Bath & North East Somerset Council

Bath and North East Somerset Council

Surface Water Management Plan

Final Report

July 2015

JBA Project Manager

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
V1.0 23/10/2014	Draft Preliminary Report – Main SWMP sections only	Stella Davies
V2.0 15/04/2015	Draft report including all sections	Stella Davies / Jim McEwen
V3.0 22/06/2015	Final report including Strategic Flood Board Comments	Stella Davies
V3.1 15/07/2015	Final report incorporating B&NES final comments and amended section 9.0	Jim McEwen
V4.0 03/08/2015	Final amendments approved	Jim McEwen

Contract

This report describes work commissioned by Stella Davies, on behalf of Bath and North East Somerset Council, by an email dated 07/05/2014. B&NES Council representatives for the contract were Stella Davies and Jim McEwen. Peter May, Lucy Nicholson, Georgina Willis and Jenny Hill of JBA Consulting carried out this work.

Prepared by ..... Gina Willis / Jenny Hill / Lucy Nicholson

Reviewed by ..... Peter May

Purpose

This document has been prepared as an Area-wide Surface Water Management Plan for Bath and North East Somerset Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

Acknowledgements

JBA would like to acknowledge and thank, Wessex Water, the Canal and River Trust the Environment Agency and Bath and North East Somerset Council for all their assistance during this project.

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Executive Summary

Bath and North East Somerset (B&NES) Council has identified the need for an Area wide Surface Water Management Plan (SWMP) to be used as an overarching framework to assist with the identification and management of flood risk from local sources within the B&NES area boundary.

This report has been prepared in accordance with the Department for Environment Food and Rural Affairs (DEFRA) Surface Water Management Plan (SWMP) Technical Guidance[2] and forms the strategic stages of the SWMP process.

A Surface Water Management Plan is a study to understand the flood risk that arises from local flooding, which is defined by the Flood and Water Management Act 2010[7] as flooding from surface runoff, groundwater, and Ordinary Watercourses.

SWMPs are led by a partnership of flood risk management authorities (RMAs) who have responsibilities for aspects of local flooding, including the Council, Sewerage undertaker, Environment Agency and other relevant authorities.

The SWMP Technical Guidance outlines three levels of SWMP, Strategic Assessment, Intermediate Assessment and Detailed Assessment. This Area wide SWMP forms a Strategic Level Assessment.

The main aim of the SWMP is to produce a long term, area wide high level Action Plan to manage local sources of flooding within the Bath and North East Somerset area.

As part of this SWMP study, it has been essential to identify the links to other local and regional delivery plans which may influence or be influenced by the SWMP. The SWMP will seek to integrate and support these plans and processes to provide a clear and robust path to delivering flood risk management objectives throughout Bath and North East Somerset.

The Local Flood Risk Management Strategy (LFRMS) for the B&NES area is currently being prepared. The B&NES area wide SWMP will feed into the LFRMS by providing an improved understanding of the risk of flooding from local sources and from interactions with Main River flooding. The SWMP will be used as a basis for identifying priorities and affordability of measures which will be included in the Local Flood Risk Management Strategy.

Within the B&NES area, flood risk is managed by multiple agencies, including the Council, the Environment Agency and the Sewerage Undertaker, Wessex Water. Often surface water flooding is caused by multiple mechanisms, which fall under the jurisdiction of different agencies.

To fully understand flood risk in the B&NES area the SWMP has strived to collate all the available data related to flood incident records and modelled flood risk. This data has been collected from the RMA project partners. Understanding the uncertainty associated with flood data is an important part of the SWMP process, as decisions are made based on the findings. Flood incident data collected through the SWMP process has been scored according to its quality.

Source-Pathway-Receptor modelling has been applied and the data has been mapped to identify key flooding locations or ‘wet-spots’. Using the flood incident data, an Action Plan has been drawn up which attributes specific project partners as owners of the action.

The B&NES area wide SWMP has also highlighted a number of drainage areas where further investigation is required to provide a better understanding of flood risk.

The Bath and North East Somerset Strategic Flood Board and Operational Flood Working Group, consisting of B&NES Council, the Environment Agency, Wessex Water, Bristol Water and the Emergency Services is well placed to lead on the delivery of the SWMP Action Plan. Co-ordination of the Action Plan requires action owners to ensure that the Plan is undertaken in a timely and cost effective manner and that the tables are 'live' documents which are updated when actions are complete and / or reviewed as and when new or more up to date information becomes available.

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Abbreviations and Terms

AONB ..... Area of Outstanding Natural Beauty

AStGWF ..... Areas Susceptible to Groundwater Flooding

AStSWF..... Areas Susceptible to Surface Water Flooding

AutoFEH..... JBA automated generation of statistical flow estimates used in JFlow

B&NES.....Bath and North East Somerset

BGS ..... British Geological Survey

CAM..... Condition Assessment Manual

CFMP..... Catchment Flood Management Plan

CIL ..... Community Infrastructure Levy

DAP ..... Drainage Area Plan

DRN ..... Digital River Network

DTM ..... Digital Terrain Model

FRA..... Flood Risk Assessment

FRIS.....Flood Reconnaissance Information System

FRISM.....Flood Risk Metrics

FMfSW..... Flood Map for Surface Water

JFes..... JBA Flood Estimation System

JFlush ..... JBA tool to apply urban ReFH method

JFlow..... JBA broad scale two dimensional flood modelling software

LLFA..... Lead Local Flood Authority

LFRMS..... Local Flood Risk Management Strategy

NLPG ..... National Land and Property Gazetteer

NPPF ..... National Planning Policy Framework

NRD ..... National Receptors Database

ReFH..... Revitalised Flood Hydrograph method

RFCC ..... Regional Flood and Coastal Committee

RMA..... Risk Management Authority

SFRA ..... Strategic Flood Risk Assessment

SuDS ..... Sustainable Drainage Systems

SWMP..... Surface Water Management Plan

uFMfSW..... updated Flood Map for Surface Water

Exception Test ..... A test applied under National Planning Policy in Flood Risk Assessment when it is not possible to the development to be located in areas with a low probability of flooding.

Flood Risk..... A combination of the probability (likelihood) and consequences of flooding

Flood Frequency..... There are several different terms which can be used to describe the likelihood and magnitude of flood events. All of these terms are based on probabilities derived from recorded flood records and the fact that larger, more severe flood events occur less frequently than

smaller ones. The three main terms used within the Flood Risk Management industry are:

- Return period…….The average number of years between events of similar magnitude
- Chance of Occurrence……..The likelihood, expressed as odds, of a flood event of a particular magnitude occurring in any one year. e.g. there is a 1 in 100 chance of flooding in any one year; OR each year there is a 1 in 100 chance of flooding
- Annual Exceedance Probability (AEP)……. The chance of a flood greater than a certain magnitude happening in any one year, expressed as a %.

The table below shows how Return Period, Chance of Occurrence and % Annual Exceedance Probability relate to each other for three different magnitudes of flooding

Return Period	Chance of Occurrence	% Annual Exceedance Probability
2 year	1 in 2	50
30 year	1 in 30	3.33
75 year	1 in 75	1.33
100 year	1 in 100	1.0
1000 year	1 in 1000	0.1

National Receptor

Database..... A spatial dataset which contains information on land use, including types of buildings, transport and utilities.

Pluvial Runoff ..... Surface water runoff

Riparian Owner ..... The owner of the land which a watercourse flows through. The rights and responsibilities of riparian owners are detailed in the Environment Agency's document "living on the Edge"

Sequential Test ..... Sequential approach applied under the National Planning Policy Framework to steer new development to areas with the lowest probability of flooding.

Wet Spot ..... Areas which include clusters of reported local flood incidents and are therefore considered vulnerable to flooding from Ordinary Watercourses, surface water or groundwater.

1 Introduction

1.1 Terms of Reference

Bath and North East Somerset Council (B&NES) has identified the need for an Area wide Surface Water Management Plan (SWMP) to be used as an overarching framework to assist with the identification and management of flood risk from surface water within the B&NES boundary.

JBA Consulting was appointed to produce the B&NES Area-wide SWMP in May 2014. This SWMP study forms the strategic stages of the SWMP process for the whole of the B&NES area as described in section 2 below.

1.2 Surface Water Management Plan

A Surface Water Management Plan is a study to understand the flood risk that arises from local flooding, which is defined by the Flood and Water Management Act 2010[7] as flooding from surface runoff, groundwater, and ordinary watercourses.

SWMPs are led by a partnership of Risk Management Authorities who have responsibilities for aspects of local flooding, including the Council, Sewerage undertaker, and other relevant authorities.

Table 1.1 lists the various flood risk management authorities and summarises their responsibilities

Table 1.1 Flood risk management authorities and their responsibilities

Flood Risk Management Authority	Responsibilities
The Environment Agency	Responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion. The Agency also has operational responsibility for managing the risk of flooding from Main Rivers, reservoirs, estuaries and the sea, as well as being a coastal erosion risk management authority
Lead Local Flood Authorities (Unitary Authorities or District Councils)	Responsible for developing, maintaining and applying a strategy for local flood risk management in their areas and for maintaining a register of flood risk assets. LLFAs also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses.
District Councils (None within the B&NES area)	Key partners in planning local flood risk management and can carry out flood risk management works on minor watercourses, working with Lead Local Flood Authorities and others, including through taking decisions on development in their area which ensure that risks are effectively managed. Districts and Unitary Councils in coastal areas also act as coastal erosion risk management authorities.
Internal Drainage Boards (None within the B&NES area)	Independent public bodies responsible for water level management in low lying areas, also play an important role in the areas they cover (approximately 10% of England at present), working in partnership with other authorities to actively manage and reduce the

	risk of flooding.
Highways Authorities	Responsible for providing and managing highway drainage and roadside ditches, and must ensure that road projects for not increase flood risk.
Water and Sewerage Companies	Responsible for managing the risks of flooding from water and foul or combined sewer systems providing drainage from buildings and yards.

Under the Flood and Water Management Act 2010 all Risk Management Authorities in the table above have a duty to co-operate with each other and to share data. A key theme of the Pitt Review was for flood risk management authorities to work in partnership to deliver flood risk management better to the benefit of their communities.

Within the study are Bath and North East Somerset Council, which is a Unitary Authority, fulfil the roles of Lead Local Flood Authority, District Council and Highways Authority. There are no Internal Drainage Boards within the B&NES area. The Water and Sewerage Companies are Bristol Water and Wessex Water. Wessex Water is a Water and Sewerage Company and Bristol Water is a Water Company operating within the Wessex Water Area.

The purpose of a SWMP is to identify what the local flood risk issues are, what options there may be to prevent them or limit the damage they cause and who should take these options forward. This is presented in an Action Plan which lists the partners who are responsible for taking the various options forward. The Action Plan, which will be reviewed periodically, is agreed by all project partners to tackle the flood risks that are identified.

The Local Flood Risk Management Strategy (LFRMS) for the B&NES area is currently being prepared. The B&NES area wide SWMP will feed into the LFRMS by providing an improved understanding of the risk of flooding from local sources and from interactions with Main River flooding. The SWMP prioritised Action Plan together with the LFRMS Action Plan will form an overarching flood risk management Action Plan for the B&NES area.

The framework for undertaking a SWMP study is illustrated using a wheel diagram, reproduced from the Defra guidance[2] as shown in Figure 1.1.

Figure 1.1: Surface Water Management Plan Wheel (Defra guidance[2])

The SWMP process is formed of four main principles:

- Preparation
- Risk Assessment
- Options
- Implementation and Review

This report has been prepared across a series of three of the stages, as follows:

- Preparation: Building a partnership approach to local flood risk management through integrated working between the risk management authorities (RMAs). Gathering evidence of and information about flooding
- Risk Assessment: An initial assessment to determine the highest risk locations and the key issues upon which the action plan should focus. We will be using publicly available datasets in combination with local records of flooding to inform this assessment
- Action Plan: Preparation of an action plan that will aim to identify a range of recommended actions for the reduction of flood risk across the SWMP area. The action plan will:
    - outline the actions required and where and how they should be undertaken;
    - set out which partner(s) or stakeholder(s) is/are responsible for implementing the actions and who will support them;
    - provide indicative costs; and
    - identify priorities.

1.3 Surface Water Flooding

1.3.1 Surface Water

The SWMP technical guidance[2] states that surface water flooding includes:

- surface water runoff; runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing flooding (known as pluvial flooding);
- flooding from groundwater where groundwater is defined as all water which is below the surface of the ground and in direct contact with the ground or subsoil;
- sewer flooding; flooding which occurs when the capacity of underground systems is exceeded due to heavy rainfall, resulting in flooding inside and outside of buildings. Note that the normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters as a result of wet weather or tidal conditions;
- flooding from any Ordinary Watercourse not designated a "Main River", including culverted watercourses which receive most of their flow from inside an urban area and perform an urban drainage function;
- overland flows from the urban/rural fringe entering the built-up areas; and
- overland flows resulting from groundwater sources.

This SWMP aims to consider surface water flooding issues in the B&NES area. Section 6 of this report summarises local flood risk issues. However it should be noted that flood risk can arise from a number of different sources, and often flooding originates from a combination of flood mechanisms. Although Main River flooding will feature within section 6, further investigation of flooding from Main River only is outside of the remit of this report.

Information on Main River flooding within the B&NES area is covered under other strategic planning documents such as the Strategic Flood Risk Assessment Level 1 for Bath and North East Somerset[9].

1.4 Policy Framework

Guidance on the preparation of Surface Water Management Plans was prepared by Defra in 2010[2]. Since the publication of this guidance the following institutional policy and responses have been influential:

- The Flood and Water Management Act 2010[7]
- The Preliminary Flood Risk Assessment (PFRA) Guidance, 2011[6]
- The introduction of Resilience Partnership Funding, 2011
- The updated Flood Map for Surface Water (uFMfSW), 2013
- The National Planning Policy Framework (NPPF), 2012[4]
- The web-based Planning Practice Guidance on Flood Risk and Coastal Management, March 2014.

In addition to these National documents, the following local documents are also taken into consideration during this SWMP:

- Avon Catchment Flood Management Plan (CFMP), June 2012[15, 16]
- The Severn District River Basin Management Plan, 2009
- B&NES Level 1 and Level 2 Strategic Flood Risk Assessments (SFRA), 2008 – 2009[9-12]
- B&NES Flood Risk Management Strategy, June 2010[14]
- B&NES Preliminary Flood Risk Assessment (PFRA), 2011[18]
- Section 19 Investigation Reports (various dates)

1.4.1 Flood Risk Regulations 2009

The Flood Risk Regulations 2009 (FRR) transpose the European Floods Directive 2007/60EC into English and Welsh law and bring together key partners to manage flood risk from all sources and in doing so reduce the consequences of flooding on key receptors. Local Authorities are assigned responsibility for management of surface water flooding.

As part of the ongoing cycle of assessments, mapping and planning, the FRR requires the undertaking of a PFRA. National guidance was published by the Environment Agency in 2011.

1.4.2 Flood and Water Management Act 2010

The Flood and Water Management Act places the responsibility for managing the risk of local floods on the Upper Tier or Unitary Authorities, in their role as Lead Local Flood Authorities (LLFAs), but allows for the delegation of Flood Risk Management functions to other Statutory Authorities.

The Act also seeks to encourage the uptake of Sustainable Drainage Systems (SuDS) by agreeing new approaches to the management of drainage systems and allowing, where delegated, for District Councils and Internal Drainage Boards (IDBs) to adopt SuDS for new developments and redevelopments.

Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems are used to manage rainfall runoff from impermeable surfaces. SuDS encompass a range of techniques which aim to mimic the natural processes of runoff and infiltration as closely as possible. These techniques can include green roofs, permeable paving, soakaways swales and ponds. Any SuDS scheme should integrate with existing drainage systems and be easily maintainable. SuDS schemes should be based on a hierarchy of methods termed “the SuDS treatment train”. Guidance recommends that the management of surface water should use a combination of site specific and strategic SuDS measures, encouraging source control where possible to reduce flood risk and improve water quality.

1.4.3 National Planning Policy Framework

The National Planning Policy Framework and associated Technical Guidance require that new development should not increase flood risk and requires developers to prioritise the use of sustainable surface water drainage systems (SuDS).

The National Planning Policy Framework states that “When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment, following the Sequential Test, and if required the Exception Test it can be demonstrated that:

- Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- Development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems”.

A SWMP will support this by informing the Local Planning Authority (LPA) of areas at risk of surface water flooding and by providing an evidence base to aid the consideration of future development options.

1.4.4 Local Planning Policy Framework

The current Planning Policy Framework for the B&NES area stated that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise. This gives considerable weight to Development Plan documents

The Development Plan for Bath and North East Somerset comprises:

- Bath and North East Somerset Adopted Core Strategy – Core policies include CP5 Flood Risk Management which states that “Development in the district will follow a sequential approach to flood risk management, avoiding inappropriate development in areas at risk

from flooding and directing development away from areas at highest risk in line with Government Policy (NPPF). Any development in areas at risk of flooding will be expected to be made safe throughout its lifetime, by incorporating mitigation measures, which may take the form of on-site flood defence works and / or a contribution towards or a commitment to undertake such off-site measures as may be necessary. All development will be expected to incorporate sustainable drainage systems to reduce surface water run-off and minimise its contribution to flood risks elsewhere. All development should be informed by the information and recommendations of the B&NES Strategic Flood Risk Assessments and Flood Risk Management Strategy.

- Saved Policies from the Bath and North East Somerset Local Plan (2007)
- West of England joint Waste Core Strategy (2011**)**

Placemaking Plan

The purpose of the placemaking[19] plan is to complement the strategic framework in the Core Strategy by setting out detailed development principles for identified development sites and other policies for managing development across Bath and North East Somerset.

The Core Strategy forms Part One of the Local Plan and the Placemaking Plan forms Part Two of the Local Plan.

The Bath and North East Somerset Placemaking Plan[19] Sustainable Drainage Systems Policy, SU.1 links with the Core Strategy Key Policy CP5 Flood Risk Management and CP7 Green Infrastructure and requires that all sites are expected to incorporate sustainable drainage systems to reduce surface water runoff and minimise its contribution to flooding.

In addition, there are site specific requirements for the Core Strategy Strategic Sites allocations and for the site allocations proposed within the Placemaking Plan.

The aims of the Placemaking Plan Sustainable Drainage System Policy are to:

- Set out the high level principles for drainage designs incorporating SuDS features and the SuDS hierarchy that will be used in the B&NES area.
- Provide a basis for the incorporation of SuDS in development schemes through the planning system, ensuring that SuDS features are considered at an early stage and incorporated into a scheme design.
- Identify key considerations and requirements for developers which should be addressed via development management.

West of England Sustainable Drainage Developers Guide

The West of England Sustainable Drainage Developers Guide (available on the B&NES Council website) provides information for developers, planners, designers and consultants on the requirements for design, approval and adoption of SuDS in the West of England and Somerset. The guidance provides information on the planning, design and delivery of attractive, high quality and well integrated SuDS schemes, promotes the need for early consideration of SuDS, and introduces the use of a “proof of concept” process to gain agreement in principle at an early stage from the approving authority

1.5 Drivers for Change

Bath & North East Somerset Council are undertaking this SWMP in order to:

Better understand the risks and consequences of surface water flooding in Bath and North East Somerset so this can be shared and used as part of an evidence base for Local Development Frameworks and the Local Flood Risk Management Strategy;

To assist in meeting some of the requirements on B&NES Council as Lead Local Flood Authority under the Flood Risk Regulations 2009 and the Flood and Water Management Act 2010.

The implementation of the SWMP and Action Plan can help to provide significant economic and environmental benefits to the community through better preparation against extreme rainfall events and surface water flooding. The SWMP process also allows the opportunity to enhance the condition of urbanised catchments helping to improve water quality.

2 Scope of the Bath and North East Somerset SWMP

2.1 Aims and Objectives

The main aim of the SWMP is to produce a long term, area wide high level plan to manage surface water for Bath and North East Somerset Council. The SWMP will be used as a basis for identifying priorities and affordability of measures which will be included in the Local Flood Risk Management Strategy.

The main objectives of this assessment are to:

1. Engage with partners and stakeholders;
2. Collect, collate and map all available flood data and its availability for future use, including an assessment of the reliability of the data
3. Identify, where possible from the available data, flood-prone areas to inform spatial and emergency planning functions
4. Identify areas where flood risk originates from a combination of sources
5. Prepare a source-pathway-receptor model for all the risks and sources that have been identified in objective 3 and 4
6. Identify locations where there may be opportunities for 'quick wins' without the need for further more detailed analysis
7. Provide data which will support the development of a Local Flood Risk Management Strategy
8. Identify any proposed or allocated developments within the study area and the likely impact on flood risk that they may have
9. Identify opportunities for SuDS and WSUD (Water Sensitive Urban Design)
10. Make recommendations for the next steps

2.2 Geographic Extent

This SWMP has been undertaken for the whole of the Bath and North East Somerset area as shown in Figure 2.1.

Bath and North East Somerset covers an area of approximately 35,000 hectares and includes the urban centres of Bath, Keynsham, Midsomer Norton and Radstock as well as numerous villages and hamlets spread across 49 rural parishes.

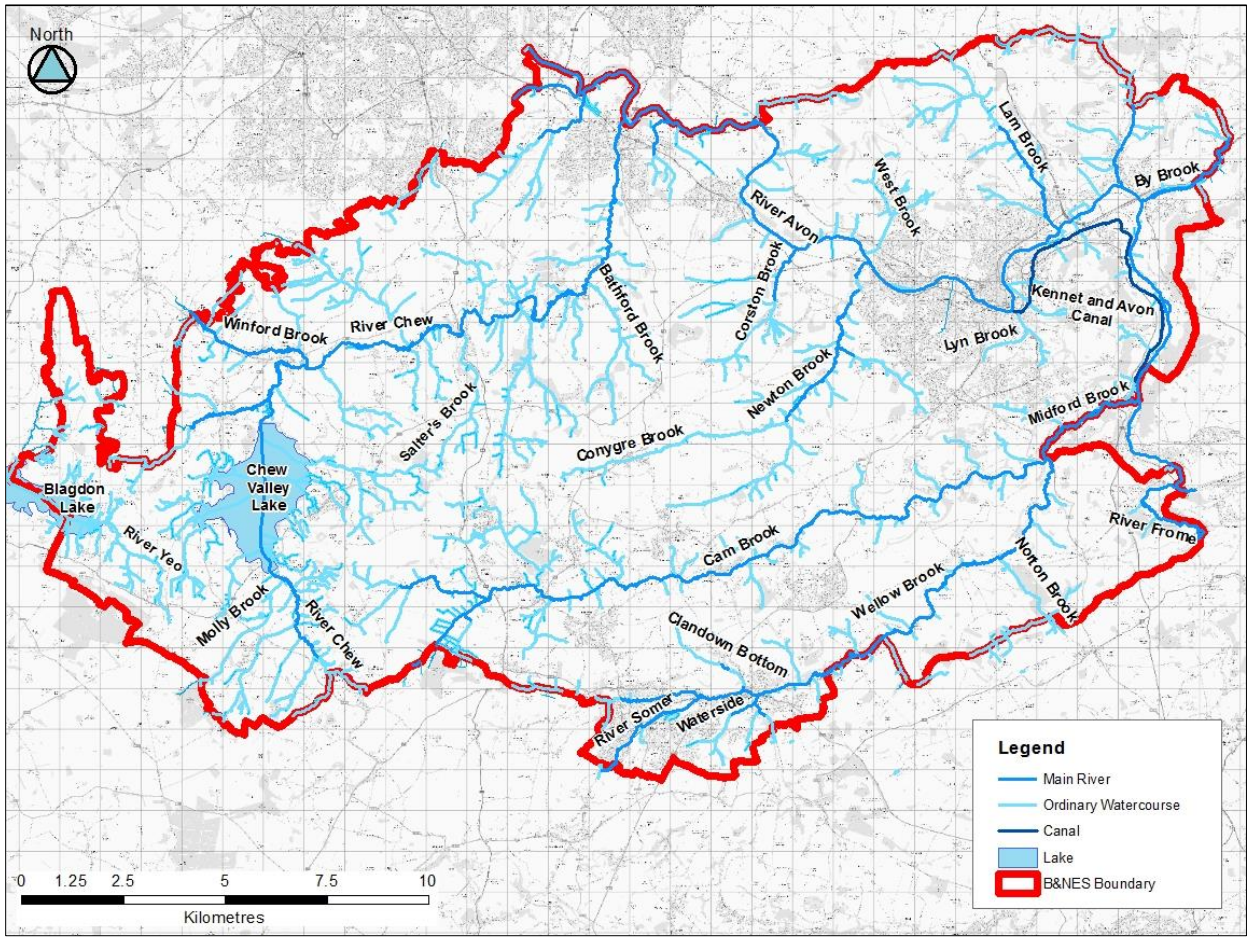

Figure 2.1: Bath and North East Somerset Area

3 Partnership Engagement

3.1 Partnership Working

The formation of partnerships has an important role in the undertaking of a SWMP, and is required under Defra's SWMP technical guidance. This guidance gives details of those partners and/or organisations which should be involved and what their roles and responsibilities should be. The following sections describe the partners involved in the B&NES area wide SWMP, their roles and responsibilities.

Within the B&NES area, flood risk is managed by multiple agencies, including the Council, the Environment Agency and the Sewerage Undertaker, Wessex Water. Often surface water flooding is caused by multiple mechanisms, which fall under the jurisdiction of different agencies. Therefore, a holistic approach is required to solve a flooding issue. As such, partnership working is a key emphasis in the B&NES SWMP process.

To fully understand flood risk in the B&NES area the SWMP has strived to collate all the available data related to flood incident records and modelled flood risk. This data has been collected from the project partners. Data collection and collation is discussed further in Section 5 of this report.

Using the flood incident data, an Action Plan has been drawn up which attributes specific project partners as owners of the action. Again, the importance of partner engagement is crucial here so that agreed actions are followed through to completion. The Action Plan is discussed further in Section 8 of this report.

The partnership approach embodied by the Strategic Flood Board and the Operational Flood Working Group, also enables effective resource allocation and efficiencies to be achieve by sharing common duties between co-operating agencies.

3.2 Partnership Approach

For the purpose of this project, partners are defined as organisations with responsibility for the decision that needs to be taken to manage flood risk. The partners involved in the B&NES SWMP are listed in Table 3.1.

Table 3.1 Partners involved in the SWMP process

Organisation	Representative(s)
Bath and North East Somerset Council	Stella Davies, Alison Szajdzicka, Jim McEwen, Jim Collings and Daniel Parr
Environment Agency	Nigel Smith, Jody Grabham and Tracy Walton
Wessex Water	Dave Ogborne

The project partners have supplied the data to inform this SWMP and have been identified as action owners in the SWMP Action Plan where appropriate.

3.3 Stakeholders

In addition, we have involved some key stakeholders in the SWMP. These parties are not responsible for managing flood risk but do hold information useful to the SWMP process. These stakeholders are listed in Table 3.2.

Table 3.2 Stakeholders involved in the SWMP process

Organisation	Representative
Canal and River Trust	John Kearsey

3.4 Data Sharing and Licensing

A number of specific agreements have been put in place for the SWMP to facilitate the sharing of data between partners:

- GIS licences for mapping and data supplied by B&NES Council;
- Environment Agency standard data licence.

4 Need for a Bath and North East Somerset SWMP

4.1 Previous documents and reports

As part of this study, it has been essential to identify the links to other local and regional delivery plans which may influence or be influenced by the SWMP. The SWMP will seek to integrate and support these plans and processes to provide a clear and robust path to delivering flood risk management objectives throughout Bath and North East Somerset.

4.1.1 Bath and North East Somerset Core Strategy[8]

The Core Strategy was published in October 2009 and has undergone a period of consultation which ended in January 2010. Following on from this a summary report was produced in December 2010.

The Strategy identifies flooding as a key issue for B&NES Council, which also takes into account the effects of climate change. The Core Strategy prioritises the management of flood risk and will therefore be supported by evidence of Strategic Flood Risk Assessments (SFRAs) (Level 1 & 2), which are detailed in later sections, as well as a Flood Risk Management Strategy, detailed later in Section 4.1.6.

4.1.2 SFRA of Bath and North East Somerset - Level 1[9]

The SFRA Level 1 for Bath and North East Somerset was completed in April 2008. The aim of the study was to provide an assessment of the extent of flood risk and its application to planning as the study would help inform the formation of the Local Development Framework.

The study investigated flooding from Main Rivers, sewers, surface water, groundwater and artificial sources.

The main findings of this report were that surface water flooding is the second largest source of flooding, with flooding incidents occurring in the impermeable upland areas of the B&NES area, and in particular along roads. The main areas affected by surface water flooding include Chew Magna, West Harptree, Compton Martin, Priston and Midsomer Norton.

4.1.3 SFRAs for Bath and North East Somerset - Level 2 for Bath (July 2009)[10], Keynsham (May 2009)[11], Midsomer Norton and Radstock (July 2009)[12].

The Level 2 SFRAs were completed in 2009, building upon the technical information and methodology in the Level 1 SFRA. The Level 2 SFRAs investigated 'critical areas' at risk from flooding in Bath, Keynsham, Midsomer Norton and Radstock from Main Rivers, sewers, surface water, groundwater and artificial sources. These reports investigate flood hazards in potential development areas where it may be necessary to apply the NPPF Exception Test.

In Bath, the incidents of surface water flooding are located close to watercourses, particularly the River Avon, indicating that Main River flooding may also contribute to these incidents. Sewer flooding incidents also occur in relatively high numbers within the city centre and near the River Avon, indicating the sewer infrastructure plays an important role in surface water flooding in Bath. Locations of sewer flooding include; central Bath, Larkhall, Walcot, Locksbrook, Weston Park and Southdown.

Keynsham and Midsomer Norton / Radstock are both considered to be prone to surface water flooding based on topography and soil characteristics, however there are no recorded incidents of surface water flooding in these areas. This may be due to a lack of reporting rather than a lack of surface water flooding. Sewer flooding also represents a higher than average number of recorded incidents.

4.1.4 Bath and North East Somerset: Flood Risk Management Strategy- Scoping Study[13]

In May 2009, B&NES Council commissioned a Scoping Study for the preparation of a Flood Risk Management Strategy (Section 4.1.6) in support of the Local Development Framework. The Scoping Study is a high level assessment which identifies potential flood risk management (FRM) options for 'critical areas' of Bath, Keynsham and Midsomer Norton / Radstock. These options provide an initial assessment and recommendations for the next stages of Strategy development.

The report describes the sources of flooding such as Main River, surface water and sewer flooding. Surface water and sewer flooding are significant in Bath, Keynsham, Midsomer Norton, Radstock and Chew Magna. However the report notes that there is less certainty in assessing surface water and sewer flooding risk at a strategic level. The three main options for these areas included increasing the standard of protection of existing flood walls and embankments, as well as building regulations and developing a Surface Water Management Plan.

4.1.5 Place Making Plan

The purpose of the placemaking[19] plan is to complement the strategic framework in the Core Strategy by setting out detailed development principles for identified development sites and other policies for managing development across Bath and North East Somerset.

The Core Strategy forms Part One of the Local Plan and the Placemaking Plan forms Part Two of the Local Plan.

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The aims of the Placemaking Plan Sustainable Drainage System Policy are to:

- Set out the high level principles for drainage designs incorporating SuDS features and the SuDS hierarchy that will be used in the B&NES area.
- Provide a basis for the incorporation of SuDS in development schemes through the planning system, ensuring that SuDS features are considered at an early stage and incorporated into a scheme design.
- Identify key considerations and requirements for developers which should be addressed via development management.

4.1.6 Bath and North East Somerset Flood Risk Management Strategy[14]

In June 2012, Atkins completed the B&NES Flood Risk Management Strategy report. This report builds upon previous work carried out such as those reports discussed in previous sections, as well as the Scoping Report, detailed in Section 4.1.4. The FRM Strategy also contributes towards the Infrastructure Delivery Plan for B&NES Council and should inform the allocation of strategic development sites, providing an approach to manage flood risk. The options of FRM were assessed, and opportunities for the implementation for SUDS were identified.

4.1.7 Bristol Avon CFMP[15, 16]

The Bristol Avon Catchment Flood Management Plan (CFMP) was published by the Environment Agency in December 2009, with a summary report published later in June 2012. The River Avon catchment covers 2200km^2 and is predominantly rural, with major urban areas such as Bristol and Bath. There are also other smaller urban areas such as Chippenham, Frome and Keynsham.

In the B&NES area, the main sources of flood risk were identified as:

- River flooding from the River Avon and its tributaries, particularly in Bristol, Bath, Chew Magna and Midsomer Norton.
- Surface water flooding in Bath and other towns
- Sewer flooding in Bath, Keynsham, Radstock and Midsomer Norton.
- Groundwater flooding is unlikely to be a significant issue

A number of flood risk management policy options were identified across the whole catchment, and those options covering areas within the B&NES area are listed in Table 4.1.

Table 4.1 Findings of Bristol Avon CFMP related to B&NES area

Area	Recommendations
Bath	Policy 5 - Areas of moderate to high flood risk where we can generally take further action to reduce flood risk
Lower Avon	Policy 3 - Areas of low to moderate flood risk where we are generally managing existing flood risk effectively
Mendip Slopes and Long Ashton (partially within the B&NES area)	Policy 4 - Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change

4.1.8 Bath and North East Somerset Preliminary Flood Risk Assessment (PFRA)[18]

The Flood Risk Regulations 2009 implement the requirements of the Floods Directive and came into force in England and Wales on 10th December 2009. Part 2 of the Regulations sets out provisions in relation to the preparation of Preliminary Flood Risk Assessments (PFRA) and sets out the responsibilities for both the Environment Agency and Lead Local Flood Authorities.

The PFRA is designed as a high level screening exercise and for LLFAs includes all local flood risk from surface water, groundwater, Ordinary Watercourses and manmade structures such as canals or sewers. The purpose of the report is to provide evidence for identifying significant Flood Risk Areas.

The PFRA will aid in the development of a Local Flood Risk Management Strategy (LFRMS).

A map of published Significant Flood Risk Areas within England and Wales was produced by the Environment Agency. These are areas where significant harmful consequences are expected to occur in a flooding event. Bath and North East Somerset is not identified as one of the 10 significant Flood Risk Areas and does not meet the National criteria for creating new areas, therefore no amendments to the indicative Flood Risk Areas are proposed and as a result no Flood Risk Areas have been recorded in Annex 3 of the PFRA. There are 10 of these areas within England although no stand-alone Flood Risk Area falls within the B&NES area. The closest Flood Risk Area to B&NES is Bristol, a small portion of which extends within the western-most extent of the B&NES administrative boundary. B&NES Council has discussed this area with Bristol City Council and it has been agreed that Bristol will take the lead on reviewing this Flood Risk Area on the basis that the area falls predominantly within the Bristol City Council administrative boundary.

A number of local flood risk areas within the B&NES area have been identified as being at risk of surface water flooding. It is recommended that those sites will be addressed within the LFRMS. It is also recommended that these areas should also be investigated further to determine whether any improvement works can be implemented to manage or to reduce the risk in the future.

The PFRA highlights the importance of establishing data recording and sharing protocols between the different authorities and partners and promotes the recording of all flooding incidents from local sources.

4.1.9 Section 19 Investigation reports – Chew Stoke, Chew Magna and Broadmead Lane Industrial Estate

Under the Flood and Water Management Act 2012, Lead Local Flood Authorities have a duty to investigate flood events that occur within its area. As Lead Local Flood Authority, B&NES Council has established it will carry out a Section 19 flood investigation when either five or more properties suffer internal flooding at any urban location, or when two or more properties suffer internal flooding at any rural location.

Chew Magna Flood Investigation Report 2013

In February 2013, B&NES Council commissioned a Section 19 Flood Investigation Report following the multiple flooding incidents in 2012 in Chew Magna.

The main findings of the flood investigation report are:

- During the floods of 2012, the prime source of flooding in Chew Magna was from the Winford Brook and the River Chew;
- Flooding was exacerbated by saturated conditions for much of 2012 leading to an excess of surface water on the roads as there was insufficient drainage capacity to cope with the heavy rainfall and runoff from agricultural land;
- Flooding was also exacerbated by flooding from the smaller tributary Ordinary Watercourses, surface water and groundwater.
- Flooding involves a number of different sources that cannot be easily distinguished from each other. As such a number of risk management authorities are involved in addressing flood risk. This requires a continuation of the close partnership working and collaboration to manage this risk in the future;
- A number of actions are proposed to mitigate the impacts and flood risk in the future.
- It is recommended that B&NES Council maintain their coordinating role and responsibility as the LLFA and establish a flood risk management partnership group to take a strategic view of the whole catchment system.

Chew Stoke Flood Investigation Report

In August 2013, a Section 19 report was produced following the 2012 flooding in Chew Stoke.

The main findings of the flood investigation report are:

- The source of flooding was from a combination of surface water, groundwater and fluvial sources
- Flooding was exacerbated by saturated conditions for much of 2012 leading to an excess of surface water on the roads as there was insufficient drainage capacity to cope with the heavy rainfall and runoff from agricultural land;
- There was little lead time for flood warnings
- A number of actions are proposed to mitigate the impacts and flood risk in the future.
- It is recommended that B&NES Council maintain their coordinating role and responsibility as the LLFA and establish a flood risk management partnership group to take a strategic view of the whole catchment system.

Broadmead Lane Industrial Estate, Keynsham Flood Investigation Report

In June 2014, B&NES Council produced a Section 19 report for Broadmead Lane Industrial Estate, Keynsham, following flooding in December 2013 and January 2014.

Broadmead Land Industrial Estate is situated approximately 1km North of Keynsham and lies adjacent to the River Avon. The Industrial Estate is within the functional floodplain of the River Avon and is described by the Environment Agency as being at 'High risk', having a greater than 1 in 30 chance of flooding each year.

The industrial Estate has been affected by fluvial flooding over many years and there are reports that flooding events have been more frequent in recent years.

The main findings of the Section 19 report were:

- Flooding of the Industrial Estate occurred as a consequence of the River Avon exceeding bank-full capacity;
- The Industrial Estate became inundated by flood plain water ponding on surrounding land as opposed to direct bank overtopping;
- The access road to the site became impassable, resulting in a high level of risk to people and properties in the Industrial Estate;

- Flood warnings were issued to the Industrial Estate units, however the Christmas holidays meant that response by property owners / occupiers was limited.

The Section 19 report has been passed to the Environment Agency as the Flood Risk Management Authority responsible for Main River flooding.

4.2 Local Flood Risk Management Strategy (2014)

The B&NES Local Flood Risk Management Strategy (LFRMS) is currently being produced. The B&NES area wide SWMP will feed into the LFRMS by providing an improved understanding of the risk of flooding from local sources and from interactions with Main River flooding. The SWMP prioritised Action Plan will also feed into the LFRMS Action Plan.

The LFRMS will explore the following themes:

- Improve the understanding of the risk of flooding from local sources, with a consideration of main rivers, canals and reservoirs;
- Manage local flood risk;
- Help local communities, individuals and businesses to better understand and manage their flood risks;
- Prevent inappropriate development that creates or increases flood risk;
- Improve flood prediction, warning, post flood recovery and resilience.

The LFRMS will involve significant consultation with the B&NES Strategic Flood Board and Operational Flood Working Group. As these groups include the same Partners and Stakeholders as those involved in the SWMP, and the LFRMS will be the format in which local flood risk management is taken forward, it was decided that, to avoid 'consultation overload', consultation for the SWMP would be limited to data collection and Action Plan sign off with the key Risk Management Authorities.

5 Evidence Base

5.1 Recorded flooding in Bath and North East Somerset

One of the purposes of a SWMP is to identify what the local flood risk issues are, and to summarise the recorded local flood incidents and predicted flood risk to the area. Flood risk can arise from a variety of different sources, as listed in this section. Often however, flooding originates from a combination of sources as flood mechanisms are integrated.

The following sections outline the flooding incidents recorded within the Bath and North East Somerset area within the context of the definition given in Section 1.3.1. This outline of recorded flood incidents should be read in conjunction with the Flood Incident Register (see Chapter 6). The recorded flooding within this report is based on the information supplied by the partners and stakeholders involved in this SWMP up to January 2014; the occurrence of flooding is not static and therefore the recorded flooding represents incidents up to this date only.

The flood incident records have been analysed and rationalised so that only recent and relevant records are included. Records of flooding prior to 2009 have been removed to prevent any misrepresentation of recorded flood incidents which may now have been actioned.

There have been over 990 reports of flooding with various sources and receptors from 2009 to 2014 within the B&NES area. All the affected locations have been grouped into a number of 'wet-spots', these are detailed in Section 6 and 7. These wet-spots can also be viewed using the interactive Map of Local Flood Incidents in Appendix B.

5.1.1 Surface Water Runoff

Surface water runoff occurs when rainfall fails to infiltrate to the ground or enter the drainage system, causing water to pond or flow over the ground surface. The likelihood of flooding is dependent on the rate of runoff and the condition of the surface water drainage system.

Locations of recorded surface water runoff incidences were provided by a number of sources, including B&NES Council and the Environment Agency.

5.1.2 Main River

A Main River is any watercourse which is designated as such on the Environment Agency's Main River Map (available online as at http://maps.environment-agency.gov.uk/wiyby/) and for which the Environment Agency has responsibilities and powers. Main Rivers are generally the larger arterial watercourses but smaller watercourses can be designated if they pose a significant flood risk. Where fluvial flooding from main rivers is the sole source of flooding, it is the responsibility of the Environment Agency.

Actions to mitigate fluvial flooding from Main River are outside the scope of a SWMP, and are addressed in a Catchment Flood Management Plan, or other more detailed local studies. However, interactions between Main River and Surface Water flooding has been included as an additional consideration to this SWMP to highlight where fluvial flooding interacts with and influences the other local flood sources.

5.1.3 Ordinary Watercourses

An Ordinary Watercourse is a statutory watercourse type in England and Wales. They include rivers, streams, ditches and drains which do not form part of a Main River. B&NES Council have permissive powers to carry out works on Ordinary Watercourses and also have responsibilities in relation to consenting and enforcement.

Within the B&NES catchment there are a number of Ordinary Watercourses which drain into the Main Rivers, see Figure 5.1 below.

5.1.4 Groundwater

In the context of surface water management plans is defined as all water which is below the surface of the ground and in direct contact with the ground or subsoil. This includes flooding from groundwater rising up from aquifers as well as sub surface flow and interflow through soils.

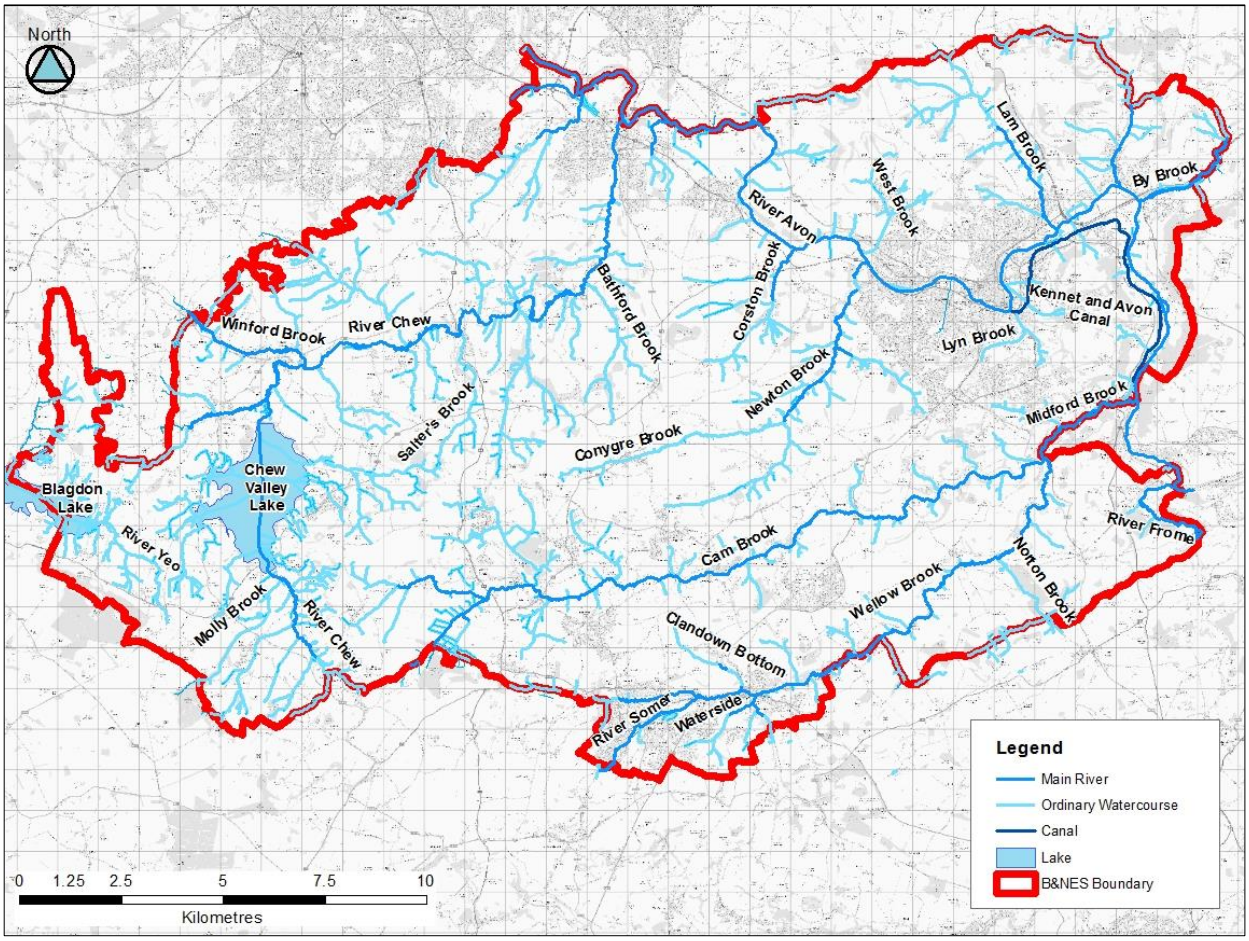

Figure 5.1: A map to identify the location of all the watercourses in Bath and North East Somerset

5.1.5 Sewers

Sewers are the underground network of pipes which remove waste water from properties. They are categorised by the type of waste water they remove. The categories include:

- Foul sewer
- Surface Water sewer
- Combined sewer
- Treated effluent

Foul sewers and treated effluent both convey waste water. Surface water sewers convey collected surface runoff and combined sewers convey a mixture of both foul water and surface water. For the purpose of this study, the surface water sewer network is the main emphasis. The performance of this drainage network relates directly to the proportion of rainfall which forms pluvial runoff and the inflow to ordinary watercourses from drainage network discharges.

Wessex Water is responsible for the Public sewer networks in this area. As partners in the SWMP process, Wessex Water has provided a list of sewer flooding incidents for the B&NES area for the period 2013-2014. These records include sewer flooding attributable to surface water. Wessex Water provided the postcode locations for 44 occurrences of sewer flooding between 2013 and 2014, this ensures confidentiality as it prevents pin pointing the exact properties which are affected.

5.2 Indicators of Potential Surface Water Flood Risk

5.2.1 EA updated Flood Map for Surface Water

In 2013 the Environment Agency produced and published the updated Flood Map for Surface Water (uFMfSW). This is the third national surface water map following on from the Areas Susceptible to Surface Water Flooding (first generation) and the Flood Maps for Surface Water (second generation). The uFMfSW assesses flood scenarios as a result of rainfall with the following chance of occurring in any given year: 1 in 30 (high risk), 1 in 100 (medium risk) and 1 in 1000 (low risk). The uFMfSW only indicates flooding caused by local rainfall and does not account for flooding that occurs from overflowing watercourses, drainage systems or public sewers.

5.3 Assets

Information on assets has been provided by stakeholders which can also be used as potential indicators of flood risk:

- Culverts and trash screens which may be susceptible to blockage;
- Watercourses which can become blocked and full of debris;
- Highway assets such as gullies, manholes etc. which may have insufficient capacity during storm events or can become blocked and full of debris;
- Sewers which may have insufficient capacity during storm events.

5.4 Maintenance Regimes

Bath and North East Somerset Council[21]

B&NES Council Highways department are responsible for routine maintenance of the highway drainage system. Gullies and their immediate pipe connection are emptied and cleansed as part of an annual proactive maintenance programme. Highway drainage with persistent problems are programmed for a greater cleansing frequency.

B&NES Council Drainage and Flooding team carry out a programme of annual watercourse maintenance on Ordinary Watercourses that are deemed to be critical in terms of flood risk (normally due to their proximity to property or infrastructure). This involves the removal of debris or vegetation that may have an impact on flow capacity and flood risk. Trash screens on these watercourses are also cleared and any build-up of trash is removed reactively.

Environment Agency

The Environment Agency carries out maintenance on rivers and streams designated as Main Rivers. Their annual maintenance programme can be found on the Environment Agency's website.

Wessex Water (sewers)

Wessex Water carries out maintenance on public sewers. More details on sewer maintenance can be sourced through the Wessex Water website www.wessexwater.co.uk

Role of Riparian Owners

If a property is adjacent to or backs onto a river, stream or other watercourse, then it is likely that the land owner will be the riparian owner and as such own the land up to the centre of the watercourse.

Riparian owners have a right to protect their property from flooding and erosion, but will need to discuss the method of doing this with the Lead Local Flood Authority within B&NES or the Environment Agency depending on the classification of the watercourse. Where the watercourse is classified as a Main River, any potential works should be discussed with the Environment Agency. Where the watercourse is classified as an Ordinary Watercourse, any potential works should be discussed with the Lead Local Flood. Riparian Owners also have responsibility for maintaining the bed and banks of the watercourse and ensuring there is no obstruction, diversion or pollution to the flow of the watercourse.

More information on Riparian Ownership responsibilities can be found in the EA document 'Living on the edge' available at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/403435/LIT_7114.pdf

6 Data Collection and Collation

6.1 Data Collection for the study

A full list of all the data received during the B&NES area SWMP is available in Appendix A - Data Register. The data is separated into:

- Data held by the Local Authority (B&NES Council)
- Data held by Partner Organisations
- Environment Agency National Data Sets

6.1.1 Sources:

Data was provided by:

- Bath and North East Somerset Council
- Environment Agency
- Wessex Water
- Canal and River Trust

6.1.2 Data Quality and Restrictions

The SWMP technical guidance emphasises the importance of understanding the quality of the data used to inform the SWMP. Data uncertainty can arise throughout any risk assessment and risk management process. Types of uncertainty can include:

- Model - models may not be accurate or complete;
- Environmental - natural variability may not be represented by conceptual model assumptions;
- Knowledge – scientific data may be incomplete;
- Sample - sample measurements may be inaccurate or the validity may be queried;
- Data - data may be extrapolated or interpolated from other sources;
- Scenario - scenarios might not fully describe the problem.

Understanding the uncertainty is an important part of the SWMP process, as decisions are made based on the findings. It is important that all project partners and stakeholders are clear about what the limitations of the findings are before making decisions on the level of investment (resources and funding) that may be needed in the future.

The SWMP guidance therefore presents a scoring system to rank the data according to its quality. For the B&NES area SWMP, this scoring system has been modified. The modified scoring system (in Table 6.1) was required because the majority of the data received a quality score of 2 and assumptions made with the data scored 3. The result was that there was nothing to distinguish between the value of the data sources. Therefore, a refined scoring system was developed to provide a more informative data score.

Table 6.1 Data quality scoring system

Data Quality Score	Description	Sub-category	Example
1	Best possible, no better data available	N/A	LIDAR Rain gauge data Surveyed data
2	Data with known deficiencies	2a) the known deficiencies are missing **or** duplicated data	
		2b) the known deficiencies are missing **and** duplicated data	
3	Assumption based on available data	3a) Assumptions confirmed with local data	
		3b) Assumed data confirmed by cross referencing with other records	
		3c) Assumed data based on a single dataset	
4	Educated guess based on experience	N/A	Ground roughness for a 2D model

Under this scoring system all supplied data receive a data quality score of 1 or 2. Information that has been assumed from the data received scored a 3 or 4. The sub-categorisation of the data score into the categories a) and b) distinguishes the relative quality of the data.

This confidence scoring system can be applied to the received data, the source-pathway-receptor model and the selected wet-spot areas (Wet-spot area are areas which are considered more vulnerable to surface water flooding, these are discussed further in section 7).

The flood incident data used to inform this SWMP has been scored according to the data which was provided, and that which was missing. Table 6.2 lists the data provided for the B&NES area SWMP and the data quality scored associated with it.

Table 6.2 Received data and allocated quality score

Data	Data Quality Score
Environment Agency	2a
Bath and North East Somerset Council	3b
Wessex Water	1

6.1.3 Data Format

Existing

Data was supplied for the study in a variety of formats, and these are also detailed in Appendix A - Data Register and Quality Score. Data was obtained in the following formats:

- GIS (both ArcGIS and MapInfo)
- ASCII
- PDF
- Excel

All data was supplied both electronically and hard copy format, this data was collated and stored. The majority of data supplied was in GIS format, this was advantageous when it came to communicating the risk as data could be geospatially displayed. Mapping the flood incidents spatially allowed the identification of key themes such as repeat flood mechanisms and interactions between flood sources. Furthermore, mapping is an effective method for

communication as it puts the risk into some context. This helps create a useful product for communication with the project partners.

6.1.4 Data Gaps and Limitations

One key limitation that has been recognised is the differing formats of the data which was received between the partners and stakeholders. This was most apparent when data was provided in PDF format, resulting in the need for increased processing to digitise the information into a GIS format.

In addition to this, the databases also needed extensive processing and cleaning before the source-pathway-receptor model could be applied. Some datasets had duplicated and/or inappropriate data, with one dataset containing maintenance incidents rather than flood incidents. Many flooding incidents did not contain co-ordinates so this data needed geo-referencing before converting to GIS. Some flooding incidents contained complete addresses and geo-references which made the source-pathway-receptor model easy to apply. Others contained incomplete and/or missing information in terms of flood source or location so it was difficult to determine the Source-Pathway-Receptor model. Those incidents that were too vague to process were removed to avoid assumptions.

Future Data Management

The relevant flood risk and incident data will be supplied to B&NES Council as part of the SWMP; it is recommended that B&NES Council remain the curator of this data and through this role is responsible for coordinating the maintenance of the databases.

It is recommended that, alongside the information already collected by flood risk management partners in order to carry out their individual roles, a common database format is to record flood incident data for the purposes of reporting to B&NES Council and updating the SWMP. This will ensure that updates to the source-pathway-receptor model and SWMP can be made efficiently in the future.

A recommended table of fields to be populated when recording flood incident data to report to B&NES Council is provided in Appendix E – Flood Incident Data Collection Fields. This data should ideally be provided to B&NES Council within a GIS database, or a Microsoft Excel table.

6.2 Flood Incident Register

As part of the SWMP, a Flood Incident Register was developed to show the recorded flood events within the B&NES area. The Source-Pathway-Receptor model concept was used to standardise the flood incident data. The Source-Pathway-Receptor model is a concept that can provide an understanding of all sources of flood hazard and is illustrated in Figure 6.1 below. It is particularly useful in this context as it can be used to generalise the data gathered from numerous sources.

- Source - the origin of flood water
- Pathway - a route or means by which a receptor can be affected by flooding
- Receptor - something that can be adversely affected by flooding

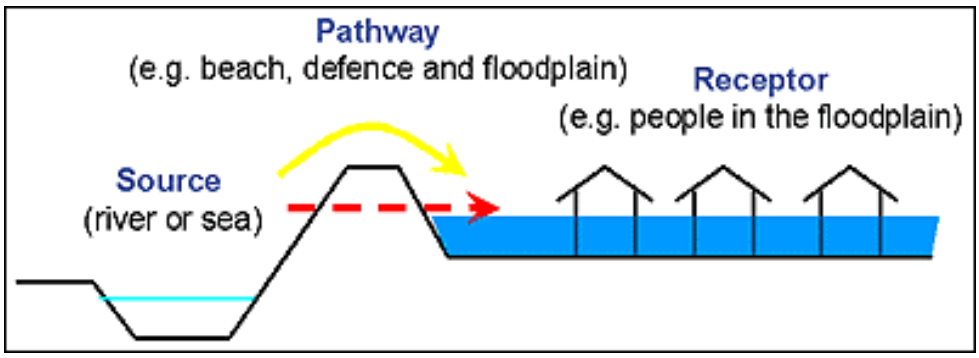

Figure 6.1 Source Pathway Receptor Model

Having applied the Source-Pathway-Receptor model it is possible to mitigate the flood risk by addressing the source (often very difficult), blocking or altering the pathway and even removing the receptor e.g. steering development away from flood risk areas.

6.2.1 Applying the source-pathway-receptor model

As mentioned previously, the information contained within each flood incident table varies between sources of data. Data from the Environment Agency and Wessex Water contained specific details on the flood source, pathway and the receptor, so in these instances the source-pathway-receptor model could be informed wholly from the recorded data and requires no assumptions. However, data provided from B&NES Council required an element of assumption. In the case where flood incidents had been fully recorded in terms of source of flooding, the pathway, and the location which was affected, no assumptions have been made. Where exact locations were missing, flood incidents were geo-referenced indicatively or based on postcodes. Therefore, the flood incident register contains approximate grid references that may not be the exact location of the flood incident. Those records with no information regarding the source of flooding were classified as 'unknown'. Data which was provided with little or no useful information was completely disregarded and removed due to low confidence in the data.

6.3 Interactive Map of Local Flood Incidents

For the SWMP to be an effective document, the risk needs to be clearly communicated.

As mentioned in Section 6.1.3, the majority of the flood incident data was supplied in database format which could be easily converted into a GIS format. The flood incidents were processed so they could be geospatially displayed.

Mapping the flood incidents spatially allowed key themes to be identified, such as repeat flood mechanisms and interactions between flood sources. Furthermore, mapping is an effective method for communication as it puts the risk into context.

Interactive Maps of Local Flood Incidents have been produced using the GeoPDF format to communicate this risk and recorded flood incidents. The advantage of using maps is that a lot of data can be displayed in a manner which is easily viewed. The advantage of using a PDF is that it cannot be edited. A GeoPDF embodies both advantages and in addition, enables some basic GIS software functionality. A GeoPDF can be opened in any PDF viewer, software which is freely available.

6.3.1 Data displayed

Recorded Local Flood Incidents

The flood incident points have been compiled from all the data received. The source-pathway-receptor model was applied to each point and the total number of repeated flood incidents was tallied. The database of flood incident points was reduced to only include flood incidents from the past 5 years, rather than the full data set which dated back to the 1960s. This prevented misrepresentation of recorded flood incidents which may now have been actioned.

The flood incident points were then thematically mapped. The colour of the flood point was dependent on the flood source, whereas the size of the flood point was dependent on the frequency of the flood incidents recorded at that location, from the same source. The colour coding and scaling allows a lot of data to be communicated simultaneously, in a clear and decipherable way. The flood points in clusters of different colours indicate flood risk from combined sources, whereas the scaling of flood incident points by frequency indicates flood prone areas.

The flood sources are descriptive of both the type of flooding (e.g. surface water) and the type of asset (e.g. highway culvert). This sub division has been made so that the Risk Management Authority (RMA) responsible for the flooding incidents is easily identified.

All the flood sources used in the B&NES area SWMP are listed in Table 6.3. This also includes the colour coding system used in each of the Interactive Maps of Local Flood Incidents.

Table 6.3 Sources of flooding colour coding system

Flood Source	Symbol	Colour
Fluvial Flooding: ordinary watercourse	○	
Surface Water: drainage ditch	○	
Surface Water: highway gulley	○	
Surface Water: pluvial runoff	○	
Surface Water: highway culvert	○	
Unknown	○	
Fluvial Interactions	□	

The size of the points depends on the number of instances. The number of recorded incidents has been divided into five categories. This scaling system has been added to the Interactive Map of Local Flood Incidents to instantly show re-occurring flood mechanisms, which can help prioritise actions.

Incidents of flooding that were recorded by the Environment Agency and attributed to interactions between Main River flooding and local sources, were also included within the analysis. These incidents are shown as blue squares on the Interactive Map of Local Flood Incidents. The inclusion of these incidents ensures that locations where several Risk Management Authorities, including the Environment Agency, need to be involved are included within the wet-spot identification and action plan in sections 7 and 8 of this report.

Sewer flooding incidents are represented by polygons of the postcode area in which flooding took place, rather than points at the affected properties. This is an approach taken by Wessex Water to protect their customers' confidentiality. It is important to note that these polygons are not representative of the extent of flooding.

The same colour and scaling system cannot be used for sewer flooding as the flood point data. Instead, the regions have been colour coded by source of flooding and number of occurrences. The polygon outline is coloured by flood source, with blue representing surface water flooding. The polygon interior colour is based on number of recorded incidents following a traffic light system.

- A low frequency event with only one or two incidents is green;
- A mid frequency event with three to four incidents recorded is amber;
- A high frequency event with five plus incidents is red.

This colour coding system is shown in Table 6.4.

It should be noted that Wessex Water report on incidents relating to hydraulic capacity, this dataset therefore excludes incidents related to blockage which are managed by Wessex Water.

Table 6.4 Sewer flooding incidents, colour coding system

Flood Source	Number of recorded incidents	Symbol
Surface Water: sewer flooding	1 – 2	
	3 – 4	
	5+	

Figure 6.2 shows an example of the Interactive Map of Local Flood Incidents with the different symbols used.

Note there were no flood incidents attributed to groundwater flooding within the flood incident records, however it is likely that interactions between ordinary watercourses, pluvial runoff and

sub-surface flows do take place for a number of flood incidents. This is believed to be the case in Chew Magna.

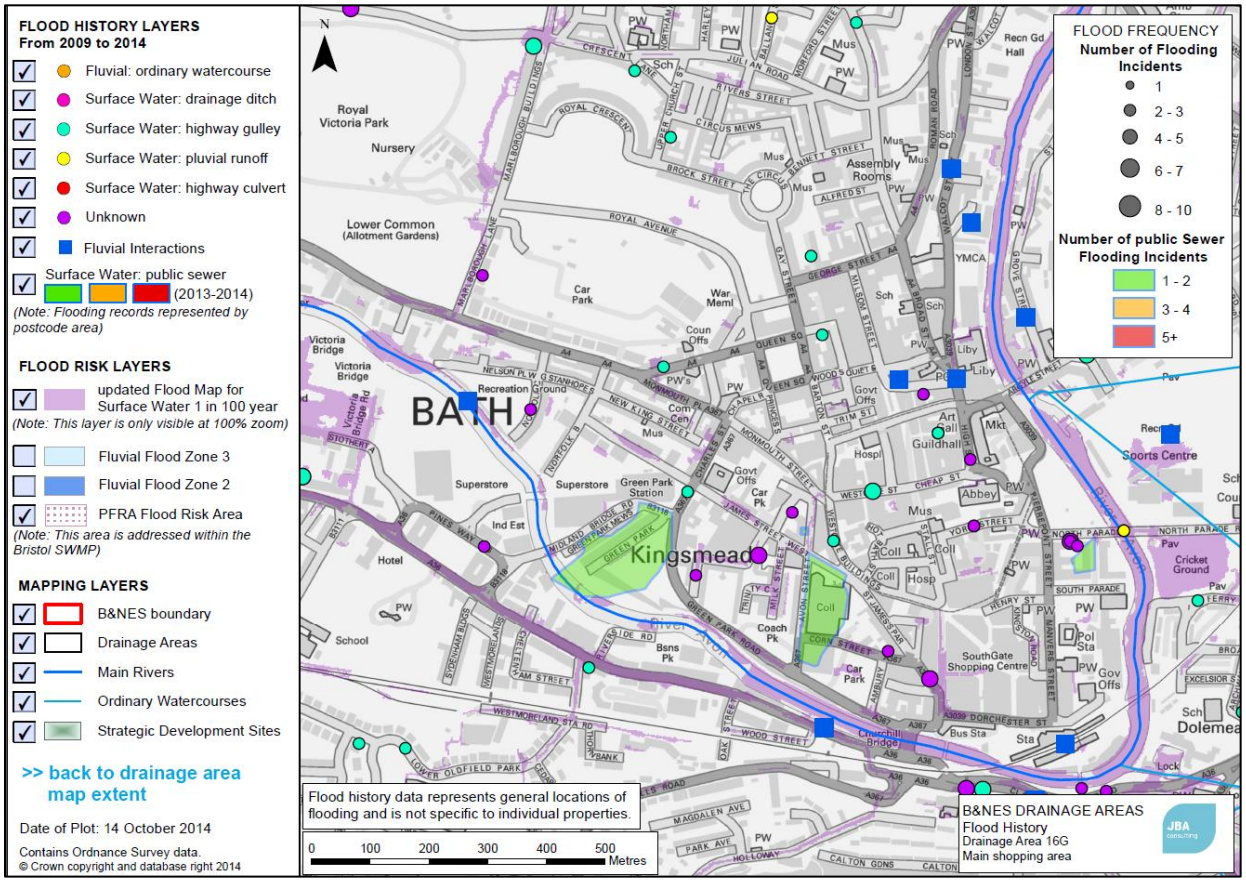

Figure 6.2 Extract from the Interactive Map of Local Flood Incidents

Flood Risk Data and Catchment mapping layers

Additional mapping layers have been added for context. These include the updated Flood Map for Surface Water, Fluvial Flood Zones, Main Rivers and Ordinary Watercourses derived from the Digital River Network (DRN), the study boundary of the B&NES area as well as boundaries for each of the drainage areas. In addition, areas allocated for strategic development and the PFRA Flood Risk Area have also been marked.

6.4 Drainage Areas and Wet Spot Selection

The principal purpose of the strategic assessment is to identify areas which are considered more vulnerable to surface water flooding. These areas are termed ‘wet-spots’ and the most vulnerable wet-spots will be taken through for further investigation and assessment.

The B&NES area has been split into 18 drainage areas based on hydrological catchments and the distribution of flood incidents within the Interactive Map of Local Flood Incidents. Each drainage area has then been further split into ‘wet-spot’ areas according to the clustering patterns of flood incidents.

As part of the Action Plan process described further in section 8.0, the flood sources and frequencies of each in the ‘wet-spot’ areas have then been analysed to identify appropriate actions to reduce flood risk.

7 Wet-spot Verification and Prioritisation

7.1 Approach

Wet-spots have been identified through the analysis of flood incident data described in section 6.0. These wet-spots, which are derived from analysis of recorded flood incident data, have been verified and prioritised through an analysis of the predicted surface water flood risk areas identified by the updated Flood Map for Surface Water and information on flood receptors held within the National Receptors Database. This section details the verification and prioritisation process of the wet-spots.

7.2 Quantifying surface water flood risk

The national scale updated Flood Map for Surface Water (uFMfSW) has been used in conjunction with the National Receptor Database (NRD) to produce a count of receptors which would intercept overland flow routes. This analysis has been carried out using JBA's Flood Risk Metrics (FRISM) tool which produces results in excel and GIS formats.

FRISM is an in-house software package developed by JBA as a cost effective tool to measure flood risk and summarise key statistics such as the number of properties flooded and flood damages. The damage calculations are based on the latest MCM2013 depth-damage curves. For this project, the capability of FRISM was used to automate and accelerate the process of identifying the number of properties within flood extents. A property is defined as "within the flood extent" as soon as the building footprint intersects in any way with the flood extent in question. National Receptor Dataset information correlating to the building footprints was used to divide the properties at risk into the three groups: dwellings (residential properties); critical infrastructure; and emergency services.

The analysis includes flood extents from all available return periods, 1 in 30 year, 1 in 100 year and 1 in 1000 year and includes dwellings, vulnerable receptors and emergency receptors.

It should be noted that the updated Flood Map for Surface Water does not include flood risk from groundwater.

7.2.1 Quantifying surface water flood risk in B&NES

The area analysed covers all of the B&NES area as illustrated in Figure 7.1. The outputs have been produced at a 250 m grid size.

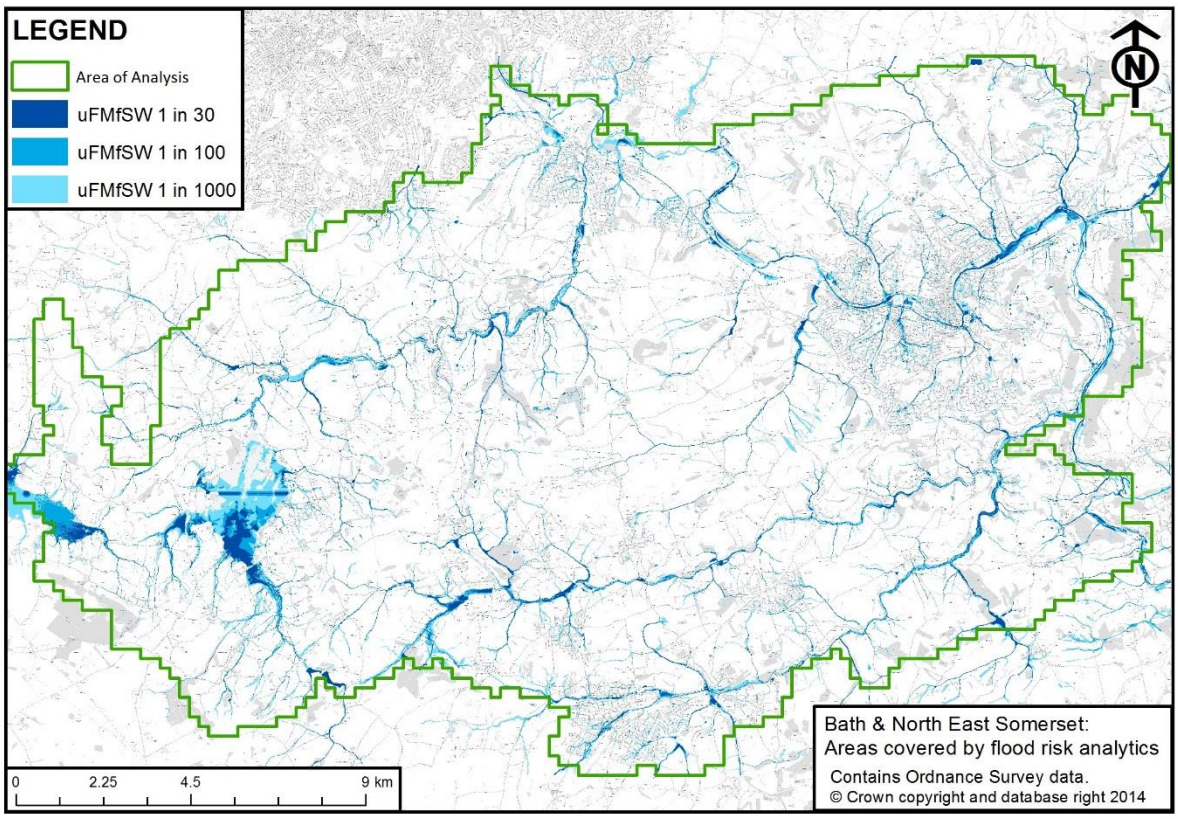

Figure 7.1: A map of area covered by the surface water flood risk quantification analysis

The receptors were extracted from the Environment Agency's National Receptor Database (NRD). All property points with type 'dwelling' have been selected to count the flood risk to homes. Dwellings at risk to surface water flooding have been counted as they are vulnerable receptors and represent the greatest potential risk to people. Furthermore, the number of receptors which are classified as "critical infrastructure" and "emergency responders" at risk to surface water flooding have also been counted (receptors considered for these categories have been listed below in Table 7.1). This will help B&NES Council understand where the greatest risk is and prioritise their emergency planning.

Table 7.1 Receptors considered as critical infrastructure and emergency responders

Critical Infrastructure	Sub-class
Education	Nursery
	Infant school
	Pre-school
	School
	Special school
	Primary school
	Private primary school
	High school
	Sixth form college
	Education
	Higher education
	University
Health	Hospital
	Hospice
	Surgery
Power	Electricity sub-station
Sewage	Sewage treatment
	Sewage storage
	Sewage pumping
	Sewage filtration
Water	Water treatment
	Water storage
	Water filtration
	Water distribution
	Reservoir
Vulnerable people	Nursing home
	Shelter
Emergency Responders	**Sub-class**
Police service	Police station
Fire service	Fire tower
Health service	Ambulance station

Table 7.2 displays the receptor count at risk from surface water for all of the B&NES area

Table 7.2 Estimated number of receptors in the B&NES area at risk from surface water flooding

Return Period	Residential Properties (NRD)	Critical infrastructure (NRD)	Emergency responders (NRD)
30	302	11	0
100	737	24	0
1000	3039	77	2

The figures show that the number of dwellings at risk from surface water flooding at a 1 in 30 year return period is relatively low as only 302 properties are predicted to be at risk. However, at a 1 in 100 year return period this value increases, with flooding is predicted to affect 737 properties. For 1 in 1000 year return period the values increase significantly with 3039 residential properties potentially at risk.

The number of critical infrastructure sites at risk from surface water flooding also increases with return period. The number of critical infrastructure sites at a 1 in 30 year event is low (11) considering the B&NES area wide scale of the analysis. However, at a 1000 year event this increases to 77 critical infrastructure sites at risk.

The locations of the emergency blue-light responders are outside the surface water flood map extent on the 30 and 100 year return periods. However, at a 1 in 1000 year return period there is surface water flood risk to 2 emergency responders across the B&NES area.

To illustrate where flood risk is most significant, the results from the dwelling receptor counts are shown in Figure 7.2**Error! Reference source not found.** – Figure 7.4 where darker blue colours represent a greater concentration of properties predicted to be at risk of surface water flooding.

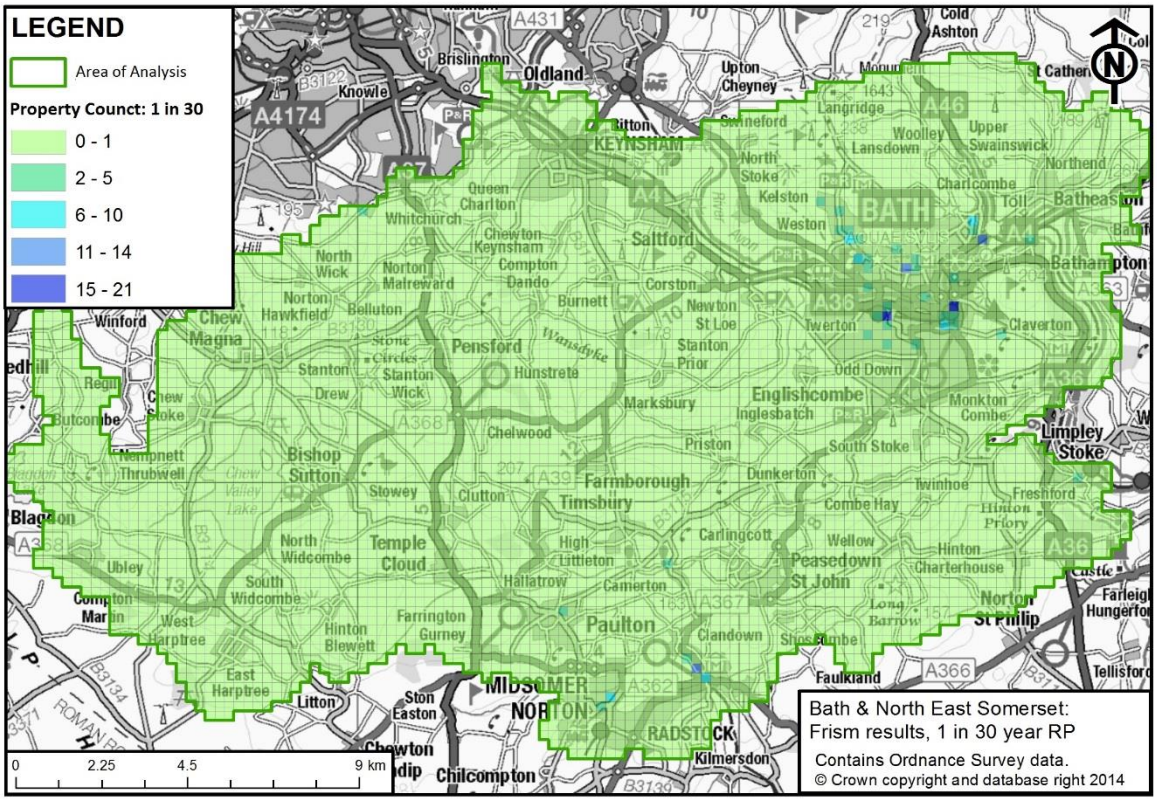

Figure 7.2 FRISM dwelling count results for the 1 in 30 year return period

The FRISM results for each return period display a consistent trend. The predominant cluster of surface water flood risk to dwellings is in Bath. In addition, there are also clusters of surface water flood risk to dwellings in Keynsham, Radstock, Midsomer Norton, Paulton and some surface water flood risk in Chew Magna.

The locations of these ‘wet spot’ areas are consistent with the areas identified within the Interactive Map of Local Flood Incidents discussed in section 6.0 above.

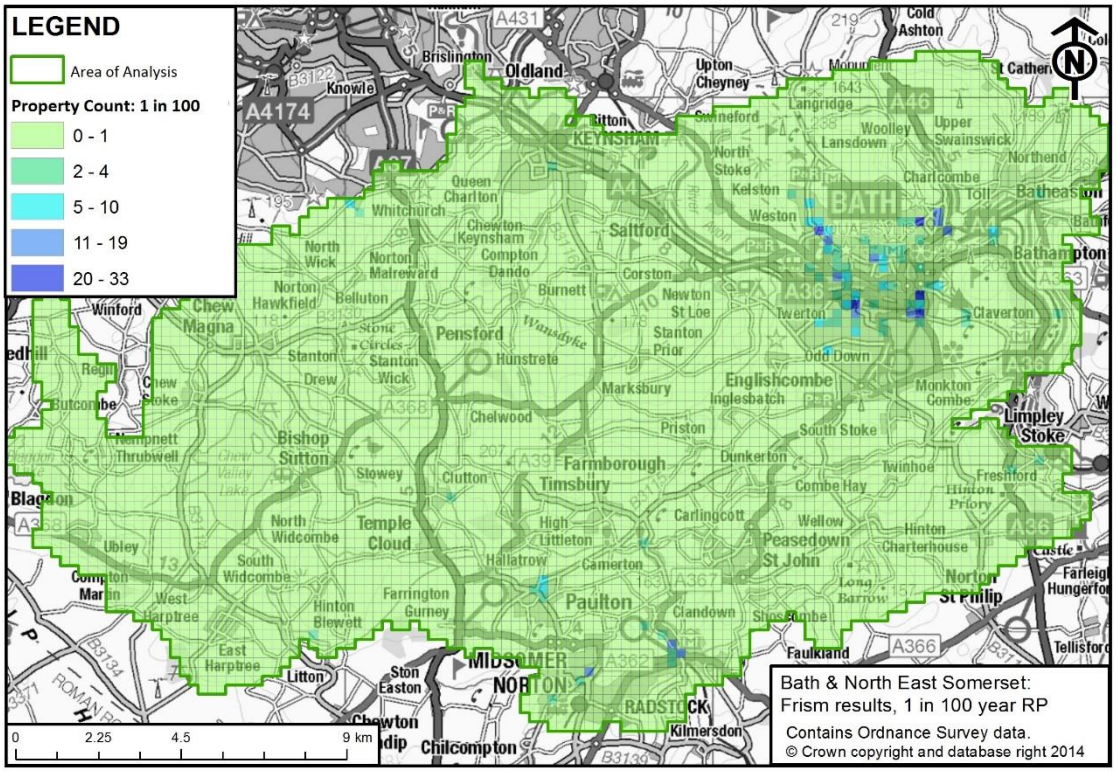

Figure 7.3: FRISM dwelling count results for the 1 in 100 year return period

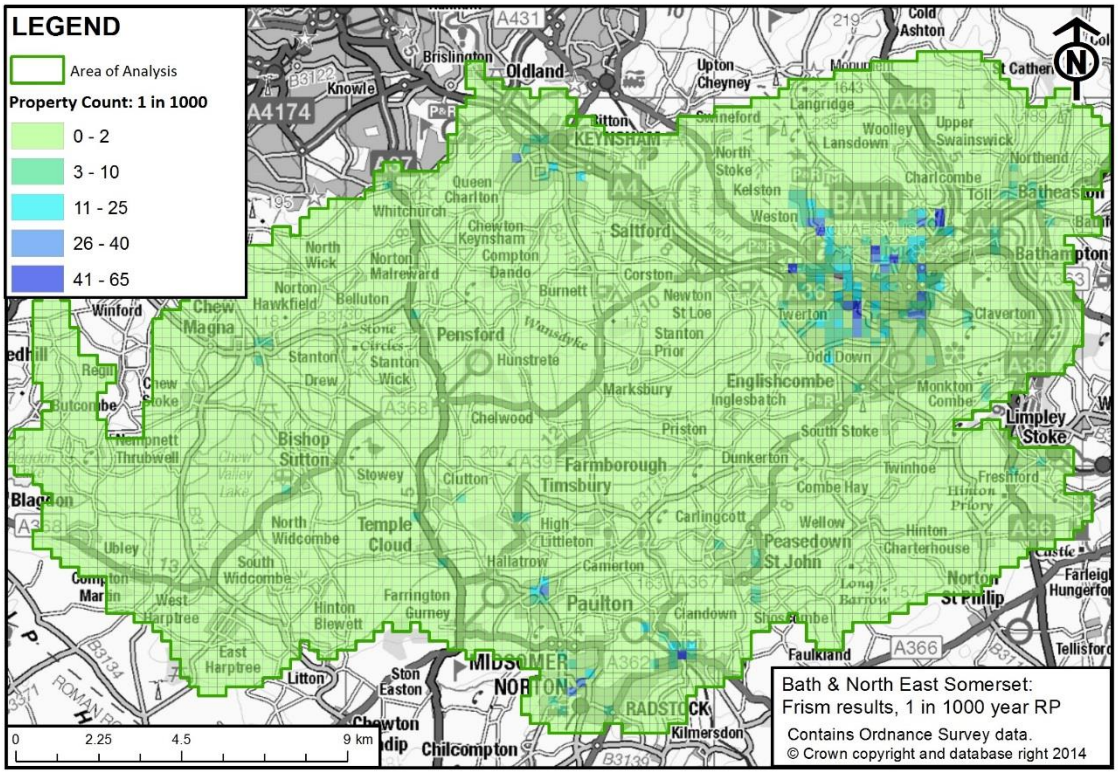

Figure 7.4: FRISM dwelling count results for the 1 in 1000 year return period

7.3 Updated Flood Map for Surface Water with Climate Change Allowance

An additional exercise carried out for this SWMP was to re-run the updated Flood Map for Surface Water (uFMfSW) modelling for the B&NES area with a 30% increase in rainfall to allow for climate change.

The results show that climate change is likely to have a notable impact on flood risk across the B&NES area. Flood outlines for the 1 in 100 year return period rainfall event are slightly larger than present day outlines in all of the flooding wet-spot locations. Increases in flood extents are generally more pronounced in flatter valleys where water would spread further at lower depths. In steep-sided valleys, flood extents do not increase significantly, however flooding becomes deeper.

Figure 7.5 shows the difference between the present day and the climate change outline for the Bath area.

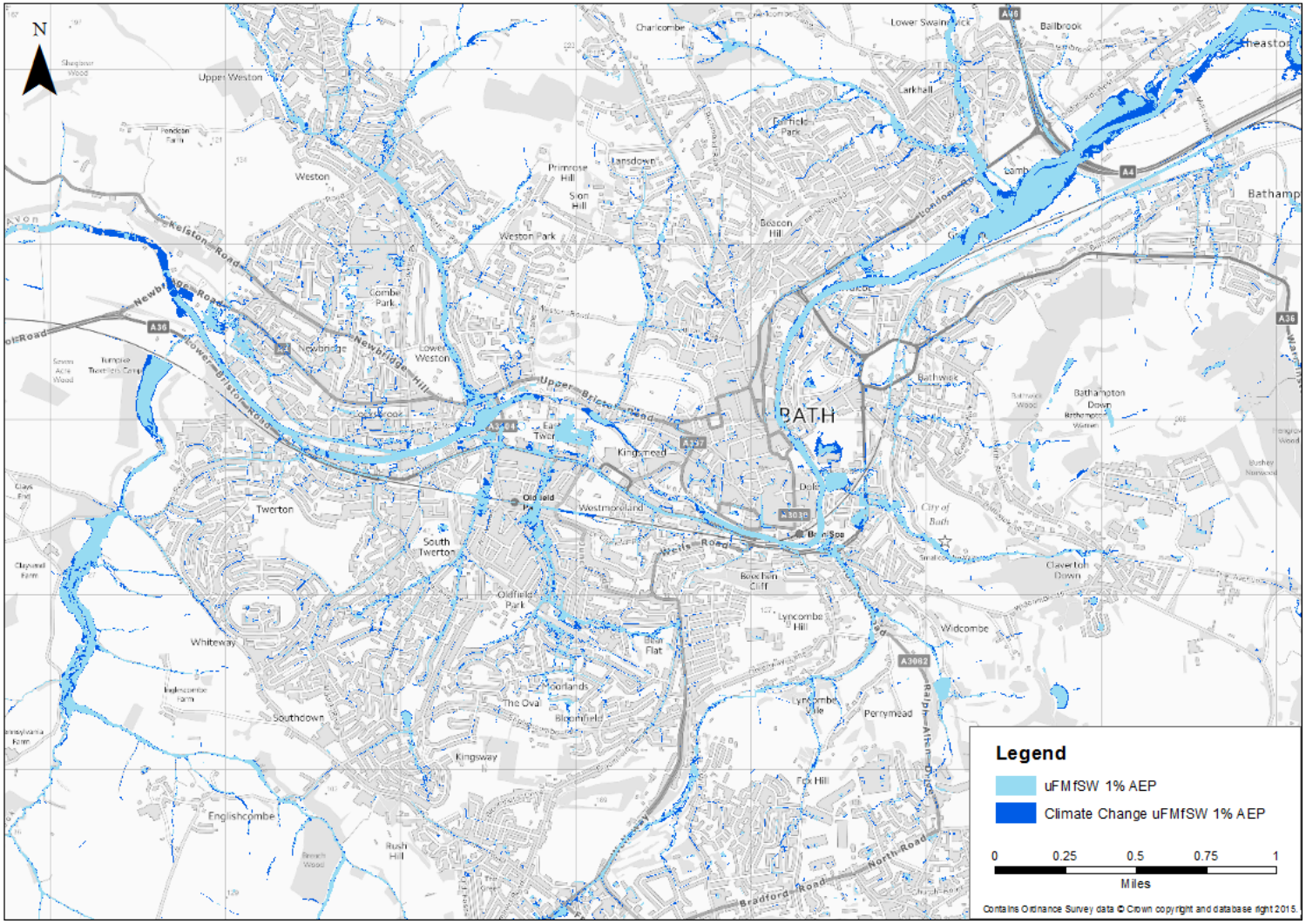

Figure 7.5 Present day and climate change updated Flood Map for Surface Water extents

The climate change outlines have been used, in conjunction with the National Receptor Database ((Version NRD 2011) to establish the additional number of properties, critical infrastructure and emergency responders across the B&NES area that may be at risk from flooding when taking climate change into account. The results of the analysis, compared with the present day numbers of properties at risk, are presented in **Error! Reference source not found.**.

Table 7.3 Increase in numbers of properties at risk from surface water flooding taking climate change into account

Return Period	Residential Properties (NRD)	Critical infrastructure (NRD)	Emergency responders (NRD)
100	737	24	0
100 + Climate Change	1393	46	2
Additional properties potentially at risk	**656**	**22**	**2**

Due to climate change, by 2085 an additional 656 residential properties within the B&NES area may potentially be at risk from surface water flooding. Flood risk to critical infrastructure and emergency responders within the area will also increase with an additional 22 critical infrastructures and two emergency responders at risk from flooding following a 1 in 100 year return period rainfall event.

8 Next Steps - Action Plan

The Action Plan uses all the information collated during the SWMP process, together with information and knowledge held within B&NES Council's Drainage and Flooding Team, to recommend measures to investigate, reduce or mitigate the flood risk in the B&NES area that can be delivered in a phased programme. The actions have been developed according to the flood source (where known).

8.1 Co-ordinating the Action Plan

The Operational Flood Working Group, consisting of B&NES Council, the Environment Agency and Wessex Water, are well placed to lead on the delivery of the SWMP action plan. Each individual Action in the Plan identifies an Action Owner whose responsibility it is to ensure that the Action is undertaken in a timely and cost effective manner. The Action Plan is a 'live' document which is updated by B&NES Council when actions are complete and / or reviewed as and when new or more up to date information becomes available.

8.2 Action criteria

Any actions included on the Plan will have met the following criteria:

- The Action must relate to a specific known flooding problem (unless a Strategic or Operational Action)
- If the flooding source includes an interaction between surface water and fluvial (river) flooding then a single Action Owner must be identified
- The Action must be specific and achievable in terms of resource, practicality and time
- The Action Plan includes two types of Action:
    1. Investigative Actions that will lead to a greater understanding of the flood mechanism.
    2. Works Actions that will directly reduce flood risk at that locality

8.3 Communicating the Action Plan

The action plan has been produced as a table (Appendix D). The details specified are:

- Wet-spot ID: to allow cross reference with the Interactive Map of Local Flood Incidents;
- Location: providing location context;
- Driver: providing justification of the action;
- Action: an outline of the mitigation measure required;
- Implementation Plan: step by step plan of tasks required to complete the action, split into numbered phases (1-4)
- Plan Progress at April 2015: The step on the implementation plan that each action is at, at the time of publication of this report. This column will be updated by B&NES Council as actions progress.
- Action Owner: sets out which partner or stakeholder is responsible for implementing the actions;
- Action Supporter: sets out which partner or stakeholder will support the implementation of the action;
- Indicative Costs: sets out the approximate price band of the action;
- Identifies priorities: sets out what order the actions should be undertaken.

Note: In the context of Action Owner, departments within B&NES Council have been distinguished from one another. The B&NES Council Drainage and Flooding team, who undertake Lead Local Flood Authority duties, have been referred to as LLFA. The Highways department within B&NES Council has been referred to Highways Mtc.

8.3.1 Prioritising the actions

A suitable action has been set for every wet-spot on the B&NES area Interactive Flood Incident Record Maps. However, to enable effective delivery of the action plan, it has been prioritised by considering frequency of flooding and vulnerability of receptors. There are four classifications of action priority: high, medium, low and complete:

- **High**: Recent flood events with a high frequency, affecting a More Vulnerable receptor
- **Medium**: high frequency flooding affecting Less Vulnerable receptors OR lower frequency flooding affecting More Vulnerable receptors
- **Low**: One off flood events affecting Low Vulnerability receptors
- **Complete**: The completed actions had been added to include where work has already been undertaken, to avoid duplicating efforts and track progress.

The vulnerability classifications are based on the definitions within the National Planning Policy Framework Technical Guidance and Planning Policy Statement 25

8.3.2 Indicative costs

Indicative costs have been included to give an approximate, potential cost band for each of the actions. The indicative costs are broad range estimates of how much an action could cost the action owner and are divided into three categories, Low Medium and High where:

- Low: £0 - £5,000
- Medium: £5,001 - £10,000
- High: > £10,001

8.4 Strategic and Operational Action Plan

Strategic and Operational actions have been identified which can be applied in general to address flood risk. These are detailed in Table 8.1 below.

Table 8.1 B&NES Area Generic Action Plan

Ref	Action	Informer	Implementation Plan	Plan Progress at April 2015	Action Owner	Supporter	Priority*	Indicative Cost (£)**
SOAP01	Improve Flood Reporting and Recording. Take key information from callers when they report a flood incident. Information to include; date, location, duration, an idea of the flood source, description of the flood extent and depth.	*There are a number of areas where flooding has been recorded, but there are limited details describing the incidents.*	1. Review the JBA database summarising flooding understand key information 2. Review B&NES Council flood incident reporting system 3. Update reporting system to include prompts for key information. 4. Undergo annual review of flood reporting and update as appropriate	4	LLFA	Highway Mtc Council Connect, EA, WW	High	Low
SOAP02	Consider the impact of development on flood risk at planning stage.	*Development is planned within the B&NES area. Further development could exacerbate the existing surface water problems as the drainage networks receive more flows from areas of hard standing.*	1. Ensure new developments consider all flood risk. Promote SuDS in accordance with the NPPF, the B&NES Council Place Making Plan, West of England SuDS Guidance and other relevant sustainable drainage requirements.	1	LPA	LLFA	High	Medium
			2. Work with developers and Planning departments to implement the most appropriate drainage strategy.	2	LLFA	EA, LPA, WW		

Ref	Action	Informer	Implementation Plan	Plan Progress at April 2015	Action Owner	Supporter	Priority*	Indicative Cost (£)**
SOAP03	Strategic Flood Board	*A strategic Flood Board has been established in line with the responsibilities of the Lead Local Flood Authority.*	1. Schedule regular meetings of the Flood Board	1	LLFA	EA, WW, Highways Mtc. LPA	HIGH	Low
SOAP04	Operational Flood Working Group		1. Schedule regular meetings of the Operational Flood Working Group	1	LLFA	EA, WW, Highways Mtc.	HIGH	
SOAP05	Improve understanding of flood risk assets		1. B&NES Council to produce an updated Flood Risk Asset Register and Record. Iterative process.	1	LLFA	EA, WW, Highways Mtc.	Medium	High
SOAP06	Establish method of identifying critical highway drainage assets, in order to undertake cost-effective targeted maintenance.		1. Investigate highway drainage flooding events to identify the critical assets. 2. Develop a revised maintenance regime for these critical assets; OR Identify assets that require replacement or improvement	1	LLFA	Highways Mtc.	High	Low
SOAP07	Flood and weather warnings		1. Develop a timely and appropriate response to flood and severe weather warnings.	1	LLFA	Highway Mtc.	HIGH	Low

Ref	Action	Informer	Implementation Plan	Plan Progress at April 2015	Action Owner	Supporter	Priority*	Indicative Cost (£)**
SOAP08	Community Engagement		1. Invite Parish's and Federation of Bath Residents Associations (FOBRA) to nominate Local Flood Representatives as a communication channel between the Operational Flood Working Group and communities. Work with Local Flood Representatives	1	LLFA	Parish council network	Medium	Low

LLFA: Bath and North East Somerset Drainage and Flooding team	*EA: Environment Agency*	*WW: Wessex Water*	*Highways Mtc: Bath and North East Somerset Highways*

8.5 Joint Action Plan

Analysis of the information collated for the SWMP has identified a number of 'Wet Spots' where appropriate actions are common to all. These actions have been grouped to form a Joint Action Plan.

There are a total of 42 Joint actions listed on the Action Plan, 13 of these are high priority; 15 are medium priority and 14 are low priority actions.

The full joint Action Plan is shown in Appendix D, Table 8.2 below summarises the high priority Joint Actions.

Table 8-2 Joint Action Plan – Summary of High Priority Actions

Wet –spot ID	Location	Action	Implementation Plan	Implementation Phase Implementation	Action Owner	Supporter	Priority	Indicative cost
DA06A	Publow Lane and Pensford Hill	**Improve highway / land drainage**	1. Monitor 2. Check cyclic maintenance has been carried out 3. Investigate performance of highway / land drainage system, identifying any maintenance or design requirements. 4. Carry out required maintenance OR design and construct engineering scheme 5. Implement continued maintenance programme	2	LLFA	Highways Mtc	Low	High
DA07B	Wells Road, Hallatrow			2	LLFA		Low	
DA07C	Rush Hill, Farrington Gurney			4	LLFA			
DA10C	Durcott Lane, Camerton and Radford			2 and 3	LLFA			
DA10D	Brookside, Paulton			2	LLFA		Low	
DA11A	Hayes Park area, Midsomer Norton			3	LLFA			
DA14A	Vicinity of Crossways, Dunkerton			1	LLFA			
DA11D	Fortescue Road, Radstock Regeneration area				(Radstock Regen)			
DA16B	Charlcombe Lane and Landon Road, Larkhall and Fairfield			1	LLFA			
DA16E	Camden Crescent, Walcot			1	LLFA			
DA16F	Bathwick Street, Bathwick			1	LLFA			
DA16H	Lymore Avenue, South Twerton			1	LLFA			
DA16J	Wellsway, Bloomfield			1	LLFA			

LLFA: Bath and North East Somerset Drainage and Flooding team	*EA: Environment Agency*	*WW: Wessex Water*	*Highways Mtc: Bath and North East Somerset Highways*

8.6 Location specific Action Plan

The location specific Action Plan describes the action plan for specific locations. The full site specific Action Plan is shown in Appendix D. The Action Plan has been divided by those actions which can be undertaken in the short term and those that are recommended for future plans of work, and can be undertaken in the longer term.

There are a total of 21 location specific actions listed on the Action Plan, 17 of these are high priority and 4 are medium priority actions.

Table 8.3 summarises the location specific actions for the B&NES area.

Table 8-3 Location Specific Action Plan

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA02A	Chew Magna	Chew Magna suffers from significant flood risk. The local flood risk mechanisms are integrated with main river flooding. Investment has been made in PLP measures to reduce the damage caused by flooding in this area.	Maintenance of drainage assets to enable effective drainage and source control.	1. Asset inspection: is the gulley or pipework blocked 2. Undertake necessary maintenance 3. Implement a continued asset maintenance programme 4. Implement source control measures to reduce surface water runoff	1	LLFA	Highway Mtc	Medium	High
DA02A	Chew Magna	Chew Magna suffers from significant flood risk. The local flood risk mechanisms are integrated with main river flooding. The Environment Agency has carried out extensive fluvial flood modelling for the catchment.	Use EA modelling to inform potential surface water schemes.	1. Analyse fluvial model in relation to surface water 2. Identify potential schemes to reduce surface water flood risk	1	LLFA	EA, WW	Low	High

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA02D	Chew Stoke	Properties on Wallycourt Road have experienced flooding from pluvial runoff.	Engineering scheme to improve capacity and conveyance route.	1. Implement drainage scheme. 2. Add upgraded highway gullies to Special Attention maintenance list.	2	LLFA	Highway Mtc, EA,	Low	High
DA02D	Chew Stoke	Bilbie Close has experienced flooding from pluvial runoff. Curo (housing association managing properties) has made investment in PLP measures to reduce the damage caused by flooding in this area.	PLP to be installed	1 Curo (housing association) to install PLP for residents	1	Curo	LLFA		
DA03C	West Harptree	West Harptree has experienced flooding as a result of blocked highway gullies.	Maintenance of drainage assets to enable effective drainage.	1. Asset inspection: is the gulley or pipework blocked 2. Undertake necessary maintenance 3. Implement a continued asset maintenance programme	1	LLFA	Highway Mtc	Medium	High

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA03C	West Harptree	West Harptree has experienced flooding as a result of surcharging surface water sewers and gullies.	Undertake scheme to improve capacity and conveyance of drainage system.	1. Engage community on potential scheme(s). 2. Implement drainage scheme. 3. Monitor perform ace of new systems.	1	LLFA	Highway Mtc	High	High
DA03C	Ridge Lane and Cowleaze Lane, West Harptree	West Harptree has experienced flooding as a result of surcharging culverted watercourses and highway drains.	Undertake scheme to improve capacity and conveyance of existing system.	1. Engage the community and inform how they can contribute to managing flood risk 2 Source control measures are required to Ridge Lane and Cowleaze. Lane.	2	LLFA,	Local Flood Reps, WW	Low	High
DA05A	Whitchurch	Development is planned on the fringe of Whitchcurch.	Upgrade surface water sewer system for the area	1. Design a drainage scheme which will work within the current restrictions	1	WW Developer	LLFA, LPA	Low High	High

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA05A	Whitchurch	This area is defined as a Flood Risk area (FAWMA) and Bristol LLFA is taking the lead on the Flood Risk Management Plan.	Any proposed developments must consider the Flood Risk Management Plan for the area.	1. Inform developers of the Flood Risk status	1	LLFA	Bristol City LLFA, LPA	Low	High
DA08B	Keynsham	East Keynsham (A4) has experienced flooding from a number of sources including pluvial runoff and highway gulley blockage.	Monitor future flood incidents in this area, if flooding continues to cause disruption, upgrade works to highway drainage may be required.	1. Monitor flooding at this location 2. Understand the cause of flooding 3. Assess the need for upgrade works to the drainage network	1	LLFA	Highway Mtc,, EA, WW	Low	High
DA10B	Timsbury	Bloomfield Road has experienced surface water flooding, particularly as a result of blocked highway gullies.	Maintenance of drainage assets to enable effective drainage.	1. Asset inspection: is the gulley or pipework blocked 2. Undertake necessary maintenance 3. Implement a continued asset maintenance programme	1	B&NES Council Highways		Medium	High

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA11A	Midsomer Norton	Midsomer Norton has experienced flooding from a number or sources across the town.	Undertake detailed SWMP to understand interactions in the flood mechanisms.	1. Commission detailed SWMP 2. Undertake integrated hydraulic modelling	1	LLFA	Highway Mtc,, EA, WW	High	High
DA16A	Weston and Upper Weston	Significant areas of development are planned on the fringes of Upper Weston and Weston.	Manage the risk of exacerbating an existing surface water problem by considering drainage at master planning stage.	1. Establish the current status of the planning applications 2. Inform the developers of the wetspot status	1	LLFA		Low	High
				3. Design a drainage scheme which will work within the current restrictions		Developer		High	
DA16A	Weston village	This is a steep catchment. There is a potential flood risk stemming from maintenance of a culverted watercourse through village.	Undertake study of flooding issues and identify potential measures.	1. Engage local community 2. Commission study 3. Identify potential improvements 4. Identify funding opportunities	1&2	LLFA	WW, EA,	Medium	High

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA16D	Weston Park	Weston Road has experienced flooding. The sources have not been well documented but includes highway gulley blockage.	Maintenance of drainage assets to enable effective drainage.	1. Asset inspection: is the gulley or pipework blocked 2. Undertake necessary maintenance 3. Implement a continued asset maintenance programme	3	LLFA		Medium	High
DA16G	Bath City Centre	Bath City Centre has experienced flooding. The sources have not been well documented, however likely sources include fluvial, surface water / pluvial, groundwater and highway gulley blockage.	Continue to monitor future flood incidents, if flooding continues to cause disruption, upgrade works to highway drainage may be required.	1. Monitor flooding at this location 2. Understand the cause of flooding 3. Assess the need for upgrade works to the drainage network	1	B&NES Council	B&NES Council Highways, EA, WW	Low	High

Wet-spot ID	Location	Driver	Action	Implementation Plan	Plan Progress at April 2015	Action Owner	Action Supporter	Indicative Cost*	Priority**
DA16G	Lower Bristol Road	Surface water flooding and highway drainage issues known. Significant development and associated river Avon flood risk improvements planned.	Ensure any development/ flood risk scheme appreciates surface water flood risk.	1. Ensure developer is aware of surface water flooding issues (and potential interaction with river Avon).	1	B&NES Council Major projects	EA, LLFA	High	High
DA18A	Batheaston and Bathford	London Road East has experienced fluvial flooding from Main River.	Education of riparian owners on their rights and responsibility.	1. Engage the community and inform how they can contribute to managing flood risk 2. Explain the importance of maintenance to ditches	1	EA	LLFA, Local Flood Reps	Low	High

LLFA: Bath and North East Somerset Drainage and Flooding team	*EA: Environment Agency*	*WW: Wessex Water*	*Highways Mtc: Bath and North East Somerset Highways*

These prioritised actions address a number of flood sources. Many of the prioritised actions address flood incident points with unknown sources. This highlights the importance of better data collection across the B&NES area. Many of the high priority actions address flooding from highway gullies. These can be considered as 'Quick Wins' as asset cleaning of these wet-spot areas can be achieved relatively easily. In addition, another source of flooding identified is flooding from drainage ditches or ordinary watercourses. Often this is due to poor asset condition. As a result, this Action Plan suggests the education of Riparian owners on their rights and responsibility. It is recommended that the Operational Flood Working Group work with Local Flood Representatives to disseminate this information.

8.7 Detailed SWMP

The B&NES area wide SWMP has highlighted a number of drainage areas where more detailed Level 2 SWMPs would provide a better understanding of flood risk. These areas, in order of priority are:

- Midsomer Norton – Further investigations;
- Weston in Bath (Rudmore Lane area) – detailed SWMP.

8.8 Sources of funding

Funding for local flood risk management may come from a wide range of sources. In the B&NES area these may include:

- Defra (Flood Defence Grant in Aid)
- Industrial estate owners and businesses
- B&NES Council (highways)
- Local communities
- New developments (directly through the developer or through CIL)
- Wessex Water
- Local Levy from the RFCC
- Environment Agency where combined sources involved dominated by Main River
- Natural England (catchment sensitive farming grants)

It is likely that in the B&NES area many of the actions will be collaboratively funded by the project partners as multiple benefits could be achieved. Additional funding streams are available when project deliverables include improvements to highways, public open spaces and bio-diversity.

8.9 Ongoing monitoring

The Strategic Flood Board and Operational Flood Working Group partnership arrangements established as part of the LFRMS and SWMP processes will continue beyond the completion of the SWMP in order to discuss the implementation of the proposed actions, review opportunities for operational efficiency and to review any legislative changes.

There may be circumstances which might trigger a review and/or an update of the action plan in the interim, for example:

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

9 Development and Surface Water Management

9.1 Impact of urbanisation

In terms of flood potential, urbanisation is probably the most significant land use change that can be made to a catchment. In recognition of this B&NES Council has provided much of the information in this chapter to highlight the risks and make the linkages to current planning policy.

The development of an urban area, covering the ground with impermeable surfaces can have a significant effect on evaporation / transpiration and surface runoff processes. This has implications for flooding and water quality with consequences including:

- **Increased runoff volume**. Urban surfaces are typically less permeable than rural surfaces, so runoff volumes are greater;
- **Faster runoff**. Urban development includes drainage works (for example, gutters, pipes, sewers and channel improvements) to convey runoff away from the source. Rainfall runs off impermeable surfaces more rapidly and the response is faster to peak. This means that the catchment becomes sensitive to shorter duration storms;
- **Antecedent catchment wetness less influential.** Urban surfaces wet-up more readily than rural surfaces, so pre-storm catchment conditions are less influential.
- **Less recharge.** An increase in impermeable surfaces leads to a reduction in natural groundwater recharge; river base flows are correspondingly reduced.
- **Interaction with soil type.** Urban effects tend to be greater for naturally permeable catchments (which have a low percentage runoff and slow response) than for impermeable catchments (which already have a typically urban high percentage runoff and fast response).
- **Interaction with return period.** Floods of all return periods are, in general, increased. Urban effects tend to be more pronounced in the response to small, short return period storms (which otherwise yielded low percentage runoff and little overland flow). Severe, high return period storms, which already have a typically urban high percentage runoff and increased overland flow, can be expected to produce a response more typical of the original catchment state.
- **Seasonality.** Rural catchments tend to respond to longer duration rainfall events, more often associated with frontal rainfall; these are more prevalent in winter (November to April). Urbanised catchments tend to respond to short duration intense rainfall events, most commonly convective storms; these are more frequent in summer (May to October). Thus, the seasonality of flooding may move from winter to summer.
- **Possible separation effect.** Where urban development is highly localised within the catchment, a separation effect can arise, particularly on naturally permeable catchments. The flood hydrograph then comprises two components: a short-term intense response from the urban area and a longer-term more attenuated response from the rural area. On catchments where a two-part response typically occurs, it may be flood frequency rather than flood magnitude that increases due to urbanisation. The location of settlements with respect to the outfall can have various effects, downplaying or emphasising the separation effect. Urbanisation in upstream areas may result in a rapid urban response which coincides with and reinforces the slower rural response from downstream, so that the effect on flood frequency may be intensified. In contrast, urbanisation in downstream areas may cause the urban response to pass before the slow rural response from upstream arrives, so that the effect on flood frequency may be less extreme. However, observed storms can consist of two or more bursts and, in some instances, the urban response from the downstream areas may reinforce the upstream rural response to an earlier burst.
- **Loss of floodplain storage.** Where urban development encroaches on to the floodplain, possibly associated with levee construction, the available overbank storage is reduced, leading to increased flooding downstream.
- **Impacts on water quality.** The rapid runoff of storm water is likely to cause pollutants and sediments to be washed off the surface or scoured by the river. In an urban area there are likely to be more pollutants on the catchment surface than there would be on the surface of a rural catchment thus increasing the risk.

Impermeable areas are defined as roads, roofs, and hard standing / paving; permeable areas account for everything else (for example, gardens and open spaces). The impacts of urbanisation will not always be the same due to differences in the characteristics (permeability, porosity) of various urban surfaces. Mitigating works such as Sustainable Drainage Systems (SuDS) can be implemented to reduce the impact of urbanisation on surface water flooding and can result in an overall reduction in peak flows in heavily urbanised areas.

One of the objectives for the SWMP is to ensure the level of future development does not exacerbate existing problems and to identify opportunities for new development to provide benefits in terms of flood risk management.

Planners, consultants and developers will need to consider the most appropriate surface water discharge method during the initial site planning process. Early consideration of the proposed drainage strategy is imperative as it will likely determine the site layout and drainage land take requirements.

The Council recognises that one of the greatest challenges for managing flood risk and surface water management is the legacy of drainage networks that struggle to cope with the increase in surface water volumes due to increased urbanisation and climate change. The proper consideration of surface water runoff as part of all developments, and the use of sustainable drainage systems (SuDS), is key to the successful management of both existing and future flood risk.

9.1.1 Identification of potential surface water flood risk

Many potential development sites fall within or are in close proximity to areas at risk of surface water flooding. In light of this it will be essential that site specific Sustainable Drainage Strategies are undertaken for any sites that are within or close to areas at risk of surface water flooding, in order to ensure that each development takes due account of the potential flood risk and the importance of the appropriate surface water management.

The Interactive Flood Incident Maps (Appendix B) and the Environment Agency Flood Map for Surface Water give an indication of the likelihood of surface water flood risk. See Chapters 6 and 7 for more details.

9.1.2 Opportunities to reduce flood risk

Another important aspect for the Council to be aware of is where development sites present opportunities to manage and mitigate local flood risk beyond the proposed development site boundary. Applicants / Developers of the major development sites should always seek to provide betterments on their site and reduce the risk of flooding.

New development should not increase the rate of run off from a site's undeveloped state and redevelopment should reduce run off rates. The topography of a development site should be managed so as not to introduce new flow paths that will increase flood risk.

9.1.3 B&NES Sustainable Drainage Systems Policy and Guidance

The Bath and North East Somerset Placemaking Plan[19] sets out the Development Management Policies to which B&NES will work. The Sustainable Drainage Systems Policy links with the Core Strategy Key Policy CP5 Flood Risk Management and CP7 Green Infrastructure and requires that all sites are expected to incorporate sustainable drainage systems to reduce surface water runoff and minimise its contribution to flooding.

In addition, there are site specific requirements for the Core Strategy Strategic Site allocations and for the site allocations proposed within the Placemaking Plan.

The Placemaking Plan Sustainable Drainage Systems policy is supported by the West of England Sustainable Drainage Developer Guide, which provides standards and guidance for developers, planners, designers and consultants on the requirements for design, approval and adoption of SuDS in the Somerset and the West of England. The guidance provides information on the planning, design and delivery of attractive, high quality and well integrated SuDS

schemes, promotes the need for early consideration of SuDS, and introduces the use of a “proof of concept” process to gain agreement in principle at an early stage from the approving authority.

The aims of the Placemaking Plan Sustainable Drainage System Policy are to:

- Set out the high level principles for drainage designs incorporating SuDS features and the SuDS hierarchy that will be used in B&NES.
- Provide a basis for the incorporation of SuDS in development schemes through the planning system, ensuring that SuDS features are considered at an early stage and incorporated into a scheme design.
- Identify key considerations and requirements for developers which should be addressed via development management.

Table 9.1 Surface water drainage policies and legislation for development

Policy / Legislation
National Planning Policy Framework (NPPF)
Sustainable drainage systems policy: Written statement (HCWS161) 18 December 2014
Bath and North East Somerset Council emerging Placemaking Plan: Policy SU1
Building Regulations Part H (HM Government, 2010)
Bath and North East Somerset Council’s Core Strategy

Table 9.2 Surface water drainage guidance for development

Guidance
Planning Practice Guidance (Department for Communities and Local Government)
Non-Statutory technical standards for sustainable drainage systems (Department for Environment, Food and Rural Affairs, 2015)
West of England Sustainable Drainage Developer Guide (West of England Partnership, 2015)
Environment Agency Local Flood Risk Standing Advice for Bath and North East Somerset (Environment Agency, 2014)

9.1.4 Infiltration Potential maps

The Discharge Hierarchy (see West of England Sustainable Drainage Developer Guide) identifies infiltration as the most sustainable method of surface water drainage and ranks alternative means of disposal in order of sustainability.

Runoff must be discharged in order of priority:

- Into the ground by infiltration
- Into a surface water body such as a river, ditch, pond or stream
- Into a surface water sewer
- Into a combined sewer

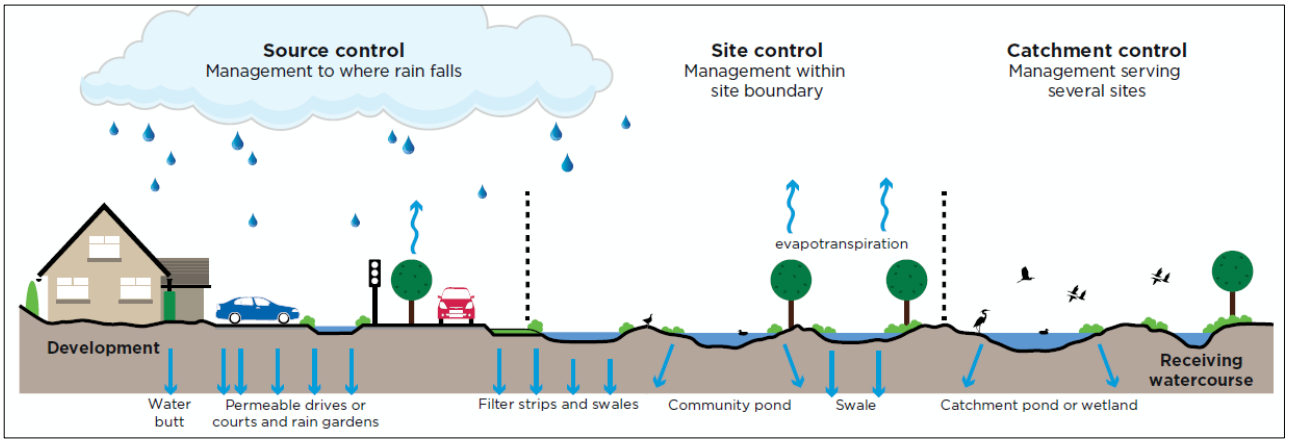

Figure 9.1 The Discharge Hierarchy, taken from the West of England Sustainable Drainage Developer Guide (Section .3)

In order to aid developers in their 'proof of concept' and / or sustainable drainage strategy, this SWMP has produced a series of Infiltration Potential Maps to identify where infiltration needs to be considered, and areas where it need not be considered.

The Infiltration Potential maps use British Geological Survey data to highlight areas that may be suitable for infiltration drainage techniques and recommends the steps that should be taken to confirm site specific infiltration potential.

It must be noted that these maps are provided as a guide only and ultimately site specific infiltration tests and ground investigations will need to be conducted and provided to the Local Planning Authority for review.

In addition to infiltration rates, any proposal to use infiltration drainage must consider a number of other influencing factors, including:

- Depth to water table
- Contaminated material / groundwater protection
- Risk of landslips

This information should be established by way of ground investigations.

9.1.5 How to use the Infiltration Potential maps

The maps are colour coded according to their likely infiltration potential. Depending on what colour band your development site falls into, you will need to either make further investigations or move down the Drainage Hierarchy.

Table 9.3 Decision Matrix for using the Infiltration Potential Maps

Colour band	Infiltration potential	Action
Green	Highly compatible for infiltration SuDS	Infiltration testing required to confirm design parameters.
Orange	Probably compatible for infiltration SuDS	Infiltration testing required. Test results needed to justify any move down the discharge hierarchy
Red	Very significant constraints are indicated	As infiltration SuDS are unlikely to be viable, a move down the Drainage Hierarchy to the next destination would be acceptable without further justification.

Figure 9.2 below shows the Infiltration Potential Map for the entire Bath and North East Somerset area. Appendix F – Infiltration Potential Maps then includes enlarged Infiltration Potential Maps for the different Drainage Areas in Bath and North East Somerset.

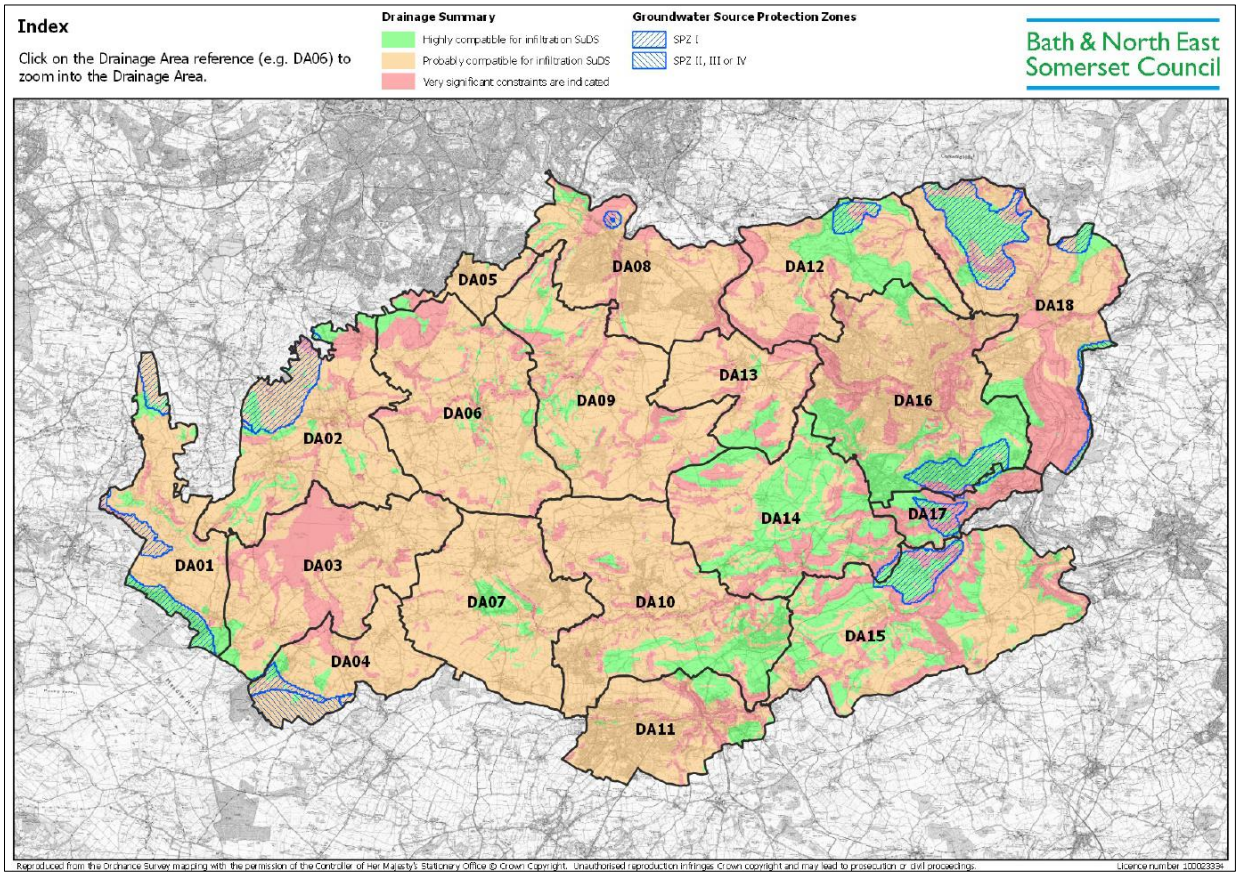

Figure 9.2 Infiltration Potential Overview Map - Supplied by B&NES Council (see Appendix F for Infiltration Maps at a Drainage Area scale)

9.1.6 Groundwater source protection

In addition to the infiltration potential, the Infiltration Potential Maps also include information about Groundwater Source Protection Zones. Groundwater Source Protection Zones identify areas where groundwater is highly sensitive to contamination (commonly because the groundwater is used as a source for drinking water). The Infiltration Potential Maps highlight:

- Groundwater Source Protection Zone I - where there is a 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.
- Groundwater Protection Zones II, III, IV – areas with a longer travel time than in Zone I, or areas identified as a 'zone of special interest'.

More information about Groundwater Protection Zones can be obtained from the Environment Agency.

If a development is likely to interact with a sensitive water body or a Groundwater Source Protection Zone (I, II, III, or IV), a water quality risk assessment will be required to quantify the potential risk. The water quality risk assessment could form part of a wider Water Framework Directive compliance assessment if required at the planning stage.

9.2 Climate Change

The nature of climate change will vary at a regional level. In the UK projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the 2000 floods could be expected. These changes will have implications for surface water flooding.

To help organisations (including local authorities and regional planning bodies) to assess their vulnerability to climate change and plan appropriate adaptation strategies, the Government established the UK Climate Impacts Programme (UKCIP).

Recommended precautionary sensitivity ranges for climate change are provided in the Defra document 'FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts'. Global sea level will continue to rise, depending on greenhouse gas emissions and the sensitivity of the climate system. The relative sea level rise in England also depends on the local vertical movement of the land, which is generally falling in the south-east and rising in the north and the west.

The suggestion is that winters will become wetter over the whole of the UK, by as much as 20% in the 2050s. A shift in the seasonal pattern of rainfall is also expected, with summer and autumn becoming much drier than at present. Snowfall amounts will decrease significantly throughout the UK, but the number of rain-days and the average intensity of rainfall are expected to increase. Although average seasonal wind speeds could increase over most of the country, there is currently much less certainty regarding the potential for greater storminess and the consequences for sea surges or extreme wave activity on coasts.

In making an assessment of the impact of climate change on flooding from the land, rivers and sea as part of a flood risk assessment, the sensitivity ranges in Table 9.4 below should be used to provide an appropriate precautionary response to the uncertainty about climate change impacts on rainfall intensities and river flow.

Table 9.4 sensitivity ranges for climate change

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		

Source: Environment Agency, September 2013, 'Climate change allowances for planners', Table 2.

9.2.1 Urban Creep

Urban creep is the conversion of permeable surfaces to impermeable over time e.g. surfacing of front gardens to provide additional parking spaces, extensions to existing buildings, creation of large patio areas. Much research has been carried out in to the effect of urban creep and its effect on the drainage systems which cater for urban areas. It has been shown that, over the lifetime of a development, urban creep can increase impermeable areas by as much as 10%.

Whilst we have always considered the impermeable areas proposed on new development sites and accounted for climate change we have not, previously, accounted for urban creep. From April 2015 an allowance for urban creep is required as part of the surface water drainage proposals for new developments and redevelopments.

The consideration of urban creep should be assessed on a site by site basis but is limited to residential development only.

The appropriate allowance for urban creep must be included in the design of the drainage system over the lifetime of the proposed development.

The allowances set out below must be applied to the impermeable area within the property curtilage:

Table 9.5 Urban Creep allowances

Residential development density (dwellings per hectare)	Change allowance (% of impermeable area)
≤ 25	10
30	8
35	6
45	4
≥50	2
Flats and apartments	0

Source: West of England Sustainable Drainage Developer Guide, Section 1 p 26.

Where the inclusion of the appropriate allowance would increase the total impermeable area to greater than 100%, 100% should be used as the maximum. “Curtilage” means area of land around a building or group of buildings which is for the private use of the occupants of the buildings.

9.3 Conclusions / Recommendations

Urbanisation and climate change have the potential to significantly impact surface water flood risk within the B&NES area.

Climate change is likely to increase surface water flood risk throughout the B&NES area, particularly in those areas that are already at risk and identified as flooding wet-spots.

Future development also has the potential to increase flood risk. It is therefore important that surface water flood mitigation measures are included in any development plans, following B&NES SuDS policy.

Appropriate development management policies are already in place to minimise the potential impact of urbanisation and climate change and it will be important for these to continue to be implemented for all new developments within the B&NES area.

10 Effects of Interference to Flow from Bridges and Structures

Bridges and structures that are within close proximity to, or cross a watercourse or overland flow route, have the potential to interfere with flows, re-directing flood water and in some cases, particularly where structures become blocked, potentially exacerbating flood risk.

A high level assessment of the effects of interference to surface water flow from bridges and structures owned and operated by B&NES Council has been carried out as part of this study to identify structures that could be having a significant impact on surface water flows and exacerbating flood risk.

Information from the B&NES Council asset register has been collected and analysed to identify potentially critical structures based on the following criteria:

- Flood incidents in proximity to a structure on the B&NES Council Asset Register
- Where properties could be affected in the event of blockage of a structure
- Where climate change results suggest that structure blockage could affect a significant number of properties
- Where properties affected are in an area of high deprivation
- Structures where there is a risk of critical infrastructure being affected in the event of blockage.

10.1 Analysis results

There are a total of 178 structures listed on the B&NES Council asset register, 137 of these are Bridges, 36 are Culverts and 5 are Screens.

10.1.1 Assessment of flood incidents in proximity to a structure on the B&NES Council Asset Register

An analysis of the 178 structures (bridges, culverts and screens) that are listed on the B&NES Council asset register was carried out to determine how many of the structures are within close proximity of a flood incident shown on the Interactive Map of Local Flood Incidents. The results of this analysis are shown in Table 10.1 below.

Table 10.1 Numbers of structures in proximity of a flood incident on the Interactive map of local flood incidents.

Structure Types on the B&NES Council Asset Register	Number of structures within a proximity of a 100m of a flood incident
Bridges	55
Culverts	9
Screens	3

A total of 67 structures - 55 bridges, 9 culverts and 3 screens - are located close to a recorded flood incident and could potentially exacerbate flooding in these areas if the structures became blocked.

10.1.2 Assessment of where properties could be affected in the event of a structure blockage

A further analysis was carried out to establish which of the 67 structures that are located close to a recorded flood incident are also located close to a residential property.

The results of this analysis are shown in Table 10.2 below.

Table 10.2 Number of structures within close proximity to a recorded flood incident AND residential properties.

Structure Types on the B&NES Council Asset Register	Number of structures within 100m of a residential property
Bridges	30
Culverts	4
Screens	2

A total of 36 structures - 30 bridges, 4 culverts and 2 screens - are located within close proximity to residential properties and a recorded flood incident shown on the Interactive Map of Local Flood Incidents. Blockage of these structures has the potential to exacerbate flooding affecting residential properties.

10.1.3 Assessment of where the properties affected are in an area of high deprivation

The Indices of Multiple Deprivation (IMD) are a long standing method used by the government to develop a single understanding of deprivation at a local level by allowing a relative comparison of all areas in England. Deprivation in these terms is used to cover a wide range of issues and looks at unmet needs across a number of issues (or "domains"). The Bath and North East Somerset Council Indices of Deprivation 2010 provides an update to this data for the 2010 indices published in March 2011.

Bath and North East Somerset is one of the least deprived authorities in the country ranking 247 out of 326 English authorities. It is ranked 49 out of 56 unitary authorities. Despite these relatively low levels of deprivation, pockets of high deprivation remain within the area. The areas of "higher" deprivation (most deprived 40%) within the B&NES area are shown in

Figure 10.1 below.

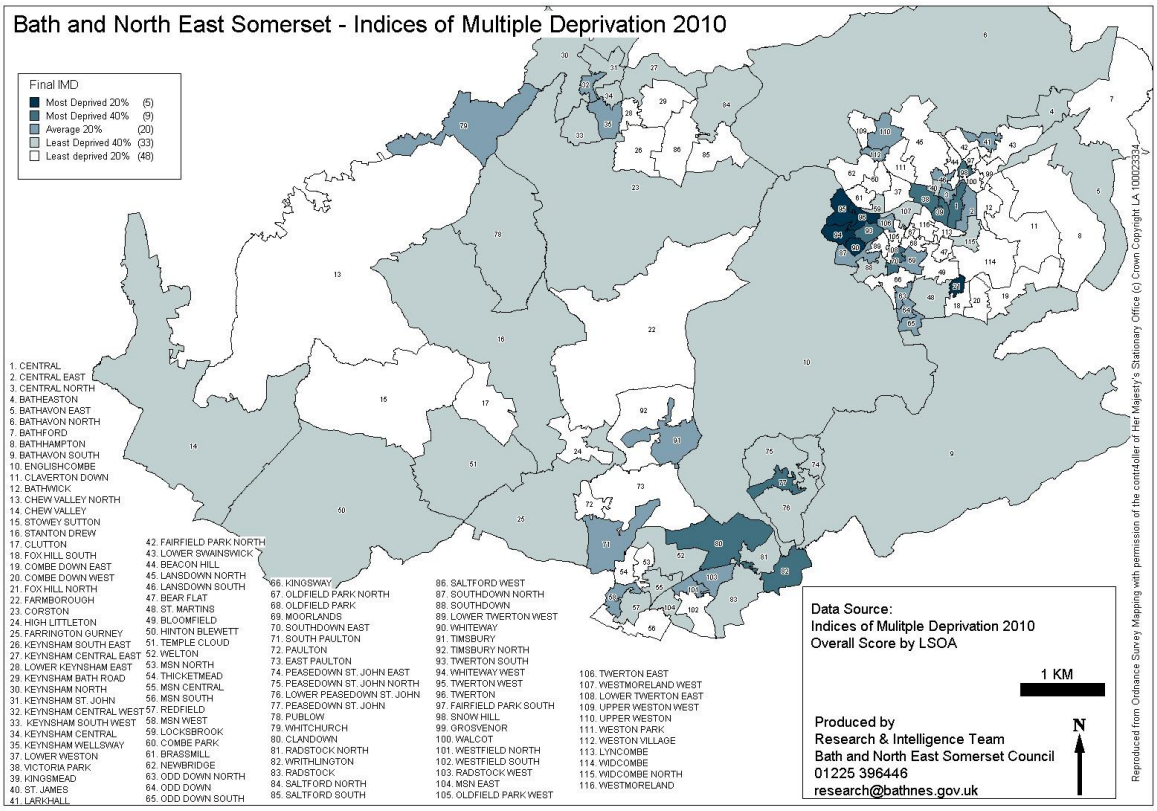

Figure 10.1 Bath and North East Somerset – Indices of Multiple Deprivation.

Five areas are within the most deprived 20% of the country with a further nine within the most deprived 40%.

An analysis was carried out to identify structures on the B&NES Council asset register that are within close proximity of a recorded flood incident, close to a residential property and within an area of deprivation.

The results are summarised in Table 10.1 below.

Table 10.3 Structures that are located within close proximity of a recorded flood incident, close to residential properties AND within an area of deprivation

Structure Types on the B&NES Council Asset Register	Number of structures within 100m of a residential property and in an area of high deprivation
Bridges	7
Culverts	0
Screens	0

There are 7 bridges within close proximity to a recorded flood incident shown on the Interactive Map of Local Flood Incidents, close to residential properties and within an area of deprivation. These structures can be considered critical for maintenance as they have to potential to exacerbate flooding to residential properties in areas of high deprivation should they become blocked.

10.1.4 Assessment of where climate change results suggest that flooding could affect a significant number of properties

The predicted flood outlines from the updated Flood Map for Surface Water with climate change allowance have been used to identify structures that are close to residential properties where flood extents are increased with climate change taken into account.

The results of the analysis are shown in Table 10.4 below.

Table 10.4 Structures which are close to residential properties where flood extents are likely to increase with climate change

Structure Types on the B&NES Council Asset Register	Number of structures within 100m of a residential property affected by climate change
Bridges	7
Culverts	0
Screens	0

There are 7 bridges that are close to residential properties and within an area where climate change is likely to increase flood extents. These structures can be considered critical for maintenance as flood risk is likely to increase in the future and flooding to properties could be exacerbated in the event of structure blockage.

10.1.5 Assessment of structures where Critical Infrastructure could be affected by structure blockage

Items which are classified as "Critical Infrastructure" within the National Receptor Database are listed in Table 7.1 and include Schools, Hospitals, Power Stations, Electrical sub-stations and Sewage and Water Treatment Works.

An analysis was carried out to identify bridges, culverts and screens on the B&NES Council asset register that are close to critical infrastructure. The results of the analysis are shown in Table 10.5 below.

Table 10.5 Structures close to Critical Infrastructure

Structure Types on the B&NES Council Asset Register	Number of structures within 100m of critical infrastructure
Bridges	20
Culverts	2
Screens	2

24 structures - 20 Bridges, 2 culverts and 2 screens - are located close to critical infrastructure. These structures can be considered critical in terms of their requirement for regular maintenance as they have the potential to exacerbate flood risk to critical infrastructure in the event of structure blockage.

10.2 Critical structures

Based on the analysis results, a total of 27 structures (2 screens, 2 culverts and 23 bridges) have been identified as potentially critical in terms of their requirement for regular maintenance. Due to the location of these structures, close to a recorded flood incident, close to residential properties and in areas of deprivation, close to residential properties in areas affected by climate change, or close to critical infrastructure, these structures have the potential to cause significant flooding if they become blocked. These structures should therefore be prioritised for maintenance to ensure that, as far as possible, they remain clear of blockages. Some of the structures are critical for more than one of the criteria analysed.

The potentially critical structures are summarised in Figure 10.2and Table 10.6 below.

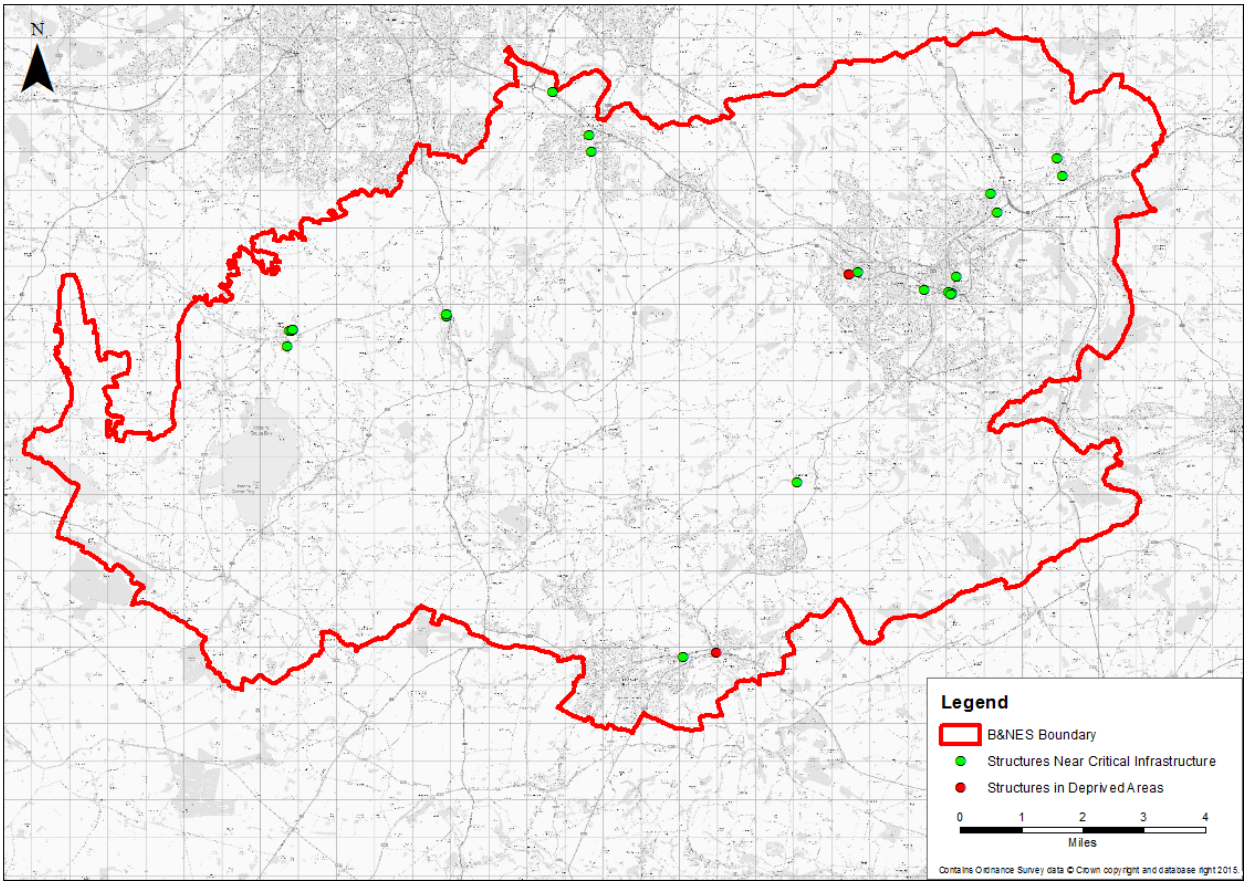

Figure 10.2 Structures near Critical Infrastructure and in Deprived Areas

Table 10.6 Structures that could be considered critical for maintenance to avoid blockage

Criteria	Easting	Northing	Asset Register ID	Name	Owner	Type	Associated Watercourse / Road
Potential to exacerbate flooding to properties in areas of deprivation *and* to critical infrastructure	372444	164802	76087	Connection Road (Railway) Bridge	Railtrack	Bridge	Connection Road
Potential to exacerbate critical flooding infrastructure *and* with climate change	357759	163320	56021	Gasworks (Silver Street) Bridge	B&NES Council	Bridge	Winford Brook
	357824	163325	56067	The Batch Footbridge	B&NES Council	Bridge	Stream
	357846	163369	56123	School Lane Footbridge	B&NES Council	Bridge	Stream
	378056	167402	76006	Stambridge Bridge	B&NES Council	Bridge	St. Catherine's Brook
	376165	166913	76114	Brooklyn Road Bridge	B&NES Council	Bridge	Lam Brook
Potential to exacerbate flooding to properties in areas of deprivation	368975	154883	65091	Radstock Co-op Bakery Bridge	Radstock Co-operative	Bridge	Wellow Brook
Potential to exacerbate flooding to critical infrastructure	368101	154755	-	Welton Road	B&NES Council	Screen	-
	357748	163441	23	Chew Magna	B&NES Council	Screen	-
	377917	167866	76058	School Lane Culvert	B&NES Council	Culvert	St Catherine's Brook
	361882	163711	66048	Side Stream (Salters Brook Culvert)	B&NES Council	Culvert	Salters Brook
	375274	164742	76161	Terrace Walk / Parade Gardens	B&NES Council	Bridge	-
	357694	162912	56043	Tun Bridge	B&NES Council	Bridge	River Chew
	375156	164304	76182	Skew Rail Bridge	Railtrack	Bridge	River Avon and Footpath
	375067	164332	76071	Churchill (Avon Services) Footbridge	B&NES Council	Bridge	River Avon
	374435	164398	76096	Lower Oldfield Park Rail Bridge	Railtrack	Bridge	Lower Oldfield Park

	376343	166435	76005	Lambridge Bridge	B&NES Council	Bridge	Lam Brook
	375104	164276	76072	Claverton Street Subway	B&NES Council	Bridge	Footway
	372687	164869	76048	Weston Cut (Canal) Footbridge	British Waterways	Bridge	Weston Cut
	371080	159346	75004	Dunkerton Chruch Bridge	B&NES Council	Bridge	Cam Brook
	365696	168031	66060	Cooks (Steel Mill) Bridge	B&NES Council	Bridge	River Chew
	365637	168459	66029	Chew Bridge (Keynsham)	B&NES Council	Bridge	River Chew
	361868	163718	66047	Pensford Old Bridge	B&NES Council	Bridge	River Chew
	361869	163765	66016	Pensford New Bridge	B&NES Council	Bridge	River Chew
	364681	169592	66109	Durley Lane Railway Bridge	Railtrack	Bridge	Durley Lane
Potential to exacerbate with climate flooding change	373554	165064	0	Windsor Footbridge	B&NES Council	Bridge	River Avon
	373568	165067	76043	Windsor Road Bridge	B&NES Council	Bridge	River Avon

It should be noted that these results are based on a very broad scale, high level analysis and that further more detailed assessments should be carried out in order to establish the actual impact of structure blockage. There are various methods available for the purpose depending on the level of detail of existing information.

11 References

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Appendix A - Data Register and Quality Score

Appendix B – Interactive Map of Local Flood Incidents

Appendix C – Local Flood Incident Table

Appendix D - Action Plan

Appendix E – Flood Incident Data Collection Fields

Appendix F – Infiltration Potential Maps

Offices at

Coleshill
Doncaster
Edinburgh
Exeter
Haywards Heath
Limerick
Newcastle upon Tyne
Newport
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
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