Basildon Borough Council

Level 2 Strategic Flood Risk Assessment

Level 2 – Final Report

September 2011

Prepared for

Basildon Council

BASILDON • BILLERICAY • WICKFORD

Revision Schedule

Basildon Borough Council Strategic Flood Risk Assessment – Level 2
September 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	June 2011	Draft Report for Client Comment	**Eleanor Cole** Assistant Hydrologist **Sarah Littlewood** Assistant Flood Risk Specialist	**Emily Craven** Senior Flood Risk Consultant	**Jon Robinson** Technical Director
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Non Technical Summary

Overview

Basildon Borough Council, in partnership with Rochford District Council and Castle Point Borough Council, has commissioned URS Scott Wilson to produce a Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25): *Development and Flood Risk*[1] and its accompanying Practice Guide[2]. This SFRA provides a revision to the Thames Gateway South Essex SFRA which was published in November 2006 and prepared under previous policy Planning Policy Guidance (PPG25) Development and Flood Risk.

The following report constitutes a Level 2 SFRA for Basildon Borough Council which builds on the findings of the Level 1 SFRA and will contribute to the evidence base for the plan-making process of the Local Development Framework (LDF), in particular the Core Strategy.

The scope of this document has been expanded from the Level 1 SFRA to include an assessment of the residual tidal flood risk facing the Borough in the event of a failure in the local flood defences, as well as up to date information regarding areas at increased risk of surface water flooding. This information, in combination with the information presented in the Level 1 SFRA, has then been used to undertake a high level review of potential development areas in relation to flood risk and appropriate mitigation measures that should be considered.

The findings from these assessments provide further specific information which will facilitate the application of the Exception Test, where required, and inform the preparation of site specific Flood Risk Assessments for individual development sites in the potential development areas.

Tidal Breach Modelling

Hydrodynamic breach modelling has been undertaken at two locations to assess the impact of a failure of the Fobbing Horse Flood Barrier in the Vange Creek and the Benfleet Creek Flood Barrier. The results demonstrate that in the event of a failure of these flood barriers, floodwaters would inundate the southern part of the Borough including the Vange marshes, Pitsea marshes and Bowers marshes. During the 0.5% AEP modelled event for 2010, flood depths are modelled to inundate parts of Pitsea marsh and Bowers marsh to approximately 0.5m. During the 0.1% AEP event including an allowance for climate change to 2110, the extent of flooding is much greater, affecting the Vange marsh to depths of 3m and Pitsea marsh and Bowers marsh to depths of up to 2m.

Modelling has also been undertaken to simulate the impact of overtopping of the existing defences. This modelling shows that no overtopping occurs in the 0.5% AEP event including an allowance for climate change to 2110. During the 0.1% AEP event with an allowance for climate change to 2110 floodwaters are shown to overtop defences and inundate parts of the Vange marshes to depths of approximately 2m. Under the Catchment Flood Management Plan for South Essex and Thames Estuary 2100 Project, the policies for this area are to sustain the current level of flood risk into the future, responding to the potential increases in risk from urban development, land use change and climate change.

[1] CLG (December 2006, revised March 2010) Planning Policy Statement 25: Development and Flood Risk
[2] CLG (June 2008, revised December 2009) Planning Policy Statement 25: Development and Flood Risk

Surface Water Flood Risk

Since the completion of the Level 1 SFRA the Environment Agency has published new information with respect to surface water flood risk in the form of the Flood Map for Surface Water (FMfSW). This dataset identifies areas at increased risk of surface water flooding. A review of this dataset highlights the corridors of the River Crouch and River Wid and the topographic tributaries that lead into these watercourses to be the key areas of increased risk of surface water flooding. This dataset has provided a useful tool for identifying potential surface water flowpaths through the areas of search and urban sites put forward by Basildon Borough Council for review as part of this study. Information regarding the appropriate use of this dataset is included in Section 3 of this report.

It is noted that further assessment of the risk of flooding from surface water is being undertaken as part of the Surface Water Management Plan for the Borough which includes pluvial modelling. As part of this work, flood depths and corresponding hazard ratings will be determined across the Borough, and Critical Drainage Areas (CDAs) will be defined. In order to assist with future surface water management, options will be identified for capital schemes that could be considered to alleviate surface water flooding within these CDAs.

Area & Site Assessments

As part of this Level 2 SFRA an assessment has been made of potential development locations identified by Basildon Borough Council with respect to the Environment Agency FMfSW, results from tidal breach modelling and Environment Agency Flood Zones delineating the risk of flooding from fluvial sources. This review is reported in Section 4 and has been undertaken for 24 'areas of search' identified by Basildon Borough Council where the potential for future development may be considered and 9 'urban sites' in which future development is likely to be concentrated.

The flood risk review determined that of the 24 areas of search, 14 are identified to contain areas at risk of fluvial flooding and with an increased risk of surface water flooding. Five of the areas of search have a low risk of flooding from fluvial sources and an increased risk of flooding from surface water. Four sites are not identified to be at risk of fluvial or surface water flooding according to available datasets. One area of search (AS21) is at risk of flooding from the tidal River Thames in the event of a breach in either the Fobbing Horse or Benfleet Creek flood barriers. Parts of this area of search are also identified to be at risk of tidal flooding during the 0.1% AEP event including allowance for climate change to 2110 when the existing flood defences would be overtopped.

Of the nine urban sites identified by Basildon Borough Council, one (Wickford Town Centre) is identified to be at risk of flooding from fluvial sources. The River Crouch passes through Wickford Town Centre and thereby presents a key flood source. Four of the urban sites are identified to be at increased risk of surface water flooding according to the FMfSW and the remaining four sites are not identified to be at risk of flooding according to the datasets used in this assessment.

Recommendations

It is recommended that the advice and guidance provided in the Level 1 SFRA with respect to the application of the Sequential Test and site selection guidance is consulted to inform where future development is allocated within the Borough. Those areas identified to be at low risk of flooding should be preferentially developed prior to consideration of those areas of search and urban sites at greater risk of flooding.

Where development cannot be avoided within Flood Zone 3a, the Exception Test will need to be applied. Section 5 of this report provides guidance on the requirements to satisfy all elements of the Exception Test in accordance with PPS25.

Section 6 provides details on when a site specific Flood Risk Assessment will be required and the requirements of such a report in terms of site and building layout and design and emergency procedures. Where development is proposed in areas at risk of flooding, development control recommendations provided in Section 6 and 7 of this report should be used to determine the safety of the proposed development (in consultation with the councils emergency planners) and to ensure that the proposed development does not increase flood risk to surrounding areas or impact upon the ability of Basildon Borough Council and their emergency services to safeguard the current population.

The information and recommendations contained in Section 7 of this Level 2 SFRA refer to policy, development control and technical issues and should be used to inform local policy specific to Basildon Borough Council to ensure that flood risk considerations are included as part of the LDF process and future strategic planning. It is also recommended that the mapping in this SFRA is used by Basildon Borough Council Emergency Planning Team to continue to inform and update the development of Emergency Response and Evacuation Plans for the existing development and occupants throughout the Borough.

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Glossary of Terms

Annual Exceedance Probability (AEP) - The probability of a storm event of given magnitude or greater occurring in any given year. See entry for 'Return Period' for further details.

Breach of Defences – A structural failure at a flood defence allowing water to flow through.

Climate change - a change in average weather or a change in the distribution of weather events around an average over a period of time e.g. greater or fewer extreme weather events.

Core Strategy - The Development Plan Document which sets the long-term spatial planning vision and objectives for the area. It contains a set of strategic policies that are required to deliver the vision including the broad approach to development.

Development Plan Documents (DPDs) - Spatial planning documents within the Council's Local Development Framework which set out policies for development and the use of land. Together with the Regional Spatial Strategy they form the development plan for the area. They are subject to independent examination. They are required to include a Core Strategy and may include a Site Allocations document, Area Action Plans (if required); and other DPDs as required e.g. for setting out development control policies.

Defra - Department for Environment, Food & Rural Affairs.

Emergency Planning – Planning for and response to emergencies such as flooding, including consideration of the resilience of emergency infrastructure that will need to operate during flood events..

Environment Agency Flood Zones - Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency.

Flood Defence – A man-made structure (e.g. wall, embankment, bund, sluice gate, reservoir or barrier) designed to prevent flooding of areas adjacent to the defence.

Flood Risk Assessment (FRA) – A site specific investigation carried out by site developers to be submitted as part of their planning applications. It assesses both current flood risk to the site and ensures development does not increase flood risk to the site or surrounding areas.

Flood Risk Vulnerability - PPS25 provides a vulnerability classification to assess which uses of land may be appropriate in each flood risk zone.

Flood Zone 1 - Low Probability - Flood Zone comprising land assessed as having a less than 0.1% (1 in 1000) annual probability of river or sea flooding in any one year.

Flood Zone 2 - Medium Probability – Land assessed as having between a 1% (1 in 100) and 0.1% (1 in 1000) annual probability of river flooding or between 0.5% (1 in 200) and 0.1% (1 in 1000) annual probability of sea flooding in any year.

Flood Zone 3a - High Probability – Land assessed as having a 1% (1 in 100) or greater annual probability of river flooding or a 0.5% (1 in 200) or greater annual probability of flooding from the sea in any year.

Flood Zone 3b - Functional Floodplain - Land where water has to be stored or flow in times of flood.

Fluvial Flooding - Flooding from a river or other watercourses.

Formal Flood Defence - A structure built and maintained specifically for flood defence purposes.

Groundwater Flooding - Flooding caused by groundwater escaping from the ground when the water table rises to or above ground level.

Hydrodynamic Model - A computational numerical model able to describe or represent the motion and flow of water.

LiDAR – 'Light Detection and Ranging' is an airborne terrain mapping technique which uses a laser to measure the distance between the aircraft and the ground. It therefore provides accurate topographical/contour mapping.

Local Development Framework (LDF) - The name for the portfolio of Local Development Documents. It consists of the Local Development Scheme, a Statement of Community Involvement, Development Plan Documents, Supplementary Planning Documents, and the Annual Monitoring Report.

Lead Local Flood Authority (LLFA) – Unitary authorities responsibly for implementing the requirements of the Flood and Water Management Act, which gained Royal Assent in April 2010.

Mitigation – where flood risk cannot be avoided or controlled, mitigation measures should be applied to further reduce the risk of flooding and/or minimise the danger and damage caused by flooding to acceptable levels. This could include options such as non-habitable ground floors, resistant and resilient design, flood warning and evacuation plans.

Pluvial Flooding - Usually associated with convective summer thunderstorms or high intensity rainfall cells within longer duration events. Pluvial flooding is a result of rainfall-generated overland flows which arise before run-off enters any watercourse or sewer. The intensity of rainfall can be such that the run-off totally overwhelms surface water and underground drainage systems.

Previously Developed (Brownfield) Land - Land which is or was occupied by a building (excluding those used for agriculture and forestry). It also includes land within the curtilage of the building, for example a house and its garden would be considered to be previously developed land. Land used for mineral working and not subject to restoration proposals can also be regarded as brownfield land.

Residual Risk - The risk which remains after all risk avoidance, substitution and mitigation measures have been implemented, on the basis that such measures only reduce risk and do not eliminate it.

Return Period – Return Period is a statistical measure of how often, on average, an event could occur. It is the inverse of Annual Exceedance Probability (AEP), where AEP is the probability of a storm event of given magnitude or greater occurring in any given year. It should be noted that both return period and AEP are probability measures, so for example an event which has a 5 year return period (or 20% AEP) has a 1 in 5 chance of occurring in any given year, and is expected to occur once every 5 years on average. The on average term is important - just because it has happened one year does not mean it will not occur again for the next 4 years; there is still a 1 in 5 chance each year of the storm, or a larger storm, occurring, but over a long period of time it is expected that a fifth of the years will have had a storm of that magnitude or larger.

Risk Management Authority – As defined by the Flood and Water Management Act, a Risk Management Authority means the Environment Agency; a lead local flood authority; a district council for an area for which there is no unitary authority; an internal drainage board; a water company; and a highway authority.

Run Off - The flow of water, caused by rainfall, from an area which depends on how permeable the land surface is. Run-off is greatest from impermeable areas such as roofs, roads and hard standings and less from vegetated areas – grassland, agricultural and forestry lands.

Storm surge - An offshore rise of water level associated with a low pressure weather system. Water levels rise primarily due to the action of high winds upon the ocean's surface.

Sustainable Development – "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (The World Commission on Environment and Development, 1987).

Sustainable Drainage Systems (SuDs) - A form of drainage that aims to control run-off as close to its source as possible using a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques and to also provide water quality treatment within the drainage control processes.

The Exception Test - If, following application of the Sequential Test, it is not possible (consistent with wider sustainability objectives) to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed, the Exception Test may apply. PPS25 sets out strict requirements for the application of the Test.

The Sequential Test - Informed by a Strategic Flood Risk Assessment, a planning authority applies the Sequential Test to demonstrate that there are no reasonably available sites in areas with less risk of flooding that would be appropriate to the type of development or land use proposed.

Tidal Flooding - Flooding from sources such as the sea, estuaries, or tidal rivers which are caused by higher than normal sea levels and/or high waves resulting in tidal waves overflowing onto the land.

Washland/Flood Storage Area - An embanked area designed to hold floodwaters arising from areas upstream. The floodwaters are released slowly from the embanked area to reduce the risks of flooding downstream.

1 in 100 year event - Event that on average will occur once every 100 years. Also expressed as an event that has a 1% Annual Exceedance Probability (1% probability of occurring in any one year).

1 in 200 year event - Event that on average will occur once every 200 years. Also expressed as an event that has a 0.5% Annual Exceedance Probability (0.5% probability of occurring in any one year).

1 in 200 year design standard - Flood defence that is designed for an event, which has an annual probability of 0.5%. In events more severe than this the defence would be expected to fail or to allow flooding.

1 in 1000 year event - Event that on average will occur once every 1000 years. Also expressed as an event that has a 0.1% Annual Exceedance Probability (0.1% probability of occurring in any one year).

1 Introduction

1.1 Background

1.1.1 URS Scott Wilson Ltd has been commissioned by Basildon Borough Council, in partnership with Rochford District and Castle Point Borough Councils, to produce a Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) in accordance with Planning Policy Statement 25 (PPS25): Development and Flood Risk[3] and its accompanying Practice Guide[4].

1.1.2 This SFRA provides a revision to the Thames Gateway South Essex (TGSE) SFRA which was published in November 2006 under previous national policy Planning Policy Guidance (PPG25) Development and Flood Risk. It was prepared by Scott Wilson Ltd to aid the South Essex Strategic Planning Authorities of Essex County Council, Southend-on-Sea and Thurrock Borough Council and the Local Planning Authorities of Rochford District, Castle Point Borough and Basildon District Council in their planning and development control processes.

1.1.3 Due to differing timescales for the publication of their Local Development Frameworks, Thurrock Council and Southend-on-Sea Borough Council have commissioned separate SFRAs for their administrative areas. It is envisaged however that all the SFRAs are able to be interpreted as a suite of SFRAs for South Essex upon completion in 2011.

1.2 SFRA Structure

1.2.1 PPS25 defines a two staged approach to the completion of a SFRA as follows:

Level 1 – A strategic overview of all potential sources of flooding which is sufficiently detailed to enable the application of the Sequential Test i.e. to steer development towards areas of Low flood risk.

Level 2 – An 'increased scope' SFRA to provide more detail of flood risk where there is development pressure in areas that are at Medium and High risk and to facilitate the application of the Exception Test where necessary.

1.2.2 The Level 1 SFRA for Basildon Borough Council was completed in June 2011. This report comprises an 'increased scope' Level 2 Strategic Flood Risk Assessment for Basildon Borough Council.

1.3 Objectives

1.3.1 The objectives of the **Level 2** SFRA are as follows:

- Undertake hydrodynamic breach modelling to determine the impact of a failure in the Fobbing Horse and Benfleet Creek Flood Barriers for the Basildon Borough study area;
- Provide mapping to illustrate the distribution of flood risk across tidal flood zones to enable a sequential approach to site allocations within Flood Zones;
- Provide mapping of updated Environment Agency surface water flood risk information for the Borough;

[3] CLG (December 2006, revised March 2010) Planning Policy Statement 25: Development and Flood Risk
[4] CLG (June 2008, revised December 2009) Planning Policy Statement 25: Development and Flood Risk

- Provide a review of 'areas of search' and 'urban sites' identified by Basildon Borough Council with respect to flood risk from fluvial, surface water and tidal sources;
- Identify policies and practices required to ensure development satisfies the Exception Test
- Provide guidance on the preparation of site specific Flood Risk Assessments (FRAs);
- Provide meaningful recommendations to inform policy, development control and technical issues.

2 Residual Tidal Flood Risk

2.1 Overview

2.1.1 It has been established in the Level 1 SFRA (June 2011) that a large proportion of the study area is at residual risk of tidal flooding in the event that the existing defences are overtopped or fail.

2.1.2 In accordance with PPS25 and its Practice Guide, part of the requirement of the Level 2 SFRA is to provide an assessment of the residual risk, i.e. the risk remaining after flood risk management measures have been taken into account. As a result, hydrodynamic modelling has been undertaken to model the impact of a failure of the Fobbing Horse and Benfleet Flood Barriers.

2.2 Potential Flooding Mechanisms

2.2.1 Flood defences and barriers are designed and constructed to rigorous structural and geotechnical codes to a specific standard of protection or return period. If these structures are subjected to a loading greater than the standard of protection, there is a significant likelihood that they will fail.

2.2.2 A breach in flood defences is defined as:

> *'The failure of a flood defence mechanism by which the structural integrity of the flood defence is compromised and part or all of the defence collapses allowing water to flow through'.*

2.2.3 Overtopping of defences can be caused when:

> *'Flood waters exceed the lowest crest height of the flood defences or if high winds begin to generate significant swells in the ocean that bring waves crashing over the top of defences'*

2.2.4 There are a number of potential circumstances and mechanisms which may lead to failure of flood defences, such as:

- Floodgate being left open;
- Operational failure at floodgate;
- Hydrostatic water pressure during high tides;
- Vehicle collision;
- Collision of shipping traffic with tidal wall;
- Floating object collision such as a partly submerged shipping container;
- Damage to a pipeline running through a tidal wall;
- Damage or explosion of an installation on the landward side of the tidal wall;
- Geotechnical failure.

2.2.5 Breaches are more likely to occur during high water level events including extreme tides when loads on the defence will be greater, or if a flood defence embankment is overtopped by significant volumes of floodwater.

2.2.6 The time taken for a breach to be blocked can have a major impact on the extent and depth of flood experienced. The highest flood hazard typically exists in the period immediately following a breach and usually, but not necessarily, in the areas closest to a breach.

2.2.7 Flooding as a result of a failure in a flood barrier has the potential to generate considerable flood hazard and damage to homes, businesses and infrastructure, as well as risk to lives.

2.2.8 As part of this SFRA, hydrodynamic modelling has been carried out to assess the impact of this residual risk. A brief overview of the methodology is provided below and a full modelling methodology is provided in Appendix E.

2.3 Tidal Modelling Methodology

Barrier Failure Assessment

2.3.1 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 Vange marshes, on the Holehaven Creek, and the Benfleet barrier, located to the south east of the Bowers marshes, on the Benfleet Creek. These are shown in Figure 2-1.

Figure 2-1 Fobbing Horse & Benfleet Barriers

2.3.2 Data from the National Flood and Coastal Defence Database (NFCDD) has been provided by the Environment Agency for the study area. Information regarding the standard of protection afforded by the tidal flood defences identifies that the southern portion of the Borough is protected to a design standard of 0.1% AEP (1 in 1000 year event).

2.3.3 Modelling has been undertaken to simulate the impact of a failure of each of these barriers, the locations and reference numbers of which are shown in Table 2-1.

Table 2-1 Breach Names and Characteristics

Code	Breach Name	Easting	Northing	Breach Width [m]
BAS01/CAS	Flood Barrier, Fobbing Horse, Vange Creek	574045	184305	45
CAS08	Benfleet Creek Flood Barrier	578068	185605	50

2.3.4 The following flood events were simulated for each of the breach locations:

- 0.5% AEP (1 in 200 annual probability) present day, 2010
- 0.5% AEP (1 in 200 annual probability) with climate change, 2110
- 0.1% AEP (1 in 1000 annual probability) present day, 2010
- 0.1% AEP (1 in 1000 annual probability) with climate change, 2110

Overtopping

2.3.5 Unlike the Thames Gateway South Essex SFRA (2006), hydrodynamic modelling has been undertaken in order to assess the impact of overtopping of the existing flood defences, without consideration of a failure in the flood barriers. The following flood events were simulated:

- 0.1% AEP (1 in 1000 annual probability) present day, 2010
- 0.1% AEP (1 in 1000 annual probability) with climate change, 2110

2.3.6 A detailed description of the modelling methodology is included in Appendix E. The following section describes the generation and mapping of the outputs from the hydrodynamic modelling.

2.4 Modelling Outputs

Maximum Flood Depth

2.4.1 The flood depth maps included in Appendix B 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.

2.4.2 The peak depth will occur at different times depending upon the location of the model under consideration. For example, immediately adjacent to the barrier, the peak depth will be experienced around the same time as the time at which the tidal water level boundary peaks. However peak depths inland will be experienced at a later time when water has spread further throughout the model. The flood depth map therefore presents a worst case scenario.

2.4.3 Figures B-1 to B-4 in Appendix B show the maximum flood depth for both of the modelled barrier failure scenarios. These maps show that during the 0.5% AEP event for 2010, floodwaters inundate parts of Pitsea Marsh and Bowers Marsh to depths of approximately 0.5m. During the 0.1% AEP modelled event, with allowance for climate change to 2110, the extent of the flooding is much greater, affecting the Vange Marsh to depths of 3m and, Pitsea Marsh and Bowers Marsh to depths of up to 2m. In general, the deeper flood depths correlate with the locations of the creek channels where the level of the channel bed is lower than the surrounding land.

2.4.4 Figures B-5 and B-6 show the maximum flood depths as a result of overtopping of the existing defences. The mapping shows that during the 0.5% AEP event with allowance for climate change to 2110, none of the study area is affected by this type of flooding. During the 0.1% AEP with allowance for climate change to 2110, depths of up to approximately 2m are modelled to occur in the Vange Marshes. The results of this modelling highlight the important function the marshlands play in storage of tidal floodwaters and the protection of urban areas in the Borough.

Hazard Rating

2.4.5 Flood hazard is a function of the flood depth and flow velocity at a particular point in the floodplain. Each element within the model is assigned one of four hazard categories 'Extreme Hazard', 'Significant Hazard', 'Moderate Hazard', and 'Low Hazard'.

2.4.6 The derivation of these categories is based on the methodology in Flood Risks to People FD2320[5] using the following equation:

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

Where v = velocity (m/s)

D = depth (m)

DF = debris factor

2.4.7 The depth and velocity outputs from the hydrodynamic modelling are used in this equation, along with a suitable debris factor. For this SFRA, a precautionary approach has been adopted inline with FD2320; a debris factor of 0.5 has been used for depths less than and equal to 0.25m, and a debris factor of 1.0 has been used for depths greater than 0.25m.

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

2.4.8 Figures C-1 to C-4 in Appendix C are composite maps showing the maximum flood hazard rating for both of the modelled barrier failure simulations. These maps show that during the 0.5% AEP event for 2010, floodwaters inundate parts of Pitsea Marsh and Bowers Marsh resulting in a hazard rating of Low to Significant. During the 0.1% AEP event, with allowance for climate change to 2110, the extent of the flooding is much greater, resulting in an Extreme hazard rating for the Vange Marsh and Significant for the Pitsea Marsh and Bowers Marsh.

2.4.9 Figures C-5 and C-6 show the flood hazard as a result of overtopping of the defences. The mapping shows that during the 0.5% AEP event with allowance for climate change to 2110, none of the study area is affected by flooding from this source. However, during the 0.1% AEP event with allowance for climate change to 2110, the hazard rating for the Vange Marshes is Extreme, primarily due to the depth of flooding modelled to occur.

Time to Inundation

2.4.10 The time taken for floodwaters to propagate from the breach location has also been mapped using the following methodology. This information is useful for assessing the length of time

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

before floodwaters reach a particular site and therefore the time available for evacuation to a place of safety.

2.4.11 Time zero is set to the time when the barrier fails in the model. This means that the <1 hour band encompasses all areas that are inundated (wet) within the first hour of water travelling through the breach and into the flood cell. Further bands have been produced to show wet cells at: 1-4 hours, 4-8 hours, 8-12 hours, 12-16 hours and 16-20 hours.

2.4.12 Time to inundation is specific to each breach location; therefore mapping of each of the 2 breach locations in the study area is provided in Appendix D. Mapping has been provided for the 0.1% AEP event plus climate change to 2110 event and the 0.5% AEP event plus climate change to 2110 event. The 0.1% AEP event plus climate change to 2110 represents the most conservative scenario and should be used for emergency planning purposes. Lower return period events including scenarios for present day scenarios are likely to lead to a lower time to inundation across the flood cells.

2.4.13 Figure D-1 shows that during the 0.5% AEP event with climate change to 2110, the failure of the Fobbing Horse Barrier (BAS01/CAS) leads to flooding of the majority of Vange Marsh within 1 hour, the Pitsea Marsh within 1-4 hours and the Bowers Marsh within 4-8 hours. The edge of the flood extent area is then affected some 8-16 hours later. The time to inundation is similar for the 0.1% AEP event with climate change to 2110 (shown in Figure D-3).

2.4.14 Figure D-2 shows that during the 0.5% AEP event with climate change to 2110, the failure of the Benfleet Barrier (CAS08) leads to flooding of the Bowers Marsh and Pitsea Marsh within 1-4 hours. The Vange Creek does not experience flooding during this modelled scenario. During the 0.1% AEP event with climate change to 2110, the Bowers Marsh and Pitsea Marsh experience flooding within 1-4 hours and floodwaters reach the Vange Marsh 4-8 hours after the modelled failure of the barrier. The edge of the flood extent area is then affected some 8-16 hours later. This is shown in Figure D-4.

2.5 Limitations

Flood Depth and Hazard Rating

2.5.1 It should be noted when using flood hazard zone maps that they **represent the hazard arising from one or more specific breach locations, and that the hazard will almost certainly vary spatially if the breach locations are moved.** This is also the case for the flood depth maps and time to inundation maps.

2.5.2 Other limitations that should be noted include:

- Not all possible breach locations have been considered. The modelling study had to be limited to those locations thought most likely to lead to flood risk for specific development areas.
- Breach width and depth, though based on Environment Agency guidance, are arbitrary and do not necessarily represent the actual dimensions of a possible breach in a given location.
- Changes in inundation extent or hazard zone are non-linear to changes in breach location.
- Hazard mapping is developed as a product of the depth, velocity and a debris factor from a particular breach event or combined breach event within a given flood cell. These hazard classifications do not indicate a change in the flood probability.

Time to Inundation

2.5.3 The values presented for time to inundation are indicative only. The modelling methodology used for this study produces results from a breach occurring prior to the second and largest tidal cycle. This allows water to overtop where defences are below the water level during the first tidal cycle. The modelling method also allows the rapid inundation of land immediately behind the breach where water has accumulated on the seaward side of the breach.

Table 2-3 Summary of Current and Future Risk of Flooding

2011 (Current Risk Situation) (0.5% AEP Event)			
Location	**Flood Depth** (Figure B-1 Composite Breach & Overtopping and Figure Composite Overtopping)	**Flood Hazard** (Figure C-1 Composite Breach and Figure Composite Overtopping)	**Time to Inundation 0.5% to 2110** (Breach at Fobbing Horse Figure D-1 and Breach at Benfleet Figure D-2)*
Bowers Marsh	Breach Flood Depth 0.5m No Overtopping flooding	Breach – Low, Moderate to Significant Flood Hazard	1-4 hours to inundation (Failure of Benfleet Barrier)
Pitsea Marsh	Breach Flood Depth 0.5m No Overtopping flooding	Breach – Low, Moderate to Significant Flood Hazard	1-4 hours to inundation (Failure of Benfleet Barrier)
Vange Marsh	No flooding caused by a breach or overtopping at either location (Fobbing Horse Barrier or Benfleet Barrier)	Benfleet Breach – no flooding Fobbing Horse Breach - no flooding Overtopping – no flooding	1 hour (Failure of Fobbing Horse Barrier. Note failure at Benfleet Barrier leads to no inundation at Vange Marsh in this scenario)

* Please note that Time to Inundation is only modelled for the 0.5% event including allowances for climate change to 2110. Present day Time to Inundation is not available.

2110 (Future Risk Scenario) (0.1% AEP Event)			
Location	**Flood Depth** (Figure B-4 Composite Breach & Overtopping and Figure B-6 Composite Overtopping)	**Flood Hazard** (Figure C-4 Composite Breach and Figure C-6 Composite Overtopping)	**Time to Inundation** (Breach at Fobbing Horse Barrier Figure D-3 and Breach at Benfleet Barrier Figure D-4)
Bowers Marsh	Breach Flood Depths 2m No overtopping flooding	Breach - Significant Flood Hazard Overtopping – No hazard	1-4 hours to inundation (Failure of Benfleet Barrier)
Pitsea Marsh	Breach Flood Depths 2m No overtopping flooding	Breach - Significant Flood Hazard Overtopping – No hazard	1-4 hours to inundation (Failure of Benfleet Barrier)
Vange Marsh	Breach Flood Depths 3m Overtopping Flood Depths 2m	Breach - Extreme Flood Hazard Overtopping – Extreme Flood Hazard	<1hour to inundation (Failure of Fobbing Horse Barrier)

3 Surface Water Flood Risk

3.1 Environment Agency Flood Map for Surface Water (FMfSW)

3.1.1 Since the completion of the Level 1 SFRA, a new dataset has been made available by the Environment Agency regarding the risk of surface water flooding.

3.1.2 The Flood Map for Surface Water (FMfSW) gives an indication of the broad areas within the Borough of Basildon that are likely to be at risk of surface water flooding. The document entitled 'Using Surface Water Flood Risk Information' (November 2010) explains how Environment Agency Surface Water Flood Risk Information can be used by local planning authorities (LPAs) to help fulfil their planning role as well as local resilience forums (LRFs) and regional resilience teams (RRTs) to help plan their emergency response to surface water flooding; and lead local flood authorities (LLFAs) to help fulfil their local flood risk management role. This work should be completed in partnership with other risk management authorities including the Highways Agency and Water Utilities to improve the understanding of local flood risk.

3.1.3 The FMfSW maps are not suitable for identifying whether an individual property will flood, neither is the intended to be definitive. Rather the FMfSW provides information to support local flood risk management in the absence of any better information.

3.1.4 The FMfSW better represents the mechanisms that cause surface water flooding and provides a further level of detail than the 2009 Areas Susceptible to Surface Water Flooding (AStSWF) map used for the Level 1 SFRA in the following ways:

- Improved ground and surface data in many areas – using 'local' data
- Sewer flow now represented – using a single 'national' figure
- Infiltration now represented – using 'national' figures
- Storm duration more representative – using a single 'national' figure
- Buildings now included – using 'local' data
- Two storm likelihoods now mapped
- Different roughness figures for urban and rural now included – using 'national' figures

Mapping

3.1.5 The FMfSW has been prepared for two return periods. The 0.5% AEP (1 in 200 year annual probability) and the 3.3% AEP (1 in 30 year annual probability).

3.1.6 The FMfSW has been mapped in Figures A-3 to A-6. For each return period, areas at increased risk of surface water flooding have been mapped depending on the depth of flooding experienced. Two categories have been used; shallow, relating to flood depths between 0.1m and 0.3m, and deep, which refers to depths >0.3m.

	Shallow >0.1m
	Deep >0.3m

Figure 3-1 Legend for FMfSW

3.1.7 The FMfSW has been used to assess the risk of surface water flooding to the urban sites and 'areas of search' that are being considered by Basildon Borough Council as part of their LDF process. The assessment is provided in Section 4.

Limitations

3.1.8 When using the FMfSW, the Environment Agency have stated that LPAs should not:

- Use the Environment Agency surface water flood maps as the sole evidence for any specific planning decision at any scale without further supporting studies or evidence;
- Use the Environment Agency surface water flood maps to identify individual properties at risk of surface water flooding;
- Rely on the Environment Agency surface water flood maps alone to show expected areas of surface water flooding;
- Interpret the Environment Agency surface water flood maps as defining the flood extent for a specific probability;
- Use the Environment Agency surface water flood maps for screening planning applications for consulting with the Environment Agency;
- With respect to mapping, the FMfSW layers should only be published or provided externally with an OS base map scale of 1:25,000 or smaller (i.e. 1:50,000 is ok, 1:10,000 is not) and with a zoom scale of 1:10,000 or smaller (i.e. 1:50,000 is ok, 1:5,000 is not).

3.1.9 Due to the way they have been produced and the fact that the extents are indicative, the Environment Agency surface water flood maps are not appropriate to act as the sole evidence for any specific planning decision (such as objecting to a planning application) at any scale without further supporting studies or evidence.

3.2 South Essex Surface Water Management Plan

3.2.1 As noted in the Level 1 SFRA, pluvial modelling using Tuflow software is currently being undertaken for the Borough as part of the South Essex Surface Water Management Plan (SWMP). This modelling will provide information on the flood depths and hazard ratings associated with surface water flood risk, going above and beyond the EA's FMfSW. However for the purposes of the Level 2 SFRA, the FMfSW is considered suitable to inform a screening of the urban sites and 'areas of search', bearing in mind the purposes for which this dataset has been prepared (paragraph 3.1.8).

4 Area & Site Assessments

4.1 Background

4.1.1 Basildon Borough Council has identified 24 'Areas of Search' (AS) within the rural areas of the Borough where the potential for future development may be considered, subject to policy review. The Council have also identified 9 'urban sites' (US) in which future development is more likely to be pursued in the future given their more sustainable locations within the existing urban areas and the limited policy constraints which affect them. The purpose of this Section is to provide a screening assessment of the AS and US that have been identified with respect to flood risk from fluvial, surface water and tidal flood sources to inform site selection in future LDF documents. It is noted that the background information regarding the risks of groundwater and sewer flooding is provided in the Level 1 SFRA.

4.2 Areas of Search

4.2.1 Tables 4-3 – 4-26 provide an assessment of each of the 24 AS within the study area. *AS21 is the only area of search that is at risk of flooding from tidal sources. As such 6 additional maps to illustrate this risk are included to inform the assessment of this area.*

4.2.2 As part of this assessment, a matrix has been included which identifies which types of development are permitted within each Flood Zone in accordance with the flood risk vulnerability classifications set out in PPS25. Table 4-1 provides a summary of the definitions of each Flood Zone and Table 4-2 defines the flood risk vulnerability classification for different types of development.

Table 4-1 Flood Zone Definitions (Table D.2 PPS25, CLG 2010)

Flood Zone	Fluvial Flood Zone Definition	Probability of Flooding
Flood Zone 1	Land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (less than 0.1%).	**Low**
Flood Zone 2	Land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding in any year (between 1.0% and 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding in any year (between 0.5% and 0.1%)	**Medium**
Flood Zone 3a	Land assessed as having a 1 in 100 or greater annual probability of river flooding in any year (greater than 1.0%) or a 1 in 200 or greater annual probability of sea flooding in any given year (greater than 0.5%)	**High**
Flood Zone 3b	The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions between the Local Planning Authority and the Environment Agency.	**Functional Floodplain**

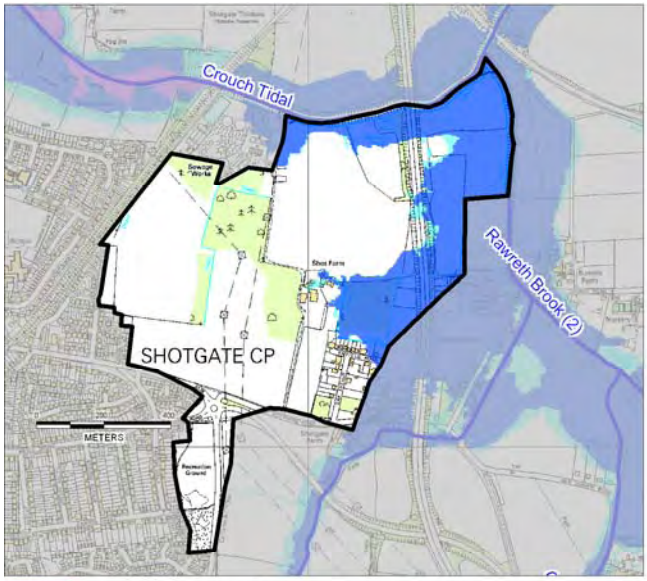
Table 4-2 PPS25 Table D.2 Flood Risk Vulnerability Classification (CLG 2010)

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 critical operational reasons, including electricity generating power stations and grid and primary substations; water treatment plants; and sewage treatment plants if adequate measures to control pollution and manage sewage during flooding events are in place. • 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.[6] (Where there is 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 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 workings. • 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.**

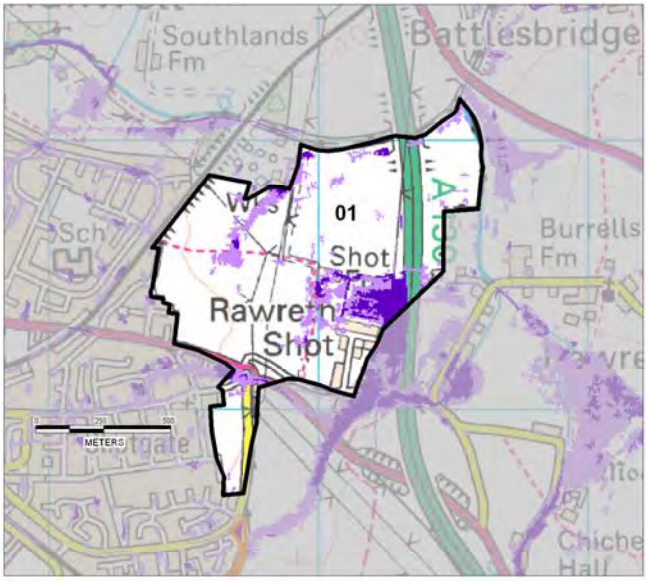
[6] DETR Circular 04/00, paragraph 18: *Planning controls for hazardous substances.* See www.communities.gov.uk/index.asp?id=1144377

Table 4-3 Area of Search No. 1 – Rawreth Shot

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
84	63.2	75.2%	1.2	1.4%	-*	-	19.6	23.3%	-	-

** Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.*

The Rawreth Brook flows from northwards to the east of the AS, and meets the River Crouch, which is tidally influenced at this location. The majority of this area (75%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources; 23% of the area is defined as Flood Zone 3a – High Probability of flooding from fluvial and tidal sources.

Permissible Development Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. In the areas of Flood Zone 3a, Less Vulnerable and Water Compatible development is permitted, Highly Vulnerable development is not permitted, and Essential Infrastructure and More Vulnerable development is only permitted subject to the satisfaction of the Sequential Test and Exception Test.

Mitigation Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

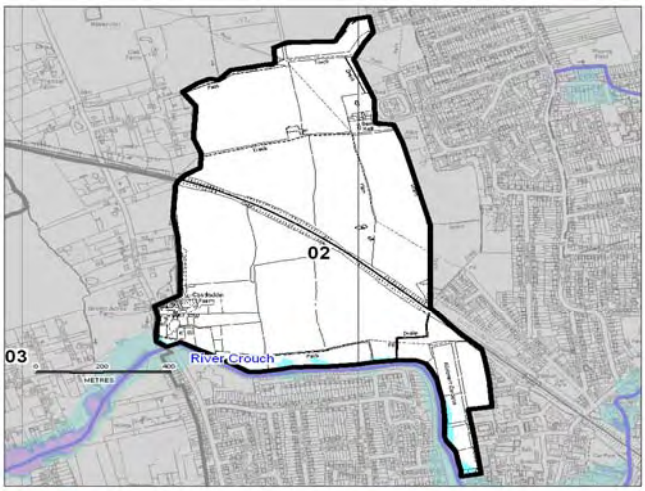
The Environment Agency operates a Flood Warning system which should be monitored by occupants of this AS.

Surface Water Flood Risk The area to the west of the A130 is shown to be at increased risk of surface water flooding on the Environment Agency FMfSW.

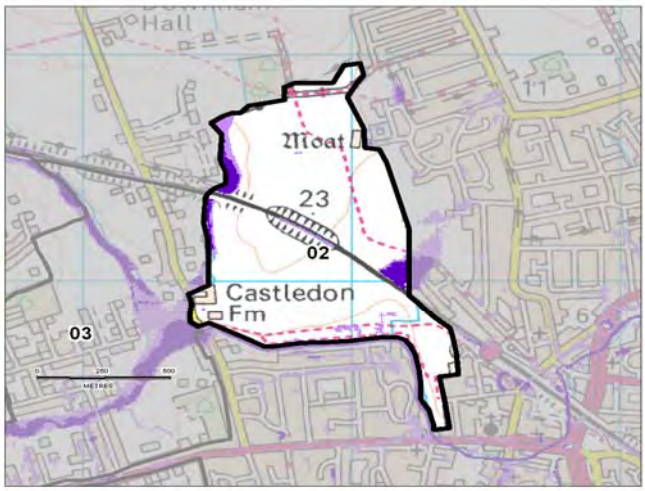
Mitigation The design of a drainage strategy for the wider area should be considered early in any masterplanning stage to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-4 Area of Search No. 2 – Castledon

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
81	79.9	98.6%	1.1	1.4%	-*	0.0%	0	0.0%	-	0.0%

** Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.*

The River Crouch flows eastwards along the southern edge of this AS. The vast majority of this area (99%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources associated with the River Crouch.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1 and therefore will satisfy the requirements of the Sequential Test. The Exception Test will not be required.

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the AS should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this AS.

Surface Water Flood Risk

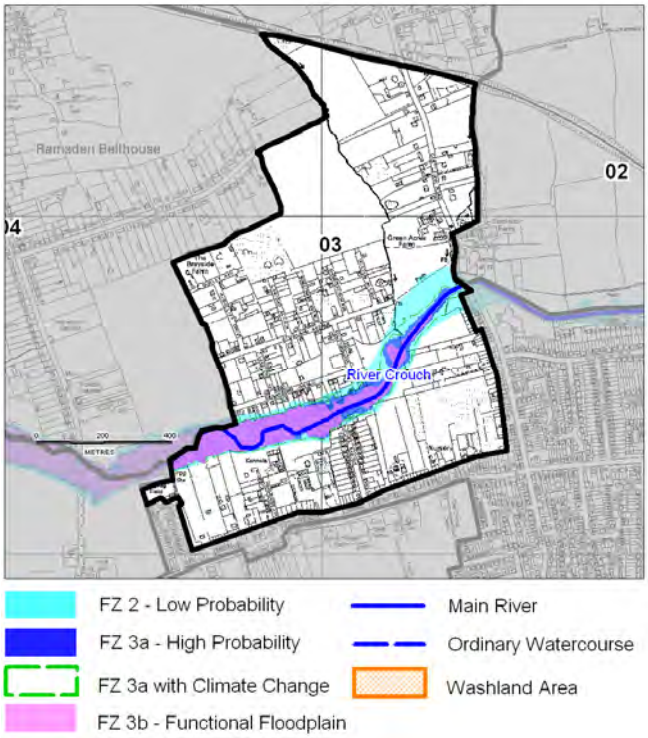
The Environment Agency FMfSW identifies land to the north of the railway line to be at increased risk of surface water flooding. Surface water is shown to pond behind the embankments associated with the railway line.

Mitigation

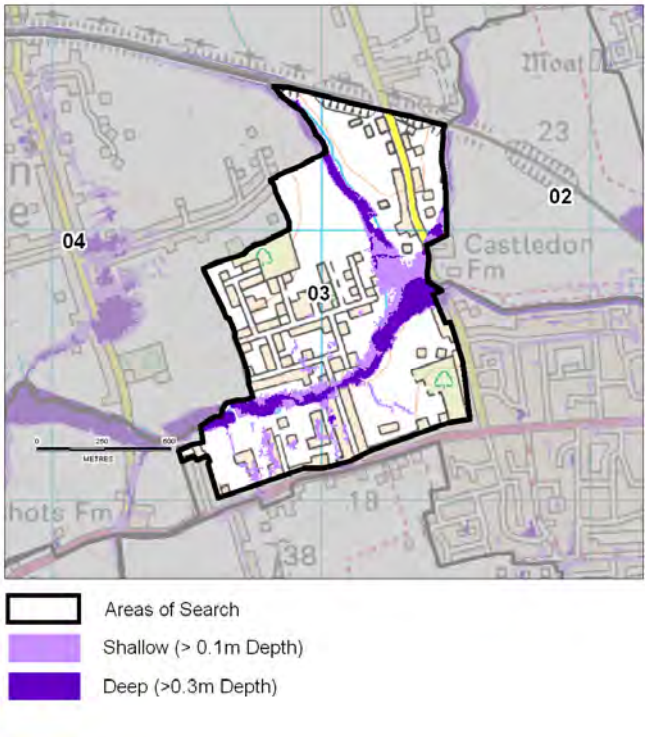
The design of a drainage strategy for the wider area should be considered early in the any masterplanning stage for any future development in the area to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-5 Area of Search No. 3 – Green Acres

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
96	84.8	88.4%	3.5	3.6%	1.2	1.2%	1.4	1.4%	5.2	5.4%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The River Crouch passes through the centre of this AS. The majority of this AS (85%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources; 5% of the AS is defined as Flood Zone 3b Functional Floodplain.

Permissible Development Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. In the areas of Flood Zone 3a, Less Vulnerable and Water Compatible development is permitted, Highly Vulnerable development is not permitted, and Essential Infrastructure and More Vulnerable development is only permitted subject to the satisfaction of the Sequential Test and Exception Test.

Mitigation Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

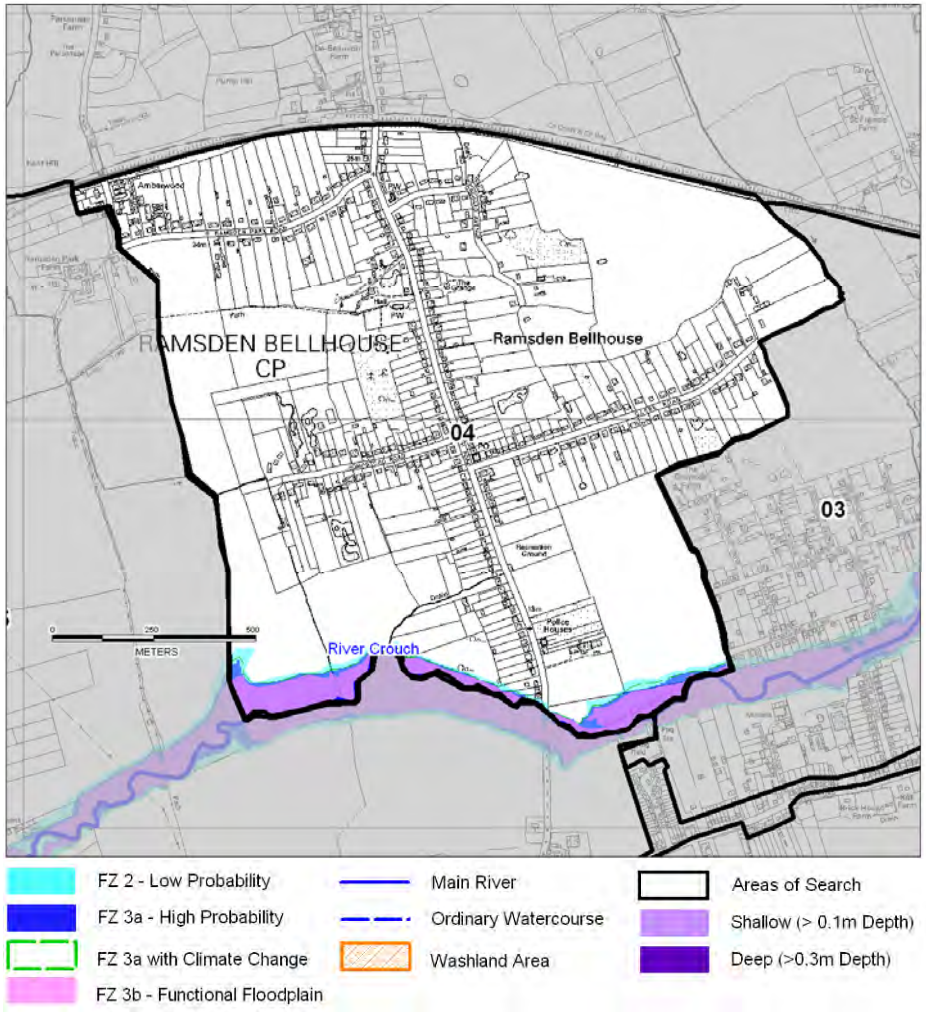
Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.
Any loss to the storage in the fluvial floodplain as a result of proposed development will need to be compensated for on a level for level and volume for volume basis within the development.
The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk The Environment Agency FMfSW identifies a surface water flow path through Green Acres Farm that feeds into the River Crouch.

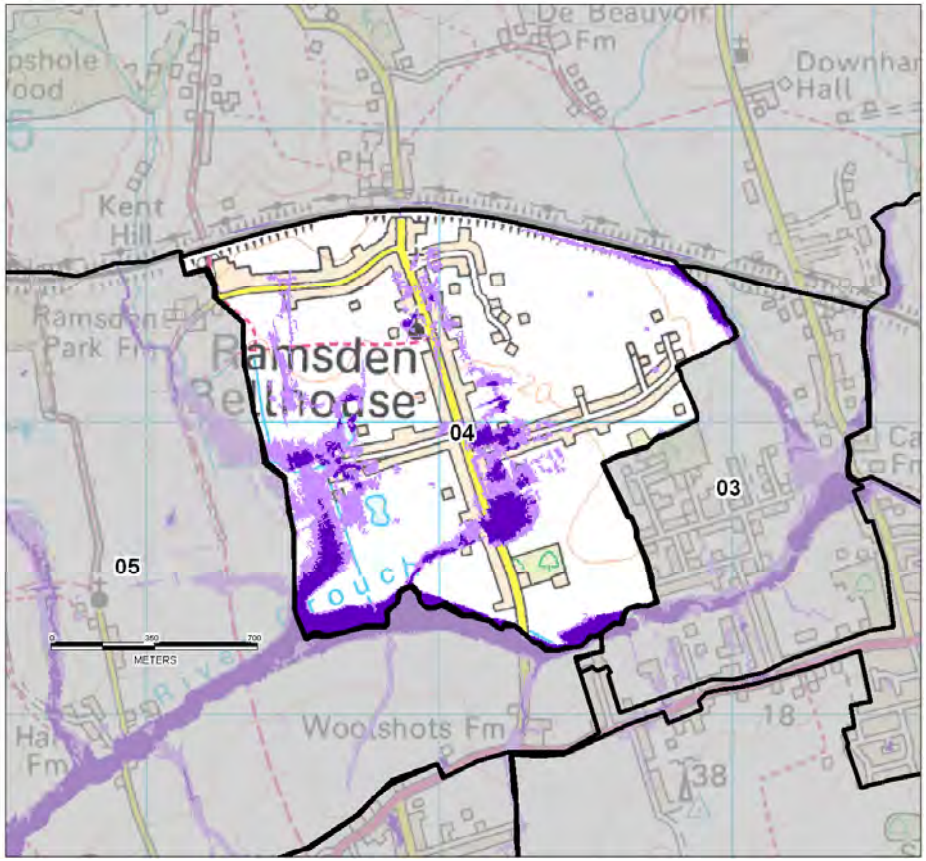
Mitigation The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-6 Area of Search No. 4 – Ramsden Bellhouse

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
188	181.1	96.3%	1.2	0.6%	0.3	17.2	3.9%	0.4%	4.7	2.5%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The River Crouch flows eastwards along the southern edge of this AS. The majority of this AS (96%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial; 2.5% of the AS is defined as Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix shows which types of development are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of proposed development will need to be compensated for on a level for level and volume for volume basis within the development area.

The Environment Agency operates a Flood Warning system which should be monitored by occupants within this area.

Surface Water Flood Risk

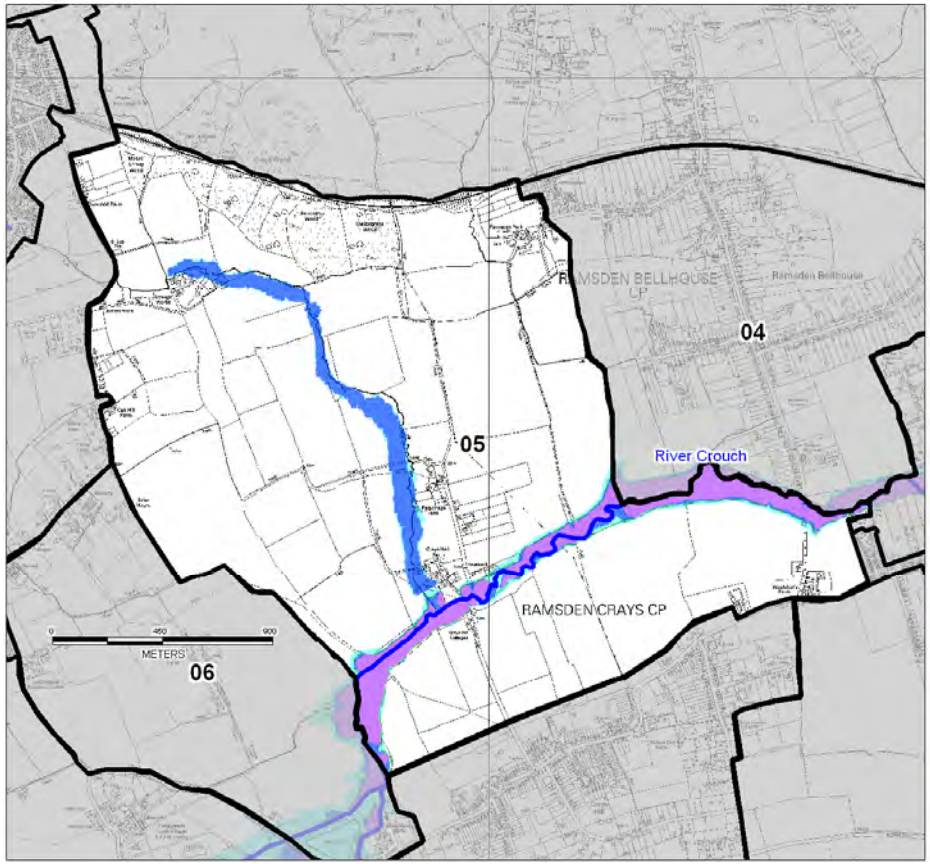
The Environment Agency FMfSW identifies parts of this area of search to be at increased risk of surface water flooding. Surface water flowpaths are identified flowing from north to south through the area which feed into the River Crouch. Ponding of surface water to depths of greater than 0.3m is shown adjacent to Church Road and Homestead Road, Ramsden Bellhouse and within the rural land in the south west of the area.

Mitigation

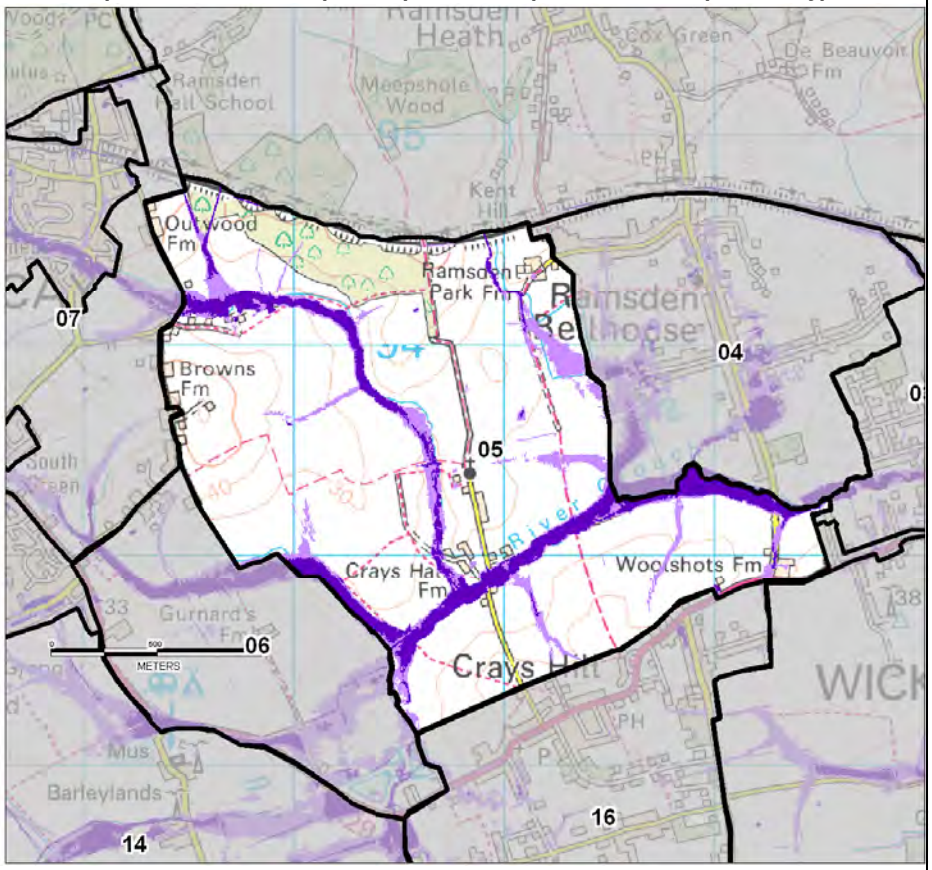
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage of any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-7 Area of Search No. 5 – Ramsden Crays

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
446	407.1	91.3%	5.5	1.2%	1.0	3.8	2.7%	3.4%	17.2	3.9%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The River Crouch flows eastwards through the AS and is adjoined by a small watercourse which drains the northern part of the area. The majority of this AS (91%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 1.2% of the area is defined as Flood Zone 2 – Medium Probability; 3.4% of the area is defined as Flood Zone 3a – High Probability; and 4% of the area is defined as Flood Zone 3b Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies which types of development are permitted in each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

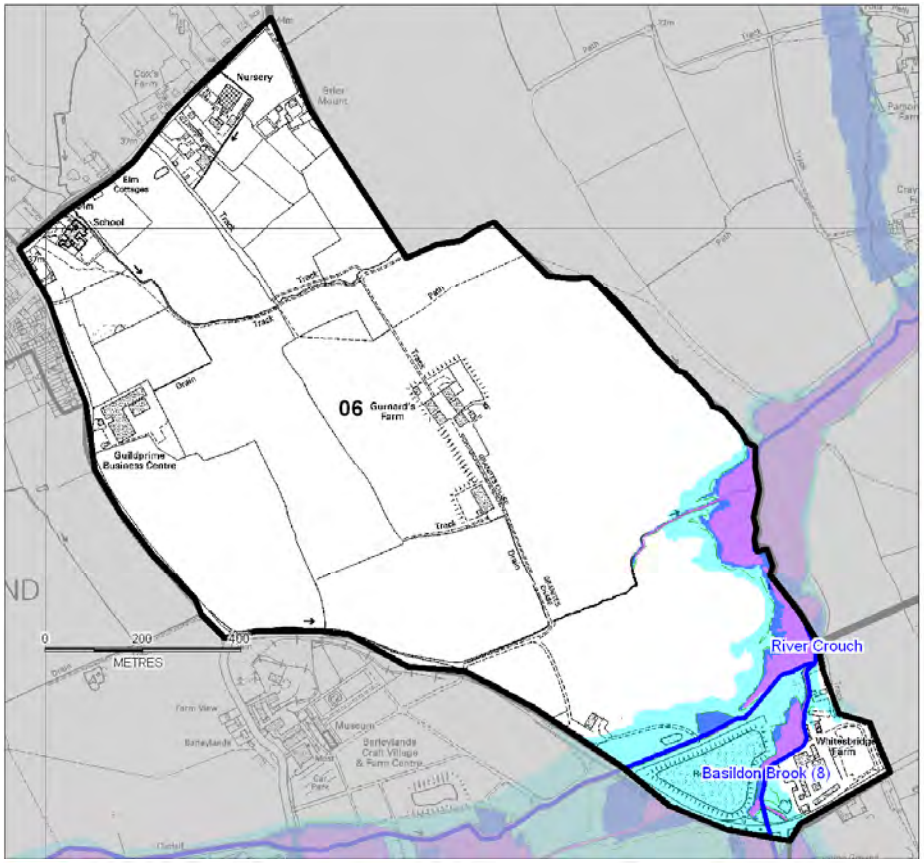
The Environment Agency FMfSW identifies parts of this area to at increased risk of surface water flooding. Surface water flow paths are identified around Outwood Farm, Gurnard's Farm and Ramsden Park Farm that feed into the fluvial watercourses in the area.

Mitigation

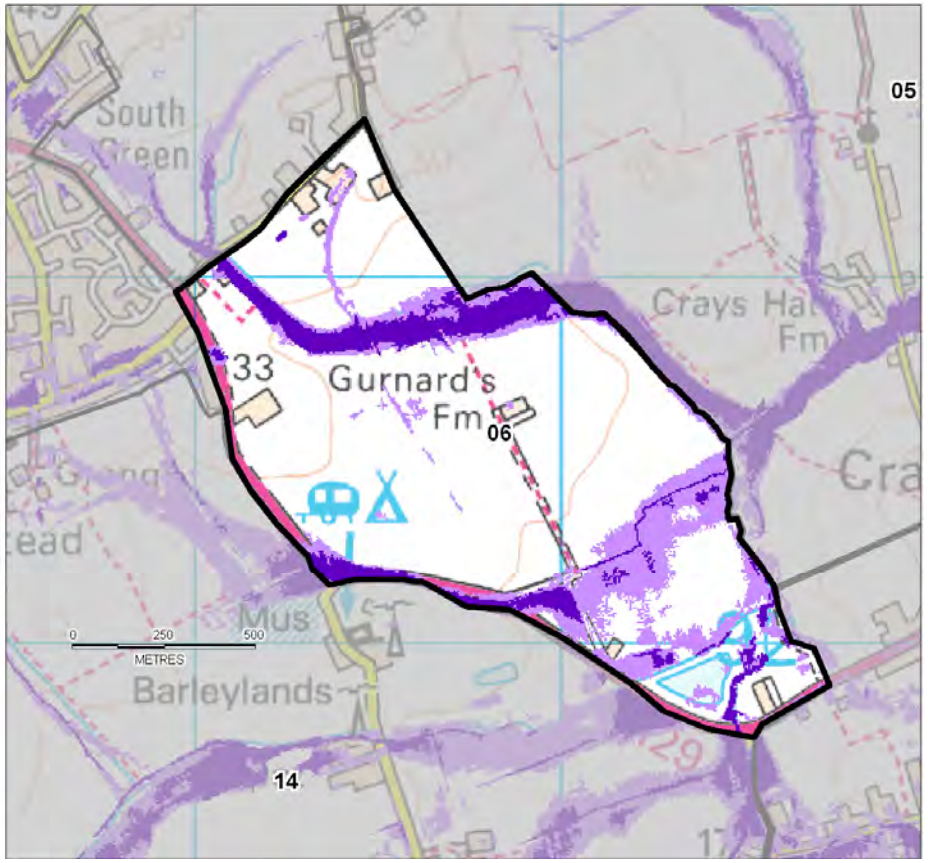
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage of any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-8 Area of Search No. 6 – Gurnard's Farm

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
139	123.9	89.1%	9.7	7.0%	0.6	0.0	0.0%	0.8%	3.8	2.7%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The River Crouch flows eastwards through the south eastern part of the AS and is joined by the Basildon Brook. The majority of this AS (89%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 7% is defined as Flood Zone 2 – Medium Probability; 1% is defined as Flood Zone 3a – High Probability; and 2.7% is defined as Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies which development vulnerability classifications are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

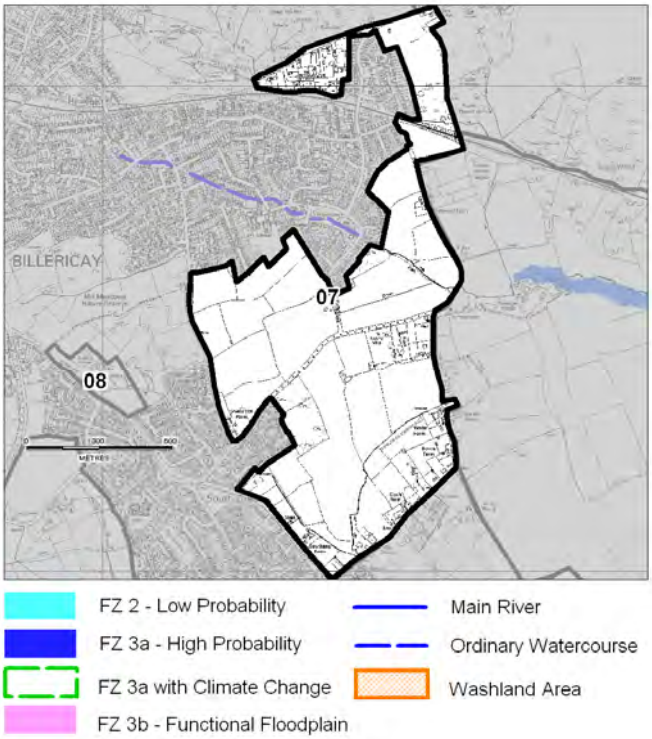
The Environment Agency FMfSW identifies that parts of this area are at increased risk of surface water flooding. A key flowpath is identified through Gurnard's Farm as well as along the field boundary adjacent to the River Crouch fluvial river channel.

Mitigation

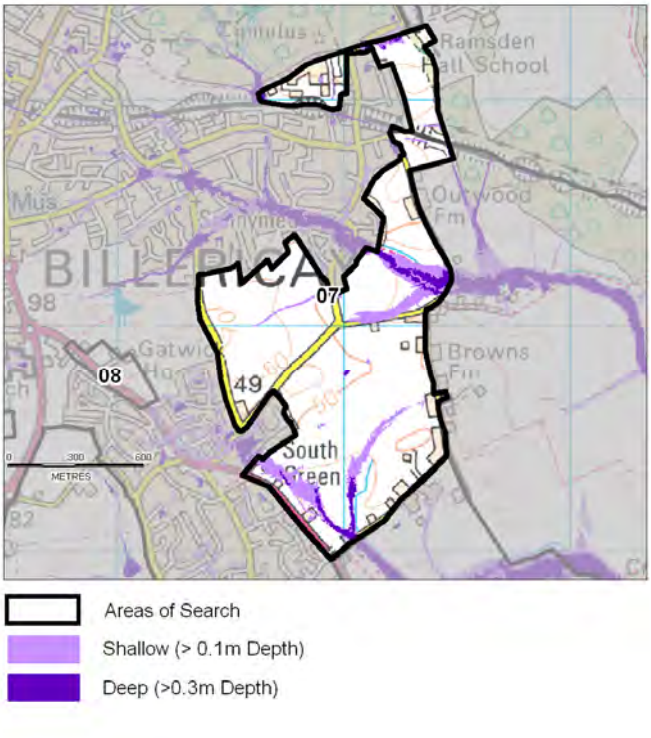
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage of any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-9 Area of Search No. 7 – East Billericay

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
127	127.0	100.0%	0.0	0.0%	0.0	0.0	0.0%	0.0%	0.0	0.0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

A small ordinary watercourse flows eastwards through this AS, however there are no flood zones associated with this watercourse and as such the area is defined as 100% Flood Zone 1 – Low Probability of flooding from fluvial sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1and therefore will satisfy the requirements of the Sequential Test. The Exception Test will not be required.

Mitigation

Any future development within the area should be set back from the ordinary watercourse to mitigate the risk of flooding.

Surface Water Flood Risk

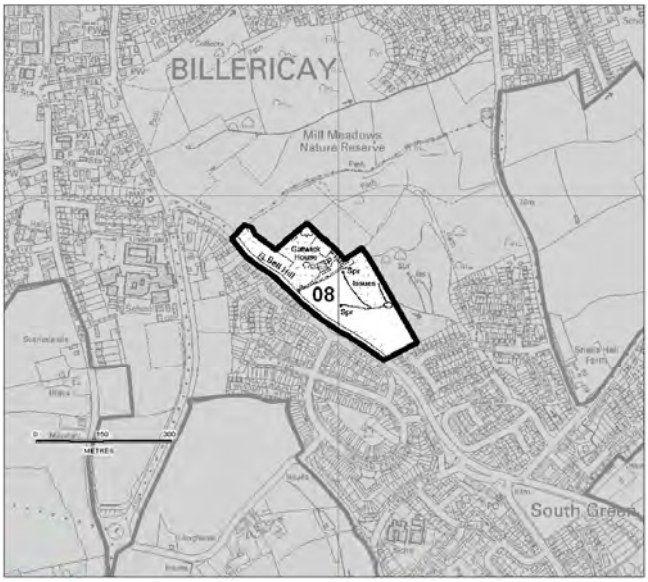
The course of the drainage ditch is identified in the Environment Agency FMfSW. Surface water flowpaths and areas of ponding are also shown in South Green in the south of this area of search.

Mitigation

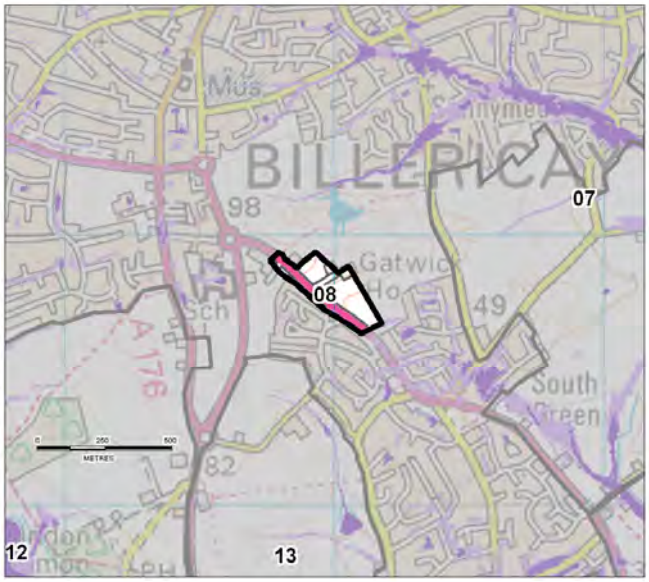
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage of any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-10 Area of Search No. 8 – Southend Road, Billericay

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
5	5.0	100.0%	0.0	0.0%	0.0	-	-	0.0%	0.0	0.0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

There are no fluvial watercourses or tidal water bodies within proximity to this AS. The AS is therefore entirely defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1 and therefore will satisfy the requirements of the Sequential Test. The Exception Test will not be required.

Surface Water Flood Risk

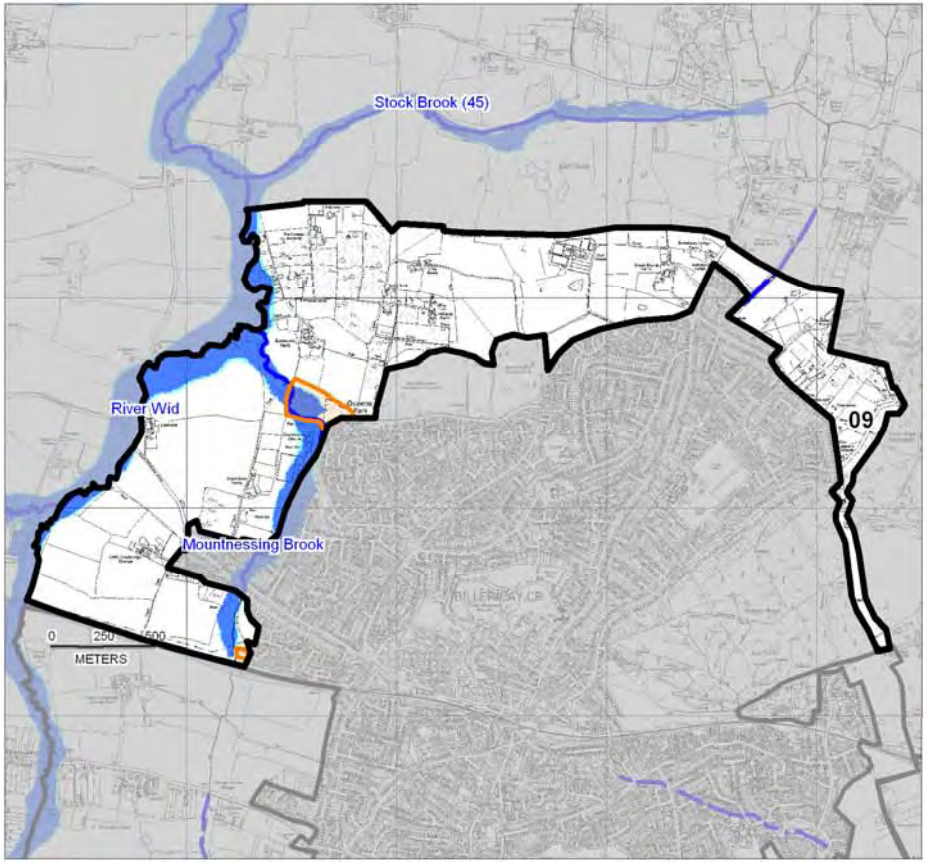
The Environment Agency FMfSW does not identify the area to be at increased risk of surface water flooding however this does not exclude the risk of surface water flooding on the site. An assessment of the risk of surface water flooding should be made during the preparation of a site specific FRA for any future development in this area. The findings of the South Essex Surface Water Management Plan should also be consulted in relation to this area.

Mitigation

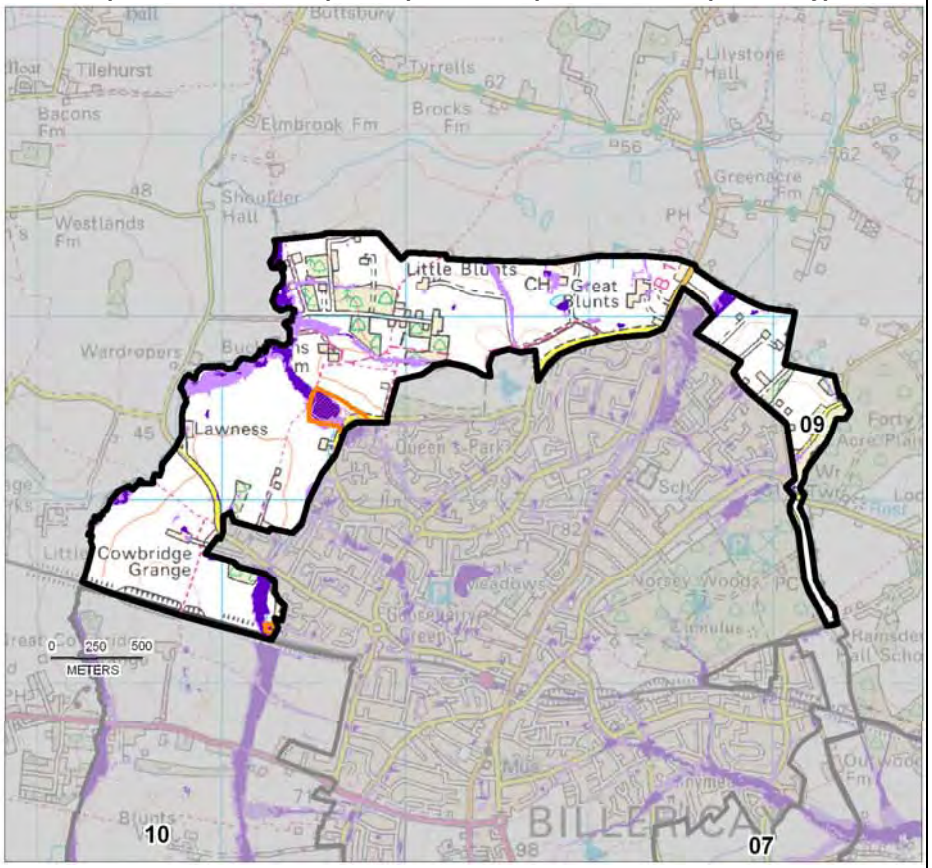
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-11 Area of Search No. 9 – North Billericay

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
299	274.5	91.8%	5.5	1.9%	-	-	19	6.3%	-	-

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The Mountnessing Brook and the River Wid flow northwards through this AS. The majority of this AS (92%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 2% is defined as Flood Zone 2 – Medium Probability; and 6% of the area is defined as Flood Zone 3a – High Probability of flooding from fluvial sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone. Refer to section 6.7 for guidance on washland areas.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

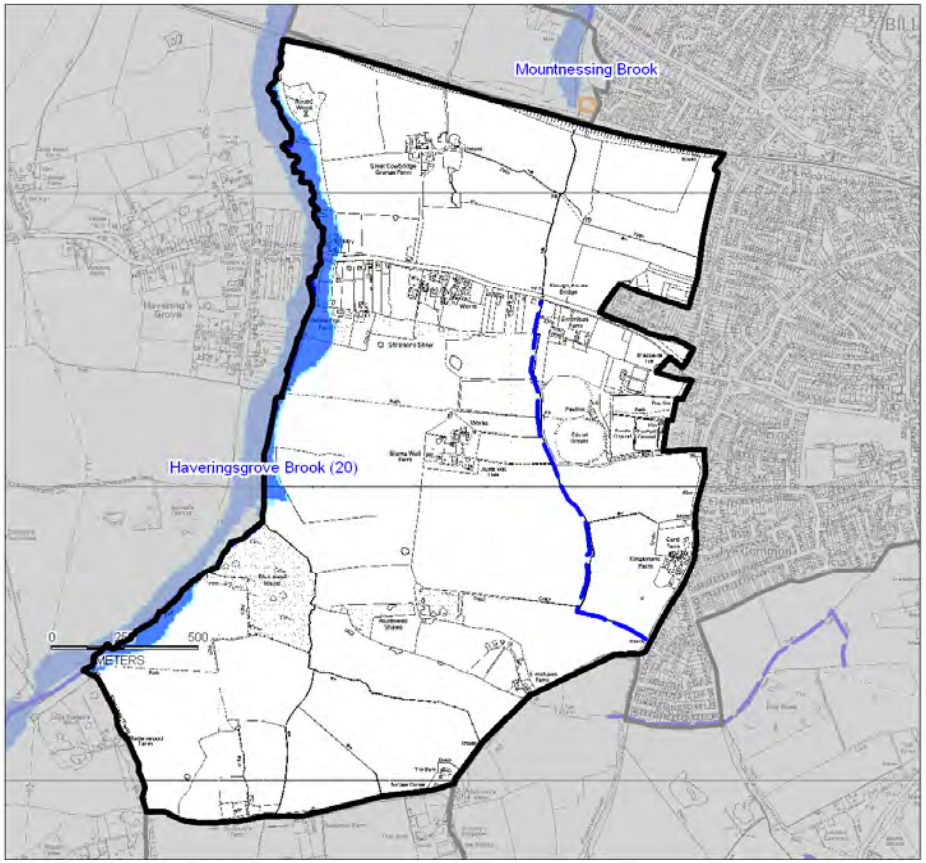
The Environment Agency FMfSW identifies several locations within this area to be at increased risk of surface water flooding. In the main, these locations coincide with areas defined as fluvial Flood Zones however the area around Great Blunts is also shown to be at increased risk of surface water flooding.

Mitigation

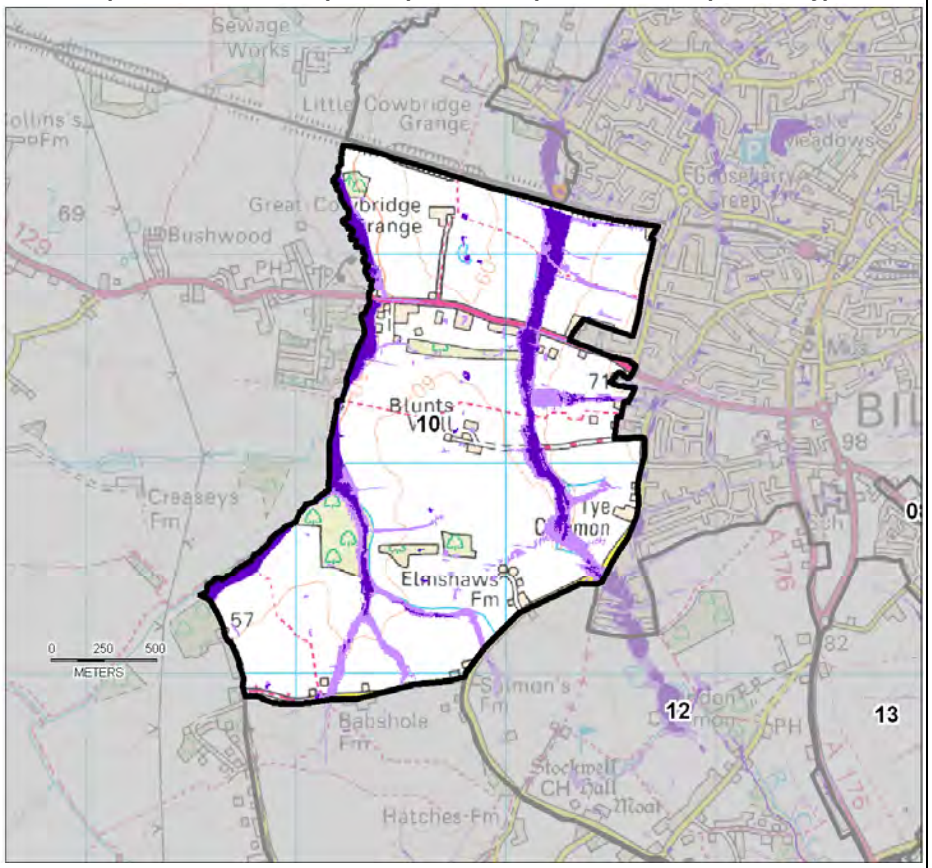
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 20% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-12 Area of Search No. 10 – West Billericay

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
339	327.7	96.7%	1.3	0.4%	-	-	10	2.9%	-	-

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The Haveringsgrove Brook flows northwards along the edge of this AS, and meets the River Wid to the north of this area of search. The vast majority of this AS (97%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 0.4% is defined as Flood Zone 2 – Medium Probability of flooding, and 3% is defined as Flood Zone 3a – High Probability of flooding from fluvial sources. Basildon Borough Council has also identified an ordinary watercourse within this area that flows northwards and feeds into the Mountnessing Brook.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
FLOOD ZONE	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development area.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of sites within this area.

Surface Water Flood Risk

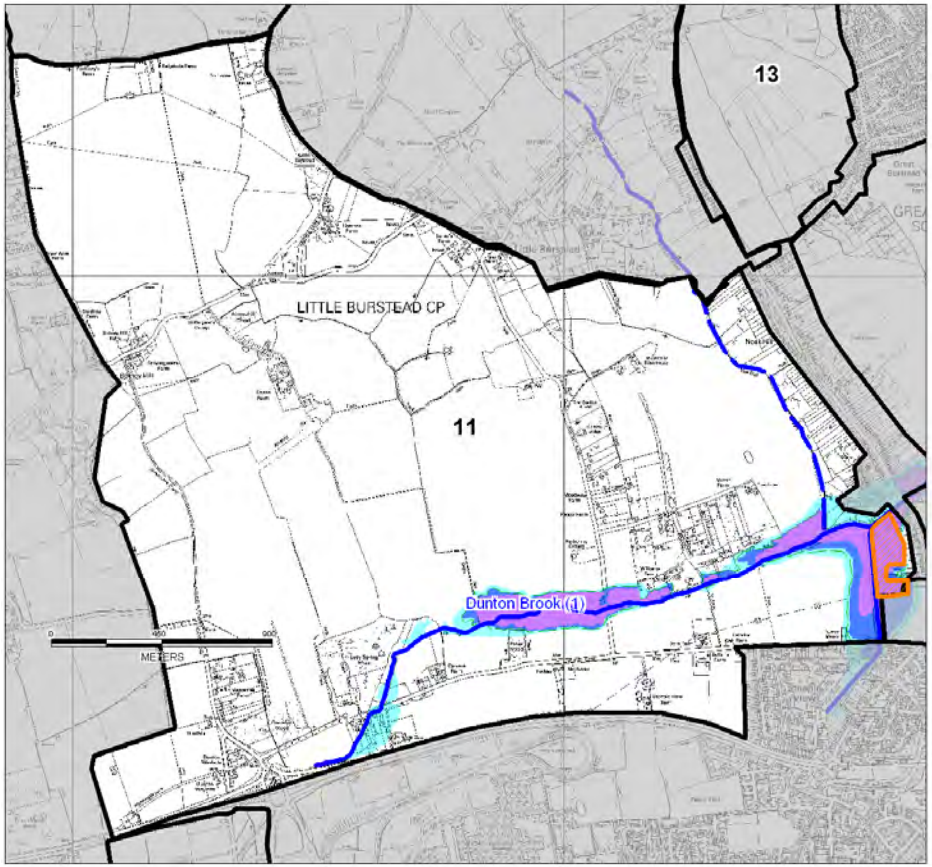
The Environment Agency FMfSW identifies key surface water flowpaths that contribute to the ordinary watercourses in the area. This gives an indication of where surface water is likely to pond and those areas at increased risk of surface water flooding which include areas adjacent to the drainage ditches around Elmshaws Farm and Tye Common.

Mitigation

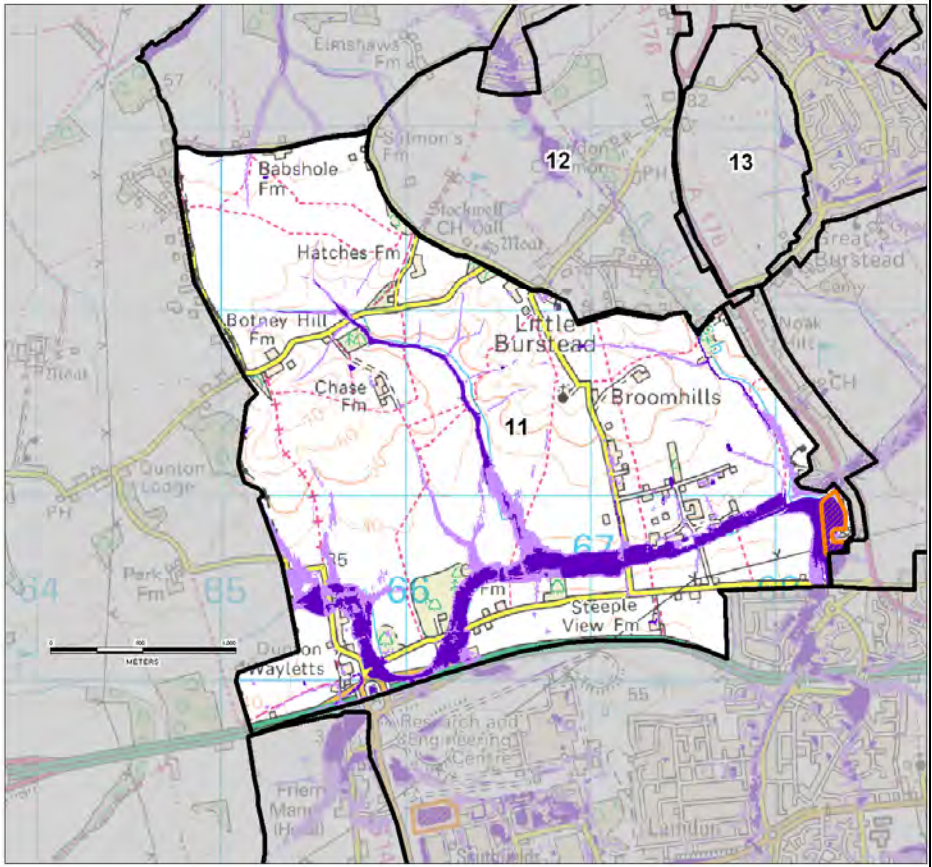
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-13 Area of Search No. 11 – Little Burstead and Broomhills

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
674	637.7	94.6%	11.2	1.7%	1.6	0.2	5.6	0.8%	17.9	2.7%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The Dunton Brook flows eastwards through this AS and meets the River Crouch. The majority of this AS (95%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 2% of the area is defined as Flood Zone 2 – Medium Probability; 0.8% of the area in Flood Zone 3a – High Probability of flooding; and 2.7% of the area is Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone. Refer to section 6.7 for guidance on washland areas.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

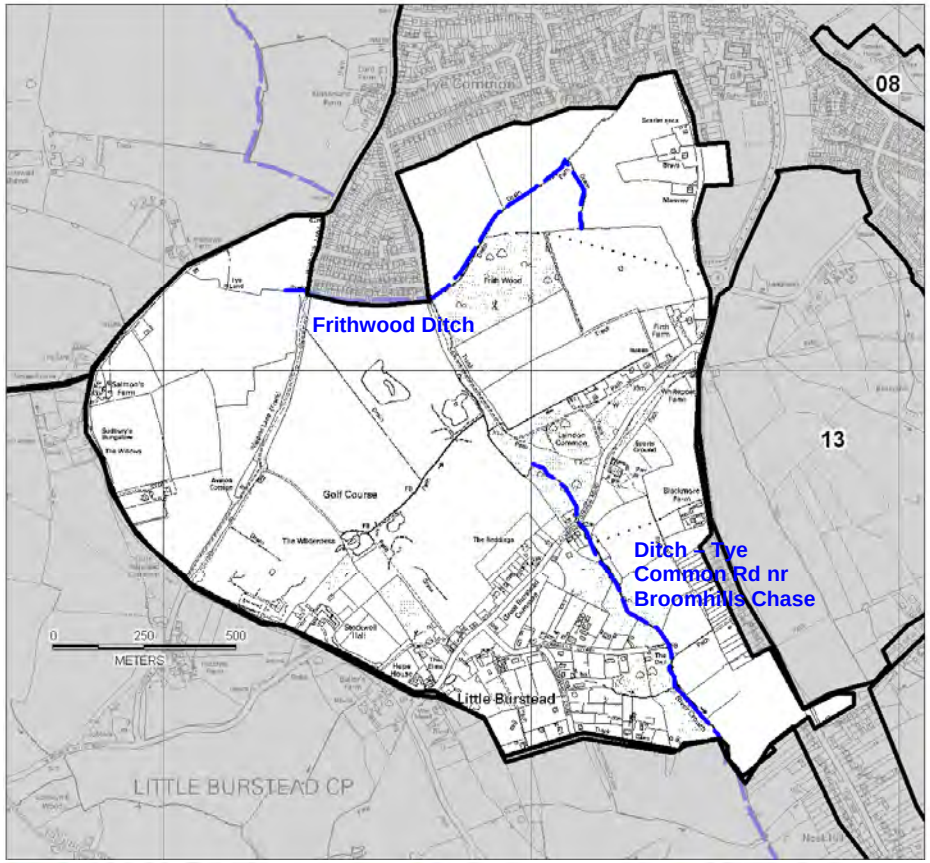
The Environment Agency FMfSW identifies key surface water flowpaths that extending from Hatches Farm and Broomhills southwards to join the Dunton Brook. This gives an indication of where surface water is likely to pond and those areas at increased risk of surface water flooding.

Mitigation

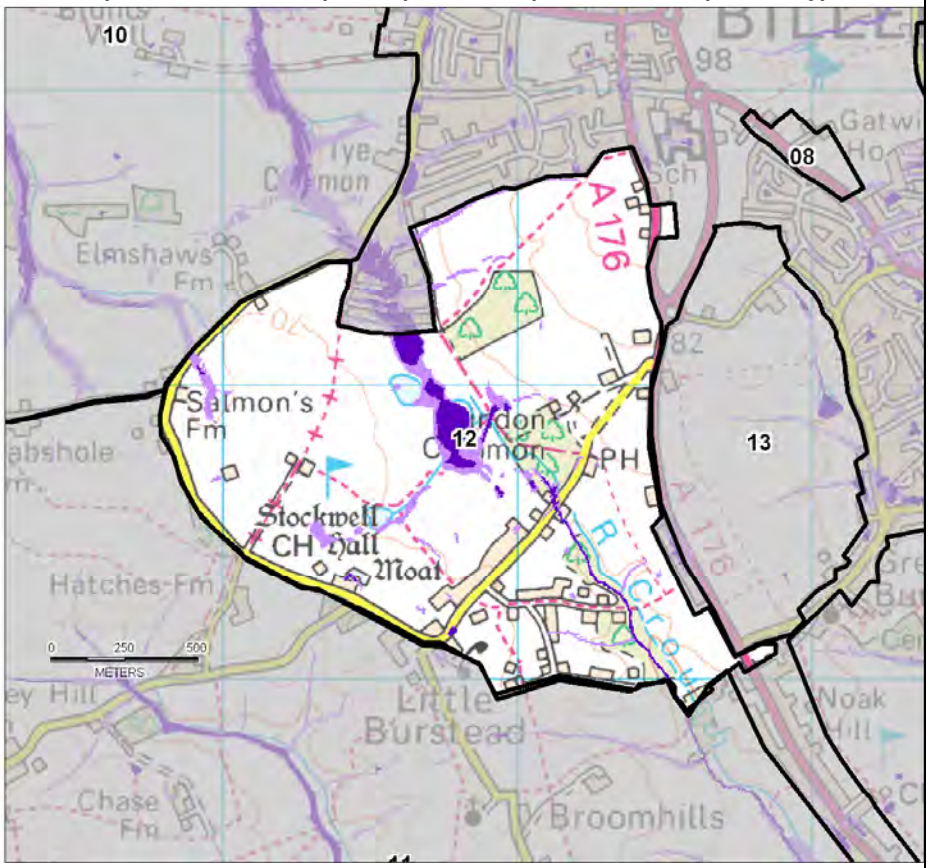
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-14 Area of Search No. 12 – Little Burstead North

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
218	218.0	100.0%	0.0	0.0%	0.0	0.0	0.0%	0.0%	0.0	0.0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

Basildon Borough Council has identified two open ditches within this AS. There are no flood zones associated with these ditches. The area is therefore entirely defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Any future development within the area should be set back from the open ditches to mitigate the risk of flooding.

Surface Water Flood Risk

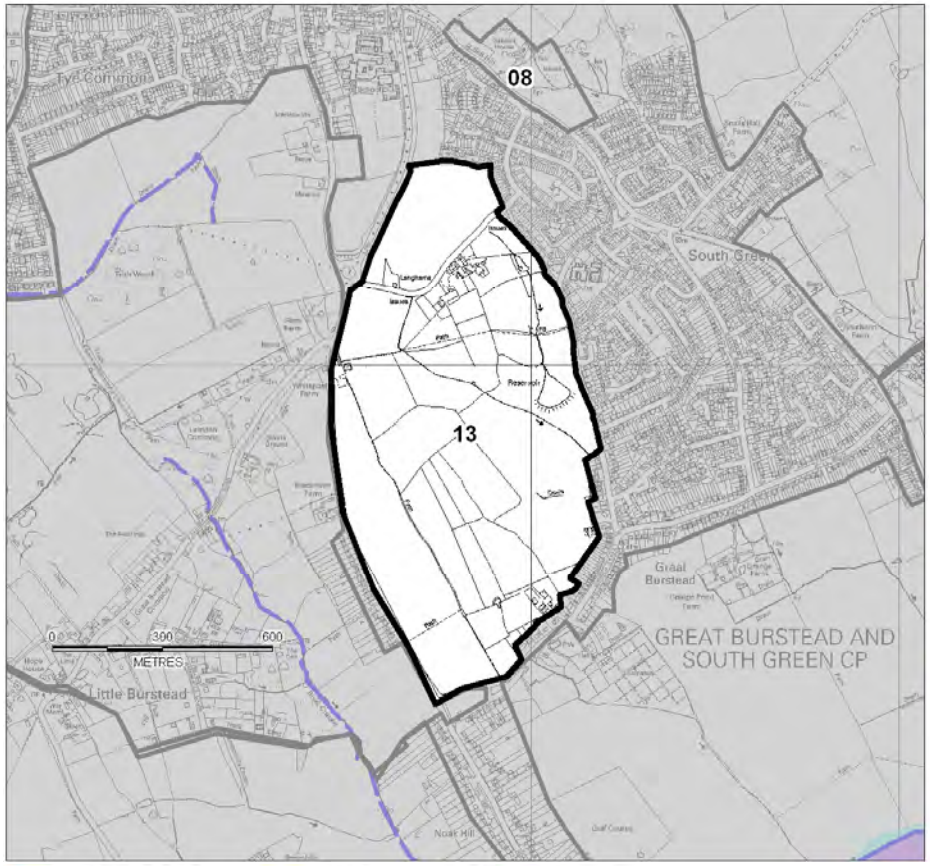
Parts of the existing golf course and Laindon Common are shown to be at increased risk of surface water on the Environment Agency FMfSW. This area forms part of the catchment for the Mountnessing Brook.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage of any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

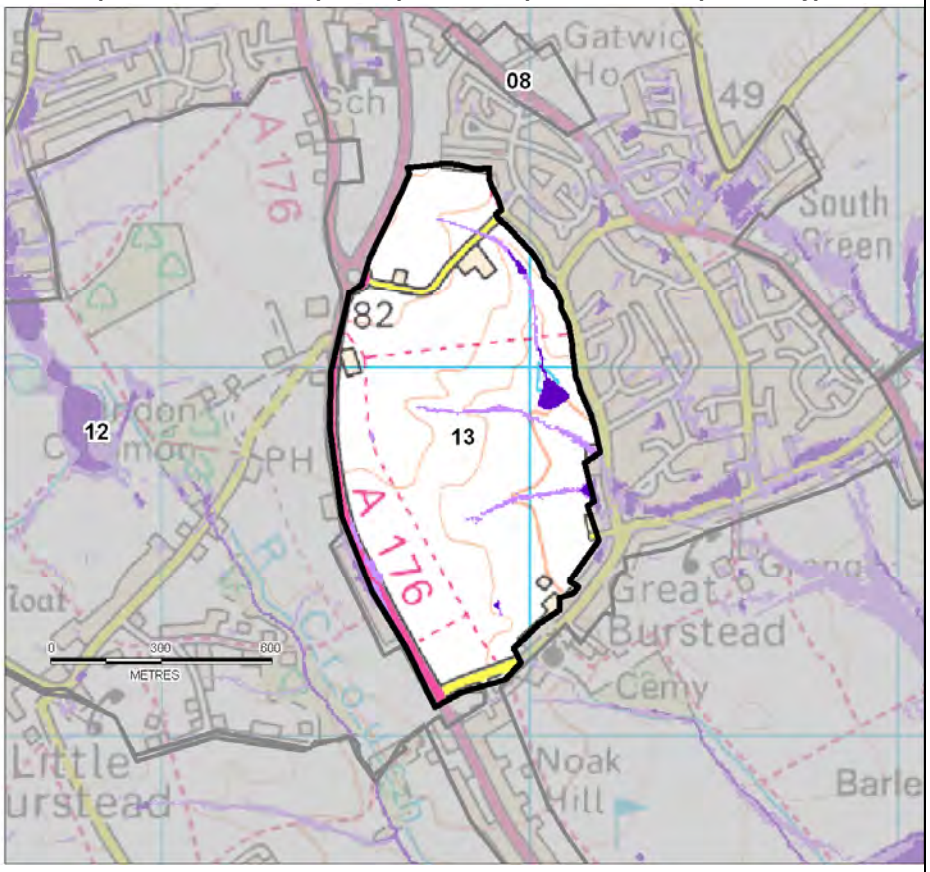
Table 4-15 Area of Search No. 13 - Langhams

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
75	75.0	100.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

There are no sources of fluvial or tidal flood risk affecting this area. The area is entirely defined as Flood Zone 1 – Low Probability of flooding from tidal or fluvial sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
FLOOD ZONE	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Surface Water Flood Risk

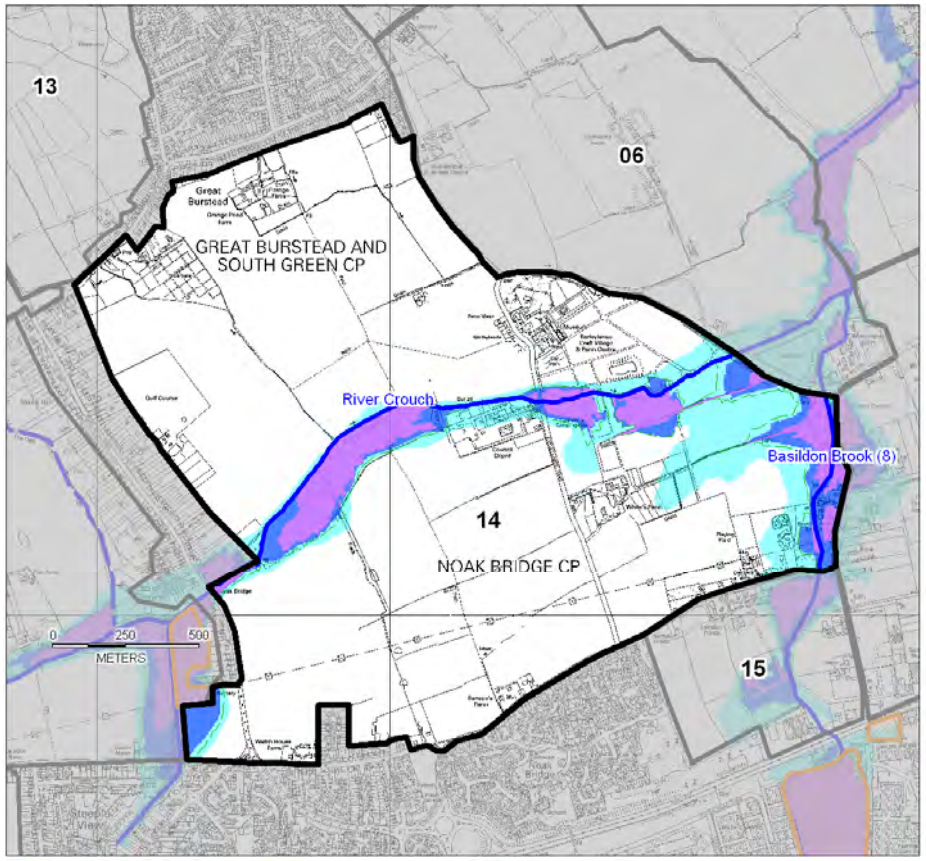
There is a small reservoir and connecting drainage ditch in the eastern part of the area. This area is shown to be at increased risk of surface water flooding on the Environment Agency FMfSW.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

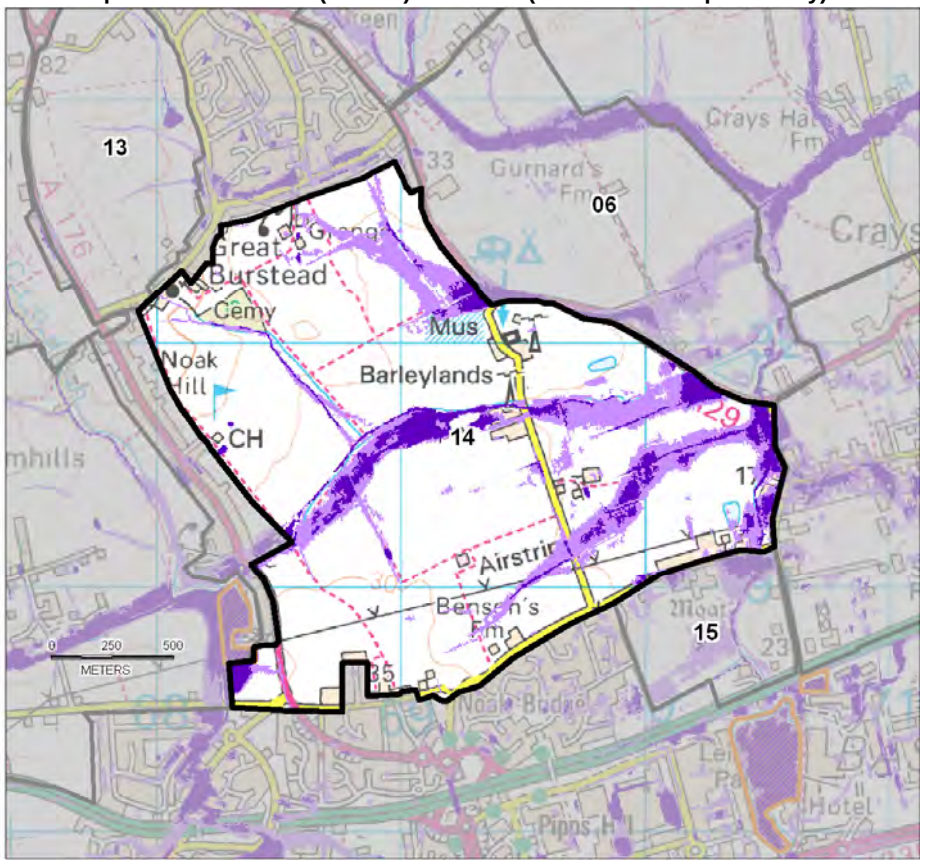
Table 4-16 Area of Search No. 14 - Barleylands

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
342	285	83.4%	26	7.5%	4.4	1.3%	9.6	2.8%	17.3	5%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The fluvial River Crouch flows eastwards through this AS. The majority of this AS (83%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 7.5% of the area is defined as Flood Zone 2 – Medium Probability; 2.8% of the area is defined as Flood Zone 3a – High Probability; and 5% of the area is defined as Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

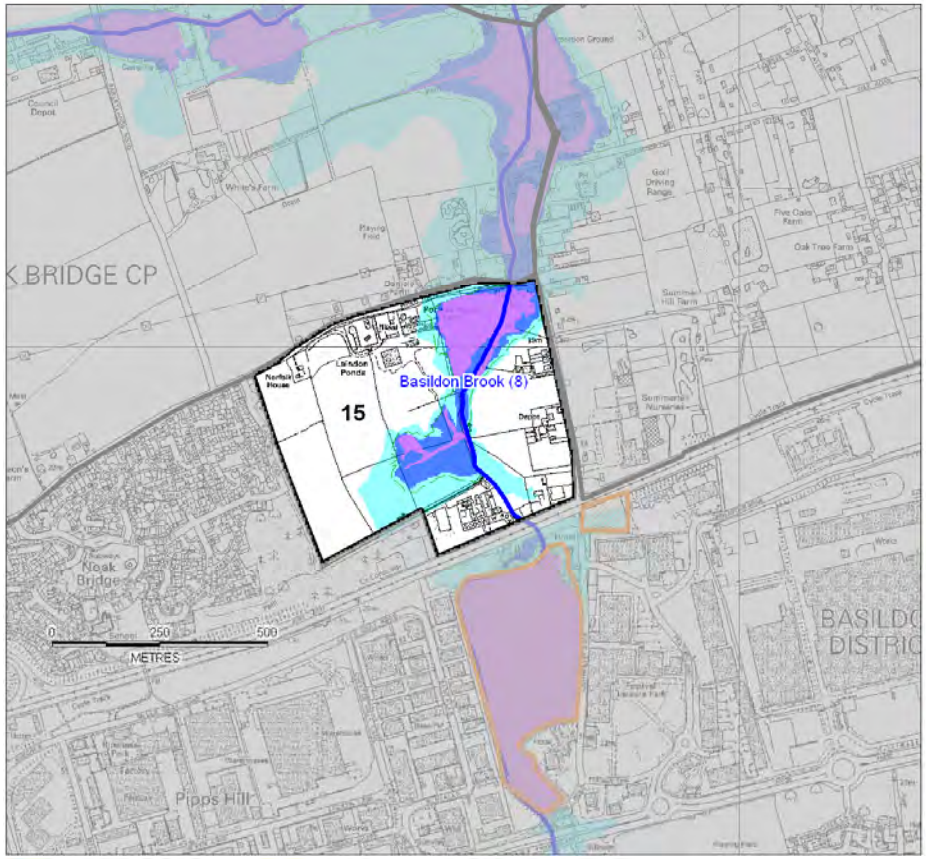
Surface Water Flood Risk

The Environment Agency FMfSW identifies key surface water flowpaths extending from Great Burstead to join the River Crouch channel and from Benson's Farm to meet the Basildon Brook. This gives an indication of where surface water is likely to pond and those areas at increased risk of surface water flooding. The Noak Hill washland is located to the west of this area of search and provides a surface water management function for the local area, draining the urban area to the south and the more rural area to the north.

Mitigation The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

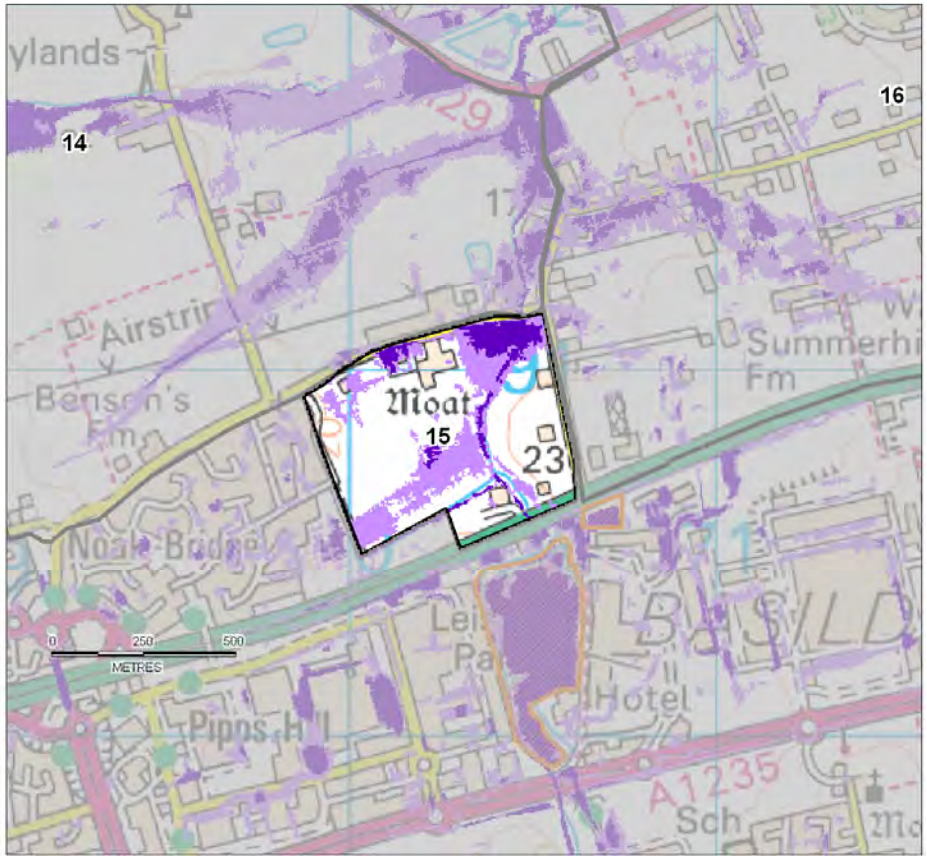
Table 4-17 Area of Search No. 15 – East of Noak Bridge

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
35	23.7	67.8%	4.3	12.3%	0.9	2.7%	2.7	7.8%	3.3	9.4%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The Basildon Brook flows northwards through this AS to meet the River Crouch. The majority of this AS (68%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 12% of the area is defined as Flood Zone 2 – Medium Probability; 8% of the area is defined as Flood Zone 3a – High Probability; and 9% of the area is defined as Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

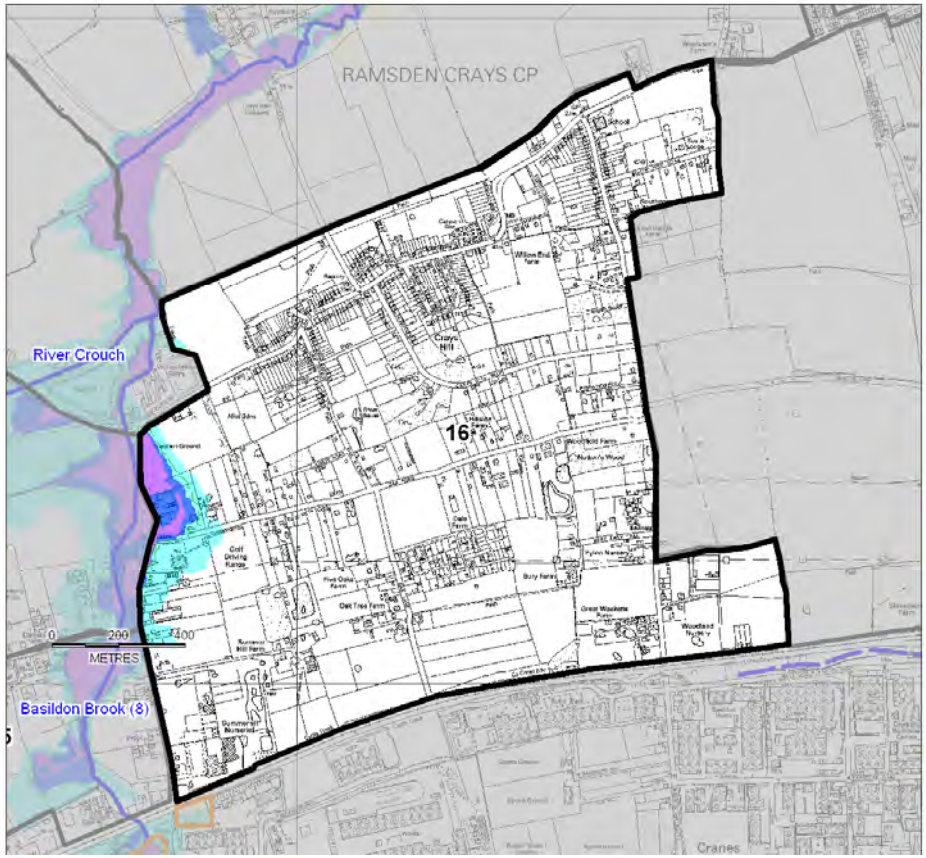
Surface Water Flood Risk

The Environment Agency FMfSW identifies areas of surface water ponding in the floodplain of the Basildon Brook as well as the Laindon Ponds areas. This gives an indication of where surface water is likely to pond and those areas at increased risk of surface water flooding. Pipps Hill Lake and Turner's Wood washland are located to the south of this area of search and provide a surface water management function for the local area.

Mitigation The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

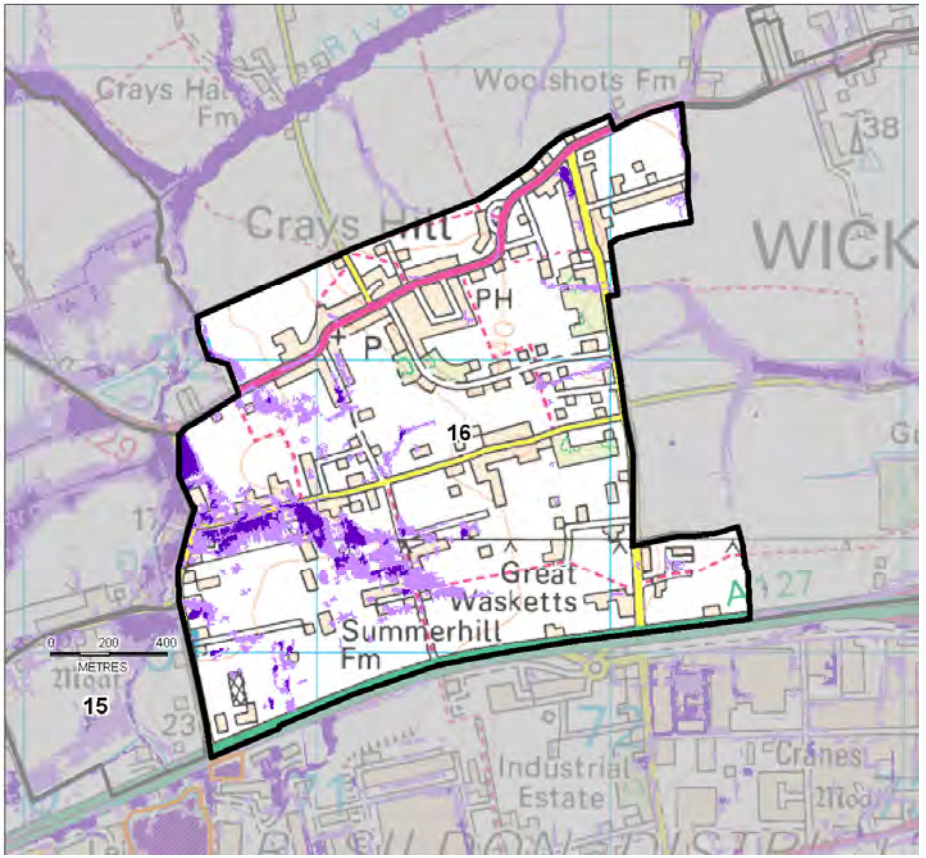
Table 4-18 Area of Search No. 16 – Crays Hill

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
251	242	96.5%	4.9	2%	0.4	0.2%	1.7	0.7%	1.7	0.7%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The River Crouch flows northwards along the western edge of this AS. The majority of this AS (75%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources; 23% of the area is defined as Flood Zone 3a – High Probability of flooding from fluvial and tidal sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

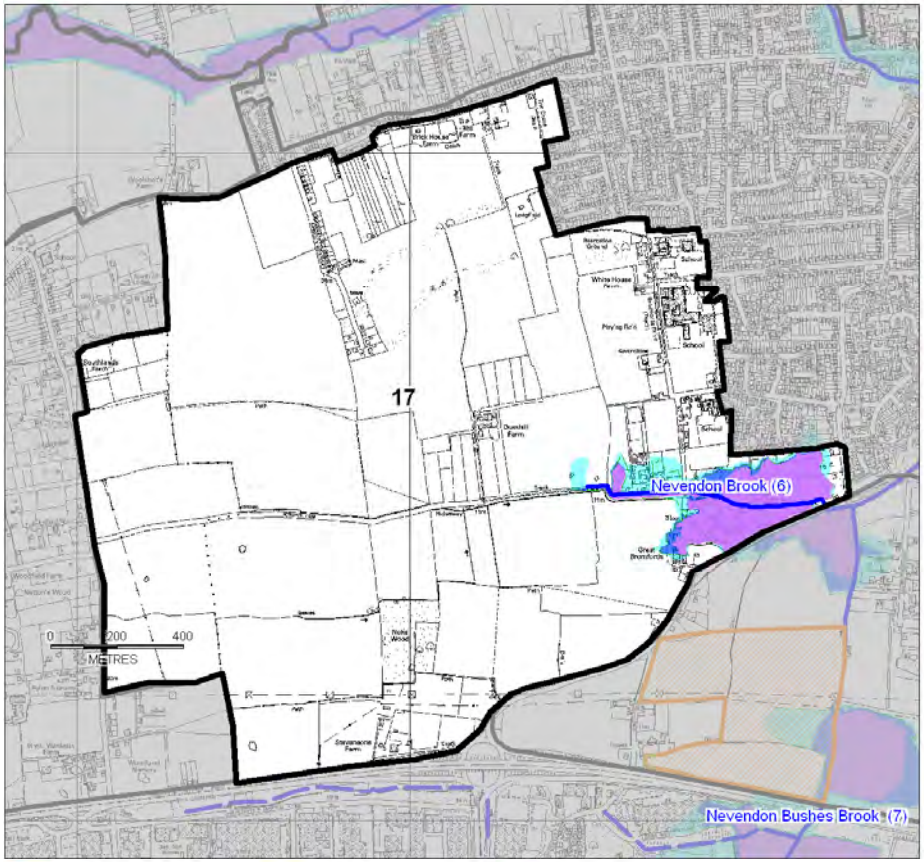
The Environment Agency FMfSW identifies areas of surface water ponding in the western part of the area of search which connect to the floodplain of the Basildon Brook. This gives an indication of where surface water is likely to pond and those areas at increased risk of surface water flooding.

Mitigation

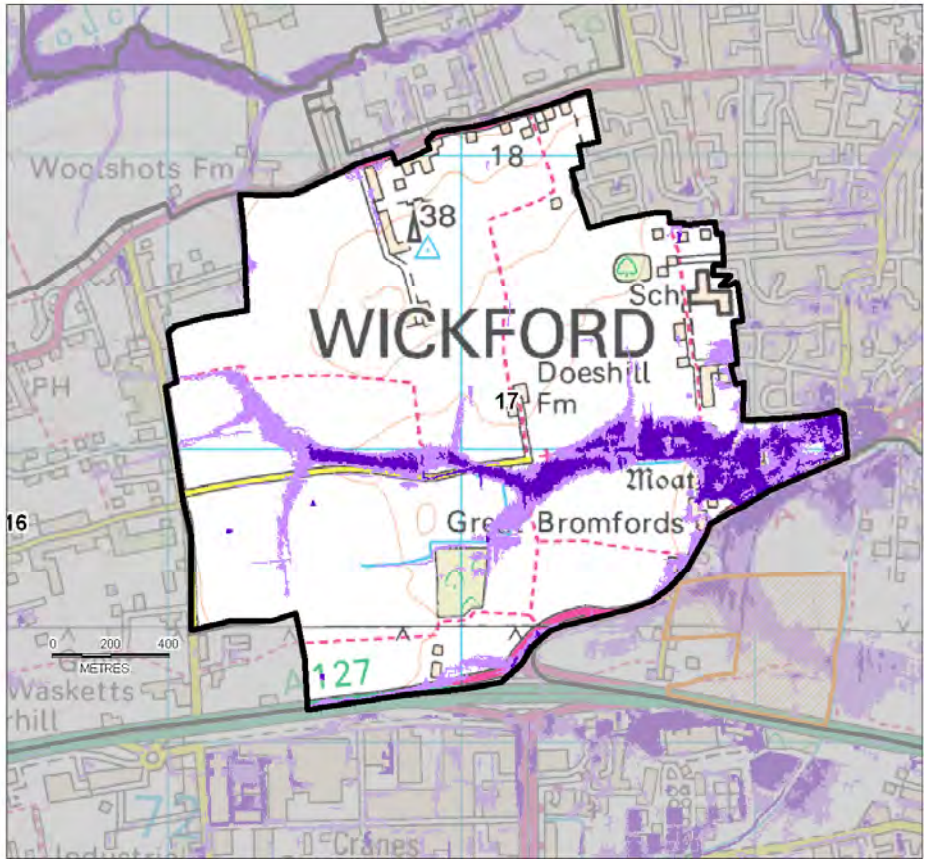
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-19 Area of Search No. 17 – South-west Wickford

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
299	286	95.7%	2.7	0.9%	1.2	0.4%	1.0	0.3%	8.2	2.7%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The Nevendon Brook flows eastwards out of the eastern part of this AS, and then flows northwards to join the River Crouch. The majority of this AS (96%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 0.9% of the area is defined as Flood Zone 2 – Medium Probability; 0.3% of the area is defined as Flood Zone 3a – High Probability; and 2.7% is defined as Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development. The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

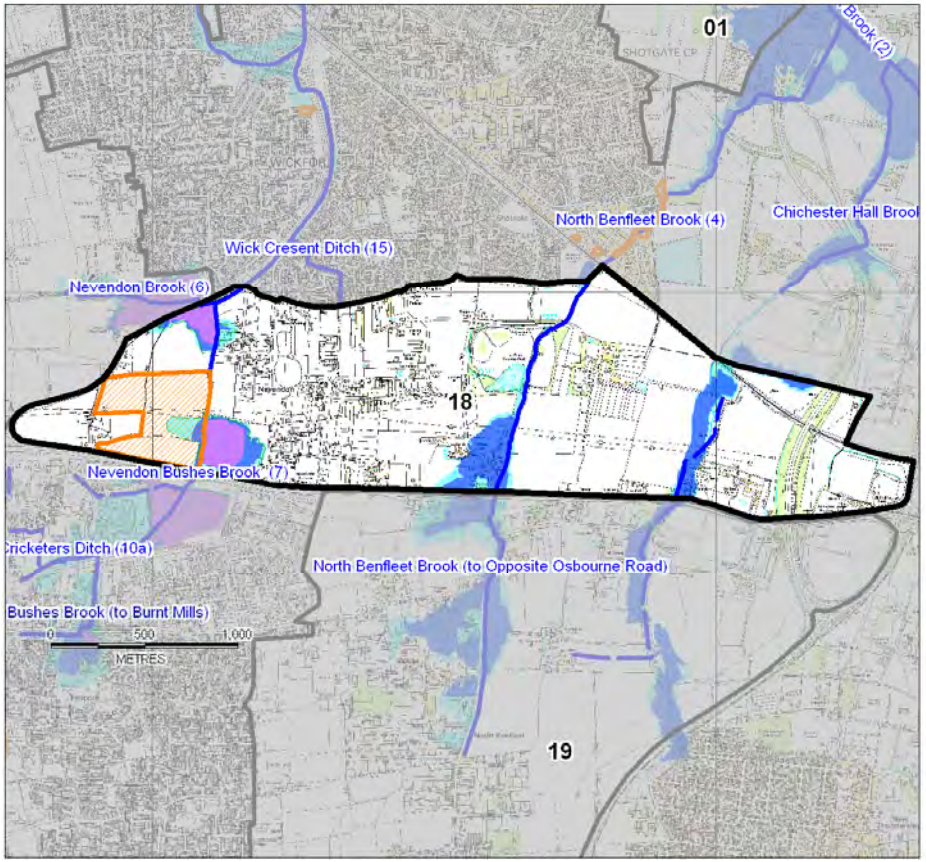
The Environment Agency FMfSW identifies key surface water flowpaths, across the centre of this area adjacent to Borwick Lane, which contributes to the Nevendon Brook. This provides an indication that in this central part of the site, surface water is likely to pond and there is an increased risk of surface water flooding to depths of greater than 0.3m in some areas.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

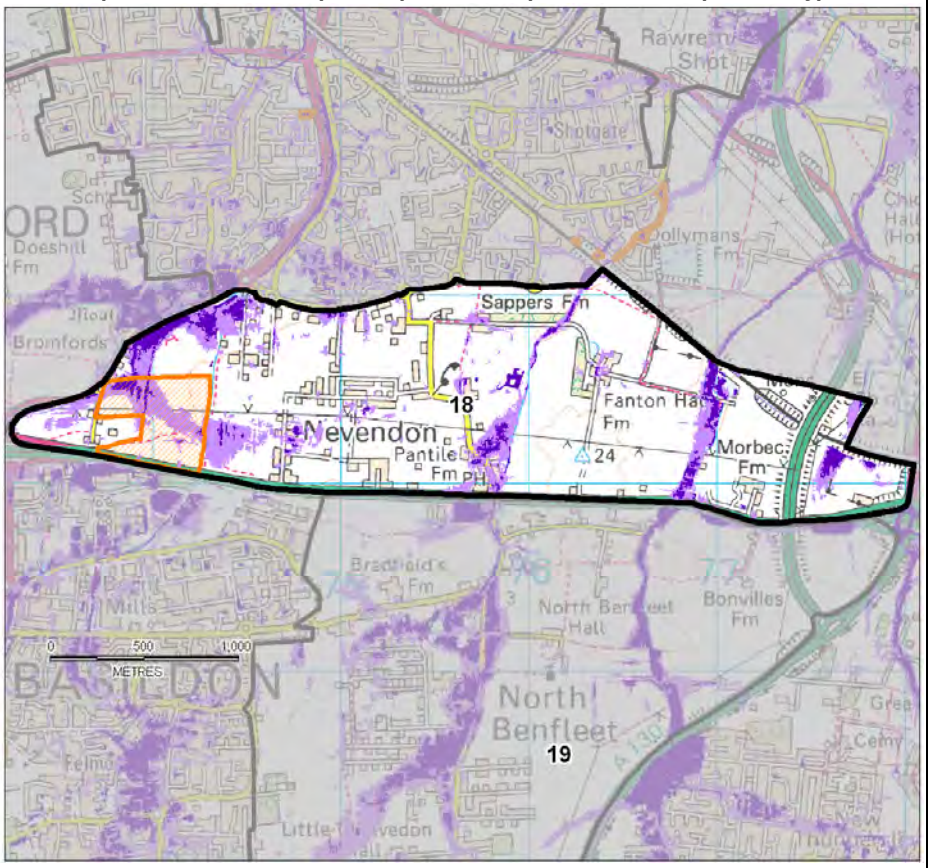
Table 4-20 Area of Search No. 18 – South of The Wick

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
398	358.4	90%	8.5	2.1%	2.6	0.7%	20.2	5.1%	8.4	2.1%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

Several watercourses pass through this AS; the Nevendon Bushes Brook flows northwards in the western part of the AS to join the Nevendon Brook. The North Benfleet Brook flows northwards through the central part of the area. There is also a drainage ditch adjacent to Pound Lane, just north of Harrow Road to the A127 which flows northwards through the site to meet the Chichester Hall Brook.

The majority of this area (90%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 2.1% of the area is defined as Flood Zone 2 – Medium Probability; 5.1% of the area is defined as Flood Zone 3a – High Probability; and 2.1% is defined as Flood Zone 3b – Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone. Refer to section 6.7 for guidance on washland areas.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3a	Exception Test required	✓	X	Exception Test required	✓
	3b	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater..

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

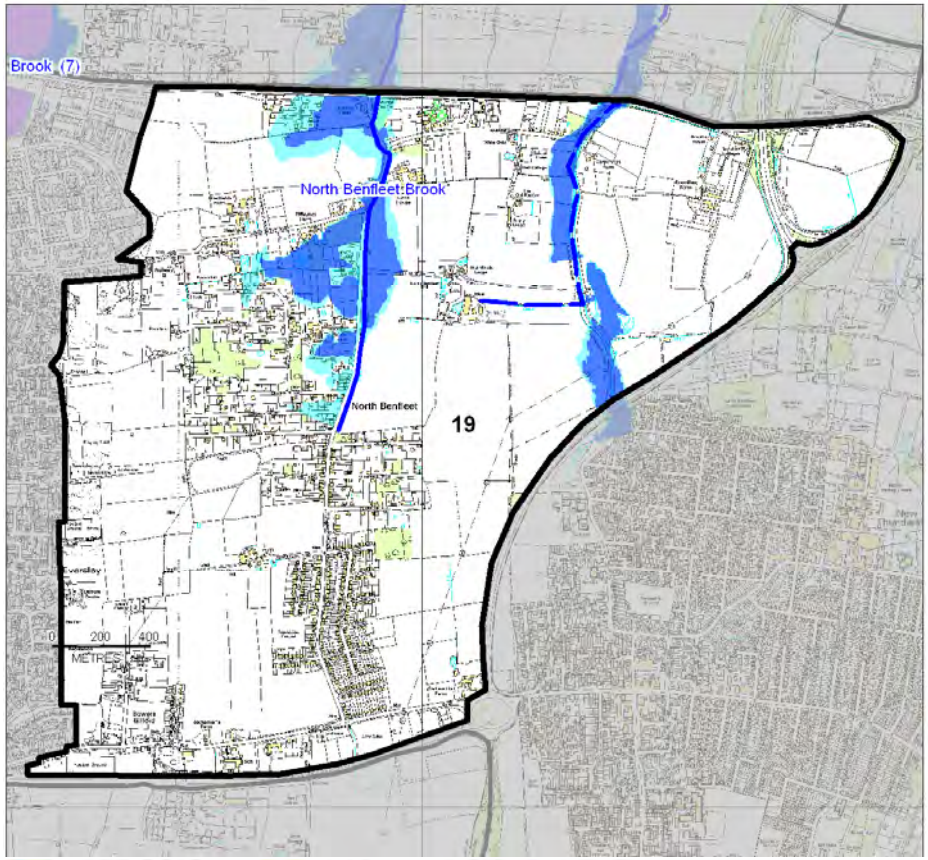
The Environment Agency FMfSW identifies areas of increased surface water flood risk. In this area, these coincide with those areas identified to be at risk of fluvial flooding. The recently relocated Courtauld Road washland area is located in the western part of this area and provides a surface water management function.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

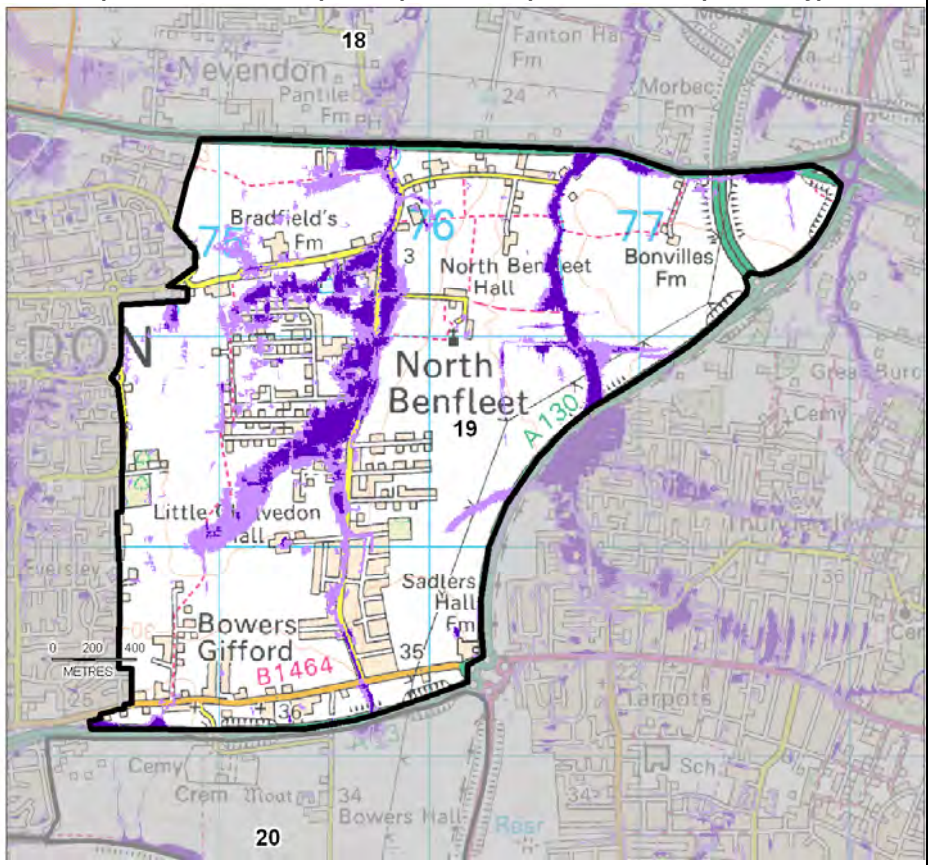
Table 4-21 Area of Search No. 19 – North Benfleet

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
612	561	91.8%	18.9	3.1%	0	0%	31.5	5.1%	0	0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The North Benfleet Brook flows northwards through the central part of this AS. In addition, there is a drainage ditch adjacent to Pound Lane, just north of Harrow Road to the A127 which flows northwards out of the area to meet the Chichester Hall Brook.

The majority of this area (92%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 3.1% of the area is defined as Flood Zone 2 – Medium Probability; and 5.1% of the area is defined as Flood Zone 3a – High Probability.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3a	Exception Test required	✓	X	Exception Test required	✓
	3b	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

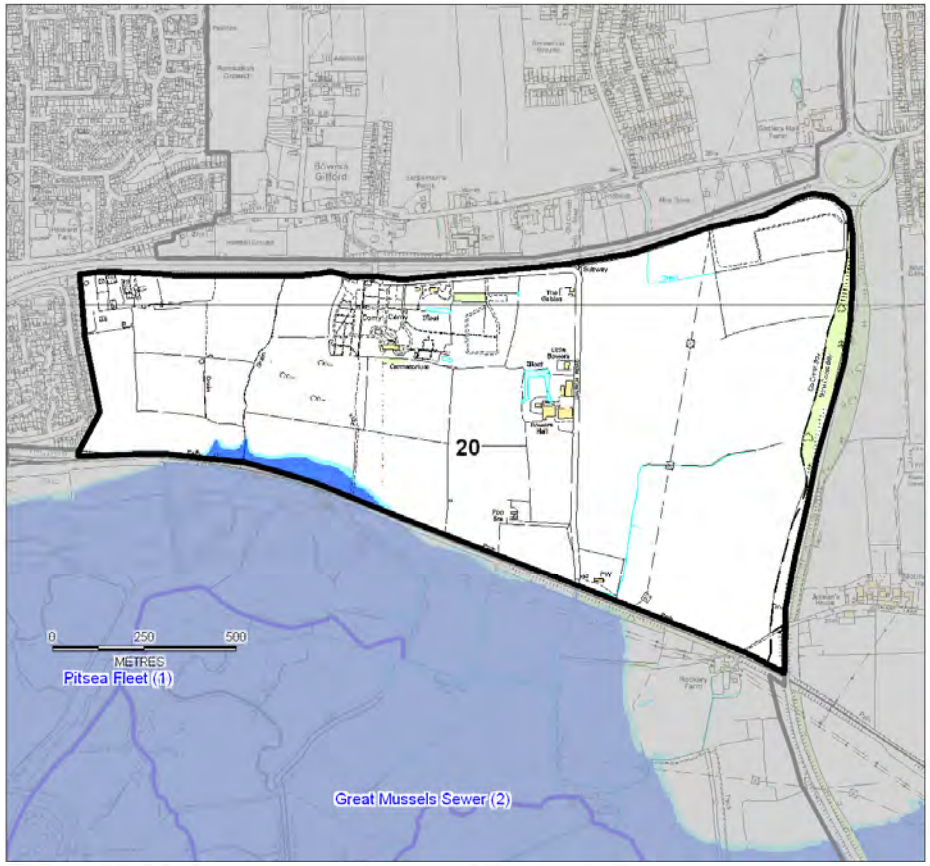
The Environment Agency FMfSW identifies areas of increased surface water flood risk. In this area, these coincide with those areas identified to be at risk of fluvial flooding. In addition, the area around Little Chalvedon Hall and Bradfield's Farm is shown to be at increased risk of surface water flooding.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

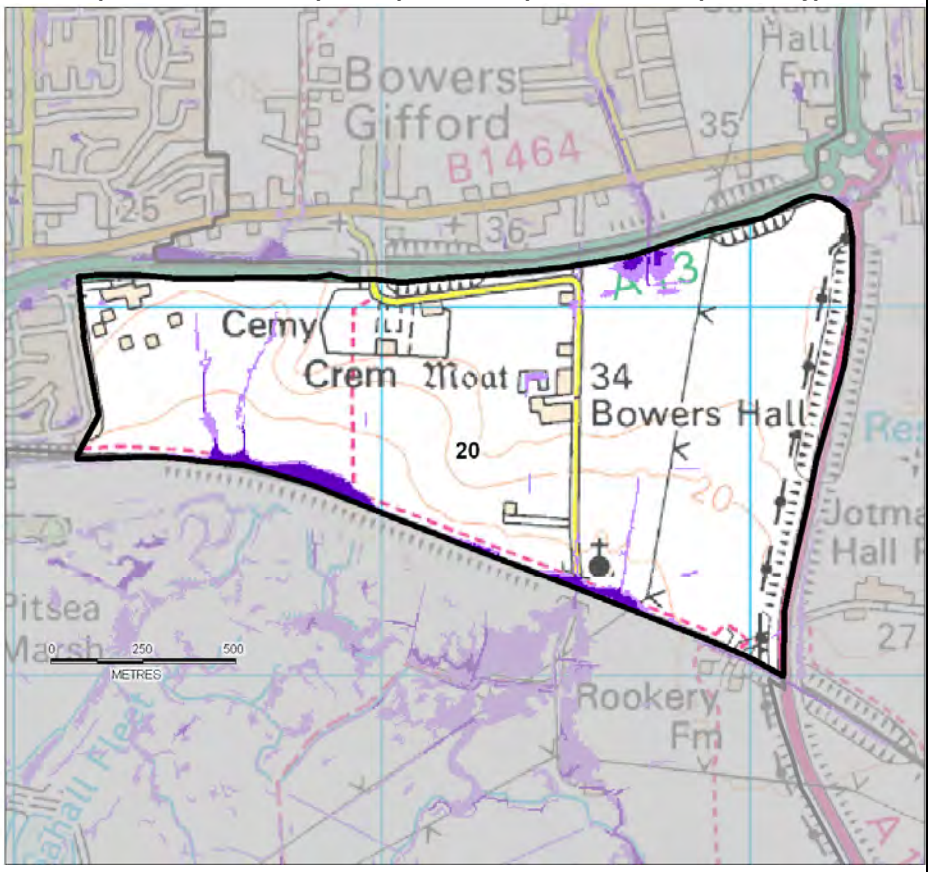
Table 4-22 Area of Search No. 20 – Old Church Road, Pitsea

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
155	152.2	98.2%	0.8	0.5%	0	0%	2	1.3%	0	0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The North Benfleet Brook flows northwards through the central part of this AS. In addition, there is a drainage ditch adjacent to Pound Lane, just north of Harrow Road to the A127 which flows northwards out of the AS to meet the Chichester Hall Brook.

The majority of this area (98%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial sources; 0.5% of the area is defined as Flood Zone 2 – Medium Probability; and 1.3% of the area is defined as Flood Zone 3a – High Probability.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3a	Exception Test required	✓	X	Exception Test required	✓
	3b	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

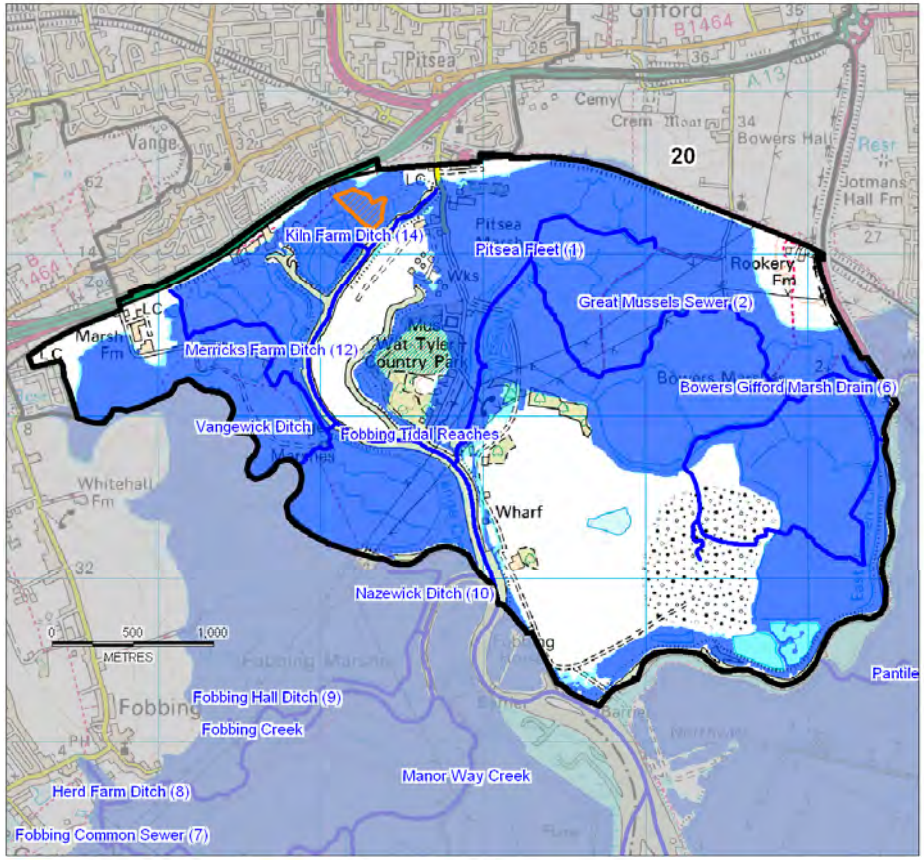
The Environment Agency FMfSW identifies areas of increased surface water flood risk adjacent to the A13 and the raised railway embankment that runs along the southern edge of the area.

Mitigation

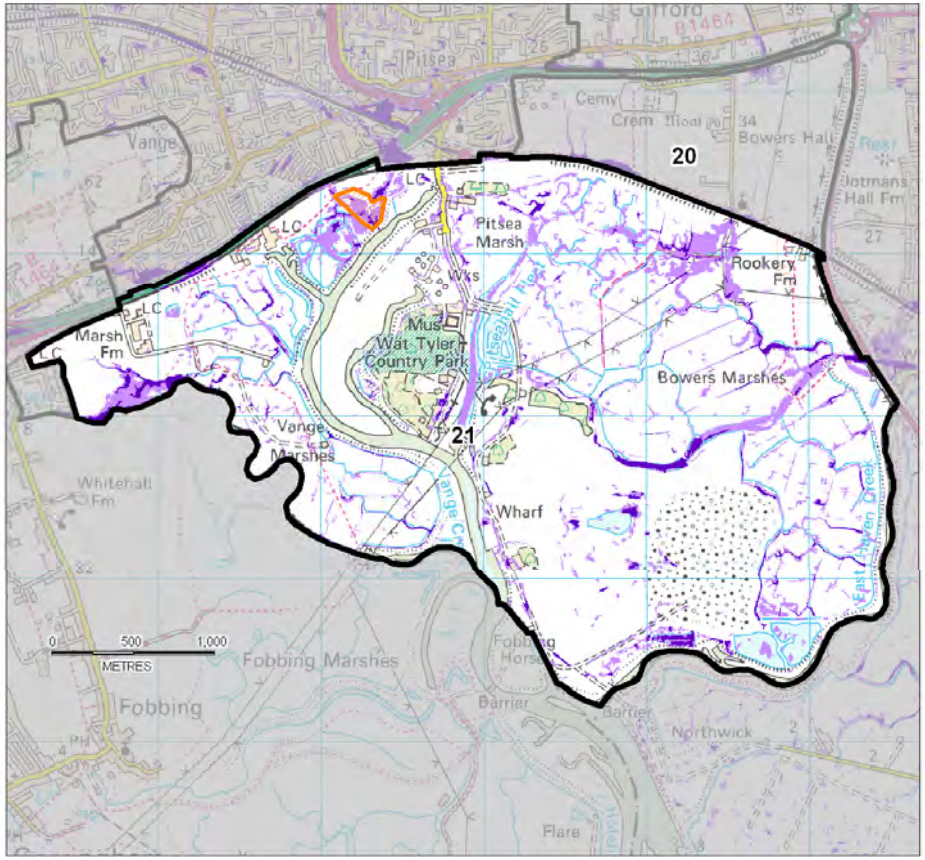
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-23 Area of Search No. 21 – Bowers Marshes

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
1078	370	34.3%	30.8	2.9%	0	0%	677	62.8%	0	0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

This AS is located predominantly within the Flood Zone 3a – High Probability of flooding from the tidal River Thames. However this area is protected by a high standard of flood defence including the Fobbing Horse flood barrier and the Benfleet Creek flood barrier. The risk of flooding from tidal sources is therefore a residual risk, in the event of a failure or overtopping of the defences. The potential impacts of a failure in these flood defences are considered further overleaf. Refer to section 6.7 for guidance on washland areas.

Surface Water Flood Risk

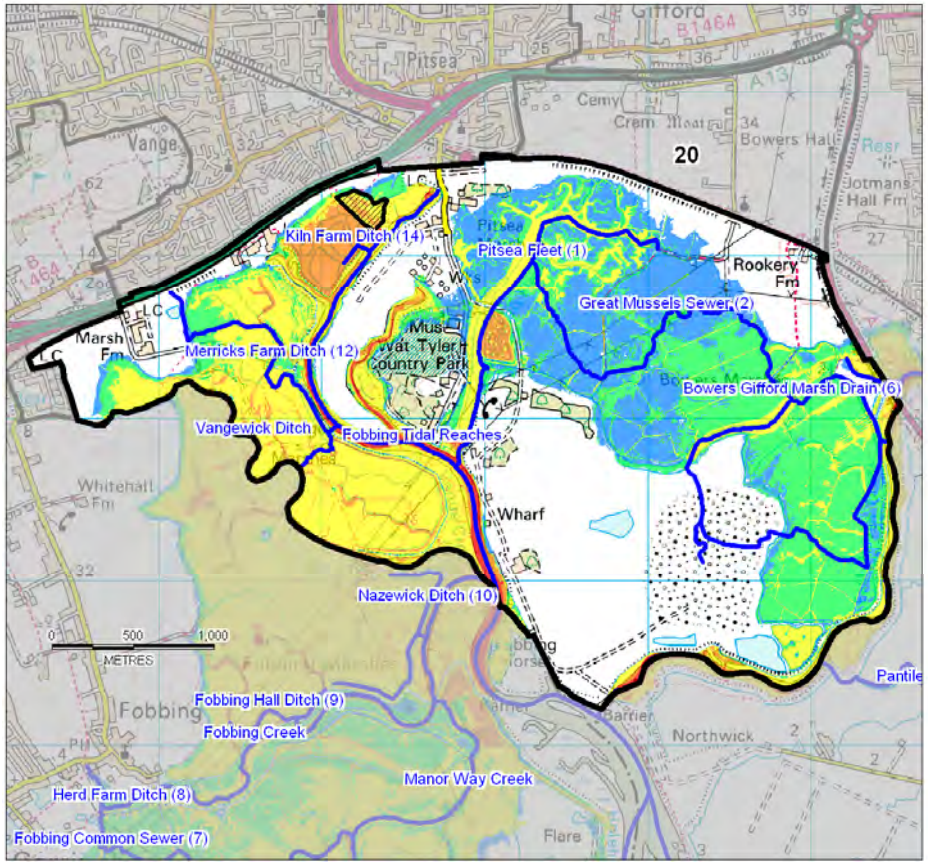
The Environment Agency FMfSW identifies small ribbons of increased surface water flood risk around the marshes, associated with the network of drains and rivers in the area. The Vange storage basin is located in the north west of the area and provides a surface water management function.

Mitigation

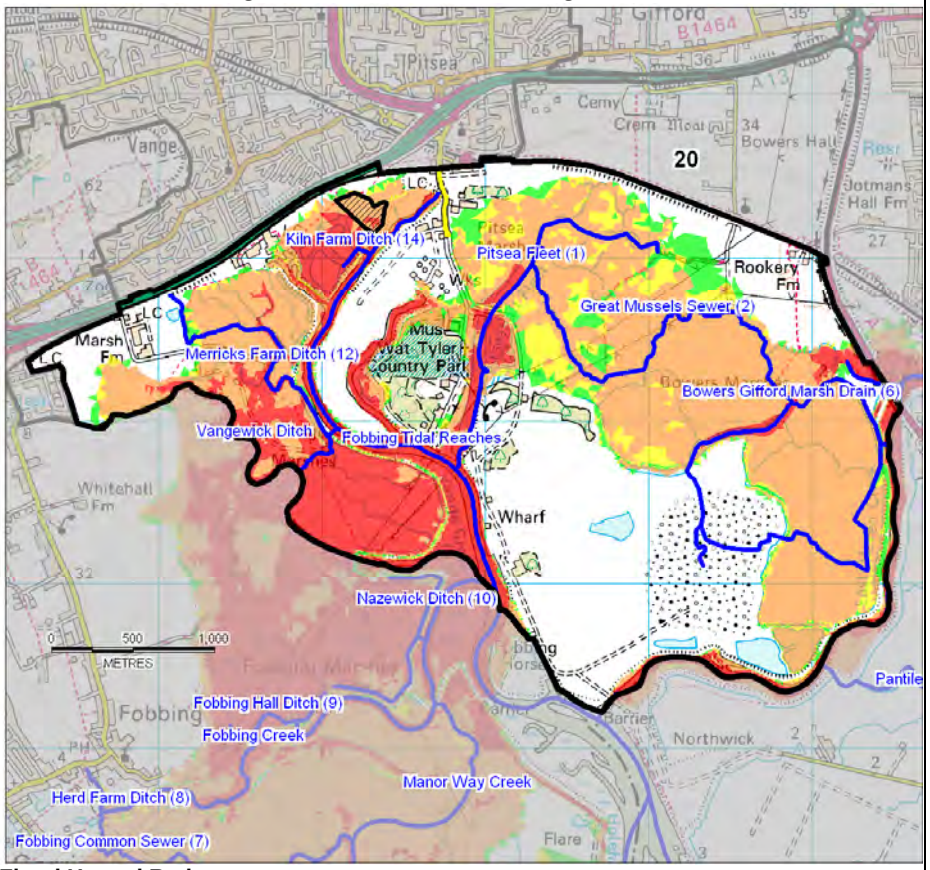
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) flood event including 30% climate change.

Residual Tidal Flood Risk - in the event of a failure of the Benfleet Creek flood barrier and the Fobbing Horse flood barrier.

Flood Depth 0.5% AEP with climate change to 2110



Flood Hazard Rating 0.5% AEP with climate change to 2110



Maximum Flood Depth [m]

- 0.0m – 0.5m
- 0.5m – 1.0m
- 1.0 – 2.0m
- 2.0 – 3.0m
- 3.0 – 5.0m and greater

These maps are composite maps and therefore represent the worst case flood depth or hazard rating resulting from both barrier failure scenarios.

Please refer to the Notes section of Figures B-03 and C-03, Section 2 of this report and Appendix E for full details on modelling methodology.

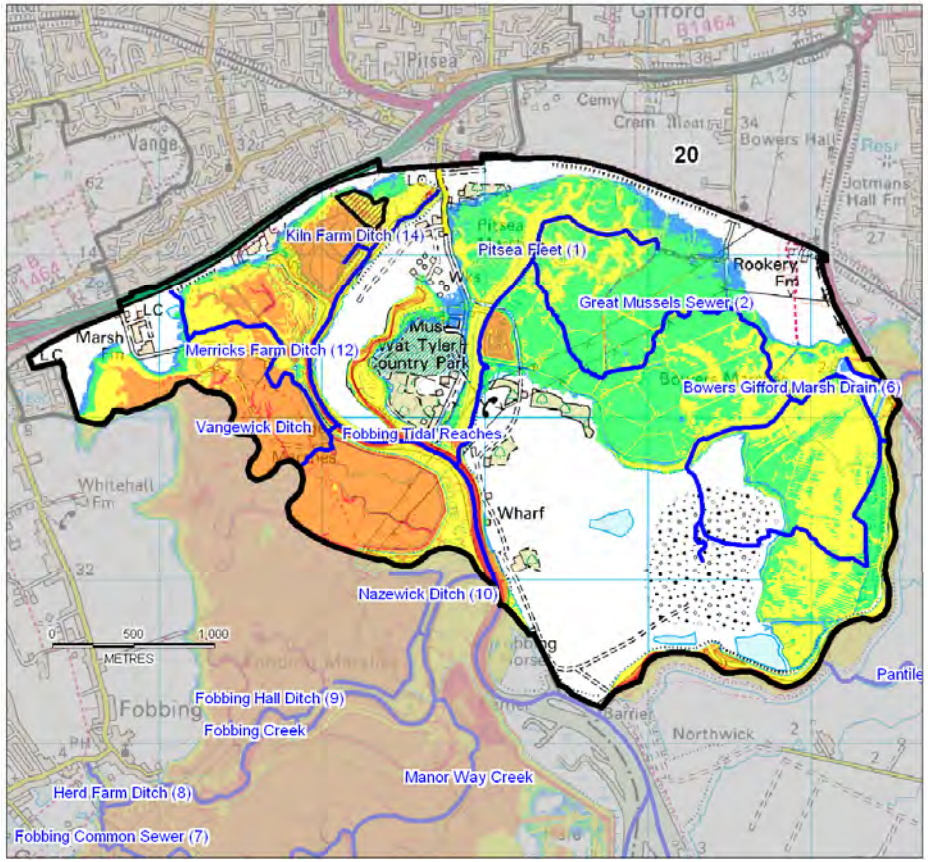
Washland Area (Flood Zone 3b)

Flood Hazard Rating

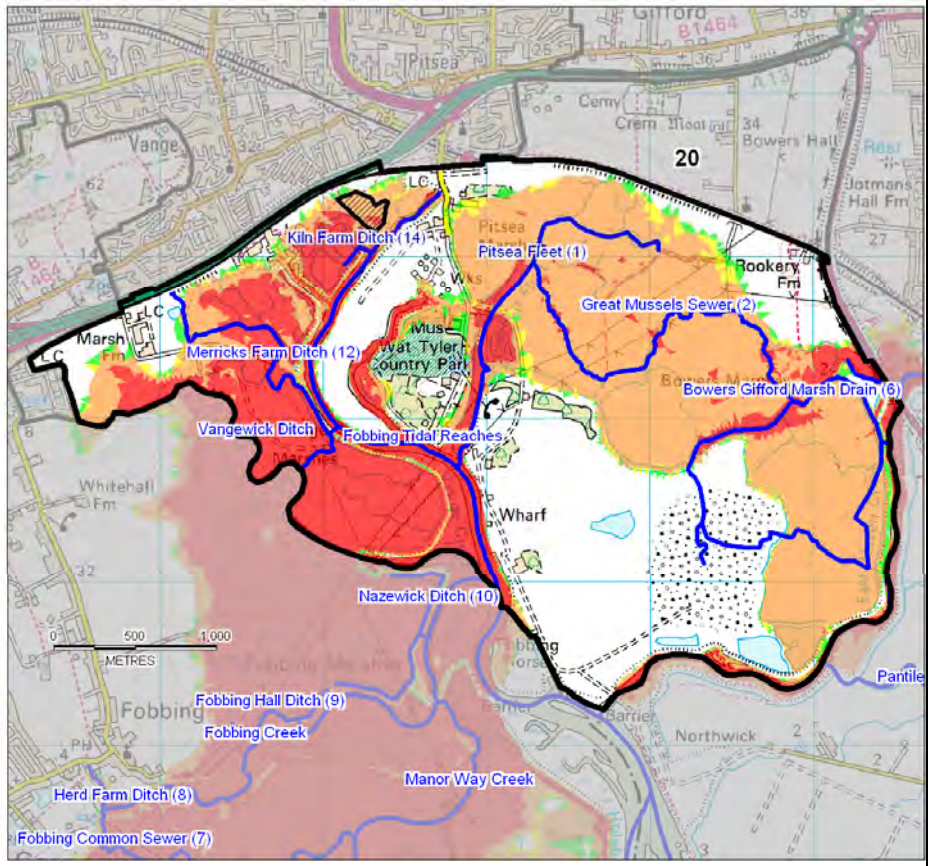
- Low Hazard
- Medium Hazard (Danger to Some)
- Significant Hazard (Danger to Most)
- Extreme Hazard (Danger to All)
- Washland Area (Flood Zone 3b)

Residual Tidal Flood Risk - in the event of a failure of the Benfleet Creek flood barrier and the Fobbing Horse flood barrier.

Flood Depth 0.1% AEP with climate change to 2110



Flood Hazard Rating 0.1% AEP with climate change to 2110



Maximum Flood Depth [m]

- 0.0m – 0.5m
- 0.5m – 1.0m
- 1.0 – 2.0m
- 2.0 – 3.0m
- 3.0 – 5.0m and greater

These maps are composite maps and therefore represent the worst case flood depth or hazard rating resulting from both barrier failure scenarios.

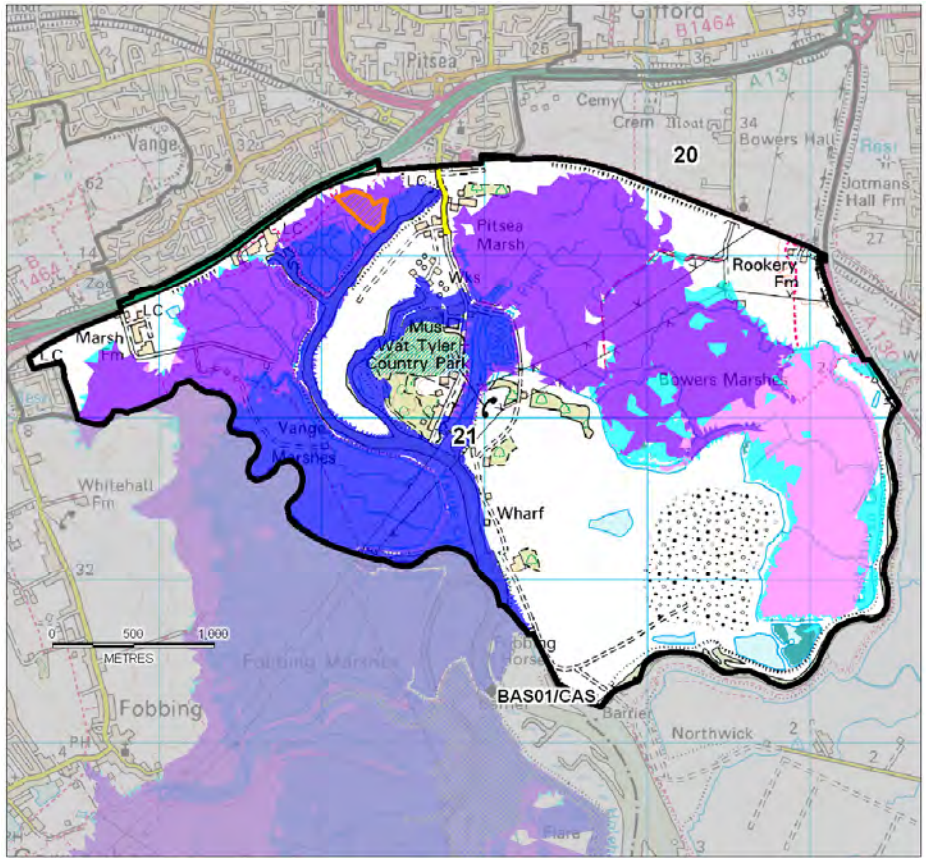
Please refer to the Notes section of Figures B-04 and C-04, Chapter 2 of this report and Appendix E for full details on modelling methodology.

Washland Area (Flood Zone 3b)

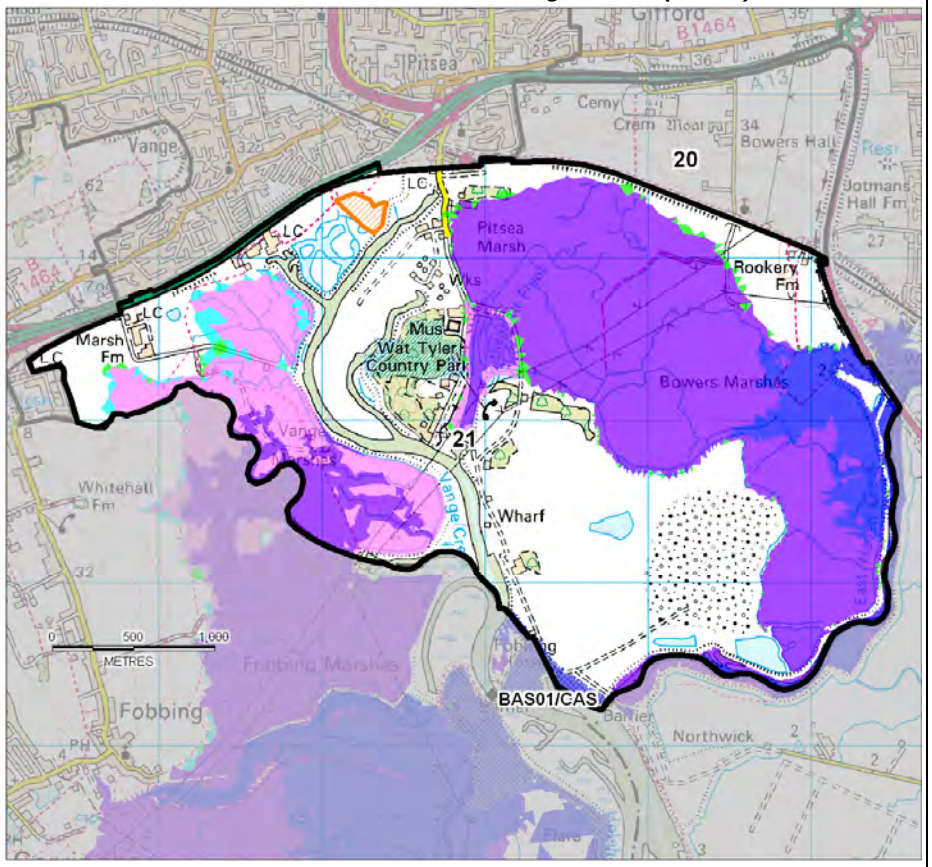
Flood Hazard Rating

- Low Hazard
- Medium Hazard (Danger to Some)
- Significant Hazard (Danger to Most)
- Extreme Hazard (Danger to All)
- Washland Area (Flood Zone 3b)

Time to Inundation 0.1% AEP with climate change to 2110 (BAS01CAS)



Time to Inundation 0.1% AEP with climate change to 2110 (CAS08)



Time to Inundation (Hours)

	< I Hour		12 – 16 Hours
	1 – 4 Hours		16 – 20 Hours
	4 – 8 Hours		Inundation from overtopping prior to modelled breach event
	8 – 12 Hours		Washland Area (Flood Zone 3b)

Please refer to the Notes section of Figures D1 and D2, Chapter 2 of this report, and Appendix E for further details regarding the modelling methodology.

Local Policy

South Essex CFMP Policy Unit 12: Thames Urban Tidal

The area covered by this policy unit is predominantly tidal but is protected by sea defences up to the 1 in 1000 year standard of protection. Current flood risk management is primarily through flood warnings. The selected policy for the area is Policy 6; to take further action to sustain the current level of flood risk into the future, responding to the potential increases in risk from urban development, land use change and climate change.

Thames Estuary 2100 Project: Bowers Marshes and Fobbing Marshes

The Bowers Marshes is an open area of freshwater grazing marshes. The area at risk of flooding includes the railway line, the main A130 road, the Wat Tyler Country Park, an electricity generation plant and a sewage works. Under the Thames Estuary 2100 Project, the flood risk management policy for this area is Policy 4; to take further action to sustain the current level of flood risk into the future, responding to potential increases in risk from urban development, land use change and climate change.

The Fobbing Marshes extend northwards just inside the Basildon Borough Council administrative boundary. This area comprises freshwater marshes, some of which are designated SSSIs. Much of the defence system of the marshes consists of embankments on Vange Creek, upstream of the Fobbing Horse Barrier. Under the Thames Estuary 2100 Project, the flood risk management policy for this area is Policy 3, to continue with existing or alternative actions to manage flood risk at the current level, accepting that flood risk will increase over time from this baseline. This approach is to be supplemented with local secondary defences to protect key sites where necessary.

Permitted Development

The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

Minimum finished floor levels should be set above the maximum flood level modelling to occur during a failure of the local flood barriers, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be implemented up to the modelled flood levels.

Access and egress from all parts of the any future development sites should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 0.1% AEP (1 in 1000 year) tidal flood level during a failure of the local flood barriers. Where this is not possible, appropriate access should be provided taking into account the vulnerability and mobility of the occupants, the use of the building, the time to inundation and the provision of safe dry refuge on the site.

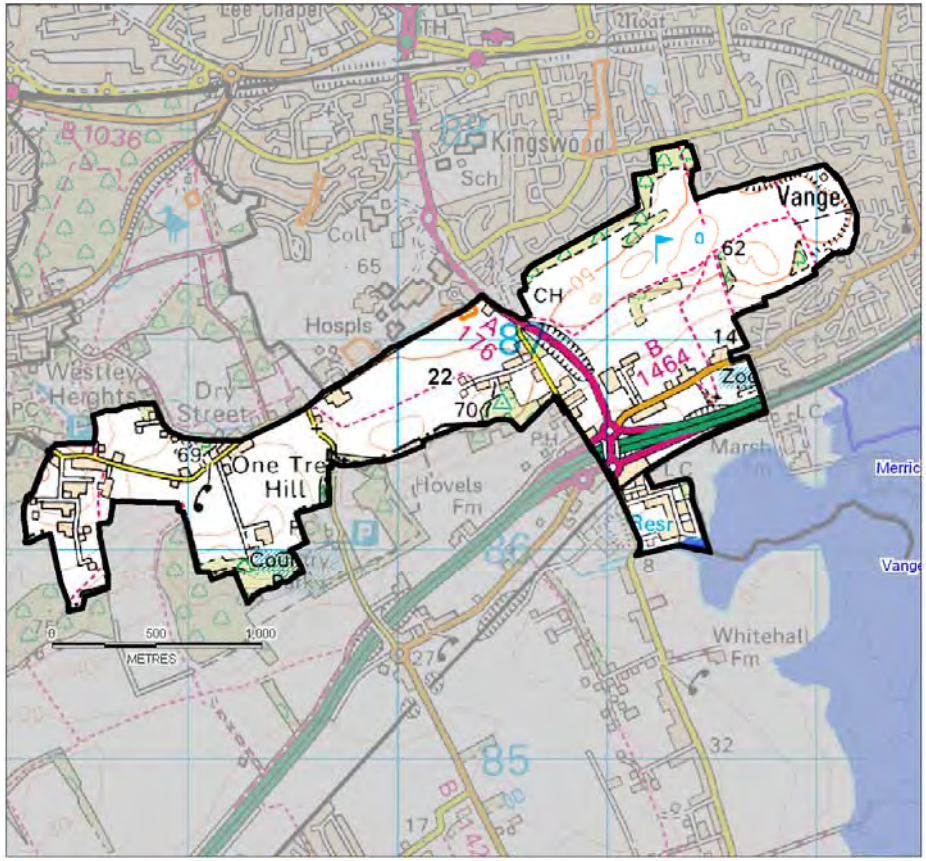
In order to achieve safe access and egress from any future development sites within this area, land raising may be required. However it must be demonstrated that the cumulative impact of any land raising will not impact on the residual risk posed to other developments.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site. Any future development within this area will need to be supported by an evacuation plan.

Further details are included in Section 6 of this SFRA.

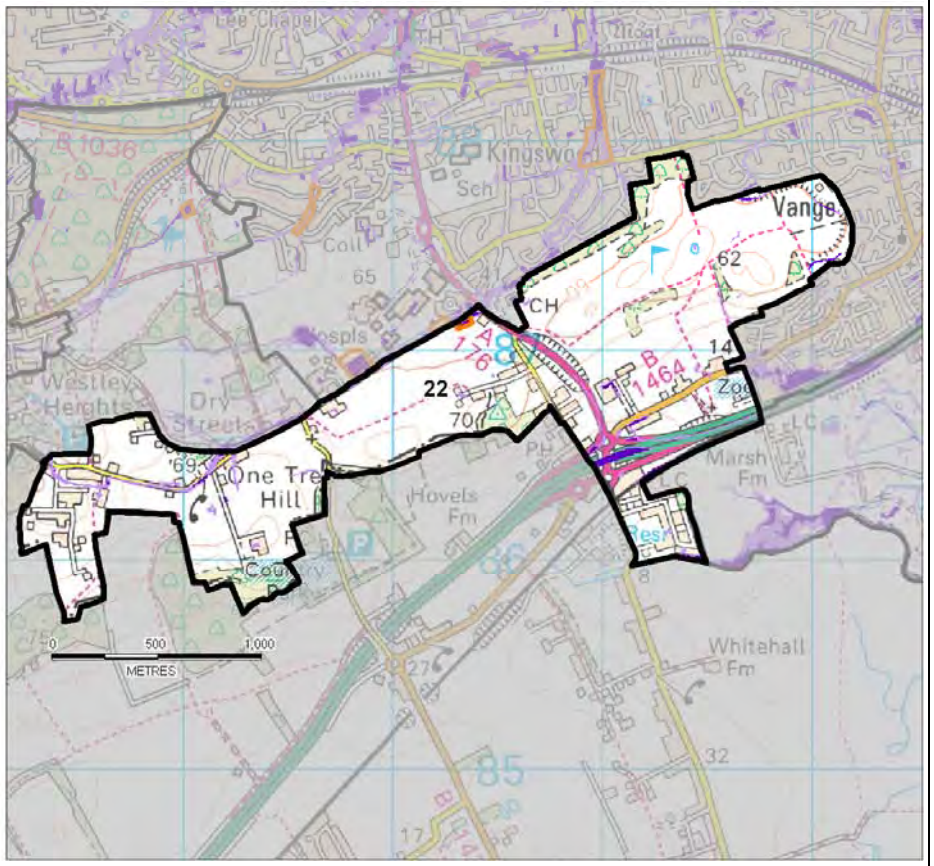
Table 4-24 Area of Search No. 22 – South Dry Street and Vange

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
289	288.1	99.7%	0.2	0.1%	-*	-	0.7	0.2%	-	-

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The vast majority of this AS (99.7%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
FLOOD ZONE	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Surface Water Flood Risk

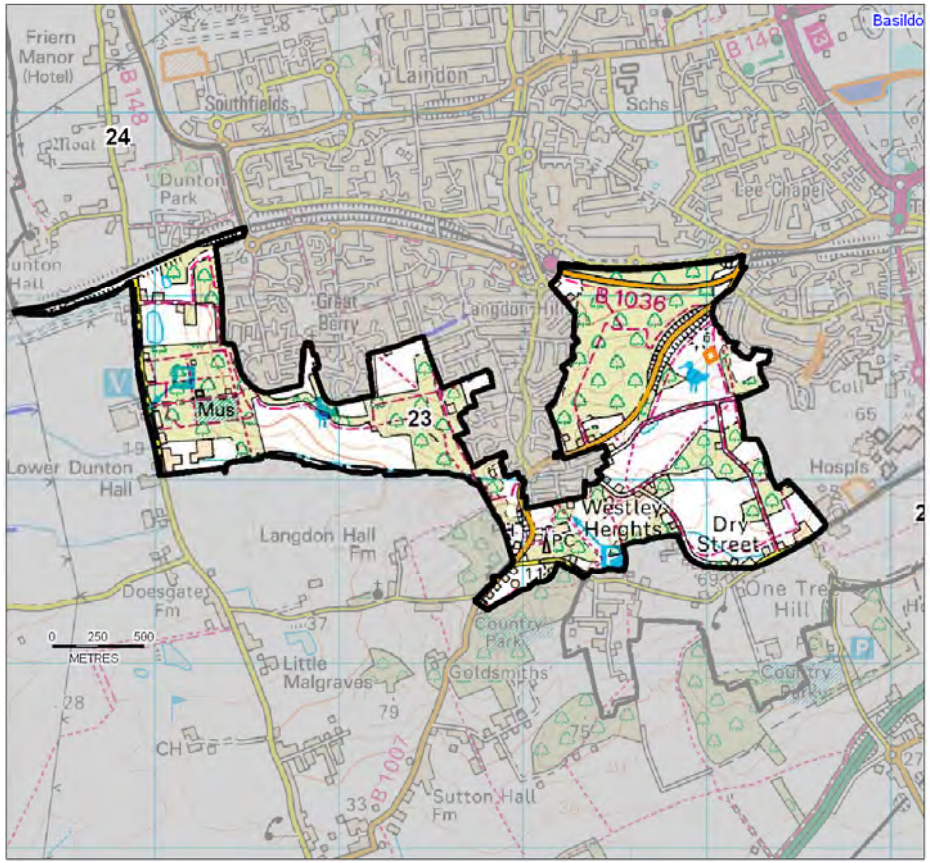
The Environment Agency FMfSW does not identify the area to be at increased risk of surface water flooding however this does not exclude the risk of surface water flooding on the site. An assessment of the risk of surface water flooding should be made during the preparation of a site specific FRA for any future development in this area. The findings of the Surface Water Management Plan should also be consulted in relation to this area.

Mitigation

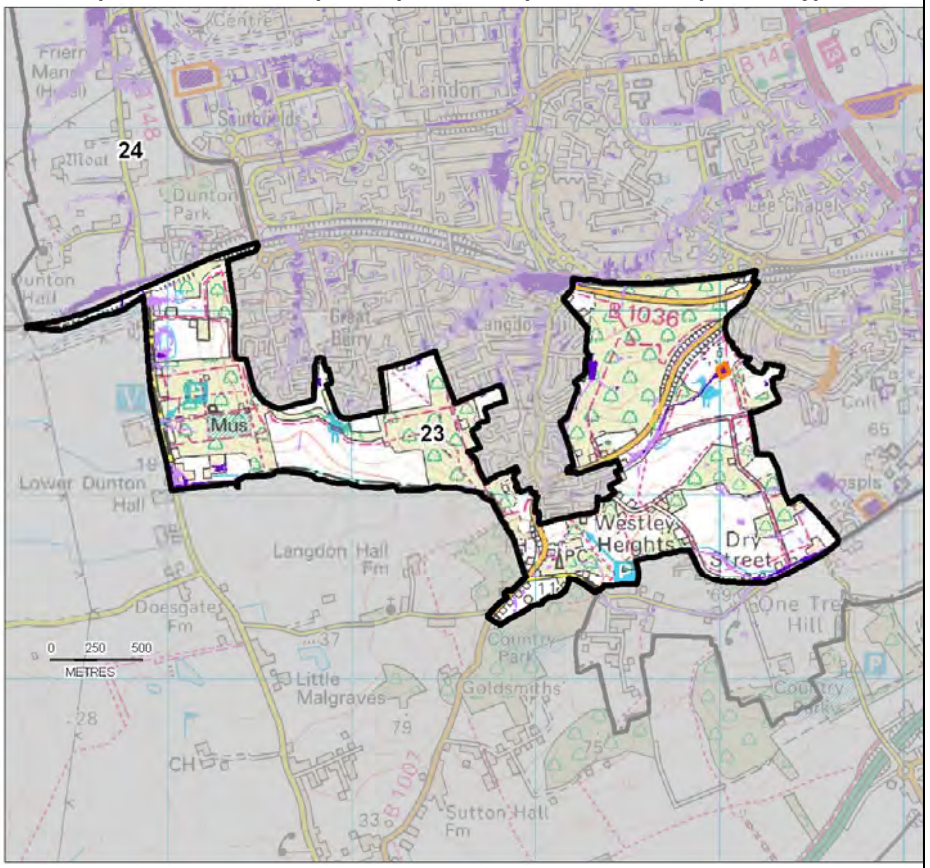
The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

Table 4-25 Area of Search No. 23 – Langdon Hills

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
315	315	100%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The vast majority of this AS (99.7%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Surface Water Flood Risk

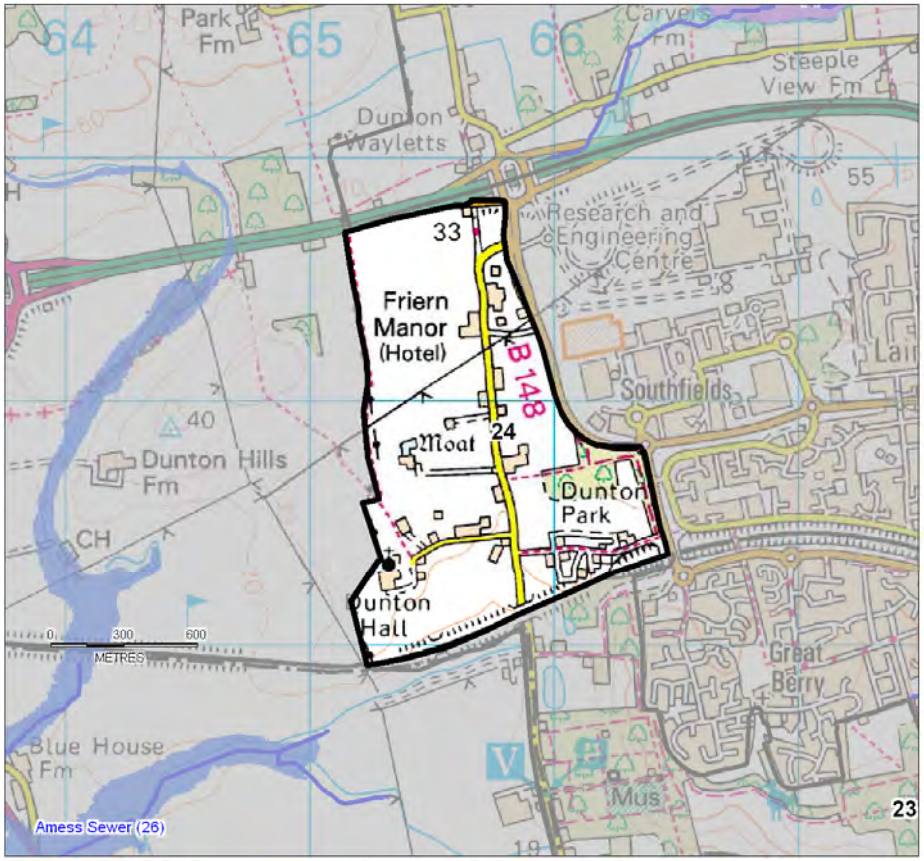
The Environment Agency FMfSW does not identify the area to be at increased risk of surface water flooding however this does not exclude the risk of surface water flooding on the site. An assessment of the risk of surface water flooding should be made during the preparation of a site specific FRA for any future development in this area. The findings of the South Essex Surface Water Management Plan should also be consulted in relation to this area.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

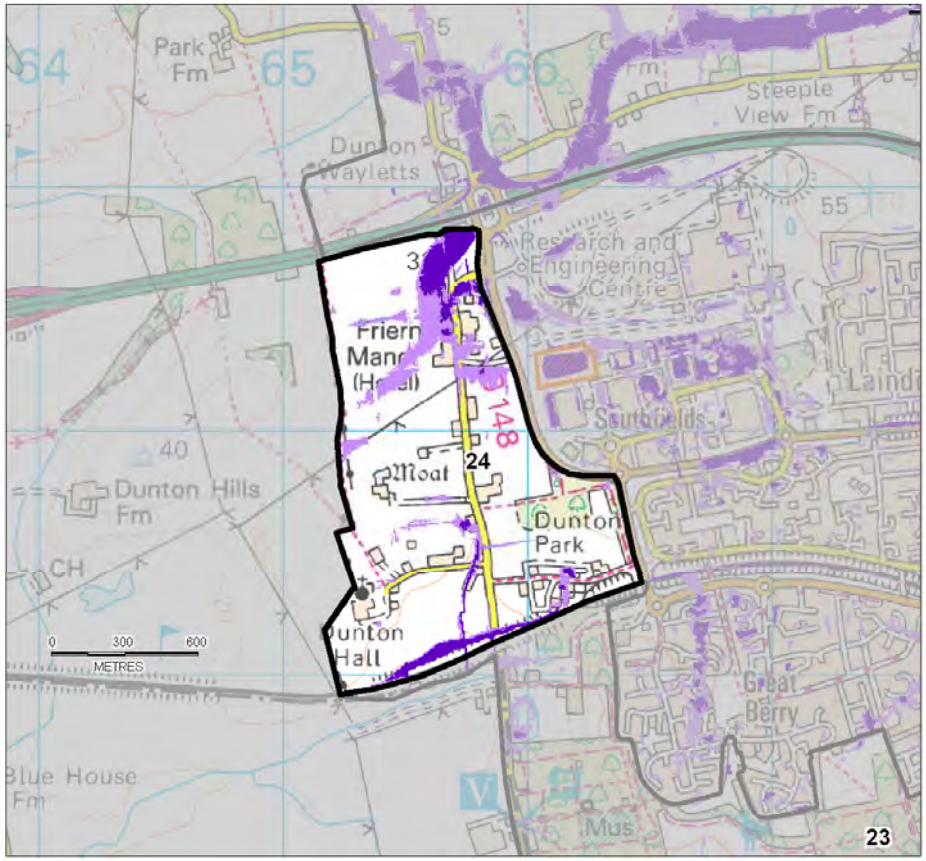
Table 4-26 Area of Search No. 24 – Lower Dunton Road, Laindon

Tidal / Fluvial Flood Zones



FZ 2 - Low Probability
FZ 3a - High Probability
FZ 3a with Climate Change
FZ 3b - Functional Floodplain
Main River
Ordinary Watercourse
Washland Area
Areas of Search
Shallow (> 0.1m Depth)
Deep (>0.3m Depth)

Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

AS Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
152	152	100%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The vast majority of this AS (99.7%) is defined as Flood Zone 1 – Low Probability of flooding from fluvial and tidal sources.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Surface Water Flood Risk

The Environment Agency FMfSW shows the northern part of this area of search around Friern Manor to be at increased risk of surface water flooding. Depths of greater than 0.3m are shown around the junction between the B148 and A13. Surface water is also shown to pond adjacent to the railway embankment in the south of the area. The Southfield washland area is located to the east of the area and provides a surface water management function.

Mitigation

The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

4.3 Urban Sites

4.3.1 Basildon Borough Council has also identified 9 Urban Sites (US) in which future development is more likely to be pursued given the more sustainable locations of these sites within the existing urban areas and the limited policy constraints applicable. Table 4-27 provides a review of the sites with respect to the fluvial and tidal Flood Zones.

Table 4-27: Summary Table – Urban Sites – Fluvial and Tidal Flood Zones

Urban Site	Area (Ha)	FZ1		FZ2		FZ3 CC		FZ3a		FZ3b	
		Area	%	Area	%	Area	%	Area	%	Area	%
Billericay Town Centre	11	11	100	-	-	-	-	-	-	-	-
Fords Dunton	98	98	100	-	-	-	-	-	-	-	-
Laindon Town Centre	4.8	4.8	100	-	-	-	-	-	-	-	-
Basildon Town Centre	71.1	71.1	100	-	-	-	-	-	-	-	-
Dry Street and College	43.6	43.6	100	-	-	-	-	-	-	-	-
Pitsea Town Centre	16.6	16.6	100	-	-	-	-	-	-	-	-
Gardiners Lane South, Basildon	37.6	37.6	100	-	-	-	-	-	-	-	-
Barn Hall, Wckford	43.7		100	-	-	-	-	-	-	-	-
Wickford Town Centre	24.7	16.9	68.5	6.1	24.6	0.8	3.4	0.3	1.0	0.6	2.4

4.3.2 The table shows that 8 of the 9 US are located within Flood Zone 1 and therefore have a low probability of flooding from fluvial or tidal sources. Tables 4-28 and 4-29 provide a review of these urban sites in relation to the Environment Agency Flood Map for Surface Water. This illustrates that all of the sites are at risk of surface water flooding to some degree. Pooling of surface water behind rail embankments creates large areas of 'deep' water including areas within Pitsea and Barn Hall.

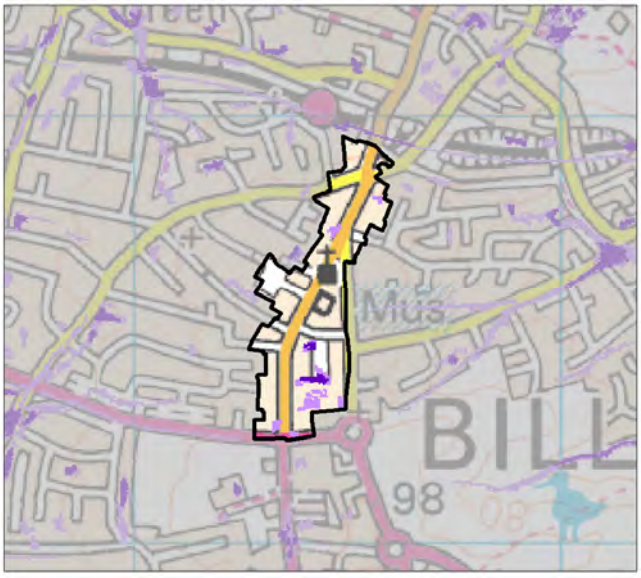
4.3.3 The River Crouch passes through Wickford Town Centre and as a result, 25% of this site is defined as Flood Zone 2 – Medium Probability, 1% is defined as 3a – High Probability of flooding from fluvial sources, and 2.4% is defined as Flood Zone 3b Functional Floodplain. Table 4-30 provides more detail regarding the fluvial and surface water flood risk issues facing Wickford Town Centre.

Table 4-28 Urban Site Assessment – Flood Map for Surface Water (FMfSW) 0.5% AEP

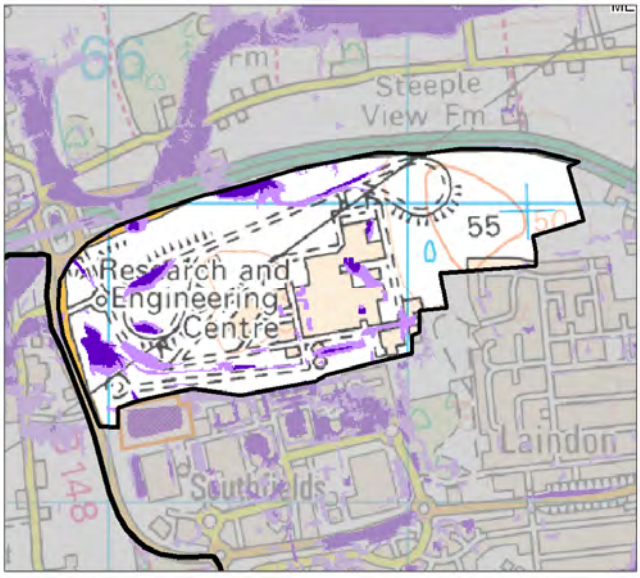
Legend

- Urban Site
- Shallow (> 0.1m Depth)
- Deep (>0.3m Depth)

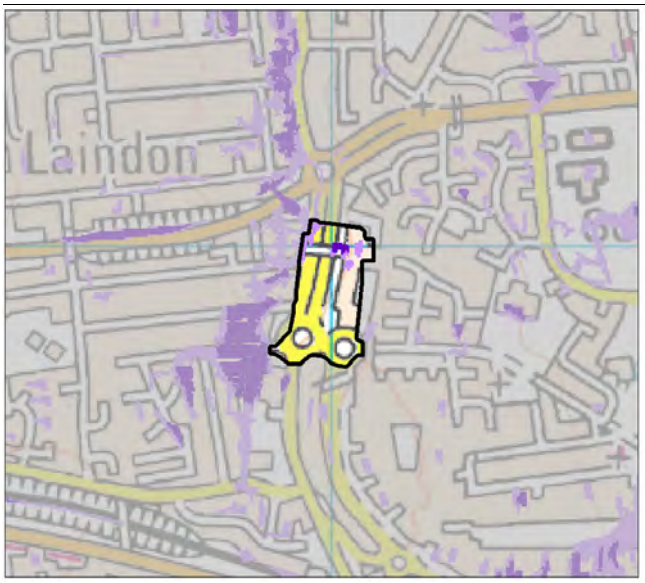
Billericay Town Centre



Fords, Dunton



Laindon Town Centre



Basildon Town Centre

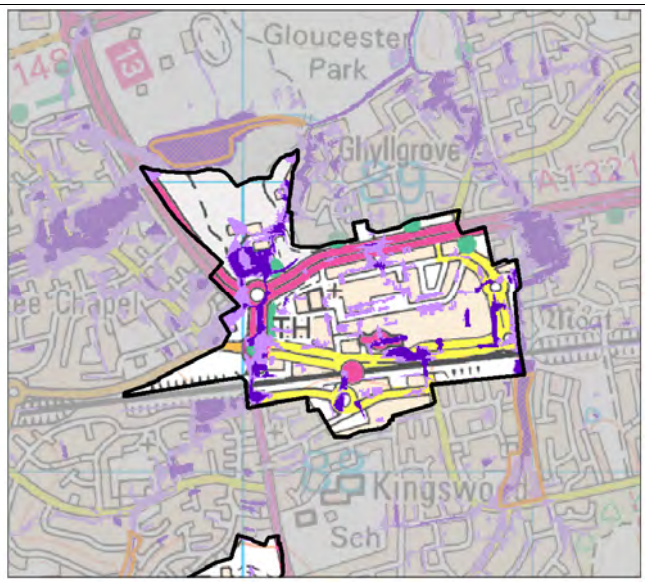
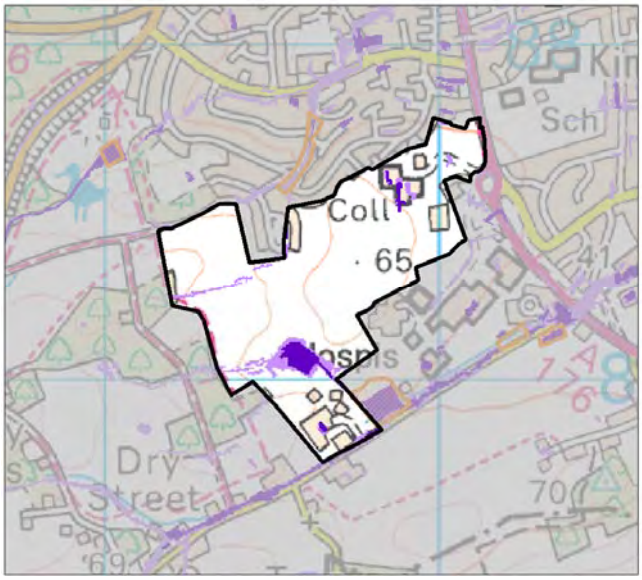


Table 4-29 Urban Site Assessment – Flood Map for Surface Water (FMfSW) 0.5% AEP

Legend

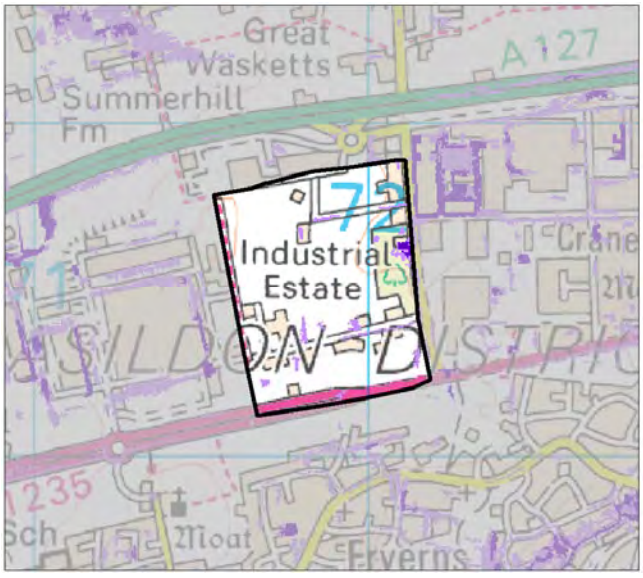
- Urban Site
- Shallow (> 0.1m Depth)
- Deep (>0.3m Depth)

Dry Street and College, Basildon



Pitsea Town Centre

Gardiners Lane South, Basildon



Barn Hall, Barn Hall

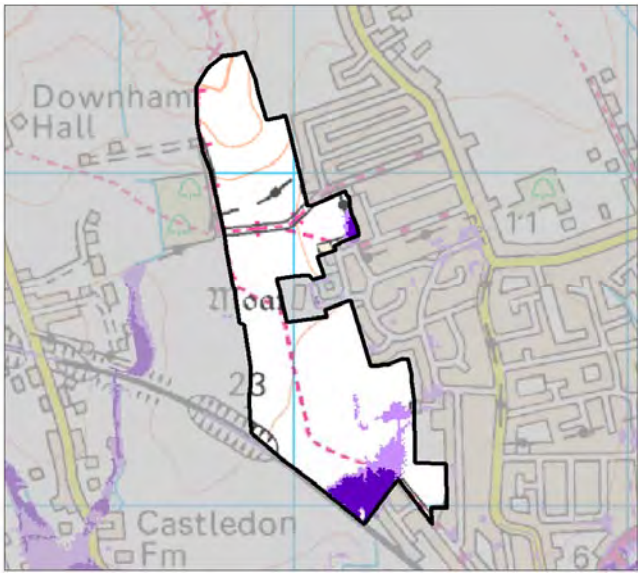
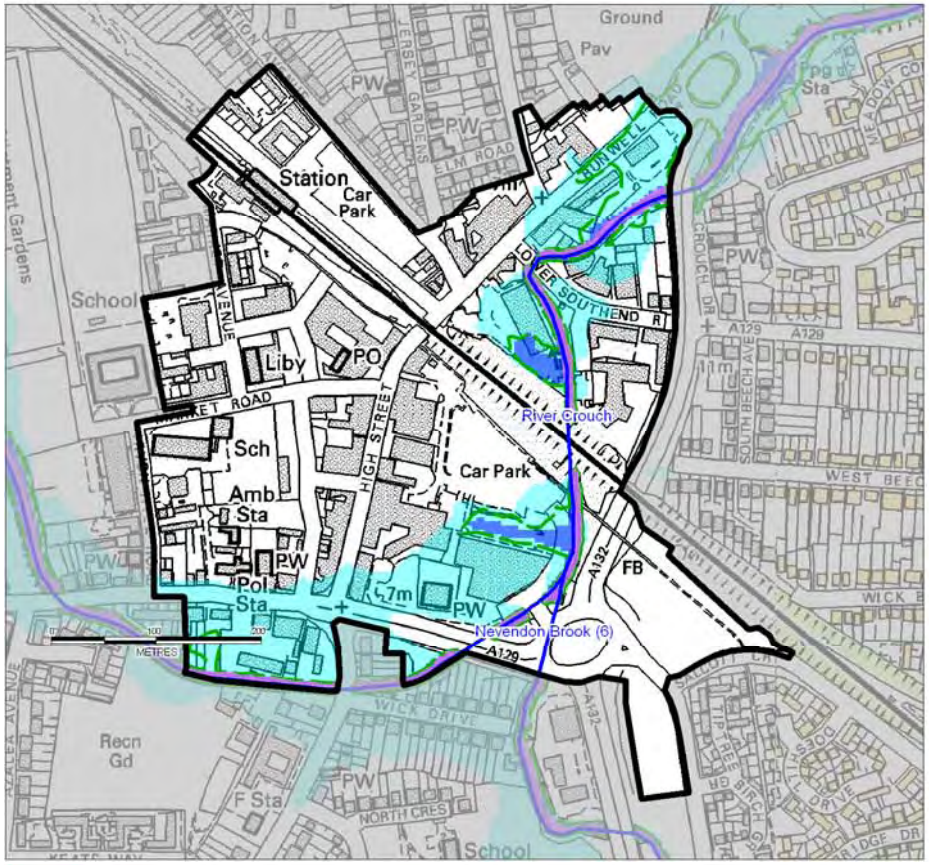
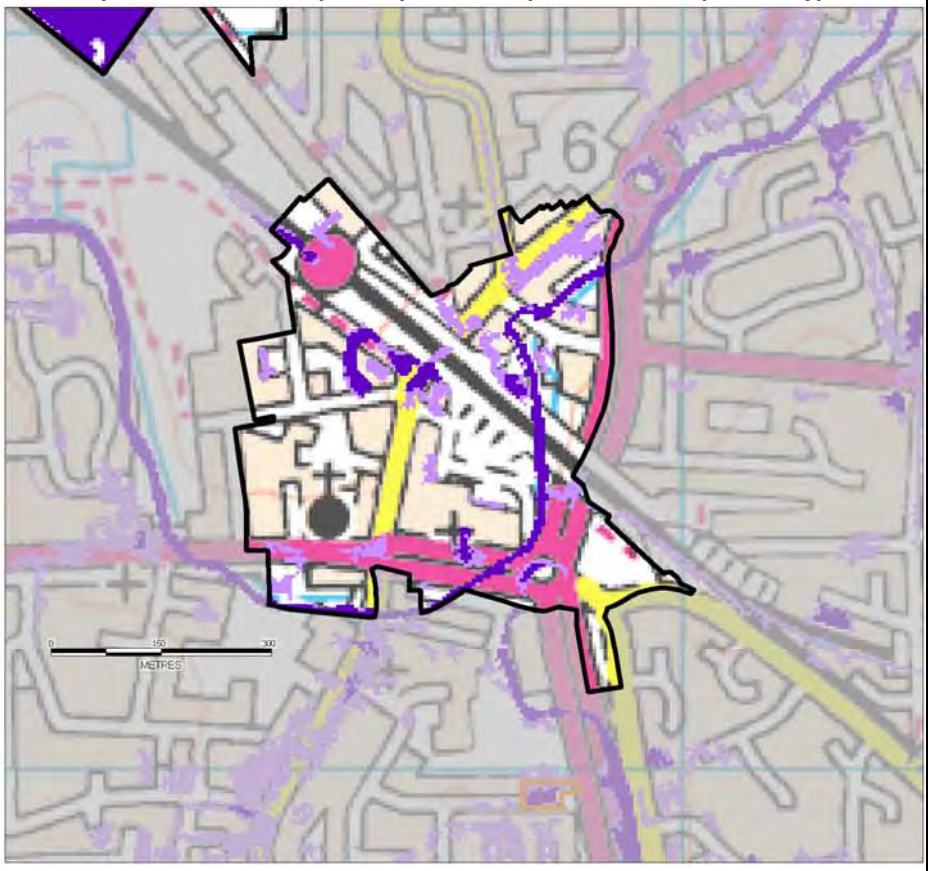


Table 4-30 Urban Site – Wickford Town Centre

Tidal / Fluvial Flood Zones



Flood Map for Surface Water (FMfSW) 0.5% AEP (1 in 200 annual probability)



Tidal / Fluvial Flood Risk

Site Area	Flood Zone 1		Flood Zone 2		Flood Zone 3a CC		Flood Zone 3a		Flood Zone 3b	
Ha	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
24.7	16.9	68.5%	6.1	24.6%	0.8	3.4%	0.3	1.0%	0.6	2.4%

* Cells have been left blank where modelling of Flood Zone 3b and 3a with Climate Change has not been undertaken as part of the Environment Agency Strategic Flood Risk Mapping (SFRM) work.

The River Crouch flows through Wickford Town Centre and is joined by the Nevendon Brook at the junction between the A129 and A132. The majority of the site (68.5%) is located in Flood Zone 1 – Low Probability of flooding from fluvial sources, however 24.6% is defined as Flood Zone 2 – Medium Probability, 3.4% is defined as Flood Zone 3a – High Probability and 2.4% is defined as Flood Zone 3b Functional Floodplain.

Permissible Development

Development should be steered towards areas in Flood Zone 1 in accordance with the sequential approach (PPS25 Para. D8). All types of development are permissible in Flood Zone 1. The following matrix identifies the development vulnerability types that are permitted within each Flood Zone.

Flood Risk Vulnerability Classification (Table D.2 PPS25)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3A	Exception Test required	✓	X	Exception Test required	✓
	3B	Exception Test required	✓	X	X	X

✓ – Development is appropriate (subject to the Sequential Test) × – Development should not be permitted

Mitigation

For any future development within Wickford Town Centre, minimum finished floor levels should be set above the maximum flood level associated with the River Crouch obtained from the Environment Agency, with an allowance of 300mm freeboard in accordance with Environment Agency guidelines. Flood resistant and resilient design measures should be considered for any development within Flood Zone 3a.

Access and egress from all parts of the site should be provided to enable the evacuation of people from the site or access for the emergency services during a flood event. Access/egress should be provided at or above the 1% AEP (1 in 100 year) fluvial flood level or 0.1% AEP (1 in 1000 year) tidal flood level, whichever is greater.

Any loss to the storage in the fluvial floodplain as a result of any proposed development will need to be compensated for on a level for level and volume for volume basis within the development.

The Environment Agency operates a Flood Warning system which should be monitored by occupants of this site.

Surface Water Flood Risk

The Environment Agency FMfSW shows some areas of surface water ponding adjacent to the railway line and around the railway station that are at increased risk of surface water flooding. The course of the River Crouch is also identified by the FMfSW.

Mitigation The design of a drainage strategy for the wider area should be considered early in the masterplanning stage for any future development to ensure that a coordinated and integrated system can be implemented. Site planning should consider flood flow routing to ensure that any potential flow paths are away from buildings into landscaped or car parking areas. Drainage systems should be designed with adequate capacity to store the 1% AEP (1 in 100 year) storm event including 30% climate change. Further guidance on this and designing safe and sustainable flood conveyance routes and storage is provided in Designing for exceedance in urban drainage good practice (CIRIA publication C635).

4.4 Summary

Areas of Search

4.4.1 24 Areas of Search have been reviewed with respect to fluvial flood zones, results from the hydrodynamic breach modelling and the Environment Agency Flood Map for Surface Water. The following areas of search have been identified to contain **areas at risk of fluvial flooding defined by Flood Zones 2 and 3a, and areas of increased risk of surface water flooding shown of the FMfSW**:

- AS01 Rawreth Shot
- AS03 Green Acres
- AS04 Ramsden Bellhouse
- AS05 Ramsden Crays
- AS06 Gurnard's Farm
- AS09 North Billericay
- AS10 West Billericay
- AS11 Little Burstead and Broomhills
- AS14 Barleylands
- AS15 East of Noak Bridge
- AS16 Crays Hill
- AS17 South-west Wickford
- AS18 South of The Wick
- AS19 North Benfleet

4.4.2 The following areas of search are identified to be at **low risk of fluvial flooding according to the Flood Zones, but increased risk of flooding from surface water as shown on the FMfSW**:

- AS02 Castledon
- AS07 East Billericay
- AS12 Little Burstead North
- AS20 Old Church Road, Pitsea
- AS24 Lower Dunton Road, Laindon

4.4.3 The following areas of search have **not been identified to be at risk of fluvial flooding according to the Flood Zones, or increased risk of surface water flooding shown on the FMfSW**:

- AS08 Southend Road, Billericay
- AS13 Langhams
- AS22 South Dry Street & Vange
- AS23 Langdon Hills

4.4.4 Area of Search 21, Bowers Marshes and Vange Marshes, is identified to be at **residual risk of flooding from tidal sources** in the event of a failure of the Fobbing Horse and/ or Benfleet Creek flood barriers.

Urban Sites

4.4.5 Of the 9 urban sites identified by Basildon Borough Council to undergo a review in relation to flood risk, 1 site is identified to be at risk of fluvial flooding; Wickford Town Centre. The River Crouch passes through this area and land within the corridor of this watercourse is at risk of fluvial flooding. This site is also identified to be at increased risk of surface water flooding by the Environment Agency FMfSW.

4.4.6 As well as Wickford Town Centre, four other urban sites are identified to be at increased risk of surface water flooding, which are:

- Basildon Town Centre
- Pitsea Town Centre
- Barn Hall, Wickford
- Dry Street and College, Basildon

4.4.7 The remaining urban sites; Laindon Town Centre, Gardiners Lane South, Billericay Town Centre and Fords Dunton are not at risk of flooding from fluvial sources and are not identified to be at increased risk of surface water flooding within the Environment Agency FMfSW.

Recommendations

Recommendation 1

4.4.8 It is recommended that the advice and guidance provided in the Level 1 SFRA with respect to the application of the Sequential Test and site selection guidance is consulted first, to inform where future development should be allocated in the Local Development Framework. Those areas identified to be at low risk of flooding should be preferentially developed prior to consideration of those areas and sites at greater risk of flooding in line with PPS25.

Recommendation 2

4.4.9 Where development cannot be avoided within Flood Zone 3a, the Exception Test will need to be applied. Section 5 of this report provides guidance on the requirements to satisfy all elements of the Exception Test in accordance with PPS25 for development proposals in the Basildon Borough.

Recommendation 3

4.4.10 Section 6 provides details on when a site specific Flood Risk Assessment will be required in the Basildon Borough and the requirements of such a report in terms of site and building layout and design and emergency procedures.

5 Guidance on the Application of the Exception Test

5.1 Overview

5.1.1 The aim of the Sequential Test is to steer all development towards areas of lowest flood risk. However, PPS25 recognises that in some exceptional circumstances, it may not be possible to locate development in areas of low or appropriate flood risk with respect to the vulnerability classification of the development. Where the Sequential Test has been carried out and it is shown that there are no reasonably available sites that would be appropriate to the type of development or land use proposed in lower flood risk areas, the Exception Test will then be required in some circumstances.

5.1.2 The Exception Test should be applied by decision makers to the LDD site allocations and used to draft criteria-based policies against which to consider planning applications. These policies should then be used to ensure that individual developer applications meet the criteria of Part c) of the Exception Test as outlined in Section 5.2 below.

5.1.3 Through the application of the Exception Test any additional wider sustainability benefits resulting from development can be taken into account in order to demonstrate that the benefits for development of a site outweigh the flood risks to the development and its occupants.

5.1.4 Reference should be made to PPS25 and its Practice Guide for details on the application of the Exception Test.

5.2 What is the Exception Test?

5.2.1 The Exception Test comprises three criteria, described below, all of which must be satisfied for development in a flood risk area to be considered acceptable.

Part A – Wider Sustainability to the Community

5.2.2 It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by this SFRA.

5.2.3 For this element to be passed, the site must be shown to positively contribute to the aims and objectives of the Council's Core Strategy Sustainability Appraisal. Where this is not the case, it must be considered whether the use of planning conditions or S106 agreements could make it do so. If neither of these are possible, the site is not deemed to pass Part 'A' and the allocation should be refused.

Part B – Redevelopment of Previously Developed Land

5.2.4 The development should be on developable previously developed land or, if not, it must be demonstrated there is no such alternative land available.

5.2.5 Planning Policy Statement 3: Housing (June 2011) defines previously developed land as:

'…that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.'

5.2.6 The definition includes defence buildings, but excludes:

- Land that is or has been occupied by agricultural or forestry buildings.
- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures.
- Land in built-up areas such as private residential gardens, parks, recreation grounds and allotments, which, although it may feature paths, pavilions and other buildings, has not been previously developed.
- Land that was previously-developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

5.2.7 There is no presumption that land that is previously-developed is necessarily suitable for housing development nor that the whole of the curtilage should be developed.

Part C – Safe from Flood Risk

5.2.8 A Flood Risk Assessment (FRA) must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall. At the level of strategic planning, the SFRA must be used in order to assess the potential feasibility of providing flood risk management measures for site allocations/broad development locations.

5.2.9 There are a number of ways a new development can be made safe:

- Avoiding flood risk by not developing in areas at risk from floods;
- Substituting higher vulnerability land uses for lower vulnerability uses in higher flood risk locations and locating higher vulnerability uses in areas of lower risk on a strategic scale, or on a site basis;
- Providing adequate flood risk management infrastructure which will be maintained for the lifetime of the development;
- Mitigating the potential impacts of flooding through design and resilient construction; and
- Confidence in robust emergency flood response plans, strategies and residents ongoing flood awareness at both community and site level linked to the level of residual risks.

5.2.10 The PPS25 Practice Guide (CLG 2009) provides further guidance for providing safe development in Chapter 6 – Risk Management by Design, and Chapter 7 – Residual Risk.

5.2.11 Section 6 of this report provides general information regarding the preparation of site specific Flood Risk Assessments and guidance for future ‘safe’ development within medium and high flood risk areas of the Basildon Borough.

6 Site Specific FRA Guidance

6.1 Overview

6.1.1 The Level 1 and Level 2 SFRAs provide a review of existing flood risk information in the area. The Level 2 SFRA has built upon the findings of the Level 1 SFRA (June 2011) with respect to residual tidal flood risk and surface water flooding information.

6.1.2 The scope of this document remains strategic and it is therefore vital that site specific Flood Risk Assessments are prepared for future development proposals. It is possible that flood risk exists within an area that has not been highlighted in the SFRAs either because the information was not available at the time of writing or due to other factors, for example the location of breach assessments relative to development areas. Therefore, site specific FRAs are required to assess the flood risk posed to proposed developments and to ensure that where necessary and appropriate, suitable mitigation measures are included in the development. They should build upon information from the SFRA, where this is helpful or strengthens the assessment.

6.1.3 This section presents recommendations and guidance for site-specific FRAs prepared for submission with planning applications in the Basildon Borough Council administrative area.

6.2 When is a Flood Risk Assessment required?

6.2.1 The Environment Agency provides flood risk standing advice for applicants and agents on their website http://www.environment-agency.gov.uk/research/planning/82587.aspx. Planning Policy Statement 25 Development and Flood Risk provides guidance on the level of detail that a Flood Risk Assessment should meet. However, PPS25 will be replaced by the 'National Planning Policy Framework' in the coming months. It is anticipated that the level of guidance provided at a national scale will be reduced, however the requirements of when a Flood Risk Assessment is likely to remain the same.

6.2.2 In the following situations a Flood Risk Assessment should always be provided with a planning application:

1. The development site is located in Flood Zones 2 or 3;
2. The area of the proposed development site area is 1 hectare or greater in Flood Zone 1. This is to ensure surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property. Surface water management will also need to be considered as part of the Flood Risk Assessment for sites of 1 hectare or greater in Flood Zone 2 and 3; and
3. The development site is located in an area known to have experienced flooding problems from any flood source.

6.3 What does a Flood Risk Assessment include?

6.3.1 The PPS25 Practice Guide (CLG 2010) sets out a staged approach to site specific Flood Risk Assessments, with the findings from each stage informing both the next level and the site

Masterplan throughout the development process. Table 6-1 provides a summary of the three levels.

6.3.2 FRAs should always be proportionate to the degree of flood risk in each case and appropriate to the scale, nature and location of the proposed development as well as its vulnerability.

Table 6-1 Levels of Site Specific FRA, PPS25 (CLG 2010)

FRA Level	Description of Report Content
Level 1 **Screening Study**	The Level 1 Flood Risk Assessment is intended to identify any flooding or surface water management issues related to the development site that may require further investigation. The study should be based on readily available existing information, including: • SFRA, • Environment Agency Flood Maps, • Standing Advice The Level 1 Flood Risk Assessment will determine the need for a Level 2 or 3 FRA.
Level 2 **Scoping Study**	Where the Level 1 Flood Risk Assessment indicates that the site may lie in an area at risk of flooding, or may increase flood risk elsewhere due to runoff, a Level 2 Flood Risk Assessment should be carried out. This report will confirm sources of flooding which may affect the site and should include the following; • Appraisal of available and adequacy of existing information; • Qualitative appraisal of the flood risk posed to the site, the potential impact of the development on flood risk on and off the site; • An appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. This Level may identify that sufficient quantitative information is already available to complete a Flood Risk Assessment appropriate to the scale and nature of the development.
Level 3 **Detailed Study**	Undertaken if the Level 2 Flood Risk Assessment concludes that further quantitative analysis is required in order to assess flood risk issues related to the development site. This Level should include: • Quantitative appraisal of the potential flood risk to the development; • Quantitative appraisal of the potential impact of development on the site under investigation on flood risk on and off the site; • Quantitative demonstration of the effectiveness of any proposed mitigation measures.

6.3.3 Annex E of PPS25 presents the minimum requirements for a Flood Risk Assessment as follows:

- Consider the risk of flooding off-site arising from the development in addition to the risk of flooding on-site to the development;
- Identify and quantify the vulnerability of the development to flooding from different sources and identify potential flood risk reduction measures;
- Assess the remaining 'residual' risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development;
- Consider the vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access as prescribed by Planning Policy Statement 25 (PPS25) and associated guidance;

- Consider the ability of the soil to receive surface water runoff generated on site, and how it would be stored and managed, along with how the proposed layout of development may affect drainage systems; and
- All calculations must fully account for current climate change scenarios and their effect on flood zoning and risk.

6.3.4 Currently, depending on the scale and risk of development, the Environment Agency will comment on site specific Flood Risk Assessments including a review surface water drainage strategies. This role is to move to the LPAs under the Suds Approval Body (SAB) which will be in place by April 2112. At all stages, Basildon Borough Council and where necessary the Lead Local Flood Risk Authority: Essex County Council, the Environment Agency and Anglian Water should be consulted to ensure the Flood Risk Assessment provides the necessary information to fulfil the requirements for Planning Applications in the Basildon Borough.

6.4 Risks of Developing in Flood Risk Areas

6.4.1 Developing in flood risk areas can result in significant risk to a development and site users. It is possible to reduce the risk through the incorporation of mitigation measures; however, these do not remove the flood risk altogether and developments situated in the floodplain will always be at risk from flooding. This creates Health and Safety considerations, possible additional costs and potential displacement of future residents during flood events, which could result in homes and businesses being uninhabitable for substantial periods of time.

6.4.2 In addition to those issues noted above, planners and developers should also be aware of the following when developing in flood risk areas:

- Failure to consider wider plans prepared by the Environment Agency or other operating authorities may result in a proposed scheme being objected to;
- Failure to identify flood risk issues early in a development project could necessitate redesign of the site to mitigate flood risk;
- Failure to adequately assess all flood risk sources and construct a development that is safe over its lifetime could increase the number of people at risk from flooding and/or increase the risk to existing populations;
- Failure to mitigate the risk arising from development may lead to claims against the developer if an adverse effect can be demonstrated (i.e. flooding didn't occur prior to development) by neighbouring properties/residents;
- Properties may be un-insurable and therefore un-mortgageable if flood risk management is not adequately provided for the lifetime of the development;
- By installing SuDS without arranging for their adoption or maintenance, there is a risk that they will eventually cease to operate as designed and could therefore present a flood risk to the development and/or neighbouring property;
- The restoration of river corridors and natural floodplains can significantly enhance the quality of the built environment whilst reducing flood risk. Such an approach can significantly reduce the developable area of sites or lead to fragmented developments, however positive planning and integration throughout the master planning process should resolve these potential issues.

6.5 Planning Requirements

PPS25 Sequential & Exception Tests

6.5.1 A site specific FRA for a proposed development should demonstrate that the development is in accordance with the LPA's Core Strategy or Site Allocations DPDs if they exist. Where the site has not been sequentially tested already, the FRA should provide the necessary information to enable the LPA to do so. If the Exception Test is required, the FRA should provide the necessary evidence to support part c) of the test.

6.6 Emergency Planning Considerations

Flood Warning Systems

6.6.1 The Civil Contingencies Act (2004) requires that the Environment Agency *'maintain arrangements to warn the public of emergencies'* including flood risk. The existing warning service provided by the Environment Agency applies only to flooding from rivers and the sea. There is no obligation on Water Companies to provide warnings of flooding from sewers or drains.

6.6.2 The Environment Agency are responsible for issuing flood warnings to the public based on meteorological reports and forecasts, including the use of radar to track storms and rainfall intensity, and data from the national tide gauge network. If flooding from rivers and the sea is forecast, warnings are issued using a set of four codes via the Environment Agency website, through TV and radio, SMS, fax, direct to peoples' homes via an automatic voice message and in some areas via public address systems. All existing development is included in the service under the 'opt out' policy; however any new development in the area will need to 'opt in' in order to benefit from the service. Flood warnings for Basildon Borough Council are mainly delivered by media-based delivery and broadcast. There is however also provision for the Council to warn residents by SMS, if they have subscribed to the Councils "Warn & Inform" system, which is free of charge.

6.6.3 It should be noted that while it is a significant challenge to provide warning of a possible flood defence failure (a breach) the likelihood of a failure is significantly increased during an extreme tide event, particularly in circumstances where an extreme tide is forecast to overtop flood defence embankments. In this scenario, warnings of a high tide will have been issued to the local community who should be on alert.

6.6.4 The degree of advance warning that can be provided is critical to the amount of action that can be taken to prevent damage. It is anticipated that the Environment Agency will be able to provide at least 12 hours of warning time of extreme tides (i.e. 200 year event or greater (0.5% annual probability)).

6.6.5 When conditions require, e.g. forecasts of high tide with high winds, the moveable flood barriers on the Benfleet Creek and at the Fobbing Horse are operated by Environment Agency staff and closed if necessary.

6.6.6 It is noted that the flood warning service provided by the Environment Agency does not extend to warnings for surface water flooding events. Extreme Rainfall Alerts available from the Met Office/National Flood Forecasting Centre to Local Authorities and the Emergency Services can be used to help identify wider geographical areas that could be affected by pluvial flooding, however this does not include provision of warnings directly to the public.

Emergency Evacuation Plans

6.6.7 The Civil Contingencies Act 2004 delivers a single framework for civil protection. Basildon Borough Council are designated as a Category 1 responder and have a legal duty to assess local risks and use this information to inform emergency planning, put in place emergency plans and put in place arrangements to warn, inform and advise the public in the event of an emergency.

6.6.8 The Civil Contingencies Act (2004) defines an emergency as:

- *An event or situation which threatens serious damage to human welfare (e.g. loss of life, injury, damage to property).*
- *An event or situation which threatens serious damage to the environment (e.g. contamination).*

6.6.9 Flood Warning and Emergency Procedures tend to form part of a higher level emergency management plan for the wider area including information such as infrastructure repair procedures (including breaches in tidal defences), evacuation routes, refuge areas, flood warning dissemination and responsibilities.

6.6.10 Flood warnings provided by the Environment Agency can be used to enable timely evacuation of residents. Rescue by the emergency services is likely to be required where flooding has occurred and prior evacuation has not been possible.

6.6.11 Basildon Borough Council has prepared an Emergency Plan (December 2009) which sets out the framework for integrated management of emergencies within the Borough, including flooding incidents. Rest centres have been identified across the Borough within the Emergency Plan.

6.6.12 Evacuation Plans for individual developments located within areas at risk of flooding should be prepared by developers in conjunction with the borough-wide Emergency Plan to direct people to safety during times of flood. This may include details of flood warning mechanisms and an evacuation route away from the site to an area outside the floodplain in cases where flood warning delivery times would allow for this; or to a place of safe refuge within the development itself if insufficient time is available to evacuate and/or the emergency services advise against evacuation. Guidance on what should be contained within a site level Emergency Flood Plan can be found within Appendix F.

6.6.13 When submitting FRAs for developments within flood risk areas, developers should make reference to Basildon Borough Council's strategic Emergency Plan and Environment Agency flood warning systems to demonstrate that their development will not impact on the ability of Basildon Borough Council and the emergency services to safeguard the population. The flood hazard in a particular area must be viewed in the context of the potential evacuation and rescue routes to and from that area and discussed as part of a site specific FRA.

6.7 Safe Development & Managing Flood Risk

6.7.1 It should be noted that the specific definition of 'safe' development will vary for each individual site based on location and development vulnerability. It is therefore recommended that developers consult with the Environment Agency, emergency planners and emergency services on a site by site basis to establish an appropriate definition of 'safe' development for specific sites.

6.7.2 For developments proposed in areas at risk of flooding, the following items should be addressed as part of a site specific FRA in order to demonstrate that proposed developments area 'safe' in line with PPS25.

Sequential Approach

6.7.3 Paragraph D8 of PPS25 (CLG 2010) identifies the need for developers to apply the sequential approach when locating development within a site. This process should ensure that elements of the redevelopment that are of greater vulnerability are located in parts of the site at lowest risk.

6.7.4 Where sites come forward that fall within a range of flood zones, it should therefore not be assumed that all of the site will be available for a particular type of development, nor should it be considered that the site must be wholly discounted as suitable for development if only part of it is covered by a flood zone.

Access and Egress

6.7.5 PPS25 requires that safe access and egress is provided to enable the evacuation of people from the development at or above the 1% AEP fluvial (1 in 100 annual probability) and the 0.5% AEP tidal (1 in 200 annual probability) flood event up to the 0.1% AEP (1 in 1000 annual probability) flood event, in order to provide emergency services with access during a flood event and enable flood defence authorities to carry out their duties during periods of flood.

6.7.6 Wherever possible, access routes should be provided so that they are located above the design flood levels (see above). Where this is not possible, limited depths of flooding may be appropriate, provided that the proposed access is designed with appropriate signage and other measures to make it safe. The acceptability of the proposed access should be assessed using Table 13.1 of Defra Research document FD2320/TR2: FRA Guidance for New Developments which takes into account the flood depth, velocities and risk of debris within the water. The access/egress route must fall within the "white cells" of this document's relevant mapping outputs.

6.7.7 This assessment should also consider the following:

- The **vulnerability** and **mobility** of those in danger of flooding; development for highly vulnerable users e.g. disabled or the elderly, should be located away from high-risk areas. Whilst the Sequential Test accounts for the vulnerability of the intended use of the development, no specific consideration is made for the vulnerability of the end users of the site. A proposed residential development for highly vulnerable end users (elderly, physically impaired etc) will still fall under the 'More Vulnerable' classification in Table D.2 of PPS25 and the Sequential and Exception Tests will apply accordingly. Where development for highly vulnerable end users cannot be avoided, safe and easy evacuation routes are essential.
- The **time to inundation** mapping relates to the amount of time it takes for a flood event to reach its maximum level, flow or height; its 'peak'. Flood events with a very short time to peak provide very little time and opportunity for evacuation. This is typically the case if a defence structure is breached or fails because the inundation will be rapid, resulting in a short time to peak for the areas local to the breach. On the other hand, during tidal events, should a breach occur early in the tidal cycle, the time to peak could be a lot slower which would allow evacuation procedures to be put in place. Typically, areas immediately adjacent to a breach location will have a shorter time to peak than areas set back from the flood defence.

6.7.8 It may not be possible for all developments to be proposed in areas where both safe access and egress can be guaranteed during a flood. In this situation, the potential implications for development should be considered by assessing the following:

- Probability of flooding;
- Expected flood hazard;
- Likelihood of occupancy during flooding, based on the proposed use;
- Acceptability of disruption based on the proposed use;
- Availability of safe refuge;
- Potential for the provision of key services (e.g. water, electricity, telecommunications);
- Expected duration of inundation.

6.7.9 The findings within this Level 2 SFRA should, where appropriate, be used to assess proposed access routes with respect to the criteria listed above.

Provision of Safe Refuge

6.7.10 In exceptional circumstances, a building may remain safe during a flood event but safe access and egress to and from the building may not be guaranteed. The acceptability of the development will then be dependent upon an assessment of the probability of flooding; expected flood hazard; likelihood of occupancy during flooding; how acceptable the disruption would be; the provision of safe refuge; availability of key services; and the expected duration of inundation by floodwaters.

6.7.11 Safe refuge must be located above the design flood level and be freely accessible by all occupants of the development via internal staircases from all areas that are below the design flood level.

6.7.12 Refuge should be provided of a quality and size that is appropriate given the potential duration of flooding at the site and the number of people that the refuge would be required to support. This should be discussed with the Council's Emergency Planning Officers and the emergency services before the submission of detailed plans.

6.7.13 The Essex Resilience Forum Multi Agency Flood Plan provides a number of definitions that are of importance when considering flood response operations:

> **Rescue** - the recovery of people from imminent danger, or place of temporary refuge when flood water has inundated an area. The key determinant in defining an activity as a rescue is whether it requires specialist trained and equipped teams to recover casualties and take them to a "place of safety", not the immediacy of the action or level of risk involved.
>
> **Evacuations** - involve the movement of people, either through their own efforts or with the assistance of others, to a "place of safety" without the need for specialist trained and equipped rescuers'. By definition, this describes activities which take place before an area is inundated by flood water.
>
> **A temporary refuge** - is any place or structure where individuals trapped by flood water can remain for a short period in relative safety whilst awaiting rescue. Given the risks arising from being cut off from essential services and support, especially for vulnerable members of society, refuges cannot be considered a place of safety even if they can guarantee the immediate physical safety of casualties from flood water.

A place of safety - can be defined as a place where people are no longer in danger from flood water and can freely access essential services or disperse without the need for specialist assistance, i.e. rescue boats or helicopters.

Finished Floor Levels

6.7.14 Where development in flood risk areas is unavoidable, the most common method of mitigating flood risk to people is to ensure habitable floor levels are raised above the maximum flood water level with an allowance of 300mm freeboard. This can substantially reduce the damage to property and risk of injury and fatalities.

6.7.15 In areas of minimal floodwater depth, raising finished floor levels may be included into the building design. Where the floodwater depth is more substantial, ground floor uses can be restricted to less vulnerable uses, such as commercial use, garage, utility areas and public space, with habitable areas above.

6.7.16 It is considered prudent to set the minimum finished floor levels 300mm above street/pavement level for all new development to act as a safeguard against internal flooding from surcharging drainage systems which is likely to be a more frequent phenomenon in the future.

It should be noted that the Environment Agency are constantly reviewing their guidance based upon experience, increasing knowledge and the findings of new research. The above criteria are therefore subject to change in the future, therefore requirements from the Environment Agency at the time of an application, may be different to the finished floor levels stated in this SFRA.

Basement Dwellings

6.7.17 Basement dwellings are classified as 'Highly Vulnerable' according to PPS25 (CLG 2010). As such they are not permitted within Flood Zone 3a and must pass the Exception Test should they be proposed for Flood Zone 2. Basements dwellings should therefore be discouraged within areas at risk of fluvial, surface water or groundwater flooding. Where they are constructed, access must be situated 300mm above the design flood level, and waterproof construction techniques should be employed to avoid seepage during flood events. An assessment of groundwater conditions will also be required to inform the structural integrity of the basement construction.

6.7.18 Where excessive surface water ponding occurs close to the sides of buildings or basements, infiltration may risk structural integrity of those structures. Surface water flow paths should be assessed to ensure that this does not occur, and to inform the strategic location of SuDS and techniques to route flows around the edge of buildings. It can be difficult to counter claims that basement dwellings will not add to flood risks. Even a minor flood can give rise to significant safety and damage consequences in a basement even when flood hazard and damage at ground level outside the development is low.

Recommendation 4

6.7.19 It is recommended that Basildon Borough Council consider adopting a policy of refusing applications for basement dwellings that are within the Flood Zone 2 and 3 extents (1 in 1000 and 1 in 100 year).

Flood Resilient / Resistant Construction

6.7.20 The Association of British Insurers (ABI) in cooperation with the National Flood Forum has published guidance on how homeowners can improve the food resilience of their properties (ABI, 2004). These measures not only reduce flood risk to properties, by reducing residual risk, but can also improve the insurability of homes in flood risk areas. The guidance identifies the key flood resistant measures for different construction methods, further details can be found in the CLG's report Improving the Flood Resilience of New Buildings (CLG, 2008), and the ODPM's report, 'Preparing for Floods' (ODPM, 2003).

6.7.21 In the document '*Improving the Flood Performance of New Buildings, Flood Resilient Construction'*, a number of design strategies are detailed including the Water Exclusion Strategy and Water Entry Strategy. 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, for example depths of less than 0.3m.

6.7.22 For significant flood depths, for example in excess of 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, i.e. the Water Entry Strategy. (It is noted that for depths between 0.3 – 0.6m, attempts should be made to exclude water in part or in full, depending on structural assessment. However if structural concerns exist, the Water Entry Strategy should be adopted).

6.7.23 The principle behind the Water Entry Strategy is not only to allow water through the property to avoid the risk of structural damage, but also to implement careful design in order to minimise damage and allow rapid re-occupancy of the building. PPS25 considers these measures to be appropriate for both changes of use and for less vulnerable uses where temporary disruption is acceptable and suitable flood warning is received.

6.7.24 Materials will 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.

6.7.25 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' (CLG, 2007).

Flow Paths and Floodplain Compensation

6.7.26 Where development proposals result in a reduction of the ***fluvial*** floodplain it is essential that new floodplain storage capacity is provided to compensate this loss. The Environment Agency requires this to be provided on a 'Level for Level, Volume for Volume Basis'. *N.B. Any encroachment into tidal floodplains does not normally require compensation storage; this should be confirmed with the Environment Agency on a site by site basis.*

6.7.27 Potential overland flow paths should be determined and appropriate solutions proposed to mitigate the impact of the development, for example through the configuration of road and building layouts to preserve existing flow paths and improve flood routing whilst ensuring that flows are not diverted

towards other properties. Any raising of the land as part of the development, for example, to achieve safe access, will need to be carefully considered as part of the FRA to ensure that no obstruction is made to flood flow routes.

Set Back Distances

6.7.28 Where development is located adjacent to a watercourse, it will be necessary to set back development from flood defences. This is required to enable the Environment Agency to gain access to the defences for maintenance and upgrades. This should also be taken into consideration when allocating sites for future development.

Land Raising

6.7.29 Land raising can have mixed results when used as a secondary flood alleviation measure. It can be an effective method of reducing flood inundation on certain areas or developments by raising the finished ground levels above the predicted flood level. However, it can result in the reduction in flood storage volume within the flood cell. As a result, floodwater levels within the remainder of the cell can be increased and flooding can be exacerbated elsewhere. Level for level compensatory storage should be provided where any loss of fluvial floodplain storage has occurred as a result of land raising or developing within the undefended floodplain.

6.7.30 Partial land raising can be considered in larger, particularly low lying areas such as marshlands. It may be possible to build up the land in areas adjacent to flood defences in order to provide secondary defences. However, again the developer should pay due regard to the cumulative effects of flooding such as increasing flood risk elsewhere.

6.7.31 It should also be remembered that although land raising may allow for development above the flood level, it may also create a 'dry island' which may still not overcome the issue of a safe access/egress route from the site. This must be considered where land raising is suggested as mitigation for developing in an area liable to flooding.

Recreation, Amenity and Ecology

6.7.32 Recreation, amenity and ecological improvements can be used to mitigate the residual risk of flooding either by substituting less vulnerable land uses, by attenuating flows or both. Examples include the development of parks and open spaces, through to river restoration schemes. The aim of these techniques is to increase flood storage, and the storage and conveyance of rainwater. Typical schemes include arrangements of pools, ponds and ditches.

Secondary Defences

6.7.33 Secondary defences are those that exist on the dry side of primary defences. Typically, their main function is to reduce the risk of residual flooding following a failure or overtopping of the primary defences.

6.7.34 Secondary defences can relocate floodwaters away from certain areas or reduce the rate of flood inundation following a residual event. Examples of secondary defences include embankments or raised areas behind flood defence walls, raised infrastructure e.g. railways or roads and, on a strategic level, canals, river and drainage networks. The latter are a form of secondary defence as they are able to convey or re-direct water away from flood prone areas even if this is not their primary function.

Existing Developed Areas in Flood Zone 3b

6.7.35 PPS25 defines Flood Zone 3b Functional Floodplain as *'land where water has to flow or be stored in times of flood'*. The definition remains open to interpretation and agreement between the Environment Agency and the Local Planning Authority, however, areas which would naturally flood with an annual exceedance probability of 5% (1 in 20 year) or greater are often used as a starting point for delineation of Functional Floodplain and have been used to map Flood Zone 3b in this SFRA.

6.7.36 Paragraph 4.91 of the PPS25 Practice Guide states that existing developed areas are not generally defined as part of the Functional Floodplain. In these cases, PPS25 advocates an approach whereby the high level of flood risk is acknowledged and recognised without applying the strict policy restrictions associated with Functional Floodplain.

6.7.37 Existing developed areas lying within Flood Zone 3b, whilst scarce and predominantly affecting rural properties, are present within the Borough. Flood Zone 3b, which is chiefly associated with the River Crouch, covers approximately 1.2km^2 across the Borough and an analysis of the Environment Agency National Receptor Database identifies that 24 dwellings are shown to lie within the Flood Zone 3b envelope. The classification of whether or not a site within these areas lies within the Functional Floodplain should be identified on a site by site basis as part of a site specific Flood Risk Assessment.

6.7.38 Where it can be demonstrated that the existing buildings exclude floodwater, for example due to raised floor levels and appropriate flood resistant building measures, these buildings are not considered to be part of the Functional Floodplain. Where the existing buildings do not exclude floodwaters, the site is Functional Floodplain and further redevelopment of the site is only permitted for Water Compatible land uses or Essential Infrastructure subject to the satisfaction of the Exception Test, in accordance with PPS25.

6.7.39 Where a site is not considered to be located within Functional Floodplain, any future redevelopment should be restricted to less vulnerable land uses. More vulnerable land uses should be actively discouraged and should only be considered within sites of an equivalent existing land use.

6.7.40 Any future redevelopment within this area must result in a reduction in the flood risk to and from the proposed development, and opportunities should be sought to create areas for the storage and conveyance of floodwaters.

Future Development of Washland Areas

6.7.41 PPS25 states that local planning authorities should identify within their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. Flood Zone 3b comprises land where water has to flow or be stored in times of flood. PPS25 states that the identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Land which would flood with an annual probability of 5% (1 in 20) or greater in any year, or is designed to flood in an extreme (0.1%) flood, should provide a starting point for consideration and discussions to identify the functional floodplain.

6.7.42 PPS25 states that Local Planning Authorities should identify within their SFRAs areas of functional floodplain, in agreement with the Environment Agency. Therefore, in accordance with PPS25 and following correspondence from the Environment Agency, the washland 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. 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.

6.7.43 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

6.7.44 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.

6.7.45 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

6.7.46 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 PPS25 would be satisfied and the Environment Agency and Basildon Borough Council would uphold this.

6.7.47 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.

Sewer Flooding

6.7.48 A review of the risk of sewer flooding across the Borough has been included within the Level 1 SFRA. In areas at risk of sewer flooding, a site specific FRA should assess the level of risk to the site. Anglian Water should be approached to obtain any information regarding sewer flooding records in the area and any recent capital improvement works undertaken, which should be reviewed in relation to local topography and potential flow paths to determine the actual risk to the site. This will allow appropriate mitigation measures to be incorporated where necessary.

Groundwater Flooding

6.7.49 A review of the risk of groundwater flooding across the Borough has been included within the Level 1 SFRA. Due to the scarcity of information with respect to groundwater flood risk in the Basildon Borough and the limitations in using historic data to define current flood risk, it is recommended that site specific investigations of geology and groundwater levels are undertaken in proportion to the nature and scale of the proposed development. Local groundwater monitoring should be identified and where possible analysed to assess ground water levels as part of a FRA, in addition to detailed geology mapping which identifies potential spring lines.

6.7.50 In addition, consideration should be made for the impact of excavation works, prior to construction on the risk of groundwater flooding to the site.

Surface Water Flooding

6.7.51 Development typically increases the coverage of impermeable areas and therefore contributes to increased overland flows. As part of a site specific FRA for new developments, an assessment of surface water runoff and temporary flood storage on the site should be undertaken. Development should seek to reduce surface water runoff rates through the appropriate application of Sustainable Drainage Systems (SuDS).

6.7.52 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. When designing a drainage system for new development it is important to consider whether surface water surcharging from other systems/areas in extreme circumstances is likely to affect the site via overland pathways. This could compromise the efficient working of SuDs devices designed to control volumes of water that arise only from hardstanding and surfaces within the development site in isolation.

6.7.53 Under the Flood and Water Management Act 2010, all new development must demonstrate that all measures have been taken to manage runoff on site before connection to the sewer is permitted. Due to the prevalence of surface water flooding and the highly urbanised nature of parts of the Basildon Borough, source control options will be an important method of surface water management. Rainwater harvesting, green roofs, attenuation features and landscaped public realm areas, will therefore be essential elements of new developments to facilitate the minimisation of runoff.

6.7.54 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 Essex County Council, through its Sustainable Drainage System Approval Board (SAB) to approve, 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.

7 Recommendations

7.1.1 Information and recommendations contained in this Level 2 SFRA should be used to inform policy, development control and technical issues. To this end. the following points should be used as guidance for informing local policy specific to Basildon Borough Council to ensure that flood risk considerations are included as part of the LDF process, future strategic and emergency planning.

7.2 Policy Recommendations

Building Design

7.2.1 Flood risk areas are largely confined to the corridors of the River Crouch, River Wid and River Thames.

- PPS25 does not permit self contained basement dwellings to be located within Flood Zone 3a, as basement occupants have the highest risk to life, even when considering shallow flooding at ground level. By definition, self contained basement properties provide no means of escape to higher floors within a development.
- Under PPS25 basements can be provided for non-residential uses with lower flood risk vulnerability, however, a satisfactory means of escape to above the floor level is absolutely essential. If escape cannot be provided then in accordance with PPS25 the basement should not be permitted;
- Single storey residential development should not normally be considered in flood risk areas as they offer no opportunity for safe refuge areas on upper floors;

Flood Risk Assessments and Vulnerability

7.2.2 Flood Risk Assessments (FRA) should be undertaken for all developments within Flood Zones 2 and 3 to assess the risk of flooding to the development and identify options to mitigate the flood risk to the development, site users and surrounding area;

7.2.3 In Flood Zone 1, FRAs are also required for all development sites greater than 1ha to ensure that flood risk is not increased to other properties due to increased site runoff. In addition, residential developments sites greater than 0.5 ha, or greater than 10 dwellings and commercial development sites greater than 1 ha or with a floor area greater than 1000 m^2 within an areas identified to have drainage problems also require site specific FRAs.

7.2.4 Potential opportunities to move existing development from within the floodplain to areas with a lower risk of flooding should be maximised. This should include consideration of the vulnerability of existing developments and whether there is potential for land swaps with lower vulnerability uses.

Developments behind Flood Defences

7.2.5 Flood defences (if present) provide flood protection and should continue to be maintained;

7.2.6 Where a development lies adjacent to an area benefiting from flood defence, opportunities should be sought for the maintenance of these flood defences to be partly funded by the development for its lifetime;

7.2.7 The Environment Agency should be consulted regarding the potential for future management regimes of the River Crouch and River Wid catchments including the potential for any flood alleviation schemes, upgrading and/or replacement of existing flood defences.

River Crouch

7.2.8 In order to develop specific policies with regard to the River Crouch consultation should be undertaken with the Environment Agency to develop suitable policies in line with the wider strategy and aims of the CFMPs set out for the relevant policy units. These highlight that the following actions need to be taken for the River Crouch:

- Produce flood storage studies to investigate the most appropriate storage options and locations for floodplain storage options and locations for floodplain storage. The studies should also consider opportunities to enhance the environment by improving the natural state of the river and its habitat;
- Opportunities should be identified where bank and channel maintenance can be reduced to improve the flow between the river and its floodplain to increase water storage on the natural floodplain;
- Continue with flood warning service including the maintenance of flood warning infrastructure (such as river flow gauging stations) and flood awareness plans;
- Encourage planners to develop policies to prevent inappropriate development in the floodplain using measures set out in PPS25. Any new development should be resilient to flooding and provide opportunities to improve river environments.
- Work with partners to develop emergency response plans for critical infrastructure and transport links at risk from flooding.
- An 8m buffer strip must be maintained along fluvial river corridors, to ensure that maintenance of the channel can be undertaken;
- River channel restoration should be undertaken where possible to return the river to its natural state and restore floodplain to reduce the impact of flooding downstream;
- The Environment Agency should be consulted regarding the potential for future management regime of the River Crouch and River Wid catchments including the potential for any flood alleviation schemes, upgrading and/or replacement of existing flood defences;
- Opportunities should be investigated to make space for water to accommodate climate change in order to assist in managing future flood risk;
- The groundwater, surface water and historic flood mapping should be reviewed to determine the risk of flooding from sources other than fluvial and/or tidal. When a proposed development is located within an area with an identified flood risk, then a FRA should determine the actual risk to the development and recommend appropriate mitigation measures. The FRA must demonstrate to the satisfaction of the Environment Agency that the development will not exacerbate the existing flooding situation, and improve existing conditions where possible.

Surface Water Flooding and the use of SuDS

- Washland areas should be safeguarded as important assets for local surface water management.

- Sustainable Drainage Systems should be promoted in new developments as a way to manage surface water and should be considered in line with the information provided in the Borough's Level 1 SFRA.
- The vulnerability and importance of local ecological resources (such as water quality and biodiversity) should also be considered when determining the suitability of drainage strategies/SuDS.
- The Local Planning Authority and Lead Local Flood Authority should ensure new development in an area known to suffer surface water flooding does not increase the discharge to the existing drainage system either though restricting site discharge rates and/or through capital contributions to improvements works of the existing drainage infrastructure.
- Basildon Borough Council should encourage the retention of soft landscaping in front gardens and other means of reducing, or at least not increasing the amount of hard standing associated with existing homes.

Water Resources (supply & demand)

- Ensure that proposed developments can be accommodated by the existing resource provision. Where a development cannot be met by current resources, ensure that the phasing of development is in tandem with resource infrastructure investment;
- For large schemes suggest a water strategy is carried out to determine there is sufficient water resources for the proposed increase in demand.

It is noted that a Water Cycle Study is currently being undertaken for the wider South Essex study area which will provide further recommendations in relation to the supply and demand of water resources and therefore should itself be consulted.

Residual Risk and Emergency Planning

- Current emergency planning strategies should be reviewed to determine the suitability of refuge centres and evacuation routes based on the Flood Zone mapping produced in this study.

7.3 Development Management Recommendations

Building Design

- When re-developing existing buildings in flood risk areas, the use of flood resilient measures should promoted at the individual property level.
- Where development occurs within a flood risk area, the designers of the development should consult with the emergency planners and emergency services to ensure that the adequate provision is made for access/egress during a flood event, or that suitable refuge is incorporated into the design to enable the design to be accepted as safe.

Flood Risk Assessments and Vulnerability

7.3.1 Developers and Local Authorities proposing to develop in Flood Zones 2 and 3 should seek opportunities to:

- Reduce flooding by considering the layout and the form of the development and the appropriate application of sustainable drainage techniques.

- Relocating existing development to land in zones with a lower probability of flooding, and;
- Create space for flooding to occur by restoring functional floodplains and flood flow pathways and by identifying, allocating and safeguarding open space for storage.
- If development is to be constructed with less vulnerable uses on the ground level to mitigate flood risk, agreements need to be in place to prevent future alteration of these areas to 'more vulnerable' uses without further study into the associated flood risks to the site.

Developments behind Flood Defences

7.3.2 The River Crouch and its tributaries flow eastwards through Basildon Borough and tributaries of the River Wid flow northwards along the northwest edge of the Borough. In the southern part of the Borough a network of channels and rivers drain the marshland into the Vange Creek and Holehaven Creek which flow south to the River Thames estuary, approximately 4km to the south.

7.3.3 Figure A07 included in the Level 1 SFRA shows that the majority of the River Crouch is defended to a standard of 1% AEP (1 in 100 year). The southern part of the Borough is protected from the River Thames to a design standard of 0.1% AEP (1 in 1000 year).

- When proposing development behind flood defences, the impact on residual flood risk to other properties should be considered. New development behind flood defences can increase the residual flood risk should defences be breached or overtopped by disrupting flow paths and or the displacement of flood water. If conveyance routes that allow flood water to pass back into a river following failure of a flood defence are blocked, this may potentially increase flood risk to existing properties;
- Opportunities should be taken to reduce the dependency on assets that do not contribute to effective flood risk management;
- Residual flood risk should be managed through emergency planning, site design and mitigation measures;

River Crouch

- An 8m buffer strip must be maintained along fluvial river corridors, to ensure that maintenance of the channel can be undertaken;
- Where floodplain storage is removed, the development should provide compensatory storage on a level for level basis to ensure that there is no net loss in flood storage capacity;
- Proposed developments located within the River Crouch and River Wid floodplains should be accompanied by a FRA including detailed hydrodynamic modelling and topographic surveys to enable accurate flood level estimation and consideration of potential flood flow paths. The external relations team at the Environment Agency office, local to the site to be developed should be consulted for further guidance and specific requirements for modelling in FRAs.
- Proposed developments located within the River Crouch and River Wid floodplains should be accompanied by a FRA including detailed hydrodynamic modelling and topographic surveys to enable accurate flood level estimation and consideration of potential flood flow paths. The external relations team at the Environment Agency office, local to the site to be developed should be consulted for further guidance and specific requirements for modelling in FRAs.

- Where floodplain storage is removed, the development should provide compensatory storage on a level for level basis to ensure that there is no net loss in flood storage capacity;
- Finished floor levels of all residential accommodation should be raised above the 1% AEP (1 in 100 year) modelled flood level including climate change. Where flood level information is not available, further hydrodynamic modelling may be required by the developer to determine the appropriate finished floor levels in relation to flood risk. Potential access & egress routes should also be considered and recommendations made for appropriate actions of future occupants in the event of a breach occurring.

Surface Water Flooding and the use of SuDS

- In areas where the potential for surface water flooding has been identified, Flood Risk Assessments should ensure suitable SuDS techniques are incorporated as part of redevelopment.
- Potential overland flow paths should be considered to ensure that buildings do not obstruct flows.
- It is considered prudent to set the minimum finished floor levels 300mm above street/pavement level for all new development to act as a safeguard against internal flooding from surcharging drainage systems which is likely to be a more frequent phenomenon in the future.
- Where basements are proposed in areas of Flood Zone 1 and 2 the risk of surface water flooding should be considered, with potential mitigation to include raising thresholds and including storage for surface water in such developments.
- Developers should aim to achieve Greenfield runoff from their site through incorporating sustainable drainage systems.
- Opportunities should be sought to reduce the risk of flooding from the sewer network through consultation with Anglian Water to determine key areas for maintenance and flood alleviation schemes.

It is noted that the Surface Water Management Plan being prepared for the Lead Local Flood Authority will provide further recommendations in relation to the management of surface water flood risk in Autumn/Winter 2011.

Water Resources (supply & demand)

7.3.4 As populations increase and climate change leads to changes in weather patterns, the prospect of droughts may increase. New development can tackle this by incorporating water efficiency measures such as grey water recycling, rainwater harvesting and water use minimisation technologies. In doing so, knock-on benefits could be felt by the sewer system which will receive less wastewater from properties, potentially freeing up capacity during flood events.

7.3.5 In addition, increasing people's awareness of the water environment around them, its importance and its hazards, will contribute to their understanding of where floods come from and what individuals can do to limit the consequences of flooding and resource shortages.

Residual Risk and Emergency Planning

- Where development within flood risk areas is absolutely necessary flood proof construction methods should be utilised to reduce the impact of flooding.

- The designers of the development should consult with the emergency planners and emergency services to ensure that the adequate provision is made for access/egress during a flood event, or that suitable refuge is incorporated into the design to enable the design to be accepted as safe.
- Emergency planning strategies should be put in place in order to direct people to safety during times of flood.
- Where a development is applying for a change of use, flood evacuation plans should be developed through liaison with the emergency planners and the emergency services. For lower to higher vulnerability conversions, a FRA would be required.

7.4 Living Document – SFRA Maintenance & Updates

7.4.1 For an SFRA to serve as a practical planning tool now and in the future, it will be necessary to undertake a periodic update and maintenance exercise. This section clarifies what specific actions are recommended to ensure correct maintenance and updating of the SFRA in the future.

GIS Layers

7.4.2 GIS layers used in this SFRA have been created from a number of different sources, using the best and most suitable information available at the time of publishing. Should new Flood Zone information become available, the data should be digitised and geo-referenced within a GIS system. A copy of the current dataset should be created and backed up and the new data should then be merged or combined with the current data set.

7.4.3 For example, should updated modelled outlines delineating Flood Zone 3b on the River Crouch become available, the current Flood Zone 3b outline should be edited to ensure that the newest data is displayed and that the old data is overwritten.

7.4.4 For other GIS layers such as the historical flood outlines or the sewer flooding information, it is likely that data will be added rather than be replaced. For example, where a new sewer flooding incident is reported in the catchment, a point should be added to the sewer flooding GIS layer rather than creating a new layer.

7.4.5 All GIS layers used in the SFRA have meta-data attached to them. When updating the GIS information, it is important that the meta-data is updated in the process. Meta-data is additional information that lies behind the GIS polygons, lines and points. For example, the information behind the SFRA Flood Zone Maps describes where the information came from, what the intended use was together with a level of confidence.

OS Background Mapping

7.4.6 The SFRA has made use of the OS 1:10000 and 1:50000 digital raster maps. Periodically these maps are updated. Under the Basildon Borough Council OS License, it is likely that these maps will be updated on at least an annual basis, if not more frequently. Updated maps are unlikely to alter the findings of the SFRA.

Data Licensing Issues

7.4.7 Prior to any data being updated within the SFRA, it is important that the licensing information is also updated to ensure that the data used is not in breach of copyright. The principal licensing bodies relevant to the SFRA at the time of publishing were the Environment Agency (Thames

Region), British Geological Survey, Ordnance Survey and Anglian Water. Updated or new data may be based on datasets from other licensing authorities and may require additional licenses.

Flooding Policy and PPS25 Practice Guidance Updates

7.4.8 This SFRA was updated inline with policy and guidance that was current in September 2010, principally PPS25 (DCLG December 2009) and the accompanying Practice Guide (March 2010). Furthermore, guidance and recommendations issued in the Pitt Review (Pitt 2008) and the subsequent Floods and Water Management Act 2010 have been incorporated into this updated revision. Should new flooding policy be adopted nationally, regionally or locally, the SFRA should be checked to ensure it is still relevant and updates made if necessary at the next available opportunity.

Stakeholder Consultation and Notification

7.4.9 The key stakeholders consulted in the SFRA were Basildon Borough Council, Anglian Water and the Environment Agency. It is recommended that a periodic consultation exercise is carried out with the key stakeholders to check for updates to their datasets and any relevant additional or updated information they may hold. If the SFRA is updated, it is recommended that the Environment Agency and the Council's Emergency Planning Team are notified of the changes and instructed to refer to the new version of the SFRA for future reference.

Frequency of Updates and Maintenance

7.4.10 It is recommended that the SFRA is maintained on an annual basis. Should any changes be necessary, the SFRA should be updated and re-issued.

References

CLG (March 2010) Planning Policy Statement 25: Development and Flood Risk

CLG (December 2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide

CLG (May 2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction'

Defra/Environment Agency (2005) Flood Risk Assessment Guidance for New Development: Phase 2, R&D Technical Report FD2320/TR2

Defra (March 2005) Making Space for Water – Taking forward a new Government strategy for flood and coastal erosion risk management in England.

Defra (March 2010) Surface Water Management Plan Technical Guidance: Living Draft

Defra (2009) National Rank Order of Settlements Susceptible to Surface Water Flooding.

Environment Agency (November 2010) Using Surface Water Flood Risk Information: Guidance for Local Resilience Forums, Regional Resilience Teams, Local Planning Authorities and Lead Local Flood Authorities v1

HMSO (November 2009) The Flood Risk Regulations 2009

HMSO (April 2010) Flood and Water Management Act Chapter 29

Office of the Deputy Prime Minister (October 2003) Preparing for Floods Interim guidance for improving the flood resistance of domestic and small business properties

Pitt, M. (2008) Pitt Review - Learning Lessons from the 2007 Floods

Limitations

URS Scott Wilson Ltd ("URS Scott Wilson") has prepared this Report for the sole use Basildon Borough Council ("Client") in accordance with the Agreement under which our services were performed (Homes and Communities Agency Panel Appointment of Consultant for the Provision of a SFRA Review for South Essex, !8th August 2010). No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by URS Scott Wilson. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of URS Scott Wilson.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by URS Scott Wilson has not been independently verified by URS Scott Wilson, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by URS Scott Wilson in providing its services are outlined in this Report. The work described in this Report was undertaken between August 2010 and May 2011 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

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Appendix A - Fluvial & Surface Water Flood Risk Mapping

Appendix B - Breach Modelling Depth Mapping

Appendix C - Breach Modelling Hazard Mapping

Appendix D - Breach Modelling Time to Inundation Mapping

Appendix E – Hydrodynamic Modelling Methodology

This Appendix presents the methodologies used to develop modelling outputs, including maximum flood depth, hazard rating and time to inundation maps, for the Strategic Flood Risk Assessments (SFRA) for Basildon and Castle Point Borough Councils and Rochford District Council.

Rapid Inundation Modelling

The modelling methodology used for this SFRA uses a 'breach at the peak' approach or 'rapid inundation' approach. Rapid inundation modelling simulates breaches that occur suddenly just before the peak tidal level. As the maximum force and volume of water behind the defences will occur at the peak of the simulated water level it was agreed that this modelling scenario would provide the most rapid inundation of the system. A greater volume of water would surge through the breach with more rapid and higher floodwater velocities simulated, particularly in the vicinity of the breaches. This would correspondingly produce the most severe time to inundation results in the area local to the breach position and hazard with velocity playing a large part in the determination of the flood hazard category in certain areas. The results from these scenarios could then be used to determine the minimum time to inundation for vulnerable locations in the flood cell, particularly for the more vulnerable properties located closer to the flood defences.

The total volume of water entering the system will be slightly less compared with a modelled situation where the breach is open throughout the modelled simulation (i.e. open flood gate situation), and inundation will be slightly lower in the outlying areas of the flood cell. The rapid inundation methodology will however more appropriately test the potential flooding in more vulnerable lower lying areas close to the breach. This methodology was agreed with the Environment Agency (EA) prior to the commencement of the project.

The modelling carried out for this SFRA was based on the previous modelling undertaken as part of the Thames Gateway SFRA 2006. 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.

Site Visit

Initially each breach was investigated to determine the location of the breach, the defence type and height, the width of the breach and the invert level of the breach. This was informed by the previous SFRA and validated using aerial photography and topographic data in the form of LiDAR. This information was then sent to the EA for confirmation and comment prior to visiting the site to ensure any points for discussion and further investigation were highlighted prior to the visit.

This database was then confirmed by a site visit where all breach locations, (with the exception of the inaccessible ones: CAS01, ROC01 & ROC02), were visited prior to commencement of the modelling process. This site visit was undertaken to ensure each breach location was positioned sensibly and properly represented within the model, and equally importantly that the wider flood cell was adequately represented with any important features noted.

Topographic Data

A key component in the modelling process is the representation of topography throughout flood prone regions of the study area. For this purpose, a Digital Terrain Model (DTM) was derived for each of the modelled areas. A DTM is a three-dimensional 'playing field' on which the model simulations are run.

The platform used for the generation of the DTM was the GIS software package MapInfo Professional (version 8.5.2) and its daughter package Vertical Mapper (version 3.1).

The DTM is primarily based on filtered LiDAR data provided by the EA. LiDAR (Light Detection And Ranging) is a method of optical remote sensing, similar to the more primitive RADAR (which uses radio waves instead of light). Filtered LiDAR data represents the "bare earth" elevation with buildings, structures (such as bridges) and vegetation removed. In this case, the LiDAR surveys return data at a horizontal resolution of 2 metres, 1 metre and 0.25metres (that is, a unique elevation level is given every two/one/0.25 metres in both the north-south and east-west directions). The LiDAR was provided by the EA for this study and the following information is provided for completeness:

- All of the data is referenced using the British National Grid OSGB36, the Z value is metres above Ordnance Datum Newlyn.
- Data from different, overlapping surveys, at different resolutions, have been merged together. The newest, and highest resolution data, has had precedence in the merging process. If the input data was at a resolution finer than 2 metres, it was re-sampled to 2 metres using the bilinear interpolation method in ESRI's Spatial Analyst software.

During the compilation of the DTM it was realised that there were gaps in the LiDAR coverage. In order to accurately represent each flood cell complete topographic data was needed. Synthetic Aperture Radar or SAR was used to infill the gaps. SAR is generally less accurate and has a lower resolution (approximately 5m compared to the 2m LiDAR) so is used only in areas where LiDAR is not available.

The LiDAR data combined with SAR data was used to create a DTM grid covering the complete study area. In addition to the 2m LiDAR some 25cm LiDAR data was obtained. This is generally available for areas of specific interest only, such as along defences, so is patchy. As 25cm LiDAR is very accurate the files are extremely large. To allow reasonable working times, the 2m LiDAR was used as a basis for the modelling and where 25cm LiDAR was available this was used to override the 2m data. This provided a more accurate representation of the topography within the flood cell.

Flood Cell Definition

Sixteen breach locations have been identified along the northern bank of the River Thames, and the Rivers Crouch and Roach within the Basildon Borough, Castle Point Borough and Rochford District Council administrative areas. Details are provided in Table E-1 and shown in Figure E-1.

Table E-0-1 Breach Characteristics

Code (TGSE update 2010)	Breach Name (TGSE update 2010)	Previous Code (TGSE SFRA 2006)	Previous Breach Name (TGSE SFRA 2006)	Easting	Northing
BAS01/CAS	Flood barrier, Fobbing Horse, Vange Creek	Cas09	Barrier Vange Creek	574044.7	184305.5
CAS01	Upper Horse	Cas01	Canvey Island 1	575200	183400
CAS02	Canvey Village, Lower Horse	Cas02	Canvey Island 2	577100	182600
CAS03	STW	Cas03	Canvey Island 3	578100	182000
CAS04	Canvey Island Golf Course	Cas04	Canvey Island 4	579437.5	182463
CAS05	Leigh Beck	Cas05	Canvey Island 5	581600	182700
CAS06	Sunken Marsh	Cas06	Canvey Island 6	580900	184300
CAS07	Castle Point Golf Course	Cas07	Canvey Island 7	579008.6	185005
CAS08	Benfleet Creek Flood Barrier	Cas08	Benfleet Marshes	578067.6	185605
ROC01	Morrin's Point	Roc05	Morrin’s Point	596298.3	186654.2
ROC02	Wakering Stairs	Roc04	Wakering Stairs	596900	187100
ROC03	Oxenham Farm	Roc06	Oxenham Farm	595745	188694.5
ROC04	Paglesham Eastend	Roc03	Paglesham East End	594767.5	192116.8
ROC05	Grapnells, Wallasea Island	Roc01	Wallasea Island	594700	195000
ROC06	Loftmans Farm, Paglesham Creek	Roc07	Paglesham Creek	592370.3	193694
ROC07	South Fambridge	Roc02	South Fambridge	585500	196200

Code (TGSE update 2010)	River	River Classification	Defence Type	Breach Width (m)*	Breach Invert Level (m)	Crest Height APPROX (m)
BAS01/CAS	Vange Creek, Thames Estuary - Estuary	Estuary	hard defence - barrier	width of barrier-45	1	6.5
CAS01	Holehaven Creek, Thames Estuary	Estuary	hard defence with earth embankment	20	2.4	6.4
CAS02	Holehaven Creek (mouth), Thames Estuary	Estuary	hard defence with earth embankment	20	2.3	6.5
CAS03	Thames Estuary	Estuary	hard defence with earth embankment	20	2	6.9
CAS04	Thames Estuary	Estuary	hard defence with earth embankment	20	1.7	6.8
CAS05	Thames Estuary	Estuary	hard defence with earth embankment (breach at flood gate)	20	1.5	6.3
CAS06	Benfleet Creek, Thames Estuary	Estuary	hard defence with earth embankment	20	2.7	6.5
CAS07	Benfleet Creek, Thames Estuary	Estuary	hard defence with earth embankment	20	3.2	6.3
CAS08	Benfleet Creek, Thames Estuary	Estuary	hard defence - barrier	width of barrier-50	2.5	7.5
ROC01	Thames Estuary - Open Sea	Open Coast	earth embankment	200	1.7	5.1-5.3
ROC02	Thames Estuary - Open Sea	Open Coast	earth embankment	200	1.7	4.9-5.4
ROC03	The Middleway	Tidal river	earth embankment	50	1.5	4.8
ROC04	River Roach	Tidal river	flood gate	50	2.3	4.5
ROC05	River Crouch	Tidal river	earth embankment	50	1.5	4.4-4.3
ROC06	Paglesham Creek, River Roach	Tidal river	earth embankment	50	1.8	4.6
ROC07	River Crouch - River	Tidal river	earth embankment	50	1.2	5.6

Code (TGSE update 2010)	Source of water level info	200 year	200 year with 100 years of Climate Change allowance	1000 year	100 year with 100 years of Climate Change allowance
BAS01/CAS	Thames Estuary Extreme Water Levels (2008)	5.15	6.25	5.68	6.77
CAS01	Thames Estuary Extreme Water Levels (2008)	5.15	6.25	5.68	6.77
CAS02	Thames Estuary Extreme Water Levels (2008)	5.12	6.22	5.63	6.75
CAS03	Thames Estuary Extreme Water Levels (2008)	5.12	6.22	5.63	6.75
CAS04	Thames Estuary Extreme Water Levels (2008)	5.05	6.14	5.54	6.65
CAS05	Thames Estuary Extreme Water Levels (2008)	5.02	6.12	5.51	6.62
CAS06	Thames Estuary Extreme Water Levels (2008)	4.95	6.05	5.43	6.55
CAS07	Thames Estuary Extreme Water Levels (2008)	4.95	6.05	5.43	6.55
CAS08	Thames Estuary Extreme Water Levels (2008)	4.95	6.05	5.43	6.55
ROC01	Anglian Region Extreme Tide Levels (2007)	4.49	5.54	4.83	5.88
ROC02	Anglian Region Extreme Tide Levels (2007)	4.48	5.53	4.82	5.87
ROC03	Anglian Region Extreme Tide Levels (2007)	4.46	5.51	4.81	5.86
ROC04	Anglian Region Extreme Tide Levels (2007)	4.43	5.48	4.58	5.63
ROC05	Anglian Region Extreme Tide Levels (2007)	4.36	5.41	4.64	5.69
ROC06	Anglian Region Extreme Tide Levels (2007)	4.43	5.48	4.58	5.63
ROC07	Anglian Region Extreme Tide Levels (2007)	4.40	5.45	4.64	5.69

Once the DTM grids and breach locations were obtained and confirmed, the flood cell for each model must be defined. The flood cell is the geographical extent of the model; the area of the overall DTM that will be used in the model. While it would be possible to run each of the breach models using all of the derived DTM topographical data, it is far more sensible and computationally efficient to define a smaller area on which to run each scenario.

Flood cells are typically defined by considering the topography of the area inland of the breach and the peak levels of the tidal events to be tested. MapInfo can be used to show areas of potential flooding by only displaying areas of the DTM that are below the predicted peak inundation levels in the vicinity of the breach, plus a freeboard. Areas of the DTM that are not shown (that is, areas that are well above the tidal levels of interest) do not need to be considered in the model.

Where the local topography does not clearly define an enclosed flood cell it may be necessary to artificially enclose certain parts of the flood cell. This should only be done for areas that are distant from the breach or any important areas of the model, and will typically be outlying or empty areas of the flood cell. For example, estuaries or flat, open fields at the far end of the flood cell. Since the model treats the boundaries of flood cells as 'glass walls' it is vital that any artificial boundaries do not affect levels in the important areas of the flood cell. This is typically not an issue in models where the inflows are based on tidal levels rather than a specific volume, as in this case.

Within this study there were a number of flood cells that had to be artificially constrained (notably ROC05 and ROC07 flood cells). In these cases local features as well as topography were used to inform the decision as to where to terminate the flood cell. In the case of the Rochford flood cells, natural water courses were used as these were thought to provide a natural break in the topography.

Extreme Water Level Derivation

Water levels were taken from *Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008* preferentially where available and appropriate for particular breach locations. Where this study did not cover particular breach locations Environment Agency, Anglian Region, Eastern and Central Areas Report on Extreme Tidal Levels, 2007 was used to obtain water level information. Where modelled nodes were present within close proximity to specific breach locations unmodified water levels were used. Where a significant distance was present between the modelled nodes and the breach locations, modelled water levels were factored based on chainage to provide more realistic water levels.

Climate Change

PPS25 recommended contingency allowances have been applied to the extreme water levels obtained from the above studies in order to simulate climate change scenarios (100 years of climate change simulated up to 2110). Where climate change modelled runs were undertaken as part of the above studies, PPS25 allowances were applied to the closest run scenario to obtain 2110 water levels (i.e. for the Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008 a model run was undertaken for 2107, so only three years of the appropriate PPS25 climate change contingency need be added).

Breach Modelling

Sixteen breach locations have been identified; eleven along the northern bank of the River Thames, two on the River Crouch and three on the River Roach. These are all located within the Castle Point, Basildon and Rochford administrative areas as shown in Figure A-1 and Table E-1.

To assess flood propagation in events where the flood defences are breached, a hydrodynamic modelling analysis has been undertaken using the two-dimensional hydrodynamic modelling software MIKE21-HDFM (Release 2009, Service Pack 4). This section discusses the modelling methodology that has been applied for the hydrodynamic modelling analysis of the breach events. The choice of model is discussed, the model schematisation is described and the boundary conditions used are presented.

Model and Software Selection

To achieve the study objectives, the model used to estimate the maximum flood conditions was required to:

- Accommodate the effects of a flood flow (propagation of a flood wave and continuous change of water level);
- Simulate the hydraulics of the flow that breach/overtop the flood defences; and
- Generate detailed information on the localised hydraulic conditions over the flooded area in order to evaluate flood hazard.

MIKE21-HDFM was developed by the Danish Hydraulic Institute (DHI) Water and Environment and simulates water level variations and flows for depth-averaged unsteady two-dimensional free-surface flows. Release 2009, Service Pack 3 was used for this study. It 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. The model utilises the numerical solution of two-dimensional shallow water equations.

Model Extent and Resolution

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 (see above).

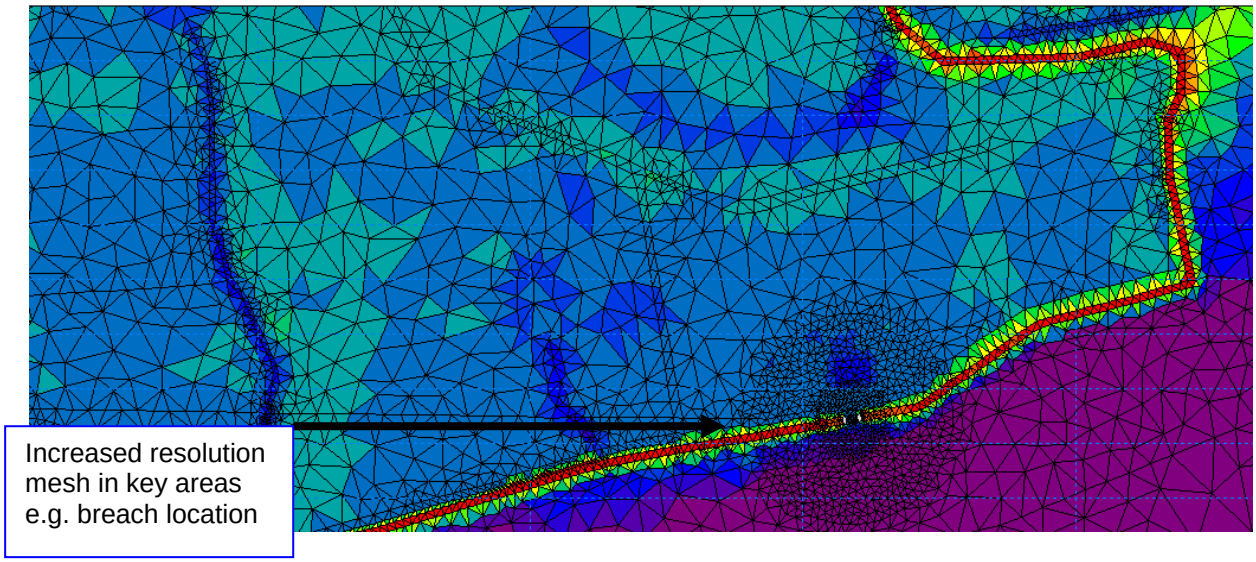
One of the advantages of the flexible mesh application is that the element size within the mesh can be varied depending upon the complexity of the floodplain, features of interest, and the location of topographic features which are thought to have a significant impact on flood propagation. By adding 'control lines' during the development of the mesh, the triangles or 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.

It was decided that considering these models are for strategic and not site specific purposes that 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 was outside the scope of the study.

In order to accurately represent the hydraulics around the breach locations a comparatively small element size has been specified in the vicinity of the breaches. The breach itself is represented with a minimum of four elements across its width.

Once the final mesh is developed and the triangles generated, elevation values are imported into the mesh at each triangle vertex from the previously created DTM, utilising the 2m LiDAR data and where available the 25cm LiDAR. This then provides the 3-dimensional 'playing field' for simulating the breach scenario.

Figure E-2 Example of MIKE 21 HD Flexible Mesh



Breach Specifications

The breach width and exposure duration are determined by the type of defences and the nature of the adjacent water body. Flood defences are categorised as either 'Hard Defences[7]' or 'Earth Embankments'. According to EA guidance (Environment Agency SFRA Guidance[8]), the breach width adopted for the above categories is 20 metres and 50 metres respectively for tidal rivers/estuary and 50 metres and 200 metres respectively for open coast (see Table E-2).

Table E-2 Environment Agency Breach Guidelines

Location	Defence Type	Breach width (m)
Open Coast	Earth bank	200
	Dunes	100
	Hard	50
	Sluice	Sluice width
Estuary	Earth bank	50
	Hard	20
Tidal River	Earth bank	50

[7] The EA consider revetted clay walls to be a hard defence. For many clay walls, either revetted or not, the main cause of failure is from overtopping and the back of the defence being compromised. Once failure has commenced, the structure will be rapidly washed out regardless of the face of the structure. The resulting gap will, by consequence of the construction, be much wider than a solid structure such as piles or concrete

[8] Agency Management System Document: Uncontrolled When Printed [10/01/07]

	Hard	20
Fluvial River	Earth bank	40
	Hard	20

The land water boundary along Canvey Island, Castle Point and Southend-on-Sea is classified as tidal river/estuary to Shoeburyness point and as open coast to the east of this point. The Rivers Crouch and Roach are considered as river/estuary (Table E-1).

Within this study there are breaches in hard defences, earth embankments and flood barriers/gates.

The repair time required to close a breach is assumed to be 20.5 hours, covering two tidal cycles. In the hydrodynamic modelling undertaken for this study, the breach in the flood defence wall occurs prior to the peak tidal level occurring on the second peak and remains open for the remainder of the simulation. This total simulation corresponds to approximately three tidal cycles, with two smaller peaks either side of the maximum peak. This allows any potential overtopping to occur on the first tidal cycle prior to the breach and a subsequent tidal cycle after the peak to allow water to enter through the open breach in the second cycle.

Defences

The defences along the coastline are variable in standard. There are lengths of defence that fall below the 0.5% AEP (1 in 200 annual probability) design standard. As such, models including the potential for overtopping as well as breaching have been constructed. These models allow a breach to be forced through a section of chosen defence but also allow overtopping of the defences to occur where the defences are lower than the simulated water level. In addition to this, an overtopping scenario was also run where no breach occurs. This gives a flood water extent from overtopping alone, or 'actual' flood risk.

Defence heights have been determine from the most appropriate and accurate supplied data. In the main this has been LiDAR data, 25cm taking precedence over 2m LiDAR data. On Canvey Island, and stretches of the coastline in Castle Point data was supplied by the EA as points with associated levels. This data was triangulated and used to determine the height of the defences in the areas where available. The EA were also contacted on a number of occasions regarding the height of the defences and for clarification on the supplied levels.

The Easthaven and Benfleet barriers were confirmed to have a crest height of 6.65m AOD with adjacent defence crest heights at 6.6mAOD. The East Haven Barrier tie in defence has a crest height of 6.7mAOD (concrete cap at 6.7mAOD and sheet pile to 6.6mAOD). This information has been used to update the supplied point data where relevant. Ideally, the defence crest heights would have been surveyed and this data used to set crest heights within the model. As this was not available the best supplied data has been used but it should be recognised that this introduces a limitation to the modelling process and results.

Hydraulic Roughness used in Modelling

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 have been identified 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.

Tidal Model Boundary Conditions

Within the MIKE21 model, tidal water level boundary files (in this case located in the Rivers Thames, Crouch and Roach) are used to provide the important input of water volumes to the mesh. The tidal water level is defined in the river and determines the flow entering the flood cell through the breach.

The water level boundary file consists of real-time tide curves, using the tidal peak levels derived from the report Environment Agency: Thames Tidal Defences Joint Probability Extreme Water Levels 2008, Final Modelling Report, April 2008 and Environment Agency, Anglian Region, Eastern and Central Areas Report on Extreme Tidal Levels, 2007 for the present day and with climate change allowances.

Boundary conditions have been applied along the middle of the River Thames, and the opposite banks of the Crouch and Roach. This was simulated to ensure a true representation of the modelled water levels were applied at the breach locations. In locations where smaller watercourses propagate flood water from the main river to the specific breach location, water levels will naturally be modified by the funnelling process of water travelling up a smaller watercourse.

Model Simulations Undertaken

The following flood events were simulated for each breach location;

- A tidal flood event with a return period of 0.5% AEP (1 in 200 year) for the present day 2010, breach and overtopping;
- A tidal flood event with a return period of 0.5% AEP (1 in 200 year) with climate change to 2110, breach and overtopping;
- A tidal flood event with a return period of 0.5% AEP (1 in 200 year) with climate change to 2110, overtopping only[9];
- A tidal flood event with a return period of 0.1% AEP (1 in 1000 year) for the present day 2010, breach and overtopping;
- A tidal flood event with a return period of 0.1% AEP (1 in 1000 year) with climate change to 2110, breach and overtopping;
- A tidal flood event with a return period of 0.1% AEP (1 in 1000 year) with climate change 2110, overtopping only[10].

Breach Time

The water levels during a tidal flood event are generated by a summation of the astronomical tide levels and the storm surge residual, as shown in Figure E-2.

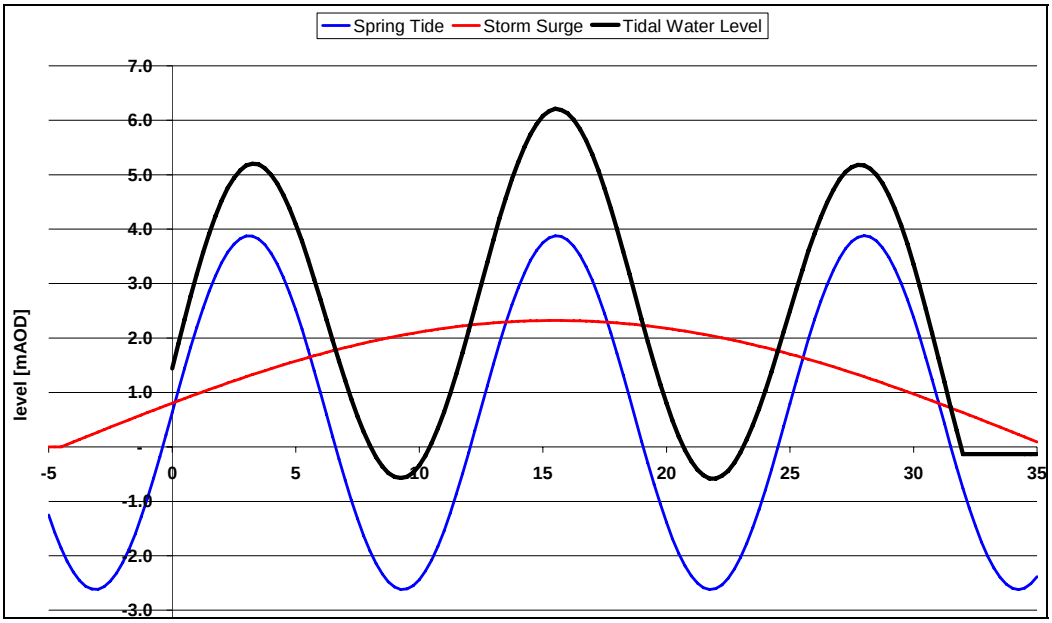
In terms of speed and force of floodwaters, the worst time for a breach to occur is when the maximum hydrostatic force has built up behind the flood defences. Therefore, the modelling undertaken for this study was run where the flood defences suddenly breach just before the tidal level acting on the flood defences is at a maximum.

[9] In the case of Canvey Island, two overtopping simulations were run: one where the Easthaven and Benfleet Barriers were operational and one where these defences failed
[10] In the case of Canvey Island, two overtopping simulations were run: one where the Easthaven and Benfleet Barriers were operational and one where these defences failed

A one hour 'lead-time' prior to the maximum flood level was included to ensure that, once the breach had occurred, the water level continued to rise and the maximum volume of water possible was able to travel through the breach at the maximum water level. This was seen as a compromise between the breach open method and the breach at peak method and the corresponding results.

The models were run for 36 hours. This allowed the potential for overtopping before the breach, during the first tidal cycle and ensured water could enter the model through the breach for the second and third tidal cycles.

Figure E-3 Example of Tidal Curve with Breach Time



Modelling Outputs

Modelling analysis presents data to identify the residual risk and actual risk of flooding from a failure or overtopping of local defences. The mapping of the model outputs as flood depth, flood hazard and time to inundation within the study area provides the three councils with flood risk information to enable more detailed consideration of the risk of flood water inundation, the Sequential Test and PPS25 vulnerability classifications within Flood Zone 3a.

Once the meshes were defined and the models run (by flooding the meshes, through the breaches/overtopping, with the tidal events using the 2D hydrodynamic modelling programme Mike21), the results were processed to produce the above outputs. GIS processing and mapping tasks have been performed using MapInfo Professional (Version 8.5.2) with the Vertical Mapper spatial analysis add-on (Version 3.1).

Maximum Flood Depth

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. This has been processed for all scenarios run. Composite depth maps were also created taking the maximum depth at each point where breaches coincided.

Hazard Rating

Flood hazard is a function of both flood depth and flow velocity. Due to this dependence on velocity, it is common during tidal flood events for the maximum flood hazard at a certain location to occur before the maximum floodwater level occurs, i.e. while floodwaters are flowing and the velocities are higher.

In order to assess the maximum flood hazard during a flood event, the hazard level at each element of the MIKE21 mesh is assessed at every time step of the model simulation.

Each element within the model is assigned one of four hazard categories 'Extreme Hazard', 'Significant Hazard', 'Moderate Hazard', and 'Low Hazard'.

The derivation of these categories is based on Flood Risks to People FD2320 (DEFRA & EA, 2005), using the following equation:

$$\textit{Flood Hazard Rating} = ((v+0.5)*D) + DF$$

Where v = *velocity (m/s)*

D = *depth (m)*

DF = *debris factor*

The depth and velocity outputs from the 2D hydrodynamic modelling are used in this equation, along with a suitable debris factor. For this SFRA, a precautionary approach has been adopted inline with FD2320; a debris factor of 0.5 has been used for depths less than and equal to 0.25m, and a debris factor of 1.0 has been used for depths greater than 0.25m.

Table E-3 Hazard categories based on FD2320, DEFRA & Environment Agency 2005

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

A flood hazard rating grid was created for each of the breach locations for all flooding scenarios. A composite grid was then created for appropriate overlapping areas by extracting the maximum flood hazard rating value (where applicable) for each point, considering all relevant model output grids.

Time to Inundation

As previously stated, a breach was simulated in the models one hour before the peak tidal level. Flows then tended to pass through the breach, inundating the flood cell, for approximately five to six hours, after which the tide level had again retreated well below the breach invert. After another six hours (11 to 12 hours after the breach) the next high tide would again push water through the breach causing further flooding for a further five to six hours.

From examining the results it was decided that the vast majority of land that was inundated by the model was inundated within six hours of the breach occurring. Some of the outlying areas (some distance from the breach) were affected by the second peak.

The MIKE21 application 'Data Extraction FM' was used to extract 'snapshots' of the model results Time 0 is set to the time when tidal water enters the breach. This means that the <1 hour band encompasses all areas that are inundated (wet) within the first hour of water travelling through the breach and into the flood cell. Further bands have been produced to show wet cells at: 1-4 hours, 4-8 hours, 8-12 hours, 12-16 hours and 16-20. Where overtopping occurred prior to the opening of the breach, this has been classified as such using a hatching.

For each model run, a mesh of polygons was derived in GIS (in this case, MapInfo format), each containing the approximate time of inundation for each triangular element composing the model mesh. All empty (zero) elements were then deleted and a 3-dimensional grid file (using the time of inundation as the vertical z-value) was created to define the time to inundation for each model simulation.

These grid files could be used as the final output of the time to inundation process. However, the results are 'patchy' and complicated in places, mainly due to a finite number of breach locations being used (sixteen in this case). Ideally, a very high number of breach locations would have been used in the modelling (for example every few hundred metres or more) but this is impractical considering the computing power and time that would be required. This should be noted by the reader for all output results, i.e. results are from a discrete number of breach locations and therefore may be subject to change if the breach location were to change.

As overtopping is possible at any point where the defences are below the water level (due to the variable defence standard), some overtopping will be classified within the time to inundation bands from the breach event. This is particularly noticeable in areas a significant distance from the breach that are shown as inundated within the first hour of the breach event (i.e. water would not have time to flow from the breach to these locations within the first hour). This should be considered by the user.

Appendix F – Emergency Flood Management Plan Information Pack

Scott Wilson is now part of URS Corporation. With its headquarters in San Francisco, URS is a leading provider of engineering, construction and technical services for public agencies and private sector companies around the world.

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