South Essex Level 1 Strategic Flood Risk Assessment

Final Report

April 2018
Project Number: 60532482

Quality information

Prepared by	Checked by	Approved by
Hannah Booth Graduate Water Consultant Joanna Bolding Hydrology Consultant Amy Ruocco Senior Consultant	Sarah Kelly Regional Director	Carl Pelling Associate

Revision History

Revision	Revision date	Details	Authorized	Name	Position
v1	November 2017	Draft for Comment	03/11/2017	Sarah Kelly	Regional Director
v2	April 2018	Final	27/04/2018	Carl Pelling	Associate Director

Prepared for:

Basildon Borough Council,
Castle Point Borough Council,
Rochford District Council,
Southend-on-Sea Borough Council, and
Essex County Council.

AECOM Limited
Midpoint
Alencon Link
Basingstoke
Hampshire RG21 7PP
UK

T: +44(0)1256 310200
aecom.com

Table of Contents

Figures

Tables

Abbreviations

ACRONYM	DEFINITION
AEP	Annual Exceedance Probability
AIMS	Asset Information Management System
AOD	Above Ordnance Datum
AStGWF	Areas Susceptible to Groundwater Flooding
AStSWF	Areas Susceptible to Surface Water Flooding
AWS	Anglian Water Services
BGS	British Geological Survey
CDA	Critical Drainage Area
CFMP	Catchment Flood Management Plan
Defra	Department for Environment, Flood and Rural Affairs
DCLG	Department for Communities and Local Government
ECC	Essex County Council
E&SW	Essex and Suffolk Water
FMfSW	Flood Map for Surface Water
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FWMA	Flood and Water Management Act 2010
GIS	Geographical Information System
IUD	Integrated Urban Drainage
LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
LRF	Local Resilience Forum
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
PPS	Planning Policy Statement
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water
SA	Sustainability Appraisal
SFRA	Strategic Flood Risk Assessment
SOP	Standard of Protection
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SWMP	Surface Water Management Plan
SuDS	Sustainable Drainage Systems
TTI	Time to Inundation
UKCP09	United Kingdom Climate Projections 2009

Glossary of Terms

GLOSSARY	DEFINITION
1D Hydraulic Model	Hydraulic model which computes flow in a single dimension, suitable for representing systems with a defined flow direction such as river channels, pipes and culverts
2D Hydraulic Model	Hydraulic model which computes flow in multiple dimensions, suitable for representing systems without a defined flow direction including topographic surfaces such as floodplains
Asset Information Management System (AIMS)	Environment Agency database of assets associated with main rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level plan 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.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions. For fluvial events a 20% increase in river flow is applied and for rainfall events, a 30% increase. These climate change values are based upon information within the NPPF and Planning Practice Guidance.
Culvert	A channel or pipe that carries water below the level of the ground.
Design flood	A flood event of a given annual probability against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed. The design event is generally taken as; fluvial flooding likely to occur with a 1% annual probability (1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year). Both should include a suitable allowance for climate change.
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.
Exception Test	The exception test should be applied following the application of the sequential test. Conditions need to be met before the exception test can be applied.
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 Resilience	Measures that minimise water ingress and promotes fast drying and easy cleaning, to prevent any permanent damage.
Flood Resistant	Measures to prevent flood water entering a building or damaging its fabric. This has the same meaning as flood proof.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Zone	Flood Zones show the probability of flooding, ignoring the presence of existing defences
Fluvial	Relating to the actions, processes and behaviour of a watercourse (river or stream).
Freeboard	Height of a flood defence's crest level (or building level) above designed water level/flood level.
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
ISIS	A 1D hydraulic modelling software package.
Lead Local Flood Authority (LLFA)	As defined by the Flood and Water Management Act, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area, in this case Southend-On-Sea Borough Council and Essex County Council.
Light Detection and Ranging (LiDAR)	Airborne ground survey mapping technique, which uses a laser to measure the distance between the aircraft and the ground.
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
main river	Watercourse defined on a 'main river Map' designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for main rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.

GLOSSARY	DEFINITION
Ordinary Watercourse	A watercourse that does not form part of a main river. This includes “all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows” according to the Land Drainage Act 1991.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	Aims to steer vulnerable development to areas of lowest flood risk.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Source Protection Zone (SPZ)	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.
Surface Water	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Topographic survey	A survey of ground levels.
TUFLOW	A modelling package for simulating depth averaged 2D free-surface flows and is in widespread use in the UK and elsewhere for 2D inundation modelling.

Executive Summary

The South Essex study area is located in the east of England and comprises the administrative areas of the following Local Planning Authorities (LPA): Basildon Borough Council, Castle Point Borough Council, Rochford District Council and Southend-On-Sea Borough Council. A joint Level 1 Strategic Flood Risk Assessment (SFRA) has been undertaken for the authorities within the study area.

The National Planning Policy Framework (NPPF)[1] emphasises the responsibilities for LPAs to ensure that flood risk is understood and managed effectively through all stages of the planning process. This Level 1 SFRA facilitates this by identifying the spatial variation in flood risk across the South Essex study area, providing guidance to the LPAs for each Authority on using the SFRA within the plan making process and providing guidance to developers in the preparation of site specific Flood Risk Assessments (FRAs).

Specifically, the SFRA;

- Refines information on flood risk taking into account all sources of flooding and the impacts of climate change;
- Informs the Sustainability Appraisal process, so that flood risk is fully taken into account;
- Informs the application of the Sequential and, if necessary, Exception Tests in the allocation of future development sites, as required by the NPPF, and planning application process;
- Identifies the requirements for site specific FRAs;
- Informs the preparation of flood risk policy and guidance;
- Determines the acceptability of flood risk in relation to emergency planning capability; and,
- Considers opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and storage for flood water.

In the preparation of the Level 1 SFRA, the most up-to-date flood risk information from all flooding sources (tidal, fluvial, surface water, groundwater, sewer and artificial sources) has been collated, reviewed and presented for use by the South Essex Authorities to inform the preparation of Local Plans and prudent decision-making by Development Management officers on a day-to-day basis. This has included collation of existing hydraulic modelling outputs combined with updated hydraulic modelling (including flood defence breach analysis) to inform the SFRA mapping.

The Environment Agency identifies the tidal and fluvial floodplains associated with main rivers and tidal sources across the study area, presented in the Flood Map for Planning and mapped within this SFRA. These maps should be used for planning purposes when testing potential development sites against the requirements of the NPPF. In addition, this SFRA has also mapped the impact of climate change, the potential extent of breaches of flood defences and extents of functional floodplain, which are not included within published Environment Agency mapping. This has been defined by additional hydraulic modelling to determine these areas of risk.

The SFRA identifies that the South Essex Authority areas are at risk of tidal flooding from a combination of estuaries and the North Sea and at risk of fluvial flooding from a number of watercourses flowing through the authority areas. Whilst each of these sources pose a potential risk of flooding to properties within the study area, formal flood defences provide a significant level of protection for much of the property and land uses. Residual risk from breaches of the defences exists and this has been defined within the SFRA using the outputs of hydraulic modelling. The potential risk of flooding from other sources exists throughout the study area, including significant areas of surface water flooding as a result of heavy rainfall and limited capacity of drainage infrastructure; this is particularly the case on Canvey Island in the Castle Point Borough. Critical Drainage Areas, as defined through Surface Water Management Plans (SWMP) undertaken across the study area, are present in all of the South Essex authority areas. Groundwater flood risk across the study are is generally low, however there are areas of risk associated with superficial geology, particularly where groundwater levels are hydraulically connected to tidal water levels. Generally, flood risk from artificial sources is low across the study area

The SFRA provides an overview of the risk of flooding from all sources across the South Essex authority area and should be used to assist in the development of policy formulation, strategic planning, development control and flood risk management.

[1] National Planning Policy Framework, Published 8th May 2012 https://www.gov.uk/government/publications/national-planning-policy-framework--3

1. Introduction

The National Planning Policy Framework (NPPF) [2] and associated Planning Practice Guidance (PPG) for Flood Risk and Coastal Change[3] emphasise the active role Local Planning Authorities (LPAs) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

The Flood and Water Management Act (FWMA)[4] attained royal assent in 2010, with the intention of enabling the provision of more effective flood management following the flooding of July 2007. As such, Essex County Council (ECC) is the designated Lead Local Flood Authority (LLFA) for Basildon Borough, Castle Point Borough and Rochford District. Southend-on-Sea Borough is the designated LLFA for its Borough. LLFA's have significant duties and powers in relation to flooding from local sources, specifically surface water, groundwater and ordinary watercourses. The Environment Agency retains responsibility for leading and coordinating the management of flood risk associated with main rivers and the sea.

AECOM has been commissioned by Basildon Borough, Castle Point Borough, Rochford District and Southend-on-Sea Borough Councils (hereon referred to as South Essex Authorities) to update their existing Level 1 SFRAs. Level 1 and 2 SFRAs for Basildon Borough[5,6], Castle Point Borough[7] and Rochford District[8] were prepared and published in 2011 as part of a joint commission and the Level 1[9] and Level 2[10] SFRAs for Southend-on-Sea Borough Council were published in 2010. The methodology followed in this study complies with the NPPF and accompanying PPG as well as guidelines from the Environment Agency, and forms a combined Level 1 SFRA for the South Essex Authorities. The SFRA has been completed in collaboration with the South Essex Authorities, ECC as the LLFA, the Environment Agency and Anglian Water Services (AWS). The results of this SFRA are intended to inform strategic land use planning and decision making from a flood risk perspective.

1.1 Approach to Flood Risk Management

The NPPF and associated PPG for Flood Risk and Coastal Change emphasise the active role LPAs should take to ensure that flood risk is assessed, avoided, and managed effectively and sustainably throughout all stages of the planning process. The overall approach for the consideration of flood risk set out in Section 1 of the PPG can be summarised as follows:

This has implications for LPAs and developers as described below.

1.1.1 Assess flood risk

Local Plans should be supported by an SFRA and LPAs should use the findings to inform strategic land use planning. Figure 1-1, reproduced from the PPG, illustrates how flood risk should be taken into account in the preparation of a Local Plan.

For sites in areas at risk of flooding, or with an area of 1 hectare or greater, developers must undertake a site specific Flood Risk Assessment (FRA) to accompany planning applications (or prior approval for certain types of permitted development).

[2] National Planning Policy Framework, Published 8th May 2012 https://www.gov.uk/government/publications/national-planning-policy-framework--3
[3] Communities and Local Government. 2014. Planning Practice Guidance: Flood Risk and Coastal Change. Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
[4] Flood and Water Management Act 2010. Available at: http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf
[5] URS Scott Wilson. 2011. Basildon Borough Council Level 1 SFRA. http://www.basildon.gov.uk/CHttpHandler.ashx?id=3280&p=0
[6] URS Scott Wilson. 2011. Basildon Borough Council Level 2 SFRA. http://www.basildon.gov.uk/CHttpHandler.ashx?id=3810&p=0
[7] URS Scott Wilson. 2011. Castle Point Borough Council Level 1 and Level 2 SFRA. https://www.castlepoint.gov.uk/download.cfm?doc=docm93jijm4n808.pdf&ver=956
[8] URS Scott Wilson. 2011. Rochford District Council Level 1 and Level 2 SFRA. https://www.rochford.gov.uk/sites/default/files/ldf_evibase_flood_1_78.pdf
[9] Scott Wilson. 2010. *Southend-on-Sea Borough Council Level 1 SFRA.* *http://www.southend.gov.uk/downloads/download/303/southend_flood_risk_assessment*
[10] Scott Wilson. 2010. *Southend-on-Sea Borough Council Level 2 SFRA.* *http://www.southend.gov.uk/downloads/download/303/southend_flood_risk_assessment*

1.1.2 Avoid flood risk

The South Essex Authorities should apply the sequential approach to site selection so that development is, as far as reasonably possible, located where the risk of flooding from all sources is lowest, taking account of climate change and the vulnerability of future users to flood risk.

In plan-making this involves applying the Sequential Test, and where necessary the Exception Test to Local Plans, as described in Figure 1-1.

In decision-making this involves applying the Sequential Test and if necessary the Exception Test for specific development proposals.

1.1.3 Manage and mitigate flood risk

Where alternative sites in areas at lower risk of flooding are not available, it may be necessary to locate development in areas at risk of flooding. In these cases, the South Essex Authorities and developers must ensure that development is appropriately flood resilient and resistant, safe for its users for the lifetime of the development, and will not increase flood risk overall. The South Essex Authorities and developers should seek flood risk management opportunities (e.g. safeguarding land), and to reduce the causes and impacts of flooding (e.g. through the use of sustainable drainage systems (SuDS)).

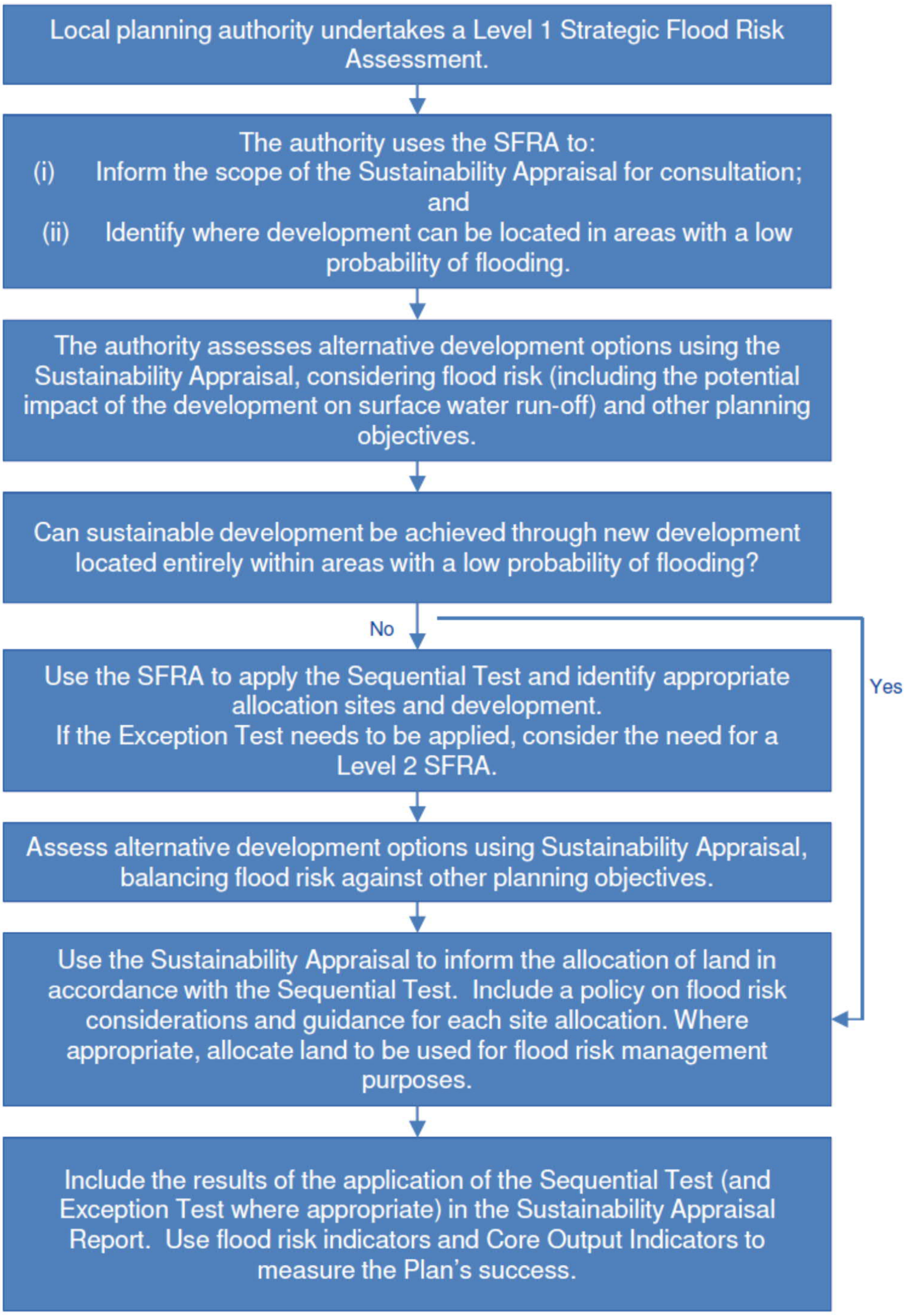

Figure 1-1 Taking flood risk into account in the preparation of a Local Plan (PPG for Flood Risk and Coastal Change, pg.6)

1.2 SFRA Aims and Objectives

The aim of this SFRA is to collate and present the most up to date flood risk information from all sources for use by the South Essex Authorities to inform the preparation of Local Plans and prudent decision-making by Development Management officers on a day-to-day basis.

In order to achieve this the SFRA:

- Refines information on flood risk taking into account all sources of flooding and the impacts of climate change;
- Informs the Sustainability Appraisal process, so that flood risk is fully taken into account;
- Informs the application of the Sequential and, if necessary, Exception Tests in the allocation of future development sites, as required by the NPPF, and planning application process;
- Identifies the requirements for site specific Flood Risk Assessments (FRAs);
- Informs the preparation of flood risk policy and guidance;
- Determines the acceptability of flood risk in relation to emergency planning capability; and,
- Considers opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and storage for flood water.

1.3 Level 1 SFRA Deliverables

The SFRA will have a number of end users, with different requirements. This Section describes how to use the SFRA and how to navigate the report and mapping deliverables.

One combined Level 1 SFRA report has been prepared for the four authority areas and is structured as follows:

- Section 1: Study Area Description and Partner Organisations
- Section 2: Level 1 Methodology and Datasets
- Section 3: Climate Change
- Section 4: Flood Risk in the Basildon Borough
- Section 5: Flood Risk in the Castle Point Borough
- Section 6: Flood Risk in the Rochford District
- Section 7: Flood Risk in the Southend-on-Sea Borough
- Section 8: Guidance on the Application of the Sequential Test
- Section 9: Guidance for Managing and Mitigating Flood Risk
- Section 10: Guidance for the Application of Sustainable Drainage Systems
- Section 11: What is a Flood Risk Assessment?
- Section 12: Next Steps
- Appendix A: Figures
- Appendix B: Flood Risk Policy and Development Management Considerations
- Appendix C: Prittle Brook Climate Change Modelling
- Appendix D: South Essex Breach Modelling Methodology
- Appendix E: South Essex Breach Mapping

Sections 4 to 7 provide a strategic assessment of flood risk from all sources across the four areas. The suite of figures included within Appendix A should be referenced when reading these Sections.

Section 8 provides guidance on the application of the Sequential Test by each LPA when allocating future development sites as part of the plan-making process, as well as by developers promoting development on windfall sites. The strategic assessment of flood risk presented in Sections 4-7 will inform the completion of the Sequential Test.

Sections 9 to 11 present guidance for managing and mitigating flood risk, the application of SuDS, and the preparation of site specific FRAs.

Appendix B outlines a number of flood risk management objectives and policy considerations which may be developed and adopted by the South Essex Authorities as formal policies within their developing Local Plans.

1.4 Study Area

The study area for this SFRA is defined by the administrative boundaries of Basildon Borough, Castle Point Borough, Rochford District and Southend-on-Sea Borough, illustrated in Appendix A Figure 1.0. These areas form a large part of South Essex bordered to the north by the Chelmsford City District and Maldon District, to the south west by Thurrock Borough and to the west by Brentwood Borough.

Further detail for each administrative boundary is included in Sections 4 to 7 of this report.

1.5 Partner Organisations

There are several organisations involved in development and flood risk management across the study area. These are identified below.

Basildon Borough Council, Castle Point Borough Council, Rochford District Council and Southend-on-Sea Borough Council are the LPAs for the study area, responsible for long term strategic planning of future development through the preparation of Local Plans, as well as for determining planning applications within each Borough. Under the FWMA Southend-on-Sea is also the LLFA for the respective administrative area, and has a duty to take the lead on the management of local flood risk, which includes flood risk from surface water, groundwater and ordinary watercourses. From 6th April 2015, SuDS are required for all major developments[11], where appropriate, and through the use of planning conditions or planning obligations, clear arrangements are required to be put in place for the ongoing maintenance of SuDS over the lifetime of the development.

Essex County Council (ECC) is the LLFA for the Basildon Borough, Castle Point Borough and the Rochford District. ECC has a duty to take the lead on the management of local flood risk, which includes flood risk from surface water, groundwater and ordinary watercourses.

The Environment Agency has a strategic overview role for flood risk management associated with main rivers in South Essex (River Crouch, River Roach, Prittle Brook, Eastwood Brook, The Thames Estuary, and Willingale Brook) and is a statutory consultee for any development proposed within Flood Zone 2 and 3 associated with these watercourses. The Environment Agency is continually improving and updating their flood map for main rivers and has permissive powers to carry out flood defence works, maintenance and operational activities for main rivers. However, overall responsibility for maintenance lies with the riparian owner.

Anglian Water Services (AWS) has a duty as a statutory water undertaker to provide waste water services to the study area and is responsible for the management, maintenance and operation of flood control structures under their ownership. Water Companies are defined as a Risk Management Authority within the FWMA and are responsible for flood risk management functions in accordance with the Water Resources Act 1991 and the Land Drainage Act 1991. AWS is responsible for surface water drainage from development via adopted sewers and for maintaining trunk sewers into which many of the highway drainage in the study area connects.

Essex and Suffolk Water (E&SW) has a duty as a statutory water undertaker to provide clean water services to the study area and is responsible for the management, maintenance and operation of flood control structures under their ownership.

1.6 Flood Risk Policy and Guidance

There is an established body of policy and guidance documents which are of particular importance when considering development and flood risk. These are identified in Table1-1 along with links to the relevant documents where these are available.

[11] Developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010)

Table 1-1 Flood Risk Policy

National Policy Documents		
National Planning Policy Framework (para. 99-104)	The NPPF was published by the UK's DCLG in March 2012, consolidating over two dozen previously issued documents called Planning Policy Statements (PPS) and Planning Policy Guidance Notes (PPG) for use in England.	https://www.gov.uk/government/publications/national-planning-policy-framework--2
Flood and Water Management Act (2010)	Provides for a more comprehensive management of flood risk and formalises risk management roles and responsibilities.	http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf
Flood Risk Regulations (2009)	The Flood Risk Regulations transpose the EU Floods Directive into law in England. It aims to provide a consistent approach to flood risk across Europe.	http://www.legislation.gov.uk/uksi/2009/3042/pdfs/uksi_20093042_en.pdf
National Strategy for Flood and Coastal Erosion Risk Management (Defra, Environment Agency, 2011)	This strategy provides the framework for all flood and coastal risk management authorities, setting out long-term objectives for managing flood and coastal erosion risks.	https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england
Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities' (Environment Agency 2016)	This document outlines new climate change allowances for river flood flows and extreme rainfall for each of the river basin districts in England.	https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities
Regional Flood Risk Policy		
Anglian River Basin District Flood Risk Management Plan (2015-2021), Environment Agency	This document sets out the proposed measures to manage flood risk in the Anglian River Basin District from 2015 to 2021 and beyond.	https://www.gov.uk/government/publications/anglian-river-basin-district-flood-risk-management-plan
Thames Estuary 2100 Plan	How the Environment Agency is planning to manage tidal flood risk in the Thames estuary until the year 2100. Specific policy from this document relating to each Borough is discussed in more detail within corresponding chapters.	https://www.gov.uk/government/publications/thames-estuary-2100-te2100
Essex and Suffolk Shoreline Management Plan	Covering 550km of coastline from the Stour and Orwell Estuaries in Suffolk to Two Tree Island near Southend-on-Sea. The SMP's policies are compatible with the policy proposed by the Thames Estuary 2100 strategy.	http://eacg.org.uk/smp8.asp
Guidance Documents		
Planning Policy Guidance – Flood Risk and Coastal Change	Describes the planning approach to development within areas at risk of flooding from all sources	http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
Environment Agency Standing Advice	Guidance on information to be included within robust site specific FRAs	https://www.gov.uk/guidance/flood-risk-assessment-standing-advice
Local Documents and Strategies		
ECC Local Flood Risk Management Strategy (LFRMS) (2013)	As LLFAs, ECC and Southend-on-Sea Borough Council each have a statutory duty to develop, maintain, apply and monitor a strategy for local flood risk management in their respective administrative areas which is outlined in their LFRMS'.	https://www.essex.gov.uk/Publications/Documents/Local_Flood_Risk_Management_strategy.pdf
Southend-on-Sea Local Flood Risk Management Strategy (2015)		http://www.southend.gov.uk/downloads/download/578/surface_water_and_flooding_strategies
ECC Surface Water Management Plan (SWMP)	A Surface Water Management Plan (SWMP) is a framework to understand the causes of surface water	http://www.basildon.gov.uk/CHttpHandler.ashx?id=5316&p=0

(including Basildon Borough, Castle Point Borough and Rochford District) 2011	flooding and agree the most cost effective way of managing surface water flood risk	
Southend-on-Sea SWMP 2015		http://www.southend.gov.uk/downloads/download/578/surface_water_and_flooding_strategies
ECC Preliminary Flood Risk Assessment (PFRA) 2017	A high level screening exercise to identify areas of significant risk as Indicative Flood Risk Areas across England where 30,000 people or more are at risk from flooding for reporting to Europe.	https://www.gov.uk/government/publications/anglian-river-basin-district-preliminary-flood-risk-assessments
Southend-on-Sea PFRA (2017)		

Figure 1-2 identifies that the main driver for the SFRA is the NPPF, and that documents and plans prepared by both the Environment Agency and each of the South Essex Authorities under the requirements of the FWMA and the Flood Risk Regulations, provide key inputs to inform the preparation of the updated SFRA and Local Plans. Detail on specific planning policy is included within Borough specific chapters of this report.

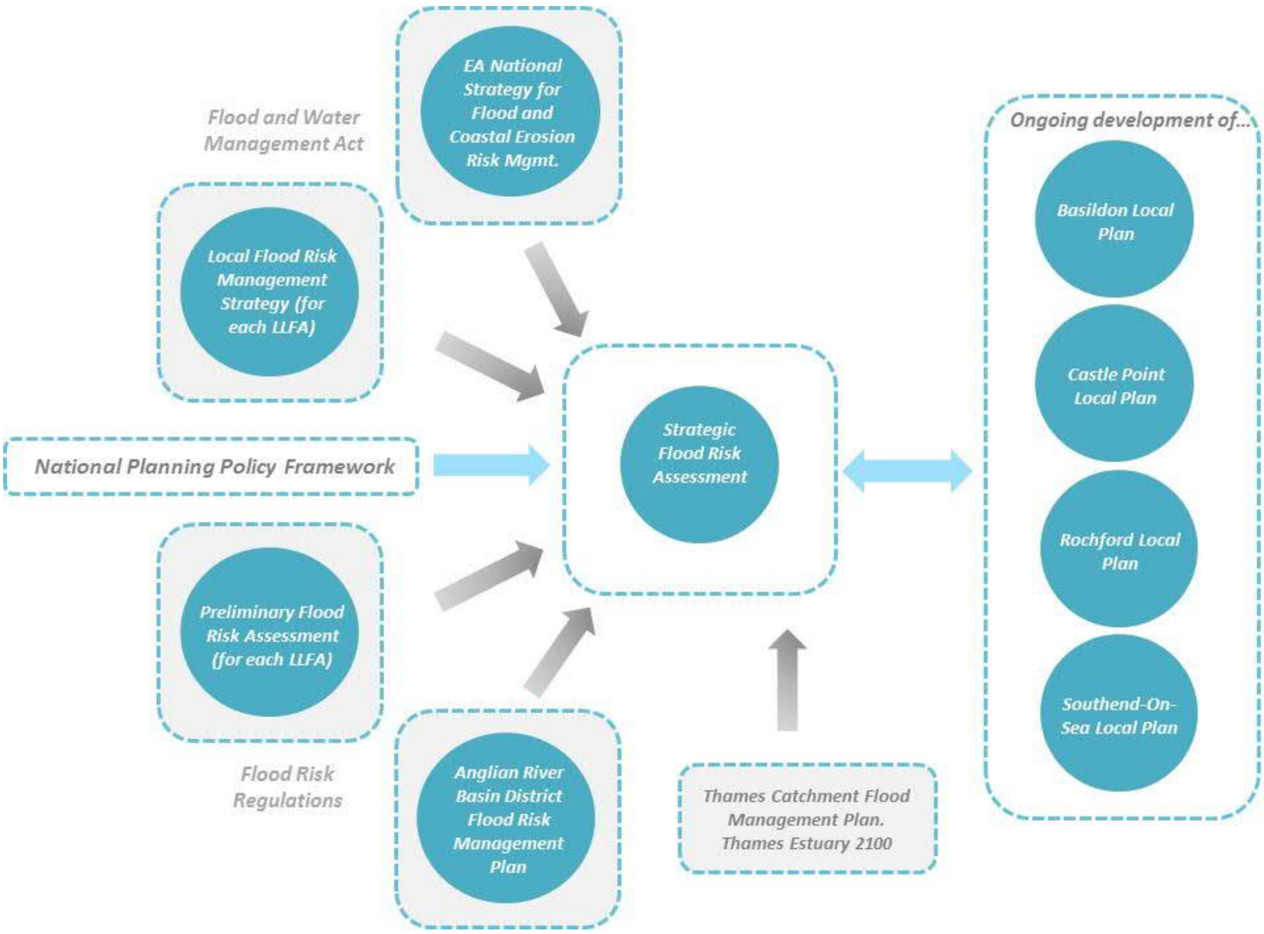

Figure 1-2 Summary of Legislative and Planning Context

2. Level 1 SFRA Methodology

2.1 Level 1 SFRA Approach

The Level 1 SFRA is a desk-based study, using readily available existing information and additional modelling datasets to enable the application of the Sequential Test and to identify where the Exception Test may be required. The main tasks in preparing the Level 1 SFRA are described below.

1. Establishing relationships and understanding the planning context - Upon project commencement, a stakeholder workshop was held to facilitate relationships between the project team, the client group, and third party stakeholders. The purpose of the meeting was to aid collaborative working and the free exchange of available information and datasets. AECOM provided an overview of the current planning context with respect to the preparation of the SFRA and the main flood risk issues in the area were identified and discussed.

2. Gathering data and analysing it for suitability - In order to provide this assessment of all sources of flooding in the study area, an extensive set of datasets was referenced or relicensed for use. This information was subject to a quality review and gap analysis by the project team to determine the best datasets for inclusion in the Level 1 SFRA update.

3. Producing strategic flood risk maps, GIS deliverables and a technical report - A series of GIS maps have been produced to illustrate flood risk across the study area. The mapping deliverables are included within Appendix A and Appendix E.

2.2 Flooding from Rivers and Sea

2.2.1 Environment Agency main rivers

The Environment Agency 'Statutory main river Map' has been used to identify main rivers within the study area. These rivers are usually larger rivers and streams which are designated by the Environment Agency as main rivers. The Environment Agency carries out maintenance, improvements or other work on main rivers to mitigate flood risk.

The Ordnance Survey 'OS Open Rivers' dataset has been used to identify watercourses in the study area, the approximate location of which are shown in Appendix A Figure 1.0.

2.2.2 Historic Records of River and Tidal Flooding

Since 2010, information on historical flooding in the study area has been gathered as part of the preparation of the LFRMS', SWMPs and PFRAs for the South Essex Authorities. Incidents of property and highway flooding have been provided to the Authorities from local residents and businesses, as well as the Environment Agency. Where possible, the source of the flooding has been identified.

The Environment Agency has provided an extract from the 'Historic Flood Map' datasets for the study area[12]. The Historic Flood Map dataset for each Authority area is also presented in Appendix A Figure 4.3 (Basildon Borough), Figure 5.3 (Castle Point Borough), Figure 6.3 (Rochford District) and Figure 7.3 (Southend-on-Sea Borough).

2.2.3 NPPF Flood Zones

The risk of flooding is a function of the probability that a flood will occur and the consequence to the community or receptor as a direct result of flooding. The NPPF seeks to assess the probability of flooding from rivers by categorising areas within the fluvial floodplain into zones of low, medium and high probability, as defined in Table 2-1.

[12] The Environment Agency 'Historic Flood Map' shows the greatest extent of past flooding and does not identify individual flood events.

Table 2-1 Fluvial Flood Zones (extracted from the PPG, 2014)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land having a less than 1 in 1000 (0.1%) annual exceedance probability (AEP) of river or tidal flooding. Shown as clear on the Flood Map – all land outside Flood Zones 2 and 3.	Low
Flood Zone 2	Land having between a 1 in 100 (fluvial) / 1:200 (tidal) and 1 in 1000 annual probability of flooding (between 1%/0.5% and 0.1% AEP).	Medium
Flood Zone 3a	Land having a 1 in 100 (fluvial) / 1:200 (tidal) or greater annual probability of flooding (greater than 1%/0.5% AEP).	High
Flood Zone 3b	As defined by the NPPF this is land where water has to flow or be stored in times of flood. Its extent can be defined in different ways, including defined flood storage areas (such as washlands designed to flood) and undefended sections of floodplain where frequent flooding occurs. The functional floodplain is not separately distinguished from Flood Zone 3a on the Environment Agency Flood Map for Planning (Rivers and Sea). LPAs are therefore required to identify areas of functional floodplain as part of their SFRA, in discussion with the Environment Agency.	Functional Floodplain

The 'Flood Map for Planning (Rivers and Sea)' is available on the Environment Agency website[13] and is the main reference for planning purposes as it maps Flood Zones 1, 2 and 3 in accordance with the PPG (Table 2-1). The 'Flood Map for Planning (Rivers and the Sea)' provides information on the areas that would flood if there were no flood defences or buildings in the "natural" floodplain.

The 'Flood Map for Planning (Rivers and Sea)' was first developed in 2004 using national generalised modelling (JFLOW) and is now routinely updated and revised using the results from the Environment Agency's programme of catchment studies, entailing topographic surveys and hydrological and/or hydraulic modelling as well as previous flood events.

It should be noted that the scope of these modelling studies typically covers flooding associated with main rivers, and ordinary watercourses that form tributaries to the main rivers may not always be included in the model. Modelling of ordinary watercourses may need to be refined when determining the probability of flooding for an individual site and preparing a site specific FRA.

Flood zones GIS layers have been provided by the Environment Agency for the study area and are presented in Appendix A Figure 4.1 (Basildon Borough), Figure 5.1 (Castle Point Borough), Figure 6.1 (Rochford District) and Figure 7.1 (Southend-on-Sea Borough). Specific detail with regard to the source of modelling data is included within each Borough-specific Section in the SFRA (Sections 4 to 7).

It should be noted that additional flood risk mapping is available on the Environment Agency website which is referred to as 'Risk of Flooding from Rivers and Sea'[14]. This map takes into account the presence of flood defences and how the standard of protection they offer affects the relative risk of flooding to land and property. While flood defences reduce the level of risk they don't completely remove it as they can be overtopped or fail in extreme weather conditions, or if they are in poor condition. As a result the maps may show areas behind defences which still have some risk of flooding. This mapping has been made available by the Environment Agency as the primary method of communicating flood risk to members of the public, however for planning purposes the 'Flood Map for Planning (Rivers and the Sea)' and associated flood zones remains the primary source of information.

2.2.4 Functional Floodplain- Flood Zone 3b

The Functional Floodplain is defined in the NPPF as 'land where water has to flow or be stored in times of flood'. The Functional Floodplain (also referred to as Flood Zone 3b), is not distinguished from Flood Zone 3a on the Flood Map for Planning (Rivers and Sea). Rather the SFRA is the means by which LPAs should identify areas of Functional Floodplain in discussion with the Environment Agency.

For the purposes of this SFRA, identification of the functional floodplain has been undertaken using a combination of modelled data (where available) to define the land area which would naturally flood with an annual probability of 1 in 20

[13] Environment Agency Flood Map for Planning (Rivers and Sea) https://flood-map-for-planning.service.gov.uk/
[14] Environment Agency 'Risk of Flooding from Rivers and Sea' https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=463722.696&northing=152577.6

(5% AEP) or greater in any year, and identifying land which is designed to flood (such as a flood attenuation scheme, washland or flood storage area). Areas which would naturally flood with an annual probability of 1 in 20 or greater, but are prevented from doing so by existing infrastructure or solid buildings will not be defined as functional floodplain. This approach has been discussed with and agreed by the Environment Agency.

Where modelled data was available to define the extent of Flood Zone 3b for each South Essex Authority area, this is shown in Appendix A Figure 4.1 (Basildon Borough), Figure 5.1 (Castle Point Borough), Figure 6.1 (Rochford District) and Figure 7.1 (Southend-on-Sea Borough). Details on where modelled data was available is set out in each Borough Section of this report.

2.2.5 Flood Defences

The 'Flood Map for Planning (Rivers and Sea)' also identifies areas which, in the event of a fluvial flood with a 1% AEP, or a tidal flood with a 0.5% AEP, would be protected from flooding by the presence of flood defences. These areas are described as 'Areas Benefitting from Defences' (ABD). Any areas which benefit from defences not owned by the Environment Agency are not represented on this map.

Flood defences are structures which affect flow in times of flooding in order to reduce the risk of water entering property. They generally fall into one of two categories described as 'formal' or 'informal':

- A 'formal' flood defence is a structure which has been specifically built to control floodwater. It is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In accordance with the Flood and Water Management Act, the Environment Agency has powers to construct and maintain defences to help against flooding. As an Operating Authority under the Coast Protection Act 1949, Southend-on-Sea Borough Council also has powers to construct and maintain defences.
- An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls) which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

A study of informal flood defences has not been made as part of this assessment. Should any changes be planned in the vicinity of road or railway crossings over rivers in the study area it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. Smaller scale informal flood defences should be identified as part of site specific FRAs and the residual risk of their failure assessed.

A high level review of formal flood defences has been carried out using data from the Environment Agency Asset Information Management System (AIMS). The AIMS dataset contains details of flood defence assets associated with main rivers and tidal defences, and provides a good starting point for identifying significant local defences and potential areas benefiting from defences, but the quantity and quality of information provided differs considerably between structures. The AIMS is intended to provide a reasonable indication of the condition of an asset and should not be considered to contain consistently detailed and accurate data (this would be undertaken as part of a Level 2 SFRA or site specific FRA where the need arises).

Flood defences and areas benefitting from flood defences in the study area are presented in Appendix A Figure 4.1 (Basildon Borough), Figure 5.1 (Castle Point Borough), Figure 6.1 (Rochford District) and Figure 7.1 (Southend-on-Sea Borough).

2.2.6 Tidal Risk and Breach Modelling

The area around South Essex including the North Thames Bank and Crouch Estuaries are exposed to the tidal influence of the North Sea. The existing tidal defences protect these areas from tidal inundation and therefore the risk of flooding to South Essex is a residual risk, only if the defences fail (breach).

Residual risk can be defined as 'the remaining risk following the implementation of all risk avoidance, reduction and mitigation measures' (Communities and Local Government, 2007).

Breach modelling for the South Essex Authorities was undertaken as part of the previous SFRAs in 2010 and 2011and included simulating a breach within the existing defences at several locations. As part of this updated Level 1 SFRA, the breach modelling has been updated to utilise current terrain data and recommended allowances for climate change on extreme water levels within the outer Thames region.

The following scenarios have been modelled:

- A tidal flood event with a return period of 0.5% AEP (present day 2016);

- A tidal flood event with a return period of 0.1% AEP (present day 2016);
- A tidal flood event with a return period of 0.5% AEP with climate change (2116); and
- A tidal flood event with a return period of 0.1% AEP with climate change (2116).

A technical note detailing the breach assessment methodology agreed with the Environment Agency and South Essex Authorities representatives has been included in Appendix D.

For Basildon and Castle Point Boroughs, each of the above scenarios were also simulated with and without the flood barriers in operation. The outputs from all scenarios have been mapped in Appendix E.

It should be noted that the residual risk from overtopping of flood defences has not been modelled as part of this Level 1 SFRA. This is because the TE2100 policy is to maintain the standard of protection of defences reducing the likelihood of overtopping.

2.2.6.1 Maximum Flood Depth

Flood depth maps show the maximum depth of flooding which is experienced at each individual element in the model throughout the entire simulation. The maximum flood depth is obtained from the water level achieved at each point in the model, minus the LiDAR topographic level at that point.

The peak depth will occur at different times of the simulation depending upon the location of the point of interest. For example, immediately adjacent to the breach location, the peak depth will be experienced around the same time as the tidal water level boundary peak. However, peak depths inland; some distance away from the breach will be experienced at a later time when water has spread further throughout the model. The 'composite' flood depth map therefore presents a worst case scenario.

The maximum flood depth for the present day 0.5% AEP event and future climate change 0.1% AEP event modelled scenarios are mapped in Appendix E. These are 'composite' maps and therefore illustrate the maximum depth experienced from all breach locations.

2.2.6.2 Maximum Flood Hazard

Flood hazard mapping categorises the danger to people for different combinations of flood water depth and velocity. The derivation of these categories is based on the methodology set out by Defra in Flood Risks to People FD2320[15] using the following equation:

Flood Hazard Rating = ((v+0.5)*D) + DF

Where v = velocity (m/s), D = depth (m), DF = debris factor

Table 2-2 Hazard categories based on FD2320, Defra & Environment Agency 2005

Flood Hazard		Description
Low	HR < 0.75	Caution – Flood zone with shallow flowing water or deep standing water
Moderate	0.75 ≥ HR ≤ 1.25	Dangerous for some (i.e. children) – Danger: flood zone with deep or fast flowing water
Significant	1.25 > HR ≤ 2.0	Dangerous for most people – Danger: flood zone with deep fast flowing water
Extreme	HR > 2.0	Dangerous for all – Extreme danger: flood zone with deep fast flowing water

The maximum flood hazard for the present day 0.5% AEP event and future climate change 0.1% AEP event modelled scenarios are mapped in Appendix E. These are 'composite' maps and therefore illustrate the maximum hazard rating experienced from all breach locations.

2.2.6.3 Time to Inundation (TTI)

Time to Inundation (TTI) mapping illustrates the length of time from a breach before floodwaters reach a particular site. This information is particularly useful for emergency planning as it provides details of the time available for evacuation to a place of safety. TTI mapping has been provided in Appendix E and is presented for each breach location separately.

[15] Defra and Environment Agency (2005) FD2320 Flood Risks to People.

2.2.7 Flood Warning Areas

The Environment Agency provides a free Flood Warning Service[16] for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency has provided a GIS layer of Flood Warning Areas in the study area which are presented in Appendix A Figure 4.6 (Basildon Borough), Figure 5.6 (Castle Point Borough), Figure 6.6 (Rochford District) and Figure 7.6 (Southend-on-Sea Borough).

2.2.8 Emergency Rest Centres

Each of the South Essex Authorities has provided details of the emergency rest centres within their administrative areas which are designated in the Multi-Agency Flood Plans prepared by each Authority. These are presented in Appendix A Figure 4.6 (Basildon Borough), Figure 5.6 (Castle Point Borough), Figure 6.6 (Rochford District) and Figure 7.6 (Southend-on-Sea Borough).

2.3 Flooding from Surface Water

Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

2.3.1 Historic Records of Surface Water Flooding

Historic flooding records from local residents and businesses, and the Environment Agency have been gathered by each of the South Essex Authorities as part of the preparation of their PFRAs, SWMPs and the LFRMS'. These records have been obtained and used to inform this Level 1 SFRA and where possible, the source of the flooding has been identified. Records of flooding which are reported to be from a surface water source are presented in Appendix A Figure 4.2 (Basildon Borough), Figure 5.2, Figure 6.2 and Figure 7.2.

2.3.2 Risk of Flooding from Surface Water

The Environment Agency has undertaken a national scale surface water flood risk mapping exercise identifying those areas at risk of surface water flooding during three annual probability events:

- 1 in 30 year (3.33% AEP);
- 1 in 100 year (1% AEP); and
- 1 in 1,000 year (0.1% AEP).

The latest version of the mapping is referred to as the 'Risk of Flooding from Surface Water' (RoFSW) and has been generated through a combination of new hydraulic modelling undertaken by the Environment Agency and collation of modelled extents produced by some LLFAs. The modelled extents from the RoFSW data set have been made available for the Level 1 SFRA and the outputs have been mapped.

The RoFSW provides all relevant stakeholders, such as the Environment Agency, LPAs and the public with access to information on surface water flood risk which is consistent across England and Wales[17]. The modelling helps the Environment Agency take a strategic overview of flooding, and assists LLFAs in their duties relating to management of surface water flood risk. For the purposes of this SFRA, the mapping provides an understanding of areas within the study area which may have a surface water flood risk using a consistent set of data.

The RoFSW modelling represents a significant improvement on previous mapping, namely the Flood Map for Surface Water (FMfSW) (2010) and the Areas Susceptible to Surface Water Flooding (AStSWF) (2009), for example:

- Increased model resolution to 2m grid;
- Representation of buildings and flow routes along roads and manual editing of the model for structural features such as flyovers;
- Use of a range of storm scenarios; and,
- Incorporation of appropriate local mapping, knowledge and flood incident records.

However, it should be noted that this national mapping has the following limitations:

- Use of a single drainage rate for all urban areas;,

[16] Environment Agency Flood Warning Service http://apps.environment-agency.gov.uk/wiyby/37835.aspx
[17] Environment Agency (2013) 'What is the Risk of Flooding from Surface Water?'

- It does not show the susceptibility of individual properties to surface water flooding;
- The mapping has significant limitations for use in flat areas;
- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses ins included;
- In a number of areas, modelling has not been validated due to a lack of surface water flood records; and,
- As with all models, the RoFSW is affected by a lack of, or inaccuracies in, available data.

In early 2018, Essex LLFA completed updated surface water flood risk modelling including some spatial coverage of the South Essex Authorities. This data was not available for the production of the Level 1 SFRA and is due to be published later in 2018. The updated 2018 modelling includes model refinements related to modelled interaction with drainage systems and improved representation of topography in key areas which results in an improvement in the representation of flood risk. For this reason, the updated dataset should be used when available to inform the Level 2 SFRAs site assessments and for developers producing site specific FRAs. However, for the purposes of completing the NPPF Sequential Test, this Level 1 SFRA presents the RoFSW maps as a set of consistent data from which to asses surface water flood risk.

The RoFSW for the study area is presented in Appendix A Figure 4.2 (Basildon Borough), Figure 5.2 (Castle Point Borough), Figure 6.2 (Rochford District) and Figure 7.2 (Southend-on-Sea Borough).

RoFSW Data and Climate Change

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

2.3.3 Critical Drainage Areas (CDAs)

The NPPF defines a Critical Drainage Area (CDA) as an area within Flood Zone 1 which has 'critical drainage problems' (as notified to the LPA by the Environment Agency). Consultation undertaken in the preparation of the Level 1 SFRA update has confirmed that there are no areas with critical drainage problems identified by the Environment Agency within the study area.

Within the SWMPs for each of the South Essex Authority areas, CDAs were delineated based on the following 'working definition':

> '..a discrete geographic area (usually within an urban setting) where there may be multiple and interlinked sources of flood risk and where severe weather is known to cause flooding of the area thereby affecting people, property or local infrastructure'.

Using this definition, 44 CDAs have been identified within the South Essex study area: 22 within Basildon Borough Council administrative area, 6 within Castle Point Borough Council administrative area, 10 within Rochford District Council administrative area and 6 within the Southend-On-Sea Borough Council administrative area. These CDAs are used by each of the South Essex Authorities in the management of local flood risk[18] and the consideration and prioritisation of potential flood mitigation and management options.

The CDAs for the study area are presented in Appendix A Figure 4.2 (Basildon), Figure 5.2 (Castle Point), Figure 6.2 (Rochford) and Figure 7.2 (Southend).

2.4 Flooding from Groundwater

Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

2.4.1 Areas Susceptible to Groundwater Flooding

This SFRA has used the Environment Agency's dataset 'Areas Susceptible to Groundwater Flooding' (AStGWF) which indicates where groundwater may emerge due to geological and hydrogeological conditions. This information is shown

[18] Local flood risk is defined as flood risk from surface water, groundwater and ordinary watercourses,

as a proportion of 1km grid squares where there is potential for groundwater emergence. The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation.

Groundwater flooding risks are often highly localised, and dependent upon geological interfaces between permeable and impermeable subsoils. It is therefore essential that an understanding of site specific ground conditions is achieved through site survey and/or review of detailed borehole data.

The AStGWF dataset has been mapped in Appendix A Figure 4.4 (Basildon Borough), Figure 5.4 (Castle Point Borough), Figure 6.4 (Rochford District) and Figure 7.4 (Southend-on-Sea Borough). The AStGWF data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale.

2.4.2 Historic Records

Information on historical flooding in the study area has been gathered by each of the South Essex Authorities in accordance with their duties as LLFAs, and as part of the preparation of the PFRA, SWMP and the LFRMS. Where possible, the source of the flooding has been identified. It should be noted that there has not been a statutory obligation to record incidents of groundwater flooding in the past and therefore it is likely that the groundwater flooding incidents recorded are not exhaustive.

2.4.3 SWMP Groundwater Flooding Assessment

As part of the SWMPs for the South Essex Authorities areas, an assessment of the risk of groundwater flooding was undertaken. Areas where there is increased potential for groundwater levels to rise were identified and separated into permeable superficial deposits and bedrock (consolidated) aquifers.

A number of potential groundwater flooding mechanisms were identified within the Basildon Borough, Castle Point Borough and Rochford District. Of significance are:

- the flooding mechanisms associated with the superficial aquifers and their hydraulic continuity with surface watercourses and Thames Estuary tidal fluctuations; and
- the response of groundwater levels within the Claygate Member and Bagshot Formation to increase the use of infiltration SUDS, leaking pipes and barriers to groundwater flow, such as sheet piling. Properties at most risk are those with basements / cellars, and areas where these properties are likely to exist can be identified through an assessment of historic stages of building development.

The SWMP for Southend-On-Sea Borough found that the groundwater flooding mechanisms include superficial aquifers along watercourses and fluctuations from the Thames Tidal Estuary. The BGS areas susceptible to groundwater flooding map indicates that susceptibility to groundwater flooding is very high in some areas where Head deposits and River Terrace Deposits are present at surface; along Prittle Brook, Eastwood Brook, Shoeburyness (eastern part of the study area) and around Southchurch in the central part of the Southend-On-Sea Borough.

2.5 Flooding from Sewers

During heavy rainfall, flooding from the sewer system may occur if:

1. The rainfall event exceeds the capacity of the sewer system/drainage system:

   Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. While AWS, as the sewerage undertaker for the study area, recognise the impact that more extreme rainfall events may have, it is not cost beneficial to construct sewers that could accommodate every extreme rainfall event.

2. The system becomes blocked by debris, sediment or fat:

   Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter). Fat build up within the main sewer system is also a contributing factor of sewer flooding.

3. The system surcharges due to high water levels in receiving watercourses:

   Within the study area there is potential for surface water outlets to become submerged due to high river levels. When this happens, water is unable to discharge. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

2.5.1 Historic Records

AWS has provided an extract from their DG5 Flood Register for the study area, which records historic internal and external sewer flooding events. Due to data protection requirements the data has not been provided at individual property level; rather the register comprises the number of properties within four digit postcode areas that have experienced flooding either internally or externally within the last 10 years.

It should be noted that records only appear on the DG5 register where they have been reported to AWS, and as such they may not include all instances of sewer flooding. Furthermore given that AWS target these areas for maintenance and improvements, areas that experienced flooding in the past may no longer be at greatest risk of flooding in the future.

The DG5 Register of internal and external property flooding has been presented in Appendix A Figures 4.5 (Basildon), 5.5 (Castle Point), 6.5 (Rochford) and 7.5 (Southend).

2.6 Flooding from Artificial Sources

2.6.1 Risk of Flooding from Reservoirs

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

The Environment Agency dataset 'Risk of Flooding from Reservoirs' available online identifies areas that could be flooded if a large[19] reservoir were to fail and release the water it holds. The mapping has been used to identify the risk across the study area.

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a managed risk.

Each South Essex Authority is responsible for working with members of the Local Resilience Forum (LRF) to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

2.7 Summary

This Section has provided an overview of the methodology and datasets used to inform the Level 1 SFRA. The following Sections form the Level 1 SFRA for each of the South Essex Authority areas as follows:

- Section 4: Flood Risk in the Basildon Borough
- Section 5: Flood Risk in the Castle Point Borough
- Section 6: Flood Risk in the Rochford District
- Section 7: Flood Risk in the Southend-on-Sea Borough

[19] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

3. Climate Change

In accordance with NPPF, developments must demonstrate how flood risk will be managed now and over the developments lifetime, taking climate change into account. In previous SFRAs and site specific Flood Risk Assessments an allowance of 20% was added to the 1% AEP return period to account for increases in flood risk due to climate change.

In February 2016 the Environment Agency published updated guidance on climate change allowances in an update to the document 'Adapting to Climate Change: Advice to Flood and Coastal Erosion Risk Management Authorities'[20].

The guidance reflects an assessment completed by the Environment Agency between 2013 and 2015 using United Kingdom Climate Projections 2009 (UKCP09) data to produce more representative climate change allowances across England. The updated guidance includes predictions of anticipated change for:

- Peak river flow by river basin district
- Peak rainfall intensity
- Sea level rise
- Offshore wind speed and extreme height

3.1 Climate Change and Peak River Flow

3.1.1 Strategic Planning

For the purposes of strategic planning and completion of the sequential test, the LPAs are advised to use the '2070 to 2115' 100 year development lifetime outlined in Table 3-1 below relating to residential development. For more vulnerable, residential development this correlates to a climate change range of impacts of between + 35% and + 65% on the 1% AEP.

Table 3-1 Climate change allowances for the Anglian River Basin[21]

River basin district	Allowance category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Anglian	Upper end (90th)	25%	35%	65%
	Higher central (70th)	15%	20%	35%
	Central (50th)	10%	15%	25%

For the purpose of the SFRA it has been agreed with the Environment Agency that where hydraulic modelling data is available for the 1% AEP + 65% (1 in 100 year +65%) scenario, this data will be mapped as outlined below:

- Fluvial models for Noblesgreen Ditch, Eastwood Brook and River Roach include the climate change allowances for the 1% AEP plus the 25%, 35% and 65% climate change scenario as shown in Appendix A Figure 5.1a (Castle Point), 6.1a (Rochford) and 7.1a (Southend).
- For the Prittle Brook, the Environment Agency holds an existing model that has been revised as part of this SFRA update to reflect the amended climate change allowances. A technical note summarising the methodology that has been undertaken to revise the climate change allowances is provided in Appendix C. The results of the analysis show that for all model nodes, the peak flood water level in the 0.1% AEP event is greater than the flood water level for the 1% AEP +65% climate change event. Therefore, for the purpose of this SFRA, the 0.1% AEP flood extent is used as a proxy for the 1% AEP plus climate change event as shown in Appendix A Figure 5.1 (Castle Point), and 7.1 (Southend).

[20] https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities
[21] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

- For all other fluvial watercourses in the study area, Flood Zone 2 should be used as a climate change proxy for the 1% AEP event in the absence of specific modelling until such time as detailed modelling is completed for site specific FRAs, or at a future date by the Environment Agency or ECC as the LLFA.

3.1.2 Site Specific Flood Risk Assessments

At a site level, when considering peak river allowances the NPPF flood zone and flood risk vulnerability classification needs to be considered to confirm which range of climate change allowances should be assessed. This is set out in Table 3-2 below.

Table 3-2 NPPF Flood Zone and Vulnerability

Flood Zone (Table 2-1)	Vulnerability (Table 8-3)	River Flow Allowances (Table 3-1)
Flood Zone 2	Essential Infrastructure	Higher Central and Upper End
	Highly Vulnerable	Higher Central and Upper End
	More Vulnerable	Central and Higher Central
	Less Vulnerable	Central
	Water Compatible	None of the allowances
Flood Zone 3a	Essential Infrastructure	Upper End
	Highly Vulnerable	Development should not be permitted
	More Vulnerable	Higher Central and Upper End
	Less Vulnerable	Central and Higher Central
	Water Compatible	Central
Flood Zone 3b	Essential Infrastructure	Upper End
	Highly Vulnerable	Development should not be permitted
	More Vulnerable	Development should not be permitted
	Less Vulnerable	Development should not be permitted
	Water Compatible	Central

In order to determine which allowance category to use, the development lifetime should be considered. This should be judged based on the characteristics of development and applicants should be able to justify the chosen lifetime. Typically:

- Residential developments should apply a minimum lifetime of 100 years, unless there is specific justification for considering a shorter period;
- Non- Residential developments should apply a 75 year lifetime.

Therefore, in this locality, if a residential (more vulnerable/100 year lifetime) development were proposed within Flood Zone 3a an allowance of between 35% and 65% should be applied typically to the 1% AEP to account for the potential impacts of climate change on peak river flows.

3.2 Climate Change and Sea Level Rise

Projections of relative mean sea levels for any location around the UK coast are provided within UKCP09. For the purposes of hydraulic breach modelling used to inform this study, recommended climate change allowances have been applied to generate extreme water levels with allowances for sea level rise for the 2116 scenario. Further detail can be found in the breach modelling technical note included in Appendix D.

3.3 Climate Change and Surface Water Flood Risk

Although it is possible to make qualitative statements as to whether extreme rainfall is likely to increase or decrease over the UK in the future, there is still considerable uncertainty regarding the magnitude of these changes locally.

3.3.1 Surface Water Climate Change at a Strategic Level

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However, a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% AEP and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

3.3.2 Surface Water Climate Change at a Site Level

When assessing climate change impacts for surface water runoff, consideration is given to the changes in peak rainfall intensity over the lifetime of the development. Where previously drainage design would include attenuation storage for the 1% AEP + 20% climate change allowance, this has increased to 1% AEP + 40% as outlined in Table 3-3 below in accordance with the latest Environment Agency guidance (February 2016).

Table 3-3 Changes to peak rainfall intensity compared to a 1961-1990 baseline[22]

Applies across all of England	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 20 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

Further guidance on managing and mitigating flood risk from surface water can be found in Section 9.

[22] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

4. Flood Risk in the Basildon Borough

4.1 Overview

This Section provides the strategic assessment of flood risk across the Basildon Borough from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historical incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This section should be read with reference to the figures in Appendix A.

4.2 Tidal Flooding

The Thames Estuary is the only potential source of tidal flooding to impact the Basildon Borough and due to the topography of the Borough, only relatively small areas in the south are at risk of tidal flooding.

Tidal flooding may occur during storm surge conditions characterised by wind driven waves and low atmospheric pressure coupled with high spring tides. In areas protected from flooding by sea defences, tidal flooding can occur as a result of a breach in the defences, failure of a mechanical barrier or overtopping of defences. In the event of a breach in the sea defences outside the Borough, the low-lying marshland and drainage channels in the south of the Borough provide pathways for floodwater. This part of the Borough does not have well defined flooding pathways, so floodwater will tend to pool at low-lying areas adjacent to a flood defence breach.

The Environment Agency flood zone map, shown in Appendix A Figure 4.1, incorporates both tidal and fluvial flood risk extents. The definition of tidal Flood Zone 3a is based on the 1 in 200 year flood event (0.5% AEP), rather than the 1 in 100 year event (1% AEP) used for fluvial Flood Zones.

4.2.1 Tidal Flood Defences

The Environment Agency AIMS data shows that the southern part of the Basildon Borough is protected from tidal flooding by earth embankments. These defences have a design standard of protection (SOP) of 1 in 1000 year.

There are two flood barriers that provide protection to the area during high tide events; the Fobbing Horse flood barrier, located to the south of the marshes, on the Holehaven Creek, and the Benfleet barrier, located to the south east of the marshes, on the Benfleet Creek.

The TE2100 Plan states that the policy for Bowers Marshes in Basildon is ‘P4’ – to take further action to keep up with climate and land use change so that flood risk does not increase. The TE2100 plan identifies that limited floodplain management is required in the largely undeveloped Bowers Marshes policy unit. However, flood warning is necessary for the railway line (which continues eastwards through the Hadleigh Marshes policy unit), and the flood risk area in South Benfleet. The plan states that flood resilience measures and careful application of planning guidelines should be used to reduce potential flood impacts on new development. An area of Bowers Marsh has been identified as a preferred site for intertidal habitat creation.

Due to the presence of flood defences, the risk of flooding from tidal sources is a residual risk in the event of failure of one of these barriers or a breach in the earth flood defence. The chances of the defences failing or being overtopped are very small, but the consequence of such a failure is very high.

4.2.2 Breach in Flood Defences

Hydraulic breach modelling has been undertaken to assess the potential impact of a breach in the flood defences at two selected locations on the Basildon Borough frontage as outlined in Table 4-1 below.

Table 4-1 Basildon Borough breach names and modelling parameters

Breach Name	Breach Location	Defence Type	Breach Width (m)	Breach coordinates	
BAS01	Flood barrier, Fobbing Horse, Vange Creek	Barrier	45	574045	184306
CAS01	Upper Horse	Earth embankment	20	575200	183400

The following flood events were simulated:

- 1 in 200 year event (0.5% AEP) present day (2016), with flood barriers operational;
- 1 in 1000 year event (0.1% AEP) present day (2016), with flood barriers operational;
- 1 in 200 year event (0.5% AEP) with climate change (2116), with flood barriers operational and non-operational; and
- 1 in 1000 year event (0.1% AEP) with climate change (2116), with flood barriers operational and non-operational.

The composite flood depth flood hazard and time to inundation mapping for the 0.5% AEP present day event and future 0.1% AEP with climate change event scenarios in Basildon are presented in Appendix E Figures E1-E17. The maps should be used by the LPA to better understand the residual risk posed to development within Flood Zone 3a and can be used by developers to better plan and understand 'safe' access and egress routes, and finished floor levels in consultation with the LPA and Environment Agency.

4.3 Flooding from Rivers

4.3.1 Flood Zones

Reference should be made to Flood Zone mapping included in Appendix A Figure 4.1.

The majority of the Basildon Borough is within Flood Zone 1, with approximately 2% of the Borough in Flood Zone 2 and 9% defined as Flood Zone 3.

In the north west of the Borough, the Mountnessing Brook and Haveringsgrove Brook flow northwards to the west of Billericay. These watercourses are tributaries of the River Wid which flows northwards towards Chelmsford. Flood Zones 2 and 3 associated with the Mountnessing Brook and Haveringsgrove Brook extend across the residential area in the outskirts of Billericay.

The Wilderness is located in Little Burstead to the south of Billericay and is the source of the River Crouch. The River Crouch flows in a south-west to a north-east direction through the Borough. The River flows to the north of the town of Basildon and through town of Wickford in an open channel before flowing out of the Borough and forming part of the tidal Crouch and Roach Estuary at Battlesbridge. Flood Zone 3 associated with the River Crouch extends across the outskirts of Basildon including the residential areas of western area of Crays Hill (Billericay) and smaller settlements along the edge of the River. The river then flows into the town of Wickford in which small areas along the course of the river are located within Flood Zone 3. Areas of Flood Zone 2 associated with the River Crouch are located along the open channel of the River Crouch through Wickford including properties along London Road, Nevendon Road, Wick Drive, High Street, Runwell Road and Wickford Memorial Park.

A number of tributaries flow from the River Crouch. These include Basildon Brook, Nevendon Brook and Nevendon Bushes Brook. Basildon Brook flows through centre of Basildon in an open channel. Flood Zones 2 and 3 associated with Basildon Brook extends across the outskirts of the residential area of Crays Hill (Billericay) and into the residential area around the Brook in Basildon. Nevendon Brook and Nevendon Bushes Brook flows through the centre of Wickford along the course of Nevendon Road. The areas of Flood Zones 2 and 3 associated with the Nevendon Brook extend along Radwinter Avenue and onto Borwick Lane. Flood zone mapping is included in Appendix A Figure 4.1.

4.3.2 Functional Floodplain

The modelled outlines for the 5% AEP event for the River Crouch and its tributaries to define the Functional Floodplain (Flood Zone 3b) associated with these watercourses, as shown in Appendix A Figure 4.1. These areas are chiefly undeveloped areas to the north of Beauchamps Drive, to the east of Church Drive, to the west of Nevedon and to the west of Waterfront Walk.

In accordance with the PPG and in agreement with the Environment Agency, the washland storage areas that have been identified by Basildon Borough Council have been designated as Flood Zone 3b Functional Floodplain for the purposes of informing spatial planning across the Borough.

Modelled data was not available for the tributary of the River Wid to the north west of Billericay and the Vange Creek. For these watercourses, the extent of Flood Zone 3a (see Appendix A, Figure 4.1) should be used as an indicator of the maximum extent of potential Functional Floodplain for the purposes of the Sequential Test. Where potential sites are required within Flood Zone 3a of these watercourses, a Level 2 SFRA should include a suitable hydraulic analysis to provide delineation between Flood Zone 3a and Flood Zone 3b (Functional Floodplain) at these specific locations.

4.3.3 Basildon Borough Washland System

As part of the development of Basildon New Town between the 1950s and 1980s, as well as the urban expansion of Wickford and Billericay, several drainage reservoirs and storage areas were created, largely by the Basildon Development Corporation and water authorities, to manage surface runoff from the urban areas. The majority of these washlands remain in use today, under mixed ownership, and continue to form a surface water management function across the highly urbanised area. The washlands operate as a system for each of the local catchment areas, with attenuated flows passed from one storage area to the next via engineered channels and regulated by structures at the outfalls of major storage areas. Table 4-2 below provides an approximate area, capacity and condition for each washland.

Table 4-2 Basildon Washlands Storage Areas (from Basildon SFRA 2011)

Washland Name	Description
Southfields Washland, Southfields, Laindon	Approximate Area: 3.2 hectares Approximate Storage Capacity: 59,500m^3 Southfields washland comprises a noticeable depression suitable for the impoundment of flood flows. The washland is overgrown with semi mature vegetation and tall grasses. Anecdotal evidence suggests that the effectiveness of this storage area may be limited by waterlogging in the Winter/Spring.
Noak Hill Washland, Laindon	Approximate Area: 3.2 hectares Approximate Storage Capacity: 56,400m^3 There is a clearly identifiable washland to the south west of Noak Hill. Flood flows would be contained by the bunded bank around the perimeter of the washland. The area is vegetated with tall grasses and light scrub. Owned by the Environment Agency.
Pipps Hill Lake, Waterfront Walk, Basildon	Approximate Area: 10.8 hectares Approximate Storage Capacity: 164,400m^3 The Pipps Hill Lake is in good condition. Where the Basildon Brook meets the Lake, a bank acts as a natural weir for the overflow of flood water from Basildon Brook. Outfall from the northern end of the Lake is maintained by a control structure, however the condition of this structure is considered to be poor. Pipps Hill Lake is owned by a Private Fishing Company.
Courtauld Road Washland, Basildon	Approximate Area: 22.8 hectares This washland has been relocated to enable the development of the area to the south of the A127 as a waste management facility. The Nevendon Brook has been diverted to enable this development. The new washland is to be managed as a privately owned nature reserve.
Northlands Park, Pitsea	Approximate Area: 3.0 hectares Approximate Storage Capacity: 57,900m^3 Northlands Park is used extensively for amenity purposes and is therefore in good condition. A large open culvert runs around the south, west and northern boundaries of the lake. Many of these drains are overgrown. On the northern boundary the culvert runs underground through a flow restrictor before flowing out of the site along an open culvert. The culverts are fed from the storm

Washland Name	Description
	water drains for a large amount of the local urban drainage. At times of heavy rain, the flow restrictor operates to back up the flow in the culvert, forcing it over a purpose built overflow section in the lake bank and into the lake. After the storm event, excess water in the lake flows back into the culverts and away. This storage area is maintained by Basildon Borough Council.
Gloucester Park Fishing Lake	Approximate Area: 3.1 hectares Gloucester Park is a large man-made lake, which is essentially a widening of a large storm water overflow drain. The storm water drain enters on the west end of the lake and exits at the east end. It does not flow under normal circumstances. The lake is suffering from a buildup of silt particularly in the long arm on the east end near the outfall (Blue Roof Report).
Long Wood Washland	Approximate Area: 0.3 hectares Approximate Storage Capacity: 9,500m^3 The washland at Long Wood is heavily overgrown by mature trees and scrub.
Lee Chapel South Flood Relief Works	Approximate Area: 0.7 hectares Approximate Storage Capacity: 6,500m^3 The Lee Chapel South Flood Relief Works comprises an open ditch feature with throttle points along its length to encourage retention of flow. During site visits, all throttle points were noted to be silted up. The final outfall from the system was completely blocked. The potential for the system to be used to its capacity is dependent upon ongoing maintenance of these outfalls and throttle points as well as regular clearance of the ditch.
Kingswood Surface Water Balancing Area	Approximate Area: 3.3 hectares Approximate Storage Capacity: 53,500m^3 This area is a local amenity area with a swale and an embanked footpath that serve to provide contained storage of flood water during heavy rainfall events. During site visits, the swale was noted to be overgrown; however this is unlikely to significantly affect the performance of the balancing area. The remainder of the storage area is considered to be in a good condition.
Dry Street Washland, Basildon	Approximate Area: 1.4 hectares Approximate Storage Capacity: 4,300m^3 The washland at Dry Street is approximately 1.4 hectares. There is a drainage ditch that links this washland to the Hospital Washland directly to the east. This washland is heavily overgrown with mature trees and scrub which may limit its capacity to store surface water flows.
Hospital Washland, Dry Street, Basildon	Approximate Area: 0.3 hectares Approximate Storage Capacity: 31,900m^3 This washland has been retained as a balancing pond within the Hospital site.
Wootens Washland	Approximate Area: 0.2 hectares Approximate Storage Capacity: 4,170m^3 Site visits identified that this small washland is heavily overgrown with mature trees and scrub which are likely to impact on its ability to store and attenuate surface floodwater.
Vange Storage Basin	Approximate Area: 3.8 hectares Approximate Storage Capacity: 89,900m^3 This storage basin is not accessible; however, a review of aerial photography indicates large area of open ground available for the retention of floodwater without impacting on sensitive receptors.
Turners Chase Washland	Approximate Area: 0.8 hectares
Wethersfield Way Washland, Wickford	Approximate Area: 1.2 hectares
Hurricane Way and 17 Blenheim Court, Wickford	Hurricane Way Approximate Area: 0.15 Ha Blenheim Court Approximate Area: 0.07 Ha
Albany Road, Wickford	Approximate Area: 0.23 Ha
Pleasant Drive, Billericay	Approximate Area: 0.21 Ha
Hannikins Meadow, Billericay	Approximate Area: 4.1 Ha

The 2011 Basildon SFRA reported that, as part of the preceding 2006 SFRA, an assessment was undertaken to provide an indication of the effectiveness of the washlands storage area in managing flood flows. This assessment concluded that when the storage system is properly maintained there is adequate storage within the existing washland basins to mitigate flood risk from rainstorms with a return period up to 200 years (0.5% AEP). However the condition of some of the storage areas and associated control structures was noted to be poor, which may significantly affect both the storage capacity available during flood events and the routing of flood waters and lead to localised flooding, that might otherwise be preventable.

It was recommended in 2006 that a programme of routine washland maintenance was developed to ensure the full capacity offered by these flood storage areas and connecting channels was available in the event of a flood. In the first instance remedial works have involved clearance of vegetation, and ensuring any incoming and out-going pipework and structures operated freely. It may also be beneficial to undertake a comprehensive survey of any connecting channels and pipework to ensure they are free of blockages. Whilst channels were inspected and noted to be in the main heavily overgrown, connecting pipework was not inspected as part of this assessment.

The South Essex SWMP (2012) recommends the following Council-wide option within its action plan with regards to washland areas and flood storage management:

"The management and maintenance of the Washland / Flood Storage areas (particularly within Basildon Borough Council) is crucial in reducing the risk of surface water flood risk. The washlands should operate in such a way that attenuated flows pass from one storage area to the next, via engineered channels and regulated by structures at the outfalls of major storage areas. Pluvial modelling undertaken for the intermediate assessment has indicated that the washland and storage areas within the study area are performing a vital role in storing surface water flows and preventing flooding further downstream in urban areas; however, it is essential that these systems continue to function to their optimum and their operational performance is not limited by poor understanding of how each washland operates and what maintenance is required to maintain storage levels and outfalls.

Areas identified as already having an important washland function, or with the potential to be used as washlands, in relation to future flood management options, should be protected from being allocated for development by the Local Planning Authority, particularly in CDAs where washland options are identified as providing the greatest benefits.

Any attenuation areas should also be given appropriate legal protections (registered as Flood Risk Management (FRM) Infrastructure) to prevent third party actions from damaging the potential functioning of these areas.

It is recommended that the following is undertaken on all existing and new washlands and flood storage areas:

- formalise the owner and operator of each washland/ flood storage area (designate it as FRM Infrastructure);
- establish what maintenance is currently undertaken, and by whom;
- create a Washland Management Plan, the purpose of which must be primarily concerned with the integrity of the washland as a drainage and flood management asset, rather than any residual uses such as how its open space role; and,
- engage local residents in the multi-functional use of the space."

4.3.4 Fluvial Flood Zones and Climate Change

Appendix A Figure 4.1.a shows the updated fluvial flood zones for the River Crouch and its tributaries, including the modelled extents for the 1% AEP event plus 25%, 35% and 65% climate change allowances. The modelled climate change scenarios include the presence of flood defences along the watercourses.

The results show a minimal increase in the flood outline north of Wickford Memorial Park, along the course of Golden Jubilee Way, the residential at the south of Nevendon Road and the residential area along Pipps Hill Road North.

Modelled data was not available for the tributary of the River Wid to the north west of Billericay, Benfleet Brook, and the tributary of Rawreth Brook. For these watercourses, the extent of Flood Zone 2 (see Appendix A, Figure 4.1) should be used as an indicator of the potential extent of the 1% AEP with an allowance for climate change.

4.3.5 Ordinary Watercourses

Environment Agency records identify ordinary watercourses in the Basildon Borough include tributaries of the River Crouch, which flow north towards Billericay, a tributary of the River Wid, which flows south along the western edge of Billericay, and tributaries of the Vange and East Haven Creek.

Table 4-3 lists the ordinary watercourses and unnamed drainage ditches in Basildon Borough, as identified in the South Essex SWMP.

Table 4-3 Ordinary watercourse in Basildon Borough

Ordinary Watercourse	Type	Ownership
Tye Common Road junction to Wiggins Lane (North), Billericay	Open Ditch	Privately owned
Rear of 22 to 32 The Meadow Way, Billericay	Open Ditch	Privately owned
Frithwood Ditch, Billericay	Open Ditch	Privately owned
Potash Road Drainage Ditch	Open Ditch	Unknown
Tye Common Road to St Agnes Road, Burstead	Open Ditch	Privately owned
Tye Common Road near Broomhills Chase, Little Burstead	Open Ditch	Privately owned
Lincewood Park Drive to Berry Lane, Langdon Hills	Open Ditch	Basildon Borough Council
Gardiners Lane South to East Mayne, Basildon	Open Ditch	Basildon Borough Council
Courtauld Road to Southend Arterial Rd A127, Basildon	Open Ditch	Unknown
Cricketers Way to Courtauld Road, Basildon	Open Ditch	Basildon Borough Council
Pound Lane Ditch, Bowers Gifford	Open Ditch/Culvert	ECC maintain the culvert

The maintenance of ordinary watercourses that are not owned by ECC (as the LLFA) or Basildon Borough Council is the responsibility of the riparian owner. Further details of the responsibilities of the riparian owners are stated in the Basildon LFRMS.

There are no historic recorded incidents of flooding from ordinary watercourses within Basildon Borough. Often, where blocked ditches or streams have been reported as being the cause of flooding this has been reported as occurring with other sources, e.g. sewer or surface water runoff, and therefore will have been reported as multiple sources of flooding in the dataset.

No modelling of the flood risk from ordinary watercourses has been undertaken to date across Basildon Borough. Therefore future flood risk is based on the potential risk that might arise based on knowledge of known flooding hotspots and potential mechanisms for flooding.

There are a number of ditches and closed watercourses within the Borough that pose a source of flood risk due to insufficient capacity or inadequate maintenance of the channels. These channels and watercourses receive the majority of their flow from inside the urban area and perform an urban drainage function.

4.3.6 Flood Defences

The Environment Agency AIMS data shows that that the Basildon Borough is protected by high ground along the edge of the River Crouch and its tributaries, including Mountnessing Brook, Haveringsgrove Brook, Basildon Brook, Nevendon Brook and Nevendon Bushes Brook. These defences have a design SOP of 1 in 100 year (1% AEP). There is a section of the River Crouch, approximately 2.5km in length which runs through north Wickford and Runwell, that is protect to a 1 in 10 year SOP. The tributary of the River Crouch that flows north through Pippshill also shows a SOP of 1 in 10 years.

4.3.7 Flood Warning Areas

There are three Environment Agency Flood Warning Areas in Basildon; one for tidal flooding, one for the Thames Estuary and one for fluvial flooding from the River Crouch. These are identified in Appendix A Figure 4.6, as follows:

- River Crouch from Noak Bridge to Runwell, including Wickford;
- Canvey Island North; and
- Shellhaven to Grays including Tilbury.

4.3.8 Emergency Rest Centres

Designated emergency rest centres for Basildon Borough are mapped in Appendix A Figure 4.6.

4.4 Risk of Flooding from Surface Water

The South Essex SWMP found that surface water flooding within the Basildon Borough is predominantly driven by the topography relating to the River Crouch and its tributaries. Localised surface water flooding within the Borough can be accredited to topographic depressions and obstructions to surface water flow. Previous flooding incidents attributed to surface water have been mainly caused by the inundation of the surface water drainage systems due to high intensity rainfall events.

Areas that have been identified within the SWMP as being particularly susceptible to surface water flooding include Southfields Business Park, Queen's Park, Gooseberry Green, High Road. Pluvial modelling undertaken as part of the SWMP indicates the potential for surface water flow paths and extensive ponding in the 22 CDAs delineated in the Borough. Further detail on each CDA can be found within the SWMP report.

At the planning stage, where there are modelled ordinary watercourses, or small drainage ditches, the RoFSW mapping is a good reference point for potential flood risk as open ordinary watercourses can also contribute to surface water flooding.

For the purposes of mapping surface water flood risk within this SFRA, reference has been made to the Environment Agency Risk of Flooding from Surface Water (RoFSW) data as illustrated in Appendix A Figure 4.2.

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

4.5 Flooding from Groundwater

The AStGWF dataset provided by the Environment Agency indicates where groundwater may emerge due to geological and hydrogeological conditions. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation.

The AStGWF dataset presented in Appendix A Figure 4.4 indicates that there are areas at 50%-75% risk of groundwater emergence along the tributaries of the River Roach. There is an area at >75% risk of groundwater emergence to the north of Basildon town, including Cranes, Burn Mills and Great Bromfords.

It should be noted that due to the resolution of the AStGWF dataset, i.e. at 1km grid squares, the AStGWF data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. Where available, site-specific information, including ground investigations and monitoring, should be used to support planning decisions for individual developments.

The South Essex SWMP identified that no groundwater flooding incidents had been reported to the Environment Agency, Basildon Council, Essex Fire and Rescue Service or the Parish Councils and no further incidents have been confirmed since completion of the SWMP to include within this SFRA.

4.6 Flooding from Sewers

AWS has supplied records of sewer flooding for the Borough through their DG5 register on the total number of properties affected by and at risk of sewer flooding (both internally and externally) based on historic flooding. This highlights that the areas of North and Central Billericay, as well as East Wickford, and have experienced a greater number of sewer flooding incidents than the rest of the Borough.

Appendix A Figure 4.5 shows the DG5 Register that has been supplied by AWS for the SFRA. It should be noted that AWS focus their efforts on removing properties from the DG5 register and therefore this information may not accurately represent those properties currently at risk.

Climate change is anticipated to increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination is likely to increase the pressure on the existing efficiency of sewer systems, thereby reducing their design standard and leading to more frequent localised flooding incidents. Any sewer flooding that may occur could be exacerbated as a result of surface water runoff during extreme rainfall events.

4.7 Flooding from Other Sources

4.7.1 Risk of Flooding from Reservoirs

The Environment Agency Flood Risk from Reservoirs map[23] identifies areas that could be flooded if a large[24] reservoir were to fail and release the water it holds. Environment Agency data shows that the residential areas along the course of the River Crouch, Basildon Brook and Nevendon Brook are at risk from reservoir flooding.

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a minimal risk.

Basildon Borough Council is responsible for working with members of the LRF to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

4.8 Historic Flood Records

The Environment Agency Historic Flood Map indicates areas that have been previously flooded but does not show the source of the flood. The map shows that extensive flooding has previously occurred on the Vange and Fobbing Marshes. There is also a record of flooding along the Felmore area, to the east of Basildon, as show in Appendix A Figure 4.3.

The ECC Fire and Rescue Service records from April 2007 to March 2009 identified 55 recorded flood incidents in the Borough. The source of flooding is unknown and these records are shown in Appendix A Figure 4.3. Where available, flood incident records held by the project stakeholders, including Basildon Borough Council, ECC, the Environment Agency and AWS, have been provided to support this Level 1 SFRA update.

A summary of past flood events is shown below in Table 4-4.

Table 4-4 Summary of past flood events in Basildon

Flood Event	Source of flooding	Description (record source in brackets, where available)
September 1958	Fluvial	76mm of rainfall fell in two hours, leading to major flooding in the Crouch catchment, notably in Wickford and Runwell.
September 1968	Fluvial	Basildon and Wickford were affected by fluvial flooding from the River Crouch. More than 50 houses and some roads between Nevendon and Wickford were affected by floodwaters and 8 houses were flooded by 0.5m floodwater in Rawreth. Water also came out of bank from the North Benfleet Brook resulting in flooding of 54 properties in Bowers Gifford and the surrounding area.
December 2002	Surface Water	Areas of Basildon, Billericay and Crays Hill were affected.
January 2003	Surface Water	Areas of Basildon, Billericay and Crays Hill were affected (South Essex Catchment Flood Management Plan)
January 2003	River Crouch	Flood Records in Billericay, Crays Hill and Basildon
2007	Unknown	14 recorded flood incidents (Fire and Rescue Service).
2008	Unknown	24 recorded flood incidents (Fire and Rescue Service).
2009	Unknown	17 recorded flood incidents (Fire and Rescue Service).
22nd February 2010	Unknown	Flood records around Basildon and Wickford. (Fire and Rescue Service)

[23] https://flood-warning-information.service.gov.uk/long-term-flood-risk/
[24] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

Flood Event	Source of flooding	Description (record source in brackets, where available)
18th January 2011	Unknown	Flood records throughout the Borough (SWMP)
December 2013	Highways	Highways flood event (Information request)

4.9 Summary of Flood Risk in Basildon

A number of sources of flooding pose a risk to the Basildon Borough. Fluvial flood risk from the River Crouch and its tributaries poses a significant risk to the residential areas of Wickford and Basildon. Fluvial flood risk posed by the Mountnessing Brook and Haveringsgrove Brook pose a risk to the west of Billericay. The tidal estuaries of Vange Creek and East Haven Creek and Timberman's Creek are located to the south eastern part of the Borough and pose a residual flood risk.

The Borough is protected from fluvial flooding by the presence of flood defences. High Ground protects the areas around the River Crouch and its tributaries. High ground and two tidal barriers protect the area to the south east of the Borough. The Washland System, created as part of the development of the Basildon New Town and the urban expansion of Wickford and Billericay, performs a surface water management function for the urban area and helps to reduce fluvial flood risk from receiving watercourses to other areas downstream of the Washlands i.e. the functioning of Basildon Washlands helps to prevent an increase in flood risk from the River Crouch at Wickford. However, the capacity of this system to continue to perform its function is highly dependent upon continued clearance and maintenance of the storage areas as well as the associated channels, ditches and supporting infrastructure.

Surface water flooding poses a significant risk to the Borough. Areas of high surface water flood risk are located along the course of the River Crouch and over areas of Basildon and Wickford. Localised surface water flooding within the Borough can be attributed to topographic depressions and obstructions to surface water flow. 22 CDAs, as defined in the South Essex SWMP, are located within the Basildon Borough, the majority of which are located within Basildon.

The maps presented in Appendix A and Appendix E provide the necessary information to facilitate the NPPF risk-based approach to planning. This process determines the compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and the Exception Test when required.

5. Flood Risk in Castle Point

5.1 Overview

This Section provides the strategic assessment of flood risk across the Castle Point Borough from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historical incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read with reference to the figures in Appendix A.

5.2 Tidal Flooding

The Borough of Castle Point comprises two distinct portions of land; Canvey Island, with an area of approximately 16km^2 and a portion of the mainland covering approximately 27km^2. These two areas are divided by the Benfleet Creek, a tidal estuary that runs from the A130 south easterly to meet the River Thames. The River Thames borders the southern edge of Canvey Island. The remaining sides of Canvey are bordered by the Holehaven Creek and East Haven Creek.

The Thames Estuary is a potential source of tidal flooding to the Castle Point Borough. Tidal flooding is most likely to occur during storm surge conditions characterised by wind driven waves and low atmospheric pressure coupled with high spring tides. In areas protected from flooding by sea defences, tidal flooding can occur as a result of a breach in the defences, failure of a mechanical barrier or overtopping of defences.

Much of Canvey Island is at or below mean high tide level and in response to this, formal raised sea defences protect the entire island. In addition to these defences, the Benfleet Creek, East Haven Creek and Fobbing Horse Barriers are operated by the Environment Agency to protect the Borough in times of flood.

The Environment Agency flood zone map incorporates both tidal and fluvial flood risk extents, excluding the presence of defences. The Environment Agency flood zone map, shown in Appendix A Figure 5.1, identifies that the majority of Canvey Island, the Hadleigh Marshes and an area to the south west of South Benfleet are within Flood Zone 3. The definition of tidal Flood Zone 3a is based on the 0.5% AEP (1 in 200 year flood event), rather than the 1% AEP (1 in 100 year event) used for fluvial Flood Zones.

5.2.1 Tidal Flood Defences

Much of Canvey Island is reclaimed land that sits at or around 1m below mean high tide level[25] and is protected by tidal flood defences. The Environment Agency AIMS data shows that Castle Point Borough is protected from tidal flooding by the following defences:

- Benfleet Creek Barrier – flood barrier to control tidal water levels on the Benfleet Creek;
- East Haven Barrier – flood barrier which controls tidal water levels on the East Haven creek;
- Secondary tidal defences (raised earth embankments) along East Haven Creek;
- Formal sheet pile walls to tie into flood barriers;
- Formal concrete flood defences along the remaining perimeter of Canvey Island; and,
- Raised earth embankments along the southern boundary of Hadleigh Marsh.

The Environment Agency AIMS data shows that the majority of Canvey Island is protected by a concrete wall that spans the southern coastline of the island, with a design SOP of 1 in 1000 year. Embankments are located along the southern edge of Hadleigh Marsh, an area to the south west of South Benfleet and the western coastline of Canvey Island, with a design SOP of 1 in 1000 year.

Where access through the flood defences is required, flood gates may be constructed. These are usually manually operated and consist of a gate that is generally watertight with an appropriate crest height to prevent overtopping. The Environment Agency is responsible for flood gates and for issuing tidal flood warnings during which flood gates are

[25] http://www.anglianwater.co.uk/_assets/media/Canvey_Island_Bid_Document_March_2015.pdf

closed as necessary. There are a total of 32 flood gates located in the Castle Point Borough, the majority of which are on Canvey Island.

The TE2100 Plan states that the policy for Hadleigh Marshes in Castle Point is 'P3' – continue with existing or alternative actions to manage flood risk, and to continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change. The plan identifies that limited floodplain management is required in the largely undeveloped Hadleigh Marshes policy unit. However flood warning is necessary for the railway line. Continued maintenance of the flood defences is required to mitigate the risks of contamination of the Thames Estuary from the landfill, which covers a large part of the Hadleigh Marshes policy unit.

The TE2100 Plan states that the policy for Canvey Island in Castle Point is 'P4' – to take further action to keep up with climate and land use change so that flood risk does not increase. The drainage systems on Canvey Island will require upgrading as the sea level rises and rainfall increases from climate change. This will consist of improvements to channels and outfalls as the need arises. The replacement of the Benfleet, East Haven and Fobbing Horse moveable gate barriers for fixed defences is a possibility for the future although it will be a costly option.

5.2.2 Breach in Flood Defences

Canvey Island is particularly vulnerable in the unlikely event of a flood defence failure as it is possible that Canvey Island could be cut off from the mainland. The low-lying marshland and drainage channels on Canvey Island provide pathways for floodwater. Drainage channels within Canvey Island include channels west of the A130, 'The Lake', a creek adjacent to the Dutch Village and Thorney Creek Fleet. Given the wide flat topography of the island, large areas could be inundated quickly following a breach event as flooding pathways are not very well defined.

Although the chances of the defences failing or being overtopped are very small, the consequence of such a failure in Castle Point Borough is very high. It should be noted that the residual risk from overtopping of flood defences has not been modelled as part of this Level 1 SFRA.

Hydraulic breach modelling has been undertaken to assess the potential impact of a breach in the flood defences at 11 selected locations on the Castle Point Borough frontage as outlined in Table 5-1.

Table 5-1 Castle Point Borough breach names and modelling parameters

Breach Name	Breach Location	Defence Type	Breach Width (m)	Breach coordinates	
BAS01	Flood barrier, Fobbing Horse, Vange Creek	Barrier	45	574045	184306
CAS01	Upper Horse	Wall	20	575200	183400
CAS02	Canvey Village, Lower Horse	Wall	20	577100	182600
CAS03	STW	Wall	20	578100	182000
CAS04	Canvey Island Golf Course	Wall	20	579438	182463
CAS05	Leigh Beck	Wall	20	581600	182700
CAS06	Sunken Marsh	Wall	20	580900	184300
CAS07	Castle Point Golf Course	Wall	20	579009	185005
CAS08	Benfleet Creek Flood Barrier	Flood Barrier	45	578068	185605
CAS09	Easthaven Barrier	Embankment	45	574757	184282
SOU01	Hadleigh Marsh	Earth (estuary)	50	583160	185661

The following flood events were simulated:

- 1 in 200 year event (0.5% AEP) present day (2016), with flood barriers operational;
- 1 in 1000 year event (0.1% AEP) present day (2016), with flood barriers operational;
- 1 in 200 year event (0.5% AEP) with climate change (2116), with flood barriers operational and non-operational; and
- 1 in 1000 year event (0.1% AEP) with climate change (2116), with flood barriers operational and non-operational.

The composite flood depth, flood hazard and time to inundation mapping for the 0.5% AEP present day event and future 0.1% AEP with climate change event scenarios in Castle Point are presented in Appendix E Figures E18-E34. The maps should be used by the LPA to better understand the residual risk posed to development within Flood Zone 3a and can be used by developers to better plan and understand 'safe' access and egress routes, and finished floor levels in consultation with the LPA and Environment Agency.

5.2.3 Flood Warning Areas

There are three Environment Agency Flood Warning Areas in the Castle Point Borough associated with tidal flooding. These are identified in Appendix A Figure 5.6, as follows:

- Canvey Island North;
- Canvey Island South; and,
- Leigh On Sea frontage from Chalkwell to Hadleigh Marshes including Two tree Island.

5.3 Flooding from Rivers

5.3.1 Flood Zones

Although the majority of the Castle Point Borough (56%) is defined as Flood Zone 1 within the north of the Borough, approximately 39% is located within Flood Zone 3 and 5% is defined as Flood Zone 2 to the south of the Borough (Appendix A Figure 5.1).

There are four main rivers located within Castle Point Borough: Prittle Brook, Benfleet Hall Sewer, Kersey Marsh Sewer and Hadleigh Marsh Sewer.

The Prittle Brook is located in the east of the Borough and flows east into the Southend-On-Sea Borough. Flood Zone mapping identifies a small area of fluvial flood risk along the edge of the Prittle Brook.

The Benfleet Hall Sewer flows through Hope's Green, to the south west of the Borough on the mainland. Water is conveyed down the steep gradient of the upper reaches to the flat playing fields at Hope's Green where the water slows suddenly due to the flat gradient. This area south of the playing fields, along with Benfleet Marsh is considered a washland and a designated flood storage area (FSA). The washland is expected to contain fluvial flooding in excess of the 1% AEP (1 in 100 years) fluvial flood event. The washland is defined by a combination of an earth embankment and fully concrete encapsulated steel sheet pile hard defence which is maintained to a level of 4mAOD. The outflow of water is restricted by a tidal flap valve located at the confluence with Benfleet Creek.

The Kersey Marsh Sewer and Hadleigh Marsh Sewer both rise in Hadleigh Marsh on the mainland and outfall to the Benfleet Creek. They are both rural catchments, which limits the potential flood consequence associated with them.

5.3.2 Functional Floodplain

The modelled outlines for the 5% AEP event for the Prittle Brook and the South Benfleet FSA have been designated as Flood Zone 3b Functional Floodplain by Castle Point Borough Council, as shown in Appendix A Figure 5.1. The functional floodplain for Prittle Brook is located to the north of Hadleigh.

5.3.3 Fluvial Flood Risk and Climate Change

Appendix A Figure 5.1.a shows the fluvial flood zones for the Prittle Brook. As part of this SFRA, the Environment Agency Prittle Brook model (2008) was updated to include the modelled extents for the 1% AEP event plus 25%, 35% and 65% climate change allowances. The results of the climate change modelling show that for all model nodes, the peak flood water level in the 0.1% AEP event is greater than the flood water level for the 1% AEP +65% climate change event. Therefore, for the purpose of this SFRA, the 0.1% AEP flood extent is used as a proxy for the 1% AEP plus climate change event.

A technical note summarising the methodology and results of the update of the Prittle Brook model to incorporate the revised climate change allowances is provided in Appendix C.

Modelled data was not available for the upper reaches of Benfleet Hall Sewer nor the tributary of Rawreth Brook. For these watercourses, the extent of Flood Zone 2 (see Appendix A, Figure 5.1) should be used as an indicator of the potential extent of the 1% AEP with an allowance for climate change.

5.3.4 Ordinary Watercourses

The South Essex SWMP identifies the following ordinary watercourses and unnamed drainage ditches in the Castle Point Borough:

- Prittle Brook (upper reaches);
- Tributary of Benfleet Brook;
- Tributary of Rawreth Brook;
- Janette Avenue; and
- East of Haven Road.

In addition to these, there are more than 16 watercourses and dykes that form the drainage system for Canvey Island, which is partly pumped and with different sections operated and maintained by Castle Point Borough Council, AWS, and the Environment Agency. Fluvial flooding from this system is possible due to the flat and low lying topography of the Island and the restrictions on flow caused by sea defences and pump drains at the downstream end of these watercourses. If water were to overtop these dykes, the flat topography of the Borough could cause it to disperse over large areas.

The maintenance of ordinary watercourses that are not owned by ECC (as the LLFA) or Castle Point Borough Council is the responsibility of the riparian owner. Further details of the responsibilities of the riparian owners are stated in the ECC LFRMS.

There are no historic recorded incidents of ordinary watercourse flooding within the Castle Point Borough. Often, where blocked ditches or streams have been reported as being the cause of flooding this has been reported as occurring with other sources, e.g. sewer or surface water runoff, and therefore will have been reported as multiple sources of flooding in the dataset.

No modelling of the flood risk from ordinary watercourses has been undertaken to date across the Castle Point Borough. Therefore future flood risk is based on the potential risk that might arise based on knowledge of known flooding hotspots and potential mechanisms for flooding. In addition, the Environment Agency RoFSW mapping (described in Section 5.4 below) may help to highlight where flood risk from ordinary watercourses could occur.

5.3.5 Flood Defences

The Environment Agency AIMS data shows that the Benfleet sewer is a maintained channel and protected by high ground, with a design SOP of 1 in 5 years. The South Benfleet FSA has a design SOP of 1 in 100 years. The Kersey Marsh Sewer is a natural vegetated channel, with a SOP of 1 in 5 years. High Ground is present along the course of the Prittle Brook within the Castle Point Borough.

5.3.6 Flood Warning Areas

Appendix A Figure 5.6 identifies three Environment Agency Flood Warning Areas in Castle Point, for tidal flood risk:

- Canvey Island North;
- Canvey Island South; and
- Leigh on Sea frontage from Chalkwell to Hadleigh Marshes including Two Tree Island.

5.3.7 Emergency Rest Centres

Designated emergency rest centres for the Castle Point Borough are mapped in Appendix A Figure 5.6 and summarised in Table 5-3.

Table 5-2 Emergency Rest Centres in the Castle Point Borough

Rest Centre	Address	Post Code	Easting	Northing
The Appleton School	The Appleton School, Croft Road, Benfleet, Essex	SS7 5RN	577084	188071
SEEVIC College	SEEVIC College, Runnymede Chase, Benfleet, Essex	SS7 1TW	579167	188057
Runnymede Hall	Runnymede Hall, Kiln Road, Thundersley, Essex	SS7 1TF	579313	187995
The Deanes School	The Deanes School, Daws Heath Road, Thundersley, Benfleet, Essex	SS7 2TD	580256	188658
The King John School	The King John School, Shipwrights Drive, Thundersley, Benfleet, Essex	SS7 1RQ	579816	187319
Castle View School	Castle View School, Foksville Road, Canvey Island, Essex	SS8 7FH	580042	183427
The Paddocks	The Paddocks, Long Road, Canvey Island, Essex	SS8 0JA	579789	183238
Cornelius Vermuyden School	Cornelius Vermuyden School, Dinant Avenue Canvey Island Essex	SS8 9QS	578202	184140

5.4 Flooding from Surface Water

Surface water flooding in Castle Point is particularly driven by local topography which predominantly slopes towards watercourse channels and their tributaries including the Benfleet Creek and Prittle Brook. Localised flooding can be attributed to topographic depressions, insufficient capacity within ordinary watercourses and culverts, as well as obstructions to surface water flow paths. Flooding from surface water can also be associated with the failure in the management of the drainage network during high rainfall events.

The Environment Agency mapping of the Risk of Flooding from Surface Water (RoFSW), as shown in Appendix A Figure 5.2, shows that there is high probability of surface water flooding on Canvey Island. There are a number of high risk fluvial flow paths in the South Benfleet and Thundersley areas. The majority of high surface water flood risk extends along the courses of the Hadleigh Ray and along the course of ordinary watercourses in the Borough.

Six CDAs have been identified in the Castle Point Borough SWMP, as shown in Appendix A Figure 5.2. The SWMP should be referred to for further detail on specific surface water flood events and CDAs.

5.4.1 Surface water flood risk and Climate Change

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

5.4.2 Canvey Island Integrated Urban Drainage Study

The Canvey Island Integrated Urban Drainage Study (IUD) has been undertaken setting out how surface water drainage should be managed and maintained on the island. The study was not available for inclusion in the Level 1 SFRA; however, the study should be used to inform the Level 2 SFRA and site specific FRAs.

5.5 Flooding from Groundwater

The AStGWF dataset provided by the Environment Agency indicates where groundwater may emerge due to geological and hydrogeological conditions. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation.

The AStGWF dataset presented in Appendix A Figure 5.4 indicates that the majority of the Castle Point Borough has a <25% risk of surface water emergence and a 25%-50% risk of groundwater emergence in the north eastern part of the Borough along the course of the Eastwood Brook.

It should be noted that due to the resolution of the AStGWF dataset, i.e. at 1km grid squares, the AStGWF data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. Where available, site-specific information, including ground investigations and monitoring, should be used to support planning decisions for individual developments.

The South Essex SWMP identified that no groundwater flooding incidents have been reported to the Environment Agency, Castle Point Borough Council, Essex Fire and Rescue Service or the Parish Councils.

5.6 Flooding from Sewers

AWS has supplied records of sewer flooding for the Borough through their DG5 register on the total number of properties affected by and at risk of sewer flooding (both internally and externally) based on historic. This highlights that the area of South Benfleet has experienced a greater number of sewer flooding incidents than the rest of the Borough.

Appendix A Figure 5.5 shows the DG5 Register that has been supplied by AWS for the SFRA. It should be noted that AWS focus their efforts on removing properties from the DG5 register and therefore this information may not accurately represent those properties currently at risk.

Climate change is anticipated to increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination is likely to increase the pressure on the existing efficiency of sewer systems, thereby reducing their design standard and leading to more frequent localised flooding incidents. Any sewer flooding that may occur could be exacerbated as a result of surface water runoff during extreme rainfall events.

5.7 Flooding from Other Sources

5.7.1 Risk of Flooding from Reservoirs

The Environment Agency Flood Risk from Reservoirs map[26] identifies areas that could be flooded if a large[27] reservoir were to fail and release the water it holds. Environment Agency data shows that the residential areas along the course of the Hadleigh Ray, Hadleigh Park and an area of South Benfleet are at risk from reservoir flooding.

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a minimal risk.

Castle Point Borough Council is responsible for working with members of the LRF to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

5.8 Historic Flood Records

The Environment Agency Historic Flood Map indicates areas that have been previously flooded but does not show the source of the flood. The map shows that the whole of Canvey Island has been previously flooded. The southern part of Hadleigh Park and the southern part of South Benfleet has also been previously flooded, as show in Appendix A Figure 5.3.

The South Essex SWMP (2012) states that there are 26 recorded flood events from Castle Point Borough Council, the Essex Fire and Rescue Service, Parish Councils and the Highways Agency. The source of flooding is unknown and these records are shown in Appendix A Figure 5.3. Where available, updated flood incident records held by the project stakeholders, including Castle Point Borough Council, ECC, the Environment Agency and AWS, have been provided to support this Level 1 SFRA update.

A summary of past flood events is shown below in Table 5-3.

[26] https://flood-warning-information.service.gov.uk/long-term-flood-risk/
[27] A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

Table 5-3 Summary of past flood events in Castle Point

Flood Event	Source of flooding	Description (record source in brackets, where available)
January 1953	Tidal	A combination of high spring tides and a severe storm led to widespread flooding across the north-sea coast. The whole of Canvey Island was inundated with the loss of 58 lives and the evacuation of many more. Following this event, structural flood mitigation measures were put in place to increase the standard of protection offered by existing flood defences.
1968	Fluvial	Fluvial flooding from the Benfleet Sewer. Following this event, structural flood mitigation measures were undertaken along the watercourse to improve the standard of protection against flooding including the construction of the bunded washlands area.
October 1987	Surface Water	Flood record in Hadleigh (North Essex Catchment Flood Management Plan)
April 2007 to March 2009	Unknown	19 recorded flood incidents (Fire and Rescue Service).
28th November 2009	Unknown	Hadleigh flood record (Fire and Rescue Service).
28th February 2010	Unknown	Canvey Island 2 flood records (Fire and Rescue Service).
29th March 2010	Unknown	Hadleigh flood record (Fire and Rescue Service).
6th June 2010	Unknown	Hadleigh flood record (Fire and Rescue Service).
18th January 2011	Heavy Rainfall	3 records of flooding in Canvey Island (Echo Newspaper)
24th August 2013	Surface Water	Flooding on Canvey Island
20th of July 2014	Surface Water	Between 13:40 and 18:00, one million cubic metres of water fell on the island[28]. The unprecedented amount of rainfall overwhelmed large parts of the drainage system on the island including infrastructure that predates the current standard of drainage infrastructure. The rainfall caused widespread flooding including internal flooding of over 330 properties and significant disruption to infrastructure.

5.9 Summary of Flood Risk in the Castle Point Borough

Tidal and fluvial flooding poses the most significant flood risk to the Castle Point Borough, in particular Canvey Island and Hadleigh Marshes. The topography and location of watercourses on Canvey Island means that the whole island is at risk from tidal and fluvial flooding. Although much of the Island is protected by the presence of defences, the island is still at residual risk of flooding if the defences were to fail or to be overtopped.

In the event that a breach in the existing flood defences was to occur, or a failure of one of the existing flood barriers (residual risk), significant depths of floodwater would be experienced on Canvey Island and the southern portion of the mainland. Given the low lying nature of these parts of the Borough, floodwaters would propagate rapidly across Canvey Island thereby reducing the time for warning and evacuation of residents.

On the mainland area of the Borough, the Prittle Brook and Benfleet Hall Sewer pose the most significant fluvial risk with the southern part of South Benfleet and Hadleigh located within Flood Zone 2 and 3 as well as a small area along the course of the Prittle Brook. High Ground and Embankments protect the area from flooding however the area is still at residual risk.

There is a high probability of surface water flooding within the Castle Point Borough. Surface water flood risk is highest on Canvey Island. A number of high risk flow paths are located in the South Benfleet and Thundersley areas associated with the route of ordinary watercourses. Localised flooding within the Borough can be attributed to topographic depressions as well as insufficient capacity within watercourses. The management of the drainage system has also been found to be an exacerbating factor for previous surface water flooding events that have occurred within the Borough.

The maps presented in Appendix A and Appendix E provide the necessary information to facilitate the NPPF risk-based approach to planning. This process determines the compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and the Exception Test when required.

[28] https://www.essex.gov.uk/Environment%20Planning/Environment/local-environment/flooding/Documents/FloodInvestigationReportCanveyIsland.pdf

6. Flood Risk in Rochford District

6.1 Overview

This Section provides the strategic assessment of flood risk across the Rochford District from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historical incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read with reference to the figures in Appendix A.

6.2 Tidal Flooding

Rochford is at risk of tidal flooding from the North Sea and the River Crouch estuary. The water levels in the rivers may fluctuate as a result of the tidal conditions. Tidal flooding is most likely to occur during storm surge conditions characterised by wind driven waves and low atmospheric pressure coupled with high spring tides. Flood Zone mapping included in Appendix A Figure 6.1 identifies that a large area covering the eastern part of the Borough is in Flood Zone 3, which is defined as land that would be expected to flood during a flood event with a 0.5% AEP, when excluding the presence of defences. Additional areas located in Flood Zone 3 are in the north of the district along the course of the River Crouch and along the River Roach to the east of the district.

6.2.1 Tidal Flood Defences

The Environment Agency AIMS data shows that the majority of tidal flood defences in the Rochford District are earth embankments along the course of the River Roach, River Crouch and along the eastern coastline.

The earth embankments are typically fronted by areas of intertidal mudflats or salt marsh habitats, which act to dissipate wave energy and reduce the probability of erosion due to tidal and river flow. The embankments may be reinforced with piles, concrete retaining wall structures or sheet pile walls driven through the crest to provide structural stability, additional resistance to breaching and to raise the level of protection.

Where bunds may be subject to high flow velocities or wave action the embankment may have a revetment or rock armour constructed on its seaward flank to prevent scour and erosion. Such flood defences are present around much of the frontage including Wallasea, Paglesham, South Fambridge and Shoeburyness New Ranges.

There is some variation in the standard of protection provided by the embankments in the Rochford District:

- Foulness Island has a SOP of 1 in 1 year;
- Wallsea Island has a SOP of 1 in 9 year;
- Shoeburyness New Range has a SOP of 1 in 10 year;
- Barling Marsh has a SOP of a 1 in 8 year; and
- Little Wakering has a SOP of a 1 in 20 year.

There is a manmade tidal seawall surrounding the tidal frontage of Paglesham and a secondary manmade clay embankment across Clements Marsh which protects the area from flooding up to a SOP of 1 in 50 years.

On the north bank of the tidal Roach estuary a blockwork revetment sea wall provides protection to Great Stambridge Hall and Rochford up to the 1 in 6 year flood event. On the southern bank of the estuary the level of protection varies between 1 in 4 to 1 in 8 year standard.

6.2.2 Breach in Flood Defences

Hydraulic breach modelling has been undertaken to assess the potential impact of a breach in the flood defences at 9 selected locations on the Rochford District frontage as outlined in Table 6-1 below.

Table 6-1 Rochford District breach names and modelling parameters

Breach Name	Breach Location	Defence Type	Breach Width (m)	Breach coordinates	
ROC03	Oxenham Farm	Earth Embankment	50	595745	188695
ROC04	Paglesham Eastend	flood gate	50	594767.5	192117
ROC07	South Fambridge	Embankment	50	585500	196200
ROC08	Havengore Bridge	Earth Embankment	20	596978	188287
ROC09	Stambridge Mills Sluice	Earth Embankment	20	588767	190318
ROC10	Horesome Green Pub	Earth Embankment	20	587730	190219
ROC11	Brandyhole Yacht Club	Earth Embankment	20	582507	195695
ROC12	Beeches No 3	Earth Embankment	20	579220	194842
ROC13	Pats Rill	Earth Embankment	20	579007	194706

The following flood events were simulated:

- 1 in 200 year event (0.5% AEP) present day (2016);
- 1 in 1000 year event (0.1% AEP) present day (2016);
- 1 in 200 year event (0.5% AEP) with climate change (2116); and
- 1 in 1000 year event (0.1% AEP) with climate change (2116).

The composite flood depth, flood hazard and time to inundation mapping for the 0.5% AEP present day event and future 0.1% AEP with climate change event scenarios in Rochford are presented in Appendix E Figures E35-E43. The maps should be used by the LPA to better understand the residual risk posed to development within Flood Zone 3a and can be used by developers to better plan and understand 'safe' access and egress routes, and finished floor levels in consultation with the LPA and Environment Agency.

6.2.3 Flood Warning Areas

There are five Environment Agency Flood Warning Areas in the Rochford District relating to tidal flooding. These are identified in Appendix A Figure 6.6, and are listed below:

- Wallasea and Foulness Islands;
- Paglesham, Rochford, The Wakerings and Potton Island;
- Eastwood Brook from downstream of Rayleigh Weir and the Prittlewell Brook to Southend Airport;
- Tidal River Crouch from Creeksea to Battlesbridge; and,
- Hullbridge waterside properties.

6.3 Flooding from Rivers

6.3.1 Flood Zones

Approximately half of the Rochford District is defined as Flood Zone 1, with 2% of the district in Flood Zone 2 and 44% defined as Flood Zone 3.

The main source of fluvial flood risk in the Rochford district is the upper reaches and tributaries of the River Roach. The Hawkwell Brook becomes a main river at Thorpe Close in Hawkwell. Hawkwell Brook flows through the east through Hawkwell village in an open channel before joins a confluence with Hockley Brook to become the River Roach. The Noblesgreen Ditch flows easterly from Rayleigh, towards Rochford where it then joins the River Roach. The flood zone mapping for Hawkwell Brook included in Appendix A Figure 6.1 shows that Flood Zone 2 and 3 associated with the River Crouch extends across the outskirts of Hawkwell including the residential areas of Clements Hall Way and Sweyne Avenue along the edge of the River. The flood plain of Hockley Brook extends across smaller settlements along the edge of the River.

The River Roach flows along the western edge of Rochford. The flood plain associated with the River Roach extends over the residential areas on the edge of Rochford including Bradley Way, Ashingdon Road, Oak Road and St Andrew's Road. The Eastwood Brook and Prittle Brook are located to the south of Rochford. The Eastwood Brook follows the line of the A1015 and joins the Noblesgreen Ditch to the west of Rochford. The Prittle Brook flows easterly through Southend-on-Sea before turning northwards to meet the River Roach at Sutton Ford Bridge. Areas of Flood Zone 2 and 3 associated with the Eastwood Brook include residential areas on the edge of Southend-On-Sea. The residential areas of Warwick Drive and Sutton Court Drive are located in Flood Zones 2 and 3 of the flood plain from the Prittle Brook. The River Roach is tidally influenced downstream of the Rochford Railway Station.

The River Crouch is not a significant source of fluvial flooding in the study area as the river is tidally influenced along the length adjacent to the Rochford district. The River Crouch flows along the west of the district to the west of the village of Battlesbridge and through the village of Raweth in an open channel. Flood zone mapping included in Appendix A Figure 6.1 shows that Flood Zone 3 associated with the River Crouch extends across the residential areas of Battlesbridge and Raweth as well as smaller settlements along the edge of the River. There are several smaller tributaries of the River Crouch located within the west of the district; the Rawreth Brook, Chichester Hall Brook and North Benfleet Brook. Areas of Flood Zone 2 and 3 associated with the rivers extend across the residential areas of Rawreth and smaller settlements along the edge of the River.

6.3.2 Functional Floodplain

The modelled outlines for the 5% AEP event for the River Roach and its tributaries to define the Functional Floodplain (Flood Zone 3b) associated with these watercourses, as shown in Appendix A Figure 6.1.a. These areas are chiefly undeveloped areas to the west of Bradley Way (south of Rochford Train Station), and along the edge of the Eastwood Brook to the south of Rochford and the south of Rayleigh and Noblesgreen Ditch.

Modelled data was not available for the smaller ordinary watercourses in the district. For these watercourses, the extent of Flood Zone 3a (see Appendix A, Figure 6.1) should be used as an indicator of the maximum extent of potential Functional Floodplain for the purposes of the Sequential Test. Where potential sites are required within Flood Zone 3a of these watercourses, a Level 2 SFRA should include a suitable hydraulic analysis to provide delineation between Flood Zone 3a and Flood Zone 3b (Functional Floodplain) at these specific locations.

6.3.3 Fluvial Flood Risk and Climate Change

Appendix A Figure 6.1.a shows the updated fluvial flood zones for the River Roach and its tributaries, including the modelled extents for the 1% AEP event plus 25%, 35% and 65% climate change allowances. The modelled climate change scenarios include the presence of flood defences along the watercourses.

Hydraulic modelling of the Prittle Brook undertaken for the this SFRA demonstrates that the Environment Agency's mapped extent of the 0.1% AEP flood extent for the Prittle Brook is a suitable representation of the 1% AEP plus climate change event (refer to Section 3.1.1 and Appendix C) and can be used for this purpose.

The results show a minimal increase in the flood outline near to Rochford Station, to the south of the Hawkwell Brook, south of the Hockley Brook, the western edge of Noblesgreen Ditch to the north of Rayleigh and the western part of the Eastwood Brook to the south of Rayleigh.

Modelled data was not available for the smaller ordinary watercourses in the district. For these watercourses, the extent of Flood Zone 2 (see Appendix A, Figure 6.1) should be used as an indicator of the potential extent of the 1% AEP with an allowance for climate change.

6.3.4 Ordinary Watercourses

There are a number of ordinary watercourses in the District which are tributaries of the main rivers, as shown in Appendix A Figure 6.1. According to Environment Agency records, the mapped ordinary watercourses in Rochford include tributaries of main rivers including the River Roach and the River Crouch.

The South Essex SWMP identifies the following ordinary watercourses in the Rochford District:

- North Benfleet Brook; and
- Noble's Green Ditch.

The maintenance of ordinary watercourses that are not owned by ECC (as the LLFA) or Rochford District Council is the responsibility of the riparian owner. Further details of the responsibilities of the riparian owners are stated in the ECC LFRMS.

There are no historic recorded incidents of ordinary watercourse flooding within the Rochford District. Often, where blocked ditches or streams have been reported as being the cause of flooding this has been reported as occurring with other sources, e.g. sewer or surface water runoff, and therefore will have been reported as multiple sources of flooding in the dataset.

No modelling of the flood risk from ordinary watercourses has been undertaken to date across the Rochford District. Therefore future flood risk is based on the potential risk that might arise based on knowledge of known flooding hotspots and potential mechanisms for flooding. In addition, the Environment Agency RoFSW mapping (described in Section 5.5 below) may help to highlight where flood risk from ordinary watercourses could occur.

6.3.5 Flood Defences

The Environment Agency AIMS shows that the flood defences along the fluvial watercourses are predominantly in the form of maintained channels with high ground. There is some significant variation in the standard of protection provided by these channels in the area.

- The Hawkwell Brook and Hockley Brook have maintained channels providing protection against the 100 year flood event. Along the fluvial section of the River Roach, the level of protection drops to the 30 year standard.
- Sections of the Eastwood Brook and Prittle Brook are designed to protect against the 100 year event. In some sections of this watercourse, this decreases to just 10 – 17 year event.
- The Rawreth Brook has maintained channels providing protection against the 50 year event.

6.3.6 Emergency Rest Centres

Designated emergency rest centres for the Rochford District are mapped in Appendix A Figure 6.6 and summarised in Table 6-2.

Table 6-2 Emergency Rest Centres in the Rochford District

Rest Centre	Address	Post Code	Easting	Northing
Clements Hall Leisure Centre	Clements Hall Way, Hawkwell	SS5 4LN	585159	191818
Rayleigh Leisure Centre	Priory Chase, Rawreth Lane, Rayleigh	SS6 9NF	579968	192605
Freight House	Bradley Way, Rochford	SS4 1BJ	587516	190358
The Mill Arts and Events Centre	Mill Hall, Bellingham Lane, Rayleigh	SS6 7ED	580682	190888

6.4 Flooding from Surface Water

The spatial extent of flooding within the Rochford District is driven by topography relating to the River Crouch, River Roach and their tributaries. Localised surface water flooding within the Borough can be accredited to topographic depressions and obstructions to surface water flow, in particular where systems conveying surface water are limited by tidal sources. Historic records of surface water flooding can be attributed to the inundation of surface water drainage systems and lack of capacity within ordinary watercourses during high rainfall events.

Pluvial modelling undertaken as part of the SWMP indicates that the greatest flood hazard from surface water is associated with the steep sloping topography. Specific flow paths are present within the CDAs in the Borough. Open ordinary watercourses also contribute to surface water flooding. 10 CDAs have been delineated within the SWMP, which should be referred to for more information.

The Environment Agency RoFSW mapping as shown in Appendix A Figure 6.2 has been used to illustrate surface water flood risk across Rochford.

6.4.1 Surface water flood risk and Climate Change

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However a range of three annual probability events have been undertaken, 3.3%, 1% and 0.1% and therefore it is considered appropriate to use the 0.1% AEP event as a substitute dataset to provide a worst case scenario and an indication of the implications of climate change.

6.5 Flooding from Groundwater

The AStGWF dataset provided by the Environment Agency indicates where groundwater may emerge due to geological and hydrogeological conditions. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation.

The AStGWF dataset presented in Appendix A Figure 6.4 indicates that there are areas at 50%-75% risk of groundwater emergence along the tributaries of the River Roach and River Crouch, and along the eastern coastal areas. There is an area at >75% risk of groundwater emergence on Foulness Island.

It should be noted that due to the resolution of the AStGWF dataset, i.e. at 1km grid squares, the AStGWF data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. Where available, site-specific information, including ground investigations and monitoring, should be used to support planning decisions for individual developments.

6.6 Flooding from Sewers

AWS has supplied records of sewer flooding for the Rochford District through their DG5 register on the total number of properties affected by and at risk of sewer flooding (both internally and externally) based on historic flooding. This highlights that the area of southern Rayleigh has experienced a greater number of sewer flooding incidents than the rest of the District.

Appendix A Figure 6.5 shows the DG5 Register that has been supplied by AWS for the SFRA. It should be noted that AWS focus their efforts on removing properties from the DG5 register and therefore this information may not accurately represent those properties currently at risk.

Climate change is anticipated to increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination is likely to increase the pressure on the existing efficiency of sewer systems, thereby reducing their design standard and leading to more frequent localised flooding incidents. Any sewer flooding that may occur could be exacerbated as a result of surface water runoff during extreme rainfall events.

6.7 Flooding from Other Sources

6.7.1 Risk of Flooding from Reservoirs

The Environment Agency Flood Risk from Reservoirs map[29] identifies areas that could be flooded if a large[30] reservoir were to fail and release the water it holds. Environment Agency data shows that the residential areas along the course of the River Roach, River Crouch, Rawreth Brook, Chichester Hall Brook and North Benfleet Brook are at risk from reservoir flooding.

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. The NPPG encourages LPAs to identify any impounded reservoirs and evaluate how they might modify the existing flood risk in the event of a flood in the catchment it is located within, and / or whether emergency draw-down of the reservoir will add to the extent of flooding.

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. These reservoirs therefore present a minimal risk.

Rochford District Council is responsible for working with members of the LRF to develop emergency plans for reservoir flooding and ensuring communities are well prepared.

6.8 Historic Flood Records

The Environment Agency Historic Flood Map indicates areas that have been previously flooded but not show the source of the flood. The map (Appendix A Figure 6.3) shows areas to the north of the district along the River Crouch and to the east of the district along the course of the River Roach that have previously been flooded. There is also an area to the south of Rochford along the course of Prittle Brook has also been previously flooded.

Where available, flood incident records held by the project stakeholders, including Rochford District Council, ECC, the Environment Agency and AWS, have been provided to support this Level 1 SFRA update.

A summary of past flood events is shown below in Table 6-3.

Table 6-3 Summary of past flood events in Rochford

Flood Event	Source of flooding	Description (record source in brackets, where available)
January 1953	Tidal	A tidal surge, 2.5m above the spring tide level, caused widespread flooding and loss of life across the whole region. Along the south bank of the River Crouch, from Battlesbridge to Canewdon, water overtopped the defences and propagated inland by up to a mile. In South Fambridge a breach, a mile and half long, occurred close to Land End Point leading to flooding of agricultural land and properties. On Wallasea Island, 37 people were resident and trapped inside buildings or on roofs due to the rising water levels. On Foulness Island, 350 – 400 people were resident. A breach at Morris Point caused the waters to surge towards Landwick. Due to the low lying nature of the topography, the majority of the island was flooded. All access roads to the island were flooded and residents had no means of communication with the mainland.
September 1958	Fluvial	76mm of rainfall fell in two hours leading to flooding of properties in Rawreth and the evacuation of a number of families by boat.
September 1968	Fluvial	Exceptionally heavy rainfall led to extensive flooding within the Rochford District from tributaries of the River Roach including the Eastwood Brook and Prittle Brook. Rochford Golf Course was flooded to a depth of nine foot and up to 50 properties in Glenwood Avenue, to the south of Hockley, were affected. 78 properties were flooded in Rochford, located on Ashingdon Road, Church Street, St Andrews Road, Oak Road, Hall Road, Newlyn Lane and South Street.
February 2001	Fluvial	Heavy rainfall combined with high tides led to tide locks on several Essex Rivers.

29 https://flood-warning-information.service.gov.uk/long-term-flood-risk/
30 A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools.

Flood Event	Source of flooding	Description (record source in brackets, where available)
		Three properties were flooded in Rochford and 5 in Rawreth during these high water levels.
January 2003	Unknown	Flooding across South Essex (South Essex Catchment Flood Management Plan)
April 2007 to March 2009	Unknown	7 recorded flood incidents (Fire and Rescue Service).
24th July 2009	Blocked Drains	Hockley train station (Fire and Rescue Service).
29th October 2009	Unknown	Flooding in Wickford and Rochford (Fire and Rescue Service).
2nd December 2009	Unknown	Three records in Hawkwell (Fire and Rescue Service).
22nd February 2010	Unknown	Several records of widespread flooding (Fire and Rescue Service).
28th February 2010	Unknown	Several records of widespread flooding (Fire and Rescue Service).
30 August 2010	Unknown	Flooding in Rochford (Fire and Rescue Service).
18th January 2011	Heavy rainfall	Four recorded points of flooding. Rochford Hundred Golf Club, The Horse and Groom Pub, Watery Lane and Brays Lane (The Echo Newspaper).

6.9 Summary of Flood Risk in Rochford District

Tidal and fluvial flooding pose the most significant flood risk to the Rochford District. The River Roach and River Crouch are tidally influenced by the North Sea. Although much of the areas at risk are protected by the presence of defences, these areas are still at residual risk of flooding if the defences were to fail or to be overtopped. Fluvial flooding primarily affects Rochford town, where the River Roach, Nobles Green Ditch and Eastwood Brook meet. A number of other smaller watercourses in Rawreth and Rayleigh also pose a fluvial flood risk.

Surface water flood risk in the Rochford District is predominantly located around the watercourses located within the district. Localised surface water flooding within the district can be accredited to topographic depressions and obstructions to surface water flow. A number of high risk surface water flow paths are located within the centre of Rochford as well as areas of Rayleigh and Hullbridge.

The maps presented in Appendix A and Appendix E of this SFRA provide the necessary information to facilitate the NPPF risk-based approach to planning. This process determines the compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and the Exception Test when required.

7. Flood Risk in the Southend-On-Sea Borough

7.1 Overview

This Section provides the strategic assessment of flood risk across the Southend-On-Sea Borough from each of the sources of flooding outlined in the NPPF. For each source of flooding, details of any historical incidents are provided, and where appropriate, the impact of climate change on the source of flooding is described. This Section should be read with reference to the figures in Appendix A.

7.2 Tidal Flooding

The Thames Estuary and North Sea pose the greatest flood risk to Southend-on-Sea. Tidal flooding may occur during storm surge conditions characterised by wind driven waves and low atmospheric pressure coupled with high spring tides. In areas protected from flooding by sea defences, tidal flooding can occur as a result of a breach in the defences, failure of a mechanical barrier or overtopping of defences.

The Environment Agency flood zone map, shown in Appendix A Figure 7.1, incorporates both tidal and fluvial flood risk extents. The definition of tidal Flood Zone 3a is based on the 0.5% AEP, rather than the 1% AEP used for fluvial Flood Zones.

7.2.1 Flood Defences

The Environment Agency AIMS data shows that there are four areas along the Southend-on-Sea Borough coastline protected from tidal flooding. To the west of the Borough, south of Leigh-on-Sea railway station, there is an earth embankment with concrete revetment, which has a design SOP of 1 in 1000 year. The frontage of Southend-on-Sea town is protected by a sea wall with a cobble stone masonry revetment, which has a design SOP of 1 in 1000 year. The frontage of Shoebury Common and the frontage of Suttons, to the east of the Borough, are both protected by concrete seawalls with a design SOP of 1 in 1000 year.

The TE2100 Plan states that the policy for Leigh Old Town and Southend-on-Sea is 'P4' – to take further action to keep up with climate and land use change so that flood risk does not increase. The TE2100 plan states that improvements to the flood risk management system should provide amenity, recreation and environmental enhancement, and be designed to minimise any adverse impacts on the frontage whilst supporting and enhancing the fishing industry activities. Any raised and new defences on the frontage of the Southend-On-Sea Borough should be designed to the following:

- They do not encroach into the Estuary;
- New defence could be implemented on a new alignment behind the sea front (where space permits) so that the heights of walls on the sea front are limited;
- Walkways are raised to provide sea views;
- Access points are improved; and,
- Demountable defences and gated access points are included in the designs in some areas.

7.2.2 Breach in Flood Defences

Hydraulic breach modelling has been undertaken to assess the potential impact of a breach in the flood defences at 7 selected locations on the Southend-on-Sea Borough frontage as outlined in Table7-1.

Table 7-1 Southend-on-Sea Borough breach names and modelling parameters

Breach Name	Breach Location	Defence Type	Breach Width (m)	Breach coordinates	
SOU1	Hadleigh Marsh	Earth (estuary)	50	583160	185661
SOU2	Chalkwell	Hard (estuary)	20	585796	185365
SOU4	City Beach	Hard (estuary)	20	589174	184919
SOU6	Shoeburyness	Hard (estuary)	20	593018	183955
SOU7	Shoeburyness/Great Wakering	Earth (open coast)	200	594700	185300
SOU8	Shoeburyness New Ranges	Earth Embankment	200	595445	185998
SOU9	Morrin's Point	Earth Embankment	200	596298	186654

The following flood events were simulated:

- 1 in 200 year event (0.5% AEP) present day (2016);
- 1 in 1000 year event (0.1% AEP) present day (2016);
- 1 in 200 year event (0.5% AEP) with climate change (2116); and
- 1 in 1000 year event (0.1% AEP) with climate change (2116).

The composite flood depth, flood hazard and time to inundation mapping for the 0.5% AEP present day event and future 0.1% AEP with climate change event scenarios in Southend-on-Sea Borough are presented in Appendix E Figures E44-E52. The maps should be used by the LPA to better understand the residual risk posed to development within Flood Zone 3a and can be used by developers to better plan and understand 'safe' access and egress routes, and finished floor levels in consultation with the LPA and Environment Agency.

7.2.3 Flood Warning Areas

There are five Environment Agency Flood Warning Areas in the Southend-On-Sea Borough; three for tidal flooding from the Thames Estuary, one for the Tidal River Crouch and one for the Roach, Prittle Brook, Eastwood Brook. These are identified in Appendix A Figure 7.6, and are listed below:

- Paglesham, Rochford, The Wakerings and Potton Island;
- Shoeburyness to Southend Pier including Southchurch Park;
- Southend Sea Front from the Pier to Chalkwell;
- Leigh On Sea frontage from Chalkwell to Hadleigh Marshes including Two tree Island; and
- Eastwood Brook from downstream of Rayleigh Weir and the Prittlewell Brook to Southend Airport.

7.3 Risk of Flooding from Rivers

7.3.1 Flood Zones

The majority of the Southend-On-Sea Borough (89%) is defined as Flood Zone 1. Approximately 3% is defined as Flood Zone 2, and 8% is defined as Flood Zone 3.

Willingale Brook is a designated main river that flows through Southchurch Park in an open channel and discharges into the Thames Estuary. Flood zone mapping included in Appendix A Figure 7.1 shows areas of Flood Zone 2 and 3 associated with the Willingale Brook extends across the residential areas of Southchurch and Southend-On-Sea including Southchurch park, Northumberland Crescent, Lifstan Way and Greenways. There are two balancing ponds within the park which collect surface water runoff from the residential area to the north. AWS own and maintain a pumping station in the south of the park as well as an additional pumping station on the Southend frontage which discharges surface water to the Thames Estuary.

Prittle Brook flows east through the Borough from Belfairs Park towards Priory Park at Prittlewell. Flood zone mapping included in Appendix A Figure 7.1 shows areas of Flood Zone 2 and 3 associated with Prittle Brook in Priory Park and along the course of the Brook.

In the 1970s the Essex River Authority installed the Prittle Brook flood relief tunnel which diverts excess flows to the River Thames during times of flooding and largely relieves drainage from the western part of the Borough and the eastern part of Castle Point District. There is a second intake at Manchester Drive where the Prittle Tunnel takes the excess from surface water and highways drainage.

Eastwood Brook is a smaller tributary of the River Roach that flows east through Eastwood (as shown in the Flood Zone mapping included in Appendix A Figure 7.1). The watercourse is culverted through residential parts of the Borough. The residential areas of White House Road, Rayleigh Road, Snakes Lane, Orchard Grove and St Lawrence Gardens are located in Flood Zone 2 and 3 of the flood plain from the Eastwood Brook.

Both Eastwood Brook and Prittle Brook flow through relatively steep urban catchments which have been extensively altered to facilitate drainage and flood alleviation. These watercourses therefore respond rapidly to rainfall and flooding is likely to occur with little warning and fast flows.

7.3.2 Functional Floodplain

The modelled outlines for the 5% AEP event for Eastwood Brook and Prittle Brook define the Functional Floodplain (Flood Zone 3b) associated with these watercourses, as shown in Appendix A Figure 7.1.a. These areas are predominantly undeveloped areas along the edge of Eastwood Brook and Prittle Brook.

Modelled data was not available for Willigale Brook and the unnamed tributary of the River Roach. For these watercourses, the extent of Flood Zone 3a (see Appendix A, Figure 7.1) should be used as an indicator of the maximum extent of potential Functional Floodplain for the purposes of the Sequential Test. Where potential sites are required within Flood Zone 3a of these watercourses, a Level 2 SFRA should include a suitable hydraulic analysis to provide delineation between Flood Zone 3a and Flood Zone 3b (Functional Floodplain) at these specific locations.

7.3.3 Fluvial Flood Risk and Climate Change

Appendix A Figure 7.1.a shows the updated fluvial flood zones for the River Roach and its tributaries, including the modelled extents for the 1% AEP event plus 25%, 35% and 65% climate change allowances. The modelled climate change scenarios include the presence of flood defences along the watercourses. The results show a minimal increase in the flood outline to the south of Rayleigh Road, south of Orchard Road and south of Comet Way.

Hydraulic modelling of the Prittle Brook demonstrates that the Environment Agency's mapped extent of the 0.1% AEP flood extent for the Prittle Brook is a suitable representation of the 1% AEP plus climate change event (refer to Section 3.1.1 and Appendix C) and can be used for this purpose.

Modelled data was not available for Willigale Brook. For this watercourse, the extent of Flood Zone 2 (see Appendix A, Figure 7.1) should be used as an indicator of the potential extent of the 1% AEP with an allowance for climate change.

7.3.4 Ordinary Watercourses

There are a number of unnamed ordinary watercourses in the Borough which are tributaries of the main rivers, as shown in Appendix A Figure 7.1.

The Southend-on-Sea SWMP identifies the following ordinary watercourses:

- Barge Pier Ditch ;
- C-X Ditch (maintained by Southend-on-Sea Borough Council);
- Tributary of Prittle Brook (Alton Gardens) (maintained by Southend-on-Sea Borough Council);
- Tributary of Prittle Brook (within Priory Park) (maintained by Southend-on-Sea Borough Council);
- Tributary of Eastwood Brook (maintained by Southend-on-Sea Borough Council);
- Tributary of Mucking Hall Brook (north of Royal Artillery Way) (maintained by Southend-on-Sea Borough Council); and
- Six small watercourses within Thorpe Hall Golf Course.

The maintenance of ordinary watercourses that are not owned by Southend-on-Sea Borough Council is the responsibility of the riparian owner. Further details of the responsibilities of the riparian owners are stated in the Southend-on-Sea Borough LFRMS.

There are no historic recorded incidents of ordinary watercourse flooding within the Southend-On-Sea Borough. Often, where blocked ditches or streams have been reported as being the cause of flooding this has been reported as occurring with other sources, e.g. sewer or surface water runoff, and therefore will have been reported as multiple sources of flooding in the dataset.

No modelling of the flood risk from ordinary watercourses has been undertaken to date across the Southend-On-Sea Borough. Therefore future flood risk is based on the potential risk that might arise based on knowledge of known flooding hotspots and potential mechanisms for flooding.

7.3.5 Fluvial Flood Defences

The Environment Agency AIMS data shows that the Willingale Brook, Prittle Brook and Eastwood Brook are mostly maintained channels with high ground or natural channels with vegetated high ground. These defences have a varying design SOP, ranging from 1 in 17 years to 1 in 100 years.

7.3.6 Emergency Rest Centres

Designated emergency rest centres for the Southend-On-Sea Borough are mapped in Appendix A Figure 7.6 and summarised in Table 7-2.

Table 7-2 Emergency Rest Centres in the Southend-On-Sea Borough

Rest Centre	Address	Post Code	Easting	Northing
Tickfield Industrial Estate	Tickfield Avenue, Southend-on-Sea	SS2 6LL	588031	186749
Leigh on Sea Community Centre	73 Elm Rd, Southend-on-Sea, Leigh-on-Sea	SS9 1SP	584131	186084
Garon Park	Eastern Ave, Southend-on-Sea	SS2 4FA	589679	187494

7.4 Flooding from Surface Water

Flooding within the Southend-On-Sea Borough is predominantly driven by the topography that slopes from west to east through the Borough. The slopes form ideal flow paths for surface water runoff and results in flooding at lower elevations. Historic records of surface water flooding can be attributed to the inundation of surface water drainage systems as well as the combination of high tides and high water levels in rivers during high rainfall events. Previous surface water flood events have been very localised within the Borough. Recent significant flood events include;

- 24th August 2013;
- 11th October 2013;
- 20th July 2014; and,
- 19th September 2014.

Following these flood events, Southend-on-Sea prepared Flood Investigation Reports in accordance with Section 19 of the FWMA to investigate which risk management authorities (RMAs) had relevant flood risk management functions, and whether each of those RMAs had exercised, or is proposing to exercise, those functions in response to the flood. Where available, the Flood Investigation Reports are published on the Southend-on-Sea Borough Council website[31]. In response to severe flooding experienced by residents and businesses in Southend in 2014, a Flood Partnership was established, made up of those organisations who share responsibility for the drainage network in Southend, including AWS; Southend-on-Sea Borough Council; the Environment Agency; and other neighbouring councils.

The SWMP has delineated six CDAs within the Borough and identified Eastwood, Chalkwell, Marine Parade, Western Esplanade and Eastern Esplanade as being at high risk of surface water flooding. Southend-on-Sea Borough Council have an ongoing programme of works to tackle surface water flood risk, including hydraulic modelling studies for the central seafront and Chalkwell, and SuDS conceptualisation throughout the town centre. The SWMP report and LFRMS identify where action areas are being considered and should be referred to for further detail.

[31] http://www.southend.gov.uk/info/200370/protecting_our_environment_and_emergencies/558/southend_flood_partnership

For the purposes of this SFRA, the Environment Agency Risk of Flooding from Surface Water (RoFSW) mapping has been used to illustrate surface water flood risk as shown in Appendix A Figure 7.2.

7.5 Flooding from Groundwater

The AStGWF dataset provided by the Environment Agency indicates where groundwater may emerge due to geological and hydrogeological conditions. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation.

The AStGWF dataset presented in Appendix A Figure 7.4 indicates that the majority of the Borough is at <25% risk of groundwater emergence. There is an area at >75% risk of groundwater emergence to the north of Shoeyburyness. Southend-on-Sea town centre is at 50%-75% risk of groundwater emergence.

It should be noted that due to the resolution of the AStGWF dataset, i.e. at 1km grid squares, the AStGWF data should not be used on its own to make planning decisions at any scale, and, in particular, should not be used to inform planning decisions at the site scale. Where available, site-specific information, including ground investigations and monitoring, should be used to support planning decisions for individual developments.

The Southend-On-Sea SWMP identified four key groundwater flooding mechanisms within the Borough. These are:

- Superficial aquifers along Prittle Brook (Priory Park and downstream of the Park), Eastwood Brook (Eastwood Area) and upstream of the Barge Pier Ditch.
- Superficial aquifers in various locations.
- Superficial aquifers along the coastline (Two Tree Island and east of Southend Pier to Pigs Bay).
- Impermeable (silt and clay) areas downslope of superficial aquifers in various locations.

The Southend-on-Sea PFRA identified that the council holds eight records of groundwater flooding within the council's datasets as well as frequent groundwater flooding on land adjacent to the River Shoe in Shoeburyness. The SWMP has identified one incident reported to the council between 1998 and 2005, related to the flooding of a basement in the Eastern Esplanade area. Two groundwater flooding incidents were reported to the fire service. These were located near to the Victoria Station and a second to the west of Leigh-on-Sea.

7.6 Flooding from Sewers

AWS has supplied records of sewer flooding for the Borough through their DG5 register on the total number of properties affected by and at risk of sewer flooding (both internally and externally) based on historic flooding. This highlights that the area to the north of Southend-On-Sea has experienced a greater number of sewer flooding incidents than the rest of the Borough.

Appendix A Figure 7.5 shows the DG5 Register that has been supplied by AWS for the SFRA. It should be noted that AWS focus their efforts on removing properties from the DG5 register and therefore this information may not accurately represent those properties currently at risk

7.6.1 Climate Change

Climate change is anticipated to increase the potential risk from sewer flooding as summer storms become more intense and winter storms more prolonged. This combination is likely to increase the pressure on the existing efficiency of sewer systems, thereby reducing their design standard and leading to more frequent localised flooding incidents. Any sewer flooding that may occur could be exacerbated as a result of surface water runoff during extreme rainfall events.

7.6.2 Surface Water Management Plan

The SWMP has identified several areas in which surface water and combined sewer networks are susceptible to flooding. The main sewer flooding hotspots are located around the following areas:

- Eastern Esplanade, Marine Parade & Hartington Road (CDA4);
- Prince Avenue & Rochford Road (CDA2);

- Ness Road & Campfield Road (CDA5); and,
- Chalkwell Avenue (CDA6).

It should be noted that following significant surface water flooding events in 2014, AWS set-out an action plan in November 2014 detailing the steps it was taking to alleviate flooding in Southend, continuing the work from the Southend Flood Partnership, made up of Southend-on-Sea Borough Council, AWS and the Environment Agency. Details and updates are available on the Southend-on-Sea Borough Council website under their 'Flood Partnership' webpage[32].

7.7 Flooding from Other Sources

7.7.1 Risk of Flooding from Reservoirs

The Environment Agency Flood Risk from Reservoirs map[33] identifies that Southend-On-Sea Borough is not at risk from Reservoir flooding.

7.8 Historic Records

The Environment Agency Historic Flood Map indicates areas that have been previously flooded but does not show the source of the flood. The map (Appendix A Figure 7.3) shows that the areas along the Southend town seafront and Willigale Brook have previously flooded, as well as areas to the south east and north east of the Borough.

Southend-On-Sea Borough Council holds records of previous flood events in the Borough. The source of flooding has been indicated where known. Where available, flood incident records held by the project stakeholders, including the Environment Agency and AWS, have been provided to support this Level 1 SFRA update.

A summary of past flood events is shown below in Table 7-3.

Table 7-3 Summary of past flood events in Southend-On-Sea

Flood Event	Source of flooding	Description (record source in brackets, where available)
Pre 2010 (exact dates unknown)	Unknown	110 Reports of flooding pre 2010
29 June 2009	Unknown	Major Water Leak
24 July 2009	Unknown	Flooding affected electrics
27 September 2009	Unknown	House flooded
30 November 2009	Unknown	Basement flooded
2 December 2009	Unknown	Flooding affected electrics
11 January 2010	Unknown	Flooding affected electrics
8 August 2010	Unknown	Flooding in basement
24 August 2013	Surface water runoff	Flooding was primarily a result of intense rainfall coinciding with a high spring tide. It is believed that flooding across the borough resulted from a number of sources occurring simultaneously, including, surface water, fluvial and sewer flooding. A total of 255 incidents of flooding were recorded, however it was considered that many incidents were not recorded. Of the recorded incidents, 151 properties were flooded internally. The greatest concern was for three properties (two of which provide sheltered accommodation) which were evacuated due to significant flooding. Widespread flooding was observed across Southend-on-Sea. Three main clusters of flooding incidents occurred in the localities of Eastwood, Chalkwell and Marine Parade & Eastern Esplanade. Further information is provided in the Flood Investigation Report published on the Southend-on-Sea Borough Council website[34].
11 October 2013	Heavy Rainfall coinciding	Widespread flooding as a result of heavy rainfall coinciding

[32] http://www.southend.gov.uk/info/200370/protecting_our_environment_and_emergencies/558/southend_flood_partnership
[33] https://flood-warning-information.service.gov.uk/long-term-flood-risk/
[34] http://www.southend.gov.uk/info/200370/protecting_our_environment_and_emergencies/558/southend_flood_partnership

Flood Event	Source of flooding	Description (record source in brackets, where available)
	with high tides	with high tides resulting in 20 recorded incidents of flooding.
13 October 2013	Unknown	Three areas saw repeated flooding on the 13th October 2013 following further rainfall. Further information is provided in the Flood Investigation Report published on the Southend-on-Sea Borough Council website[35]. The flood investigation examined specific sites in more detail to determine the likely mechanisms of flooding, RMA responsibilities and responses and suggest actions. The sites examined were limited to those that suffered repeated flooding and included; • Chalkwell Esplanade and Chalkwell Avenue; • Clifton Drive and Western Esplanade; • Victoria Avenue; • Warners Bridge Roundabout; • Rodbridge Drive; • Thorpe Hall Avenue; • Wakering Road; • Campfield Road and Ness Road; and, • Ness Road and Shoebury Common Road.
January 2014	Surface Water	Record of flooding on Rebels Lane
20 July 2014	Short duration of heavy rainfall	Southend-on-Sea was subject to widespread flooding, particularly within the western areas, as a result of heavy rainfall. In total 30 incidents of flooding were recorded, including the internal flooding of Southend General Hospital. Further information is provided in the Flood Investigation Report published on the Southend-on-Sea Borough Council website[36]. The Flood Investigation focuses on the incidents of flooding recorded at the Southend General Hospital as well as in areas where flooding had also been recorded to occur previously on the 24th August or 11th October 2013 i.e. repeat occurrences of flooding, including; • Southend General Hospital; • Glenwood Avenue; • Throndon Park Drive and Park View Drive; • Highlands Boulevard; • Prince Avenue; • Rochford Road; • Cavendish Gardens; • Chalkwell; • Manor Road; • Queensway; and • Lifstan Way.
19th September 2014	Short duration of heavy rainfall	61 Records of flooding.

7.9 Summary of Flood Risk in Southend-On-Sea

The coastline of the Borough is at risk from tidal flooding from the Thames Estuary and the North Sea. Although Southend-On-Sea is protected by the presence of a sea wall flood defence, it is still at residual risk of flooding if the defences were to fail or to be overtopped.

[35] http://www.southend.gov.uk/info/200370/protecting_our_environment_and_emergencies/558/southend_flood_partnership
[36] http://www.southend.gov.uk/info/200370/protecting_our_environment_and_emergencies/558/southend_flood_partnership

Three watercourses pose a fluvial flood risk to the Borough. Willingale Brook poses the most significant fluvial flood risk in the Borough as a large part of the residential area around the watercourse is at risk from flooding. Small areas of flood risk around the course of Prittle Brook and Eastwood Brook also pose a risk to nearby residential development.

Surface water flooding poses a significant flood risk to the Southend-On-Sea Borough. The topography of the Borough slopes from west to east, forming flow paths for surface water and ponding at lower elevated areas. Surface water has been the cause of a number of previous flood events in the Borough. Lack of capacity in the drainage system has also been found to be a cause and exacerbating factor for previous surface water flooding events that have occurred within the Borough.

Groundwater flooding poses a risk to the eastern part of the Borough and to a small area of the south of the Borough. Eight previous flood events in the Borough have been attributed to groundwater flooding. These were located in Shoeburyness, Eastern Esplanade, Victoria Station and west of Leigh-on-Sea.

The maps presented in Appendix A and Appendix E of this SFRA provide the necessary information to facilitate the NPPF risk-based approach to planning. This process determines the compatibility of various types of development within each flood zone, subject to the application of the Sequential Test and the Exception Test when required.

8. Guidance for the application of the Sequential Test

8.1 SFRA Process

The NPPF approach aims to ensure that flood risk is considered at all stages of the planning process, and to avoid inappropriate development in areas of greatest flood risk; steering development towards areas of lower risk.

Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, the sustainability benefits outweigh flood risks and, the development will be safe for its lifetime without increasing flood risk elsewhere. Such development is required to include mitigation/management measures to minimise risk to life and property should flooding occur.

Building on these principles, the NPPF and Technical Guidance have established a process for the assessment of flood risk, with each stage building upon the previous assessment with a refinement of the evidence base. Utilising a Source – Pathway – Receptor approach, the source of flooding, the spatial distribution of flood risk and the vulnerability of development types are assessed to inform decision making through each of the key stages of the Flood Risk Management Hierarchy, as outlined in the Technical Guidance and shown in Table 8-1 below.

Table 8-1 Flood Risk Management Hierarchy and the SFRA Process

Hierarchy

Stage	Approach
Level 1 SFRA	Assessment (broad scale and comprehensive)
Sequential Test Across Planning Area	Avoidance
Level 2 SFRA (if required)	Detailed Assessment (Growth Area or Site Specific)
Sequential Approach at Site	Avoidance
Control and Improvement	Through Design (e.g. SuDS)
Mitigate Remaining Risks	Flood Resilient Design and Construction

8.2 Sequential Approach

The sequential approach is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. This will help avoid the development of sites that are inappropriate on flood risk grounds. The subsequent application of the Exception Test, where required, will ensure that new developments in areas of particular flood risk will only occur where flood risk is clearly outweighed by other sustainability drivers and will ensure that development can be made safe from flooding and not increase flood risk elsewhere.

The sequential approach can be applied at all levels and scales of the planning process, both for sites between flood zones and where a site has to be located in a higher risk zone, within the extent of that flood zone by locating the more vulnerable elements of the development in the areas of lowest risk. All opportunities to locate new developments in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

8.3 Applying the Sequential Test – Plan-Making

Each LPA must demonstrate that it has considered a range of possible sites in conjunction with the flood zone and vulnerability information from the Level 1 SFRA and applied the Sequential Test, and where necessary, the Exception Test (Level 2 SFRA), in the site allocation process.

Table 8-2 shows the flood risk definitions for all sources of flooding and should be used to inform the Sequential Test. Figure 8-1 illustrates the approach for applying the Sequential Test for sites without tidal flood defences. Figure 8-2 illustrates the approach for applying the Sequential Test for sites with existing tidal flood defences,

The Sequential Test should be undertaken by each South Essex Authority and accurately documented to ensure decision making processes are consistent and transparent.

Table 8-2 Flood Risk Definitions for Sequential Test

Risk	Fluvial / Tidal Flood Zone	Other Sources of Flood Risk			
		Surface Water	Groundwater	Sewer Consideration	Reservoir
Low	Flood Zone 1	RoFSW Very Low	“Not considered to be at risk of groundwater flooding” OR “Limited potential for groundwater flooding”	AWS to assess the sewer network for each site	Use Environment Agency Flooding from Reservoirs map
Medium	Flood Zone 2	RoFSW Low to Medium	“Potential for groundwater flooding of property below ground surface” OR “Potential for groundwater flooding at surface”		N/A
High	Flood Zone 3a	RoFSW High	Historic records of groundwater flooding		N/A
Very High	Flood Zone 3b	N/A	N/A		N/A

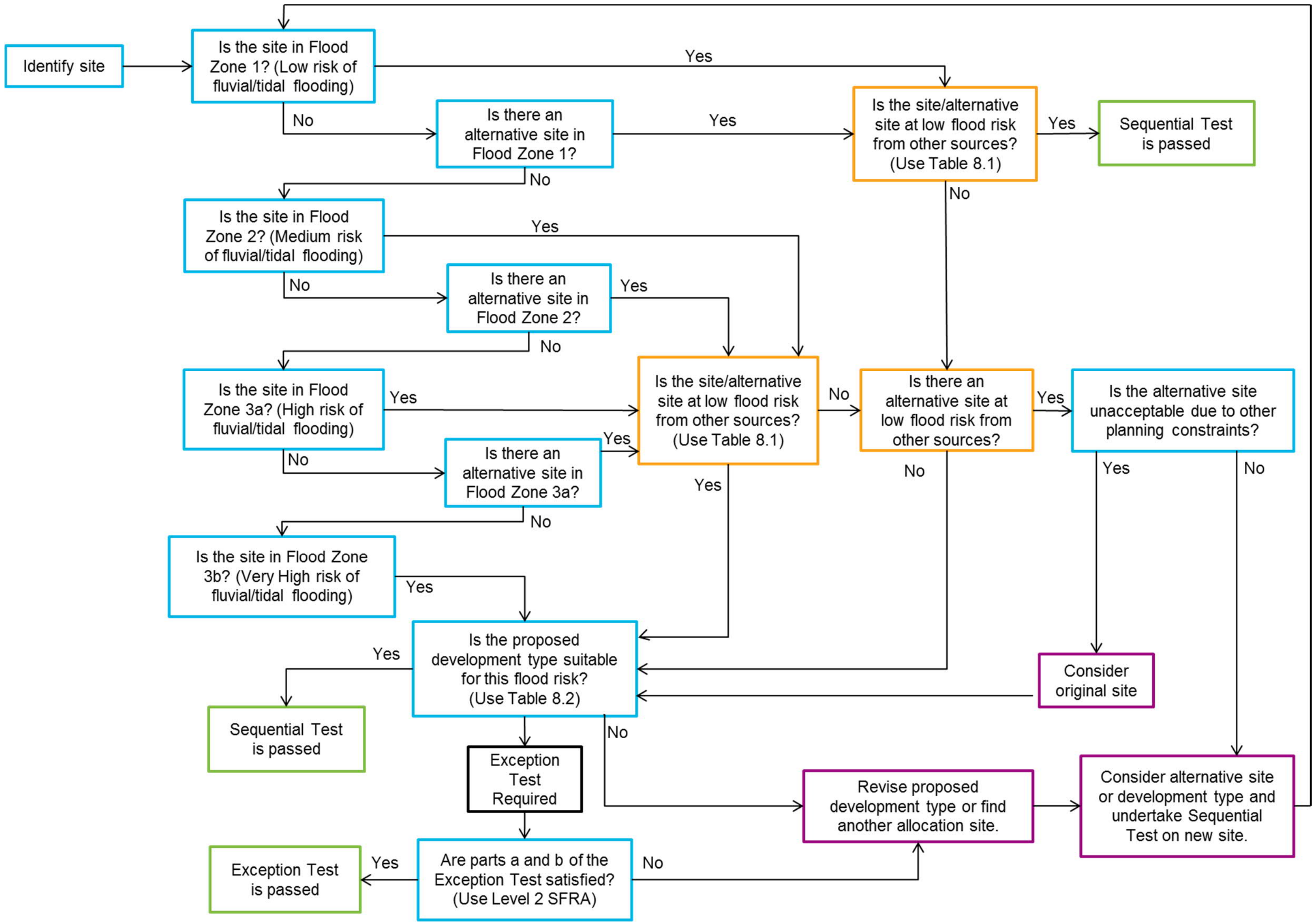

Figure 8-1 Application of Sequential Test for Local Plan preparation – Undefended sites

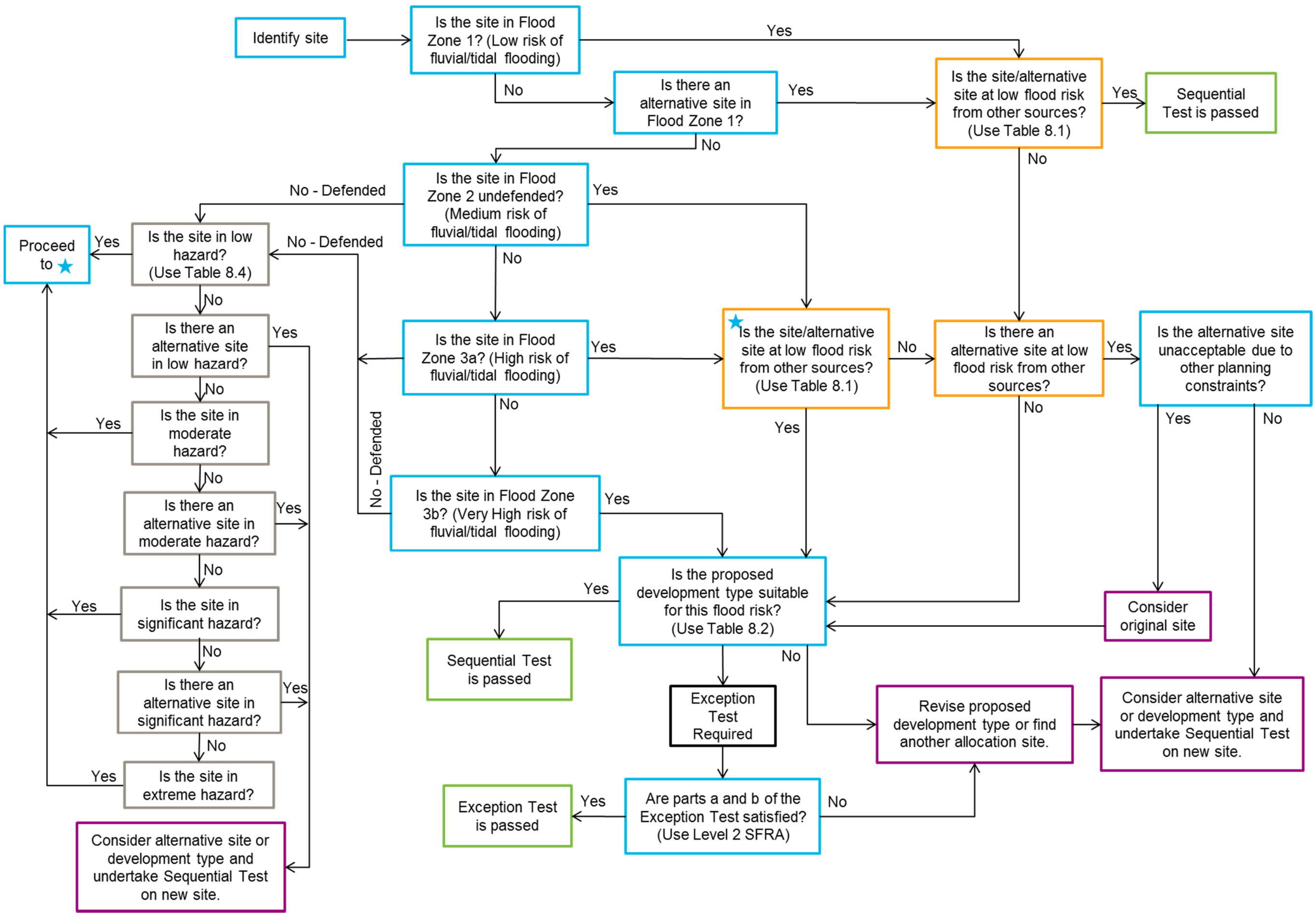

Figure 8-2 Application of Sequential Test for Local Plan preparation – Tidal defended sites

The Sequential Test requires an understanding of the flood zones in the study area and the vulnerability classification of the proposed developments. Flood zone definitions are provided in Table 2-1 and mapped in Appendix A Figure 4.1, Figure 5.1, Figure 6.1 and Figure 7.1 (and the Flood Map for Planning (Rivers and Sea) on the Environment Agency website). Flood risk vulnerability classifications, as defined in the PPG, are presented in Table 8-3.

Table 8-3 Flood Risk Vulnerability Classification (PPG, 2014)

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in “more vulnerable”, and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible

	activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

The NPPF acknowledges that some areas will (also) be at risk of flooding from sources other than fluvial. All sources must be considered when planning for new development including: flooding from land or surface water runoff; groundwater; sewers; and artificial sources.

If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

The recommended steps in undertaking the Sequential Test are detailed below. This is based on the flood zone and flood risk vulnerability and is summarised in Table 8-4. Table 8-4 indicates the compatibility of different development types with the flood zones.

Table 8-4 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014)

Flood Risk Vulnerability Classification		Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	Exception test Required	✓	✓	✓
	3a	Exception Test Required	×	Exception Test Required	✓	✓
	3b *1	Exception Test Required*	×	×	×	✓*

✓ - Development is appropriate × - Development should not be permitted

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

If there here are some areas within Flood Zone 3b that are already developed and are prevented from flooding by the presence of existing infrastructure or solid buildings. Whilst these areas will be subject to frequent flooding it may not be practical to refuse all future development.

8.3.1 Stages for LPA application of the Sequential Test in Plan-Making

The information required to address many of these steps is provided in the accompanying GIS layers and maps presented in Appendix A. When preparing the Local Plan a database of the potential allocation sites across the South Essex Authority areas will be generated and information for each site populated using the GIS layers presented in the maps. This database can be used when applying the steps below.

1. Assign potential developments with a vulnerability classification (Table 8-3). Where development is mixed, the development should be assigned the highest vulnerability class of the developments proposed.
2. The location and identification of potential development should be recorded.

3. The flood zone classification of potential development sites should be determined based on a review of the Flood Map for Planning (Rivers and Sea). Where these span more than one flood zone, all flood zones should be noted.
4. Identify existing flood defences serving the potential development sites. (However, it should be noted that for the purposes of the Sequential Test, flood zones ignoring defences should be used).
5. The design life of the development should be considered with respect to climate change:
   - 100 years – up to 2118 for residential developments; and
   - 75 years – up to 2093 for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.
6. Highly Vulnerable developments to be accommodated within the LPA area should be located in those sites identified as being within Flood Zone 1. If these cannot be located in Flood Zone 1, because the identified sites are unsuitable or there are insufficient sites in Flood Zone 1, sites in Flood Zone 2 can then be considered. Highly Vulnerable developments in Flood Zone 2 will require application of the Exception Test. If sites in Flood Zone 2 are inadequate then the LPA may have to identify additional sites in Flood Zones 1 or 2 to accommodate development or seek opportunities to locate the development outside their administrative area. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test.
7. Once all Highly Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as More Vulnerable. In the first instance More Vulnerable development should be located in any unallocated sites in Flood Zone 1. Where these sites are unsuitable or there are insufficient sites remaining, sites in Flood Zone 2 can be considered. If there are insufficient sites in Flood Zone 1 or 2 to accommodate More Vulnerable development, sites in Flood Zone 3a can be considered. More Vulnerable developments in Flood Zone 3a will require application of the Exception Test. As with Highly Vulnerable development, within each flood zone More Vulnerable development should be directed to areas at lowest risk from all sources of flooding. It should be noted that More Vulnerable development is not appropriate in Flood Zone 3b.
8. Once all More Vulnerable developments have been allocated to a development site, the LPA can consider those development types defined as Less Vulnerable. In the first instance Less Vulnerable development should be located in any remaining unallocated sites in Flood Zone 1, continuing sequentially with Flood Zone 2, then Flood Zone 3a. Less Vulnerable development types are not appropriate in Flood Zone 3b – Functional Floodplain.
9. Essential Infrastructure should be preferentially located in the lowest flood risk zones, however this type of development may be located in Flood Zones 3a and 3b, provided the Exception Test is satisfied.
10. Water Compatible development has the least constraints with respect to flood risk and it is considered appropriate to allocate these sites last. The sequential approach should still be followed in the selection of sites; however it is appreciated that Water Compatible development by nature often relies on access and proximity to water bodies.
11. On completion of the Sequential Test, consideration will be given to the risks posed to a site within a Flood Zone in more detail as part of the Level 2 SFRA. By undertaking the Exception Test, this more detailed study should consider the detailed nature of flood hazard to allow a sequential approach to site allocation within a Flood Zone. Consideration of flood hazard within a flood zone would include:
    - flood risk management measures,
    - the rate of flooding,
    - flood water depth,
    - flood water velocity.

8.3.2 Stages for LPA application of the Sequential Test in Plan-Making – Tidal Defended Sites

For sites that are within the tidal floodplain of the Thames Estuary or Roach Estuary (Flood Zone 3a), but are protected by the presence of tidal defences, it is recommended that the partner authorities use additional flood risk information to consider the variation in flood risk within the flood zone when applying the Sequential Test. In this case, the flood hazard mapping in Appendix E should be used to apply the Sequential Test to ensure that development is directed towards areas of Low hazard prior to the consideration of areas at Moderate, Significant and Extreme hazard.

8.3.3 Windfall Sites

Windfall sites are those which have not been specifically identified as available in the Local Plan process. They comprise previously-developed sites that have unexpectedly become available. In cases where development cannot be fully met through the provision of site allocations, LPAs are expected to make a realistic allowance for windfall development, based on past trends and expected future trends. It is recommended that the acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

8.4 Applying the Sequential Test – Individual Applications

If development is proposed in Flood Zone 2 or 3, and the Sequential Test has not already been carried out for the site for the same development type at the Local Plan level, then it is necessary to undertake a Sequential Test for the site. The Environment Agency publication 'Demonstrating the Flood Risk Sequential Test for Planning Applications'[37] sets out the procedure as follows:

- Identify the geographical area of search over which the test is to be applied; this could be the Borough area, or a specific catchment if this is appropriate and justification is provided (e.g. school catchment area or the need for affordable housing within a specific area identified for regeneration in Local Plan policies).
- Identify the source of 'reasonably available' alternative sites; usually drawn from evidence base / background documents produced to inform the Local Plan.
- State the method used for comparing flood risk between sites; for example the Environment Agency Flood Map for Planning, the SFRA mapping, site specific FRAs if appropriate, other mapping of flood sources.
- Apply the Sequential Test; systematically consider each of the available sites, indicate whether the flood risk is higher or lower than the application site, state whether the alternative option being considered is allocated in the Local Plan, identify the capacity of each alternative site, and detail any constraints to the delivery of the alternative site(s).
- Conclude whether there are any reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development or land use proposed.
- Where necessary, as indicated by Table 8-4, apply the Exception Test.
- Apply the Sequential approach to locating development within the site.

It should be noted that it is for LPAs, taking advice from the Environment Agency as appropriate, to consider the extent to which Sequential Test considerations have been satisfied, taking into account the particular circumstances in any given case. The developer should justify with evidence to the LPA what area of search has been used when making the application. Ultimately the LPA needs to be satisfied in all cases that the proposed development would be safe and not lead to increased flood risk elsewhere.

8.4.1 Sequential Test Exemptions

It should be noted that the Sequential Test does not need to be applied in the following circumstances:

- Individual developments proposed on sites which have been allocated in development plans through the Sequential Test.
- Minor development, which is defined in the NPPF as:
- minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m^2;
- alterations: development that does not increase the size of buildings e.g. alterations to external appearance;
- householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats;
- Change of Use applications, unless it is for a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site;
- Development proposals in Flood Zone 1 (land with a low probability of flooding from rivers or the sea) unless the SFRA, or other more recent information, indicates there may be flooding issues now or in the future (for example, the site was identified as being at risk of surface water or through the impact of climate change);

[37] Environment Agency, April 2012, ' Demonstrating the flood risk Sequential Test for Planning Applications ' , Version 3.1

- Redevelopment of existing properties (e.g. replacement dwellings), provided they do not increase the number of dwellings in an area of flood risk (i.e. replacing a single dwelling with an apartment block).

8.5 Exception Test

The purpose of the Exception Test is to ensure that, following the application of the Sequential Test, new development is only permitted in Flood Zone 2 and 3 where flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

The Exception Test provides a method of managing flood risk while still allowing necessary sustainable development to occur. The test is only appropriate for use when there are large areas in Flood Zones 2 and 3a where the Sequential Test alone cannot deliver acceptable sites, but where some continuing development is necessary for wider sustainable development reasons. The flow charts presented in Figure 8-1 and Figure 8-2 demonstrate the methodology to determine whether an Exception Test is required for proposed site allocations.

In order to pass the Exception Test, the NPPF Technical Guidance identifies two elements that need to be demonstrated/fulfilled to the satisfaction of the LPA:

- Part 1 - "It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and
- Part 2 - A site specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall."

Satisfying the Exception Test involves consideration of the reasons behind the selection of the site for development, from the sustainability appraisal, as well as consideration in planning and design, such that the site will remain safe and operational in the event of flooding. This may involve demonstrating:

- A sequential approach is taken to development site layout, such that within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- Buildings are designed to be appropriately flood resilient and resistant, with essential services remaining functional in the event of flooding, and quick recovery following a flood;
- Provision of safe means of access and egress during a flood event;
- Emergency evacuation procedures are developed, to be utilised following receipt of a flood warning;
- Priority is given to the use of SuDS.

In order to determine Part 1) of the Exception Test, applicants should assess their scheme against the objectives set out in the LPA's Sustainability Appraisal.

In order to demonstrate satisfaction of Part 2) of the Exception Test, relevant measures, such as those presented within Section 9 should be applied and demonstrated within a site specific FRA (as detailed in Section 11).

9. Guidance for Managing and Mitigating Flood Risk

9.1 Overview

The NPPF appreciates that it may not always be possible to avoid locating development in areas at risk of flooding. This Section provides guidance on the range of measures that could be considered in order to manage and mitigate flood risk. These measures should be considered when preparing site specific FRAs.

It is essential that the development control process influencing the design of future development within the study area carefully mitigates the potential impact that climate change may have upon the risk of flooding. As a result mitigation measures should be designed with an allowance for climate change over the lifetime of proposed development as follows:

- 100 years (up to 2118) for residential developments; and
- 75 years (up to 2093) for commercial / industrial developments, or other time horizon specific to the non-residential use proposed.

9.2 Development Layout and Sequential Approach

A sequential approach to site planning should be applied within new development sites.

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. Most large development proposals include a variety of land uses of varying vulnerability to flooding. The sequential approach should be applied within development sites to locate the most vulnerable elements of a development in the lowest risk areas (considering all sources of flooding) e.g. residential elements should be restricted to areas at lower probability of flooding whereas parking, open space or proposed landscaped areas can be placed on lower ground where there may be a higher probability of flooding. Reference should be made to Environment Agency breach modelling to provide further detail of fluvial and tidal flood risk within Flood Zones.

9.2.1 Finished Floor Levels

For the purposes of informing a site specific FRA, all More Vulnerable and Highly Vulnerable development within Flood Zones 2 and 3 should set Finished Floor Levels 300mm above the known or modelled 1 in 100 annual probability (1% AEP) fluvial flood level including an appropriate allowance for climate change or 600mm above the estimated tidal flood or sea level.

Where developing in Flood Zone 2 and 3 is unavoidable, the recommended method of mitigating flood risk to people, particularly with More Vulnerable (residential) and Highly Vulnerable land uses, is to ensure internal floor levels are raised a freeboard level above the design flood level (typically the 1 in 100 year plus a suitable climate change allowance for fluvial events).

In certain situations (e.g. for proposed extensions to buildings with a lower floor level or conversion of existing historical structures with limited existing ceiling levels), it could prove impractical to raise the internal ground floor levels to sufficiently meet the general requirements. In these cases, the Environment Agency and/or the LPA should be approached to discuss options for a reduction in the minimum internal ground floor levels provided flood resistance measures are implemented up to an agreed level. There are also circumstances where flood resilience measures should be considered first, these are described further below. For both Less and More Vulnerable developments where internal access to higher floors is required, the associated plans showing the access routes and floor levels should be included within any site specific FRA. Table 9-1 provides an overview of the requirements for finished floor levels in areas of at risk of fluvial flooding.

Table 9-1 Finished Floor Levels for fluvial flood risk areas

<table>
<tr><th>Development Type</th><th>Flood Zone 3</th><th>Flood Zone 2</th></tr>
<tr><td>Minor development (i.e. non-residential extensions with a floor space <250m^2 and householder developments)</td><td>Provide evidence to Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Southend-On-Sea Borough Council that EITHER,

Floor levels within the proposed development will be set no lower than existing levels AND, flood proofing of the proposed development has been incorporated where appropriate. Details of flood proofing / resilience and resistance techniques to be included in accordance with ‘Improving the flood performance of new buildings’ DCLG (2007).

OR,

Floor levels within the extension will be set 300mm above the known or modelled 1 in 100 annual probability river flood (1%) in any year including climate change. This flood level is the extent of the Flood Zones. Applicants should provide a plan showing floor levels relative to flood levels. All levels should be stated in relation to Ordnance Datum.</td><td>Provide evidence to Basildon Borough Council, Castle Point Borough Council, Rochford District Council, Southend-On-Sea Borough Council that,

Floor levels within the proposed development will be set no lower than existing levels AND, flood proofing of the proposed development has been incorporated where appropriate. Details of flood proofing / resilience and resistance techniques to be included in accordance with ‘Improving the flood performance of new buildings’ DCLG (2007).</td></tr>
<tr><td>New residential development (More Vulnerable)</td><td colspan="2">Where appropriate, subject to there being no other planning constraints (e.g. restrictions on building heights), finished floor levels should be set a minimum of 300mm above the 1% AEP flood level (1 in 100 years) including climate change. The design flood level should be derived for the immediate vicinity of the site (i.e. relative to the extent of a site along a watercourse as flood levels are likely to vary with increasing distance downstream) as part of a site specific FRA.

Sleeping accommodation should be restricted to the first floor or above to offer the required safe place of refuge. Internal ground floors below this level could however be occupied by either Less Vulnerable commercial premises, garages or non-sleeping residential rooms (e.g. kitchen, study, lounge) (i.e. applying a sequential approach within a building).</td></tr>
<tr><td>New non-residential development (e.g. Less Vulnerable)</td><td colspan="2">Finished floor levels may not need to be raised. For example, Less Vulnerable developments can be designed to be floodable instead of raising floor levels, and this may be beneficial to help minimise the impact of the development on the displacement of floodwater and the risk of flooding to the surrounding area. However, it is strongly recommended that internal access is provided to upper floors (first floor or a mezzanine level) to provide safe refuge in a flood event. Such refuges will have to be permanent and accessible to all occupants and users of the site and a FWEP should be prepared to document the actions to take in the event of a flood.</td></tr>
<tr><td>Basements</td><td>Basements, basement extensions, conversions of basements to a higher vulnerability classification or self-contained units are not be permitted in Flood Zone 3b. Self-contained residential basements and bedrooms at basement level are not permitted in Flood Zone 3a. Internal access to a higher floor situated 300mm above the 1% annual probability flood level (1 in 100 year) including climate change must be provided for all other basements, basement extensions and conversions.</td><td>All basements, basement extensions and conversions must have internal access to a higher floor situated 300mm above the 1% annual probability flood level (1 in 100 year) including climate change.</td></tr>
</table>

9.3 Flood Resistance 'Water Exclusion Strategy'

There is a range of flood resistance and resilience construction techniques that can be implemented in new developments to mitigate potential flood damage. The Department for Communities and Local Government (DCLG) have published a document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[38], the aim of which is to provide guidance to developers and designers on how to improve the resistance and resilience of new properties to flooding through the use of suitable materials and construction details. Figure 9-1 provides a summary of the Water Exclusion Strategy (flood resistance measures) and Water Entry Strategy (flood resilience measures) which can be adopted depending on the depth of floodwater that could be experienced.

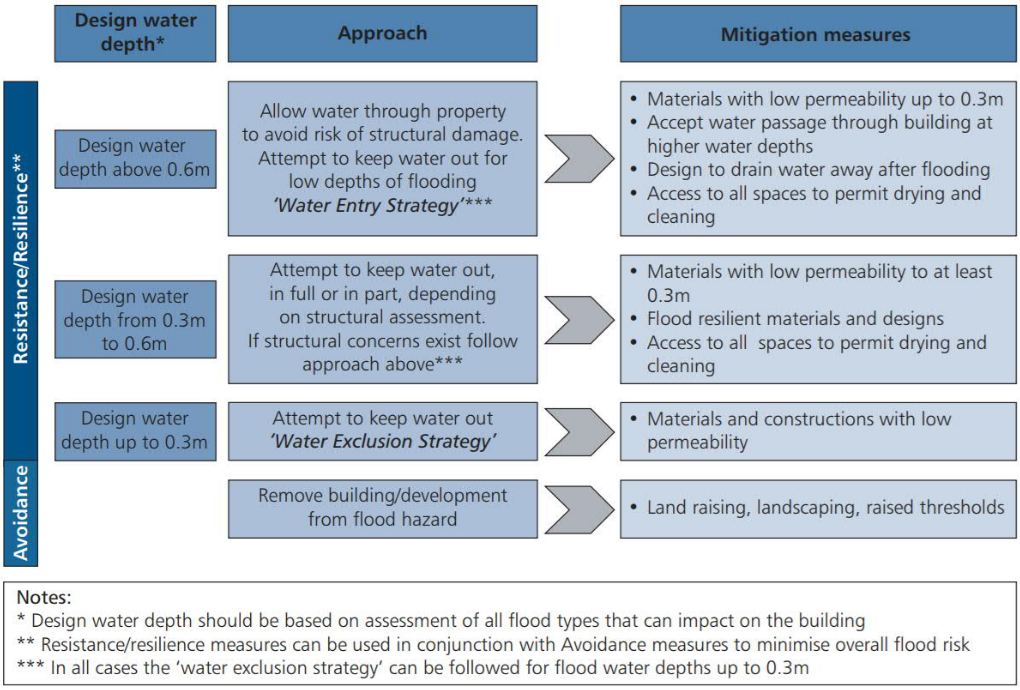

Figure 9-1 Flood Resistant / Resilient Design Strategies, Improving Flood Performance, DCLG 2007

Resistance measures are aimed at preventing water ingress into a building (Water Exclusion Strategy); they are designed to minimise the impact of floodwaters directly affecting buildings and to give occupants more time to relocate ground floor contents. These measures will probably only be effective for short duration, low depth flooding, i.e. less than 0.3m, although these measures should be adopted where depths are between 0.3m and 0.6m and there are no structural concerns.

In areas at risk of flooding of low depths (<0.3m), implement flood resistance measures such as:

- Using materials and construction with low permeability.
- Land raising (subject to this not increasing flood risk to neighbouring properties).
- Landscaping e.g. creation of low earth bunds (subject to this not increasing flood risk to neighbouring properties).
- Raising thresholds and finished floor levels e.g. porches with higher thresholds than main entrance.
- Flood gates with waterproof seals.
- Sump and pump for floodwater to remove waste faster than it enters.

There is a range of property flood protection devices available on the market designed specifically to resist the passage of floodwater. These include removable flood barriers and gates designed to fit openings, vent covers and stoppers designed to fit WCs. These measures can be appropriate for preventing water entry associated with fluvial flooding as

[38] DCLG (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction

well as surface water and sewer flooding. The success of such devices relies on their being deployed before a flood event occurs. It should also be considered that devices such as air vent covers, if left in place by occupants as a precautionary measure, may compromise safe ventilation of the building in accordance with Building Regulations.

9.4 Flood Resilience 'Water Entry Strategy'

For flood depths greater than 0.6m, it is likely that structural damage could occur in traditional masonry construction due to excessive water pressures. In these circumstances, the strategy should be to allow water into the building, but to implement careful design in order to minimise damage and allow rapid re-occupancy. This is referred to as the Water Entry Strategy. These measures are appropriate for uses where temporary disruption is acceptable and suitable flood warning is received.

Materials should be used which allow the passage of water whilst retaining their structural integrity and they should also have good drying and cleaning properties. Alternatively sacrificial materials can be included for internal and external finishes; for example the use of gypsum plasterboard which can be removed and replaced following a flood event. Flood resilient fittings should be used to at least 0.1m above the design flood level. Resilience measures are either an integral part of the building fabric or are features inside a building that will limit the damage caused by floodwaters.

In areas at risk of frequent or prolonged flooding, implement flood resilience measures such as:

- Use materials with either, good drying and cleaning properties, or, sacrificial materials that can easily be replaced post-flood.
- Design for water to drain away after flooding.
- Design access to all spaces to permit drying and cleaning.
- Raise the level of electrical wiring, appliances and utility meters.
- Coat walls with internal cement based renders; apply tanking on the inside of all internal walls.
- Ground supported floors with concrete slabs coated with impermeable membrane.
- Tank basements, cellars or ground floors with water resistant membranes.
- Use plastic water resistant internal doors.

Further specific advice regarding suitable materials and construction techniques for floors, walls, doors and windows and fittings can be found in 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[39].

9.5 Structures

Structures such as (bus, bike) shelters, park benches and refuse bins (and associated storage areas) located in areas with a high flood risk should be flood resilient and be firmly attached to the ground and designed in such a way as to prevent entrainment of debris which in turn could increase flood risk and/or breakaway posing a danger to life during high flows.

9.6 Safe Access and Egress

Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

A safe access/egress route should allow occupants to safely enter and exit the buildings and be able to reach land outside the flooded area (e.g. within Flood Zone 1) using public rights of way without the intervention of emergency services or others during design flood conditions, including climate change allowances. This is of particular importance when contemplating development on sites within Flood Zone 1, but the surrounding area is within Flood Zone 2 or 3.

Guidance prepared by the Environment Agency[40] uses a calculation of flood hazard to determine safety in relation to flood risk. Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain along with

[39] DCLG, 2007, Improving the Flood Performance of New Buildings, Flood Resilient Construction. http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf?bcsi_scan_E956BCBE8ADBC89F=0&bcsi_scan_filename=flood_performance.pdf

a suitable debris factor to account for the hazard posed by any material entrained by the floodwater. The derivation of flood hazard is based on the methodology in Flood Risks to People FD2320, the use of which for the purpose of planning and development control is clarified in the abovementioned publication. Flood hazard mapping is presented within Appendix E.

Table 9-2 Hazard to People Rating (HR=d x (v +0.5) + DF)

Flood Hazard (HR)	Description
Less than 0.75	Very low hazard – Caution
0.75 to 1.25	Dangerous for some – includes children, the elderly and the infirm
1.25 to 2.0	Dangerous for most – includes the general public
More than 2.0	Dangerous for all – includes the emergency services

For developments located in areas at risk of tidal and / or fluvial flooding safe access and egress must be provided for new development as follows in order of preference:

- Safe dry route for people and vehicles.
- Safe dry route for people.
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people.
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater.

For fluvial flooding, a 'dry' access/egress is a route located above the 1% annual probability flood level (1 in 100 year) including an allowance for climate change.

For developments located in areas of defended tidal floodplain, a 'dry' access/egress is a route located above the breach flood level or within an area modelled as low hazard, and leads to an area of high ground outside the floodplain.

9.7 Safe Refuge

In exceptional circumstances, dry access above the 1% AEP flood level including climate change associated with fluvial flooding, and above the modelled breach flood levels for tidal flooding, may not be achievable. In these circumstances the Environment Agency and the LPA should be consulted to ensure that the safety of the site occupants can be satisfactorily managed. This will be informed by the type of development, the number of occupants and their vulnerability and the flood hazard along the proposed egress route. For example, this may entail the designation of a safe place of refuge on an upper floor of a building, from which the occupants can be rescued by emergency services. It should be noted that sole reliance on a safe place of refuge is a last resort, and all other possible means to evacuate the site should be considered first. Provision of a safe place of refuge will not guarantee that an application will be granted.

9.8 Floodplain Compensation Storage

All new development within Flood Zone 3 associated with fluvial watercourses must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.

[40] Environment Agency, HR Wallingford, May 2008, Supplementary note on Flood hazard ratings and thresholds for development planning and control purpose. Clarification of Table 13.1 FD2320/TR2 and Figure 3.2 FD2321/TR1. http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2321_7400_PR_pdf.sflb.ashx

Where proposed development results in a change in building footprint, the developer must ensure that it does not impact upon the ability of the floodplain to store water, and should seek opportunities to provide betterment with respect to floodplain storage.

Similarly, where ground levels are elevated to raise a development out of the fluvial floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.

Floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it must be in the immediate vicinity, in the applicant's ownership and linked to the site[41]. Floodplain compensation must be considered in the context of the 1% AEP flood level including an allowance for climate change. When designing a scheme flood water must be able to flow in and out and must not pond. An FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C624[42].

The requirement for no loss of floodplain storage from the fluvial floodplain means that it is not possible to modify ground levels on sites which lie completely within the floodplain (when viewed in isolation), as there is no land available for lowering to bring it into the floodplain. It is possible to provide off-site compensation within the local area e.g. on a neighbouring or adjacent site, or indirect compensation, by lowering land already within the floodplain, however, this would be subject to detailed investigations and agreement with the Environment Agency to demonstrate (using an appropriate flood model where necessary) that the proposals would improve and not worsen the existing flooding situation or could be used in combination with other measures to limit the impact on floodplain storage.

9.8.1 Areas of Residual Tidal Risk

For areas at residual risk of tidal flooding, there is not usually a requirement from the Environment Agency to provide floodplain compensation storage within the defended floodplain, assuming that the defences will be maintained for the lifetime of the development. However, the impact of residual risk on other properties should be considered, and where the potential increase of flood levels or potential disruption of flow routes as a result of development is significant, compensatory flood storage should be provided.

9.9 Flood Voids

The use of under-floor voids with adequate openings beneath the raised finished floor levels can be considered for development in Flood Zone 2 and 3 associated with fluvial flooding. They are generally considered to provide indirect compensation or mitigation, but not true compensation for loss of floodplain storage. The use of under-floor voids will typically require a legal agreement or planning condition and maintenance plan for them to remain open for the lifetime of the development and agreement that the LPA will enforce. Sole reliance on the use of under-floor voids to address the loss of floodplain storage capacity is generally not acceptable on undeveloped sites or for individual properties.

Should it not be possible to achieve all the level for level compensation required, the Environment Agency may consider that the remainder be provided through the use of under-floor voids instead. The amount of level for level compensation would need to be maximised and any under-floor voids would need to be appropriately designed and kept clear to enable them to function effectively.

Ideally, void openings should be a minimum of 1m long and open from existing ground levels to at least the 1% annual probability (1 in 100 year/ Flood Zone 3) plus climate change flood level. By setting finished floor levels at a minimum of 300mm above the design flood level, there is usually enough space provision for voids below. There should be a minimum of 1m of open void length per 5m length of wall. Void openings should be provided along all external walls of the proposed extension. If security is an issue, 10mm diameter vertical bars set at 100mm centres can be incorporated into the void openings. The Environment Agency is likely to seek confirmation from the LPA that the voids be maintained in a free and open condition for the lifetime of the development.

9.10 Car Parks

Where car parks are specified as areas for the temporary storage of surface water and fluvial floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent the vehicles from floating out of the car park. Signs should be in

[41] In hydrological connectivity.
[42] CIRIA January 2004, CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry.

place to notify drivers of the susceptibility of flooding and flood warning should be available to provide sufficient time for car owners to move their vehicles if necessary.

9.11 Flood Routing

All new development in Flood Zones 2 and 3 should not adversely affect flood routing and thereby increase flood risk elsewhere. Opportunities should be sought within the site design to make space for water, such as:

- Removing boundary walls or replacing with other boundary treatments such as hedges, fences (with gaps).
- Considering alternatives to solid wooden gates, or ensuring that there is a gap beneath the gates to allow the passage of floodwater.
- On uneven or sloping sites, consider lowering ground levels to extend the floodplain without creating ponds. The area of lowered ground must remain connected to the floodplain to allow water to flow back to river when levels recede.
- Create undercroft car parks or consider reducing ground floor footprint and creating an open area under the building to allow flood water storage.
- Where proposals entail floodable garages or outbuildings, consider designing a proportion of the external walls to be committed to free flow of floodwater.

In order to demonstrate that 'flood risk is not increased elsewhere', development in the floodplain will need to prove that flood routing is not adversely affected by the development, for example giving rise to backwater effects or diverting floodwaters onto other properties.

Potential overland flow paths should be determined and appropriate solutions proposed to minimise the impact of the development, for example by configuring road and building layouts to preserve existing flow paths and improve flood routing, whilst ensuring that flows are not diverted towards other properties elsewhere.

Careful consideration should be given to the use of fences and landscaping walls so as to prevent causing obstruction to flow routes and increasing the risk of flooding to the site or neighbouring areas.

9.12 Riverside Development

Retain an 8 metre wide undeveloped buffer strip alongside main rivers and ordinary watercourses and explore opportunities for riverside restoration. A 16 metre wide buffer strip alongside a tidal main river is required.

New development within 8 metres from a fluvial main river and from any flood defence structure or culvert or 16m from a tidal main river and from any flood defence structure or culvert will require an Environmental Permit.

The Environment Agency would seek an 8 metre wide undeveloped buffer strip alongside main fluvial rivers for maintenance purposes, and a 16 metre wide undeveloped buffer strip alongside tidal main rivers and tidal flood defences. The Environment Agency would also ask developers to explore opportunities for riverside restoration as part of any development. Recommendation 7 of the TE2100 Plan Action Zone 7 advises that opportunities for creating a better riverside environment should be explored and the Environment Agency will promote these works as part of ongoing development applications.

Under the Flood and Water Management Act (2010) and/or Environment Agency Byelaws, any works within 8 metres of any statutory main river (both open channels and culverted sections) or 16 metres of a main tidal river requires an Environmental Permit (Flood Risk Activity Permit). Whilst Environmental Permits for Flood Risk Activities are dealt with outside of the planning process, since requirements of the permitting process in relation to flood risk, biodiversity and pollution may result in changes to development proposals or construction methods, the Environment Agency aims to advise on such issues as part of its statutory consultee role in the planning process. Should proposed works not require planning permission, the Environment Agency can be consulted regarding permission to do work in, under, over or near a main river, flood or sea defence by contacting enquiries@environment-agency.gov.uk

As of 6 April 2012 responsibility for the consenting of works by third parties on ordinary watercourses under Section 23 of the Land Drainage Act 1991 (as amended by the Flood and Water Management Act 2010) has transferred from the Environment Agency to the LLFAs. ECC and Southend-On-Sea Borough Council are now responsible for the consenting of works to ordinary watercourses in the study area and have powers to enforce un-consented and non-compliant works. This includes any works (including temporary) within 8 metres that affect flow within the channel (such as in channel structures or diversion of watercourses). Enquiries and applications for ordinary watercourse consent should be sent to the following contact information for each Council:

Essex County Council:	Southend-on-Sea Borough Council:
floods@essex.gov.uk	council@southend.gov.uk
Flood and Water management Team Essex County Council County Hall Chelmsford CM1 1QH 0345 603 7631	Southend-on-Sea Borough Council Civic Centre Victoria Avenue Southend-on-Sea Essex SS2 6ER 01702 215005

Consent will be refused if the works would result in an increase in flood risk, a prevention of operational access to the watercourse and/ or an unacceptable risk to nature conservation.

9.13 Flood Warning and Evacuation Plans

Evacuation is where flood alerts and warnings provided by the Environment Agency enable timely actions by residents or occupants to allow evacuation to take place unaided, i.e. without the deployment of trained personnel to help people from their homes, businesses and other premises. Rescue by the emergency services is likely to be required where flooding has occurred and prior evacuation has not been possible.

> For all developments (excluding minor developments and change of use) proposed in Flood Zone 2 or 3, a Flood Warning and Evacuation Plan should be prepared to demonstrate what actions site users will take before, during and after a flood event to ensure their safety, and to demonstrate their development will not impact on the ability of the local authority and the emergency services to safeguard the current population.
>
> For sites in Flood Zone 1 it is important to consider the surrounding area to assess the flood risk of the evacuation route and emergency vehicle access route to the site. If these routes incorporate areas in Flood Zone 2 or 3, it may also be necessary to prepare a Flood Warning and Evacuation Plan to determine potential egress routes away from the site through areas that may be at risk of flooding during the 1% AEP flood event including an allowance for climate change.
>
> The Environment Agency has a tool on their website to create a Personal Flood Plan[43]. The Plan comprises a checklist of things to do before, during and after a flood and a place to record important contact details. Where proposed development comprises non-residential extension <250m^2 and householder development (minor development), it is recommended that the use of this tool to create a Personal Flood Plan will be appropriate.

Flood Warning and Evacuation Plans should include:

How flood warning is to be provided, such as:

- availability of existing flood warning systems (refer to Sections 4.3.7, 5.2.3, 5.3.6, 6.2.3, and 7.2.3 and Appendix A Figure 4.6 (Basildon Borough), Figure 5.6 (Castle Point Borough), Figure 6.6 (Rochford District) and Figure 7.6 (Southend-on-Sea Borough));
- where available, rate of onset of flooding and available flood warning time; and

[43] Environment Agency Tool 'Make a Flood Plan'. https://www.gov.uk/government/publications/personal-flood-plan

- how flood warning is given.

<u>What will be done to protect the development and contents, such as:</u>

- How easily damaged items (including parked cars) or valuable items (important documents) will be relocated;
- How services can be switched off (gas, electricity, water supplies);
- The use of flood protection products (e.g. flood boards, airbrick covers);
- The availability of staff/occupants/users to respond to a flood warning, including preparing for evacuation, deploying flood barriers across doors etc.; and
- The time taken to respond to a flood warning.

<u>Ensuring safe occupancy and access to and from the development, such as:</u>

- Occupant awareness of the likely frequency and duration of flood events, and the potential need to evacuate;
- Safe access route to and from the development;
- If necessary, the ability to maintain key services during an event;
- Vulnerability of occupants, and whether rescue by emergency services will be necessary and feasible; and
- Expected time taken to re-establish normal use following a flood event (clean-up times, time to re-establish services etc.)

There is no statutory requirement for the Environment Agency or the emergency services to approve evacuation plans. Each South Essex Authority is accountable via planning condition or agreement to ensure that plans are suitable. This should be done in consultation with emergency planning staff.

Flood warning areas and emergency rest centres for each of the South Essex Authorities are described in (refer to Sections 4.3.7, 5.2.3, 5.3.6, 6.2.3, and 7.2.3 and Appendix A Figure 4.6 (Basildon Borough), Figure 5.6 (Castle Point Borough), Figure 6.6 (Rochford District) and Figure 7.6 (Southend-on-Sea Borough)).

The Environment Agency issues flood warnings to residents and businesses that have registered for the service in these specific areas when flooding is expected. It should be noted that whether each of the emergency rest centres are operational during a flood event is dependent upon the locations and extent of flooding across the Borough/District at that particular time. The Multi Agency Flood Plan prepared by each of the South Essex Authorities will provide more detail on the appropriate use of each rest centre.

9.14 Surface Water Management

All major developments and other development should not result in an increase in surface water runoff, and where possible, should demonstrate betterment in terms of rate and volumes of surface water runoff.

SuDS should be used to reduce and manage surface water runoff to and from proposed developments as near to source as possible in accordance with the requirements of the Technical Standards and supporting guidance published by DCLG and Department for the Environment, Food and Rural Affairs (DEFRA)[44]., SuDS must be implemented for sites in Flood Zone 2 and 3. SuDS must be considered for sites in Flood Zone 1.

It is essential that the design of SuDS is considered early in the design process for a development area to ensure that a coordinated and integrated system can be implemented. Under the Flood and Water Management Act (2010), it will become the responsibility of ECC to adopt and maintain these drainage systems into the future and therefore an integrated approach to surface water management across new development areas will need to be established.

Guidance on the application of SuDS in South Essex is detailed in Section 10 of this SFRA.

[44] Sustainable drainage systems: non-statutory technical standards - https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards; PPG Flood Risk and Coastal Change - http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/reducing-the-causes-and-impacts-of-flooding/why-are-sustainable-drainage-systems-important/

10. Guidance for the Application of Sustainable Drainage Systems

10.1 What are Sustainable Drainage Systems?

Suitable surface water management measures should be incorporated into new development designs in order to reduce and manage surface water flood risk to, and posed by the proposed development. This should be achieved by incorporating Sustainable Drainage Systems (SuDS).

SuDS are surface water drainage solutions designed to manage surface water runoff and mitigate the adverse effects of urban storm water runoff by reducing flood risk and controlling pollution[45]. SuDS techniques allow surface water runoff from development to be controlled in ways that imitate natural drainage by controlling the rate of discharge to a receiving watercourse. SuDS may also provide valuable habitat and amenity value when carefully planned for in development.

The SuDS Manual[46] identifies four processes that can be used to manage and control runoff from developed areas. Each option can provide opportunities for storm water control, flood risk management, water conservation and groundwater recharge:

A. Infiltration: the soaking of water into the ground. This is the most desirable solution as it mimics the natural hydrological process. The rate of infiltration will vary with soil type and condition, the antecedent conditions and with time. The process can be used to recharge groundwater sources and feed baseflows of local watercourses, but where groundwater sources are vulnerable or there is risk of contamination, infiltration techniques are not suitable.

   The use of traditional infiltration techniques that infiltrate to the ground is dependent on the underlying ground conditions. An assessment of the suitability of using infiltration SuDS techniques across the Basildon Borough, Castle Point Borough, Rochford District and Southend-On-Sea Borough has been undertaken as part of the South Essex and Southend-on Sea SWMPs using the detailed BGS Infiltration SuDS Map. However, it is also possible to use shallow infiltration techniques in combination with storage techniques on sites which have impermeable geology, and therefore these techniques should not be overlooked.

B. Detention/Attenuation: the slowing down of surface flows before their transfer downstream, usually achieved by creating a storage volume and a constrained outlet. In general, though the storage will enable a reduction in the peak rate of runoff, the total volume will remain the same, just occurring over a longer duration.

   Detention measures are not constrained by geology, though in areas of permeable geology, there will also be a degree of infiltration of runoff taking place.

C. Conveyance: the transfer of surface runoff from one place to another, e.g. through open channels, pipes and trenches.

D. Water Harvesting: the direct capture and use of runoff on site, e.g. for domestic use (flushing toilets) or irrigation of urban landscapes. The ability of these systems to perform a flood risk management function will be dependent on their scale, and whether there will be a suitable amount of storage always available in the event of a flood.

As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development. Table 10-1 has been reproduced from the SuDS Manual, CIRIA C753 and outlines typical SuDS techniques.

45 Defra, Environment Agency (March 2015) Cost Estimation for SuDS – Summary of Evidence
46 CIRIA C753 SuDS Manual. http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

Table 10-1 Typical SuDS Components (Y; primary process. * some opportunities, subject to design)

Technique	Description	Conveyance	Detention	Infiltration	Harvesting
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.		Y	Y	*
Filter Drains	Linear drains/trenches filled with a permeable material, often with perforated pipe in the base of the trench. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site.	Y	Y		
Filter Strips	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable areas and filter out silt and particulates.	*	*	*	
Swales	Shallow vegetated channels that conduct and/or retain water, and can permit infiltration when unlined.	Y	Y	*	
Ponds	Depressions used for storing and treating water.		Y	*	Y
Wetlands	As ponds, but the runoff flows slowly but continuously through aquatic vegetation that attenuates and filters the flow. Shallower than ponds. Based on geology these measures can also incorporate some degree of infiltration.	*	Y	*	Y
Detention Basin	Dry depressions designed to store water for a specified retention time.		Y		
Soakaways	Sub-surface structures that store and dispose of water via infiltration.			Y	
Infiltration Trenches	As filter drains, but allowing infiltration through trench base and sides.	*	Y	Y	
Infiltration Basins	Depressions that store and dispose of water via infiltration.		Y	Y	
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. It is noted that the use of brown/green roofs should be for betterment purposes and not to be counted towards the provision of on-site storage for surface water. This is because the hydraulic performance during extreme events is similar to a standard roof (CIRIA C697).		Y		
Rainwater Harvesting	Storage and use of rainwater for non-potable uses within a building, e.g. toilet flushing. It is noted that storage in these types of systems is not usually considered to count towards the provision of on-site storage for surface water balancing because, given the sporadic nature of the use of harvested water, it cannot be guaranteed that the tanks are available to provide sufficient attenuation for the storm event.	*	*	*	Y

The application of SuDS is not limited to a single technique per site. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS. It should be noted, each development site must offset its own increase in runoff and attenuation cannot be "traded" between developments.

Other measures may also be required in relation to water and sewerage infrastructure that might include pipes and below ground storage required as part of a wider strategic scheme, to deal with surface water flood risk. Options may include:

- Increasing capacity in drainage systems;
- Separation of foul and surface water sewers;
- Improved drainage maintenance regimes; and,
- Managing overland flows.

10.2 Management Train

The concept used in the development of drainage systems is the surface water 'management train'[47] whereby different techniques can be used in series to change the flow and quality characteristics of runoff in stages that attempt to mimic natural drainage. The hierarchy of techniques that should be considered in developing the management train are[49]:

1. Prevention – the use of good site design and site housekeeping measures to prevent runoff and pollution (e.g. sweeping to remove surface dust and detritus from car parks), and rain water reuse/harvesting. Prevention policies should generally be included within the site management plan.
2. Source controls – control of runoff at or very near its source (e.g. soakaways, other infiltration methods, green roods, pervious pavements).
3. Site controls – management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin.)
4. Regional controls – management of runoff from a site or several sites, typically in a balancing pond or wetland.

Generally the aim should be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

A. Into the ground (infiltration)
B. To a surface water body
C. To a surface water sewer, highway drain, or another drainage system
D. To a combined sewer

Where possible, stormwater should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas. The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at the source should always be considered before site or regional controls. However, where upstream control opportunities are restricted, a number of lower hierarchy options should be used in series. Water should only be conveyed elsewhere if it cannot be dealt with at the site.

The passage of water between stages of the management train should be considered through the use of natural conveyance systems (e.g. swales and filter trenches) wherever possible. Pipework and sub-surface proprietary produce may still be required, especially where space is limited. Pre-treatment (i.e. the removal of silt and sediment loads) and maintenance is vital to ensure the long-term effectiveness of SuDS. Overland flow routes will also be required to convey and control floodwaters safely and effectively during extreme flood events. Generally, the greater the number of techniques used in a series the better the performance is likely to be and the lower the risk of overall system failure.

SuDS can be applied in all development situations, although individual site constraints may limit the potential of some sites achieving full benefits for all functions. The variety of SuDS available allows planners and designers to make full potential of the local land and consider the needs of local people when implementing the drainage design. The wishes of all the relevant stakeholders needs to be balanced in additional to the risk associated with each design option.

10.3 What is the role of the LLFAs?

As described in Section2.4, ECC and Southend-On-Sea Borough Council are statutory consultees for surface water drainage as part of their role as LLFAs. From 6 April 2015, all major development[48] should include provision for SuDS and a Sustainable Drainage Strategy will need to be completed and signed by a competent drainage engineer to verify that the proposals conform to the Government's 'Sustainable Drainage Systems: Non-Statutory Technical Standards[49].

The following sections provide an overview of the Technical Standards and items which applicants should include when preparing a Sustainable Drainage Strategy for submission to the LLFA. Reference should also be made to local planning policy documents to identify local needs with regard to surface water drainage design.

[47] http://www.susdrain.org/delivering-suds/using-suds/suds-principles/management-train.html
[48] Developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010).
[49] Sustainable drainage systems: non-statutory technical standards - https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

10.3.1 What are the Technical Standards?

A set of non-statutory Technical Standards have been published, to be used in conjunction with supporting guidance in the PPG, which set the requirements for the design, construction, maintenance and operation of SuDS. The Technical Standards that are of chief concern in relation to the consideration of flood risk to and from development relating to peak flow control and volume control are presented below:

Peak flow control

S2 For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

S4 Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

S6 Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.

Flood risk within the development

S7 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

S9 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

All major[50] developments and other development should not result in an increase in surface water runoff, and where possible, should demonstrate betterment in terms of rate and volumes of surface water runoff.

Sustainable Drainage Systems (SuDS) should be used to reduce and manage surface water runoff to and from proposed developments as near to source as possible in accordance with the requirements of the Technical Standards and supporting guidance published by DCLG and Department for the Environment, Food and Rural Affairs (Defra)[51].

[50] Major development – 10 or more dwellings and 1000 sqm floorspace
[51] Sustainable drainage systems: non-statutory technical standards - https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards; PPG Flood Risk and Coastal Change - http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/reducing-the-causes-and-impacts-of-flooding/why-are-sustainable-drainage-systems-important/

10.3.2 Essex County Council Sustainable Drainage Systems Design Guide

ECC has produced a Sustainable Drainage Systems Design Guide (April 2016)[52], which provides guidance on ECC's requirements for the design of sustainable surface water drainage in Essex. It provides information on the planning, design and delivery of attractive and high quality SuDS schemes which should offer multiple benefits to the environment and community alike.

The ECC, as LLFA for Basildon, Rochford and Castle Point, will refer to this Guide when it is consulted on planning applications relating to sustainable drainage. The guidance is based on and complements the SuDS Manual (CIRIA, 2015)[53].

10.3.3 What should a Sustainable Drainage Strategy include?

A strategy should include:

- A plan of the existing site.
- A topographical level survey of the area to metres Above Ordnance Datum (MAOD).
- Demonstration of a clear understanding of how surface water flows across the site and surrounding area. This could use the topographic survey and the information presented on the 'Risk of Flooding from Surface Water maps' on the Environment Agency website and with the Council's Surface Water Management Plan (SWMP).
- Plans and drawings of the proposed site layout identifying the footprint of the area being drained (including all buildings, access roads and car parks).
- Calculations of:
- Changes in permeable and impermeable coverage across the site.
- The existing and proposed controlled discharge rate for a 1 in 1 year event, 1 in 30 year and a 1 in 100 year event (with an allowance for climate change), which should be based on the estimated greenfield runoff rate.
- Proposed storage volume (attenuation) including the water storage capacity of the proposed drainage features, with demonstration that they meet the requirements of the Technical Standards.
- Plans, drawings and specification of proposed SuDS measures. This should include detail of hard construction, soft landscaping and planting. A drainage design can incorporate a range of SuDS techniques.
- A design statement describing how the proposed measures manage surface water as close to its source as possible.
- Geological information including borehole logs, depth to water table and/or infiltration test results in accordance with BRE365.
- Details of overland flow routes for exceedance events.
- Details of any offsite works required, together with necessary consents (where relevant).
- A management plan for future maintenance and adoption of drainage system for the lifetime of the development.

Applicants are strongly encouraged to discuss their proposals with the LLFA at the pre-application stage. Requests can be made using the contact details set out overleaf:

Essex County Council:	Southend-on-Sea Borough Council:
suds@essex.gov.uk Flood and Water management Team Essex County Council County Hall Chelmsford CM1 1QH 0345 603 7631 http://flood.essex.gov.uk/new-development-advice/apply-for-suds-advice/	council@southend.gov.uk Southend-on-Sea Borough Council Civic Centre Victoria Avenue Southend-on-Sea Essex SS2 6ER 01702 215005

[52] https://www.essex.gov.uk/Environment%20Planning/Environment/local-environment/flooding/View-It/Documents/suds_design_guide.pdf
[53] https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

10.4 Use of infiltration SuDS

Improper use of infiltration SuDS can lead to contamination of superficial deposits and bedrock aquifers, leading to deterioration of groundwater quality, or increased flood risk. On the other hand, appropriate use of infiltration SuDS may improve groundwater quality status and decrease the flood risk.

The locations most appropriate for infiltration SuDS exist where there is a combination of high ground and permeable geology. However, when implementing this type of SuDS, it is vital that the impact on properties down gradient is considered. Increasing infiltration in an area will lead to increased groundwater levels, thus an increased susceptibility to groundwater flooding down the catchment.

At each development site groundwater levels should be assessed prior to the implementation of SuDS. This will help confirm their potential function (e.g. soakaways) even after long periods of rainfall. This is particularly important where superficial deposit dominate as their thickness is unpredictable. If they are thick and impermeable, shallow soakaways may not intercept the underlying permeable bedrock. If they are thin and permeable, but perched over impermeable bedrock, they may not receive the additional recharge from the infiltration SuDS.

Infiltration SuDS should not be implemented near to areas of historic landfill or any other areas of known contamination. This is to ensure that drainage does not re-mobilise latent contamination which would exacerbate the risk to groundwater quality.

If ground conditions are not suitable for infiltration SuDS techniques then surface waters can still be managed using surface infiltration techniques in combination with attenuation SuDS measures. These attenuate surface runoff to reduce flood risk both within the site and to the surrounding areas. Furthermore, areas upstream of critical flood areas can be used to install attenuation SuDS to slow the flood of water reaching the high risk area.

Table 10-4 identifies where infiltration SuDS could be applied in each Borough/District based on the bedrock and superficial geology of each area.

Table 10-2 Suitability of Infiltration SuDS for each authority

	Suitability of Infiltration SuDS based on Geology
Basildon Borough	• Due to the extensive London Clay Formation in the Basildon Borough, the majority of the Borough is not suitable for infiltration SuDS. Two areas are deemed potentially suitable for infiltration SuDS. These are located in the east and south of Billericay and the south of Basildon. The change in bedrock geology can be seen in Figure 3.1 in Appendix A. • However, areas overlain by superficial deposits are likely to be variable in composition and depth; therefore individual site investigations should be encouraged to understand the local groundwater conditions, thus suitability of infiltration SuDS. • Developers are expected to collect subsoil information derived from trial pit information at their sites as this will form the basis for discussions with the LLFA, AWS and the Environment Agency over the SuDs techniques that most appropriate to the site. • It is strongly recommended that options for the use of attenuation measures are explored for use in development sites across the Borough. These measures will require a portion of the development site and should therefore be considered from an early stage in the Masterplanning process for future development sites.
Castle Point Borough	• Given the low-lying nature of Canvey Island, Hadleigh and South Benfleet, this area would not be suitable for infiltration SUDS. Instead, source control mechanisms such as green / brown roofs and rainwater harvesting and grey water recycling should be encouraged for new developments to restrict the volumes and rates of surface water runoff leaving a site.
Rochford District	• The underlying geology of Rochford District and therefore suitability of SuDS is divided across the district. • In the west of the district, including the area around Rayleigh, Hullbridge, Hockley, Ashingdon and Hawkwell, the geology is predominantly clay and are no drift deposits overlying this area. The soils are relatively impermeable and surface water typically runs off rapidly. As a result infiltration SuDS are not deemed suitable for this area. The use of attenuation measures should be explored when considering site design and layout. • The east of the district, including Rochford, Great Wakering and Foulness Island is characterised by the

	Suitability of Infiltration SuDS based on Geology
	presence of river terrace deposits and alluvium. These are relatively permeable and therefore result in a relatively low rainfall to runoff conversion rate. There may be potential for the use of infiltration SuDS in these areas, however on site infiltration testing should be undertaken on a site by site basis to determine its suitability. The underlying geology in this area is still clay and therefore it is likely that attenuation measures will be more suitable in this area as well. • The suitability of a proposed site for the use of different SuDS will need to be determined on a site by site basis. Investigation will be required including geology, infiltration rates and groundwater vulnerability. Where infiltration SuDS are used, consideration may need to be given to pollution control.
Southend-on-Sea	• It is recommended that source control measures and surface water management practices are adopted within Southend-on-Sea. This includes measures such as SuDS, green roofs, rainwater harvesting or permeable paving, which can capture and infiltrate rain where it falls, thus reducing surface water runoff and improving the water quality of surrounding watercourses. These measures should be encouraged as part of all new development proposals. • Developers should maximise potential flood attenuation benefits of existing parks, green spaces and other public open spaces through modification (e.g., re-profiling, re-grading parks, constructing flood attenuation areas). • Site-level investigation should be undertaken to identify the suitability for infiltration SuDS associated with the underlying geology in the Southend-on-Sea area.

11. What is a Flood Risk Assessment?

A site specific FRA is a report suitable for submission with a planning application which provides an assessment of flood risk to and from a proposed development, and demonstrates how the proposed development will be made safe, will not increase flood risk elsewhere and where possible will reduce flood risk overall in accordance with paragraph 100 of the NPPF and PPG. A FRA must be prepared by a suitably qualified and experienced person and must contain all the information needed to allow the LPAs (Basildon Borough Council, Castle Point Borough Council, Rochford District Council and Southend-On-Sea Borough Council) to be satisfied that the requirements have been met.

11.1 When is a Flood Risk Assessment required?

The NPPF states that a site specific FRA is required in the following circumstances:

- Proposals for new development (including minor development[54] and change of use) in Flood Zones 2 and 3.
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)[55].
- Proposals of 1 hectare or greater in Flood Zone 1.
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

11.2 How detailed should a FRA be?

The PPG states that site specific FRAs should be proportionate to the degree of flood risk, the scale and nature of the development, its vulnerability classification (Table 8-3) and the status of the site in relation to the Sequential and Exception Tests. Site specific FRAs should also make optimum use of readily available information, for example the mapping presented within this SFRA and available on the Environment Agency website, although in some cases additional modelling or detailed calculations will need to be undertaken. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, the LPA would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater the LPA may require a more detailed assessment, for example, the preparation of site specific hydraulic modelling to determine the flood risk to and from the site pre and post-development, and the effectiveness of any management and mitigation measures incorporated within the design.

As a result, the scope of each site specific FRA will vary considerably. Table 11-1 presents the different levels of site specific FRA as defined in the CIRIA publication C624[56] and identifies typical sources of information that can be used. Sufficient information must be included to enable the Council and where appropriate, consultees, to determine that the proposal will be safe for its lifetime, not increase flood risk elsewhere and where possible, reduce flood risk overall. Failure to provide sufficient information will result in applications being refused. Castle Point has developed Flood Risk Assessment guidance, in conjunction with the Environment Agency, for small scale development. This is available from the council website[57]

[54] According to the PPG, minor development means:

minor non-residential extensions: industrial / commercial / leisure etc. extensions with a footprint <250m2.

alterations: development that does not increase the size of buildings e.g. alterations to external appearance.

householder development: for example; sheds, garages, games rooms etc. within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.

[55] Consultation has confirmed that there are no areas with critical drainage problems identified by the Environment Agency.

[56] CIRIA, 2004, Development and flood risk – guidance for the construction industry C624.

[57] https://www.castlepoint.gov.uk/flood-risk-assessments

Table 11-1 Levels of Site specific Flood Risk Assessment

<table>
<tr><th>Level of Site specific Flood Risk Assessment</th><th>Description</th></tr>
<tr><td>Level 1 Screening study</td><td>Identify whether there are any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information. The screening study will ascertain whether a FRA Level 2 or 3 is required.

Typical sources of information include:
• Strategic Flood Risk Assessment (SFRA)
• Flood Map for Planning (Rivers and Sea)
• Surface Water Management Plan (SWMP)
• Risk of Flooding from Surface Water
• Local Flood Risk Management Strategy (LFRMS)
• Environment Agency Standing Advice
• NPPF Tables 1, 2 and 3</td></tr>
<tr><td>Level 2 Scoping study</td><td>To be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding, or the site may increase flood risk due to increased runoff. This study should confirm the sources of flooding which may affect the site. The study should include:
• An appraisal of the availability and adequacy of existing information;
• A qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; and
• An appraisal of the scope of possible measures to reduce flood risk to acceptable levels.
• The scoping study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.
Typical sources of information include those listed above, plus:
• Local policy statements or guidance.
• Anglian River Basin District Flood Risk Management Plan (FRMP).
• South Essex Catchment Flood Management Plan (CFMP).
• Thames Estuary 2100 Plan.
• Basildon Borough Council, Castle Point Borough Council, Rochford District Council and Southend-On-Sea Borough Council's PFRA and LFRMS.
• Data request from the Environment Agency to obtain result of existing hydraulic modelling studies relevant to the site and outputs such as maximum flood level, depth and velocity.
• Consultation with LLFA, Environment Agency, AWS and other flood risk consultees to gain information and to identify in broad terms, what issues related to flood risk need to be considered including other sources of flooding.
• Historic maps.
• Interviews with local people and community groups.
• Walkover survey to assess potential sources of flooding, likely routes for floodwaters, the key features on the site including flood defences, their condition.
• Site survey to determine general ground levels across the site, levels of any formal or informal flood defences.</td></tr>
<tr><td>Level 3 Detailed study</td><td>To be undertaken if a Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The study should include:
• Quantitative appraisal of the potential flood risk to the development;
• Quantitative appraisal of the potential impact of the development site on flood risk elsewhere; and
• Quantitative demonstration of the effectiveness of any proposed mitigations measures.

Typical sources of information include those listed above, plus:
• Detailed topographical survey.
• Detailed hydrographic survey.
• Site specific hydrological and hydraulic modelling studies which should include the effects of the proposed development.</td></tr>
</table>

Level of Site specific Flood Risk Assessment	Description
	• Monitoring to assist with model calibration/verification. Continued consultation with the LPA, Environment Agency and other flood risk consultees.

11.2.1 Environment Agency Data Requests

The Environment Agency offers a series of 'products' for obtaining flood risk information suitable for informing the preparation of site specific FRAs as described on their website https://www.gov.uk/planning-applications-assessing-flood-risk.

- Products 1 – 4 relate to mapped deliverables including flood level and flood depth information and the presence of flood defences local to the proposed development site;
- Product 5 contains the reports for hydraulic modelling of the main rivers, or Breach Modelling;
- Product 6 contains the model output data so the applicant can interrogate the data to inform the FRA.
- Product 7 comprises the hydraulic model itself.
- Product 8 contains flood defence breach hazard mapping.

Products 1 – 6 and 8 can be used to inform a Level 2 FRA. In some cases, it may be appropriate to obtain Product 7 and to use as the basis for developing a site specific model for a proposed development as part of a Level 3 FRA. This can be requested via either their National Customer Contact Centre via enquiries@environment-agency.gov.uk.

11.2.2 Modelling of Ordinary Watercourses

It should be noted that the scope of modelling studies undertaken by the Environment Agency typically cover flooding associated with main rivers, and therefore ordinary watercourses that form tributaries to the main rivers may not always be included in the model. Where a proposed development site is in close proximity to an ordinary watercourse and either no modelling exists, or the available modelling is considered to provide very conservative estimates of flood extents (due to the use of national generalised JFLOW modelling), applicants may need to prepare a simple hydraulic model to enable more accurate assessment of the probability of flooding associated with the watercourse and to inform the site specific FRA. This should be carried out in line with industry standards and in agreement with the Environment Agency and the LLFAs.

11.3 What needs to be addressed in a Flood Risk Assessment?

The PPG states that the objectives of a site specific flood risk assessment are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable.

11.4 Flood Risk Assessment Checklist

Table 11-2 provides a checklist for site specific FRAs including the likely information that will need to be provided along with references to sources of relevant information. As described in Section 11.3, the exact level of detail required under each heading will vary according to the scale of development and the nature of the flood risk. It is expected that this Checklist is completed for all planning applications.

Table 11-2 Site specific Flood Risk Assessment Checklist (building on guidance in PPG)

What to Include in the FRA		Source(s) of Information
1.Site Description		
Site address	-	-
Site description	-	-
Location plan	Including geographical features, street names, catchment areas, watercourses and other bodies of water	-
Site plan	Plan of site showing development proposals and any structures which may influence local hydraulics e.g. bridges, pipes/ducts crossing watercourses, culverts, screens, embankments, walls, outfalls and condition of channel	OS Mapping Site Survey
Topography	Include general description of the topography local to the site. Where necessary, site survey may be required to confirm site levels (in relation to Ordnance datum). Plans showing existing and proposed levels.	Site Survey Ground Investigation Report South Essex SWMP (Basildon, Castle Point and Rochford) http://www.basildon.gov.uk/CHttpHandler.ashx?id=5316&p=0 Southend-On-Sea SWMP: http://www.southend.gov.uk/download/downloads/id/3770/sbc_surface_water_management_plan_-_november_2015.pdf
Geology	General description of geology local to the site.	
Watercourses	Identify main rivers and ordinary watercourses local to the site.	
Status	Is the development in accordance with the LPA's Local Plan?	Seek advice from the relevant LPA if necessary: Basildon Borough Council: http://www.basildon.gov.uk/article/2009/Local-Plan-2014---2034 Castle Point Borough Council: https://www.castlepoint.gov.uk/adopted-local-plan Rochford District Council https://www.rochford.gov.uk/planning-and-building/planning-policy/adopted-plans Southend-On-Sea Borough Council: http://www.southend.gov.uk/info/200420/planning_policy_documents
2. Assessing Flood Risk		
The level of assessment will depend on the degree of flood risk and the scale, nature and location of the proposed development. Refer to Table 11-1 regarding the levels of assessment. Not all of the prompts listed below will be relevant for every application.		
Tidal Flooding	Provide a plan of the site and Flood Zones. Identify any historic flooding that has affected the site, including dates and depths where possible. How is the site likely to be affected by climate change? Determine hazard risk and flood levels on the site from the updated Environment Agency Thames breach modelling. If necessary, undertake new hydraulic breach modelling to determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.	SFRA Appendix A Figures 4.1, 5.1, 6.1 and 7.1. Updated Environment Agency Thames breach modelling outputs (Environment Agency Product 8). New hydraulic model.
Flooding from	Provide a plan of the site and Flood Zones.	SFRA Appendix A Figures 4.1, 4.1.a, 5.1,

What to Include in the FRA		Source(s) of Information
Rivers	Identify any historic flooding that has affected the site, including dates and depths where possible. How is the site likely to be affected by climate change? Determine flood levels on the site for the 1% AEP flood event including an allowance for climate change. Determine flood hazard on the site (in terms of flood depth and velocity). Undertake new hydraulic modelling to determine the flood level, depth, velocity, hazard, rate of onset of flooding on the site.	5.1a, 6.1, 6.1.a, 7.1 and 7.1a Flood Map for Planning (Rivers and Sea) (Environment Agency website). Environment Agency Products 1-7. New hydraulic model.
Flooding from Surface water	Identify any historic flooding that has affected the site. Review the local topography and conduce a site walkover to determine low points at risk of surface water flooding. Review the Risk of Flooding from Surface Water mapping. Where necessary, undertake modelling to assess surface water flood risk.	SFRA Appendix A Figures 4.2, 5.2, 6.2 and 7.2. Site survey and walkover. Risk of Flooding from Surface Water mapping (Environment Agency website). New modelling study.
Flooding from Groundwater	Desk based assessment based on high level BGS mapping in the SFRA. Ground survey investigations. Identify any historic flooding that has affected the site.	SFRA Appendix A Figures 4.4, 5.4, 6.4 and 7.4. Ground Investigation Report
Flooding from Sewers	Identify any historic flooding that has affected the site.	SFRA Appendix A Figures 4.5, 5.5, 6.5 and 7.5. Refer to SFRA Section 4.7, 5.7, 6.7 and 7.7.
Reservoirs, canals and other artificial sources	Identify any historic flooding that has affected the site. Review the Risk of Flooding from Reservoirs mapping.	Risk of Flooding from Reservoirs mapping (Environment Agency website). Refer to SFRA Section 4.8, 5.8, 6.8 and 7.8.
3. Proposed Development		
Current use	Identify the current use of the site.	-
Proposed use	Will the proposals increase the number of occupants / site users on the site such that it may affect the degree of flood risk to these people?	-
Vulnerability Classification	Determine the vulnerability classification of the development. Is the vulnerability classification appropriate within the Flood Zone?	SFRA Table 8-2 SFRA Table 8-3
4. Avoiding Flood Risk		
Sequential Test	Determine whether the Sequential Test is required. Consult the LPA to determine if the site has been included in the Sequential Test. If required, present the relevant information to the LPA to enable their determination of the Sequential Test for the site on an individual basis.	SFRA Section 8.3
Exception Test	Determine whether the Exception Test is necessary. Where the Exception Test is necessary, present details of: Part 1) how the proposed development contributes to the achievement of wider sustainability objectives as set out in each of the South Essex Authorities Sustainability Appraisal Reports. (Details of how part 2) can be satisfied are addressed in the following part 5 'Managing and Mitigating Flood Risk'.)	SFRA Section 8.3 Refer to the sustainability objectives set out in the LPA's Sustainability Appraisal.

What to Include in the FRA		Source(s) of Information
5. Managing and Mitigating Flood Risk		
Section 9 of the SFRA presents measures to manage and mitigate flood risk and when they should be implemented. Where appropriate, the following should be demonstrated within the FRA to address the following questions: How will the site/building be protected from flooding, including the potential impacts of climate change, over the development's lifetime? How will you ensure that the proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere? Are there any opportunities offered by the development to reduce flood risk elsewhere? What flood-related risks will remain after you have implemented the measures to protect the site from flooding (i.e. residual risk) and how and by whom will these be managed over the lifetime of the development (e.g. flood warning and evacuation procedures)?		
Development Layout and Sequential Approach	Plan showing how sensitive land uses have been placed in areas within the site that are at least risk of flooding.	SFRA Section 9.2
Finished Floor Levels	Plans showing finished floor levels in the proposed development in relation to Ordnance Datum taking account of indicated flood depths.	SFRA Section 9.2.1
Flood Resistance	Details of flood resistance measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 9.3
Flood Resilience	Details of flood resilience measures that have been incorporated into the design. Include design drawings where appropriate.	SFRA Section 9.4
Safe Access / Egress	Provide a figure showing proposed safe route of escape away from the site and/or details of safe refuge. Include details of signage that will be included on site. Where necessary this will involve mapping of flood hazard associated with river flooding. This may be available from Environment Agency modelling, or may need to be prepared as part of hydraulic modelling specific for the proposed development site.	SFRA Sections 9.6 and 9.7
Floodplain Compensation Storage	Provide calculations or results of a hydraulic modelling study to demonstrate that the proposed development provides compensatory flood storage and either will not increase flood risk to neighbouring areas or will result in an overall improvement. This should be located and designed to achieve level for level and volume for volume compensation, should be provided on land that is in hydrological continuity with the site within the applicant's ownership and subject to appropriate maintenance regimes for its lifetime. Include cross sectional drawings clearly showing existing and proposed site levels.	SFRA Section 9.8
Flow Routing	Provide evidence that proposed development will not impact flood flows to the extent that the risk to surrounding areas is increased. Where necessary this may require modelling.	SFRA Section 9.11
Riverside Development Buffer Zone	Provide plans showing how a buffer zone of relevant width will be retained adjacent to any main river or ordinary watercourse in accordance with requirements of the Environment Agency or the South Essex Authorities.	SFRA Section 9.12
Surface Water Management	Details of the following within FRA for all major development proposals in Flood Zones 1, 2 or 3: • Calculations (and plans) showing areas of the site that are	SFRA Sections 9.14 and 10

What to Include in the FRA		Source(s) of Information
	permeable and impermeable pre and post-development. • Calculations of pre and post-development runoff rates and volumes including consideration of climate change over the lifetime of the development. • Details of the methods that will be used to manage surface water (e.g. permeable paving, swales, wetlands, rainwater harvesting). • Reference the supporting Sustainable Drainage Strategy for the site. • Information on proposed management arrangements	
Flood Warning and Evacuation Plan	Where appropriate reference the Flood Warning and Evacuation Plan or Personal Flood Plan that has been prepared for the proposed development (or will be prepared by site owners).	SFRA Section 9.13

11.5 Pre-application Advice

At all stages, the LPA (Basildon, Castle Point, Rochford and Southend-On-Sea Council's) and where necessary the Environment Agency and/or AWS may need to be consulted to ensure the FRA provides the necessary information to fulfil the requirements for planning applications.

The Environment Agency and South Essex Authorities offer pre-application advice services which should be used to discuss particular requirements for specific applications.

- Basildon Borough Council

  http://www.basildon.gov.uk/article/3616/Pre-Planning-Application-Advice
- Castle Point Borough Council

  https://www.castlepoint.gov.uk/pre-application-meetings-and-advice
- Rochford District Council

  https://www.rochford.gov.uk/pre-application-advice
- Southend-On-Sea Borough Council

  http://www.southend.gov.uk/info/200155/make_a_planning_application_and_planning_advice/365/planning_advice_and_guidance
- Environment Agency

  https://www.gov.uk/government/publications/planning-advice-environment-agency-standard-terms-and-conditions

12. Next Steps

12.1 Sequential Test

Using the strategic flood risk information presented within this Level 1 SFRA, each Borough/District should undertake the Sequential Test to document the process whereby future development is steered towards areas of lowest flood risk.

12.2 Level 2 SFRA

Where it is not possible to accommodate all the necessary development outside those areas identified to be at risk of flooding, a Level 2 SFRA will be required to provide information to support the application of the Exception Test for future development sites. The scope of the Level 2 SFRA will be to consider the detailed nature of the flood characteristics within a flood zone including:

- flood probability;
- flood depth;
- flood velocity;
- rate of onset of flooding;
- duration of flood;
- delineation of Functional Floodplain where this has not been modelled as set out in the Level 1 SFRA; and
- definition of appropriate 1% AEP climate change extents where this has not been modelled as part of in the Level 1 SFRA.

The Level 2 SFRA will be delivered as four separate documents for each of the South Essex Authorities and will provide a more detailed assessment of the flood risk for specific development sites which may require the application of the Exception Test.

12.3 Future Updates to the SFRA

This SFRA has been updated building heavily upon existing knowledge with respect to flood risk within the South Essex Authorities. The Environment Agency review and update the Flood Map for Planning (Rivers and Sea) on a quarterly basis and a rolling programme of detailed flood risk mapping is underway. Future new modelling of watercourses in the area will improve the current knowledge of flood risk within each Authority area, and may alter predicted flood extents within parts of the South Essex Authorities in the future.

New information may influence future development management decisions within these areas. Therefore it is important that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives, flood risk datasets and an improving understanding of flood risk within the South Essex Authorities.

Areas in which each Borough/District could look to improve their understanding of flood risk include detailed mapping of their ordinary watercourses and working closely with AWS to understand local sewer capacity issues.

Checklist on factors to trigger an update to the SFRA

The checklist below provides examples of when an update to the Level 1 SFRA may be required.

1. A significant flood event occurs, following which relevant information should be detailed within an addendum to the Level 1 SFRA. The following information should be included:
   - The mapped extent of the flooding;
   - The date on which the event occurred;
   - The source of the flooding;

- If known, the return period of the flood event – the likelihood of an event of the same magnitude occurring in any given year;
- Any amendments to Flood Zone 2 and 3 carried out by the Environment Agency as a result of the flooding.

2. Changes in the understanding of local sources of flood risk, for example:
   - Updates to surface water flood risk mapping, or the SWMPs undertaken by the LLFAs; and
   - Implementation of flood alleviation schemes for ordinary watercourses or surface water flood risk.

3. The NPPF or PPG are amended, with subsequent impacts on the approach to flood risk, for example:
   - An amendment is made to the application of the Sequential or Exception Test;
   - An amendment is made to the definition of fluvial flood zones;
   - Land use vulnerability definitions, presented in the PPG, are amended;
   - The approach to management of SuDS is amended.

4. The Environment Agency releases updates or amendments to its detailed modelling of the River Roach, River Crouch, Thames Estuary, or amends its standing advice. An update would be required if:
   - Updates to the River Roach, River Crouch, Thames Estuary models alter the 1 in 20 year plus climate change (defended), 1 in 100 year (undefended), 1 in 100 year plus climate change (defended) or 1 in 1000 year (undefended) outline. If this is the case Flood Zone 3b, Flood Zone 3, Flood Zone 3 with climate change and Flood Zone 2 should be re-mapped within the Level 1 SFRA;
   - If any other flood risk data is updated, such that the SFRA does not provide the most relevant and up-to-date information;
   - Environment Agency standing advice is altered so that it is no longer in-line with Flood Risk Management Policy Considerations, or other guidance within this Level 1 SFRA. Should this be the case, it is recommended that the Environment Agency is consulted.

Appendix A Figures

Appendix B - Flood Risk Policy and Development Management Considerations

Introduction

All four planning authorities are undertaking a review of their Local Plans including revisions to strategic policies and proposals for future development, as well as revisions to site allocations and development management policies. As set out in Section 2, at the point of preparation of the SFRA, each of the South Essex Authorities are at slightly different stages in the development of their Local Plans.

The purpose of this Appendix is to present recommendations consistent with the NPPF and PPG for consideration by the South Essex Authorities when developing flood risk management policies. Some of the recommendations are common to all four authorities, and some are specific to particular LPAs. It should be noted that it is ultimately the responsibility of the LPAs to formally formulate these policies and implement them.

Policy Considerations

It is recommended that the following flood risk objectives are taken into account during the policy making process. Guidance on how these objectives can be met throughout the development control process for individual development sites is included within Section 9.

Seeking Flood Risk Reduction through Spatial Planning and Site Design

- Use the Sequential Test to locate new development in areas of lowest risk, giving highest priority to areas within Flood Zone 1.
- Use the Sequential Test within development sites to inform site layout by locating the most vulnerable elements of a development in the lowest risk areas. For example, the use of low-lying ground in waterside areas for recreation, amenity and environmental purposes can provide an effective means of flood risk management as well as providing connected green spaces with consequent social and environmental benefits.
- Avoid development immediately downstream of flood storage reservoirs which will be at high hazard areas in the event of failure.
- Seek opportunities for new development to achieve reductions to wider flood risk issues where possible, e.g. larger developments may be able to make provisions for flow balancing within new attenuation SuDS features.
- Identify long-term opportunities to remove development from the floodplain through land swapping.
- Build resilience into a site's design (e.g. flood resistant or resilient design, raised floor levels).
- Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible. Dry pedestrian access/egress should be possible for the 1% AEP return period event including an allowance for climate change associated with fluvial flooding. In the defended tidal floodplain, safe access should also be provided during the MLWL including an allowance for climate change over the lifetime of the proposed development.

Reducing Surface Water Runoff from New Developments

- All sites require the following:
- Use of SuDS (where possible use of strategic SuDS should be made).
- Discharge rates should be restricted to Greenfield runoff rates.
- 1% AEP attenuation of surface water, taking including an allowance for climate change.
- Space should be specifically set aside for SuDS and used to inform the overall layout of development sites.
- Surface water drainage proposals should have a clear plan for the long term maintenance and adoption of the systems, prior to approval of any planning permission in line with national planning policy.
- Large potential development areas with a number of new allocation sites should look to develop a strategy for providing a joint SuDS scheme. This should be on an integrated and strategic scale and where necessary would require the collaboration of all developers involved in implementing a specific expansion area or site.

Enhancing and Restoring the River Corridor

- An assessment of the condition of existing assets (e.g. bridges, culverts, river walls) should be made. Refurbishment and/or renewal of the asset should ensure that the design life is commensurate with the design life of the development. Developer contributions should be sought for this purpose.
- Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water. Enhancement opportunities should be sought when renewing assets.
- Avoid further culverting and building over culverts. Where practical, all new developments with culverts running through their site should seek to de-culvert rivers for flood risk management and conservation benefit. Any culverting or works affecting the flow of a watercourse requires the prior written consent of either the Environment Agency (for main rivers), or the LLFA (for ordinary watercourses) under the terms of the Land Drainage/Water Resources Act 1991 and Flood and Water Management Act 2010. These regulatory bodies seek to avoid culverting, and their consent for such works will not normally be granted except as a means of access.
- Set development back from rivers, seeking an 8 metre wide undeveloped buffer strip for development by all watercourses including those where the Flood Zone does not exist. Under the terms of the Water Resources Act 1991 and the Land Drainage Byelaws, the prior written consent of the Environment Agency or LLFA is required for any proposed works or structures in, under, over or within 8m of a main river, 16m from a tidal river or within 8m of ordinary watercourse asset or structure. This is to allow easy maintenance of the water course, and includes consent for fencing, planting and temporary structures.

Protecting and Promoting Areas for Future Flood Alleviation Schemes

- Protect Greenfield functional floodplain from future development (our greatest flood risk management asset) and reinstate areas of functional floodplain which have been developed (e.g. reduce building footprints or relocate to lower flood risk zones).
- Basildon Borough Council, Rochford District Council and Southend-On-Sea Borough Council should develop appropriate flood risk management policies for the areas within Flood Zone 3b Functional Floodplain that are currently developed, focusing on risk reduction measures, such as:
- Reducing the land use vulnerability wherever possible;
- Not permitting proposals for the change of use or conversion to a use with a higher vulnerability classification;
- Seeking opportunities to ensure there is no increase or achieve a reduction in the number of people at risk (e.g. avoiding conversions and rebuilds of properties that result in an increase in the number of residential dwellings);
- Maintaining or reducing built footprint;
- Raising finished floor levels;
- Increasing floodplain storage capacity and creating space for flooding to occur by restoring functional floodplain;
- Reducing impedance to floodwater flow and restoring flood flow paths;
- Incorporating flood resilient and/or resistance measures;
- Ensuring development remains safe for users in time of flood (this may refer to the timely evacuation of properties prior to the onset of flooding in accordance with an individual Flood Warning and Evacuation Plan for the site).
- Identify sites where developer contributions could be used to fund future flood risk management schemes or can reduce risk for surrounding areas.
- Seek opportunities to make space for water to accommodate climate change.

Improving Flood Awareness and Emergency Planning

- Seek to improve the emergency planning process using the outputs from the SFRA.
- Encourage all those within existing Flood Zone 3a and 3b (residential and commercial occupiers) to sign up to Flood Warning Service operated by the Environment Agency.
- Ensure robust emergency (evacuation) plans are implemented for new developments.

Development Management Considerations

Flood Zone 3b Functional Floodplain

The Functional Floodplain has been defined by each LPA in this SFRA. These areas should be safeguarded from development, with exemptions where development could reduce flood risk overall or improve floodplain storage.

Within this Level 1 SFRA, each LPA has defined Flood Zone 3b Functional Floodplain for their respective administrative areas using the 5% AEP defended flood outline as a starting point for the definition (as described in Section 2.2.4).

Only Water Compatible developments are permitted in Flood Zone 3b, and Essential Infrastructure developments require the Exception Test (see Table 8-4). Where Water Compatible or Essential Infrastructure development cannot be located elsewhere, it must:

- Remain operational and safe for users in times of flood;
- Result in no net loss of flood storage;
- Not impede water flows; and
- Not increase flood risk elsewhere.

Proposals for the change of use or conversion to a use with a higher vulnerability classification should not be permitted. Basements, basements extensions, conversions of basements to a high vulnerability classification or self-contained units should not be permitted.

Where minor development is proposed, schemes should not affect floodplain storage or flow routes through the incorporation of the following mitigation measures in line with CIRIA guidance on SuDS:

- Raised finished floor levels;
- Voids and where possible;
- Direct or indirect floodplain compensation;
- Flood resilience measures;
- The removal of other non-floodable structures;
- Replacement of impermeable surfaces with permeable;
- Improved surface water drainage through the implementation of SuDS features such as water butts/rainwater harvesting;
- Living roofs;
- Infiltration trenches/soakaways; and
- Below ground attenuation tanks.

Development in Flood Zone 3b Washland Areas (Basildon Borough)

Flood Zone 3b comprises land where water has to flow or be stored in times of flood and therefore Basildon Borough Council has identified all the washland areas within the Borough as Flood Zone 3b for the purposes of informing spatial planning across the Borough. Any application to develop within a washland area will receive a holding objection from the Environment Agency and Basildon Borough Council would treat such an application with extra caution.

However, it is recognised that in some cases, it will be necessary to safeguard the future development potential of these areas. When considering the potential for future development within a washland area, the following principles must be considered:

Sequential Test

The status of the washland prior to its designation as Flood Zone 3b within this SFRA will be a consideration. For example if the washland was in Flood Zone 3a prior to its designation as Flood Zone 3b, there should be a presumption against development. Other sites in areas of lower flood risk throughout the Borough should be considered prior to the consideration of a washland site in Flood Zone 3a, in accordance with the principles of the sequential test within PPS25. Only where it can be demonstrated that there are no other sites in areas of lower risk could the site be considered for development.

For washlands that are located within areas of Flood Zone 1 and it is only the washland that has been designated Flood Zone 3b within this SFRA, this in itself would be material to determining whether a redevelopment scheme could be deemed acceptable.

Betterment

Where development of a washland site is appropriate in accordance with the Sequential Test, it will be necessary to prove that full or partial development of the site would not increase the flood risk to the site or the surrounding area. Where this is the case, the requirements of NPPF would be satisfied and the Environment Agency and Basildon Borough Council would uphold this.

Wherever possible, additional capacity on site or off site should be created to ensure that additional benefit can be brought to the area, for example in the form of added gain of flood protection or biodiversity.

Flood Zone 3a High Probability

Flood Zone 3a High Probability comprises land having a 1% (1 in 100 year) annual probability or greater. Water Compatible and Less Vulnerable developments are permitted in Flood Zone 3a; Essential Infrastructure and More Vulnerable developments require the Exception Test and Highly Vulnerable development is not permitted in this flood zone (see Table 8-4). Where development is proposed opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding;
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- Ensure it remains safe for users in times of flood; and
- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

Flood Zone 2 Medium Probability

Flood Zone 2 Medium Probability comprises land having between a 1% (1 in 100 year) and 0.1% (1 in 1000 year) annual probability of flooding from fluvial watercourses. Water Compatible, Essential Infrastructure, Less Vulnerable and More Vulnerable developments are permitted in the Flood Zone 2, and Highly Vulnerable development requires the Exception Test (see Table 8-4). Where development is proposed in areas of Flood Zone 2, the planning policy approach is similar to Flood Zone 3a. Opportunities should be sought to:

- Relocate existing development to land in zones with a lower probability of flooding;
- Reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques;
- Ensure it remains safe for users in times of flood; and
- Create space for flooding to occur by restoring natural floodplain and flood flow paths and by identifying, allocating and safeguarding open space for flood storage.

Flood Zone 1 Low Probability

Flood Zone 1 Low Probability comprises land having a less than 0.1% (1 in 1000 year) annual probability of flooding from fluvial watercourses. All development vulnerability classifications are permitted in Flood Zone 1 (see Table 8-4). Where development over 1ha is proposed or there is evidence of flooding from another localised source in areas of Flood Zone 1, opportunities should be sought to:

- Ensure that the management of surface water runoff from the site is considered early in the site planning and design process;
- Ensure that proposals achieve an overall reduction in the level of flood risk to the surrounding area, through the appropriate application of sustainable drainage techniques.

Cumulative Impact of Minor and Permitted Development

The PPG advises that minor developments (as defined in Section 8.3) are unlikely to result in significant flood risk issues unless:

- they would have an adverse effect on a watercourse, floodplain or its flood defences;
- they would impede access to flood defence and management facilities; or

- where the cumulative impact of such developments would have a significant impact on local flood storage capacity or flood flows.

In parts of the study area there is potential for both minor development as well as permitted development to be considered to be having a cumulative impact on flood risk in the local area as a result of impacts on local flood storage capacity and flood flows. Given the small scale of the development in the context of the wider fluvial catchments it is not possible to undertake modelling to confirm the impact of such development.

There is opportunity for LPAs to consider making an Article 4 direction[58] to remove national permitted development rights for developed areas of land within Flood Zone 3b where cumulative impact is considered to be a problem. The removal of permitted development rights will ensure that a planning application and site specific FRA will be required for any development in these areas.

FRAs for all minor development within Flood Zone 3 should demonstrate that the proposal is safe and will not increase flood risk elsewhere by not impeding the flow of flood water, reducing storage capacity of the floodplain. Details of flood mitigation measures to reduce the impact of flooding on the proposed development and ensure that the proposed development does not result in an increase in maximum flood levels within adjoining properties should be provided. This may be achieved by ensuring (for example) that the existing building footprint is not increased, that overland flow routes are not truncated by buildings and/or infrastructure, hydraulically linked compensatory flood storage is provided within the site (or upstream), and/or the incorporation of floodable voids (more information will be provided in the Level 2 SFRA). It is acknowledged that full compensation may not be possible on all minor developments, however, an applicant must be able to demonstrate that every effort has been made to achieve this and provide full justification where this is not the case.

Changes of Use

Where a development undergoes a change of use and the vulnerability classification of the development changes, there may be an increase in flood risk. For example, changing from industrial use to residential use will increase the vulnerability classification from Less to More Vulnerable (Table 8-3).

For change of use applications in Flood Zone 2 and 3, applicants must submit a FRA with their application. This should demonstrate how the flood risks to the development will be managed so that it remains safe through its lifetime including provision of safe access and egress and preparation of Flood Warning and Evacuation Plans where necessary. Further guidance will be provided within the Level 2 SFRA Report.

As changes of use are not subject to the Sequential or Exception Tests, the South Essex Authorities should consider when formulating policy what changes of use will be acceptable, having regard to paragraph 157 (6th bullet) of the NPPF: “identify areas where it may be necessary to limit freedom to change the uses of buildings, and support such restrictions with a clear explanation” and taking into account the findings of this SFRA. This is likely to depend on whether developments can be designed to be safe and that there is safe access and egress.

Basement Development

Basement development may involve either the extension of an existing habitable basement under a house, or the construction of a completely new basement. It is becoming increasingly popular to construct basements which extend beyond the footprint of the host property and under the amenity area.

In accordance with the PPG, self-contained dwellings or bedrooms at basement level in Flood Zone 3 should not be permitted due to the vulnerability of users. Basements, basement extensions, conversions of basements to a higher vulnerability classification or self-contained units are not acceptable in Flood Zone 3b. Basements for other uses in Flood Zone 3a and 2 may be granted provided there is a safe means to escape via internal access to higher floors 300mm above the 1% annual probability (1 in 100 year) flood level including an allowance for climate change.

The Environment Agency Areas Susceptible to Groundwater Flooding maps provided in Appendix A Figures 4.4 (Basildon Borough), 5.4 (Castle Point Borough), 6.4 (Rochford District) and 7.4 (Southend-on-Sea Borough) should be used to help assess the suitability of potential basement developments. However, it should be made clear that the Areas Susceptible to Groundwater Flooding maps are high level strategic maps and even though there are areas of no risk is mapped it does not mean that there is no risk present. Therefore, it is recommended that ground investigations and groundwater monitoring should be undertaken at each potential basement development site.

[58] An article 4 direction is a direction under article 4 of the General Permitted Development Order which enables the Secretary of State or the local planning authority to withdraw specified permitted development rights across a defined area.

Basement development may affect groundwater flows, and even though the displaced water will find a new course around the area of obstruction this may have other consequences for nearby receptors e.g. buildings, trees. If basement development is located within an aquifer corridor, it may lead to localised elevations in groundwater and increase flood levels. An FRA must provide details of an appropriate sustainable urban drainage system for the site and investigation to determine whether a perimeter drainage system or other suitable measure is necessary to ensure any existing sub-surface water flow regimes are not interrupted.

The FRA must also address the impact of the proposed extension on the ability of the floodplain to store floodwater during the 1% annual probability (1 in 100 year) event including allowance for climate change and where necessary provide compensatory floodplain storage on a level for level, volume for volume basis.

Appendix C Prittle Brook Climate Change Modelling

Introduction

As part of the update to the South Essex Strategic Flood Risk Assessment (SFRA), the councils are required to map the predicted outlines of Flood Zone 3 including allowances for climate change (CC). In February 2016, the Environment Agency amended the projected impacts of climate change on river flow[59]. Previous climate change allowances considered only a 20% increase in river flows across all river basins. This was amended to include a range of projected increases in river flows for each river basin, for a range of epochs, and for different development vulnerability classifications. As such, previous modelled outlines for the 1% Annual Exceedance Probability (AEP) event (equivalent to the 1 in 100 year event or the maximum extent of Flood Zone 3) are not in line with the amended climate change allowances.

For the Prittle Brook, the Environment Agency holds an existing model that has been acquired and revised to reflect the amended climate change allowances. This technical note summarises the methodology that has been undertaken to revise the climate change allowances and presents the results of the analysis.

Methodology

Existing Model

The existing model for the Prittle Brook was obtained from the Environment Agency. The model is from July 2008 and is a one dimensional (1D) model that was originally built and run using the hydraulic modelling package ISIS. At the time of the SFRA this model is in the process of being revised; however, for the purposes of the SFRA it has been assumed that the existing model is suitable for use in this assessment. The model includes the channel of the Prittle Brook from Westwood Gardens (Hadleigh) to Sutton Road close to the confluence with the River Roach. AECOM has not reviewed in detail the representation of the watercourse, the model parameters or model assumptions as part of this project.

Inflow Boundaries

The model includes six inflow boundaries that have been represented as Flood Estimation Handbook (FEH) inflows. These are either representing point inflows at specific locations or lateral inflows to account for the cumulative input from the contributing urban area. The FEH inflow boundaries are referenced PB1-PB6. Table C-1 presents the peak flows associated with the existing 1% AEP, 1% AEP plus 20% climate change and 0.1% AEP flood events. Peak flows for updated climate change allowances associated with a 25%, 35% and 65% increase in river flow are also provided in Table C-1 for each of the FEH inflow boundaries.

The resulting peak flows for the revised climate change allowances demonstrate that, even for the 1% AEP plus 65%CC event, peak flows are individually between 46% and 56% of the peak inflows for the 0.1% AEP event in this model.

Table C-1 - Prittle Brook Climate Change Peak Flows

	Existing Model Inflows (m^3/s)			Updated CC Inflows (m^3/s)		
Inflow Reference	1% AEP	1% AEP +20% CC	0.1% AEP	1% AEP +25% CC	1% AEP +35% CC	1% AEP +65% CC
PB1	2.83	3.40	9.21	3.54	3.82	4.67
PB2	3.77	4.52	11.64	4.71	5.09	6.22
PB3	0.37	0.44	1.12	0.46	0.50	0.61
PB4	7.39	8.86	25.79	9.24	9.98	12.19
PB5	1.20	1.44	4.27	1.50	1.62	1.98
PB6	1.37	1.64	4.07	1.71	1.85	2.26

[59] Environment Agency, February 2016. URL: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. Last accessed October 2017.

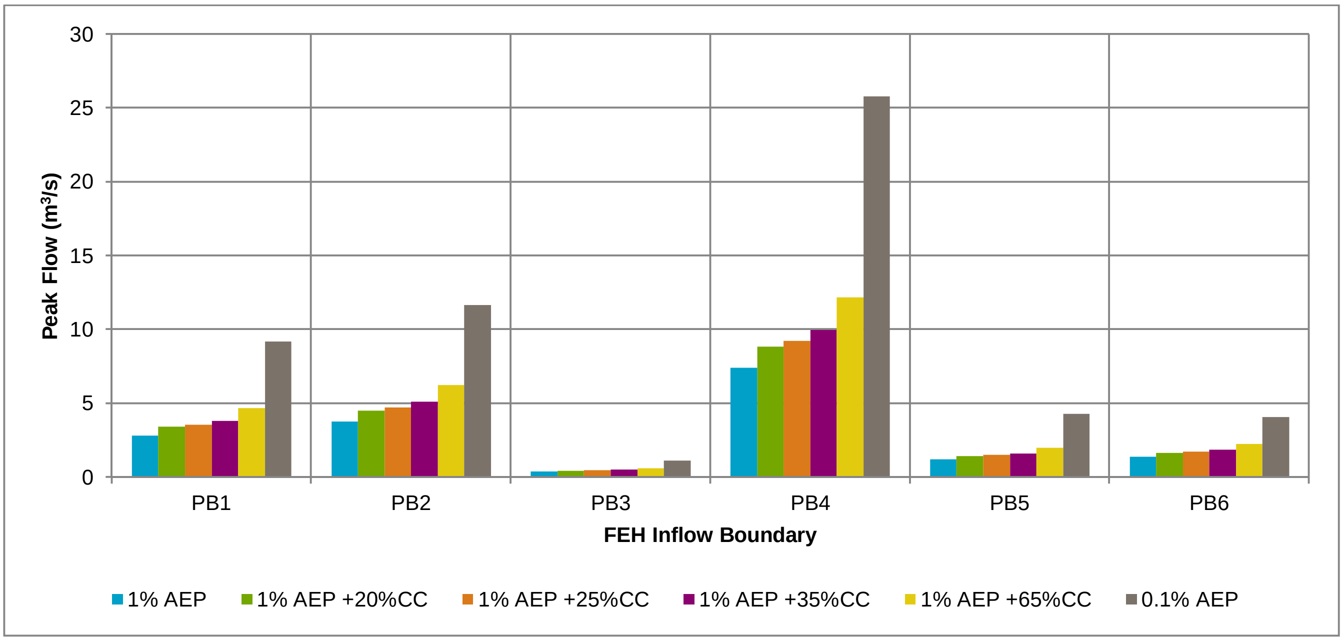

Figure C1 - Prittle Brook Climate Change Peak Flows

Revised Model

Copies were made of the existing ISIS model for the 1% AEP event and the FEH inflow boundaries within each of the models were scaled to the peak flows as shown in Table C-1 for each of the three climate change allowances. The model was subsequently re-run to produce results for the 25%, 35% and 65% climate change scenarios.

Results

The model results have been exported and reviewed in detail. It was not possible to produce flood outlines for each of the climate change allowances due to the lack of a Triangular Irregular Network (TIN) that was used to produce the original flood outlines. The results show, however, that for all nodes the peak flood water level in the 0.1% AEP event is greater than the flood water level for the 1% AEP +65% CC event. This is shown at a high level in Figure C2, which shown a long section through the entire model. In addition, for a significant proportion of the urban area through which the Prittle Brook flows, the flow remains in the channel and does not extend onto a floodplain. As such, it is recommended that the 0.1% AEP flood outline be retained as the 1% AEP +CC outline. This additional hydraulic modelling has confirmed that this is an appropriate and conservative assumption throughout the modelled reach of the Prittle Brook.

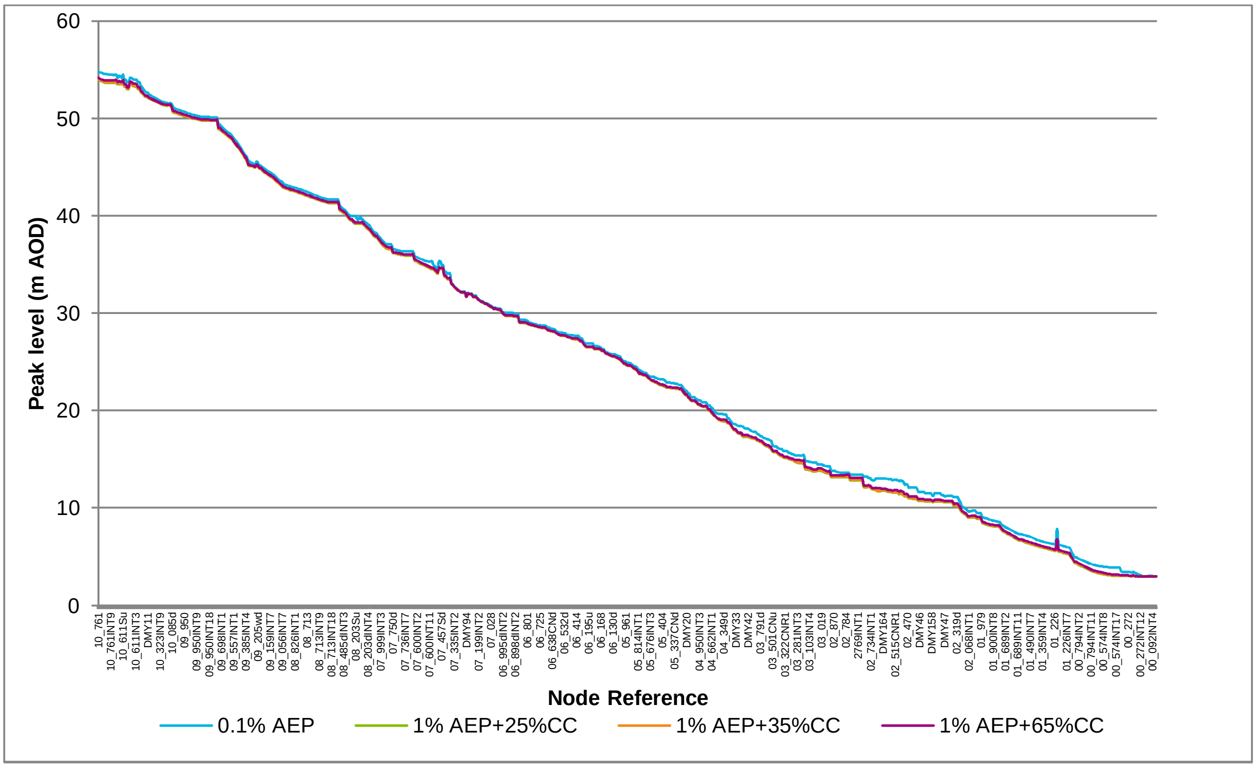

Figure C2 - Prittle Brook Peak Flood Level Long Section

Assumptions and Limitations

The following assumptions and limitations are noted as part of this modelling study:

- It is noted that the hydraulic modelling of the Prittle Brook is currently being updated. The climate change outlines in the SFRA should be reviewed once this has been completed to ensure that the mapping is accurate and representative.
- A detailed model review, including a review of the assumptions and parameters in the existing model used as part of this study has not been undertaken. It is noted that the model is a 1D only model that does not represent two dimensional (2D) overland floodplain flow or the risk of surface water flooding.
- Transposition of the peak flood water levels onto the ground surface has not been undertaken as part of this study due to the lack of an underlying TIN upon which the previous flood outlines were created.

Appendix D South Essex Breach Modelling Methodology

This modelling methodology was prepared by AECOM and agreed with the South Essex Authorities and the Environment Agency in January 2017 to inform the preparation of the Level 1 SFRA update for Basildon Borough, Castle Point Borough, Rochford District, Southend-on-Sea Borough and Essex County Councils.

Introduction

The area around South Essex (Figure D1) including the North Thames Bank and Crouch Estuaries are exposed to the tidal influence of the North Sea and as such, are at risk of tidal flooding. The existing tidal defences protect these areas from tidal inundation and therefore the risk of flooding to South Essex is only if the defences fail (breach).

As part of the Level 1 SFRA, AECOM are required to update tidal breach modelling carried out as part of the previous SFRA (2010) to inform the assessment of residual flood risk at a strategic scale.

The previous SFRA was prepared by URS Scott Wilson in 2010 and included simulating a breach within the existing defences at some 27 locations. These breach models are required to be updated to utilise current terrain data and recommended allowances for climate change on extreme water levels within the outer Thames region.

The purpose of this technical note is to document the agreed breach assessment methodology (January 2017) by the Environment Agency and Local Council representatives.

The methodology described below is based on the previous SFRA methodology and guidance contained within the Environment Agency breach methodology document[60] and discussion from the meeting with the Environment Agency Asset Performance Team (February 2017). It should be noted that although many of these breach locations were previously identified, all of the breach modelling conducted within this study is original and does not use or incorporate any previous modelling; each breach cell has been reconstructed exclusively for this study. In addition, every breach location has been assessed for suitability to this study.

The South Essex SFRA is split into four discrete areas these are:

1. Basildon Borough Study Area;
2. Castle Point Borough Study Area;
3. Rochford District Study Area; and
4. Southend-on-Sea.

[60] Environment Agency (2005) ‘Requirements for Hazard Mapping v5_EA Breach modelling methodology’,

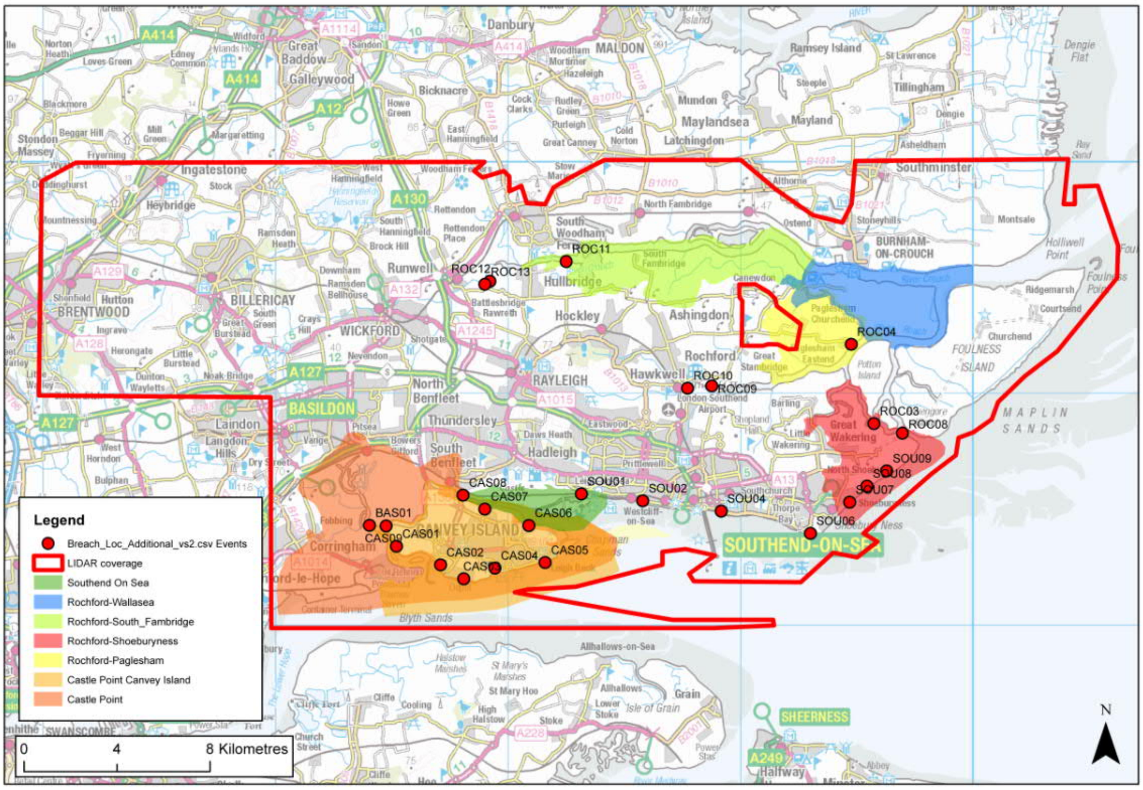

Figure D-1 Study Area with the identified 25 breach locations.

Information received / requested

Information requested or carried forward from the previous SFRA relevant to the breach modelling is summarised in Table D-1.

Table D-1 Information received / carried forward relevant to South Essex breach modelling

Dataset	Description and use in breach modelling	Format
Light Detecting and Ranging Data (LiDAR) – 0.25m, 0.5m, 1m and 2m resolution flown in 2015	Terrain data obtained from Environment Agency	ASCI
OS 1 to 10,000 raster mapping	Background mapping obtained from the relevant local Council authorities to be used in flood mapping	JPEG
OS MasterMap Data	Background mapping obtained from the relevant local Council authorities to be used to apply roughness to ground surfaces	GIS / CAD
South Essex administrative boundary	Boundary condition used in flood mapping	GIS
2017 SFRA Breach Locations / Details	Breach locations to be modelled as part of the Level 1 SFRA (2017)	Excel
Levels Flows	Maximum flows and levels for 1 in 20 year, 1 in 75 year, 1 in 100 year, 1 in 20 year CC and 1 in 100 year CC for any river discharges i.e. Crouch / Roach Estuaries.	Excel / GIS
Requirements for Hazard Mapping v5_EA Breach modelling methodology	Specification for breach modelling provided by the Environment Agency	PDF
Thames Tidal Defences, Joint Probability Modelling (2008)	Extreme water levels in the Tidal Thames to be used as the boundary conditions in the breach modelling	Excel
As built drawings of sluice structures	To inform breach widths	PDF
Environment Agency Fluvial and Coastal Models	Model files including relevant input data and supporting metadata	Digital
BGS	Geological and permeability maps	Digital

Dataset	Description and use in breach modelling	Format
ECC Historical Flooding Events	Historical Flooding Events	GIS/CAD
Flood Defence Information	AIMS data source, provides description of defence location and elevation.	Excel / GIS / CAD / Digital

Methodology

Software

2D modelling of the breach scenarios is required to provide flood hazard information suitable for use in a SFRA. It is proposed to use the most up to date version of MIKE by DHI available at the start of the project; currently Version 2017.

The MIKE21 model is specifically oriented towards establishing flow patterns in complex water systems, such as coastal waters, estuaries and floodplains using a flexible mesh (FM) approach. The flexible mesh model has the advantage that the resolution of the model can be varied across the model area. A further advantage of using Mike by DHI is to be consistent with the previous SFRA (2010).

Breach Parameters

Locations

A review of the proposed breach locations was carried out during a workshop with the Environment Agency representative from the Partnership & Strategic Overview team, Local Council Project Manager, representatives from the Environment Agency Asset Performance Team (February 2017). The proposed breach locations were reviewed to ensure that these are appropriate.

Widths and time of closure

The breach widths are stated in Table D-2 and are consistent with the Environment Agency's methodology60 and shown below. If applicable, sluice and outfall structures provided by the Environment Agency will also be used to inform the selection of breach widths. It will be assumed that the breach is 'open' for the duration of three tidal cycles (36 hours); this is the same duration of the previous SFRA breach models (2010).

Table D-2 Environment Agency (2005) 'Requirements for Hazard Mapping v5_EA Breach modelling methodology'

Location	Defence type	Breach width (m)	Time to Closure (hrs)
Open coast	Earth bank	200	72
	Dunes	100	72
	Hard	50	72
Estuary	Earth bank	50	72
	Hard	20	72
Tidal river	Earth bank	50	72
	Hard	20	72
Fluvial river	Earth bank	40	36
	Hard	20	36

Breach Invert Level

The invert level of the breach will be determined through an interrogation of the LiDAR on the landward side of the breach location. As a rule of thumb the lowest ground level within a radius the same width as the breach will be used as the breach invert level. For example, in the breach shown in Figure D2 below, the width is 20 m and the invert level is proposed to be set to 2.3 m AOD.

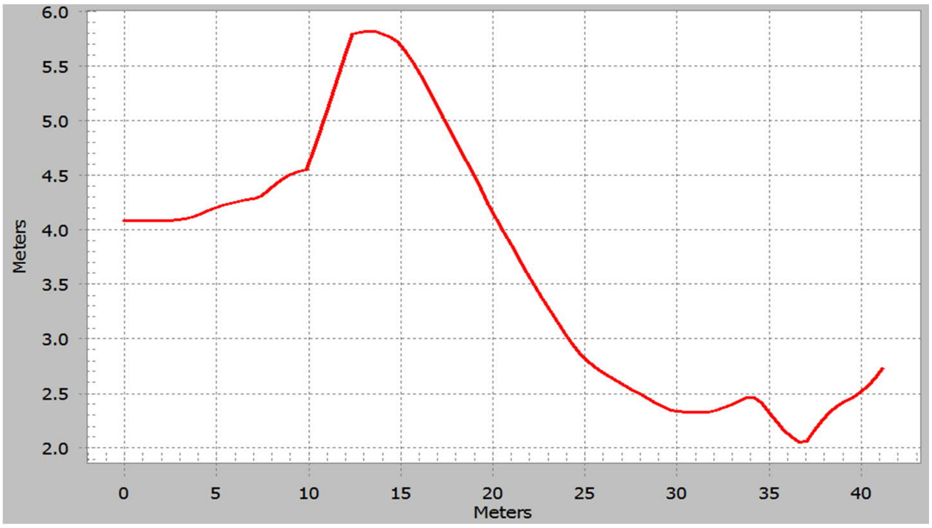

Figure D-2 Example cross-section profile through breach

It is expected that the breach invert levels will be the same or similar to the previous SFRA models, but these will be reviewed, taking into consideration at a high level the degree of scour expected into the floodplain. The breach invert level will be set within the 2D domain. The same level will be set throughout the model simulation, which is a conservative assumption.

Extreme Water Levels (Boundary Conditions)

Design tide boundaries

Each of the breach models is required to simulate:

- A tidal flood event with a return period of 1 in 200 years (present day 2016);
- A tidal flood event with a return period of 1 in 200 years (with climate change 2116);
- A tidal flood event with a return period of 1 in 1000 years (present day 2016);

Extreme water level data for use in this modelling will be based on the Environment Agency Thames Tidal Defences Joint Probability Extreme Water Levels Final Modelling Report (April 2008) for the Thames Estuary, CFB Extreme Sea Levels (2011) for the North Sea coast, and the Crouch Roach Levels (2011) for Crouch estuary. Where extreme water level points are present within close proximity to the breach location, unmodified water levels will be used. Where a significant distance (more than 250m) is present between the modelled nodes and the breach locations, modelled water levels will be interpolated (based on chainage) to provide a more appropriate water level.

As shown in Figure D3 a series of 3 typical spring tides spanning a period of 1.5 days (36 hours) will be included in all tidal breach scenarios. The surge will be gradually applied (Figure D3) with the maximum surge effect occurring on the second high tide (about 18 hrs after the start of the simulation). The model will then continue to run for the remainder of the 36hr simulation period.

For the 0.5% (1 in 200 year) and 0.1% (1 in 1000 year) AEP 2116 scenarios, the recommended climate change factors (UKCP09 medium emissions 95%tile) will be applied to generate the extreme water levels with allowances for sea level rise for the 2116 scenarios. The Thames Tidal Defences Joint Probability Extreme Water Levels (2008) and Anglian Region Extreme Tide Levels (2007) data contains modelling extreme water levels up to 2115 and therefore one year of climate change will need to be applied.

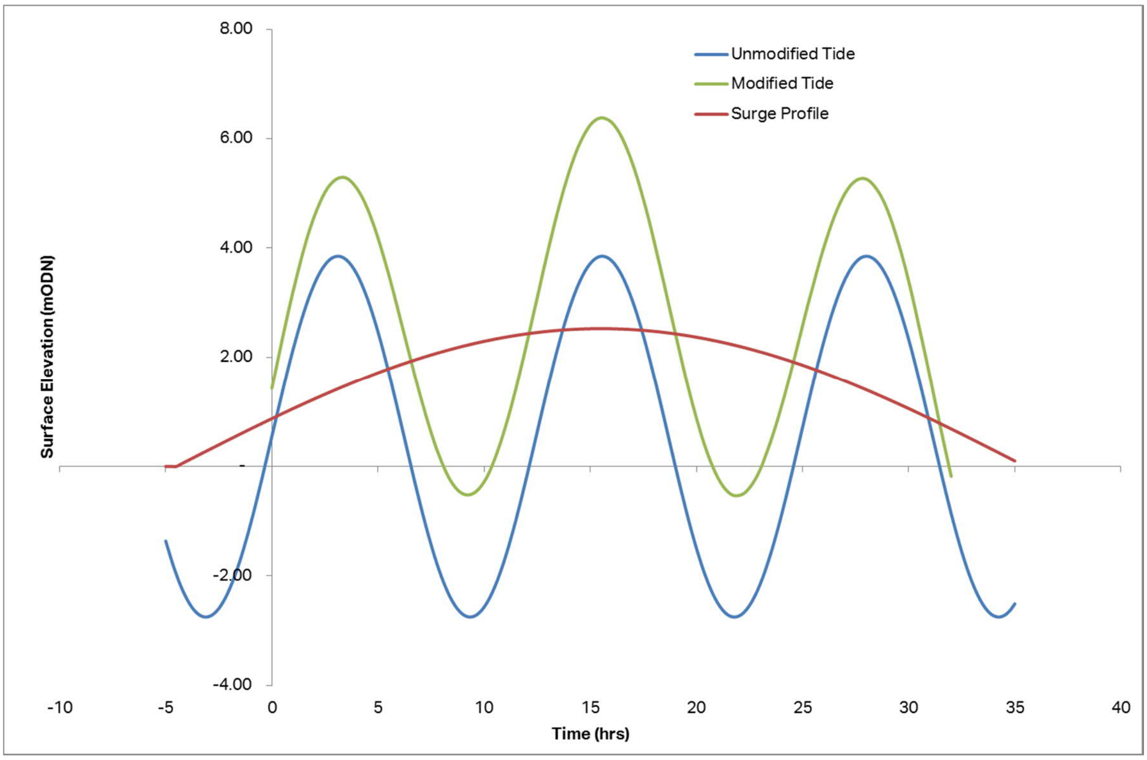

Figure D-3 Example Tide Curve Including Surge Profile

Skew Surge Analysis

The addition of the surge skew analysis as described in the UKCP09 guidance has been reviewed for the study area. A slight negative surge component is predicted for these areas in South Essex. However, given the very small negative magnitude (<1mm) increment for each return period, the level of uncertainty and to ensure consistency with previous studies, these slight modifications to the tidal boundary have been excluded from this strategic analysis. This assumption provides a slightly more conservative boundary condition which is not considered significant and within the level of uncertainty of the modelling study.

Application of boundaries to MIKE by DHI

The design boundary conditions will be applied directly to the 2D model using a boundary file containing Height / Time (HT) information of the tidal cycles. The boundary will be applied across the seaward extent of the model domain.

Flood Cells

The extent of the 2D models has been defined by adopting a flood cell approach. A flood cell is defined through a review of the LiDAR data against the extreme water levels and includes all land that is at a lower elevation than the extreme water level.

Model Topography

Flexible meshes were developed to define the topography of the land within each flood cell, using the MIKE21 program's mesh generator application which creates a mesh of triangular elements covering the defined 'flood cell' - the land that has an elevation below the peak tidal level with the potential to flood.

One of the advantages of the flexible mesh application is that the element size within the mesh can be varied depending upon the complexity of the floodplain, features of interest, and the location of topographic features which are thought to have a significant impact on flood propagation. The mesh elements are forced to follow the alignment of the features ensuring the elevations of important features are picked up during the mesh generation. For example, control lines would be placed along each side of a road/ditch/topographic feature. In this way, the mesh is 'forced' to follow the features accurately and use level values at very specific points.

Considering these models are for strategic and not site specific purposes, small features such as culverts and small drainage ditches will not be included within the mesh. Taking into account the size of the study areas, the determination of all culverts and small features is outside the scope of the study.

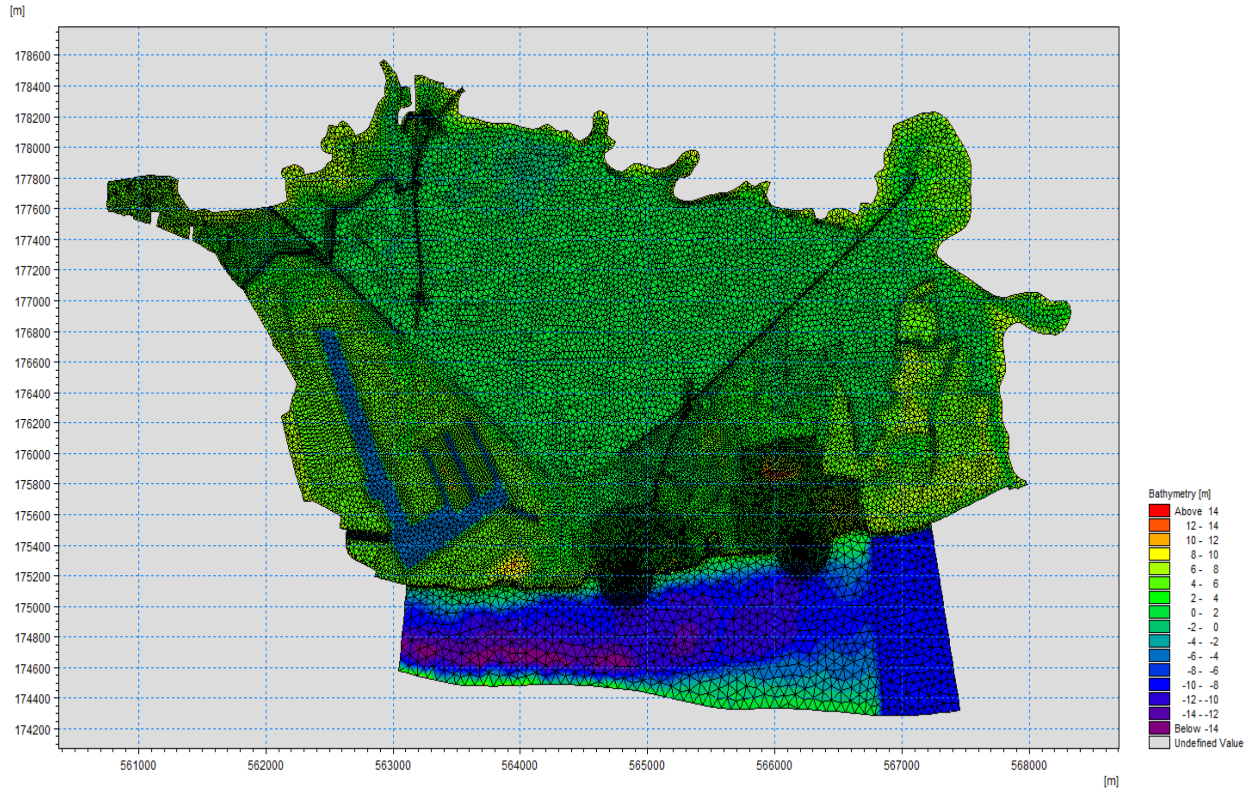

Figure D-4 Example MIKE Flexible Mesh Flood Cell

Where surface features, for example embankments, are not represented in the model topography, additional MIKE by DHI geometry files will be used for definition. Model interpolated defence crest levels will be validated against the information received from AIMS and the Environment Agency topographic spot level data, a review of the model defence heights will be undertaken to ensure that these levels are consistent.

Defences / Barriers

The defences along the coastline are variable in standard. Defence heights have been determine from the most appropriate and accurate supplied data (AIMS). This data was triangulated and used to determine the height of the defences in the areas where available.

Roughness

A specify varying Manning's roughness coefficients will be used throughout the model extent according to land use. Hydraulic roughness represents the conveyance capacity of the land or riverbed where flows are occurring. Within the MIKE21 model, hydraulic roughness is defined by the dimensionless Manning's 'n' roughness coefficient.

A number of material roughness classifications will be applied within the study area, for example water - 0.03 (for the river), urbanised - 0.08, rural/non-urbanised land - 0.04, road - 0.02, and rail - 0.03. The distribution of these factors has been defined using aerial photography, OS maps and knowledge gained by the site visit in order to vary the conveyance rates throughout the flood cell domain.

Buildings

Representation of buildings in hydraulic modelling varies from assuming no buildings are present, increasing the roughness across a building polygon to blocking buildings completely out of the floodplain, thus assuming no water would flow through.

The Environment Agency methodology document60 does not specify how buildings should be represented. Raising buildings as solid blocks assumes that no flow can pass through the buildings which can be considered an over-conservative assumption. Therefore it is proposed for this SFRA modelling that buildings will not be represented. This approach is consistent with the previous investigation.

Naming convention and folder structure

The breach names have been updated to provide a clear distinction between the 2009 and 2016 models. The model folder structure will follow the standard MIKE by DHI modelling structure.

Outputs

All of the results have been post-processed to provide maximum asci grids for flood depth, flood hazard and maximum current speeds. These outputs will be used to create the necessary mapping for the SFRA.

Table D-3 Breach Characteristics

ID	Code	Breach Name	Easting	Northing	Defence Type	Breach Width (m)
1	BAS01/CAS	Flood barrier, Fobbing Horse, Vange Creek	574044.7	184305.5	Hard defence - barrier	width of barrier-45
2	CAS01	Upper Horse	575200	183400	Hard defence with earth embankment	20
3	CAS02	Canvey Village, Lower Horse	577100	182600	Hard defence with earth embankment	20
4	CAS03	STW	578100	182000	Hard defence with earth embankment	20
5	CAS04	Canvey Island Golf Course	579437.5	182463	Hard defence with earth embankment	20
6	CAS05	Leigh Beck	581600	182700	Hard defence with earth embankment	20
7	CAS06	Sunken Marsh	580900	184300	Hard defence with earth embankment	20
8	CAS07	Castle Point Golf Course	579008.6	185005	Hard defence with earth embankment	20
9	CAS08	Benfleet Creek Flood Barrier	578067.6	185605	Hard defence - barrier	width of barrier-45
10	CAS09	Easthaven Barrier	574757	184282	Hard defence - barrier	width of barrier-45
11	SOU01	Hadleigh Marsh	583160	185661	Earth (estuary)	50
12	SOU02	Chalkwell	585796	185365	Hard (estuary)	20
13	SOU04	City Beach	589174	184919	Hard (estuary)	20
14	SOU06	East Southend	593018	183955	Hard (estuary)	20
15	SOU07	Shoeburyness/Great Wakering	594700	185300	Earth (open coast)	200
16	SOU08	Shoeburyness New Ranges	595445	185998	Earth Embankment	200
17	SOU09	Morrin's Point	596298	186654	Earth Embankment	200
19	ROC03	Oxenham Farm	595745	188694.5	Earth Embankment	50
20	ROC04	Paglesham Eastend	594767.5	192116.8	flood gate	50
21	ROC07	South Fambridge	585500	196200	Earth Embankment	50
22	ROC08	Havengore Bridge	596978	188287	Earth Embankment	20
23	ROC09	Stambridge Mills Sluice	588767	190318	Earth Embankment	20
24	ROC10	Horesome Green Pub	587730	190219	Earth Embankment	20
25	ROC11	Brandyhole Yacht Club	582507	195695	Earth Embankment	20
26	ROC12	Beeches No 3	579220	194842	Earth Embankment	20
27	ROC13	Pats Rill	579007	194706	Earth Embankment	20

Appendix E South Essex Breach Mapping

Basildon Borough

Castle Point Borough

Rochford District

Southend-on-Sea Borough