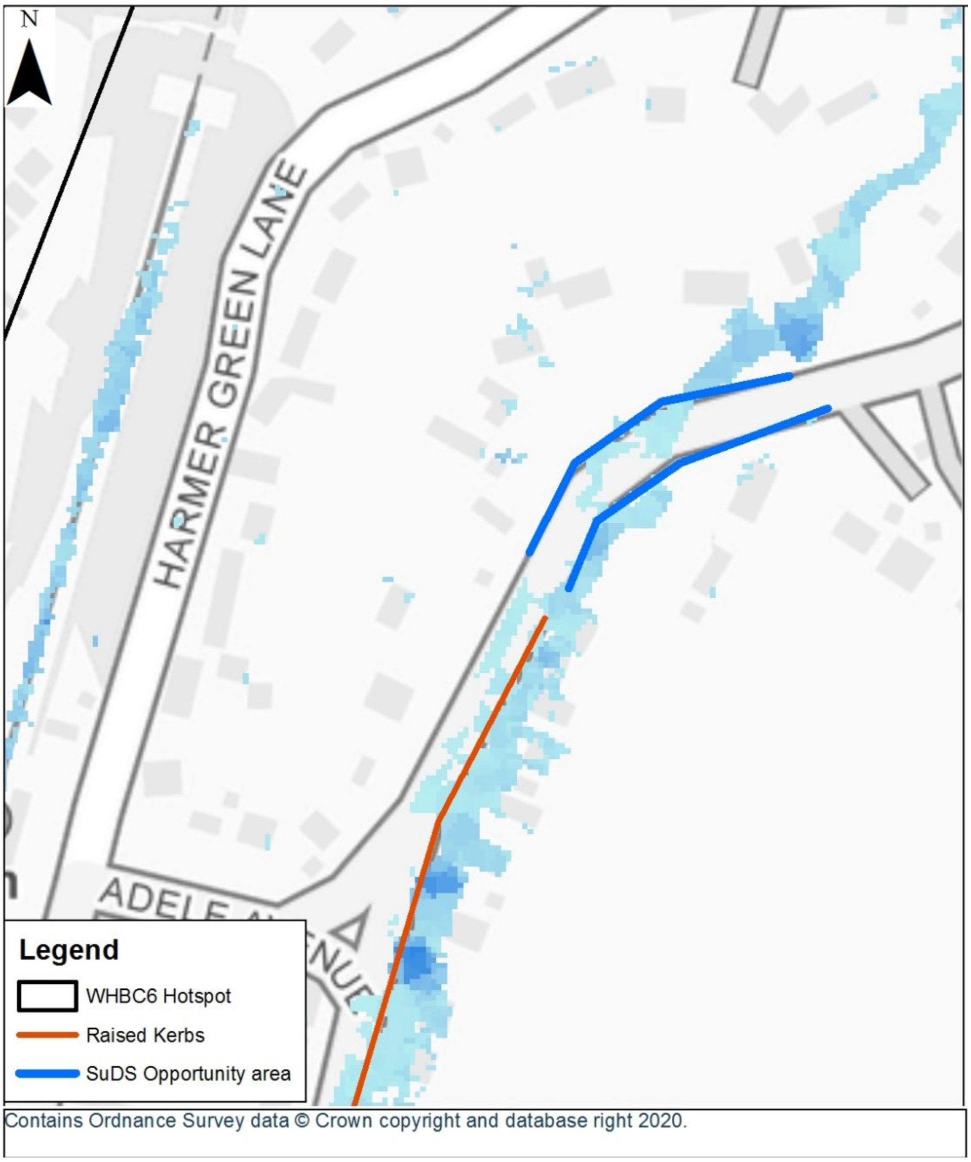

Figure 5-8: SuDS Opportunity area on New Road

It is noted that due to limited opportunities for construction of SuDS features in the upper catchment some properties may still be affected by flooding. For these properties, Option 3 considered the installation of Property Flood Resilience (PFR) measures to reduce the risk of internal flooding at key properties. PFR can include active measures such as demountable defences on driveways or doorway, or passive measures such as installing flood-proof doors or raising or covering flood entry points like airbricks. This is likely to involve permanent fixtures, such as the addition of flood doors, which do not require assembly ahead of a flood. As the risk to most properties is surface water, there is not a long-advanced warning, and so permanent features would be most suitable. For those at risk of fluvial flooding within the hotspot, demountable features may be an option.

PFR is most effective where flood depths are less than 0.6m and would therefore be suitable for locations such as St Ives Close, The Alders and along Hertford Road and Digswell Lane which recorded flooding in the 2017 flooding.

The Mimram River flows through the centre of the hotspot from east to west, resulting in a fluvial flood risk to properties. To manage this risk, it is suggested that catchment management of the watercourse is discussed with the EA (Option 4).

This would involve actions to slow flows in the upper catchment but also detain some of the volumes. Catchment management would likely reduce the fluvial flood risk to the hotspot, but this is only to a small area. Therefore, this is not deemed a viable option for this hotspot and is not taken forward to the short list.

The options chosen as the preferred methods for the hotspot are:

- Option 2 – Retrofitting of SuDS;
- Option 3 – Property flood resilience.

It is unlikely that one option alone would not provide protection for the affected properties and the options above should be combined for an effective response to the flood risk.

6 SWMP Action Plan

This section sets a plan for managing the flood risk identified in this SWMP. The action plan uses the information collated during the SWMP process to recommend measures to reduce or mitigate the flood risk in Welwyn-Hatfield Borough. The actions are dependent on the identified flood mechanisms.

6.1 Monitoring the action plan

It is proposed that the monitoring and reporting of the implementation of the action plan will be undertaken locally and it is expected that partners will take forward actions independently. The action plan should be reviewed and updated quarterly, and the SWMP steering group should convene as and when appropriate.

6.2 Communicating the action plan

The action plan is divided into three components, each of which look at mitigating flood risk at a different scale. The three action components are: the generic plan, the hotspot action plan and the incident specific action plan. The geographic area and purpose of each action plan is explained in Table 6-1.

Table 6-1: List of action plans

Geographic area	Action plan	Purpose
Study area wide	Generic action plan (Section 6.3)	Outline broad scale actions applicable across the study area
Hotspots	Hotspots action plan (Section 6.4)	Recommend strategic actions to manage the flood risk in hotspots
Incident	Incident action plan (Incident specific)	Use information in this SWMP to inform Multi Agency Flood Plans

6.3 Generic action plan

Some of the actions derived from this SWMP are applicable across the Borough. Actions to mitigate these issues are listed in the generic action plan.

6.3.1 Ongoing maintenance of the partnership

To successfully undertake the action plan and continue to improve the management of flood risk in the area, it is important to maintain the links between the RMAs involved in the production of the SWMP. The on-going partnership will discuss the implementation of the proposed actions, review opportunities for operational efficiency and review any legislative changes. It is proposed that the monitoring and reporting on the implementation of the action plan will be undertaken locally.

6.3.2 Planning and surface water drainage

Although flood risk from fluvial flood sources is accounted through the NPPF, surface water and groundwater flood risk issues can be less well represented at the planning stage. For major development, Hertfordshire County Council as Lead Local Flood Authority review all sources of flood risk to the site and the suitability of surface water drainage proposals. However, the same level of scrutiny is not possible for all minor development.

6.3.3 Asset maintenance

Frequency of asset maintenance should be informed by the susceptibility of a drainage asset to become blocked and cause a flooding issue. This helps to pre-empt flooding and optimise maintenance by targeting key assets.

However, delivery of proactive maintenance is often informed by the reactive response to a reported flood incident or asset defect. Figure 6-1 outlines the typical process operated by Risk Management Authorities in responding to a reported incident.

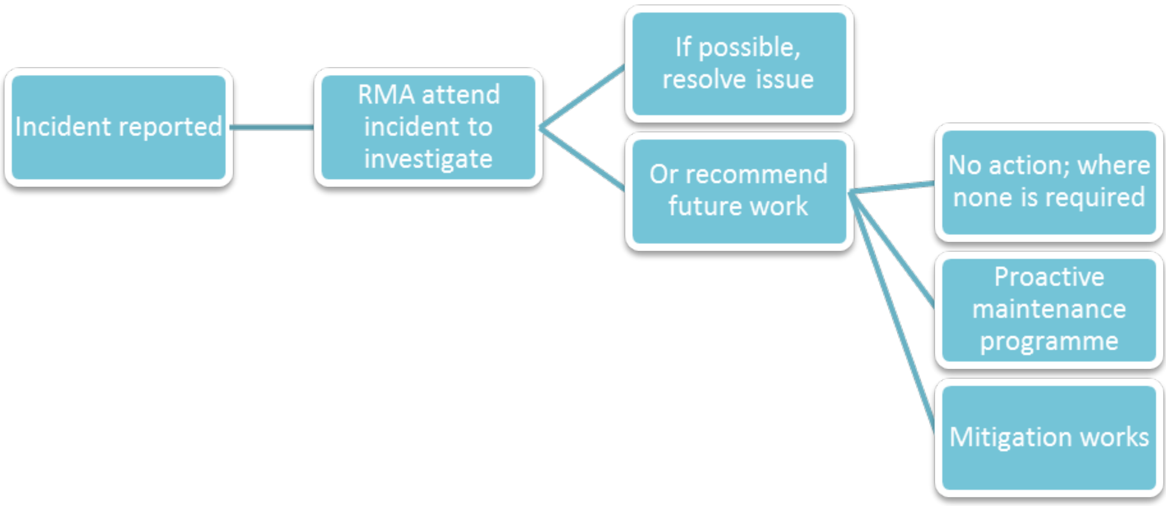

Figure 6-1: Typical process of asset maintenance by RMAs

This approach is largely being adopted by RMAs in Welwyn-Hatfield Borough Council, with HCC Highways having identified a series of priority areas for drainage works and gully maintenance across the county, and Thames Water Utilities Limited maintaining a proactive, rather than reactive, asset management system. As a result, maintenance works should be undertaken before a flood incident occurs due to a blockage or collapse.

Maintenance of private owned assets in Welwyn-Hatfield Borough such as flap valve outfalls onto one of the main rivers and property downpipes are the responsibility of the landowner although it may not be evident. Co-ordinated awareness raising of asset ownership by the RMAs and providing advice, would help to the secure the future maintenance of these assets.

6.4 Hotspot action plan

For the hotspots, strategic actions have been recommended to address integrated flood mechanisms operating in these areas. Table 6-2 identifies the recommended actions.

Table 6-2: Hotspot action plan

Hotspot	Actions	Owner
WHBC3 – Hyde Valley	Consider catchment-wide utilisation of small areas of green space as detention areas and / or swales to intercept flow paths. There are multiple spaces in the northern areas of the hotspot that provide ideal opportunity for this.	WHBC, HCC
WHBC3 – Hyde Valley	Increased highway capacity to convey and temporarily store surface water and prevent water reaching properties. This should be incorporated in the south of the hotspot where there is lesser opportunity to implement green storage areas.	HCC, WHBC, Highways
WHBC6 – Digswell Valley	Consider PFR survey and installation for key at risk properties.	HCC,
WHBC6 – Digswell Valley	Explore the retrofitting of SuDS where existing parcels of green space are utilised as storage and / or conveyance features. For example, along New Road whereby there are grassy spaces between the pavement and highway.	WHBC, HCC

6.5 Way forward

Whilst HCC has taken responsibility for leading the Phase 2 of the SWMP, it is recommended that the responsibility for monitoring the progress of the action plan and maintaining the links between the partners would be better served at the local level. The immediate next step should be to agree who will lead the delivery of the action plan and the continuation of the partnership between HCC and Welwyn-Hatfield Borough.

It is also recommended that the progress of the SWMP to the later, more detailed stages should be focused on the areas where repeated flood incidents have been recorded together with high predicted flood risk. For the Welwyn-Hatfield Borough SWMP area, further detailed assessment is recommended in some of the hotspot areas, including hotspot areas of Hyde Valley and Digswell Water. This may include integrated hydraulic modelling to better understand the risk of flooding, and where required could also lead to a flood risk mitigation options appraisal.

Finally, as part of an iterative process of revision, the outputs of the SWMP should be incorporated into future revisions of the Hertfordshire LFRMS.

Appendices

A Project data register

B Stakeholder Communications and Engagement Plan

C Hotspot assessment sheets

D Modelling methodology

E Hotspot flood risk mapping

F Options long-list

G Options mapping

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