Harlow Surface Water Management Plan

Final Draft Report
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- Environment Agency;
- Thames Water;
- British Geological Survey;
- Canal and River Trust (formerly British Waterways);
- Epping Forest District Council; and
- Essex Highways.

Executive Summary

This document forms the Surface Water Management Plan (SWMP) for Harlow. The report outlines the preferred surface water management strategy for Harlow. 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 has been 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 houses, 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, 13 CDAs have been identified and are presented in Figure A below. The dominant mechanisms for flooding can be broadly divided into the following categories:

- River 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 - Areas such as underpasses, subways and lowered roads beneath railway lines are more susceptible to surface water flooding;
- Railway Cuttings: stretches of railway track in cuttings are susceptible to surface water flooding and, if flooded, will impact on services;
- Railway Embankments - Discrete surface water flooding locations along the upstream side of the raised rail embankment;
- Topographical Low Points – Areas which are at topographical low points throughout the district 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 Flood Risk - Areas where extensive and deep surface water flooding is likely to be the influence of fluvial flooding mechanisms (alongside pluvial, groundwater and sewer flooding sources).

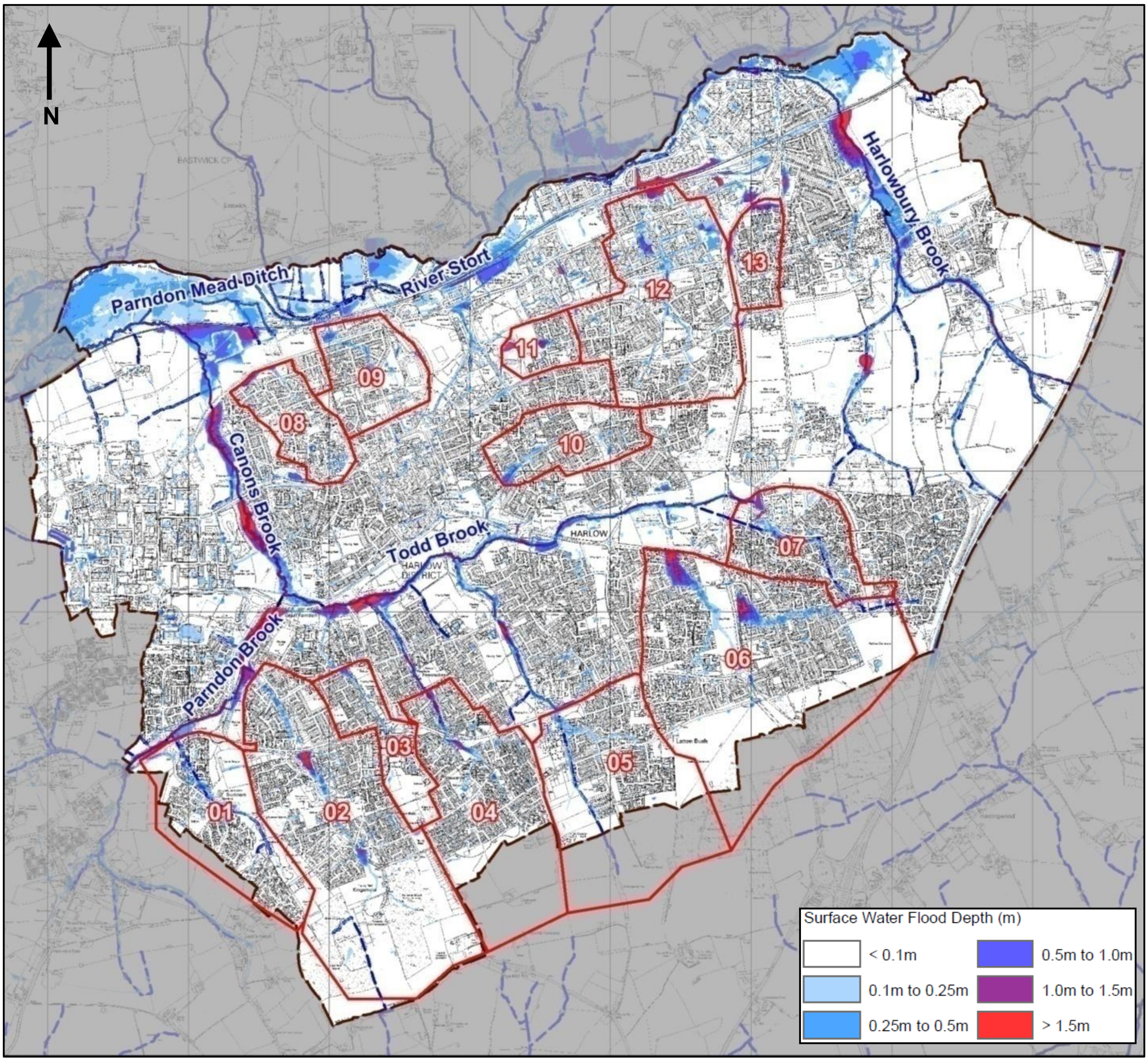

Figure A: Critical Drainage Areas within the Study Area

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 indicates that 2,248 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 ii below.

Table ii. Flooded Properties Summary – 1 in 100 Year Flood Event. Depths Greater Than 0.1m

Administration Boundary	Infrastructure	Households		Commercial / Industrial	Other (Unclassified Landuse)	Total
		Non-Deprived	Deprived			
Harlow	3	1,716	15	36	478	**2,248**

Phase 3: Options Assessment

There are a number of opportunities for measures to be implemented across the study area 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 Harlow.

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 soakaways, 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 alleviate 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 river valleys, and impacts a number of regionally important infrastructure assets. It is recommended that in the short-to-medium term Harlow District and Essex County Councils:

- 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, and 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 Harlow District Council (HDC) and Essex County Council (ECC) to assist in their delegated role under the 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 HDC as delegated by ECC (LLFA) under 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 District.

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
Thames 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.
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.
EA	Environment Agency, Government Agency reporting to DEFRA charged with protecting the Environment and managing flood risk in England.

Term	Definition
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.
HDC	Harlow District Council
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 District 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
PPS25	Planning and Policy Statement 25: Development and Flood Risk (replaced by NPPF)
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.
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	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 (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
HDC	Harlow District Council
BGS	British Geological Survey
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
CDA	Critical Drainage Area
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
IDB	Internal Drainage Board
IUD	Integrated Urban Drainage
JCS	Joint Core Strategy
LDF	Local Development Framework
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
PPS25	Planning Policy Statement 25: Development and Flood Risk
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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Appendix D: CDA Prioritisation
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1 Introduction

Capita Symonds have been commissioned by Essex County Council and Harlow District Council (hereinafter referred to as ECC and HDC) to prepare a Surface Water Management Plan (SWMP) for the HDC administration 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) 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 Harlow area – including Thames 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 Harlow area is vulnerable to surface water flooding and is ranked 137th out of 2,500 settlements in England.

Essex County Council PFRA indicates that Harlow and Epping Forecast, which cover just 10% of the overall spatial area of Essex, are responsible for providing nearly two-thirds (63%) of the recorded flood event data.

As part of the duties created by the Floods and Water Management Act 2010, local authorities are responsible for management of local flood risk – including surface water and groundwater. As it has been previously identified that the Harlow 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 below):

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 Chapters 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 Chapter7); and

4. Implementation and Review: Prepare Action Plan and implement the monitoring and review process for these actions (refer to Chapter8 and 9).

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 within Figure 1-2.

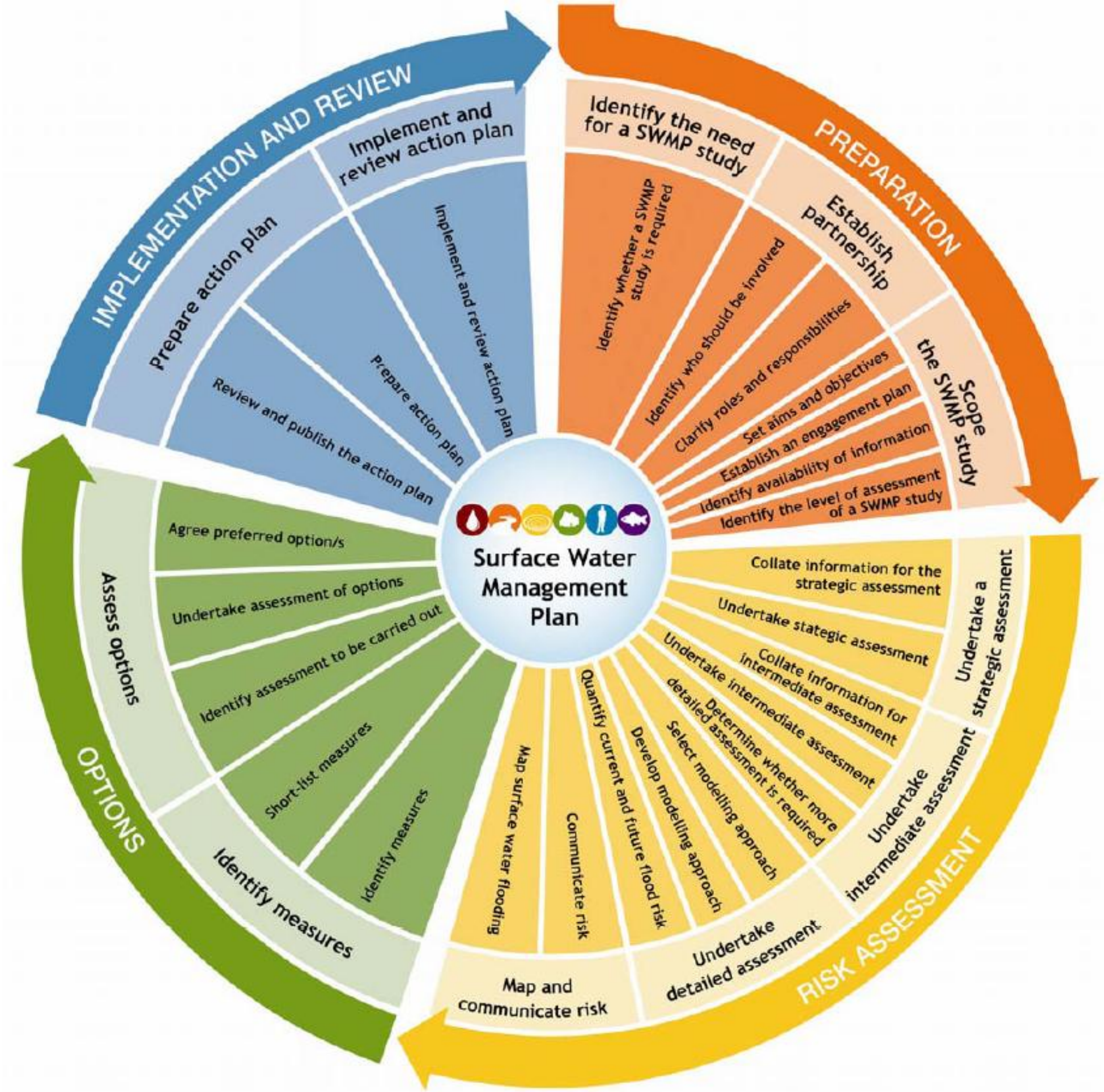


Figure 1-1 Recommended Defra SWMP Process (Source Defra 2010)

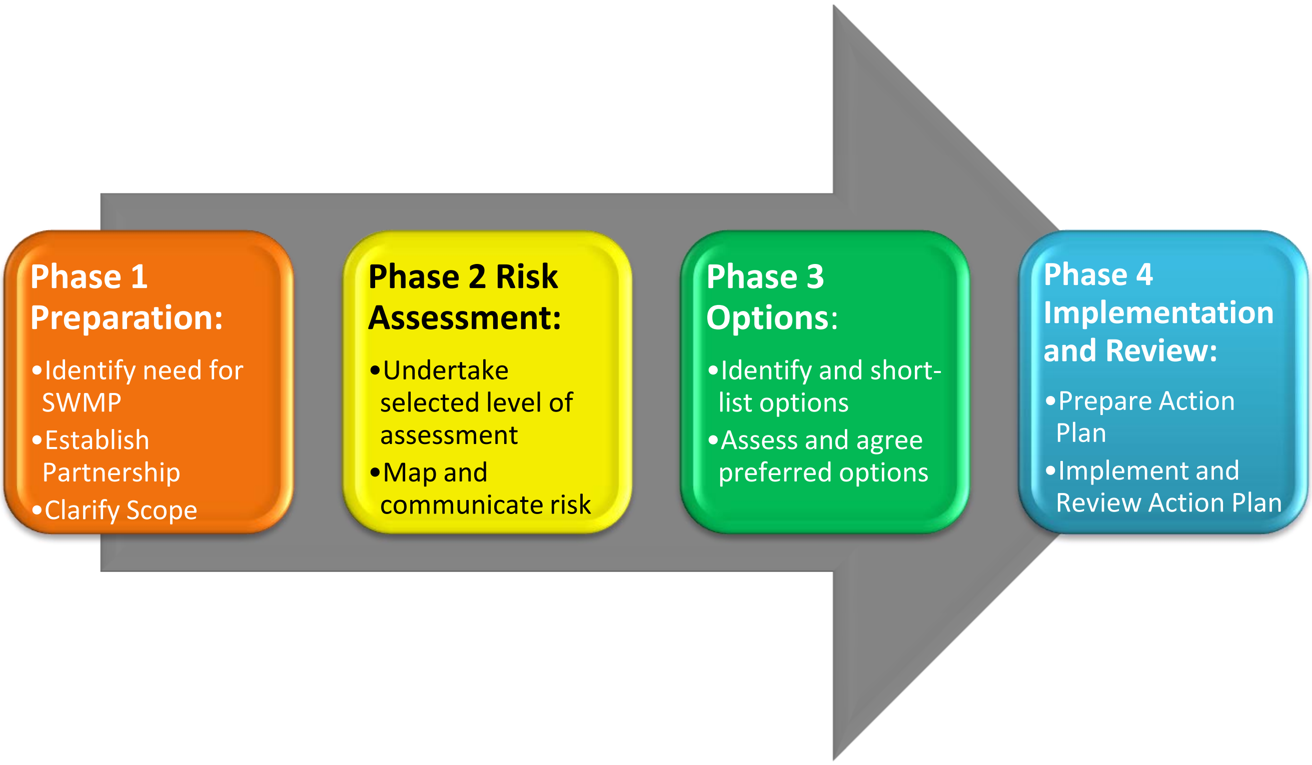


Figure 1-2 Summary of the Defra SWMP Phases

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 surrounding Harlow;
- 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

Harlow District Council is located within the County of Essex and covers an area of over 30km^2. It is borders both Epping Forest (to the south) and Hertfordshire (to the north). Harlow District Council (HDC) 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 Harlow area. The spatial extent of the study area within this SWMP is illustrated in Figure 1-3, below.

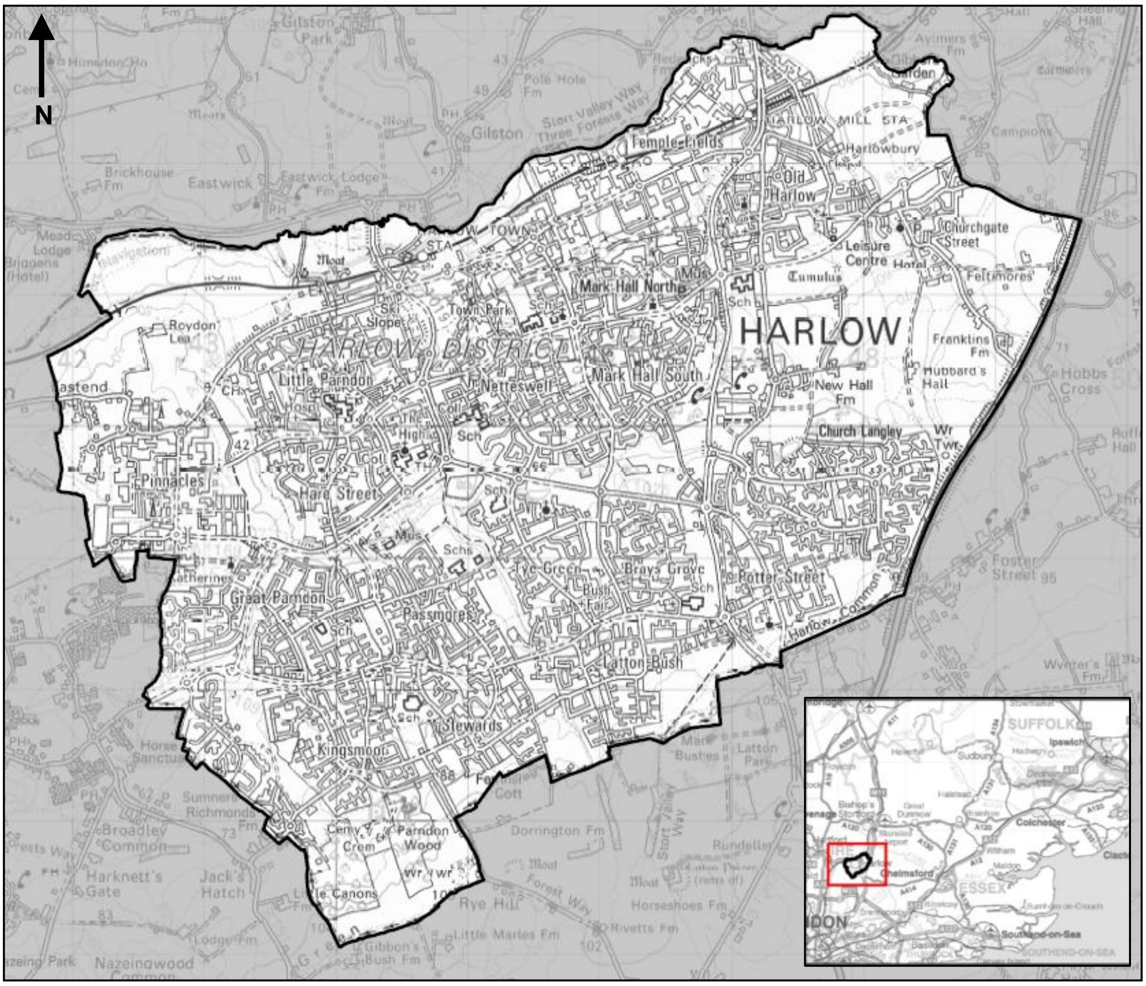


Figure 1-3 Harlow Administrative Boundary

1.5.1 Location and Characteristics

Harlow is located in the west of the county within the Stort Valley on the border with Hertfordshire. It is located on the border with Hertfordshire. Harlow is bordered by the following Councils; Epping Forest District Council to the west, south and east, and East Herts District Council to the north, with the River Stort forming a natural boundary between these two Councils. Harlow is a former new town, conceived in the 1940's in response to the need for housing arising from wartime destruction in London and the south east, thus attempting to reduce the overcrowding in London.

The development of the 'New Town' incorporated the market town of Harlow, now a neighbourhood known as Old Harlow, and the villages of Great Parndon, Latton, Tye Green, Potter Street, Churchgate Street, Little Parndon, and Netteswell. The town is divided into neighbourhoods, each self-supporting with their own shopping precincts, community facilities and pub. The original purpose behind the development of Harlow to house people in the south east in genuine well designed communities with access to good services and amenities while protecting and enhancing environmental quality is as relevant today as it was in 1947 when Gibberd's Masterplan was originally unveiled. The building blocks provided by the Masterplan, have contributed positively to the creation of Harlow's distinct character.

Figure 1-4 (and Figure 3 within Appendix C), below, provides an overview of the land uses within the District. This clearly shows how open space linkages were retained within the Masterplan prepared by Gibbard with urban.

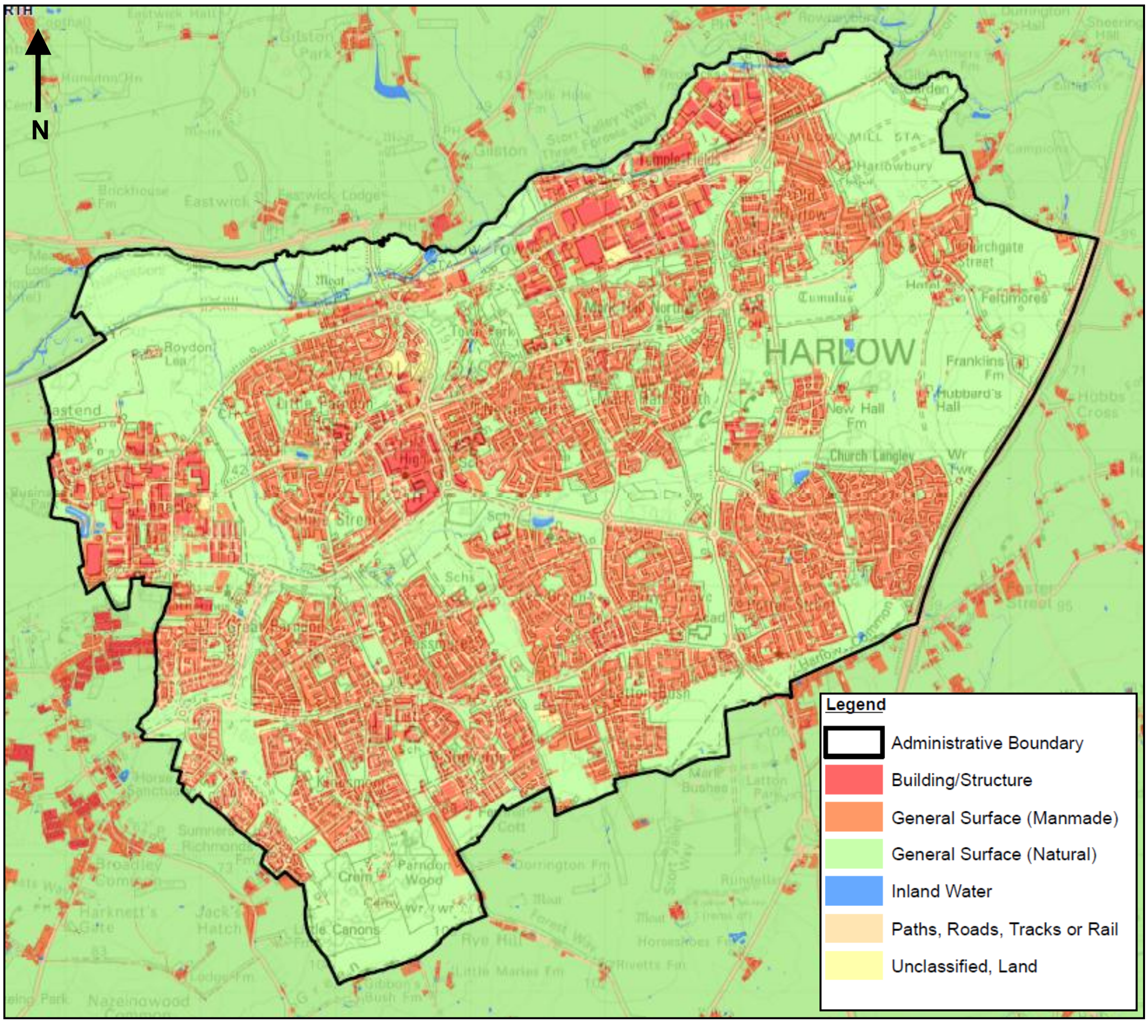


Figure 1-4 Land Uses within the District

1.5.2 Major Rivers and Waterways within the District

There are several watercourses within the study area with the largest being the River Stort which flows along the northern boundary of the district. The River Stort is a tributary of the River Lea, and rises in Langley Hills near Clavering in Essex. This river flows through Bishop's Stortford and Hertfordshire past Harlow before flowing into the River Lea near Hoddesdon.

The watercourses are identified in Figure 1-5 (refer to Appendix C for more detailed mapping).

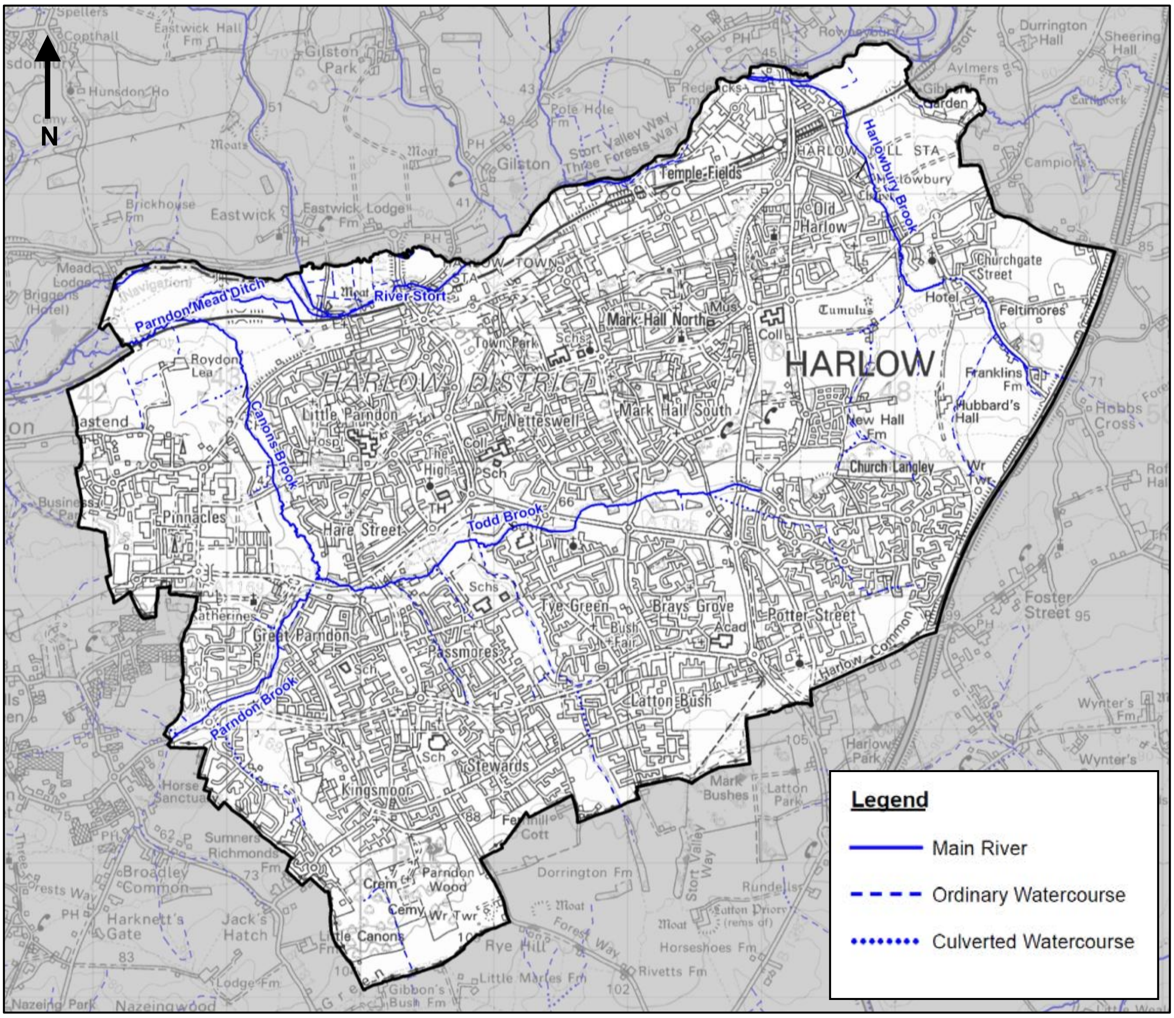


Figure 1-5 Watercourses within Harlow

1.5.3 Topography and Geology

The higher ground in Harlow is located to the south east and falls north west towards the River Stort. Figure 1-6, overleaf, identifies the topography of Harlow.

The bedrock geology of the District is primarily clay with sand and gravel superficial deposits. The nature of the underlying geology affects the potential for groundwater flooding as well as the surface water drainage mechanisms and possible mitigation actions. Clay substrata inhibits the use of infiltrating SuDS features but also indicates a lower risk of groundwater flooding due to the inherent absence of large bodies of groundwater.

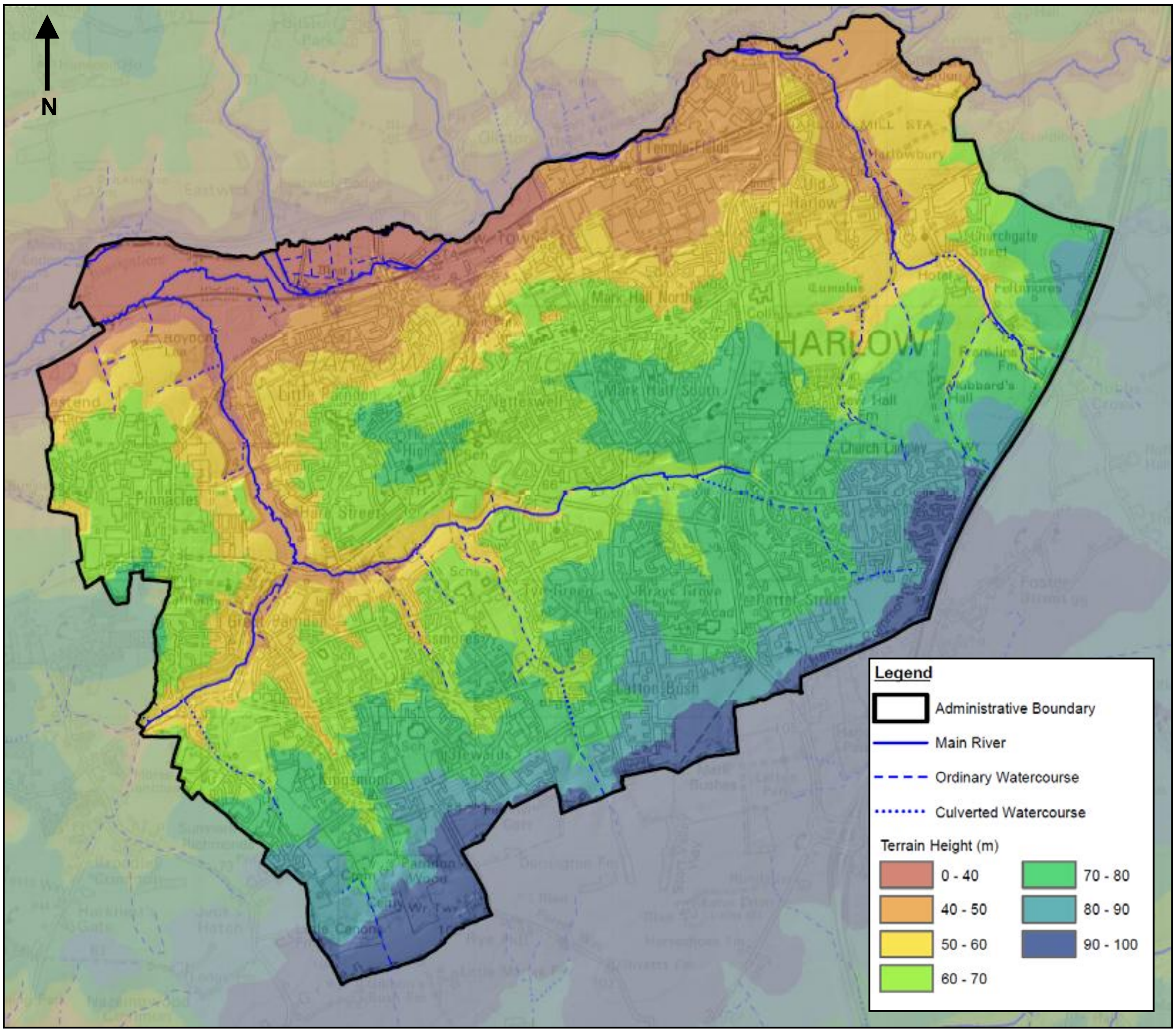


Figure 1-6 DTM Representation of the Topography within the District

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 is responsible for leading local flood risk management including establishing effective partnerships with stakeholders such as the District Council, Environment Agency, Thames Water, Essex Highways and Network Rail 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 District. 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 holistic manner. 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 Stort and its associated 'main river' tributaries within the study area. 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.

Thames Water is the sewerage undertaker within the HDC area and Affinity Water the water supplier.

The study area also falls within the zone of responsibility for Thames 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. HDC is located within the Anglian East RFCC with the Essex County Council representative being the ECC Cabinet Member for Communities and Planning.

1.8 Significant future development plans

The Local Development Framework (LDF) for Harlow identifies a series of growth and regeneration priority areas and places within the District.

Harlow Council is currently working on the LDF Core Strategy. It will set the strategic context for planning in the District over the period to 2026 and contain a locational strategy and strategic policies on sustainable development and other environmental requirements. A site allocations and policies development plan document is also being prepared. The detailed site allocations will be guided by the findings of the SWMP.

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 provides an illustration of these flood sources. Each of these sources of flood risk are further explained within Section 3 of this report.

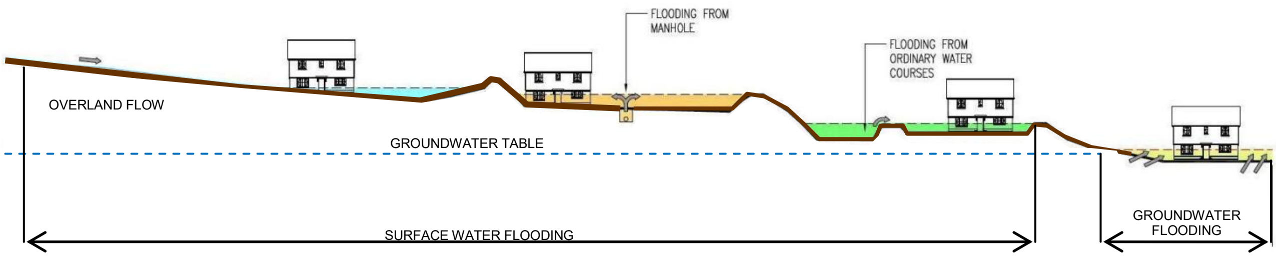


Figure 1-8 Illustration of Flood Sources[1]

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 Harlow SWMP, the evidence base and how the SWMP supports the delivery of other key planning and investment processes.

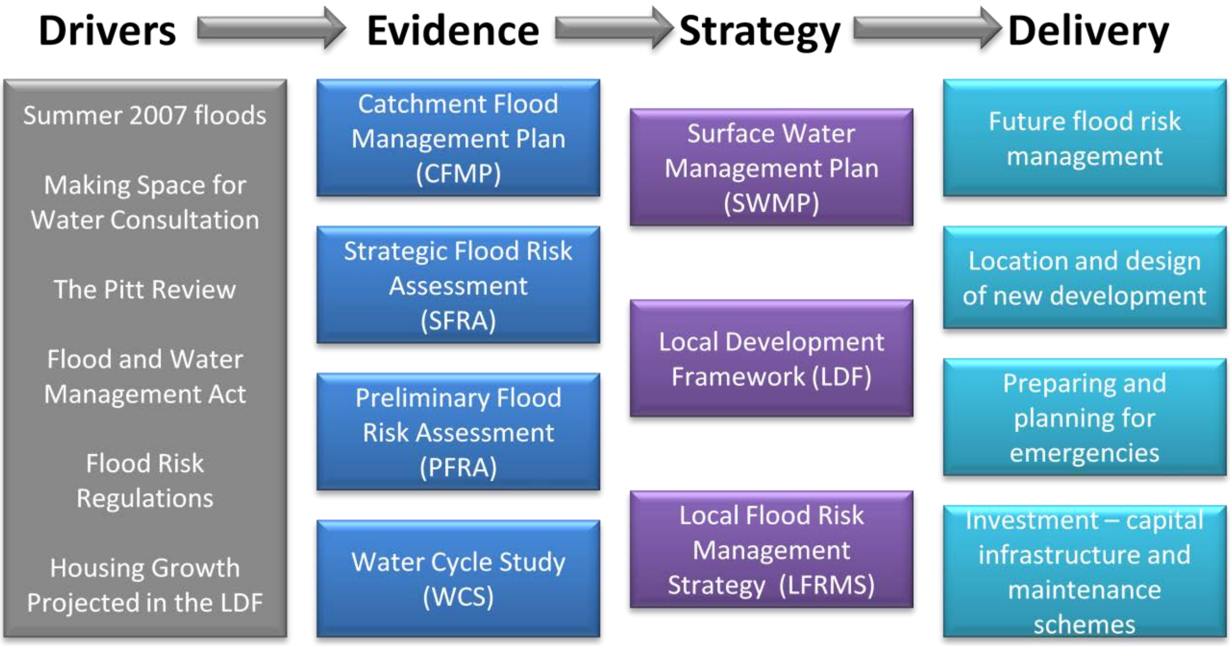


Figure 1-9 Where SWMPs fit in

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.

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

Some key details for these different studies and plans and how they are relevant to the study area are included below:

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.

Thames Catchment Flood Management Plan (CFMP)

The Thames Catchment Flood Management Plan (July 2008) and Summary Report (December 2009) by the Environment Agency includes the Harlow boundary in its study area. The plan gives an overview of flood risk in the Thames catchment and sets out the preferred plan for sustainable flood risk management over the 50 to 100yrs.

The two relevant policies to this SWMP are:

Policy 2 – Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions*. This policy will tend to be applied where the overall level of risk to people and property is low to moderate. It may no longer be value for money to focus on continuing current levels of maintenance of existing defences if we can use resources to reduce risk where there are more people at higher risk. We would therefore review the flood risk management actions being taken so that they are proportionate to the level of risk.*

Policy 4 – Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change*. This policy will tend to be applied where the risks are currently deemed to be appropriately-managed, but where the risk of flooding is expected to significantly rise in the future. In this case we would need to do more in the future to contain what would otherwise be increasing risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.*

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 was required to produce a SFRA under Planning Policy Statement 25 (PPS25) – now replaced by 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. HDC and Epping Forest District Council have produced a Level 1 SFRA in April 2011.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 Harlow.

Local Development Documents (LDD)

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.

Rye Meads Water Cycle Study (WCS)

Harlow District Council and Stevenage Borough Council, in partnership with the Environment Agency and other project partners have completed a Water Cycle Strategy for the Rye Meads catchment area. The objective of a WCS is to provide an integrated approach to managing flood risk, water supply and wastewater infrastructure and to look at potential growth areas in order to identify areas which are suitable for development.

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 1-10, below) illustrates how the CFMP, PFRA, SWMP and SFRA link to and underpin the development of a Local Flood Risk Management Strategy.

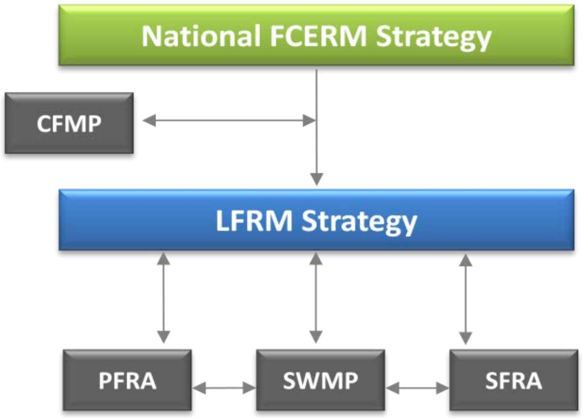


Figure 1-10 Links to local strategies

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; and

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 1-11, below, illustrates how this SWMP fits into the delivery of local flood and coastal risk management, and where the responsibilities for this lie.

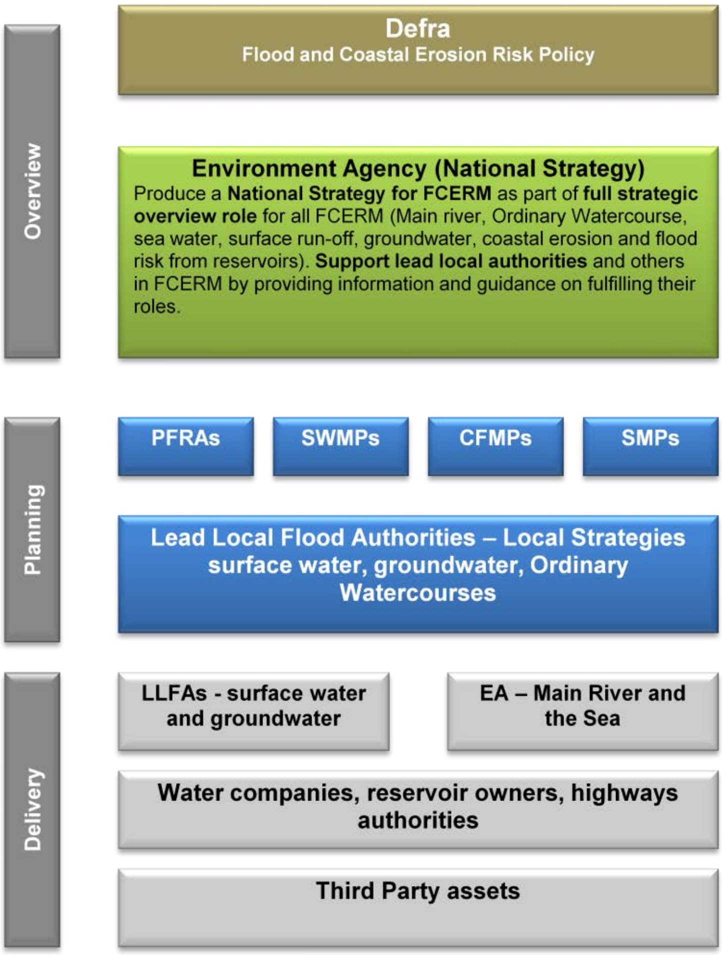


Figure 1-11 Where the SWMP is Located within the Delivery of Local Flood and Coastal Risk Management

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. The register must be available for inspection and the Secretary of State will be able to make regulations about the content of the register and records.

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;
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; and
6. **Designation powers** – LLFAs, as well as 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.

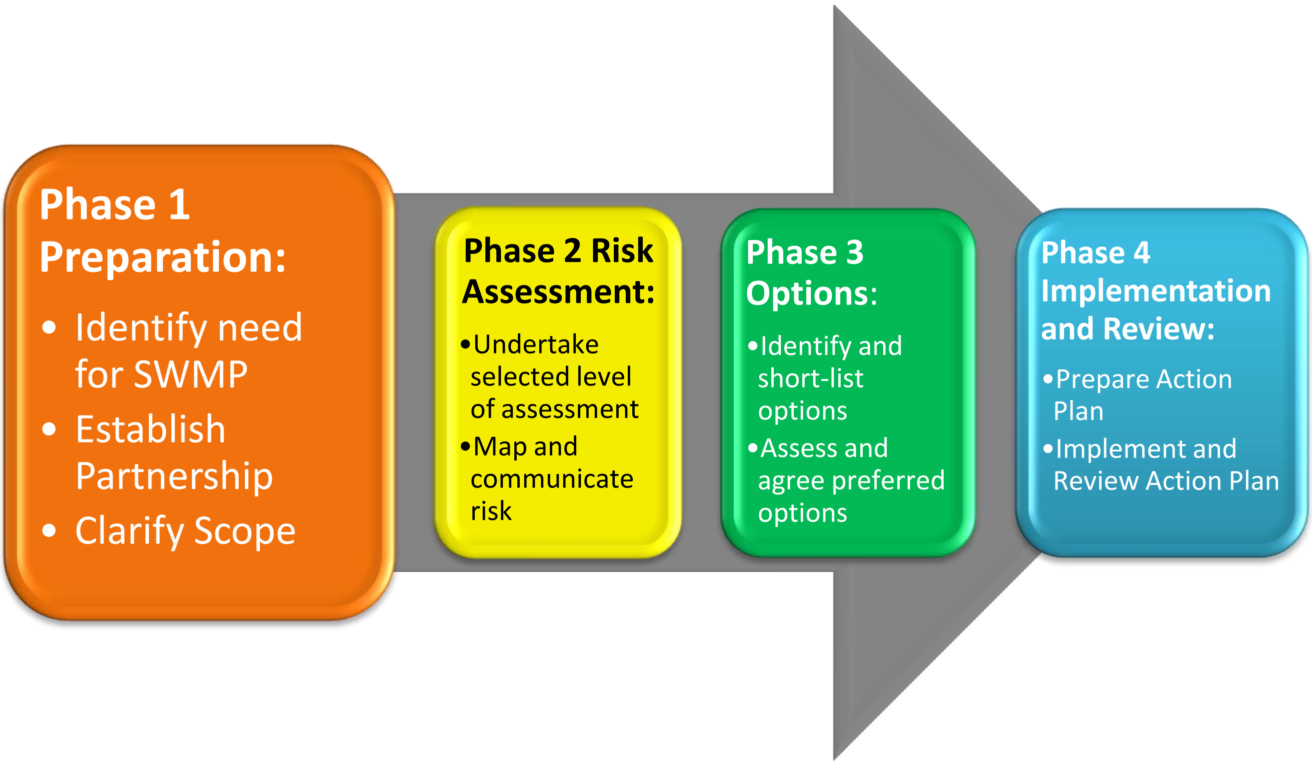
These LLFA requirements have been considered in the production of this document. The SWMP will assist the LLFA in providing evidence for points 1, 2, 3 and 4.

1.13 Local District Responsibilities

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

- Maintain ditches and balancing ponds on District owned land;
- Enforcing maintenance of land drainage by riparian owners;
- Category One Responder to local and national emergencies;
- Providing temporary accommodation in an emergency; and
- Provision of sand bags in flood events.

PHASE 1: PREPARATION



2 Phase 1: Preparation

2.1 Partnership

The FWMA 2010 defines the LLFA for an area as the unitary 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 Thames Water Utilities 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 of this report, the study area falls within the Thames RFCC. HDC is currently represented as part of their ‘constituent authority group’ on the Thames

HDC participate in the Essex Flood Risk Management Officer Group which currently includes departmental representatives from Operations, Sustainability and Emergency Planning, 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 District. 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:

Harlow District Council;

British Geological Survey;

Environment Agency;

Canal and River Trust (formerly British Waterways);

Essex Highways.

Essex County Council;

Thames Water;

Essex Fire Authority;

Epping Forest District Council; and

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 District.
	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 the District 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)	1 - 2m resolution terrain model compiled from aerial surveys.	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
	Thames 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
Harlow District Council	Strategic Flood Risk Assessment (SFRA) – Level 1	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	Topographic maps of the study area	Used to derive modelling parameters
	Core Strategy Development Plans	Local Development Scheme	Understanding of areas of future development.
	Flood Alleviation Schemes	Location and description of existing flood alleviation schemes within the District.	Used in Phase 3: Options Assessment to determine options of each CDA.

Essex County Council	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.
	Historic Flood Records	Locations of historic flooding	Used to assist with the verification of modelling results and CDA locations (where available)
Thames 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; Susceptibility to groundwater flooding; Permeability; Bedrock and superficial geology.	Understanding the geology of the District and assessment of groundwater flood risk
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 HDC 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.

Thames 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 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 provides good coverage along the majority of the study area, but omits several areas within HDC. Additional LiDAR base elevation data was obtained from InfoTerra and was used to cover the missing urban areas within the study boundary. No LiDAR data was available for the rural areas to the south of the study area. To cover these areas, photogrammetry data was obtained from InfoTerra. The elevation data used in the modelling part of this SWMP is therefore a combination of these three data sources.

Main River Information

A substantial quantity of high quality information on the River Stort and its 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;
- 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:

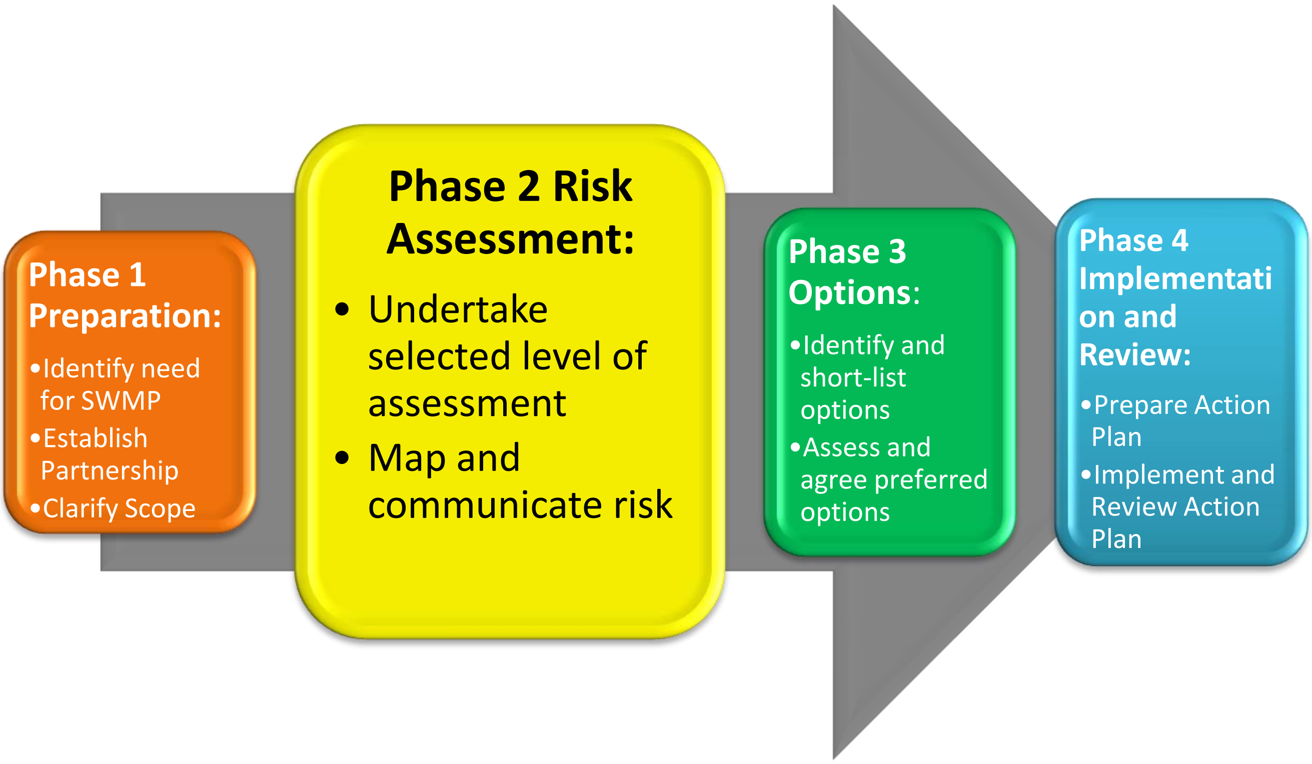
- Strategic Flood Risk Assessment;
- Catchment Flood Management Plan;
- Preliminary Flood Risk Assessment; and
- Index of Multiple Deprivation.

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 Thames Water Utilities Ltd; and
- British Geological Society geology 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

The SFRA indicates that from the founding of the new urban area of the Harlow, the flood of 1947 seems to have had the most impact on the town. It covered an extensive area of the River Stort valley and covered significant areas of the town's major employment area at Templefields. In addition both Todd Brook and Parndon Brook flooded.

Since then the town's development has to a great extent ameliorated the potential flooding in the town. Floods of 1947, 1968, 1974, 1992, 1993, 2001, 2002, 2003, have been mostly confined to the functional flood plain. More recent events (in particular 2006 and 2007), have recorded both when storm event occurred and the location and (where identified) the description of the flood event or works undertaken to reduce the risk (e.g. sandbags provides, drains flooded etc). Where available photographic evidence was also utilised to highlight areas at risk of surface water flooding. Figure 3-1 illustrates a surface water flood event in 2009 which lead to surface water flooding (from surcharging sewers) on Southern Way. A summary of key historic events which were provided for this report have been geo-referenced and mapped in Figure 3-2.

Figure 3-1 Photo of Recent Surface Water Flooding along Southern Way (A1169)

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. Harlow)	• 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, such as the settlements selected within the Phase 2 site assessments. 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 Harlow.

The purpose of the intermediate assessment will be to further identify areas within Harlow 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:

- <u>Pluvial flooding</u>: 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.
- <u>Flooding from ordinary watercourses:</u> 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; and
- 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 – Pluvial Flooding

Past records of surface water flooding within the study area have been provided by various stakeholders and previous studies undertaken for the District (SFRA, WCS). These incidents have been mapped as part of the SWMP and shown in Figure 3-2 below. A breakdown of the data provided for the SWMP can be located within Appendix C, Figure 7.

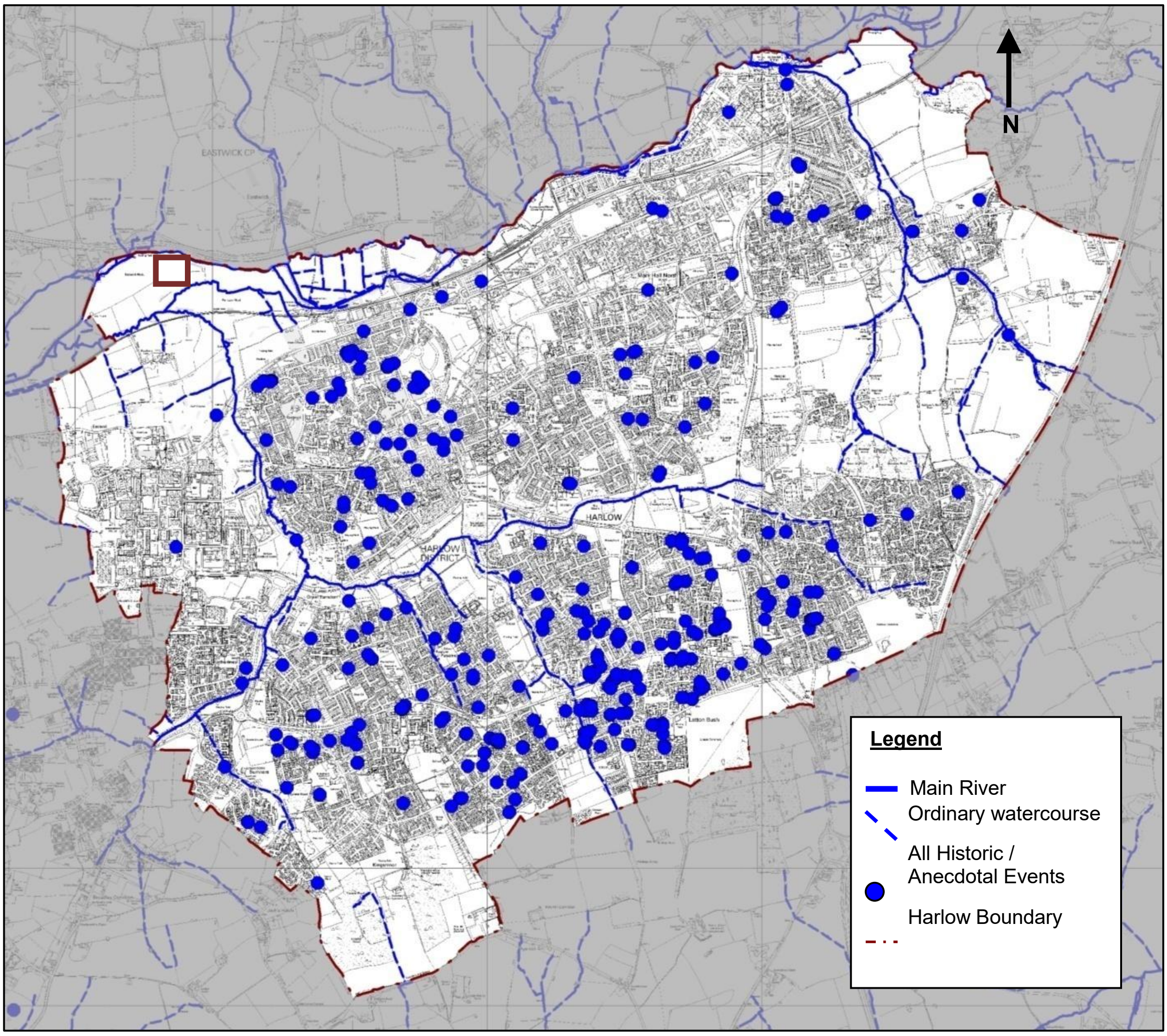


Figure 3-2 Historic Flood Events within the District

A review of this data indicates that a majority of these recorded incidents occur within southern and north-western areas of Harlow. It is concluded that the majority of the flooding within south Harlow is a result of urban watercourses being lost to urban expansion and the obstruction of natural flow patterns (predominantly by roads and properties).

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.

The surface water modelling was undertaken using TUFLOW modelling software (TUFLOW 2012-05-AA-iDP-w64). TUFLOW is a computational engine that provides two-dimensional (2D) solutions of free-surface flow equations used to simulate flood propagation. It is specifically beneficial where the hydrodynamic behaviour and flow patterns in urban drainage environments are complex, as TUFLOW simulates water level variations and flows for depth-averaged unsteady two-dimensional free-surface flows. TUFLOW has been successfully used in many projects to model the flow of water across extensive urban floodplains.

An integrated approach to modelling (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

To facilitate the accurate review and retrieval of 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.

As part of the SWMP process, hydraulic modelling has been undertaken for the study area. Two 2-dimensional direct rainfall models were created using TUFLOW software to determine the likelihood, mechanisms and consequences of pluvial flooding. The results of the models provide an indication of key flow paths, velocities and areas where water is likely to pond.

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

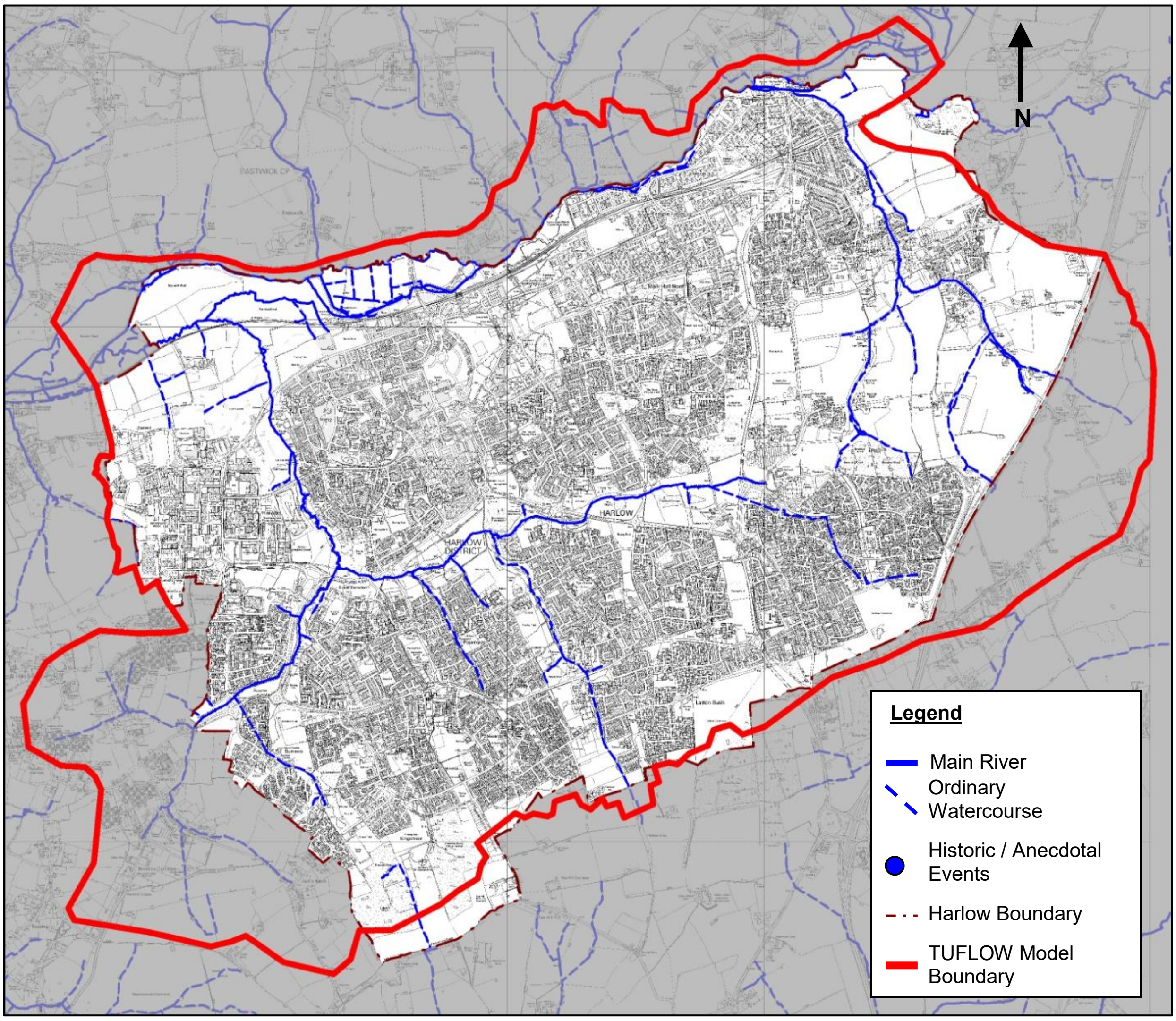


Figure 3-3 TUFLOW Model Boundaries

The selected return periods were chosen through consultation with the steering group. As part of this report, figures have been prepared for the Harlow boundary 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 HDC for use within their in-house GIS system. Table 3-3 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 30 year event *(3.3% AEP)*	Thames Water sewers are (now) typically designed to accommodate rainfall events with a 1 in 30 year return period or less. This layer will identify areas that are prone to regular flooding and could be used by highway teams to inform maintenance regimes.
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.
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.

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 constricted behind an obstruction or embankment.

Roads and Railway lines with ‘cuttings’ may also be particularly susceptible to flooding. This is highlighted within the model outputs where there is predicted flooding on the rail line along the northern boundary of Harlow.

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 does not include underground sewerage and drainage systems with a pipe diameter less than 300mm (refer to Section 3.5.7 for the assumptions utilised in this study);
- 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; and
- 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

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

- All pipes below 300mm have not been included within the hydraulic model due to the minimum benefit in flood storage that they provide during an extreme storm event;
- 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;
- Watercourses (where easily identifiable of designated by Environment Agency GIS information) within the study area have been modelled as being 'bank full' in order to represent the worst case mechanism for flooding in the District;
- 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
- It has been assumed that no infiltration occurs across the study area – however indirect losses are included as a result of the runoff coefficients utilised within the model. Given the likely intensity of a summer storm this is not considered to be over-conservative.

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 Infoworks CS, 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;
- 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; and
- 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 displays the variation in level of detail available between these datasets.

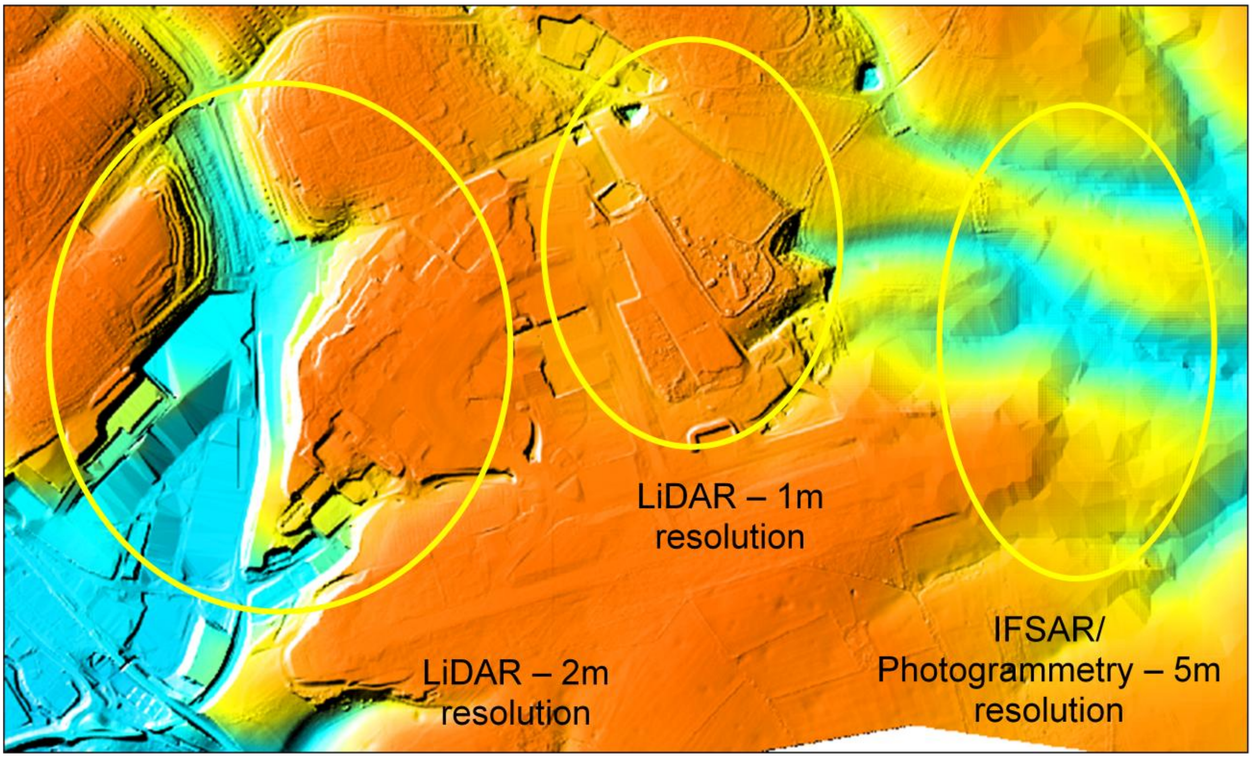


Figure 3-4 Variation in Information utilised to Create the Model DTM

LiDAR data was available at a 1m resolution for the majority of the study area, Where LiDAR was not available, Photogrammetric data was used (in particular the upper catchment area) 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 Harlow 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

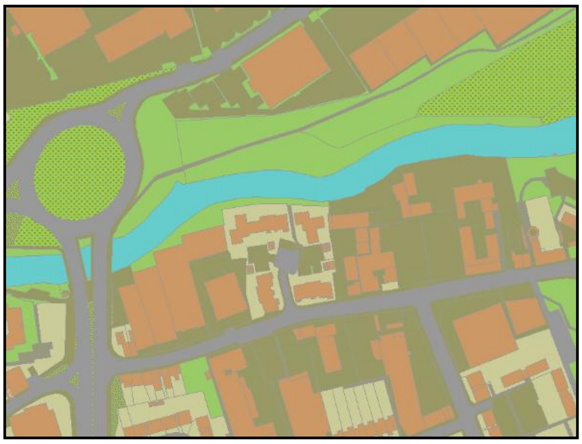


Figure 3-5: OS Mastermap land type layers

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. 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 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 on the whole the outputs with relation to ponding locations 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.

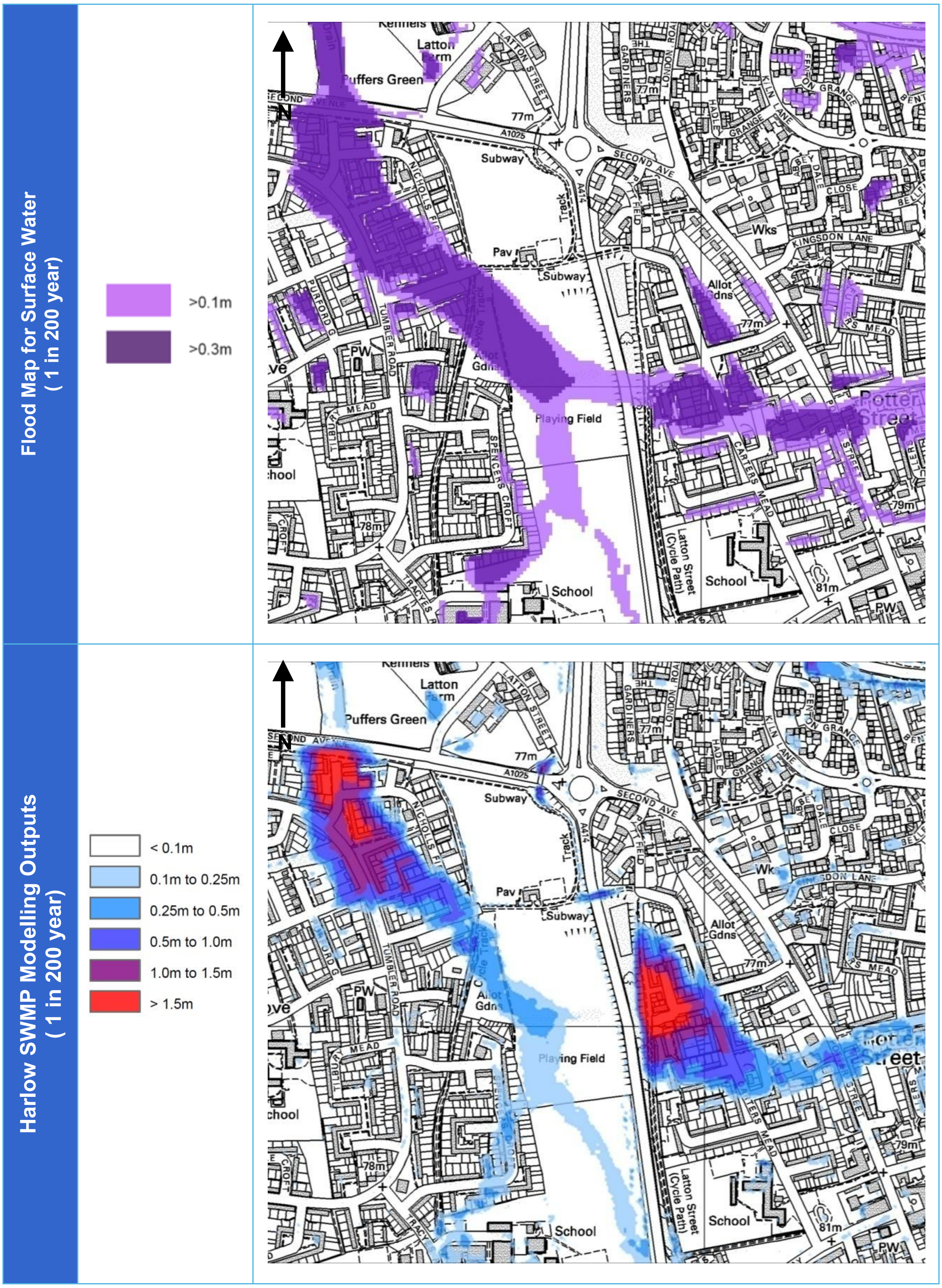


Figure 3-6 Example comparison between FMfSW and SWMP model outputs

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 it's 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 Floods 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 Environment Agency main river dataset should be utilised by ECC and District Council 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;
- The watercourses are assumed to be bank full at the start of the rainfall event, hence river flows and channel capacities have not been taken into account – more detailed assessment of larger ordinary watercourses may assist in understanding the risk from this source and could be undertaken at a later date; 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 or 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 BGS Groundwater Flood Susceptibility Map.

3.7.3 Groundwater Historic Records

Figure 3-8 also includes a summary of the previous records of flooding attributed to groundwater in the study area. Only two records of this type of flooding were identified within the provided EA data.

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 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
BGS Groundwater Flooding Susceptibility Map	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.	This was identified as the best available dataset for assessment of potential groundwater flood risk and used to classify risk to settlements based on the following criteria. Very low Low Moderate High Very high
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% ≥25%<50% ≥ 50% <75% ≤75%
EA Groundwater Flooding Database	This database only provided two records for the study area.	Assisted in verifying the flood risk identified in the AStGWF maps

The basis for the groundwater flood risk assessment for this study is predominantly the BGS Groundwater Flood Susceptibility Map. This map uses underlying geological information to infer groundwater flood susceptibility.

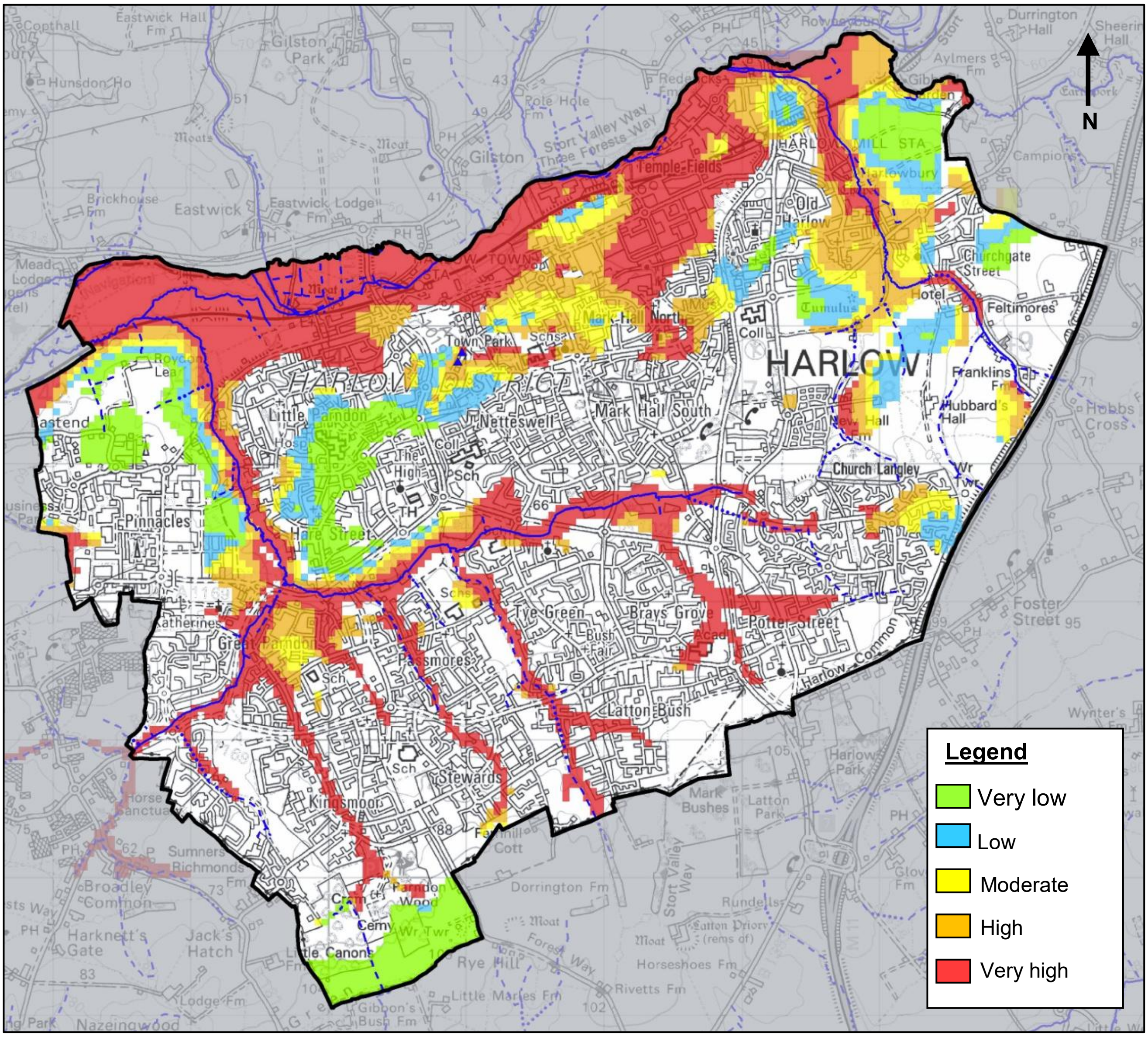


Figure 3-8 British Geological Society Groundwater Flooding Susceptibility Map

The majority of Harlow falls within the lowest classification of the BGS Groundwater Flooding Susceptibility Maps. Most of the Critical Drainage Areas are predominantly at no risk of groundwater flooding, largely due to the low permeability of the underlying clay bedrock. A number of small, topographically high regions of the catchment are at risk of flooding from consolidated aquifers (‘clearwater flooding’), as is the small region in the north-east of the catchment underlain by Chalk. Larger regions at risk of superficial deposits flooding exist throughout the District, corresponding to regions where the bedrock is overlain by Head and Glaciofluvial Deposits. Most of these regions primarily occur along rivers and dry valleys and are classified as being at very high risk of groundwater flooding. The most notable example of this is along the River Stort valley, where a large region overlain by Alluvium, Head and Glaciofluvial Deposits is at very high risk of groundwater flooding

3.7.5 Geology

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

The bedrock geology of the District is primarily London Clay Formation (clay, silt and sand), with small regions of Thanet Sand Formation and Lambeth Group (undifferentiated) around the District boundary in the north-west and north-east. A small region of Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated) exists in the north-east of the catchment, The bedrock is largely overlain by Lowestoft Formation and Glaciofluvial Deposits, with Head deposits in river valleys and dry valleys. Alluvium deposits overly the bedrock along the River Stort, which forms the northern boundary of the District. The nature of the underlying geology affects the potential for groundwater flooding as well as the surface water drainage mechanisms and possible mitigation actions. Chalk sub-strata, indicating the presence of groundwater, can be linked to a heightened risk of groundwater flooding but also enables the use of infiltrating sustainable drainage (SuDS) features to reduce runoff volumes from urban areas. Conversely, clay substrata inhibits the use of infiltrating SuDS features but also indicates a lower risk of groundwater flooding due to the inherent absence of large bodies of groundwater.

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.

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; and

- 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.

Environment Agency guidance on infiltration SuDS is available on their website at: http://www.environment-agency.gov.uk/business/sectors/36998.aspx. This 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. Figures 6-1 to 6-4 contained within Appendix C provide the summary outputs of the Infiltration SuDS Map across Essex County Council. Clarification of each summary map can be obtained from the British Geological Survey

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. It is also recommended that developers consider the potential for infiltration SuDS to cause the development of solution features within the Chalk, leading to potential subsidence issues.

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 is largely a separated foul and surface water system.

3.8.2 Causes of sewer flooding

The main causes of sewer flooding are:

- Lack of capacity in the sewer drainage networks due to original under-design – this is 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 ('locked outfalls').

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.

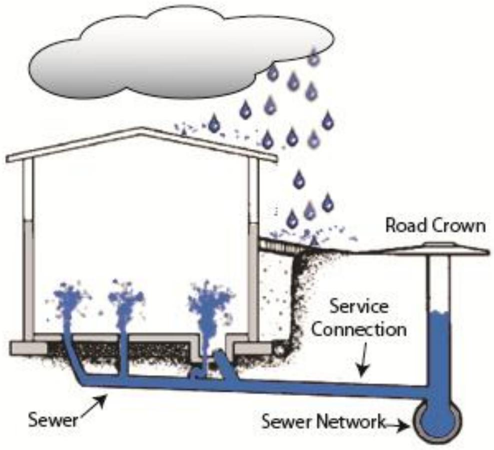


Figure 3-9 Surcharging of the sewer system (left) and internally within a property (right)

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 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 Thames Water.

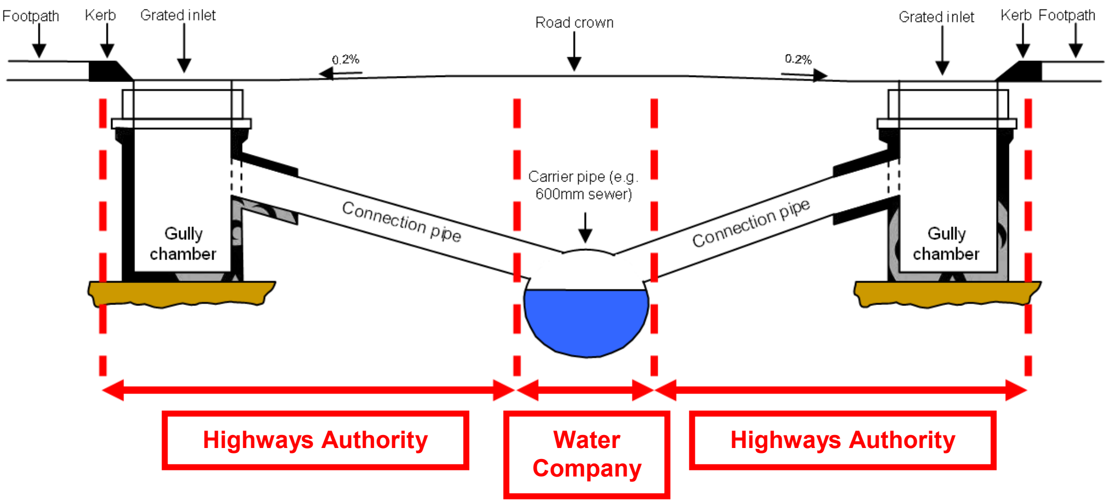


Figure 3-10 Surface water sewer responsibility

As illustrated in Figure 3-10, 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 Thames 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 to be served, with allowance for infiltration. Thames 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.

The Rye Meads Water Cycle Strategy (Hyder, 2009) highlighted that the sewerage network is known to be close to capacity in certain areas, indicating a significant risk from sewer flooding. Thames Water are proposing upgrades in Harlow in order to provide sufficient capacity to account for new proposed developments across the District.

Thames Water have provided post code-linked data (DG5 register) on records of sewer flooding. The DG5 postcode sewer flooding information data provided by Thames Water (March 2012), for use in this SWMP, identifies 118 historic records of sewer flooding within the District. Figure 7 (within Appendix C) provides a graphical representation of the DG5 data provided by Thames Water.

3.8.4 Drainage Network

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

Thames Water provided details of the infrastructure network including sewers, manholes, pumping stations and outfalls in GIS format. This information was overlaid onto the pluvial modelling outputs to assist with the identification of high risk areas by reviewing the type of pipe network (combined, foul, separated) to determine if ponding could exist due to the existing capacity of the network (pipe size, outfall location).

3.8.5 Methodology for Drainage Network Modelling

In consultation with the client steering group, it was concluded that the all surface water network pipes, equal to and greater than 300mm in diameter, would be included within the hydraulic model to account for the benefit of the system during the model storm events. If a detailed assessment of any Critical Drainage Area (or sub-catchment) is undertaken, it is recommended that all drainage pipes and gulley inlets are included within the hydraulic model, as this may improve the capacity and conveyance within the local area and could reduce the risk of surface water flooding.

3.8.6 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.

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

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

Use of historic data to estimate the probability of sewer flooding is the most practical approach; however, it does not take account 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 a ‘bank full’ condition, in the same way that ordinary watercourses have been modelled. Structures such as weirs, locks and gates along watercourses have not been explicitly modelled.

The SFRA indicates that the flood of 1947 seems to have had the most impact on Harlow. It covered an extensive area of the River Stort valley and covered significant areas of the town's major employment area at Templefields. In addition both Todd Brook and Parndon Brook flooded. Since then the town's development has to a great extent ameliorated the potential flooding in the town. Floods of 1947, 1968, 1974, 1992, 1993, 2001, 2002, 2003, have been mostly confined to the functional flood plain. Some if these historic events have been utilised to define Flood Zone 2.

A network of flood defences has been constructed to reduce flood risk within Harlow. Whilst managing flood risk over large areas of Harlow, as shown in Figure 3-11, 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 - refer to the SFRA for further information on these flood risks. Figure 3-11 displays the Environment Agency's Flood Risk Zones. The outlines indicate that the risk of fluvial flooding from main rivers is largely concentrated around the floodplain of the River Stort and its contributing watercourses (Harlowbury Brook, Cannon Brook, Todd Brook and Parndon Brook).

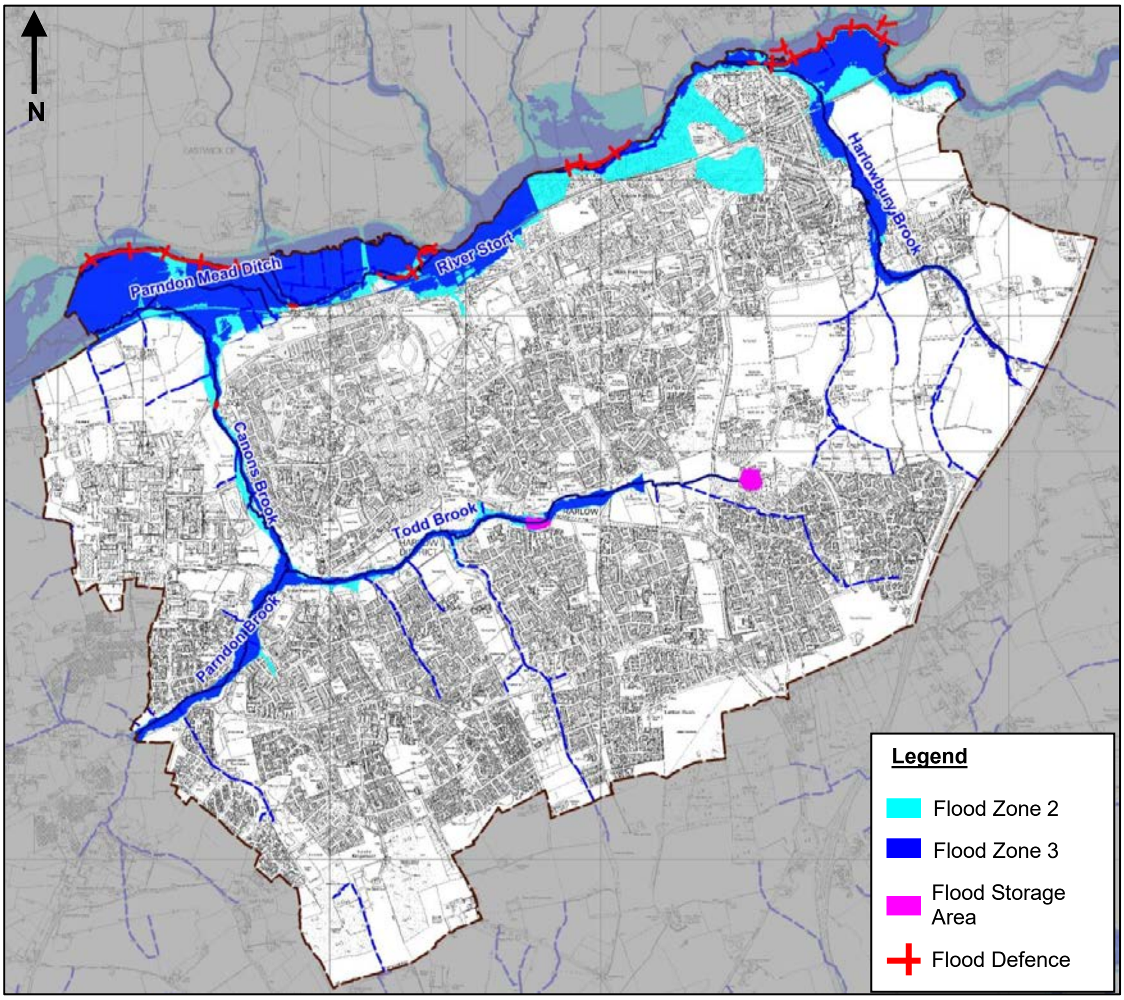


Figure 3-11 Flood Zones and Defence Locations within Harlow

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 Level 1 SFRA (prepared April 2011 by Epping Forest District Council and Harlow District Council).

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 settlements 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, EA AStGWF and BGS Groundwater Susceptibility dataset identifying areas most susceptible to groundwater flooding;
- **Sewer capacity issues** – based on sewer flooding assessment and information obtained from Thames 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 spatial extent of predicted flooding in a single location.

4.2 Harlow CDA Assessment

Based on the above criteria, and identified flood risk within the study area, it has currently been concluded that there are 13 CDAs, which have been 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 identifies the location of the LFRZs and CDAs within Harlow.

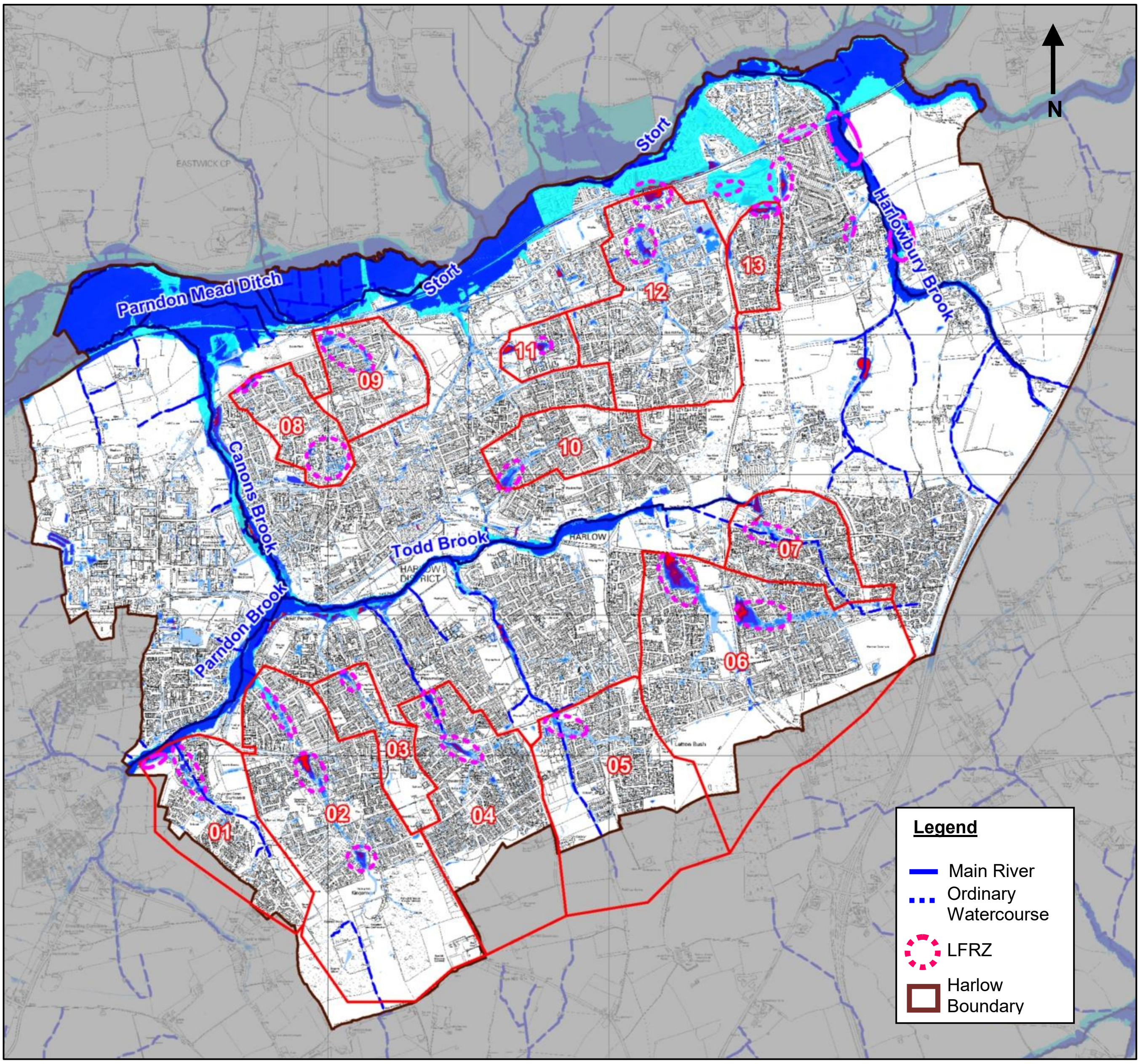


Figure 4-1 Local Flood Risk Zones within Harlow

The following legend applies to all of the CDA summaries.

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

Flood Hazard Rating

Caution (Very Low Hazard)	Significant (Danger for Most)
Moderate (Danger for Some)	Extreme (Danger for All)

Flow direction

Main river

Ordinary watercourse

CDA 001 – Sumners Area

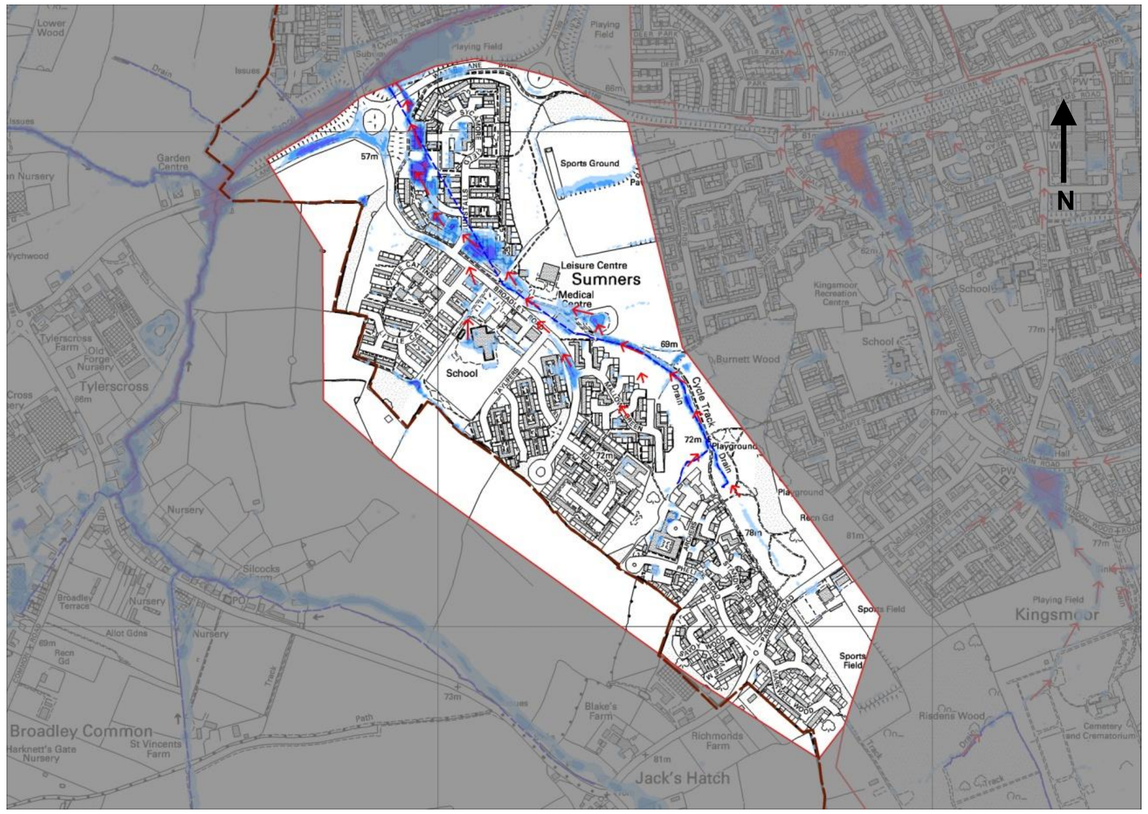


Figure 4-2 CDA 001 - 1 in 100 year Depth Results

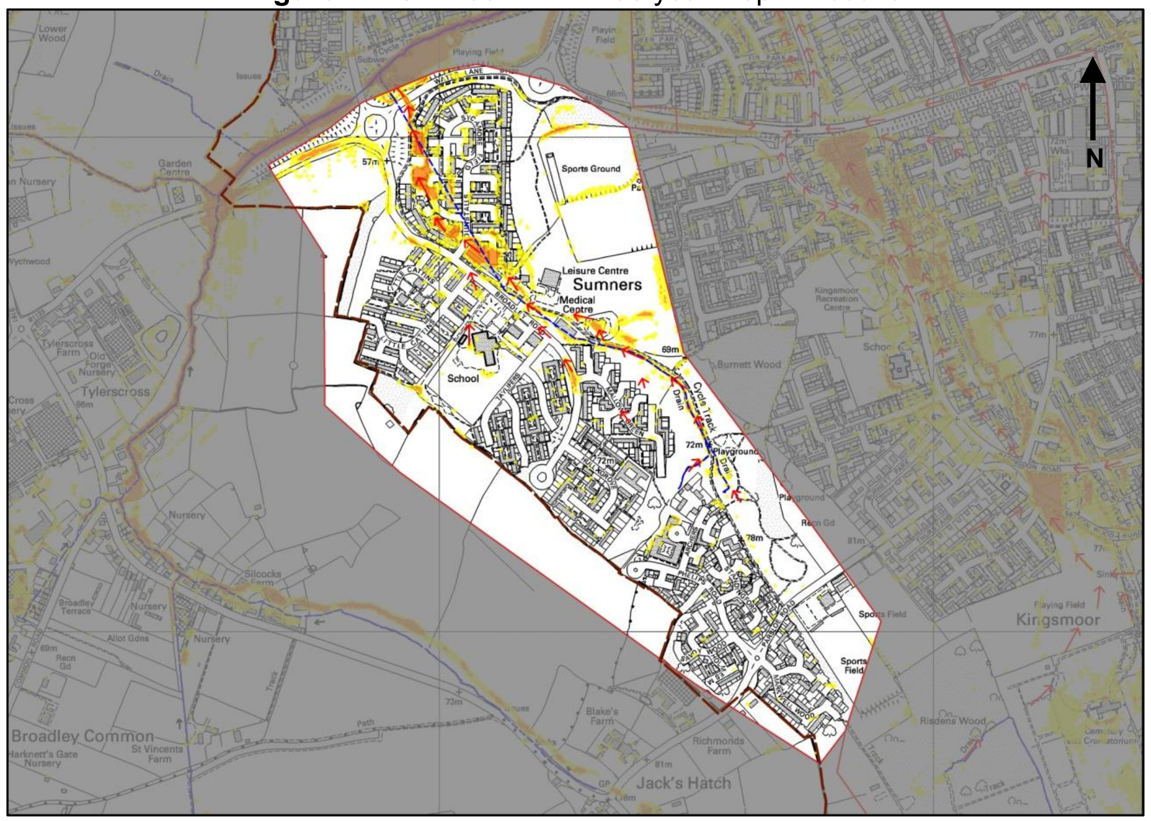


Figure 4-3 CDA 001 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Sumners area of Harlow. Surface water flows generally from south to north towards Parndon Brook. The pluvial modelling predicts surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads). The main cause of surface water flooding is predicted to occur from an ordinary water course (OWC) flowing through the CDA which is culverted and the capacity of the culvert may not be sufficient. Flooding from this location generates the greatest impact to downstream properties.

Fluvial Flood Zones 2 and 3are located north of the CDA.

Table 4-1 Summary of local flood risk within the CDA 001 – Sumners Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from both greenfield and urban areas are conveyed within an unnamed drain before generating an overland flow path into the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground	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	Residential properties , roads, open space
Hazard	Moderate and significant hazards are expected within the CDA.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Historic events are located within the CDA, which assist to confirm the risk in the CDA. A site inspection confirmed the possible flood mechanisms within the CDA.		
Groundwater	The majority of the CDA is not considered to be at risk of groundwater flooding. A small area in the south-east of the CDA is at very low risk of clearwater flooding, while the region around a drain running north-west through the CDA is at very high risk of superficial deposits flooding.		

CDA 002 – Kingsmoor Area

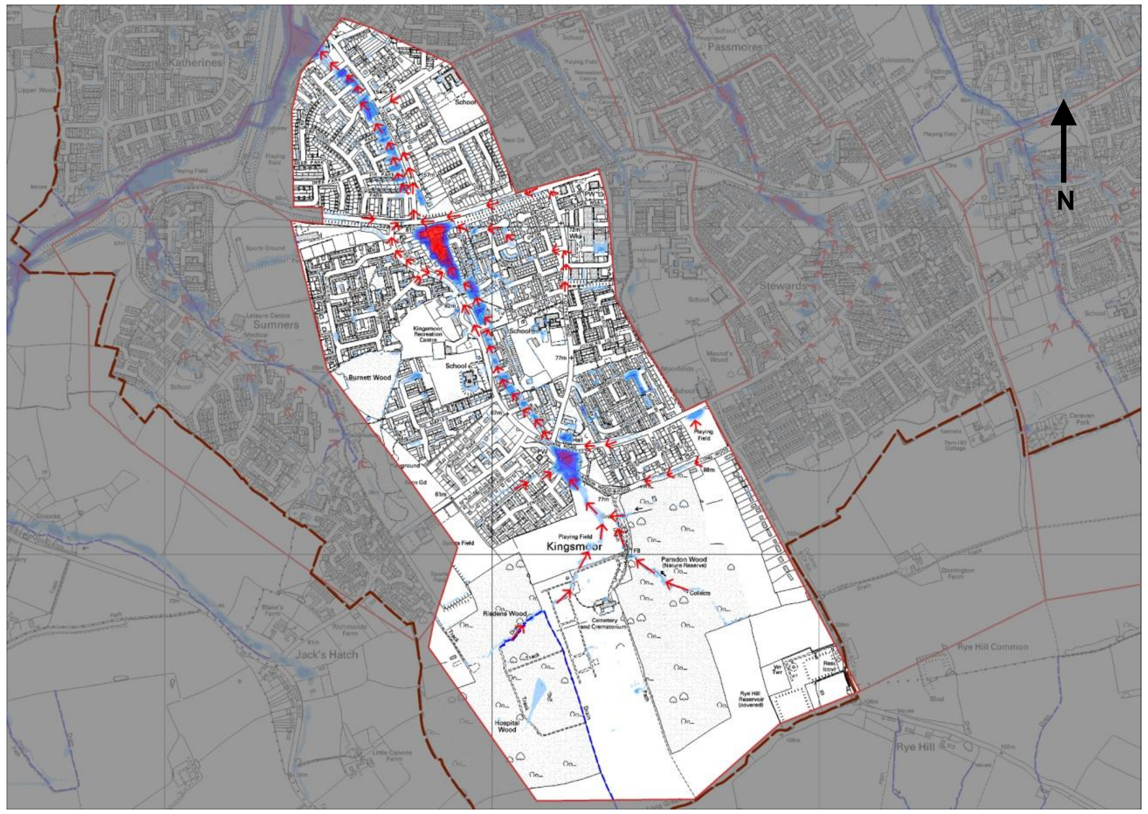


Figure 4-4 CDA 002 - 1 in 100 year Depth Results

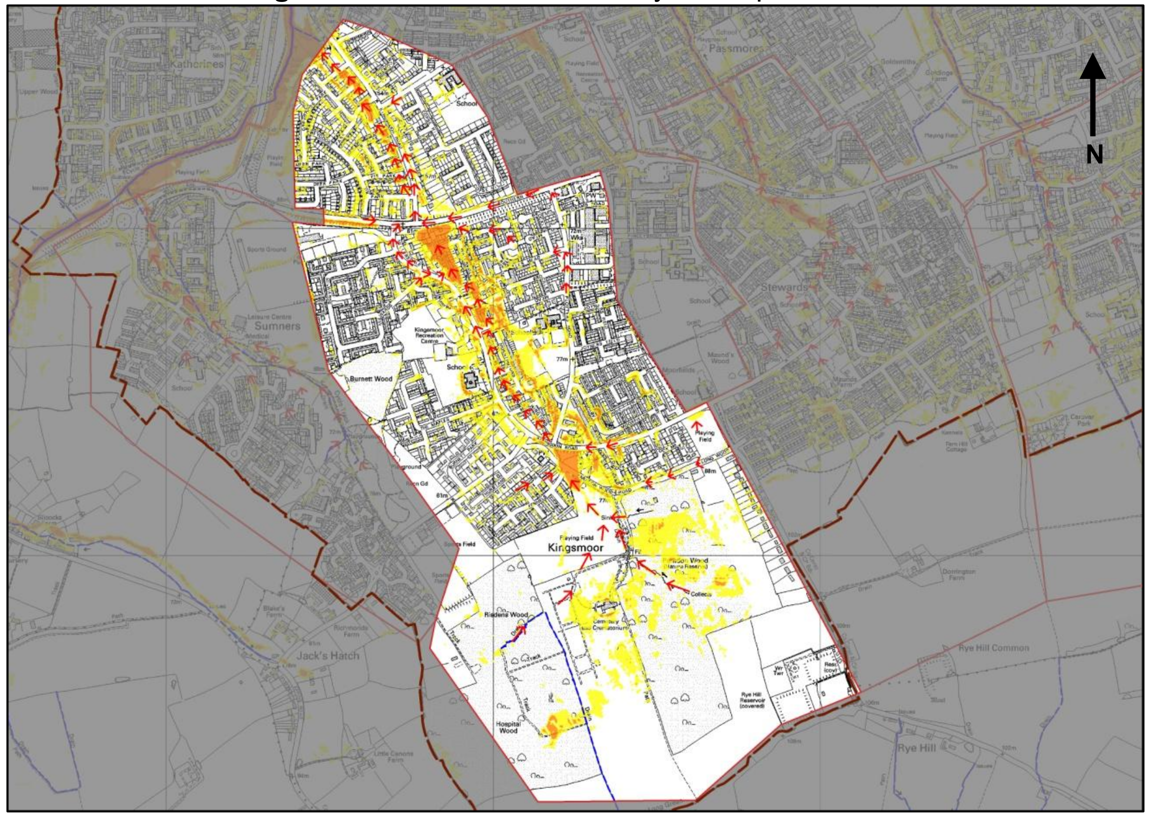


Figure 4-5 CDA 002 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Kingsmoor area of Harlow. Surface water flows generally from south to north towards Parndon Brook. The pluvial modelling predicts surface water flooding across the central portion of the CDA as a result of the topography and water being trapped behind raised building pads. This flooding may be a result of a historic ordinary water course (OWC) being lost due to urban expansion. Water flows from the upper catchment in a northerly direction where it appears to concentrate in the lower elevations forming an overland flow route flowing in a northerly direction through properties (parallel to Paringdon Road and Kingsmoor Road).

Fluvial Flood Zones 2 enters a small portion in the north of the CDA and Flood Zone 3 is located along the northern boundary.

Table 4-2 Summary of local flood risk within the CDA 002 – Kingsmoor Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from both greenfield and urban areas generate an overland flow path through the centre of the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground	Residential properties and gardens
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	The main area of ponding occurs within Watersmeet as a result of the A1190 being at a higher elevation.	Residential properties adjacent to ponding areas.
Hazard	Moderate and significant hazards are expected within the main area of ponding along with any depressions along the overland flow route.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Historic events are located within the CDA, which assist to confirm the risk in the CDA. A site inspection confirmed the possible flood mechanisms within the CDA along with the main area of ponding behind the A1169.		
Groundwater	A region classified as being at very low to 'low' risk of clearwater flooding lies along the southern boundary of the CDA. An area of primarily at' high' risk of superficial flooding runs through the CDA in a north-eastern direction along a dry valley.		

CDA 003 – West Passmores Area

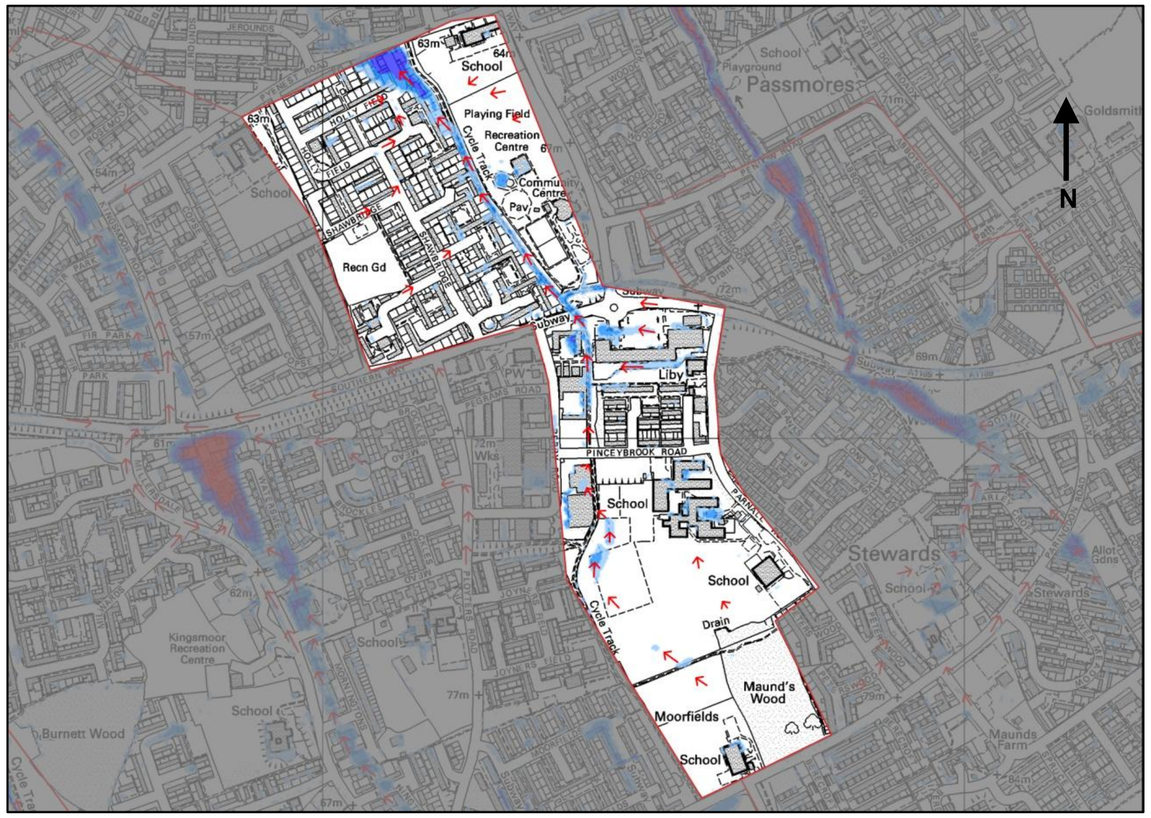


Figure 4-6 CDA 003 - 1 in 100 year Depth Results

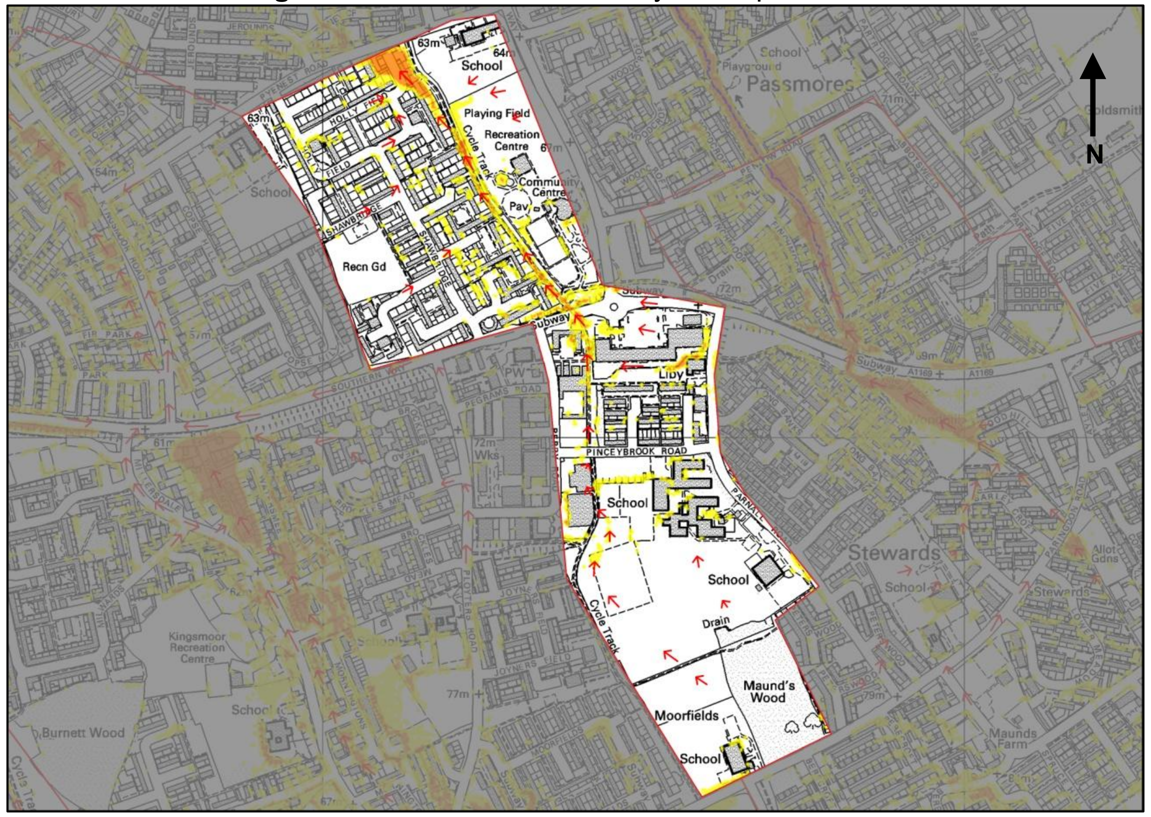


Figure 4-7 CDA 003 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in West Passmores (an area south of Pyenest Road to an area north of Maund's Wood). Surface water flows generally from south west to north east towards Todd Brook. The pluvial modelling predicts the greatest risk of surface water flooding along the northern portion of the CDA as a result of the topography and water being trapped behind Pyenest Road (which is approximately 1.5m above the land to the south of the road). This flooding is possibly a result of a historic ordinary water course (OWC) being lost due to urban encroachment into the flow path. An overland flow route along the pedestrian walkway (located west of the existing fields of the Passmores Youth Centre) conveys flows from the upper catchment into the Local Flood Risk Zone near Holly Field.

No fluvial flood zones are located within the CDA.

Table 4-3 Summary of local flood risk within the CDA 003 – West Passmores Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from both greenfield and urban areas generate an overland flow path through the centre of the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground	Residential properties and gardens
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	The main area of ponding occurs within Holly Field as a result of the A1190 being at a higher elevation.	Residential properties adjacent to ponding areas.
Hazard	Moderate and significant hazards are expected within the main area of ponding along with any depressions along the overland flow route.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Historic events are located within the CDA and assist with the confirmation of the CDA. A site inspection confirmed the possible flood mechanisms (in particular the area of possible ponding near Holly Field).		
Groundwater	A region classified as being at very low to 'low' risk of clearwater flooding lies along the southern boundary of the CDA. An area of primarily at' high' risk of superficial flooding runs through the CDA in a north-eastern direction along a dry valley.		

CDA 004 – Stewards Area

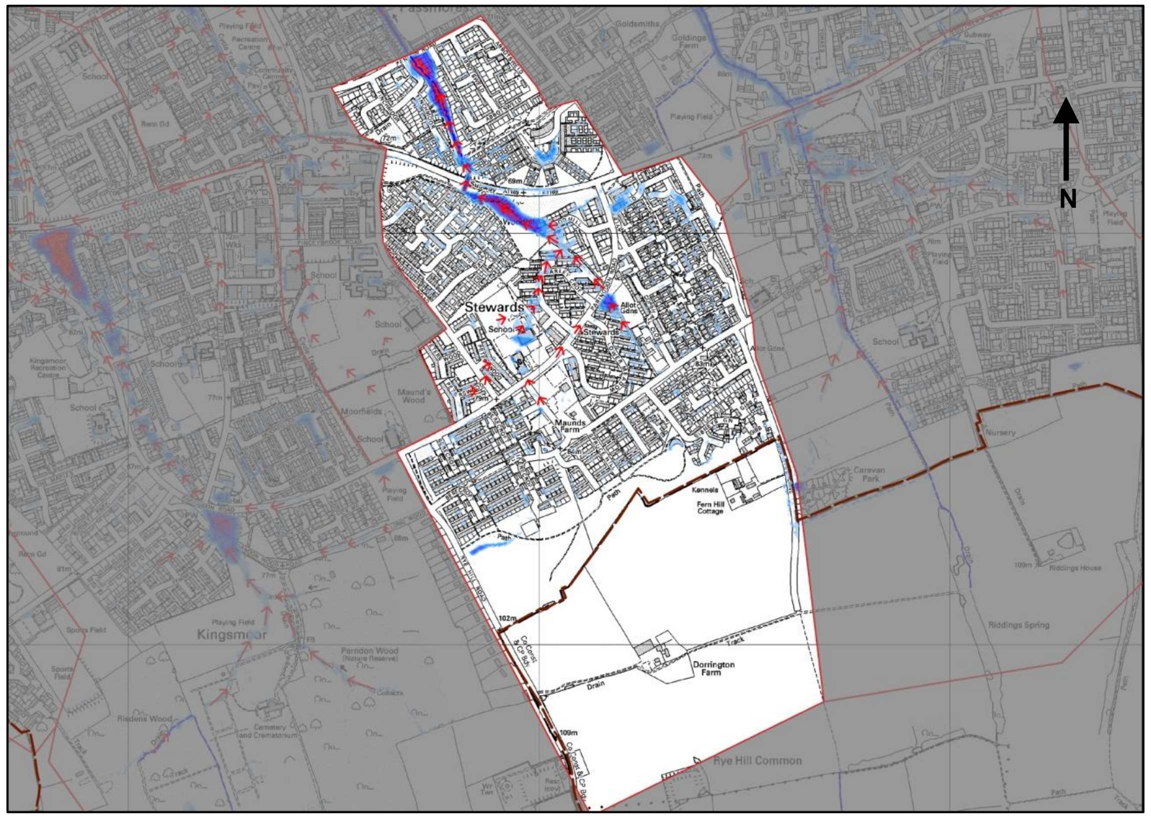


Figure 4-8 CDA 004 - 1 in 100 year Depth Results

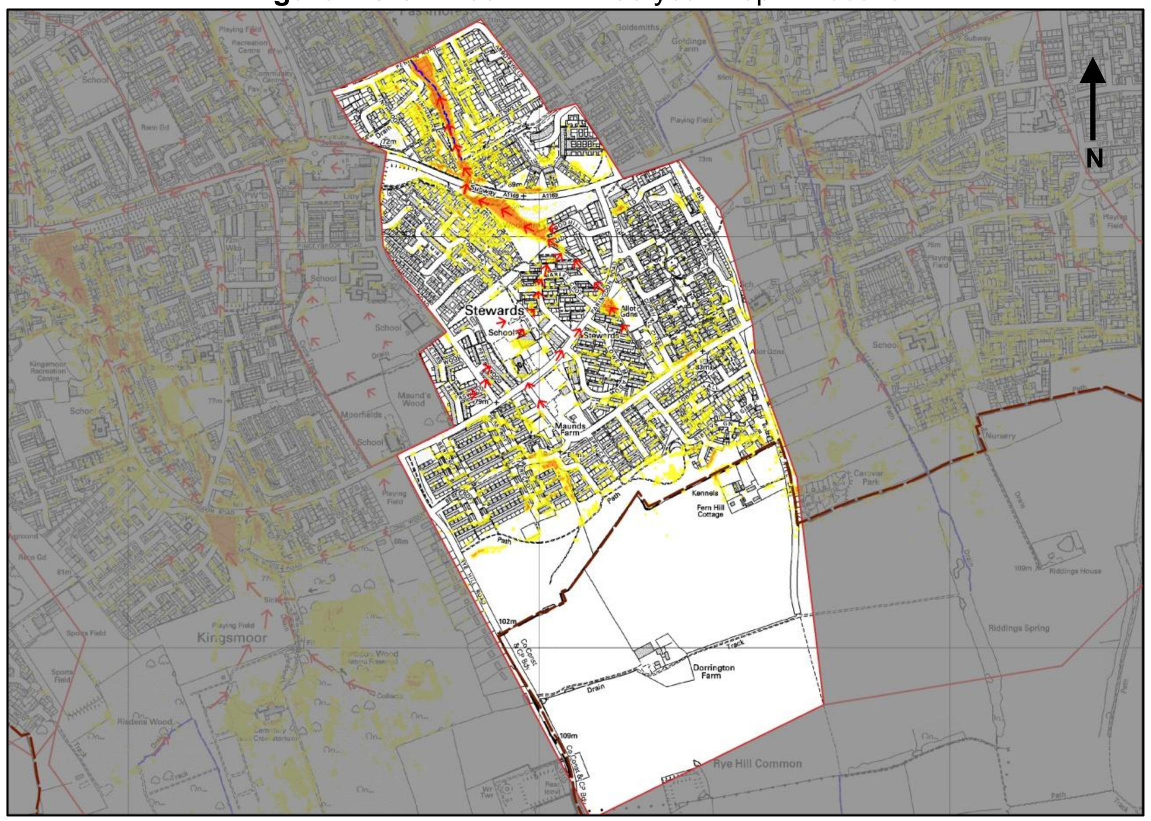


Figure 4-9 CDA 004 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Stewards and Passmores area of Harlow. Surface water flows generally from south west to north east towards Todd Brook. The pluvial modelling predicts the greatest risk of surface water flooding along a lost watercourse (as a result of development) and with an existing portion of the drain (located south of Penlow Road). There are other minor flow paths that convey flows into this area (along Barley Croft and Aylets Field).

No fluvial flood zones are located within the CDA.

Table 4-4 Summary of local flood risk within the CDA 004 – Stewards Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff the upper catchment create an overland flow path the existing drain which can flood properties	Overland flow from the south and south west impact properties before being conveyed into an existing unnamed drain	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 within the unnamed drain that due to a Penlow Road obstructing the continuous flow can lead to ponding when the connecting culverts are at capacity.	Residential properties adjacent to ponding areas.
Hazard	Moderate and significant hazards are expected within the area of ponding, with the areas contributing to the overland flow path being at a predominantly moderate risk.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Historic events are located within the CDA and assist with the confirmation of the CDA. A site inspection confirmed the possible flood mechanisms (in particular the area of ponding behind Penlow Road within the unnamed drain).		
Groundwater	The majority of the CDA is not at risk of groundwater flooding. A small area is at a high risk of superficial deposits flooding which is located in a north-western direction through the catchment, corresponding to the location of an unnamed drain and possible lost upstream ordinary watercourse.		

CDA 005 – Latton Bush Area

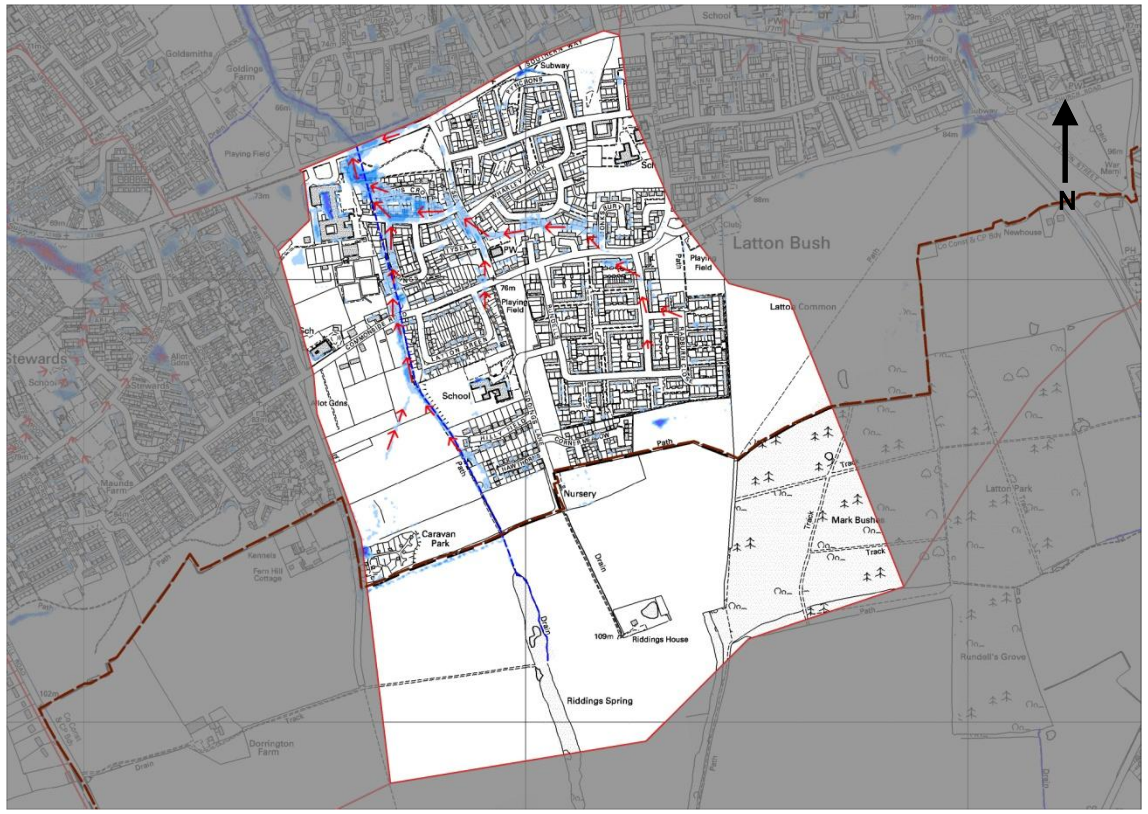


Figure 4-10 CDA 005 - 1 in 100 year Depth Results

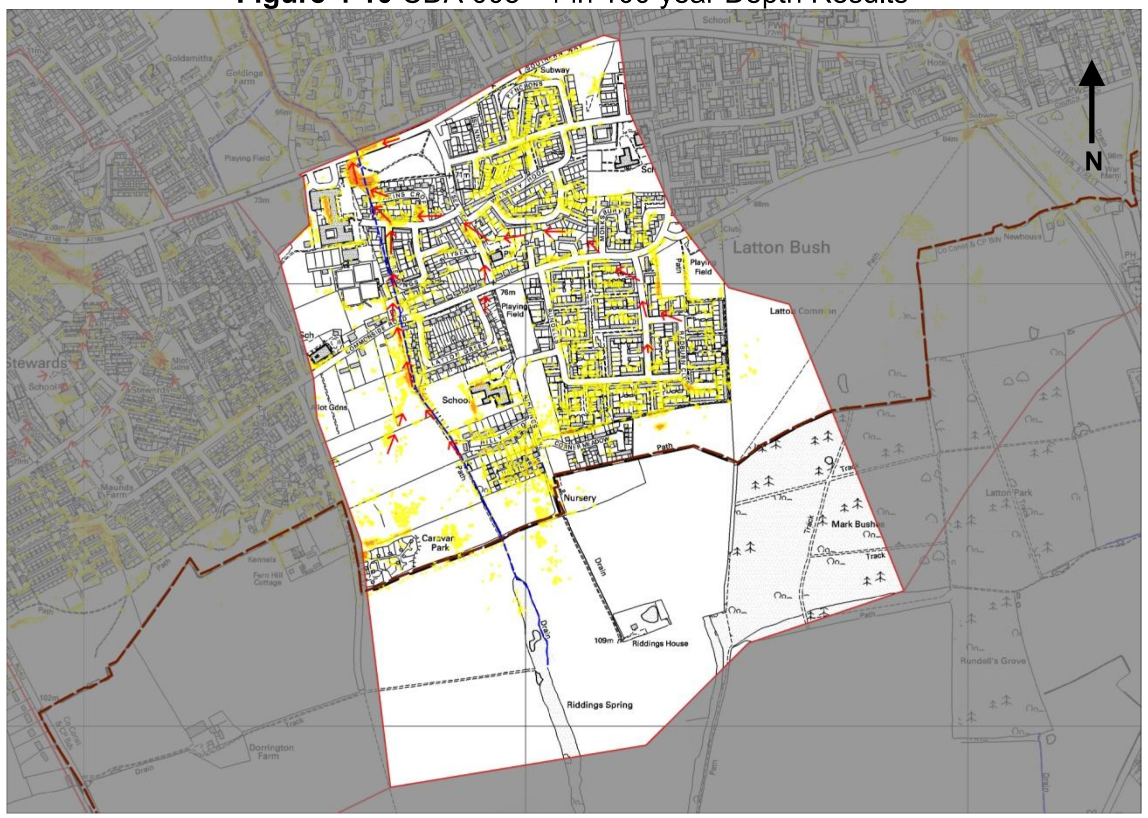


Figure 4-11 CDA 005 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Latton Bush area of Harlow. Surface water flows to the LFRZ (near Sakins Croft) from both a southerly and easterly direction as a result of being located at a lower elevation. The pluvial modelling predicts the greatest risk of surface water flooding is within the LFRZ with other properties at a lower risk as a result of an overland flow path formed between properties between Monksbury and Tysea Road and from a downstream OWC which is culverted west of Latton Green County Primary School (within a possible attenuation feature).

No fluvial flood zones are located within the CDA.

Table 4-5 Summary of local flood risk within the CDA 005 – Latton Bush Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff from both greenfield and (predominantly) urban areas generate two overland flow paths into the LFRZ.	A culverted watercourse is locate near the western boundary and when full can flood properties near The Readings, whilst flows from the east are conveyed down a possible lost watercourse.	Residential properties, gardens and roads
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	There are main are of ponding is within Sakins Croft due to the low (locally) topography of the area.	Residential properties adjacent to ponding areas.
Hazard	Predominantly moderate within some areas of significant hazards being predicted within the lowest elevations within the LFRZ.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Several historic events are located within the CDA (and LFRZ) and assist with the confirmation of the CDA.		
Groundwater	While the majority of the CDA is at low risk of groundwater flooding, a region at high risk of superficial deposits flooding forks out from the north boundary, corresponding to an unnamed drain and dry valley.		

CDA 006 – Brays Grove Area

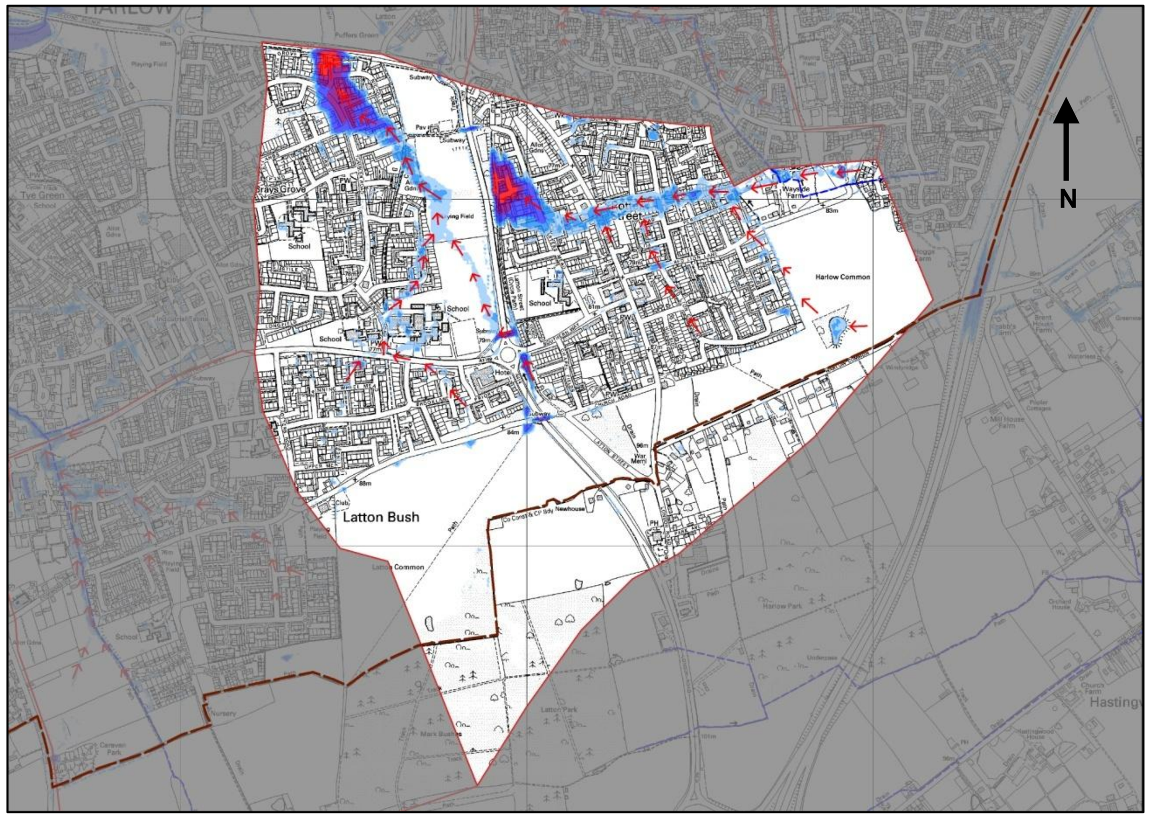


Figure 4-12 CDA 006 - 1 in 100 year Depth Results

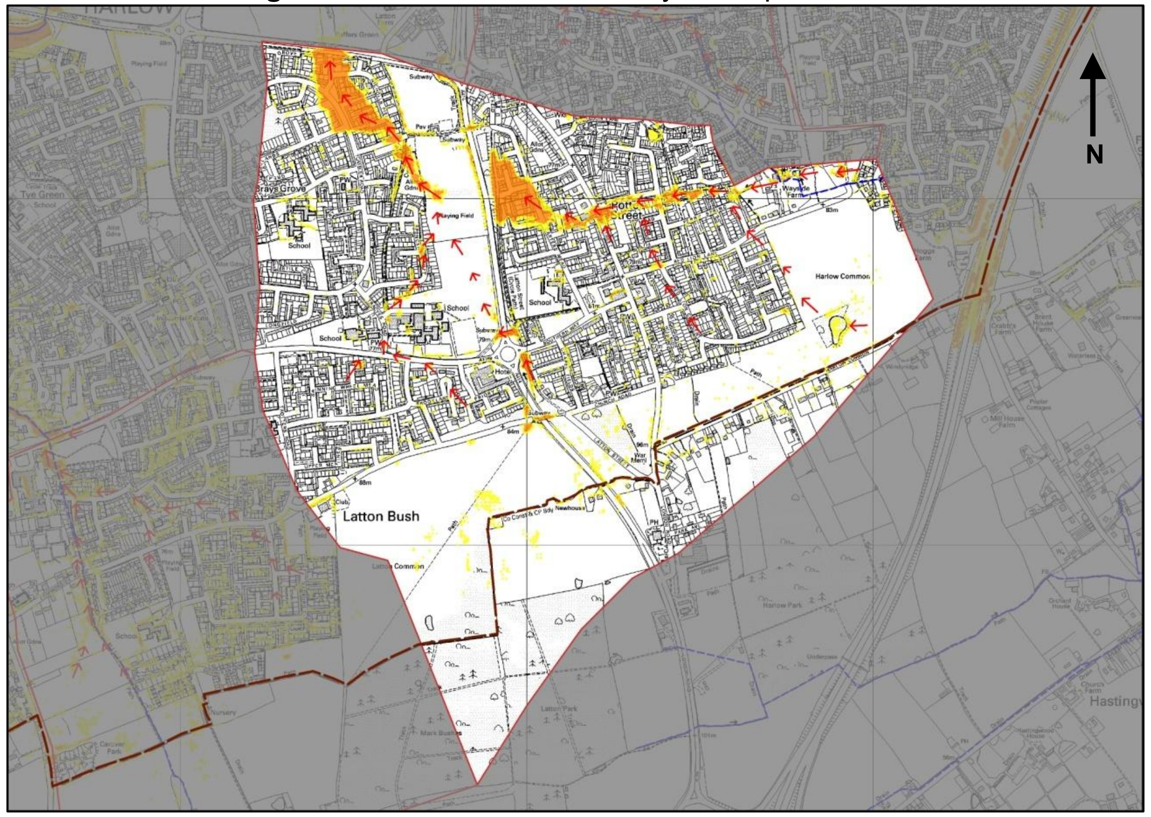


Figure 4-13 CDA 006 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Brays Grove and Potters Street areas of Harlow. There are two LFRZs within the CDA located near Carters Mead and North Grove. Within both CDAs it is predicted that runoff from the upper catchment is obstructed by the raised roads which create a damming effect on the runoff. Flooding of the Carters Mead LFRZ appears to be a result runoff being conveyed within a lost watercourse, which in turn impacts the properties located along its length. The main cause of the North Grove CDA is predicted to be a combination of the downstream obstruction and low elevation (compared to the local area).

No fluvial flood zones are located within the CDA.

Table 4-6 Summary of local flood risk within the CDA 006 – Brays Grove Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff from both greenfield and urban areas generate an overland flow path into each of the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground.	Residential properties and gardens and roads
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 within the behind obstructions to flow. The two main obstructions are the London Road (A414) and the Second Avenue (A1025).	Residential properties adjacent to ponding areas.
Hazard	Moderate and significant hazards are predicted within the areas of ponding,		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Historic events are located within the CDA and assist with the confirmation of the CDA. A site inspection confirmed the possible flood mechanisms (in particular the area of ponding behind the A1025 and A414.		
Groundwater	Although the majority of the CDA is not at risk from groundwater flooding, three dry valleys constitute a region at high risk of superficial deposits flooding		

CDA 007 – Victoria Gate Area

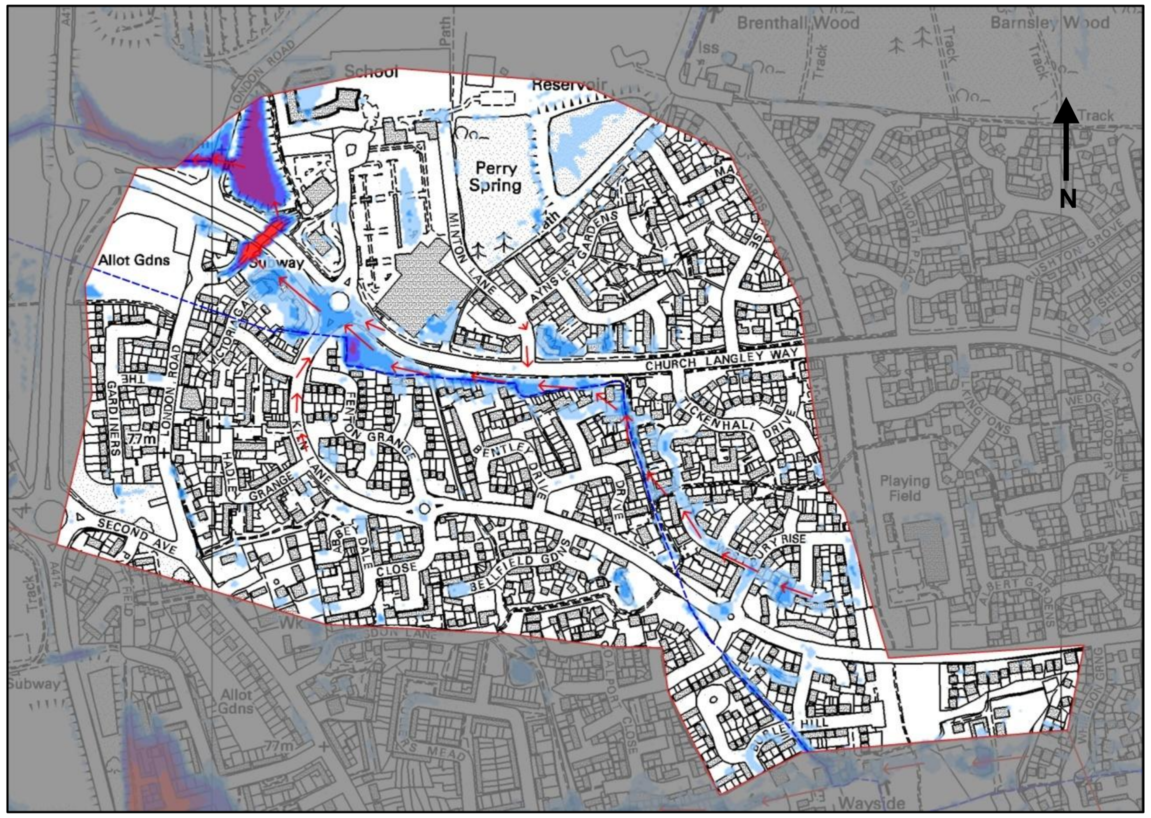


Figure 4-14 CDA 007 - 1 in 100 year Depth Results

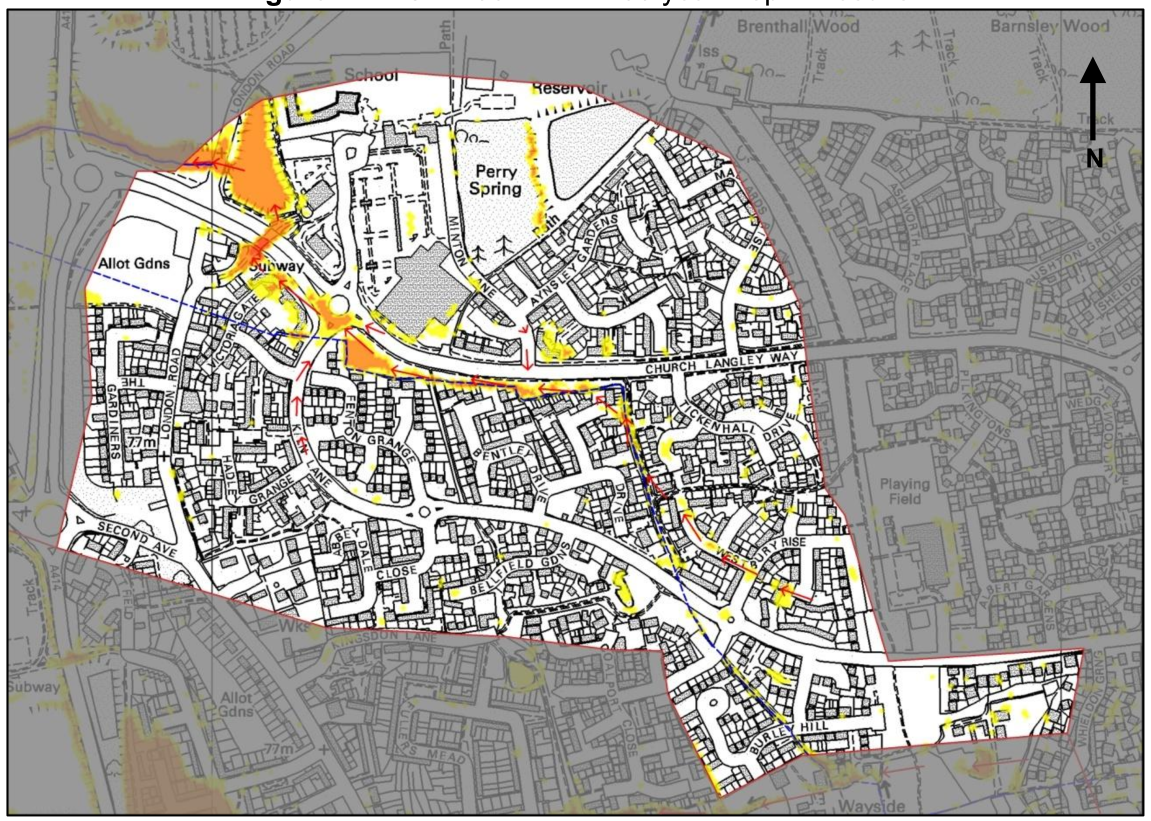


Figure 4-15 CDA 007 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the north western portion of the Potters Street area of Harlow. There is one LFRZ around Victoria Gate. Flooding between Westbury Rise and Victoria Gate is predicted to be a result of runoff being conveyed above ground where the Todd Brook once flowed before being culverted. The main cause of this is predicted to be a combination of the downstream obstruction from the road which is at a higher elevation and the original flowpath of the Todd Brook through the CDA.

No fluvial flood zones are located within the CDA.

Table 4-7 Summary of local flood risk within the CDA 007 – Victoria Gate Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff from predominantly urban areas generate an overland flow path into the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ where the Todd Brook previously existed.	Residential, road and open space.
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	Ponding near Westbury Rise and Victoria Gate is a result of these area of land being at a lower topography	Residential properties adjacent to ponding areas.
Hazard	Moderate and significant hazards are expected within the area of ponding.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	The hydraulic modelling undertaken as part of this study indicates a reduced flood extent than that identified within the EA Flood Map for Surface Water (FMfSW) flooding. This can be attributed to more accurate LiDAR being used within the SWMP model along with the inclusion of the drainage network and other hydraulic structures.		
Groundwater	The majority of the CDA is at no risk of groundwater flooding; however a small region corresponding to Todd Brook is at very high risk of superficial deposits flooding.		

CDA 008 – Little Parndon Area

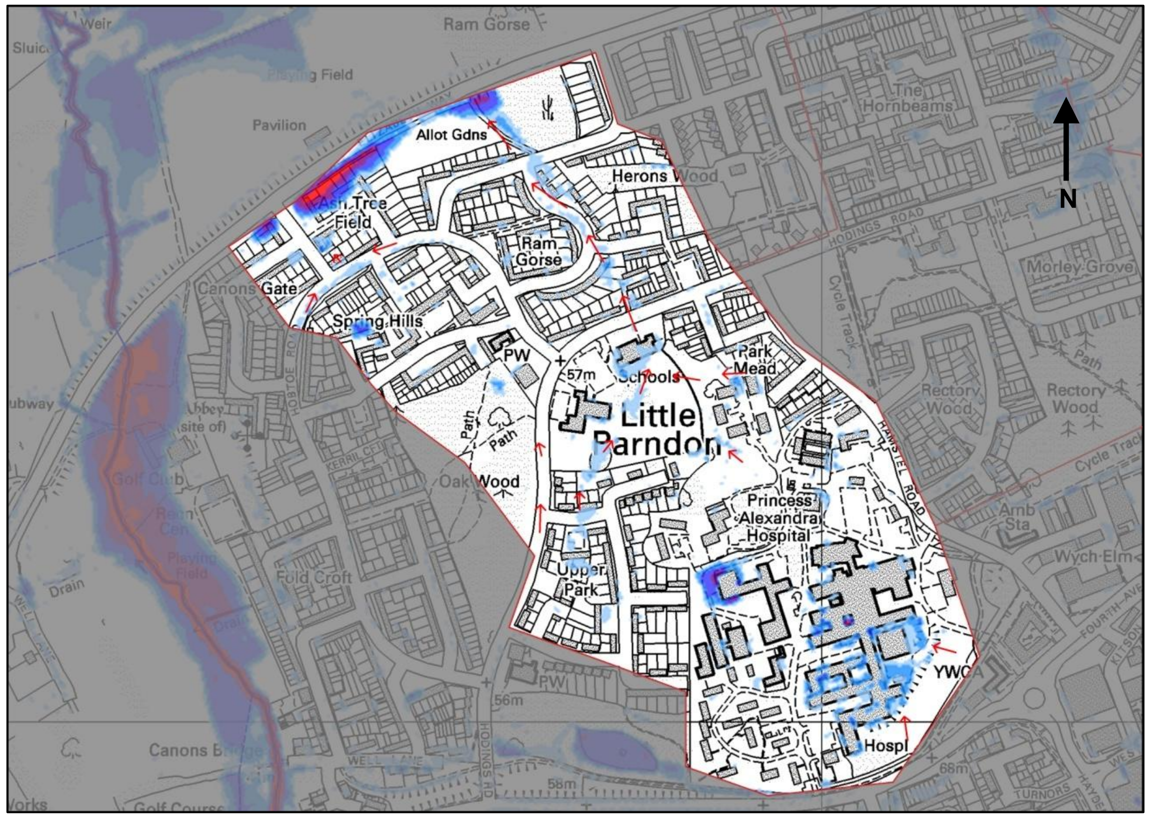


Figure 4-16 CDA 008 - 1 in 100 year Depth Results

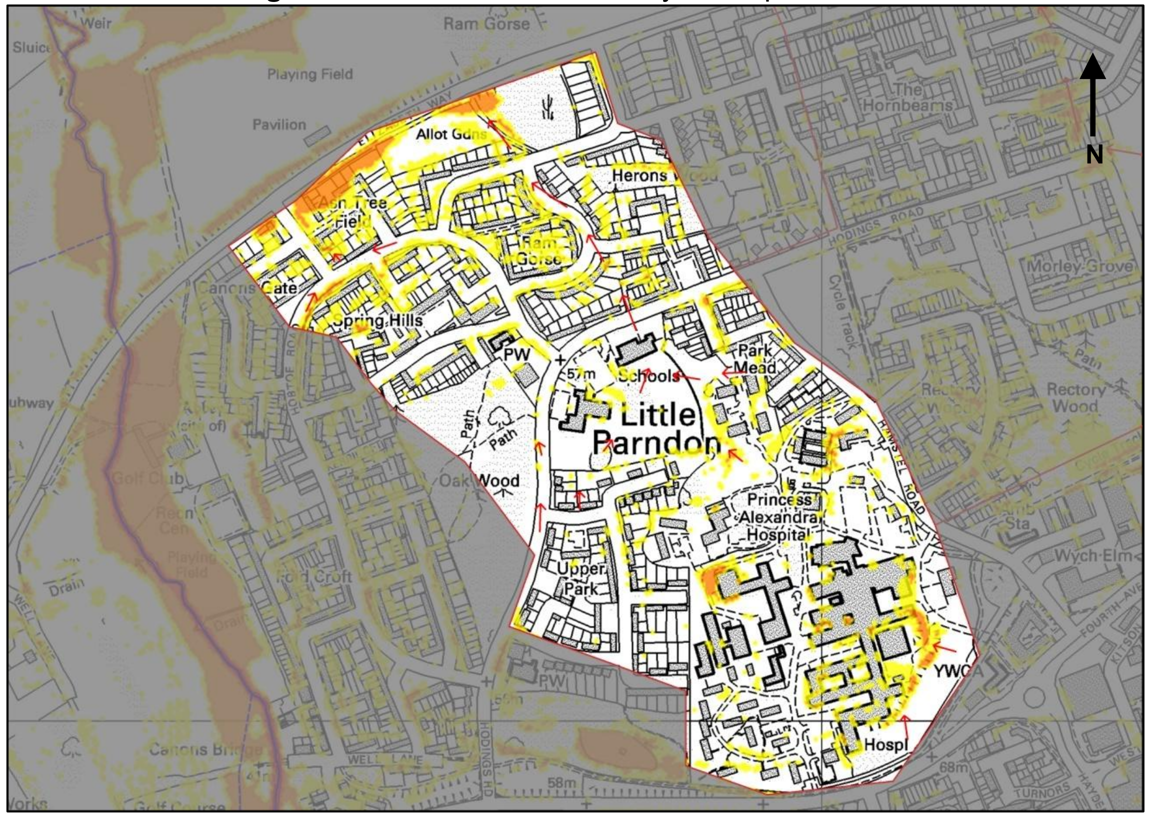


Figure 4-17 CDA 008 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Little Parndon area of Harlow. There are two LFRZs within the CDA. One is located within the Princess Alexandra Hospital whilst the other is located near Ash Tree Field. Flooding at the hospital is predicted to be a result of runoff ponding between building structures and may reduce in reality if the internal private drainage is operating effectively, whilst predicted flooding in Ash Tree Field is a result of Elizabeth Way obstructing to overland flows due to its raised elevation.

No fluvial flood zones are located within the CDA.

Table 4-8 Summary of local flood risk within the CDA 008 – Little Parndon Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	An overland flow path into the LFRZ is formed from Upper Park.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground.	Residential properties, gardens, roads
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	Some ponding is located around Princess Alexandra Hospital along with the LFRZ south of Elizabeth Way.	Hospital and residential properties and gardens
Hazard	Moderate and significant hazards are expected within the areas of flooding.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	The hydraulic modelling undertaken as part of this study indicates a good correlation with the EA Flood Map for Surface Water (FMfSW) flooding. Historic events within the CDA assist with confirming the risk in the CDA.		
Groundwater	A sizeable region in the south-west of the CDA is at 'very low' to 'low' risk of superficial deposits flooding; the north and west of the CDA are not highlighted as being at risk of groundwater flooding.		

CDA 009 – Rivermill Area

Figure 4-18 CDA 009 - 1 in 100 year Depth Results

Figure 4-19 CDA 009 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the north-eastern portion of the Little Parndon area of Harlow. There is one LFRZs within the CDA, which is located between Hodings Road, Rivermill, and the Hornbeams. The hydraulic model results predict that runoff from the local catchment is conveyed down roads and ponds behind the higher Elizabeth Way (A1169). When runoff ponds to a similar level to that of the Elizabeth Way, it is predicted that surface water flows into an area of lower ground within Burnt Mill and then on to the rail line.

No fluvial flood zones are located within the CDA.

Table 4-9 Summary of local flood risk within the CDA 009 – Rivermill Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	In extreme rainfall events surface water runoff from both greenfield and urban areas generate an overland flow path into the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground	Predominantly roads and open space.
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	Ponding from overland flow within various locations within the CDA.	Residential and industrial properties within the areas of ponding and rail line.
Hazard	Moderate and significant hazards are expected within the areas of ponding.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	The hydraulic modelling undertaken as part of this study indicates a good correlation with the EA Flood Map for Surface Water (FMfSW) flooding. Historic events within the CDA assist with confirming the risk in the CDA.		
Groundwater	The higher topographical region in the south of ranges from 'very low' to 'high risk 'of superficial deposits flooding, stretching down to the central region, which is not at risk of groundwater flooding. The northern half of, within the lower lying regions of the River Stort valley, is at 'high' to 'very high' risk of superficial deposits flooding.		

CDA 010 – Netteswell Area

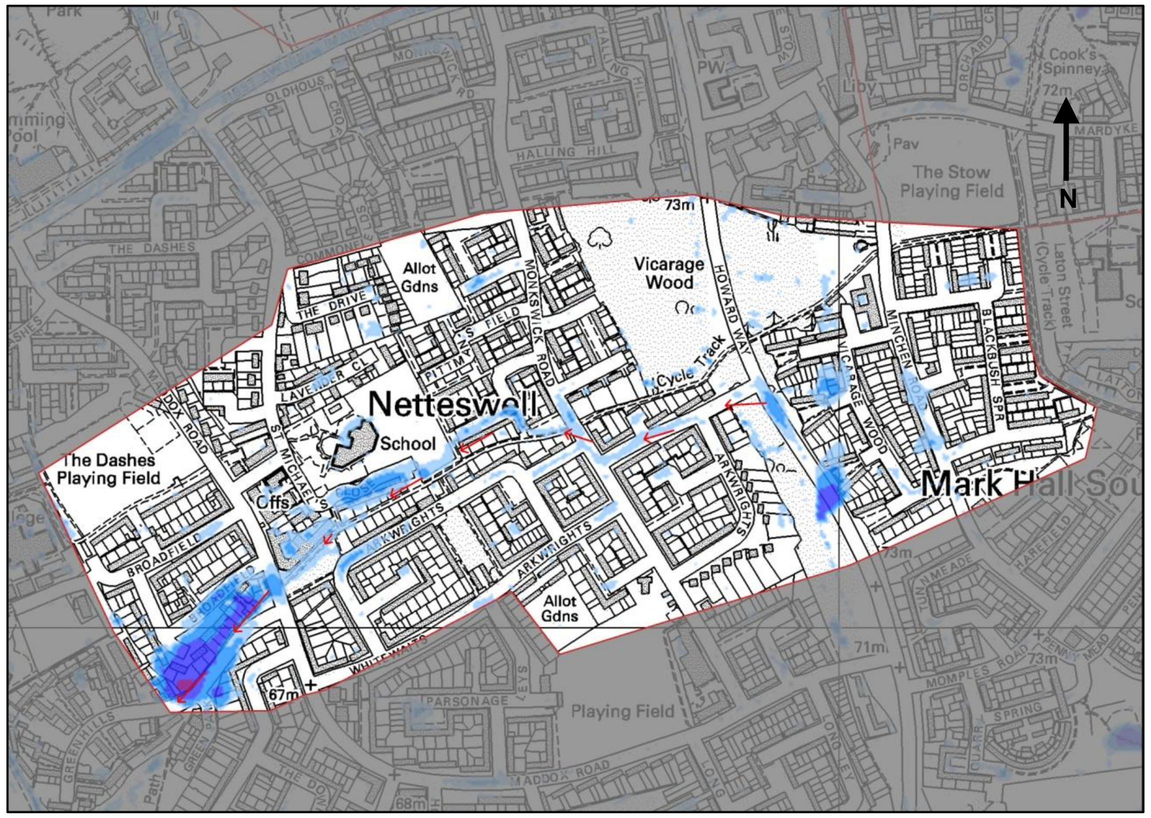


Figure 4-20 CDA 010 - 1 in 100 year Depth Results

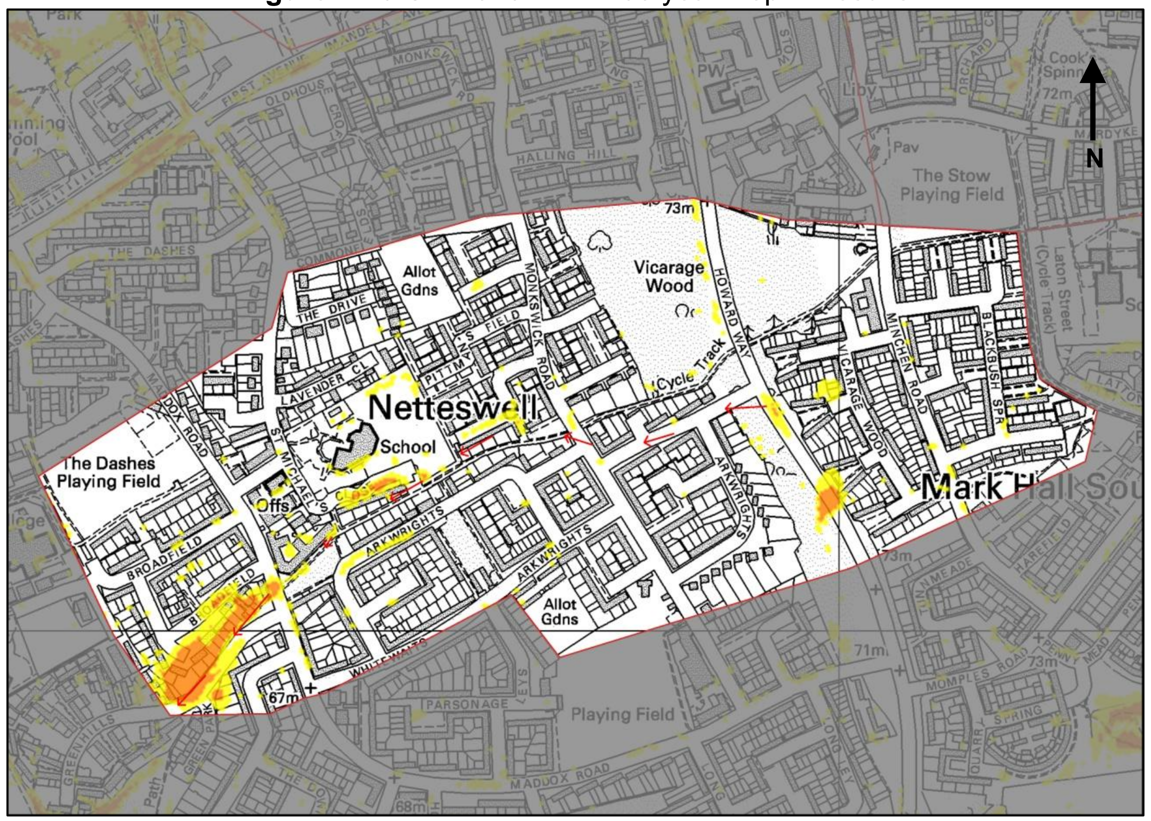


Figure 4-21 CDA 010 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in Netteswell area of Harlow. There is one LFRZ within the CDA, which is located between St Michael's Close and Green Park. The hydraulic model results predict that runoff from the local catchment is conveyed down local roads/pathways and is predicted to pond within topographic low points within the catchment.

No fluvial flood zones are located within the CDA.

Table 4-10 Summary of local flood risk within the CDA 010 – Netteswell Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff from both greenfield and urban areas generate an overland flow path into the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground via roads and pathways	Predominantly residential and roads.
Ponding of surface water (in topographic low spots)	Natural valleys, depressions and topographic low spots.	Ponding from the overland flow path occurs due to the low (local topographic area located within Greenhills/Green Park).	Residential properties and roads.
Hazard	Moderate and significant hazards are expected within the area of ponding,		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	The hydraulic modelling undertaken as part of this study indicates a good correlation with the EA Flood Map for Surface Water (FMfSW) flooding – albeit the modelled extents are smaller. This can be attributed to more accurate LiDAR being used within the SWMP model along with the inclusion of the drainage network and other hydraulic structures. A review of photographs in the area confirm that a topographic low point may exist in the area which could lead to the predicted ponding identified within the model.		
Groundwater	This CDA is not at risk of groundwater flooding. There is an area of ' high risk' groundwater flooding from superficial deposits flooding from groundwater sources, but this is located outside (south-west) of the CDA.		

CDA 011 – Altham Grove Area

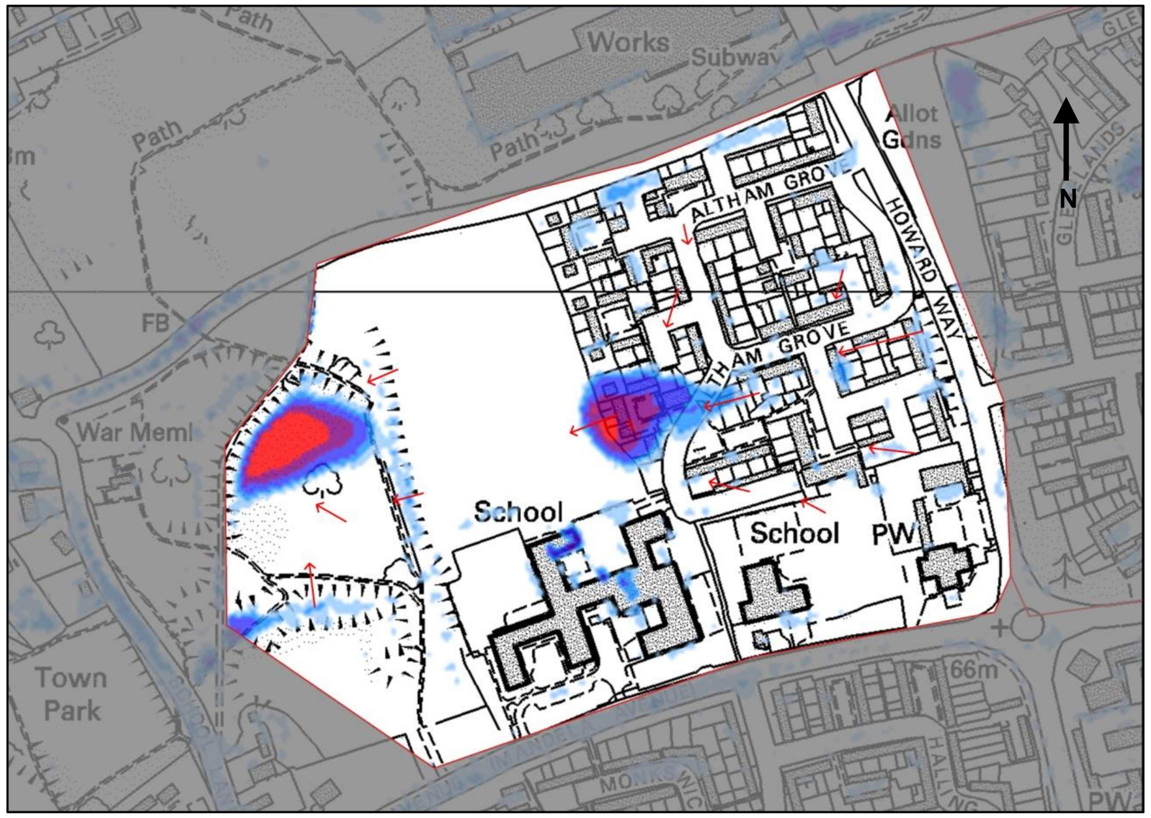


Figure 4-22 CDA 011 - 1 in 100 year Depth Results

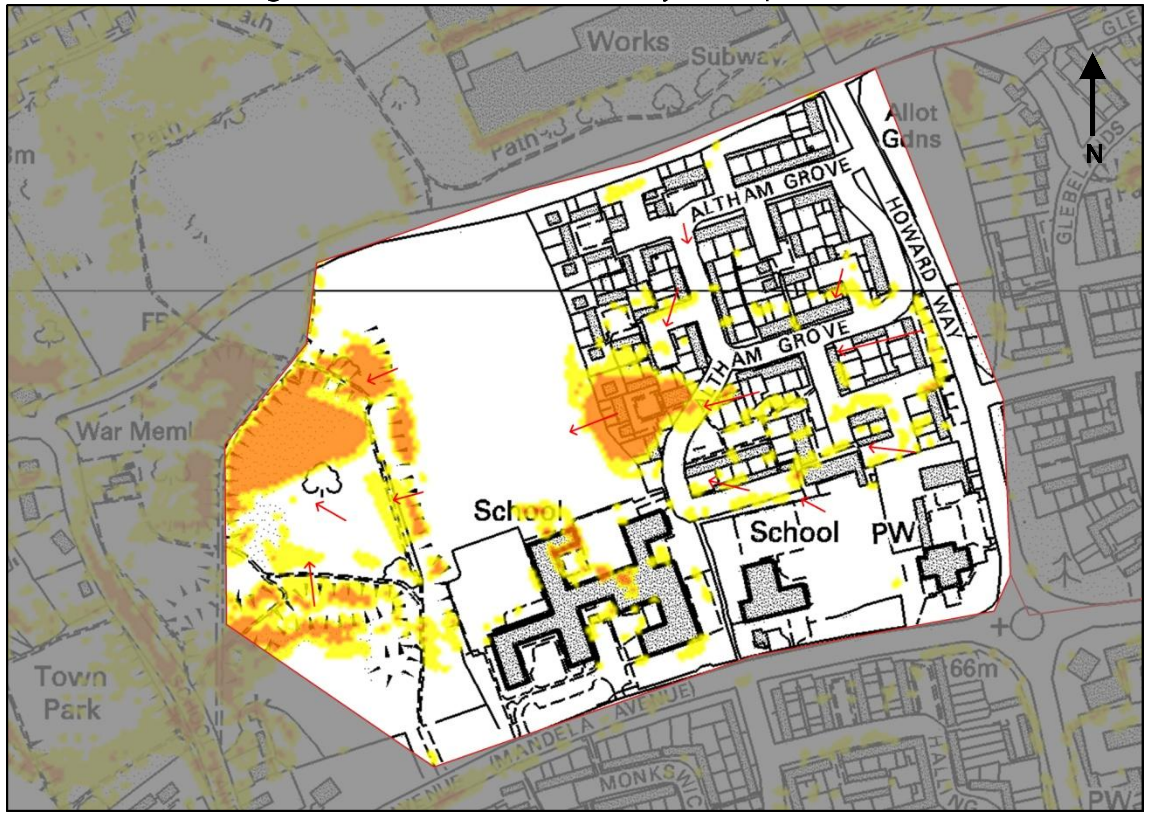


Figure 4-23 CDA 011 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located near Altham Grove, Harlow. There is one LFRZs within the CDA, which is located around Altham Grove. The hydraulic modelling results predict that runoff from areas at a higher elevation are conveyed to Altham Grove where water ponds behind an area of higher ground (which obstructs flow further to the west). A flood storage area appears to be located west of the LFRZ with the drainage pipe connected to this area running at 100% capacity during the peak of the storm. A site inspection of this area indicated that when the pipe system is running at capacity an overflow manhole might allow the surface water network to surcharge surface water into the open space east of School Lane (shown on the western boundary of the CDA).

No fluvial flood zones are located within the CDA.

Table 4-11 Summary of local flood risk within the CDA 011 – Altham Grove Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	No specific overland flow path is indentified within the CDA	Shallow sheet flow into the LFRZ with the greatest flows coming from west to east towards the area of ponding.	Residential and roads
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots located behind raised ground.	Ponding within the LFRZ is predicted to occur due to it being located at the low point within the catchment with the downstream embankment being over 3m higher than the area of ponding	Residential properties, open space.
Hazard	Moderate and significant hazards are expected within the area of ponding,		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	The hydraulic modelling undertaken as part of this study indicates a good correlation with the EA Flood Map for Surface Water (FMfSW) flooding. A site inspection confirmed the possible flood mechanisms (in particular the area of ponding within the topographic low point.		
Groundwater	The majority of CDA is at risk of superficial deposits flooding. The risk varies from 'very low' to 'very high risk', with a region at no risk running through the centre of the CDA from west to east.		

CDA 012 – Temple Fields Area

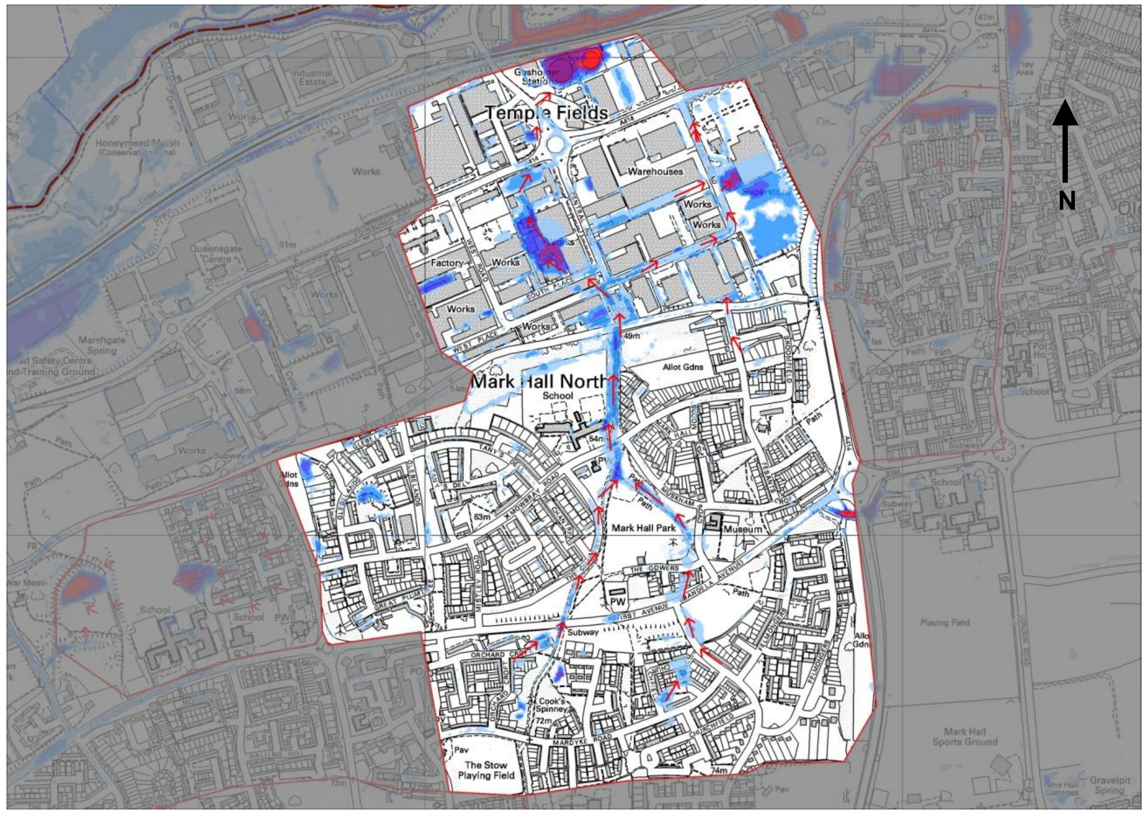


Figure 4-24 CDA 012 - 1 in 100 year Depth Results

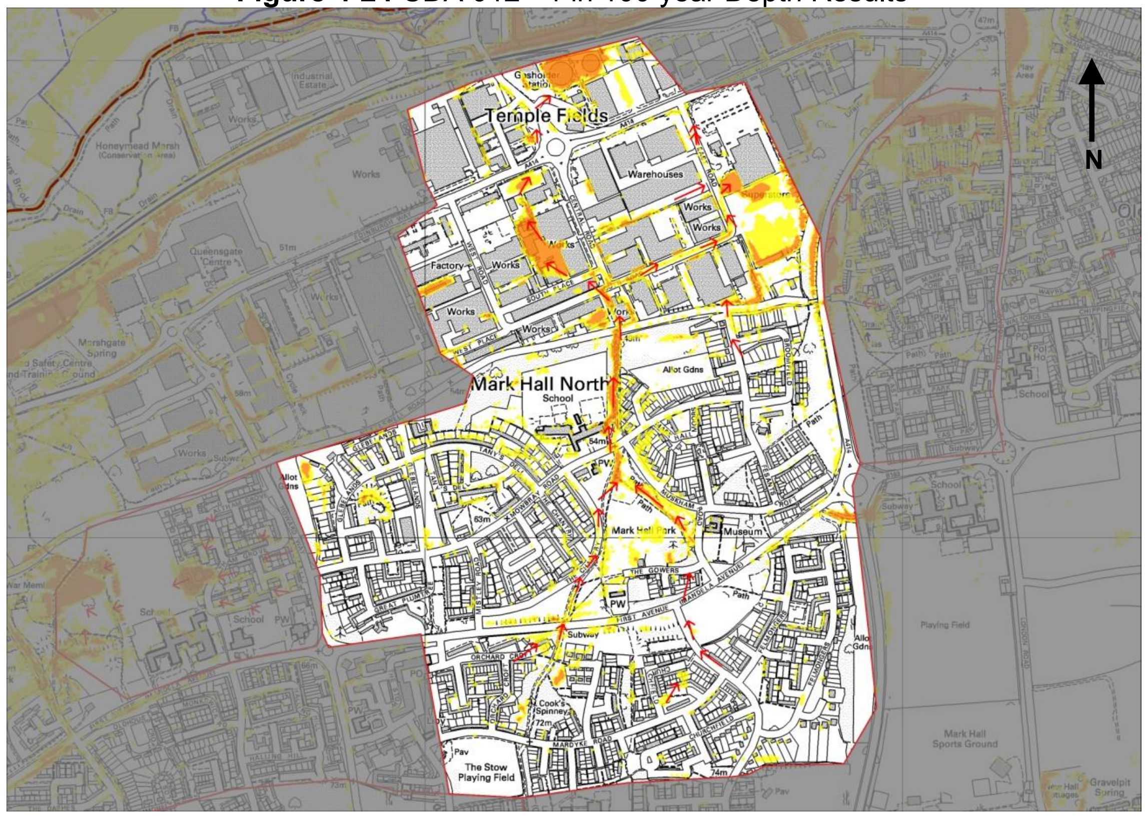


Figure 4-25 CDA 012 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the Temple Fields area of Harlow with predicted runoff from the Mark Hall North portion of the catchment influencing ponding in the two LFRZs. The two LFRZs are located within the Temple Fields industrial area and could impact the existing gas holder station. The hydraulic modelling results predict that runoff from areas at a higher elevation are conveyed to temple fields down existing paths (which may be a lost watercourses) where surface water ponds within topographic low points and behind the raised railway embankment.

No fluvial flood zones are located within the CDA.

Table 4-12 Summary of local flood risk within the CDA 012 – Temple Fields Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff from predominantly urban areas create an overland flow path into the LFRZ.	Due to the topography of the area two overland flow paths is conveyed into the LFRZ from higher ground – these are assumed to be lost watercourse reactivated by heavy rainfall.	Predominantly residential, industrial/commercial and open space.
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	There are two areas of ponding; one near the gas holding station as a result of the rail line being at a higher elevation and creating an obstruction to flow and another within the industrial area which is at a low topography when compared to the local surroundings.	Predominantly industrial/commercial properties and the gas holding facility.
Hazard	Moderate and significant hazards are expected within the area of ponding and along portions of the overland flow path.		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	The hydraulic modelling undertaken as part of this study indicates a good correlation with the EA Flood Map for Surface Water (FMfSW) flooding. Historic events and a review of photography of the areas of ponding confirm the mechanisms of flood risk.		
Groundwater	The topographic highs along the south of the CDA are not at risk of groundwater flooding; the northern, lower lying region of the River Stort valley is at 'high' to 'very high' risk of groundwater flooding.		

CDA 013 – Old Harlow Area

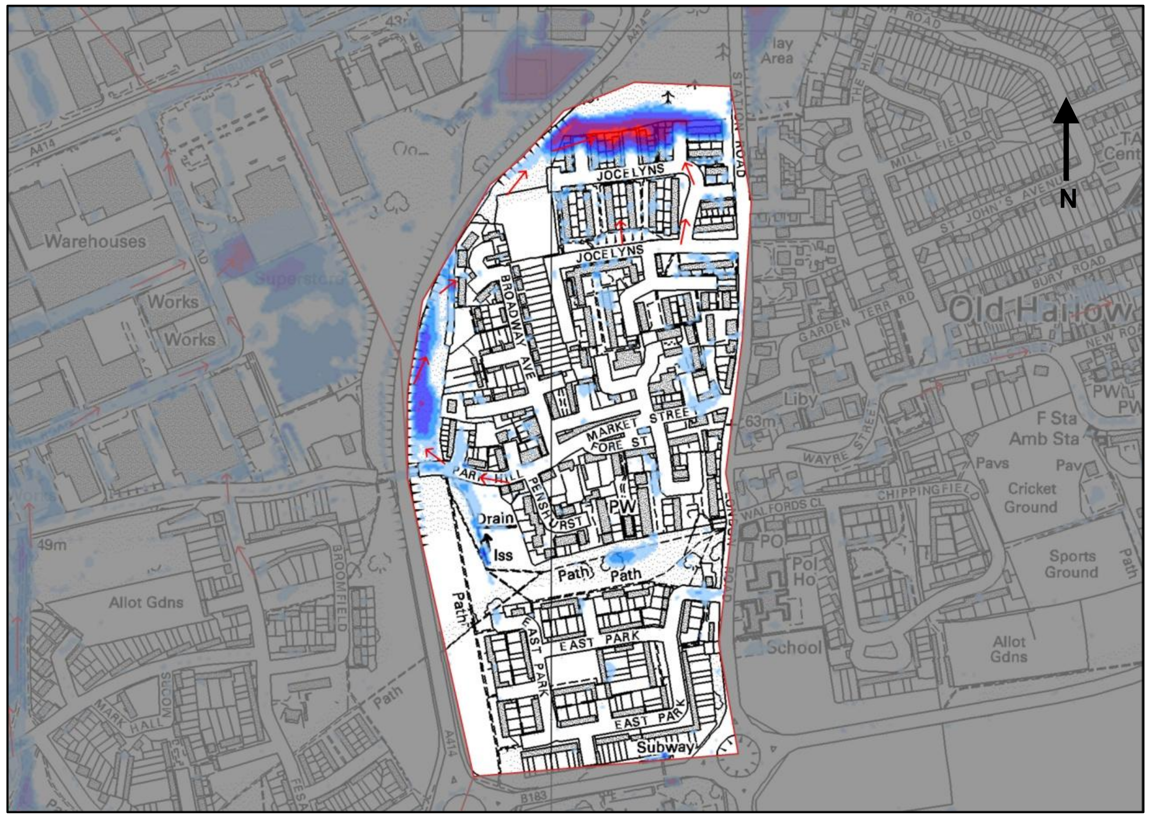


Figure 4-26 CDA 013 - 1 in 100 year Depth Results

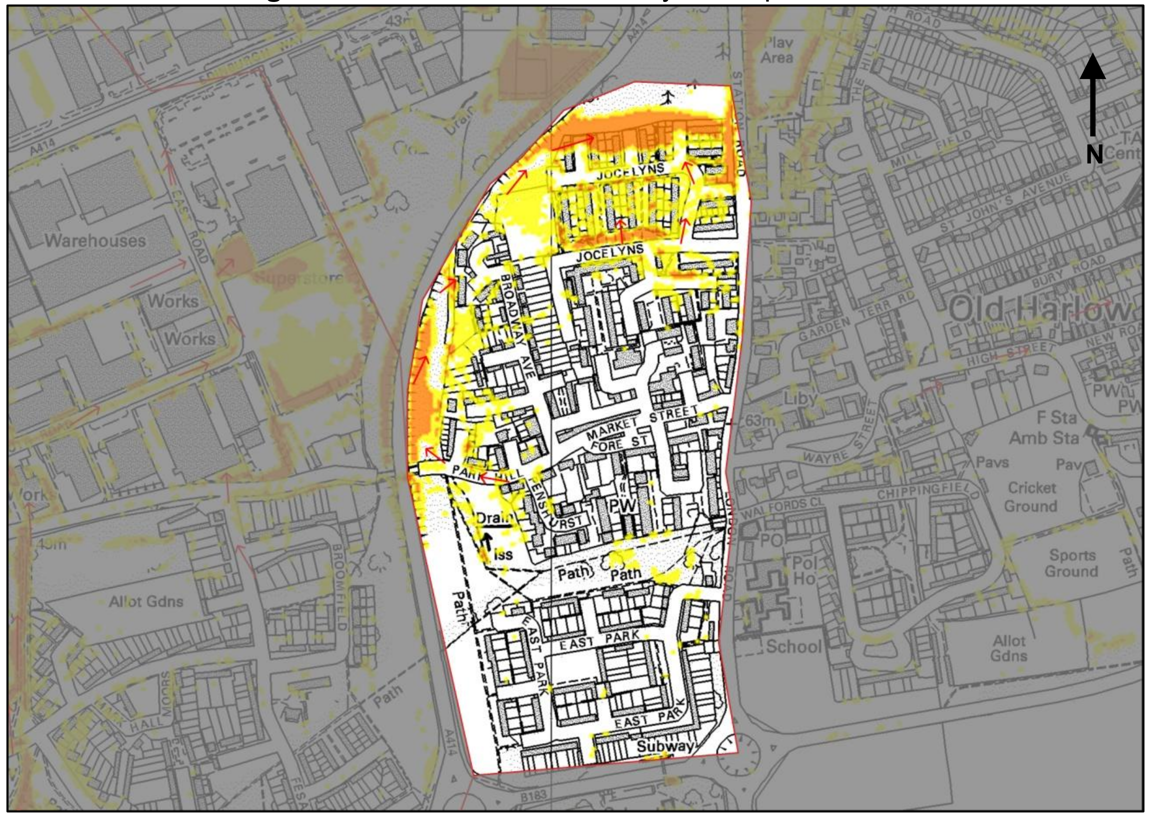


Figure 4-27 CDA 013 - 1 in100 year Hazard Results

Summary of risk:

This CDA is located in the western portion of the Old Harlow area. The LFRZ is located around Jocelyns. The hydraulic modelling results predict that runoff from areas at a higher elevation are either conveyed to the west to an existing attenuation feature where runoff ponds and flows to the LFRZ due to the A414 causing an obstruction to flow (where an only drainage channel may have existed). These flows (along with flows from the south) are predicted to then pond within the LFRZ due to the ground north of the LFRZ being at a higher elevation.

There is a small area of Flood Zone 2 located north of Jocelyns.

Table 4-13 Summary of local flood risk within the CDA 013 – Old Harlow Area

Flood Classification/ Type	Source	Pathway	Receptor
Overland flow	Surface water runoff predominantly urban areas generate an overland flow path into the LFRZ.	Due to the topography of the area a natural overland flow path is conveyed into the LFRZ from higher ground from the northern portion of the CDA whilst the A414 obstructs the direction of natural flow and create a flow path along the western boundary into the LFRZ	Residential and open space.
Ponding of surface water (within topographic low spots)	Natural valleys, depressions and topographic low spots.	There are area of ponding near Jocelyns is a result of the open space to the north being at a higher elevation and creating an obstruction to flows	Residential properties adjacent to/ within ponding areas.
Hazard	Moderate and significant hazards are expected within the area of ponding		
Sewer	The drainage network within the CDA is a separated foul and surface water system.		
Validation	Historic events and a review of photography of the areas of ponding confirm the mechanisms of flood risk. The hydraulic modelling undertaken as part of this study indicates a greater area of flooding than that identified within the EA Flood Map for Surface Water (FMfSW) flooding. This can be attributed to more accurate LiDAR being used within the SWMP model.		
Groundwater	The groundwater flood risk varies from no risk (approximately half of the CDA) to a 'moderate' risk of superficial deposits flooding.		

4.3 Flood Risk Summary

4.3.1 Overview of Flood Risk in Harlow

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 predicted risk to Harlow from surface water, groundwater, ordinary watercourses and sewer flooding.[2] 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, embankments etc) being at the greatest risk. It is acknowledged that flooding within Harlow is not limited to the identified CDAs; in fact there are several localised areas at risk of surface water flooding. 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, predicted pluvial flooding across Harlow is moderate in the lower order rainfall events (such as the modelled 1 in 30 year event) and is predicted to experience more severe 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 4-14 and Table 4-15 identify the categories used in the assessment of flooded properties.

Table 4-14 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; and • Water treatment works.
Highly Vulnerable	• Police stations, Ambulance stations, Fire stations, Command Centres and telecommunications installations; and • 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; and • Prisons.

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

Table 4-15 Household and Basement Sub-Categories

Category	Description
Households	• All residential dwellings; • Caravans, mobile homes and park homes intended for permanent residential use; and • 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 4-16 below, indicates the approximate number of predicted properties and critical infrastructure which may be affected in Harlow during a 1 in 100 year probability rainfall event (1% AEP).

Table 4-16 Predicted 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	0	0	0
	Highly Vulnerable	1	1	0
	More Vulnerable	2	0	0
	Sub-total	**3**	**1**	**0**
Households	Non-Deprived (All)	1,716	487	296
	Non-Deprived (Basements Only)	0	0	0
	Deprived (All)	15	0	0
	Deprived (Basements Only)	0	0	0
	Sub-total	**1,731**	**487**	**296**
Commercial / Industrial	Units (All)	36	8	2
	Units (Basements Only)	0	0	0
Others	Other Flooded Properties	0	0	0
	Unclassified Flooded Properties	476	162	75
	Infrastructure Other	2	1	1

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 30 year probability event (3.3% AEP) was used for this assessment and the results are summarised in Table 4-17 overleaf.

Figure 4-28, below, identifies the difference in flooded properties between the two events.

Table 4-17: Predicted Flooded Properties Summary 1 in 30 year probability event

Property Type	Flood Risk Vulnerability Classification	Modelled Depths Greater Than		
		0.1m	0.3m	0.5m
Infrastructure	Essential Infrastructure	0	0	0
	Highly Vulnerable	1	1	0
	More Vulnerable	1	0	0
	Sub-total	**2**	**1**	**0**
Households	Non-Deprived (All)	1,333	312	183
	Non-Deprived (Basements Only)	0	0	0
	Deprived (All)	12	0	0
	Deprived (Basements Only)	0	0	0
	Sub-total	**1,345**	**312**	**183**
Commercial / Industrial	Units (All)	23	4	2
	Units (Basements Only)	0	0	0
Others	Other Flooded Properties	0	0	0
	Unclassified Flooded Properties	394	121	53
	Infrastructure Other	1	1	1

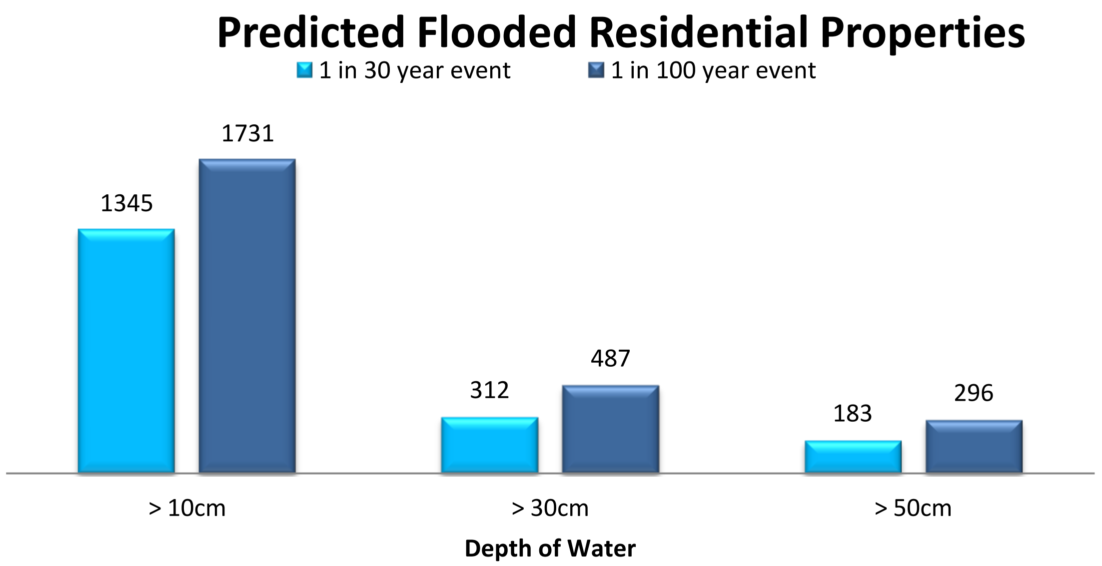


Figure 4-28 Comparison of Predicted Flooded Properties for the 1 in 30 year and 1 in 100 year Rainfall Event

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

4.3.3 Risk to Future Development

As discussed in Section 1.8, a number of sites will be 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 Plan process.

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 Harlow 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 results for these model runs are included in Appendix C along with the other mapped outputs from the modelling process.

Figure 4-29, 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 red indicate where the climate change events results are predicted to be greater and is most obvious in areas that have flow obstructions (raised ground downstream). This comparison highlights that although the predicted effects of climate change may increase the flood risk within certain areas of Harlow (particularly adjacent to the River Stort) the predicted impacts from the 1 in 100 year are suitable for assessing the risk to Harlow.

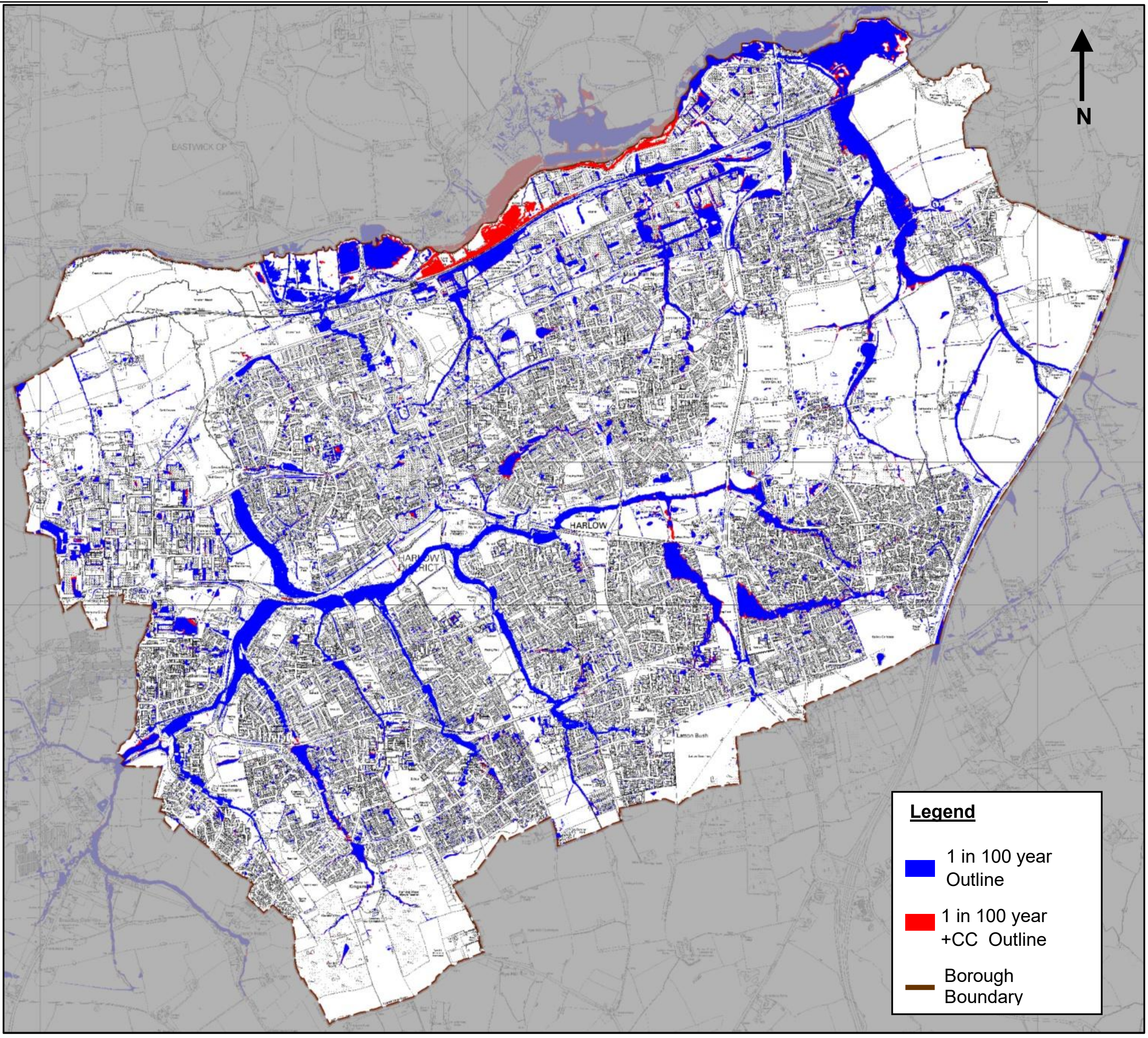


Figure 4-29 Comparison of Predicted 1 in 100 year Pluvial Flood Extent against the Predicted 1 in 100 year with an Allowance for Climate change (30% Increase in Rainfall Volumes) Flood Extent.

4.4 Summary of Risk - CDAs

Table 4-18 (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 modelled pluvial event.

Table 4-18: Summary of Surface Water Flood Risk in CDAs for the Predicted 1 in 100 year Pluvial Event

Property Type	Flood Risk Vulnerability Classification	Critical Drainage Areas																									
		001		002		003		004		005		006		007		008		009		010		011		012		013	
		>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	>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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Highly Vulnerable	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	More Vulnerable	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-total	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Households	Non-Deprived (All)	85	19	205	21	32	3	98	10	109	0	322	117	44	0	42	9	74	4	67	6	28	12	30	0	46	20
	Non-Deprived (Basements Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Deprived (All)	0	0	0	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
	Sub-total	85	19	205	21	32	3	98	10	109	0	322	117	44	0	42	9	74	4	67	6	28	12	30	0	46	20
Commercial / Industrial	Units (All)	0	0	2	0	1	0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0	12	2	1	0
	Units (Basements Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	Other Flooded Properties	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Unclassified Flooded Properties	20	0	47	17	4	0	14	0	6	2	14	1	9	0	21	0	24	0	0	0	2	0	69	22	0	0
	Infrastructure Other	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Total		106	19	255	38	37	3	112	10	115	2	340	119	53	0	63	9	102	4	67	6	30	12	112	24	47	20

4.5 Summary of Risk – Non-Critical Drainage Areas

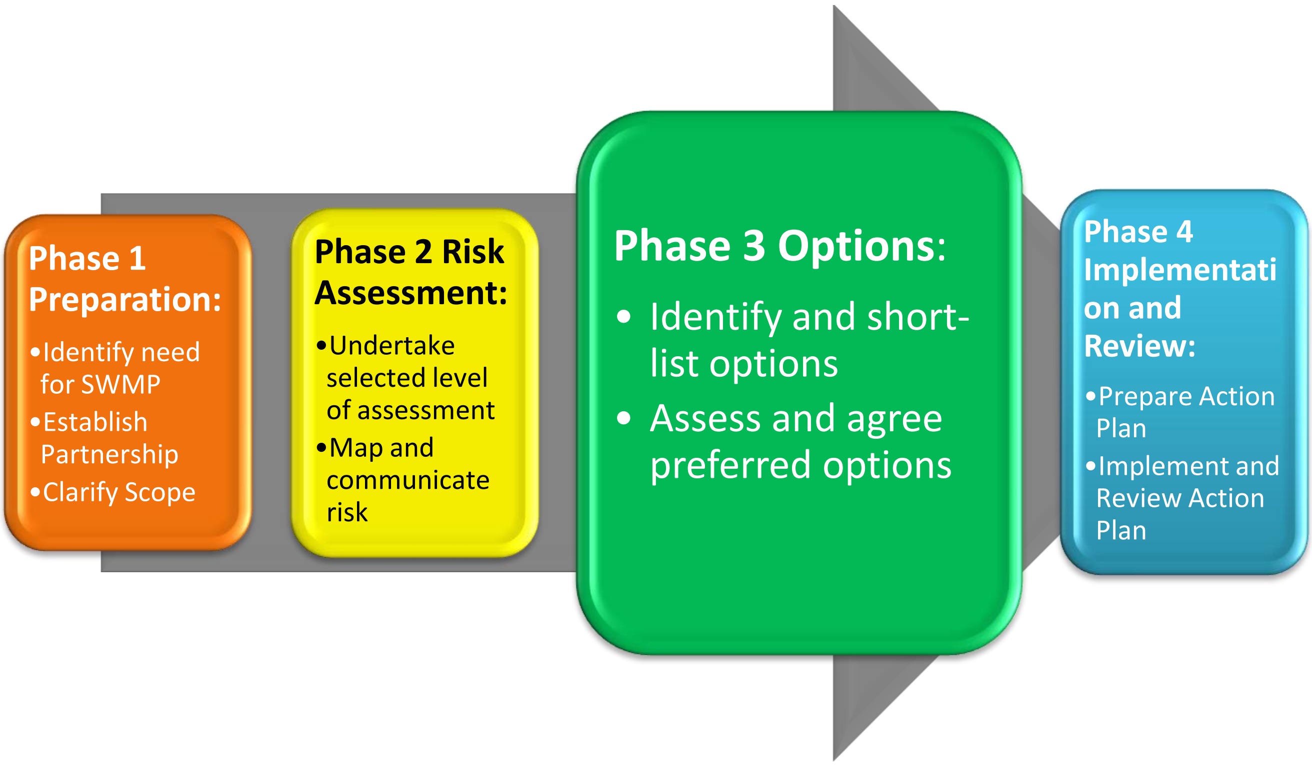
As can be seen in the figures in the previous section, surface water flood risk is also predicted to affect other parts of the study area that are not within defined CDA extents. Predicted flooding in these areas is generally from non-point source surface water runoff that does not accumulate into large, deep areas of flooding – but ponds in smaller areas that generally only affect small groups of properties, or where the predominant risk is from fluvial flooding. The greatest predicted surface water flooding impacts (outside of a CDA) is located within the Harlowbury Brook catchment. This area has been excluded from a CDA classification as the predominant risk is from fluvial sources. Table 4-19 highlights the number of properties predicted to be at risk of flooding during the 1 in 100 year modelled pluvial event.

Table 4-19: Summary of Surface Water Flood Risk in the Harlowbury Brook Area for the 1 in 100 year Pluvial Event

Infrastructure								Households				Commercial / Industrial		Other (Unclassified Landuse)	
Essential		Highly Vulnerable		More Vulnerable		Other		Non-Deprived		Deprived					
All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep	All	> 0.5m Deep
0	0	0	0	0	0	0	0	188	71	0	0	1	0	24	3

It is predicted that 188 residential properties (based on NRD 1.1 database) are predicted to be at risk during the 1 in 100 year pluvial event. It is recommended that ECC, HDC and the EA undertake a collaborative review of fluvial, pluvial and groundwater risks to determine the most appropriate methods for managing flood risk in the catchment. It is recommended that upstream storage is investigated along with increasing the capacity of the downstream culvert and providing resilience and resistance measures to at risk properties.

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 Harlow. 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 can be further 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.

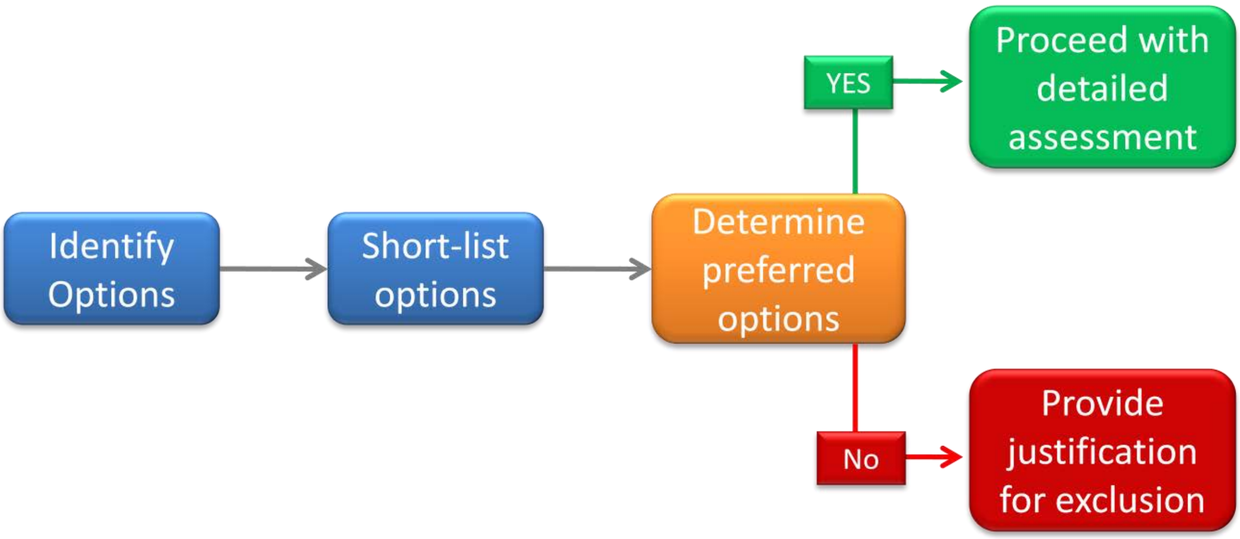


Figure 5-1 Process of identifying and short-listing options and measures [adapted from Defra SWMP Guidance]

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 Harlow 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 Harlow.

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

- Local Green Infrastructure Delivery Plans;
- Local Investment Plan and Programme (funding plan for delivery of the LDF);
- Major commercial and housing development is an opportunity to retro-fit surface water management measures (housing associations and private developers);
- Essex Highways department investment plans; and
- Thames 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 Harlow. 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[3]:

- 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.

[3] 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 the study area.

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.

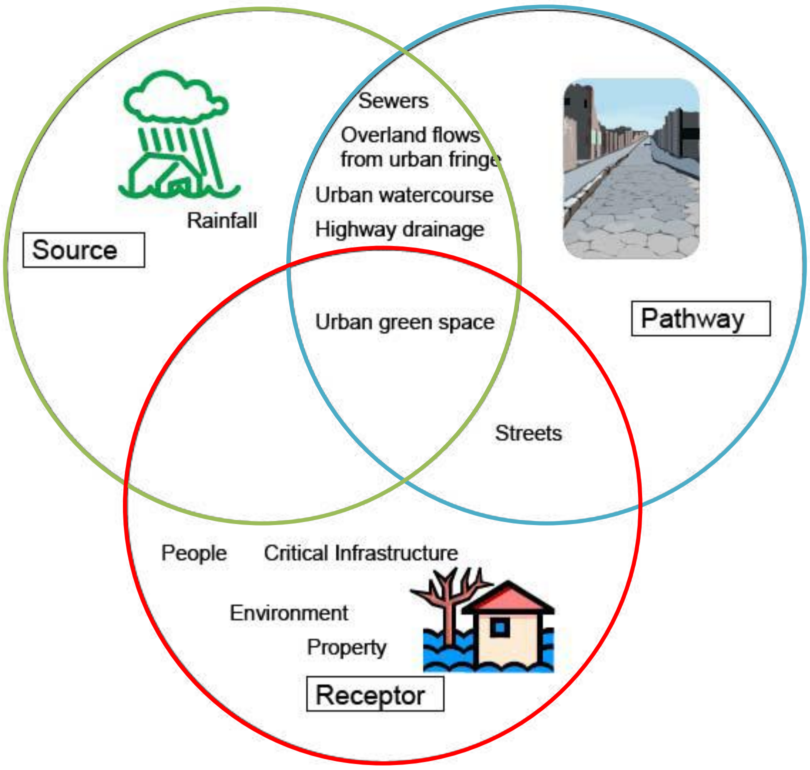


Figure 5-2 Illustration of Sources, Pathways & Receptors (extracted from SWMP Technical Guidance, Defra 2010)

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. 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.).

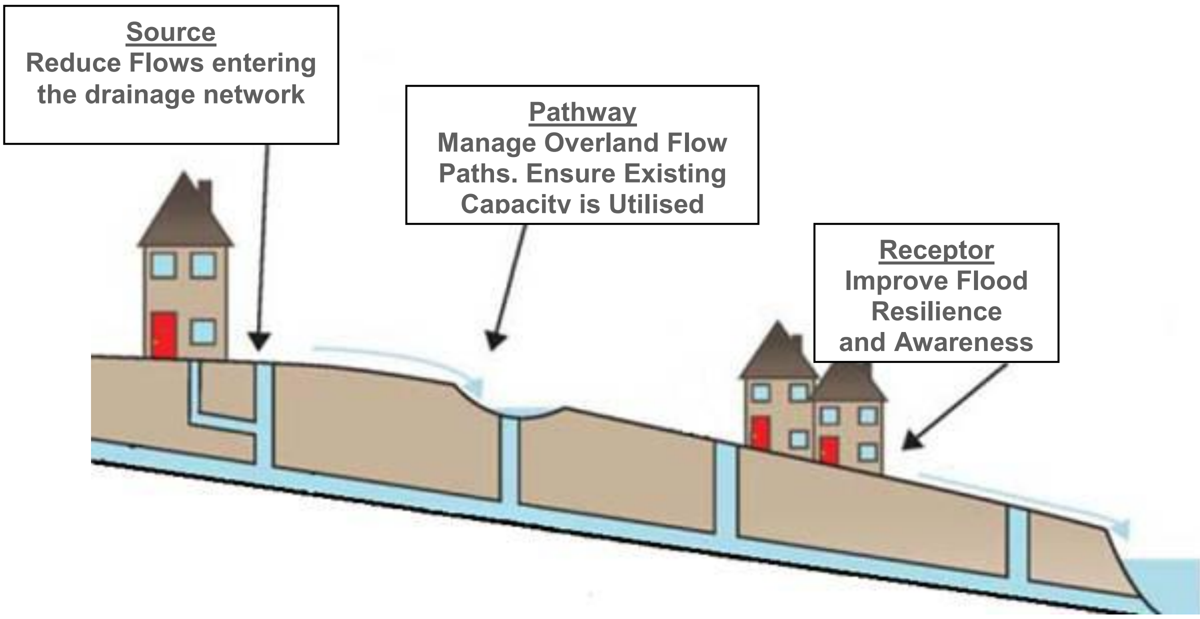


Figure 5-3 Source, Pathway and Receptor Model
(adapted from Defra SWMP Technical Guidance, 2010)

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 4-1, 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.); and

- 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 and resistance 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 Identifying Options

Following the identification of a number a measures (as described in Table 5-1 above), a series of District-wide options were defined based on this assessment. These options were based initially on a range of options (scheme categorisations) identified in Table 5-2. Each of the standard measures (from Table 5-1) have been categorised within an option.

Table 5-2: 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

Description		Standard Measures Considered
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
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.	

5.6 Options Assessment Guidance

Unless a detailed appraisal of cost and benefits of every measure is undertaken, a high-level scoring system for each of the options can be 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 5-3.

Table 5-3: 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>

Table 5-4 (overleaf) provides an example of applying the options scoring system on a Harlow wide assessment.

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 system for each CDA can be located within Appendix E of this report.

Table 5-4: Summary of options assessment

Area /CDA	Option Category	Option Description	Options Assessment: Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward?	Summary of Scheme
Harlow (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							Summary of Scheme
			Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward?	
	Improvement to Drainage Infrastructure	Improve drainage network capacity within key risk areas	2	1	0	0	2	5	✓	Work collaboratively with Thames 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 Harlow.
	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.

5.7 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 in Appendix D and summarised in Table 5-5. Based on the final identified score the following range has been applied to these results:

- ≥ 301 = High priority;
- 300 – 101 = Medium priority; and
- ≤ 100 = 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
006	325	117	442	1115	High
002	208	21	229	526	High
001	86	19	105	266	Medium
004	98	10	108	236	Medium
005	109	0	109	218	Medium
013	47	20	67	173	Medium
009	78	4	82	168	Medium
010	67	6	73	158	Medium
008	43	9	52	140	Medium
011	28	12	40	104	Medium
007	44	0	44	88	Low
003	33	3	36	77	Low
012	42	2	44	76	Low

A graphical representation of these rankings can be located overleaf 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.

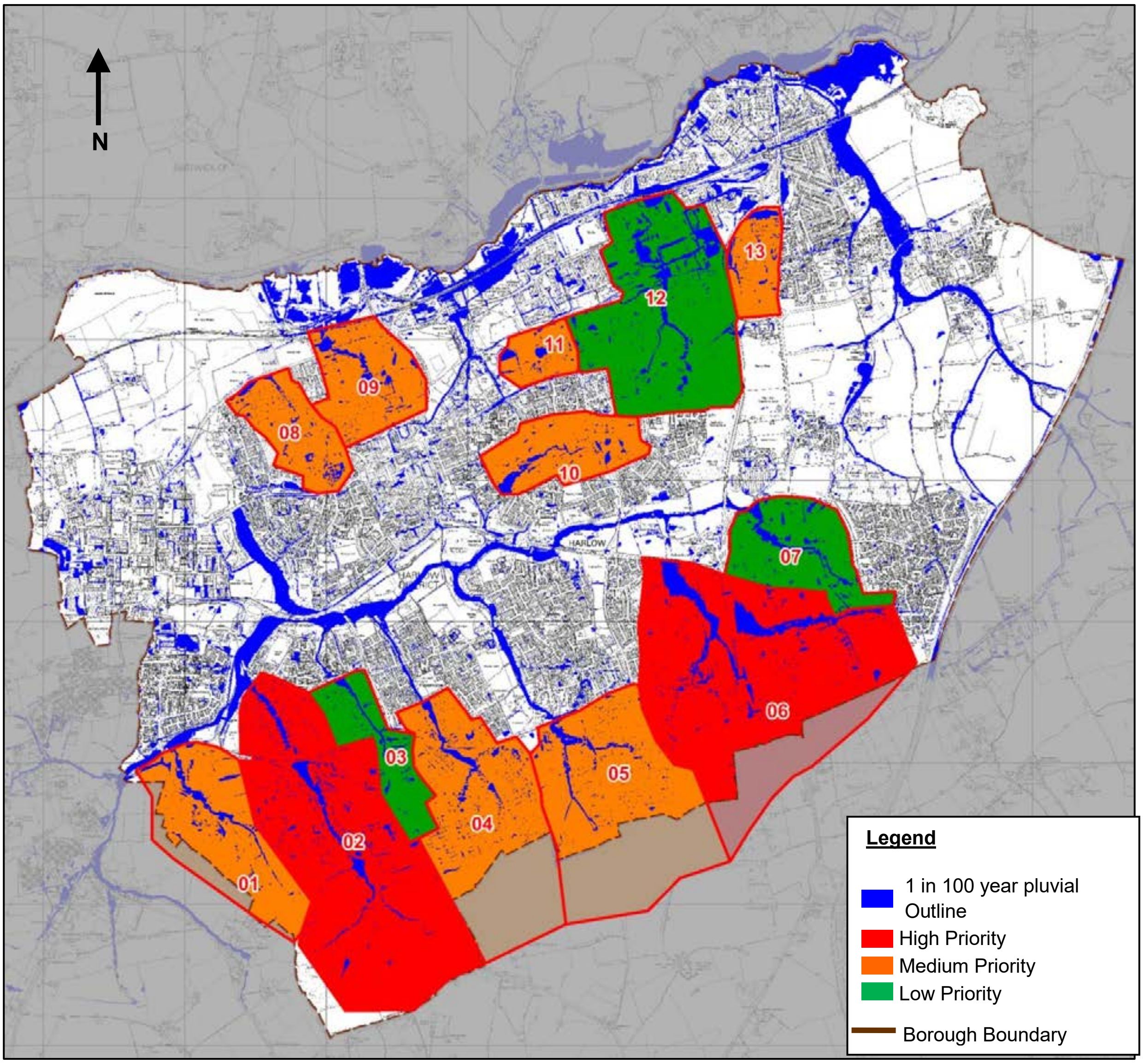


Figure 5-4 Flood Risk Impacts to each CDA

5.7.3 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.

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 carpark pods 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 001 – Sumners Area

Preferred Option:

- Include Additional gullies along the pedestrian footpath to capture surface water flows.
- Storage area east of drain and playing area – control flows into it from the culvert;
- Partial deculvert and improvement of the drain south of Dunstalls to reduce the overland flowpath into Dunstalls. A new pedestrian bridge will be required over the deculverted section to allow users to access Dunstalls;
- Preferred flowpath - raised kerb and speed bumps along Broadley Road; and
- Lowered greenspace north of Hintons with a flood wall or preferential flow path (via swale or other feature) to divert excess flows into the pedestrian subway away from properties in Sycamore Field.

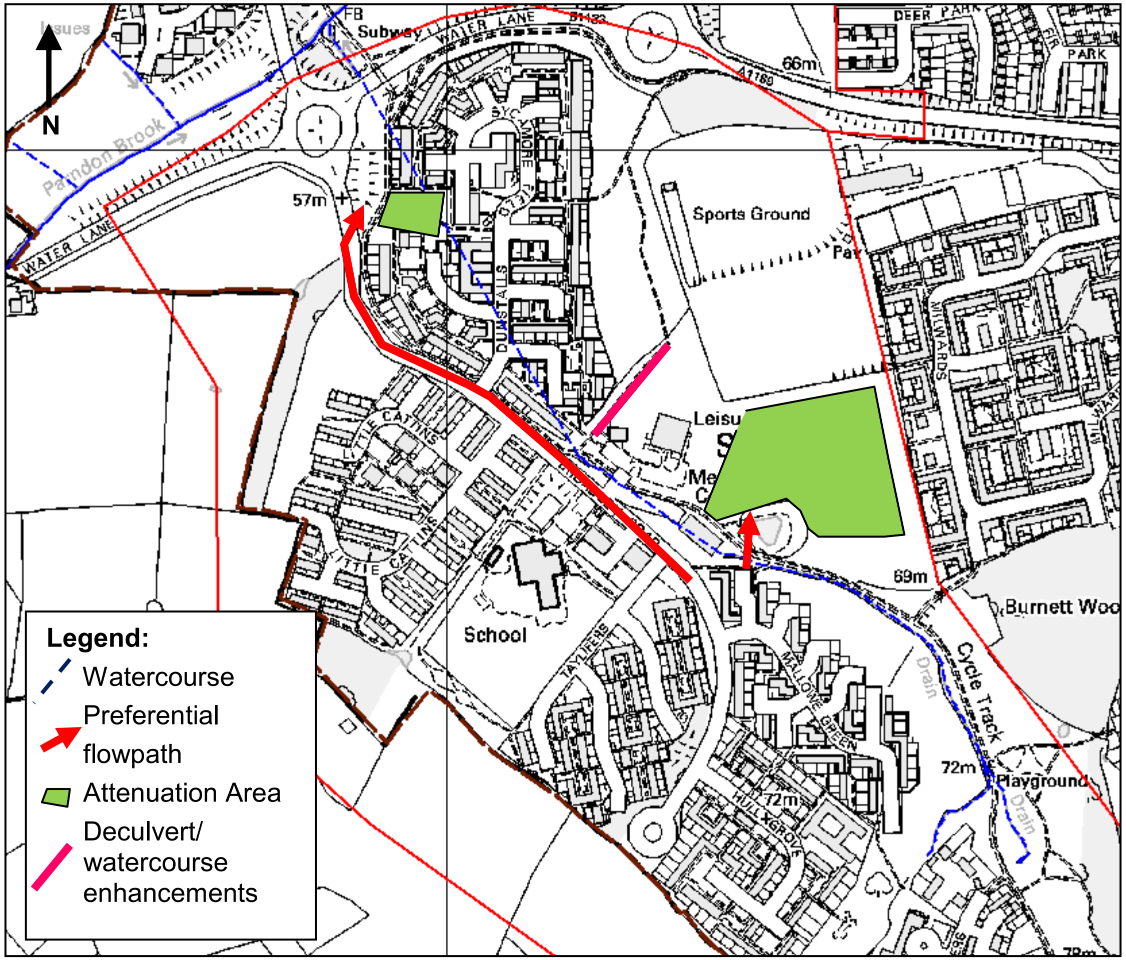


Figure 5-5 Preferred Options CDA 001- Sumners Area

CDA_002 – Kingsmoor Area

Preferred Option:

- Formal swale/cut off drain and upstream attenuation feature south of Parndon Wood Road to capture flows from upstream Greenfield catchment. This may be school land and the design of these features would need to ensure that the safety of the children is considered;
- Preferential overland flow route – raised kerbs and where necessary raised speed bumps along the Paringdon Road, along Watersmeet and Kingsmoor Road to divert flows away from properties;
- Flood resistance/resilience within Watersmeet and Milwards CP School and Milwards Primary School;
- Investigate if lowering school ovals by 0.3m or creating a downstream bund will reduce downstream risk of flooding; and
- Assess the addition of a drainage culvert from Watersmeet through Southern Way through to open space next to Kingsmoor Road with an attenuation area in this location to reduce risk of upstream flows impacting these properties.

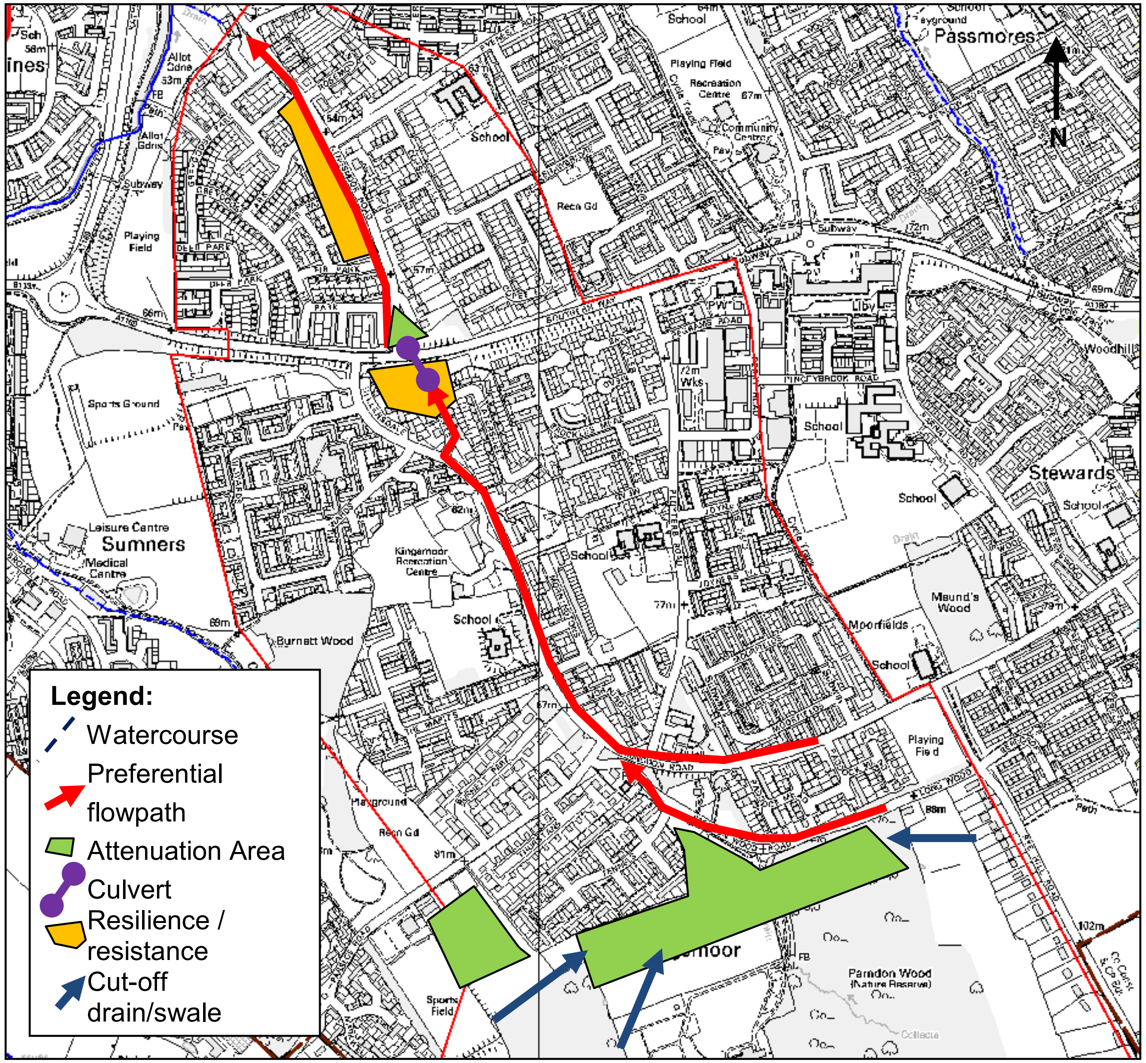


Figure 5-6 Preferred Options CDA 002- Kingsmoor Area

CDA_003 – West Passmores Area

Preferred Option:

- Formal swale and upstream attenuation feature south of Pinceybrook Road to capture flows from upstream greenfield catchment;
- Preferential overland flow route downs pedestrian walkway/cycle track – possible swale to enhance water quality;
- Flood resistance/resilience within Holly Field;
- Investigate if a flood storage area can be created within the open space near Passmores Youth Centre; and
- Possible underground storage within Holly Field to assist in reducing total depth of flooding.

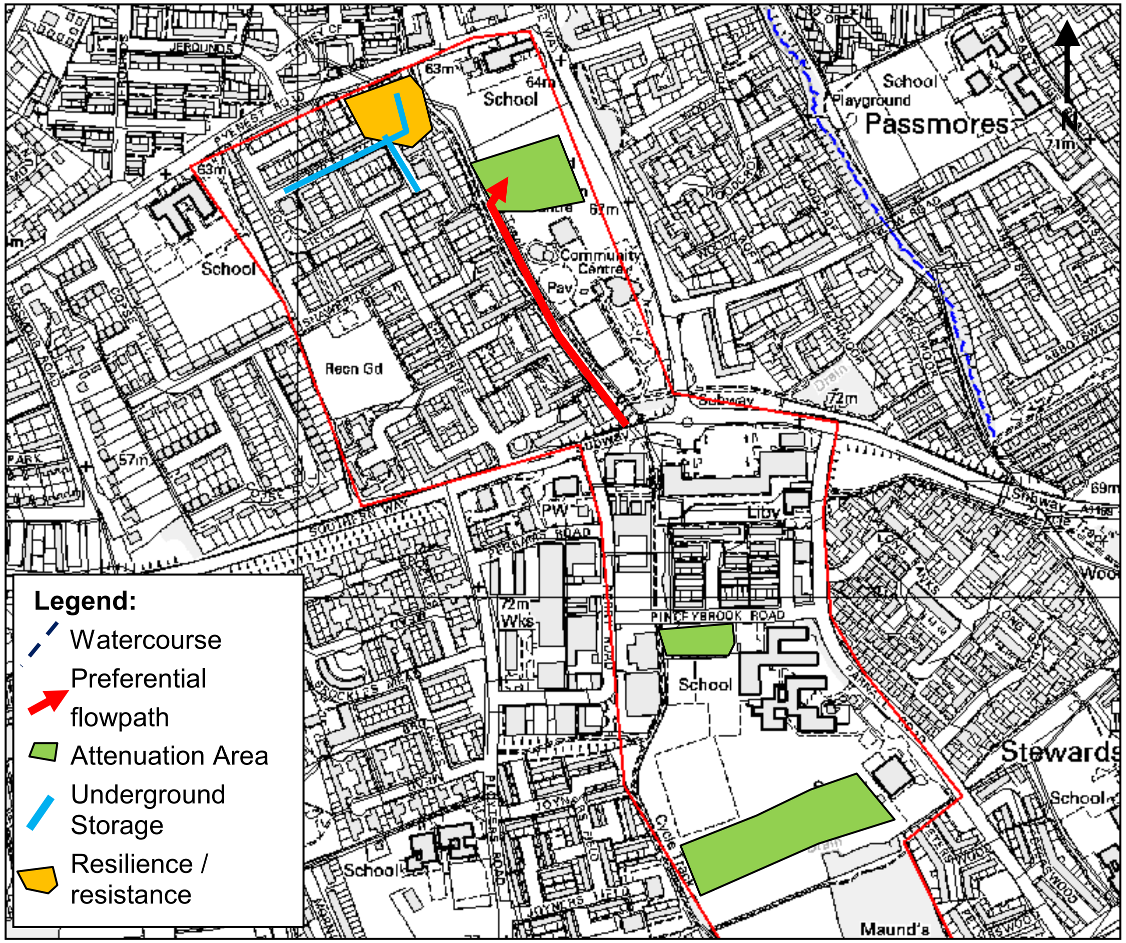


Figure 5-7 Preferred Options CDA 003- West Passmores Area

CDA_004 – Stewards Area

Preferred Option:

- Formal swale and upstream attenuation feature south of urban extent (west of Fern Hill Cottage);
- Formal attenuation area within open space north of Barley Croft to control the total volume of runoff entering the downstream watercourse during the peak of the storm;
- Modify ground levels within the allotment west of Copshall Close and divert flows to flood this area instead of urban properties. Include a piped culvert from the allotment north into the pedestrian walkway to assist in drainage flows from this area or modify the levels within Paringdon Road and its verge to create a sag point to reduce any obstruction to flows;
- Modify ground levels within Longwood Primary School to reduce impact of flooding to school building or incorporate flood resilience / resistance measures within the school. Create a bund within the eastern boundary of the school to reduce an overland flowpath into Barley Court;
- Preferential overland flow route around barley croft to an attenuation feature discussed above; and
- Flood resistance/resilience to properties with historic flooding within Barley Croft and properties predicted to flood near Penlow Road.

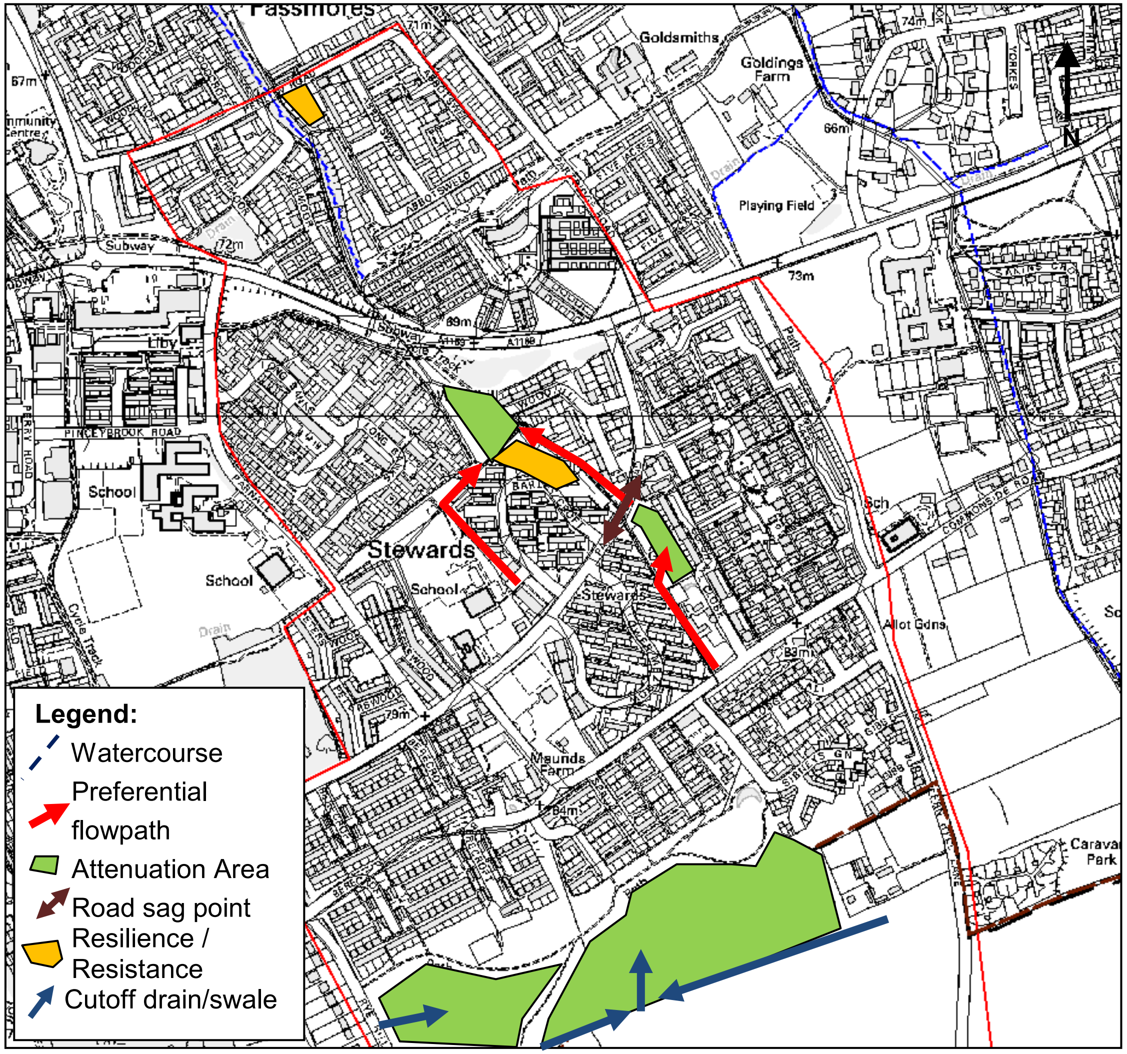


Figure 5-8 Preferred Options CDA 004- Stewards Area

CDA_005 – Latton Bush Area

Preferred Option:

- Enhance storage area south west of Latton Green and create additional swales/cut off drains to direct flows to this device from upstream areas;
- Preferential flow paths (raised kerbs) down Sakins Croft and Tysea Road with possible underground storage and additional gulley inlets. The modelling predicts that the pipe network may not be flowing at full capacity until the Sakins Croft area; and
- Flood resistance/resilience to properties at risk along the Readings and Sakins Croft and propertied near Monksbury and Tysea.

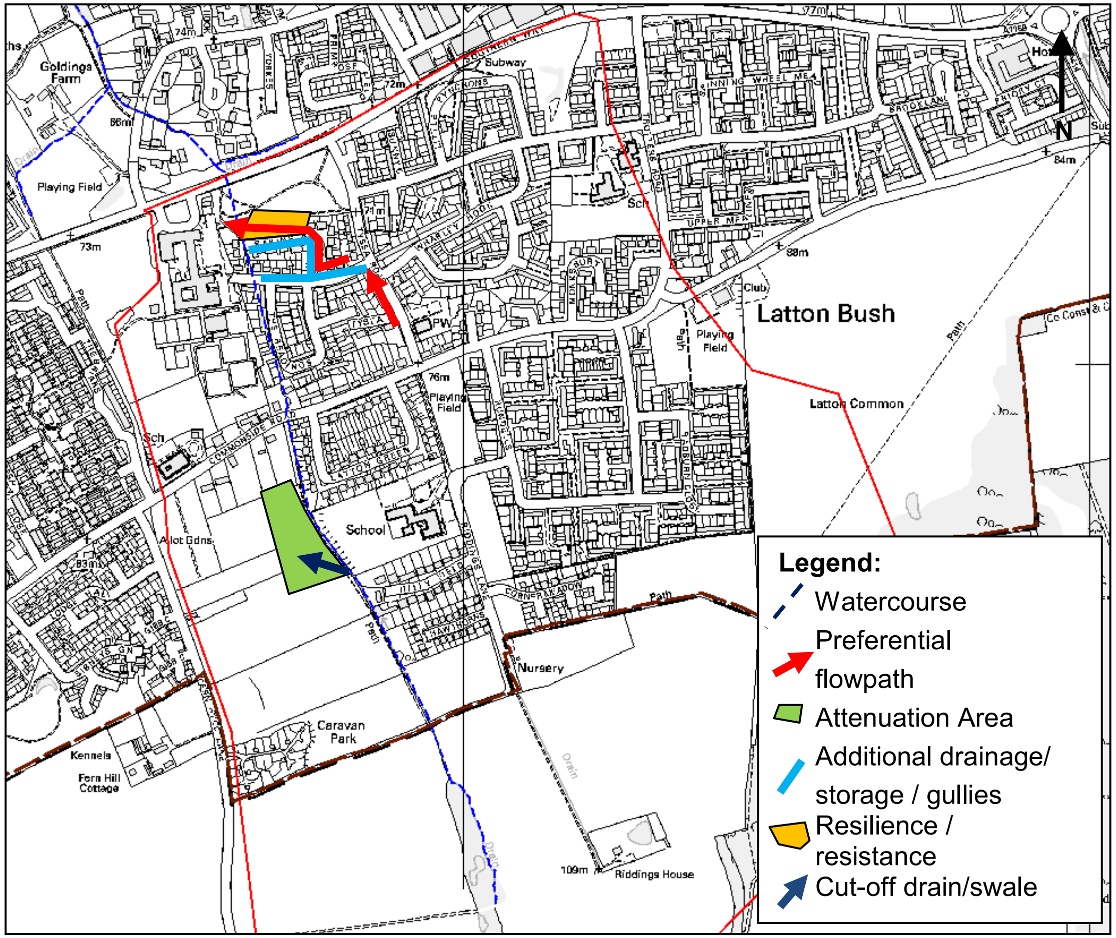


Figure 5-9 Preferred Options CDA 005- Latton Bush Area

CDA_006 – Brays Grove Area

Preferred Option:

- Formal cut-off drain / swale and temporary attenuation within Latton Common and Harlow Common to reduce volume of runoff entering urban area from upstream permeable/greenfield land;
- Formal attenuation area within land east of Perry Spring and Burley Hill / Oaktree Gardens to capture flows;
- Increase frequency of gullies along flowpath. Add storage area under footpath (within overland flowpath) east of Fullers Mead;
- Increase culvert size on eastern side of A414 (near Carters Mead/Campbell Close) to reduce risk of ponding;
- Modify ground levels within Nicholls Field to create a temporary attenuation basin so that flows from the enhanced culvert do not increase the risk to properties to the west;
- Include additional surface drainage within Brays Grove Community College to discharge runoff towards Nicholls Field to reduce the risk to the school;
- Create cut-off drain / swale along property boundaries fronting Nicholls Field to reduce flood risk to properties within Spencers Croft;
- Assess the benefit of including a culvert under Second Ave (A1025) to reduce risk of ponding within North Grove - some re-profiling of land to the north of the A1025 may be required to facilitate a flowpath into the existing drain which discharges into Todd Brook; and
- Flood resistance/resilience to properties with historic flooding within North Grove.

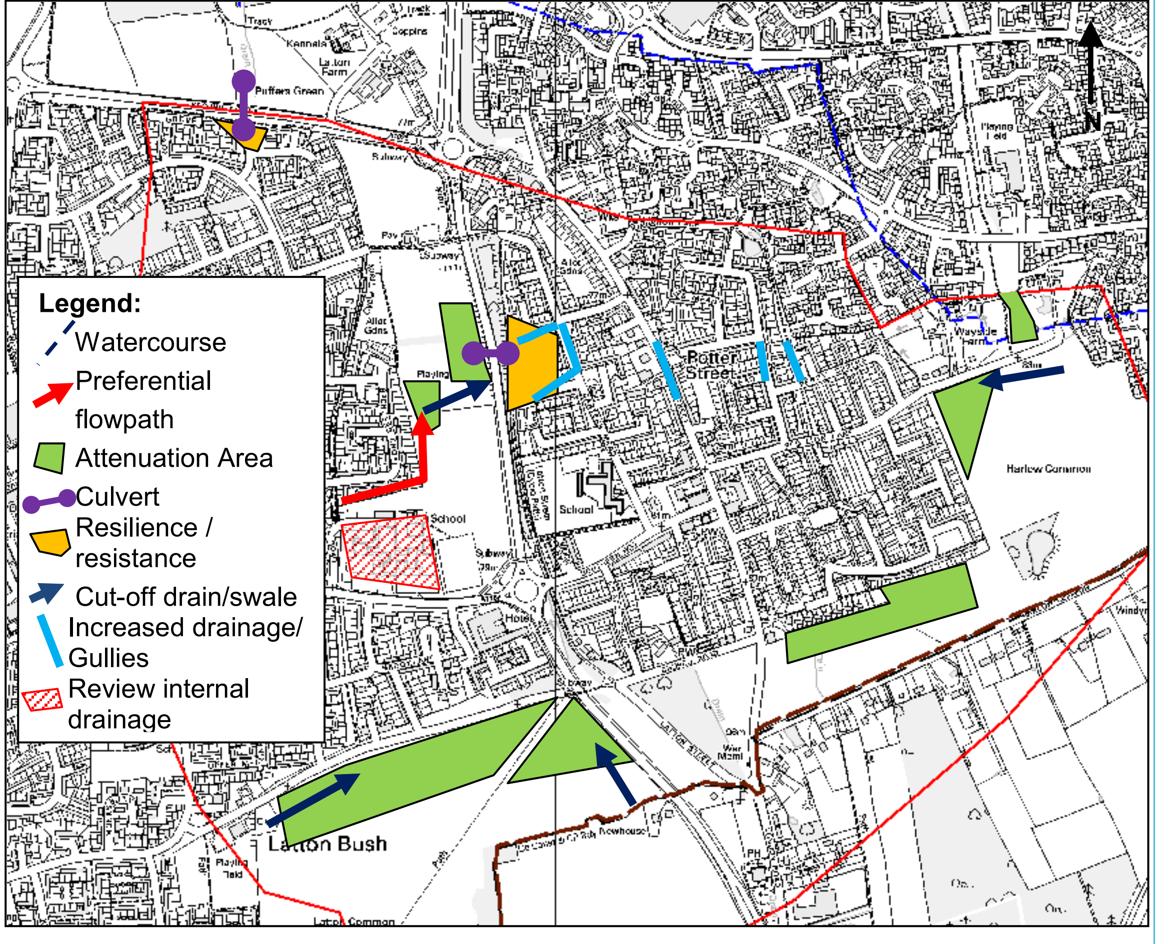


Figure 5-10 Preferred Options CDA 006 – Brays Grove Area

CDA_007 – Victoria Gate Area

Preferred Option:

- Create a shallow temporary attenuation area within open space north of Coalport Close;
- Establish a preferential flow route from the temporary attenuation area along the pedestrian footpath (the flowpath of the culverted watercourse);
- Determine ecological significance of vegetated land near the roundabout of Church Langley Way and Kiln Lane and determine if a vegetated attenuation basin could be located within this space;
- Investigate benefit of increasing gulley numbers and pipe capacity within Westbury Rise; and
- Once the benefits of these measures have been assessed the use of flood resistance/resilience should be incorporated within the properties that are still at risk along the flow path.

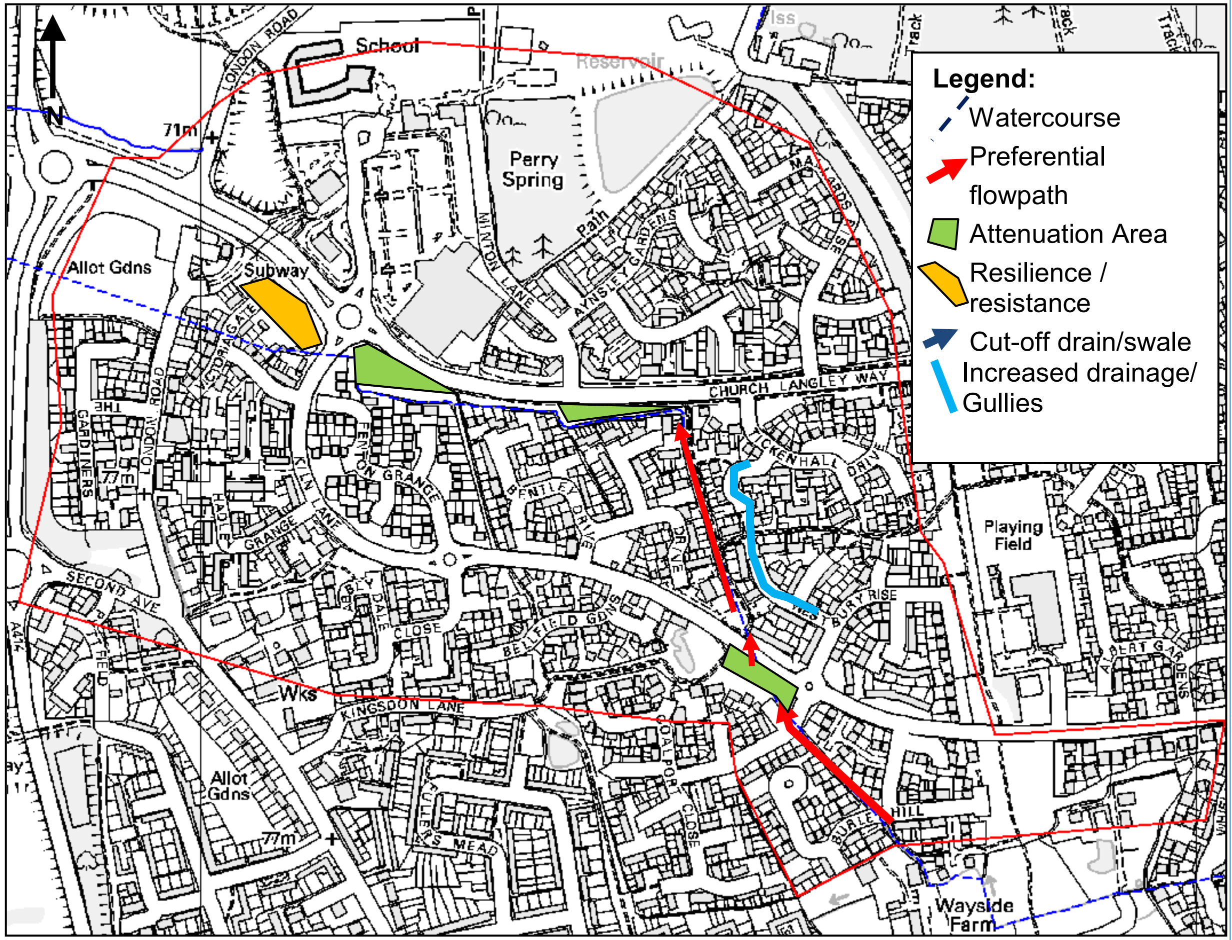


Figure 5-11 Preferred Options CDA 007 – Victoria Gate Area

CDA_008 – Little Parndon Area

Preferred Option:

- Review surface drainage within Princess Alexandra Hospital to determine the efficiency of the network and (if necessary) include flood resilience / resistance measures or highlight retrofitting options;
- Modify ground levels (e.g. lower by 0.2 – 0.3m) within the open space behind Little Parndon School to reduce the total volume of runoff entering the LFRZ during the peak of the storm;
- Preferential overland flow route (via raised kerbs etc.) down Ram Gorse to reduce risk of flooding to properties in this area;
- Create a culvert under Elizabeth Way (A1169) where ponding begins upstream of the CDA to reduce risk of ponding within Ash Tree Field and Cannons Gate – determine from model if increased flows will impact downstream area and if an additional formal flow path is required to the existing drain within the property;
- Preferential overland flow route via raised kerbs etc. down Ram Gorse to reduce risk of flooding to these properties; and
- Once the benefits of these measures have been assessed the use of flood resistance/resilience should be incorporated within the properties located within Ash Tree Field and Cannons Gate.

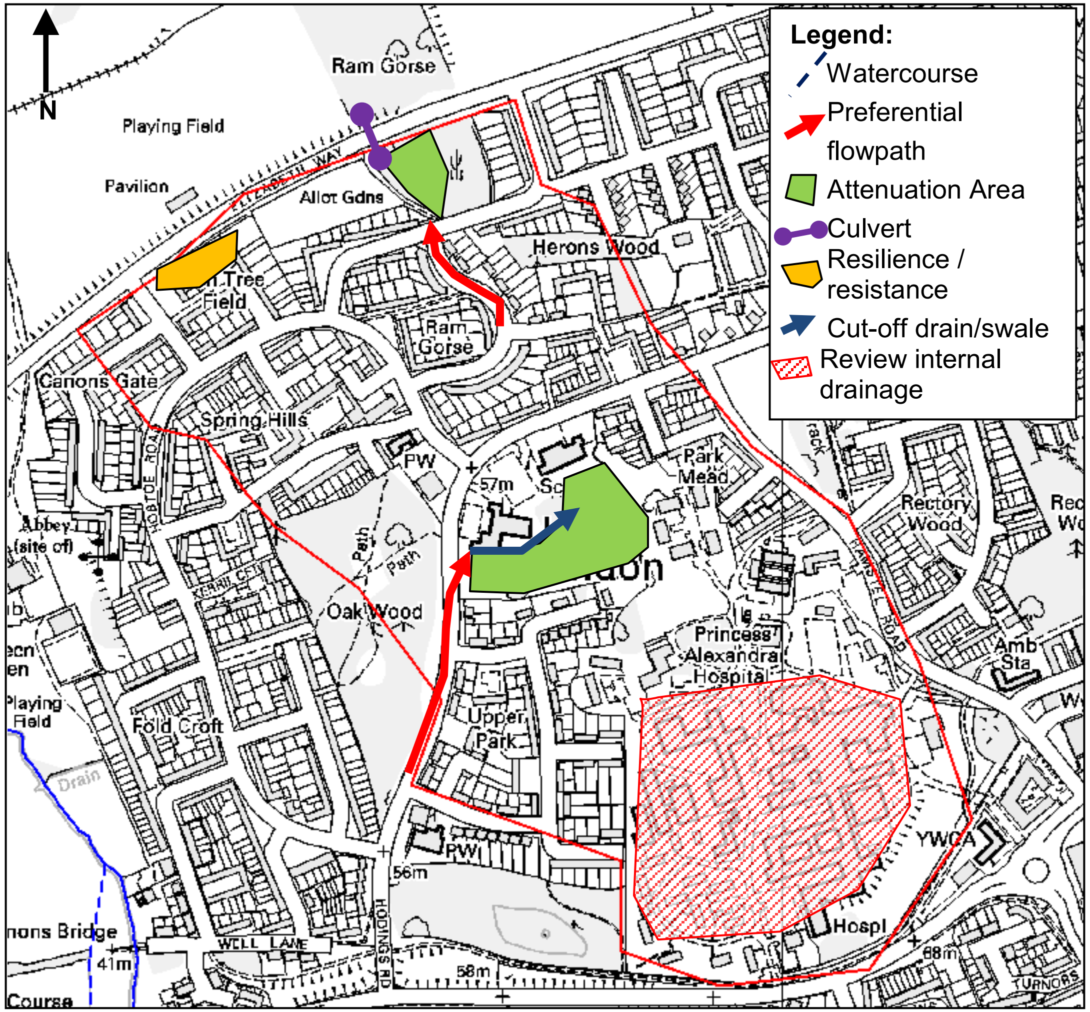


Figure 5-12 Preferred Options CDA 008- Little Parndon Area

CDA_009 – Rivermill Area

Preferred Option:

- Investigate increasing the pipe size (providing storage) under Burnt Mil, Rivermilll and The Hornbeams as the hydraulic model indicates that these are flowing at 100% capacity during the peak of the storm;
- Create a preferential flow path to reduce risk of flooding to properties within Rivermill;
- Review internal drainage infrastructure of industrial/commercial units to determine if any flood risk reduction measures have been incorporated in these areas;
- Incorporate flood resistance/resilience within the properties located within the overland flow path;
- Undertake and assessment to determine if flows can be diverted west to avoid flooding of the rail line – e.g. possible road level changes on Elizabeth Way; and
- Review emergency procedures and contingency measures with Network Rail to determine impacts during an extreme storm event.

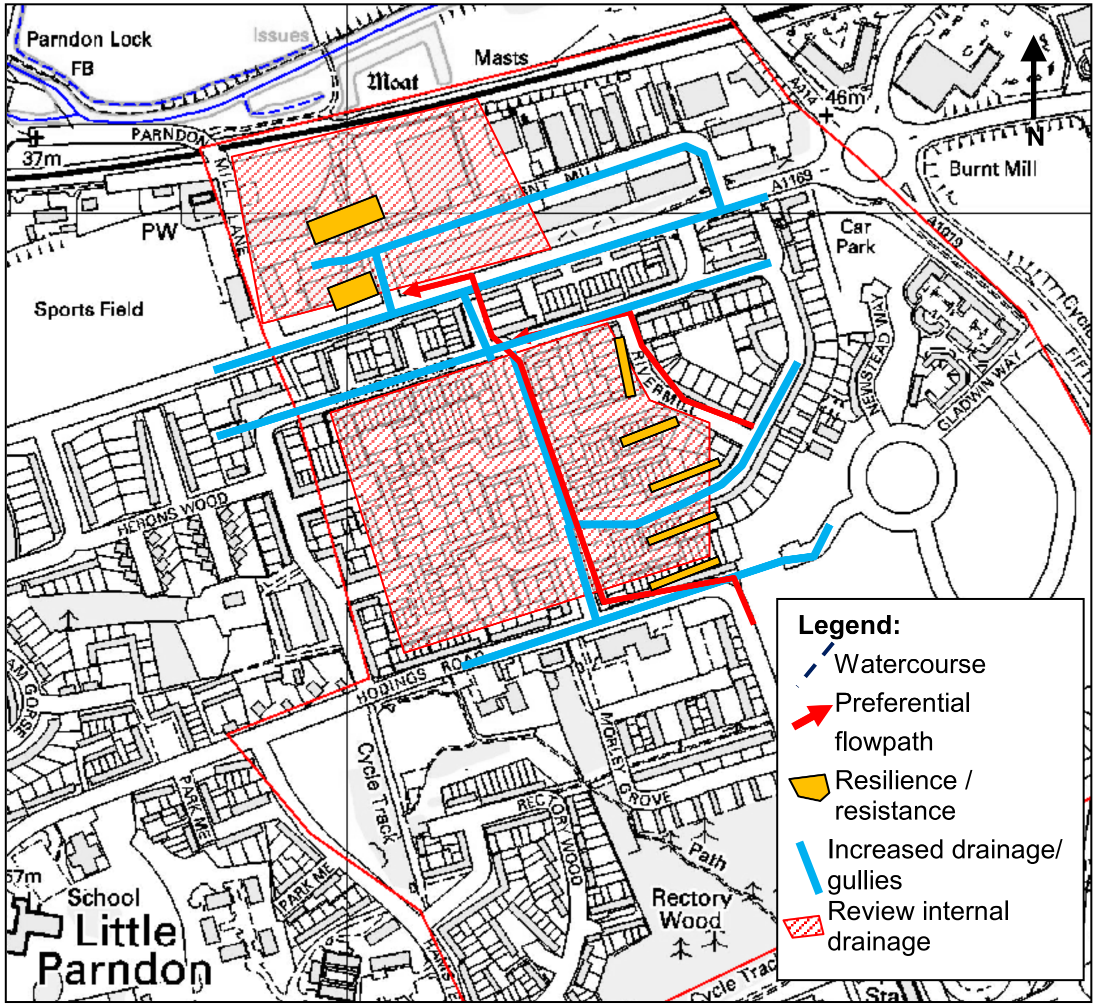


Figure 5-13 Preferred Options CDA 009- Rivermill Area

CDA_010 – Netteswell Area

Preferred Option:

- Preferential overland flow route via raised kerbs or swale etc. along the pedestrian pathway between Whitewaits and St Michael's Close – investigate amending open space ground levels within the Broadfields County Primary School to divert flows from the preferential route in times of flood;
- Create an additional point of discharge for ponding near Green Park (the current model indicates the pipe network is flowing at capacity during the peak of the storm); and
- Once the benefits of these measures have been assessed, the use of flood resistance/resilience should be incorporated within the properties located within the areas still identified to be at risk of surface water flooding.

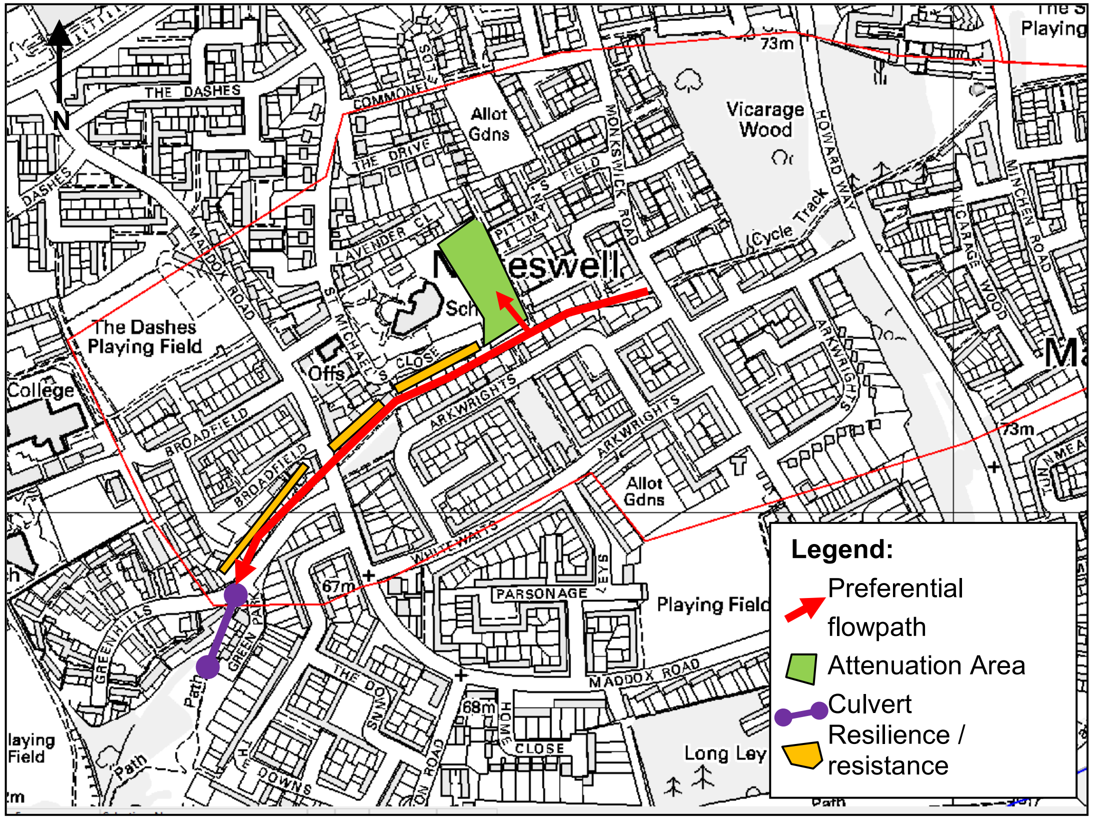


Figure 5-14 Preferred Options CDA 010 – Netteswell Area

CDA_011 – Altham Grove Area

Preferred Option:

- Create an additional point of discharge for ponding near the LFRZ as the current model indicates the pipe network is flowing at full capacity during the peak of the storm;
- Once the benefits of this measures has been assessed the use of flood resistance/resilience should be incorporated within the properties located within the areas still identified to be at risk of surface water flooding; and
- Investigate including additional gulley inlets and increasing the drainage network capacity in the local area.

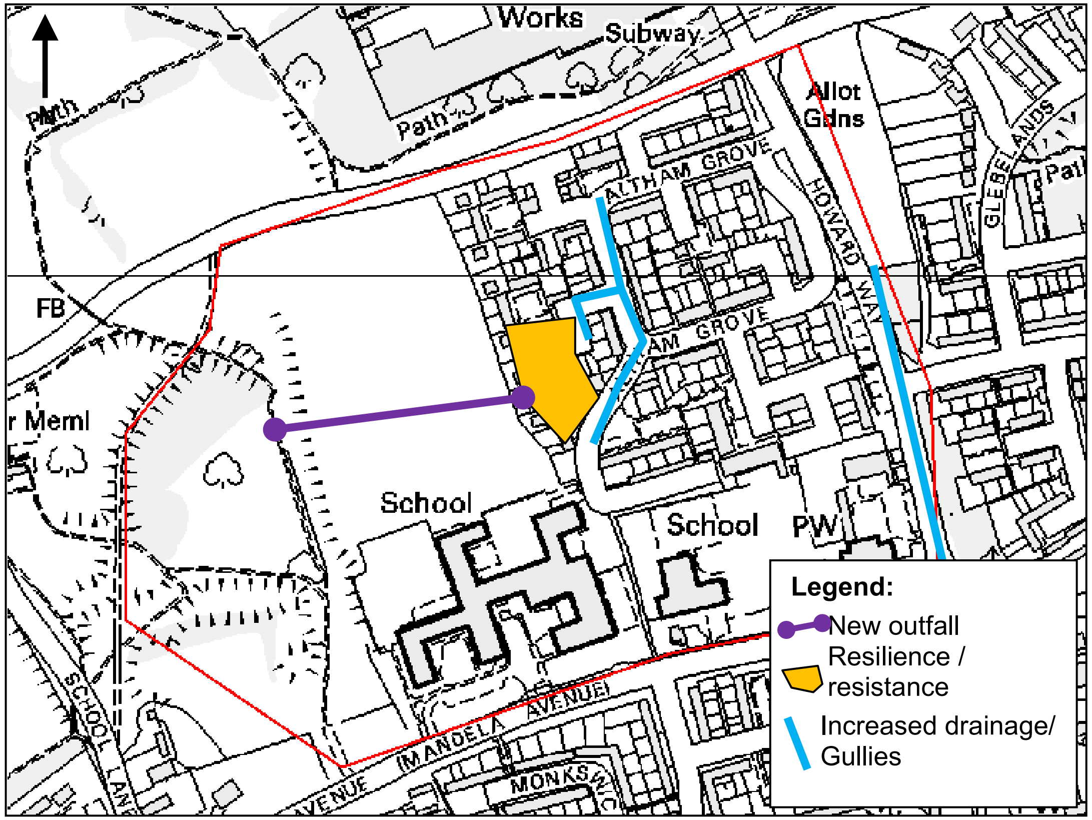


Figure 5-15 Preferred Options CDA 011 - Altham Grove Area

CDA_012 – Temple Fields Area

Preferred Option:

- Modify ground levels within Mark Hall Park (potentially south of Mowbray Road) to create a temporary attenuation basin to reduce the total volume of runoff entering the downstream drainage network during the peak of a storm event;
- Create a cut-off drain / swale along Tany's Dell Community Primary School to reduce surface water runoff entering the school (alternatively flood resilience / resistance measures could be used if the upstream attenuation measure in Mark Hall Park is determined to offer a minor benefit in reducing flood risk.
- Determine the feasibility of including an additional attenuation measure between Tany's Dell Community Primary School and Netteswell Road with a flow diversion measure (e.g. raised footpath and fencing);
- Create a preferential flow path down Central Road (via raised kerbs) to reduce the risk of ponding within the buildings located within the South Place Central Road area;
- Determine if an additional discharge point between the gas holding facility (with a one way flap valve) can be provided between the gas facility and the drain to the north of the rail line;
- Review internal drainage infrastructure of industrial/commercial units to determine if any flood risk reduction measures have been incorporated in these area and may reduce the overall risk within the LFRZ and CDA; and
- Once the benefits and feasibility of these measures have been assessed, the use of flood resistance/resilience should be incorporated within the any building/infrastructure that is still at risk.

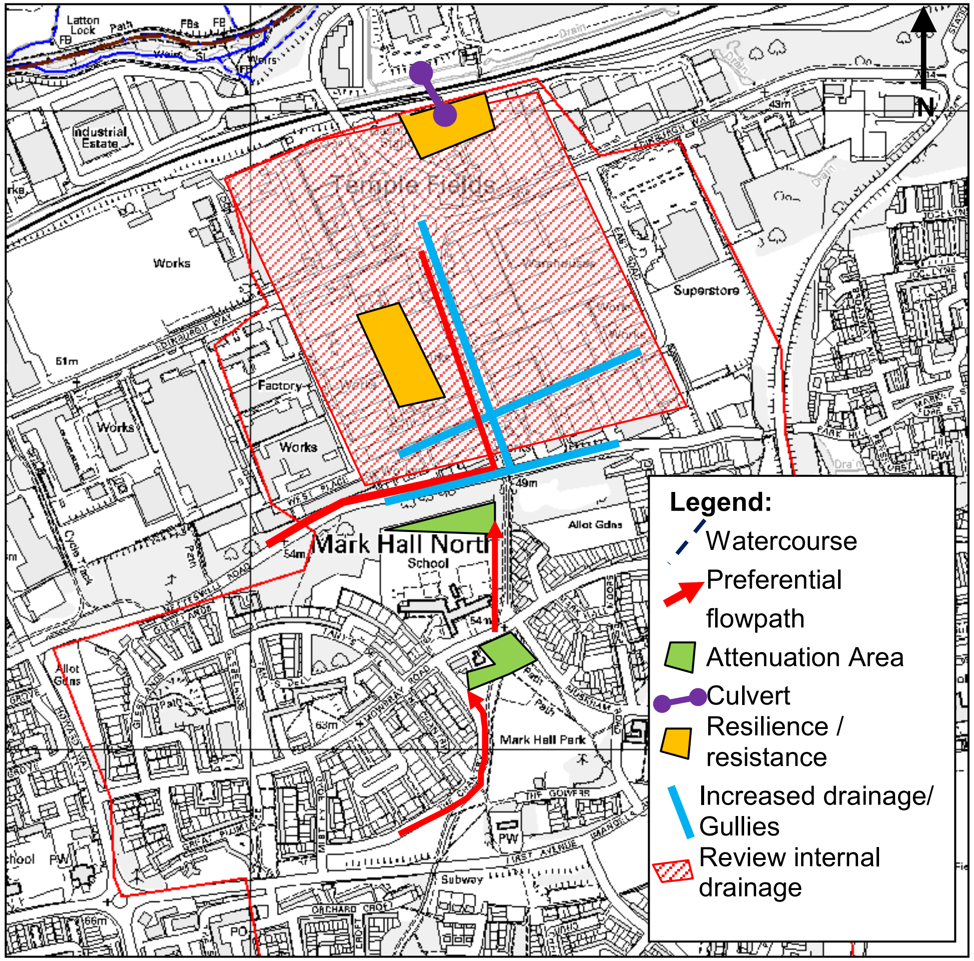


Figure 5-16 Preferred Options CDA 012 – Temple Fields Area

CDA_013 – Old Harlow Area

Preferred Option:

- Determine if a culvert under the A414 to allow overland flow to discharge into the existing watercourse on the northern side of the road and if this will assist in reducing the risk within the CDA or increase the risk tot others;
- Determine if any minor works can be undertaken in the woodland located between Long Acre and the A414 to formalise this area as an attenuation basin – A site inspection indicated that this could be the purpose of the area;
- Investigate including additional gulley inlets and increasing the drainage network capacity in the LFRZ area; and
- Once the benefits and feasibility of these measures have been assessed, the use of flood resistance/resilience should be incorporated within the any building/infrastructure that is still at risk.

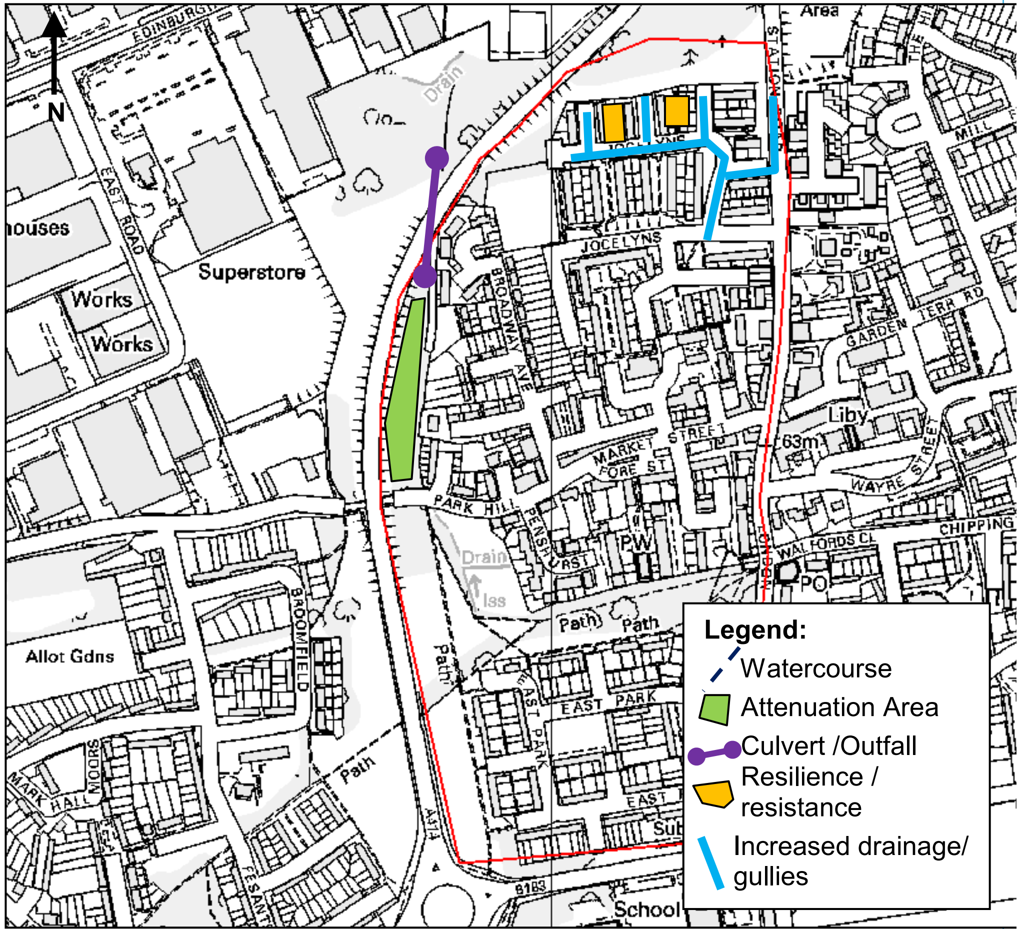


Figure 5-17 Preferred Options CDA 013 – Old Harlow Area

5.7.4 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); and
    - Conceptual sizing and locating of proposed measures / options based on updated data and constraints.
- Initial consultation:
    - Discussions with residents to confirm flooding history;
    - internal discussions HDC and ECC teams; and
    - Discussions with EA and Thames 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 District 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 HDC implement policies which will reduce the risk from surface water flooding throughout the whole District, 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 (please note that these policies will require that the appropriate on-going maintenance responsibilities are understood by the responsible party):

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 50% of the existing site conditions. If this results in a discharge rate lower than the Greenfield conditions it is recommended that the Greenfield rates (calculated in accordance with IoH124[4]) are used.*

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).

[4] 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)

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:

- 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 HDC (and ECC) to undertake internal consultation with their and spatial planning and development compliance staff to determine how this type of policy could be implemented.

7 Preferred Options

Following consultation with the SWMP steering group and relevant stakeholders, a number of preferred options have been identified for Harlow. 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 HDC 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 Harlow 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 predicted to be 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 during this period.

Improve drainage network capacity: A key recommendation of this study is to look at improving the drainage network capacity across the District, 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 Thames Water to assess the possibility of upgrading the network capacity in these key areas, which could reduce the risk of surface water flooding (locally).

Improve community resilience: It is recommended that a general approach to improving community resilience is adopted across the study area, particularly in areas that are predicted to be 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.

Improve flood warning systems: Installation of rainfall monitoring systems in key areas, in and around the study area, will provide an evidence base for setting 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

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 rainwater harvesting on all new development within the existing urban areas, and in addition, retrofitting these to existing properties where possible (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 catchment would provide a stronger understanding of rainfall patterns and flows that lead to surface water flooding. 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 Harlow.

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 Harlow 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 study area 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+, Facebook, MySpace 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.

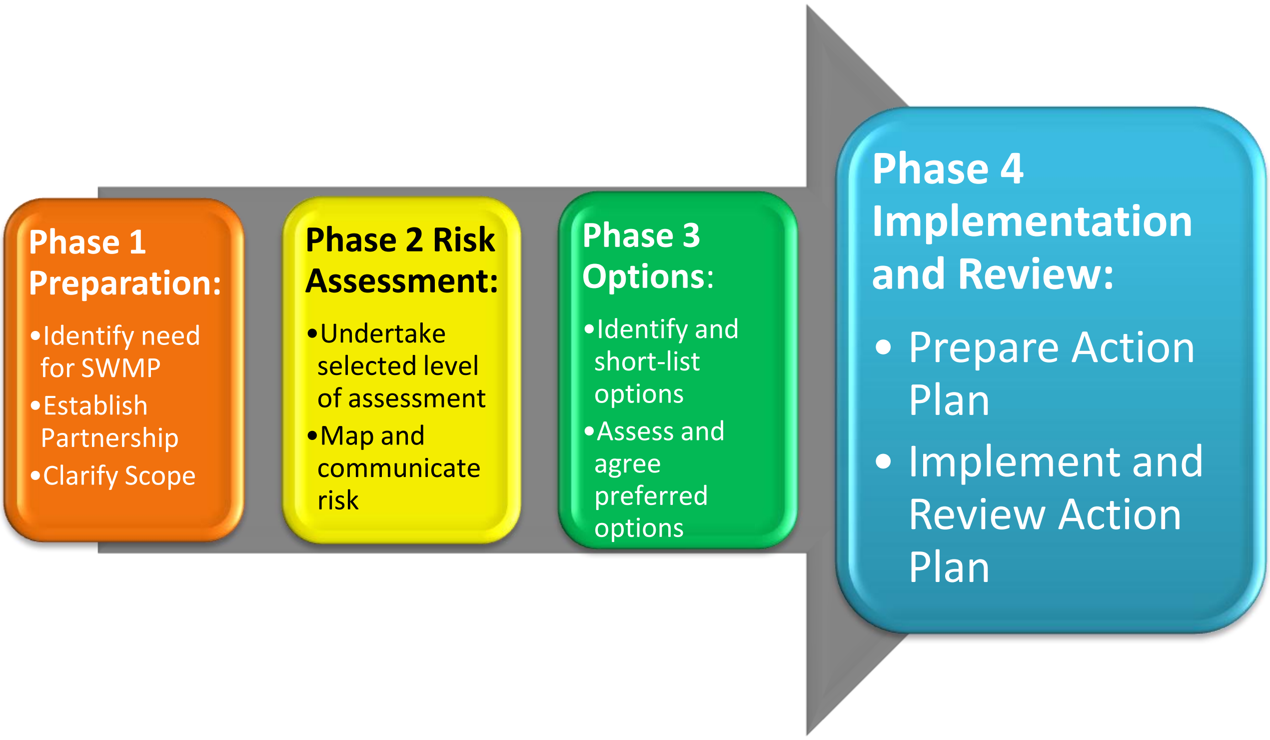
7.2 Short – Medium Term Recommendations

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

- In consultation with Thames 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 Thames Water indicated that no surface water network model was available for the study area. Discussions between HDC, ECC and Thames Water should be held to determine if any element of the TUFLOW model can be provided to Thames Water so that a formal drainage model can be created for Harlow;
- Undertake a feasibility study for providing source control and flow path management measures in relevant open space areas within Harlow;
- 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 Network Rail assets and agree a timeframe for the detailed assessment of areas of concern;
- 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 District wide feasibility study to determine which roads may be retrofitted to include bioretention capark pods;
- 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 study 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; and
    - link to websites/information sources providing further information;
    - An update on work being undertaken in Harlow 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.
- ECC to produce 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; and
- 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 Harlow 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 Harlow. 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) – the draft LFRMS can be located on the ECC website. ECC and HDC 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 Essex County Council (the LLFA) and the District, as actions are progressed and investigated.

New actions may be identified by the LLFA and the District, 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/District services and external partner organisations;
- *Policy actions* to assist ECC and the District 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 and rail risk assessment* actions to understand and the highlight risk to network rail assets and pedestrian underpasses.

9 Implementation and Review

9.1 Overview

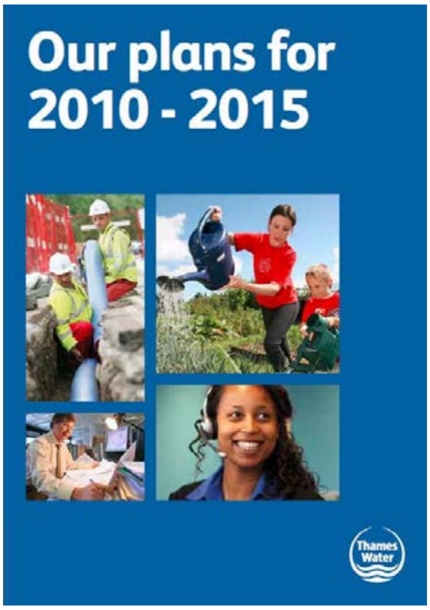
Following the completion of the SWMP, the actions detailed in the Action Plan will need to be implemented. This will require continued work within the Council and the steering group to ensure all partners are involved in the implementation and ongoing maintenance and performance measures.

Essex County Council 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, Essex Highways, planning policy and the countryside section. Key external partners include HDC development and regeneration services, environmental health, emergency planning and leisure and public spaces; Thames 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 Thames 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. Thames 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 Thames Water's investment and funding schedule for drainage improvements and maintenance programmes across Harlow. 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.

Thames 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). Thames Water's Business Plan outlines future investment strategy within the water company. 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 the District.

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.

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 Harlow, 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 may 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 could 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 could 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, could 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 contributes significant amounts of surface water to a Local Flood Risk Zone, the SFRA should identify this and suggest that the application of sustainable drainage measures are included and that the exclusion of SuDS is justified with supporting evidence.

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 Harlow. 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 could inform the consideration of how proposed new development(s) 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 Harlow and Essex Policy Area these should be examined for:

- Local Flood Risk Zones that affect the area;
- Groundwater Flooding Susceptibility; 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 influence the location, uses, design and resilience of the proposals. Therefore, a Flood Risk Assessment could 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 (all forms), 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 and/or CDA, 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 Authority 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 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 Harlow. 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 the study areas 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. This should be undertaken for all areas within Harlow. 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; and

- Opportunities for joint funding on improvement work within Harlow 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 area with minimal impacts to 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 the District.

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, HDC 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; and
- 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 HDC and the residents of the catchment, that the SWMP Action Plan remains current and up-to-date. To help facilitate this, the HDC 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 could 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, HDC 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

Limitations

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CAPITA SYMONDS
Flood Risk Management

MASTER ACTION PLAN - CONFIDENTIAL

Group	ID	Action: What?	Action: How?	Action: Where?	Priority Ranking	Cost: Investigation / Feasibility	Cost: Capital	Cost: Other	Benefit	Potential Funding Source	Timing: Timeframe	Timing: Start Date	Timing: Approx. Duration	Action Type	Comments	Responsibility: Lead Organisation	Responsibility: LLFA Dept.	Responsibility: Primary Support	Other Stakeholders	EU Related?	Review: Frequency	Review: Next Review Date	Location: CDA ID	Location: Policy Area ID	Linkages: Related Action IDs?	Linkages: Related Partners' Action IDs?
Local Actions - General Flood Risk Management	1	Take forward actions set out in the SWMP with partners and other flood risk management authorities (if any)	Continue to run a Flood Management Group within the Council and liaise with HDC and others as necessary	District Wide	High	-	-	-	Co-ordinated delivery of local flood risk management across the catchment	ECC, partners, HDC, others	Ongoing	2013	Long	FMA		ECC and HDC	FWM Team	Steering Group, partners, HDC, others	Environment Agency, Thames Water, Network Rail	No	Annually	2014	N/A	N/A	N/A	N/A
	2	Seek opportunities to integrate fluvial and surface water flood risk reduction measures	Review and monitoring of policy implementation and in partnership with EA	District Wide	High	-	-	-	Mid-long term reduction in flood risk and improvement in water quality	Private developer	Ongoing	2013	LDF Plan Period	Policy		ECC and HDC	FWM Team	All other LLFA Departments and HDC Departments		No	Annually	2014	N/A	N/A	N/A	N/A
	3	Look for opportunities to reduce flood risk to critical transport infrastructure whilst upgrading the existing drainage network in partnership with Thames Water, Highways Authority and Network Rail	Discussion with relevant officers of ECC & HDC	District Wide	High	-	-	-	Refine understanding of risk to critical infrastructure. Prioritise localised drainage improvements	Highways Agency, TW and Network Rail	Medium	2013	1-2 years	I / F / D, FMA		ECC	Highways	Highways Agency and Thames Water	Thames Water, Network Rail,	No	Annually	2014	N/A	N/A	N/A	N/A
	4	Ensure current emergency response to catchment-wide surface water flooding is appropriate	Liaise with Emergency Planning forum	District Wide	High	-	-	-	Emergency response based on best available information	ECC and HDC	Short	2013	1 year	I / F / D		ECC and HDC	Resilience Team	Local Resilience Forum	Network Rail	No	N/A	N/A	N/A	N/A	N/A	N/A
	5	Determine extent of i) residential use of at-risk basements [if any], ii) groundwater boreholes and iii) geological conditions, and decide if a risk from flooding exists.	No basements are identified in the EA NRD however this should be confirmed with local knowledge. If basements are identified then use predicted extent of 75year flood to enable determination.	District Wide	High	-	-	-	Better understanding of scope of flooding impact, and improving identification of solutions and funding	ECC and HDC	Medium	2013	1 year	I / F / D		ECC and HDC	FWM Team	Development Control	Local Residents, ECC	No	Annually	2014	N/A	N/A	20	N/A
	6	Consider retrofitting flood resilience and resistance measures to areas at risk of flooding in local topographic low points and basement properties where there is a history (and likely future risk) of groundwater ingress	No basements are identified in the EA NRD however this should be confirmed with local knowledge. If identified then impermeable membranes, additional drainage should be investigated. Determine risk of flooding in areas at topographic low points (i.e. does a pumping scheme assist in reducing risk)	District Wide	Medium	-	-	-	Reduction in the impact of flooding	Property Level Flood Protection (Defra), FDGiA	Long	2013	10 years	FMA		ECC and HDC	FWM Team	Building Control	Local Residents, ECC	No	Annually	2014	N/A	N/A	20	N/A
	7	Determine whether services (e.g. power, telecommunications) are resilient to surface water flooding	Discuss the overall resilience of services with relevant companies	District Wide	Medium	-	-	-	Community resilience to flooding	Service providers	Medium	2013	3 year	CP, FR		ECC and HDC	FWM Team	Essex Resilience Forum		No	Annually	2014	N/A	N/A	N/A	N/A
	8	Installation of additional road gullies or alternative drainage systems to reduce standing water depth and duration	As part of highways improvement programme include additional construction task of installing additional gullies or alternative drainage systems where feasible and required. Consultation with Thames Water may be required.	In relevant CDAs across the catchment	Medium	-	-	-	Reduction in the probability of flooding	ECC/HDC/Developer contributions / other?	Medium	2013	Ongoing	FMA		ECC	FWM Team	Thames Water and ECC Highways	HDC	No	Annually	2014	N/A	N/A	N/A	N/A
	9	Determine areas within the catchment which are appropriate for retrofitting bioretention basins and carparking pods	Desktop study to determine feasibility of incorporating these SUDs	District Wide	Medium	-	-	-	Will assist in reducing runoff volumes and improving quality of water discharging to watercourses	Developer contributions / other?	Medium	2013	1-2 years	I / F / D		ECC	FWM Team		Environment Agency	No	Annually	2014	N/A	N/A	N/A	N/A
Policy	10	Developments across the catchment to include at least one 'at source' SUDS measure, resulting in a net improvement in water quantity or quality discharging to sewer	Development Control Review and Monitoring of policy implementation	District Wide	High	-	-	-	Mid-long term reduction in flood risk and improvement in water quality	Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Planning Strategy		Environment Agency, ECC	No	Annually	214	N/A	N/A	Nov-14	N/A
	11	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	Development Control Review and Monitoring of policy implementation	District Wide	High	-	-	-	Mid-long term reduction in the probability of flooding	Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Planning Strategy	Environment Agency?	Environment Agency, ECC	No	Annually	2014	N/A	N/A	10, 13 & 14	N/A
	12	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 50% of the existing site conditions. If this results in a discharge rate lower than the Greenfield conditions it is recommended that the Greenfield rates (calculated in accordance with IoH124) are used.	Development Control Review and Monitoring of policy implementation	District Wide	High	-	-	-	Mid-long term reduction in the probability of flooding	Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Planning Strategy	Environment Agency?	Environment Agency, ECC	No	Annually	2014	N/A	N/A	10-Dec	N/A
	13	Developments located in Critical Drainage Areas (CDAs) and for redevelopments of more than one property or area greater than 0.1 hectare require a betterment to Greenfield runoff rates (calculated in accordance with IoH124). It is recommended that a SUDS treatment train is utilised to assist in this reduction.	Development Control Review and Monitoring of policy implementation	District Wide	High	-	-	-	Mid-long term reduction in the probability of flooding	Borough and Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Planning Strategy	Environment Agency	Environment Agency, ECC	No	Annually	2014	N/A	N/A	Oct-13	N/A
	14	Implement Policy relating to Best management practises in relation to Water Quality and a reduction in pollutant loads (investigate using the water quality computer software [MUSIC or similar])	Development Control Review and Monitoring of policy implementation	District Wide	High	-	-	-	Mid-long term reduction in the probability of flooding	Borough and Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Development Control	Environment Agency	Environment Agency, ECC	No	Annually	2014	N/A	N/A	N/A	N/A
Maintenance	15	Ensure drainage systems are operating at capacity - maintenance of gullies	Review existing gully clearance/ maintenance schedules and if necessary revise/prioritise CDAs	District Wide	High	-	-	-	Flooding isn't exacerbated	ECC and HDC	Ongoing	2013	Long	FMA		ECC and HDC	Highways	Street Cleansing	Thames Water	No	Quarterly	2014	N/A	N/A	N/A	N/A
		Gully Cleaning - Improving 'Visibility'	Clearly identify gullies prone to flooding (possibly painted yellow)	Borough Wide / CDA Specific	Medium			£25k+	Improved maintenance regimes. May promote residents and ground sweeping teams to maintain them	ECC and HDC	Medium		1 year	FMA		HDC	*Operations*	Transport and Highways	ECC	No			All CDAs			
	37	Gully Cleaning - Enforcement Powers	Encourage gully cleansing contractors to use powers to enforce movement of parked cars to ensure all gullies are regularly	Borough Wide / CDA Specific	Medium			<£25k	Improved maintenance regimes	ECC and HDC	Medium		1 year	FMA		HDC	*Operations*	Transport and Highways	ECC	No			All CDAs			
	38	Gully Cleaning - Timing of Cleansing Rounds	Coordinate timing of gully cleansing rounds to ensure that they do not coincide with school opening and closing times and other	Borough Wide / CDA Specific	High			<£25k	Improved maintenance regimes	ECC and HDC	Short		3 months	FMA		HDC	*Operations*	Transport and Highways	ECC	No			All CDAs			
	39	Clear Blocked Gullies	Focus attention on the maintenance of gully pots in the identified Critical Drainage Areas (CDAs) which are considered to be high risk	Borough Wide	High		Unknown		Reduction in the probability of flooding	ECC and HDC	Short		1 year	FMA		HDC	*Operations*	Transport and Highways	ECC	No			All CDAs			
	16	Ensure drainage systems are operating at capacity - maintenance of Thames Water sewers. Thames Water to recommend SWMP findings to PPM programme, if flooding identified as drainage serviceability issue.	May require mapping of existing drainage infrastructure. Review existing maintenance schedules and if necessary revise/prioritise CDAs	District Wide	High	-	-	-	Flooding isn't exacerbated	Thames Water	Ongoing	2013	Long	FMA		Thames Water	FWM Team	ECC Highways and HDC	Thames Water	No	Quarterly	2014	N/A	N/A	N/A	N/A
	17	Maintain ditches and balancing ponds on Borough owned land and enforce maintenance of land drainage by riparian owners;	Review existing maintenance schedules and if necessary revise/prioritise area of historic blockage (may require public consultation)	District Wide	High				Flooding isn't exacerbated	HDC	Ongoing	2013	Long	FMA		HDC	FWM Team	HDC	Thames Water Environment Agency,	No	Quarterly	2014	N/A	N/A	N/A	N/A
	18	Review all natural assets to ensure the environmental integrity of the area(s) are not compromised by surface water runoff and any changes from development or flow regime	Undertake monitoring of areas(water quality, debris, flora/ fauna, etc)	District Wide	High				Maintain environmental benefits	ECC and HDC	Ongoing	2013	Long	FMA		HDC/ECC	FWM Team	Environment Agency,		Yes	Quarterly	2014	N/A	N/A	N/A	N/A

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Group	ID	Action			Priority Ranking	Cost			Benefit	Potential Funding Source	Timing			Action Type	Comments	Responsibility			Other Stakeholders	EU Related?	Review		Location		Linkages	
		What?	How?	Where?		Investigation / Feasibility	Capital	Other			Timeframe	Start Date	Approx. Duration			Lead Organisation	LLFA Dept.	Primary Support			Frequency	Next Review Date	CDA ID	Policy Area ID	Related Action IDs?	Related Partners' Action IDs?
Local Actions - General CDA/LFRZ	19	Proposed developments in urban areas at risk of flooding in Critical Drainage Areas (CDAs) and /or Local Flood Risk Zones (LFRZs) to contribute to measures to reduce surface water flood risk in the CDA.	Section 106, Community Infrastructure Levy, Development Control Policy	District Wide	High	-	-	-	Mid-long term reduction in the probability of flooding	Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Development Control	Building Control	Environment Agency, ECC	No	Annually	2014	N/A	N/A	N/A	N/A
	20	Seek to include SUDS retrofitting policies in Planning reform to enhance or replace conventional drainage systems in CDAs/LFRZs, or elsewhere as opportunities arise	Review and monitoring of policy implementation	District Wide	Low	-	-	-	Mid-long term reduction in flood risk and improvement in water quality	Private developer	Medium	2013	LDF Plan Period	Policy		ECC and HDC	Planning Strategy	Building Control		No	Annually	2014	N/A	N/A	N/A	N/A
	21	Use SWMP mapped outputs to require developers In areas at risk of flooding to demonstrate compliance with NPPF to ensure development will remain safe and will not increase risk to others, where necessary supported by more detailed integrated hydraulic modelling.	Development Control Policy	District Wide	High	-	-	-	Mid-long term reduction in the consequences of flooding	Private developer	Ongoing	2013	LDF Plan Period	Policy		ECC/HDC	Planning Strategy	Building Control		No	Annually	2014	N/A	N/A	N/A	N/A
	22	Ensure any development falling within a Strategic Growth Area (or rural/open space plots) are designed to limit runoff to low predevelopment Greenfield runoff rates.	Development Control Policy	All Strategic Growth Areas	High	-	-	-	Long term reduction in flood risk in the GA	Private developer	Ongoing	2013	LDF Plan Period	Policy		HDC	Planning Strategy		Environment Agency, ECC	No	Annually	2014	N/A	N/A	N/A	N/A
	23	Investigate (confirm) whether flooding incidents have occurred in CDAs/LFRZs and other areas identified as being at risk of flooding	Review flooding reports, then conduct survey of local residents (e.g. mail drop, door knocking) to update database	District Wide	High	-	-	-	Validate model outputs, resident 'buy in'	ECC and HDC	Short	2013	1 year	I / F / D		HDC	FWM Team	Local Resilience Forum	Local Residents ECC	No	N/A	N/A	N/A	N/A	N/A	N/A
	24	Monitor flood risk related problems and manage future development to minimise impact on flood risk	Development control policy and monitoring of flood risk incident register	Areas with ponding >0.3m	Low / Medium	-	-	-	Proactive management of potential flood risk in areas of higher risk probability	ECC and HDC	Ongoing	2013	Ongoing	FMA		HDC	FWM Team	ECC Highways	ECC	No	Annually	2014	N/A	N/A	N/A	N/A
	25	Carry out more detailed studies including further investigation of the technical issues and consultation with local stakeholders	Site investigations and modelling	Areas with ponding >0.3m	High	-	-	-	Refine understanding in flood risk within the Borough	ECC and HDC	Short	2013	5 years	I / F / D		ECC	FWM Team	Highways and HDC	Environment Agency, Thames Water	No	N/A	N/A	N/A	N/A	29	N/A
	26	Work proactively to monitor the condition of ordinary watercourse and its culverts.	Assess condition of ordinary watercourses	District Wide	High	-	-	-	Understanding of culvert condition and associated potential collapse risk	EA / ECC/HDC	Ongoing	2013	Ongoing	FMA		ECC/HDC	FWM Team	EA	Local Residents	No	Monthly	2014	N/A	N/A	27	N/A
	27	Work proactively with the EA to monitor the condition of Main Rivers, culverts and Defences.	Share condition assessment information and jointly review other information as it becomes available	District Wide	High	-	-	-	Understanding of standard of defences	EA / ECC/HDC	Ongoing	2013	Ongoing	FMA		EA		ECC	Local Residents	No	Monthly	2014	N/A	N/A	26	N/A
	28	Engage Highways Agency to monitor any future flooding and assess the associated risk on all Major Roads	Maintain regular contact with relevant parties to share flood risk information	District Wide	High	-	-	-	Understanding of local flood risk and potential impacts	Highways Agency	Ongoing	2013	Ongoing	FMA		ECC	Highways	Highways Agency		No	Quarterly	2014	N/A	N/A	32	N/A
Local Actions - depth >0.5m	29	Undertake a detailed feasibility study to confirm significant level of flood risk predicted by SWMP study and use as justification for possible FDGiA funding	Engage consultant to complete detailed study and work with EA to investigate FDGiA opportunities	District Wide	High	£40k	TBC	TBC	Improved understanding of LFRZ flood mechanisms and potential funding opportunities for mitigation solutions	FDGiA / ECC / EA	Short	2013	4 months	FMA		ECC	FWM Team	EA and HDC	Thames Water, Local Residents	No	6months	Mid 2014	N/A	N/A	25	N/A
	30	Investigate large areas of deep (>0.5m) flooding. These 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.	Site investigations and modelling	Areas with ponding >0.5m	High	-	-	-	Refine understanding in LFRZs	ECC and HDC	Short	2013	5 years	I / F / D		ECC	FWM Team	HDC	Environment Agency, Thames Water	No	N/A	N/A	N/A	N/A	N/A	N/A
	31	Work with Thames Water to mitigate the water quality impacts related to sewer surcharges	Joint investigation of mitigation solutions that have multiple benefits	District Wide	High	£15k	TBC	TBC	Partnership working with others to achieve multiple benefits for local flood risk mitigation and river water quality improvement	ECC / EA / Thames Water / EU	Short	2013	4months	FMA		ECC	FWM Team	EA and HDC	Thames Water	No	Quarterly	2014	N/A	N/A	N/A	N/A
Road / Underpass Risk Assessment	32	Carry out a flood risk assessment for roads highlighted to flood during extreme events e.g. major roads (A Roads) and determine if any contingency plans are required	This should include ascertaining the standard of protection currently provided and, if necessary, carrying out further investigation/ modelling to improve the level of understanding. Establish need for more detailed analysis and/or higher standard of protection.	District Wide	Low	-	-	-	Refine understanding of flood risk on key routes	ECC/HDC	Medium	2013	6 months	I / F / D		ECC/HDC	N/A	Highways Agency		No	Annually	2014	N/A	N/A	N/A	N/A
	33	Carry out a flood risk assessment for pedestrian underpasses and provide signage for those at risk of flooding.	Review of topography and model results to determine risk to users	District Wide	Low	-	-	-	Refine understanding of flood risk in pedestrian underpass	ECC/HDC	Medium	2013	6 months	I / F / D		ECC/HDC	N/A	Highways Agency		No	Annually	2014	N/A	N/A	N/A	N/A
Rail Assessment	34	Carry out a flood risk assessment of the flood risk to the Network Rail infrastructure within Harlow to confirm risk	In collaboration with Network Rail and assessment of the existing procedures and flood risk infrastructure should be	Networkl Riail infrastructure	Medium / High	£10k			Refine understanding of flood risk to rail infrastructure	Network Rail	Medium	2013	6 months	I / F / D		Network Rail	Emergency Planning / drainage teams	HDC	Environment Agency and ECC	No	Annually	2014				

Appendix B – Risk Assessment: Modelling Details

Introduction

Capita Symonds constructed two hydraulic models to represent the study area using TUFLOW (**T**wo **D**imensional **U**nsteady **F**low) software (www.tuflow.com – an industry standard hydraulic modelling package for pluvial flooding).

The extent of the model is based upon both the catchment boundary and Harlow District council boundary. Figure 1 shows the extent of the study area model and Table 1 shows the naming convention applied during the modelling process.

The model naming convention applied during the modelling process (eg. 200 year rainfall event for 3 hours duration), and the abbreviations used are detailed below.

HAR_BSC02_200R_03HR_016

HAR – Harlow
BSC02 – Baseline Detailed Integrated Urban Drainage Model
xxxR – Rainfall Event Probability
xxHR – Duration Event
0xx – Version number

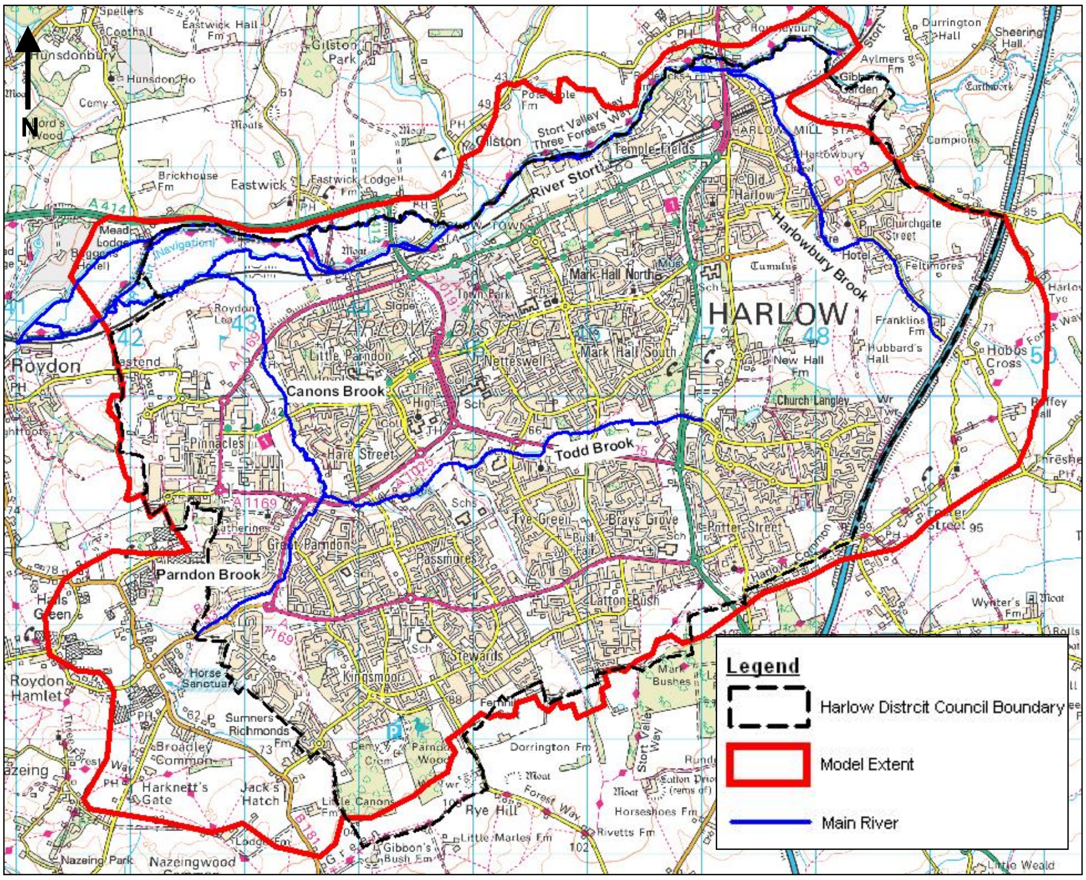

Figure 1: Model Coverage

Software Version

The model has been run using TUFLOW build 2012-05-AA-iDP-w64 software. The model has been run on the 64bit version of this build to take advantage of the faster simulation times and more advanced handling of larger models.

Direct Rainfall Methodology

The purpose of this modelling task is to analyse the impact of significant rainfall events across the study area by assessing flow paths, velocities and catchment response. This method essentially consists of building a virtual representation of the ground topography, then applying water to the surface and using a computational algorithm to determine the direction, depth and velocity of the resulting flows. Further explanation of this industry standard method is available in the Defra SWMP Guidance – Annexes C and D.

Key Assumptions

This method incorporates conservative allowances for the infiltration. The following key assumptions were made to generate the model input:
Initial Loss – None
Infiltration Loss – None
No aerial reduction factor applied
'Summer' rainfall profile was used

Runoff Coefficients and Continuous Losses

Runoff Coefficients and continuous losses have been applied to the rainfall profiles as per the table below.

Table 2: Runoff Coefficients and Losses

Feature Code	Descriptive Group	Comment	Runoff Coefficients	Drainage - Continuous Loss (mm/hr)
10021	Building		0.9	6.5
10053	General Surface	Residential yards	0.5	6.5
10054	General Surface	Step	0.8	6.5
10056	General Surface	Grass, parkland	0.35	0
10062	Building	Glasshouse	0.95	6.5
10076	Land; Heritage And Antiquities		0.85	6.5
10089	Water	Inland	1	0
10111	Natural Environment (Coniferous/NonConiferous Trees)	Heavy woodland and forest	0.2	0
10119	Roads Tracks And Paths	Manmade	0.85	6.5
10123	Roads Tracks And Paths	Tarmac or dirt tracks	0.75	6.5
10167	Rail		0.35	6.5
10172	Roads Tracks And Paths	Tarmac	0.85	6.5
10183	Roads Tracks And Paths (roadside)	Pavement	0.85	6.5

Feature Code	Descriptive Group	Comment	Runoff Coefficients	Drainage - Continuous Loss (mm/hr)
10185	Structures	Roadside structure	0.9	6.5
10187	Structures	Generally on top of buildings	0.9	6.5
10203	Water	foreshore	1	0
10210	Water	tidal water	1	0
10217	Land (unclassified)	Industrial Yards, Car parks	0.85	6.5

Hydrology – Rainfall Events

Rainfall inputs were generated at a standard 10km grid square resolution. Hyetographs for the following rainfall events were generated:

1 in 30 year
1 in 75 year
1 in 100 year
1 in 100 year plus climate change (+30%)
1 in 200 year

Total rainfall depths at each 10km grid centroid for all required return periods were extracted from the FEH CD-ROM (v3) Depth Duration Frequency (DDF) model. A comparison between the peak rainfall depths in adjacent 10km grid squares was completed to confirm the suitability of the 10km grid resolution for modelling purposes. The difference in total rainfall depths between the grid centroids for 10km grid squares was approximately 2%. This suggests that the 10km grid data is suitable for use in the study as a finer grid would have a minimal effect on the hyetographs. It was decided to extract the rainfall from a point at NGR TL 45600 09550.

Hydrology – Critical Duration

Critical duration is a complex issue when modelling large areas for surface water flood risk. The critical duration can change rapidly even within a small area, due to the topography, land use, size of the upstream catchment and nature of the drainage systems. The ideal approach would be to model a wide range of durations. However, this is not always practical or economic when modelling large areas using 2D models which have long simulation times – such as within this study. Therefore it has been assumed that the critical duration is 3 hours since the area is relatively small and will react fast to a flood event. The selection of this duration has been verified through sensitivity analysis, by applying a 1 hour and 6 hour duration.

The maximum flood depth and the extent for the surface water flooding for the three durations were compared against each other, the results showed that there was no significant difference in the results. In the areas where there was a difference the 3 hours duration tended to produce the large flood extent and maximum flood depth therefore providing the most conservative results.

Grid Size

The model was constructed with a 5m grid size. This grid size was chosen as it represented a good balance between the degree of accuracy (i.e. ability to model overland flow paths along roads or around buildings) whilst maintaining reasonable model run ("simulation") times. For example, refining the grid size from a 5m grid to a 2m grid will significantly increase the model simulation time to days rather than hours. .

Topography

LiDAR data from Environment Agency covers most of the model extent, the resolution of the ara is mainly 2m with parts being 1m and 5m. A small area to the south west of the model extent was obtained from Geostore as this was not available from the Environment Agency. Extents of each dataset are shown in Figure 2.

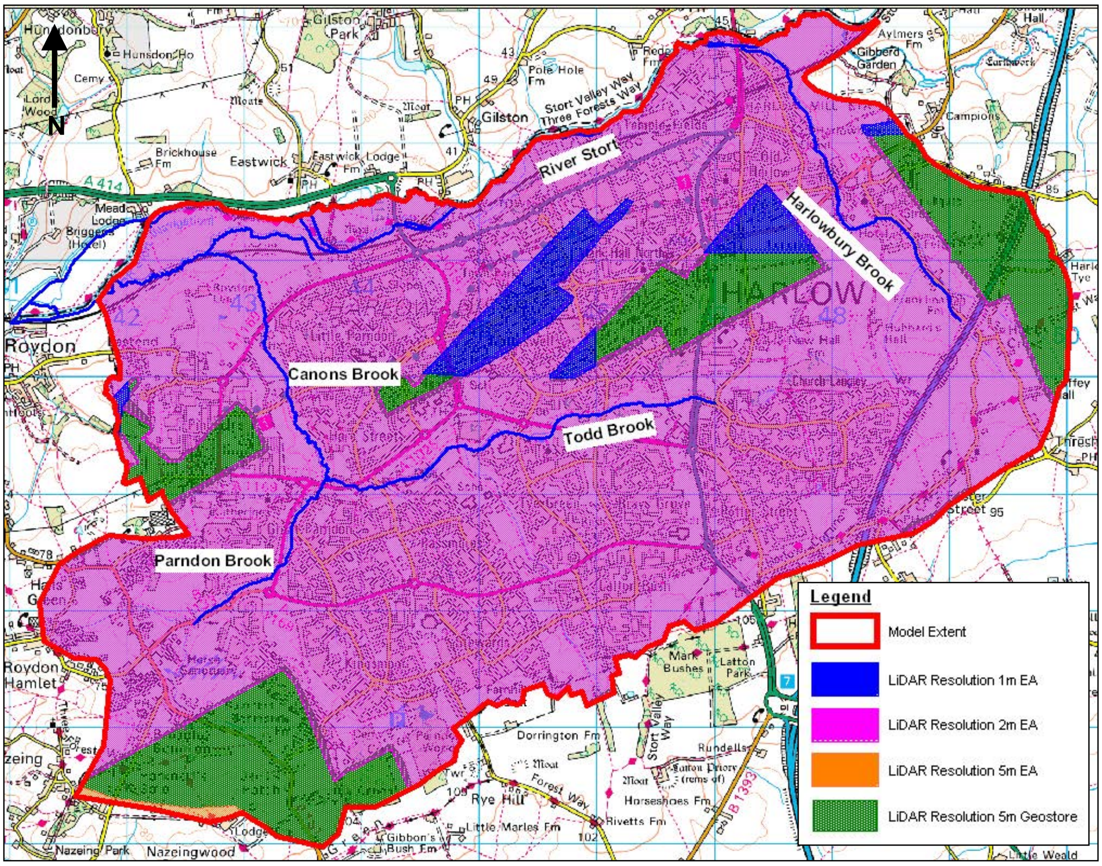

Figure 2: Topographic data

The topographic data was reviewed as part of the model build process. It was observed in several locations that the DTM showed inconsistent ground elevations where the two LiDAR types meet. This mainly happened between the 5m and 2m LiDAR provided by the Environment Agency. There were also locations where the LiDAR had not been filtered appropriately, specifically around buildings at Pardon Wood (NGR 543020, 208860).

Main River

The main river comprises of four rivers, Parndon Brook, Todd Brook, Cannon Brook and Harlowbury Brook. Parndon Brook and Todd Brook, are located in the western side of the Harlow catchment area, these rivers joined forming the Cannon Brook which flows to the north and meets River Stort. Harlowbury Brook is located in the eastern side Harlow catchment area, and also meets the River Stort to the north.

The main rivers have been represented TUFLOW model using a 2d_fsch shape. This layer allows narrow rivers to be modelled using a larger grid size, and ensures that water is conveyed through the 2D grid. The location of the river was digitised from the LiDAR and the main river network. The levels applied to the layer were extracted from the LiDAR. Since the level has been extracted from the LiDAR it has been assumed that the rivers area bank full at the beginning of the simulation, therefore no further initial conditions have been used.

The following parameters are applied to the 2d_fcsh layer:

- **Shape_Width_or_dMax:** This is the width the flow constriction, at least 2 cells wide need to be applied to ensure that water is conveyed along the river, therefore a value of 10(m) has been applied in the upstream areas and then 15(m) in the downstream areas.
- **pBlockage:** In most situations the width of the channel is smaller than the width applied above (2 cells), therefore this factor is applied to account the actual width of the river. The pblockage reduces the available flow area of an individual cell. This value has been determined using the equation bellow:

  pblockage = 1 – (Channel Width / Shape_Width_or_dMax)

To account for the width that has been applied to the model opposed to the actual width of the channel, the 2d_SRF (and the pBlockage) has been used to adjust the available storage area in the cells. The SRF polygon has been created by buffering the existing polyline, digitised for the 2d_fcsh by 5m.

Drainage Network

The drainage network in Harlow has been defined using two sources of information:

- Thames Water data - Gravity Sewer layer;
- Thames Water data – Drains layer
- Thames Water dataset – Manhole layer.

The following criterion was used to extract relevant information from the Gravity Sewer and Drains layers:

- Surface Water pipes, which are denoted as Purpose 'S'
- Surface Water pipes, which are greater than or equal to 300mm.

The criteria provided an initial pipe network, however in some locations the pipes did not link back to the main drainage network, therefore additional surface water pipes were copied from the Gravity Sewer layer. There were some situations where only one pipe was located in the area. The initial model results (which was the model run without the drainage network) where checked to see whether this pipe provided an important drainage path to the area (ie. did the initial results show a large area of flooding that would possibly reduce if the pipe was included in the model), if not the pipe was removed from the drainage network.

The relevant manhole data was extracted from the Manholes layer, this included all the surface water manholes that intersected the final drainage network.

Both sets of data had limited information available, therefore automatic procedures were applied to fill the missing data. For the pipes the upstream and downstream inverts, and pipe dimension was missing. For the manholes the cover and invert levels, and chamber dimensions.

The following automatic procedures were used to apply the missing data:

- **Manhole, cover and invert level:** If there was no upstream or downstream assigned it has been assumed that the cover level (upstream level) is the ground level (extracted from the LiDAR) and then the invert level (downstream level) is the ground level minus 1.5m.
- **Manhole, chamber size:** An average manhole dimension of 1050mm was applied to all manholes that did not have dimensions. Then a manual check has been done to ensure that the correct chamber size has been assigned to the pipe size. It has been assume that the chamber size is always larger than the pipe size. The chamber size increase as follows, 1050mm, 1200mm, 1500mm, 1800mm & 2100mm.
- **Drainage Pipe, upstream and downstream invert levels:** Using the 'Update column' in MapInfo function, the Upstream & Downstream column has been extracted from the Manhole data by assuming the upstream is the maximum and downstream is the minimum.

Defining the pipe dimensions could not be done automatically, this was done manually by assuming that the pipe dimension would increase going downstream. The surrounding pipes were also checked and a number of pipe sizes were modified, where it was believed that in correct values had been entered into the data set.

The following manual checks were done on the drainage network:

- The pipe downstream invert level was always less than the upstream level;
- The pipe dimensions always increased flowing downstream (towards the main drainage path);
- The invert levels in the pipe have been cross checked against the manholes inverts level, to ensure they are higher.

In the locations where the topography is flat or undulates slightly some of the pipes were assigned the levels in the reverse order this meant that the upstream was higher than the downstream. These locations have been checked, some locations have been left as is especially if the area is flat and there was not a large different between the levels, however in most of the locations the invert levels were manually changed, the topography was used to help determine the appropriate level.

The final drainage network represented in 1d_nwk_HAR_drainage_007.MIF shows a full drainage network which allows the water to flow back into the main watercourses. The final manhole layer represented in 1d_nwk_mnh_HAR_ALL_007.MIF allows the water to flow from the ground into the drainage network.

Structures

Hydraulically significant structures have been modelled in 1D in the study area. These structures were indentified during the site visits, analysis of the existing Surface Water Maps and from initial model runs.

Initially, a base hydraulic model was simulated without the structures to identify where structures should be included or not represented at all. Based on the output, the hydraulic model was then amended to better represent the key structures (large culverts, road underpasses etc). The key structures that are explicitly modelled in 1D are listed in Table 3 (overleaf).

Table 3: List of Structures

Structure Name	NGR	Location & Brief Description
PARD01	542838, 208092	Brookside
PARD02	543265, 208372	A1169, Box Concrete Culvert (headwall and culvert)
PARD03	543332, 208758	Katherine's Way, Circular Culvert with trash grill on inlet
PARD04	543398, 208755	Paycock Road, Box Culvert
PARD05	543596, 208973	A1025, Circular Culvert
CANB01	543367, 209813	Fourth Avenue, Box Culvert
CANB03	543162, 210458	Elizabeth Way, Rectangular Culvert
CANB04	542860, 211035	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
TODB01*	547005, 209780	London Road
TODB02	546827, 209829	A414, Rectangular culvert
TODB03	546074, 209704	Howard Way, there is also an underpass
TODB04	545608, 209538	Second Avenue, Box culvert
TODB05*	545340, 209503	Tripton Road
TODB07*	544259, 209082	Private Road off Third Avenue
TODB10	543942, 209050	Third Avenue, Culvert Box
HARB01	548037, 211612	Moor Hall Road & Gilden Way, Culvert Box
HARB03	547628, 212560	Railway Line, Circular culvert
HARB04	549270, 210620	M11, Circular Culvert
HARB05	549160, 210420	M11, Circular Culvert
RAIL01	543013, 211052	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL02	543092, 211055	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL03	543343, 211041	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL04	543431, 211029	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL05	543564, 211023	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL06	544693, 211260	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL07	545029, 211430	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
RAIL08	545273, 211575	Railway Line, Rectangular Culvert (details have been extracted from existing ISIS TUFLOW model)
DR01	544268, 211345	Culvert under Fifth Avenue
M11_01	548780, 209970	Culvert under M11, Circular Culvert
M11_02	548426, 209154	Culvert under M11, Circular Culvert

* Please note these structures are currently in the model as 2d zlines.

Manning's Values

The Manning's roughness coefficient values contained within Table 4 (overleaf) were used across both hydraulic models.

Table 4: Mannings Roughness

Feature Code	Descriptive Group	Comment	Mannings Roughness
10021	Building		0.500
10053	General Surface	Residential yards	0.040
10054	General Surface	Step	0.025
10056	General Surface	Grass, parkland	0.030
10062	Building	Glasshouse	0.500
10076	Land; Heritage And Antiquities		0.500
10089	Water	Inland	0.035
10111	Natural Environment (Coniferous/NonConiferous Trees)	Heavy woodland and forest	0.100
10119	Roads Tracks And Paths	manmade	0.020
10123	Roads Tracks And Paths	tarmac or dirt tracks	0.250
10167	Rail		0.050
10172	Roads Tracks And Paths	Tarmac	0.020
10183	Roads Tracks And Paths (roadside)	Pavement	0.020
10185	Structures	Roadside structure	0.030
10187	Structures	Generally on top of buildings	0.500
10203	Water	foreshore	0.040
10210	Water	tidal water	0.035
10217	Land (unclassified)	Industrial Yards, Car parks	0.035
10096	Land, (Cultivation lands)	Dense vegetation, Cliff, Cultivation areas	0.100

Building Representation

In order to determine the influence raised building pads will have within the model, the following approach has been used for the representation of buildings in the models through the coding of the TUFLOW Materials File (*.tmf) file. The method is also described in Figure 3.

- A GIS layer containing the locations of all ‘buildings’ was created based on the buildings polygons in the OS Mastermap dataset;
- The LiDAR DTM was then interrogated to obtain an average ‘bare earth’ ground level for each building polygon.
- This average ground level was applied to the building polygons to give them their base elevation in the Tuflow model; and
- The building polygons were then raised 100mm above their average ‘bare earth’ ground level to create stubby building pads (reflecting an average building threshold level). This ensures that the buildings form an obstruction to flood water and that shallow flows must pass round the buildings (and not flow through them).

A high Manning’s n value (n = 0.5) was applied to the buildings to represent the high resistance that buildings have to flow. However, for very shallow depths of flow (up to 30mm) a lower Manning’s n value (n = 0.015) ensure shallow flows did not incorrectly accumulate within the building footprint.

The TUFLOW model used is a direct rainfall model which applies a rainfall hyetograph to every active cell within the 2D model extent. This includes the cells representing buildings. The Manning's n value for buildings is reduced for these very shallow depths so that the flow which is created on buildings as a consequence of the application of direct rainfall is able to flow away from the building. If the Manning's n value was not reduced for these shallow depths, the rainfall applied to the building cells would pond here in an unrealistic manner.

The only exception to this method was in situations where more than one polygon in OS Mastermap represented a building. In these locations, the ground level applied varied across the building area, this occurred in a number of building in the south of the Harlow. For these locations the building polygons were group and a constant level was applied across the buildings.

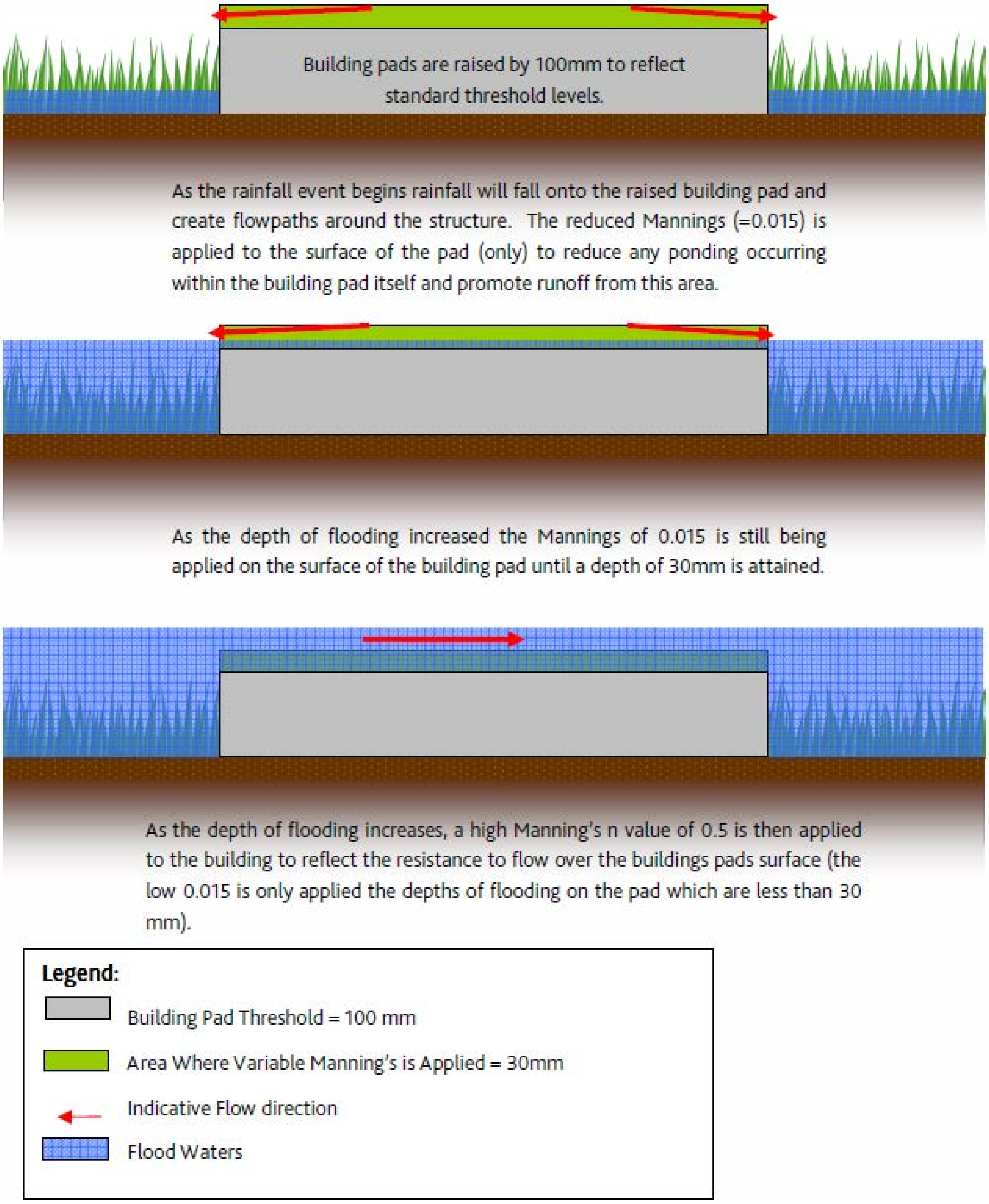

Figure 3 Building Pad Methodologies

Model Boundaries

Along the River Stort a downstream boundary has been applied, a constant water level boundary that varies spatial. The water levels have been extracted from the existing fluvial ISIS TUFLOW model of the River Stort. The purpose of this boundary is not to model fluvial flooding, it is to allow the surface water to drain into the River Stort and flow further downstream. The water levels assigned along the River Stort are in bank levels.

Other downstream boundaries in the models were included where it was observed that water was able to flow outside of the model extent. The type of downstream boundary used was a flow vs. stage (level) relationship, or HQ boundary. The rating relationship is generated by TUFLOW automatically using a gradient provided by the modeller.

Simulation Time

The design events for the Harlow models were run for 10 hours. The model was then assessed to determine whether this duration was suitable for the models. This was carried out by viewing the model results for the final few time steps. The results were checked to determine if water depths were still increasing significantly, and whether new flow paths were forming or existing flow paths still propagating. If either of these conditions were found to exist, the simulation time was extended for a further hour after which the checks were repeated until none of the conditions were satisfied.

Model Parameters

Time Step

The model was simulated with a 1 second time step. These results showed sensible results, since the topography of Harlow is fairly flat.

Other Tuflow Parameters

Table 8 describes other key TUFLOW parameters that have been changed in the TUFLOW runs.

Table 8: Changes to Default TuFlow Parameters

Parameter	Value
Cell Wet/Dry Depth	0.001m
Maximum Velocity Cut-off Depth	0m/s
Rainfall Gauges	One per Cell
Wetting and Drying	ON

Model Stability

Assessing the stability of a model is a critical step in understanding the robustness of a model and its ability to simulate a flood event accurately. Stability in a TUFLOW model is assessed by examining the cumulative error (or mass balance) of the model as well as the warnings outputted by the model during the simulation. Figures 5 and 6 (overleaf) show the cumulative error of the models are within the recommended range of +/-1% throughout the simulation.

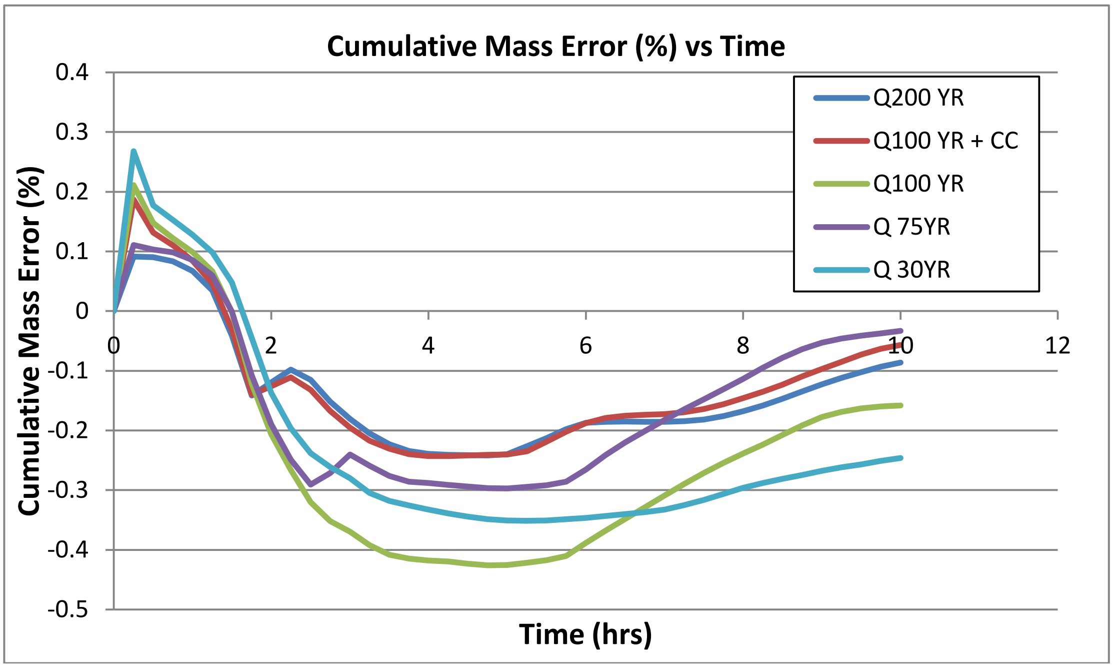

Figure 5: Mass Balance of Harlow Model

Conclusions and Recommendations

The hydraulic models constructed for Harlow Surface Water Management Plan represents an 'intermediate' approach to identifying areas at risk of surface water flooding. It represents a significant refinement on the previously available information on surface water flooding in the study area. Recommendations for future improvements to the models include (but are not limited) to the following:

- Explicitly model the existing drainage network in key areas of risk;
- Inclusion of survey data for critical structures;
- Inclusion of river flows and channel capacity (where applicable);
- Reduction in model grid size in key areas of risk;
- The use of better quality or more up to date topographic information particularly in areas of recent development

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID CDA_001
CDA Name Sumners

Validation Validated

	Flood Risk Vulnerability Classification	Weighting	Weighting (flood depth > 0.5m)	Total number of units flooded (100yr ARI)	Number of units flooded where depth >0.5m (100yr ARI)	Score
Infrastructure	Essential Infrastructure	40	80	0	0	20
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	1	0	
Households	Non-deprived (All)	2	4	85	19	246
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**86**	**19**	
	Impacts Score				**266**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID	CDA_002
CDA Name	Kingsmoor
Validation	Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	30
	Highly vulnerable	30	60	1	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	205	21	494
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	2	0	2
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**208**	**21**	
	Impacts Score				**526**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Essex County Council

CAPITA SYMONDS
Flood Risk Management

Critical Drainage Area ID	CDA_003
CDA Name	West Passmores
Validation	Validated

	Flood Risk Vulnerability Classification	Weighting	Weighting (flood depth > 0.5m)	Total number of units flooded (100yr ARI)	Number of units flooded where depth >0.5m (100yr ARI)	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	32	3	76
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	1	0	1
	Units (Basements only)	2	4	0	0	

Total Units Flooded	**33**	**3**
Impacts Score		**77**

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID CDA_004
CDA Name Stewards

Validation Validated

	Flood Risk Vulnerability Classification	Weighting	Weighting (flood depth > 0.5m)	Total number of units flooded (100yr ARI)	Number of units flooded where depth >0.5m (100yr ARI)	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	98	10	236
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	

Total Units Flooded	**98**	**10**
Impacts Score		**236**

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID CDA_005
CDA Name Latton Bush

Validation Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure						
	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households						
	Non-deprived (All)	2	4	109	0	218
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial						
	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**109**	**0**	
	Impacts Score				**218**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID CDA_006
CDA Name Brays Grove

Validation Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	322	117	1112
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	3	0	3
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**325**	**117**	
	Impacts Score				**1115**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

Harlow Council — Working together for Harlow | Environment Agency | Thames Water | Essex County Council | CAPITA SYMONDS Flood Risk Management

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID CDA_007
CDA Name Victoria Gate

Validation Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	44	0	88
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**44**	**0**	
	Impacts Score				**88**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW

SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID	CDA_008
CDA Name	Little Parndon
Validation	Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	20
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	1	0	
Households	Non-deprived (All)	2	4	42	9	120
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**43**	**9**	
	Impacts Score				**140**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID	CDA_009
CDA Name	Rivermill
Validation	Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure						
	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households						
	Non-deprived (All)	2	4	74	4	164
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial						
	Units (All)	1	2	4	0	4
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**78**	**4**	
	Impacts Score				**168**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, train stations at risk)

Non-standard assumptions applied to cost estimate, if any

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Harlow Council – Working together for Harlow | Environment Agency | Thames Water | Essex County Council | CAPITA SYMONDS Flood Risk Management

Critical Drainage Area ID	CDA_010
CDA Name	Netteswell
Validation	Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	67	6	158
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**67**	**6**	
	Impacts Score				**158**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

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HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID: CDA_011
CDA Name: Altham Grove

Validation: Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	28	12	104
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	0	0	0
	Units (Basements only)	2	4	0	0	

Total Units Flooded	**28**	**12**
Impacts Score		**104**

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

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HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID	CDA_012
CDA Name	Temple Fields
Validation	Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	30	0	60
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	12	2	16
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**42**	**2**	
	Impacts Score				**76**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

Harlow Council — Working together for Harlow | Environment Agency | Thames Water | Essex County Council | CAPITA SYMONDS Flood Risk Management

HARLOW
SURFACE WATER FLOOD IMPACT SCORE

Critical Drainage Area ID	CDA_013
CDA Name	Old Harlow
Validation	Validated

	Flood Risk Vulnerability Classification	*Weighting*	*Weighting (flood depth > 0.5m)*	*Total number of units flooded (100yr ARI)*	*Number of units flooded where depth >0.5m (100yr ARI)*	
Infrastructure	Essential Infrastructure	40	80	0	0	0
	Highly vulnerable	30	60	0	0	
	More vulnerable	20	40	0	0	
Households	Non-deprived (All)	2	4	46	20	172
	Non-deprived (Basements only)	4	8	0	0	
	Deprived (All)	4	8	0	0	
	Deprived (Basements only)	8	16	0	0	
Commercial / Industrial	Units (All)	1	2	1	0	1
	Units (Basements only)	2	4	0	0	
	Total Units Flooded			**47**	**20**	
	Impacts Score				**173**	

Additional Information

Additional information on nature of the alleviation scheme

Information on flooded units - if deemed necessary (e.g. unusual assets, tube stations at risk)

Non-standard assumptions applied to cost estimate, if any

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

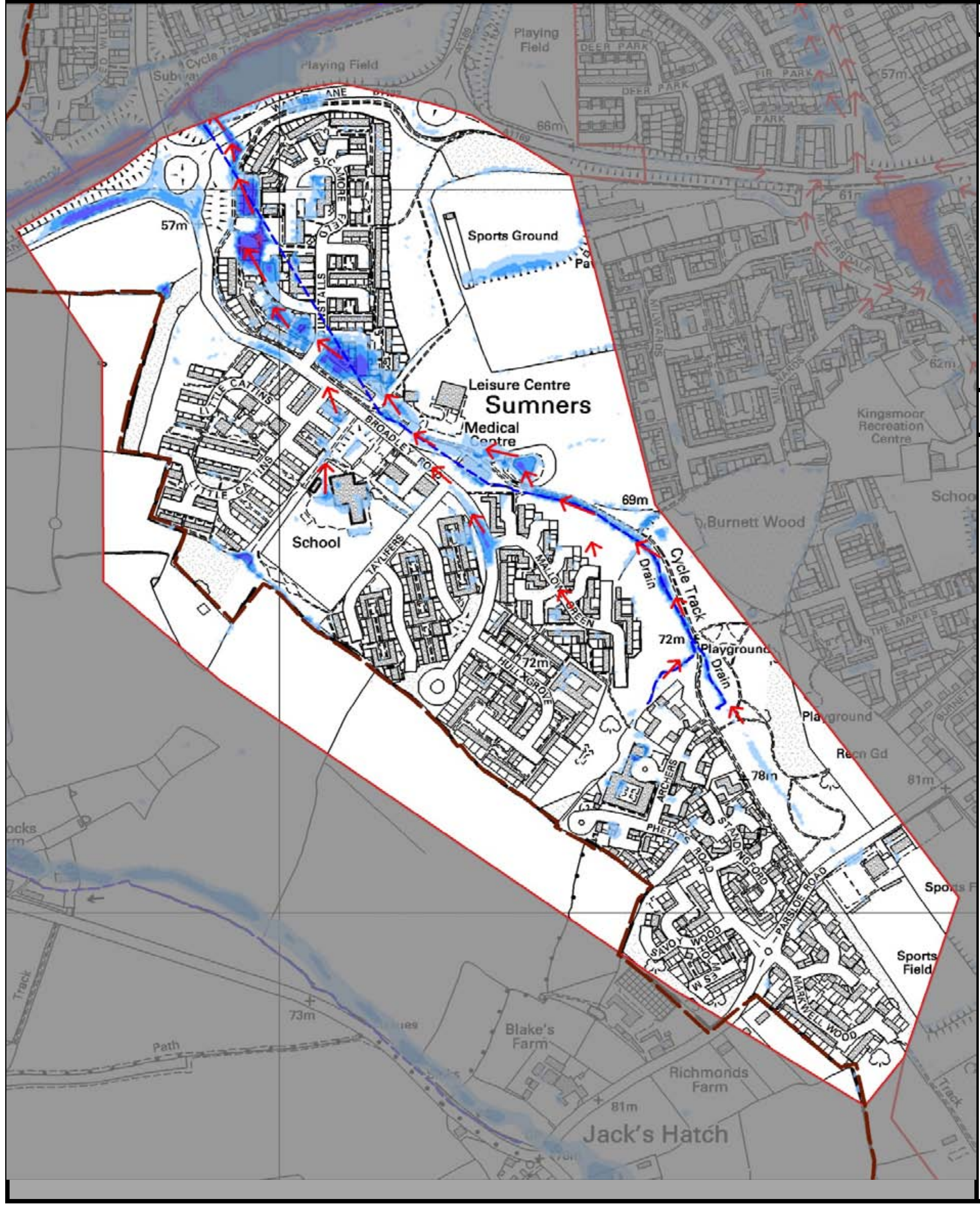
This CDA is located in the Sumners area of Harlow. Surface water flows generally from south to north towards Parndon Brook. The pluvial modelling predicts surface water flooding across various locations of the CDA (as a result of the topography and water being trapped behind raised building pads). The main cause of surface water flooding is predicted to occur from an ordinary water course (OWC) flowing through the CDA which is culverted and the capacity of the culvert may not be sufficient. Flooding from this location generates the greatest impact to downstream properties.

Fluvial Flood Zones 2 and 3 are located north of the CDA.

The majority of the CDA is not considered to be at risk of groundwater flooding. A small area in the south-east of the CDA is at very low risk of clearwater flooding, while the region around a drain running north-west through the CDA is at very high risk of superficial deposits flooding.

Critical Drainage Area

Harlow_001



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Sumners Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	Yes
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	Yes

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CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID:	Harlow_001				
	Measure	**Opportunity Assessment**	**Description**	**Location / Specific Details**	**Comments**
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible location on Waterlane Primary School and estate located upon the two (2) flat roof estate buildings located within the cente of Sycamore Field	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	Throughout CDA	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark areas such as	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Waterlane Primary School and local leisure centre.
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank as a result of the unnamed drain being culverted under the downstream urban area	(located south of the medical centre) so that runoff is diverted and attenuated within the existing playing field east of the medical centre.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	N/A	Likely to have limited space in the CDA for these to be implemented.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to divert flows (particularly from the OWC)into this the Broadley Road drainage asset	The model results indicate that the main drainage network within the CDA is not operating at full capacity (900mm sewer under Broadley Road).
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features along Broadley Road to minimise any runoff flowing east of the road.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)		Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	Partial deculverting of the ditch located north-west of the Sumners Leisure Centre could assist in cutting off the overland flowpath that floods properties near Dunstalls and Sycamore Field	An assessment of the risk of public assess over this area should be assessed. Any proposed crossing should be permeable to allow flows to discharge through the deck.
	Other 'Pathway' Measures	N/A			
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - around Dunstalls and Sycamore Field	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_001

Option No.	Option (Scheme Category)	SOURCE: Green Roof	SOURCE: Soakaways	SOURCE: Swales	SOURCE: Permeable Paving	SOURCE: Rainwater Harvesting	SOURCE: Detention Basins	SOURCE: Ponds and Wetlands	SOURCE: Other 'Source' Measures	PATHWAY: Increasing Capacity in Drainage Systems	PATHWAY: Separation of Foul and Surface Water Sewers	PATHWAY: Improved Maintenance Regimes	PATHWAY: Managing Overland Flows (Online Storage)	PATHWAY: Managing Overland Flows (Preferential Flowpaths)	PATHWAY: Land Management Practices	PATHWAY: Deculverting Watercourse(s)	PATHWAY: Other 'Pathway' Measures	RECEPTOR: Improved Weather Warning	RECEPTOR: Planning Policies to Influence Development	RECEPTOR: Temporary or Demountable Flood Defences	RECEPTOR: Social Change, Education and Awareness	RECEPTOR: Improved Resilience and Resistance Measures	RECEPTOR: Other 'Receptor' Measures	Appropriate Measures Available?
1	**Do Nothing**																							✓
2	**Do Minimum**																							✓
3	**Improved Maintenance**																N/A							✓
4	**Planning Policy**																							✓
5	**Source Control, Attenuation and SUDS**																						N/A	✓
6	**Flood Storage / Permeability**																N/A							✓
7	**Separate Surface Water and Foul Water Sewer Systems**																							×
8	**De-culvert / Increase Conveyance**																N/A							✓
9	**Preferential / Designated Overland Flow Routes**																N/A							✓
10	**Community Resilience**																						N/A	✓
11	**Infrastructure Resilience**																							✓
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓
13	**Other or Combination of Above**																							✓

Option No.	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	2	0	-1	0	-1	0	✓	
3	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	1	1	0	1	2	5	✓	Providing additional storage witin the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment (out of bank flows from the OWC) is investigated within the area of open space near the south of the leisure centre.
7								
8	1	1	0	1	2	5	✓	Partial deculverting of the ditch located north-west of the Sumners Leisure Centre could assist in cutting off the overland flowpath that floods properties near Dunstalls and Sycamore Field.
9	2	1	0	0	2	5	✓	Raise kerbing and construct speed bump features along Broadley Road to minimise any runoff flowing east of the road. The overall benefits from this option would need to be assessed within hydrauli model to determine its benefit.
10	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows and the partial deculverting of the existing drain (south of Dunstalls) to assist in 'cutting off' the upstream overland flow routes

Harlow Surface Water Management Plan - Options Appraisal Summary

Critical Drainage Area

Harlow_002

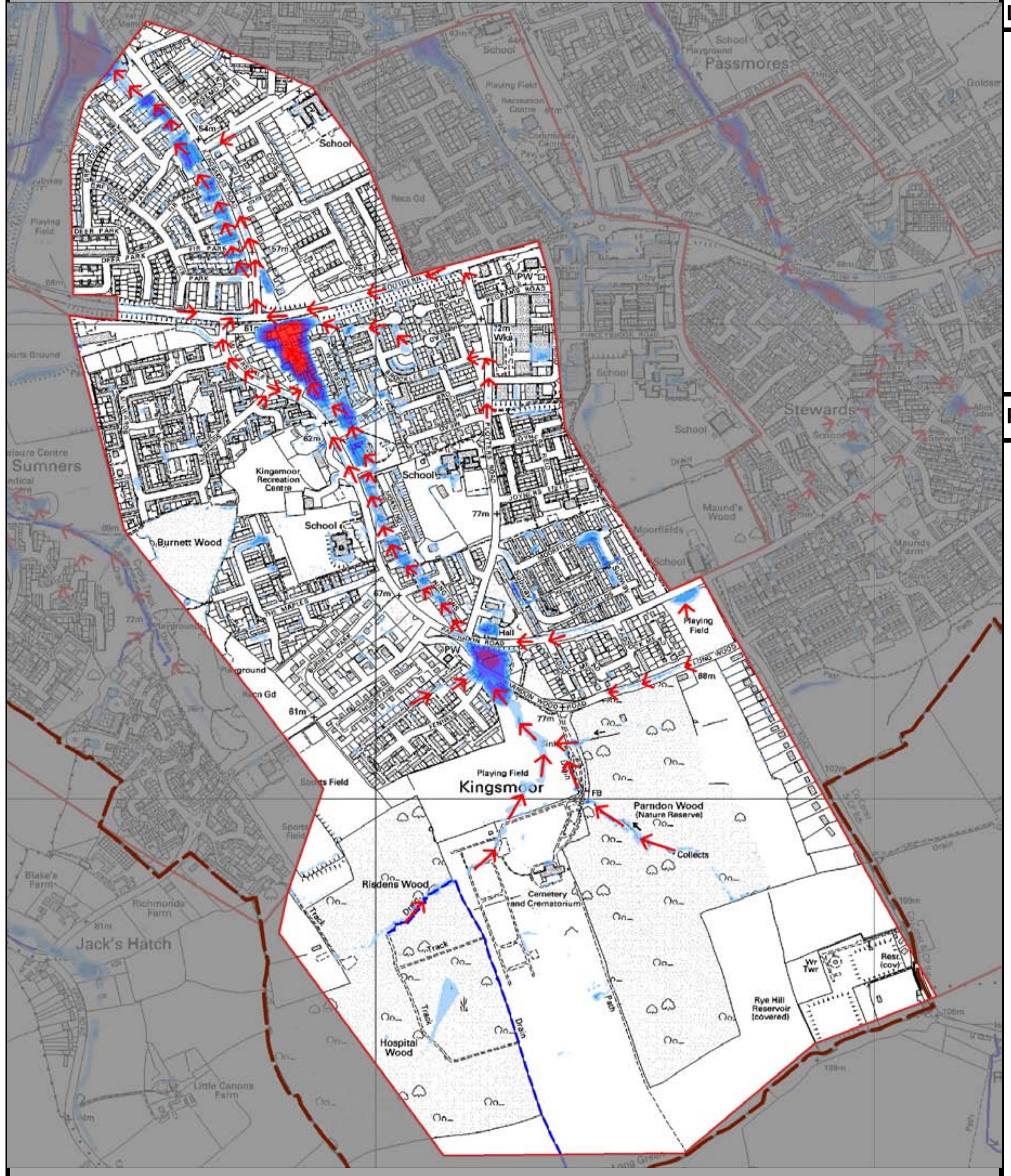
PROBLEM IDENTIFIED:

This CDA is located in the Kingsmoor area of Harlow. Surface water flows generally from south to north towards Parndon Brook. The pluvial modelling predicts surface water flooding across the central portion of the CDA as a result of the topography and water being trapped behind raised building pads. This flooding may be a result of a historic ordinary water course (OWC) being lost due to urban expansion. Water flows from the upper catchment in a northerly direction where it appears to concentrate in the lower elevations forming an overland flow route flowing in a northerly direction through properties (parallel to Paringdon Road and Kingsmoor Road).

Fluvial Flood Zones 2 enters a small portion in the north of the CDA and Flood Zone 3 is located along the northern boundary.

The drainage network within the CDA is a separated drainage infrastructure

A region classified as being at very low to low risk of clearwater flooding lies along the southern boundary of CDA 2. A n area at high risk of superficial flooding runs through CDA 2 in a north-eastern direction along a dry valley.



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	Green	Grey
Do Minimum	Green	Grey
Improved Maintenance	Green	Green
Planning Policy	Green	Grey
Source Control, Attenuation and SUDS	Green	Green
Flood Storage / Permeability	Green	Green
Separate Surface Water and Foul Water Sewer Systems	Red	Grey
De-culvert / Increase Conveyance	Red	Grey
Preferential / Designated Overland Flow Routes	Green	Green
Community Resilience	Green	Green
Infrastructure Resilience	Red	Grey
Other - Improvement to Drainage Infrastructure	Green	Green
Other or Combination of Above	Green	Green

Kingsmoor Area

Flood Risk Source

Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation

Historic Events	Yes
Site Inspection	Yes

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HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_002

	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (Kingsmoor County Junior and Milwards Nursery and Primary)	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	Upstream within the Kingsmoor playing field located north of the cemetery and crematorium	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Kingsmoor County Junior and Milwards Nursery and Primary)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Kingsmoor County Junior and Milwards Nursery and Primary Schools
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the Kingsmoor playing field located north of the cemetery and crematorium. Lower all area of large open space by 300mm to provide storage during large storm events.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the Kingsmoor playing field located north of the cemetery and crematorium	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to divert flows (particularly from the OWC)into the Southern Way and Milwards drainage asset.	The model results indicate that the main drainage line within the CDA is at or close to capacity.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features along Paringdon Road to minimise any runoff.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)		Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
	Other 'Pathway' Measures	N/A			
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - around Kingsmoor Road and Millersdale	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_002

		Standard Measures																							Short listing Options							
		SOURCE								PATHWAY								RECEPTOR														
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																N/A							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits. Formal swale/cut off drain and upstream attenuation feature south of Parndon Wood Road to capture flows from upstream Greenfield catchment. This may be school land and the design of these features would need to ensure that the safety of the children is considered.
6	**Flood Storage / Permeability**																N/A							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space near north of the cemetery and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**																							×								
8	**De-culvert / Increase Conveyance**																N/A							×								
9	**Preferential / Designated Overland Flow Routes**																N/A							✓	2	1	0	0	2	5	✓	Preferential overland flow route – raised kerbs and where necessary raised speed bumps along the Paringdon Road, along Watersmeet and Kingsmoor Road to divert flows away from properties Assess the addition of a drainage culvert from Watersmeet through Southern Way through to open space next to Kingsmoor Road with an attenuation area in this location to reduce risk of upstream flows impacting these properties.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in west Passmores (an area south of Pyenest Road to an area north of Maund's Wood). Surface water flows generally from south west to north east towards Todd Brook. The pluvial modelling indicates the greatest risk of surface water flooding along the northern portion of the CDA as a result of the topography and water being trapped behind Pyenest Road (which is approximately 1.5m above the land to the south of the road. This flooding is possibly a result of a historic ordinary water course (OWC) being lost due to urban encroachment into the flow path. A overland flow route along the pedestrian walkway (located west of the existing fields of the Passmores Youth Centre) conveys flows from the upper catchment into the Local Flood Risk Zone.

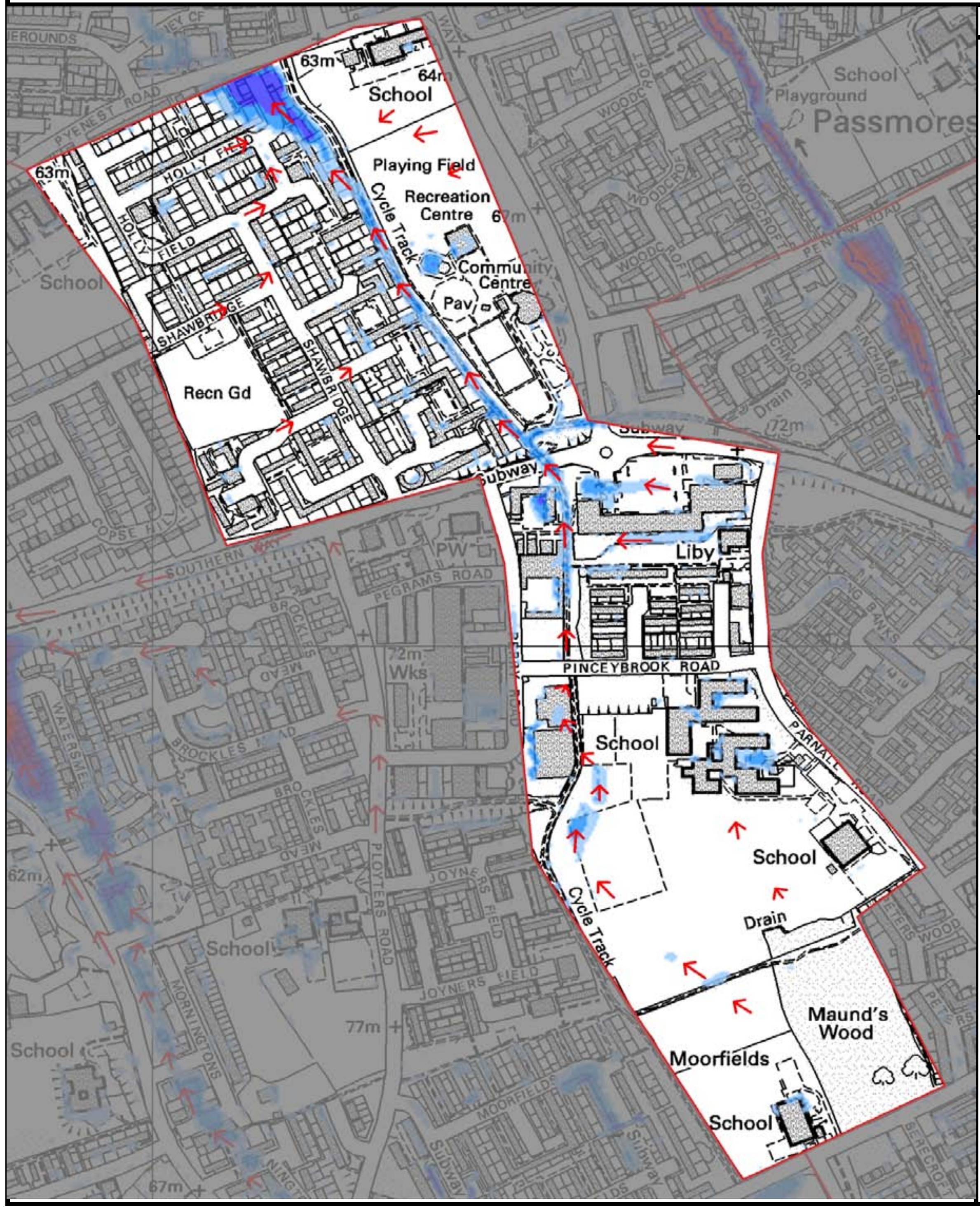
No fluvial flood zones are located within the CDA.

The draiange network within the CDA is a seperated system.

The majority of the CDA is not at risk of groundwater flooding; however a small region (confined to the overland flow path) corresponding to a dry valley is at very high risk of superficial deposits flooding.

Critical Drainage Area

Harlow_003



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

West Passmores Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	Yes

Essex County Council · Environment Agency · Harlow Council · Working together for Harlow · Thames Water

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID: Harlow_003

	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (St Lukes Catholic School and Stewards School) in the CDA	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA - mostly in northern areas	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	South of Pinceybrook Road	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within St Lukes Catholic School, Stewards School and near the Southern Way roundabout)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the St Lukes Catholic School, Stewards School and near the Southern Way roundabout
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the Passmores Youth Centre, Stewards School and the area above Maud's Wood.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the fields above Maud's Wood	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA	The model results indicate that the main drainage network within the CDA is operating at full capacity at the downstream junctions.
	Separation of Foul and Surface Water Sewers	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features along Abercrombie Way to minimise runoff.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	There are no culverted watercourses
	Other 'Pathway' Measures	N/A			
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - within Holly Field	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID:	Harlow_003																															
		Standard Measures																						Short listing Options								
		SOURCE								PATHWAY								RECEPTOR														
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																N/A							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits. Formal swale and upstream attenuation feature south of Pinceybrook Road to capture flows from upstream greenfield catchment
6	**Flood Storage / Permeability**																N/A							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space near Passmores Youth Centre, Stewards School and above Maud's Wood and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**										N/A													×								
8	**De-culvert / Increase Conveyance**															N/A	N/A							×								
9	**Preferential / Designated Overland Flow Routes**																N/A							✓	2	1	0	0	2	5	✓	Preferential overland flow route downs pedestrian walkway/cycle track – possible swale to enhance water quality;
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits. Flood resistance/resilience within Holly Field
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the Stewards and Passmores area of Harlow. Surface water flows generally from south west to north east towards Todd Brook. The pluvial modelling predicts the greatest risk of surface water flooding along a lost watercourse (as a result of development) and with an existing portion of the drain (located south of Penlow Road). There are other minor flow paths that convey flows into this area (along Barley Croft and Aylets Field).

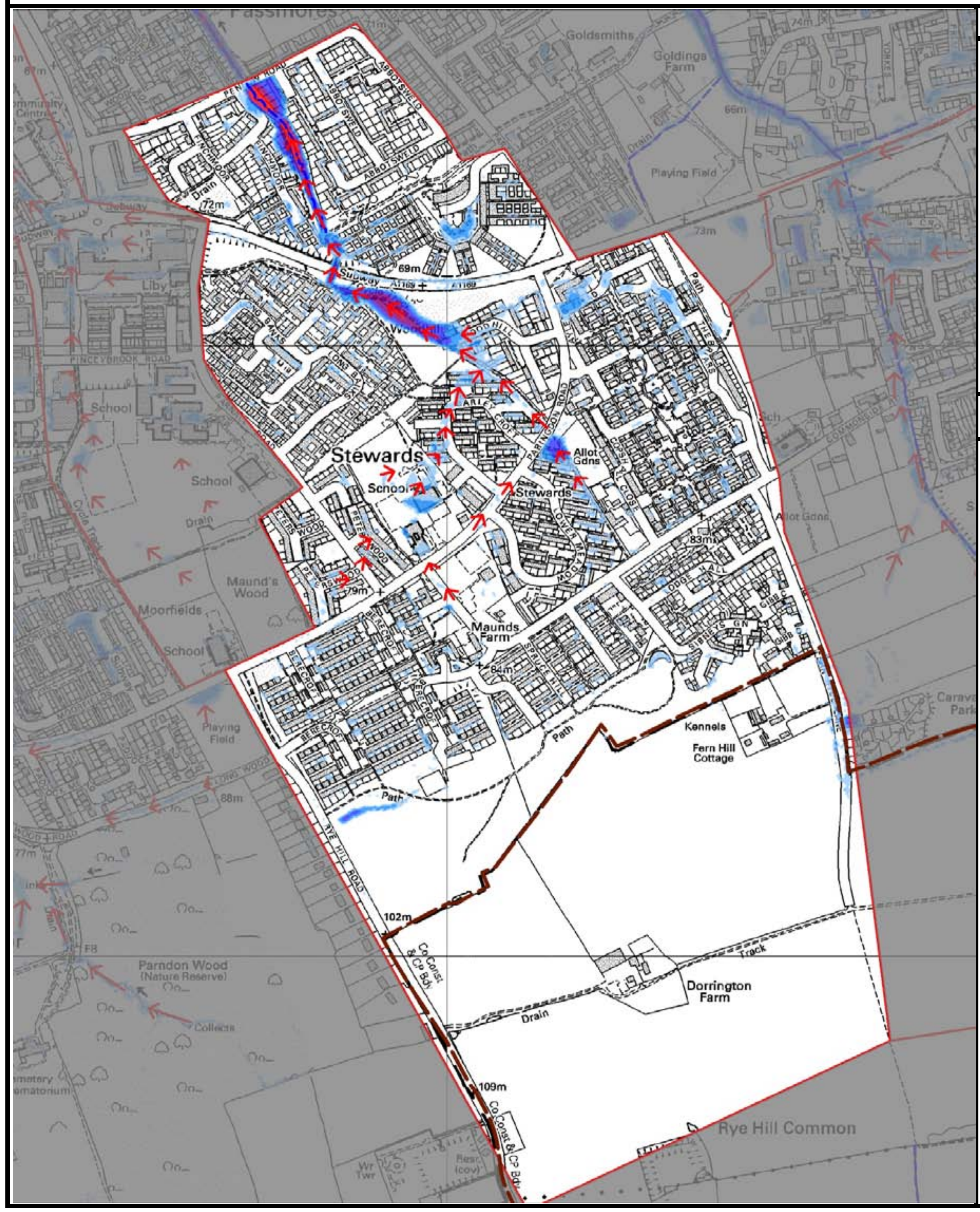
No fluvial flood zones are located within the CDA.

The drainage network within the CDA utilises a seperated system.

The majority of the CDA is not at risk of groundwater flooding. A small area is at a high risk of superficial deposits flooding which is located in a north-western direction through the catchment, corresponding to the location of an unnamed drain and possible lost upstream ordinary watercourse.

Critical Drainage Area

Harlow_004



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

Stewards Area

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	(green)	(grey)
Do Minimum	(green)	(grey)
Improved Maintenance	(green)	(green)
Planning Policy	(green)	(grey)
Source Control, Attenuation and SUDS	(green)	(green)
Flood Storage / Permeability	(green)	(green)
Separate Surface Water and Foul Water Sewer Systems	(red)	(grey)
De-culvert / Increase Conveyance	(red)	(grey)
Preferential / Designated Overland Flow Routes	(green)	(green)
Community Resilience	(green)	(green)
Infrastructure Resilience	(red)	(grey)
Other - Improvement to Drainage Infrastructure	(green)	(green)
Other or Combination of Above	(green)	(green)

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	Yes
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	Yes

Essex County Council · Environment Agency · Harlow Council – Working together for Harlow · Thames Water

CAPITA SYMONDS

Essex County Council
Environment Agency
Harlow Council
Working together for Harlow
Thames Water

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

	Critical Drainage Area ID:	Harlow_004			
	Measure	**Opportunity Assessment**	**Description**	**Location / Specific Details**	**Comments**
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (Longwood Primary School)	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
SOURCE	**Soakaways**		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Swales**		Generic Measure	Upstream, west of Fern Hill Cottage	To be identified on site-by-site basis but likely to have limited space within CDA.
SOURCE	**Permeable Paving**		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Longwood Primary School, Chinese Community Centre and the area around Bishopsfield)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Rainwater Harvesting**		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the within Longwood Primary School, the Chinese Community Centre and the area around Bishopsfield.
SOURCE	**Detention Basins**		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the open space north of Barley Croft, west of Copshall Close and within the open space in the southern part of the CDA west of the Fern Hill Lane Caravan Site.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Ponds and Wetlands**		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the open space in the southern part of the CDA west of the Fern Hill Lane Caravan Site.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Other 'Source' Measures**		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that the main trunk drainage network within the CDA is operating at or close to capacity
PATHWAY	**Separation of Foul and Surface Water Sewers**	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
PATHWAY	**Improved Maintenance Regimes**		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
PATHWAY	**Managing Overland Flows (Online Storage)**		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
PATHWAY	**Managing Overland Flows (Preferential Flowpaths)**		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features around Barley Croft to minimise runoff.	Disabled access along the road would need to be considered when assessing this measure.
PATHWAY	**Land Management Practices**		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
PATHWAY	**Deculverting Watercourse(s)**	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	No watercourse to deculvert	
PATHWAY	**Other 'Pathway' Measures**	N/A			
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
RECEPTOR	**Planning Policies to Influence Development**		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
RECEPTOR	**Temporary or Demountable Flood Defences**		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
RECEPTOR	**Social Change, Education and Awareness**		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
RECEPTOR	**Improved Resilience and Resistance Measures**		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - around Penlow Road and near the intersection of Paringdon Road and Barley Croft.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
RECEPTOR	**Other 'Receptor' Measures**	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID:	Harlow_004																															
		Standard Measures																							Short listing Options							
		SOURCE								PATHWAY								RECEPTOR														
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																N/A							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits. Formal swale and upstream attenuation feature south of urban extent (west of Fern Hill Cottage). Formal attenuation area within open space north of Barley Croft to control the total volume of runoff entering the downstream watercourse during the peak of the storm; Modify ground levels within the allotment west of Copshall Close and divert flows to flood this area instead of urban properties. Include a piped culvert from the allotment north into the pedestrian walkway to assist in drainage flows from this area or modify the levels within Parringdon Road and its verge to create a sag point to reduce any obstruction to flows. Modify ground levels within Longwood Primary School to reduce impact of flooding to school building or incorporate flood resilience / resistance measures within the school. Create a bund within the eastern boundary of the school to reduce an overland flowpath into Barley Court.
6	**Flood Storage / Permeability**																N/A							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space north of Barley Croft, west of Copshall Close, within the open space in the southern part of the CDA west of the Fern Hill Lane Caravan Site and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**										N/A													×								
8	**De-culvert / Increase Conveyance**															N/A	N/A							×								
9	**Preferential / Designated Overland Flow Routes**																N/A							✓	2	1	0	0	2	5	✓	Preferential overland flow route around Barley Croft to an attenuation feature. The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Flood resistance/resilience to properties with historic flooding within Barley Croft and properties predicted to flood near Penlow Road.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) and the partial deculverting of the existing drain could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the Latton Bush area of Harlow. Surface water flows to the LFRZ (near Sakins Croft) from both a southerly and easterly direction as a result of being located at a lower elevation. The pluvial modelling predicts the greatest risk of surface water flooding is within the LFRZ with other properties at a lower risk as a result of an overland flow path formed between properties between Monksbury and Tysea Road and from a downstream OWC which is culverted west of Latton Green County Primary School (within a possible attenuation feature)

No fluvial flood zones are located within the CDA.

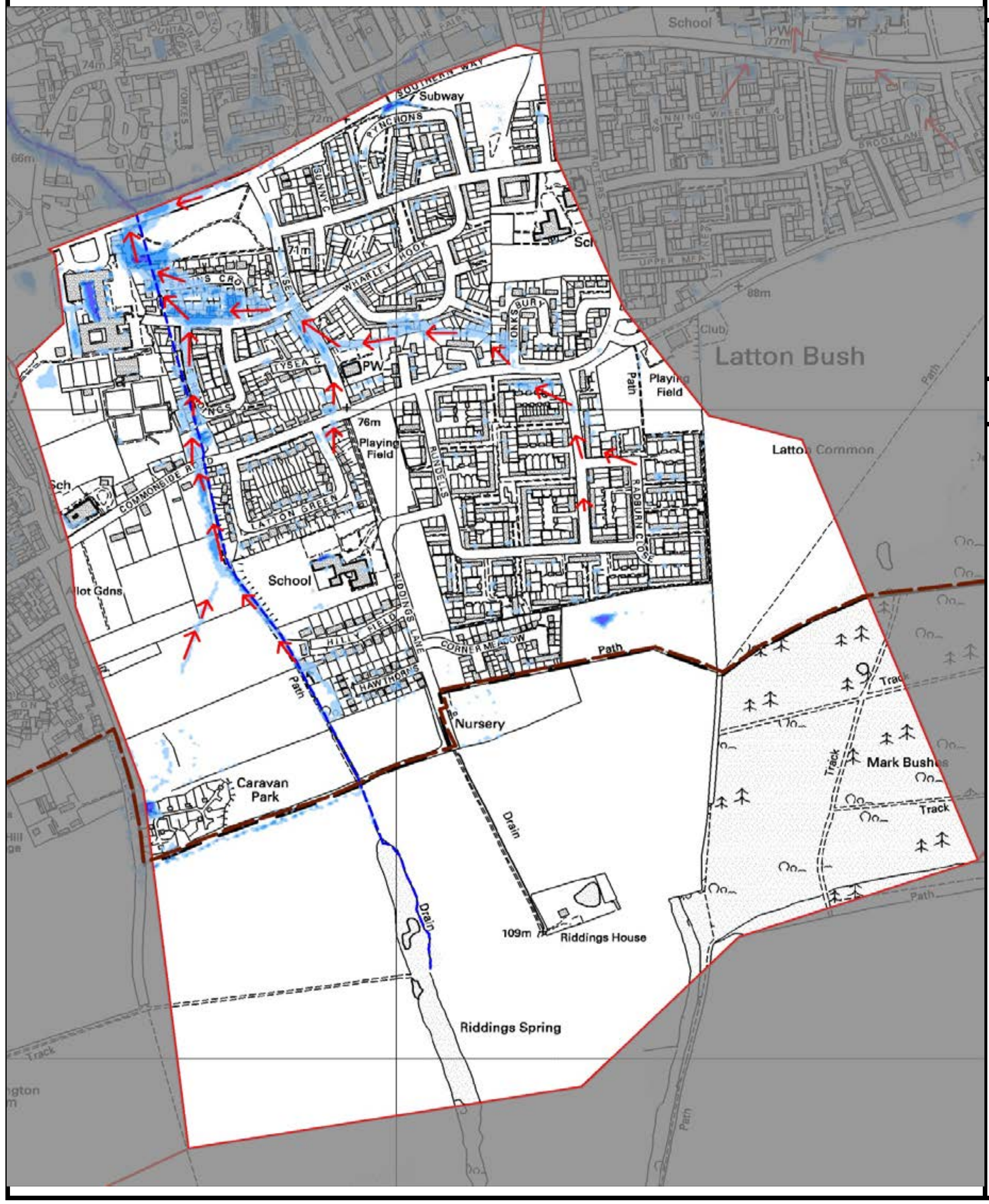
The drainage network within the CDA utilises a seperated system.

While the majority of the CDA is at low risk of groundwater flooding, a region at high risk of superficial deposits flooding forks out from the north boundary, corresponding to an unnamed drain and dry valley.

Critical Drainage Area

Harlow_005

Latton Bush Area



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	Green	Grey
Do Minimum	Green	Grey
Improved Maintenance	Green	Green
Planning Policy	Green	Grey
Source Control, Attenuation and SUDS	Green	Green
Flood Storage / Permeability	Green	Green
Separate Surface Water and Foul Water Sewer Systems	Red	Grey
De-culvert / Increase Conveyance	Red	Grey
Preferential / Designated Overland Flow Routes	Green	Green
Community Resilience	Green	Green
Infrastructure Resilience	Red	Grey
Other - Improvement to Drainage Infrastructure	Green	Green
Other or Combination of Above	Green	Green

Flood Risk Source

Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	Yes
Fluvial	No
Tidal	No

Validation

Historic Events	Yes
Site Inspection	NO

Essex County Council Harlow Council Working together for Harlow Environment Agency Thames Water

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID:	Harlow_005				
	Measure	**Opportunity Assessment**	**Description**	**Location / Specific Details**	**Comments**
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (Pear Tree Mead Primary and Nursery School, Latton Green County Primary School), in Harlow Chiropractic Clinic building and in Brenda Taylor School of Dance & Performing Arts building in the CDA.	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
SOURCE	**Soakaways**		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Swales**		Generic Measure	Within the area south west of Latton Green.	To be identified on site-by-site basis but likely to have limited space within CDA.
SOURCE	**Permeable Paving**		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Pear Tree Mead Primary and Nursery School, Latton Green County Primary School, Harlow Chiropractic Clinic and Brenda Taylor School of Dance & Performing Arts)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Rainwater Harvesting**		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Pear Tree Mead Primary and Nursery School, Latton Green County Primary School, Harlow Chiropractic Clinic and Brenda Taylor School of Dance & Performing Arts
SOURCE	**Detention Basins**		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the area south west of Latton Green	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Ponds and Wetlands**		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	In the area west of Latton Green County Primary School and Rum Tum Tuggers Nursery near Riddings Lane.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Other 'Source' Measures**		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that the main drainage network within the CDA is operating at full capacity at the downstream boundary and approximately 50% capacity for the upstream pipes.
PATHWAY	**Separation of Foul and Surface Water Sewers**	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
PATHWAY	**Improved Maintenance Regimes**		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
PATHWAY	**Managing Overland Flows (Online Storage)**		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
PATHWAY	**Managing Overland Flows (Preferential Flowpaths)**		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features down Sakins Croft and Tysea Road to minimiserunoff.	Disabled access along the road would need to be considered when assessing this measure.
PATHWAY	**Land Management Practices**		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
PATHWAY	**Deculverting Watercourse(s)**		Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	Attempting to deculvert the watercourse would require the resumption of several private properties.	-
PATHWAY	**Other 'Pathway' Measures**	N/A			
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
RECEPTOR	**Planning Policies to Influence Development**		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
RECEPTOR	**Temporary or Demountable Flood Defences**		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
RECEPTOR	**Social Change, Education and Awareness**		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
RECEPTOR	**Improved Resilience and Resistance Measures**		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - around Sakins Croft	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
RECEPTOR	**Other 'Receptor' Measures**	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Essex County Council · Environment Agency · Harlow Council – Working together for Harlow · Thames Water

Critical Drainage Area ID:	**Harlow_005**																															
		Standard Measures																						Short listing Options								
		SOURCE								PATHWAY								RECEPTOR														
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																N/A							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits. Enhance storage area south west of Latton Green and create additional swales/cut off drains to direct flows to this device from upstream areas.
6	**Flood Storage / Permeability**																N/A							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space near north of the the Pear Tree Mead Primary and Nursery School, Latton Green County Primary School, Harlow Chiropractic Clinic and Brenda Taylor School of Dance & Performing Arts and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**										N/A													×								
8	**De-culvert / Increase Conveyance**																N/A							×								
9	**Preferential / Designated Overland Flow Routes**																N/A							✓	2	1	0	0	2	5	✓	Preferential flow paths (raised kerbs) down Sakins Croft and Tysea Road with possible underground storage and additional gulley inlets.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Review offering flood resistance/resilience measures to properties at risk along the Readings and Sakins Croft and propertied near Monksbury and Tysea. This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) and the partial deculverting of the existing drain to assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the Brays Grove and Potters Street areas of Harlow. There are two LFRZs within the CDA located near Carters Mead and North Grove. Within both CDAs it is predicted that runoff from the upper catchment is obstructed by the raised roads which create a damming effect on the runoff. Flooding of the Carters Mead LFRZ appears to be a result runoff being conveyed within a lost watercourse, which in turn impacts the properties located along its length. The main cause of the North Grove CDA is predicted to be a combination of the downstream obstruction and low elevation (compared to the local area).

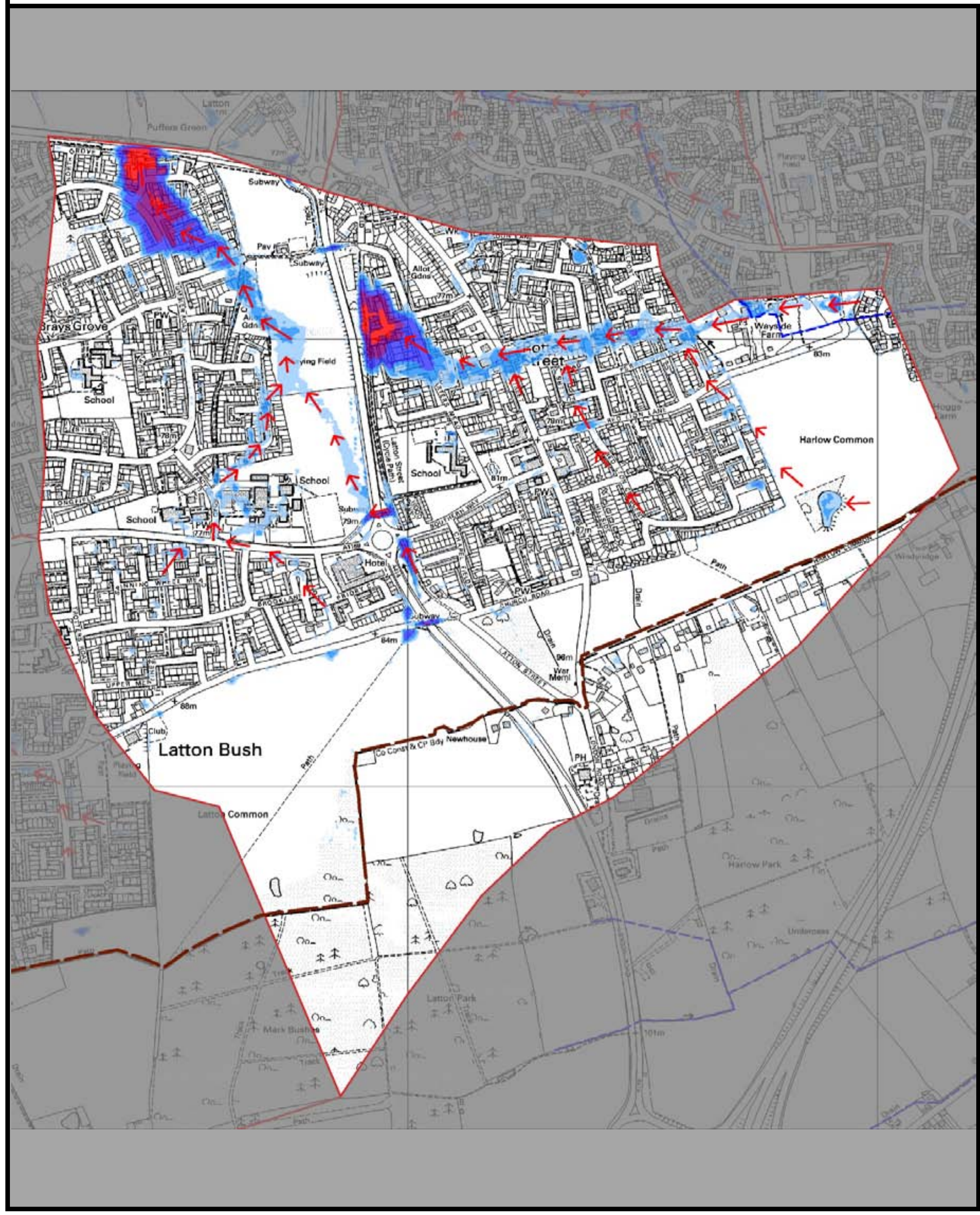
No fluvial flood zones are located within the CDA.

The drainage network within the CDA utilises a seperated system.

Although the majority of the CDA is not at risk from groundwater flooding, three dry valleys constitute a region at high risk of superficial deposits flooding

Critical Drainage Area

Harlow_006



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Brays Grove Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	Yes
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	Yes

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CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

	Critical Drainage Area ID: Harlow_006				
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (Purford Green Primary School, Holy Cross Roman Catholic Primary School).	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	Within Latton Common, Harlow Common and Nicholis Field.	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Purford Green Primary School, Holy Cross Roman Catholic Primary School and Potter Street County Primary School)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Purford Green Primary School, Holy Cross Roman Catholic Primary School and Potter Street County Primary School
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within Latton Common and Harlow Common, east of Perry Spring and Burley Hill / Oaktree Gardens	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the Nicholis playing field, north of Rundell's Grove and in the fields near Harlow Common	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that the main drainage network within the CDA is approaching capacity.
	Separation of Foul and Surface Water Sewers	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features below Spencers Croft towards Nicholis Field to minimise runoff.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
	Other 'Pathway' Measures			Increase culvert size on eastern side of A414 (near Caters Mead/Campbell Close), create a culvert under Second Ave (A1025) (near North Grove) to reduce risk of ponding	Eastern side of A414 (near Caters Mead/Campbell Close) and under Second Ave (A1025) (near North Grove) to minimise ponding near residential properties
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - within North Grove	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: **Harlow_006**

Option No.	Option (Scheme Category)	Standard Measures: SOURCE: Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	PATHWAY: Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	RECEPTOR: Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Short listing Options: Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Formal cut-off drain / swale and temporary attenuation within Latton Common and Harlow Common to reduce volume of runoff entering urban area from upstream permeable/greenfield land; Formal attenuation area within land east of Perry Spring and Burley Hill / Oaktree Gardens to capture flows; Modify ground levels within Nicholis Field to create a temporary attenuation basin so that flows from the enhanced culvert do not increase the risk to properties to the west; Create cut-off drain / swale along property boundaries fronting Nicholis Field to reduce flood risk to properties within Spencers Croft; Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	**Flood Storage / Permeability**																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space within Latton Common and Harlow Common, east of Perry Spring and Burley Hill / Oaktree Gardens and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**										N/A													×								
8	**De-culvert / Increase Conveyance**															N/A								✓	1	1	0	1	2	5	✓	Increase culvert size on eastern side of A414 (near Caters Mead/Campbell Close), create a culvert under Second Ave (A1025) (near North Grove) to reduce risk of ponding
9	**Preferential / Designated Overland Flow Routes**																							✓	2	1	0	0	2	5	✓	Raise kerbing and construct speed bump features below Spencers Croft towards Nicholis Field to minimise any runoff flowing east of the road. The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Flood resistance/resilience to properties with historic flooding within North Grove. This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																							✓	1	0	1	1	2	5	✓	Include additional surface drainage within Brays Grove Community College to discharge runoff towards Nicholis Field to reduce the risk to the school. A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space), increasing a culvert and creating a new one could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the north western portion of the Potters Street area of Harlow. There is one LFRZ around Victoria Gate. Flooding between Westbury Lane and Victoria Gate is predicted to be a result of runoff being conveyed above ground where the Todd Brook once flowed before being culverted. The main cause of this is predicted to be a combination of the downstream obstruction from the road which is at a higher elevation and the original flowpath of the Todd Brook through the CDA.

No fluvial flood zones are located within the CDA.

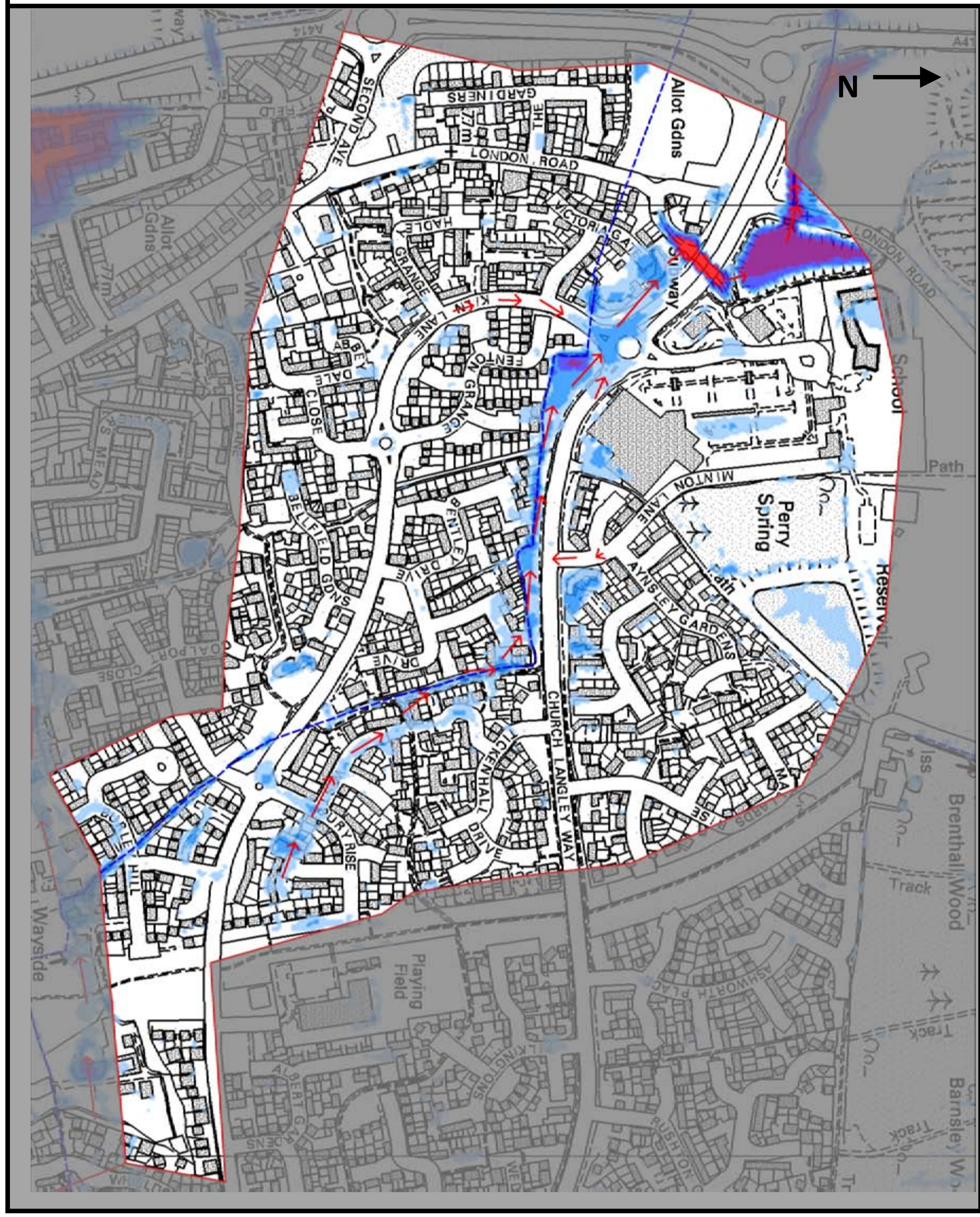
The drainage network within the CDA utilises a separated system.

The majority of the CDA is at no risk of groundwater flooding; however a small region corresponding to Todd Brook is at very high risk of superficial deposits flooding.

Critical Drainage Area

Harlow_007

Victoria Gate Area



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	Yes
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	No

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Essex County Council | Environment Agency | Harlow Council – Working together for Harlow | Thames Water

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

	Critical Drainage Area ID:	Harlow_007			
	Measure	**Opportunity Assessment**	**Description**	**Location / Specific Details**	**Comments**
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible location in the building situated on Minton Lane, south-west of Perry Spring would require feasibility assessment.	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	N/A	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. near Minton Lane, south-west of Perry Spring)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the building situated on Minton Lane, south-west of Perry Spring
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the open space north of Coalport Close, along Church Langley Way near Bentley Drive and Fenton Grange.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	North of Church Langley Way near the intersection with London Road	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that the main drainage network within the CDA is operating near capacity.
	Separation of Foul and Surface Water Sewers	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features east of Burley Hill and Bentley Hill up to Church Langley Way to minimise runoff.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)		Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	Deculverting within the area of existing open space Bentley Drive	An assessment of the depth of the watercourse would be required before this measure was considered any further as it might be 'unsafe' to expose it in the limited area of open space.
	Other 'Pathway' Measures	N/A			
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - south-west the roundabout of Kiln Lane and Church Langley Way	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

Critical Drainage Area ID: Harlow_007

Option No.	Option (Scheme Category)	Standard Measures: SOURCE: Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	PATHWAY: Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	RECEPTOR: Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures
1	Do Nothing																						
2	Do Minimum																						
3	Improved Maintenance																N/A						
4	Planning Policy																						
5	Source Control, Attenuation and SUDS																						N/A
6	Flood Storage / Permeability																N/A						
7	Separate Surface Water and Foul Water Sewer Systems										N/A												
8	De-culvert / Increase Conveyance																N/A						
9	Preferential / Designated Overland Flow Routes																N/A						
10	Community Resilience																						N/A
11	Infrastructure Resilience																						
12	Other - Improvement to Drainage Infrastructure																N/A						
13	Other or Combination of Above																						

Option No.	Appropriate Measures Available?	Short listing Options: Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	✓	2	0	-1	0	-1	0	✓	
3	✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	✓	1	1	1	1	1	5	✓	Create a shallow temporary attenuation area within open space north of Coalport Close. Determine ecological significance of vegetated land near the roundabout of Church Langley Way and Kiln Lane and determine if a vegetated attenuation basin could be located within this space. Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space north of Coalport Close, along Church Langley Way near Bentley Drive and Fenton Grange and also utilised within all large open space areas (creating shallow temporary detention basins)
7	×								
8	✓	1	0	0	2	2	5	✓	Partial deculverting within areas of existing open space might assist in reducing the risk to the local area - further investigations would be required to determine depth of watercourse
9	✓	2	1	0	0	2	5	✓	Establish a preferential flow route from a temporary attenuation area along the pedestrian footpath (the flowpath of the culverted watercourse). The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit.
10	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	✓	1	0	1	1	2	5	✓	Investigate benefit of increasing gulley numbers and pipe capacity within Westbury Rise. A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) and the partial deculverting of the existing drain could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the Little Parndon area of Harlow. There are two LFRZs within the CDA. One is located within the Princess Alexander Hospital whilst the other is located near Tree Field. Flooding at the hospital is predicted to be a result of runoff ponding between building structures and may reduce in reality if the internal private drainage is operating effectively, whilst predicted flooding in Tree Field is a result of Elizabeth Way obstructing to overland flows due to its raised elevation.

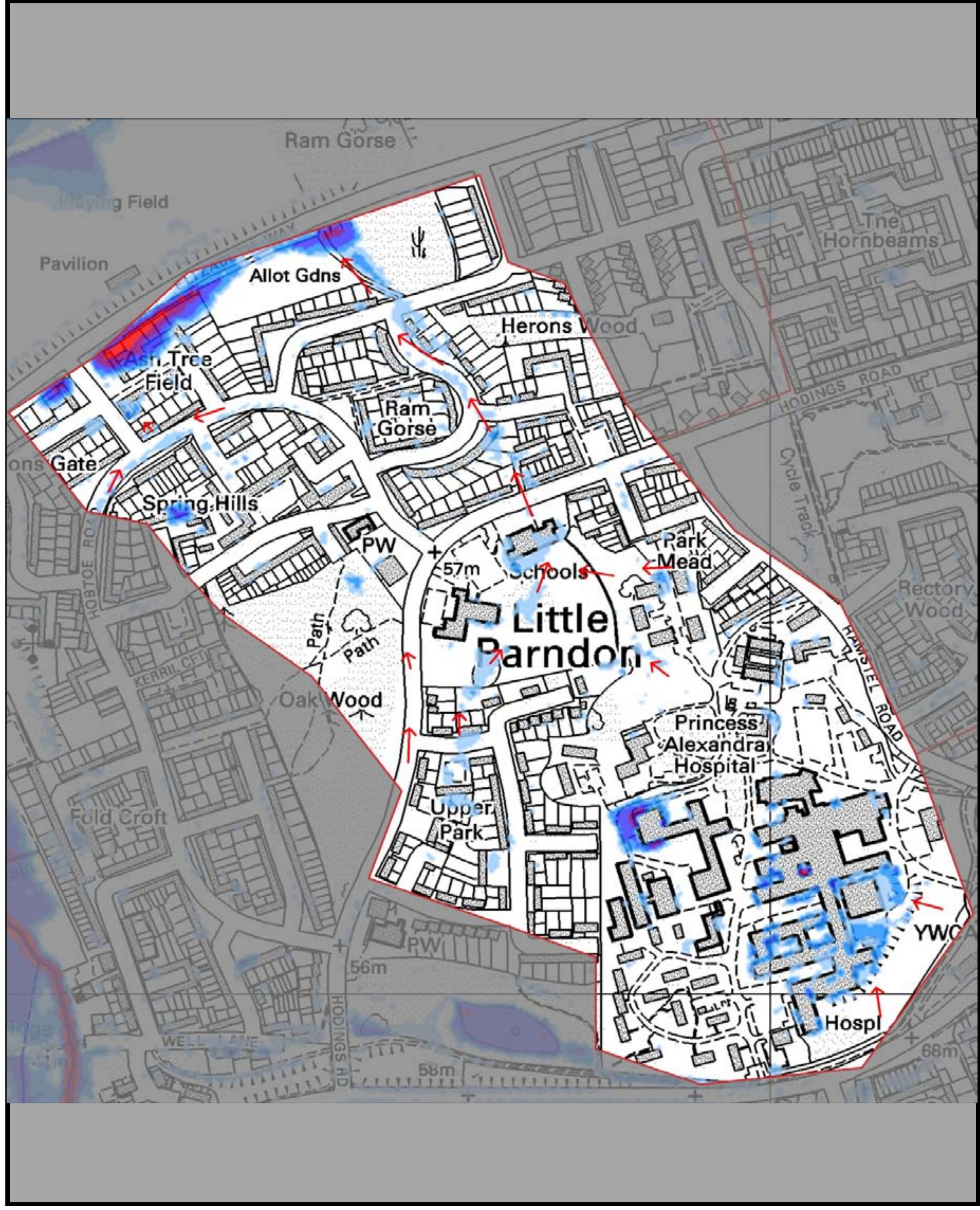
No fluvial flood zones are located within the CDA.

The drainage network within the CDA utilises a separated system.

A sizeable region in the south-west of the CDA is at 'very low' to 'low' risk of superficial deposits flooding; the north and west of the CDA are not highlighted as being at risk of groundwater flooding.

Critical Drainage Area

Harlow_008



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	Green	Grey
Do Minimum	Green	Grey
Improved Maintenance	Green	Green
Planning Policy	Green	Grey
Source Control, Attenuation and SUDS	Green	Green
Flood Storage / Permeability	Green	Green
Separate Surface Water and Foul Water Sewer Systems	Red	Grey
De-culvert / Increase Conveyance	Green	Grey
Preferential / Designated Overland Flow Routes	Green	Green
Community Resilience	Green	Green
Infrastructure Resilience	Red	Grey
Other - Improvement to Drainage Infrastructure	Green	Green
Other or Combination of Above	Green	Green

Little Parndon Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	Yes

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Essex County Council

Environment Agency

Harlow Council Working together for Harlow

Thames Water

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID: Harlow_008

	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (Little Parndon School) and Princess Alexandra Hospital.	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA - mostly in the northern part of the CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	Behind Little Parndon School	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Little Parndon School and Princess Alexandra Hospital)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Little Parndon School and Princess Alexandra Hospital
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Behind Little Parndon School and east of Allot Gardens along Elizabeth Way.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	N/A due to lack of space	Likely to have limited space in the CDA for these to be implemented.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that the main drainage network within the CDA is not operating at full capacity throughout the whole CDA
	Separation of Foul and Surface Water Sewers	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features down Ram Gorse to minimise any runoff flowing east of the road.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices	N/A	Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
	Other 'Pathway' Measures			Create new culvert under Elizabeth Way (A1169) to reduce risk of ponding	Under Elizabeth Way (A1169) where ponding begins upstream of the CDA to reduce risk of ponding within Ash Tree Field and Cannons Gate
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - within Ash Tree Field and Cannons Gate	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_008

Option No.	Option (Scheme Category)	Standard Measures – SOURCE								Standard Measures – PATHWAY								Standard Measures – RECEPTOR							Short listing Options							
		Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**														N/A								N/A	✓	1	1	1	1	1	5	✓	Modify ground levels (e.g. lower by 0.2 – 0.3m) within the open space behind Little Parndon School to reduce the total volume of runoff entering the LFRZ during the peak of the storm. Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	**Flood Storage / Permeability**														N/A									✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space near north of the cemetery and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**										N/A													×								
8	**De-culvert / Increase Conveyance**															N/A								✓	1	1	0	1	2	5	✓	A new culvert under Elizabeth Way (A1169) could assist in reducing risk of ponding
9	**Preferential / Designated Overland Flow Routes**																							✓	2	1	0	0	2	5	✓	Raise kerbing and construct speed bump features down Ram Gorse to minimise runoff impacting local properties. The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																							✓	1	0	1	1	2	5	✓	Review surface drainage within Princess Alexander Hospital to determine the efficiency of the network and (if necessary) include flood resilience / resistance measures or highlight retrofitting options;. A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) and the creation of a new culvert could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the north-eastern portion of the Little Parndon area of Harlow. There is one LFRZs within the CDA, which is located between Hodings Road, Rivermill, and the Hornbeams. The hydraulic model results predict that runoff from the local catchment is conveyed down roads and ponds behind the higher Elizabeth Way (A1169). When runoff ponds to a similar level to that of the Elizabeth Way, it is predicted that surface water flows into an area of lower ground within Burnt Mill and then on to the rail line.

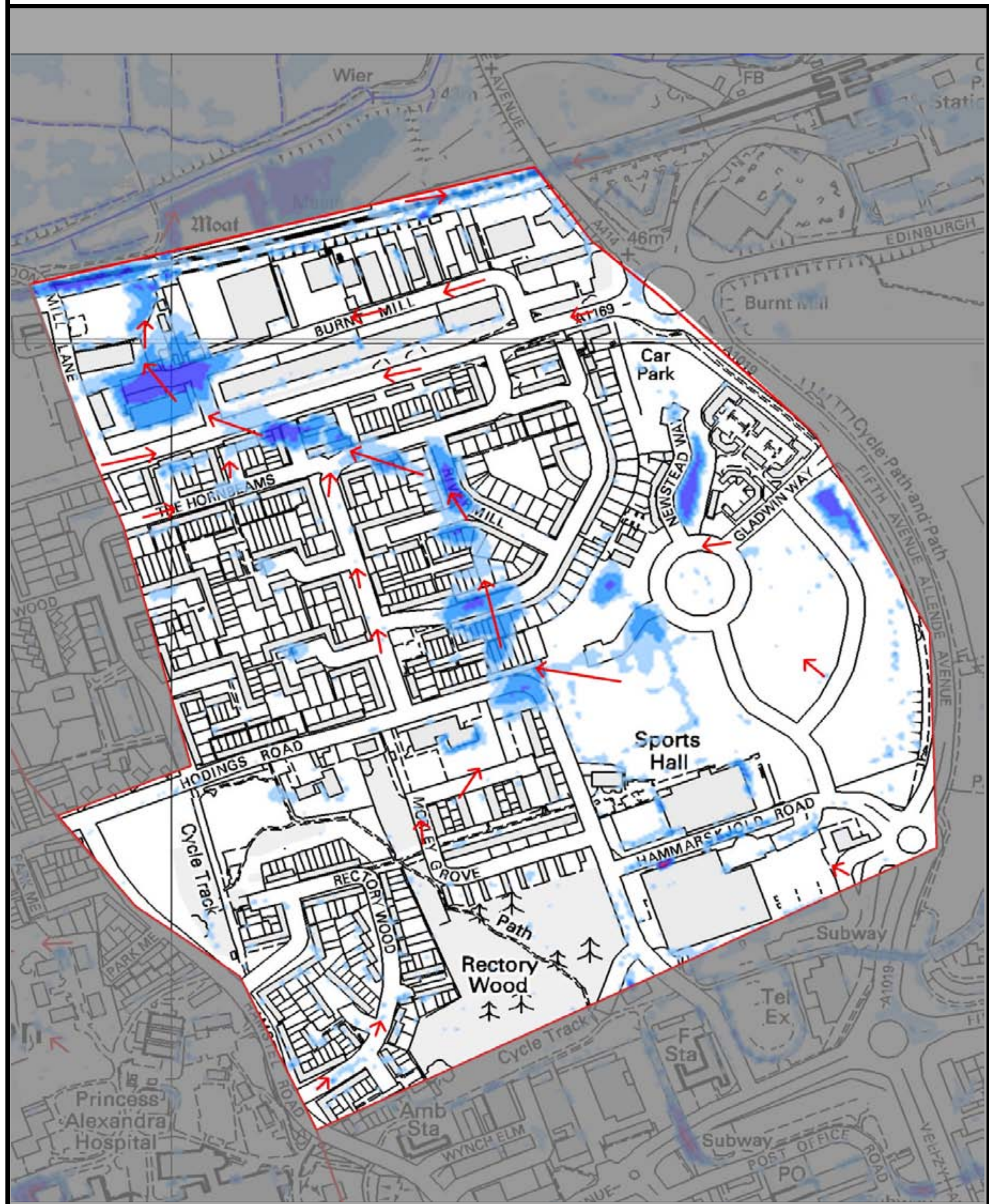
No fluvial flood zones are located within the CDA.

The drainage network within the CDA utilises a separated system.

The higher topographical region in the south of ranges from 'very low' to 'high risk 'of superficial deposits flooding, stretching down to the central region, which is not at risk of groundwater flooding. The northern half of, within the lower lying regions of the River Stort valley, is at 'high' to 'very high' risk of superficial deposits flooding.

Critical Drainage Area

Harlow_009



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	(green)	(grey)
Do Minimum	(green)	(grey)
Improved Maintenance	(green)	(green)
Planning Policy	(green)	(grey)
Source Control, Attenuation and SUDS	(green)	(green)
Flood Storage / Permeability	(green)	(grey)
Separate Surface Water and Foul Water Sewer Systems	(red)	(grey)
De-culvert / Increase Conveyance	(red)	(grey)
Preferential / Designated Overland Flow Routes	(green)	(green)
Community Resilience	(green)	(green)
Infrastructure Resilience	(red)	(grey)
Other - Improvement to Drainage Infrastructure	(green)	(green)
Other or Combination of Above	(green)	(green)

Rivermill Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	No

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HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_009					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Generic Measure	Throughout CDA - possible location on Faber music distrubution in Burnt Mill and on Adult Community Learning building (Rivermill Centre) would require feasibility assessment	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA - mostly in the northern part of the CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	N/A	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Faber music distrubution in Burnt Mill and in the Adult Community Learning (Rivermill Centre))	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Kingsmoor County Junior and Milwards Nursery and Primary Schools
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	N/A	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	N/A due to lack of space	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that certain areas of the drainage network within the CDA are operating at full capacity - the main area to manage may be under Burnt Mill, Elizabrth Way, Rivermill and Hodings Road
	Separation of Foul and Surface Water Sewers	N/A	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features along Rivermill and The Hornbeams to minimise runoff.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
	Other 'Pathway' Measures	N/A			
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - within the area west of Burnt Mill and around Rivermill.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_009

Option No.	Option (Scheme Category)	Standard Measures: SOURCE								PATHWAY								RECEPTOR						Appropriate Measures Available?	Short listing Options						Take Forward Option to Detailed Assessment?	Comments
		Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures		Technical	Economic	Social	Environmental	Objectives	Overall		
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																N/A							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	**Flood Storage / Permeability**																N/A							✓	1	1	0	2	1	5	✓	Devices in sag points within the road could assist in capturing runoff for attenuation and treatment.
7	**Separate Surface Water and Foul Water Sewer Systems**										N/A													×								
8	**De-culvert / Increase Conveyance**															N/A	N/A							×								
9	**Preferential / Designated Overland Flow Routes**																N/A							✓	2	1	0	0	2	5	✓	Raise kerbing and construct speed bump features along Rivermill and The Hornbeams to minimise any runoff. The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit. Undertake an assessment to determine if flows can be diverted west to avoid flooding of the rail line.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Incorporate flood resistance/resilience within the properties located within the overland flow path. This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																N/A							✓	1	0	1	1	2	5	✓	Investigate increasing the pipe size (providing storage) under Burnt Mil, Rivermilll and The Hornbeams as the hydraulic model indicates that these are flowing at 100% capacity during the peak of the storm. A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation. Review internal drainage infrastructure of industrial/commercial units to determine if any flood risk reduction measures have been incorporated in these areas.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) could assist in reducing the peak volume of runoff entering the drainage network within the CDA. Review emergency procedures and contingency measures with Network Rail to determine impacts during an extreme storm event.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in Netteswell area of Harlow. There is one LFRZ within the CDA, which is located between St Michael's Close and Green Park. The hydraulic model results predict that runoff from the local catchment is conveyed down local roads/pathways and is predicted to pond within topographic low points within the catchment.

No fluvial flood zones are located within the CDA.

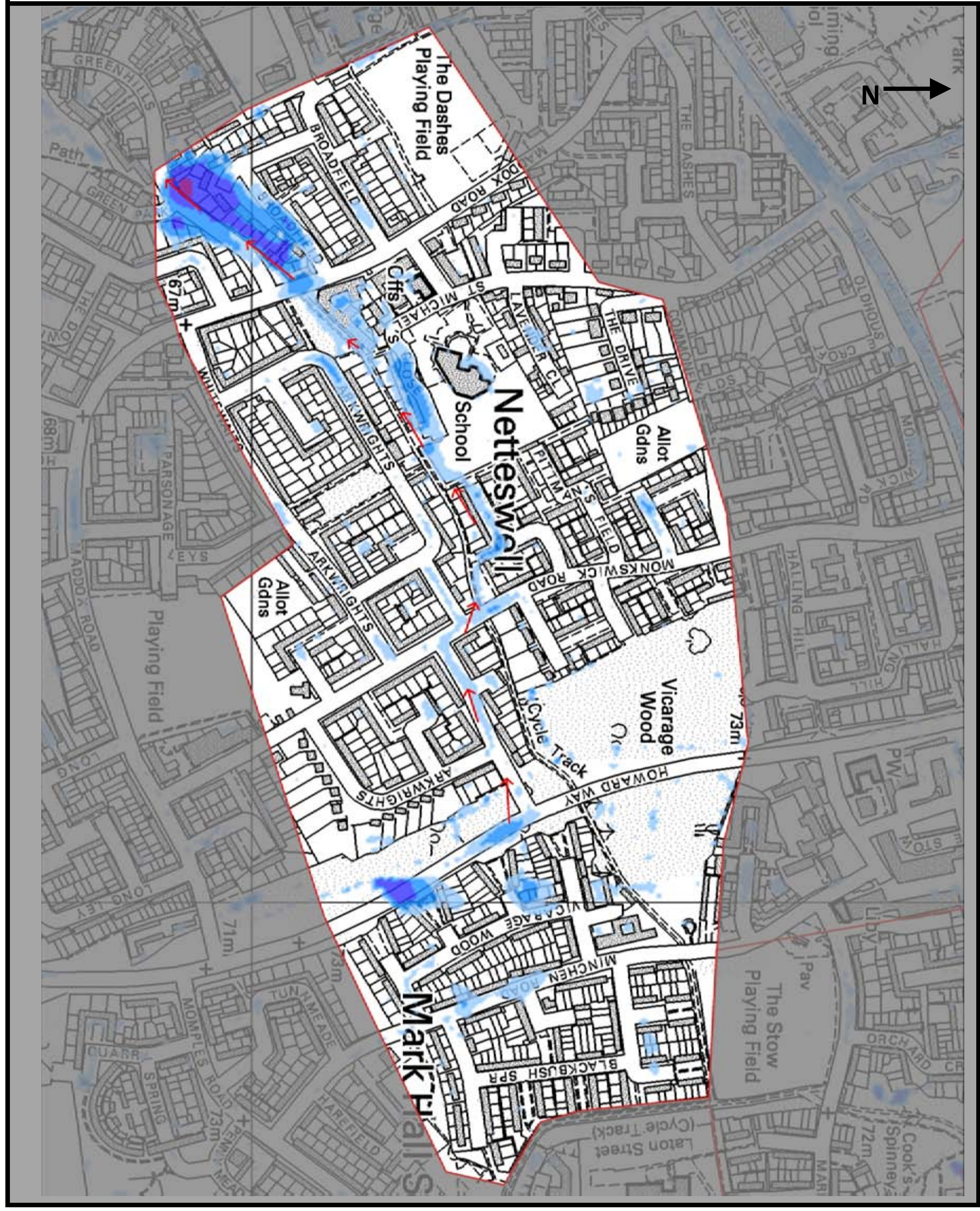
The drainage network within the CDA utilises a separated system.

This CDA is not at risk of groundwater flooding. There is an area of ' high risk' groundwater flooding from superficial deposits flooding from groundwater sources, but this is located outside (south-west) of the CDA

Critical Drainage Area

Harlow_010

Netteswell Area



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source	
Surface Water	Yes
Groundwater	No
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	No

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HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID: Harlow_010

	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**	(red)	Generic Measure	Throughout CDA	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
SOURCE	**Soakaways**	(red)	Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Swales**	(orange)	Generic Measure	Along the pedestrian pathway between Whitewaits and St Michael's Close.	To be identified on site-by-site basis but likely to have limited space within CDA.
SOURCE	**Permeable Paving**	(orange)	Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Broadfields County Primary School)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Rainwater Harvesting**	(green)	Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Broadfields County Primary School
SOURCE	**Detention Basins**	(green)	A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the Broadfields County Primary School playing field.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Ponds and Wetlands**	(green)	A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the Broadfields County Primary School playing field.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Other 'Source' Measures**	(green)	Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**	(green)	The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	The model results indicate that the upstream portion of the drainage network (within the CDA) is not operating at full capacity - the main area which is at capacity is near Green Park and Maddox Road.
PATHWAY	**Separation of Foul and Surface Water Sewers**	(red)	Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
PATHWAY	**Improved Maintenance Regimes**	(green)	Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
PATHWAY	**Managing Overland Flows (Online Storage)**	(orange)	Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
PATHWAY	**Managing Overland Flows (Preferential Flowpaths)**	(green)	Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features along the pedestrian pathway between Whitewaits and St Michael's Close to minimise runoff.	Disabled access along the road would need to be considered when assessing this measure.
PATHWAY	**Land Management Practices**	(orange)	Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
PATHWAY	**Deculverting Watercourse(s)**	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
PATHWAY	**Other 'Pathway' Measures**	(green)		Create new culvert near Green Park to reduce risk of ponding	Near Green Park to minimise ponding near residential properties
RECEPTOR	**Improved Weather Warning**	(orange)	Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
RECEPTOR	**Planning Policies to Influence Development**	(green)	Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
RECEPTOR	**Temporary or Demountable Flood Defences**	(green)	Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
RECEPTOR	**Social Change, Education and Awareness**	(green)	Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
RECEPTOR	**Improved Resilience and Resistance Measures**	(green)	Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - along the pedestrian pathway between Whitewaits and St Michael's Close.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
RECEPTOR	**Other 'Receptor' Measures**	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_010

		Standard Measures																							Short listing Options							
		SOURCE								PATHWAY								RECEPTOR														
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	**Flood Storage / Permeability**																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated Within the Broadfields County Primary School playing field and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**																							×								
8	**De-culvert / Increase Conveyance**															N/A								✓	1	1	0	1	2	5	✓	Create new culvert near Green Park to reduce risk of ponding
9	**Preferential / Designated Overland Flow Routes**																							✓	2	1	0	0	2	5	✓	Preferential overland flow route via raised kerbs or swale etc. along the pedestrian pathway between Whitewaits and St Michael's Close – investigate amending open space ground levels within the Broadfields County Primary School to divert flows from the preferential route in times of flood. Create an additional point of discharge for ponding near Green Park (the current model indicates the pipe network is flowing at capacity during the peak of the storm) The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Once the benefits of these measures have been assessed, the use of flood resistance/resilience should be incorporated within the properties located within the areas still identified to be at risk of surface water flooding. This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) and creating a new culvert could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located near Altham Grove, Harlow. There is one LFRZs within the CDA, which is located around Altham Grove. The hydraulic modelling results predict that runoff from areas at a higher elevation are conveyed to Altham Grove where water ponds behind an area of higher ground (which obstructs flow further to the west). A flood storage area appears to be located west of the LFRZ with the drainage pipe connected to this area running at 100% capacity during the peak of the storm. A site inspection of this area indicated that when the pipe system is running at capacity an overflow manhole might allow the surface water network to surcharge surface water into the open space east of School Lane (shown on the western boundary of the CDA).

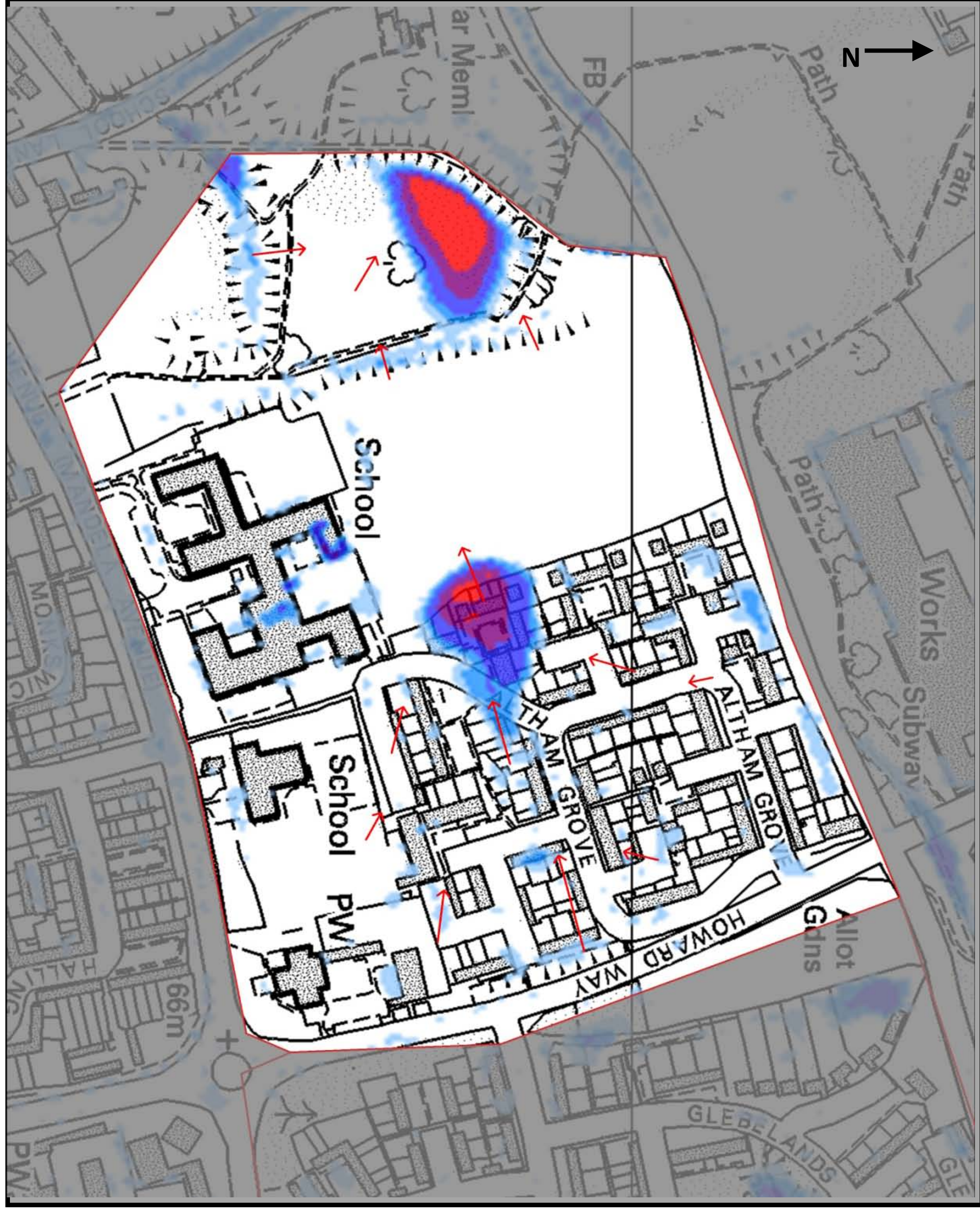
No fluvial flood zones are located within the CDA.

The drainage network within the CDA utilises a separated system.

The majority of CDA is at risk of superficial deposits flooding. The risk varies from 'very low' to 'very high risk', with a region at no risk running through the centre of the CDA from west to east.

Critical Drainage Area

Harlow_011



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

- < 0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- > 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	Green	Grey
Do Minimum	Green	Grey
Improved Maintenance	Green	Grey
Planning Policy	Green	Grey
Source Control, Attenuation and SUDS	Green	Grey
Flood Storage / Permeability	Green	Grey
Separate Surface Water and Foul Water Sewer Systems	Red	Grey
De-culvert / Increase Conveyance	Green	Grey
Preferential / Designated Overland Flow Routes	Green	Green
Community Resilience	Green	Green
Infrastructure Resilience	Red	Grey
Other - Improvement to Drainage Infrastructure	Green	Green
Other or Combination of Above	Green	Green

Altham Grove Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	No

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CAPITA SYMONDS

Essex County Council | Environment Agency | Harlow Council – Working together for Harlow | Thames Water

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

	Critical Drainage Area ID:	Harlow_011			
	Measure	**Opportunity Assessment**	**Description**	**Location / Specific Details**	**Comments**
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible retrofit on the existing school roofs (Burnt Mill School and Saint Albans Catholic Primary School) in the CDA	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
SOURCE	**Soakaways**		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Swales**		Generic Measure	N/A	To be identified on site-by-site basis but likely to have limited space within CDA.
SOURCE	**Permeable Paving**		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Burnt Mill School and Saint Albans Catholic Primary School)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Rainwater Harvesting**		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Burnt Mill School and Saint Albans Catholic Primary SchoolSchools
SOURCE	**Detention Basins**		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	N/A	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Ponds and Wetlands**		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the Burnt Mill School and Saint Albans Catholic Primary School playing fields.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Other 'Source' Measures**		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to divert flows (particularly from the OWC)into the Howard Way and Altham Grove drainage asset	The model results indicate that the main drainage network (>0.3m) within the CDA is operating at full capacity and may contribute to podning within the LFRZ
PATHWAY	**Separation of Foul and Surface Water Sewers**		Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
PATHWAY	**Improved Maintenance Regimes**		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
PATHWAY	**Managing Overland Flows (Online Storage)**		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
PATHWAY	**Managing Overland Flows (Preferential Flowpaths)**		Modifying street and kerb levels to create a formal flow path (blue corridor)	N/A	Disabled access along the road would need to be considered when assessing this measure.
PATHWAY	**Land Management Practices**		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
PATHWAY	**Deculverting Watercourse(s)**		Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	No watercourses impact the CDA	NA
PATHWAY	**Other 'Pathway' Measures**			Create an additional point of discharge for ponding within the area of open space north of Burnt Mill School	Near the Burnt Mill School to minimise ponding near residential properties
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
RECEPTOR	**Planning Policies to Influence Development**		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
RECEPTOR	**Temporary or Demountable Flood Defences**		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
RECEPTOR	**Social Change, Education and Awareness**		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
RECEPTOR	**Improved Resilience and Resistance Measures**		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - around Altham Grove	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
RECEPTOR	**Other 'Receptor' Measures**	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CAPITA SYMONDS

Critical Drainage Area ID: Harlow_011

Option No.	Option (Scheme Category)	Standard Measures																						Appropriate Measures Available?	Short listing Options						Take Forward Option to Detailed Assessment?	Comments
		SOURCE								PATHWAY								RECEPTOR														
		Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures		Technical	Economic	Social	Environmental	Objectives	Overall		
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	**Flood Storage / Permeability**																							✓	1	1	0	2	1	5	✓	A pond or wetland Within the Burnt Mill School and Saint Albans Catholic Primary School playing fields could have impacts on the dual use (recreation and runoff management).
7	**Separate Surface Water and Foul Water Sewer Systems**																							×								
8	**De-culvert / Increase Conveyance**																							✓	1	1	0	1	2	5	✓	Create an additional point of discharge for ponding near the Burnt Mill School
9	**Preferential / Designated Overland Flow Routes**																							✓	1	1	0	1	2	5	✓	Create an additional point of discharge for ponding near the LFRZ as the current model indicates the pipe network is flowing at full capacity during the peak of the storm;
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Once the benefits bypassing flows through the area of open space then use of flood resistance/resilience should be incorporated within the properties predicted to still be at risk of surface water flooding. This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and creating new culvert could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the Temple Fields area of Harlow with predicted runoff from the Mark Hall North portion of the catchment influencing ponding in the two LFRZs. The two LFRZs are located within the Temple Fields industrial area and could impact the existing gas holder station. The hydraulic modelling results predict that runoff from areas at a higher elevation are conveyed to temple fields down existing paths (which may be a lost watercourses) where surface water ponds within topographic low points and behind the raised railway embankment.

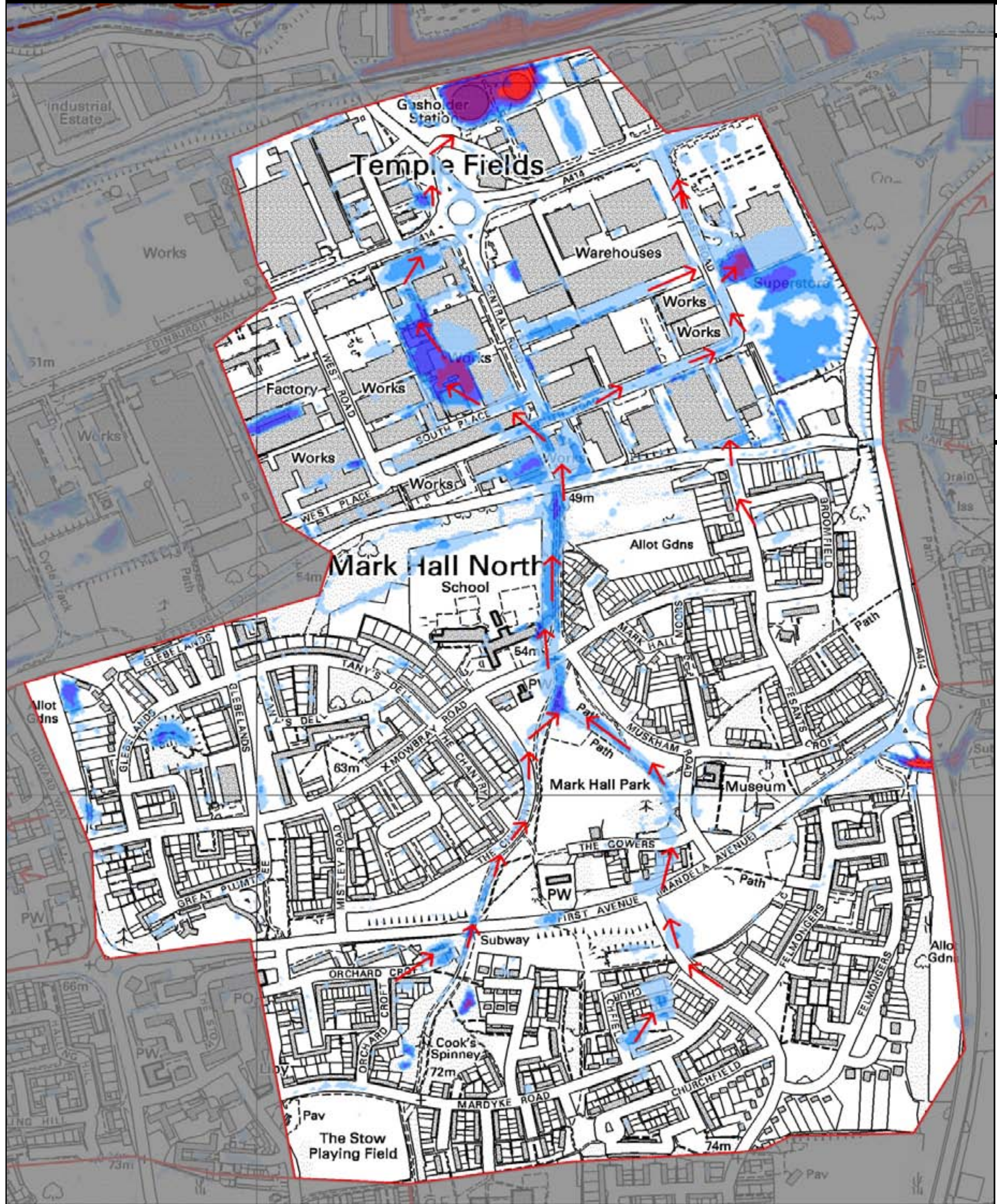
No fluvial flood zones are located within the CDA.

The drainage network within the CDA utilises a separated system.

The topographic highs along the south of the CDA are not at risk of groundwater flooding; the northern, lower lying region of the River Stort valley is at 'high' to 'very high' risk of groundwater flooding.

Critical Drainage Area

Harlow_012



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing	[green]	[grey]
Do Minimum	[green]	[grey]
Improved Maintenance	[green]	[grey]
Planning Policy	[green]	[grey]
Source Control, Attenuation and SUDS	[green]	[green]
Flood Storage / Permeability	[green]	[green]
Separate Surface Water and Foul Water Sewer Systems	[red]	[grey]
De-culvert / Increase Conveyance	[green]	[green]
Preferential / Designated Overland Flow Routes	[green]	[green]
Community Resilience	[green]	[green]
Infrastructure Resilience	[green]	[green]
Other - Improvement to Drainage Infrastructure	[green]	[green]
Other or Combination of Above	[green]	[green]

Temple Fields Area

Flood Risk Source

Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation

Historic Events	Yes
Site Inspection	No

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CAPITA SYMONDS

Essex County Council
Environment Agency
Harlow Council
Working together for Harlow
Thames Water

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID: Harlow_012

	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible location on Harlow Retail Park, on the buildins in the corner of West Road and South Place and on Harlow Pupil Referral Unit would require feasibility assessment	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Generic Measure	Throughout CDA - mostly in the Norther part of the CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Generic Measure	Along Tany's Dell Community Primary School	To be identified on site-by-site basis but likely to have limited space within CDA.
	Permeable Paving		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. within Kingsmoor County Junior and Milwards Nursery and Primary)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Harlow Retail Park, on the buildins in the corner of West Road and South Place and on Harlow Pupil Referral Unit
	Detention Basins		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within Mark Hall Park and between Tany's Dell Community Primary School and Netteswell Road	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	Within the Harlow Pupil Referral Unit playing field located north of the Redeemed Christian Church Of God	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA	The model results indicate that the main drainage network within the CDA is not operating at full capacity but it close to it on several branches - the main area to manage may be near Central road and Temple Fields
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Raise kerbing and construct speed bump features down Central Road to minimise any runoff. Create a cut-off drain / swale along Tany's Dell Community Primary School to reduce surface water runoff entering the school.	impacts on disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
	Other 'Pathway' Measures			Create new culvert between the gas facility and the drain to reduce risk of ponding	North of the rail line near River Way to minimise ponding near residential properties
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
	Improved Resilience and Resistance Measures		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - the gas holding facility (north of the rail line) and near the intersection of Central Road and South Place.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

Critical Drainage Area ID: Harlow_012

		Standard Measures – SOURCE								PATHWAY								RECEPTOR							Short listing Options							
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	**Flood Storage / Permeability**																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within Mark Hall Park and between Tany's Dell Community Primary School and Netteswell Road and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**																							×								
8	**De-culvert / Increase Conveyance**															N/A								✓	1	1	0	1	2	5	✓	Create new culvert between the gas facility and the drain to reduce risk of ponding
9	**Preferential / Designated Overland Flow Routes**																							✓	2	1	0	0	2	5	✓	Preferential flow routes down Central Road and create a cut-off drain / swale along Tany's Dell Community Primary School to reduce surface water runoff entering the school . The overall benefits from this option would need to be assessed within hydraulic model to determine its benefit.
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	1	5	✓	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																							✓	1	0	1	1	2	5	✓	Review internal drainage infrastructure of industrial/commercial units to determine if any flood risk reduction measures have been incorporated in these area . A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation. Determine if an additional discharge point between the gas holding facility (with a one way flap valve) can be provided between the gas facility and the drain to the north of the rail line.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices, preferential overland flows temporary storage (via detention basins within open space) and creating a new culvert could assist in reducing the peak volume of runoff entering the drainage network within the CDA.

Harlow Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the western portion of the Old Harlow area. The LFRZ is located around Jocelyns. The hydraulic modelling results predict that runoff from areas at a higher elevation are either conveyed to the west to an existing attenuation feature where runoff ponds and flows to the LFRZ due to the A414 causing an obstruction to flow (where an only drainage channel may have existed). These flows (along with flows from the south) are predicted to then pond within the LFRZ due to the ground north of the LFRZ being at a higher elevation.

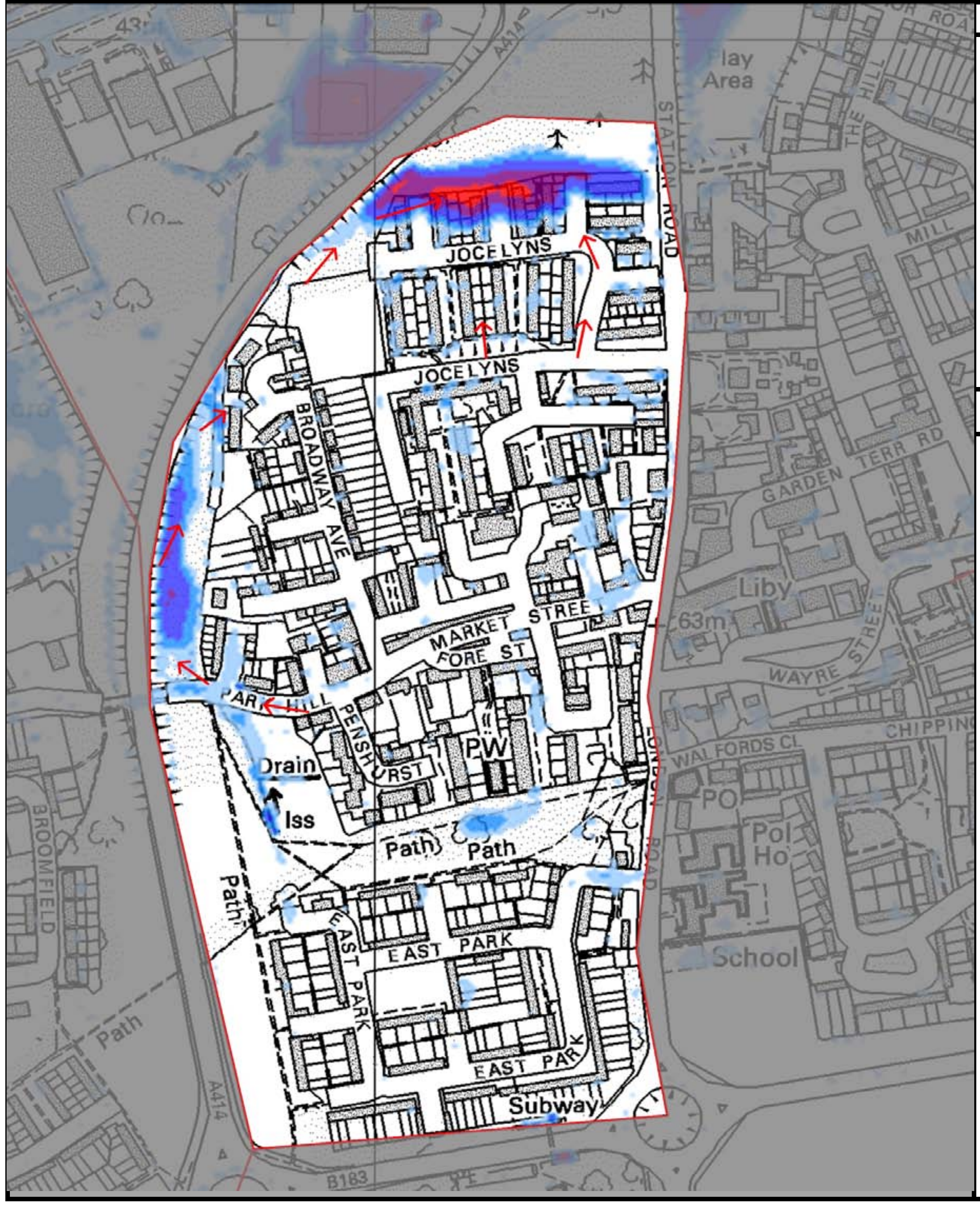
There is a small area of Flood Zone 2 located north of Jocelyns.

The drainage network within the CDA utilises a separated system.

The groundwater flood risk varies from no risk (approximately half of the CDA) to a 'moderate' risk of superficial deposits flooding.

Critical Drainage Area

Harlow_013



LEGEND

- Flow Direction
- Main River
- Ordinary Watercourse

Surface Water Flood Depth (m)

< 0.1m	0.5m to 1.0m
0.1m to 0.25m	1.0m to 1.5m
0.25m to 0.5m	> 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Old Harlow Area

Flood Risk Source	
Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	Yes
Tidal	No

Validation	
Historic Events	Yes
Site Inspection	Yes

Essex County Council Environment Agency Harlow Council Working together for Harlow Thames Water

CAPITA SYMONDS

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

IDENTIFICATION OF MEASURES

Critical Drainage Area ID: Harlow_013

	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	**Green Roof**		Generic Measure	Throughout CDA - possible location on Harlow Baptist Hall in Fore street and on Dennis C & Co building in the corner of Market street and Black Lion Court.	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
SOURCE	**Soakaways**		Generic Measure	Throughout CDA	Likely to be limited due to geology. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Swales**		Generic Measure	N/A - due to lack of space	To be identified on site-by-site basis but likely to have limited space within CDA.
SOURCE	**Permeable Paving**		Generic Measure	Throughout CDA - most suitable locations with large carpark or hard landscaping areas (e.g. In Broadway Avenue and in Seeleys)	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
SOURCE	**Rainwater Harvesting**		Generic Measure. For all new development and within existing dwelling (retrospective application)	Throughout CDA.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on Dennis C & Co building in the cornet of Market street and Black Lion Court, in Broadway Avenue and in Seeleys
SOURCE	**Detention Basins**		A strategically located detention basin could be constructed in the upper catchment to manage the volume of runoff discharging during the peak of the storm	Within the woodland located between Long Acre and the A414.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Ponds and Wetlands**		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA.	N/A - due to lack of space	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
SOURCE	**Other 'Source' Measures**		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Where possible locate these devices in sag points within the road to capture runoff for attenuation and treatment	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	**Increasing Capacity in Drainage Systems**		The existing drainage system capacity could be increased to accommodate storm water	It is recommended that additional gullies and drainage are included within the CDA to assist with draining areas of ponding between events.	Due to the inclusion of pipe >0.3m a large majority of this CDAs drainage network is not modelled.
PATHWAY	**Separation of Foul and Surface Water Sewers**		Separation of combined drainage networks into foul and surface water systems	N/A	There is a separate sewer system already in place.
PATHWAY	**Improved Maintenance Regimes**		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course
PATHWAY	**Managing Overland Flows (Online Storage)**		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' comments above	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
PATHWAY	**Managing Overland Flows (Preferential Flowpaths)**		Modifying street and kerb levels to create a formal flow path (blue corridor)	N/A	Disabled access along the road would need to be considered when assessing this measure.
PATHWAY	**Land Management Practices**		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates	Not applicable due to CDA being heavily urbanised.
PATHWAY	**Deculverting Watercourse(s)**	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA
PATHWAY	**Other 'Pathway' Measures**			Create new culvert under A414 to reduce risk of ponding	Above the woodland located between Long Acre and the A414 to minimise ponding near residential properties
RECEPTOR	**Improved Weather Warning**		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
RECEPTOR	**Planning Policies to Influence Development**		Generic Measure	Throughout CDA	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
RECEPTOR	**Temporary or Demountable Flood Defences**		Household / building level demountable flood barriers.	For all ground floor (and basement) properties in the CDA.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
RECEPTOR	**Social Change, Education and Awareness**		Generic Measure	Throughout CDA - particularly within areas at risk of flooding	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure
RECEPTOR	**Improved Resilience and Resistance Measures**		Property level resilience measures	The properties modelled to experience the greatest depths of flooding or vulnerable developments may benefit from this - around Jocelyn's	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
RECEPTOR	**Other 'Receptor' Measures**	N/A			

HARLOW SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

Critical Drainage Area ID: **Harlow_013**

		Standard Measures																						Short listing Options							
		SOURCE								PATHWAY								RECEPTOR													
Option No.	Option (Scheme Category)	Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sewers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures	Improved Weather Warning	Planning Policies to Influence Development	Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures	Appropriate Measures Available?	Technical	Economic	Social	Environmental	Objectives	Overall	Take Forward Option to Detailed Assessment?	Comments
1	**Do Nothing**																							✓	2	-1	-2	0	-2	-3	✓	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	**Do Minimum**																							✓	2	0	-1	0	-1	0	✓	
3	**Improved Maintenance**																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	**Planning Policy**																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on greenfield land within the CDA.
5	**Source Control, Attenuation and SUDS**																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits. It is recommended that temporary storage of flows from the upper catchment is investigated within the woodland located between Long Acre and the A414 and also utilised within all large open space areas (creating shallow temporary detention basins).
6	**Flood Storage / Permeability**																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the woodland located between Long Acre and the A414 and also utilised within all large open space areas (creating shallow temporary detention basins)
7	**Separate Surface Water and Foul Water Sewer Systems**																							×								
8	**De-culvert / Increase Conveyance**															N/A								✓	1	1	0	1	2	5	✓	Create new culvert between the gas facility and the drain to reduce risk of ponding
9	**Preferential / Designated Overland Flow Routes**																							✓	2	1	0	0	2	5	✓	Create new culvert under A414 to reduce risk of ponding
10	**Community Resilience**																						N/A	✓	2	1	1	0	1	5	✓	Once the benefits and feasibility of these measures have been assessed, the use of flood resistance/resilience should be incorporated within the any building/infrastructure that is still at risk. This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	**Infrastructure Resilience**																							✓	2	1	1	0	0	4	×	This option could be considered for schools and infrastructure predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	**Other - Improvement to Drainage Infrastructure**																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	**Other or Combination of Above**																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and the creation of a new culvet could assist in reducing the peak volume of runoff entering the drainage network within the CDA.