Colchester Town
Surface Water Management Plan

Final Draft Report
July 2013

Prepared for

Essex County Council

Colchester

Revision Schedule

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RELATED DOCUMENTS

Doc Ref	Document Title	Author	Date of Issue	Version
-	Essex Preliminary Flood Risk Assessment	Scott Wilson / URS	2011	02
	Mid Essex Strategic Flood Risk Assessment – Appendix C Colchester Subsidiary Report	Scott Wilson	2008	04
	North Essex Catchment Flood Management Plan	Environment Agency	2008	11

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- Environment Agency;
- Anglian Water;
- British Geological Survey;
- Essex Highways; and
- Essex County Council.

Executive Summary

This document forms the Surface Water Management Plan (SWMP) for the town of Colchester, Essex. The report outlines the predicted risk and preferred surface water management strategy for Colchester. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall.

A four phase approach has been undertaken in line with Defra's SWMP technical guidance documentation (2010). These are:

Phase 1 – Preparation;
Phase 2 – Risk Assessment;
Phase 3 – Options; and
Phase 4 – Implementation and Review.

Phase 1: Preparation

Phase 1 work involved the collection and review of surface water information from key stakeholders and the building of partnerships between key stakeholders responsible for local flood risk management.

Phase 2: Risk Assessment

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

Within the study area, nine (9) CDAs have been identified and are presented in the figure below. The dominant mechanisms for flooding can be broadly divided into the following categories:

- Watercourse valleys (current and historical) - Across the study area, the areas particularly susceptible to overland flow are formed by narrow corridors associated with topographical valleys which represent the routes of 'lost' rivers;
- Topographical low lying areas - are more susceptible to surface water flooding particularly where downstream obstructions impeded flow;
- Road and rail embankments - discrete surface water flooding locations along the upstream side of the raised road and rail embankments;
- Topographical low points – areas which are at topographical low points throughout the town which result in small, discrete areas of deep surface water ponding;
- Sewer flood risk – areas where extensive and deep surface water flooding is likely to be the influence of sewer flooding mechanisms alongside pluvial and groundwater sources; and
- Fluvial / tidal flood risk - areas where extensive and deep surface water flooding is likely to be the influence of fluvial and tidal flooding mechanisms (alongside pluvial, groundwater and sewer flooding sources).

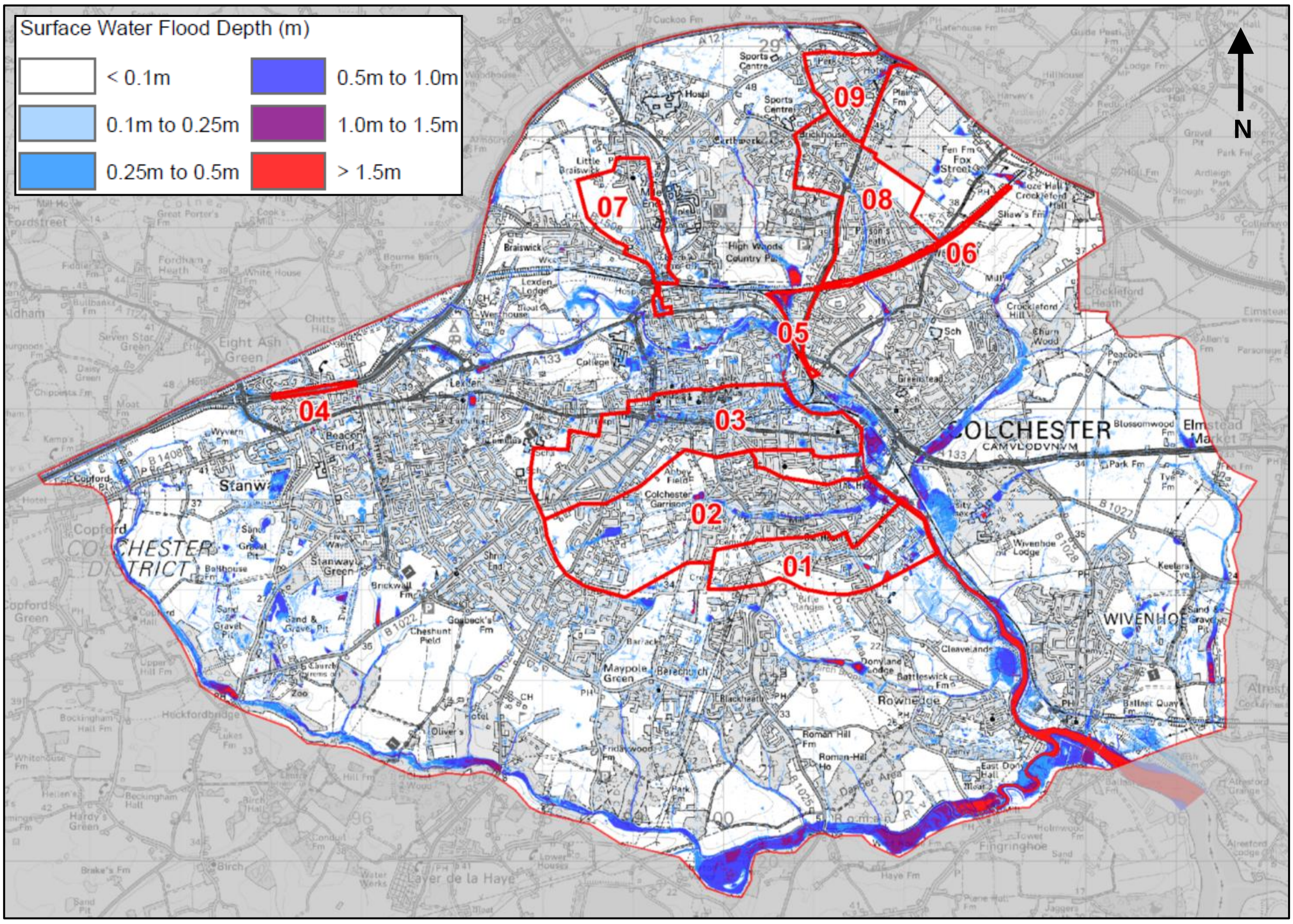

Figure i: Critical Drainage Areas with Predicted 1 in 100 year Surface Water Flood Event Depths

Analysis of the number of properties at risk of flooding has been undertaken for the rainfall event with a 1 in 100 probability of occurrence in any given year. A review of the results predicts that over 3,000 properties in the study area could be at risk of surface water flooding of a depth greater than 0.1m during a 100 year rainfall event (above an assumed 0.1m building threshold), refer to Table i below.

Table i. Predicted Flooded Properties Summary – 1 in 100 Year Flood Event. Depths > 0.1m

Administration Boundary	Infrastructure	Households		Commercial / Industrial	Other (Unclassified Landuse)	Total
		Non-Deprived	Deprived			
Colchester	18	2,203	15	281	782	**3,299**

Phase 3: Options Assessment

There are a number of opportunities for measures to be implemented across the catchment to reduce the impact of surface water flooding. Ongoing maintenance of the drainage network and small scale improvements are already undertaken as part of normal operation within the study area.

It is important to recognise that flooding within the catchment is not confined to just the CDAs, and therefore, there are opportunities for generic measures to be implemented through the establishment of a policy position on issues including the widespread use of water conservation measures such as water butts and rainwater harvesting technology, use of swales, permeable paving, bioretention car park pods and green roofs. In addition, there are study area wide opportunities to raise community awareness.

For each of the CDAs identified within the study area, site-specific measures have been identified that could be considered to help reduce the risk of surface water flooding. These measures were subsequently short listed to identify a potential preferred option for each CDA.

Pluvial modelling undertaken as part of the SWMP has identified that flooding is heavily influenced by existing and historic watercourse valleys, and impacts a number of regionally important infrastructure assets. It is recommended that in the short to medium term CBC and ECC:

- Engage with residents regarding the flood risk in their areas, to make them aware of their responsibilities for property drainage (especially in the CDAs) and steps that can be taken to improve flood resilience;
- Provide information to residents, to inform them of measures that can be taken to mitigate surface water flooding to/around their property;
- Prepare and implement a communication strategy to effectively communicate and raise awareness of surface water flood risk to different audiences using a clearly defined process for internal and external communication with stakeholders and the public; and
- Improve maintenance regimes to target those areas identified to regularly flood or known to have blocked gullies / culverts / watercourses.

Phase 4 Implementation & Review

Phase 4 establishes a long-term Action Plan for ECC and other Risk Management Authorities to assist in their roles under the Flood and Water Management Act 2010 (FWMA 2010) to lead in the management of surface water flood risk across the catchment. The purpose of the Action Plan is to:

- Outline the actions required to implement the preferred options identified in Phase 3;
- Identify the partners or stakeholders responsible for implementing the action;
- Provide an indication of the priority of the actions and a timescale for delivery; and
- Outline actions required to meet the requirements of ECC and other Risk Management Authoritiesunder the FWMA 2010.

The SWMP Action Plan is a 'living' document, and as such, should be reviewed and updated regularly, particularly following the occurrence of a surface water flood event, when additional data or modelling becomes available, following the outcome of investment decisions by partners and following any additional major development or changes in the catchment which may influence the surface water flood risk within the town.

Glossary

Term	Definition
AEP	Annual Exceedance Probability (represented as a %)
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
AMP	Asset Management Plan, see below
Anglian Water	The Water Authority for this area.
Asset Management Plan	A plan for managing water and sewerage company (WaSC) infrastructure and other assets in order to deliver an agreed standard of service.
AStGWF	Areas Susceptible to GroundWater Flooding. A national data set held by the Environment Agency identifying the risk of groundwater emergence within an area.
AStSWF	Areas Susceptible to Surface Water Flooding. A national data set held by the Environment Agency and based on high level modelling which shows areas potentially at risk of surface water flooding.
Bank Full	The flow stage of a watercourse in which the stream completely fills its channel and the elevation of the water surface coincides with the top of the watercourses banks.
Catchment Flood Management Plan (CFMP)	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CBC	Colchester Borough Council.
CDA	Critical Drainage Area, see below.
Critical Drainage Area	A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan, see entry above
CIRIA	Construction Industry Research and Information Association
Civil Contingencies Act	This UK Parliamentary Act delivers a single framework for civil protection in the UK. As part of the Act, Local Resilience Forums have a duty to put into place emergency plans for a range of circumstances including flooding.
CLG	Government Department for Communities and Local Government
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions.
Culvert	A channel or pipe that carries water below the level of the ground.
Defra	Government Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model: a topographic model consisting of terrain elevations for ground positions at regularly spaced horizontal intervals. DEM is often used as a global term to describe DSMs (Digital Surface Model) and DTMs (Digital Terrain Models).
Dendritic	Irregular stream branching, with tributaries joining the main stream at all angles. e.g. drainage networks converge into larger trunk sewers and finally one outfall.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DSM	Digital Surface Model: a topographic model of the bare earth/underlying terrain of the earth's surface including objects such as vegetation and buildings.
DTM	Digital Terrain Model: a topographic model of the bare earth/underlying terrain of the earth's surface excluding objects such as vegetation and buildings. DTMs are usually derived from DSMs.

Term	Definition
EA	Environment Agency, Government Agency reporting to Defra charged with protecting the Environment and managing flood risk in England.
ECC	Essex County Council. The Lead Local Flood Authority in the area.
FCERM	Flood and Coastal Erosion Risk Management Strategy. Prepared by the Environment Agency in partnership with Defra. The strategy is required under the Flood and Water Management Act 2010 and will describe what needs to be done by all involved in flood and coastal risk management to reduce the risk of flooding and coastal erosion, and to manage its consequences.
Flood defence	Infrastructure used to protect an area against floods such as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	See entry under Indicative Flood Risk Areas.
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Flood and Water Management Act	An Act of Parliament which forms part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England. The Act was passed in 2010 and is currently being enacted.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a watercourse (river or stream). In this report the term Fluvial Flooding generally refers to flooding from Main Rivers (see later definition).
FMfSW	Flood Map for Surface Water. A national data set held by the Environment Agency showing areas where surface water would be expected to flow or pond, as a result of two different chances of rainfall event, the 1 in 30yr and 1 in 200yr events.
FRR	Flood Risk Regulations, see above.
Hyetograph	A graphical representation of the variation of rainfall depth or intensity with time.
IDB	Internal Drainage Board, see below.
Internal Drainage Boards	Internal Drainage Board. An independent body with powers and duties for land drainage and flood control within a specific geographical area, usually an area reliant on active pumping of water for its drainage.
Indicative Flood Risk Areas	Areas determined by the Environment Agency as potentially having a significant flood risk, based on guidance published by Defra and WAG and the use of certain national datasets. These indicative areas are intended to provide a starting point for the determination of Flood Risk Areas by LLFAs.
IUD	Integrated Urban Drainage, a concept which aims to integrate different methods and techniques, including sustainable drainage, to effectively manage surface water within the urban environment.
LDF	Local Development Framework is the spatial planning strategy introduced in England and Wales by the Planning and Compulsory Purchase Act 2004 and given detail in Planning Policy Statements 12. These documents typically set out a framework for future development and redevelopment within a local planning authority.
Lead Local Flood Authority	Local Authority responsible for taking the lead on local flood risk management. The duties of LLFAs are set out in the Floods and Water Management Act.
LFRZ	Local Flood Risk Zone, see below.
Local Flood Risk Zone	Local Flood Risk Zones are defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location

Term	Definition
LiDAR	Light Detection and Ranging, a technique to measure ground and building levels remotely from the air, LiDAR data is used to develop DTMs and DEMs (see definitions above).
LLFA	Lead Local Flood Authority, see above.
Local Resilience Forum	A multi-agency forum, bringing together all the organisations that have a duty to cooperate under the Civil Contingencies Act, and those involved in responding to emergencies. They prepare emergency plans in a co-ordinated manner and respond in an emergency. Roles and Responsibilities are defined under the Civil Contingencies Act.
LPA	Local Planning Authority, see below.
Local Planning Authority	The local authority or Council that is empowered by law to exercise planning functions for a particular area. This is typically the local borough or district Council.
LRF	Local Resilience Forum, see above.
Main River	Main rivers are a statutory type of watercourse in England and Wales, usually larger streams and rivers, but also include some smaller watercourses. A main river is defined as a watercourse marked as such on a main river map, and can include any structure or appliance for controlling or regulating the flow of water in, into or out of a main river. The Environment Agency's powers to carry out flood defence works apply to main rivers only.
NPPF	National Planning Policy Framework (replaces PPS25)
NRD	National Receptor Dataset – a collection of risk receptors produced by the Environment Agency. A receptor could include essential infrastructure such as power infrastructure and vulnerable property such as schools and health clinics.
Ordinary Watercourse	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, IDBs are termed Ordinary Watercourses.
PA	Policy Area, see below.
Partner	A person or organisation with responsibility for the decision or actions that need to be taken.
PFRA	Preliminary Flood Risk Assessment, see below.
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial Flooding	Flooding from water flowing over the surface of the ground; often occurs when the soil is saturated and natural drainage channels or artificial drainage systems have insufficient capacity to cope with additional flow.
Policy Area	One or more Critical Drainage Areas linked together to provide a planning policy tool for the end users. Primarily defined on a hydrological basis, but can also accommodate geological concerns where these significantly influence the implementation of SuDS
NPPF	National Planning Policy Framework
Preliminary Flood Risk Assessment	Assessment required by the EU Floods Directive which summarises flood risk in a geographical area. Led by LLFAs.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Return Period	The return period is defined as the average period of time expected to elapse between occurrences of events at a certain location.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, combined with the consequence of the flood.

Term	Definition
Risk Management Authority	As defined by the Floods and Water Management Act. These can be (a) the Environment Agency, (b) a lead local flood authority, (c) a district council for an area for which there is no unitary authority, (d) an internal drainage board, (e) a water company, and (f) a highway authority.
RMA	Risk Management Authority, see above
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment, see below
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
Strategic Flood Risk Assessment	SFRAs (SFCAs in Wales) are prepared by local planning authorities (in consultation with the Environment Agency) to help guide local planning. They allow them to understand the local risk of flooding from all sources (including surface water and groundwater). They include analysis and maps of the impact of climate change on the extent of future floods. You can find these documents on the website of your local planning authority.
SuDS	Sustainable Drainage Systems, see below.
Sustainable Drainage Systems	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques. Includes swales, wetlands, bioretention devices and ponds.
Surface water runoff	Rainwater (including snow and other precipitation) which is on the surface of the ground (whether or not it is moving), and has not entered a watercourse, drainage system or public sewer.
SWMP	Surface Water Management Plan
UKCIP	The UK Climate Impacts Programme. Established in 1997 to assist in the co-ordination of research into the impacts of climate change. UKCIP publishes climate change information on behalf of the UK Government and is largely funded by Defra.
WaSC	Water and Sewerage Company
Water Cycle Strategy / Study	A method for determining what sustainable water infrastructure is required and where and when it is needed; based on a risk based approach ensuring that town and country planning makes best use of environmental capacity and opportunities, and adapts to environmental constraints.
WCS	Water Cycle Strategy or Study (see above)

Abbreviations

Term	Definition
AEP	Annual Exceedance Probability
AMP	Asset Management Plan
AStGWF	Areas Susceptible to Ground Water Flooding
AStSWF	Areas Susceptible to Surface Water Flooding
BGS	British Geological Survey
CBC	Colchester Borough Council
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
CLG	Government Department for Communities and Local Government
Defra	Department for Environment, Food and Rural Affairs
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EA	Environment Agency
ECC	Essex County Council
FGS	Flood Guidance Statement
FMfSW	Flood Map for Surface Water
FRR	Flood Risk Regulations
FWMA	Flood and Water Management Act 2010
IUD	Integrated Urban Drainage
JCS	Joint Core Strategy
LDF	Local Development Framework
LFRZ	Local Flood Risk Zone
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
NPPF	National Planning Policy Framework
NRD	National Receptor Dataset
PFRA	Preliminary Flood Risk Assessment
NPPF	National Planning Policy Framework
RMA	Risk Management Authority (as defined by the Flood and Water Management Act)
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

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1 Introduction

Capita Symonds have been commissioned by Essex County Council and Colchester Borough Council (hereinafter referred to as ECC and CBC) to prepare a Surface Water Management Plan (SWMP) which covers Phases 1, 2, 3 and 4 of the Defra guidance for the town of Colchester (within the Colchester Borough Council administrative area).

1.1 What is a Surface Water Management Plan?

A Surface Water Management Plan (SWMP) is a plan produced by the Lead Local Flood Authority (LLFA), Essex County Council, which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall.

This SWMP study has been undertaken in partnership with key local stakeholders who are responsible for surface water management and drainage in the Colchester town area – including Anglian Water and the Environment Agency. The Partners have worked together to understand the causes and effects of surface water flooding and agree the most cost effective way of managing surface water flood risk for the long term.

This document also establishes a long-term action plan to manage surface water and will influence future capital investment, maintenance, public engagement and understanding, land-use planning, emergency planning and future developments

1.2 Background

Defra's National Rank Order of Settlements Susceptible to Surface Water Flooding (Defra, 2009) indicates that the Colchester area is vulnerable to surface water flooding and is ranked 134th out of 4,215 settlements in England, with an estimated 2,500 properties at risk of flooding.

Essex County Council's Preliminary Flood Risk Assessment (PFRA) indicates that the Colchester Borough Council region is responsible for providing 4% of the recorded flood event data for the county, although differences between different council authorities in recording and storing flood event data mean this cannot be taken as a reliable representation of the range in frequency or severity of flood risk within the county. In addition, there is anecdotal evidence to suggest that surface water flooding within Colchester is exacerbated during high tidal cycles when gravity drains and outfalls are blocked by high tidal waters. The tidal limit within Colchester is at the East Mill Sluice located towards the east of the town.

As part of the duties created by the Flood and Water Management Act 2010, local authorities are responsible for the management of local flood risk – including surface water and groundwater. As it has been previously identified that the Colchester area is susceptible to surface water flooding, this SWMP will provide a basis for more effective management of surface water within it and the risk of flooding from it.

1.3 SWMP Process

The Defra SWMP Technical Guidance (2010) provides the framework for preparing SWMPs. This report has been prepared to reflect the four principal stages identified by the guidance (refer overleaf):

1. Preparation: Identify the need for a SWMP, establish a partnership with the relevant stakeholders and scope SWMP (refer to Section 2);

2. Risk Assessment: Select an appropriate level risk assessment and complete it – a Level 2 Intermediate assessment was selected for this study (refer to Sections 3 and 4);

3. Options: Identify options/measures (with stakeholder engagement) which seek to alleviate the surface water flood risk within the study area (refer to Section 5); and

4. Implementation and Review: Prepare Action Plan and implement the monitoring and review process for these actions (refer to Section 8).

The scope of this study includes elements of all phases of the process. These phases and their key components are illustrated in Figure 1-1 and summarised in Figure 1-2.

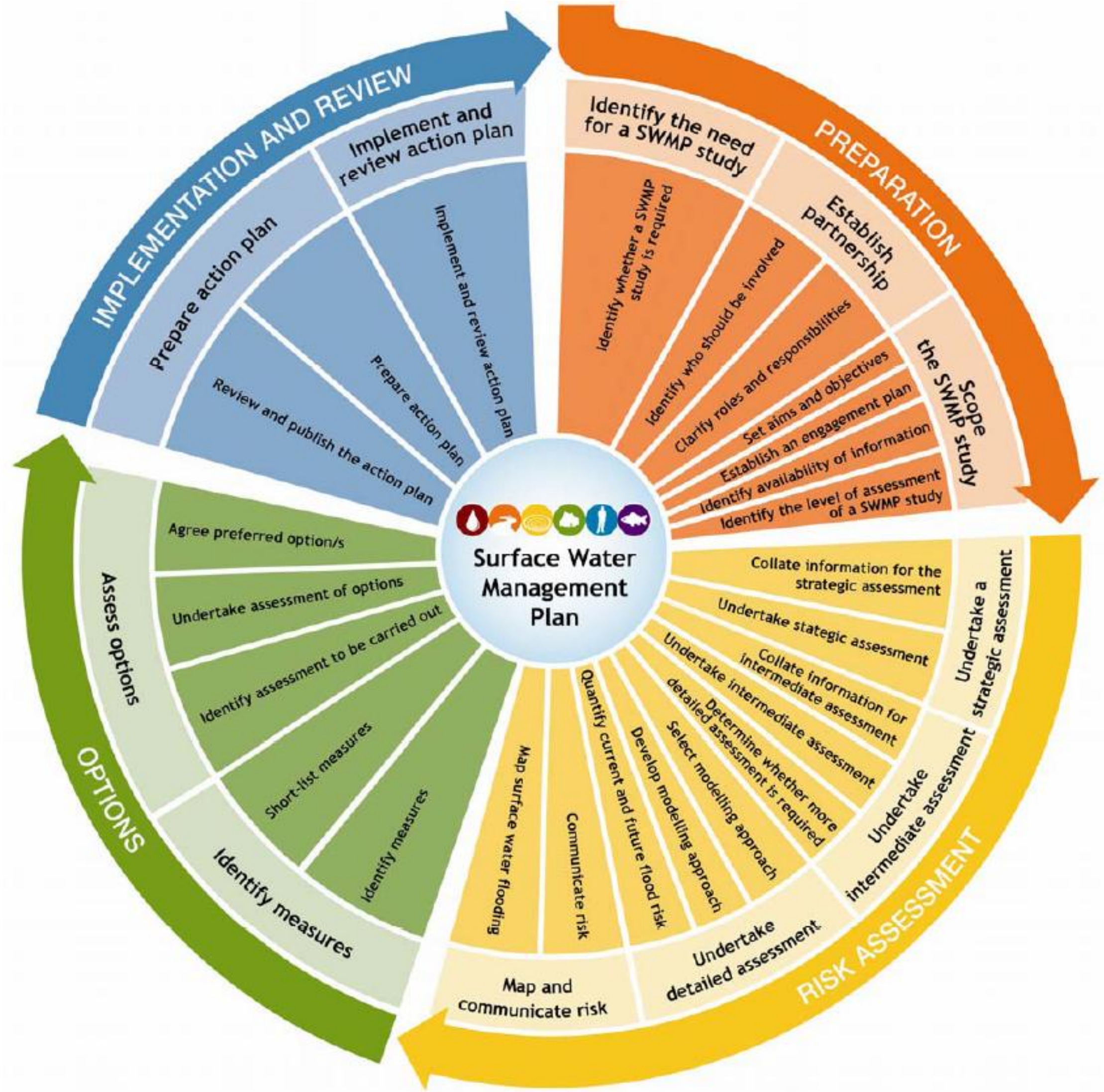


Figure 1-1 Recommended Defra SWMP Process (Source Defra 2010)

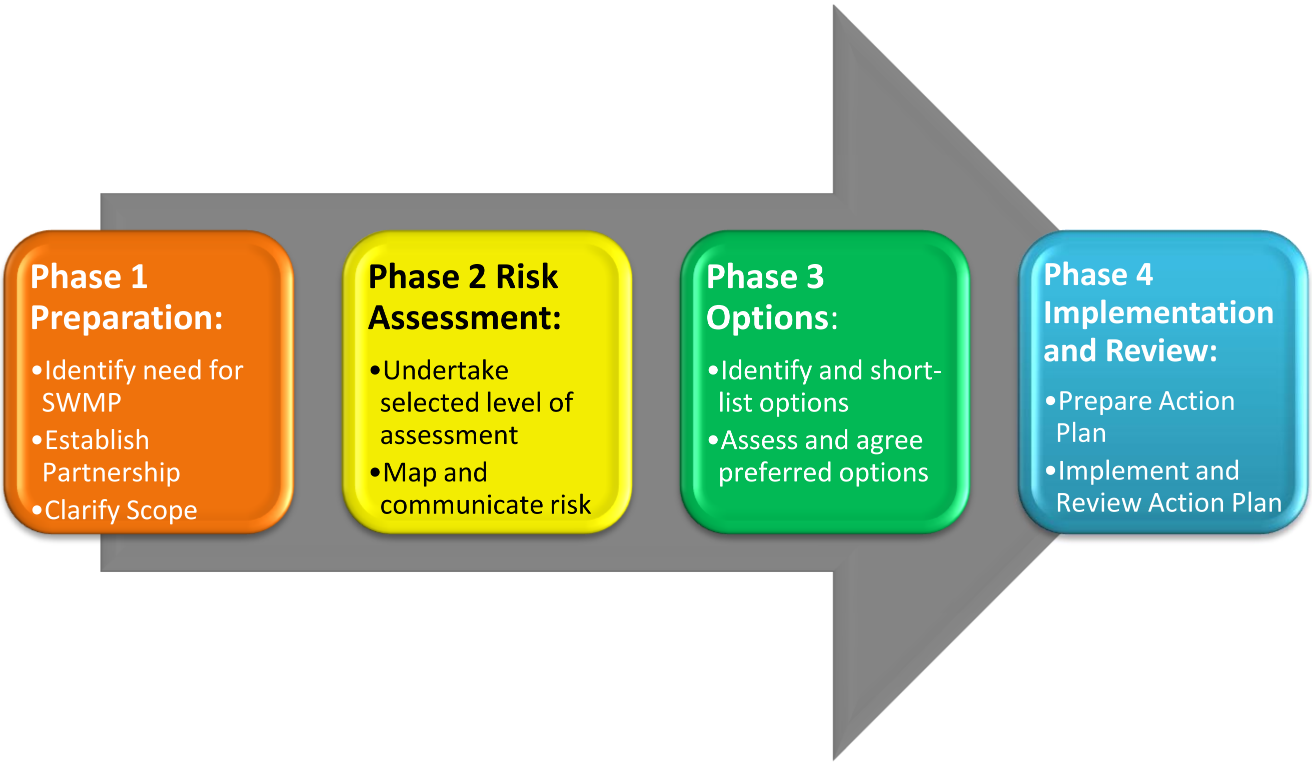


Figure 1-2 Summary of the Defra SWMP Phases

1.4 Objectives

The objectives of the SWMP are to:

- Develop a thorough understanding of surface water flood risk in and around the study area, taking into account the implications of climate change, population and demographic change and increasing urbanisation in and around Colchester town;
- Identify, define and prioritise Critical Drainage Areas, including further definition of existing local flood risk zones and mapping new areas of potential flood risk;
- Make recommendations for holistic and integrated management of surface water management which improve emergency and land use planning, and support better flood risk and drainage infrastructure investments;
- Establish and consolidate partnerships between key stakeholders to facilitate a collaborative culture, promoting openness and sharing of data, skills, resource and learning, and encouraging improved coordination and collaborative working;
- Engage with stakeholders to raise awareness of surface water flooding, identify flood risks and assets, and agree mitigation measures and actions; and
- Deliver outputs to enable practical improvements or change where partners and stakeholders take ownership of their flood risk and commit to delivering and maintaining the recommended measures and actions.

1.5 Study Area

The borough of Colchester is located within the County of Essex and covers an area of over 333km^2. Colchester Borough Council (CBC) is a second tier local authority in which Essex County Council (ECC) are the upper tier local authority and responsible for delivering the Lead Local Flood Authority (LLFA) requirements of the FWMA in the Colchester area. The spatial extent of the study area within this SWMP is approximately 88km^2, and is illustrated in Figure 1-3, below.

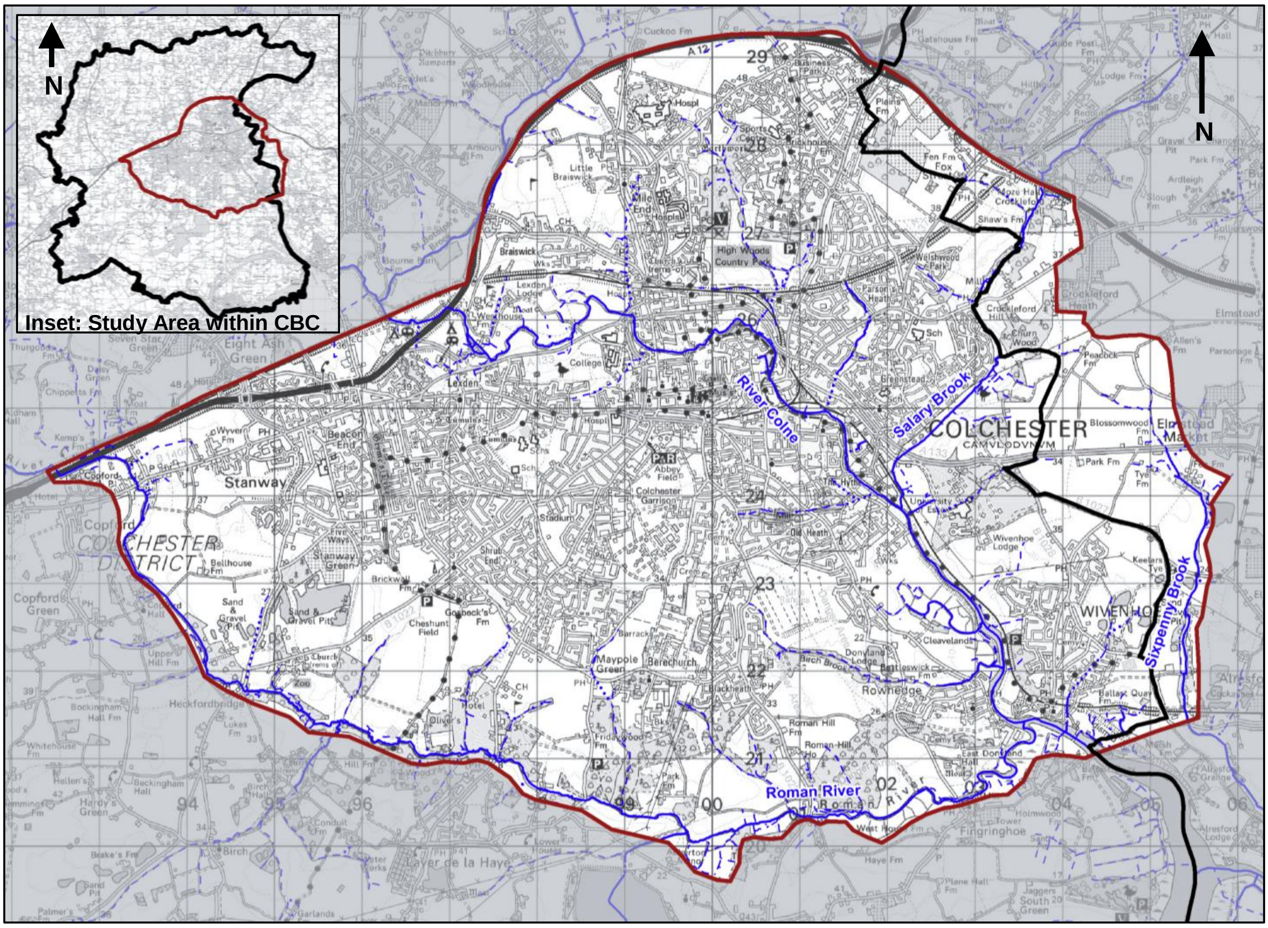


Figure 1-3 Colchester Town Study Area

1.5.1 Location and Characteristics

The study area comprises the town of Colchester and the surrounding settlements of Wivenhoe, Stanway, Beacon End and Lexden. The River Colne dominates the catchment, running from the north-west to the south-east, while the Roman River forms the southern study area boundary, before joining the Colne at Wivenhoe. The Colne is influenced by tidal fluctuations within the study area.

The Blackwater Estuary, to the south-east of the study area, is prominent in the region and features various coastal and estuary conservation designations. The nearby coastline features the Dengie and Bradwell Marshes, fronted by salt marsh and tidal mudflats.

Figure 1-4 (and Figures 2.0 – 2.5, within Appendix C), overleaf, provides an overview of the land uses within the study area.

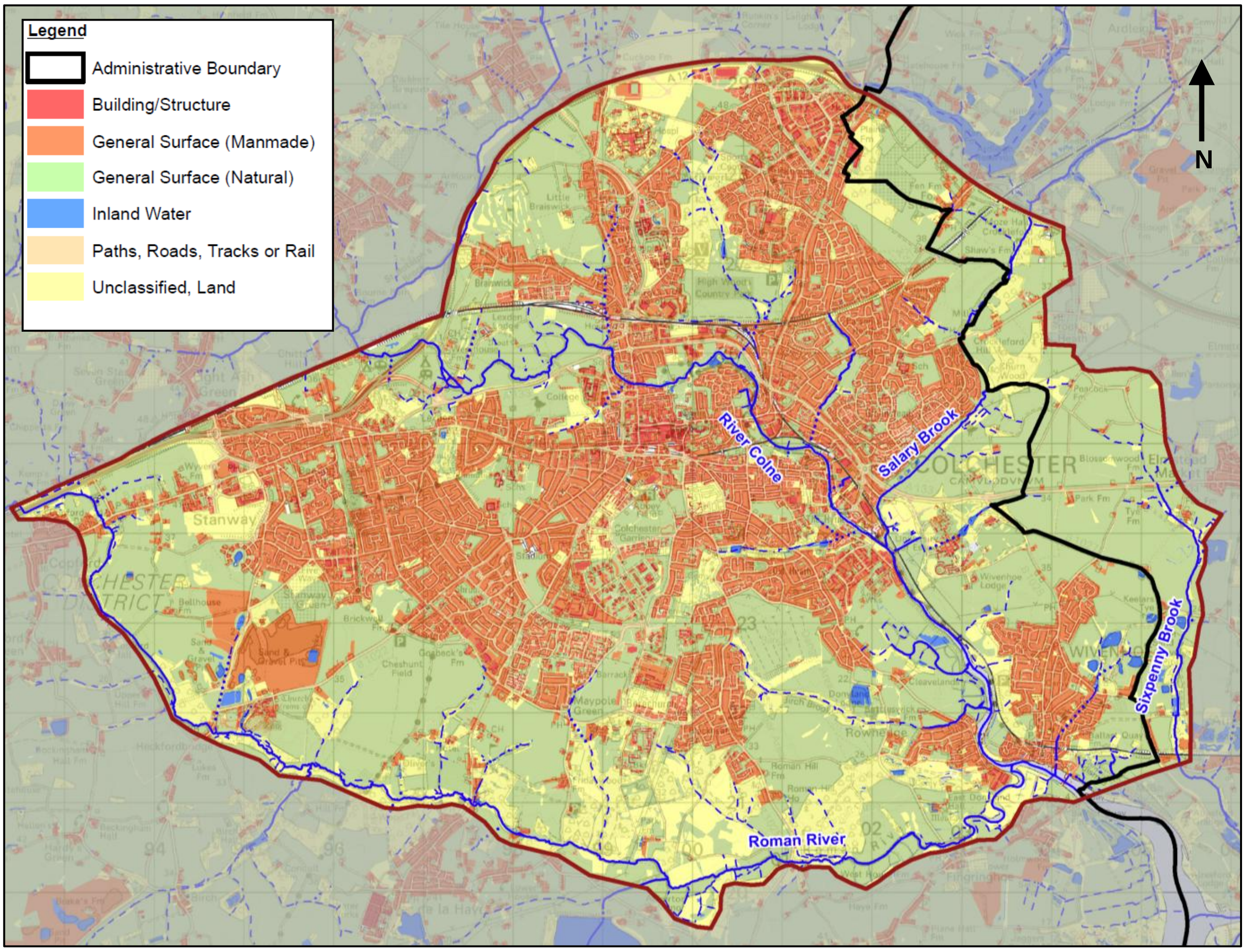


Figure 1-4 Land Uses within Colchester

1.5.2 Major Rivers and Waterways within Colchester

The River Colne dominates the catchment, flowing in a south-eastern direction through the centre of the town. Of the four main tributaries that discharge into the River Colne, the Salary Brook and Roman River are located within the study area. In addition to these, there are a number of smaller tributaries, creeks and brooks, particularly within the tidal reaches of the watercourses.

The River Colne converges with the Blackwater Estuary at Mersea Island and Brightlingsea. The location of the watercourses within the study area are identified in Figure 1-5 (refer to Appendix C for more detailed mapping).

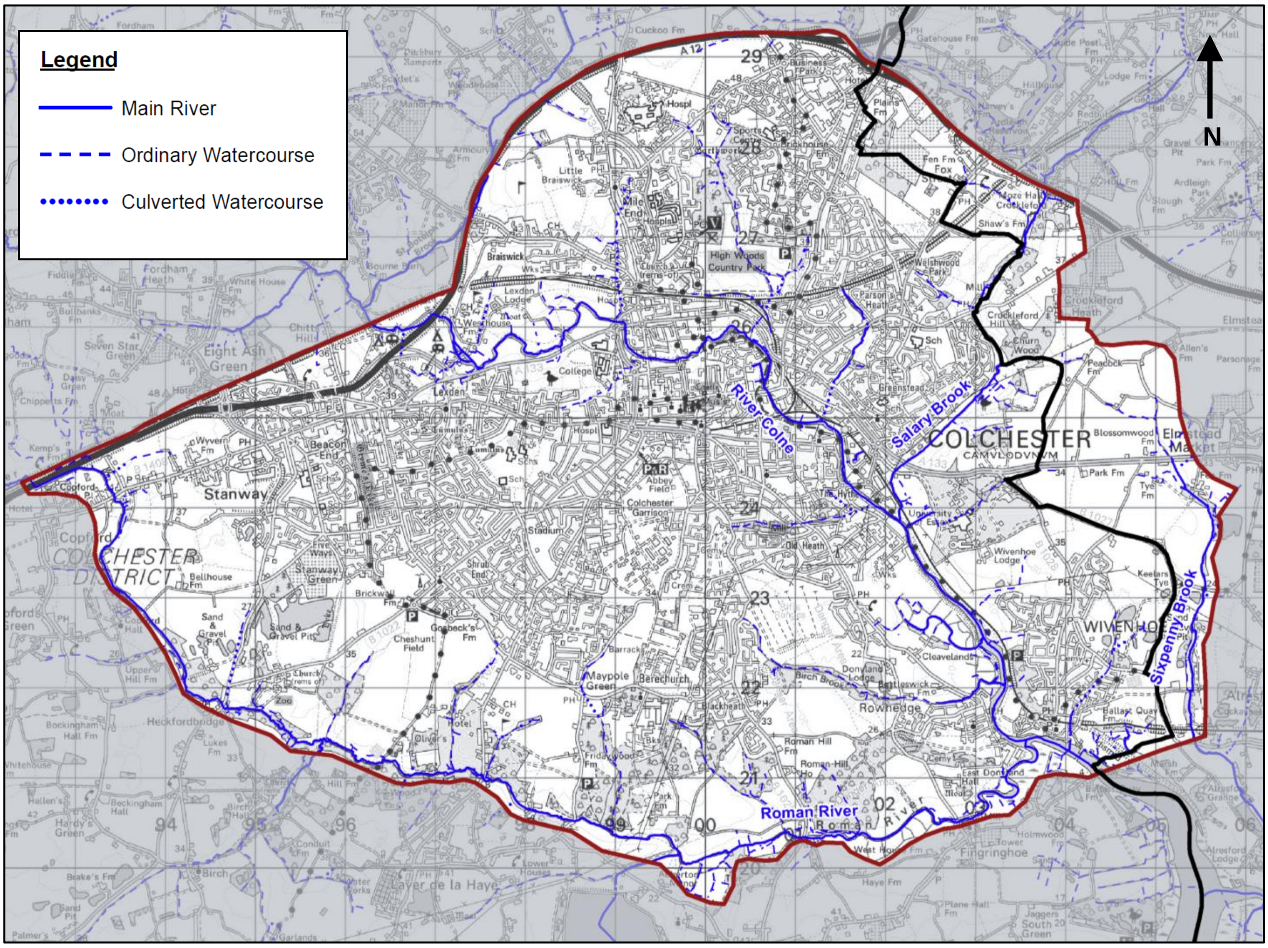


Figure 1-5 Watercourses within Colchester Town and Nearby Settlements

1.5.3 Topography and Geology

Figure 1-6, overleaf, identifies the general topography of the study area. This figure highlights that the topography of the Colchester town catchment varies between areas of high ground (35mAOD – 60mAOD) located in the south-western and north-north-western portions of the town through to areas which are at a lower elevation (0mAOD – 15mAOD) which are typically confined to the river corridors.

The solid geology of the area is dominated by London Clay, which is exposed along the sides of the river valley and at the ground surface in some areas. In locations where London Clay is overlain by drift deposits these are composed of the Lowestoft Formation, head deposits, alluvium and river terrace deposits. It is thought that the London Clay formation slopes from west to east, indicating that the River Colne may flow through alluvium deposits. Kesgrave Sands and Gravels, river terrace deposits and alluvial deposits are found in and around river channels.

The SFRA indicated that groundwater levels surrounding the River Colne at Colchester are thought to be in hydraulic continuity with the River Colne, although, fluctuations of 1m in groundwater levels during spring tides suggest the groundwater is not completely in continuity with the tide but is not completely unconfined. As such, groundwater flooding from this source is not likely to be as pronounced as if the groundwater was in complete hydraulic continuity with the tide.

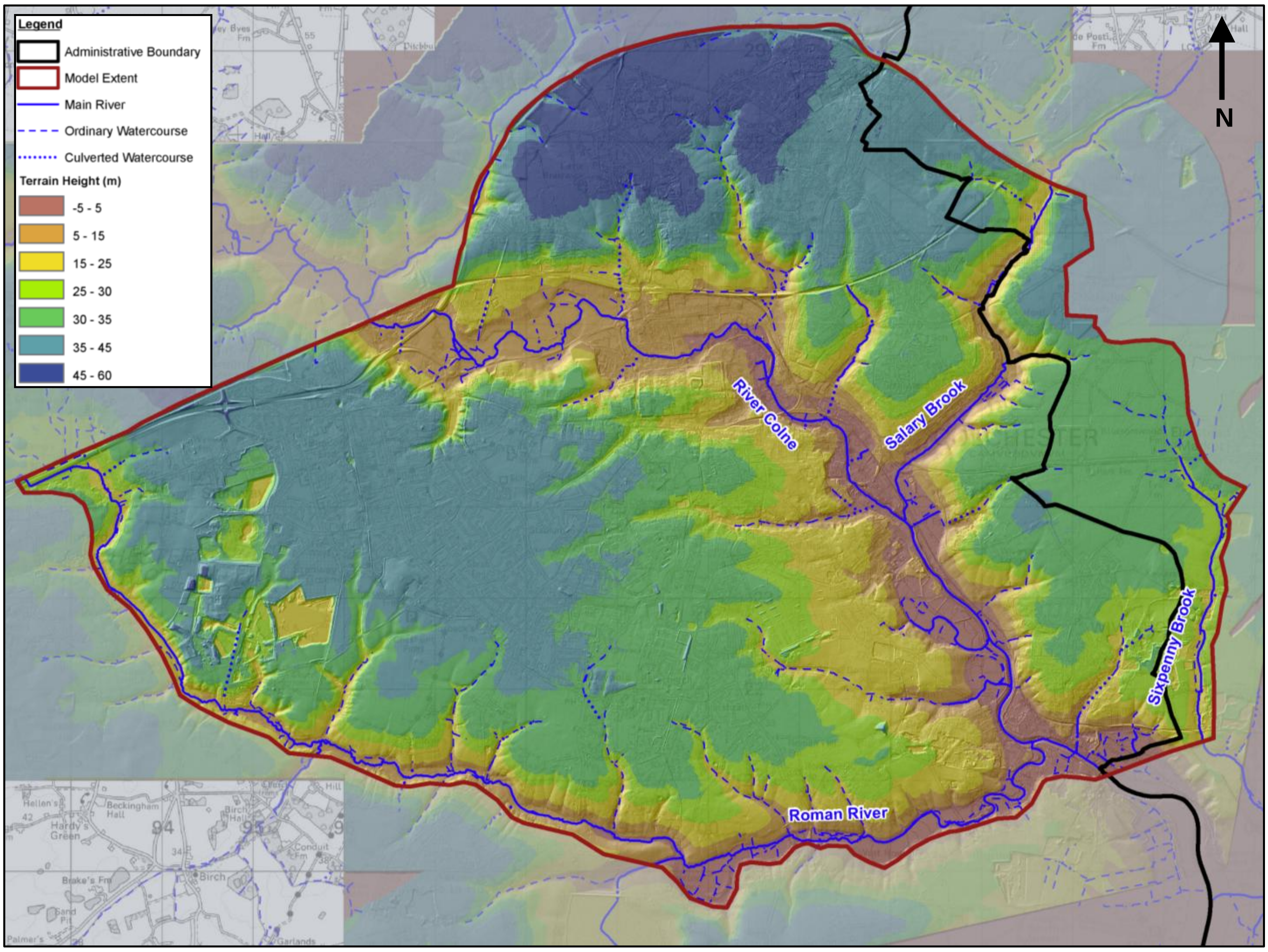


Figure 1-6 DTM Representation of the Topography within Colchester Town

1.6 Partnership

The Flood and Water Management Act 2010 defines the Lead Local Flood Authority (LLFA) for an area as the unitary authority for the area, or if there is no unitary authority, the county council for the area. As such ECC are responsible for leading local flood risk management including establishing effective partnerships with stakeholders such as the Borough Council, Environment Agency, Anglian Water and Essex Highways as well as others. Ideally these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memorandums of Understanding (MoU). It is recommended that the partnerships created as part of the SWMP work are maintained into perpetuity.

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

1.7 Stakeholder Engagement

In order to provide an integrated approach to surface water management, it is important that key stakeholders with responsibility for different flood mechanisms are able to work together in a coordinated effort. To this end, key stakeholders have been engaged throughout the duration of this study through the establishment of a Steering Group, which contains representatives from the organisations illustrated in Figure 1-7. These groups have been consulted throughout the SWMP process and have provided key input at a number of stages of the study.

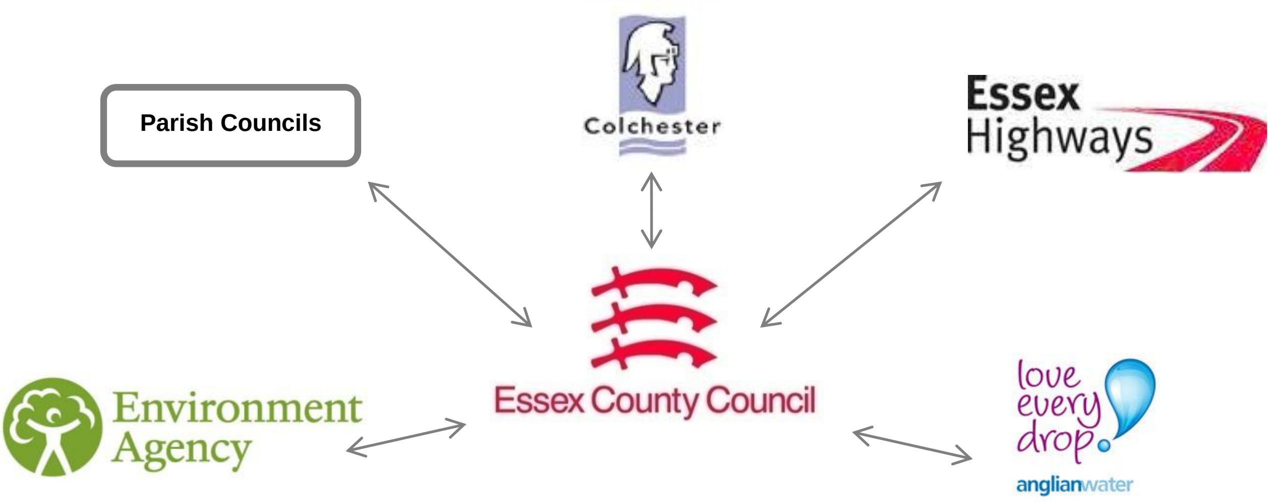


Figure 1-7: Key stakeholders engaged in the SWMP process

1.7.1 Key Stakeholders / Study Area Governance

Essex County Council are the LLFA for the administrative county boundary of Essex as defined by the FWMA 2010.

The Environment Agency (EA) is responsible for flood risk and water quality management of the River Colne and its associated 'main river' tributaries within the study area (refer to Figure 1-5). These rivers receive a large proportion of the surface water runoff in this study area and the EA are an essential partner for flood risk management.

Anglian Water is the sewerage undertaker within the CBC area.

The study area also falls within the zone of responsibility for Anglian Eastern Regional Flood and Coastal Committee (RFCC). This committee replaced the previous Regional Flood and Coastal Defence (RFCD) committee that existed until 31 March 2011 as part of national changes initiated by the FWMA 2010. The ECC representative on the RFCC is the Cabinet Member for Communities and Planning.

1.8 Significant future development plans

Colchester Borough Council is currently completing a 'Focused Review' of its Local Plan to ensure conformity with the National Planning Policy Framework. The Focused Review of the Local Plan has recently been published for public consultation (Issues and Options Stage) Further public consultation will be held during October / November 2013 prior to the submission of the document for examination. It is anticipated that the Focused Review of the Local Plan will be adopted in June 2014.

Preliminary work has also started on a Full Review of Colchester's Local Plan. This mainly currently involves commissioning new studies to support the development of the Full Review of the Colchester's Local Plan. Along with other studies, the SWMP will form part of the Local Plan evidence base, to inform and guide the development of both the Focused and Full Reviews of the Local Plan.

The Full Review of the Local Plan will set out the spatial strategy for growth across the District over the next 15 years, to guide the delivery of employment, homes, retail, community facilities and infrastructure provision in the future.

The current Local Plan focuses significant levels of growth in five Regeneration and Growth Areas in the Town Centre or on the edge of urban Colchester. Smaller amounts of growth has also been directed to the District Centres of Tiptree, West Mersea, Wivenhoe and Rowhedge with only small amounts of growth directed to the rural villages and hamlets up to 2023.

The Spatial Strategy in the Full Review of Colchester's Local Plan is likely to continue to focus the majority of growth in and around Urban Colchester to deliver the most sustainable developments. Detailed work is not scheduled to commence on the Full Review of the Local Plan until September / October 2015 when the Issues and Options consultation will be published. The Full Review of the Local Plan is timetable for submission to the Secretary of State in December 2016.

1.9 Sources of Flooding

The SWMP technical guidance (Defra 2010) identifies four primary sources of surface water flooding that should be considered within a SWMP as described below:

- **Pluvial flooding**: High intensity storms (often with a short duration) are sometimes unable to infiltrate into the ground or be drained by formal drainage systems since the capacity of the collection systems is not large enough to convey runoff to the underground pipe systems (which in turn might already be surcharging). The pathway for surface water flooding can include blockage, restriction of flows (elevated grounds), overflows of the drainage system and failure of sluice outfalls and pump systems.
- **Sewer flooding**: Flooding which occurs when the capacity of the underground drainage network is exceeded, resulting in the surcharging of water into the nearby environment (or within internal and external building drainage networks). The discharge of the drainage network into waterways and rivers can also be affected if high water levels in receiving waters obstruct the drainage network outfalls.
- **Ordinary Watercourses**: Flooding from small open channels and culverted urban watercourses (which receive most of their flow from the urban areas) can either exceed their capacity and cause localised flooding of an area or can be obstructed (through debris or illegal obstruction) and cause localised out of bank flooding of nearby low lying areas.
- **Groundwater flooding:** Flooding occurs when the water level within the groundwater aquifer rises to the surface. In very wet winters these rising water levels may lead to flooding of areas that are normally dry. This can also lead to streams that only flow for part of the year being reactivated. These intermittent streams are typically known as 'bournes'. Water levels below the ground can rise during winter (dependant on rainfall) and fall during drier summer months as water discharges from the saturated ground into nearby watercourses.

Figure 1-8, overleaf, provides an illustration of these flood sources. Each of these sources of flood risk are further explained within Section 3 of this report.

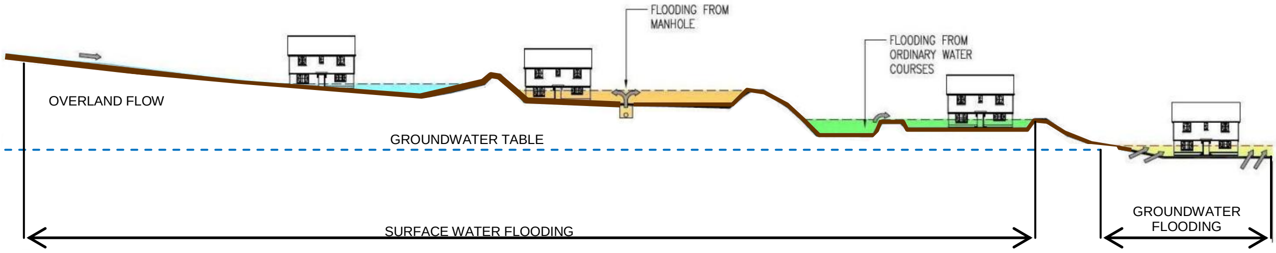


Figure 1-8 Illustration of Flood Sources[1]

1.10 Links with Other Studies

It is important that the SWMP is not viewed as an isolated document, but one that connects with other strategic and local plans. It is also important that it fits in with other studies and plans and does not duplicate existing work.

Figure 1-9, shows an interpretation of the drivers behind the Colchester Town SWMP, the evidence base and how the SWMP supports the delivery of other key planning and investment processes.

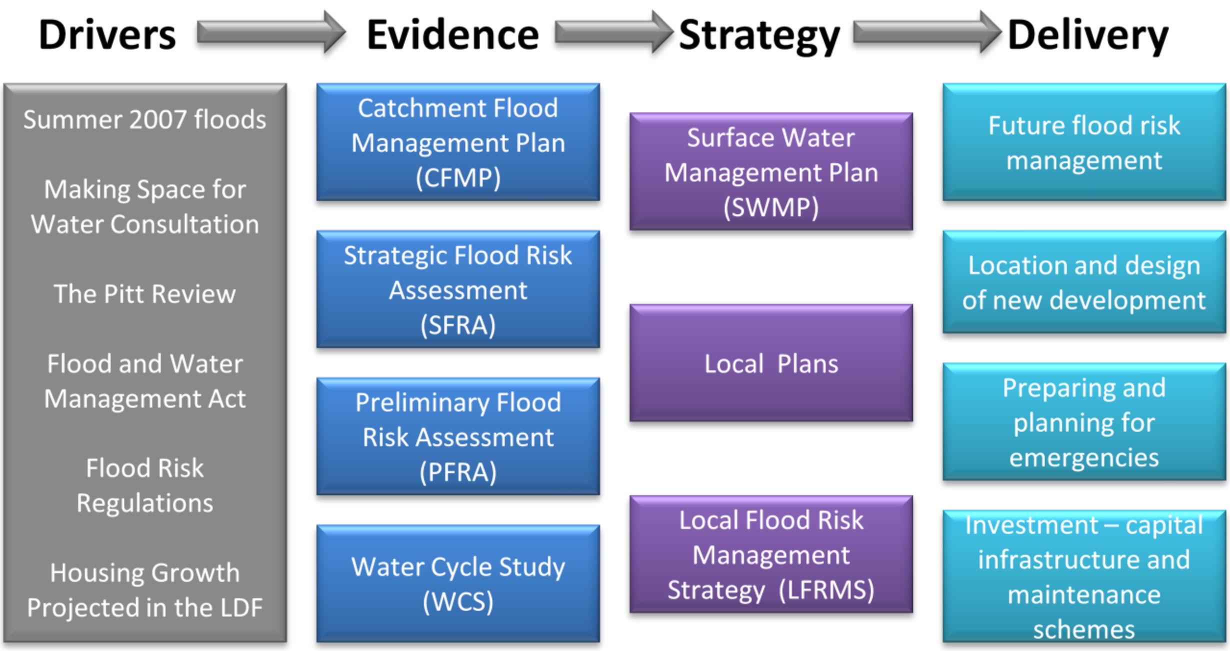


Figure 1-9 Where SWMPs fit in with Policy and Other Strategic Documents

Figure 1–9, highlights reports compiling evidence on flood risk (CFMP, SFRA, PFRA and WCS) and strategy documents (SWMP and LFRMS). The number of these reports and their nature running parallel to each other has primarily been driven by the timings of their production and data availability; however, the creation and existence of numerous different documents can be confusing. Some key details for these different studies and plans and how they are relevant to the study area are included below:

[1] Adopted from Thatcham Surface Water Management Plan Volume One

Regional Flood Risk Appraisal (RFRA)

The East of England RFRA was produced in 2009 by the East of England Regional Assembly (EERA). As of 31 March 2010, the EERA was dissolved as an organisation and much of their work is now undertaken by the East of England Local Government Association (East of England LGA). Nevertheless, the RFRA still exists as a document and provides a summary of flood risk in the region with the aim of informing Strategic Flood Risk Assessments and other local development plans. With the introduction of the new National Planning Policy Framework replacing the current Planning Policy Statements, the RFRA is unlikely to be revised in future.

North Essex Catchment Flood Management Plan (CFMP)

The North Essex Catchment Flood Management Plan (July 2008) and Summary Report (December 2009) by the Environment Agency includes Colchester in its study area. The plan gives an overview of flood risk in the North Essex catchment and sets out the preferred plan for sustainable flood risk management over the next 50 to 100 years. The three (3) relevant CFMP policies located within the study area boundary are highlighted within Figure 1–10 (below).

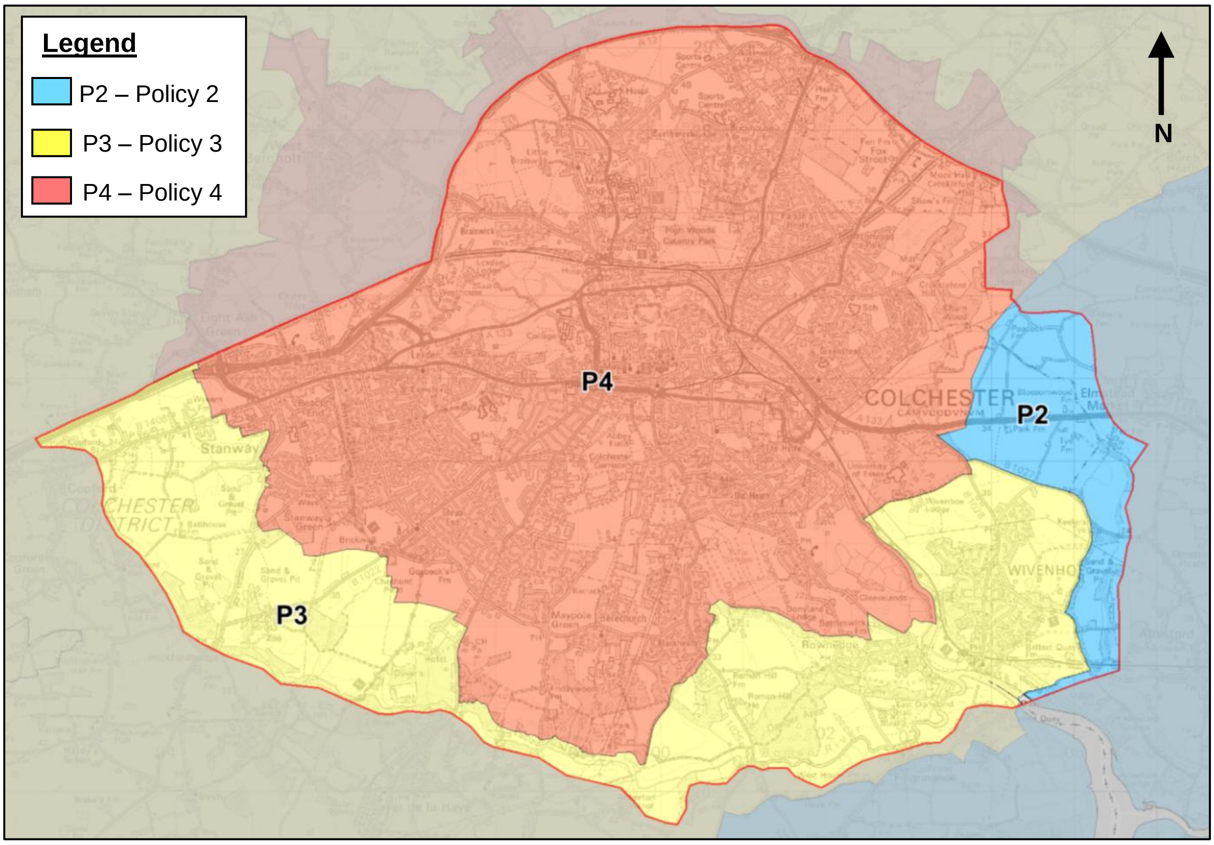


Figure 1-10 Local of CFMP Policy Areas

The relevant CFMP policies are described below and overleaf:

Policy 2. (P2) - Reduce existing flood risk management actions (accepting that flood risk will increase over time). *We may select this policy for places where current and future risks do not warrant as much intervention (for example on maintenance) and it is clearly not worth continuing. Here, we can allow the risk of flooding to increase naturally over time. Following this policy, where we have assets in place now, we may look at the options and timing of withdrawing or retreating flood defences in our Asset Management Plans.*

Policy 3. (P3) - Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time). *We may select this policy where the risks are currently managed appropriately and where the risk of flooding is not expected to increase significantly in the future. We may need to review if what we are doing currently is the best way of managing the risk in the longer term. This policy may lead to reviewing our flood warning service, or how we manage our assets.*

Policy 4. (P4) - Take further action to sustain the current level of flood risk into the future (responding to the potential increases in risk from urban development, land use change and climate change). *We may select this policy in places where the risk is currently managed appropriately, but risk is expected to rise significantly in the future. In this case, we would need to do more in the future to reduce the increase in risks.*

The CFMP is intended to be periodically reviewed, approximately five years from when it was published, to ensure that it continues to reflect land use changes in the catchment.

Strategic Flood Risk Assessments (SFRA)

Each local planning authority is required to produce a SFRA under Planning Policy Statement 25 (PPS25) and the new National Planning Policy Framework (NPPF). This document provides an important tool to guide planning policies and land use decisions. Current SFRAs have a strong emphasis on flooding from main rivers and the sea and are less focussed on evaluating flooding from local sources such as surface water, groundwater and ordinary watercourses; the information from this study will improve this understanding. CBC, as a member of the Mid Essex Area Liaison Group, produced a Level 1 SFRA in October 2007 (this includes the updated Appendix C Colchester Supplementary report, dated February 2008). It is recommended that future updates to this document take into account the findings of the SWMP study.

Preliminary Flood Risk Assessment (PFRA)

A Preliminary Flood Risk Assessment for Essex County Council, as Lead Local Flood Authority, has been prepared as part of the Flood Risk Regulations. The PFRA process provides a consistent high level overview of the potential risk of flooding from local sources such as surface water, groundwater and ordinary water courses. The outputs from this SWMP will be able to inform future PFRA cycles, which will benefit from an increased level of information and understanding relating to surface water flood risk in Colchester.

Local Plans

LDDs including the Core Strategy and relevant Area Action Plans (AAPs) will need to reflect the results from this study. This may include policies for the whole study area (Policy Areas) or for specific parts of the study area (Critical Drainage Areas). There may also be a need to review Area Action Plans where surface water flood risk is a particular issue.

National Flood and Coastal Erosion Risk Management Strategy (National FCERM Strategy)

The FWMA 2010 requires the EA to produce a national strategy to inform and guide local flood risk management strategies. This NFRMS document was consulted upon in early 2011 and became law on 19 July 2011. The strategy's overall aim is to ensure that flooding and coastal erosion risks are well-managed and co-ordinated, so that their impacts are minimised.

The National FCERM Strategy for England stresses the need for risk to be managed in a co-ordinated way across river catchments and along the coast, embracing the full range of practical options and helping local decision-making.

Haven Gateway Water Cycle Study (WCS)

The Haven Gateway Partnership commissioned a Water Cycle Study which covered all of Colchester Borough, Ipswich Borough and Tendring District Council and parts of Babergh District, Mid Suffolk District and Suffolk Coastal District Councils.

The objective of the WCS was to ensure that water supply, water quality, sewerage and flood risk management issues can be properly addressed and thus enabling the substantial growth proposed in the East of England Plan to 2021 to be accommodated in a sustainable way.

Local Flood Risk Management Strategy (LFRMS)

The Flood and Water Management Act (2010) requires each LLFA to produce a Local Flood Risk Management Strategy for their administrative area. This SWMP will provide a strong evidence base to support the development of the Essex County LFRMS.

Summary of Documents

The schematic diagram (Figure 1-11, below) illustrates how the CFMP, Shoreline Management Plan (SMP), PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.

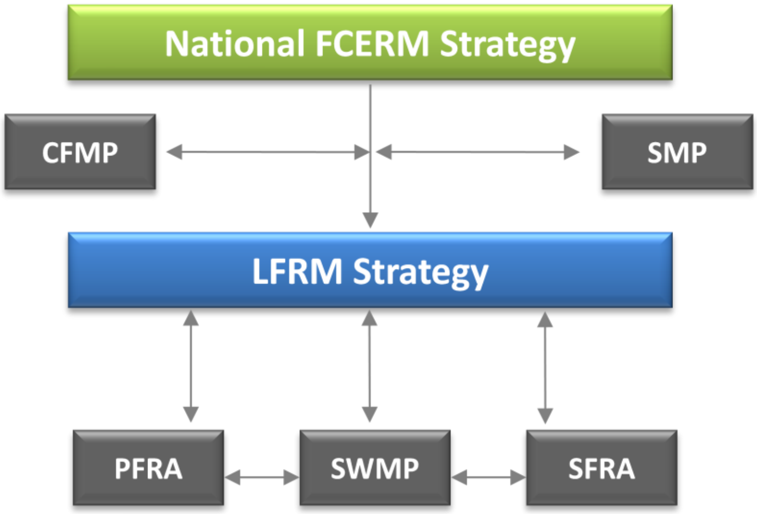


Figure 1-11 Links to local strategies

1.11 Existing Legislation

The FWMA 2010 presents a number of challenges for policy makers and the flood and coastal risk management authorities identified to co-ordinate and deliver local flood risk management (surface water, groundwater and flooding from ordinary water courses). ‘Upper Tier’ local authorities have been empowered to manage local flood risk through new responsibilities for flooding from surface and groundwater.

The FWMA 2010 reinforces the need to manage flooding holistically and in a sustainable manner. This has grown from the key principles within Making Space for Water (Defra, 2005) and was further reinforced by the summer 2007 floods and the Pitt Review (Cabinet Office, 2008). It implements several key recommendations of Sir Michael Pitt’s Review of the Summer 2007 floods, whilst also protecting water supplies to consumers and protecting community groups from excessive charges for surface water drainage.

The FWMA 2010 must also be considered in the context of the EU Floods Directive, which was transposed into law by the Flood Risk Regulations 2009 (the Regulations) on 10 December 2009. The Regulations requires three main types of assessment / plan to be produced:

a) Preliminary Flood Risk Assessments (maps and reports for Sea, Main River and Reservoirs flooding) to be completed by LLFA and the Environment Agency by the 22 December 2011. . Flood Risk Areas, at potentially significant risk of flooding, must also be identified. Maps and management plans will be developed on the basis of these flood risk areas. Within the PFRA the LLFA address the local flood risk whilst the Environment Agency provides advice on strategic flood risk.

b) Flood Hazard Maps and Flood Risk Maps. The Environment Agency and LLFA are required to produce Hazard and Risk maps for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2013.

c) Flood Risk Management Plans. The Environment Agency and LLFA are required to produce Flood Risk Management Plans for Sea, Main River and Reservoir flooding as well as 'other' relevant sources by 22 December 2015.

It should be noted that only (a) above is compulsory for all LLFAs. Where an LLFA is not located within a nationally defined 'Flood Risk Area', then (b) and (c) above are not required. Figure 1-12, overleaf, illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

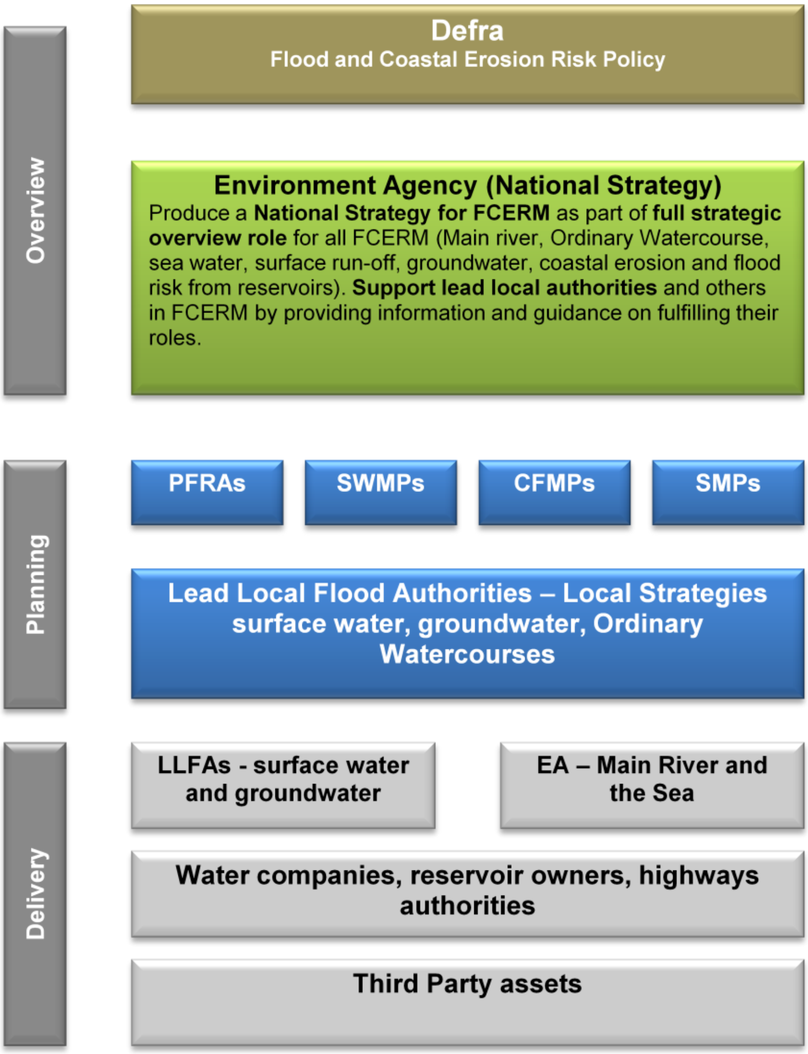


Figure 1-12 Where the SWMP is located within the Delivery of Local Flood and Coastal Risk Management

1.12 LLFA Responsibilities

In addition to forging partnerships and coordinating and leading on local flood management, there are a number of other key responsibilities that have arisen for Lead Local Flood Authorities from the Flood & Water Management Act 2010, and the Flood Risk Regulations 2009. These responsibilities include:

1. **Investigating flood incidents** – LLFAs have a duty to investigate and record details of significant flood events within their area. This duty includes identifying which authorities have flood risk management functions and what they have done or intend to do with respect to the incident, notifying risk management authorities where necessary and publishing the results of any investigations carried out.
2. **Asset Register** – LLFAs also have a duty to maintain a register of structures or features which are considered to have a significant effect on flood risk, including as a minimum details of ownership and condition.

3. **SuDS Approving Body** – LLFAs are designated the SuDS Approving Body (SAB) for any new drainage system, and therefore must approve, adopt and maintain any new sustainable drainage systems (SuDS) within their area. This responsibility is anticipated to commence in April 2014. It should be noted that the Environment Agency are a statutory consultee and currently have the responsibility of providing comments to the Local Planning Authority (LPA) relating to the surface water management of new developments.
4. **Local flood risk management strategies** – LLFAs are required to develop, maintain, apply and monitor a strategy for local flood risk management in its area. The local strategy will build upon information such as national risk assessments and will use consistent risk based approaches across different local authority areas and catchments.
5. **Works powers** – LLFAs have powers to undertake works to manage flood risk from surface runoff and groundwater, consistent with the local flood risk management strategy for the area.
6. **Designation powers** – LLFAs, as well as borough / district Councils and the Environment Agency, have powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management.

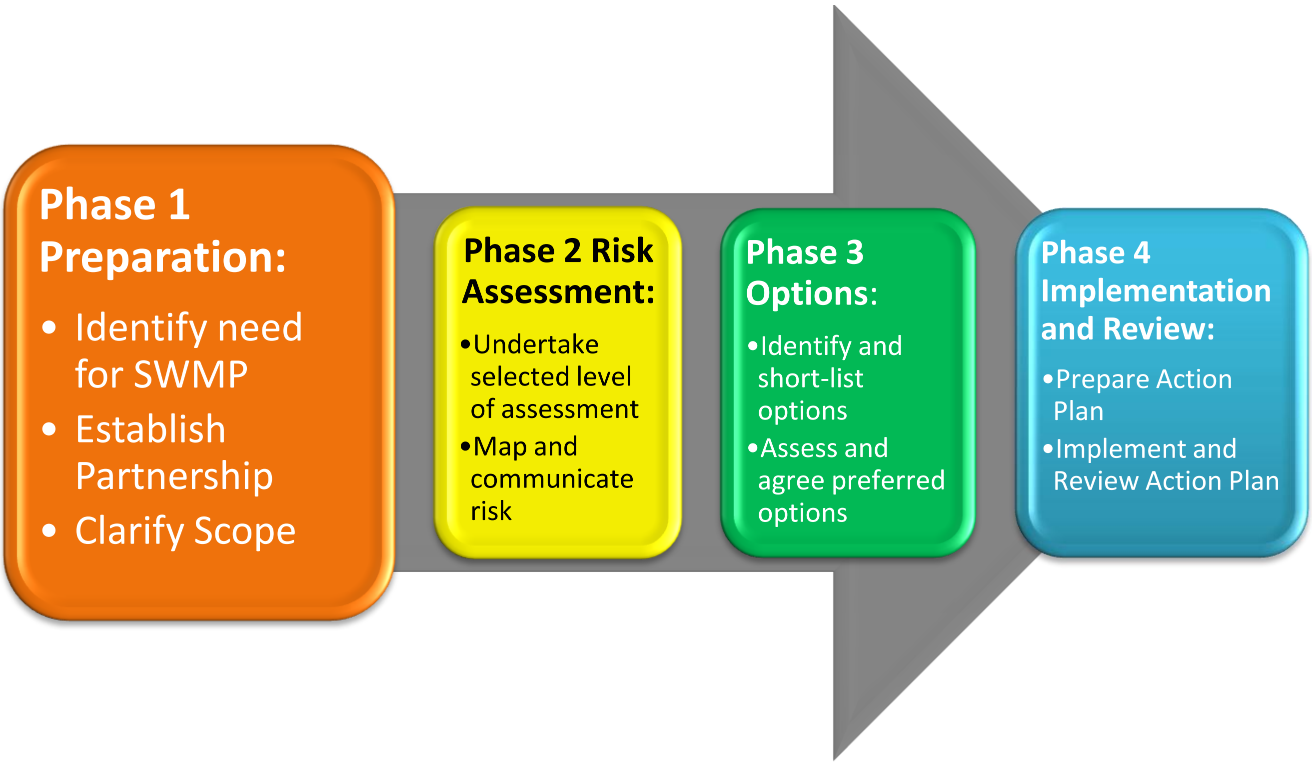
These LLFA requirements have been considered in the production of this document. The SWMP will assist the LLFA in providing evidence for points 1, 2, 3 and 4.

1.13 Local Borough Responsibilities

In order to assist the LLFA in delivering their responsibilities, CBC should undertake the following:

- Maintain ditches and balancing ponds on Borough owned land;
- Category One Responder to local and national emergencies; and
- Providing temporary accommodation in an emergency.

PHASE 1: PREPARATION



2 Phase 1: Preparation

2.1 Partnership

The FWMA 2010 defines the LLFA for an area as the unitary authority or upper tier authority for the area, in this case Essex County Council. As such, ECC is responsible for leading local flood risk management including establishing effective partnerships with stakeholders such as the Environment Agency and Anglian Water Services Ltd as well as others. Ideally these working arrangements should be formalised to ensure clear lines of communication, mutual co-operation and management through the provision of Level of Service Agreements (LoSA) or Memoranda of Understanding (MoU). An initial MoU has been formally established between the parties noted above as part of the SWMP study

As mentioned in Section 1.7, the study area falls within the Anglian Eastern RFCC. CBC participate in the Essex Flood Risk Management Groups which currently includes departmental representatives from Development Management, Spatial Policy and Engineering Services, in recognition of the cross-department input required on managing local flood risk.

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

2.2 Data Collection

Data was collected from each of the following organisations:

- Colchester Borough Council;
- Essex County Council;
- British Geological Survey;
- Anglian Water;
- Environment Agency;
- Essex Fire Authority; and
- Essex Highways.

Table 2-1 provides a summary of the data sources held by the organisations listed above and provides a description of each dataset, and how the data was used in preparing the SWMP.

Table 2-1 Data Sources and Use

Source	Dataset	Description	Use in this SWMP
Environment Agency	Main River centre line	GIS dataset identifying the location of Main Rivers across they study area	To define waterway locations within the study area.
	Environment Agency Flood Map (Flood Zones)	Shows extent of flooding from rivers during a 1 in 100yr flood and 1 in 1000yr return period flood. Shows extent of flooding from the sea during 1 in 200yr and 1 in 1000yr flood events. Ignores the presence of defences.	To identify the fluvial and tidal flood risk within Colchester and areas benefiting from fluvial and tidal defences.
	Areas Susceptible to Surface Water Flooding	A national outline of surface water flooding held by the EA and developed in response to Pitt Review recommendations.	To assist with the verification of the pluvial modelling
	Flood Map for Surface Water	A second generation of surface water flood mapping which was released at the end of 2010.	To assist with the verification of the pluvial modelling
	Groundwater Flooding Incidents	Records of historic incidents of groundwater flooding as recorded by the Environment Agency.	To identify recorded groundwater flood risk – assist with verifying groundwater flood risk
	LiDAR topographic data (main river corridor only)	2m, 1m, 50cm and 25cm resolution terrain model compiled from aerial surveys in 2002, 2004 and 2006	Creation of terrain model for pluvial modelling
	Historic Flood Outline	Attributed spatial flood extent data for flooding from all sources.	Used to assist with the verification of modelling results and CDA locations (where available)
	Areas Susceptible to Groundwater Flooding	Mapping showing areas susceptible to groundwater flooding	To assess groundwater flood risk
	North Essex Catchment Flood Management Plan Summary Report	Summarises the scale and extent of flooding now and in the future, and set policies for managing flood risk within the catchment.	To ensure a coordinated approach is taken for mitigation solutions
	National Receptors Dataset	A nationally consistent dataset of social, economic, environmental and cultural receptors including residential properties, schools, hospitals, transport infrastructure and electricity substations.	Utilised for property/infrastructure flood counts and to determine CDAs.
Colchester Borough Council	Strategic Flood Risk Assessment (SFRA)	Contains useful information on historic flooding, including local sources of flooding from surface water and groundwater.	Provide a background to flood risk in the study area.
	Anecdotal information relating to local flood history and flood risk areas	Records of flooding from surface water, groundwater and ordinary watercourses.	Where available used to assist with the verification of modelling results and CDA locations.
	OS Mapping / MasterMap / Aerial Photography	Topographic maps of the study area	Used to derive modelling parameters

Source	Dataset	Description	Use in this SWMP
Essex County Council	Core Strategy	Identification of broad locations for growth in Colchester.	Understanding of areas of future development.
	Flood Alleviation Schemes	Location and description of existing flood alleviation schemes within the study area.	Used in Phase 3: Options Assessment to determine options of each CDA.
	Historic Flood Records	Locations of historic flooding	Used to assist with the verification of modelling results and CDA locations (where available)
Anglian Water	DG5 Register	DG5 Register logs and records of sewer flooding incidents in each area.	Mapping sewer flooding incidents.
	Sewer pipe network	GIS dataset providing the geo-referenced location of surface water, foul and combined sewers across the study area. Includes pipe size and some information on invert levels.	Verifying CDA locations and Phase 3:Options Assessment
British Geological Society	Geological datasets	Licensed GIS datasets including: Geological indicators of flooding; Permeability; Bedrock and superficial geology; Infiltration SuDS Maps.	Understanding the geology of the study
Essex Fire Authority	Historic flooding records	Locations of historic flooding	Validation of hydraulic modelling results
InfoTerra	LiDAR topographical data	High resolution elevation data derived from airborne sources – at a 0.5m grid to fill the gaps in the equivalent EA LiDAR data. A laser is used to measure the distance between the aircraft and ground and between the aircraft and the vegetation canopy or building tops. Typical (unfiltered) accuracy ranges are +/- 0.15m.	Filtered LiDAR was utilised within the creation of the pluvial models to define the ground surface of the catchment and to understand the general topography of the study area.
	Photogrammetry	Lower resolution elevation data derived from aerial photography at a 5m resolution grid.	Data was used to fill LIDAR coverage gaps in the rural areas around the edges of the study area.

2.3 Data Review

Historic Records of Local Flooding

The most significant data gap across the study area relates to records of past 'local' flooding incidents. This is a common issue across the UK as record keeping of past floods has historically focussed on flooding from rivers or the sea, or has incorrectly attributed flooding to these sources. Records of past incidents of surface water, sewer, groundwater or ordinary watercourse flooding have been sporadic. ECC and CBC have provided all available historic records that were accessible at the time of request. Where possible, these have been digitised into GIS from, however there is very little information on the probability, hazard or consequence of flooding.

Anglian Water have provided postcode linked data on records of sewer flooding, (known as the DG5 register). However, more detailed data on the location and cause of sewer flooding is not currently available.

Similarly, the Essex County Fire and Rescue and Essex Highways have recorded incidents of call outs related to flooding, however there is no information on the source of flooding (e.g. pipe bursts or rainfall), or probability, hazard or consequence of the flooding.

Groundwater Flooding

Groundwater flooding is dependent on local variations in topography, geology and soils. The causes of groundwater flooding are generally understood; however it is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets.

There is a lack of reliable measured datasets to undertake flood frequency analysis and even with datasets, this analysis is complicated due to the non-independence of groundwater level data. Surface water flooding incidents are sometimes mistaken for groundwater flooding incidents, such as where runoff via infiltration seeps from an embankment, rather than locally high groundwater levels.

Flooding Consequences

The National Receptors Database (NRD), version 1.1 data set, was provided by the EA allow property counts to be undertaken for this SWMP.

Topographic / Elevation Data

A mixture of elevation data has been obtained for this study. The EA LiDAR information at 2m provides good coverage of most of the catchment, while additional 1m, 50cm and 25 cm data is available for regions near the urbanised extent and along the river corridor.

Main River Information

A substantial quantity of high quality information on the River Colne (and their tributaries) within the study area has been provided by the EA. This data provides a good basis for understanding fluvial impacts on flooding.

2.4 Security, Licensing and Use Restrictions

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

The following national datasets provided by the Environment Agency are available to LLFA for local decision making:

- EA Flood Zone Map (including historic mapping);
- Areas Susceptible to Surface Water Flooding;
- Areas Susceptible to Groundwater Flooding
- Flood Map for Surface Water; and
- National Receptor Database.

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

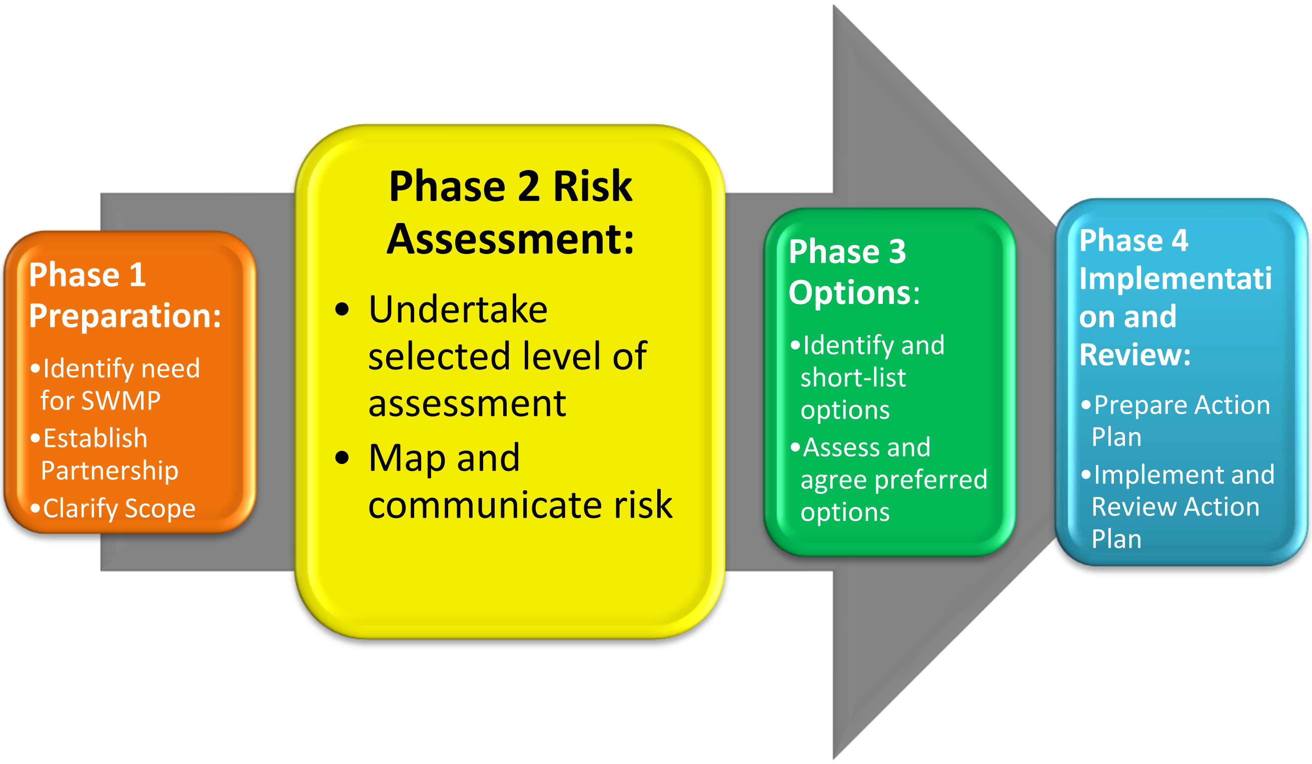
- Strategic Flood Risk Assessment;
- Catchment Flood Management Plan;
- Water Cycle Strategy;
- Preliminary Flood Risk Assessment; and
- Index of Multiple Deprivation.

The use of some of the datasets made available for this SWMP has been restricted. These include:

- Records of property flooding held by the Council and by Anglian Water Services Ltd; and
- British Geological Society geological datasets.

Necessary precautions must be taken to ensure that all restricted information given to third parties is treated as confidential. The information must not be used for anything other than the purpose stated in the terms and conditions of use accompanying the data. No information may be copied, reproduced or reduced to writing, other than what is necessary for the purpose stated in the agreement.

PHASE 2: RISK ASSESSMENT



3 Surface Water Flooding

3.1 Overview

Surface water flooding, also known as pluvial flooding or flash flooding, occurs when high intensity rainfall generates runoff which flows over the surface of the ground and ponds in low lying areas. It is usually associated with high intensity rainfall events and can be exacerbated when the ground is saturated (or baked hard) and the drainage network has insufficient capacity to manage the additional flow.

3.2 Historic Flooding

Various flood records were utilised within the collected from a range of sources including:

- Colchester Borough Council;
- Essex County Council;
- Essex County Fire and Rescue Service;
- Essex Highways
- Essex Resilience Forum; and
- Local Parish Councils

A summary of key historic events which were provided for this report have been geo-referenced and mapped in Figure 3-1.

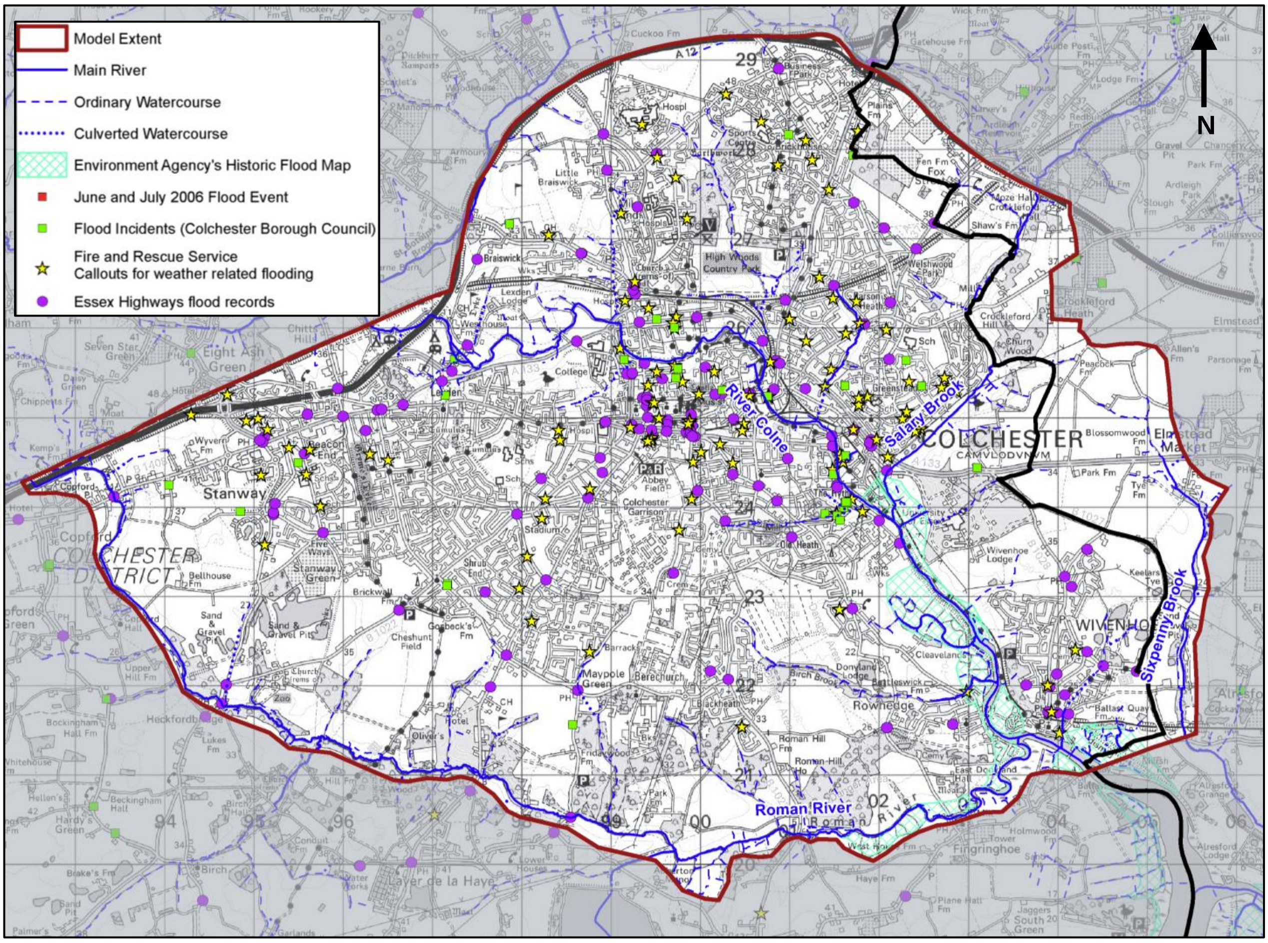


Figure 3-1 Historic Flood Events within Colchester

3.3 Level of Assessment

SWMPs can function at different geographical scales and as a result of this differing levels of detail may be necessary. Table 3-1 defines the levels of assessment that can be used within a SWMP.

Table 3-1: Level of assessment (adapted from Defra SWMP Guidance, March 2010)

Level of Assessment	Appropriate Scale	Outputs
Strategic Assessment	County or large conurbation (e.g. Essex county area)	• Broad understanding of locations that are more vulnerable to surface water flooding. • Prioritised list for further assessment. • Outline maps to inform spatial and emergency planning.
Intermediate Assessment	Large town or city (e.g. Colchester)	• Identify flood hotspots which might require further analysis through detailed assessment. • Identify immediate mitigation measures which can be implemented. • Inform spatial and emergency planning.
Detailed Assessment	Known flooding hotspots (e.g. Critical Drainage Areas)	• Detailed assessment of cause and consequences of flooding. • Use to understand the mechanisms and test potential mitigation measures.

3.3.1 Intermediate Assessment

As shown in Table 3-1, an intermediate assessment is applicable across a large town or city. Discussions with the Steering Group concluded that an intermediate assessment is considered to be an appropriate level of assessment to further quantify the risks within Colchester and nearby settlements.

The purpose of the intermediate assessment will be to further identify areas within Colchester that are likely to be at greatest risk of surface water flooding and which may require further analysis through more detailed assessment.

The outputs from this assessment should be used to inform spatial and emergency planning. The outputs can also be used to identify potential mitigation measures which can be implemented immediately in order to reduce surface water flood risk. These may include quick win measures such as improving maintenance and clearing blockages/obstruction to the drainage infrastructure.

3.4 Risk Overview

The following sources of flooding have been assessed and are discussed in detail in the following sections of this report:

- Pluvial flooding: 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 a watercourse.
- Flooding from ordinary watercourses: flooding which occurs as a result of the capacity of the watercourse being exceeded resulting in out of bank flow (water coming back out of rivers and streams).

- Sewer flooding: Flooding which occurs when the capacity of the underground drainage system is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters as a result of wet weather conditions.
- Flooding from groundwater sources: Occurs when the water level within the groundwater aquifer rises to the surface.

The identification of areas at risk of flooding has been dominated by the assessment of surface water and ordinary watercourse flooding as these sources are expected to result in the greater consequence (risk to life and damage to property), as well as by the quality of the information available for informing the assessment.

3.5 Pluvial Flooding

3.5.1 Description

Pluvial flooding is the term used to describe flooding which occurs when intense, often short duration rainfall is unable to soak into the ground or to enter drainage systems and therefore runs over the land surface causing flooding. It is most likely to occur when soils are saturated (or baked hard) so that they cannot infiltrate any additional water or in urban areas where buildings tarmac and concrete prevent water soaking into the ground. The excess water can pond (collect) in low points and result in the development of flow pathways often along roads but also through built up areas and open spaces. This type of flooding is usually short lived and associated with heavy downpours of rain.

The potential volume of surface runoff in catchments is directly related to the size and shape of the catchment to that point. The amount of runoff is also a function of geology, slope, climate, rainfall, saturation, soil type, urbanisation and vegetation.

3.5.2 Causes and classifications

Pluvial flooding can occur in rural and urban areas, but usually causes more damage and disruption in the latter. Flood pathways include the land and water features over which floodwater flows. These pathways can include drainage channels, rail and road cuttings. Developments that include significant impermeable surfaces, such as roads and car parks may increase the volume and rate of surface water runoff.

Urban areas which are close to artificial drainage systems, or located at the bottom of hill slopes, or in valley bottoms and hollows, may be more prone to pluvial flooding. This may be the case in areas that are down slope of land that has a high runoff potential including impermeable areas and compacted ground.

3.5.3 Impacts of pluvial flooding

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

- Residential, commercial and industrial properties;
- Infrastructure, such as roads and railways, electrical infrastructure, telecommunication systems and sewer systems;

It can also impact on:

- Agriculture; and
- Amenity and recreation facilities.

This type of flooding is usually short-lived and may only last as long as the rainfall event. However occasionally flooding may persist in low-lying areas where ponding occurs. Due to the typically short duration, this type of flooding tends not to have consequences as serious as other forms of flooding, such as flooding from rivers; however it can still cause significant damage and disruption on a local scale.

3.5.4 Historic Records – Flooding

Past records of surface water flooding within the study area have been provided by various stakeholders and previous studies undertaken for the study area (SFRA, WCS). A breakdown of the data provided for the SWMP can be located within Appendix C, Figure 7. Figure 3-2 highlights a historic flood event which occurred near Colchester Rail Station (on the A134) in April 1919.

Figure 3-2 A Flood Near Colchester Rail Station (on the A134) Dated 28th April 1919 [2]

A review of this data indicates that a majority of these recorded incidents occur within the urbanised areas of Colchester, with the greatest number of records being found around the town centre. Some of the areas that have experienced historic flooding are located near known watercourses and within areas near lost watercourses (that can be reactivated during a significant storm event). Other causes for flooding appear to be associated with the obstruction of natural flow patterns (predominantly by roads and properties), drainage assets being compromised by debris and / or at capacity.

3.5.5 Methodology for Assessment of Pluvial Flooding

Modelling Overview

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

[2] Source: http://www.bowcott.com/postcards/page3.htm

To facilitate the accurate identification, retrieval and review of model data a number of actions were undertaken, including:

- The use of a standard folder structure for all model files;
- A standardised naming convention that included the model name, grid size, scenario and version number;
- A model log was initiated at the start of the modelling process that provides a clear and concise record of model development; and
- The model was reviewed by a senior modeller following Capita Symonds standard Quality Assurance protocol. This review incorporated all the model files that were used in the model set-up.

An integrated modelling approach (see Table 3-2) has been selected where rainfall events of known probability are applied directly to the ground surface and water is routed overland to provide an indication of potential flow paths and areas where surface water will pond during an extreme event.

Table 3-2: Levels of pluvial modelling

Rolling Ball	Surface water flow routes are identified by topographic analysis, most commonly in a GIS package
Direct Rainfall	Rainfall is applied directly to a surface and is routed overland to predict surface water flooding
Drainage Systems	Based around models of the underground drainage systems
Integrated Approach	Representing both direct rainfall and drainage systems in an integrated manner, or through linking different models together dynamically

Hydraulic modelling of the pluvial and ordinary watercourses component of surface water flooding was undertaken using TUFLOW software (Build 2012-05-AE). TUFLOW simulates water level variations and flows for depth-averaged, unsteady two-dimensional (2D), free-surface flows and has been used successfully for many SWMPs to capture the hydrodynamic behaviour and flow patterns in complex urban environments.

The extent of the hydraulic model has been based upon catchment boundaries as agreed with the SWMP Client Steering Group with an agreed resolution of 5m. Figure 3-3, overleaf, indicates the extent of the models utilised within the risk assessment.

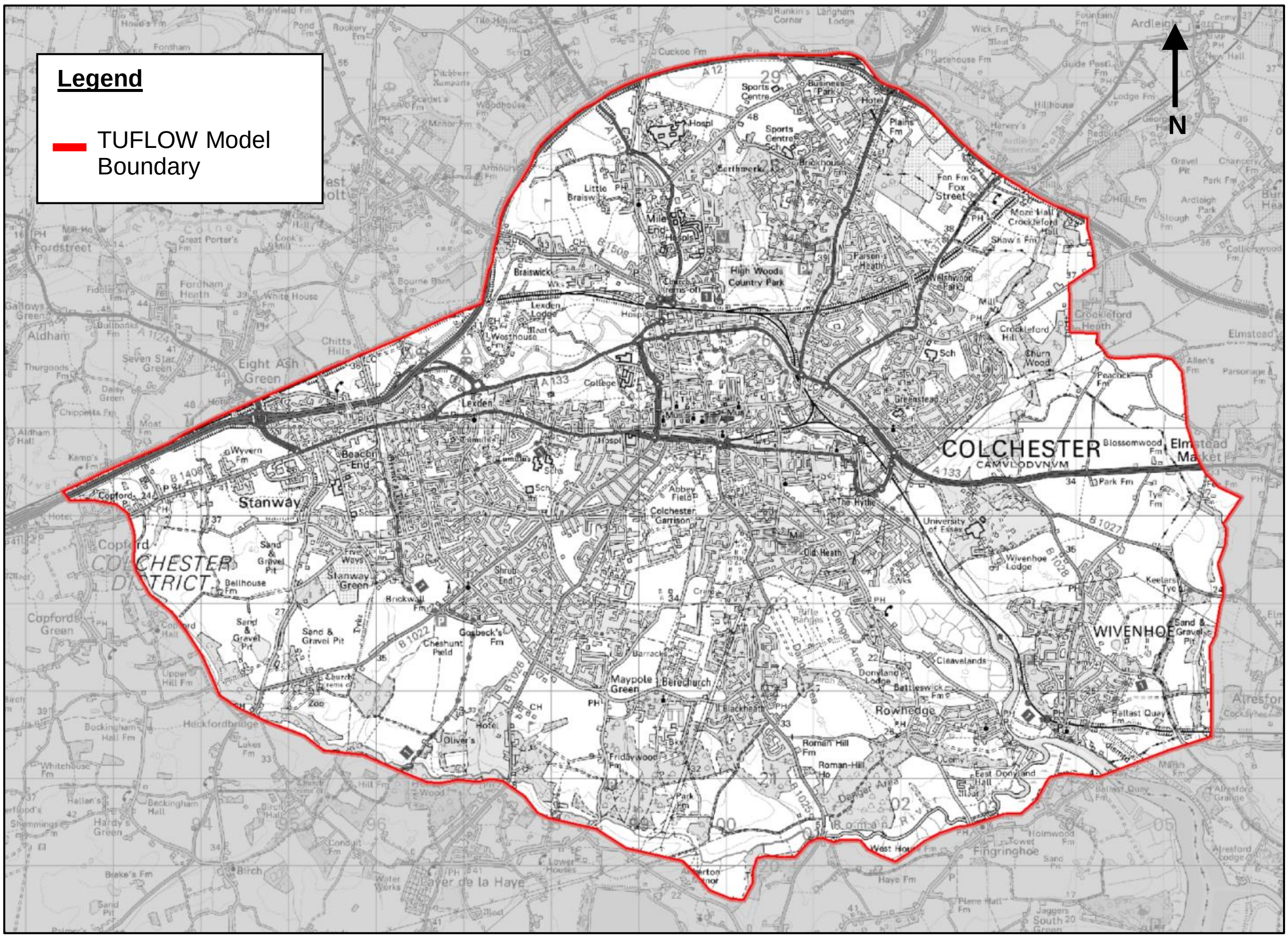


Figure 3-3 TUFLOW Model Boundaries

The selected return periods were chosen through consultation with the Steering Group. As part of this report, figures have been prepared for the modelled settlements based on the 1 in 100 year rainfall event (1% AEP). GIS layers of results for the remaining return periods have also been produced and are included in Appendix C. Additionally, ASCII grids and ESRI Shape files have been created and distributed to CBC and ECC for use within their in-house GIS system.

Table 3-3, overleaf, provides details of the return periods that have been selected and the suggested uses of the various modelling outputs.

Table 3-3: Selected return periods and suggested use of outputs

Modelled Return Period	Suggested use
1 in 20 year event *(5% AEP)*	Anglian Water utilise the 1 in 20 year to identify properties that might be at risk of flooding. The identification of flooding from this scenario is also required for populating the Flood Defence Grant in Aid (FDGiA) funding applications as it assist with highlighting areas at a very significant risk of flooding.
1 in 75 year event *(1.3% AEP)*	In areas where the likelihood of flooding is 1 in 75 years or greater insurers may not guarantee to provide cover to property if it is affected by flooding. This layer should be used to inform spatial planning as if property cannot be guaranteed insurance, the development may not be viable. Based on the new (January 2013) National Flood Risk Assessment (NaFRA) proposals by the EA, this return period event is considered to border the 'significant' flood likelihood band – results from this event will help provide an audit trail as flood likelihood bands change or some processes are slow to change.
1 in 100 year event *(1% AEP)*	Can be overlaid with Environment Agency Flood Zone 3 layer to show areas at risk under the same return period event from surface water and main river flooding. Can be used to advise planning teams – please note that the pluvial 1 in 100 year event may differ from the fluvial event due to methods in runoff and routing calculations.
1 in 100 year event (plus climate change)	NPPF requires that the impact of climate change is fully assessed. Reference should be made to this flood outline by the spatial planning teams to assess the sustainability of developments.
1 in 200 year event *(0.5% AEP)*	To be used by emergency planning teams when formulating emergency evacuation plans from areas at risk of flooding. The new NaFRA banding indicates that this event is also required by Cabinet Office policy for determining the risk and resilience of critical infrastructure.

A summer rainfall profile was selected as it produces a higher intensity storm event in comparison to a winter profile, which is considered to be the worst-case scenario. Models simulations were run at double the critical duration in order to allow runoff to be conveyed down overland flow paths.

As part of this study, maps of maximum water depth and hazard for each of the return periods above have been prepared and are presented in Appendix C of this report. When viewing the maps, it is important that the limitations of the modelling are considered – refer to key assumptions and uncertainties discusses later in this report.

The figures presented in Appendix C indicate that water is predicted to pond over a number of roads and residential properties. These generally occur at low points in the topography or where water is confined behind an obstruction or embankment.

Some of the records of surface water flooding shown in Figure 3-2 have been used to verify the modelling results. Discussions with Council staff have also provided anecdotal support for several of the locations identified as being susceptible to flooding.

The results of the assessment have been used to identify 'Local Flood Risk Zones' (LFRZs) and Critical Drainage Areas (CDAs) across the study area.

3.5.6 Uncertainty in flood risk assessment – Surface Water Modelling

The surface water modelling provides the most detailed information to date on the mechanisms, extent and hazard which may result from high intensity rainfall across the study area. However, due to the strategic nature of this study and the limitations of some data sets, there are limitations and uncertainties in the assessment approach of which the reader should be aware.

There is a lack of reliable measured datasets and the estimation of the return period (probability) for flood events is therefore difficult to verify. The broad scale mapping provides an initial guide to areas that may be at risk, however there are a number of limitations to using the information:

- The mapping should not be used in a scale to identify individual properties at risk of surface water flooding. It can only be used as a general indication of areas potentially at risk.
- Whilst modelled rainfall input has been modified to reflect the possible impacts of climate change it should be acknowledged that this type of flooding scenario is uncertain and likely to be very site specific. More intense short duration rainfall and higher volume more prolonged winter rainfall are likely to exacerbate flooding in the future.

3.5.7 Key Assumptions for Surface Water Modelling

The surface water modelling methodology for the study has used the following key assumptions:

- It has been assumed that land roughness varies with land type (e.g., roads, buildings, grass, water, etc) and therefore different Manning's roughness coefficients have been specified for different land types to represent the effect different surfaces have on the flow of water;
- The watercourses, within the study area, have been modelled at the elevations obtained when the DTM information was gathered;
- Building thresholds have been included in the model in order to represent the influence they have on surface water flow paths. All building polygons within the model were raised by 0.1m, meaning they act as barriers to flood waters in the model, up until the water depth becomes greater than 0.1m where it is assumed that the building would flood and water would flow through the building, as would be the case in an actual flood event;
- Fences and other thin obstructions have not been considered to influence overland flow paths; and
- Infiltration from permeable landuses (based on Matermap) occurs across the study area utilising the Green–Ampt Method.

3.5.8 Hydrology

An important aspect of establishing suitable rainfall profiles is to estimate the critical storm duration for the study area. In order to ensure that the most appropriate scenario is assessed and the entire catchment is contributing surface water runoff, the critical storm duration must be estimated.

Two methods were used to calculate an estimate of the critical storm duration for the rainfall profiles used in the model. A summary of these methods is given below:

- The Bransby-Williams formula was used to derive the *time of concentration,* defined as the time taken for water to travel from the furthest point in the catchment to the catchment outfall, at which point the entire site is considered to be contributing runoff; and

- The Flood Estimation Handbook (FEH) equation for critical storm duration - the standard average annual rainfall (SAAR) value for each a catchment has been extracted from the FEH CD-ROM v3 and the Revitalised Flood Hydrograph method (ReFH) model has been used to derive the time to peak (Tp) from catchment descriptors.

Based on this assessment a critical storm duration of three (3) hours was utilised within the direct rainfall model, with the model being run at a length of six (6) hours to capture the impacts of ponding and overland flow after a storm has passed.

The catchment descriptors, from the centre of each catchment, were exported from the Flood Estimation Handbook (FEH) into the rainfall generator within ISIS, which was used to derive rainfall hyetographs for a range of return periods. The hyetographs generated using this methodology, and incorporated within the pluvial model can be located within Appendix B.

3.5.9 Model Topography

The boundary of the models was based on a review of the topographical information available for the area. This included the following information (in order of preference):

- Light Detecting and Ranging data (LiDAR) was used as the base information for the model topography. LiDAR data is an airborne survey technique that uses laser to measure the distance between an aircraft and the ground surface, recording an elevation accurate to ±0.15m at points 1m apart (and 2m apart). The technique records elevations from all surfaces and includes features such as buildings, trees and cars. This raw data is then processed to remove these features and provide values of the ground surface, which is merged to create a Digital Terrain Model (DTM) of the ground surface itself; and

- Photogrammetry is frequently more reliable in areas which pose difficulties for the collection of LiDAR and IFSAR data. Factors such as steep or rapid changes in terrain and the coverage of buildings causes fewer problems to the accuracy of photogrammetric data. For instance, photos can clearly define a ridge or the edges of a building when the point cloud footprint from LiDAR and IFSAR cannot. Conversely, photogrammetry is relatively less reliable in flat and featureless areas. Typically, height data derived from photogrammetry is more accurate than LiDAR and IFSAR data in the x and y (horizontal) direction but less accurate in the z (vertical) direction.

- IFSAR (Interferometric Synthetic Aperture) - An aircraft-mounted sensor designed to measure surface elevation, which is used to produce topographic imagery. Sold under the name NEXTmap. Depending on the terrain and vegetation, IFSAR can have a vertical accuracy of ±1m.

Figure 3-4 overleaf, displays the variation in level of detail available between these datasets.

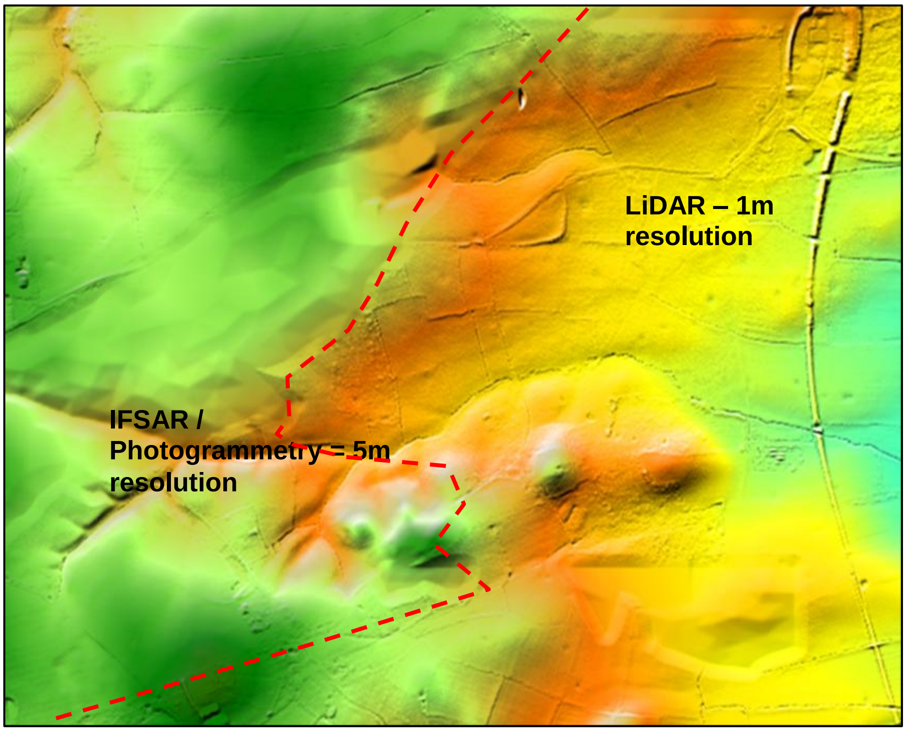


Figure 3-4 Variation in Information utilised to Create the Model DTM

LiDAR data was available at a 1m resolution for the majority of the study area, Where LiDAR was not available, Photogrammetric data was used to assist in creating the DTM. Filtered LiDAR (and photogrammetric) data (in preference to unfiltered) has been used as the base topography to provide the model with a smoother surface to reduce the potential instabilities in the model and areas of unexpected ponding.

An image of the DTM used to represent the topography of the study area in the pluvial models are shown in Appendix C – the general topography of the study can be seen in Figure 1-6.

The ground elevations were represented in TUFLOW using a 5m grid. The decision to use a 5m grid is an optimisation of the computational time required due to the size of the study area and the need for accuracy in the model in order to resolve features in the urban environment.

3.5.10 Land Surface

The type of land surface has a significant effect on the flow of water along surface water flow paths due to the relatively shallow depths of flooding. As such, a number of roughness coefficients have been specified in order to accurately represent different land types within the hydraulic model and the effect they have on the flow of water.

OS MasterMap data has been used to produce different land type layers (such as roads, grass, water, etc, as shown in Figure 3-5), for which different Manning's roughness coefficients have been specified.

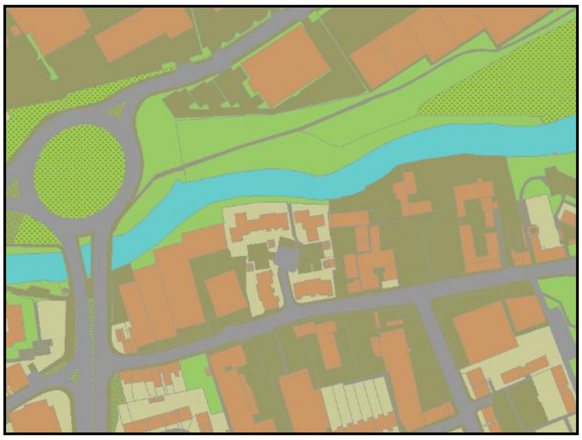


Figure 3-5: OS MasterMap land type layers

These layers have been applied across the modelled areas and included within the TUFLOW model in order to represent the different behaviour of water as it flows over different surfaces.

3.5.11 Model Verification

It is important to ensure that the outputs from the modelling process are as reliable as possible. To this end, a number of actions and data sources have been used to check the validity of the model outputs, including the following:

Ground-truth model

This stage of verification involved reviewing the hydraulic model outputs against the initial site inspections/assessment to ensure that the predictions were realistic and considered local topography and identified drainage patterns. Where previous site inspection data did not provide sufficient information on a specific area within the study, the model outputs were assessed against aerial photography from third party sources to assist in the model verification.

EA national surface water mapping

The Environment Agency has produced two national surface water datasets using a coarse scale national methodology:

- Areas Susceptible to Surface Water Flooding (AStSWF); and
- Flood Map for Surface Water (FMfSW).

As a method of validation, the outputs from these datasets have been compared to the SWMP modelling outputs to ensure similar flood depths and extents have been predicted. There are slight variations, due to the more accurate methodology used in the SWMP risk assessment, but generally the outputs with relation to ponding locations and flow paths are very similar. However, the extent of the depths was noticed to vary, as shown in the example in Figure 3-6, overleaf.

This observation provides confidence in the final model outputs as the variation in the results is concluded as being related to the more refined DTM (used within this study) and the catchment specific critical durations (as the Environment Agency FMfSW maps utilised a single duration to represent runoff throughout England) defined in this report. Please note that the Environment Agency is preparing new surface water mapping products coming out shortly that the LLFA's will be able to utilise which improve the level of detail and confidence in the predicted surface water flood risk. The LLFA's will be able to utilise this data or more detailed modelling outputs (such as those presented in this study) to display the predicted risk in an area.

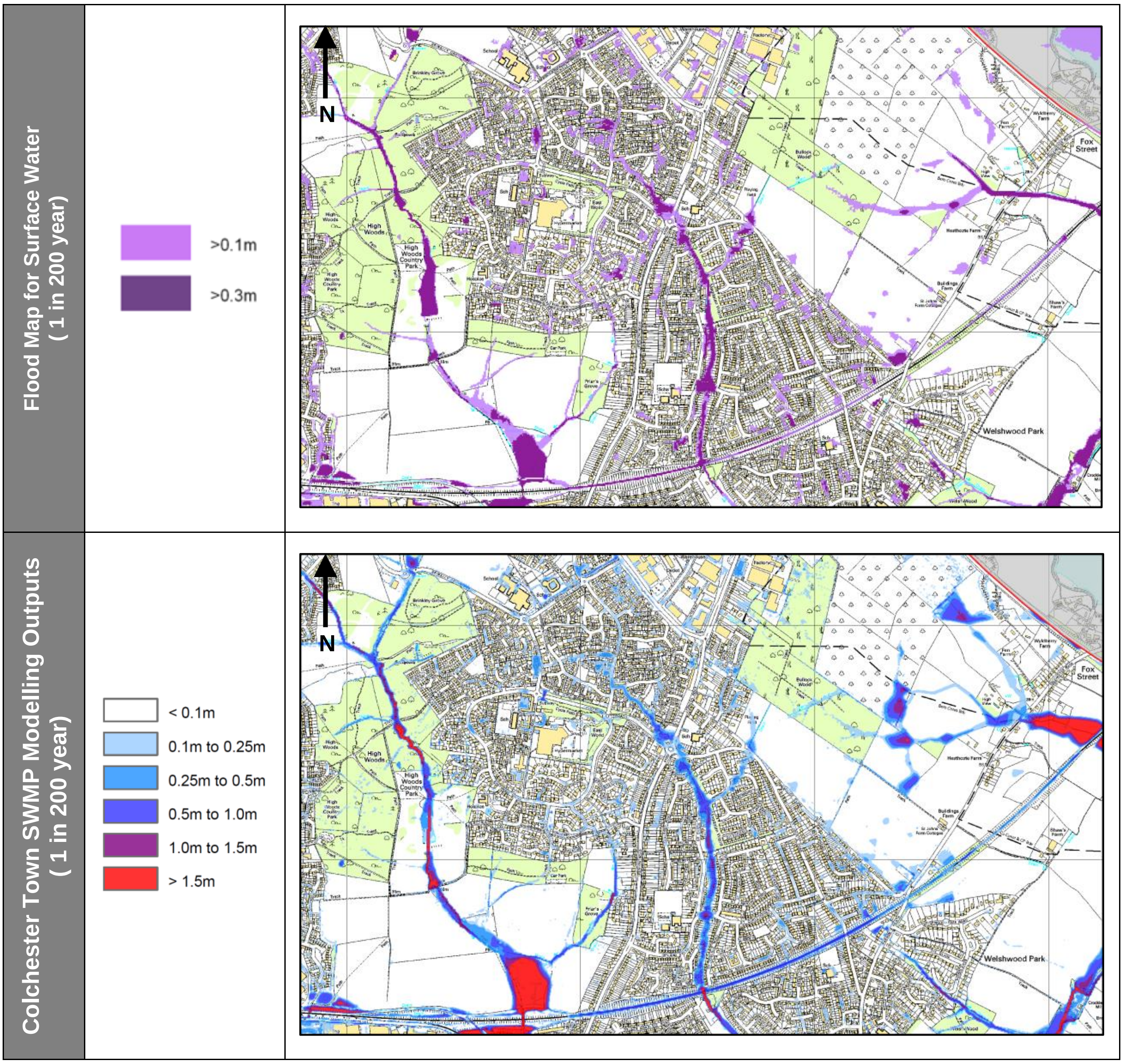


Figure 3-6 Example comparison between FMfSW and SWMP model outputs

Flood history and local knowledge

Recorded flood history has also been used to verify areas which are identified as being at risk of flooding with previous known flood events. As discussed in Section 3.2, information on historical flood events was collected from a number of sources. In addition to this, members of the Steering Group, have an extensive knowledge of the study area and the drainage and flooding history through living locally.

The use of a stakeholder workshop, with all Council representatives, was also an effective way to validate the model outputs. The members who attended the workshop examined the modelling outputs and were able to provided anecdotal information on past flooding which confirmed several of the predicted areas of ponding.

Mass balance checks

The accuracy of the hydraulic calculations driving the TUFLOW model, and the performance of the model itself, can be checked using a simple analysis of the data from the model. The percentage mass error is calculated every five (5) minutes and output with the other results files. The percentage mass error is a mass error based on the maximum volume of water that has flowed through the model and the total volume of water in the model. It is normal for the figure to be large at the start of a simulation, particularly with steep models using the direct rainfall approach, as the cells are rapidly becoming wet as it begins to rain but flow through the model is relatively small. Mass balance graphs can be located within Appendix B.

3.5.12 Model Outputs

TUFLOW outputs data in a format which can be easily exported into GIS packages. As part of the surface water modelling exercise, a series of ASCII grids and MapInfo TAB files have been created including:

- Flood depth grids;
- Flow velocity grids; and
- Flood hazard grids.

Flood hazard is a function of the flood depth, flow velocity and a debris factor (determined by the flood depth). Each grid cell generated by TUFLOW has been assigned one of four hazard rating categories: ‘Extreme Hazard’, ‘Significant Hazard’, ‘Moderate Hazard’ and ‘Low Hazard’. Guidance on the depths and velocities (hazard) of floodwater that can be a risk to people is shown within Figure 3-7 (overleaf).

The hazard rating (HR) at each point and at each time step during a flood event is calculated according to the following formula (Defra/Environment Agency FD2320/TR1 report, 2005):

$$HR = d\,(v + 0.5) + DF$$

Where: HR = flood hazard rating

d = depth of flooding (m)

v = velocity of floodwater (m/s)

DF = Debris Factor, according to depth, d (see below)

Guidance within the FD2320 report recommends the use of a Debris Factor (DF) to account for the presence of debris during a flood event in the urban environment. The Debris Factor is dependent on the depth of flooding; for depths less than 0.25m a Debris Factor of 0.5 was used and for depths greater than 0.25m a Debris Factor of 1.0 was used.

The maximum hazard rating for each point in the model is then converted to a flood hazard rating category, as described in

Table 3-4, overleaf. These are typically classified as caution (very low hazard), moderate (danger for some), significant (danger for most), extreme (danger for all).

HR	Depth of flooding - d (m)												
	DF = 0.5				DF = 1								
Velocity v (m/s)	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.0	0.03 + 0.5 = 0.53	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.13 + 0.5 = 0.63	0.15 + 1.0 = 1.15	0.20 + 1.0 = 1.20	0.25 + 1.0 = 1.25	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25
0.1	0.03 + 0.5 = 0.53	0.06 + 0.5 = 0.56	0.12 + 0.5 = 0.62	0.15 + 0.5 = 0.65	0.18 + 1.0 = 1.18	0.24 + 1.0 = 1.24	0.30 + 1.0 = 1.30	0.36 + 1.0 = 1.36	0.48 + 1.0 = 1.48	0.60 + 1.0 = 1.60	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.55
0.3	0.04 + 0.5 = 0.54	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.19 + 0.5 = 0.69	0.23 + 1.0 = 1.23	0.30 + 1.0 = 1.30	0.38 + 1.0 = 1.38	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	1.13 + 1.0 = 2.13	1.50 + 1.0 = 2.50	1.88 + 1.0 = 2.88
0.5	0.05 + 0.5 = 0.55	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.25 + 0.5 = 0.75	0.30 + 1.0 = 1.30	0.40 + 1.0 = 1.40	0.50 + 1.0 = 1.50	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	2.50 + 1.0 = 3.50
1.0	0.08 + 0.5 = 0.58	0.15 + 0.5 = 0.65	0.30 + 0.5 = 0.80	0.38 + 0.5 = 0.88	0.45 + 1.0 = 1.45	0.60 + 1.0 = 1.60	0.75 + 1.0 = 1.75	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50	2.25 + 1.0 = 3.25	3.00 + 1.0 = 4.00	3.75 + 1.0 = 4.75
1.5	0.10 + 0.5 = 0.60	0.20 + 0.5 = 0.70	0.40 + 0.5 = 0.90	0.50 + 0.5 = 1.00	0.60 + 1.0 = 1.60	0.80 + 1.0 = 1.80	1.00 + 1.0 = 2.00	1.20 + 1.0 = 2.20	1.60 + 1.0 = 2.60	2.00 + 1.0 = 3.00	3.00 + 1.0 = 4.00	4.00 + 1.0 = 5.00	5.00 + 1.0 = 6.00
2.0	0.13 + 0.5 = 0.63	0.25 + 0.5 = 0.75	0.50 + 0.5 = 1.00	0.63 + 0.5 = 1.13	0.75 + 1.0 = 1.75	1.00 + 1.0 = 2.00	1.25 + 1.0 = 2.25	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	3.50	4.75	6.00	7.25
2.5	0.15 + 0.5 = 0.65	0.30 + 0.5 = 0.80	0.60 + 0.5 = 1.10	0.75 + 0.5 = 1.25	0.90 + 1.0 = 1.90	1.20 + 1.0 = 2.20	1.50 + 1.0 = 2.50	1.80 + 1.0 = 2.80	3.40	4.00	5.50	7.00	8.50
3.0	0.18 + 0.5 = 0.68	0.35 + 0.5 = 0.85	0.70 + 0.5 = 1.20	0.88 + 0.5 = 1.38	1.05 + 1.0 = 2.05	1.40 + 1.0 = 2.40	1.75 + 1.0 = 2.75	3.10	3.80	4.50	6.25	8.00	9.75
3.5	0.20 + 0.5 = 0.70	0.40 + 0.5 = 0.90	0.80 + 0.5 = 1.30	1.00 + 0.5 = 1.50	1.20 + 1.0 = 2.20	1.60 + 1.0 = 2.60	3.00	3.40	4.20	5.00	7.00	9.00	11.00
4.0	0.23 + 0.5 = 0.73	0.45 + 0.5 = 0.95	0.90 + 0.5 = 1.40	1.13 + 0.5 = 1.63	1.35 + 1.0 = 2.35	1.80 + 1.0 = 2.80	3.25	3.70	4.60	5.50	7.75	10.00	12.25
4.5	0.25 + 0.5 = 0.75	0.50 + 0.5 = 1.00	1.00 + 0.5 = 1.50	1.25 + 0.5 = 1.75	1.50 + 1.0 = 2.50	2.00 + 1.0 = 3.00	3.50	4.00	5.00	6.00	8.50	11.00	13.50
5.0	0.28 + 0.5 = 0.78	0.60 + 0.5 = 1.10	1.10 + 0.5 = 1.60	1.38 + 0.5 = 1.88	1.65 + 1.0 = 2.65	3.20	3.75	4.30	5.40	6.50	9.25	12.00	14.75

Figure 3-7 Combinations of flood depth and velocity that cause danger to people (Source: DEFRA/Environment Agency research on Flood Risks to People - FD2320/TR2)

Table 3-4: Derivation of Hazard Rating category

Degree of Flood Hazard	Hazard Rating (HR)		Description
Low	<0.75	Caution	Flood zone with shallow flowing water or deep standing water
Moderate	0.75b – 1.25	Dangerous for some (i.e. children)	Danger: Flood zone with deep or fast flowing water
Significant	1.25 -2.5	Dangerous for most people	Danger: Flood zone with deep fast flowing water
Extreme	>2.5	Dangerous for all	Extreme danger: Flood zone with deep fast flowing water

3.6 Ordinary Watercourse Flooding

3.6.1 Description

All watercourses in England and Wales are classified as either 'Main Rivers' or 'ordinary watercourses'. The difference between the two classifications is based largely on the perceived importance of a watercourse, and in particular its potential to cause significant and widespread flooding. However, this is not to say watercourses classified as ordinary watercourses cannot cause localised flooding. The Water Resources Act (1991) defines a 'main river' as "a watercourse shown as such on a Main River Map". The Environment Agency stores and maintains information on the spatial extent of the Main River designations. The Flood and Water Management Act (2010) defines any watercourse that is not a Main River an ordinary watercourse – including ditches, dykes, rivers, streams and drains (as in 'land drains') but not public sewers.

The Environment Agency have duties and powers in relation to Main Rivers. Local Authorities, or in some cases Internal Drainage Boards, have powers and duties in relation to ordinary watercourses.

Flooding from ordinary watercourses occurs when water levels in the stream or river channel rise beyond the capacity of the channel, causing floodwater to spill over the banks of the watercourse and onto the adjacent land. The main reasons for water levels rising in ordinary watercourses are:

- Intense or prolonged rainfall causing rapid run-off increasing flow in watercourses, exceeding the capacity of the channel. This can be exacerbated by wet antecedent (the preceding time period) conditions and where there are significant contributions of groundwater;
- Constrictions/obstructions within the channel causing flood water to backup;
- Blockage/obstructions of structures causing flood water to backup and overtop the banks; and
- High water levels in rivers preventing discharge at the outlet of the ordinary watercourse (often into a main river).

The EA Main River dataset should be utilised by ECC and CBC to determine which watercourses they are required to maintain and manage under the FWMA.

3.6.2 Impacts of Flooding from Ordinary Watercourse

The consequence of ordinary watercourse flooding is dependent upon the degree of hazard generated by the flood water (as specified within the Defra/Environment Agency research on Flood Risks to People - FD2321/TR2) and what the receptor is (e.g. the consequence of a hospital flooding is greater than that of a commercial retailer). The hazard posed by flood water is related to the depth and velocity of water, which, in Ordinary Watercourses, depends on:

- Constrictions in the channel causing flood water to backup;
- The magnitude of flood flows;
- The size, shape and slope of the channel;
- The width and roughness of the adjacent floodplain; and
- The types of structures that span the channel.

The hazard presented by floodwater is proportional to the depth of water, the velocity of flow and the speed of onset of flooding. Hazardous flows can pose a significant risk to exposed people, property and infrastructure.

Whilst low hazard flows are less of a risk to life (shallow, slow moving/still water), they can disrupt communities, require significant post-flood clean-up and can cause costly and possibly permanent structural damage to property.

3.6.3 Methodology for Assessing Ordinary Watercourses

Ordinary watercourses have been included in the pluvial flood modelling. Watercourses have been defined by digitising 'breaklines' along the centre line of each watercourse. 'Breaklines' are used primarily to raise the elevation of the watercourse to the level of the surrounding banks to represent a "bank full" scenario. Elevations of watercourses have been determined from LiDAR.

Structures along the watercourse have been modelled as either 1D or 2D elements, depending on the length and location of the structure. The dimensions of structures have been determined from asset information obtained in the data collection stage where available or inferred from site visits or LiDAR data.

The assessment of flood risk from ordinary watercourses has been based on outputs from the pluvial modelling process described earlier in this Section, and presented in Appendix C.

3.6.4 Uncertainties and Limitations – Ordinary Watercourse Modelling

As with any hydraulic model, these models have been based on a number of assumptions which may introduce uncertainties into the assessment of risk. The assumptions within the models should be noted and understood such that informed decisions can be made when using model results.

In relation to ordinary watercourses, the limits of the modelling include (but are not limited to):

- Modelling of structures has not been based on detailed survey data; and
- Only one storm duration was considered for this study.

Taking these uncertainties and constraints into consideration, the estimation of risk of flooding from rivers presented in this report is considered robust for the level of assessment required in the SWMP.

3.7 Groundwater Flooding

3.7.1 Description

Groundwater flooding is water originating from sub-surface permeable strata which emerges from the ground, either at a specific point (such as a spring) or over a wide diffuse location, and inundates low lying areas. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land.

The actual flooding can occur some distance from the emergence zone, with increased flows in local streams resulting in flooding at downstream constrictions / obstructions. This can make groundwater flooding difficult to categorise. Flooding from groundwater tends to be long in duration, developing over weeks or months and continuing for days or weeks.

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

- Direct contribution to channel flow;
- Springs emerging at the surface;

- Inundation of drainage infrastructure; and
- Inundation of low-lying property (basements).

3.7.2 Impacts of Groundwater Flooding

The main impacts of groundwater flooding are:

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

In general terms groundwater flooding rarely poses a risk to life. Figure 3-8 shows the Environment Agency Areas Susceptible to Groundwater Flooding dataset.

3.7.3 Groundwater Historic Records

No historic groundwater flooding records where highlighted within the data provided as part of this assessment.

3.7.4 Groundwater Flooding Risk Assessment

The data sources listed below have been reviewed to produce an overall interpretation of groundwater flood risk in the study area.

- Environment Agency Groundwater Flooding Database (EA, 2012);
- EA Areas Susceptible to Groundwater Flooding Map (EA 2012); and
- British Geological Survey (BGS) Groundwater Flood Susceptibility Map (BGS, 2012).

The information sources listed above were reviewed as part of this study. Table 3-5 (page 42) summarises the content of each source and how it has been used within the risk assessment.

Table 3-5: Review of Available Groundwater Information

Source	Summary	Risk Assessment Application
EA Areas Susceptible to Groundwater Flooding (AStGWF) Map	This data has used the top two susceptibility bands of the British Geological Society (BGS) 1:50,000 Groundwater Flood Susceptibility Map. It shows the proportion of each 1km grid square where geological and hydrogeological conditions show that groundwater might emerge.	This provides an overview of proportional area that is at high or very high risk of groundwater flooding. The categories are as follows: <25% (low) ≥25%<50%(moderate) ≥ 50% <75% (high) ≤75% (very high)
EA Groundwater Flooding Database	This database indicated no records within the study area.	-

The basis for the groundwater flood risk assessment for this study is predominantly the EA Areas Susceptible to Groundwater Flooding map. This map uses underlying geological information to infer groundwater flood susceptibility.

If more detailed data relating to the risk of groundwater flooding is required, it is recommended that the reader contact the British Geological Society in order to obtain the Groundwater Flooding Susceptibility Maps. This data covers consolidated aquifers (chalk, sandstone etc., termed 'clearwater' in the data attributes) and superficial deposits. It does not take account of the chance of flooding from groundwater rebound and classify the susceptibility into the following categories; very low, low, moderate, high and very high and is not restricted to identifying the risk with 1km square grids.

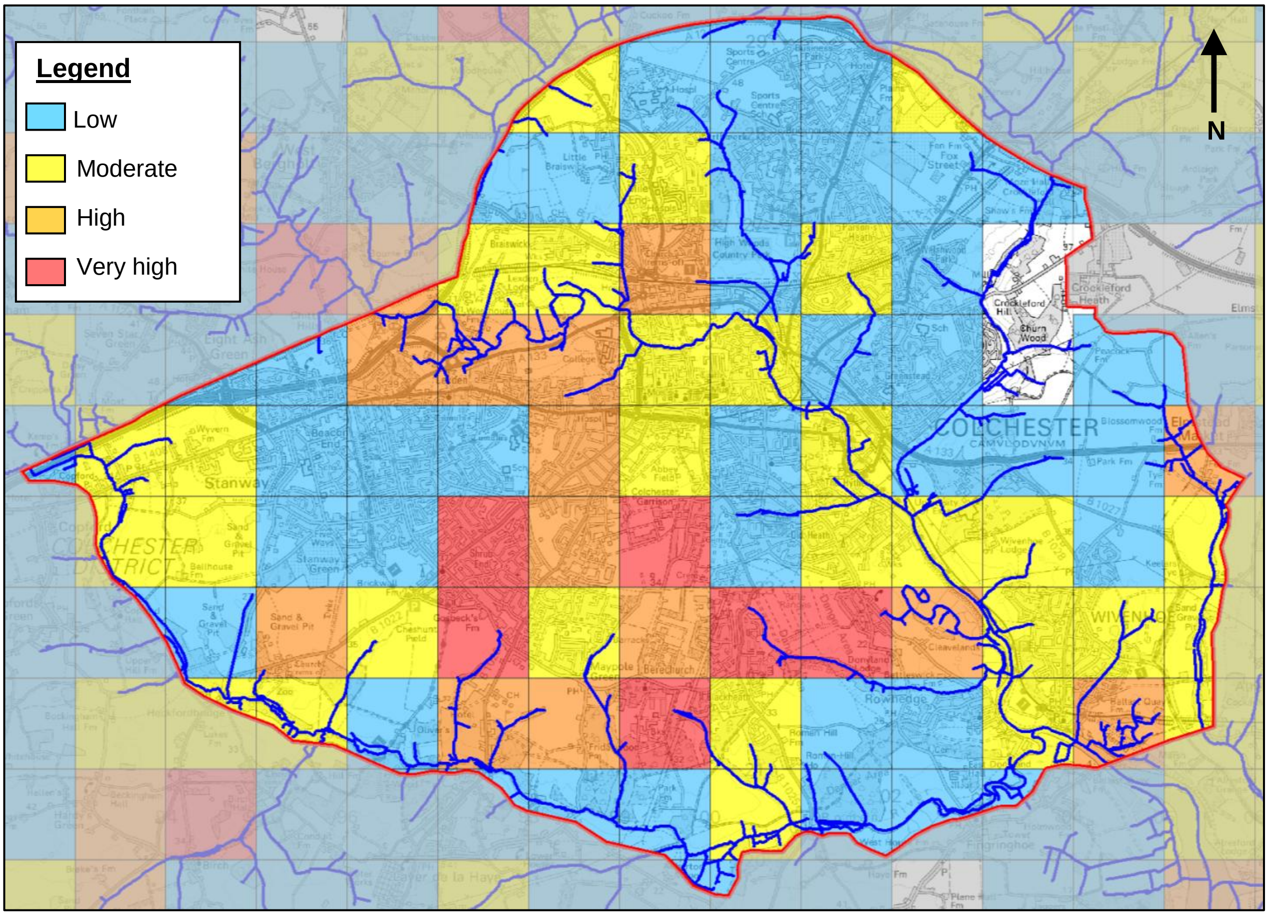


Figure 3-8 Environment Agency Areas Susceptible to Groundwater Flooding

3.7.5 Geology

A geological map for the study area is provided in Appendix C (Figure 4), reproduced from the British Geological Survey (BGS) 1:50,000 scale geological series.

The solid geology of the area is dominated by London Clay, which is exposed along the sides of the river valley and at the ground surface in some areas. In locations where London Clay is overlain by drift deposits these are composed of the Lowestoft Formation, head deposits, alluvium and river terrace deposits. It is thought that the London Clay formation slopes from west to east, indicating that the River Colne may flow through alluvium deposits. Kesgrave Sands and Gravels, river terrace deposits and alluvial deposits are found in and around river channels.

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

The SFRA indicated that groundwater levels surrounding the River Colne at Colchester are thought to be in hydraulic continuity with the River Colne, although, fluctuations of 1m in groundwater levels during spring tides suggest the groundwater is not completely in continuity with the tide but is not completely unconfined. As such, groundwater flooding from this source is not likely to be as pronounced as if the groundwater was in complete hydraulic continuity with the tide

Groundwater flooding is often highly localised and complex. Large areas within the study area are underlain by permeable substrate and thereby have the potential to store groundwater. Under some circumstances groundwater levels can rise and cause flooding problems in subsurface structures or at the ground surface. The mapping technique adopted by BGS aims to identify only those areas in which there is the greatest potential for this to happen.

There is currently limited research which specifically considers the impact of climate change on groundwater flooding. The mechanisms of flooding from aquifers are unlikely to be affected by climate change, however if winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers.

3.7.6 Groundwater Flooding Management

Management is highly dependent upon the characteristics of the specific situation. The costs associated with the management of groundwater flooding are highly variable. The implications of groundwater flooding should be considered and managed through development control and building design. Possible responses include:

- Raising property ground or floor levels or avoiding the building of basements in areas considered to be at risk of groundwater flooding.
- Provide local protection for specific problem areas such as flood-proofing properties (such as tanking, sealing of building basements, raising the electrical sockets/TV points etc).
- Replacement and renewal of leaking sewers, drains and water supply reservoirs. Water companies have a programme to address leakage from infrastructure, so there is clear ownership of the potential source.
- Major ground works (such as construction of new or enlarged watercourses) and improvements to the existing surface water drainage network to improve conveyance of floodwater from surface water of fluvial events through and away from areas prone to groundwater flooding.

Most options involve the management of groundwater levels. It is important to assess the impact of managing groundwater with regard to water resources, and environmental designations. Likewise, placing a barrier to groundwater movement can shift groundwater flooding from one location to another. The appropriateness of infiltration based drainage techniques should also be questioned in areas where groundwater levels are high or where source protection zones are close by.

3.7.7 Uncertainties and Limitations – Groundwater Flooding

Within the areas delineated, the local rise of groundwater will be heavily controlled by local geological features and artificial influences (e.g. structures or conduits) which cannot currently be represented. This localised nature of groundwater flooding compared with, say, fluvial flooding suggests that interpretation of the map should similarly be different. The map shows the area within which groundwater has the potential to emerge but it is unlikely to emerge uniformly or in sufficient volume to fill the topography to the implied level. Instead, groundwater emerging at the surface may simply runoff to pond in lower areas.

Locations shown to be at risk of surface water flooding are also likely to be most at risk of runoff/ponding caused by groundwater flooding. Therefore the susceptibility map should not be used as a “flood outline” within which properties at risk can be counted. Rather, it is provided, in conjunction with the surface water mapping, to identify those areas where groundwater may emerge and what the major water flow pathways would be in that event.

It should be noted that this assessment is broad scale and does not provide a detailed analysis of groundwater; it only aims to provide an indication of where more detailed consideration of the risks may be required.

The causes of groundwater flooding are generally understood. However, groundwater flooding is dependent on local variations in topography, geology and soils. It is difficult to predict the actual location, timing and extent of groundwater flooding without comprehensive datasets.

There is a lack of reliable measured datasets to undertake flood frequency analysis on groundwater flooding and even with datasets this analysis is complicated due to the non-independence of groundwater level data. Studies therefore tend to analyse historic flooding which means that it is difficult to assign a level of certainty.

The impact of climate change on groundwater levels is highly uncertain. The UK Climate Impact Programme (UKCIP) model indicates that, in future, winters may be generally wetter and summers substantially drier across the UK. The greater variability in rainfall could mean more frequent and prolonged periods of high or low water levels. The effects of climate change on groundwater in the UK therefore may include increased frequency and severity of groundwater-related floods. It should be noted that although winter rainfall may increase the frequency of groundwater flooding incidents, the potential of drier summers and lower recharge of aquifers may counteract this effect.

3.7.8 Infiltration SuDS

Improper use of infiltration SuDS could lead to contamination of the superficial deposit or bedrock aquifers, leading to deterioration in aquifer quality status or groundwater flooding / drainage issues. However, correct use of infiltration SuDS is likely to help improve aquifer quality status and reduce overall flood risk.

Information on infiltration SUDS and their appropriate application within Colchester (and Essex) can be obtained via the draft Essex County Councils SuDS Design and Adoption Guide located at http://www.essex.gov.uk/Environment%20Planning/Environmental-Issues/local-environment/flooding/Pages/Sustainable-drainage-systems.aspx. The Environment Agency also provide guidance on infiltration SuDS at the following website: http://www.environment-agency.gov.uk/business/sectors/36998.aspx. These documents should be considered by developers and their contractors, and by the Councils when approving or rejecting planning applications.

The areas that may be suitable for infiltration SuDS exist where there is a combination of high ground and permeable geology. However, consideration should be given to the impact of increased infiltration SuDS on properties further down gradient. An increase in infiltration and groundwater recharge will lead to an increase in groundwater levels, thereby increasing the susceptibility to groundwater flooding at a down gradient location. This type of analysis is beyond the scope of the current report, but it could be as significant problem where there is potential for perched water tables to develop. Figure 3–9 (overleaf) provides the summary outputs of the Infiltration SuDS Map across Essex County Council as produced by the British Geological Survey (BGS), refer to Figures 6-1 to 6-4 contained within Appendix C for more detailed mapping. Clarification of each summary map can be obtained from the BGS

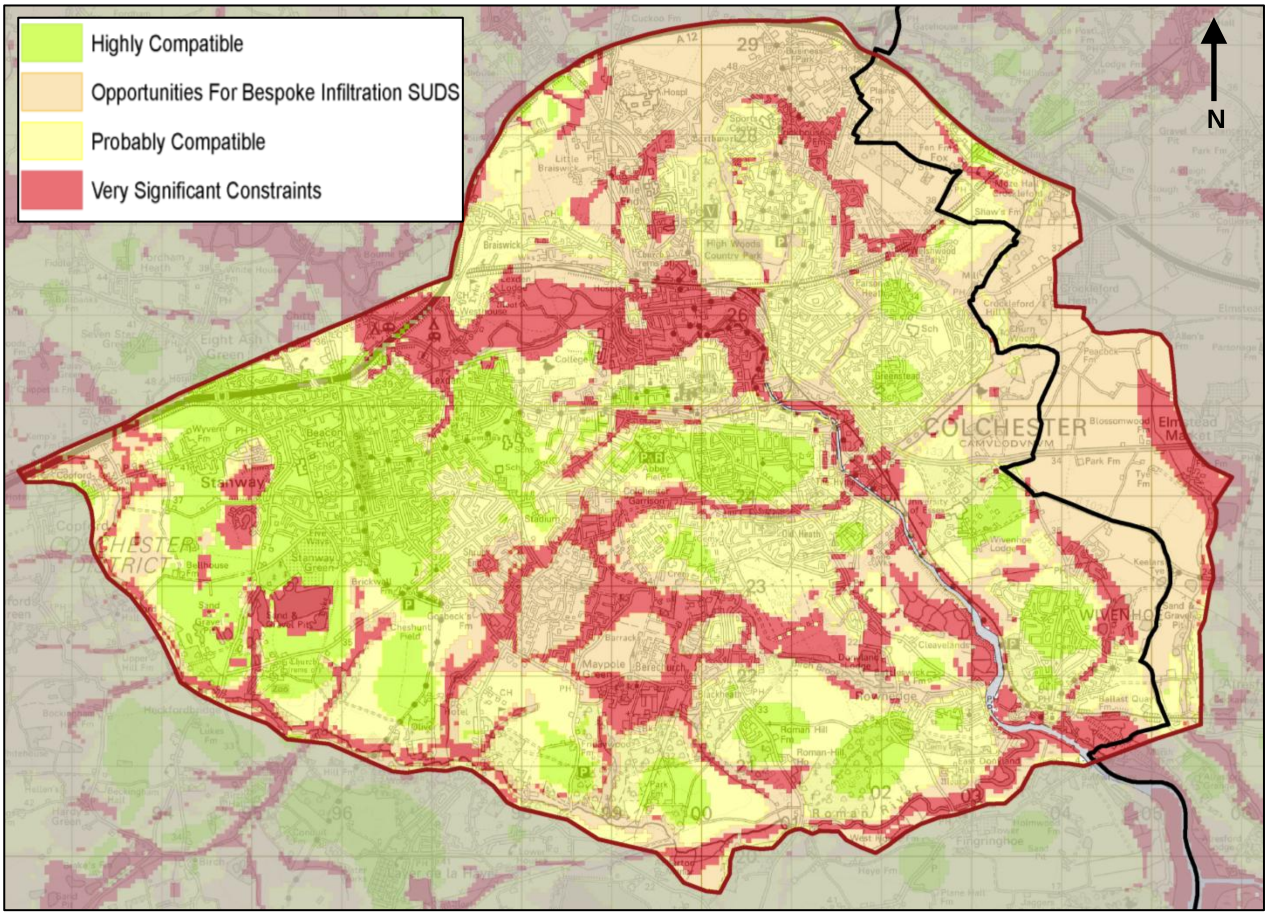


Figure 3-9 BGS SUDS Suitability Mapping – Infiltration Suitability

Source protection zones (SPZs) should be considered when applying mitigation measures, such as SuDS, which have the potential to contaminate the underlying aquifer if this is not considered adequately in the design. Generally, it will not be acceptable to use infiltrating SuDS in an SPZ 1 if the drainage catchment comprises trafficked surfaces or other areas with a high risk of contamination. Restrictions on the use of infiltration SuDS apply to those areas within Source Protection Zones (SPZ). Developers must ensure that their proposed drainage designs comply with the available Environment Agency guidance.

3.8 Sewer Flooding

3.8.1 Description

Flooding which occurs when the capacity of the underground drainage network is exceeded, resulting in the surcharging of water into the nearby environment (or within internal and external building drainage networks) or when there is an infrastructure failure. The discharge of the drainage network into waterways and rivers can also be affected if high water levels in receiving waters obstruct the drainage network outfalls. In the study area, the sewer network varies from a largely combined system within the central portion of the town to separated surface water and foul system within the areas of urban expansion.

3.8.2 Causes of sewer flooding

The main causes of sewer flooding are:

- Lack of capacity in the sewer drainage networks– this is often a result of the original design criteria requiring a reduced standard of protection which was acceptable at the time of construction;
- Lack of capacity in sewer drainage networks due to an increase in flow (such as climate change and/or new developments connecting to the network);
- Exceeded capacity in sewer drainage networks due to events larger than the system designed event;
- Loss of capacity in sewer drainage networks when a watercourse has been fully culverted and diverted or incorporated into the formal drainage network (lost watercourses);
- Lack of maintenance or failure of sewer networks which leads to a reduction in capacity and can sometimes lead to total sewer blockage;
- Failure of sewerage infrastructure such as pump stations or flap valves leading to surface water or combined foul/surface water flooding;
- Additional paved or roof areas i.e. paved driveways and conservatories connected onto existing network without any control;
- Lack of gully maintenance restricting transfer of flows into the drainage network;
- Groundwater infiltration into poorly maintained or damaged pipe networks; and
- Restricted outflow from the sewer systems due to high water or tide levels in receiving watercourses (‘tide locking’).

3.8.3 Impacts of Sewer Flooding

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

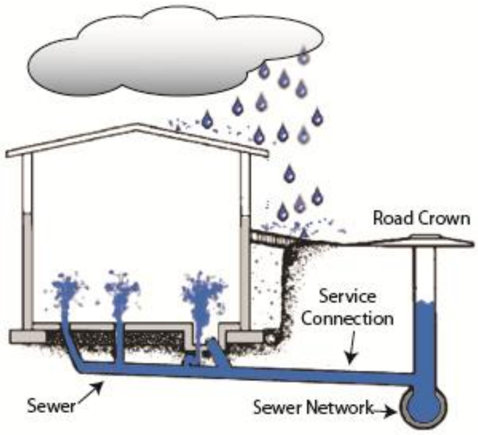


Figure 3-10 Surcharging of the sewer system within a road (left) and internally within a property (right)

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

The diversion of "natural" watercourses into culverted or piped structures is a historic feature of the study area drainage network. Where it has occurred, deliberately or accidentally it can result in a reduced available capacity in the network during rainfall events when the sewers drain the watercourses catchment as well as the formal network. Excess water from these watercourses may flow along unexpected routes at the surface (usually dry and often developed) as its original channel is no longer present and the formal drainage system cannot absorb it.

In order to clearly identify problems and solutions, it is important to first outline the responsibilities of different organisations with respect to drainage infrastructure. The responsible parties are primarily the Highways Authority and Anglian Water.

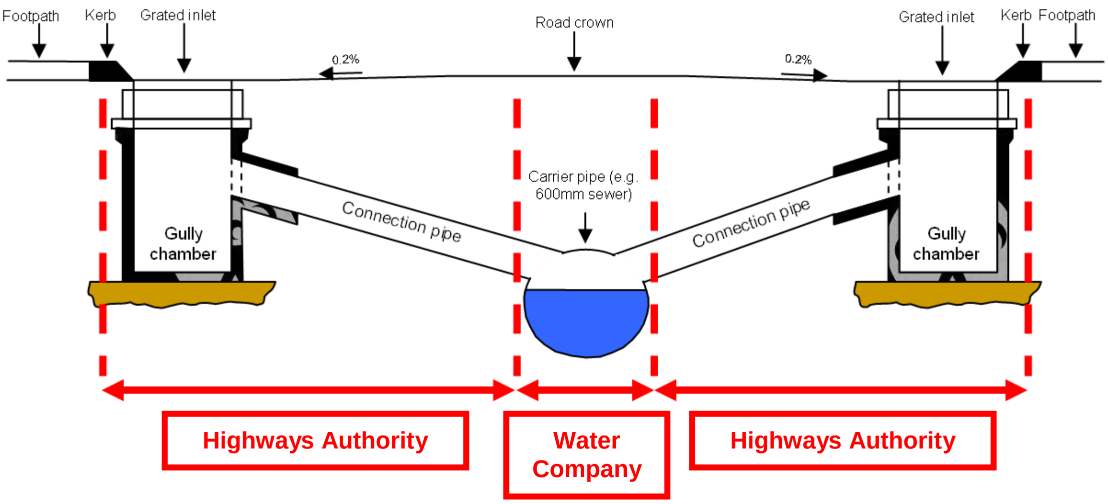


Figure 3-11 Surface water sewer responsibility

As illustrated in Figure 3-11, Essex Highways, as the Highways Authority, is responsible for maintaining an effective highway drainage system including kerbs, road gullies and the pipes which connect the gullies to the trunk sewers and soakaways. Essex Highways are also the Highways Authority for all roads except trunk roads. The sewerage undertaker, in this case Anglian Water, is responsible for maintaining the trunk sewers.

New drainage networks are designed as separate foul and surface water sewers. New surface water systems are typically designed to accommodate 1 in 30 year storm events. New foul sewers are designed for the population which is to be served, with allowance for infiltration. Anglian Water have indicated that only existing foul/combined systems that flood during storm conditions will be upgraded to accommodate 1 in 30 year storm returns for internal flooding and 1 in 20 for external flooding. Therefore, rainfall events with a return period or frequency greater than 1 in 30 years would be expected to result in surcharging of some of the sewer system.

Colchester Sewage Treatment Works (STW) receives wastewater from the majority of the Colchester town together with land to the north east of the A12. The area is shown in Figure 3-12.

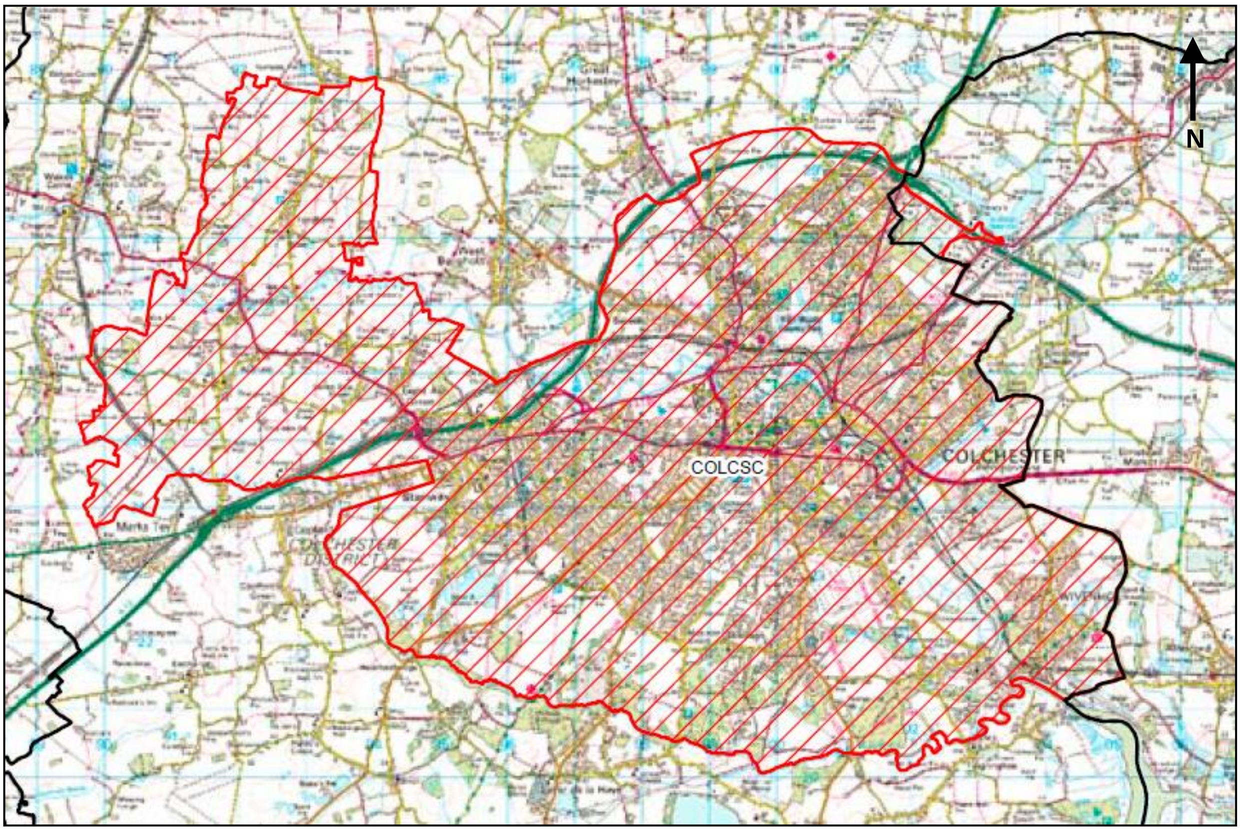


Figure 3-12 Catchment of the Colchester Sewage Treatment Works

The WCS indicates that Anglian Water commented that the Colchester STW has no spare capacity. In most of the catchment, Anglian Water also identified the sewer network as currently operating close to, or at, capacity.

Based upon both scenarios of development (including employment development and without), the Colchester STW is already operating beyond capacity with the discharge continuing to increase beyond consent throughout the planning period. In addition, many areas of the catchment will require improvement of the sewer network to accommodate the additional development with actions required from either AW and/or individual developers.

The WCS also highlighted that measures are in place for growth accommodation within AMP5, AW have stated that there is no capacity within the existing sewers for this development area. As the town centre is served by a combined sewer network, surface water will need to be separated from the foul for all new developments as a main planning consideration.

Anglian Water's *Strategic Direction Statement 2010 - 2035* indicates that Anglian Water plan to deliver a problem-free service and an effective response on the occasions when things do not go according to plan. Over the period from 2010 to 2035 Anglian Water aims to minimise risks of service failure to their customers. Specifically, they will aim to:

- Have minimal planned or unplanned interruptions to service; and
- Unless weather conditions are exceptional, have no properties that are at risk of sewer flooding by 2020 and a substantial reduction against today's levels at risk by 2015.

Anglian Water have provided post code-linked data (DG5 register) on records of sewer flooding up to November 2012 for use in this SWMP. Figure 7 (Appendix C) provides a graphical representation of the DG5 data provided by Anglian Water.

3.8.4 Drainage Network

A number of different data sources were used to obtain a detailed understanding of the sewer network across Colchester, primarily through consultation with Anglian Water. Anglian Water (AW) is keen to work with CBC and the LLFA (Essex County Council), in order to mitigate flood risk issues in an integrated manner.

AW currently do not have a hydraulic model for the surface water drainage network within the study area, but provided details of the infrastructure network including sewers, manholes, pumping stations and outfalls in GIS format. A review of this information highlighted that this data set omitted information which in discussion with the Steering Group, indicated that without obtaining significant amounts of survey information on AW's assets (invert levels and pipe diameters) the data could not be incorporated within the pluvial model. Due the missing information it was agreed that a continuous loss rate should be applied to all impervious surfaces to reflect benefit of the drainage network within the catchment.

3.8.5 Methodology for Drainage Network Modelling

The sewer system was not modelled explicitly; hence the interaction between the sewer system and surface water modelling is not investigated. Once the missing data is obtained for the drainage assets, the network could be incorporated within the pluvial model as part of future enhancements.

3.8.6 Assumptions for the Drainage Network Model

- A continuous infiltration rate of 3.5 mm/hr was utilised as a conservative approach for representing the drainage network within the study area – this value represents approximately 10% of the predicted rainfall depth for the study area;
- Drainage losses are only applied to impermeable surfaces (as defined by MasterMap); and
- No pumping stations have been included within the model.

3.8.7 Uncertainties in Flood Risk Assessment – Sewer Flooding

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

The number of assumptions included within the drainage element of the model can impact the final result and should be reviewed once more detailed data is available to ensure the model reflect the actual assets included within the study area.

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

3.9 Main River Fluvial and Tidal Flooding

Interactions between surface water and fluvial flooding are generally a result of watercourses unable to receive and convey excess surface water runoff. Where the watercourse in question is defended, surface water can pond behind defences. This may be exacerbated in situations where high water levels in the watercourse prevent discharge via flap valves through defence walls.

Main Rivers have been considered in the surface water modelling by assuming the flows water level at the time the DTM was obtained, in the same way that ordinary watercourses have been modelled. Structures such as weirs, locks and gates along watercourses have not been explicitly modelled.

Historically, a network of flood defences has been constructed to reduce flood risk within Colchester, and large drainage features are used to manage discharge during flood events. Whilst managing flood risk over large areas of Colchester, as shown in Figure 3-13, this flood defence infrastructure does increase the residual risk of flooding in these areas due to the possibility of its failure (and can also influence flooding on the upstream side as a result of the unnatural obstruction to surface water flows). There are two primary modes of defence failure; overtopping and breach. The latter is commonly far more destructive than the former and has been the focus of numerous modelling exercises within the study area; refer to the SFRA (Appendix C Colchester Supplementary Report) for further information.

A review of the Environment Agency's Flood Risk Zones indicates that the risk of fluvial flooding from Main Rivers and Tidal sources is largely concentrated around the river corridors of the River Colne and its tributaries.

Figure 3-13 (overleaf) displays the Flood Risk Zones and identifies the areas benefiting from defences

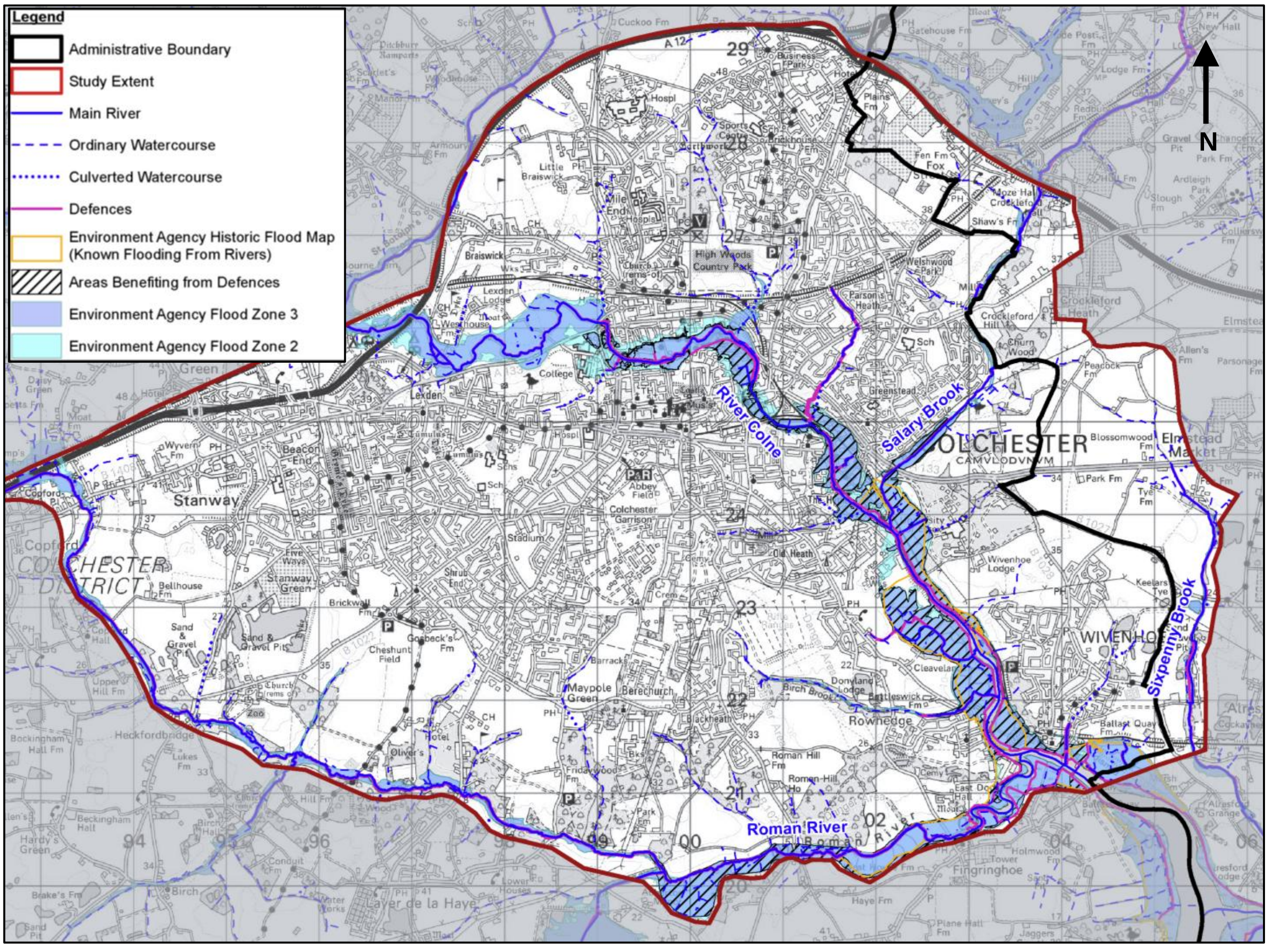


Figure 3-13 Flood Zones and Defence Locations within Colchester

Please note that the effects of main river flooding have not been assessed as part of this study; more information can be found in the CFMP and SFRA documents. Further information on fluvial (Main River) flooding can be found in the following SFRA documents:

- Scott Wilson (2007) Mid Essex Strategic Flood Risk Assessment;
- Scott Wilson (2008) Strategic Flood Risk Assessment – Appendix C Colchester Supplementary Report. Add to reference list
- Scott Wilson (2010) Essex County Council Level 1 Minerals & Waste Strategic Flood Risk Assessment;
- Environment Agency (2008) North Essex Catchment Flood Management Plan; and
- URS Scott Wilson (2011) Essex County Council Preliminary Flood Risk Assessment.

4 Identification of Flood Risk Areas

4.1 Overview

The purpose of the intermediate risk assessment is to identify those parts of the study area that are likely to require more detailed assessment to gain an improved understanding of the causes and consequences of surface water flooding. The intermediate assessment was used to identify areas where the flood risk is considered to be most severe; these areas are identified as Critical Drainage Areas (CDAs). The working definition of a CDA in this context has been agreed as:

> *'a discrete geographic area (usually a hydrological catchment) where multiple or interlinked sources of flood risk cause flooding during a severe rainfall event thereby affecting people, property or local infrastructure.'*

The CDA comprises the upstream 'contributing' catchment, the influencing drainage catchments, surface water catchments and, where appropriate, a downstream area if this can have an influence on CDA. They are typically located within Flood Zone 1 but should not be excluded from other Flood Zones if a clear surface water (outside of other influences) flood risk is present. In spatially defining a CDA, the following should be taken into account:

- **Flood depth and extent** – CDAs should be defined by looking at areas within the study area which are predicted to suffer from deep levels of surface water flooding;
- **Surface water flow paths and velocities** – Overland flow paths and velocities should also be considered when defining CDAs;
- **Flood hazard** – a function of flood depth and velocity, the flood hazard ratings across the modelled study area should also be used to define CDAs;
- **Potential impact on people, properties and critical infrastructure** – including residential properties, main roads (access to hospitals or evacuation routes), rail routes, rail stations, hospitals and schools;
- **Groundwater flood risk** – based on groundwater assessment and EA AStGWF dataset identifying areas most susceptible to groundwater flooding;
- **Sewer capacity issues** – based on sewer flooding assessment and information obtained from Anglian Water and their sewer modelling consultants;
- **Significant underground linkages** – including underpasses, tunnels, large diameter pipelines (surface water, sewer or combined) or culverted rivers;
- **Cross boundary linkages** – CDAs should not be curtailed by political or administrative boundaries;
- **Historic flooding** – areas known to have previously flooded during a surface water flood event;
- **Definition of area** – including the hydraulic catchment contributing to the CDA and the area available for flood mitigation options; and
- **Source, pathway and receptor** – the source, pathway and receptor of the main flooding mechanisms should be included within the CDA.

Where CDAs are difficult to identify, it is recommended that Local Flood Risk Zones (LFRZ) are identified to enable further investigation to determine if they are part of a wider CDA. A LFRZ is defined as discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect properties, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location.

4.2 Colchester Town CDA Assessment

Based on the above criteria, and identified flood risk within the study area, it has been concluded that there are nine (9) CDAs, which are reviewed within the following sections. In order to quantify the risk across the CDAs an assessment has been carried out to determine the amount of properties and critical infrastructure at risk from surface water flooding during a range of flood events. Details on this assessment are included in the following sections. Figure 4-1 (below) identifies the location of the CDAs within Colchester, the predicted 1 in 100 year depth outputs and Flood Zone 3 (cyan colour).

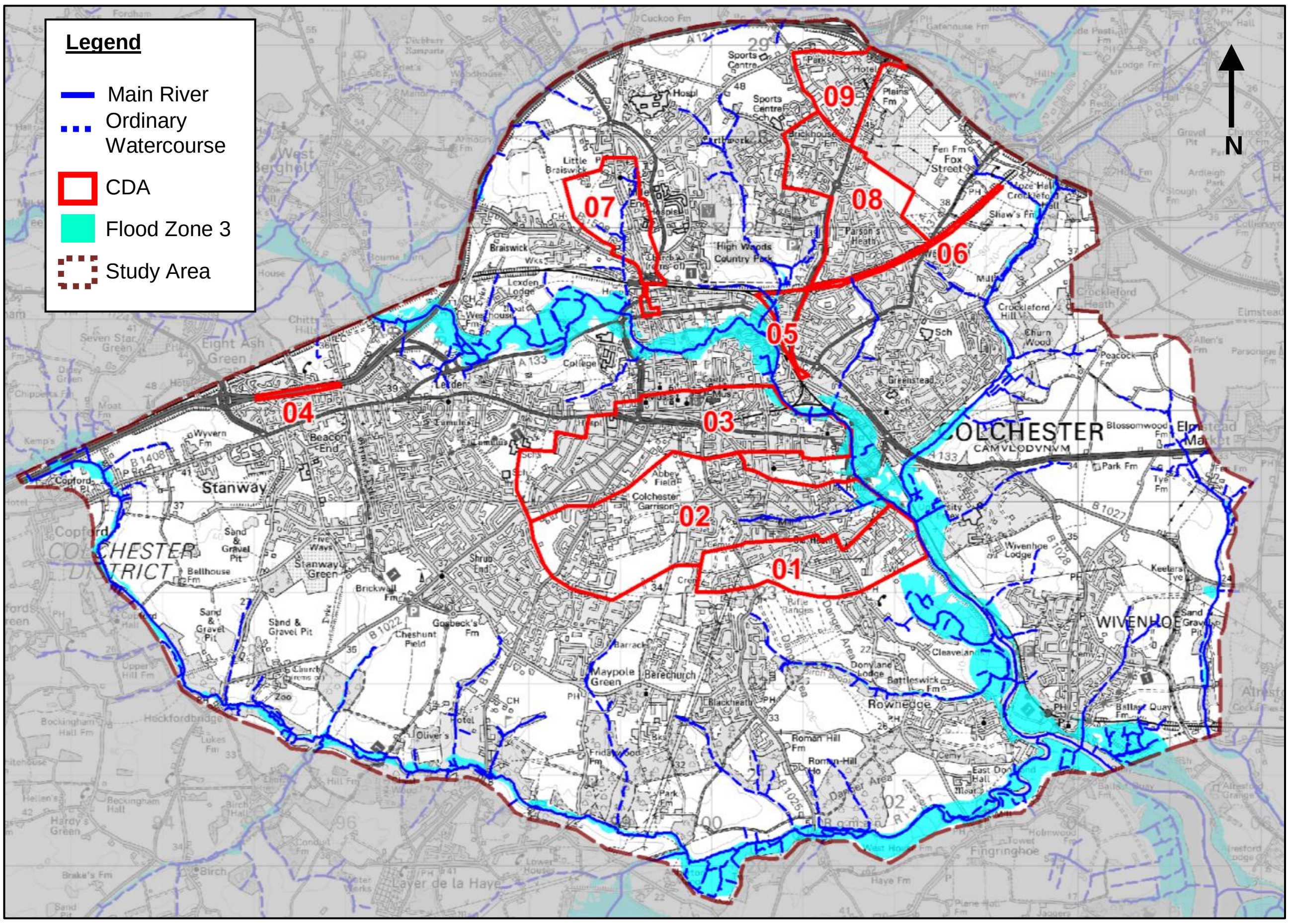
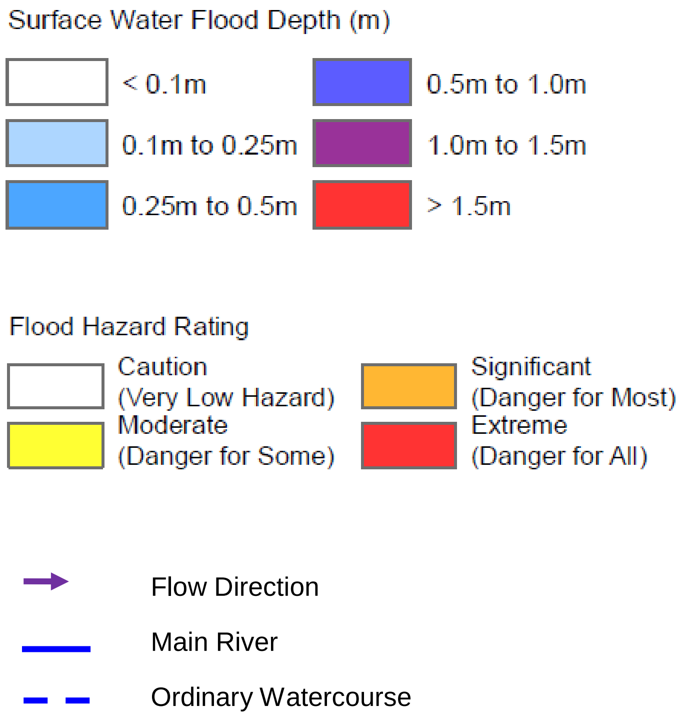


Figure 4-1 Critical Draiange Areas and Environment Agency Flood Zone 3 shown within Colchester

Please note that only CDA within the Colchester town area was assessed. The model was extended to Wivenhoe in order to model the River Colne and Salary Brook, but the assessment of risk for areas east of these watercourses was not undertaken as part of this study.

The following legend applies to all of the CDA summaries.



CDA 01 – Old Heath Area

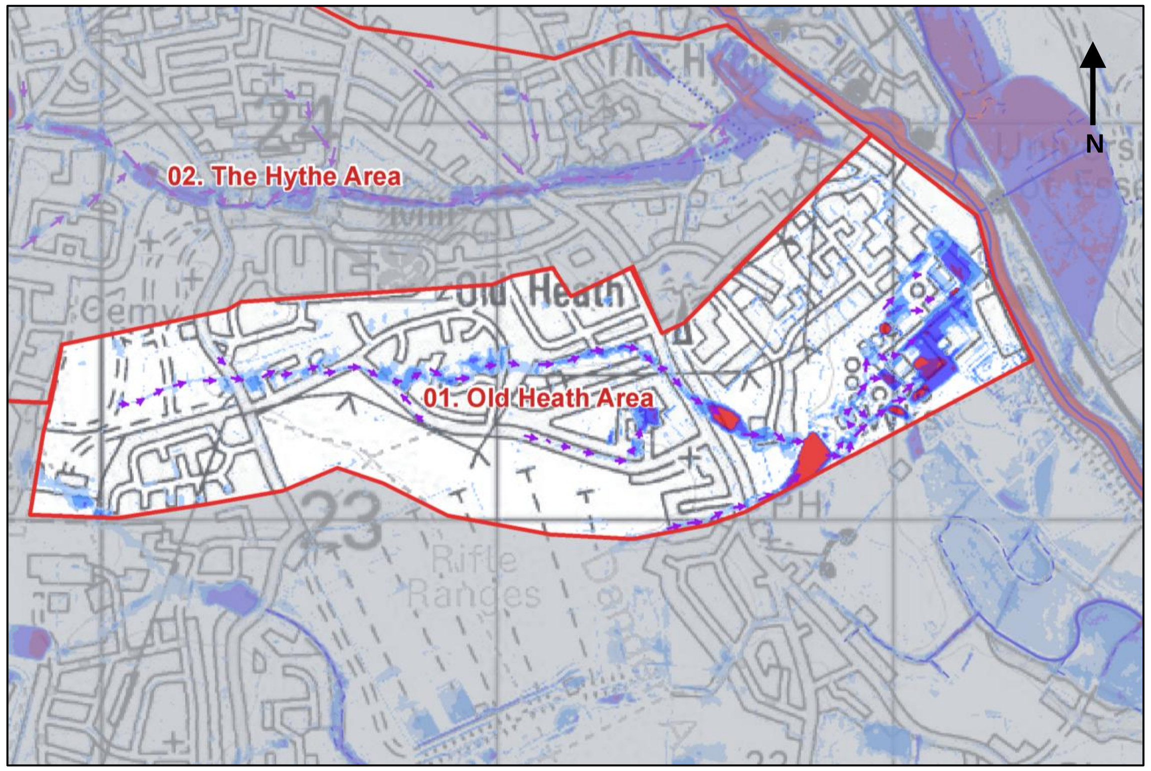


Figure 4-2 CDA 01 - 1 in 100 year Depth Results

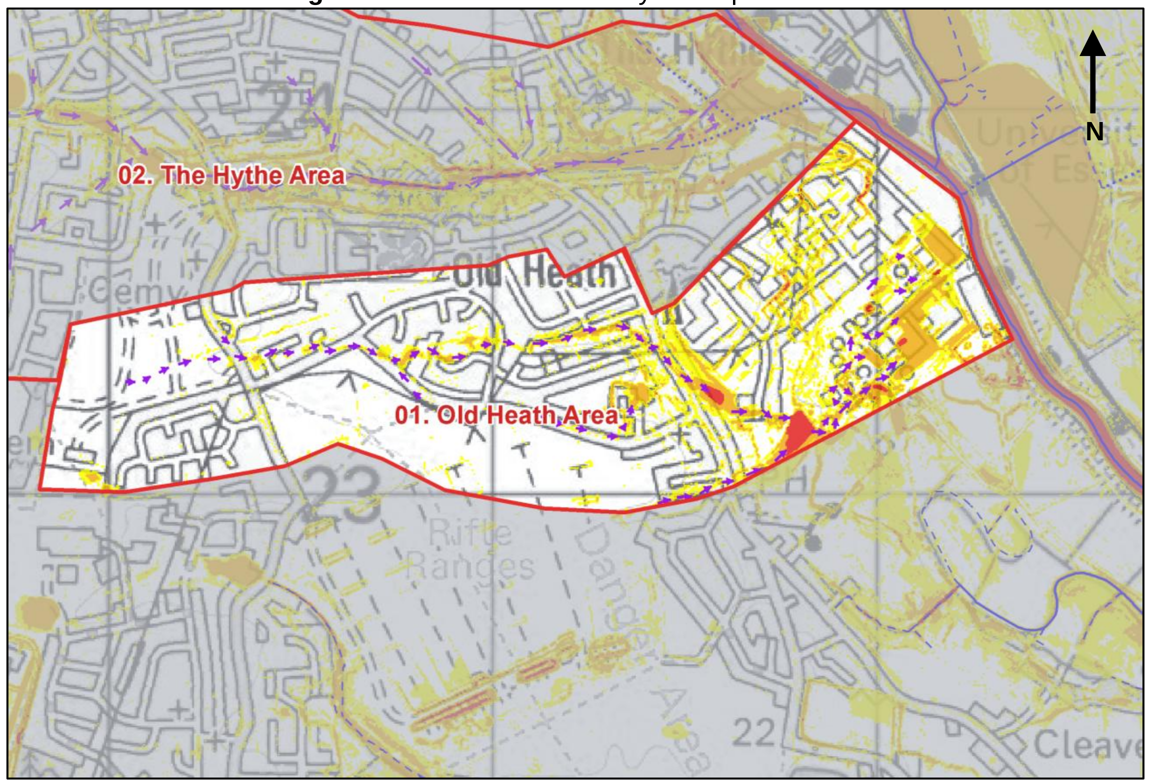


Figure 4-3 CDA 01 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in south-eastern portion of Colchester within the area of Old Heath.

Surface water is predicted to flow generally from west to east towards the River Colne. The pluvial modelling indicates predicted surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads). Water flows from the upper catchment in an easterly direction where it appears to flow in an easterly as a result of the preferential flow route for overland sheet runoff – a possible lost watercourse.

Tidal/fluvial flood zones are located within the CDA. Both Flood Zones 2 and 3 are located along the CDAs boundary with the River Colne. This CDA benefits from Main River flood defences.

Table 4-1 Summary of local flood risk within the CDA 01 – Old Heath Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from predominantly urban areas are conveyed as overland sheet flow via what appears to be a lost watercourse.	Due to the topography of the area a natural overland flow path is conveyed into the east portion of the CDA from higher ground.	Open space, residential properties, gardens, sewage treatment plant roads.
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	The main area of ponding is located east of Old Heath Road and the sewage treatment plant	Open space, residential properties, gardens, sewage treatment plant roads.
Hazard	Predominantly 'low' with 'moderate' and 'significant' hazards predicted within large areas of ponding.		
Sewer	The drainage network within the CDA is a separated surface water drainage system.		
Validation	Two historic events are located within the eastern boundary of the CDA which support the predicted results.		
Groundwater	The western portion of the CDA is highlighted to be at a low risk whilst the eastern half is at a moderate susceptibility to groundwater flooding.		

CDA 02 – The Hythe Area

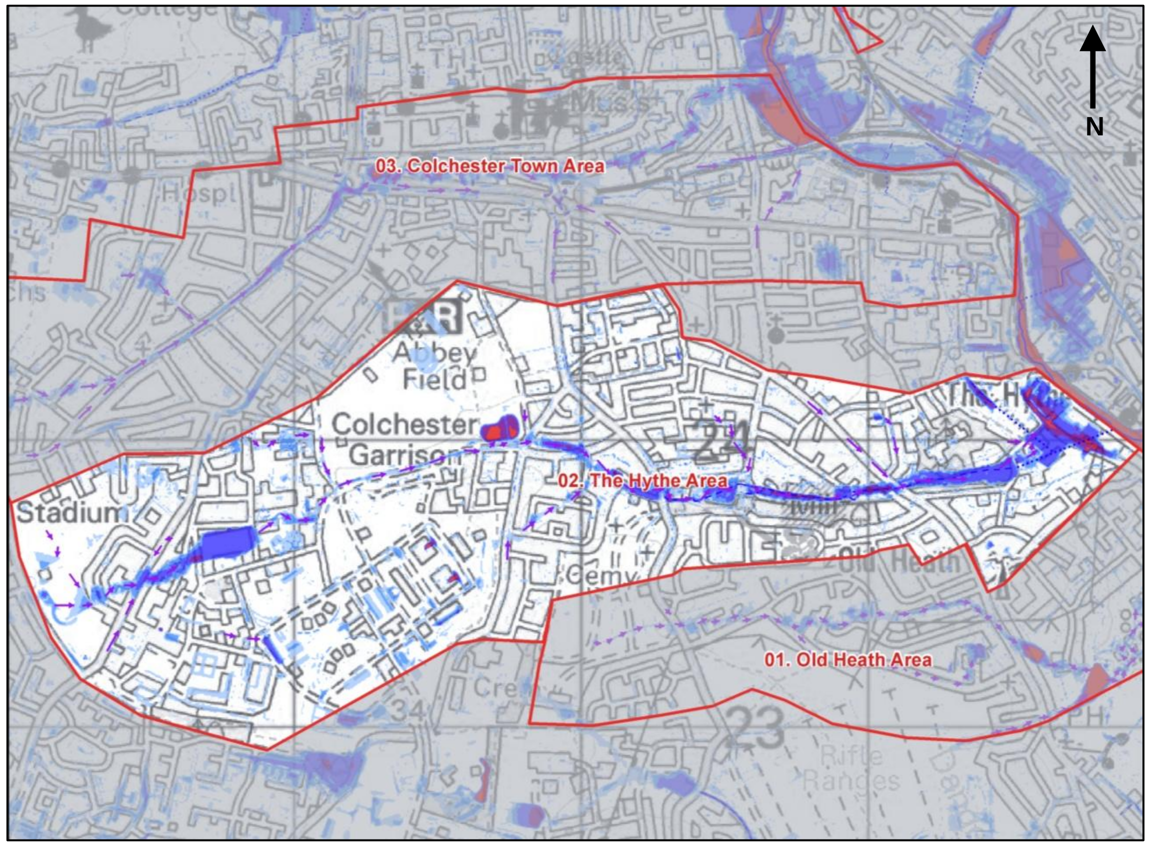


Figure 4-4 CDA 02 - 1 in 100 year Depth Results

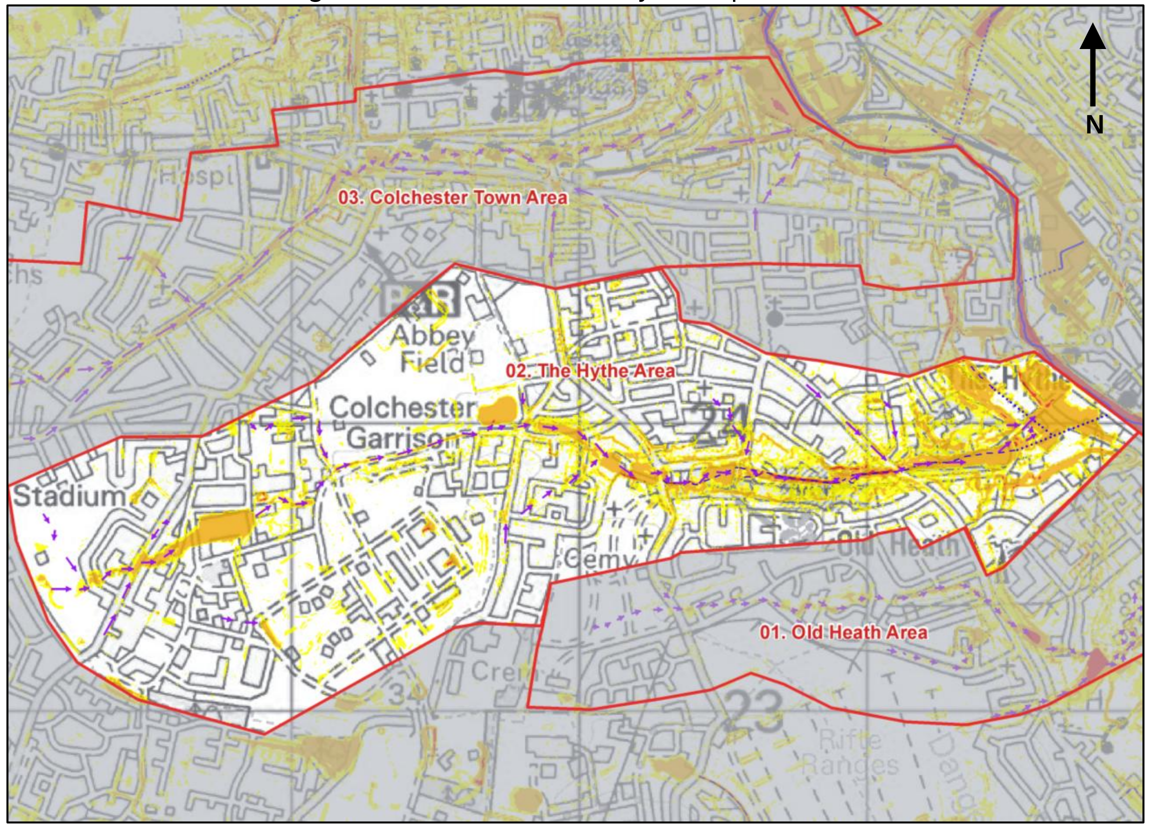


Figure 4-5 CDA 02 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located between Shrub End and the area of Colchester known as 'The Hythe'. Surface water flows generally from west to east to south south-east towards the Bourne Pond watercourse before discharging into the River Colne. The pluvial modelling predicts surface water impacting various areas within the CDA as a result of the topography and water being trapped behind elevated obstructions. Water flows from the upper catchment in an easterly direction along a route that may have been the original extent the Bourne Pond watercourse.

Tidal/fluvial flood zones are located within the CDA. Both Flood Zones 2 and 3 are located along the CDAs boundary with the River Colne. This CDA benefits from Main River flood defences.

Table 4-2 Summary of local flood risk within the CDA 02 – The Hythe Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from predominantly urban areas are conveyed as overland sheet flow towards the east of the CDA.	Due to the topography of the area a natural overland flow path is conveyed towards the higher ground (and a possible extension of the Bourne Pond watercourse).	Open space, residential properties, gardens and roads.
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	The main area of ponding is located within the topographic low areas along the overland flow path and within what appears to be a purpose built attenuation feature near the intersection of Pownall Crescent and Berechurch Road	Residential properties , roads, open space, commercial and industrial uses.
Hazard	Predominantly 'low' with 'moderate' and 'significant' hazards predicted within formal flow routes.		
Sewer	The drainage network within the CDA is a separated surface water drainage system in the western portion of the catchment and is a mixture of combined and separated within the eastern half.		
Validation	Historic events are located within the CDA, which assist to confirm the risk in the CDA.		
Groundwater	The eastern portion of the CDA is highlighted to have a 'low' to moderate susceptibility to groundwater flooding, whilst the western half is highlighted to have a high to significant susceptibility.		

CDA 03 – Colchester Town Area

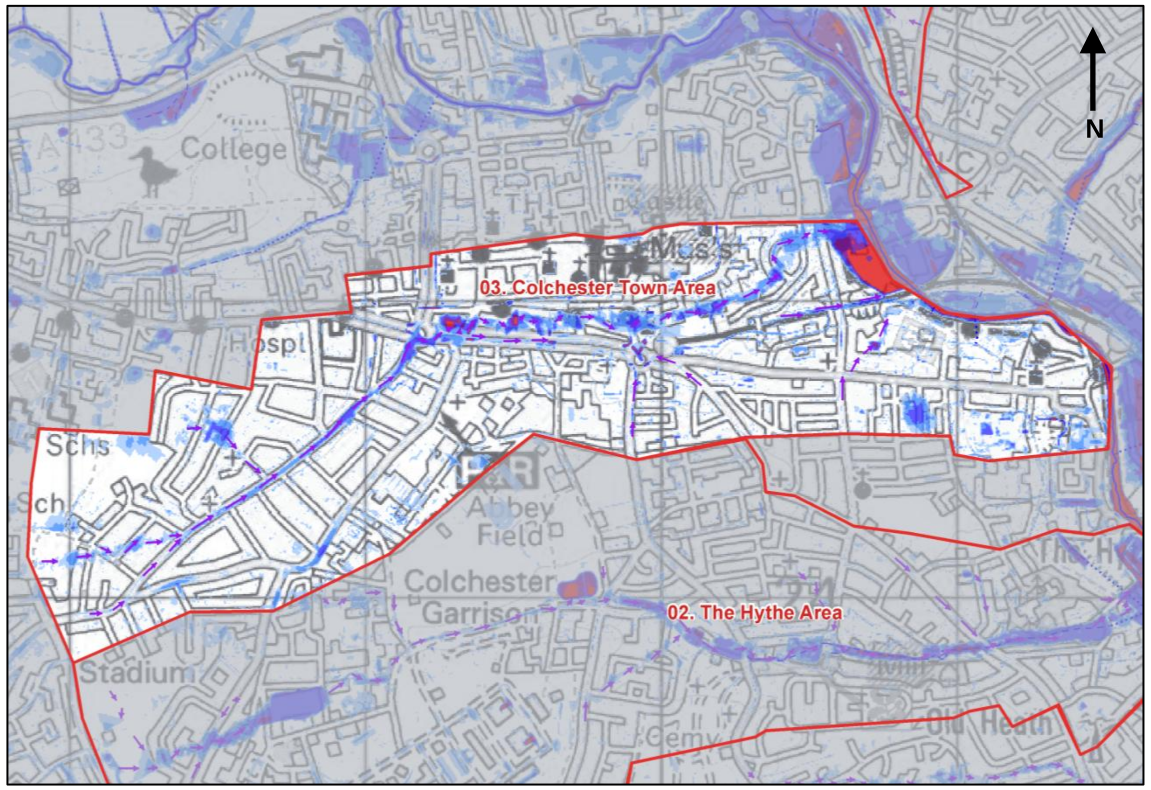


Figure 4-6 CDA 03 - 1 in 100 year Depth Results

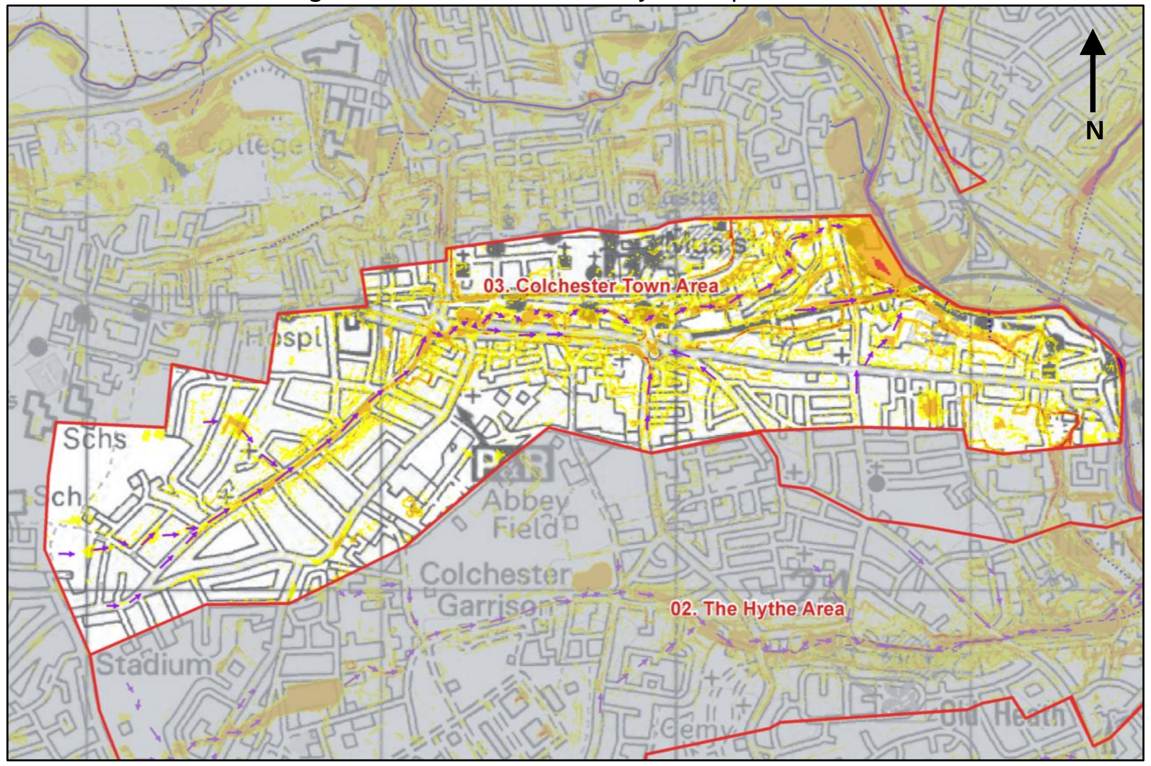


Figure 4-7 CDA 03 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located around the Colchester Town train station. The pluvial modelling indicates the greatest risk of surface water flooding along the eastern interfaced with the River Colne which is fed by an overland flow path from the west of the catchment..

Tidal/fluvial flood zones are located within the CDA. Both Flood Zones 2 and 3 are located along the CDAs boundary with the River Colne. This CDA benefits from Main River flood defences.

Table 4-3 Summary of local flood risk within the CDA 03 – The Colchester Town Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from predominantly urban areas are conveyed as overland sheet flow via what appears to be a lost watercourse.	Due to the topography of the area a natural overland flow path is conveyed into the east-north-east portion of the CDA.	Commercial and residential properties
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	Ponding within the valley of lost watercourse	Rail infrastructure, underpasses, commercial and residential properties.
Hazard	'Moderate' and 'significant' hazards are predicted within the main area of ponding and along the predicted flow paths.		
Sewer	The combined drainage network is largely utilised within the CDA with small areas of separation visible.		
Validation	Several historic events are located within the CDA, which assist to confirm the risk in the CDA.		
Groundwater	The eastern portion of the CDA is highlighted to have a 'moderate' to 'low' susceptibility to groundwater flooding, whilst the western half is highlighted to have a 'high' susceptibility.		

CDA 04 – A12 Colchester

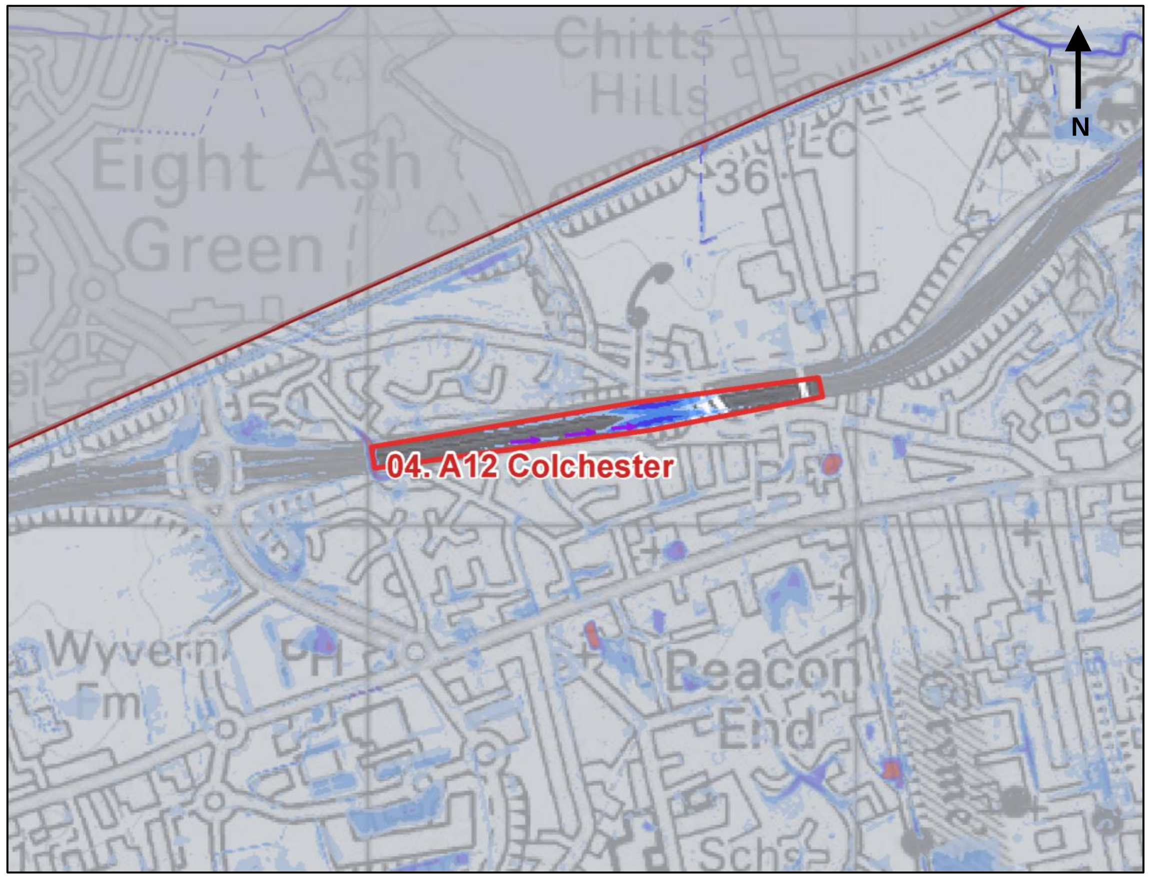


Figure 4-8 CDA 04 - 1 in 100 year Depth Results

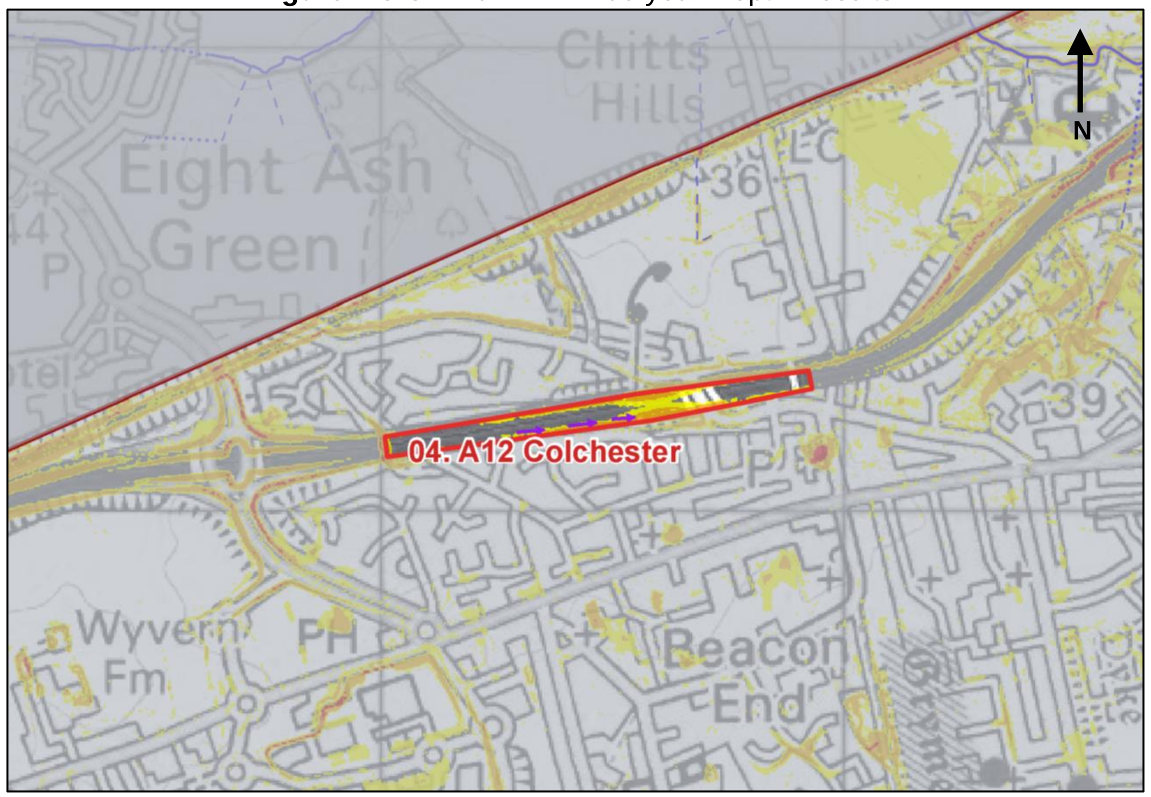


Figure 4-9 CDA 04 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located on a portion of the A12 north of Beacon End which is located within a cutting. The cutting accommodates the A12 which is an ‘A’ road which provides access (in an west-to east direction) along the northern boundary of the study area. The flood depth predicted on the road is up to 0.5m at the centre of the road sag. It is possible that Highways Agency maintains drainage systems along this route, but this data was not made available for this study and could not be accessed during site visits. Other areas of ponding along the A12 should also be investigated to ensure minimal impacts to the road during extreme rainfall events.

The CDA is located within Flood Zone 1.

Table 4-4 Summary of local flood risk within the CDA 04 – A12 Colchester

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Urban area surrounding the cutting.	Due to the topography of the area surface water runoff is captured by the road cutting and directed to the lowest point.	Road
Ponding of surface water (within topographic low spots and behind obstruction)	Artificial road cuttings, depressions and topographic low spots.	An area and depth of ponding is predicted in the depression adjacent east of King Coel Bridge	Road
Hazard	‘Moderate’ and ‘significant’ hazards are predicted within the area of ponding.		
Sewer	No drainage information was made available to the study. A review of photographs on the A12 indicate that gulley inlets are located on the road which would confirm that a drainage system might serve the road network.		
Validation	Historic events are located within the CDA.		
Groundwater	The CDA is highlighted to have a ‘low’ susceptibility to groundwater flooding (due to superficial deposits).		

CDA 05 – St. Anne's Area

Figure 4-10 CDA 05 - 1 in 100 year Depth Results

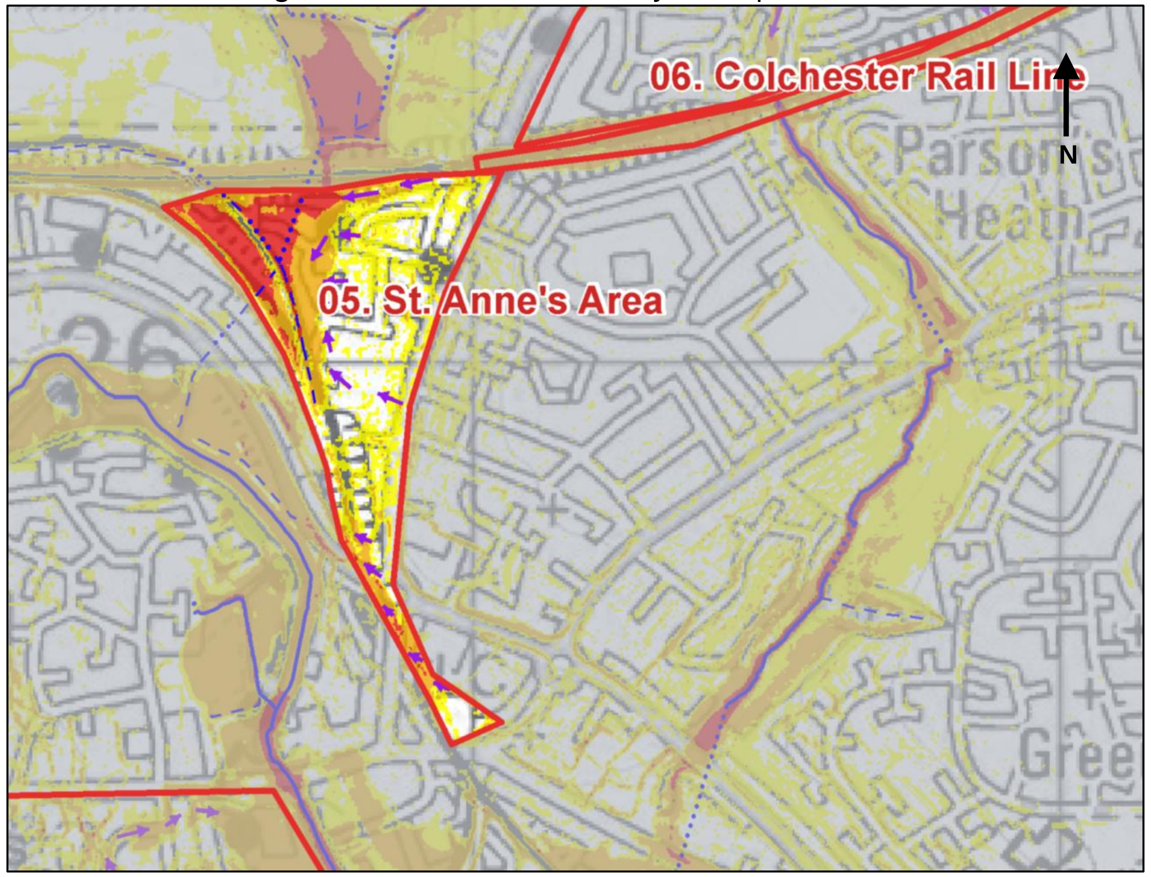


Figure 4-11 CDA 05 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the ward of St Anne's within central Colchester. The predicted flooding with the CDA includes residential areas, open space (between two network rail lines). Surface water flows are generated within the upstream catchment where runoff into the CDA is controlled by the culvert flowing under embankment which forms part of Network Rail line. The pluvial modelling predicts the greatest risk to the CDA is a combination of surface water flooding entering the CDA and being obstructed by another raised embankment along its western boundary.

The CDA is located within all flood zone classifications, with Flood Zones 2 and 3 located along the north eastern portion of the boundary.

Table 4-5 Summary of local flood risk within the CDA 05 – St. Anne's Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff the upper catchment create an overland flow path into the CDA through a culvert which then is predicted to flood properties	Overland flow from the north is conveyed into the CDA via the culvert under the Network Rail embankment which are then obstructed by an additional rail embankment along the CDAs western boundary.	Open space, roads and residential areas.
Ponding of surface water (within topographic low spots and behind obstruction)	Artificial embankment, topographic low spots	The main area of ponding occurs, between the two rail embankments within the north-western portion of the CDA.	Opens space local roads and residential properties adjacent to ponding areas.
Hazard	'Moderate' and 'significant' hazards are predicted within the area of ponding. 'Extreme' hazards are predicted to occur adjacent to the culvert discharging into the CDA.		
Sewer	The urban drainage network within the CDA is a separated surface water drainage system.		
Validation	No historic events were located near the predicted area of ponding, but a site inspection confirmed the possible flood mechanisms.		
Groundwater	The majority of the urbanised portion of the CDA is highlighted to have a 'low' susceptibility to groundwater flooding with the southern portion having a 'moderate' susceptibility (due to superficial deposits).		

CDA 06 – Colchester Rail Line

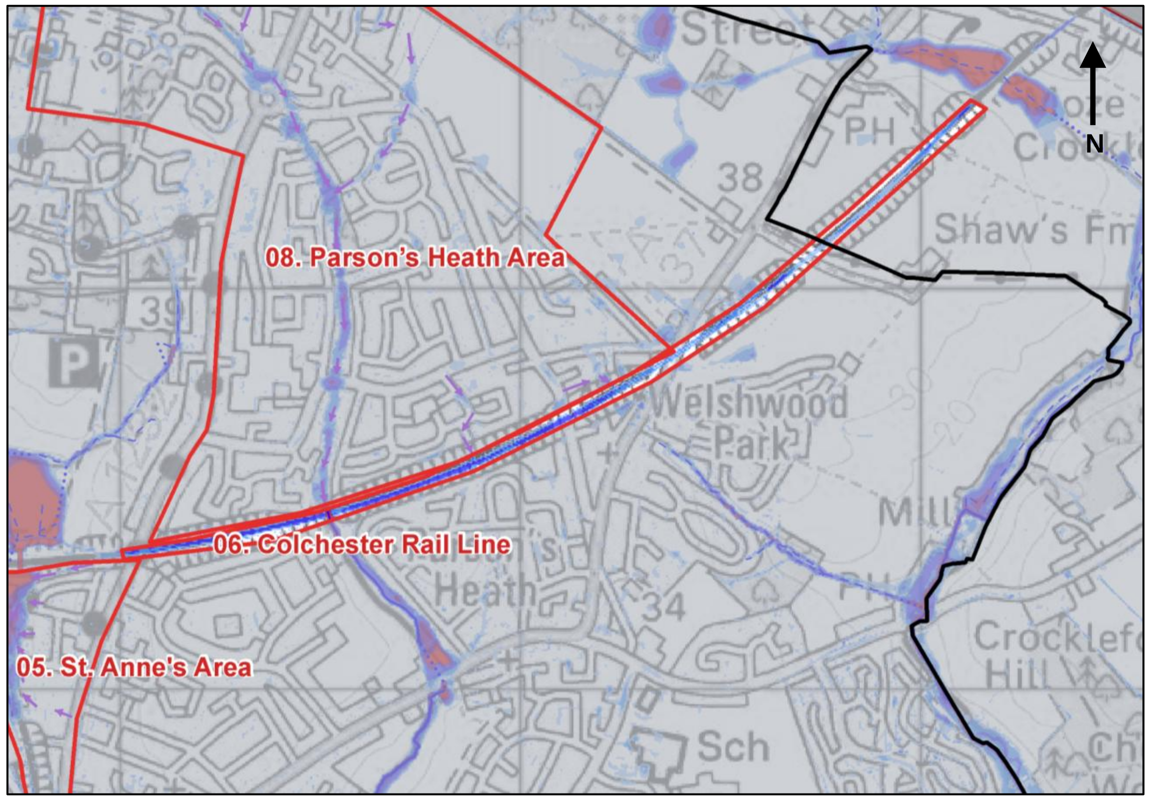


Figure 4-12 CDA 06 - 1 in 100 year Depth Results

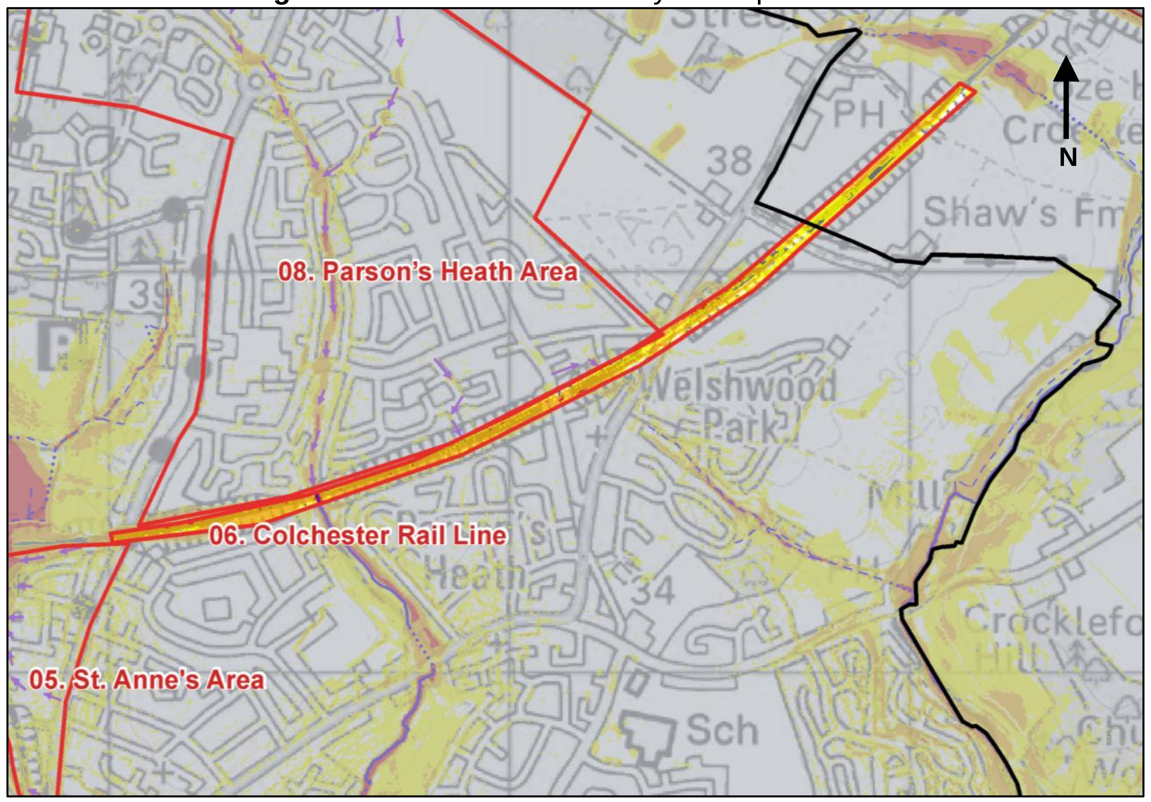


Figure 4-13 CDA 06 - 1 in100 year Hazard Results

Summary of risk:

A rail cutting is located along the Network Rail line located near the Parsons Heath area of Colchester. The cutting accommodates the main rail line serving the local area and stations further to the north east including Clacton-on-Sea and Norwich. The rail cutting is predicted to collect surface runoff from the urban area to the north and convey it to the lowest point. Predicted flood depths on the railway may create disruptions to the service during extreme events. It is possible that Network Rail maintains drainage systems along this route, but this data was not made available for this study and could not be accessed during site visits. No fluvial flood zones are located within the CDA.

Table 4-6 Summary of local flood risk within the CDA 06 – Colchester Rail

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Urban area to the north of the rail cutting	Due to the topography of the area surface water runoff is captured by the rail cutting and directed along the base of the cutting.	Rail and open space
Ponding of surface water (within topographic low spots and behind obstruction)	Artificial rail cuttings, depressions and topographic low spots.	A substantial area and depth of ponding is predicted in the areas at a lower elevation.	Rail and open space
Hazard	Predominantly 'significant' hazards are predicted within the centre of the rail cutting.		
Sewer	The drainage network within the CDA is currently unknown.		
Validation	No historic events are located within the CDA (It should be noted that Network Rail did not provide any information for this study)		
Groundwater	The eastern portion of the CDA is at a 'low' susceptibility to groundwater flooding, whilst the western portion (near Porter's Brook) is highlighted as being at a 'moderate' (superficial deposits flooding) susceptibility.		

CDA 07 – Mile End Area

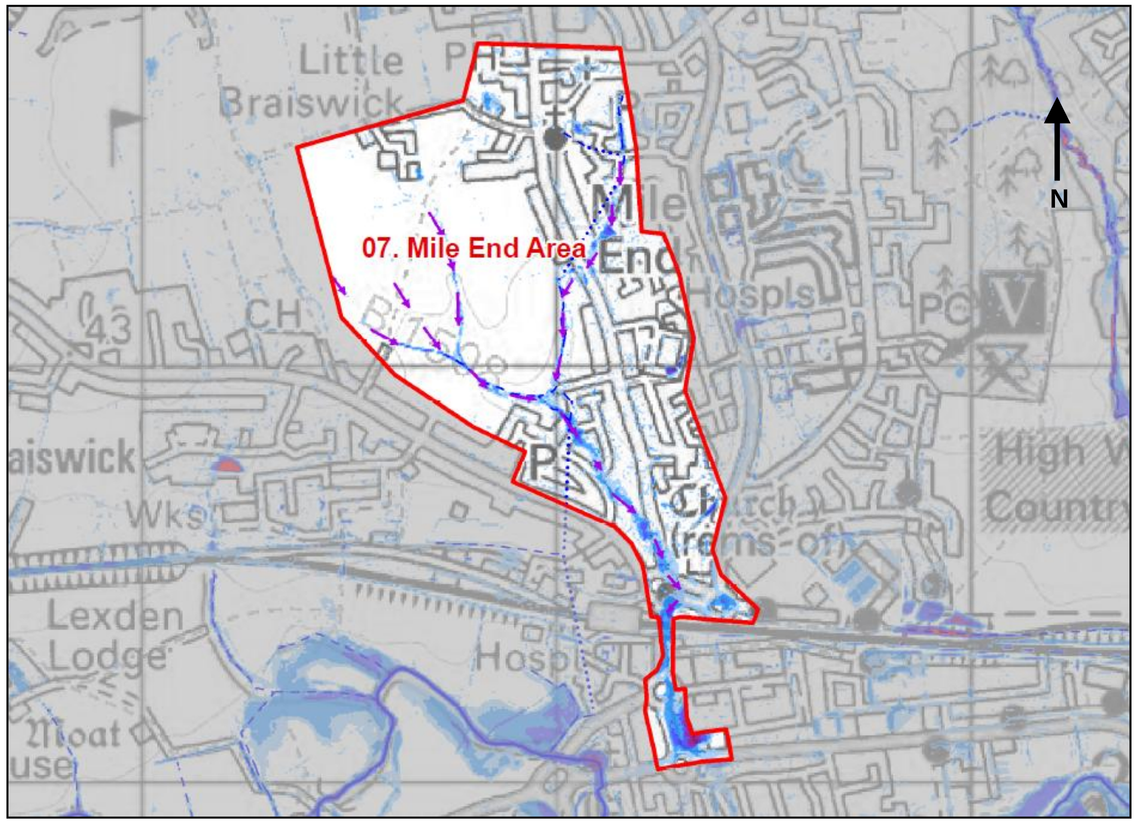


Figure 4-14 CDA 07 - 1 in 100 year Depth Results

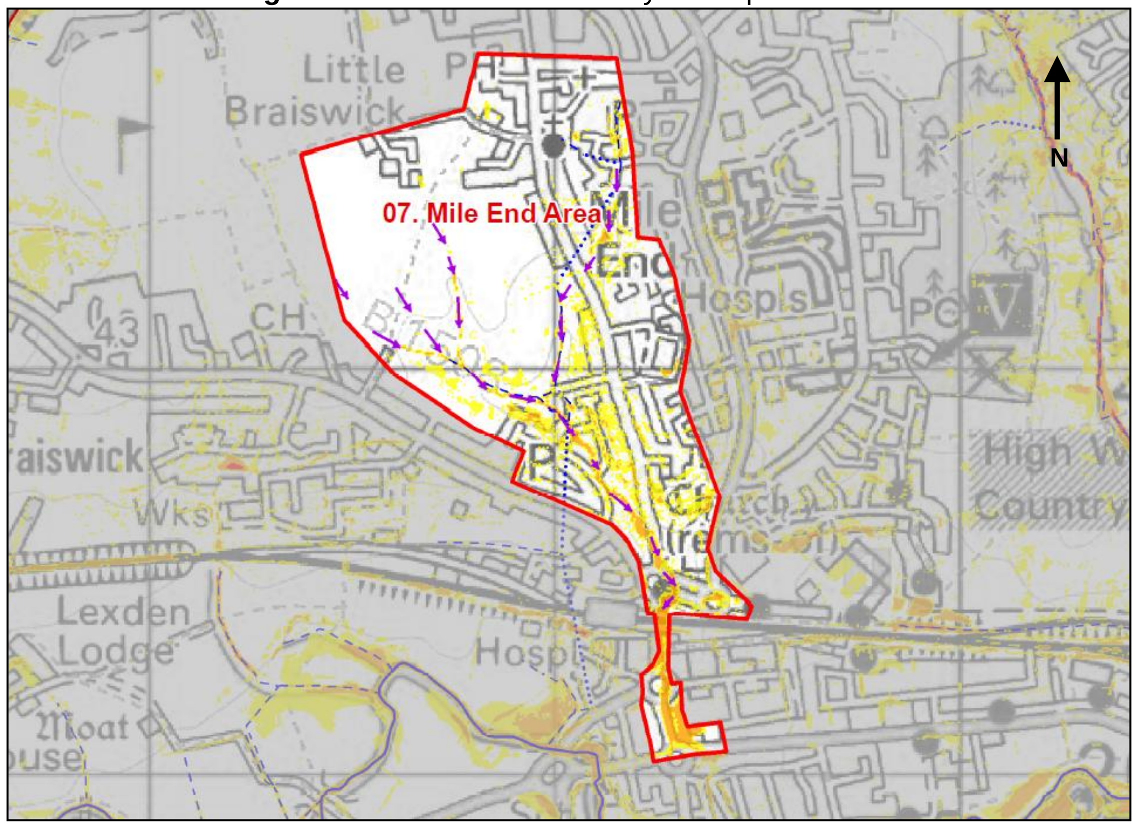


Figure 4-15 CDA 07 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Mile End ward of Colchester. The CDA is a mixture of open space (in the west) and urban development within the balance. Surface water flows are generated within the undeveloped upper catchment along the west and conveyed via an unnamed ordinary watercourse (OWC) to the south. The OWC is culverted near Golden Dawn Way, but the predicted pluvial results indicate that the original flowpath of this watercourse is reactivated and flows towards the A134 roundabouts.

The CDA is located within Flood Zone 1.

Table 4-7 Summary of local flood risk within the CDA 07 – Mile End Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff the upper catchment create an overland flow path into the existing OWCs which bypasses its' culverting during an extreme event	Overland flow from the north is conveyed along the existing watercourses. Flows during extreme events may bypass the culverting of the OWC and reactivate its original flowpath towards the southern boundary of the CDA.	Open space, roads and residential areas.
Ponding of surface water (within topographic low spots and behind obstruction)	Natural valleys, depressions, topographic low spots and behind flow obstructions	The main area of ponding occurs near the culverted section and along topographic low points within the urbanised catchment and the A134.	Residential properties and roads.
Hazard	'Moderate' and 'significant' hazards are predicted within the area of ponding and along the contributing overland flow paths.		
Sewer	A combined sewer line is located within the centre of the CDA (north to south), whilst the balance of the network appears to be a separated system.		
Validation	There are several historic events located within the areas predicted to be at risk of flooding.		
Groundwater	The susceptibility to groundwater flooding varies from 'high' in the south east to 'low' in the north west.		

CDA 08 – Parson's Heath Area

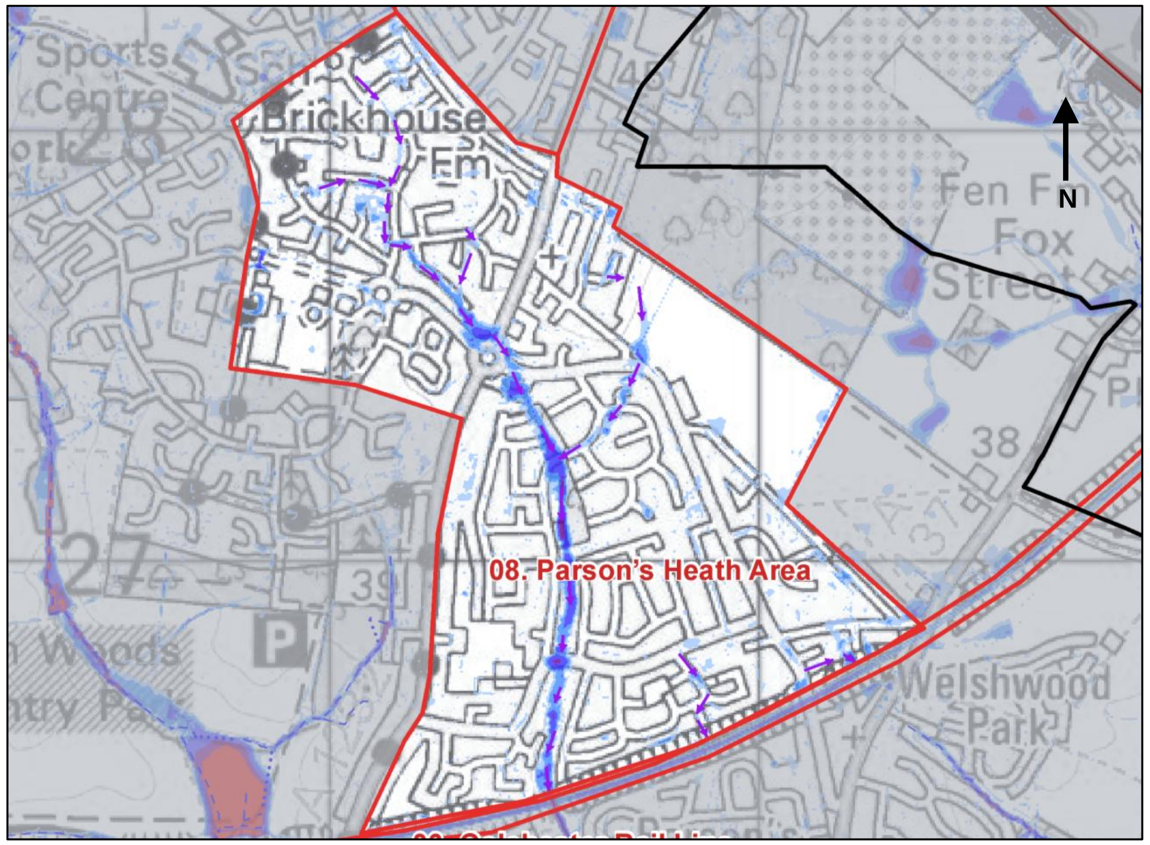


Figure 4-16 CDA 08 - 1 in 100 year Depth Results

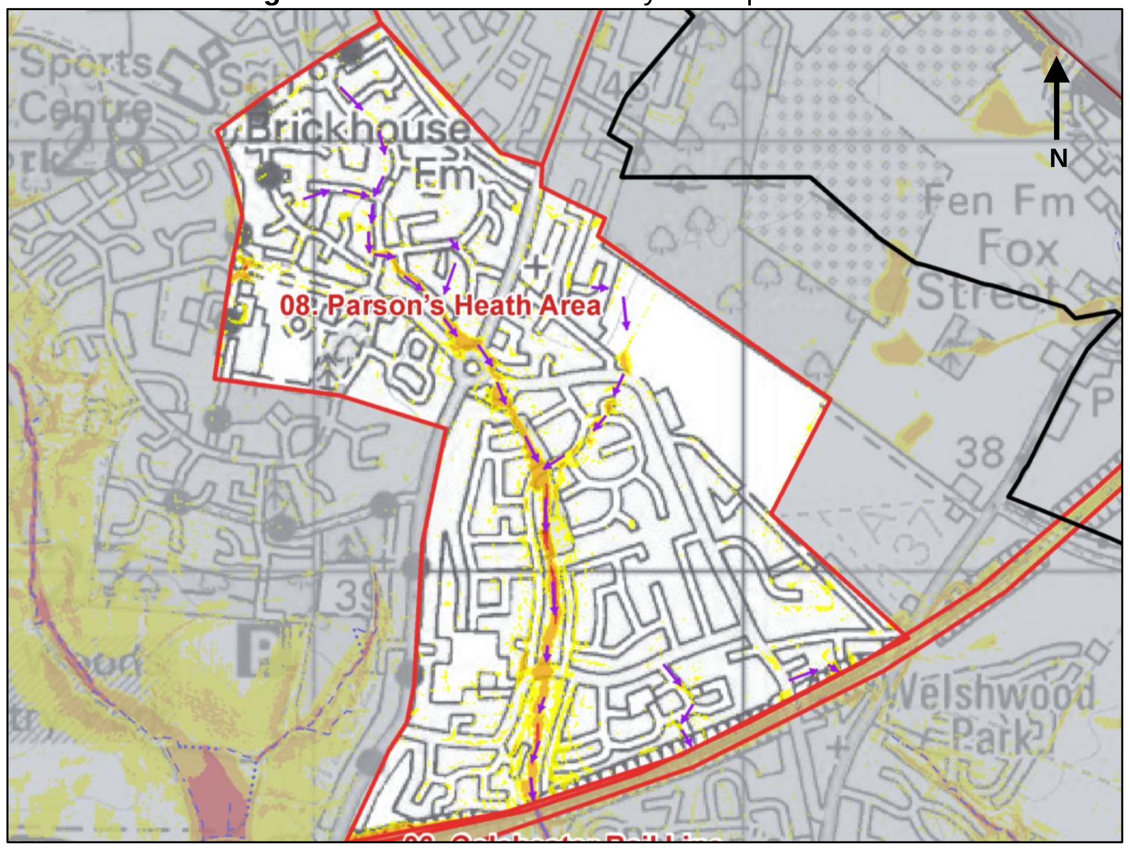


Figure 4-17 CDA 08 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Parson's Heath area of Colchester. The CDA appears to be the local catchment for a lost ordinary watercourse (possible upstream extension of the Porter's Brook) that flows through the CDA in a southerly direction (when it is reactivated). The EA's river network database does not highlight a culverted watercourse in the area, but does indicate that the downstream discharge location might be the Porter's Brook. Shallow ponding is also expected along the A1232 near the roundabout with St John's Road.

The CDA is located within Flood Zone 1.

Table 4-8 Summary of local flood risk within the CDA 08 – Parson's Heath Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff within the catchment creates an overland flow path into downstream Porter's Brook.	Overland flow could impact properties and is conveyed into the downstream Porter's Brook via a historic flow path	Open space, roads and residential areas. Possible influence on the Network Rail Line.
Ponding of surface water (within topographic low spots and behind obstruction)	Flow path obstructions, natural valleys, depressions, and topographic low areas.	The main area of ponding occurs, within the residential area of the town with extensive ponding predicted within rear gardens along the flow path.	Residential properties adjacent to ponding areas. Possible influence on the Network Rail Line.
Hazard	Predominantly 'low' with 'moderate' and 'significant' hazards being predicted within the overland path.		
Sewer	The drainage network within the CDA is a separated surface water drainage system.		
Validation	Several historic records report call outs to clear flooding.		
Groundwater	The majority of the CDA is highlighted to have a 'low' susceptibility to groundwater flooding (due to superficial deposits) with the exception of the southern boundary having a moderate susceptibility.		

CDA 09 – Highwoods Area

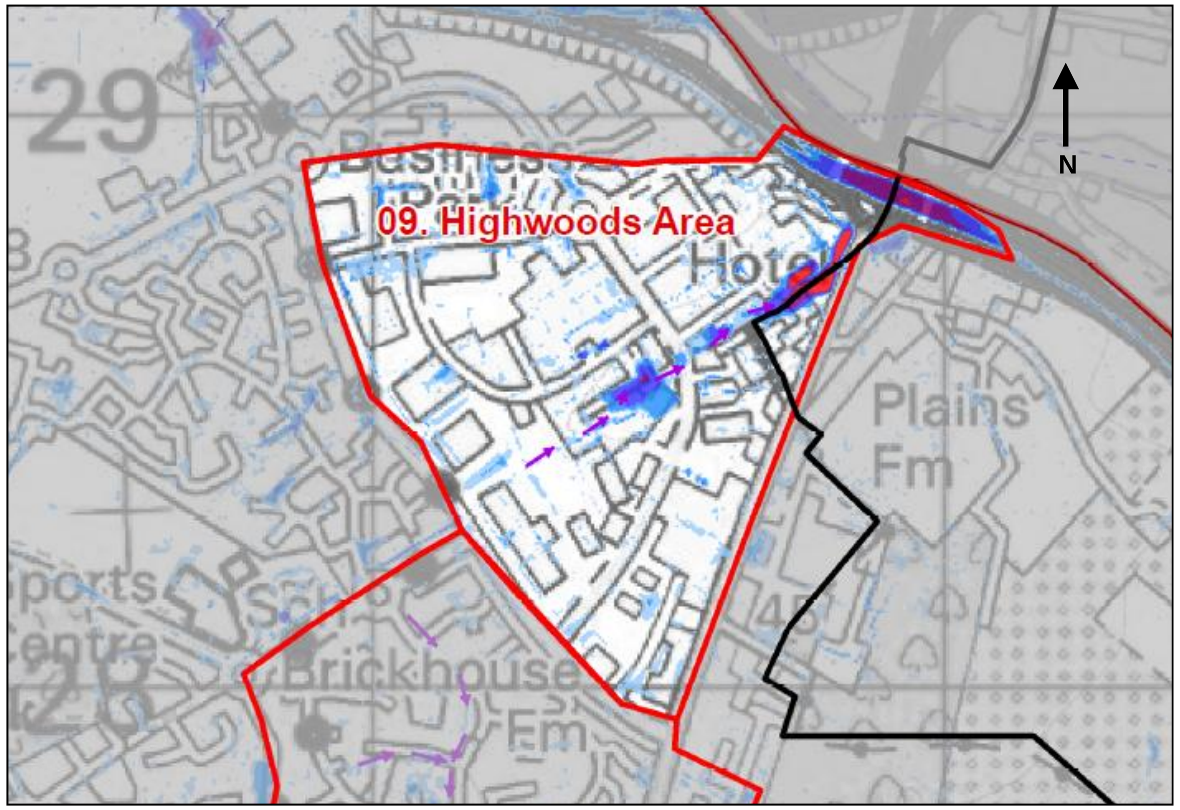


Figure 4-18 CDA 09 - 1 in 100 year Depth Results

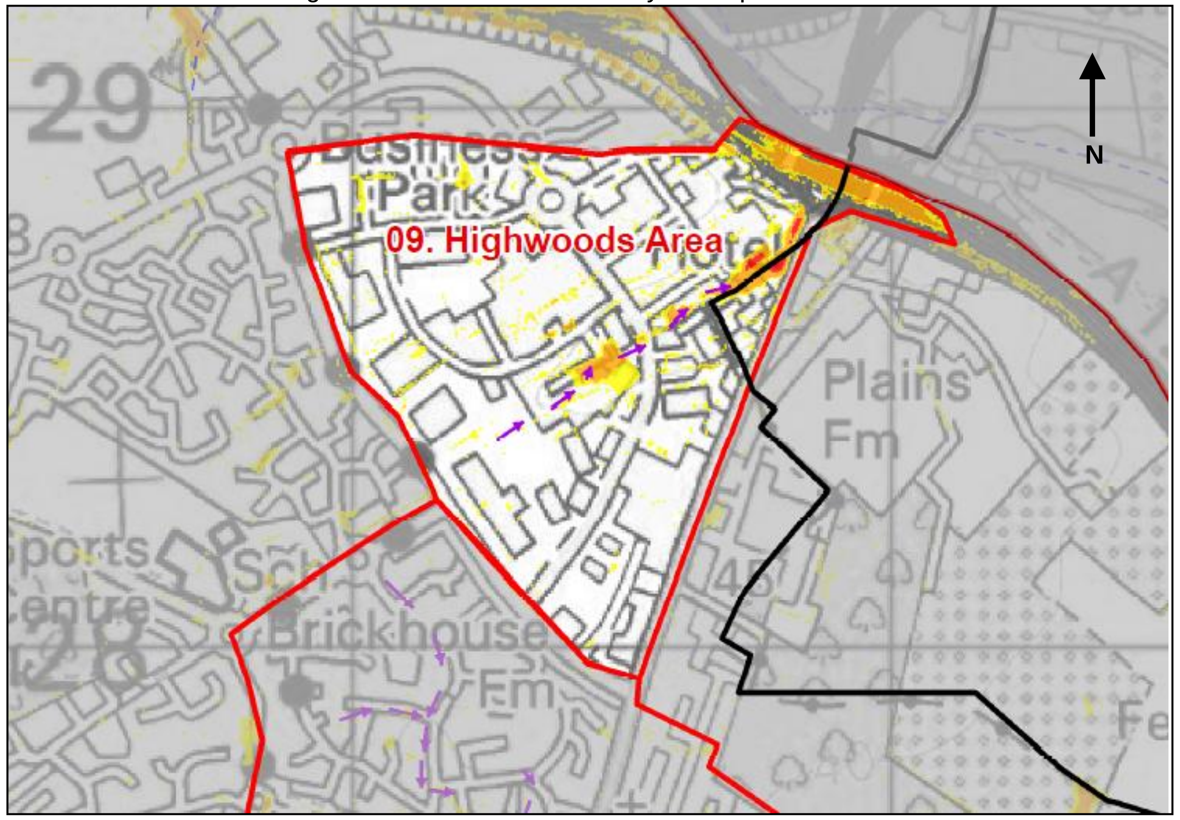


Figure 4-19 CDA 09 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the ward of Highwood, north Colchester. The dominant land use in this area appears to be commercial/industrial. The pluvial modelling predicts that overland flow will pond in various areas throughout the CDA as a result of the ground modifications to create the large warehouse and carpark facilities. An overland flow route is located within the north-eastern portion of the CDA with flows ponding along the downstream boundary as a result of raised embankments. Predicted flooding within the A120 is a result of overland flow from the local catchment being conveyed in to sag point of the road (under the A1232 overpass).

No fluvial flood zones are located within the CDA.

Table 4-9 Summary of local flood risk within the CDA 09 – Highwoods Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff from the local catchment is conveyed towards the junction of the A120 and A1232.	Runoff form from the local catchment is are conveyed through commercial properties and roads.	Commercial/industrial land uses, and roads
Ponding of surface water (within topographic low spots)	Topographic low points and obstructions to flow	Ponding within car park areas and behind the raised A1232.	Commercial/industrial land uses, and roads
Hazard	Predominantly 'low' with areas of 'moderate' and 'significant' hazards being predicted within the LFRZ. Small areas of 'extreme' hazard are predicted within the deepest areas of ponding.		
Sewer	The drainage network within the CDA is a separated surface water drainage system.		
Validation	No historic events have been identified within the CDA.		
Groundwater	The CDA is highlighted to have a 'low' susceptibility to groundwater flooding (due to superficial deposits).		

4.3 Flood Risk Summary

4.3.1 Overview of Flood Risk in Colchester Town

The results of the intermediate level risk assessment, combined with site visits and a detailed review of existing data and historical flood records, indicate that there is moderate to high risk to Colchester from surface water, groundwater, ordinary watercourses and sewer flooding[3] – particularly as rainfall intensities increase. The results indicate that the flood risk is very widely dispersed across the study area with areas with low elevations within the catchment and / or adjacent to obstructions to flow (raised road, rail embankments etc) being at the greatest risk.

Urban development within historic watercourse flow paths are also a risk, as the hydraulic model highlights the predicted flow paths which still convey runoff when reactivated. It is acknowledged that flooding within the town is not limited to the identified CDAs; in fact there are several localised areas at risk of surface water flooding along with areas that may flood from identified main rivers (not assessed in this study). Where these are located within a Flood Zone it is recommended that these area are assessed and analysed (in the future) with the support of the Environment Agency.

In general, flooding across the study area is low to moderate in the lower order rainfall events (such as the modelled 1 in 20 year event) and is predicted to experience greater levels of flooding across the study area during higher order events (such as a 1 in 100 year event). This is reflected in the analysis of risk to properties, businesses and infrastructure that is discussed below.

4.3.2 Predicted Risk to Existing Properties & Infrastructure

Maps of predicted flood depths and extents which have been generated from the surface water modelling results are included in Appendix C. In order to provide a quantitative indication of potential risks, building footprints (taken from the OS MasterMap dataset) and the National Receptor Dataset have been overlaid onto the modelling outputs in order to estimate the number of properties at risk within the study area. The National Receptor Dataset is not entirely comprehensive and may not include all known or recent properties. Table 4-10 and with Table 4-11 identifying the categories used in the assessment of flooded properties.

Table 4-10 Infrastructure Sub-Categories

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

[3] Methodology and limitations relating to each source of flooding can be located within Section 2.

Table 4-11 Household and Basement Sub-Categories

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

Table 4-12 below, indicates the approximate number of predicted properties and critical infrastructure which may be affected during a 1 in 100 year probability rainfall event (1% AEP).

Table 4-12 Flooded Properties Summary 1 in 100 year probability event

Property Type	Flood Risk Vulnerability Classification	Modelled Depths Greater Than –		
		0.1m	0.3m	0.5m
Infrastructure	Essential Infrastructure	4	4	4
	Highly Vulnerable	0	0	0
	More Vulnerable	15	8	5
	Sub-total	**18**	**11**	**8**
Households	Non-Deprived (All)	2203	728	322
	Non-Deprived (Basements Only)	2	0	0
	Deprived (All)	15	0	0
	Deprived (Basements Only)	0	0	0
	Sub-total	**2218**	**728**	**322**
Commercial / Industrial	Units (All)	281	112	64
	Units (Basements Only)	0	0	0
Others	Other Flooded Properties	200	50	29
	Unclassified Flooded Properties	568	226	138
	Infrastructure Other	14	9	5

An analysis was also carried out to determine the predicted risk to properties and infrastructure from a lower order rainfall event, which would have a higher probability of occurring. The 1 in 20 year probability event (5% AEP) was used for this assessment and the results are summarised in Table 4-13 overleaf.

Figure 4-20, below, identifies the difference in flooded properties between the two events.

Table 4-13: Flooded Properties Summary 1 in 20 year probability event

Property Type	Flood Risk Vulnerability Classification	Modelled Depths Greater Than –		
		0.1m	0.3m	0.5m
Infrastructure	Essential Infrastructure	4	4	3
	Highly Vulnerable	0	0	0
	More Vulnerable	6	2	2
	Sub-total	**8**	**5**	**4**
Households	Non-Deprived (All)	1187	293	129
	Non-Deprived (Basements Only)	2	0	0
	Deprived (All)	11	0	0
	Deprived (Basements Only)	0	0	0
	Sub-total	**1200**	**293**	**129**
Commercial / Industrial	Units (All)	147	38	19
	Units (Basements Only)	0	0	0
Others	Other Flooded Properties	138	29	18
	Unclassified Flooded Properties	374	88	33
	Infrastructure Other	10	3	1

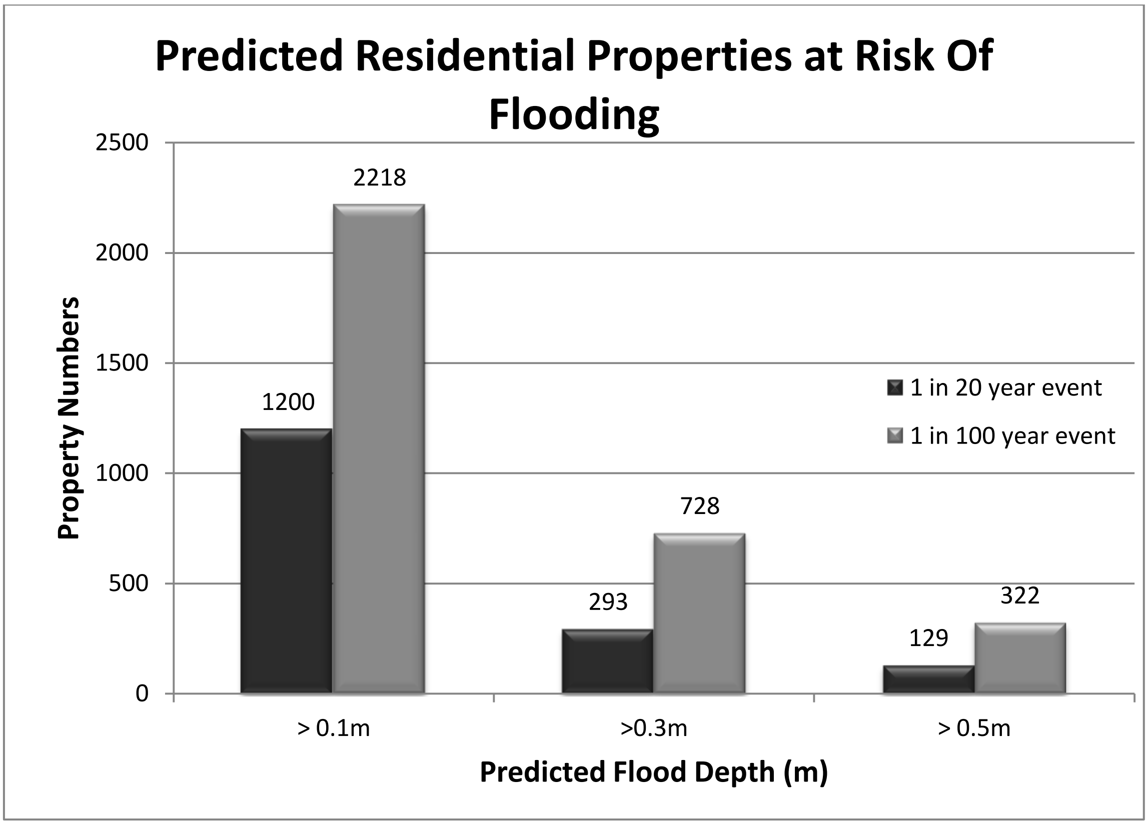


Figure 4-20 Comparison of Predicted Flooded Properties for the 1 in 20 year and 1 in 100 year Rainfall Event

As can be expected, properties with at a shallow flood risk (>0.1m) are greater than those at a deeper risk (>0.3m), with the amount of properties at risk increasing as the storm probability increases due to the volume of predicted rainfall within the storm will increase.

4.3.3 Risk to Future Development

As discussed in Section 1.8, a number of sites have been identified for future development through Site Allocation Plans. It is therefore important that surface water flood risk identified within the report should be a consideration in the Site Allocation Plans as their current locations can either assist or exacerbate the risk to existing properties within Colchester. It is recommended that these developments adhere to specific policy relating to surface water management in addition to the requirements of NPPF.

4.3.4 Effect of Climate Change

The effect of climate change on surface water flood risk has also been analysed through the risk assessment phase of this study. Based on current knowledge and understanding, the effects of future climate change are predicted to increase the intensity and likelihood of summer rainfall events, meaning surface water flooding may become more severe and more frequent in the future.

To analyse what impact this might have on flood risk across Colchester in the future, the surface water model was run for a 1 in 100 year probability event (1% AEP) to include the effect of climate change. Based on current guidance (taken from Table 2 of NPPF) an increase in peak rainfall intensity of 30% was assumed for this model scenario.

The depth grids for these model runs are included in Appendix C along with the other mapped outputs from the modelling process.

Figure 4-21, overleaf, provides a comparison between the 1 in 100 year probability event and the 1 in 100 year probability event with climate change. The area of green indicates where the climate change events results are predicted to be greater and is most obvious in areas that have flow obstructions (raised ground downstream) and where urbanisation has impacted the flow path of historic watercourses.

This comparison highlights that although the predicted effects of climate change may increase the flood risk within certain areas of Colchester the predicted impacts from the 1 in 100 year are suitable for assessing the risk to study area. Increases in flood depth are noted on all main river and ordinary watercourses (including lost watercourses) within the study area – the greatest variance is along the corridor of the River Colne, which is predominantly at risk of fluvial and tidal sources and any works in this location should be undertaken in consultation with the Environment Agency.

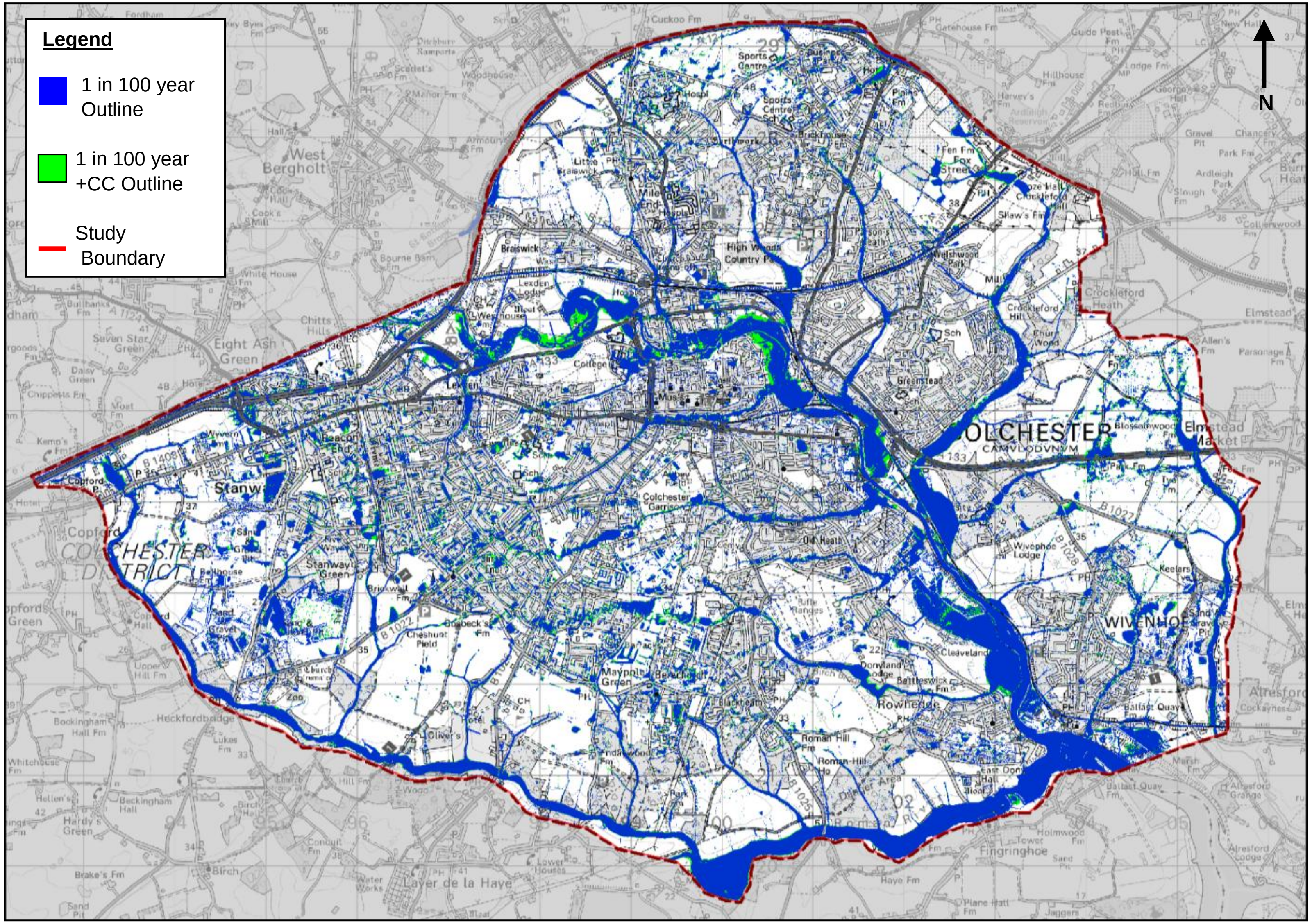


Figure 4-21 Comparison of Predicted 1 in 100 year Pluvial Flood Extents and 1 in 100 year with an Allowance for Climate change (30% Increase in Rainfall Volumes) Flood Extents (Depths >0.1m)

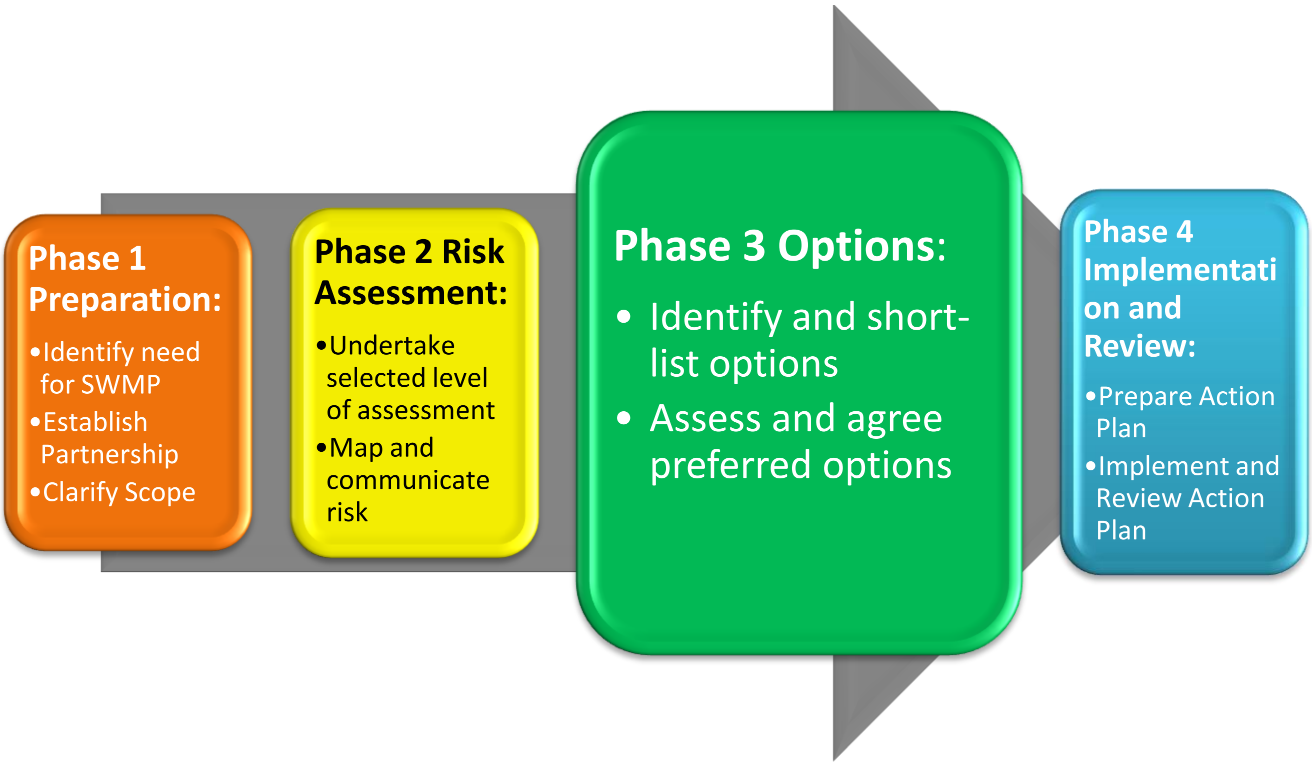
4.4 Summary of Risk – CDAs

Table 4-14 (below) summarises the surface water flood risk to infrastructure, households and commercial/industrial receptors for each of the CDAs for the 1 in 100 year event.

Table 4-14: Summary of Surface Water Flood Risk in CDAs

Property Type	Flood Risk Vulnerability Classification	Critical Drainage Areas																	
		01		02		03		04		05		06		07		08		09	
		>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep	>0.1m deep	>0.5m deep
Infrastructure	Essential Infrastructure	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	1
	Highly Vulnerable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	More Vulnerable	0	0	1	1	4	1	0	0	0	0	0	0	0	0	1	0	0	0
	Sub-total	0	0	1	1	4	1	1	1	0	0	1	1	0	0	1	0	0	0
Households	Non-Deprived (All)	55	6	161	36	392	60	0	0	61	39	0	0	51	2	125	5	1	0
	Non-Deprived (Basements Only)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	Deprived (All)	14	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Deprived (Basements Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total	69	6	162	36	392	60	0	0	61	39	0	0	51	2	125	5	1	0
Commercial / Industrial	Units (All)	6	5	10	5	83	8	0	0	0	0	0	0	4	0	1		11	2
	Units (Basements Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	Other Flooded Properties	13	2	25	2	51	4	0	0	0	0	0	0	1	0	0	0	0	0
	Unclassified Flooded Properties	30	11	42	12	64	9	0	0	1	0	0	0	8	1	8	2	7	0
	Infrastructure Other	3	2	1	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0
Total		**121**	**26**	**241**	**56**	**600**	**83**	**1**	**1**	**62**	**39**	**1**	**1**	**64**	**3**	**135**	**7**	**19**	**2**

PHASE 3: OPTIONS



5 Options Assessment Methodology

5.1 Objectives

Phase 3 provides the methodology for undertaking a high level options assessment and indicates what options are generally available for reducing flood risk within Colchester. This involves identifying a range of structural and non-structural options for alleviating flood risk in the study area, and assessing the feasibility of these options. As well as surface water, consideration must be given to other sources of flooding and their interactions with surface water flooding, with particular focus on options which will provide flood alleviation from combined flood sources.

The purpose of this phase of work is to assess and shortlist options in order to eliminate those that are not feasible or cost beneficial. Options which are not suitable are discarded and the remaining options are developed and tested against their relative effectiveness, benefits and costs. Measures which achieve multiple benefits, such as water quality, biodiversity or amenity, should be encouraged and promoted. The target level of protection is typically set as the 1 in 75 year probability event (1.3% AEP); this will allow potential solutions to be aligned with the current level of insurance cover which is available to the public.

The flow chart below (Figure 5-1) presents the process of identifying and short-listing options that have been identified as part of the Phase 3.

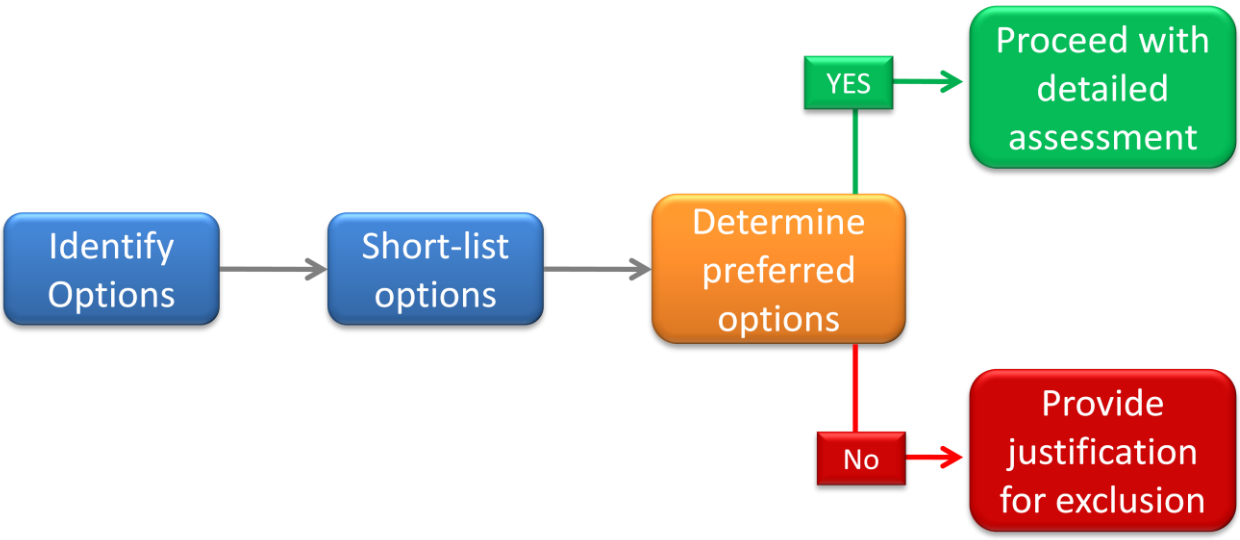


Figure 5-1 Process of identifying and short-listing options and measures [adapted from Defra SWMP Guidance]

To maintain continuity within the report and to reflect the flooding mechanisms within the study area, the options identification should take place on an area-by-area basis following the process established in Phase 2. Therefore, the options assessment undertaken as part of the SWMP identifies the options which are applicable to the study area as a whole, then further detail is provided for each CDA where locally specific measures should be considered.

The options assessment presented here follows the high level methodology described in the Defra SWMP Guidance and is focussed on highlighting areas for further analysis and immediate ‘quick win’ actions.

5.2 Links to Funding Plans

It is important to consider local investment plans and initiatives and committed future investment when identifying measures that could be implemented within Colchester.

The following schemes could provide linked funding solutions to flood alleviation work in Colchester, which would provide a cost effective and holistic approach to surface water flood risk management:

- Local Green Infrastructure Delivery Plans;
- Local Enterprise Plans (funding plan for delivery of the Local Plans);
- Major commercial and housing development is an opportunity to retro-fit surface water management measures (housing associations and private developers);
- Essex County Council highways department investment plans; and
- Anglian Water Business Plan / Asset Management Plan

5.3 Options Identification

The Defra SWMP Technical Guidance defines measures and options as:

> *"A measure is defined as a proposed individual action or procedure intended to minimise current and future surface water flood risk or wholly or partially meet other agreed objectives of the SWMP. An option is made up of either a single, or a combination of previously defined measures."*

This stage aims to identify a number of measures and options that have the potential to alleviate surface water flooding across Colchester. It has been informed by the knowledge gained as part of the Phase 1 and Phase 2 assessment. Where possible, options have been identified with multiple benefits such as also alleviating flooding from other sources. At this stage the option identification pays no attention to constraints such as funding or delivery mechanisms to enable a robust assessment.

The options assessment considers all types of options including[4]:

- Options that change the source of risk;
- Options that modify the pathway or change the probability of flooding;
- Options that manage or modify receptors to reduce the consequences;
- Temporary as well as permanent options;
- Options that work with the natural processes wherever possible;
- Options that are adaptable to future changes in flood risk;
- Options that require actions to be taken to deliver the predicted benefits (for example, closing a barrier, erecting a temporary defence or moving contents on receiving a flood warning);
- Innovative options tailored to the specific needs of the project; and,
- Options that can deliver opportunities and wider benefits, through partnership working where possible.

[4] Environment Agency (March 2010) *'Flood and Coastal Flood Risk Management Appraisal Guidance',* Environment Agency: Bristol.

5.4 Identifying Measures

Surface water flooding is often highly localised and complex. There are few solutions which will provide benefits in all locations, and therefore, its management is largely dependent upon the characteristics of the CDA. This section outlines potential measures which have been considered for mitigating the surface water flood risk within Colchester.

The SWMP Plan Technical Guidance (Defra 2010) identifies the concept of Source, Pathway and Receptor as an appropriate basis for understanding and managing flood risk. Figure 5-2 identifies the relationship between these different components, and how some components can be considered within more than one category.

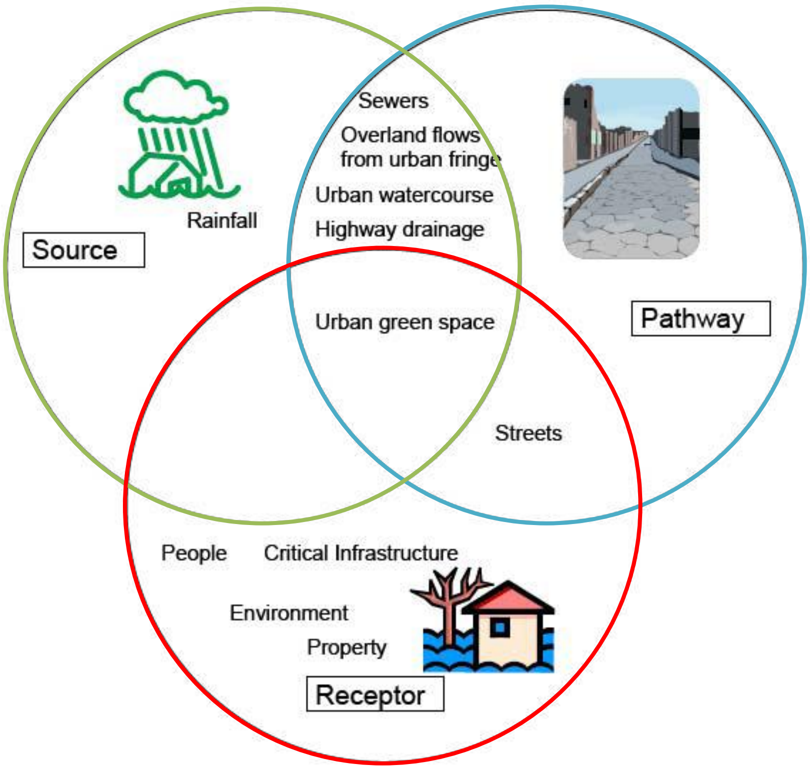


Figure 5-2 Illustration of Sources, Pathways & Receptors
(extracted from SWMP Technical Guidance, Defra 2010)

When identifying potential measures, it is useful to consider the source, pathway, receptor approach (refer to Figure 5-2 and Figure 5-3). Both structural and non-structural measures should be considered in the optioneering exercise undertaken for future CDAs. Structural measures can be considered as those which require fixed or permanent assets to mitigate flood risk (such as a detention basin, increased capacity pipe networks). Non-structural measures may not involve fixed or permanent facilities, and the benefits to of flood risk reduction is likely to occur through influencing behaviour (education of flood risk and possible flood resilience measures, understanding the benefits of incorporating rainwater reuse within a property, planning policies etc).

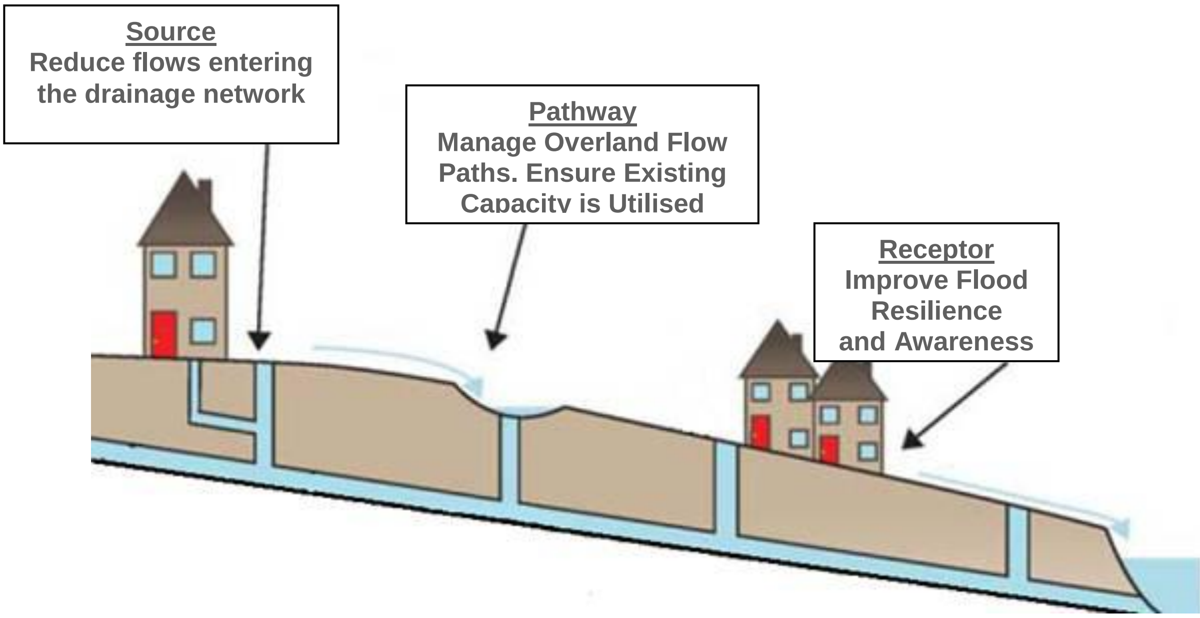


Figure 5-3 Source, Pathway and Receptor Model
(adapted from Defra SWMP Technical Guidance, 2010)

Methods for managing surface water flooding can be divided into methods which influence either the Source, Pathway or Receptor, as described below, (refer to Table 5-1, overleaf.):

- Source Control: Source control measures aim to reduce the rate and volume of surface water runoff through increasing infiltration or storage, and hence reduce the impact on receiving drainage systems. Examples include retrofitting SuDS (e.g. bioretention basins, wetlands, green roofs etc) and other methods for reducing flow rates and volume.

- Pathway Management: These measures seek to manage the overland and underground flow pathways of water in the urban environment, and include: increasing capacity in drainage systems; separation of foul and surface water sewers etc.

- Receptor Management: This is considered to be changes to communities, property and the environment that are affected by flooding. Mitigation measures to reduce the impact of flood risk on receptors may include improved warning and education or flood resilience measures.

Table 5-1 Typical Surface Water Flood Risk Management Measures

	Generic measures	Site specific measures
	• Do Nothing (do not continue maintenance) • Do Minimum (continue current maintenance)	
Source control	• Bioretention carpark pods • Soakaways, water butts and rainwater harvesting • Green roofs • Permeable paving • Underground storage; • Other 'source' measures	• Swales • Detention basins • Bioretention basins; • Bioretention carpark pods; • Bioretention street planting; • Ponds and wetlands
Pathway Management	• Improved maintenance regimes • Increase gulley assets	• Increase capacity in drainage system • Separation of foul & surface water sewers • Managing overland flows • Land Management practices • Other 'pathway' measures
Receptor Management	• Improved weather warning • Planning policies to influence development • Social change, education and awareness • Improved resilience and resistance measures • Raising Doorway/Access Thresholds • Other 'receptor' measures	• Temporary or demountable flood defences - collective measure

5.5 Options Assessment Guidance

A high-level scoring system for each of the options has been utilised to short-list preferred options. The approach to short-listing options is based on the guidance in FCERM and Defra's SWMP guidance. The scoring criteria are provided in Table 5-2 (overleaf).

Table 5-2: Options Assessment Short-Listing Criteria

<table>
<tr><th>Criteria</th><th>Description</th><th>Score</th></tr>
<tr><td>Technical</td><td>• Is it technically possible and buildable?
• Will it be robust and reliable?
• Would it require the development of new techniques in order to be implemented?</td><td rowspan="5">U: Unacceptable (measure eliminated from further consideration)

-2: High negative outcome

-1: Moderate negative outcome

0: Neutral

+1: Moderate positive outcome

+2: High positive Outcome</td></tr>
<tr><td>Economic</td><td>• Will the benefits exceed the cost?
• Is the option within the available budget / funding? (This will depend on available funding, although it must be remembered that alternative routes of funding could be available)</td></tr>
<tr><td>Social</td><td>• Will the community benefit from the option?
• Does the option have benefits for local amenity?
• Does the option result in any objection from local communities?</td></tr>
<tr><td>Environmental</td><td>• Will the environment benefit from the option?
• Will the option provide benefits to water quality or biodiversity?</td></tr>
<tr><td>Objectives</td><td>• Does it help achieve objectives of SWMP partnership?
• Does the option meet the overall objective of alleviating flood risk?</td></tr>
</table>

Any agreed short-listed options can been taken forward for further assessment, possibly detailed modelling if necessary, including an overview assessment of costs, benefits and feasibility. These include the 'Do Nothing' (no intervention and no maintenance) and 'Do Minimum' (continuation of current practice) options which, in line with the Project Appraisal Guidance (PAG), should be taken forward to the detailed assessment stage (even though they might not offer the desired results). The option scoring for each CDA can be located within Appendix E of this report. Table 5-3 (overleaf) provides an example of applying the options scoring system.

Table 5-3: Example of a Conceptual Options Assessment

Area /CDA	Option Category	Option Description	Options Assessment: Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward?	Summary of Scheme
Colchester (all areas 'at risk')	Do nothing	Do nothing	-	-	-	-	-	-	✓	Make no intervention or maintenance – no benefit to area
	Do minimum	Do minimum	-	-	-	-	-	-	✓	Continue existing maintenance regimes – minimal benefit and (currently) does not include increased maintenance for the predicted increase in rainfall as a result of climate change.
	Planning Policy	Adapt spatial planning policies	2	2	1	0	2	7	✓	Adapt spatial planning policy for all new developments, especially within areas identified at high risk of surface water flooding.
	Improved Maintenance	Improved maintenance of drainage network	2	1	2	1	1	7	✓	Improved and targeted maintenance of the drainage network to avoid potential blockages which would reduce the drainage network capacity. Suggest list of targeted areas (i.e. areas at highest risk within the CDAs) to focus on.
	Community Resilience	Improve community resilience to reduce damages from flooding	2	1	2	0	1	6	✓	Improve community resilience to flooding through establishing a flood warning system, reviewing emergency planning practices and encouraging the installation of individual property protection measures (such as flood-gates).
	Source Control, Attenuation and SuDS	Install rainwater harvesting systems water-butts, and bioretention features	2	2	1	1	2	8	✓	Install rainwater harvesting systems, bioretention systems and water-butts in key risk areas in order to reduce the rate and volume of surface water runoff. Upstream attenuation via wetlands and ponds could also be considered.
	Flood Storage / Permeability	Install permeable paving in key areas	2	2	1	1	2	8	✓	Install permeable paving systems in key areas and along key overland flow paths in order to reduce local runoff.

Area /CDA	Option Category	Option Description	Options Assessment: Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward?	Summary of Scheme
	Improvement to Drainage Infrastructure	Improve drainage network capacity within key risk areas	2	1	0	0	2	5	✓	Work collaboratively with Anglian Water to assess the possibility of increasing sewer network capacity in key areas (or those identified as having poor capacity.
	Preferential Overland Flow Routes	Increase kerb heights and/or lower road levels along key flow paths	2	1	2	1	1	7	✓	Investigate the potential of increasing footpath heights and/or lowering road levels along key flow paths in order to retain flood water within the roads and channel it away from properties at risk of flowing.
	Other	Hydrometric monitoring	2	2	0	1	2	7	✓	Install hydrometric monitoring equipment in order to gain a better understanding of rainfall patterns and mechanisms that lead to localised flooding across the study area.
	Other	Community Awareness	2	2	2	0	1	7	✓	Increase awareness of flooding within communities at risk through the use of newsletters, drop-in workshops, websites and social media.

5.6 Identifying Options

Following the identification of a number a measures (as described in Table 5-1), a series of Colchester-wide options were defined based on this assessment. These options were based initially on a range of options (scheme categorisations) identified in Table 5–4. Each of the standard measures (from Table 5-1) have been categorised within an option.

Table 5-4 Potential options

Description		Standard Measures Considered
Do Nothing	Make no intervention / maintenance	• None
Do Minimum	Continue existing maintenance regime	• None
Improved Maintenance	Improve existing maintenance regimes e.g. target improved maintenance to critical points in the system.	• Improved Maintenance Regimes • Other 'Pathway' Measures
Planning Policy	Use forthcoming development management policies to direct development away from areas of surface water flood risk or implement flood risk reduction measures.	• Planning Policies to Influence Development
Source Control, Attenuation and SUDS	Source control methods aimed to reduce the rate and volume of surface water runoff through infiltration or storage, and therefore reduce the impact on receiving drainage systems.	• Green roofs • Soakaways • Swales • Permeable paving • Rainwater harvesting • Detention Basins • Ponds and Wetlands • Land Management Practices • Other 'Source' Measures
Flood Storage / Permeability	Large-scale SuDS that have the potential to control the volume of surface water runoff entering the urban area, typically making use of large areas of green space. Upstream flood storage areas can reduce flows along major overland flow paths by attenuating excess water upstream, which reduce the demands on downstream networks.	• Detention Basins • Ponds and Wetlands • Managing Overland Flows (Online Storage) • Land Management Practices • Other 'Source' Measures • Other 'Pathway' Measures
Separate Surface Water and Foul Water Sewer Systems	Where the settlement is served by a combined drainage network separation of the surface water from the combined system should be investigated. In growth areas separation creates capacity for new connections.	• Separation of Foul and Surface Water Sewers
De-culvert / Increase Conveyance	De-culverting of watercourses and improving in-stream conveyance of water.	• De-culverting Watercourse(s) • Other 'Pathway' measures
Preferential / Designated Overland Flow Routes	Managing overland flow routes through the urban environment to improve conveyance and routing water to watercourses or storage locations.	• Managing Overland Flows (Preferential Flowpaths) • Temporary or Demountable Flood Defences • Other 'Pathway' measures

Description		Standard Measures Considered
Community Resilience	Improve community resilience and resistance of existing and new buildings to reduce damages from flooding, through, predominantly, non-structural measures.	• Improved Weather Warning • Temporary or Demountable Flood Defences • Social Change, Education and Awareness • Improved Resilience and Resistance Measures • Other 'Receptor' Measures
Infrastructure Resilience	Improve resilience of critical infrastructure in the settlements that are likely to be impacted by surface water flooding e.g. electricity substations, pump houses.	• Improved Resilience and Resistance Measures • Other 'Receptor' Measures
Other - Improvement to Drainage Infrastructure	Add storage to, or increase the capacity of, underground sewers and drains and improving the efficiency or number of road gullies.	• Increasing Capacity in Drainage Systems • Other 'Pathway' measures
Other or Combination of Above	Any alternative options that do not fit into above categories and any combination of the above options where it is considered that multiple options would be required to address the surface water flooding issues.	

5.7 CDA Prioritisation

5.7.1 Methodology

To assist with prioritisation and programming of further work on all CDAs, a basic prioritisation methodology was applied to the CDAs identified in Section 4. At this stage of flood risk investigation and mitigation it is important to keep this method simple and transparent to ensure clear interpretation of the decision making process to prioritise one area over another. This will aid in demonstrating that future spending on surface water management is distributed equitably around the study area. The general method proposed is summarised below:

- Identify high priority CDAs based upon overall verified risk and potential synergy with other projects;
- To prioritise further work in remaining medium and low priority CDAs, use risk assessment outputs to count the number of properties flooded within the following general categories:
    - Infrastructure
        - Essential (e.g. water treatment works, primary electricity substations and mass evacuation routes);
        - Highly Vulnerable (e.g. Police stations, fire stations and ambulance stations); and
        - More Vulnerable (e.g. Hospitals, retirement homes and schools)
    - Households; and
    - Commercial / Industrial.
- For each category above determine the number of properties which are predicted to be flooded to a depth of:
    - 0.1m or more; and
    - 0.5m or more (highest confidence banding of depth).
- Assign a relative importance weighting associated with each of the above parameters; and
- Multiply and sum the parameters above to produce a 'total impacts' score.

5.7.2 Prioritisation Outcomes

The outcomes of the above prioritisation process are detailed Appendix D and summarised within Table 5-5. Based on the final identified score the following range has been applied to these results:

- ≥ 360 = High priority
- 359 – 183 = Medium priority
- ≤ 182 = Low priority

Table 5-5 Results of Prioritsation Assessment

CDA No.	Total number of units flooded (100yr ARI)	Number of units flooded where depth >0.5m (100yr ARI)	Total Units Flooded	Impacts Score	Priority Rank
03	482	70	552	**1371**	High
02	173	42	215	**550**	High
08	127	5	132	**291**	Medium
05	61	39	100	**278**	Medium
01	75	11	86	**206**	Medium
09	13	3	16	**137**	Low
06	1	1	2	**120**	Low
04	1	1	2	**120**	Low
07	55	2	57	**114**	Low

A graphical representation of these rankings can be located below within Figure 5-4.

It is recommended that any future assessments into flood alleviation within the CDAs is undertaken by reviewing the identified flood impact score against the cost / benefit of any proposed scheme.

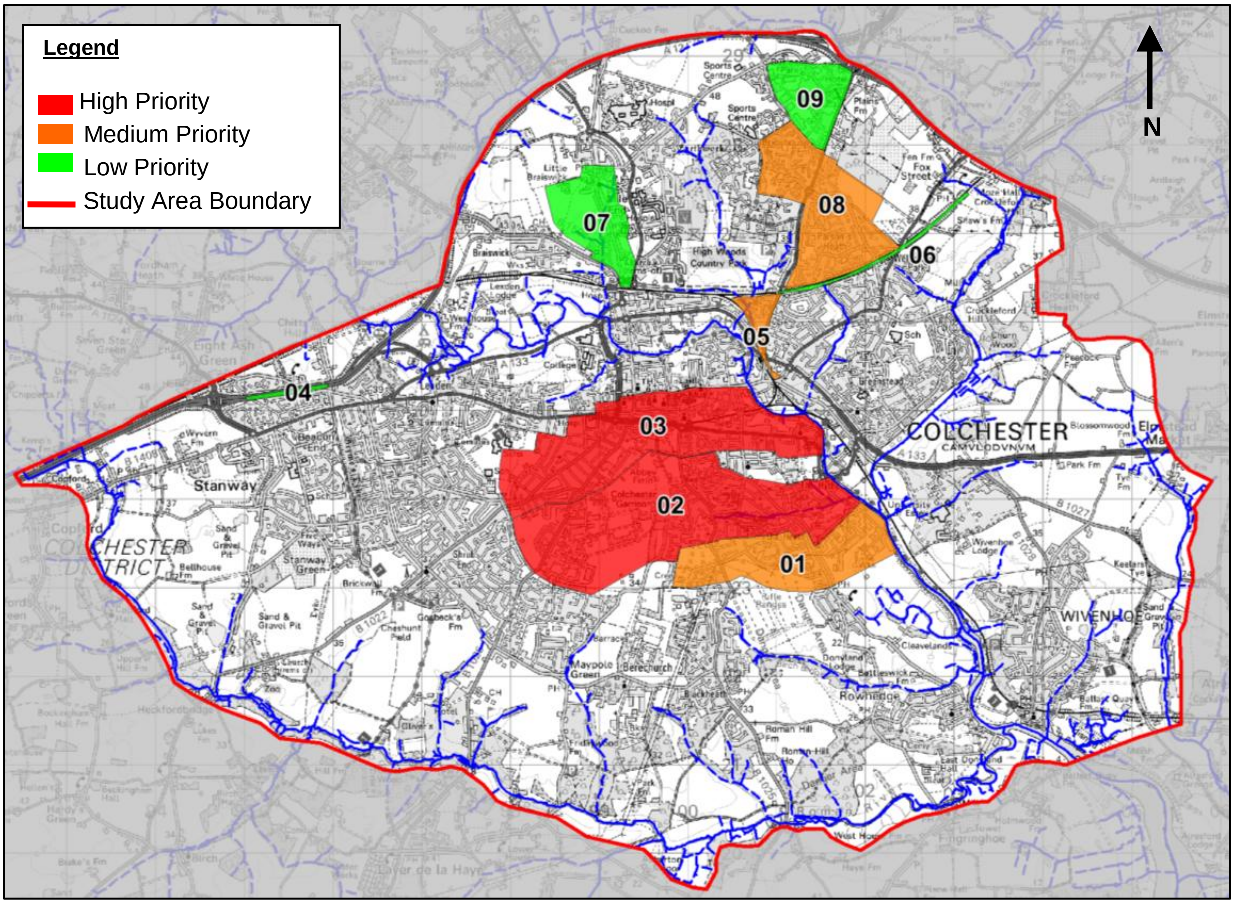


Figure 5-4 CDA Prioritisation

5.8 Preferred CDA Options

This section discusses the preferred option identified for each CDA based on the measures discussed earlier within this section. Conceptual option appraisal assessments were undertaken on a range of options for each CDA before the preferred option was chosen. This process was fully documented and details can be located within Appendix E. Issues relating to feasibility, land ownership and conflicts with other service should be assessed before these conceptual options are progressed further.

It is recommended that a community flood plan should be created for all CDA areas. This document should advise residents and site users of the risk of flooding and appropriate techniques for flood risk management.

The council should consider; retrofitting permeable surfacing and retrofitting bio-retention car park pods (and other street scale SUDS) throughout the CDA (where appropriate), and also consult the local community with respect to the benefits of including of water butts, rainwater harvesting within the businesses and private properties.

It is also recommended that maintenance practises are reviewed and increased where it is deemed appropriate and that additional gulley pits are included within areas of ponding.

CDA 01 – Old Heath Area

Preferred Option:

- Divert overland flow into attenuation features located within the open space south of Abbot's Road. One way cross falls along the road (including rain gardens) and swales could be used to divert flows into these storage areas.
- Connect storage areas via landscaped swales to enhance the aesthetics of the SuDS;
- Review drainage infrastructure at Co-op supermarket to ensure existing storage capacity. Review risk of flooding and determine if warning signs are necessary once other measures have been implemented to reduce the risk of the CDA.
- Review management practices at the Colchester STW and adopt additional resistance / resilience measures if necessary.
- Enhance storage area upstream of STW and assess the inclusion of a culvert (if necessary include a pumping regime) to divert flows to an OWC east of the STW.
- Once the benefits of the above measures has been assessed, include local drainage improvements within the CDA for the areas predicted to be at risk of ponding (additional capacity, gullies etc.).

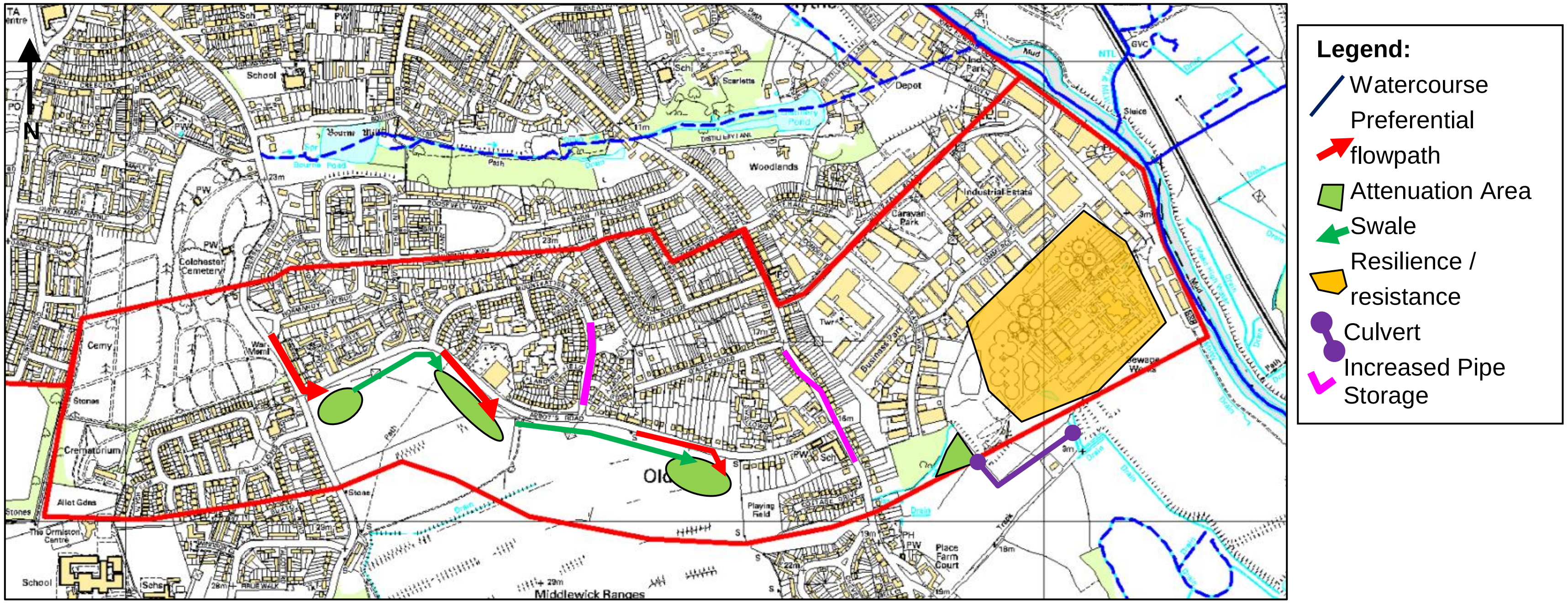


Figure 5-5 Preferred Options CDA 01 – Old Heath Area

CDA 02 – The Hythe Area

Preferred Option:

- Introduce a swale within the upper catchment to divert flows into an attenuation feature within Scrub End Sports Ground. Determine if preferential flow paths can be created within Layer Road to discharge into this device;
- Promote preferential flow paths (remove kerbs and include swales) to divert flows into the attenuation feature within Abbey Field;
- Investigate if expanding the attenuation feature within Abbey Field will benefit the CDA;
- Promote preferential flow paths which divert (out)flows from Abbey Field attenuation area into Bourne Pond via local roads (raised kerbs and local resistance and resilience measures may be required once other measures have been assessed);
- Review maintenance within channels linking permanent water bodies to ensure no objects/features reduce flood storage volumes within the area and if this can be enhanced;
- Investigate utilising a culvert from Distillery Pond into the River Colne (including pumping regime) during times of peak flooding to reduce downstream ponding; and
- Review if resistance/resilience measures should be incorporated within the electrical sub-station and industrial park – review drainage and investigate pumping scheme (update existing if suitable) to reduce risk of ponding within this location.

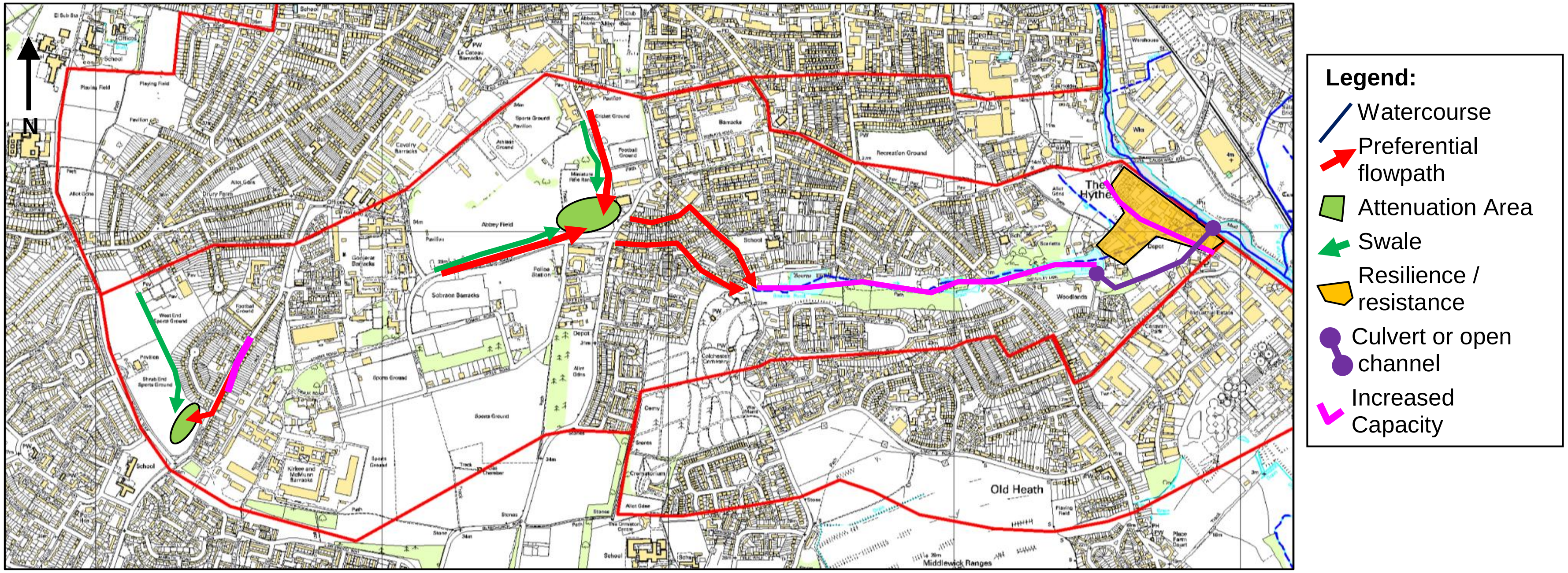


Figure 5-6 Preferred Options CDA 02 – The Hythe Area

CDA 03 – Colchester Town Area

Preferred Option:

- Enhance the hydraulic model (in consultation with AW) to include the drainage network in the CDA (and upper catchment);
- Investigate attenuating (via vegetated bio-retention /soakaways) upstream flows within attenuation areas north and west of Irvine Road (this may impact the existing allotment) with cut off swales directing flows into these attenuation areas;
- Investigate the benefit of including a swale (directing flows to a proposed attenuation soakaway area) within the sports fields of Colchester County High School for Girls to assist with reducing ponding near Cambridge Road area;
- Investigate the benefit of extending the separating the drainage system up Maldon Road and review redesigning the roundabout(s) to attenuate runoff;
- Determine if pipe capacity can be increased and if necessary a pumping regime in place to divert ponding from flooding of commercial/residential areas;
- Determine benefit of retrofitting storage under the car park north of the Colchester Town station which also includes permeable surfacing;
- Determine risk to Network Rail line (including their management procedures) and determine if during extreme events the rail line can be used as a preferential flow path to convey flows into a potential attenuation area within the allotment area north of the line; and
- Review pipe network within Victor Road can determine if a capacity increase is feasible and its benefits and confirm if resistance/resilience measures should be included in the area at risk.

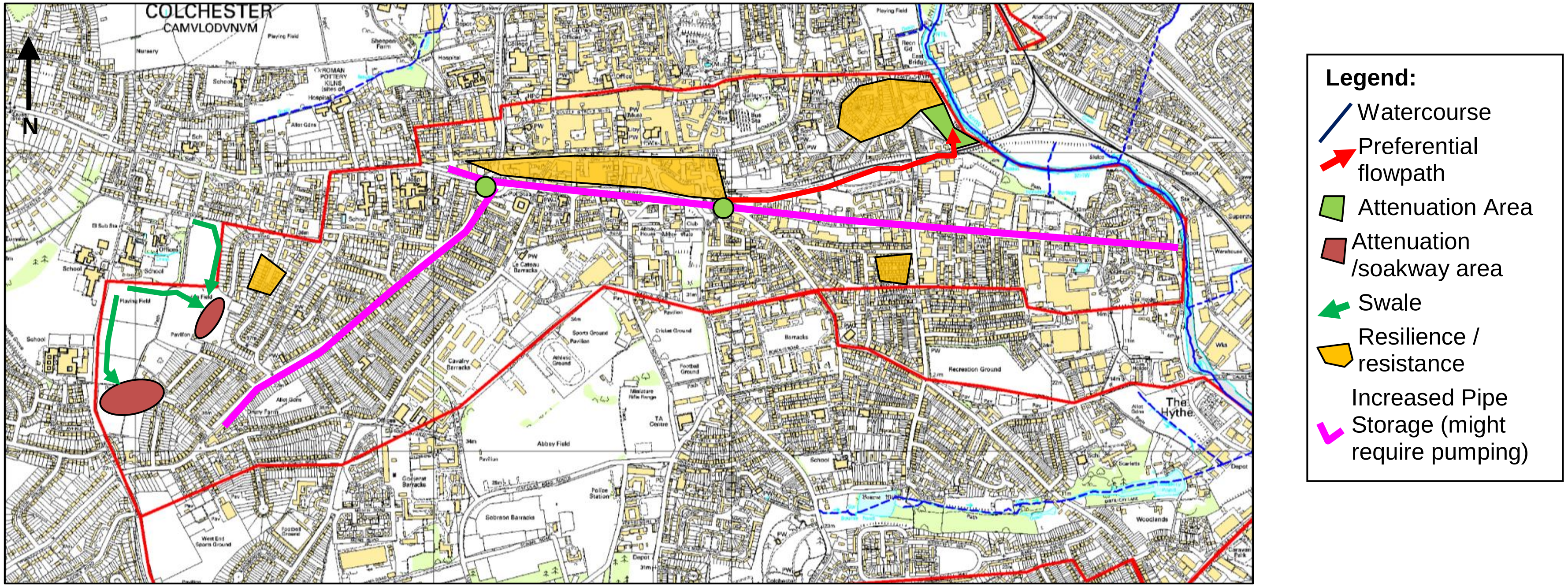


Figure 5-7 Preferred Options CDA 03 – Colchester Town Area

CDA 04 – Colchester A12

Preferred Option:

- A flood plan should also be implemented, linked to extreme rainfall alerts, that would enable traffic management (e.g. diversions) and monitoring of surface water on the road to be put in place, minimising disruption to people utilising the A12;
- As a preliminary step, this CDA will require consultation with the Highways Agency and confirm if known risk exists in this location or anywhere else along the A12 route within Colchester. Other areas of predicted risk along the A12 should also be investigated;
- Information should be sought on the capacity of the existing drainage system. Ensure that road corridor is adequately draining and confirm what management measures are in place for this road.
- If no measures are in place review if a pumping regime can be incorporated within the sag point of the road which will pump flows into a temporary attenuation (soakaway) area located within the sports field south of Holmwood House School;
- Based on the findings, it may be necessary to undertake more detailed modelling.

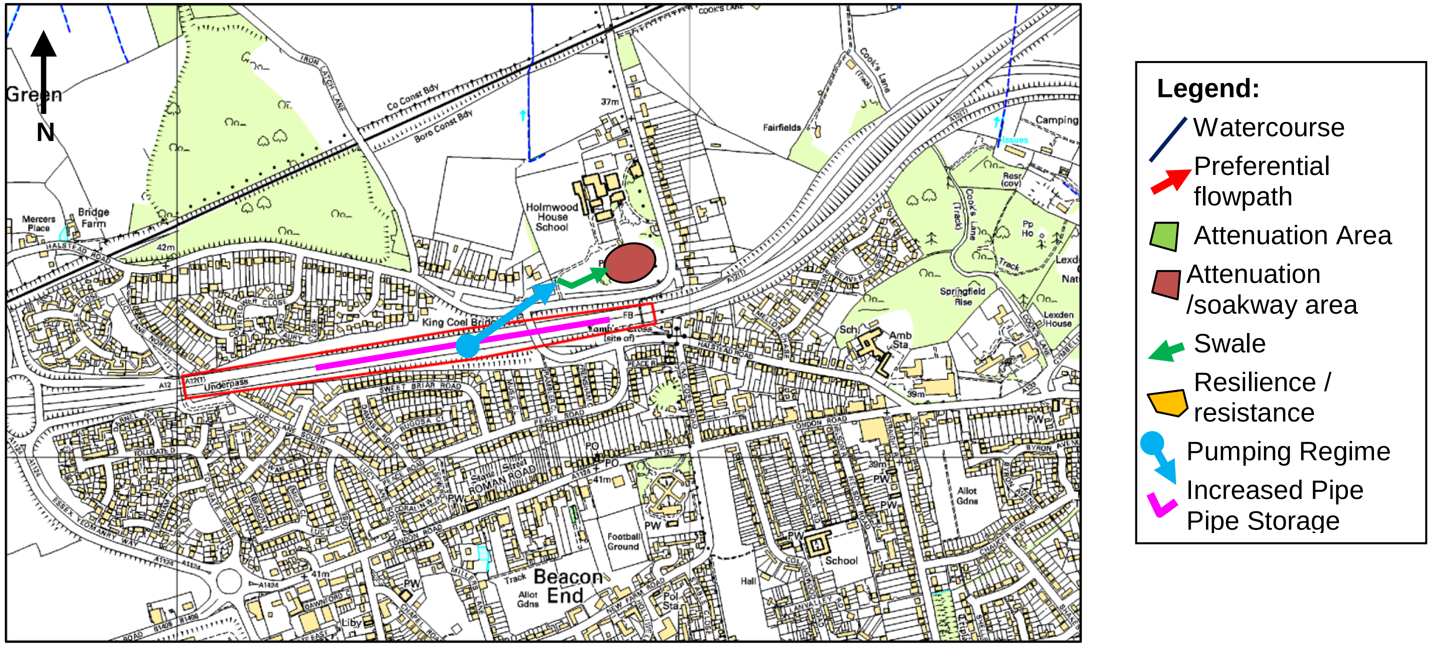


Figure 5-8 Preferred Options CDA 04 – Colchester A12

CDA 05 – St. Anne's Area

Preferred Option:

- Review the existing flow management measures upstream of the CDA (north of the rail underpass), as an area of ponding is predicted to occur near the confluence of the OWC's. After review, determine if this area can be enhanced and additional storage provided within the open space;
- It is recommended that flows from the western upstream OWC are diverted to a soakaway west of the existing natural storage area and that an additional area of storage to the east of the existing storage area is proposed to assist with providing additional storage for flows from the eastern OWC;
- Construct a bund to increase the storage potential and reduce the risk to downstream properties. The outfalls from the basin(s) should incorporate flow control measures to limit the runoff rate discharging through the pedestrian underpass;
- Review existing AW pumping system within the CDA and determine its rate and purpose. Confirm if any increase in its capacity is required to reduce risk of ponding within the CDA and / or if pumping into the River Colne or other storage area (between rail lines) is possible; and
- Once above measures have been assessed determine if resistance/resilience measures are still necessary within the CDA.

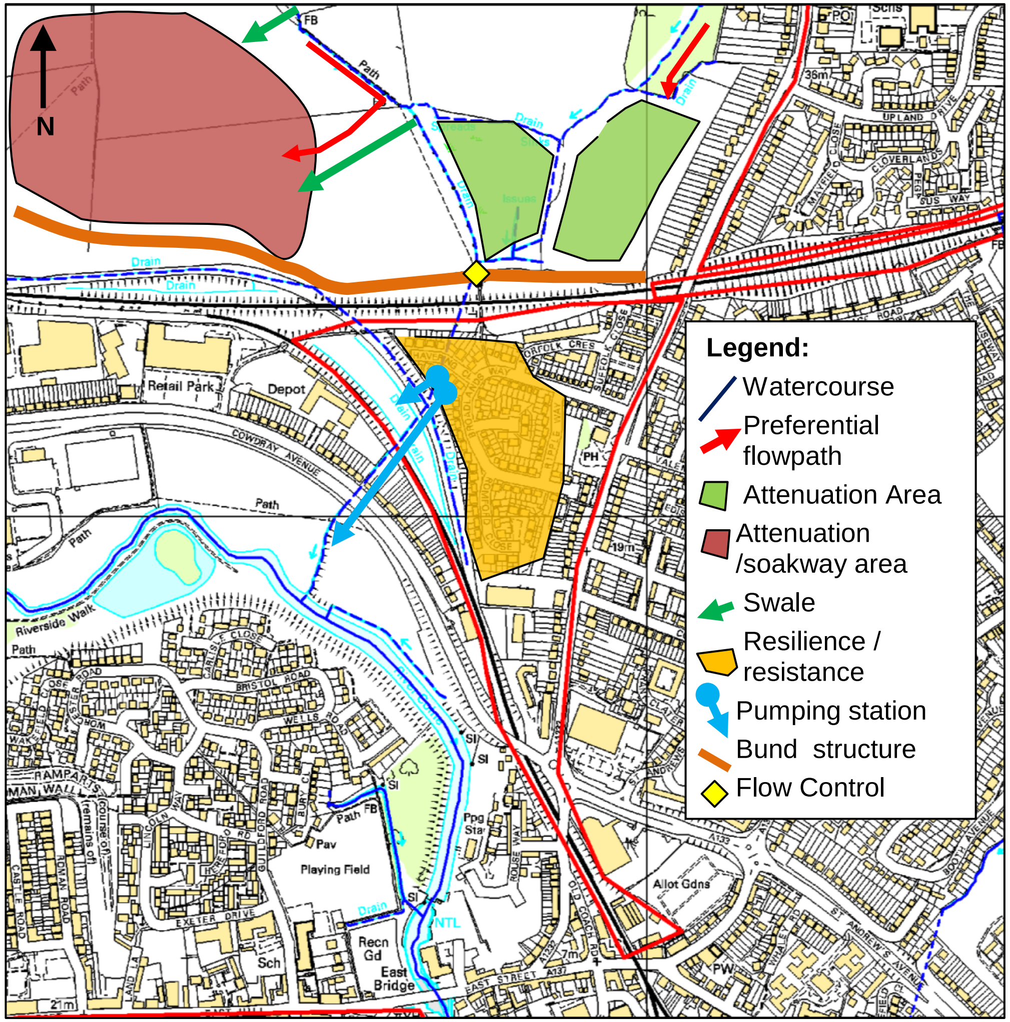


Figure 5-9 Preferred Options CDA 05 – St. Anne's Area

CDA 06 – Colchester Rail Line

Preferred Option:

- A flood plan should also be implemented, linked to extreme rainfall alerts, that would enable rail management (e.g. diversions, halting of service) and monitoring of surface water on the track to be put in place, minimising disruption to people utilising rail network near Colchester;
- As a preliminary step, this CDA will require consultation with Network Rail to confirm if there is a known risk in this location (or anywhere else along the route within Colchester);
- Information should be sought on the capacity of the existing drainage system within the Network Rail system. Ensure that the rail corridor is adequately draining and confirm what management measures are in place for this area;
- If no measures are in place review if a pumping regime (or flow diversion) can be incorporated within the low points of the rail line which could pump flows into temporary attenuation areas located near the area of ponding;
- Upstream attenuation (within CDA08) may assist with reducing ponding within this CDA;
- Based on the findings, it may be necessary to undertake more detailed modelling once additional drainage information is made available by Network Rail.

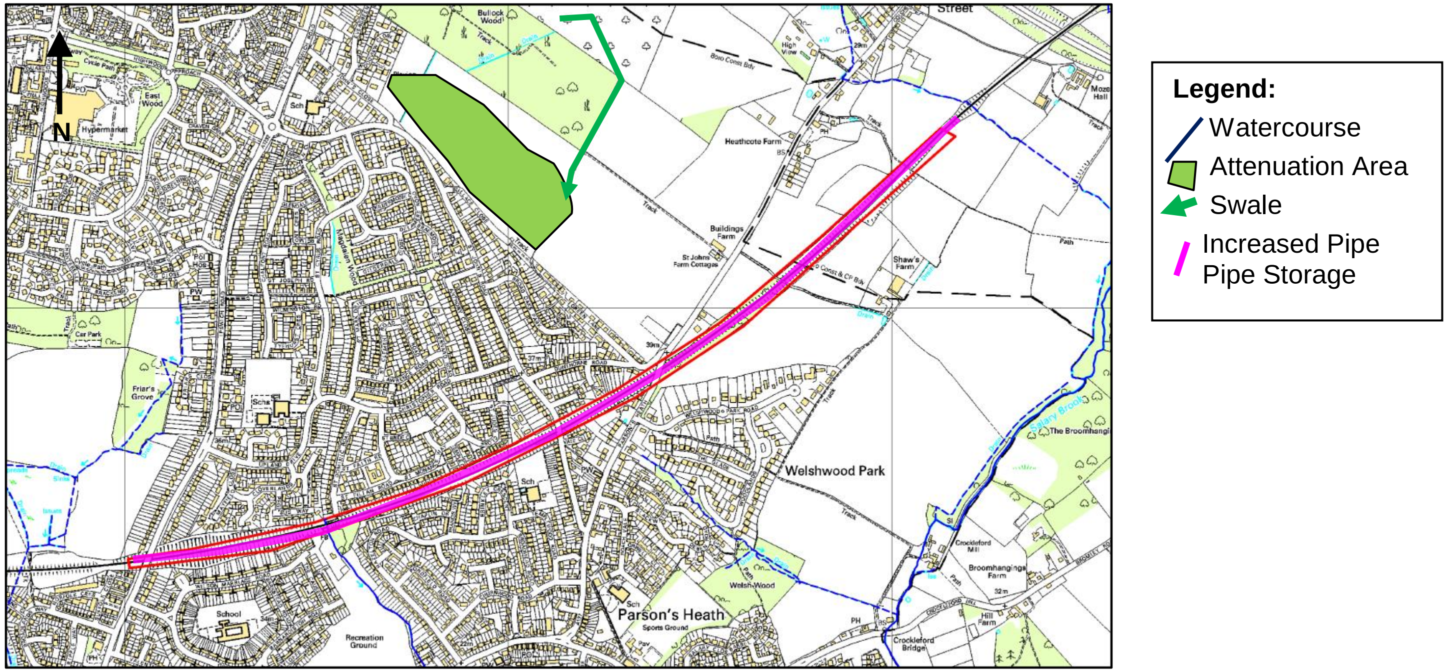


Figure 5-10 Preferred Options CDA 06 – Colchester A12

CDA 07 – Mile End Area

Preferred Option:

- Review culvert (control structure) structure and condition located on the eastern arm of the OWC near Dickenson Road;
- Ensure proposed development site north of Golden Dawn Way (known as Colchester North) restricts runoff rates to Greenfield conditions (or better) to ensure that any downstream risk is not increased as a result of this development;
- Investigate the cost/benefits of fully or partially separating the combined sewer system located within Mile End Road;Determine if underground storage south of the roundabout (mentioned above) is necessary once the above measures as assessed. This could assist in reducing the predicted flood risk to downstream properties and vehicles using the A134;
- Flood storage should be investigated within the A134, Clarendon Way and Essex Hall Road roundabout (south of the CDA) to determine if it can assist with reducing predicted ponding within these roads;
- Determine if any outfall improvements into the River Colne can occur that reduce the pluvial flood risk without increase the fluvial flood risk
- Consider including resistance and resilience measures for properties near the Mile End Road, A134 and B1508 roundabout and along the North Station Road between Clarendon Way and Cowdray Avenue. This should only be undertaken once the outcome of reviewing the above measures has been undertaken.

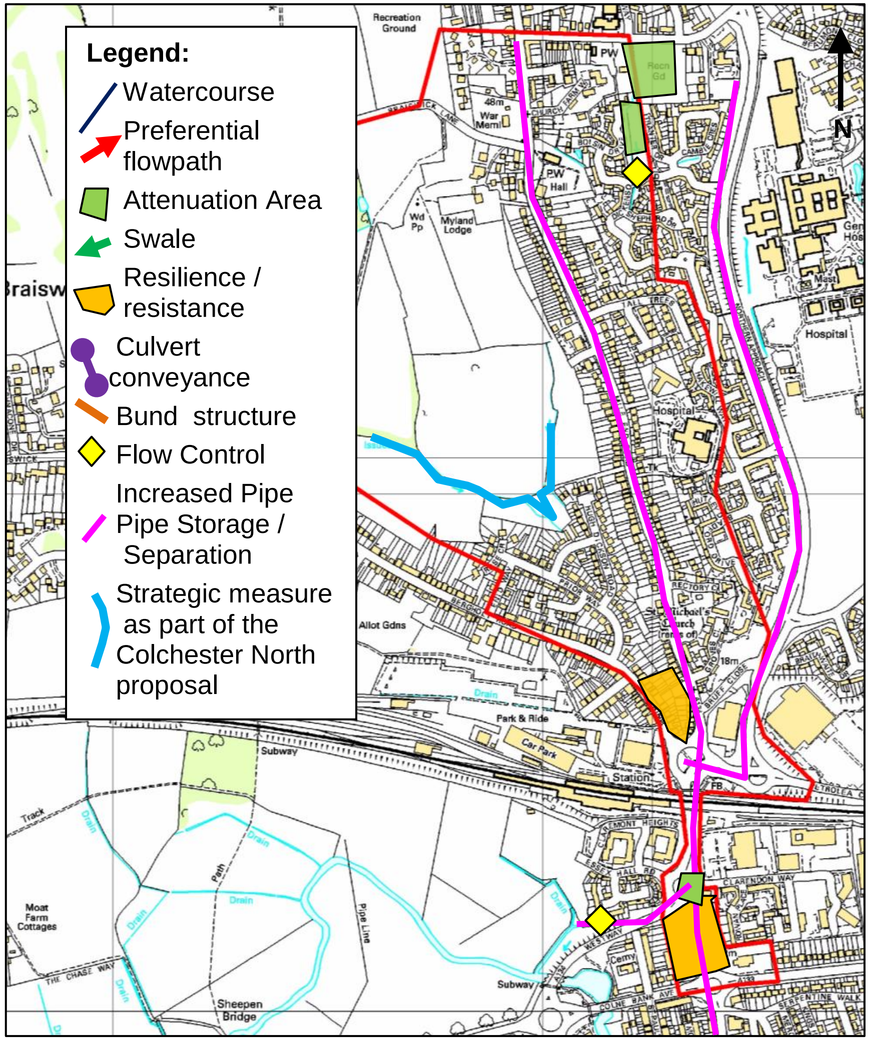


Figure 5-11 Preferred Options CDA 07 – Mile End Area

CDA 08 – Parson's Heath Area

Preferred Option:

- Obtain drainage asset information in consultation with AW and refine the pluvial model – This may require undertaking additional surveys to confirm pipe size, location and invert information. Once these elements have been included within the model it should be re-run to determine the revised predicted risk;
- Determine where local improvements can be undertaken to reduce creation of overland flowpaths within CDA – increased pipe capacity and gulley numbers;
- Provide and attenuation basin; north of the A132 and within the St Johns Church Of England Primary School and within the eastern boundary of the CDA to reduce additional flows entering the central flowpath during the peak of storm events;
- Investigate if a pumping regime can displace flows from:
    - The A132, St John's Road roundabout area; and
    - The culvert of the OWC near Magdalen Wood.

  The removal of runoff into a storage area may assist with reducing the risk of downstream flooding.
- Provide resistance and resilience measures for properties located within the overland flowpath. This should be assessed once the feasibility of the above options has been considered (and any impacts/benefits from works within the adjacent CDAs).

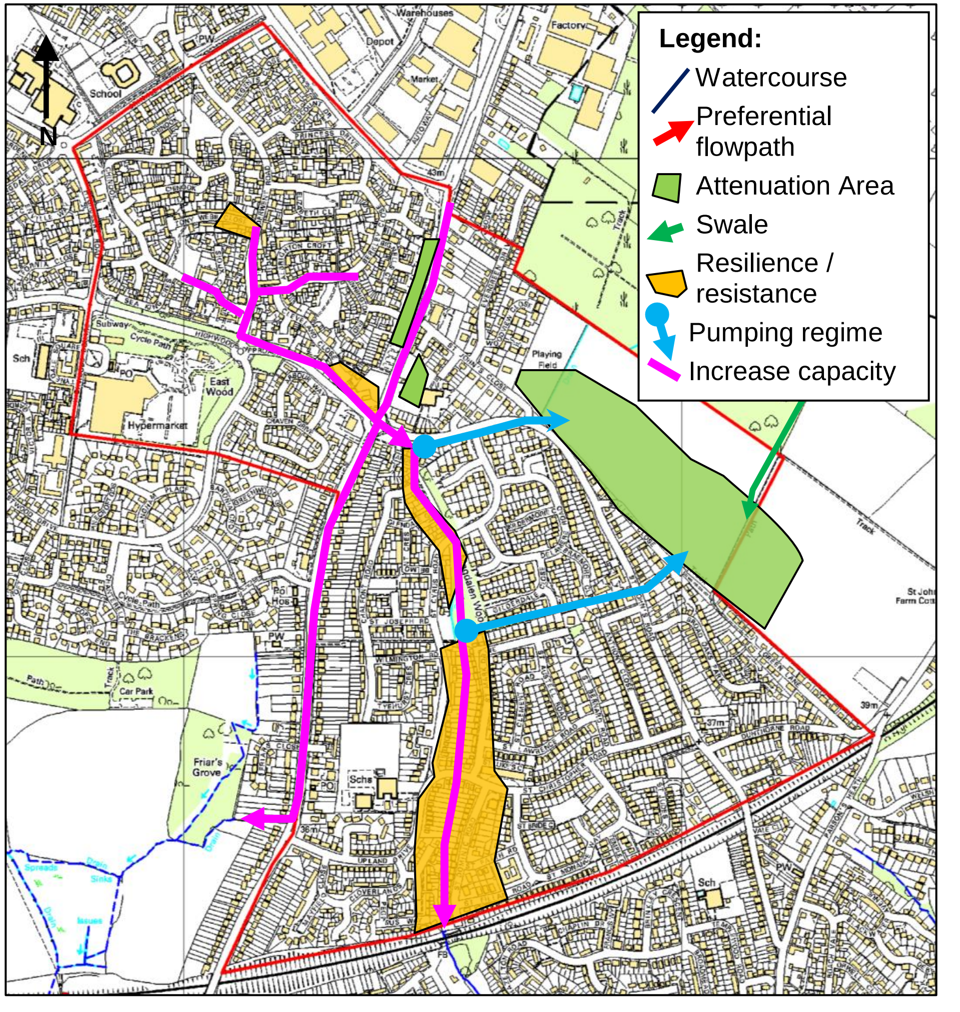


Figure 5-12 Preferred Options CDA 08 – Parson's Heath Area

CDA 09 – Highwoods Area

Preferred Option:

- Obtain drainage asset information in consultation with AW and private developers to refine the pluvial model to determine the risk once these elements have been included – This may require undertaking additional surveys to confirm pipe size, location and invert information;
- Determine where local improvements within both the public and private drainage networks can be undertaken to reduce the creation of the predicted overland flowpath within CDA;
- Investigate the use of green roof areas on commercial buildings and permeable surfaces within exposed hard standing areas;
- Investigate if a pumping regime into the Ardleigh Reservoir can displace flows from the predicted area of ponding behind the raise A120 – a combined pumping regime for this CDA and predicted ponding within the A120 underpass could reduce depths;
- Determine if resistance and resilience measures can benefit properties and infrastructure within the CDA. This should be assessed once the feasibility of the above options has been considered.

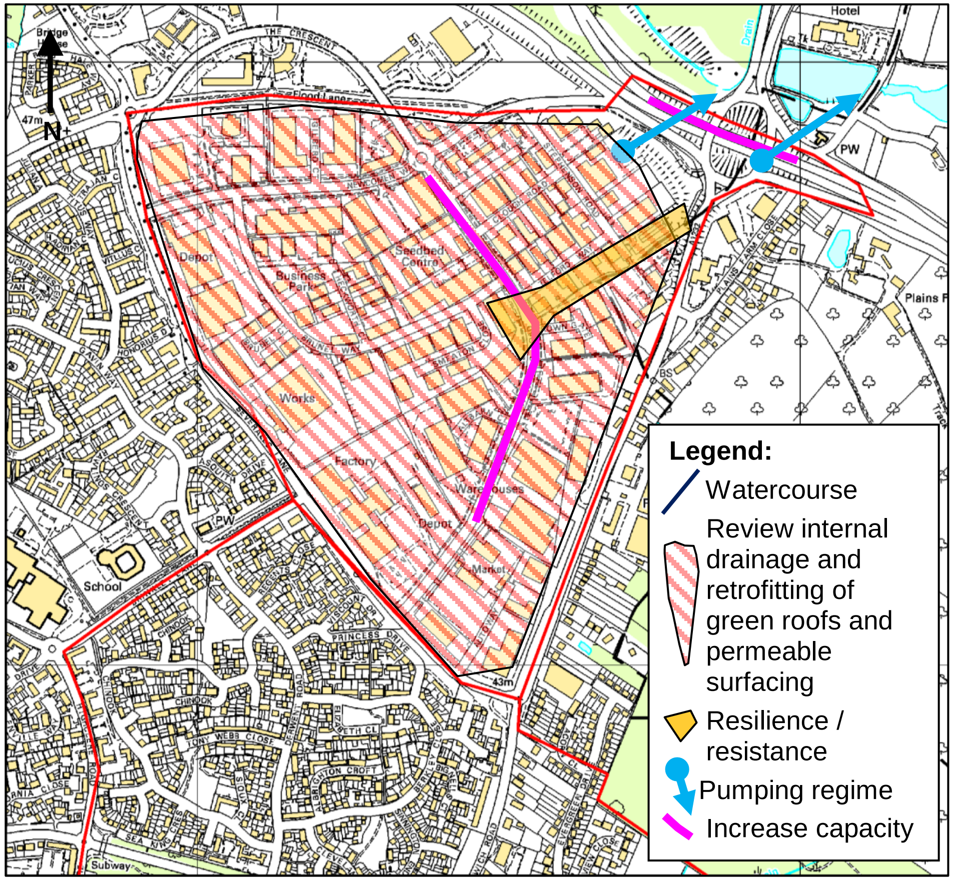


Figure 5-13 Preferred Options CDA 09 – Highwoods Area

5.8.1 Recommendations for all CDAs

Before any works are undertaken in a CDA, it is recommended that a combination of actions are undertaken to further confirm the risk in the CDA, reduce costs of a preferred option / measure and establish the benefit of the proposed scheme. The following recommendations proposed:

- Undertake a detailed feasibility study which includes:
  - Asset investigations (e.g. Inspection / CCTV of existing infrastructure to confirm condition, size and connectivity);
  - Detailed modelling of the CDA (i.e. refined model grid size, include all pipes and gullies);
  - Initial underground service investigations (obtain and review relevant service plans);
  - Confirmation on land ownership issues; and
  - Conceptual sizing and locating of proposed measures / options based on updated data and constraints.
- Initial consultation:
  - Discussions with residents / land owners to confirm flooding history;
  - Internal discussions CBC and ECC teams; and
  - Discussions with EA and Anglian Water to determine if any synergy can be provided within any proposed schemes and determine potential for funding (FDGiA funding, Local Levy Funding, AMP 5 / 6 etc.).

6 Proposed Surface Water Management Policy

6.1 Borough Wide Policy

CDAs delineate the areas where the impact of surface water flooding is expected to be greatest, it is acknowledged that the CDAs (and LFRZs) do not account for all the areas that could be affected by surface water flooding. It is therefore recommended that CBC implement policies which will reduce the risk from surface water flooding throughout the whole Borough, that Essex County Council also implement similar policies, so that both authorities promote and apply Best Management Practises to the implementation of SuDS and the reduction of runoff volumes.

The SWMP Action Plan (discussed in Section 8.1), which is a major output of this project, recommends that the following policies are implemented within the boundaries of the catchment to reduce the flood risk therein:

Policy 1*: All developments across the catchment (excluding minor house extensions less than 50m^2) which relate to a net increase in impermeable area are to include at least one 'at source' SuDS measure (e.g. water butt, rainwater harvesting tank, bioretention planter box etc). This is to assist in reducing the peak volume of runoff discharging from the site.*

Policy 2*: Proposed 'brownfield' redevelopments of more than one property or area greater than 0.1 hectare are required to reduce post-development runoff rates for events up to and including the 1 in 100 year return period event with an allowance for climate change (in line with NPPF and UKCIP guidance) to that of a Greenfield condition (calculated in accordance with IoH124[5]).*

Policy 3: *Developments located in Critical Drainage Areas (CDAs), Local Flood Risk Zones (LFRZs) and for redevelopments of more than one property or area greater than 0.1 hectare should seek betterment to a Greenfield runoff rate (calculated in accordance with IoH124). It is recommended that a SuDS treatment train is utilised to assist in this reduction.*

The Councils may also wish to consider the inclusion of the following policy to manage the pollutant loads generated from proposed development applications:

Policy 4: *Best Management Practices (BMP) are required to be demonstrated for development applications greater than 0.1 hectare within the catchment. The following load-reduction targets must be achieved when assessing the post-developed sites SuDS treatment train (comparison of unmitigated developed scenario versus developed mitigated scenario):*

- 80% reduction in Total Suspended Sediment (TSS);

- 45% reduction in Total Nitrogen (TN);

- 60% reduction in Total Phosphorus (TP); and

- 90% reduction in litter (sized 5mm or greater).

The Councils may also wish to consider specific policy relating to site based flood risk assessments for surface water that is similar to the current practice of the EA for fluvial flood risk. The flood risk maps produced as part of the SWMP can be used to trigger the need for a Flood Risk Assessment under the National Planning Policy Framework (NPPF). The level of assessment required could be implemented in a similar fashion to the EA Flood Zones:

[5] Defra/Environment Agency, September 2005, Flood and Coastal Defence R&D Programme: Preliminary Rainfall Runoff Management for Developments (R&D Technical Report W5-074/A/TR/1 Revision D)

- 100yr Surface Water Flood Depth >0.5m = Assessment similar to EA Flood Zone 3
- 100yr Surface Water Flood Depth between 0.1 and 0.5m = Assessment similar to EA Flood Zone 2

Implementation of this policy is beyond the scope of this SWMP document and an action has been included in the Action Plan for the CBC to undertake internal consultation with their spatial planning and development compliance staff to determine how this type of policy could be implemented.

6.2 Policy Areas

This section provides an outline of planning policy tailored to specific areas within the study area that can be implemented to manage surface water flood risk. The purpose of this type of policy is to address the non-point source flooding that occurs in:

- Parts of CDAs that are not specifically addressed by a capital works solution;
- Areas not defined as CDAs; and
- Areas allocated for development which may impact downstream flood risk.

The purpose of Policy Areas (PAs) are to influence potential growth areas in Colchester that have the potential to impact local flood risk in the catchment. PAs have been defined for the SWMP study area and are shown in Figure 6-1.

The PAs within the CBC boundary have been defined based on highlighted areas of potential development (provided by CBC), geological suitability to accommodate Sustainable Urban Drainage Systems (SUDS) along with a portion of the upstream hydrological catchments which contribute runoff into the allocated development areas. The latter factors influence the type of SUDS that can be implemented to manage property-level surface water runoff. The two main types of SUDS are i) infiltration based and ii) storage based. Infiltration base SUDS are generally limited to areas with good soil permeability and away from areas that are used for groundwater abstraction (infiltration type SUDS can introduce groundwater contamination in certain situations) – refer to Section 3.7.8.

This method provides the opportunity to integrate the concept of Urban Blue Corridors (Defra Scoping Study FD2619 – 2011) in the planning process. The development and delivery of Urban Blue Corridors offers the potential for the delivery of multiple social, environmental and economic benefits from multifunctional land use, and the opportunity to deliver climate change resilient development. It is recommended that areas showing to either convey or store runoff are given due consideration within the masterplanning of each site to ensure that changes to ground levels and reduction of storage areas do not increase the risk of flooding to the urbanised portions of Colchester.

As with the borough-wide policy, it is recommended that CBC and ECC officers involved with the SWMP discuss this proposal with the CBC planning team to obtain initial feedback on the concept. Discussion should focus on how this type of policy can be integrated into current documents and procedures. ECC should also consider how they plan to accommodate the SUDS Approval Body (SAB) role as required by the FWMA 2010 in future as discussed within Section 1.11. Implementation of this type of policy is closely linked to this new role for LLFA.

Table 6-1 Proposed Policy Summary in Colchester

PA No.	Proposed Policy	Justification	Timeframe
1	Development within this area (inside and outside area allocations) should seek to reduce runoff volumes and clearly demonstrate a reduction in surface water flood risk in the downstream areas. The target level of protection of downstream properties and infrastructure should be 1 in 75 year with proposed development maintaining runoff rates that the existing greenfield runoff rates.	This area consists of the growth area proposed within Stanway. The SWMP indicates are varying degree of predicted flood risk in this area which could increase downstream flooding of existing properties and the Roman River.	Short to Medium (allocated areas) Long (unallocated areas)
2 and 3	Development within the area allocation should not increase overall runoff volume and seek to reduce runoff volume within any proposed masterplan(s). Runoff reduction measures should support or enhance local biodiversity and ensure no degradation of water quality or runoff entering the tributaries of the River Colne and reduce peak runoff volumes into CDA07. Upstream flow patterns should be retained where possible with no loss on conveyance or storage demonstrated through a NPPF compliant FRA.	The WCS indicates that although measures are in place for growth accommodation within AMP5, AW have stated that there may not be capacity within the existing sewers for these development. As the town centre is served by a combined sewer network, surface water will need to be separated from the foul for all new developments as a main planning consideration.	Short to Medium (allocated areas) Long (unallocated areas)
4	Development within the area allocation should not increase overall runoff volume and seek to reduce runoff volume within any proposed masterplan(s). Runoff reduction measures should support or enhance local biodiversity and ensure no degradation of water quality or runoff entering the tributaries of the River Colne. Development in this area should assist with reducing flood risk within CDA01, CDA02 and CDA03 by providing upstream attenuation measures.	The overland flow routes within CDA01, CDA02 and CDA03 may benefit from a reduction in peak flows as this could assist with minimising the flood risk from overland flow paths within the OWC and lost OWCs.	Short to Medium (allocated areas) Long (unallocated areas)
5	Development within the area allocation should not increase overall runoff volume, seek to reduce runoff volumes within any proposed masterplan(s) and consider the impacts of the tidal local on surface water discharges. Ponding within topographic low points and behind raised defences will also need to be considered and where possible assist with reducing the predicted flood extents within the downstream boundaries of CDA01, CDA02 and CDA03.	The proposed area is located within the downstream boundaries of CDA01, CDA02 and CDA03 and development in this area can assist with reducing this downstream extent and should consider the risk of tidal locking and locating development behind raised defences.	Medium (allocated areas) Long (unallocated areas)

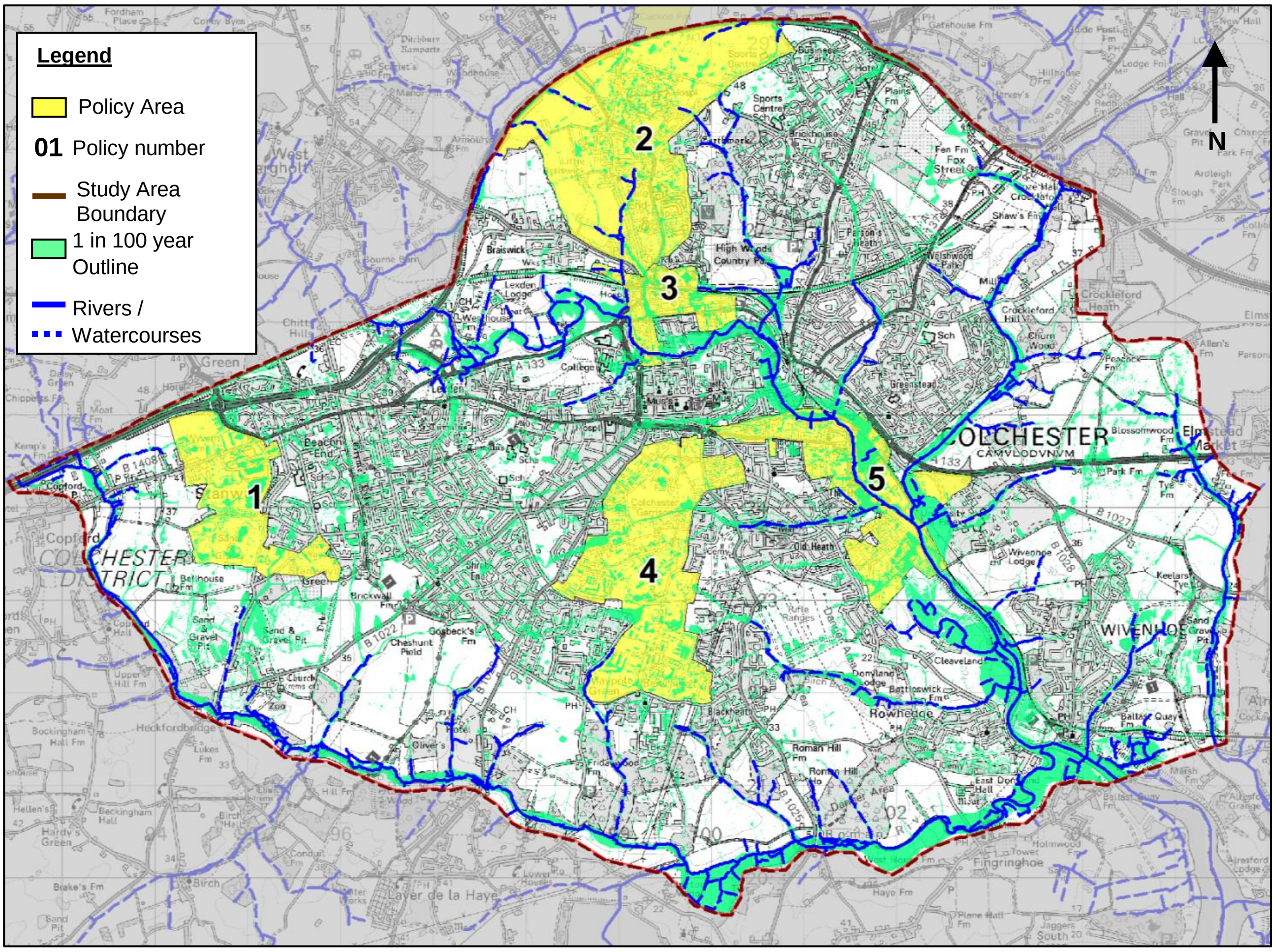


Figure 6-1 Policy Areas and Proposed Site Allocations

7 Preferred Options

Following consultation with the SWMP Steering Group and relevant stakeholders, a number of preferred options have been identified for the study are and wider Borough. A range of preferred options have been identified to help alleviate surface water flood risk alongside further investigations and studies that both ECC (as the LLFA) and the CBC should look to take forward. These are all identified in the Action Plan and ranked as high, medium and low priority actions with a long, medium or short timescale for implementation.

7.1 Colchester Town Wide Options

Adaptation of spatial planning policy: Spatial planning policies (such as those being drafted for Development Management or Sites Allocations DPDs) should be adapted to reflect the outputs and findings of the SWMP study. It is recommended that emphasis is placed on the requirement for appropriate measures to reduce surface water runoff, and the requirement for FRAs to inform the detailed design of new development, particularly within those areas that have been identified at high risk of surface water flooding. This may include mitigation measures, such as SuDS, where these are appropriate. This will ensure that any redevelopment or new development does not negatively contribute to the surface water flood risk of other properties and that appropriate measures are taken to ensure flood resilience of new properties and developments in surface water flood risk areas.

Improve maintenance of the drainage network: Drainage maintenance schedules should be evaluated to reflect the findings of this study. The potential for blockages in the drainage network would exacerbate surface water flooding; this would be a particular issue in all the areas identified as being at risk of surface water flooding during an extreme event. It is recommended that a risk-based approach is applied so that drainage infrastructure in key areas is kept clear and maintained.

Despite overall funding cuts, by targeting key areas for more frequent and comprehensive maintenance while reducing maintenance in other areas, overall cost savings may be achieved in addition to reducing the chance of blockages in key areas.

Plans should be put in place to warn residents of when the gullies (and land drains/swales) are due to be cleaned and request that cars are parked elsewhere.

Improve drainage network capacity: A key recommendation of this study is to look at improving the drainage network capacity across the study, especially within areas that may have capacity issues. When undertaking pipe replacement works it is recommended that an assessment is undertaken to confirm of the area can benefit from an increase in pipe size rather than a like-for-like replacement.

It is recommended that work is carried out in collaboration with Anglian Water to assess the possibility of upgrading the network capacity in these key areas, which would reduce the risk of surface water flooding in these areas.

Improve community resilience: It is recommended that a general approach to improving community resilience is adopted across the study area, particularly in areas that have been identified as being at risk. This should include establishing a flood warning system and improving emergency planning procedures (described in more detail below) as well as encouraging property resilience through the installation of individual property protection measures, such as raising property thresholds or installing flood gates or air brick covers.

Options for funding of property protection measures should also be investigated, including the possibility of offering grants or subsidies for individual properties who are interested in installing such measures.

Improve flood warning systems: Installation of rainfall monitoring systems in key areas, in and around the study area, will provide an evidence base for flooding trigger levels and could provide data for a localised flood warning system. Providing a warning to key council operational departments and emergency services will enable the preparation and implementation of the Council's flood incident management strategy. Relaying this information to households and businesses before a large rainfall event could be achieved through text messages or phone calls warning of potential flooding, as the Environment Agency currently do with their fluvial flood alert system. This, with prior education, will allow individuals to respond with appropriate actions and measures.

Emergency planning (flood incident management): Reviewing the emergency planning procedures in areas at risk from surface water flooding will help to ensure the safety of people and to develop additional planning where required.

Due to the rapid nature of surface water flooding following a rainfall event, resources will need to be in place for immediate implementation following a Flood Warning. Within flooded areas, actions such as the closure of roads and diversion of traffic may be required. A strategy for the safe evacuation of residents will also need to be revised based on the surface water modelling outputs contained within this document.

Permeable paving: Installing permeable paving in key risk areas and along key overland flow routes. These systems can assist in reducing the amount of runoff entering the drainage network, and assist in reducing the overall risk of flooding from an extreme rainfall event.

Rainwater harvesting and water-butts: Improving the resilience of local communities to flooding can be achieved through raising awareness of simple measures and systems that can be installed at their homes. Local residents and property owners may, for example, be encouraged to install simple systems such as water butts to capture roof runoff. Alternatively, rainwater harvesting systems could be installed in new developments or schools.

The principle of rainwater harvesting is that rainfall from roof areas is passed through a filter and stored within large underground tanks. When 'grey water' is required, it is delivered from the storage tank to toilets, washing machines and garden taps for use. Any excess water can be discharged via an overflow to a soakaway or into the local drainage network.

One of the preferred options to reduce peak discharges and downstream flood risk is the implementation of water butts on all new development within the existing urban areas, and in addition, retrofitting these to existing properties where possible.

Water butts often have limited storage capacity given that when a catchment is in flood, water butts are often full and have no spare capacity for flood waters. However, it is still considered that they have an important role to play in the sustainable use of water. There is potential to use 'leaky' water butts that provide overflow devices to soakaways or landscaped areas to ensure that there is always some volume available for storage during heavy rainfall events.

Larger rainwater harvesting systems should also be implemented within suitable developments within the town (e.g. school facilities, commercial buildings etc)

Retrofitting bioretention/rain gardens carpark bays: retrofitting bioretention features in key risk areas and along key overland flow routes will act as a source control measure to reduce the amount of runoff entering the drainage network, and reducing the overall risk of flooding from an extreme rainfall event. These devices also can enhance the aesthetics and biodiversity of an area due to their landscaping. These devices have been found to assist in reducing the total amount of phosphorus and nitrogen that discharge into downstream waterways as a result of adsorption and absorption processes within the filter media and plant growth and die off and therefore improve the quality of the runoff discharging into the downstream network.

Hydrometric monitoring: It is recommended that installing a series of hydrometric monitoring systems across the Colchester catchment would provide a stronger understanding of rainfall patterns and flows that lead to surface water flooding across the study area. Rain gauges and flow gauges should be installed in targeted areas so that a detailed understanding of the catchment hydrology can be established. This evidence base can be used to inform future studies and flood alleviation projects across Colchester.

Essex County Council should develop an integrated framework to support emergency response and flood incident management. In conjunction with this, it is recommended that rainfall gauging stations can be used to assist with this aim, as well as to assist with the Council's responsibility of investigating flood incidents as required under the FWMA 2010.

Preferential overland flowpaths (Urban Blue Corridors): Surface water can be managed through the designation of existing highways as Urban Blue Corridors. This concept aims to manage the conveyance of surface water across an area of the catchment through the redesign of the urban landscape to create specific channels to convey surface water. This can be achieved through increasing kerb heights and property thresholds to retain water on the roads. This option could be combined with existing highways maintenance and improvement projects and funding which would make it more cost-effective.

Raising community awareness: Communicating the risk of flooding and raising awareness within local communities across the town can be implemented in the short-term and provides a 'quick win' measure to surface water management. This will mean residents are more aware of the flood risk across the town and can encourage people to become more proactive within their community. Increasing awareness can be achieved through public consultation events, newsletters and online resources such as Council websites and social media.

It is also important that modern technology is fully utilised in order to communicate with the local community as best as possible. The Environment Agency have produced an iPhone and Blackberry App which delivers data from their online flood warning service straight to people's phones; this is an excellent example of how innovative thinking and technology can be applied to the communication of flood risk. In the first instance, it is recommended that social media platforms such as Google+, MySpace, Facebook or Twitter are utilised as a way of communicating with local residents and providing information on the council's flood and water management activities; this can be an easy 'quick win' action.

7.2 Short – Medium Term Recommendations

Accounting for the nature of the surface water flooding in the town, it is considered that the following actions should be prioritised in the short to medium-term:

- In consultation with Anglian Water, review the surface water network within the study area to confirm the areas at risk, which are under capacity or conveying flows from unintentional sources (open space, residential and other impervious landuses that discharge directly onto the road etc) – initial consultation with Anglian Water indicated that no surface water network model was available for the study area. Discussions between CBC, ECC and Anglian Water should be held to discuss the outputs of the drainage element of the model and confirm if additional data can be obtained to 'clarify' any assumed elements;
- Undertake a feasibility study for providing source control and flow path management measures in relevant open space areas within Colchester;
- Undertake a feasibility study to determine benefits of including water butts and rainwater harvesting measures throughout the study area;
- Confirm the flood risk to all Highways Authority assets and agree if any contingency measures should be put in place for key routes through the town;
- Undertake a town-wide feasibility study to determine which roads may be retrofitted to include bioretention capark pods and other street scale SUDS;
- Improve maintenance regimes, and target those areas identified as having blocked gullies;
- Identify and record surface water assets which are likely to have a significant effect on flood risk as part of the LLFAs Asset Register, prioritising those areas that are known to regularly flood and are therefore likely to require maintenance / upgrading in the short-term;

- Collate and review information on ordinary watercourses in the area to gain an improved understanding of surface water flooding in the vicinity of these watercourses. This may require detailed hydraulic modelling to determine the risk posed by these watercourses;

- Provide an 'Information Portal' via ECC website, for local flood risk information and measures that can be taken by residents to mitigate surface water flooding to / around their property. This could include:

  - A list of appropriate property-level flood risk resilience measures that could be installed in a property;

  - A list of 'approved' suppliers for providing local services, such as repaving of driveways, installation of rainwater tanks and water butts etc;

  - Link to websites/information sources providing further information;

  - An update on work being undertaken in Colchester by the Council and/or the Stakeholders to address surface water flood risk; and

  - A calendar showing when gullies are to be cleaned in given areas, to encourage residents to ensure that cars are not parked over gullies / access is not blocked during these times.

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

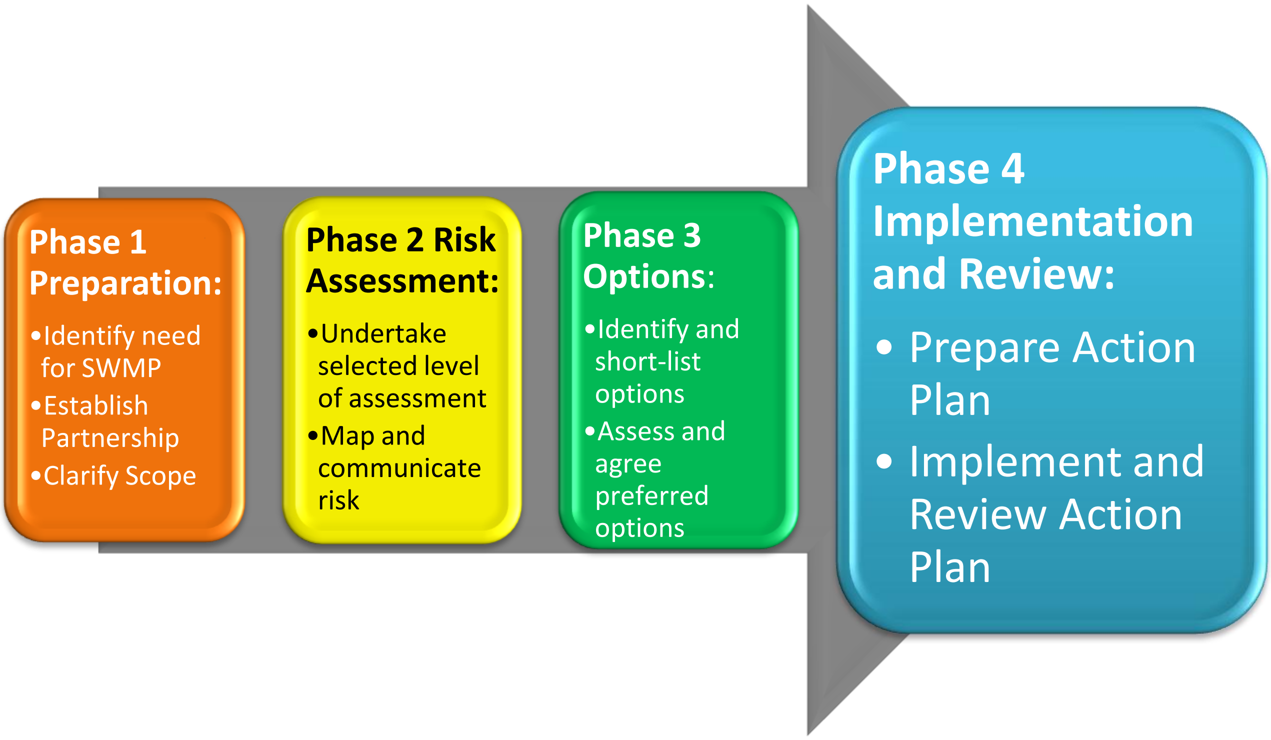
- Refine the direct rainfall hydraulic model with:

  - Detailed survey of structures that may influence the hydraulics of the catchment;

  - All surface water drainage assets and refined grid size (including kerb lines if possible to determine overland flow routes); and

  - Incorporate actual infiltration losses based on results of actual testing of insitu soils within the catchment.

PHASE 4: IMPLEMENTATION AND REVIEW



8 Purpose of an Action Plan

The Action Plan outlines a wide range of recommended measures that should be undertaken to manage surface water within Colchester more effectively. The Action Plan has been developed to outline the responsibilities and implications of both structural and non-structural preferred options discussed in Phase 3 of the SWMP. The Action Plan details the methods, timescale and responsibility of each proposed action.

Within the Action Plan there are details of general measures that could be implemented across Colchester. The general actions are non-structural and encourage improved surface water management through planning policy and public education and awareness. The general actions also include the development of a flood response strategy and surface water flood warning system, which would be beneficial in ensuring successful response, with minimal harmful consequences, in the event of extreme surface water flooding.

Recent guidance and policy has led to the requirement for a Local Flood Risk Management Strategy (as required by the Flood and Water Management Act, 10th December 2010). ECC (and CBC) must ensure the SWMP is aligned as closely as possible to their local strategy; this Action Plan will provide the early stages of these documents and can be used to support and inform future studies.

The Action Plan should be read in conjunction with details of the preferred options. The Action Plan is included in Appendix A of this report.

8.1 Action Plan Details

This Action Plan is a simple summary spreadsheet that has been formulated by reviewing the previous phases of the SWMP in order to create a useful set of actions relating to the management and investigation of surface water flooding going forward. It is the intention that the Action Plan is a live document, maintained and regularly updated by ECC (the LLFA) and the CBC, as actions are progressed and investigated.

New actions may be identified by the LLFA and CBC, or may be required by changing legislation and guidance over time.

The Action Plan identifies:

- *General flood risk management actions* to integrate outcomes and new information from this study into the practices of other ECC/CBC services and external partner organisations;
- *Policy actions* to assist ECC and the CBC to manage future developments in the context of local flood risk management;
- *Maintenance actions* to prompt review of current schedules in the context of new information presented in this study;
- *General CDA actions* to be implemented across all CDAs identified within this study;
- *High priority CDA actions* that are being implemented to better understand flood risk in specific areas and proactively manage operational risks; and
- *Underpass, road and rail risk assessment* actions to understand and the highlight risk to Network Rail assets, Highways Agency assets and pedestrian underpasses.

9 Implementation and Review

9.1 Overview

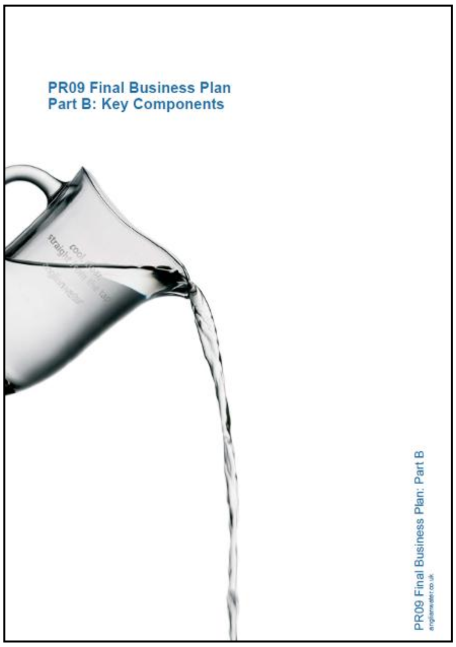
Following the completion of the SWMP, the actions detailed in the Action Plan will need to be implemented. This will require continued work within the Council and the Steering Group to ensure all partners are involved in the implementation and ongoing maintenance and performance measures.

ECC should coordinate with relevant internal and external partners in order to ensure a holistic approach to the implementation of outputs and actions from the SWMP. Key internal Council partners include emergency planners, the highways department, planning policy and the countryside section. Key partners include CBC development and regeneration services, environmental health, emergency planning and leisure and public spaces; Anglian Water, and the Environment Agency.

The outputs of the SWMP should be used, where appropriate, to update and adjust policies and actions. The implications of the SWMP for these partners are described below.

9.2 Anglian Water

Ofwat, the water company regulator, has also outlined their intention for water companies to work with other key partners to deliver SWMPs. In addition the Flood Risk Regulations (2009) outline a duty for water companies to provide information and co-operate with such studies. Anglian Water has been extremely helpful throughout the SWMP process and it is important that this partnership is continued into the future.



One example of how the partnership can be developed upon completion of this study is to look at how the outputs from this SWMP could be used to influence Anglian Water's investment and funding schedule for drainage improvements and maintenance programmes across Colchester. It would be extremely beneficial if their investments plans can be influenced by this study to target areas which have been identified as being at significant risk of surface water flooding due to drainage capacity issues.

Anglian Water is currently in the AMP5 period of work (set out between 2010 and 2015), and therefore it is recommended that the outputs of the SWMP should be incorporated into the next planning period (AMP6). Anglian Water's Business Plan outlines future investment strategy within the water company with the Strategic Direction Statement indicating that Anglian Water proposes that over the next 10 years they aim to make sure that none of the properties in their region are at risk of sewer flooding, due to sewer overloading, other than in exceptionally severe weather conditions. The outputs and recommendations from the SWMP should feed into the decisions made about drainage and sewer flooding in key locations.

The overall aim is for the SWMP outputs to encourage a more holistic approach to future funding arrangements and schemes for drainage improvements within Colchester. For example, the SWMP model outputs can feed into the investments plans for areas with an identified flood risk.

9.3 Spatial Planning

Implications and actions arising for Local Planning Authorities

The Defra SWMP Technical Guidance (March 2010) states that a SWMP should establish a long-term action plan to manage surface water in an area and should influence land-use planning.

The National Planning Policy Framework (NPPF) replaced Planning Policy Statement 25 *Development and Flood Risk* in March 2012 and sets out national planning policy for development in relation to flood risk. Planning Authorities have a duty to ensure that any new development does not add to the causes or sources of flood risk. NPPF takes a risk based approach and categorises land uses into different vulnerabilities, which are appropriate to different flood zones.

Although NPPF applies to all forms of flood risk, surface water, groundwater and ordinary watercourse flood risks are generally less understood than fluvial or coastal flood risk. This is due in part to the much faster response times of surface water flooding, a perception that the impacts are relatively minor and the highly variable nature of influences, e.g. storm patterns, local drainage blockages, interactions with the sewer system. In addition, until production of this report, detailed information on surface water flooding has not generally been available to local authorities.

However climate change models are predicting more frequent heavy storms and there is emerging evidence that this is already happening. It is also clear from the flooding that occurred in several parts of England in the summer of 2007 that surface water flooding can have major impacts. The detailed modelling and historical research that has been undertaken to prepare this SWMP has identified that in some parts of the modelled settlements, the risks are significant and it is important that appropriate consideration is given to these risks when new development is proposed. The planning system is a key tool in reducing flood risk and with this new and more accurate information; this can be applied to surface water flood risk as well as fluvial and tidal flood risk.

The interrelationship between SWMPs and planning was highlighted by Recommendation 18 of the Pitt Review (Cabinet Office, 2008) which states that SWMPs should:

"*build on Strategic Flood Risk Assessments (SFRAs) and provide the vehicle for local organisations to develop a shared understanding of local flood risk, including setting out priorities for action, maintenance needs and links into local development frameworks and emergency plans".*

The following section identifies important implications for land use planning arising from the findings of the detailed SWMP modelling. It recommends actions for implementing the Surface Water Management Action Plan that fall within the responsibility of the statutory local planning authorities, i.e. those are responsible for the development and implementation of land use and spatial planning policy.

There are three key avenues by which the findings of this Surface Water Management Plan (SWMP) are recommended to be taken forward through the planning system:

1. The SWMP maps which identify potential areas that are more vulnerable to surface water flooding should be used to update information in SFRAs;
2. The SWMP maps which identify potential areas that are more vulnerable to surface water flooding should be used to update/prepare policies in Development Plan Documents (Development Management or Sites Allocations DPDs); and
3. The SWMP maps which identify potential areas that are more vulnerable to surface water flooding should be used to inform development decisions for sites or areas by either:
    - Resulting in modifications to strategies, guidance, or policies for major development locations (e.g. through Area Action Plans and Supplementary Planning Guidance); or
    - Influencing planning decisions in relation to the principle, layout or design of particular development proposals.

It is recommended that the Environment Agency utilise the findings of this SWMP within any future planning response until such a time that the SAB is established and operational.

Using the SWMP to update SFRAs

Defra's SWMP guidance (March 2010) suggests that local authority planning departments use the map outputs from a SWMP to help update SFRAs where surface water flooding has not been addressed in detail. In accordance with the Defra guidance, it has been identified that the existing SFRAs do not address flooding from surface water, groundwater or ordinary watercourses in any detail.

The mapping within this SWMP shows some areas that are vulnerable to extensive deep accumulations of water (>0.5m). These areas have a high certainty of flooding during extreme storms and the damage occurring is likely to be significant. The mapping also shows some small areas of potentially deep accumulations of water (>0.5m). These areas may have particular risks associated with them, but may also occur due to irregularities in mapping and modelling. Even relatively shallow water flowing at high velocities can be a threat to life and can cause damage.

For Colchester, the production of this SWMP will be a significant addition of new/updated data. Therefore, in due course, this new information should trigger a review of the Level 1 SFRA. The SFRAs should consider these newly identified risks in the following ways:

- Large areas of deep (>0.5m) flooding should be shown as Local Flood Risk Zones, unless there is evidence to suggest that the risk has been mitigated, for example by high capacity drainage or pumping infrastructure.
- Small, isolated areas of deep (>0.5m) flooding should be investigated to determine how likely they are to be at flood risk, but do not need to be shown if there is no significant risk.
- Large areas of shallower flooding should be identified as Local Flood Risk Zones if they pose a significant risk, but do not need to be shown if the risks are relatively minor.

- Smaller isolated areas of shallower flooding should generally not be identified as Local Flood Risk Zones, unless there is a particular significant risk associated with that area, as it must be expected that most areas will be affected to some extent by rainwater.
- Routes of fast flowing water may be considered as Local Flood Risk Zones if they pose a significant risk.
- Areas susceptible to groundwater flooding should be shown where they are likely to pose a significant risk of flooding or where they are likely to affect the nature of future development, especially for the design and use of sub-surface spaces.

Identifying an area as a Local Flood Risk Zone, should mean that it is then treated in a similar way to Environment Agency Flood Zone 3, is that development proposals will require a Flood Risk Assessment which demonstrates that measures have been implemented to reduce the likelihood and impact of any flooding.

Where a Critical Drainage Area (if identified by future studies) contributes significant amounts of surface water to a Local Flood Risk Zone, the SFRA should identify this and suggest strict application of sustainable drainage measures in this area.

Mapping Checklist

The table below indicates the SWMP maps which are of potential use to spatial planning, and indicates which maps may be suitable for replacing existing SFRA maps:

Table 9-1: SWMP maps which are of potential use to spatial planners

Issue	SWMP map reference	Consider replacing existing SFRA maps?
Surface water flood risk	Figures 9 to 12 (Appendix C)	Yes – more detailed methodology to that used for the SFRA.
Susceptibility to Groundwater Flooding	Figure 5 (Appendix C)	Yes – more detailed methodology to that used for the SFRA.
Recorded incidents of flooding	Figure7 (Appendix C)	May include more recent records.

Using the SWMP to update/modify policies in Development Plan Documents

Ideally the review and update of the SFRAs should be a pre-cursor to any significant change to local Development Plan Documents. Therefore, reference to the SFRA within any local Development Plan Documents should automatically update the approach to local flood risks. Where authorities choose not to update the SFRA, any review of Development Plan Documents should consider the same steps outlined in Table 9-1 for the SFRA review.

Where Development Plan Documents (e.g. those covering site allocations and development management policies) are yet to be adopted, there is an opportunity to influence both policies and those sites which are being put forward for development.

Whether or not a review of the SFRAs is undertaken, the production of the SWMP should act as a catalyst for a review of the proposed sites being put forward through the Sites Allocations Development Plan Documents which are being prepared for Colchester. Identification of areas of Local Flood Risk which have similar levels of hazard significance as the areas identified by the Environmental Agency as Flood Zone 3 should be reflected in the site selection and screening process.

Using the SWMP to influence areas of major growth and development

The SWMP should inform consideration of how proposed new development will drain to areas of existing surface water flood risk, and therefore the runoff requirements from those development sites.

The LDF has identified a number of areas of 'Major Housing Growth and Associated Facilities' and 'Strategic Employment Sites' where significant growth is proposed.

Where major development proposals are brought forward within the Colchester, these should be examined for:

- Local Flood Risk Zones that affect the area;
- Increased Potential for Elevated Groundwater; and
- Contribution of run-off to Local Flood Risk Zones beyond the actual redevelopment area.

Local flood risk should not necessarily prevent development from taking place, but it may affect the location, uses, design and resilience of the proposals. Therefore, a Flood Risk Assessment should be undertaken to consider:

- the location of different types of land use within the site(s);
- application of the sequential approach to development layout and design;
- the layout and design of buildings and spaces to take account of flood risk, for example by dedicating particular flow routes or flood storage areas;
- measures to reduce the impact of any flood, through flood resistance /resilience measures/materials;
- incorporating sustainable drainage and rainwater storage to reduce run-off to adjacent areas; and
- linkages or joint approaches for groups of sites, possibly including those in surrounding areas.

These requirements can be set out in Development Management policies or as site specific policies in the Site Allocations DPD.

Using the SWMP to influence specific development proposals

Where development is proposed in an area covered wholly or partially by a Local Flood Risk Zone, this should trigger a Flood Risk Assessment, as already required under NPPF.

Whilst some small scale developments may not be appropriate in high risk areas, in most cases it will be a matter of ensuring that the Flood Risk Assessment considers those items listed above and also considers some or all of the following site specific issues:

- Are the flow paths and areas of ponding correct, and will these be altered by the proposed development?
- Has the site been planned sequentially to keep major surface water flow paths clear?
- Has exceedance of the site's drainage capacity been adequately dealt with? Where will exceedance flows run off the site?
- Could there be benefits to existing properties at risk downstream of the site if additional storage could be provided on the site?
- In the event of surface water flooding to the site, have safe access to / egress from the site been adequately considered?
- Have the site levels been altered, or will they be altered during development? Consider how this will impact surface water flood risk on the site and to adjacent areas.
- Have inter-dependencies between utilities and the development been considered? (for example, the electricity supply for building lifts or water pumps)

9.4 Emergency Planning

The Civil Contingencies Act 2004 requires that Category 1 responders undertake a number of duties including risk assessments for an emergency. This duty is defined in the Act as 'an event or situation which threatens serious damage to human welfare in a place in the UK, an event or situation which threatens serious damage to human welfare in a place in the UK'. Within this context, all local authorities have this responsibility and this includes County, District, Borough, City Councils and Unitary Authorities who all have a duty, as a Category 1 responder, to prepare a local Community Risk Register (CRR), collectively and individually.

The Essex Community Risk Register is a multi agency document and has been prepared by the Essex Resilience Forum as part of their duties under the Civil Contingencies Act 2004 (CCA). Emergency response and recovery is a multi agency activity and the framework within the CCA

Essex, with its partners, has a long tradition of taking a pro-active approach to Emergency Planning and encouraging partnership arrangements with all Essex local authorities and other stakeholders who are committed to making Essex a safer place to live.

Over recent years Essex has had its share of emergencies to respond to (e.g. Foot & Mouth Disease, Flooding (coastal and river); Korean Air 747 Crash; Hijackings at Stansted; Fuel Crisis; flooding events), and the effects of the London Bombings on Essex families and communities.

For the first time, the introduction of the Civil Contingencies Act (CCA) 2004 placed a statutory duty upon all local authorities and identified new areas of development including provision for business continuity and public information.

Essex Civil Protection & Emergency Management Team (ECPEM) is a partnership between Essex County Council (ECC) and Essex County Fire and Rescue Service to deliver the emergency planning service on behalf of ECC. In addition to this, the service also supports a number of the Essex District/Borough Councils through a Service level Agreement to support and advise them on the delivery of their duties under the CCA which ultimately is to safeguarding the public. However the ultimate responsibilities of delivering the CCA duties still remain with the statutory authorities as mentioned above.

This Team plays a key role in co-ordinating the County Council's arrangements by supporting Services in their planning, preparedness and response and providing appropriate training. This enables Services and individuals to fulfil their emergency roles effectively thereby assisting them in helping our communities to recover from emergency situations. Additionally, if a major event was to occur and affect a large area of the county of Essex, this service would, if required, assist in the coordination of the response and recovery on behalf of the other local authorities at a strategic level.

Therefore, the Services role during a major incident (including flooding) would be to facilitate and coordinate the deployment of ECC Services and if necessary assist in the provision of resources during the emergency and recovery phase. At the Strategic and Tactical level the Command, Control and Coordination groups within ECC have been reviewed and updated to better respond to any given emergency and this is reflected in the ECC Civil Contingencies Plan. They will also coordinate the role of the Voluntary Network should they be required.

Each Category 1 Responder has a responsibility under the Act to ensure they have adequate Warning and informing procedures in place and they fully supports the SWFM measures recommended within the plan. Additionally, ECPEM have developed sophisticated educational and awareness packages for all ages of children, and the wider community and they will work with all the Essex District, Borough, City Councils and Unitary Authorities to raise awareness through a variety of methods including children.

As an example of this, the ECPEM Service is working with the lead authority to support them in public awareness and to extend their 'Whatif…' Schools project; which is designed to inform children in a fun way, of the various ways they can be prepared for an emergency and to give them greater community awareness. A web page (www.whatif-guidance.org) is currently available with views to extend this to accommodate the more formal teaching methods. This is supported by the public awareness events, using a multi agency approach, giving advice to the public on a range of issues including severe weather and flooding.

9.5 Highways

Essex Highways (a strategic partnership between Essex County Council and Ringways Jacobs Ltd) are the highways authority in Essex, and are responsible for managing and maintaining the road drainage network within Colchester. It has a variety of responsibilities ranging from repairing potholes to salting the roads during cold and icy weather. It is also responsible for ensuring that drains and gullies are kept clear from debris such as soil, dead leaves and rubbish.

This type of debris often builds up in drains preventing the flow of water into the surface water or combined sewers and requires frequent maintenance. If drains become blocked during a heavy rainfall event it can exacerbate the severity of flooding that occurs locally.

Essex Highways are identified as one of the key partners in this SWMP study and its involvement and engagement in the process has been actively encouraged. It is important that the outputs from this SWMP are used effectively in order to support and inform the future management practices of Colchester's road infrastructure. In particular, consideration should be given to the key recommendations which are discussed in the following section.

The main recommendations and actions that the highways department should take from the SWMP process include the following key points:

- The existing schedule of drain and gully maintenance is recommended to be re-evaluated in order to give particular attention to areas considered to be at the highest risk of surface water flooding. Drains and gullies in these areas should be kept clear throughout the year to maximise the capacity of the drainage network and reduce the risk of blockages; this should be reflected in the highways maintenance schedule.

- Opportunities for joint funding on improvement work within Colchester should be considered. Highway maintenance and improvement projects could be combined with drainage improvement or flood alleviation projects through a more holistic approach within the Council. For example, highways drainage programmes may offer opportunities to incorporate useful changes to overland flow paths or increase drainage capacity within a surface water flood risk hot spot with little extra cost. This would provide a time and cost effective way to manage the resources of the Council and ensure different departments are involved in working together to reduce the flood risk across Colchester.

9.6 Review Timeframe and Responsibilities

Proposed actions have been classified into the following categories:

- Short term: Actions to be undertaken within the next one to three years;
- Medium term: Actions to be undertaken within the next one to five years; and
- Long term: Actions to be undertaken beyond five years.

The Action Plan identifies the relevant internal departments and external partnerships that should be consulted and asked to participate when addressing an action. After an action has been addressed, it is recommended that the department responsible for completing the action should review the Action Plan and update it to reflect any issues (communication or stakeholder participation) which arose during the completion of an action and whether or not additional actions are required.

It is recommended that the Action Plan is regularly reviewed and updated to reflect any necessary amendments. In order to capture the works undertaken by the ECC, CBC and other stakeholders, it is recommended that the Action Plan review should be on a not greater than annual basis.

For clarity, it is noted that the FWMA 2010 places immediate or in some cases imminent new responsibilities on LLFAs. The main actions required are summarised below:

- Develop, maintain, apply and monitor a Strategy for local flood risk management of the area.
- Duty to maintain a local flood risk asset register.
- Investigate flood incidents and record in a consistent manner.
- Establish a SuDS Approval Body (SAB).
- Contribute towards achievement of sustainable development.
- On-going responsibility to co-operate with other authorities through sharing of data and expertise.
- Preparation of Local Flood Risk Management Strategies

9.7 Ongoing Monitoring

It is intended that the partnership arrangements established as part of the SWMP process, 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.

The SWMP Action Plan should be reviewed and updated annually as a minimum, but there may be circumstances which might trigger a review and/or an update of the Action Plan in the interim. In fact, Action Plan updates may be as frequent as every few months. Examples of something which would be likely to trigger an Action Plan review include:

- 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, and;
- Additional (**major**) development or other changes in the catchment which may affect the surface water flood risk.

It is in the interest of CBC and the residents of the catchment, that the SWMP Action Plan remains current and up-to-date. To help facilitate this, the CBC and ECC will liaise with other flood risk management authorities and monitor progress.

9.8 Incorporating new datasets

The following tasks should be undertaken when including new datasets in the SWMP:

- Identify new dataset;
- Save new dataset/information; and
- Record new information in log so that next update can review this information.

9.9 Updating SWMP Reports and Figures

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

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

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

10 References

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Appendix A: SWMP Action Plan

Appendix B: Modelling Details

Appendix C: Maps and Figures

Appendix D: CDA Prioritisation

Appendix E: Conceptual Options Assessment

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