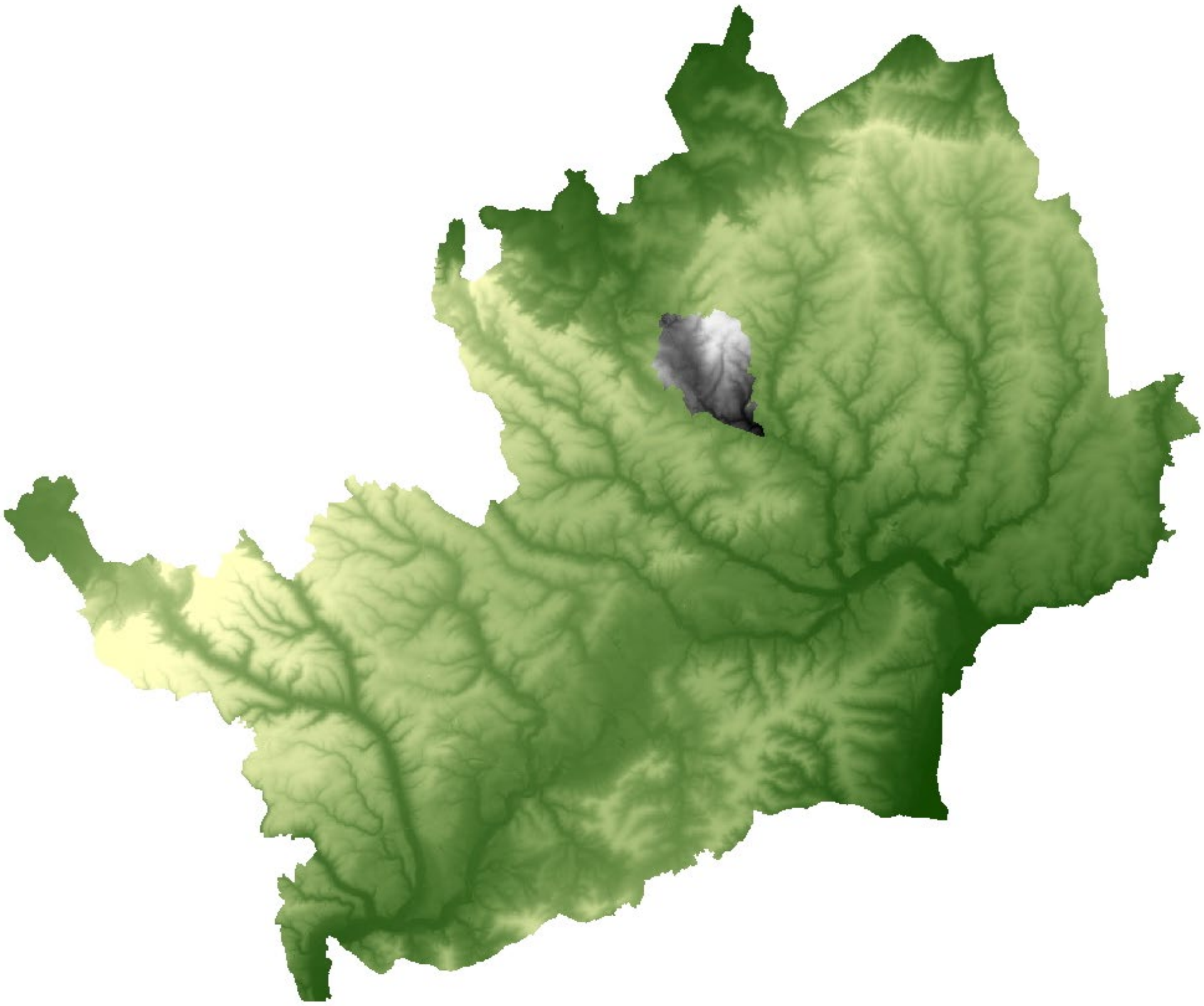

Stevenage Borough Surface Water Management Plan

Final Report

March 2021

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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 Stevenage Borough SWMP has been prepared alongside parallel studies including Hertsmere, Three Rivers and Welwyn-Hatfield. Together, these four studies will complete coverage of SWMPs for the county.

A SWMP is a framework to improve the understanding 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; Stevenage 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.

Stevenage is a largely urban borough in Hertfordshire, England. The borough is situated between Letchworth Garden City to the north, and Welwyn Garden City to the south. The borough is on elevated land at the eastern end of the Chiltern Hills on the watershed between the Thames and Great Ouse river catchments. Most of Stevenage Borough lies within the catchment of Stevenage Brook, a major tributary of the River Beane, which it joins at Frogmore Hall, approximately 1.5km downstream of the borough boundary. 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 Stevenage, 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:

- SBC1 – Matthews Close, Rectory Lane and Chancellors Road;
- SBC2 – Bragbury Lane;
- SBC4a and b – Blair Close and London Road, and Roebuck Gate.

Using the outputs from the detailed modelling, potential strategies 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
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
SBC..........................Stevenage Borough Council
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 Stevenage 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 1.3.

1.2 Study area

Stevenage is a largely urbanised borough in Hertfordshire. The borough is situated between Letchworth Garden City to the north, and Welwyn Garden City to the south and is located approximately 33 miles north of central London. Urbanisation of the area occurred in the 1950's and 1960's after Stevenage was designated a New Town. Areas around Stevenage include the Old Town, Chells Manor, Broadwater and Poplars. The borough covers an area of approximately 26 km^2.

The borough is on elevated land at the eastern end of the Chiltern Hills on the watershed between the Thames and Great Ouse river catchments as shown in Figure 1-1. The River Beane is one of the principal tributaries of the River Lee which drains a substantial area of Hertfordshire and East London. Most of Stevenage Borough lies within the catchment of the Stevenage Brook, a major tributary of the River Beane, which it joins at Frogmore Hall, approximately 1.5km downstream of the borough boundary.

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

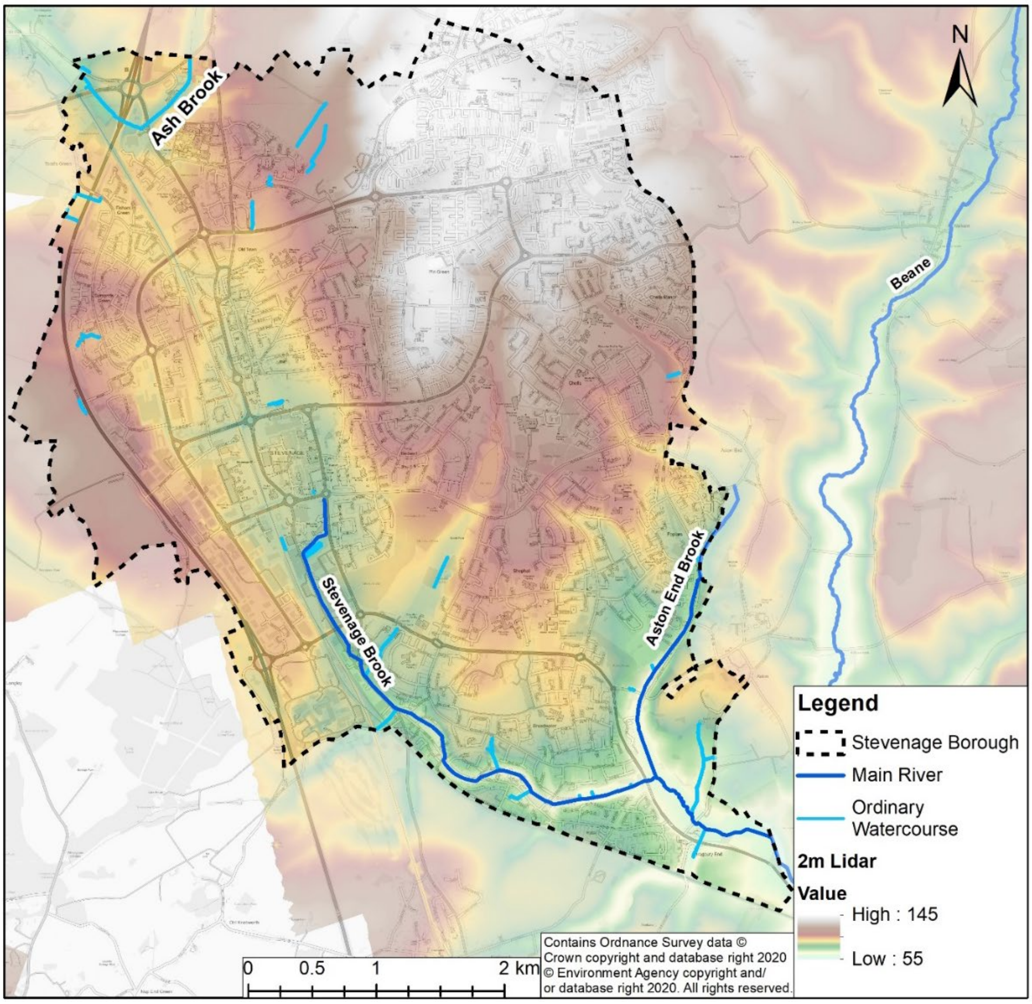

Figure 1-1: Location plan of the SWMP study area and topography of Stevenage Borough

1.2.1 Geology

The borough is situated at the upper catchment of the River Lee and the underlying geology is predominately chalk. This has produced the landforms typical of the Chiltern Hills with often dry valleys and gently rolling uplands that are separated by broad chalk ridges. Across much of the borough the chalk has been covered with a blanket of Boulder Clay and other glacial deposits (sands, gravels and clays) during the ice ages, however a strip of exposed chalk is present stretching south from Chesfield Park to the Fairlands Valley at Bedwell. There is also a small exposure of chalk in the northeast corner of the borough at Box Wood. A simplified map of the bedrock and superficial geology of the borough is shown in Figure 1-2.

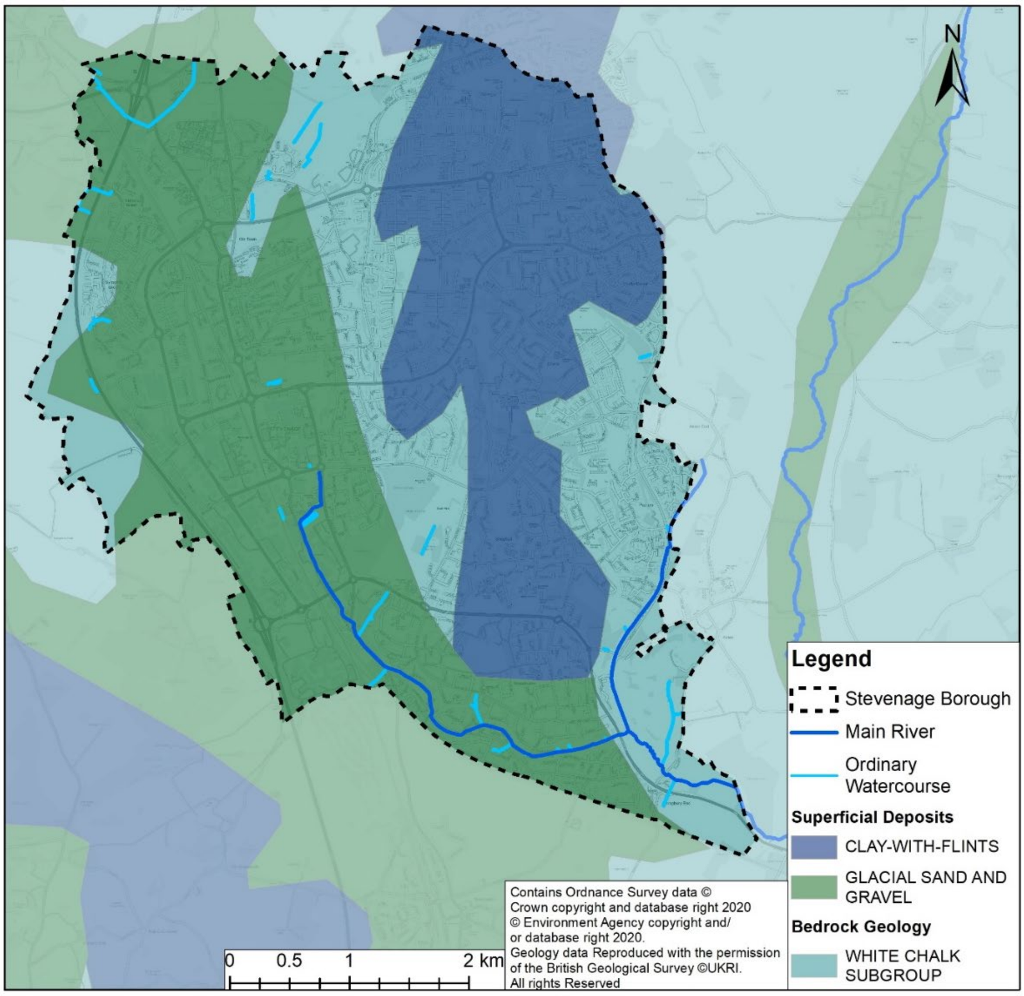

Figure 1-2: Bedrock and superficial geology underlying Stevenage Borough

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.

The majority of Stevenage Borough lies within the catchment of Stevenage Brook, a major tributary of the River Beane, which it joins at Frogmore Hall approximately 1.5km downstream on the borough boundary (see Figure 1-3). Within Stevenage, the main channel of the Stevenage Brook drains the western side of the Borough and the town centre. The Stevenage Brook is defined as Main River south of Six Hills Way.

The brook has two principal tributaries; the Fairlands Valley Stream which drains the central part of Stevenage, and the Aston End Brook which drains the eastern side of the Borough. All three streams flow from north to south. The catchments of the first two streams are almost entirely urbanised. The Aston End Brook is also defined as Main River south of Tatlers Lane.

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 or a public sewer. Hertfordshire County Council (HCC) as the LLFA, has permissive powers to regulate works on ordinary watercourses within Hertfordshire.

Several ordinary watercourses drain the study area including Ash Brook and Langley Brook that drain from the western boundary Stevenage Borough. The ordinary watercourses within the study area are shown in Figure 1-3.

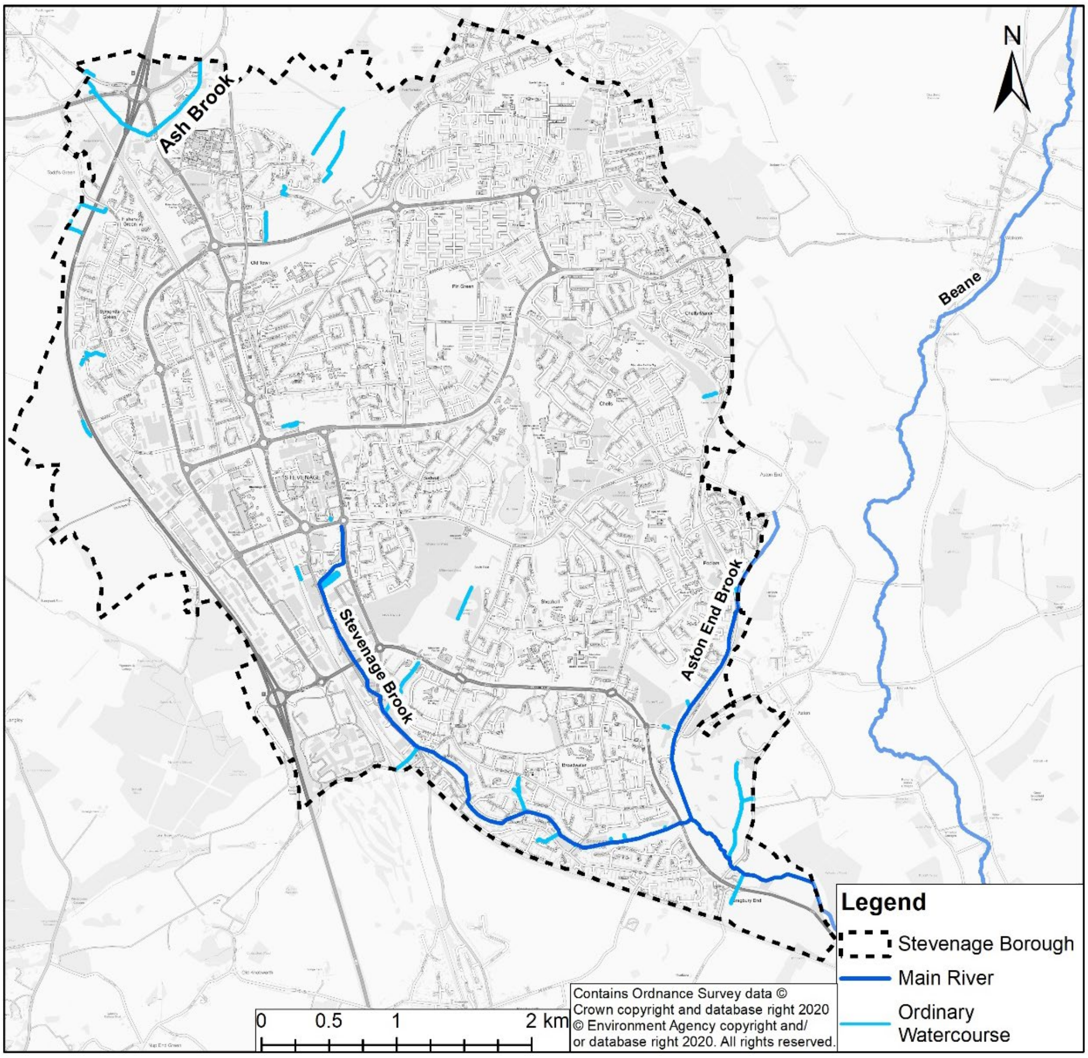

Figure 1-3: Location of main rivers and ordinary watercourses in Stevenage

1.2.3 Sewers

Sewers describe infrastructure, generally below ground, for the conveyance of wastewater. Sewers are categorised by the type of wastewater removed. The categories 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, and (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 Stevenage. 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 network is the responsibility of TWUL. Foul water 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 (EA) 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 a 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 in Stevenage Town centre. Fluvial flood risk to Stevenage Brook and the River Beane will increase with the impact of climate change, which is likely to impact the fluvial flood risk exposed to Stevenage, and flooding from surface water drainage systems restricted by higher river levels.

1.2.6 Integrated flood risk

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

1.3 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.

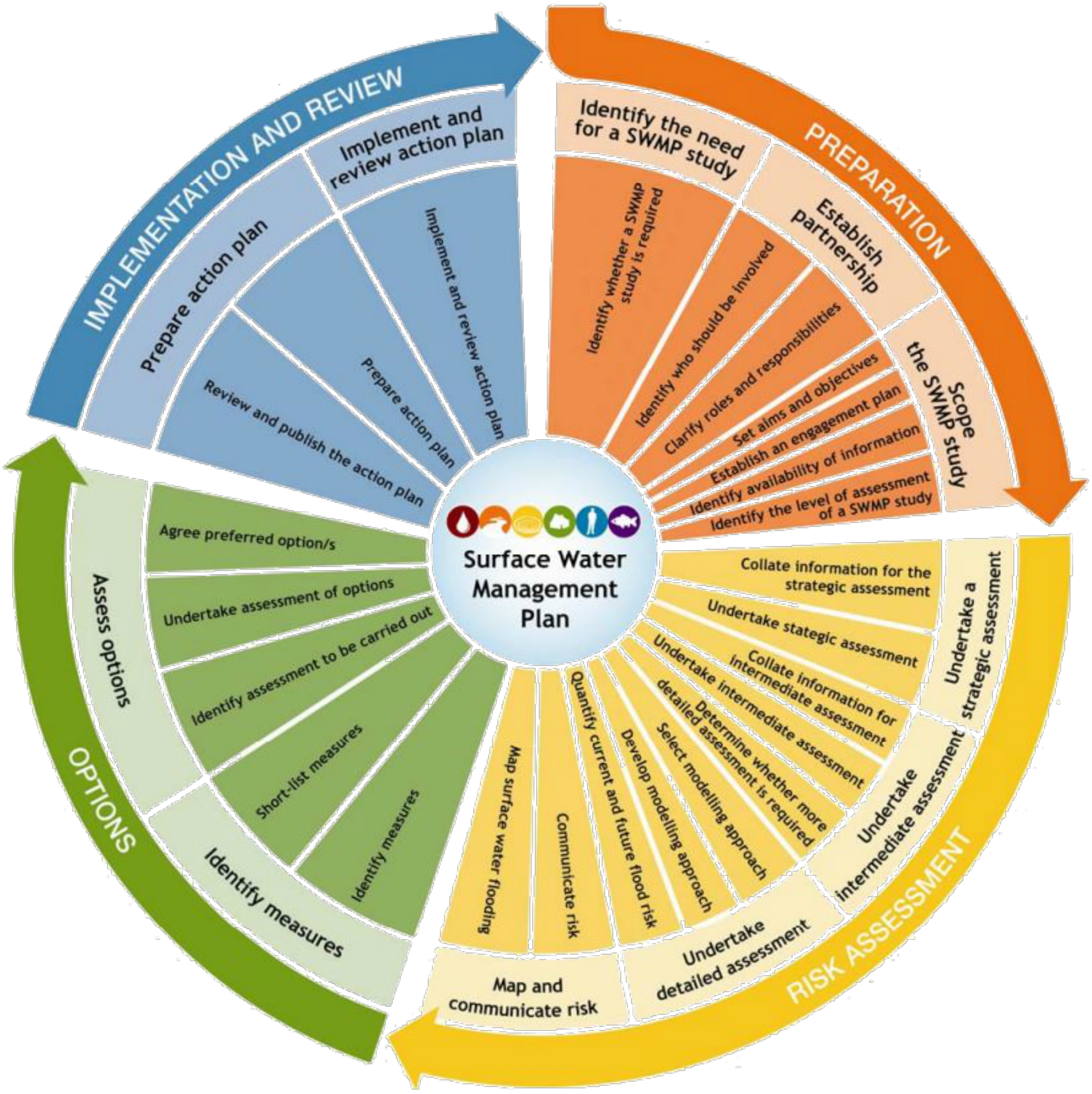

Figure 1-4: Defra Surface Water Management Plan "Wheel"

1.4 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 Hertfordshire[4] 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, Three Rivers and Welwyn-Hatfield. 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 Stevenage, include:

- Hertfordshire County Council;
- Stevenage 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.

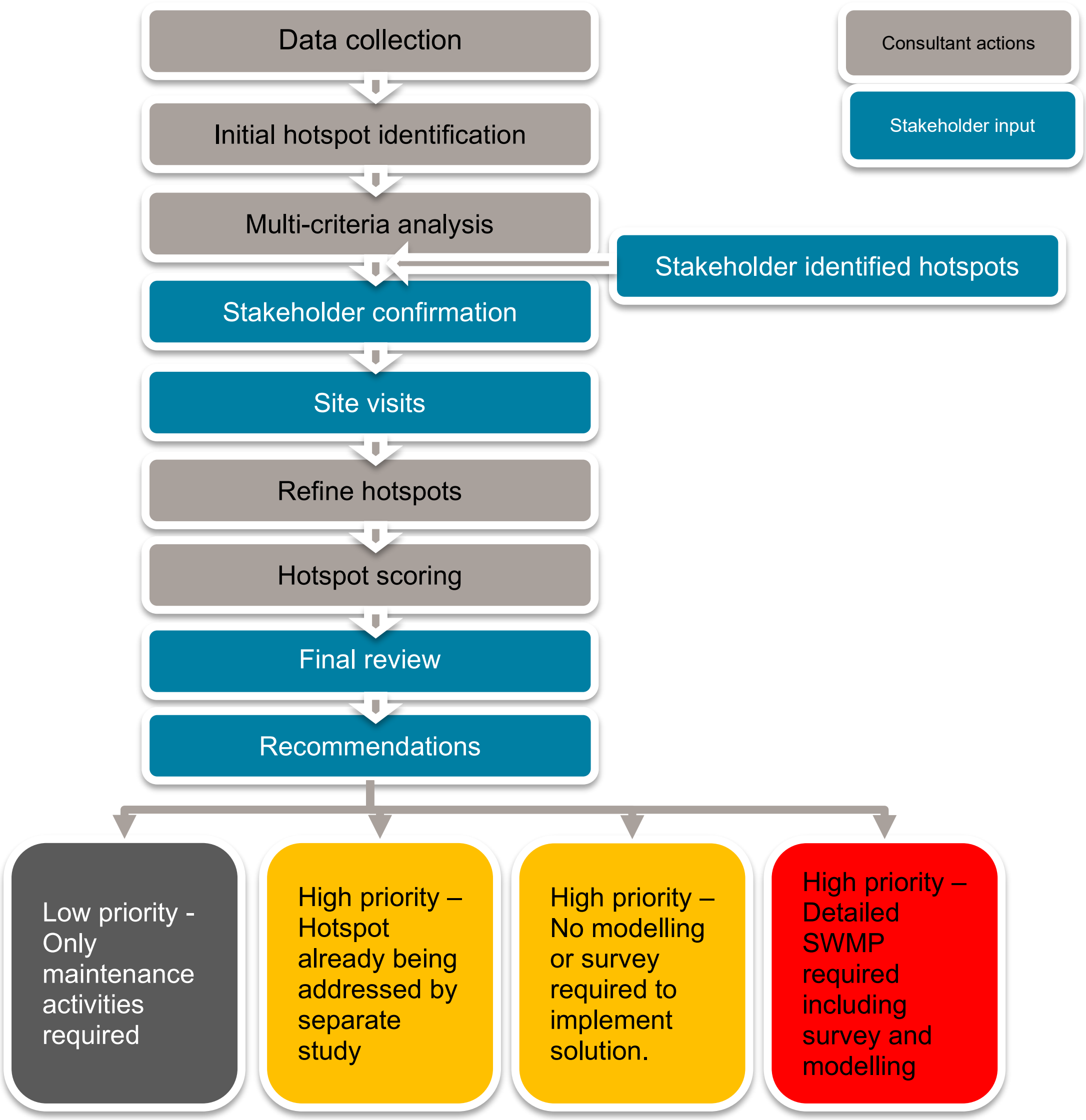

Figure 3-1: Hotspot selection process flow chart

3.3 Data collection

Relevant data was collected and analysed for Stevenage, from Stevenage Borough Council (SBC), 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 (BGS) Geology - bedrock and surface
BGS Website	British Geological Survey Hydrogeology
Stevenage Borough Council	Evidence of flood history
Stevenage 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. TWUL advised that they would be able to provide additional information, in confidence, following the hotspot selection.

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 SBC. Hotspots were given unique identification codes, for example SBC1, as shown in Table 3-2 and Figure 3-2 below.

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[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: Stevenage draft hotspots

Hotspot Reference	Location
SBC1	Matthews Close, Rectory Lane and Chancellors Road
SBC2	Bragbury Lane
SBC3	St Georges Way
SBC4	Roebuck Gate, Blair Close and London Road
SBC5	Oxleys Road, Hydean Way, Foxfield and Kymswell Road
SBC6	Mildmay Road and Durham Road
SBC7	Primett Road Brick and Kiln Road
SBC8	Corey's Mill Lane (Lister Hospital, Martins Way and Hitchin Road (Fire and Rescue service)

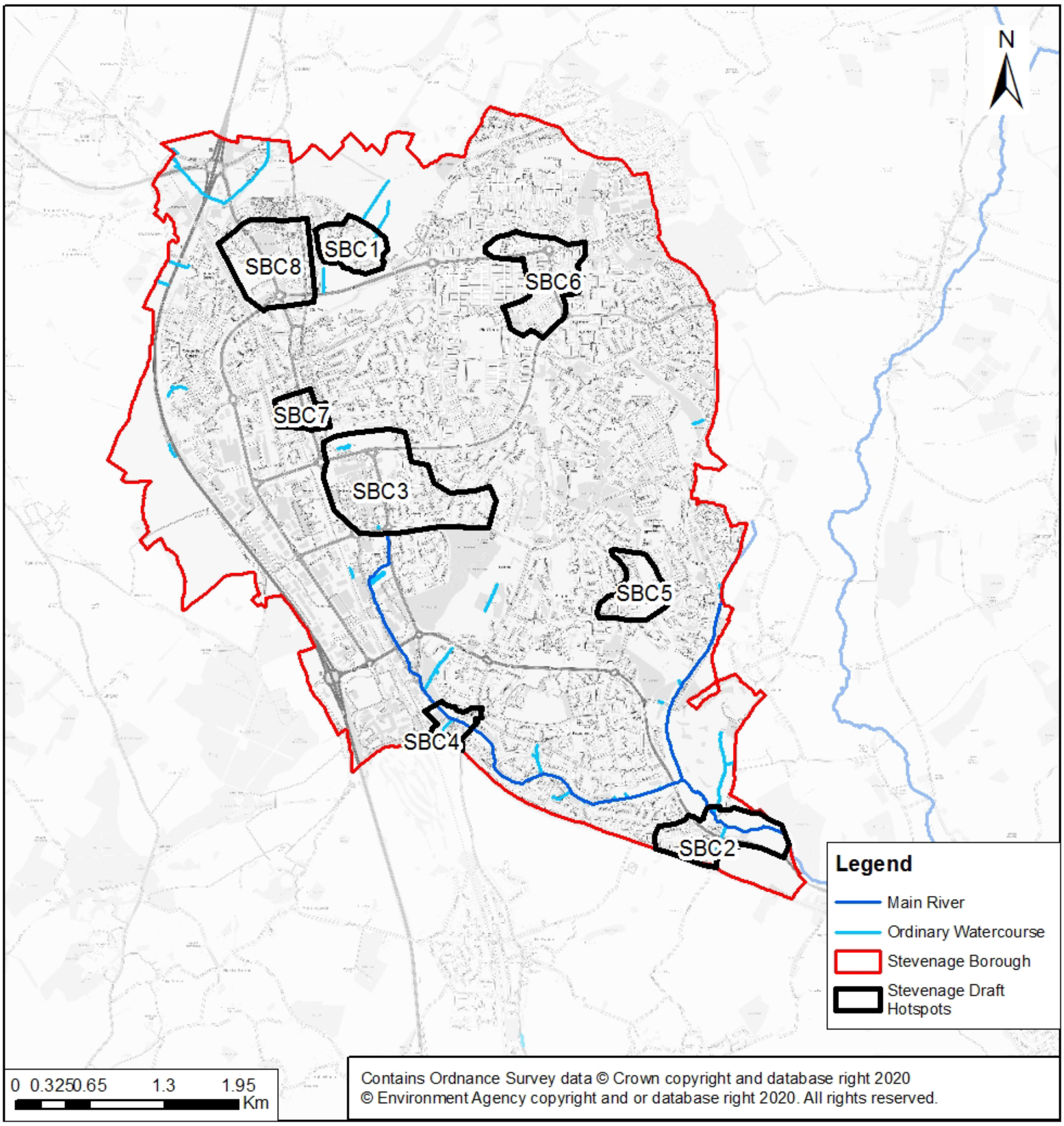

Figure 3-2: Stevenage draft hotspots

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 are 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 each of the Local Planning Authorities. 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, SBC, 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, SBC 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, the number of hotspots within SBC increased from 8 to 9, with hotspot SBC4 being split into two (SBC4a and SBC4b) along the line of the river as the flooding mechanisms were considered independent in the town main areas of risk in the hotspot. Minor alterations were also made to some hotspot boundaries being taken forward. No additional hotspots were identified by stakeholders.

The hotspot assessment sheets (see to 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, using data provided by the EA and TWUL.

Within Stevenage, SBC2, SBC4a and SBC4b are covered by the EA's River Beane model and will also be impacted by the model of the Stevenage Brook that was in development by the EA at the time of the hotspot assessment. All hotspots 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. The TWUL modelled coverage for the borough is displayed in Figure 3-3.

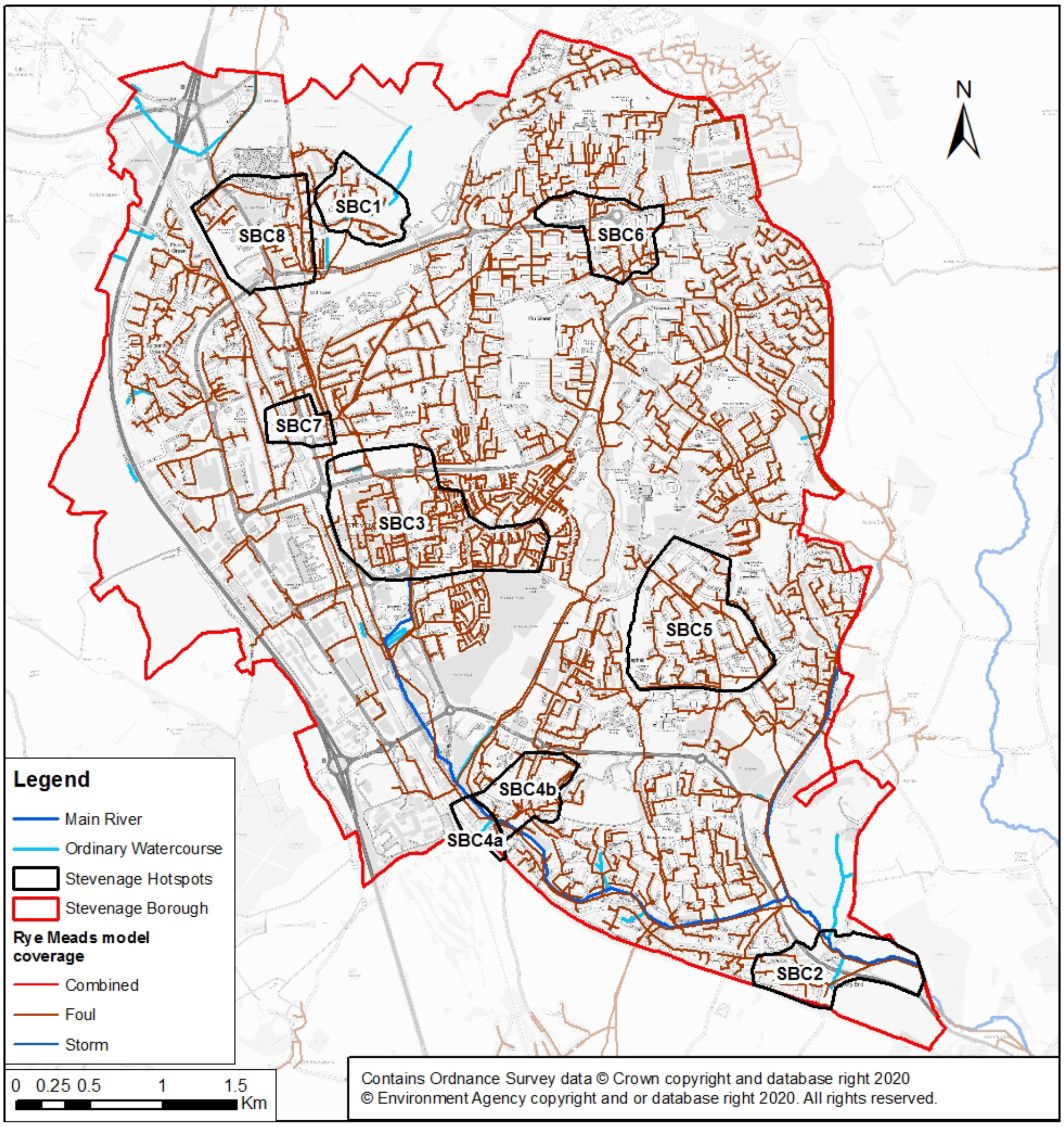

Figure 3-3: Map displaying TWUL model coverage for Stevenage

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 (%)
SBC1	10	10	20	40
SBC2	0	10	20	30
SBC3	30	20	10	60
SBC4a	0	10	10	20
SBC4b	30	10	10	50
SBC5	0	20	10	30
SBC6	20	10	0	30
SBC7	10	10	0	20
SBC8	0	10	10	20

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.

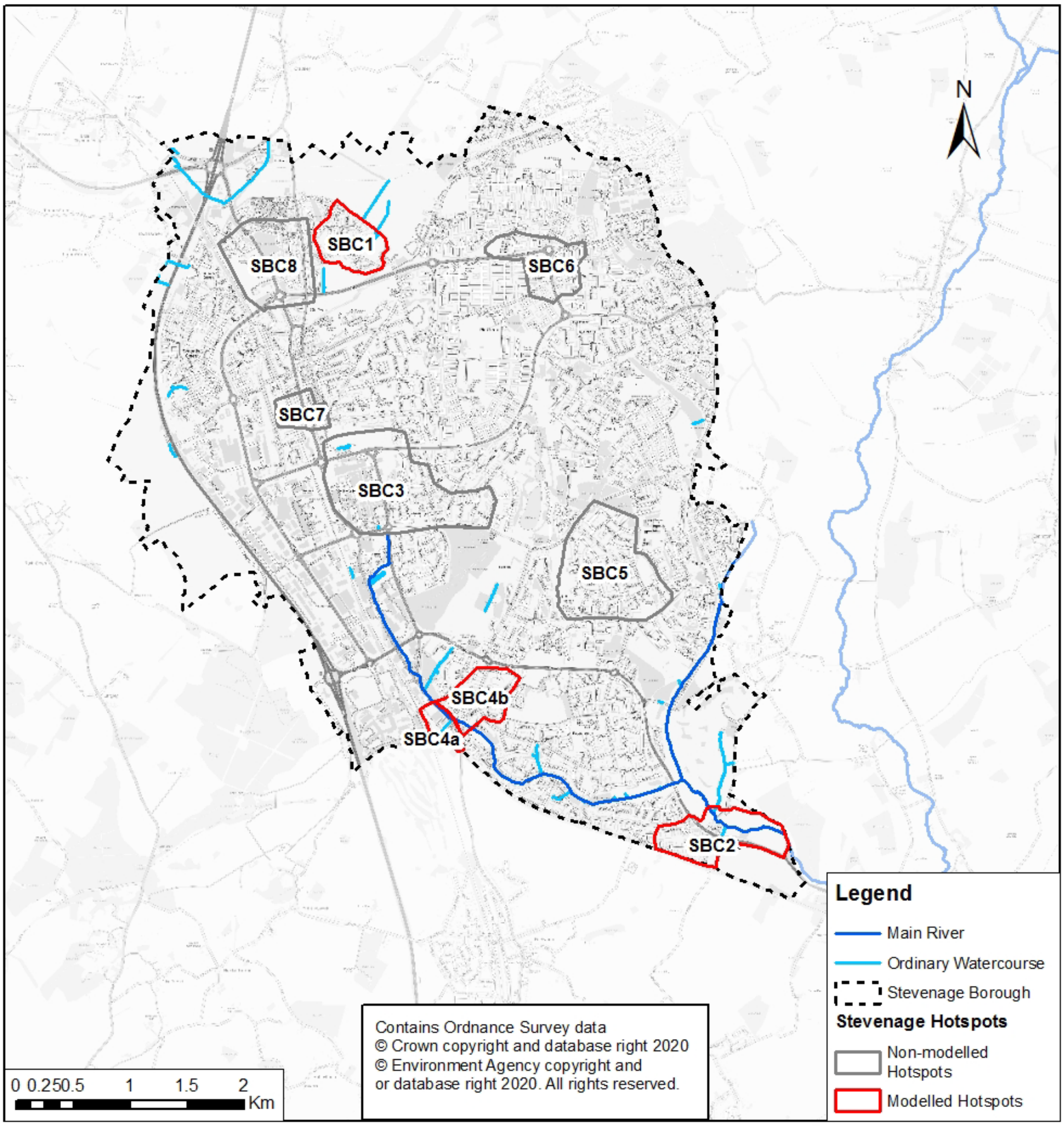

Figure 3-4: Map of modelled hotspots for Stevenage Borough

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
SBC1 - Matthews Close, Rectory Lane and Chancellors Road	It is recommended that the upstream area of the hotspot is modelled to estimate flows. Will require survey of the culvert and channels. Upstream storage is a possible option here. Model will involve surveying the sewer network and the watercourse to assess the capacity of the current network. At the survey stage an assessment of the storage capacity at this site should be made. N/A	✓	N/A	N/A
SBC2 - Bragbury Lane	Based on the flood incidents identified and the RoFSW it is recommended that this hotspot is taken forward to the modelling stage. We recommend carrying out a hydrological assessment and a topographic survey as well. We advise this hotspot to be one of the smaller scale models that is undertaken, to assess the amount of upstream storage and the feasibility of connecting the ditch. It is recommended that the culverts are surveyed as well.	✓	N/A	N/A
SBC3 - St Georges Way	Historical flood risk is relatively dispersed. It is recommended that this hotspot is not carried forward to the next phase of this project as there is not enough flood history property counts to warrant it being taken forward. There is a lot of regeneration around this area of Stevenage which means that the risk to the hotspot is likely to change. It was recommended that this hotspot is reviewed in 2019 when the corresponding EA study on the Stevenage Brook was complete. The flood incidents and recorded history of flooding around the church and	N/A	N/A	✓

Hotspot code	Recommended way forward	Decision: Significant risk identified and further modelling required	Decision: Non-modelled hotspot	Decision: No further actions
	Stevenage Museum is localised, so it is worth considering carrying out PFR work.			
SBC4a - Blair Close	This hotspot originally formed part of SBC4, but after the site visit it was recommended that it was split into two smaller hotspots to allow for the model to focus on the two separate surface water flow paths (now hotspot SBC4a and SBC4b). It is recommended that only small-scale modelling is undertaken in this hotspot area. It is recommended that this hotspot should consider the surface water and fluvial flood risk. The surface water risk comes from the south-east along to the north-east.	✓	N/A	N/A
SBC4b - Roebuck Gate	This hotspot originally formed part of SBC4, but after the site visit it was recommended that it was split into two smaller hotspots to allow for the model to focus in on the two separate surface water flow paths (now hotspot SBC4a and SBC4b). It is recommended that only small-scale modelling is undertaken in this hotspot area.	✓	N/A	N/A
SBC5 - Oxleys Road, Hydean Way, Foxfield and Kymswell Road	Flood incidents have been identified in this hotspot as well as significant modelled risk. It is recommended that the hotspot is modelled to improve understanding of risk and to test potential options to manage risk.	✓	N/A	N/A

Hotspot code	Recommended way forward	Decision: Significant risk identified and further modelling required	Decision: Non-modelled hotspot	Decision: No further actions
SBC6 - Mildmay Road and Durham Road	It is recommended that this site is carried forward as a non-modelled hotspot as it has been identified as one that is of lower priority.	N/A	✓	N/A
SBC7 - Primett Road Brick and Kiln Road	There is not enough flood history to warrant this hotspot being taken forward to the next phase.	N/A	N/A	✓
SBC8 - Corey's Mill Lane (Lister Hospital, Martins Way and Hitchin Road (Fire and Rescue service)	This hotspot has a small number of flood incidents that are scattered across the area. We recommend not taking this hotspot to detailed modelling, however a site investigation of the reported flooding at Lister Hospital would be advisable given the sensitivity of this receptor.	N/A	N/A	✓

In summary, within Stevenage Borough, four hotspots were recommended for a detailed SWMP investigation, three as a non-modelled hotspot and two for no further action.

Hotspots recommended for detailed SWMP investigation:

- SBC1 - Matthews Close, Rectory Lane and Chancellors Road;
- SBC2 - Bragbury Lane;
- SBC4a – Blair Close
- SBC4b - Roebuck Gate

3.10 Hotspot selection workshop

A hotspot selection workshop was carried out on 16 January 2018, attended by representatives of HCC, HBC, SBC, 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 three 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 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).

4.2.5 Fluvial model

The EA provided outputs from the Stevenage Brook modelling study to support the SWMP. The model was developed in the Flood Modeller-TuFLOW software package to assess the fluvial flood risk associated with the Stevenage Brook and tributaries and Includes key hydraulic structures along the brook including bridges, weirs and culverts.

A review of the model was completed to considered how the outputs could be incorporated into the SWMP. Following the review, it was decided that directly incorporating the fluvial model into the individual SWMP hotspot models would provide little additional benefit and may instead lead to greater uncertainty about the flood mechanisms due to the combination of modelling methods applied in the two models. Instead the modelled river levels were used as boundary conditions within the SMWP models to test the effect that changes in the fluvial levels have on the urban drainage network.

4.3 Model build and validation

Using the data and surveys described above, integrated models were constructed to represent all of 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 Stevenage 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 Stevenage 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 (CPI; 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

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.

4.7.5 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 2018 added with a CPI of 106.5. 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.

4.8.4 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 Environment Agency 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.

4.8.5 Indirect and intangible damages

In additional 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 Hotspot SBC1 – Matthews Close, Rectory Lane, Chancellors Road

This hotspot, shown in Figure 5-1, includes the areas around the roads Matthews Close, Rectory Lane and Chancellors Road. Modelling was recommended for the upstream area of the hotspot to estimate flows. Survey of the watercourse and sewer network was carried out as advised. The hotspot was extended north to represent the topographic catchment. This increased the amount of greenspace included within the hotspot. The remaining area is largely urbanised.

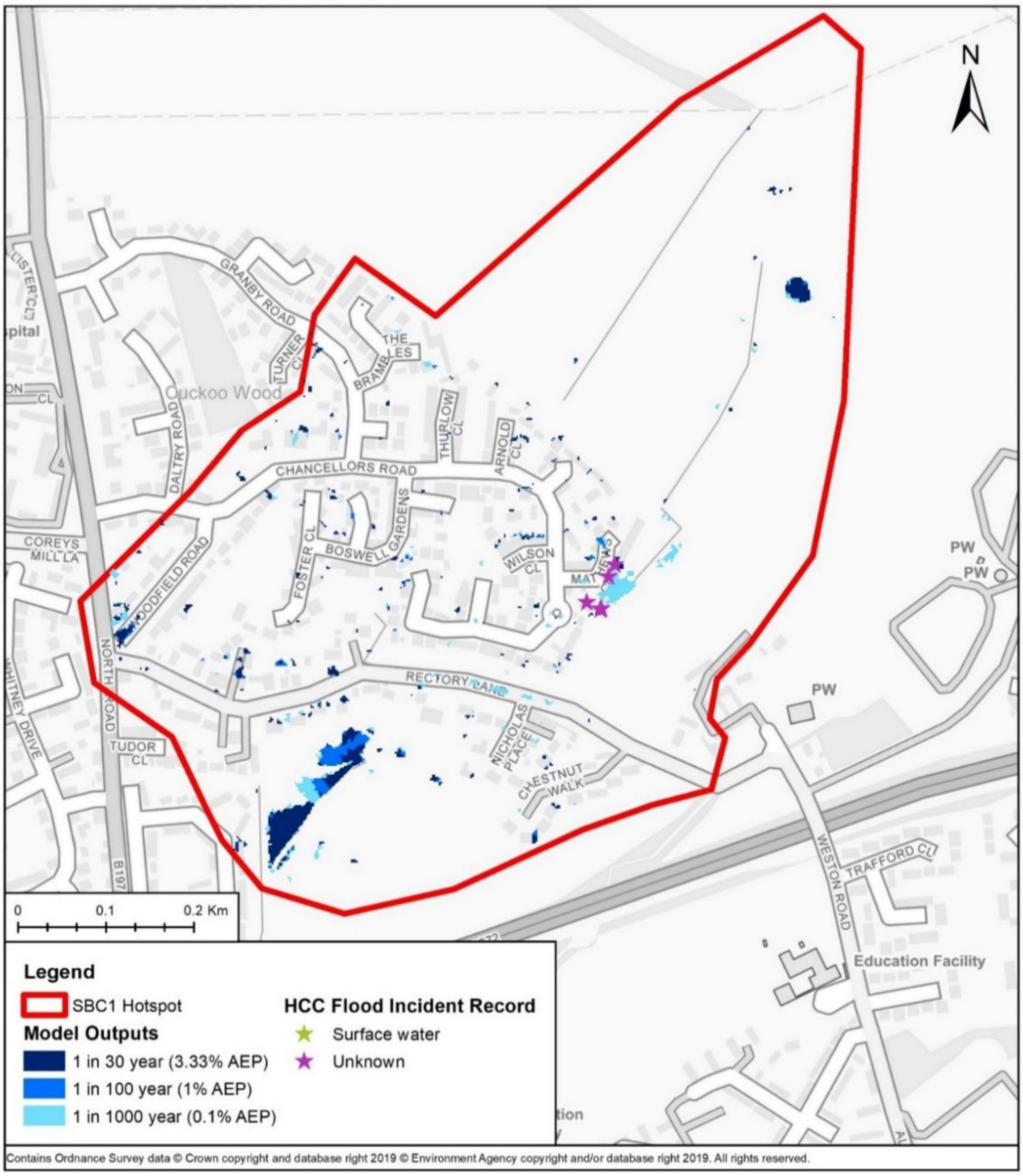

Figure 5-1: Detailed model outputs for SBC1 – Matthews Close, Rectory Lane, Chancellors Road

5.2.1 Assessment of flood mechanisms - Source-Pathway-Receptor

Flooding across the hotspot occurs for various reasons. Areas of localised ponding is a common occurrence during the 1 in 30-year event and greater. The main area of flood risk is associated with the ordinary watercourse to the east of Matthews Close where flood incidents have been reported. This ordinary watercourse has no outlet and the channel stops within the field to the east of Matthews Close, meaning there is nowhere for the water to go. As a result of the natural topography, the water moves towards the properties in Matthews Close.

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 consistent between the datasets. The main difference between the two outputs is the small areas of localised flooding that are included within the detailed modelling. These areas of ponding mostly occur against buildings (in the detailed modelling) and therefore result in larger numbers being shown to be at risk of flooding. It should be noted that any ponding areas smaller than 25m^2 were excluded when counting the properties at risk of flooding.

Table 5-1: SBC1 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	9	N/A	17	N/A	63
SBC1 detailed modelling	18	19	20	23	24	32
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	6	N/A	9	N/A	22
SBC1 detailed modelling	2	2	2	3	3	6

The flood events recorded in this hotspot have all occurred along Matthews Close. All these events are reported in the Flood Incident Record with an unknown flood type and have no additional comments. The five flood occurrences reported external flooding and one reported internal flooding.

5.2.2 SBC1 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 SBC1

Option Number	Option Type	Description	Areas Applicable	Shortlisted?
Option 1	Allocation of Land within Local Planning	Land designation based upon at-risk areas	Proposed development in north	×
Option 2	Flow restrictions on new development	Limiting the runoff from new developments to the greenfield rate	Proposed development in north	×
Option 3	Natural flood management (NFM)	Utilisation of natural methods to reduce the flood risk downstream	Rural area in north of the hotspot	×
Option 4	Property flood resilience	Individual protection of properties	Matthews Close	✓
Option 5	Obstruction of flow path associated with ordinary watercourse	Flood bund north of Matthews Close to detain flows associated with the watercourse	Upstream of Matthews Close	×
Option 6	Obstruction of flow path associated with ordinary watercourse	Flood bund to the east of Matthews Close to detain water within the existing greenspace	Field to the east of Matthews Close	✓
Option 7	Connection of watercourse to sewer network	Provide an outlet to the watercourse to the east of Matthews Close associated with flow path	Ordinary Watercourse beyond Matthews Close	×

Options 1 and Option 2 (see Table 5-2 and Appendix F) considered possible measure that SBC in their role as the LPA could put into place with the support of HCC. Option 1 considered the potential for using the allocation of land at higher risk of surface water flooding for less vulnerable users 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.

A key consideration within this hotspot is the proposed development of the land to the north of the hotspot. The area is currently greenfield land and covers a significant proportion of the topographic catchment of the dominant flow path through the hotspot. Option 2 considered whether a hotspot-wide policy to limit any additional flows from new development could be implemented. In this instance, the development must maintain the greenfield runoff rate and accommodate the flow path onsite. As the LLFA, HCC would advise the LPA on the suitability of the proposed drainage plans on the site. It is the LPA that can enforce lower than greenfield runoff rates, if it is justifiable through the SFRA and Local Plan. It is noted that this may also apply to smaller scale urban creep.

Option 3 (see Appendix F) considered the use of NFM techniques to alleviate flood risk through slowing and reducing volumes associated with the dominant flow path. NFM is often a preferable option as it has typically low costs associated and works alongside the environment. The proposed development to the north of the hotspot reduces the opportunity for these schemes to be designed and implemented, as the existing greenfield space in the north will be reduced by the development; however, the plans for the development should include suitable levels of flood attenuation to minimise the impact of the development.

Option 4 (see Appendix F) considered the installation of Property Flood Resilience (PFR) measures to reduce the impact of flooding on 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. PFR is most effective where flood depths are less than 0.6m and would therefore be suitable at key locations across the hotspot including Matthews Close which has recorded the most incident of flooding in the recent flood events.

The flow path identified from the north is shown to contribute to the flood risk along Matthews Close. The land beyond Matthews Close is currently undeveloped, with an ill-defined channel. Option 5 and Option 6 (see Appendix F) considered the potential construction of a bund in the vicinity of Matthews Close to prevent runoff from reaching the properties. Initial testing of the options indicated that Option 6, which proposed a bund is constructed parallel with the properties to prevent the flooding provided the greater benefit to the properties in Matthews Close. Figure 5-2 illustrates flood risk once this flow path has been obstructed. The land could also be lowered here to increase the capacity of volumes that can be stored and potentially provide further betterment downstream, however this addition was not directly considered at this stage. The construction of a bund in this area would not provide any other benefits, such as amenity or ecological enhancement, besides the reduction in flood risk but it is the most effective method. Bund construction is typically a costly solution. If a detention basin were also to be constructed onsite, the excavated materials should be used (if suitable) to reduce costs and environmental impacts.

To manage the volumes of water that flood beyond Matthews Close, Option 7 (see Appendix F) considered the connection of the ditch into the sewer network. It is proposed that the sewer would connect to the open watercourse in the south. The survey of the watercourse, carried out in July 2017, found no evidence to suggest that there is a current connection. A connection would reduce the volumes that currently can freely flood as it would be culverted into the sewer system. However, connections to the sewer system are very costly operations and would result in large disruption during the laying of pipe network. In most cases, water companies will object to land drainage being connected to a public sewer. Furthermore, the additional network would require incorporation into the existing maintenance scheme.

Figure 5-2: SBC1 - Option 6 - Bund adjacent to Matthews Close

5.2.3 Shortlisted options

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

- Option 4 – Property flood resilience;
- Option 6 – Flood bund to the east of Matthews Close.

It is unlikely that one option alone would provide protection for the affected properties and the options above should be combined for an effective response to the flood risk.

5.3 Hotspot SBC2 – Bragbury Lane

This hotspot is located in the southern tip of Stevenage Borough within the area of Bragbury Lane. It includes Bragbury Lane, Broadhall Way (A602) and Blenheim Way. The Stevenage Brook flows through the hotspot. The modelling in the hotspot is to improve the understanding of the surface water flood risk across the area and the associated surface water flood events. The southern area is greenfield space, currently used as agricultural land. North of the railway line, the hotspot is urbanised.

5.3.1 Assessment of flood mechanisms - Source-Pathway-Receptor

Within this hotspot (see Figure 5-3), the primary source of flooding is associated with pluvial runoff. There are two dominant flow paths within the hotspot; one originates in Knebworth and flows across the agricultural land on the west of Bragbury Lane, and the other also flows towards Bragbury End but on the east of Bragbury Lane. Maps showing flood depths in the 1 in 30, 100 and 1,000 year return periods are included within Appendix E.

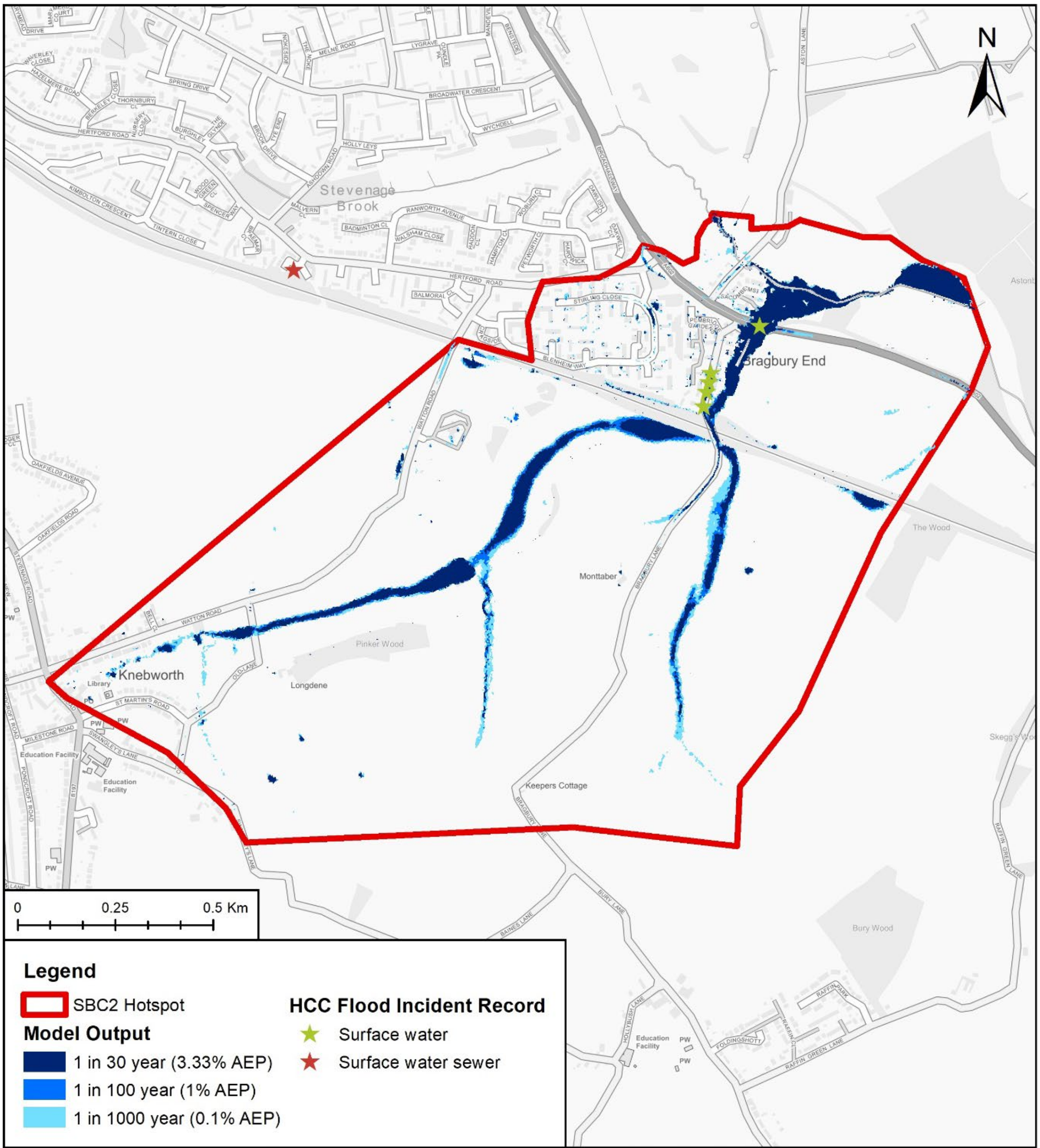

Figure 5-3: Detailed model outputs for SBC2 – Bragbury Lane

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 SBC2. Generally, the surface water flooding aligns between the RoFSW mapping and the modelled outputs, with the dominant flow paths appearing. During the 1 in 30-year and 1 in 100-year events, a higher number of properties are at risk of flooding, within the detailed modelling, as a result of the areas of ponding that occur in the residential area. Conversely, the flood extent for the 1 in 1000-year event is greater within the RoFSW mapping due to properties within the fluvial flood risk areas of the Stevenage Brook being included in the RoFSW flood extents. These higher values are as a result of much larger flow paths in the residential areas. The detailed modelling shown in Appendix E is at increased resolution and more representative of the existing landscape, and so likely to provide a more accurate representation of flood risk.

Table 5-3: SBC2 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	3	N/A	11	N/A	125
SBC2 detailed modelling	22	24	29	31	42	57
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	0	N/A	1	N/A	12
SBC2 detailed modelling	4	7	7	7	7	10

In total, five incidents have been reported within the hotspot. The modelled flood extents closely correlate with the reported flood incidents, with the eastern flow path passing below the railway bridge onto Bragbury Lane whereby four of the incidents have occurred (in February 2014). These incidents have been caused by surface water runoff from the road. The flooding on Broadhall Way (July 2015) was also surface water flooding, however the exact mechanism is unknown. All five of the properties reported external flooding, and 2 also reported internal flooding.

5.3.2 SBC2 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 SBC2

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	✘
Option 2	Flow restrictions on new development	Limiting the runoff from new developments to the greenfield rate	Area-wide application	✘
Option 3	Natural flood management (NFM)	Utilisation of natural methods to manage flood risk downstream	Large fields upstream of Bragbury End	✘
Option 4	Property flood resilience	Protection for individual properties	Bragbury Lane	✓
Option 5	Detention of flows west of Bragbury Lane	Construction of a flood bund near the railway bridge and west of Bragbury Lane	Fields west of Bragbury Lane	✘
Option 6	Detention of flows east of Bragbury Lane	Construction of a flood bund near the railway bridge and east of Bragbury Lane	Fields east of Bragbury Lane	✓
Option 7	Attenuation basins	Excavation of attenuation basins within field to detain flows associated with flow paths	Field east of Bragbury Lane	✘
Option 8	Gullies or grips along Bragbury Lane	Installation of additional gullies along Bragbury Lane to reduce ponding on the road surface	Bragbury Lane	✘
Option 9	Slow/divert flow path along Bragbury Lane	Use of speed bumps along Bragbury Lane to divert flows into drainage	Bragbury Lane	✘

Option Number	Option Type	Description	Areas Applicable	Shortlisted?
Option 10	Increased conveyance and temporary storage within highway	Increased kerb height to increase volumes that can remain within the highway before flowing over pavements to properties	Bragbury Lane	✘
Option 11	Improved flow path	Increased channel capacity to accommodate the flow path	Within fields east of Bragbury Lane	✓

Option 1 and Option 2 (see Appendix F) considered possible measure that SBC, in their role as the LPA, could put into place with the support of HCC to manage surface water flood risk. Option 1 considered the potential for using the allocation of land at higher risk of surface water flooding for less vulnerable users 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 rather than residential development. The model results highlight the importance of runoff generated within the hotspot on local flood risk. To address this, Option 2 considered whether a hotspot-wide policy to limit any additional flows from new development could be implemented. 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 detailed modelling identified the two clear surface water flow paths from the southwest, that converge and flow through the railway bridge and along Bragbury Lane. Preventing these flows from reaching Bragbury Lane was the key focus of the optioneering.

Option 3 (see Appendix F) considered whether the NFM techniques could be incorporated along the main flow paths within the fields and greenfield space to the southwest of the railway. To manage the flow path, a series of techniques could be incorporated such as leaky barriers, cross-slope woodland or ponds and swales. It is noted that the land is currently used for farming and land management techniques could also contribute to the reduction in downstream flood risk. For the landowners, reducing the surface water flow path across the field would reduce soil loss and pesticide/fertiliser runoff and limit the chance of waterlogged land resulting in the prolonged inundation of farmland. NFM could also have wider benefits, including improved habitats for wildlife and little visual impact upon the environment. The modelling indicated that substantial volumes are associated with the flow paths across the upper catchment and it is unlikely that NFM alone would be suitable for managing the volumes effectively in higher order events. Installation of a scheme of this nature would also require consultation and agreement with the landowners as land take would require consideration.

Option 4 (see Appendix F) considered the installation of PFR measures to reduce the impact of flooding on 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. PFR is most effective where flood depths are less than 0.6m and would therefore be suitable for the key, at-risk properties in Bragbury Lane which have recorded the most incident of flooding in the recent flood events.

Option 5 (see Appendix F) considered management of the flow path to the west of Bragbury Lane which originates in the village of Knebworth. A bund was included in the model (Figure 5-4) to obstruct the flow from the west in an area adjacent to the railway embankment shown in Figure 5-5 and prevent it from reaching the railway bridge. The results showed that the flow under the railway continues and therefore it was concluded that this flow path is not the principal source of flooding on Bragbury Lane. With the bund in place, the flow path accumulated against the railway embankment rather than flowing onto the road. This option was not considered further as it would have very limited benefit to the at-risk properties.

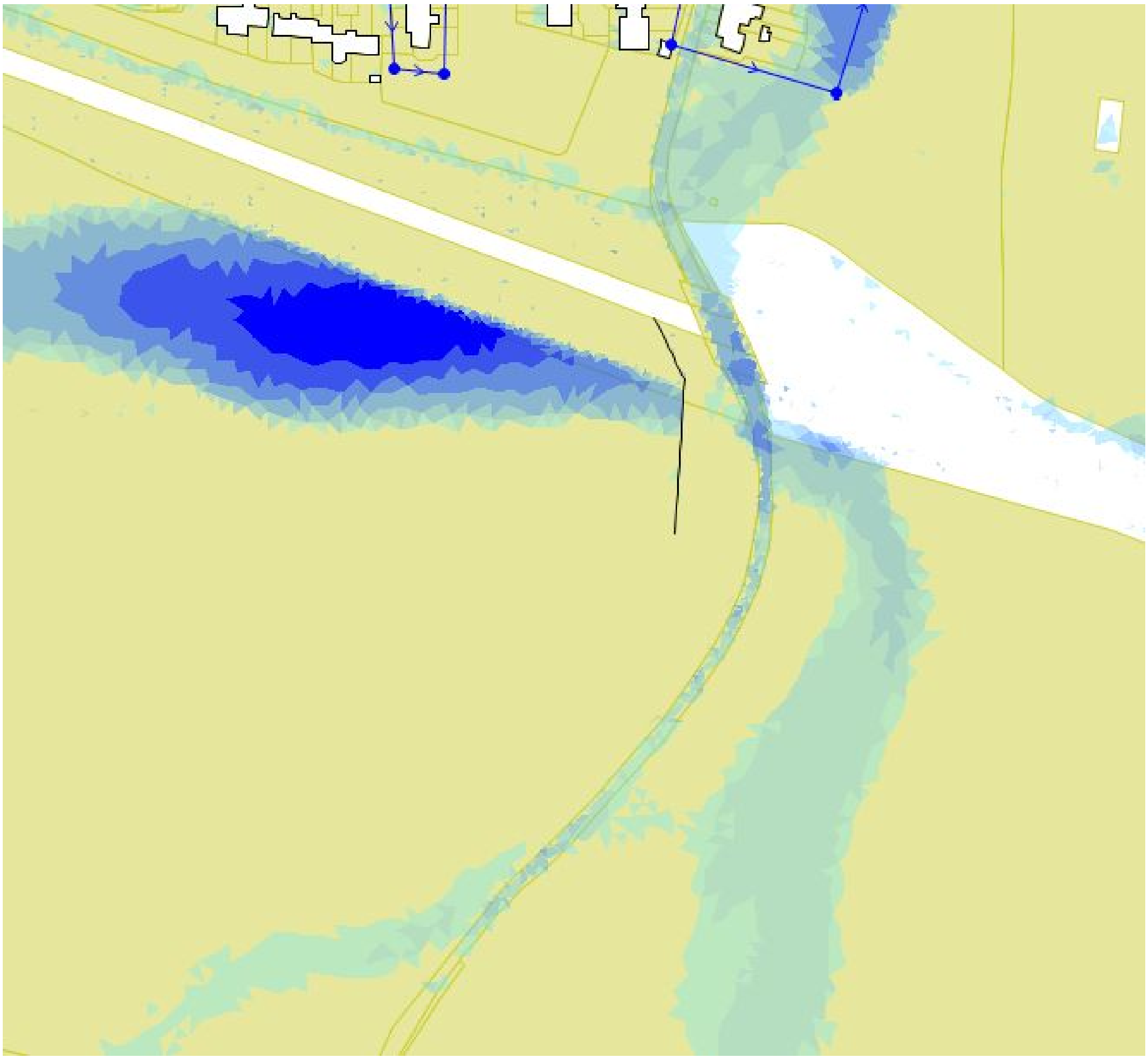

Figure 5-4: SBC2 Option 5 - Embankment south of railway

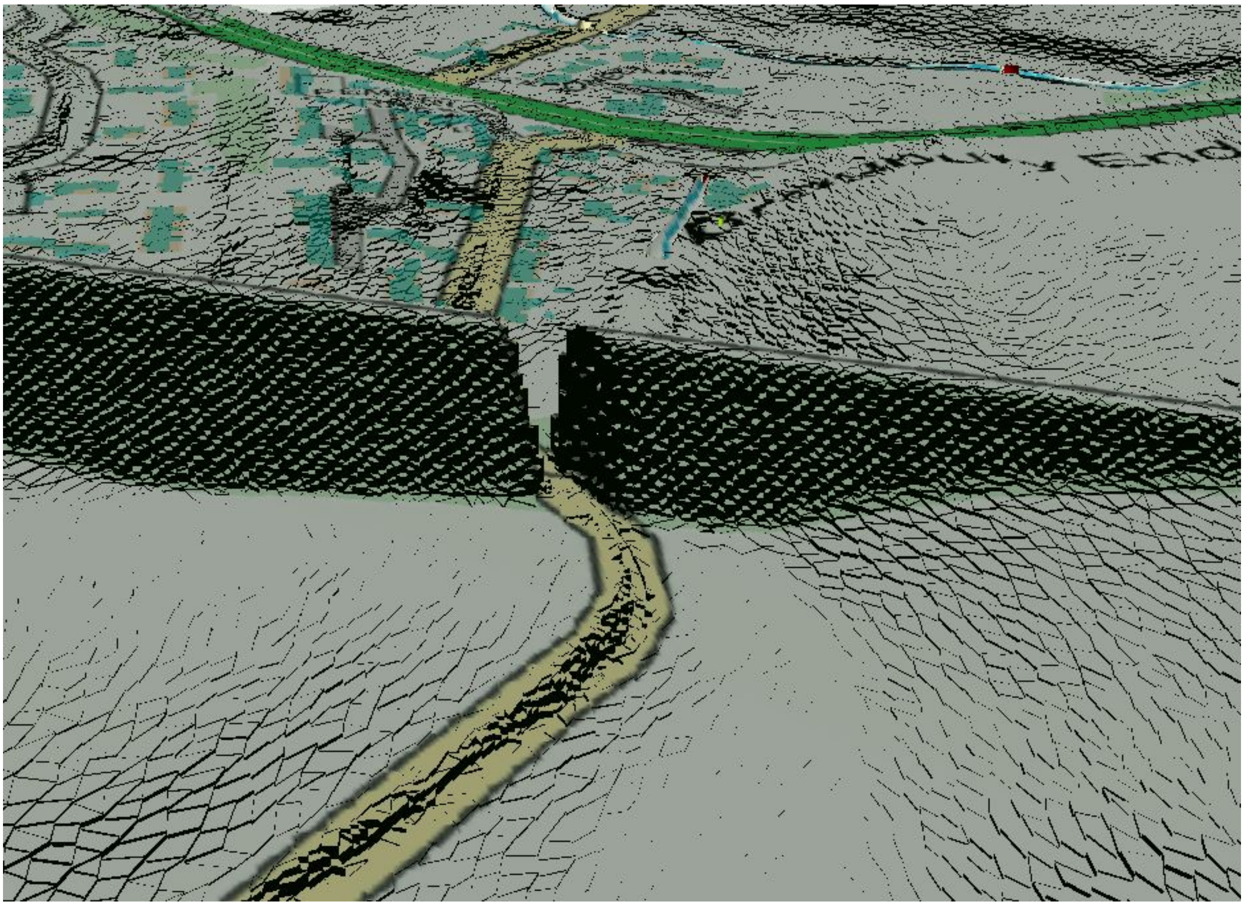

Figure 5-5: SBC2 Railway embankment to the south of the residential area

The same approach was applied in Option 6, where the flow path from the south was obstructed upstream of Bragbury Lane as shown in Figure 5-6 and Figure 5-7. The inclusion of the bund in the model (shown in red in Figure 5-6) resulted in a significant reduction in the flow depths below the railway, as shown in Figure 5-6. The obstruction of this flow path is key for limiting the volume of water that flows along Bragbury Lane and consequently floods properties. The model results indicated potential depths in excess of 1.5m close to the railway embankment and this would require consideration in any detailed design of this option to ensure a suitable bund height was practical. Construction of a bund may require liaison with the landowner and possible purchase of land and provides no other benefits to the area other than flood protection, although could be combined with planting within the storage area to provide habitat benefits. Liaison would also be required with Network Rail if construction was to be undertaken close to the railway curtilage.

Figure 5-6: SBC2 Option 6 - Embankment to southeast of railway

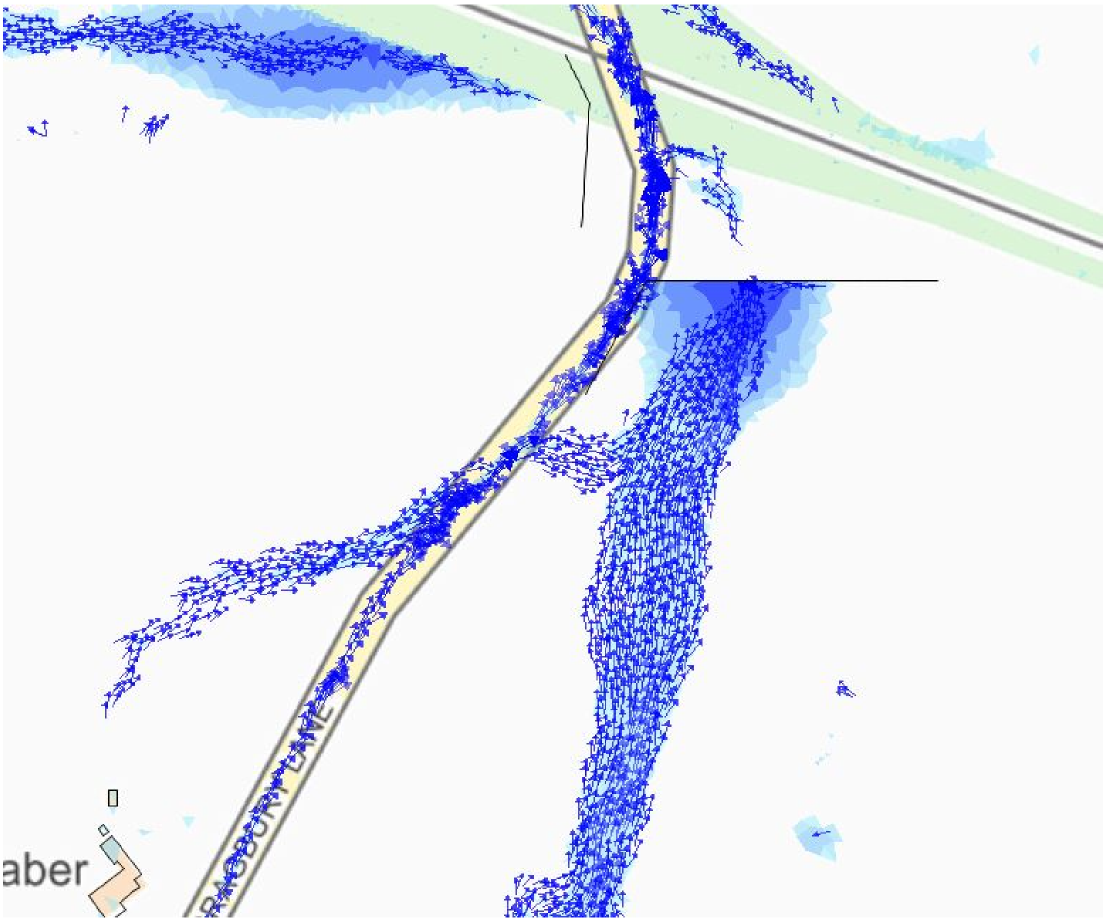

Figure 5-7: SBC2 Option 6 flow control to the southeast of the railway

Alongside the NFM measures considered in Option 3, Option 7 (see Appendix F) considered the excavation of basins within the fields to attenuate the flows and store excess water in the upper catchment. A series of basins may be preferable to one large basin and ponds could be used to provide greater environmental enhancement. If permanently wet ponds were installed, the potential storage capacity would be lower, but this may provide greater biodiversity benefit. Land take from the current agricultural uses would be the greatest disadvantage of this option. Future management would also require consideration, as any accumulation of sediment would reduce the storage capacity.

The modelling for Option 6 shows that obstructing the flow path from the west is critical to reducing the flood risk in Bragbury End. However, it is noted that flooding is still predicted, although significantly lower depths as a result of the road sitting lower than the fields on either side, represented in Figure 5-7. Therefore, to limit the volumes of water flowing from the fields and then along Bragbury Lane, Option 8 considered whether gullies or grips could be installed along the roadside to intercept the flow path. This would require a connection to the highway drainage network as an outlet. The installation of these would result in disruption, with road closures likely to be required.

Option 9 and Option 10 (see Appendix F) considered how changes to the highway and highway drainage may improve the management of surface water flows along Bragbury Lane and therefore reduce the risk to properties adjacent to the road. Once flows enter the residential area of the hotspot to the east of the railway the potential use of speed humps or raised kerbs was considered to slow and manage the flows within the highway and provide improved conveyance and temporary storage, rather than impacting properties. These options are likely to have limited benefit to the at-risk properties and provide no wider benefits so have not been considered further.

Using satellite imagery, it is clear that there is a slight depression in the topography associated with the flow path. Option 11 considered enhancing this to provide greater flow capacity for the channel. The initial model results indicate that this reduces downstream flows, but it would be recommended that it is utilised in conjunction with another method such as a bund (Option 6) to then obstruct overflows. Alternatively overflow ponds could be utilised.

5.3.3 Shortlisted options

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

- Option 4 – Property flood resilience;
- Option 6 – Flood bund on the east of Bragbury Lane;
- Option 11 – Improved flow path channel.

Initial testing suggests that Option 6 may provide the best option of reducing flood volumes along Bragbury Land, however, it may be more appropriate that a combination of options is applied to reduce flow volumes as opposed to reliance upon a single solution.

5.4 Hotspots SBC4a and 4b – Blair Close, London Road and Roebuck Gate

During the hotspot selection phase of the study it was recommended that hotspot SBC4 be considered as two separated areas due to the differing flood mechanisms either side of the Stevenage Brook, however following initial modelling it was found that the flood risk could be represented using a single area and therefore the hotspots have been combined.

These hotspots are located within the southwest of Stevenage and the Stevenage Brook flows through the south of the area. The main areas of risk are focused around Broadwater Crescent in the centre of the hotspot, and Blair Close in the south. The hotspot modelling included the surface water sewer networks and the Stevenage Brook in the south. The area is densely urbanised throughout, with little available greenspace.

5.4.1 Assessment of flood mechanisms - Source-Pathway-Receptor

Surface water flow paths within the hotspot are largely associated with the road network. The dominant flow path is associated with Broadwater Crescent, and the modelling shows that there is a combination of surface water flooding and manhole exceedance. Although this is the dominant flow path, there are no reported flood incidents along here (Figure 5-8). There are also areas of isolated ponding across the hotspot that accumulate as a result of the natural topography. In the south of the hotspot, around the Blair Close, localised areas of ponding correlate with the reports of property flooding (Figure 5-8).

The site visit confirmed that the surface water mapping is accurate and the flow path along Roebuck Gate is separate to that along London Road.

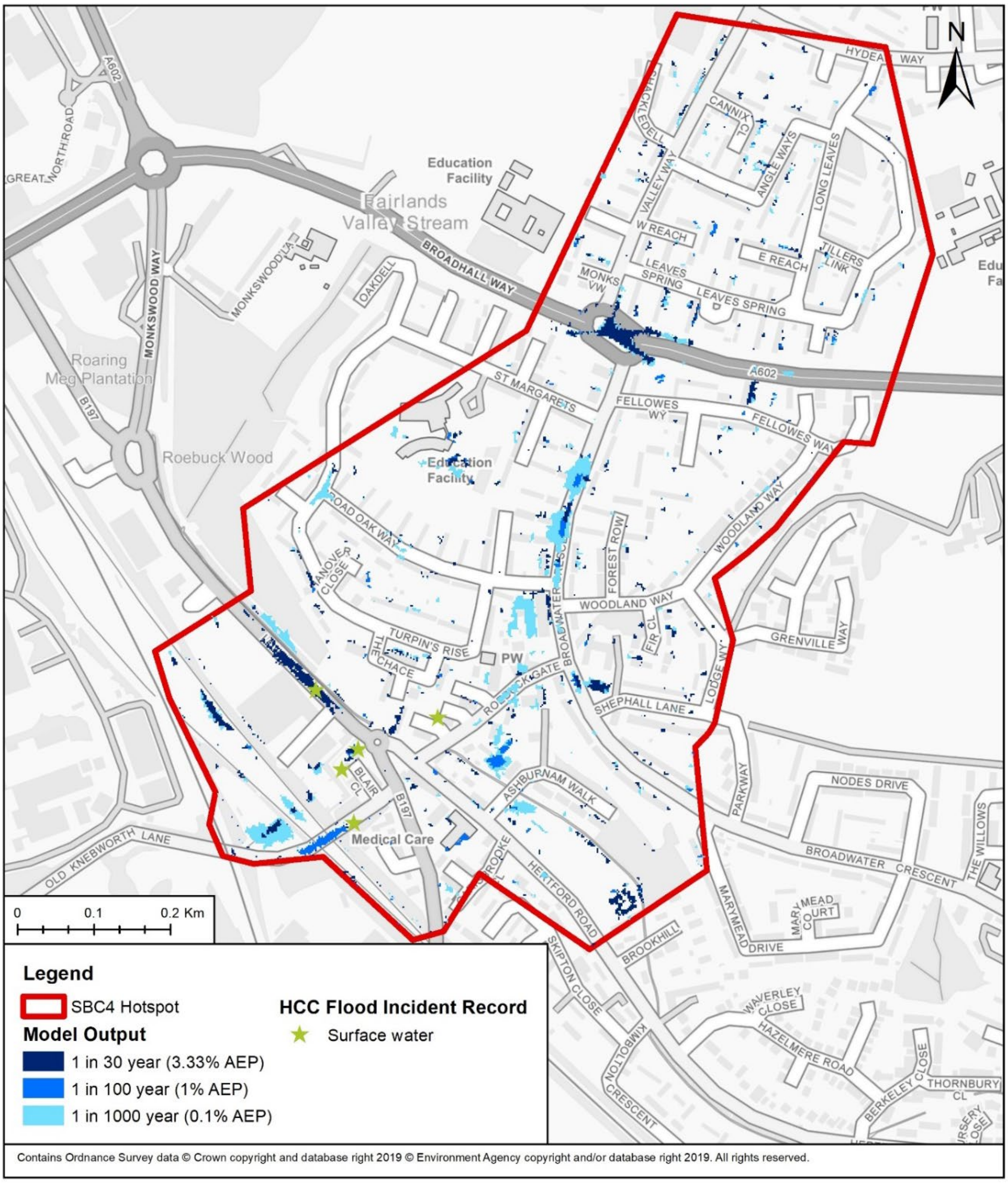

Figure 5-8: Detailed modelling outputs for SBC4

Table 5-5 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 SBC4. The detailed modelling shows flooding in the same areas as that within the RoFSW mapping. However, the outputs from the detailed modelling does not suggest large flow paths (like the RoFSW mapping), and instead shows a series of large ponding areas. The number of properties at risk is larger in the detailed modelling compared with the RoFSW up to the 1 in 100-year event, however in the 1 in 1000-year event the RoFSW outputs suggest a great number of properties at risk as the properties closer to the Stevenage Brook are included within the flood extents. The main difference between the two outputs is the small areas of localised flooding that are included within the detailed modelling. These areas of ponding mostly occur against buildings (in the detailed modelling) and therefore result in larger numbers being shown to be at risk of flooding.

Table 5-5: SBC4 Properties at risk of flooding from surface water

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	18	N/A	75	N/A	274
SBC4 detailed modelling	58	63	109	112	159	240
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	3	N/A	9	N/A	22
SBC4 detailed modelling	6	6	6	6	9	15

There is correlation between reported flood incidents and modelled flood risk areas. Within the hotspot, there have been five reported flood incidents, all attributed to surface water flooding. These are all located in the south of the hotspot, along Roebuck Gate, Blair Close and Old Knebworth Lane. There have also been 38 sewer flooding incidents reported across the SG2 8 postcode district, which correlates with the manhole exceedance shown in the modelling.

5.4.2 SBC4a and SBC4b 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 5-6 and further information about the options considered and the locations for options is included in Appendix F and Appendix G respectively.

Table 5-6: Summary of mitigation options for SBC4a and SBC4b

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	✘
Option 2	Flow restrictions on new development	Limiting the runoff from new developments to the greenfield rate	Area-wide application	✘
Option 3	Property flood resilience	Protection for individual properties	Blair Close	✓
Option 4	Installation of rills within highway	Highway rills to transfer water within highway	Broadwater Crescent	✘
Option 5	Upsizing of sewers	Increased sewer capacity to reduce surface water on the surface	Broadwater Crescent	✘
Option 6	Retrofitting of SuDS	Disconnection of surface water from public sewers via SuDS	Blair Close	✓
Option 7	Disconnection of surface water from sewers	Property-level capture of surface water to have an area-wide impact	Blair Close	✓

Option 1 and Option 2 (see Appendix F) considered possible measure that SBC, in their role as the LPA, could put into place with the support of HCC to manage surface water flood risk. Option 1 considered the potential for using the allocation of land at higher risk of surface water flooding for less vulnerable users 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 rather than residential development.

The model results highlight the importance of runoff generated within the hotspot on local flood risk. To address this, Option 2 considered whether a hotspot-wide policy to limit any additional flows from new development could be implemented. 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.

Option 3 (see Appendix F) considered the installation of PFR measures to reduce the impact of flooding on 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.

PFR is most effective where flood depths are less than 0.6m and would therefore be suitable for the key at-risk properties in Blair Close which have recorded the most incident of flooding in the recent flood events.

Option 4 (see Appendix F) considered the installation of rills along Broadway Crescent to manage flow paths moving south along Broadwater Crescent that contribute to areas of ponding that occur and extend beyond the highway. Rills along the road could improve the conveyance of surface water and therefore reducing the extent and depths of flooding. Following discussions with HCC it was recommended that that this option was not taken forward for further consideration as the risk to the highway was no acceptable.

Option 5 (see Appendix F) considered upsizing of surface water sewers along Broadwater Crescent to provide additional capacity and reduce surface water runoff. This scheme would be undertaken by TWUL and upsizing sewers in built-up area would have to take into account land ownership and existing utilities in the public roads. Installation of a large diameter sewers unlikely to be viable and initial testing indicated that the option would provide limited benefit.

Option 6 and Option 7 considered retrofitting of SuDS techniques and disconnection of surface water from the drainage network along Broadwater Crescent and Blair Close. There are grassy areas between the pavement and highway which provide an ideal opportunity for the implementation of swales that would both store and convey water along Broadwater Crescent (see Appendix G). These would reduce the volumes of water within the highway and the chance of water reaching properties. Flooding occurring in Blair Close is highly localised and likely to be occurring as a result of runoff from roofs. Installation of small scales SuDS features such as water butts or rain gardens would provide a source of infiltration for the water that is ponding adjacent to the properties. It is noted that there is very limited space in the area and therefore the opportunity to implement SuDS in this area will be limited.

5.4.3 Shortlisted options

The preferred options for the hotspot are:

- Option 3 – Property flood resilience;
- Option 6 – Retrofitting of SuDS;
- Option 7 – Disconnection of surface water from the system.

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 Stevenage 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 risk management authorities 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 to 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, HCC as LLFA 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.

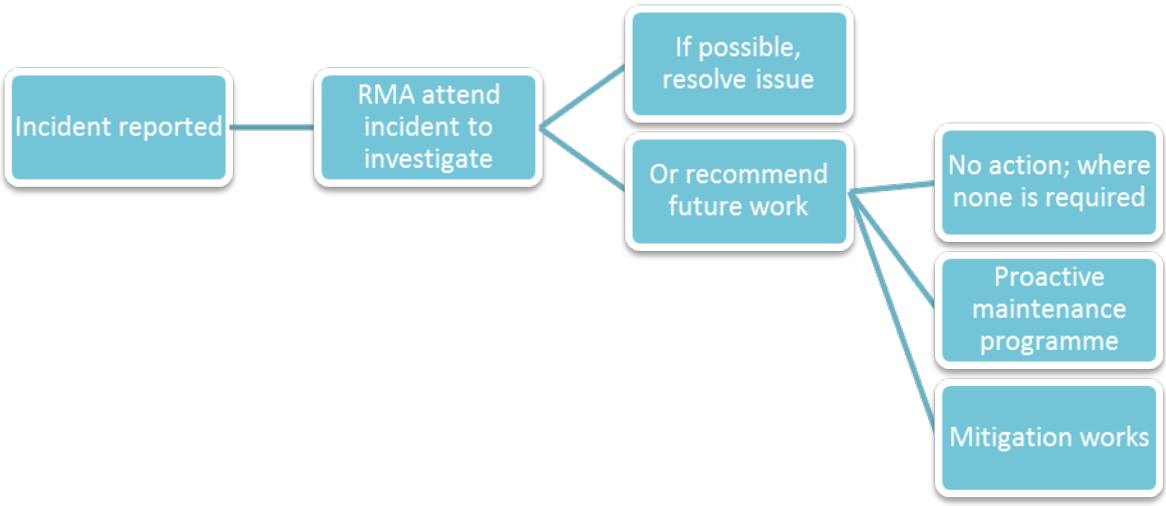

Figure 6-1: Typical process of asset maintenance by RMAs

This approach is largely being adopted by RMAs in Stevenage Borough, with HCC Highways having identified a series of priority areas for drainage works and gully maintenance across the county, and TWUL 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. This is an ambition of the LLFA and covered in the LFRM Strategy in its Policy 9, Action 5.

Maintenance of private owned assets in Stevenage 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	Leading stakeholder
SBC1 – Matthews Close	Investigate the creation of a storage area and flood bund beyond Matthews Close to capture the surface water associated with the ditch which currently has nowhere to drain to.	HCC
SBC1 – Matthews Close	Property level protection for those that flood as a result of localised flooding which is not prevented through the bund.	HCC
SBC2 – Bragbury Lane	Improvement of the flow path channel within the agricultural land on the eastern side of Bragbury Lane. Enhancing the channel will allow for increased capacity which will limit the amount of water downstream.	HCC
SBC2 – Bragbury Lane	Explore in more detail the potential Construction of a flood bund in the north of the agricultural field on the eastern side of the Bragbury Lane. Linking this to the railway embankment would help to prevent water reaching the road.	HCC
SBC2 – Bragbury Lane	Property level protection for properties along Bragbury Lane whereby flood risk continues despite efforts upstream.	HCC
SBC4a and 4b – Blair Close and London Road, Roebuck Gate	Investigate the Retrofitting of SuDS across the hotspot. Swales along Broadwater Crescent would help to convey and store flow paths which exist along here. Around Blair Close, systems to implement infiltration such as rain gardens should be used.	HCC, HCC Highways
SBC4a and 4b – Blair Close and London Road, Roebuck Gate	Property level protection	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 Stevenage 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 Stevenage Borough SWMP area, further detailed assessment is recommended in some of the hotspot areas, including hotspot areas of Matthews Close, Bragbury End and Roebuck Gate. This should include integrated hydraulic modelling to better understand the risk of flooding, and where required could also lead to a full 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 Local Flood Risk Management Strategy.

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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