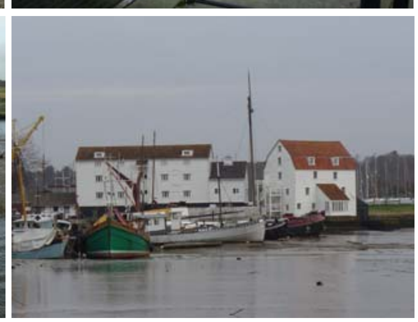
Suffolk Coastal and Waveney District Councils

Suffolk Coastal and Waveney District Strategic Flood Risk Assessment

Main Report

Report
February 2008



Prepared for:

Waveney District Council
Serving the Community

Suffolk Coastal District Council

Suffolk Coastal

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Revision Schedule

Strategic Flood Risk Assessment
February 2008

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	May 2007	Draft SFRA	**Elizabeth Williams** Senior Consultant **Eleanor Cole** Graduate Hydrologist	**Elizabeth Williams** Senior Consultant	**Jon Robinson** Principal Consultant
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GLOSSARY

Term	Definition
Actual Risk	The actual risk of flooding to any area is the risk associated with the current local defences. This is expressed, in terms of probability, as the probability that the defence will be overtopped and/or the probability that the defence will suffer a structural failure and the consequences of these scenarios.
Breaching	Failure of a flood defence structure such that the crest of the existing defence is lowered allowing water to pour over or through the defence. This may lead to rapid inundation of the land behind the defence.
Critical Ordinary Watercourse	A watercourse that passes through an intensively developed urban area and at risk from flooding or, a less extensive urban area with some high grade agricultural land and/or environmental assets of international importance requiring protection. The watercourse is only defined as 'critical' for the length that is within the areas outlined above. If however, the length of watercourse is situated out of the areas outlined above, but is considered to have significant impact on the lengths of watercourse within the above areas, it can be designated as critical.
Flood plain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Freeboard	Height of flood defence crest level (or building level) above designed water level.
Hard Flood Defence	Engineered, structural defence often constructed using brick, concrete or metal, e.g. floodwall, sheet piling, or earth embankment with additional engineered toe protection.
Hazard	The potential for something to cause harm, for example a flood, independent of its likelihood of occurring
Inundation	Flooding.
Local Development Framework (LDF)	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, potential development sites and a proposals map.
Overtopping	Passage of floodwater over a defence. May range from wind-driven spray to severe overflowing when flood levels exceed the defence crest level.
Permissive Powers	Powers which may be used, but where there is no statutory duty for them to be used.
Residual Risk	Residual Risk is a term often used in impact and risk assessment across a variety of topics. For this reason, it is also a term that is often inappropriately applied or misused. In a general sense, residual risk is usually taken to refer to that portion of overall risk that remains once risk-aversion measures have been put in place. In a flood risk sense therefore, residual risk can be seen as the risk of flooding that remains after flood defence measures have been implemented.
Risk	The probability or likelihood of an event occurring.
Soft Flood Defence	A non-structural method of flood defence, often a strategic approach such as managed retreat or flood forecasting and warning system.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

Acronym	Definition
AONB	Area of Outstanding Natural Beauty
CFMP	Catchment Flood Management Plan
COW	Critical Ordinary Watercourse
DCLG	Department of Communities Local Government
DEFRA	Department of Environment, Food and Rural Affairs
DEM	Digital Elevation Model
EA	Environment Agency
EHD	External Hard Drive
FRA	Flood Risk Assessment
GIS	Geographical Information Systems
IDB	Internal Drainage Board
LDD	Local Development Documents
LDF	Local Development Framework
LiDAR	Light Detection and Ranging
LPA	Local Planning Authority
NFCDD	National Flood and Coastal Defence Database
NNR	National Nature Reserve
ODPM	Office of the Deputy Prime Minister
PPG25	Planning Policy Guidance Note 25: Development and Flood Risk
PPS25	Planning Policy Statement 25: Development and Flood Risk
RFRA	Regional Flood Risk Assessment
RPG	Regional Planning Guidance
RSS	Regional Spatial Strategy
SAC	Special Areas of Conservation
SAR	Synthetic Aperture Radar
SCP	Sustainable Communities Plan
SEA/SA	Strategic Environmental Appraisal / Sustainability Assessment
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
UDP	Unitary Development Plan
WHS	World Heritage Site

1 Introduction

1.1 Background

1.1.1 Since the publication of the Planning and Compulsory Purchase Act 2004 (HMSO, 2004), local authorities have been required to update the existing system of Local, Structure and Unitary Development Plans and replace them with Local Development Frameworks (LDF). LDFs are a portfolio of documents, which collectively deliver the spatial planning strategy for the authority area. LDF documents are subject to a Sustainability Appraisal, to assess their likely economic, environmental and social impacts. The Council is required to produce a Strategic Flood Risk Assessment (SFRA) to inform the LDF process including site allocations and Sustainability Appraisals.

1.1.2 Scott Wilson was commissioned by a partnership between the councils of Suffolk Coastal District Council and Waveney District Council to undertake a joint SRFA of both districts. A SFRA aims to assist the planning process by identifying flood risk areas and outlining the principles for policies for sustainable development. This information should then be used in strategic land allocations and development plans

1.1.3 Planning Policy Statement 25: Development and Flood Risk (PPS25) was released in December 2006 (Communities and Local Government, 2006) and supersedes Planning Policy Guidance Note 25: Development and Flood Risk (PPG25). This modification in policy guidance represents a shift from the previous reactive resolution of flooding problems as a result of development to the effective management of flood risk within the planning system. Recent government guidance presented in PPS25 describes the function of SFRAs.

> *"Decision-makers should use the SFRA to inform their knowledge of flooding, refine the information on the Flood Map and determine the variations in flood risk from all sources of flooding across and within their area".* (Communities and Local Government, 2006)

1.1.4 The SFRA will enable a more detailed understanding of the flood risk issues to existing and proposed developments within the individual authorities, allowing a direct input into the strategic planning of the Suffolk Coastal and Waveney districts through Local Development Frameworks. The current general reference materials for flooding throughout the region are the Environment Agency's Flood Zone Maps.

1.1.5 Spatial Planning documents such as the Draft East of England Plan outlines potential targets for the region with respect to potential residential development, regeneration, policy and employment. The spatial planning of these must be considered with regard to the current and future risk of flooding from a combination of sources, including tidal inundation, fluvial overspill, storm water management and groundwater. It is therefore vitally important that flood risk is considered at a strategic scale to inform land allocations and future developments within the emerging Local Development Frameworks.

1.2 Suffolk Coastal and Waveney SFRA

1.2.1 The districts of Suffolk Coastal and Waveney, (Figures 1.1 and 1.2), include extensive low-lying coastal areas that are potentially at risk from flood events, both fluvial and tidal. Furthermore, these areas are potential sites for future development allocations as these districts aim to meet future housing and regeneration requirements. Developing low-lying areas creates challenges, especially associated with sustainable development and flood risk.

1.2.2 Flooding and coastal processes discussed in this SFRA are not unique to these districts and may be experienced by neighbouring councils. It is intended that this report be used in conjunction with similar studies in the Norfolk, Suffolk and Essex areas, thus providing comprehensive cover of the flood risk issues facing the area of East Anglia. The Suffolk Coastal and Waveney study regions are shown in Figures 1.1 and 1.2. The area of Waveney covered by the Broads Authority has not been included, as this area will be covered by the separate SFRA of this area.

1.2.3 The local authorities of Suffolk Coastal and Waveney have identified several growth areas within their administrative boundaries, as potential areas for future site allocations within their preferred options and Local Development Frameworks.

1.2.4 The growth areas within Suffolk Coastal are principally focused on the settlement areas of: Aldeburgh, Alderton, Bramfield, Earl Soham, Felixstowe, Foxhall, Framlingham, Grundesburgh, Hollesley Ipswich Eastern Fringe Warren Heath, Knodishall, Martelsham Heath, Melton, Orford, Peasenhall, Rushmere, Saxmundham, Sizewell, Snape, Wickham, Witnesham, Woodbridge, and Yoxford.

1.2.5 The growth areas within Waveney are principally focused on the settlement areas of: Barnby and North Cove, Beccles, Blundeston, Bungay, Carlton Colville, Halesworth, Kessingland, Oulton, Wangford, Wrentham, Lowestoft, and Southwold and Reydon.

1.2.6 The spatial planning of these areas must be considered with regard to the current and future risk of flooding from a number of sources, including fluvial, tidal, stormwater management and groundwater. It is therefore vitally important that flood risk is considered at a strategic scale to inform land allocations and future developments proposed by the emerging Local Development Frameworks.

1.2.7 At the time of writing this document no site-specific allocations had been finalised, therefore pending the finalisation of these, the growth areas were used to identify the flood risks to potential growth and development areas. If, on completion of the preferred options there are any allocations that fall outside these growth areas, then the Sequential Test and potential exception test for these sites will need to be explored at that time.

1.3 Scope and Objectives

1.3.1 This SFRA has been undertaken for the areas of Suffolk Coastal District Council and Waveney District Council..

1.3.2 The SFRA should be regarded as an advisory study informing a multitude of policies within the two districts. The purpose of this SFRA is to:

- Assist the local planning authority (LPA) when defining their appropriate potential development areas and sub-areas (zones) to accord with the principles of PPS25 policies;
- Enable a more detailed understanding of the flood risk issues relating to existing and proposed development;
- Identify areas which are vulnerable to flooding;
- Help identify particular land use types that may require restrictions in areas vulnerable to flooding;
- Assess the degree of alteration resulting from climate change through the impact of likely sea level rise and increased peak flood flows though rivers and the storm water drainage system;
- Provide an increased understanding of flood risk for Suffolk Coastal District Council and Waveney District Council;
- Inform the planning process to enable integration of flood risk management into the strategic spatial planning of the Suffolk Coastal and Waveney region.

1.4 SFRA Approach

1.4.1 The draft PPS25 practise guidance note (Feb 2007) recommends a two-tiered approach to SFRA's:

- A level 1 SFRA, the first stage in the SFRA process, identifies data sources and assesses flood risk using existing data for draft site allocations.
- A level 2 SFRA, the second phase in the SFRA process, provides a greater level of information and detail on site allocations within the study area and flood risks, to inform future policies and provide detailed flood risk information.

1.4.2 This document was preceded by an Inception Report, which was completed in November 2006 by Faber Maunsell. The Inception Report located and identified available data and information that would be useful for completion of the SFRA. In addition the report outlined the extents of the study areas, the modelling approach and highlighted various specific flood risk issues for both districts.

1.4.3 The Inception Report stated the scope for the SFRA as follows:

- Flood risk should be considered as the actual, current risk, taking into account not only the presence of existing flood defences but also any artificial features such as roads and railway embankments, arterial drainage channels etc. These artificial features could have a significant impact on flood risk to any land protected by such features/obstructions.
- Although the Flood Risk Zones defined in PPS25 relate to risk in the absence of defences, the same numerical probability levels should be used to define flood risk categories and associated flood envelopes in the study, namely:
- **Flood Zone 1** Annual probability of flooding less than 0.1%
- **Flood Zone 2** Annual probability of flooding greater than 0.1% but less than 1% (fluvial) or 0.5% (tidal)

- **Flood Zone 3** Annual probability of flooding greater than 1% (fluvial) or 0.5% (tidal)
- The results of the tidal embankment breach analyses undertaken for both of the authorities should be used to refine the SFRA
- Climate change assessments should be made for 50 years time, assuming existing defences are maintained at their present defence height and physical condition over the next fifty years[1].

1.4.4 The Inception Report formed the basis for the overall SFRA methodology, stressing the importance in this area to residual risk from tidal flooding. In addition the document also identified issues that were specific to each of the local authorities. These components are addressed in the relevant local authority appendices.

1.5 Synopsis

1.5.1 The Inception Report was completed prior to the release of the draft PPS25 practise guide; omitting the level 1 assessment for broad areas of potential growth. To ensure consistency with future policy these have been included in this report. In addition, climate change requirements have changed under PPS25 to those described in Section 1.4.3 in the Inception Report. This SFRA has been produced using the climate change guidance in PPS25.

1.5.2 The Inception Report identifies areas of specific interest within the two districts where more detailed flood risk assessments are required to assist in the application of PPS25. These locations have been subjected to dynamic two-dimensional (2D) hydraulic modelling to determine the pattern of propagation of floodwater flowing through breaches and overtopping of the existing defences. This information has been presented in the relevant local authority appendices.

1.5.3 The SFRA has been structured as follows:

- Main Report: Strategic Flood Risk Assessment
- Annex 1: PPS25 Extracts
- Annex 2: Data Collection and Sources
- Appendix A:Waveney District Council
- Appendix B:Suffolk Coastal District Council

1.5.4 The main SFRA report details the processes and methodologies employed in the assessment and mapping of flood risk. It presents information on tidal and fluvial sources, giving an overview of flood risk data and flood pathways throughout the study area.

1.5.5 Annex 1 - PPS25 Extracts relevant to Chapter 3

[1] New climate change guidance in PPS25 was released after the Inception Report had been completed. This recommends a period of 100 years of climate change be assessed for residential developments, and also provides new guidance levels that should be applied. These are significantly greater than the previous recommendations and suggest an increase of 1.03m be added for the 100-year climate change allowance. The increased water levels suggest many of the existing defences could be overtopped as a result of climate change, therefore the assumption from the Inception Report that existing defences will be maintained at their present height for the next fifty years is not suitable for this study. An alternative methodology was discussed and approved by the Environment Agency, which is detailed in Chapter 5 Methodology.

1.5.6 Annex 2 - Prior to the instigation of this SFRA a wide variety of data was made available and stored on an External Hard Drive (EHD). This information was collaborated by Faber Maunsell and outlined in the Inception Report (2006). This data is discussed in detail in Annex 2.

1.5.7 One of the key deliverables for the SFRA is accurate, high quality mapping of flood risk zones and hazard zones. The relevant inundation flood maps and hazard maps detailing the high, medium and low classifications can be seen in the relevant authority appendices (Appendices A and B).

Level 1 SFRA

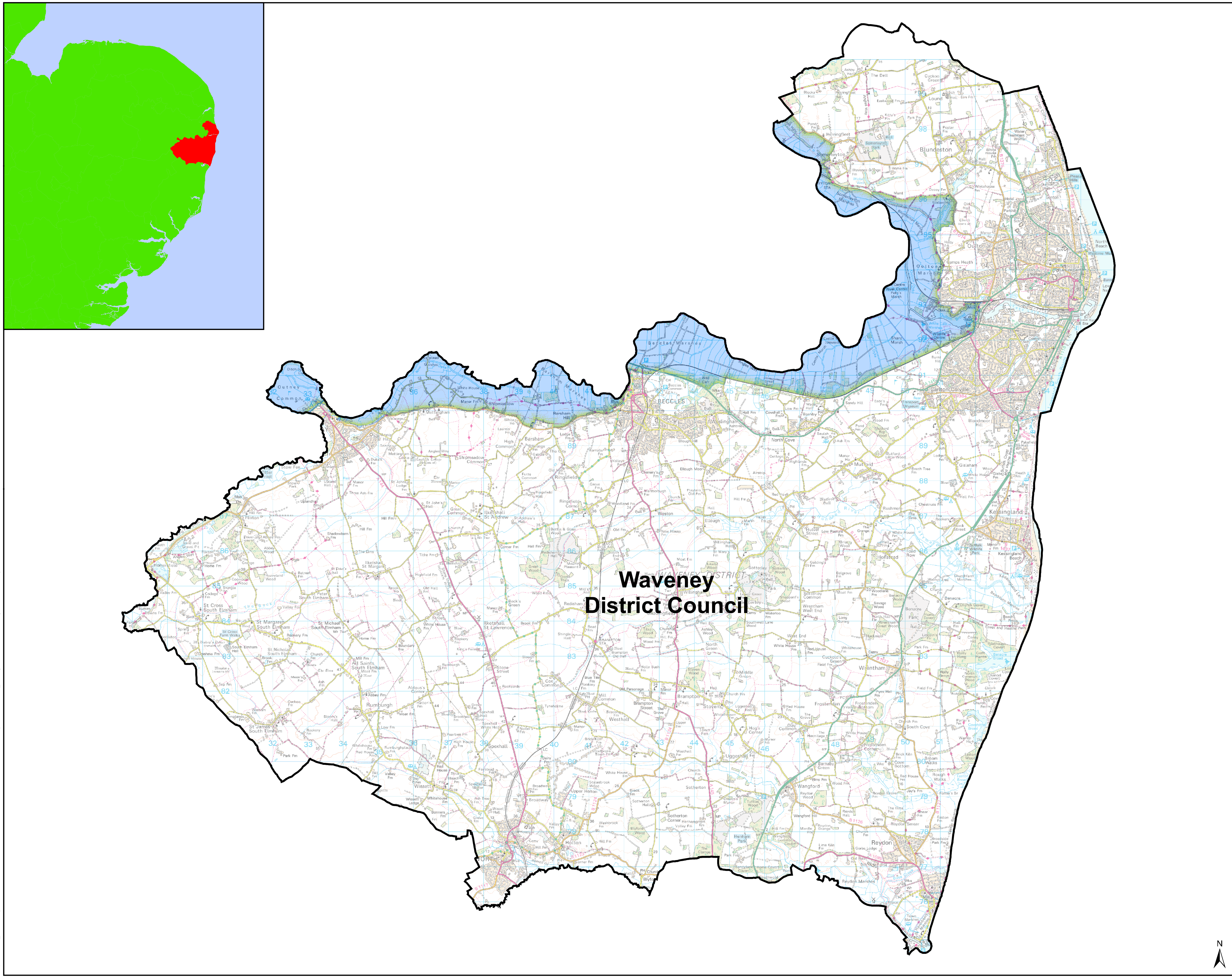
1.5.8 The aim of the Level 1 SFRA, principally a desk based study, is to enable the Local Authorities to apply the Sequential Test. The SFRA aims to facilitate this process by identifying the variation in flood risk across the Districts allowing an area-wide comparison of potential future development sites with respect to flood risk considerations. This information can also be used to assess how present environmental objectives relating to flooding and defined in the sustainability appraisal can be affected by additional development.

1.5.9 The key development areas within the study area LPA's, outlined in the Inception Report, were investigated with regard to flooding. These are presented in the specific LPA appendices and issues surrounding flooding in these areas discussed.

Level 2 SFRA

1.5.10 Where it can be demonstrated by the Local Planning Authority that the Sequential Test is passed, it will also be necessary in some circumstances for the Council to demonstrate that all three elements of the Exception Test are satisfied.

1.5.11 To assist the Local Authority in the application of the Exception Test, the 'Level 2' SFRA introduces an 'increased scope' taking into account the flood hazard and presence of defences. This information has been assessed within each of the Local Authority specific studies, with hazard mapping presented in each of the specific appendices.



NOTES

- Waveney District Council Boundary
- Broads Authority Area

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: SUFFOLK COASTAL AND WAVENEY SFRA

Drawing Title: WAVENEY LOCATION PLAN

Scale at A3: 1:100,000

Drawn	TD	Approved	EC
Stage 1 check	Stage 2 check	Originated	Date

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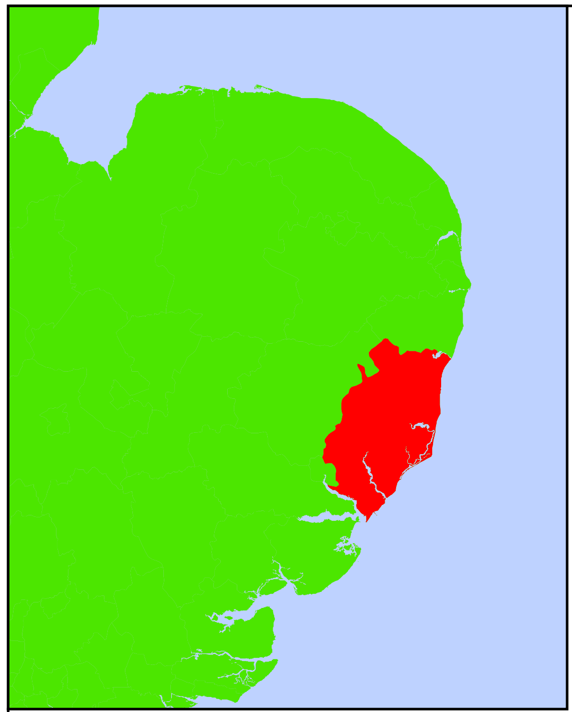
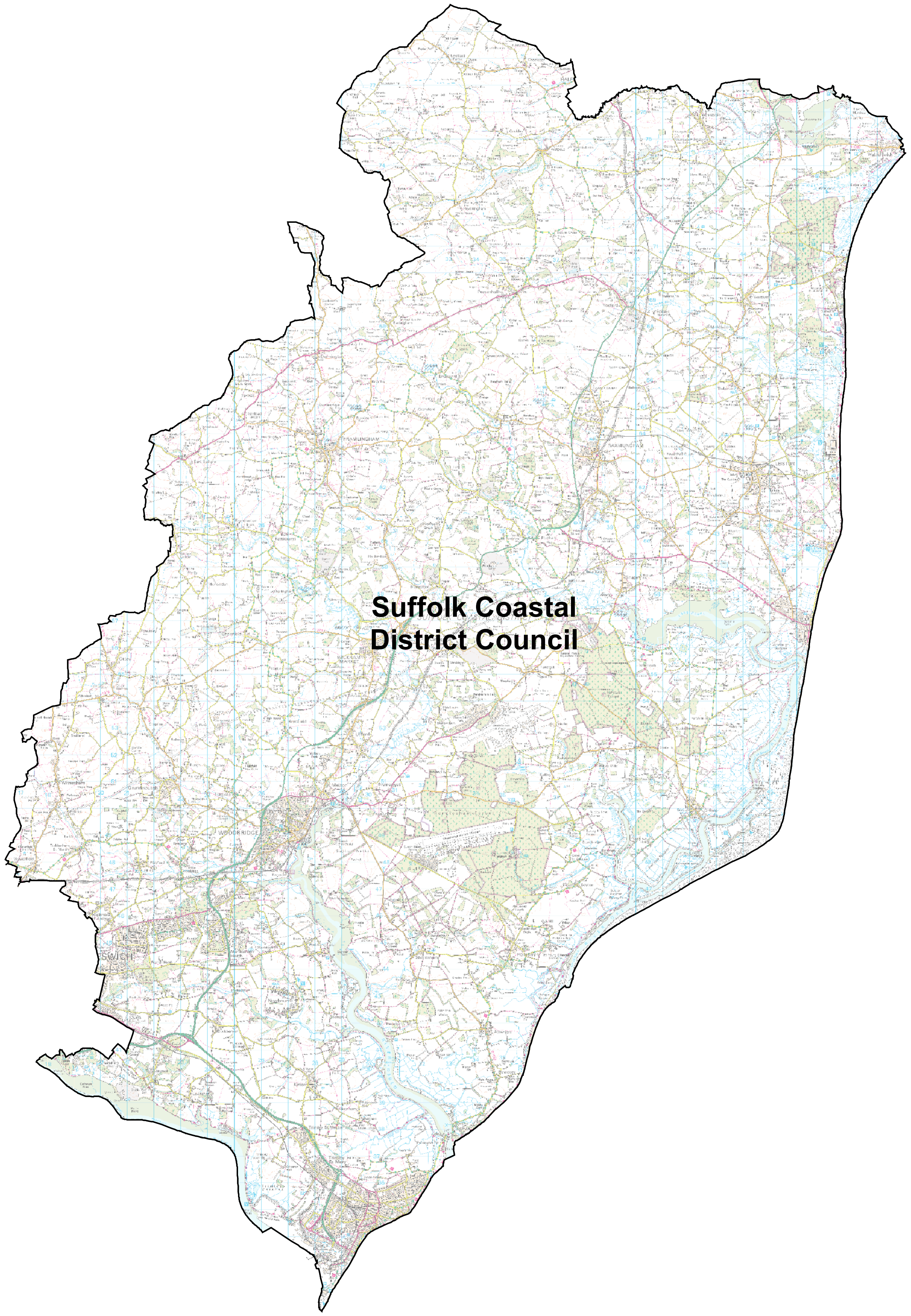
Drawing Number: **FIGURE 1.1** Rev

Plot Date: 17th July 2007
Filepath: L:\IBA_Water\Projects & Jobs\D114000 to D114999\D114264 - Suffolk Coastal and Waveney SFRA\GIS\Tim_Basingstoke\MXDs\Finals\Figure 1.1 Waveney Location Plan.mxd





NOTES

Suffolk Coastal District Council Boundary

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: SUFFOLK COASTAL AND WAVENEY SFRA

Drawing Title: SUFFOLK COASTAL LOCATION PLAN

Scale at A3: 1:200,000

Drawn	TD	Approved	EC
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Drawing Number: **FIGURE 1.2**

Rev

N

Plot Date: 17th July 2007
Filepath: L:\BA_Water\Projects & Jobs\D114000 to D114999\D114264 - Suffolk Coastal and Waveney SFRA\GIS\Tim_Basingstoke\MXDs\Finals\Figure 1.1 Suffolk Coastal Location Plan.mxd

2 Background

2.1.1 The study extent for this SFRA is confined to the areas of Suffolk Coastal and Waveney District Council, situated within the county of Suffolk, which lies in the eastern part of the Environment Agency's (EA) Anglian Region.

2.1.2 The study area is predominantly rural, however there are areas of dense settlement and industry centred around the two main towns of Felixstowe and Lowestoft and the Ipswich Policy Area. In addition there are multiple Market Towns scattered throughout the area. The area is bounded by the North Sea to the east with the large fluvial system of the Norfolk and Suffolk Broads to the north. This stretch of coastline is characterised by alternating areas of low sandy cliffs and natural shingle banks separating the sea from areas of salt marsh.

2.1.3 The main watercourses in the study area are characterised by extensive tidally influenced lower reaches and estuarine systems. These are the Rivers Waveney, Blyth, Alde, Ore, Deben, Butley and Orwell. There are also a number of smaller rivers that do not possess large estuaries, including the Hundred River and Minsmere River, The Tang enters the Rivers Butley, Mill, Fynn and Gull, all of which drain into the River Deben. The North Sea borders the east of the study area and is the main influence on the tidal sections of the above watercourses.

2.1.4 To the north of the study is the widespread low-lying wetland area of The Broads, which are situated in the counties of Norfolk and Suffolk. The Broads stretch over 303sq km and include unique areas of rivers, broads (shallow lakes), marshlands and fens (un-drained marshlands). River systems incorporated in the Broads area are the lower valleys of the River Waveney, River Yare and associated tributaries, the River Chet, and the River Bure. The diverse habitats of the Broads area support many rare species of flora and fauna and consequently has been issued with National Park status. This area attracts many tourists who come to see the unique waterways and surroundings.

2.1.5 The tides on the Suffolk Coast are semidiurnal and the mean spring tidal range decreases northwards from Felixstowe, reaching a minimum of 1.9m at Lowestoft. Minsmere experiences the minimum level of predicted high waters relative to Ordnance Datum. The area is frequently affected by surges that act to change the height and duration of predicted tidal levels. Major surges have occurred along this stretch of the coast in 1953, 1976 and 1978, as well as a number of earlier events (Pye and Blott 2006).

2.1.6 Surges are caused by slow moving depressions present in the North Sea that act to draw down a strong northerly/north easterly airflow which piles water against the coast. Low pressure systems also act to raise the mean surface water level of the sea, heightening tidal levels. As the astronomical tidal range is small along this part of the coast, (Pye and Blott 2006), surge events have a relatively large impact on resultant tidal levels. It is believed that the recorded storm surge of 31st January 1953 resulted in the highest high tide levels recorded in this area, 3.5 maOD (metres above Ordnance Datum) at Southwold and 3.78 maOD at Aldeburgh (Pye and Blott 2006). Tidal surges of 1m are regularly recorded along this stretch of coast but there has not been a surge of 1953 magnitude for some time (Pye and Blott 2006).

2.1.7 As a result of climate change this area will be increasingly at risk from flooding due to rising sea levels and increased rainfall intensity. Tidally influenced watercourses are thus thought to present the greatest threat to people, property and infrastructure in this area (East Suffolk Catchment Flood Management Plan Inception Report march 2006).

2.1.8 The coastline of Waveney and Suffolk Coastal is littered with Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR's), Special Areas of Conservation (SAC's), Special Protection Areas (SPA's) and Ramsar Sites. In addition, the majority of the Suffolk coastline, extending inland has been designated an Area of Outstanding Natural Beauty (AONB) and one of the 43 designated Heritage Coasts in England and Wales. This stretch of coastline is thus hugely important and needs to be responsibly developed and protected.

2.2 History of Flooding

2.2.1 A number of flooding events have affected both districts and have been monitored and recorded in the Suffolk area since 1883. Notable events include (from East Suffolk Catchment Flood Management Plan – Draft Scoping Report, July 2006):

- Coastal flooding arising from the North Sea in 1947. This was the worst flooding seen in the area since 1888
- In late January 1953 the area experienced tidal flooding from the North Sea following a full northwest gale and a swelling spring tide, causing the sea to rise to very dangerous levels. Coastal flood defences were breached by huge waves in 1200 locations, inundating coastal towns along the east coast from Hull in the north to Deal in the south, including Lowestoft, Southwold, Aldeburgh and Felixstowe amongst others. This event resulted in 300 deaths in England, including 5 people in bungalows on Ferry Road in Southwold and 39 in Felixstowe. There were 24,000 flooded properties as a result of the 1953 flooding event, including 700 in Felixstowe, 30 in Southwold and 400 in Lowestoft. A number of communication networks were also seriously affected, including the railway line from Lowestoft to Norwich, the main road in Aldeburgh and the Railway station in Woodbridge, which was abandoned (BBC Suffolk).
- In 1979 the Hundred River and the River Alde flooded due to snowmelt and rainfall falling on frozen ground, causing flood damage in their valleys.
- In 1981 the River Blyth, Alde and Deben flooded affecting their river floodplains and valleys. Extensive pumping was initiated in an attempt to limit the flood levels in the Hundred River.
- In February of 1993 the area experienced flooding from combined fluvial and tidal events, caused by a number of low-pressure systems passing the area and runoff generated from saturated catchments. This resulted in £250K damage. Then in October 1993 fluvial and surface water flooding hit the area leading to the damage of 167 properties. Details of flood damage to Suffolk Coastal District as a result of this event can be found in the Suffolk Flood Record Database (Appendix B).
- In 1995 widespread tidal flooding caused £800K damage to the area.
- Widespread flooding also occurred in the area during 2000. Information regarding flood damage to Suffolk Coastal District can be found in the Flood Records Database.

- A period of high intensity rainfall in September 2006 resulted in surface water flooding in the Lowestoft area. In addition, a combination of high tides and high rainfall intensity lead to widespread flooding across the district of Waveney in 2006.
- Strong winds, high tides and a storm surge threatened the East coast in November 2007. Extensive flooding resulted, from Lowestoft in Waveney to Felixstowe in Suffolk Coastal. Six homes were flooded in Southwold Harbour. However, the extent of the flooding was not as extreme as was predicted due to a shift in the wind direction and the tidal surge not coinciding with the exact timing of the high tide.

2.2.2 Flooding events with specific importance to the two districts are discussed in the relevant Appendices.

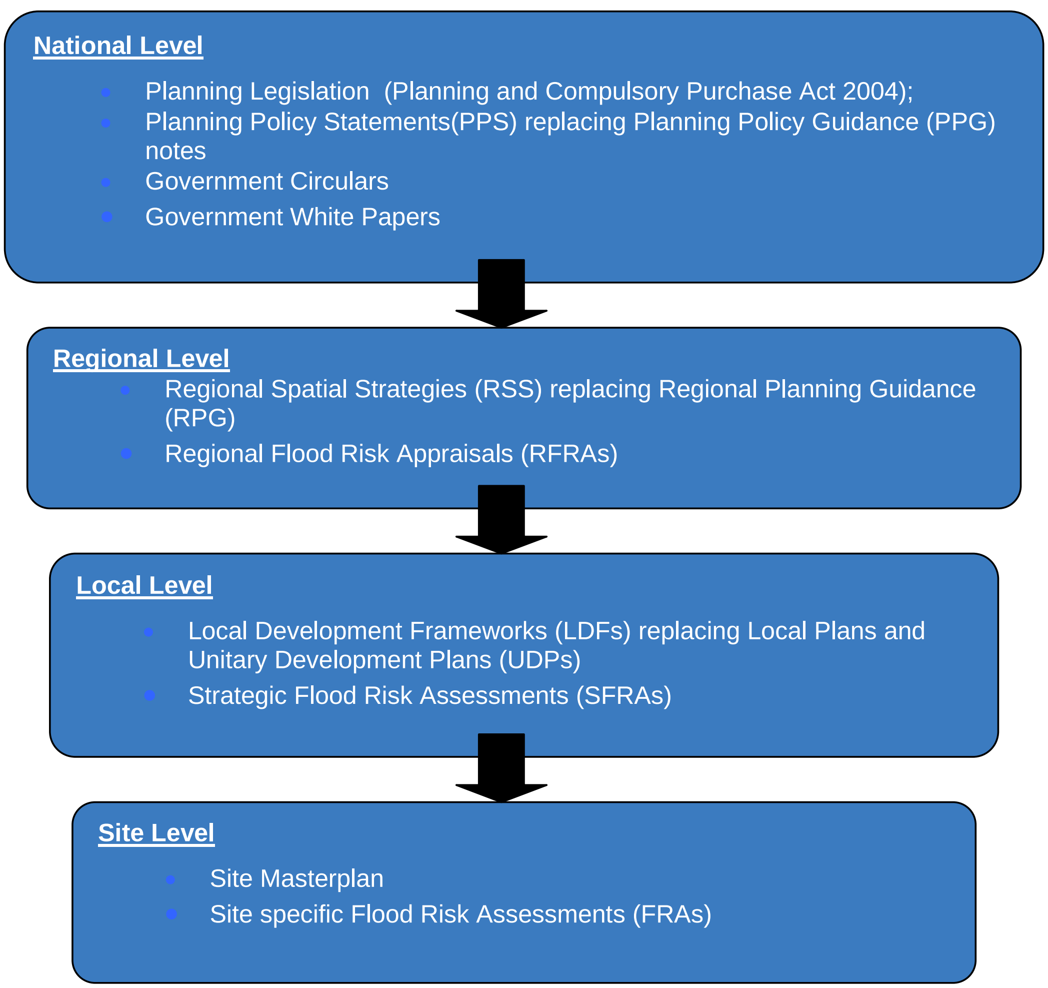
3 Flooding and Planning Policy

3.1.1 This chapter covers the statutory and non-statutory documents that relate to Strategic Flood Risk Assessments (SFRAs). Firstly, there is an overview of the English planning system followed by an in depth review of Planning Policy Statement 25: Development and Flood Risk. Subsequent sections examine other relevant statutory and non-statutory policy and guidance relating to flooding at the national, regional and local level.

3.2 Overview of the English Planning System

3.2.1 The English planning system is a hierarchical plan-led system whereby central government determines national policies on different aspects of planning and the rules that govern the operation of the system. The national policies consist of broad guidelines and principles that filter down through regional and local policies to site-specific policies. This system is illustrated in Figure 3-1.

FIGURE 3-1 STRUCTURE OF THE PLANNING SYSTEM



3.2.2 Integrating the previous level's policies with more regional, local or site-specific detail generates each level of policy.

3.2.3 Flood risk is a core issue to be considered when making land use decisions. The Strategic Flood Risk Assessment is intended to inform the SA/SEA process. Following this, local policies and strategies can be developed to create pragmatic solutions taking into account of the various requirements of these policies, and deliver guiding principles to steer future development to the most suitable locations, avoiding areas of flood risk wherever possible.

3.3 Introduction to Flooding and Planning Policy

3.3.1 Planning Policy Statement 25: Development and Flood Risk (PPS25, 2006) describes flooding from rivers and coastal waters as a:

'…*natural process that plays an important role in shaping the natural environment.*'

Unmitigated flooding can cause injury or loss of life and damage or destruction to property. The severity of flooding and its associated negative impacts can be intensified as a consequence of previous land use decisions such as location, design and nature of development. In addition, the cumulative effects of climate change could also contribute to the relative severity of flooding events.

PPS25 makes explicitly clear that all forms of flooding and their impact on the natural and built environment are a material planning consideration[2]. Planning Policy Statement 1: Delivering Sustainable Development (PPS1, 2005) is the Government's flagship planning policy document on how planning should facilitate and promote sustainable patterns of development. This document also advocates the avoidance of flood risk and accommodating the impacts of climate change.

Flooding, from any source, can never be entirely prevented but the severity of impacts can be avoided through good planning and management.

3.4 Statutory National Planning Policy and Guidance

Planning Policy Statement 25: Development and Flood Risk

3.4.1 The relevant Planning Policy Statement in terms of managing flood risk that pertains to development is PPS25. PPS25 requires local authorities to take a risk-based approach to flooding in relation to the preparation of local development documents or plans.

3.4.2 This document aims to ensure that flood risk is taken into account at all stages in the planning process from the inception of regional and local policy through to individual development control decisions.

3.4.3 The document seeks to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of high risk through the application of the sequential approach and the precautionary principle. It is acknowledged that, in some

[2] A material planning consideration is a factor that is relevant to a planning application or an appeal. Such factors include density, privacy, cumulative impact, and flooding. Factors not relevant to applications or appeals include loss of view, commercial competition and restrictive covenants. Each application or appeal is judged on its own merits.

exceptional circumstances, it might not be possible to deliver available sites in lower risk zones through the sequential approach. Here, policy will aim to ensure that the development will be safe, without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

Key Planning Objectives

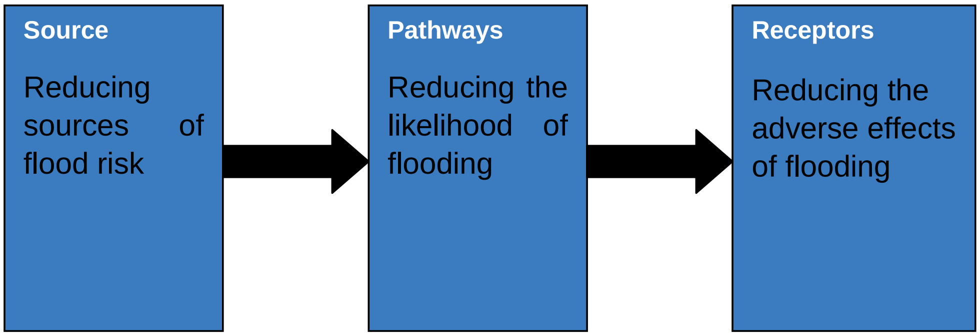
3.4.4 PPS25 identifies means by which Regional Planning Bodies (RPBs) and Local Planning Authorities (LPAs) should prepare and implement strategies that help to deliver sustainable development. These include:

- Appraising risk
  - Identifying land at risk and the degree of risk of flooding from river, sea and other sources in the area;
  - Preparing Regional Flood Risk Assessments (RFRAs) or Strategic Flood Risk Assessments (SFRAs) as appropriate;
- Managing risk
  - Framing policies for the location of development which avoid flood risk to people and property where possible, and manage any residual risk and accounting for climate change;
  - Only permitting development in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and benefits of the development outweigh the risks from flooding;
- Reducing risk
  - Safeguarding land from development that is required for current and future flood management e.g. conveyance and storage of flood water, and flood defences;
  - Reducing flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SUDS);
  - Using opportunities offered by new development to reduce the causes and impacts of flooding e.g. surface water management plans; making the most of the benefits of green infrastructure for flood storage, conveyance and SUDS; re-creating functional floodplain; and setting back defences;
- A partnership approach
  - Ensuring spatial planning supports flood risk management policies and plans, River Basin Management Plans and emergency planning.

Risk Based Approach

3.4.5 PPS25 advocates a risk-based approach at all levels of planning. This approach utilises the Source-Pathway-Receptor Model to planning for development in areas at risk from flooding. This is illustrated in Figure 3-2

FIGURE 3-2 SOURCE-PATHWAY-RECEPTOR MODEL



Flood Risk Assessments

3.4.6 PPS25 explains that SFRAs should be carried out by the LPA to inform the preparation of its Local Development Documents (LDDs), having regard to catchment-wide flooding issues. Thus, the SFRA provides the information, such as aerial photography, flood zone maps provided by the Environment Agency (EA) and the National Flood and Coastal Defence Database (NFCDD), needed to apply the Sequential Test or the Exceptions Test. These tests are risk-based and aim to steer new development to areas at the lowest risk of flooding and will be discussed in the following sections.

The Sequential Test

3.4.7 A sequential risk-based approach to determining the suitability of land for development in flood risk areas should be applied at all levels of the planning process.

3.4.8 PPS25 aims to encourage decision-makers to steer all new development into Flood Zone 1. Where there are no available sites in Flood Zone 1, land allocations or development of any kind should consider reasonably available sites in Flood Zone 2, taking into consideration the flood risk vulnerability of the proposed use and applying the Exception Test where necessary. Only if there are no available sites in Flood Zones 1 or 2 should sites in Flood Zone 3 be considered, again taking into account the flood risk vulnerability of the proposed use and applying the Exception Test where necessary. Within each Flood Zone, decision-makers are expected to steer allocations and developments to those areas of lowest hazard as identified by the SFRA.

3.4.9 Table D.3 illustrates the developments that might be considered to be appropriate in certain flood zones once the Sequential Test has been applied. This table should be referred to in conjunction with Tables D.1 and D.2 of PPS25.

3.4.10 Where Table D.3 indicates an Exception Test is required (i.e. when 'more vulnerable' development and 'essential infrastructure' cannot be located in Zones 1 or 2 and 'highly vulnerable' development cannot be located in Zone 1), the scope of the SFRA will be widened to consider the impact of the flood risk management infrastructure on the frequency, impact, speed of onset, depth and velocity of flooding within the Flood Zones considering a range of flood risk management maintenance scenarios.

The Exception Test

3.4.11 The Exception Test is only appropriate for use when there are large areas of development in Flood Zones 2 and 3, where the Sequential Test alone cannot deliver acceptable sites, but where continuing development is necessary for wider sustainable development reasons. There must be evidence to prove that the Sequential Test has been applied to a particular area to support the outcome.

3.4.12 For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA;
- The development should be on developable previously developed land or, if not, it must be demonstrated there is no such alternative land available; and
- A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

3.4.13 All three parts of this test must be satisfied in order for the development to be considered appropriate in terms of flood risk. There must be robust evidence in support of every part of the test.

Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft'

3.4.14 This document is due to be published late in 2007 with the consultation process closing in August 2007. However, the document is a living document and a working version is currently available, though only on-line. This copy was made available on 19th February 2007.

3.4.15 The draft Practice Guide provides advice on the practical implementation of PPS25 policy.

Strategic Flood Risk Assessments

3.4.16 With regards to SFRAs the draft guide explains that there are two levels of assessment, Level 1 and Level 2. A Level 1 SFRA should provide sufficient data and information to enable the LPA to apply the Sequential Test to land use allocations and to identify whether the application of the Exception Test will be necessary. The draft guide explains that the Level 1 SFRA should also enable LPAs to:

- Prepare appropriate policies for the management of flood risk within the LDDs;
- Inform the sustainability appraisal so that flood risk is taken account of when considering options and in the preparation of strategic land use policies;
- Identify the level of detail required for site-specific FRAs in particular locations; and
- Enable them to determine the acceptability of flood risk in relation to emergency planning capability.

3.4.17 The draft guide goes on to explain the variety of sources of information that can be drawn upon including Environment Agency (EA) maps and RFRAs and the outputs to be expected from an SFRA. These include, amongst other things, plans outlining LPA boundaries, main rivers and watercourses, an assessment of the implications of climate change on flood risk, other potential sources of flooding and current flood management measures.

3.4.18 The Level 2 SFRA corresponds to a more in depth study of flood risk required to facilitate the application of the Exception Test, and to allow a sequential approach to site allocation within a flood zone i.e. preferentially developing those sites situated in an area of lower hazard within a flood zone.

3.4.19 The draft Practice Guide also explains the full scope of a Level 2 SFRA, the variety of data sources available ad the expected outputs of this more detailed analysis.

3.4.20 The draft guide concludes that:

> *'…the SFRA should aim to provide clear guidance on appropriate risk management measures for adoption on sites within Flood Zones 2 and 3 , which are protected from flooding by existing defences, to minimise the extent to which individual developers need to undertake separate studies of the same problem. In some instances improvements to existing flood defences may be required to manage residual flood risks (see Annex G of PPS25). Where such flood defence works are considered, the SFRA should include an appraisal of the extent of any works required to provide or raise the flood defence to an appropriate standard'*

DCLG Circular 04/2006: Town and Country Planning (Flooding)(England) Direction 2007

3.4.21 This document was published in December 2006 and highlights that on 1st October 2006 the Environment Agency was made a statutory consultee on matters relating to flood risk under The Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006. LPAs now have a duty to consult with the Environment Agency on all applications for development in areas of flood risk or where critical drainage problems exist and for developments where the site is larger than 1 hectare, at risk of flooding or not.

3.4.22 In addition, the document details that a LPA must notify the Secretary of State (SoS) of any application for a major development in a flood risk area, where it is minded to grant permission against the advice on flood risk grounds from the Environment Agency. This direction came in to force 1st January 2007.

Planning Policy Statement 1: Delivering Sustainable Development (PPS1)

3.4.23 The application of PPS25 will be closely linked with the application of Planning Policy Statement 1: Delivering Sustainable Development (PPS1) published in February 2005. PPS1 sets out the parameters for planning policy to deliver sustainable development across the planning system. It advocates that local authorities need to take into account the risks of flooding when producing development plan policies. PPS1 emphasises that new development should be avoided in areas that are at risk of flooding and sea level rise, unless such development meets the needs of the wider objectives of sustainable development. Therefore, planning authorities are advised to ensure that developments are 'sustainable, durable and adaptable'.

Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1

3.4.24 Planning and Climate Change sets out how spatial planning should contribute to reducing emissions and stabilising climate change (mitigation) and take into account the unavoidable consequences (adaptation).

3.4.25 The document states that climate change in the UK could mean more extreme weather events, including hotter and drier summers, flooding and rising sea levels leading to coastal erosion and realignment.

3.4.26 These expected changes will have knock-on effects for land use decisions. The document explains that when deciding which sites and areas are suitable for development, and deciding the type and intensity of development, planning authorities should take into account:

> *'…known physical and environmental constraints on the development of land such as sea level rises, flood risk and stability, and take a precautionary approach to increases in risk that could arise as a result of likely changes to the climate'* (p18, para. 19)

3.4.27 The document also requires Local Planning Authorities, in determining planning applications, to recognise the benefits of public and private open space and the opportunities they provide for flood storage.

Planning Policy Statement 3: Housing (PPS3)

3.4.28 PPS3: Housing was developed in response to recommendations in the Barker Review of Housing Supply in March 2004 (Barker, 2004). A principal aim of the new PPS3 is to underpin the Government's response to the Barker Review of Housing Supply and the necessary step-change in housing delivery, through a new, more responsive approach to land supply at the local level.

3.4.29 The document states that at the local level, LDDs should set out a strategy for the planned location of new housing which contributes to the achievement of sustainable development. LPAs should, working with stakeholders, set out the criteria to be used for identifying broad locations and specific sites taking into account of flood risk.

Planning Policy Guidance 20: Coastal Planning (PPG20)

3.4.30 This guidance note covers planning policy for the coastal areas of England. It sets the general context for policy and identifies planning policies for the coast and policies for development that requires coastal location. Guidance is also given on how these policies should be reflected in development plans.

3.4.31 The document explains that, on the coast, opportunities for development may be limited by physical circumstances, such as risk of flooding, erosion, land instability, and by conservation policies. Where the coastal zone is only a small part of the territory of a local planning authority it is reasonable to expect provision of land for housing and employment to be made elsewhere in the district, for example.

3.4.32 In areas at risk of flooding, policy should avoid putting further development at risk. In particular, new development should not generally be permitted in areas that would need expensive engineering works to defend land that might be inundated by the sea. There is also the need to consider the possibility of such works causing a transfer of risks to other areas. PPG20 highlights the particular risk posed by flooding to low-lying coastal areas.

3.5 Non-Statutory National Planning Documents

Making Space for Water

3.5.1 During 2004, the Department for Food and Rural Affairs (DEFRA) undertook a consultation exercise, the object of which was to engage a wide range of stakeholders in the debate regarding the future direction of flooding strategy. The consultation document 'Making Space for Water' is part of the Governments overall approach to managing future flood risks and sets out the following aim:

'To manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches which reflect both national and local priorities, so as to:

- *Reduce the threat to people and their property; and*
- *Deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles'* (p1)

Thus, the aim of the strategy is to balance the main pillars of sustainable development, namely social, economic and environmental factors.

3.5.2 Making Space for Water examines the impact of climate change on flood levels. Experts consider that the primary impacts on flood risk will be from changes in precipitation, extreme sea levels and coastal storms. DEFRA and the Environment Agency will produce revised guidance for use by those implementing flood and coastal erosion risk management measures. The revised guidance, yet to be published, will ensure that adaptability to climate change through robust and resilient solutions becomes an integral part of all flood and coastal erosion management decisions.

3.5.3 Making Space for Water emphasises the Government's commitment to ensure that a pragmatic approach to reduce flood risk is adopted. However, the paper notes that 10 per cent of England is already within mapped areas of flood risk. Contained within these areas are brownfield sites, which policy has identified as a priority for future development. The document asserts that over the past five years 11 per cent of new houses were built in flood risk areas.

3.5.4 The plan advocates the use of European Union (EU) funding streams, such as INTERREG IIIB, to enable local authorities to undertake trans-national projects aimed at advancing knowledge and good practice in flood risk management. The document also encourages integration with water management initiatives, in particular Catchment Flood Management Plans. The document proposes that RSSs and LDFs should take full account of strategic flood risk assessment and incorporates the sequential approach as set out in PPS25.

3.5.5 At the development control level, the document encourages local planning authorities to follow the existing guidance to require site-specific FRAs. In addition, the use of FRAs as supporting documents to planning applications in areas of flood risk is encouraged. The document proposes that if mitigating measures are shown to be required, they should be fully funded as part of the development.

Sustainable Communities Plan

3.5.6 The Sustainable Communities Plan (SCP, ODPM, 2003a) was launched by the ODPM in February 2003. The plans main aims include improving the overall quality of housing in England, a step change in housing supply to meet demand, encouraging new growth areas while maintaining and protecting the Green Belt. These objectives are to be achieved with sustainability at the centre to ensure a legacy of improved, liveable communities.

3.5.7 The challenge is to reconcile the SCP's requirement to identify sufficient land for large volumes of new homes whilst ensuring that the sites allocated satisfy sustainability criteria specifically with regard to the avoidance of flood risk.

3.5.8 '*Sustainable Communities in the East of England: Building for the Future*' is the document that covers the districts commissioning this SFRA and will be discussed further in the Regional Planning Policy and Guidance Section.

3.6 Regional Planning Policy and Guidance

Draft East of England Plan

3.6.1 The Draft East of England Plan or Regional Spatial Strategy (RSS, East of England Regional Assembly, 2004) sets out the regional strategy for planning and development in the East of England to the year 2021. The Plan provides policy direction for matters such as economic development, housing, the environment, transport, and waste management.

3.6.2 The Plan plays a significant role in contributing to sustainable development and sets out policies that address the needs of the region and key sub- regions. These policies provide a development framework for the next 15 to 20 years that will influence the quality of life, the character of places and how they function, and will inform future strategies and plans.

3.6.3 The East of England is one of the largest of the English regions with an area of 19,000 square kilometres. It extends from the fringes of London in the south to the North Norfolk coast. The area is generally considered low-lying in character with parts at or below sea level. It is a region of diverse landscape with a rich built environment and is of national heritage importance.

3.6.4 The Plan highlights population growth in the East of England within the last few decades. This has been driven by inward migration from the rest of the UK, principally from London due to job opportunities and low house prices making commuting to London a viable proposition. A key objective of the Plan is to ensure these demands are accommodated in a sustainable manner.

3.6.5 The Plan identifies key drivers of change in the region, which are most likely to influence the scale and location of development within the next 20 – 30 years. They include:

- Social progress, which recognises the needs of everybody;
- Effective protection of the environment;
- Prudent use of natural resources; and
- The maintenance of high and stable levels of economic growth and employment.

3.6.6 The housing targets set out in the East of England Plan indicate the intense pressure the region is under to provide new housing. Inevitably this pressure for housing will increase the need for land for development and redevelopment. As supplies of Flood Zone 1 land are utilised so the pressure on more marginal land will increase and, unchecked, so will the risk of flooding.

3.6.7 A key objective of the East of England Plan is to minimise the risk of flooding within the region. The Plan states that the coastline is naturally dynamic, with strong natural processes. These processes, principally coastal erosion, can result in increased stress on flood defences. Consequently, climatic change, also a contributor to increasing sea levels, is highlighted as a key issue that will need to be addressed.

3.6.8 The Plan states that climate change will be inevitable over the period of this strategy and for many years into the future. It will impact on existing development and natural resources and must influence our decisions about the location of future development.

3.6.9 Areas now at risk from flooding will become more vulnerable and there will be new areas at risk. The Plan states that sea levels in the region may be between 22 and 82 centimetres above the current level by 2080. This is expected to have significant impacts on coastal and low-lying areas. Water is likely to become scarcer in the summer months adding to the supply-demand issues already faced in this, the driest of the English regions. The Plan also notes that changes in biodiversity may occur in response to climate change and that climate change is also likely to cause disruption in international trade and the region's vulnerability to this needs to be reduced.

The Secretary of State's Proposed Changes to the Draft Revision to the Regional Spatial Strategy for the East of England and Statement of Reasons

3.6.10 These proposed changes by the SoS to the East of England Plan were published in January 2007.

3.6.11 The changes include a proposed growth in jobs from the Draft Plans original 421,000 to 452,000. In addition, housing provision in the region has been proposed to increase from 478,000 to 508,000. Both these increased targets are stressed to be floor targets rather than ceiling targets and, where possible, should be exceeded.

3.6.12 These increased targets will add further pressure for new land to develop and could increase the need for using more marginal land, at greater risk of flooding.

3.6.13 The proposed changes also add an objective to reduce the regions impact on and exposure to climate change by reducing the risk of damage by flooding.

3.6.14 In addition, Policy SS14: Development and Flood Risk has been proposed to be replaced by Policy WAT4: Flood Risk Management. This new proposed policy prioritises the defence of existing properties from flooding and to locate new development areas with little or no flood risk. The policy states that local development documents should:

- Use strategic flood risk assessments to guide development away from flood plains, areas at high or medium risk (now and in the future) of flooding and where flood risk would be increased elsewhere as a result of a development;
- Include policies to identify and protect flood plains and land at risk from tidal and coastal flooding from development (based on such information as EA flood maps);

- Only propose departures from the above principles in exceptional cases where land at less risk is unavailable or the benefits of the development outweigh the risks and where appropriate mitigation is implemented; and
- Require that sustainable drainage systems are employed in all appropriate developments.

3.6.15 Lowestoft is identified as a Key Centre for Development and Change in Policy SS3, along with Great Yarmouth. These areas will be targeted for concentrated growth and due to their coastal nature could be at increased risk of flooding and could thus conflict with Policy WAT4.

3.6.16 Finally, the draft East of England Plan and the proposed changes by the SoS have not been informed by a Regional Flood Risk Assessment.

The Secretary of State's Further Proposed Changes to the Draft East of England Plan

3.6.17 On 23 October 2007 the Government published Further Proposed Changes to the Draft East of England Plan. The Further Proposed Changes relate exclusively to the protection of sites of European or international importance for wildlife.

3.6.18 A minor change to WAT 2: Water Resource Development, requires a coordinated approach to plan making through a programme of water cycle studies to address flood risk issues in receiving water courses relating to development proposed in the RSS.

3.6.19 The second notable change relates to paragraph 10.13. The proposed change clarifies the distinction between the approach to flood defences in areas within and outside settlements in order to avoid significant effects on sites of European and international importance for wildlife. The distinction lies in the fact that flood defences protecting settlements will be retained and in some cases enhanced, a more flexible approach is required in areas outside settlements which are vulnerable to tidal flooding, based on policies of managed realignment and relocation.

Regional Planning Guidance 6 for East Anglia to 2016 (RP6)

3.6.20 This document was published in 2000 and since its creation the regions have been re-divided. The East of England is now the region incorporating Waveney and Suffolk Coastal and the new RSS (draft East of England Plan) will replace RPG6 during 2007. Though RPG6 is the adopted document it carries less weight than the new RSS due to this documents proximity to adoption.

3.6.21 One of the main stated objectives of RPG6 is to ensure that development does not take place in areas that have an unacceptable risk of flooding or which may exacerbate flooding elsewhere. In addition, the document aims to ensure the promotion of sustainable flood defences and coastal protection policies.

3.6.22 Sea and fresh water flooding and coastal erosion are problems in low-lying coastal areas and fenland, as well as within river floodplains in East Anglia. RPG6 explains that the problem will be exacerbated even if there is only a small rise in the sea level as a result of climate change. Continuing to improve defences as levels rise would involve considerable public expenditure and managed retreat, with resources being concentrated on the most valuable assets at risk, may be the only alternative.

3.6.23 The document goes on to say that climate change is likely to have significant implications for East Anglia within the timescale of this guidance. These include an increased likelihood of fluvial, estuary and coastal flooding.

Sustainable Communities in the East of England: Building for the Future

3.6.24 This document sets out proposals for maintaining and creating sustainable communities in the East of England and is the regional version of the national document, the Sustainable Communities Plan, both of which are non-statutory guidance.

3.6.25 One of the strategic challenges for the region is to address problems of high and rapidly rising house prices. This would indicate a high and increasing level of demand for housing reflected in the fact that household numbers increased by 5.4% between 1996-2001 while supply for the same period has only increased by 4.6%. The problems of added development pressure on land at risk from flooding have already been discussed previously.

3.6.26 Another strategic challenge the document foresees is that of managing development with the increased threat of rising sea levels for coastal and low lying areas.

3.6.27 The SCP identifies development in the East of England as a national priority. The Plan recognises the following factors as key tools to support regeneration in the area:

- Location within close proximity to London;
- The strategic location of major transport links to the continent;
- One of the largest concentrations of brown field sites in the country; and
- Creation of an opportunity for 232,000 new jobs and 128,500 homes between 2001-2016.

3.6.28 The Plan reiterates that the development of sustainable communities and regenerating existing areas will be avoided in unsustainable locations in terms of flood risk. The plan states 'development proposals will be subject to flood risk assessment in consultation with the Environment Agency'. Furthermore, the Plan suggests that development will be concentrated on brownfield land and protected by flood defence infrastructure.

3.7 Sub-Regional Planning Policy and Guidance

Suffolk Structure Plan

3.7.1 The Structure Plan is a statement of strategic policies for the protection of the environment and the control of development over the next 15 years. It provides a basis for investment decisions by local authorities, businesses and individuals, and for the plans and programmes of other organisations. However, as with RPG6 this document and all its policies will be abolished and have no affect once the East of England Plan is adopted and the Local Development Frameworks are in place for the respective Local Authorities.

3.7.2 Additionally, policies relevant to flood risk in the Suffolk Structure Plan were deleted on 27th September 2007 in accordance with the Planning and Compulsory Purchase Act 2004 and therefore have no weight.

East Suffolk Catchment Flood Management Plan (CFMP)

3.7.3 This document will be a high level strategic plan that will look to assess how flood risks might change and be managed over the next 50 to 100 years. The scoping consultation concluded in December 2006.

3.7.4 At the time of writing, this plan had not yet been published by the EA, as it has been subject to delay.

Suffolk and Waveney Shoreline Management Plan (SMP)

3.7.5 Shoreline Management Plans (SMP) exist to promote good and prudent management of the coastline. They achieve this as they are large scale assessments of the risks associated with coastal processes and help to highlight and reduce these risks to people and the environment. They are a component of the government strategy for managing flood and coastal erosion. Discreet lengths of coastline are determined and preferred policies for the coastal management of these sections are ascertained in line with central government policy constraints (including budgetary limits, sustainability over 100 years and environmental impact).

3.7.6 SMP's, completed in the 1990's, are in place along the coastline. The SMP covering Suffolk and Waveney will include measures to sustain the future of coastal settlements and the environment. The SMP sets out preferred policies to safeguard the natural and human environments.

3.7.7 There are two Shoreline Management Plans relevant to the study area: Sub Cell 3B covers Sheringham to Lowestoft and Sub Cell 3C covers Lowestoft to Harwich. A review of Sub-cell 3B has been completed and was approved by Waveney District Council in September 2007. A review of Sub-cell 3C is underway and due for completion in late 2008. Sub-Cell 3B covers the North Waveney coast, including Corton and North Lowestoft. The first SMP for this section of coast was produced in 1996. Following this report, a review was undertaken and the final report was published in November 2006. While the report recognised that measures will be taken to prevent coastal erosion in some places, it also indicates that in the future it will not always be justifiable, in economic, technical and environmental terms, to pursue measures to prevent coastal erosion in all locations, (for example Corton). As such the plan discusses the implications of this. Sub-Cell 3C covers south Lowestoft to Harwich. Again, the first SMP for this section of coastline was produced in 1996 and a review is currently underway.

Water Framework Directive in the Anglian River Basin District

3.7.8 The Water Framework Directive was introduced by the European Commission (EC) in 2000 and applies to all EC Member States. It primarily aims to ensure that the quality of all waters is of 'Good ecological status' by 2015 (UK TAG, 2006). In addition to this, the directive is aiming to reduce the effects of floods and droughts. It was transposed into UK law in 2003, at which time the various River Basin Districts were derived. The Mid Essex area falls within the Anglian River Basin District, stretching from Lincolnshire in the north, Northamptonshire in the west, Essex in the south with the East Anglian coastline forming the eastern border (the area itself is similar to the Environment Agency's Anglian administrative boundary).

3.7.9 As part of the WFD process, River Basin Management Plans will be undertaken for each River Basin District. These plans will be produced in 2009 and will be subsequently subjected to three-yearly reviews

3.8 Local Planning Policy and Guidance

3.8.1 The following table (Table 3-1) outlines the main local, statutory planning policy documents for Suffolk Coastal District Council and Waveney District Council. For each of these documents all policies in relation to flooding from any source have been provided (including potential future policies from the, as yet, unadopted Local Development Framework of Waveney District Council. Suffolk Coastal District Council are less advanced in their Local Development Framework and are as yet only at the Issues and Options Consultation).

TABLE 3-1 LOCAL PLANNING AUTHORITIES AND RELEVANT POLICY

Local Planning Authority	Policy Document	Relevant Policy	Policy Text
Suffolk Coastal District Council	Suffolk Coastal Local Plan incorporating the First & Second Alterations	AP92	New development, or the intensification of existing development, will not be permitted in areas at risk from flooding. In addition, development (including the raising of land) will not be permitted where it is likely to impede materially the flow or storage of flood water or increase the risk of flooding elsewhere (for example, due to additional surface water run-off), or increase the number of people or properties at risk of flooding, unless the development includes appropriate measures to prevent these occurring.
Waveney District Council	Waveney Local Plan – adopted Nov 1996	ENV13	Proposals for development which are likely to lead, directly or indirectly, to an increase in coastal erosion or flooding will not be permitted.
	Waveney Interim Local Plan	DC16	Development proposals in areas identified as being at risk from flooding must be supported by a Flood Risk Assessment (FRA), of a level of detail appropriate to the scale and flood risk of the proposed development. The Council will not permit development which is likely to be at risk from flooding or which would increase the risk of flooding elsewhere, unless the results of the FRA indicate to the satisfaction of the Environment Agency and/or the Council that, through appropriate mitigation measures, the development can be built and occupied safely.
	Waveney Core Strategy Preferred Options Document (this document is currently under consultation and	Core Strategy Policy 1 – Sustainable Development	To achieve sustainable development in Waveney, all proposals for development must address flooding and coastal erosion.

Local Planning Authority	Policy Document	Relevant Policy	Policy Text
	consultation and not yet adopted policy but still carries some weight)	Core Strategy Policy 4 - Infrastructure	Provision may also include drainage and flood protection.
		Core Strategy Policy 16 – Climatic Events	Proposals for development in Waveney will need to respect the environment of the District and in particular be aware of the potential impact of climate change. Sustainable design and in particular sustainable drainage systems will therefore be an important consideration in the determination of all appropriate development. Proposals should avoid areas at risk from flooding unless there is an overriding need for the development, land at a lower risk is not available and the risk can be fully mitigated by engineering and design measures. Appropriate developments will require a flood risk assessment. Proposals should similarly avoid areas at risk from coastal erosion and ensure they are compatible with the appropriate Shoreline Management Plan. Proposals close to cliff edges or existing coastal defences will be required to undertake a risk assessment.

Blyth Flood Management Strategy (BFMS)

3.8.2 The BFMS has been developed in several stages. Firstly the flood risk, strategy objectives and flood management options have been defined through a series of consultation exercises. Following this, a short list of flood management options have been appraised and a preferred flood management strategy produced. The consultation stage on the Preferred Options document finished in January 2006. Subsequently, the EA have revised their proposals and intend to release a document for further consultation in July 2007.

3.8.3 The Preferred Option has identified several key objectives for the estuary. The first of these is to hold the Northern Harbour Arm. The loss of this harbour arm would cause the estuary mouth to widen to a more natural 'trumpet' shape with several different negative impacts.

3.8.4 Another objective is to hold the line at Reydon Marshes. It has been highlighted that management of the estuary processes and the predictability of estuary behaviour depends on being able to prevent Reydon Marshes' defences from breaching. Reydon Marshes is a large area of land several metres lower than sea level. Flooding of this area at every tide would lead to a doubling of water flow in and out of the estuary. The movement of such a large volume of water would quickly erode all defences downstream of the breach and destabilise the harbour mouth.

3.8.5 The final objective is to manage the realignment of Tinkers Marsh and Robinson Marshes, which will enable better management of estuary processes and flood risk.

Deben Flood Management Strategy and Alde & Ore Flood Management Strategy

3.8.6 The Deben Flood Management Strategy has undergone the first stage of consultation. A Preferred Options document will be produced and published for consultation following the Preferred Options consultation for the combined Alde & Ore and Thorpeness to Hollesley Coastal Strategy (see below)

3.8.7 The Alde & Ore Flood Management Strategy is being combined with the Thorpeness to Hollesley Coastal Strategy. A combined Preferred Options consultation will be prepared sometime in the future. The EA website will publish these in due course.

4 Flood Sources, Defences and Mechanisms

4.1.1 The combined area of Waveney District and Suffolk Coastal District is large and supports coastal, fluvial and estuarine systems, including a wide distribution of creeks and marsh areas. These diverse fluvial and coastal systems pose different sources of potential flood risk to the surrounding areas. Within this SFRA a broad scale approach was required to focus on the flood risks from sources that were considered to produce the more severe consequences.

4.1.2 Much of the Waveney and Suffolk Coastal areas are low lying, with some coastal areas below current sea level. These areas include the Blyth and Alde-Ore Estuaries (East Suffolk CFMP: Inception Report, March 2006). There are many areas of marshland, such as Beccles Marshes and Barsham Marshes surrounding the River Waveney, Beachfarm Marshes around the Hundred River, Sudbourne Marshes and Gedgrave Marshes situated in the lower reaches of the River Alde-Ore and Trimley Marshes located near the mouth of the River Orwell. Much of the coastal and estuary areas are protected by sea defences and river defences respectively. Higher ground exists at the sources of the rivers towards the westerly limits of the district boundaries.

4.1.3 Large sections of the Waveney and Suffolk Coastal areas are protected from tidal flooding by embankments and hard defences, including numerous floodgates and sluices. The area of Woodbridge is a prime example of an area heavily defended by floodgates, with several located immediately around the boat yard and station where infrastructure merges with the line of flood defence. There are embankments located along estuary bank areas on most of the estuarine areas found in Suffolk and Waveney. Low lying areas behind the defences are pump-drained through channels and ditches to tidal locked outfalls and pumping stations.

4.2 Coastal Flood Sources in the study area

4.2.1 The eastern boundary of Waveney and Suffolk Coastal districts is formed by the land/sea interface from Corton Cliffs in the north to the mouth of Harwich Harbour in the south. This area is very low lying, especially in coastal locations where land has been reclaimed for agriculture and conservation purposes, and can be below current sea level. This coastal stretch is sparsely developed and supports a number of nationally and internationally important conservation sites and habitats. This land will become more prone to flooding from the higher tide levels that will result from future sea level rise.

4.2.2 Tidal flooding constitutes the main form of flooding along this boundary, which forms an exposed but defended coastline. Defence comes in the form of a natural frontage of embankments, cliffs and natural shingle ridge, all of which are erodable and in front of potentially floodable land. In addition there are sections of ‘man-made’ defenses, such as embankments and sea walls at Felixstowe, Kessingland, Southwold, Lowestoft and Corton and around the mouths of the Deben and Alde-Ore estuaries, particularly at Slaughden, just south of Aldeburgh (East Suffolk CFMP: v1.0, March 2006).

4.2.3 Tidal information for the North Sea from Felixstowe Pier, Lowestoft and Southwold harbour is available from the Admiralty Tide Tables (2006 edition). The reported mean high water spring tide at Felixstowe Pier is +5.75m OD and the reported mean low water spring tide is +2.35m OD. These figures indicate a tidal range of 3.4m under normal conditions but do not account for waves or storm surge, which increase the water levels significantly.

4.2.4 The flood defences along this stretch of coastline consist of a combination of large earth embankments and hard defences. The overall condition of these defences is good, although the defences were not originally built to a high specification. Indeed, the defence crest height falls below the 1 in 200 year level and subsequently considerably beneath climate change levels for this stretch of coastline.

4.2.5 The areas with the greatest potential risk from a 200-year (0.5% AEP) tidal event are Lowestoft and, as outlined in the East Suffolk CFMP (Draft Scoping Report, July 2006), Ipswich, Felixstowe, Aldeburgh, Woodbridge, and Walberswick. The main flooding process considered in the CFMP was tidal in respect of tide-locking conditions. This occurs when rivers and streams can not discharge their water load into estuaries or the sea, causing the river and stream water to 'back up' and reach high levels. Tide-locking has the greatest impact when tidal events coincide with high river flows. There are a number of coastal draining rivers in the study area, including the Hundred River and the River Minsmere. High tide levels also affect rivers discharging into the many estuaries in the area.

4.3 Fluvial Flood Sources in Waveney

River Waveney

4.3.1 The River Waveney marks the northern border of the Waveney District. The river runs west to east for 40 km through the settlements of Diss and Bungay and becomes tidal downstream of Ellingham sluice. The river has a gradient of 1 in 2100 so generally has a gentle profile with an associated low carrying capacity and limited ability to alter its course during a flooding event. The river has limited energy available for erosion as it has not gained energy from gravity thus this river will not extensively erode along its course, possess a great deal of energy for carrying any eroded material and consequently may deposit it. As areas surrounding the low-lying reach of the River Waveney are fairly flat, the river will spread into an extensive flood plain during times of high flow when the river overtops its banks. This floodplain area will subsequently drain slowly, due to low gradients, and may be boggy and marshy.

4.3.2 The source of the River Waveney is found in Redgrave Fen. A main tributary, the River Dove, joins the main river downstream of the town of Diss. The catchment landscape is rural and relatively flat with floodplains drained by a network of drainage channels flanking the river. The primary land uses in the catchment are agriculture and tourism. There are a multitude of sluices found along the non-tidal reaches of the river to regulate river levels during low flow conditions, and to assist in land drainage and to supply a limited amount of flood storage to the system (The River Waveney Flood Risk Study, March 2006).

4.3.3 There are approximately 92 properties at risk of flooding from the 1% annual exceedance probability event, of which 56 are located within the town of Bungay, according to the Flood Zone map, (The River Waveney Flood Risk Study, March 2006). There are 62 flood warning flood risk areas and 11 flood-warning areas. The total number of properties within flood warning areas is approximately 252, which accounts for 80% of all floodplain properties within the catchment of the River Waveney. A short section of flood relief channel has been constructed between Earsham and Bungay, along with the creation of two flood-warning areas between Diss and Bungay and Bungay and Ellingham. The majority of land at risk from flooding in this area is agricultural, (The River Waveney Flood Risk Study, March 2006).

Hundred River

4.3.4 The Hundred River catchment is approximately 71km^2 and runs west to east, discharging into the sea adjacent to the south side of Kessingland, by the EA's Benacre pumping station. A number of tributaries join the main river along its course. Around the lower reaches of the river, west of the sluice and east of the A12, are a number of marshlands, specifically Churchfarm Marshes and Beachfarm Marshes. A network of drainage channels drains these marshes.

4.3.5 The Hundred River valley forms the northern boundary of the Suffolk Coast and Heaths Area of Outstanding Natural Beauty and the Heritage Coast.

River Blyth

4.3.6 The River Blyth catchment is approximately 97km^2 and runs from west to east. Two stretches of the river make up the border between Waveney and Suffolk Coastal, one area east of Halesworth to Blyford, and the other area from Reydon Marshes to the mouth of the river. The river is joined by a number of tributaries, including the Walpole, Wissett, Spexhall, Chediston and Cookley Watercourses. This river is also host to a number of flood plains surrounding the lower reaches, including Reydon Marshes, Tinker's Marshes and Town Marshes. There is a sluice present downstream of the confluence of Buss Creek across the main channel. One particularly challenging characteristic of this river is that a large estuary, upstream of the marsh areas, discharges to the sea via a narrow outlet.

4.3.7 The catchment is predominantly rural and dominated by arable cropping. The town of Halesworth is situated in the lower reaches of the catchment and has a history of flooding. The river discharges through Southwold Harbour, to the south of Southwold and the north of Walberswick. There is only one flow gauge located within the catchment but there are four level gauges. These showed a quick response to the October 1993 flood event and flow remained high for a long period of time due to the large number of tributaries that join the main river, (East Suffolk CFMP: Draft Scoping Report, July 2006 EA).

4.3.8 The Blyth estuary discharges to the sea at Southwold harbour, which is protected to the north side by a harbour pier, a structure that is considered to offer coastal protection. The straight length of the harbour north wall is considered unstable and it currently subject of a project appraisal. The internal drainage network of the estuary is a brackish system with overtopping of the seawall and saline intrusion through flood defences. The area is drained by two sluices to the west, which then discharge into the River Blyth via Charity Sluice, (Appendix f East Suffolk CFMP: v1.0, March 2006 EA).

4.4 Fluvial Flood Sources in Suffolk Coastal

River Alde-Ore

4.4.1 The Alde-Ore catchment is approximately 173km^2. The Rivers Alde and Ore are situated within a catchment characterized by arable farming and horticulture. There are a number of significant settlements in the catchment, the largest of which are Saxmundham and Framlingham. There is good coverage of hydrometric and rain gauge stations in the catchment. In response to the October 1993 event the catchment responded quickly to the heavy rainfall but the three rivers receded at varying speeds due to the differing sizes and different natures of the catchments, (East Suffolk CFMP: Draft Scoping Report, July 2006 EA).

4.4.2 The River Alde-Ore has an extensive Estuary, fed by the Rivers Alde and Butley, which combine elements of the typical coastal plain estuary with that of a bar-built estuary. In the upper area of this estuary the main channel meanders through a broad area of inter tidal mudflat and saltmarsh. At Orfordness there are flood defences that act to restrict the width and alignment of the main channel, consequently the rivers flow is constrained through a narrow channel until the River Butley joins the main channel. The tidal limit of the Butley River is adjacent to Butley mills. Further downstream the channel is increasingly restricted by man-made embankments impacting on the channel flow (Suffolk Coast and Estuaries Coastal Habitat Management Plan, Final Report, October 2002, Posford Haskoning Ltd.).

River Deben

4.4.3 The River Deben Catchment is approximately 184km^2 and the source can be found west of the town of Debenham in the district of Mid Suffolk. The river winds southeast to the town of Wickham Market and then changes direction and runs southwest to Woodbridge. From Woodbridge the river is estuarine in character with marsh areas and tidal mud flat areas on either side of the channel. Embankments are located to the eastern side of Woodbrige and in downstream locations. There are also a number of floodgates found in the Woodbridge area; these are generally located where access and infrastructure intersect the line of flood defence.

4.4.4 The Fynn and Lark catchment is approximately 80km^2 and flows east before its outfall into the Deben Estuary just south of Martlesham. There are a number of small villages situated within the catchment including Great Bealings, Little Bealings and Playford but no major settlements. The River Lark flows between Martlesham and Woodbridge before outfalling to the Deben Estuary. There are a number of minor tributaries in the catchment, the largest/most significant of which is Hasketon watercourse. During the flooding event of October 1993 the catchment responded in a flashy manner, suggestive of runoff from saturated soils as a result of prolonged rainfall during the days leading up to the event, (East Suffolk Catchment Flood Management Plan – Draft Scoping Report, July 2006 EA).

River Orwell

4.4.5 The River Orwell forms the southern limit of the Suffolk Coastal District. The River Gipping and Belstead Brook feed this river. A number of marsh areas are found on the peripheries of this river, two sluices discharge water from the marshes. Dams are strategically positioned to maintain water levels in dykes during dry weather.

4.4.6 The Gipping catchment is approximately 313km^2 and outfalls to the Orwell Estuary. The main land use in the catchment is agriculture. There are a number of urban areas within the catchment including Ipswich. The main river is joined by a number of tributaries including the Rattlesden River, Earl Stonham watercourse and Somersham watercourse. There is a sparse coverage of rainfall gauging stations within the catchment, however these indicated the river responded quickly to the October 1993 event due to the large number of tributaries flowing into the main watercourse and the presence of large urban areas. High flows have been significantly affected by flood relief schemes since the late1980s, (East Suffolk CFMP: Draft Scoping Report, July 2006 Environment Agency).

4.4.7 The Belstead Brook catchment is approximately 49.0km^2 and also outfalls into the Orwell Estuary. Again, this catchment is largely rural and used for arable cultivation or pasture. There is a significant area of Ipswich suburb in the lower part of the catchment, namely Chantry, Stoke Park and Maidenhall. Spring Brook is the only significant tributary and joins Belstead Brook just upstream of Washbrook. Hydrometric stations (flow and rainfall) are located in the lower reaches of the catchment. The lower reaches of Belstead Brook responded quickly to the October 1993 rainfall, potentially as a result of surface water runoff generated from surrounding urban areas (East Suffolk CFMP: Draft Scoping Report, July 2006 Environment Agency).

4.5 Flood Defences in Suffolk Coastal and Waveney

4.5.1 This section describes some of the main flood defence types encountered in the SFRA study area. Figures 4-1 and 4-2 show the locations of different types of defences available from the NFCDD for the districts of Suffolk Coastal and Waveney. It can be seen that there are extensive man made coastal defences around estuarine sections of main rivers. The defences are generally in a good condition, however, they are not to a high specification and may not withstand increased water depths as a result of climate change.

4.5.2 In Suffolk Coastal the Orwell, Deben, Alde-Ore and Blyth Estuaries have raised defences to protect areas of Ipswich, Woodbridge, and Aldeburgh. The coastal defences at Ipswich are to be improved to a 300-year Standard of Protection (SoP) as part of the Ipswich Flood Defence Management Strategy. This Strategy has however suffered from cuts in Defra funding and as such has been put on hold at present. The majority of inland river channels in the study area are undefended to promote frequent flooding of marshland and floodplain areas. The NFCDD shows that the inland river reaches of the Deben, Alde-Ore and Blyth catchments have a defence standard of 5-years or less so are not up to climate change standard. In order to improve and reach this standard and to facilitate future development, contributions will need to be made from private parties.

4.5.3 There are a number of bodies responsible for the raised defences in the area, including the EA, relevant district councils and private landowners. As such these authorities and organisations undertake ongoing maintenance, including: routine site maintenance, structure maintenance, annual channel maintenance, weed cutting, de-silting, cut and clear and bank repairs. The following defence works are also either in the consultation stage or are to be undertaken over the next three to five years: works on defence walls for the rivers Deben, Blyth, Alde and Orwell; river flood alleviation scheme for Halesworth; tidal flood defence works for Ipswich; sea defence works for Felixstowe, Minsmere, Walberswich to Dunwich, Sizewell, Kessingland to Benacre, and Aldeburgh to Slaughden, (East Suffolk CFMP: Draft Scoping Report, July 2006).

Broadland Flood Alleviation Project

4.5.4 The Broadland Flood Alleviation Project (BFAP) covers the tidal areas of the Rivers Yare, Bure and Waveney and associated tributaries. It is a long term project providing flood defence improvements, maintenance of flood defences and emergency response services within the area outlined above. The Environment Agency appointed Broadland Environmental Services Ltd in May 2001 to work with the EA to deliver these services over a 20 year programme of works. Broadland is an extensive area of wetlands, open water, The Broads, and marshland surrounding the tidal reaches of these Rivers. The area is used as an inland navigation system and is an important tourist location. In addition, the area is a unique habitat to many species of flora and fauna and as such is protected by Law as the area is designated as SPA's or SAC's and was designated as an EAS. Most of the area is used for appropriate livestock grazing.

4.5.5 An area of approximately 21,300 hectares containing many properties is protected by approximately 240km of flood banks. These flood banks were originally made of silty clay and steel/timber piles are subject to deterioration and decreased performance over time. This is exacerbated by erosion resulting from wind, wave and tidal action and boat wash.

Climate change, leading to sea level rise, will only add to the pressure imposed on these defences.

4.5.6 The project aims to improve the current defences to the 1995 height (defined by the Environment Agency) with additional allowances for sea level rise and settlement of the flood banks. This will be achieved by floodbank strengthening, floodbank setback and floodbank rollback and using hydraulic modelling.

Earth Bunds (Earth Embankments)

4.5.7 Earth bunds, also known as earth embankments, protect an area from flooding by providing a mass of earth, which raises the surrounding land level preventing inundation from a specific direction, (Figure 4-1). Typically the crest of a bund is flat and a minimum of 3m wide. Wider bunds have a reduced risk of breaching, but have greater land take and costs associated with them. Side slopes down from the crest to the natural level of the land should have a gradient of 1 in 3 as a maximum, but the actual slope depends on the material used to construct the bund.

4.5.8 Bunds are constructed from mass fill material, the majority is usually earth, but other bulk fill material, such as aggregates, may be used to form the core. Bunds may be reinforced with piles, concrete retaining wall structures, or sheet pile walls driven through the crest, to provide structural stability, additional resistance to breaching and to raise the level of protection. In these situations the failure is significantly different. Therefore for breach analysis, reinforced earth bunds are classified as hard defences.

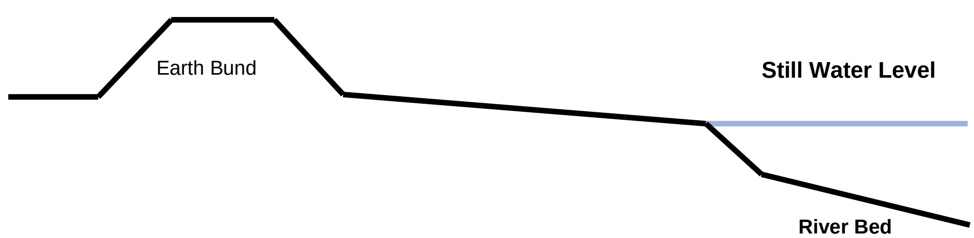


FIGURE 4-1 TYPICAL CROSS SECTION OF EARTH BUND

4.5.9 Bunds are typically covered with grass to prevent erosion. Where bunds may be subject to high flow velocities or wave action the bund may have a revetment on its watercourse face or toe rock armour to prevent scour and erosion. Bunds may be placed directly along the watercourse edge or setback and can often be used further inland to limit possible flood extents.

4.5.10 Earth bunds in Waveney and Suffolk Coastal (Plate 4-1), are common defence structures along estuary boundaries, often incorporating extra toe protection from scour and erosion. Earth bunds can be seen as protection features around the River Deben estuary, Butley River and the River Alde-Ore estuary. Earth bunds can also be found along the River Blyth in Southwold.

PLATE 4-1 EARTH EMBANKMENTS. THE EARTH EMBANKMENTS PROVIDE COASTAL PROTECTION BY RAISING THE LAND LEVEL OVER WHICH WATER HAS TO TRAVEL IN ORDER TO INUNDATE INLAND AREAS. THESE EMBANKMENTS CAN BE RE-ENFORCED AT THE BASE WITH CONCRETE. (SELECTION OF EARTH EMBANKMENTS IN SOUTHWOLD (TOP) AND WOODBRIDGE (BELOW)).

Revetment

4.5.11 Revetments are armouring placed along embankments or natural channel banks to prevent erosion and scour from wave action and/or high flow velocities (Figure 4-2). The armouring may be constructed from a wide range of materials including concrete, Essex blocks (small rectangular blocks), or rock armouring.

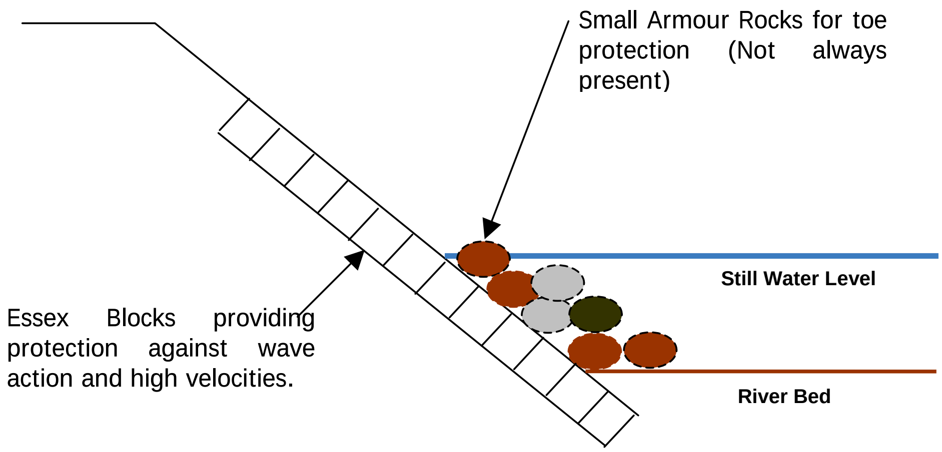


FIGURE 4-2 TYPICAL CROSS SECTION OF ESSEX BLOCK REVETMENT WITH ROCK ARMOUR TOE PROTECTION

PLATE 4-2 REVETMENT. REVETMENTS PROVIDE COASTAL PROTECTION BY REINFORCING EMBANKMENTS AND PROVIDING PROTECTION AGAINST THE ACTION OF WAVES AND WATER, E.G. WOODBRIDGE

River Walls

4.5.12 River walls (also known as seawalls when used along open coastline) are protective walls built along the bank/shoreline (Figure 4-3 and Plates 4.3-4.5). They provide protection from high water levels and heavy wave action.

4.5.13 The majority of walls are constructed from steel reinforced concrete but can also be constructed from timber and sheet pile wall (Figure 4-4, Plate 4-6). Walls can vary in shape and style depending upon the requirements of the location.

4.5.14 River walls can be found around Woodbridge as flood protection defences and along the frontage at Aldeburgh and Felixstowe as sea walls providing protection from erosion as well as tidal inundation. Sea walls with concrete block toe protection are present at Corton and Ness Point in Lowestoft.

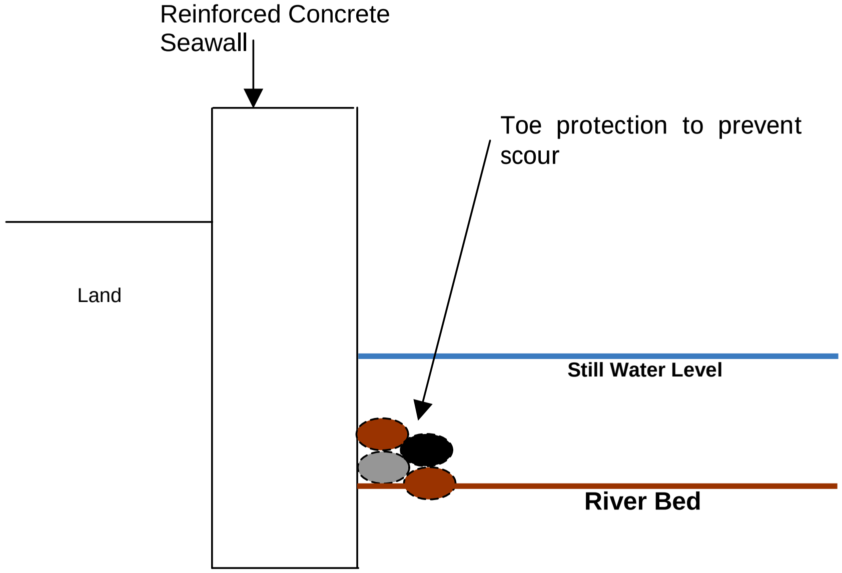


FIGURE 4-3 TYPICAL CROSS SECTION OF QUAY WALL

PLATE 4-3 SEA WALL. THE LOWESTOFT NORTH DENES SEA WALL IS PROVIDING COASTAL FLOODING PROTECTION (THE CONCRETE DEBRIS ON THE BEACH IS THE REMENENTS OF AN OLD COLLAPSED SEA WALL BUT MAY STILL PROVIDE SOME PROTECTION AGAINST SCOUR)

PLATE 4-4 SEA WALL IN NORTH LOWESTOFT. VIEW OF THE ABOVE SEA WALL FROM THE INLAND SIDE. THE WALL IS PROVIDING COASTAL FLOODING PROTECTION TO INLAND AREAS.

PLATE 4-5 SEA WALL NORTH OF SOUTHWOLD. THE SEA WALL IS PROVIDING COASTAL FLOODING PROTECTION.

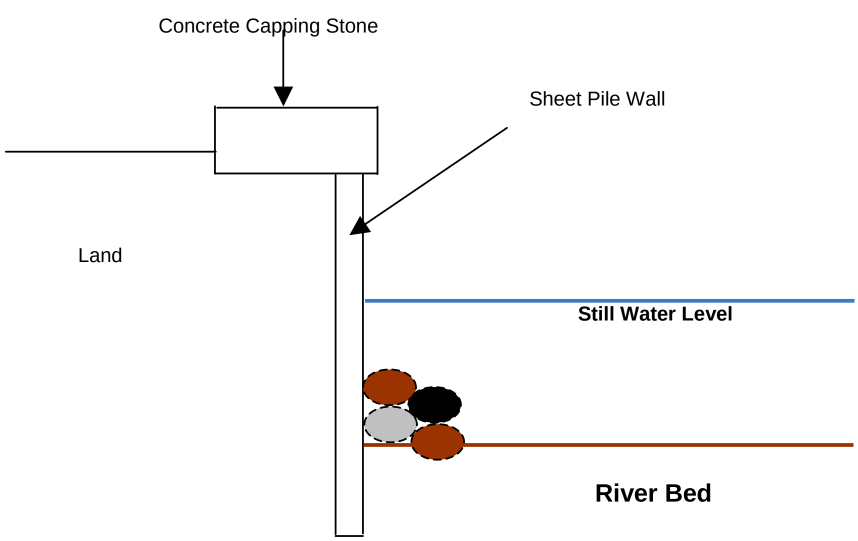


FIGURE 4-4 TYPICAL CROSS SECTION OF SHEET PILE WALL

PLATE 4-6 SHEET PILE WALL IN LOWESTOFT AS AN EXAMPLE OF A FLOOD DEFENCE

Floodgates

4.5.15 Where access is required through the flood defences, floodgates may be constructed (Plate 4-7). These are normally operated manually, and consist of a gate that is generally watertight with an appropriate crest height to prevent overtopping. The Environment Agency is generally responsible for floodgates, and is responsible for issuing tidal flood warnings and ensuring the floodgates are closed as necessary. In some places local agreements exist between the council and private landowners regarding floodgate operation.

PLATE 4-7 FLOODGATE. EXAMPLE OF A FLOOD GATE AS A FLOOD DEFENCE

4.5.16 Floodgates are found, for example, around Felixstowe, Ness Point in Lowestoft, Southwold and in the Woodbridge area, where there are about 17 floodgates throughout the length of the flood defence.

Culverts

4.5.17 Culverts are covered channels where flow passes through or under an obstruction (embankments, roads, railway lines, etc.). They are often constructed of a rectangular (also know as box) or circular channel section made from concrete (Figure 4-5). Culverts can be idealised as a large pipe where flow is rarely enough to fill the cross section.

4.5.18 Culverts are used as a means of controlling watercourse flow and function as a flood defence structure along fluvial watercourses. Culverted channels are often constructed with tide flaps at their discharge point to avoid surcharges and backflow during high tides (Plate 4-8).

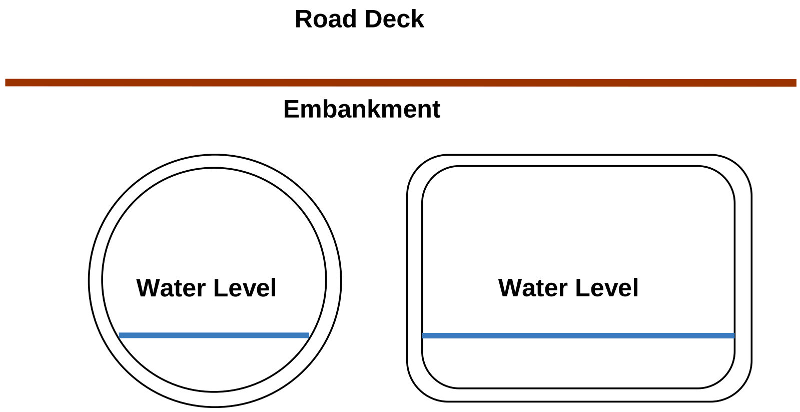


FIGURE 4-5 CROSS SECTION OF A CIRCULAR CULVERT AND BOX (RECTANGULAR) CULVERT.

4.5.19 Culverts are commonly found in Suffolk Coastal and Waveney on smaller ordinary watercourses and surface drains from marsh areas, supporting surface water drainage systems.

PLATE 4-8 EXAMPLES OF CULVERTS INSTALLED THROUGH FLOOD DEFENCES SHOWING TIDE FLAPPED OUTFALLS TO PREVENT A BACKWATER EFFECT DURING HIGH TIDE EVENTS.

Lock Gates

4.5.20 Lock gates are found at the interface between Lake Lothing, which leads to the North Sea and Oulton Broad (Plate 4-9). The gates, consisting of 2 x 2 lock gates, a lifting road bridge (A1117), and a control room, provide a gateway between the River Waveney and the Broads system, and Lake Lothing.

4.5.21 As a flood defence feature lock gates act to separate river and seawater and help to regulate flow.

PLATE 4-9 EXAMPLES OF LOCK GATES IN LOWESTOFT AS FLOOD DEFENCE MECHANISMS.

Sluices

4.5.22 A sluice is a flood control mechanism as it acts to regulate flow, and if necessary separate channel water and seawater. Water behind the sluice is then released under controlled conditions, ensuring the river level will never rise to dangerous flooding levels. There are sluices situated at Thorpeness, north of Aldeburgh, on the Hundred River which discharges to the sea via two pipe sluices, and south of Ellingham on the River Waveney

Groynes

4.5.23 Groynes are fixed structures that extend out from a sea wall (Plate 4-10). They are used to impede erosion and promote deposition. In this way they can decrease flooding by reducing wave impact and thus overtopping. As an example there is an extensive stretch of groynes situated on an area of sandy beach stretching along the coast from the north of Lowestoft to the south.

PLATE 4-10 EXAMPLES OF GROYNES AS COASTAL FLOOD DEFENCES IN FELIXSTOWE

Weirs

PLATE 4-11 EXAMPLE OF A WEIR AS A FLUVIAL FLOOD DEFENCE IN WOODBRIDGE

4.5.24 Weirs can operate as flood defence structures as they act to limit the rate of river flow over the structure. This has the effect of reducing flood water velocities and the volume of flood water inundating the surrounding area in times of high water flow (Plate 4-11).

4.6 Flood Warnings

4.6.1 The Civil Contingencies Bill requires that the Environment Agency 'maintain arrangements to warn the public of emergencies'. The Environment Agency are responsible for issuing flood warnings to the public based on 24 hour monitoring of rainfall, river levels and sea state. This data is combined with weather data and tidal reports from the Met Office, including the use of radar to track storms and rainfall intensity, and data from the national tide gauge network. The warnings are issued by local radio, supplemented by direct dial telephone systems, (Floodline Warnings Direct), on www.environment-agency.gov.uk/floodwarnings which is updated every 15 minutes, and other local systems as appropriate. The Environment Agency also endeavors to raise awareness of flooding in areas prone to it and suggest that people living in vulnerable areas make preparations in advance.

4.6.2 The Environment Agency has general supervisory and other statutory duties for flood defence and flood warnings in Waveney and Suffolk Coastal. The work carried out to meet these duties includes:

- Maintaining main river channels and flood defence structures
- Providing and operating a flood warning service

4.6.3 The existing warning service provided by the Environment Agency applies only to flooding from rivers and the sea. Some parts of the country provide a nominal groundwater flood warning service. There is no obligation on Water Companies to provide warnings of flooding from sewers or drains.

4.6.4 The degree of advance warning that can be provided is critical to the amount of action that can be taken to prevent damage. A minimum of 2 hours advance warning is the standard currently used in England and Wales for river flooding. The ability to provide this depends on the geography of an area, the intensity of the rainfall and the type of weather systems causing the rain as these variables can act together to produce an unlikely and therefore unpredictable event. In the case of flooding from the sea an entirely different set of natural parameters needs to be measured and assimilated into forecasting systems, such as tidal levels and storm surges in order to provide predictions of sea level and wave height.

4.6.5 When conditions require, e.g. forecast high tide with high winds, the EA provide local forecasts on the possibility of flooding and determine which defences to operate and when, closing moveable defence features if necessary.

4.6.6 The cause of coastal flooding is usually from high tides and waves overtopping defences. The astronomical element of high tides is predictable years in advance but independently seldom results in flooding. The surge element of high tides is not predictable years in advance.

4.6.7 Flooding on the coast is usually the result of a combination of high tides, storm surges and waves. Storm surges are caused by atmospheric conditions and wind action and are usually accompanied by strong winds that cause severe waves. DEFRA funds the Met Office to provide daily forecasts of surge and wave conditions that are used by the EA, in combination with tide levels and local knowledge, to provide coastal flood warnings.

4.6.8 The role of flood warnings in flood risk and residual risk reduction can be either a stand-alone measure or in combination with built defences. Flood warning as a stand-alone measure can reduce the consequences of flooding to properties by enabling reactive action to protect life and reduce the effect of flooding on property. Flood warning in combination with built defences can protect life and reduce damage in the event of the defence level being exceeded by the severity of the flood. In the case of Waveney and Suffolk Coastal this could take the form of a breach in the tidal defences.

4.6.9 The need for flood warnings in defended areas, such as Waveney and Suffolk Coastal, is particularly important, as the consequence of flooding in areas where people's perception of flood risk is low can be significant. In such cases flood warning needs to work closely with local authority emergency planning to allocate potential evacuation routes and contingency plans following a flood event. The difficulties of issuing effective warnings of possible defence failure poses a significant challenge and in some cases it will not be practical to provide a reliable or timely flood warning service to an area because of the rapidity or unpredictable nature of flooding.

4.6.10 There are a number of flood warning areas in Suffolk Coastal, which aim to provide two hours lead time for flood warnings. The Environment Agency issue flood warnings. However, the flashy nature of many of the catchments in the area to winter rainfall and high intensity summer thunderstorms make issuing warnings difficult. In the future Flood Warning Areas and Flood Watch Areas, targeted at a community level will see an increase in flood warnings in the area so that only communities at risk from individual events will be notified. Suffolk Coastal supply filled sandbags as an emergency measure in certain circumstances. Emergency Planning, which reacts to flood warnings, is a partnership between Suffolk County Council and Suffolk Coastal and Waveney Districts.

4.6.11 Waveney District Council supplement flood warning systems provided by the Environment Agency by ensuring that its emergency response plans include appropriate arrangements for flooding emergencies and that such plans are reviewed, in consultation with the Environment Agency, at least every two years. This includes maintaining an awareness of the Environment Agency's flood warning dissemination plan for the Waveney area and contributing to its implementation as necessary, and playing an agreed role in any flood warning emergency exercises organised by the Environment Agency in the area (Waveney District Council – Policy Statement on Flood and Coastal Defence).

4.7 Flood Mechanisms for Suffolk & Waveney

4.7.1 The Inception Report identified that the main focus of the SFRA should be on breaching, as these events are likely to have the greatest consequence. Table 4-2 gives an overview of the sources of flood risk and an indication of the scale of consequence associated with such an event. This identifies the greatest consequence arising from overtopping or breaching of defences during extreme events. The terms for scale of consequence are broadly based on the number of dwellings an event might impact. The following scale, developed by Scott Wilson from previous flood risk experience, has been used:

- Very large 100+ houses/buildings
- Large 50-100 houses/buildings
- Medium 10-50 houses/buildings
- Small 1-10 houses/buildings

4.7.2 This section describes the main flooding mechanisms throughout Suffolk Coastal and Waveney, providing a background for the flood risk analysis later in the subsequent Appendices.

Overtopping

4.7.3 Overtopping occurs when water passes over a flood defence. Low levels of overtopping may arise even when the defence crest level is higher than the water cycle, due to the action of winds, waves and spray. Higher levels of overtopping occur when water levels exceed the defence level.

4.7.4 When flow exceeds the capacity of the conveying channel, the water level will rise in that channel until its banks are overtopped. Water will then spill over the channel banks and onto adjoining land. With an upland river the adjoining land is its natural floodplain, which will generally be of limited extent and fairly well defined. In a downstream river where the gradient flattens the floodplain can be much wider (i.e. Sudbourne Marshes to the west of the River Alde/Ore). Flood defences and urban development can significantly alter natural flow paths within the floodplain area and affect the dispersion of floodwater.

4.7.5 The area of Suffolk Coastal and Waveney is predominantly flat low-lying land with small areas of higher relief in the west, towards the edge of the study area. Marshland features heavily in this region including the Beccles Marshes and Barsham Marshes around the River Waveney, Reydon Marshes towards the mouth of the River Blyth, Sudbourne Marshes to the west of the River Alde/Ore and Trimley Marshes at the mouth of the River Orwell.

4.7.6 Flood defences are usually designed with a degree of 'freeboard', the height by which the crest level of the defence exceeds the design flood level. Main river and tidal embankments are designed to have a constant freeboard above their design level so, in theory, when they are overtopped the overflow should be small in volume and of uniform depth along the full length of the defence embankment, occurring during the highest water levels at the peak of the tide/flood. In reality the freeboard varies from point to point due to the natural subsidence of defences over time, and water heights can be exacerbated by wave action. Even so, the embankment acts like a weir limiting the rate of flow and volume over the embankment and limiting flooding velocities and volume to the immediate area.

4.7.7 Overtopping from a fluvial source is likely to be lower in magnitude and volume than overtopping from tidal sources. This is because the source of water from a river is limited, and once the capacity of the channel has been increased through overtopping the general water level in the fluvial channel may recede below the defences. In tidal conditions this mechanism does not exist. The source of water is far greater from a tidal source, and will only cease to overtop when the tide levels have decreased below the height of the defences.

Breaching

4.7.8 Breaching of flood embankments is one of the main causes of major flooding in lowland areas. Breaches can occur in any situation where there is a defence which has a crest raised above adjacent land levels. An earth embankment may be breached as a result of overtopping, which weakens the structure through erosion, eventually creating a breach in the defences. Breaches in tidal and fluvial embankments are more likely during high water level events including extreme tides or periods of high river flow. A fluvial breach in an embankment will result in the dispersal of floodwater from the channel resulting in a lowering of the water levels and flow through the breach. However with tidal embankments the level of water flow driving through the breach will remain unaffected by the volume flowing through the breach.

4.7.9 The time taken for a breach to be sealed can have a major effect on the extent and depth of flooding. This is discussed in more detail in Section 5. In addition to the flood risk associated with a breach event, there is an implied flood hazard. The highest hazard exists in the period immediately following a breach, and usually, but not necessarily, in the areas closest to the breach. Floodwater flowing through a breach will be of high velocity and volume, dissipating rapidly across large low-lying areas, and possibly affecting evacuation routes. Flooding as a result of a breach in defences, either from fluvial or tidal sources, can be life threatening with far reaching consequences.

Breach Locations

4.7.10 The risk of flooding from breaches in flood defences was recognised by the Inception Report. Consequently the Inception Report specified that the SFRA should consider the risk to Suffolk Coastal and Waveney from breaches in local flood defences. To assist in this assessment the participating Districts were asked to contribute specific breach locations they considered important for assessment, in consultation with the Environment Agency. These are located such that they represent places of known weakness or vulnerability in the existing defences, or in locations where a breach would be expected to have the greatest consequence.

4.7.11 The breach locations specified by the participating Districts are presented in Table 4-1

TABLE 4-1 BREACH LOCATIONS AND SFRA REFERENCE

Flood cell	Event	Breach Location	OS Grid Reference	
			X	Y
Lowestoft	Lowestoft A1	Open coast	655,437	294,258
	Lowestoft A2	Tidal river	653,609	292,895
	Lowestoft A3	Tidal river	654,038	292,601
	Lowestoft A4	Tidal river	652,670	292,797
Southwold	Southwold B1	Open coast	651,246	276,986
Sizewell	Sizewell C1	Open coast	647,794	266,169
Aldeburgh	Aldeburgh D1	Open coast	646,998	258,689
	Aldeburgh D2	Open coast	646,395	255,467
Woodbridge	Woodbridge E1	Tidal river	627,902	249,375
	Woodbridge E2	Tidal river	627,310	248,444
Felixstowe	Felixstowe F1	Tidal river	629,039	233,630

Mechanical or Structural Failure

4.7.12 Flooding may result from the failure of engineering installations such as tidal barriers, land drainage pumps, sluice gates and floodgates. Structural failure in the context of this section is also taken to include the failure of hard defences along the Waveney and Suffolk Coastal coastlines. Hard defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement and toe protection or the failure of ground anchors. Such deterioration is often difficult to detect, so that failure when it occurs is often sudden and unexpected. Failure is more likely when the structure is under maximum stress, such as during extreme tides, when pressures on the structure are at its most extreme.

4.7.13 The risks associated with flooding of this type are difficult to quantify. The Environment Agency regularly monitors the condition of the flood defences in Suffolk Coastal and Waveney districts, and has continual programme for maintenance of flood defences. Flooding resulting from mechanical failure has been considered in this SFRA in the context of flood gate failure during extreme tides in the River Deben, and at the major flood structures of Suffolk Coastal and Waveney. The results are detailed in the relevant appendices.

4.8 Localised Flooding

Surface Water

4.8.1 Localised flooding can occur as a result of severe storms, which are localised in extent and duration. The intensity of the rainfall in urban areas can create runoff volumes that temporarily exceed the natural or urbanised sewer and drainage capacities, creating ‘flash’ flooding, referred to in this document as Surface Water Flooding.

4.8.2 Surface water is the overflow from any urban runoff and from sewage systems when the rainfall intensity exceeds the capacity for the drainage systems. This will become a more common occurrence in the future, due to climate change and an increase in the number and intensity of convective storms. It is now fairly widely accepted that one of the main effects of climate change in the South East will be a higher intensity rainfall and winter storms, which will increase the risk of flooding from surface water.

4.8.3 In lowland areas such as Suffolk Coastal and Waveney, the topography results in dispersal over a wide area. Local flooding of this kind is often exacerbated by deficiencies in the local surface water drainage system, temporary blockages or saturated ground conditions. These can often be remedied through reactive management once they have been identified in a flooding event.

Groundwater

4.8.4 There is a risk of groundwater flooding in the Suffolk Coastal and Waveney region. Groundwater flooding usually occurs following a prolonged period of low intensity rainfall and although there are no records of significant groundwater flooding in the region, it is still a possibility. The future risk from this source is more uncertain than surface water as the climate change predictions indicate that although sea levels will rise, thus possibly raising groundwater levels, overall summer rainfall will decrease, therefore having a long-term effect of lowering the groundwater levels. However, long periods of wet weather, such as those experienced in the autumn and winter of 2000/01 are predicted to increase. These are the type of weather patterns that can cause ground water flooding to occur.

Data Availability

4.8.5 PPS25 states that all sources of flooding should be considered through the application of the Sequential Test, to include surface water and groundwater. Records for surface water, groundwater and other historic flooding events from the participating authorities in Suffolk Coastal and Waveney have therefore been included in the relevant appendices. However, due to the unpredictability of this type of flooding, data collection is generally of a sporadic nature, and flood risk relating to surface and ground water should be addressed at a localised site-specific scale through the flood risk assessment process.

4.8.6 The data sets included in the appendices are not comprehensive and of little constructive use on a spatial scale. If surface water and groundwater flooding are to be considered on a strategic scale in future, local authorities, water companies and the Environment Agency need to consider improved methods for consistent and comprehensive data collection relating to these flooding sources.

TABLE 4-2 SOURCE PATHWAY RECEPTOR TABLE, CONSEQUENCE SUMMARY

Source	Pathway	Receptor	Scale of Consequence	Comments Further descriptions of the receptor areas and flood implications through breach scenarios are discussed in later chapters.
Tidal Flooding from the North Sea	Breach, overtopping of defences	Flood cells	Very large	A large number of significant infrastructures, industrial, commercial and residential developments are located near the North Sea defences and could suffer severe flooding with significant risk to people.
Fluvial Flooding from the River Waveney	Breach, overtopping of defences	Flood cells	Large	Although less built up the flood cells in this area are quite extensive. Therefore a potential large number of developments could be flooded with significant risk to people.
Fluvial Flooding from the Hundred River	Failure of the two tidal sluices would result in upper reaches and area behind sluices from fluvial overtopping of defences.	Property located in upstream area of the sluice, and in the upper reaches of the floodplains.	Medium to large	A failure in the sluice would result in either tidal inundation or the backing up of fluvial water. A small number of properties would be at risk directly upstream from the sluice and along the upper reaches. Possibly not of risk to life as flooding from this source would be gradual.
Tidal/Fluvial Flooding from the River Blyth	Failure of the tidal sluice would result in upper reaches and area behind sluice from fluvial overtopping of defences.	Property located in upstream area of the sluice, and in the upper reaches of the floodplains.	Medium to large	A failure in the sluice would result in either tidal inundation or the backing up of fluvial water. A small number of properties would be at risk directly upstream from the sluice and along the upper reaches. Possibly not of risk to life as flooding from this source would be gradual.

Source	Pathway	Receptor	Scale of Consequence	Comments Further descriptions of the receptor areas and flood implications through breach scenarios are discussed in later chapters.
Tidal/Fluvial flooding of River Alde-Ore, River Deben and River Orwell	Breach, overtopping of defences	Flood cells	Large	Although less built up the flood cells in these areas are quite extensive. Therefore a potential large number of developments could be flooded with significant risk to people.
Surface Water Flooding	Drain blockage, saturated marshland and drainage systems. Failure of pumps or sluice outfalls.	Properties in the local vicinity of surface water drains, marsh systems, and upstream of sluice outfalls.	Small to Medium	A limited number of properties are involved with surface water flooding, which varies seasonally, and is limited in duration and volume. This should be addressed on a site-by-site basis in site specific Flood Risk Assessments.
Groundwater Flooding	Rising groundwater levels.	Properties in low-lying areas such as marshlands etc., civil infrastructure including road tunnels, underpasses, and excavation sites such as quarries.	Small to Medium	A limited number of properties would be involved with groundwater flooding. Locally restricted through capacity and geology. Groundwater flooding is dependent on various factors, including abstractions, local geology etc. Groundwater levels are also subject to seasonal variation. This source of flooding should be addressed in site specific Flood Risk Assessments.

Source	Pathway	Receptor	Scale of Consequence	**Comments** Further descriptions of the receptor areas and flood implications through breach scenarios are discussed in later chapters.
Structural/ Mechanical Failure in flood defences, i.e. failure to shut floodgates at Woodbridge.	If floodgates unclosed would resemble Breach of defences.	Related Flood Cells, i.e. Woodbridge, by a failure in the floodgates.	Very Large	A large number of properties could be at risk in the event of floodgate failure. This could also result in a significant risk to people. Floodgates by their very purpose tend to provide flood protection to large low-lying areas; therefore a failure could result in very large consequences.

NB: The Scale of consequence used in the table above refers to the number of properties effected, described in further detail in section 6.4

5 Methodology

5.1.1 This chapter presents the methodologies used in developing the maximum flood depth and hazard zone maps for this SFRA.

5.2 Digital Terrain Map (DTM) Generation

5.2.1 A key component in the SFRA is the representation of topography throughout flood prone areas of the study area. For the SFRA, various data sources, that were made available by the Environment Agency, were utilised (e.g. LiDAR, SAR, OS maps, aerial photography).

5.2.2 The platform used for the generation of the DTM was the GIS package Map Info Professional (version 8.5) and its daughter package Vertical Mapper (version 3.1).

5.2.3 The topographical information for the SFRA is primarily based on filtered LiDAR data provided by the Environment Agency. 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). In this case, the LiDAR surveys return data as a horizontal resolution of approximately 2 metres. Filtered LiDAR data represents the “bare earth” elevation with buildings, structures and vegetation removed.

5.2.4 Where LiDAR data was not available, or there were gaps in the LiDAR coverage, SAR (Synthetic Aperture Radar) data was used. Although similar to LiDAR data, SAR data is of lower resolution (approximately 5 metre squares compared to 2 metres for LiDAR). However, it is an ideal source of infilling data where the LiDAR is lacking.

5.2.5 CMAP data was also used, where applicable, to define ocean and estuary bathymetry. CMAP is a worldwide database of ocean depths, particularly along coastlines and estuarine areas. As both LiDAR and SAR data is not well defined over water, CMAP is extremely useful for defining the bathymetry of the model in these areas.

5.2.6 Through use of these data sources, the DTM used in hydraulic modelling has the highest resolution possible (i.e. 2m for the LIDAR data and 5m for the SAR data).

5.3 Flood Cell Definition

5.3.1 The breach locations were specified by Suffolk and Waveney Councils based on local knowledge of the condition of the defences; the location of future development sites, historical flooding events and/or the vulnerability of local communities. Figures A2 to A4, and Figures B2 to B5, in Appendix A and B respectively present the breach locations considered for the SFRA.

5.3.2 Once the DTM grids and breach locations have been obtained, 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 to define a smaller area on which to run each scenario.

5.3.3 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 of several hundred millimetres. 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.

5.3.4 Ideally, the entrance to the flood cell will be at the breach itself, and inflows into the model will occur at this point. However, where areas of overtopping also occur near the breach, the breach and overtopping and their interactions must be considered within the flood cell. In such situations, the entrance to the flood cell must be situated some way downstream of the breach.

5.3.5 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 not near 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. However, this is typically not an issue in models where the inflows are based on tidal levels rather than a specific volume.

5.3.6 During the modelling analysis (detailed below), additional overtopping locations were proposed. These supplemented the breach simulations identified during the initial stage of specifying the breach locations. The locations of the additional overtopping scenarios were selected based on a review of the current defence height. By including overtopping scenarios, a more accurate representation of a potential flooding event can be simulated.

5.3.7 The overtopping scenarios represent the actual risk of flooding to the areas where this situation has been modelled. If a flood event of the modelled magnitude occurred, the modelled flood extents would occur in those areas. In the case of the breach scenarios, the resulting flood extents are classified as residual risk, that is, these extents would not occur unless there was a breach in the flood defences under the modelled scenario.

5.3.8 The defence heights used for the overtopping scenarios were determined by querying the DTM. The defence walls were divided into a number of small sections approximately 10 – 15 metres long along the entire stretch of coastline subjected to tidal influx within the flood cell. Each section was assigned the maximum defence wall height within the section.

5.3.9 The range of defence heights obtained this way has been tabulated below (Table 5-1)

TABLE 5-1 DEFENCE HEIGHTS

	Max metres AOD	Min metres AOD
Lowestoft		
Southwold River defences	5.3	1.64
Southwold Coastal defences	8.9	3.0
Woodbridge	4.9	2.4

5.3.10 The reason for the large range in defence height can partly be explained by the fact that higher ground linked up with the defences are likely to have been included as part of the defence structure to ensure a continuous defence line.

5.3.11 To mitigate for the potential future flood risk, the height of the defence walls will need to be raised above the predicted 1 in 200 year tidal level inclusive of climate change. The maximum sea water levels for all locations have been tabulated in Table 5-3 Maximum sea water levels.

5.3.12 For the single breach scenarios, the defence walls are deemed to be sufficiently high to prevent any overtopping from occurring. The defence walls can therefore be modelled as a land boundary, which prevents any water from entering the flood cell. The defence walls do not therefore require a specific height to be assigned to them.

5.3.13 Flood cells for the Suffolk Coastal and Waveney SFRA were defined from a review of the DTM and supporting OS 1:25,000 mapping.

5.3.14 For the study area, 6 flood cells were defined. The flood cells are shown on Figures A2 - A4 and Figures B2 - B5, Appendix A and B respectively.

5.3.15 Table 5-5 presents the flood cell references (indicative of their location), and the number of breach points located within each flood cell.

5.3.16 2-D hydrodynamic models were constructed for each flood cell enabling separate model runs to be undertaken for each breach location within a flood cell and for the extreme water level scenarios presented in Table 5-3 Maximum sea water levels.

TABLE 5-2 FLOOD CELLS AND THE ASSOCIATED NUMBER OF ANALYSED BREACH/OVERTOPPING EVENTS

Flood cell	Location of event	Nature of Event	Current or Residual Risk?
Lowestoft	Lowestoft A0	Overtopping of existing defences	Current Risk
	Lowestoft A1	Overtopping of existing defences combined with a breach at the North Denes	Residual Risk
	Lowestoft A2	Breach of improved defences at North Quay	Residual Risk
	Lowestoft A3	Breach of improved defences at Kirkely Ham	Residual Risk
	Lowestoft A4	Breach of improved defences at School Rd Quay	Residual Risk
Southwold	Southwold B0	Overtopping of existing defences	Current Risk
	Southwold B1	Overtopping of existing defences combined with a breach at Buss Creek	Residual Risk

Flood cell	Location of event	Nature of Event	Current or Residual Risk?
Sizewell	Sizewell C1	Breach of defences near Minsmere sluice	Residual Risk
Aldeburgh	Aldeburgh D1	Breach of natural defences north of Aldeburgh	Residual Risk
	Aldeburgh D2	Breach of defences south of Aldeburgh	Residual Risk
Woodbridge	Woodbridge E0	Overtopping of existing defences	Current Risk
	Woodbridge E1	Breach of defences at north Woodbridge	Residual Risk
	Woodbridge E2	Breach of defences at south Woodbridge	Residual Risk
Felixstowe	Felixstowe F0	Overtopping of existing defences	Current Risk
	Felixstowe F1	Breach of improved defences	Residual Risk

5.4 Extreme Water Level Derivation

5.4.1 The extreme sea water levels associated with tidal flood events along the Anglian coastline vary throughout the study area and consequently are specific to each breach location. The extreme sea water levels for the breach locations along the coastline are based on information obtained from the *'Report on Extreme Tide Levels: Anglian Region, Central and Eastern Areas'* (Royal Haskoning, 2007)' obtained from the Environment Agency.

Climate Change

5.4.2 Estimates of the effects of climate change on extreme water levels were based on current DEFRA guidelines. These assume a progressive increase in water levels with time. For the East of England, East Midlands, London and South England the increases in peak tidal levels as a result of climate change are predicted as 4mm/year increase during the first 18 years, 8.5mm/year during the next 30 years, 12mm/year during the following 30 years and 15mm/year during the last 22 years. The accumulative effect of which results in a net increase of 1.02m.

5.4.3 The extreme water levels for each breach location simulated in this assessment are presented in Table 5-3 Maximum sea water levels.

TABLE 5-3 MAXIMUM SEA WATER LEVELS

Floodcell	1 in 20-year [m AOD]	1 in 20-year + climate change [m AOD]	1 in 200-year level [m AOD]	1 in 200-year + climate change [m AOD]	1 in 1000 year level [m AOD]	1 in 1000yr + climate change [m AOD]
Lowestoft	2.75	3.77	3.29	4.31	3.67	4.69
Southwold	2.73	3.75	3.26	4.28	3.63	4.65

Floodcell	1 in 20-year [m AOD]	1 in 20-year + climate change [m AOD]	1 in 200-year level [m AOD]	1 in 200-year + climate change [m AOD]	1 in 1000 year level [m AOD]	1 in 1000yr + climate change [m AOD]
Sizewell	2.72	3.74	3.24	4.26	3.61	4.63
Aldeburgh	2.72	3.74	3.24	4.26	3.60	4.62
Woodbridge	3.50	4.52	3.73	4.75	4.09	5.11
Felixstowe	3.33	4.35	3.89	4.91	4.26	5.28

Tide Curve

5.4.4 It is necessary to superimpose extreme sea levels onto a tidal curve. This enables a model run to accurately estimate the total volume of water flowing through a breach. In general, the sea water level profile during a tidal flood event consists of two components, an astronomical tide and a surge residual. The astronomical tide is assumed to be independent of the metrological conditions. The tidal curve applied in this study has been obtained by superimposing an astronomical tide on a storm surge residual.

Astronomical tide

5.4.5 For the astronomical tide the mean spring tide at the breach locations has been used. Mean Spring Tidal Water levels at the breach location were obtained from the Admiralty Tidal Tables (UKHO, 2004).

Storm Surge Profile

5.4.6 The surge component was simulated by a regular half-sinusoidal shaped water level increase. The duration of the surge event was assumed to be 40 hours (equivalent to 1.7 days). The storm surge peaks at the same moment as the second astronomical high tide.

5.4.7 The water levels during a tidal flood event can be found by summing the astronomical tide levels and the storm surge residual. An example of the sea water levels used for the breach modelling analysis is shown in Figure 5-1.

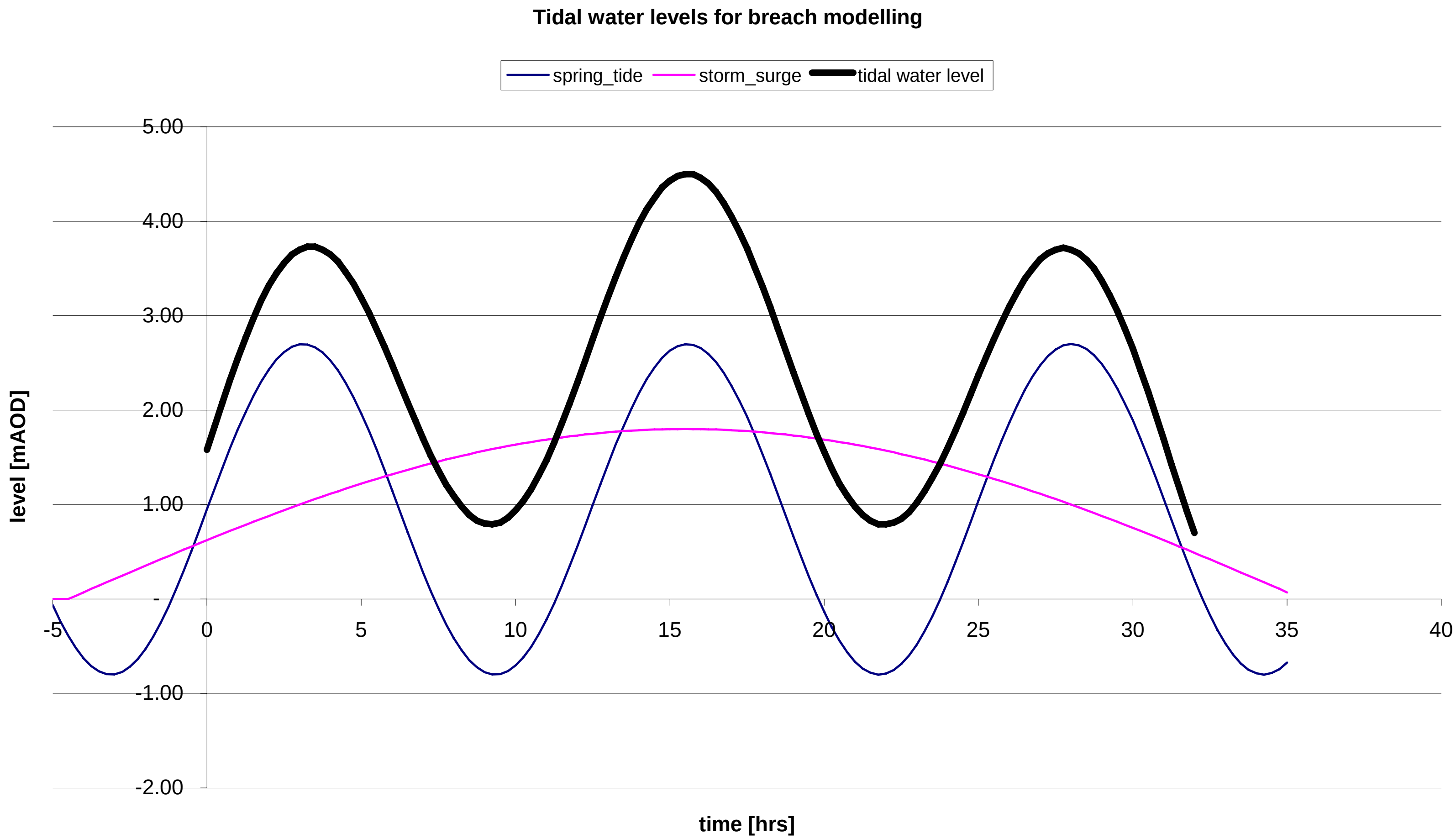


FIGURE 5-1 TIDAL CURVE USED IN ASSESSMENT OF BREACH EVENT

5.5 Breach Modelling

5.5.1 Due to the relatively low-lying nature of the area long the Suffolk and Waveney coastline, and the numerous tidal inlets and creeks, tidal flooding is considered to have the largest potential impact from a single flood source. Flood protection for these areas is provided by a combination of man-made and natural flood defences of various types and design standards.

5.5.2 Breaching of these flood defences has the potential to generate the greatest flood risk hazard for this area. To assess flood propagation in events where the flood defences are breached, a hydraulic modelling analysis has been undertaken using the two-dimensional hydraulic modelling software MIKE21-HDFM (version 2007).

5.5.3 This section of the report discusses the methodology that has been applied for the hydraulic 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

5.5.4 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 the flood defences; and
- Generate detailed information on the localised hydraulic conditions over the flooded area in order to evaluate flood hazard.

5.5.5 To investigate the flood conditions resulting from every breach location over the study domain, the two-Dimensional (2D) hydraulic modelling software MIKE21-HDFM (MIKE21-Hydrodynamic Flexible Mesh Model, 2007 version) has been used.

5.5.6 MIKE21-HDFM simulates water level variations and flows for depth-averaged unsteady two-dimensional free-surface flows. MIKE21 is specifically oriented towards establishing flow patterns in complex water systems, such as coastal waters, estuaries and floodplains. The MIKE21 hydraulic modelling software is developed by Danish Hydraulic Institute (DHI) Water and Environment.

5.5.7 MIKE21-HDFM is a new modelling system based on a flexible mesh 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

5.5.8 For each flood cell, a MIKE21 flexible mesh model has been developed using the MIKE21 program, Mesh Generator. The mesh generator creates a mesh over the flood cell DTM using triangular elements Figure 5-2 . The element size varies throughout the model domain and depends upon the complexity of floodplain topographic features and/or areas of interest.

5.5.9 Using the flexible mesh module it is possible to generate a highly resolved mesh in areas of particular interest or in areas that are important from a hydrodynamic viewpoint and have a lower resolution in areas that have a lower priority reducing demands on computational resources.

5.5.10 To represent the hydraulics around the breach with a relatively high level of accuracy, a comparatively small element size has been applied in the vicinity of breaches. The breach has been represented by a minimum of 5 elements. Urban areas and structures within the floodplain have the potential to affect the free flow of floodwater. Embankments, flood defences, significant water courses and other linear features have been incorporated into the flexible mesh by creating break-lines parallel to the feature.

5.5.11 By adding break lines, the mesh orientation is forced to follow the alignment of the features and the localised elevations of structures are used by the mesh generator. The break lines of linear man-made features were schematised by reference to the DTM, 1:25000 OS maps and high-resolution aerial photographs. The crest levels of linear features, such as secondary flood embankments, road embankments and railway embankments, have been established by interrogation of the DTM. It should be noted that the majority of the features described above have been identified through a desktop analysis only, and have not been verified on the ground. **Results from the breach modelling which show strong dependence on barriers should therefore be used with caution.**

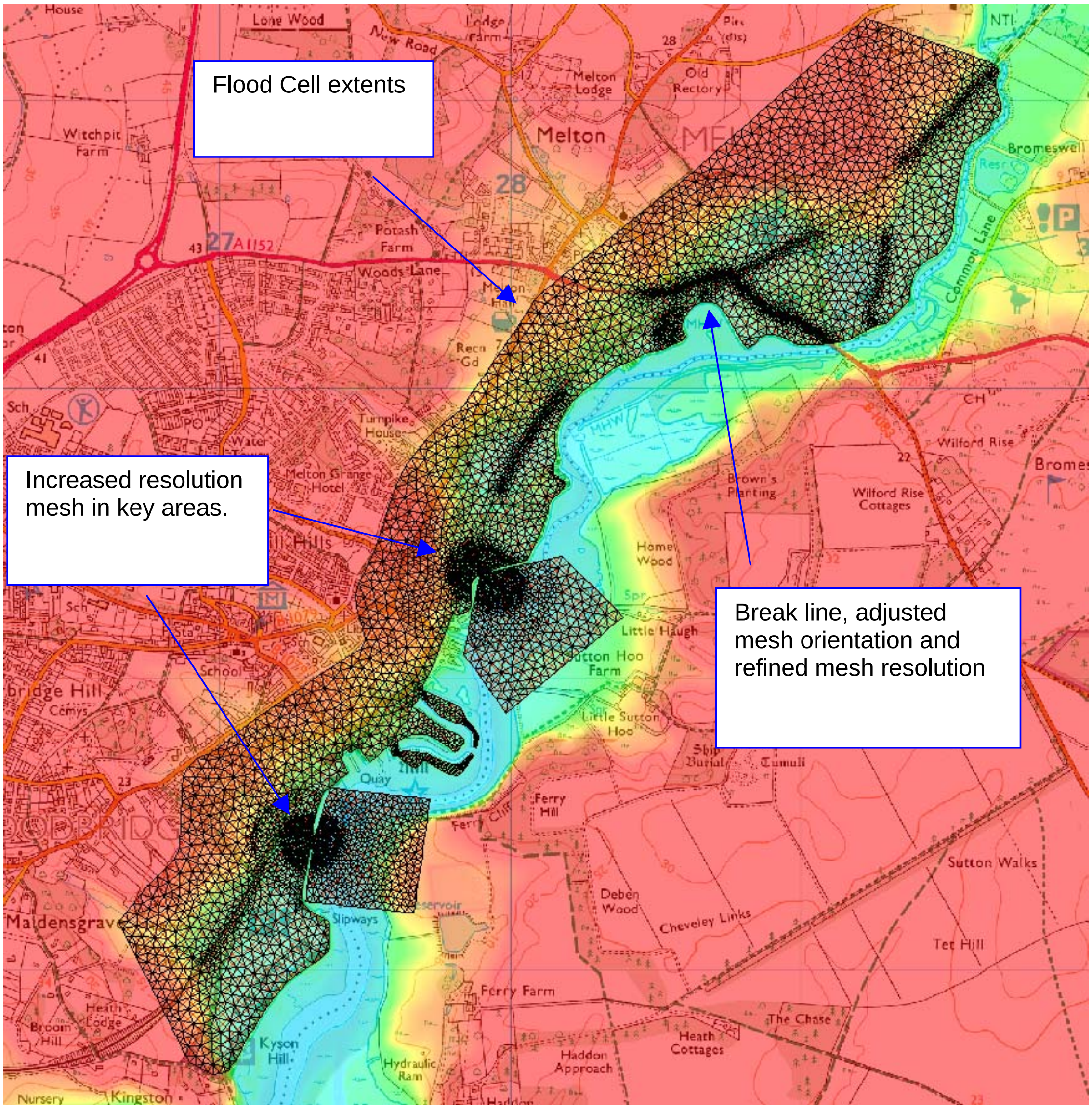


FIGURE 5-2 EXAMPLE OF MIKE 21 HD FLEXIBLE MESH

Breach specifications

5.5.12 Breach modelling was undertaken for 15 breach/overtopping locations. The flood conditions (i.e. inundation rate, flood extent, depth of flooding) that may be experienced if a flood defence were to breach are a function of the breach dimensions, time required to repair the breach (exposure duration) and tidal conditions. Since it is not possible to set repair times in the modelling software, the breach and tidal details are the two major factors that determine the extent of inundation due to breaching.

5.5.13 Overtopping is simulated, where applicable, 'automatically' in the model when it is run as the levels of the defences and other structures will have been determined by the DTM topography details.

5.5.14 The breach dimensions were determined using the Environment Agency Strategic Flood Risk Assessment (SFRA) Guidance.

5.5.15 The breach width is determined on the location and type of embankment as tabulated in .

TABLE 5-4 BREACH WIDTH CATEGORIES

Location	Defence type	Breach width (metres)
Open coast	Earth bank	200
	Dunes	100
	Hard	50
	Sluice	Sluice width
Estuary	Earth bank	50
	Hard	20
Tidal river	Earth bank	50
	Hard	20
Fluvial river	Earth bank	40
	Hard	20

5.5.16 For each breach location, the type of embankment has been derived from inspection during site visits, aerial photographs, and 1:10000 OS maps. The breach widths applied to these defence types are presented in Table 5-5 .

TABLE 5-5 DEFENCE TYPE BREACH WIDTH

Flood cell	Event	Location	Defence type	Breach width [metres]
Lowestoft	Lowestoft A1	Open coast	Hard	50
	Lowestoft A2	Tidal river	Hard	20
	Lowestoft A3	Tidal river	Hard	20
	Lowestoft A4	Tidal river	Hard	20
Southwold	Southwold B1	Open coast	Hard	50
Sizewell	Sizewell C1	Open coast	Earth bank	200
Aldeburgh	Aldeburgh D1	Open coast	Earth bank	200
	Aldeburgh D2	Open coast	Hard	50
Woodbridge	Woodbridge E1	Tidal river	Earth bank	50
	Woodbridge E2	Tidal river	Earth bank	50
Felixstowe	Felixstowe F1	Tidal river	Hard	20

5.5.17 The base level of the breaches have been set to the lowest elevation of the land directly behind (landward) the flood defence.

5.5.18 In the hydraulic modelling undertaken for this study, the breach in the flood defence was present during the whole flood event, i.e. it is deemed to have occurred prior to the onset of the extreme tidal event, as it is not possible to vary the DTM during the simulation period. This is a conservative assumption.

5.5.19 It is important to note that the current condition of the defences has not been used as a criterion on which to base the breach dimensions. Instead, it has been assumed that over time all defences will be maintained to the required standard, that is the standard they are currently built to. **In effect, no assessment has been taken of probability of failure.**

Boundary conditions

5.5.20 The MIKE21 breach models require one boundary condition to be defined. This is a time dependent head boundary (HT) at the seaward side of the breach location, which replicates the extreme tide levels/cycle during a tidal flood event.

5.5.21 Six tidal flood events were analysed for each breach location. The tidal flood events analysed were:

- A tidal flood event with a return period of 1 in 20 years
- A tidal flood event with a return period of 1 in 20 years including the effect of climate change
- A tidal flood event with a return period of 1 in 200 years;
- A tidal flood event with a return period of 1 in 200 years including the effect of climate change
- A tidal flood event with a return period of 1 in 1000 years in 2005
- A tidal flood event with a return period of 1 in 1000 years including the effect of climate change

5.5.22 An exception was made with Woodbridge E0, which was only run for the 200 yr event including the effect of climate change and the 1000 yr event including the effect of climate change, as the other two scenarios did not pose a potential flood risk.

Hydraulic roughness

5.5.23 Hydraulic roughness represents the conveyance capacity of the vegetative growth, bed and bank material, channel, sinuosity and structures of the floodplain. Within the MIKE21 model, hydraulic roughness is defined by the dimensionless Manning's 'n' roughness coefficient.

5.5.24 Estimation of the hydraulic roughness was based on aerial photographs and 1:10000 OS maps. Three material roughness classifications have been identified within the study area, including sea/rivers, urbanised areas and non-urbanised areas.

5.5.25 The assigned hydraulic roughness coefficients for the three defined areas are based on engineering judgement and available literature (e.g. Chow, 1979).

5.5.26 The applied Manning's 'n' roughness coefficients for the seabed, urbanised and non-urbanised areas were 0.03, 0.07 and 0.04 respectively.

Model simulations undertaken

5.5.27 To investigate the flood conditions throughout the study area, several model simulations were undertaken. A total of 86 model simulations were undertaken for 15 breach locations.

5.5.28 The model results of the individual model simulations have been processed and converted into maximum depth and hazard maps presented in Appendix A and B for Suffolk and Waveney respectively. The model results of the tidal flood event with a return period of 1 in 200 years plus climate change are also presented as digital animations showing the propagation of flooding on the floodplain.

5.6 Definition of Tidal Hazard Categories

5.6.1 Breach analysis presents data to identify the residual risk of flooding from a failure of local defences. The mapping of hazard zones within Suffolk and Waveney presents the residual risk to provide an additional level of information to local planning authorities allowing them to make more detailed consideration of the Sequential Test and PPS25 vulnerability classifications within Flood Zone 3.

5.6.2 Flood hazard is a function of both the flood depth and flow velocity, hence to assess the hazard risk, the breach model outputs of both flood water depth and flow velocities resulting from each model scenario have been used.

5.6.3 In most flood events the maximum hazard of a flood at a certain location is not experienced at the peak of the flood but before the maximum floodwater level occurs. This is point at which the greatest flood depths and velocities typically occur. Thus in order to determine the maximum flood hazard, the hazard level was assessed at every time step of the model simulation by using an “In-House” tool which assigns one of three hazard categories: “High hazard”, “Medium hazard” and “Low hazard” to each element in the mesh.

5.6.4 The relationship between flood depth and flow velocity and the definition of hazard zones and presented in Figure 5-3. This methodology was originally derived using the DEFRA Flood and Coastal Defence R&D Programme ‘Risk to people’ FD2321, using velocity and depth variable to determine the appropriate hazard classification. A debris factor has not been included in our methodology as this is difficult to assess on a strategic scale.

5.7 Definition of Fluvial Hazard Categories

5.7.1 To provide a greater level of detail on the fluvial flood risks, an assessment has been made on the hazard associated with the River Waveney and River Hundred/Thorpeness in Waveney District Council with an assessment of the Cove Run, River Minsmere and River Deben in the Suffolk Coastal District. The hazard mapping was based on the outputs from the revised modelling. The models were re-run for the 1 in 20, 1 in 100 and 1 in 1000 year events for current and future climate change. The modelling is 1-dimensional and does not have an associated velocity output; therefore the hazard has been classified as a function of depth, assuming zero velocity.

5.7.2 The River Alde/Ore and River Blyth were not re-run as part of the SFRA due to the age and poor quality of the models. It is understood the Environment Agency intend to remodel these catchments in future, but this work was not possible within the given the time constraints and budget of this project. For areas affected by these rivers, detailed Flood Risk Assessments will be needed for any future developments.

5.7.3 The Hazard categories have been mapped using the 'FD2320/TR2 –Flood Risks Assessment Guidance for New Development' depths and associated hazard with an assumed zero velocity as shown in Table 13.1 of that document.

Key (depth of flooding in metres assuming a 0 m/s velocity*):	
0.30-0.50	**Danger for Some**
0.50-1.50	**Danger for Most**
1.50 +	**Danger for All**

**Taken from Table 13.1 Defra/ EA Flood and Coastal Defence R&D Programme FD2320.*

5.7.4 An estimation of velocity to refine the hazard classification for a site could be made on a site-specific basis in relation to distance from the river, local topography, flow paths etc.

5.8 Functional Floodplain

5.8.1 Two different methods were used for deriving the functional flood plain for locations falling within tidal-influenced catchments and locations located upstream of the tidal sections of the rivers. This was done in order to allow the effect of climate change to be taken into account accurately in both fluvial and tidal environments.

TABLE 5-6 SUMMARY OF LOCATIONS

Location	River	Tidal Influence
Lowestoft and Carlton Colville	Lake Lothing	Yes
Bungay, Beccles, Barnby and North Cove, Blundeston, Oulton	River Waveney	No
Southwold and Wangford	River Blyth	Yes
Halesworth	River Blyth	No
Wrentham	Tributary	No
Kessingland	North Sea and River Hundred	Yes
Sizewell, Peasenhall, Yoxford	Minsmere River	Yes
Woodbridge, Melton, Alderton	River Deben	Yes
Saxmundham	River Fromus	No
Wickham market, Earl Soham, Martlesham Heath	River Deben	No

Location	River	Tidal Influence
Aldeburgh, Snape	River Alde	Yes
Hollesley, Orford	River Ore	Yes
Felixstowe	River Deben	Yes
Saxmundham, Framlingham	River Alde	No
Bramfield	River Blyth	No
Foxhall, Ipswich Eastern Fringe Warren Heath	Mill River	No
Witnesham, Ipswich Eastern Fringe Warren Heath, Rushmere, Grundisburgh	River Fynn	No
Knodishall	River Hundred	No

5.8.2 The functional flood plains outline for the tidal locations have been mapped using the 1 in 20 water level provided in the "Report on extreme tide levels – Environment Agency, Anglian region, Eastern and Central areas", Royal Haskoning 2007. In accordance with PPS25 and Environment Agency guidelines one hundred years of climate change, in terms of net sea level rise, was added to the 1 in 20 year levels to determine the impact of climate change on the extent of flood zone 3b. The outline contour was then defined based on the resulting water levels, whilst taking all man-made structures and current defences into account. No floodwater overtopped the defence at Sizewell, thus limiting the functional floodplain to the immediate coastline only.

5.8.3 According to guidelines in PPS25, the effect of 100years of climate change on fluvial watercourses should be taken into account by assuming a 20% increase in peak flows. Thus in order to establish the water levels resulting from the 1 in 20yr + climate change event, the river models were re-run (with the exception of the River Blyth and Alde/Ore) for the 1 in 20 plus 20% climate change increase. Flood outlines were mapped from the revised modelling results which take into account the presence of defences.

5.8.4 In accordance with PPS25 and Environment Agency guidance it should be noted that where functional floodplain extents have not been mapped (such as on the River Blyth and the River Alde/Ore) all areas within Flood Zone 3 should be considered as Zone 3b (functional floodplain) unless, or until, an appropriate FRA shows to the satisfaction of the Environment Agency that the it falls within Flood Zone 3a.

5.8.5 Functional floodplain has been mapped for areas at risk from river and coastal flooding. It does not include areas soley at risk from other sources of flooding such as sewer and surface water flooding.

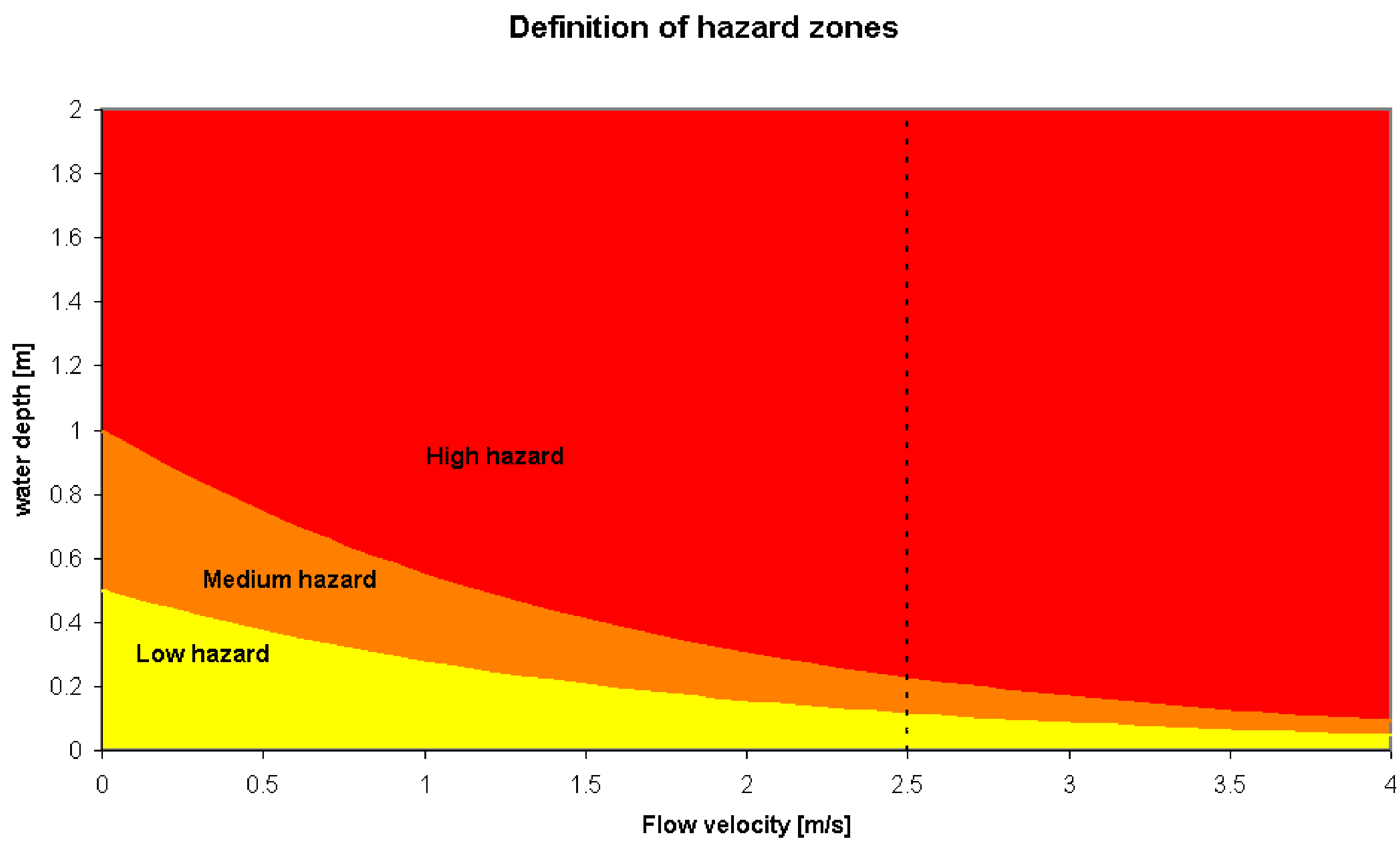


FIGURE 5-3 DEFINITIONS OF HAZARD ZONES

6 Flood Mapping and Application

6.1 Introduction

6.1.1 The following section is intended for use in conjunction with the flood zone and hazard zone mapping presented in the Appendices of this study. Planning guidance indicating what type of development is likely to be appropriate in certain flood zones is presented in Tables D.2 and D.3 of PPS25 (Communities and Local Government, 2006). These tables can then be viewed in conjunction with the hazard zone mapping for specific areas to inform planning decisions and enable the LPA to apply the sequential approach within a flood zone, as well as between the flood zones.

6.2 Flood Zone Mapping

6.2.1 The current flood zones (2007) were mapped for the main settlement and growth areas for each of the Local Authority areas. These maps present the Flood Zones 1, 2, 3a and 3b in relation to current levels of flood risk (2007). In addition these areas were also mapped to take into account the climate change recommended by PPS25 for residential development at 100 years (2107). These figures are included in each of the Appendices and should enable the local authorities to undertake the Sequential Test as part of a 'Level 1 SFRA'.

Functional Floodplain

6.2.2 Functional floodplains have the highest probability of flooding of all the Flood Zones defined within Table D.1 of PPS25. As outlined by Table D.1, there are only two appropriate land uses that should be permitted in this zone – water compatible land uses and essential infrastructure. Any planning applications for proposed appropriate development must be accompanied by a site-specific Flood Risk Assessment that proves that the proposed development will not impede flood flows, will not increase flood risk elsewhere and will remain operational in times of flood. In light of the above, it is important that functional floodplain is illustrated by the SFRA in order for the LPAs to consider its location when preparing LDF documents and other strategic documents.

6.2.3 A functional floodplain is defined by Table D.1 in PPS25 as an area of land where water has to flow or be stored at times of flood (Communities and Local Government, 2006). The functional floodplain has an annual probability of flooding of 5% (i.e. from a 1 in 20 year return period event). Table D.1 of PPS25 also classifies functional floodplains as being Flood Zone 3b.

6.2.4 The Suffolk Coastal and Waveney tidal and fluvial floodplains are generally defended from flooding to a minimum of 1 in 200 year flood level. PPS25 states that functional floodplain should be determined considering the effects of defences and other flood risk management infrastructure.

6.2.5 Functional flood plains have been created for relevant locations within the SFRA study area. The locations, along with the corresponding watercourse, have been tabulated in Table 5-6. It has not been possible to create any more functional floodplain at this stage since the functional floodplains can only be created for locations where modelled data is available.

6.3 Hazard Zones

6.3.1 In order to aid the spatial planning process of each district, for the allocation of development sites, a detailed assessment on the flood risk in Suffolk Coastal and Waveney was required. Such assessment has taken into consideration the extent, design standard and condition of existing flood defences along with the refined hazard map for both Flood Zones 2 and 3.

Fluvial Hazard Mapping

6.3.2 The fluvial hazard maps have been created for areas at risk from river flooding where revised modelling has been completed as part of this study. Section 5.8 of this report goes into further detail on the methodology.

Tidal Hazard Mapping

6.3.3 The hazard maps, shown in Appendix A and B indicate the variation of flood risk within the Environment Agency defined Flood Zones 2 and 3 into areas of High, Medium and Low hazard as a result of overtopping and breach scenarios. They were produced using the consequence and risk methodology outlined in Chapter 5.

6.3.4 The 2D breach modelling produces variables for both depth and velocity during the tidal inundation as a result of a breach. The hazard zone methodology on a strategic scale is similar to the Flood Hazard guidance provided in DEFRA/EA R& D publication FD2320/TR2 Table 13.1. The debris factor cannot be considered on a strategic scale as the source and volume of debris would vary hugely on a spatial basis resulting in ambiguous results.

6.3.5 The tidal flood hazard maps present the results of each breach scenario and include overtopping and breach assessments where relevant. In areas where the existing standard of defence was below the 1 in 200 year water level, the flood cells have modelled overtopping inundation for the 200-year and 1000 year existing scenarios i.e. the actual flood risk that would result at present day defence heights- Actual Risk.

6.3.6 The hazard zone maps have been produced by calculating the depth and velocity of inundation water from particular breach events. It is important to remember that the hazards maps represent the hazard arising from one or more breach scenario in a specific location and will almost certainly vary spatially should the breach location differ. The breach locations were derived during the initial scoping and modelling stages through consultation with the Environment Agency and district councils. The locations were considered in relation to most likely areas to breach as well as greatest potential consequences.

6.3.7 In addition, further issues to be considered whilst using the hazard maps are:

- Not all possible breach locations in each authority area have been considered. The modelling study had to be limited to those locations thought most likely to lead to flood risk for specific growth areas.
- Breach width and depth, though based on EA guidance, are arbitrary and do not necessarily represent the actual dimensions of a breach in a given location.

6.3.8 Changes in inundation extent or hazard zone do not vary linearly with changes in breach location so interpolation is not possible.

6.4 Rapid Inundation Zone

6.4.1 The draft "Practice Guide Companion to PPS25 'Living Draft'" identifies a rapid inundation zone as an area at risk from rapid flooding should a flood defence structure be breached or overtopped (Communities and Local Government, 2007). Unsurprisingly, these areas tend to be located close behind the flood defences. In general, the zone of rapid inundation suggests that development should be avoided within the first few hundred metres of the defences because there is a risk to all people exposed to floodwater (Environment Agency Flood and Coastal Defence R&D Programme, 2005). There is an inherent risk to properties in this area from the potential high floodwater velocities following a potential breach event.

6.4.2 As part of the breach and overtopping modelling undertaken as part of this assessment, flood inundation animations have been supplied to the participating authorities and Environment Agency to provide further detail with regards the main flood routes and speed of inundation relating to a particular breach event.

6.4.3 For an SFRA located in a more urbanised location a 500m buffer zone, to include the zone of rapid inundation, is commonly used. The study area for the Suffolk Coastal and Waveney SFRA included large areas of coastline and river/estuary areas that are largely rural, therefore breach locations were concentrated in more urbanised areas such as Lowestoft and Felixstowe. The existing breach scenarios provide information in relation to depth, speed and related hazard for the various flood cells in these specific areas.

6.4.4 It is important to consider the probability of a breach event occurring, even in the sparsely populated areas. Therefore in rural areas where breach scenarios were not examined in greater detail, an assumption of 500m (Environment Agency Flood and Coastal Defence R&D Programme, 2005) for the zone of rapid inundation and associated high hazard would not be overly conservative. Although the local topography and existing defences would need to be considered, the definition of this area for a particular site or masterplan should be identified in a site specific flood risk assessment.

6.5 Using the Hazard Maps

6.5.1 PPS25 requires local planning authorities to review flood risk across their districts, steering all development towards areas of lowest risk. Development is only permissible in areas at risk of flooding in exceptional circumstances where it can be demonstrated that there are no reasonably available sites in areas of lower risk, and the benefits of that development outweigh the risks from flooding. Such development is required to include mitigation/management measures to minimise risk to life and property should flooding occur.

6.5.2 It will be necessary for the Local Planning Authority to demonstrate that the Sequential Test has been passed. Following this, the LPA may then have to apply the Exception Test, (dependent on the vulnerability of the development and the flood zone for development within, Table D.3, PPS25), and demonstrate that all 3 elements of the Exception Test have been satisfied before the development is approved.

6.5.3 It is intended that the hazard maps will provide the Local Planning Authority with an appreciation of the actual and residual flood risks faced in their areas taking into consideration the presence of flood defences.

6.5.4 The hazard maps will inform policies and practices required to ensure development satisfies the requirements of the Exception Test through the detailed consideration of flood hazard. Presenting information such as depth variation for fluvial flood zones, depth and velocity variation including onset of flooding for tidal flood zones.

6.5.5 The tidal hazard maps take into consideration the existing infrastructure, modelling overtopping and potential breach scenarios to identify potential flood hazards to areas behind existing defences.

6.5.6 A number of further considerations in addition to flood hazard should be taken into account when allocating specific areas for development or placing one area ahead of another in terms of suitability for development. Potential evacuation routes, flood warning times and the time to peak flood hazard are some of the additional factors that should be taken into account. Further details are provided in Chapter 8.

7 Residual Risk Management

7.1.1 Residual risk in a generic sense can be defined as being the remaining risk following the implementation of all reasonable risk avoidance, reduction and mitigation measures (Communities and Local Government, 2007). In a flood risk context, this residual risk pertains to the flood risk that remains after flood avoidance and alleviation measures have been put in place. Examples of such residual risks include overtopping or breaching of flood walls or embankments.

7.1.2 Residual risk management therefore aims to prevent or mitigate the consequences of flooding that can occur despite the presence of flood alleviation measures.

7.1.3 Much of the study area is protected by various flood defence structures. However, the sizes of these structures have been limited by economic considerations and some are older than others. Therefore there is a risk of overtopping or breach leading to inundation by floodwater. Examples of this have been identified by the breach analysis and flood mapping exercises undertaken as part of this SFRA.

7.1.4 Application of the Sequential Test as part of PPS25 aims to preferentially develop or relocate potential development sites into areas with low flood risk. Where this is not realistically possible, some development sites may be located in higher flood risk areas, such as PPS25 defined Flood Zones 2 and 3. As a result, such developments will require residual risk management to minimise the consequences of potential flooding, e.g. following a breach or overtopping of local defences.

7.1.5 Ensuring properties are defended to an appropriate design standard reduces flood risk. However, further options are also available should the residual risk to a development prove unacceptable. This chapter presents some of the information and options available to understand and manage residual risk.

7.2 Managing Residual Risk

Potential Evacuation and Rescue Routes

7.2.1 In the event of a flood incident, it is essential that the evacuation and rescue routes to and from any proposed development remain safe. The Environment Agency deem evacuation routes safe if they fall within the white cells of Table 13.1 of the Defra/EA document FD2320 for a 1 in 100/200 year design event as a minimum, and the Environment Agency inform the LPA of the risk posed during the extreme event (1 in 1000 year). This allows the LPA to consult with the emergency services over the suitability of the access route. If potential evacuation routes are likely to become inundated so that safe access/egress would not be possible, then the proposed development should be relocated. This may also be the case should the possible evacuation routes be particularly long or across difficult terrain.

7.2.2 A key consideration in relation to the presence and use of evacuation routes is the vulnerability and mobility of those in danger of being inundated. Development for highly vulnerable users e.g. disabled or the elderly, should, be located away from high-risk areas. The Sequential Test does not however differentiate between the vulnerability of the end users of the site, only the vulnerability of the intended use 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.

Time to Peak of Flood Hazard

7.2.3 The time to the peak of the flood hazard relates to the amount of time it takes for a flood event to reach its maximum level, flow or height. The greater the time to peak, the greater the time available for evacuation. The time to peak can, for residual flooding, be very short. Should a defence structure breach then inundation can 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. Typically, areas immediately adjacent to a breach location will have a shorter time to peak than areas setback from the flood defence.

Methods of Managing Residual Flood Risk

7.2.4 The following sub-sections outline various methods available for the management of residual flood risk. The methods outlined will not be appropriate for all development types or all geographical areas. Therefore, they should be considered on a site-by-site basis. In addition, it is important that the use of such techniques do not exacerbate flooding elsewhere within the flood cell.

Recreation, Amenity and Ecology

7.2.5 There are many different ways in which recreation, amenity and ecological improvements can be used to mitigate the residual risk of flooding either by substituting less vulnerable land uses or by attenuating flows or both. They range from the development of parks and open spaces through to river restoration schemes. In addition, they have wider ecological, biodiversity and sustainability benefits.

7.2.6 The basic function of these techniques is increased flood storage and the storage or conveyance of rainwater. Typical measures include various guises of pools, ponds, and ditches. These all can have the added benefit of improving the ecological and amenity value of an area. These features can provide a haven for local wildlife. In addition, they can contribute to a sites amenity value both aesthetically and for recreation by providing attractive areas available for activities such as walking, cycling, water sports or wildlife watching.

Secondary Defences

7.2.7 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.

7.2.8 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.

Land Raising

7.2.9 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 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 within the flood cell. Level for Level compensation storage should be provided where any loss of floodplain storage had occurred as a result of land raising or development within the floodplain.

7.2.10 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.

Finished Floor Levels

7.2.11 Where developing in flood risk areas is unavoidable, the most common method of mitigating flood risk is to ensure habitable floor levels are raised above the maximum flood water level. The Environment Agency require 300mm freeboard for precisely computated flood levels, and 600mm for less precisely computated levels in addition to modelled flood levels when setting finished floor levels. It is also necessary to ensure that roads levels are such that emergency access and evacuation routes are maintained. This can significantly reduce the risk of the proposed development becoming inundated by flooding. As with the land raising option, it is imperative that any assessment takes into consideration the volume of floodwater potentially displaced by such raising.

7.2.12 In areas where significant depths of floodwater are predicted to inundate the site, development design can incorporate the use of non-habitable uses on the ground floor. These can include garage areas, utility or storage spaces. This method can be somewhat contentious as it can be difficult to ensure that the ground floor remains uninhabited for the lifetime of the development and emergency access can be difficult.

Flood Resilience

7.2.13 The Association of British Insurers in cooperation with the National Flood Forum has produced published guidance on how homeowners can improve the flood resilience of their properties (ABI, 2004). These measures can not only improve properties against flood risk, by reducing the residual risk, but can also improve the insurability of homes in flood risk areas. The guidance identifies the key flood resistant measures as being:

- Replace timber floors with concrete and cover with tiles,
- Replace chipboard/MDF kitchen and bathroom units with plastic equivalents,

- Replace gypsum plaster with more water-resistant material, such as lime plaster or cement render,
- Move service meters, boiler, and electrical points well above likely flood level, and,
- Put one-way valves into drainage pipes to prevent sewage backing up into the house.

7.2.14 Advice on flood mitigation for homes and businesses is also given in the ODPM's 2003 report, 'Preparing for Floods' (ODPM, 2003b).

Flood Warning and Emergency Procedures

7.2.15 Flood warning and emergency procedures are typically higher-level management strategies. Such procedures typically include information such as warning, evacuation and repair procedures. Documents providing guidance on how to use flood resistance and resilience measures to limit damage caused by flooding, such as 'Improving the Flood Performance of New Buildings, (Department for Communities and local Government, May 2007), can also offer important guidance and should be referred to.

7.2.16 When undertaking flood risk assessments for developments within flood risk areas, the local flood warning and emergency response plans should be referred to as a flood damage mitigation method.

7.2.17 Where these procedures already exist they should be updated to include the information generated by this SFRA. Emergency planning maps are provided in each of the supporting appendices and should be consulted in order to identify places of refuge within each District. This will ensure that emergency plans are appropriate to the conditions expected during a flood event and that local authorities and emergency services are fully aware of the likely conditions and how this may affect their ability to safeguard the local population.

8 Sustainable Drainage systems

8.1.1 Traditionally, built developments have utilised piped drainage systems to manage storm water and convey surface water run-off away from developed areas as quickly as possible. Typically these systems connect to the public sewer system for treatment and/or disposal to local watercourses. Whilst this approach rapidly transfers storm water from developed areas, the alteration of natural drainage processes can potentially impact on downstream areas by increasing flood risk and reducing water quality. Receiving watercourses are therefore much more sensitive to rainfall intensity, volume and catchment land uses after a catchment or areas of a catchment have been developed.

8.1.2 Due to the difficulties associated with updating sewer systems it is uncommon for sewer and drainage systems to keep pace with the rate of development/re-development and the increasingly stringent controls placed on discharges to watercourses. As development progresses and/or urban areas expand these systems become inadequate for the volumes and rates of storm water they receive, resulting in increased flood risk and/or pollution of watercourses. Allied to this are the implications of climate change on rainfall intensities, leading to flashier catchment/site responses and surcharging of piped systems.

8.1.3 In addition, as flood risk has increased in importance within planning policy, a disparity has emerged between the design standard of conventional sewer systems (1 in 30 year) and the typical design standard flood (1 in 100 year). This results in drainage inadequacies for the flood return period developments need to consider, often resulting in potential flood risk from surface water/combined sewer systems.

8.1.4 A sustainable solution to these issues is to reduce the volume and rate of water entering the sewer system and watercourses.

8.2 What are Sustainable Drainage Systems?

8.2.1 Sustainable Drainage Systems (SuDS) are the preferred method for managing the surface water run-off generated by developed sites. The Environment Agency as well as PPS25 (Annex F) and Buildings Regulations (Approved Document Part H) advocate the use of SuDS for surface water runoff. PPS25 notes that regional planning bodies and Local Authorities should promote their use for the management of runoff. SuDS seek to manage surface water as close to its source as possible, mimicking surface water flows arising from the site, prior to the proposed development. Typically this approach involves a move away from piped systems to softer engineering solutions inspired by natural drainage processes.

8.2.2 Discharge rates from a developed area vary depending on the characteristics of the site pre development. If the site was originally Greenfield in nature surface water discharge rates should mimic the Greenfield rate. In accordance with PPS25 peak flow rates of surface water leaving a developed site should be no greater than the rates prior to the proposed development, unless specific off-site arrangements can be made that result in the same net effect. Where possible, efforts should be made to improve the current situation with regard to discharge from the site, particularly in areas known to suffer from surface water inundation.

8.2.3 SuDS should be designed to take into account the surface run-off quantity, rates and also water quality ensuring their effective operation up to and including the 1 in 100 year design standard flood including an increase in peak rainfall of 30% to account for climate change. In addition, these systems must be proven to be effective for the lifetime of the development, 100 years for residential developments and 60 years for commercial (as outlined by PPS25).

8.2.4 Wherever possible, a SuDS technique should seek to contribute to each of the three goals identified below with the favoured system contributing significantly to each objective:

- Reduce flood risk (to the site and neighbouring areas),
- Reduce pollution, and,
- Provide landscape and wildlife benefit.

8.2.5 The goals of SuDS can be achieved by utilising a management plan incorporating a chain of techniques, (as outlined in Interim Code of Practice for Sustainable Drainage Systems 2004), where each component adds to the performance of the whole system:

- Prevention: good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping)
- Source control: runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements)
- Site control: water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site)
- Regional control: integrate runoff manage from a number of sites (e.g. into a detention pond)

8.2.6 In keeping with the guidance of PPS25 local authorities should encourage the application of SuDS techniques. This chapter presents a summary of the SuDS techniques currently available and a review of the soils and geology of the Suffolk Coastal and Waveney areas, enabling the local authorities to identify where SuDS techniques could be employed in development schemes.

8.2.7 The application of SuDS techniques is not limited to one technique per site. Often a successful SuDS solution will utilise a number of techniques in combination, providing flood risk, pollution and landscape/wildlife benefits. In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed SuDS.

Planning

8.2.8 All relevant organisations should meet at an early stage to agree on the most appropriate drainage system for the particular development. These organisations may include the Local Authority, the sewage undertaker, Highways Authority, and the Environment Agency. There are, at present, no legally binding obligations relating to the provision and maintenance of SuDS. However, PPS25 states that:

"where the surface water system is provided solely to serve any particular development, the construction and ongoing maintenance costs should be fully funded by the developer."

8.2.9 The most appropriate agreement is under Section 106 of the Town and Country Planning Act. Under this agreement a SuDS maintenance procedure can be determined.

8.2.10 When a decision has been made regarding a SuDS method, the various organisations involved should agree on a management and responsibility strategy. Problems arise when this has not been decided upon prior to adoption and the SuDS system can fail.

8.3 SuDS Techniques

8.3.1 SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc). Various SuDS techniques are available, however the techniques operate on two main principles:

- Infiltration
- Attenuation

All systems generally fall into one of two categories, or a combination of the two.

8.3.2 The design of SuDS measures should be undertaken as part of the drainage strategy and design for a development site. A ground investigation will be required to assess the suitability of using infiltration measures, with this information being used to assess the required volume of on-site storage. Hydrological analysis should be undertaken using industry-approved procedures such as the Flood Estimation Handbook to ensure a robust design storage volume is obtained.

8.3.3 During the design process, liaison should take place with the Local Planning Authority, the EA (if the site is over 1ha in size or identified as situated within a critical drainage area), and Anglian Water in order to establish that the design methodology is satisfactory and to also agree on a permitted rate of discharge from the site.

8.4 Infiltration SuDS

8.4.1 This type of Sustainable Drainage System relies on discharges to ground, where suitable ground conditions allow. Therefore, infiltration SuDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as water resources etc) for their successful operation.

8.4.2 Various infiltration SuDS techniques are available for directing the surface water run-off to ground. However, development pressures and a desire to maximise development potential often result in typically small areas available for infiltration systems. These small areas, allied to the rapid rates of run off generation, often require some form of attenuation as part of the infiltration system. The storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway or as a pond/water feature.

8.4.3 Infiltration measures include the use of permeable surfaces and other systems that are generally located below ground.

8.5 Attenuation SuDS

8.5.1 Should it be found that the ground conditions are not favourable for infiltration techniques, the surface water run-off discharged from a site will need to be attenuated using on-site storage. While this is a SuDS technique that will reduce the rate of discharge from the site, the overall volume will not be minimised using on-site storage alone. An important factor that needs to be taken into consideration when assessing the suitability of on-site storage as part of a proposed development is the volume required and the associated impacts the storage will impose on development proposals and risks to neighbouring properties.

8.5.2 An allowable rate of discharge from the site will need to be agreed with the Environment Agency, Anglian Water, and the Local Planning Authority. This can have significant implications to the proposed development with regards to the large volume of storage that may be required. On-site storage can be constructed both above ground and below ground with the above ground systems usually being the cheaper option on a cost per m^3 of storage basis. It should be noted however that the below ground systems may pose less constraints on the developable area of the site.

8.5.3 On site storage measures include basins, ponds, and other more engineered forms of storage underground, (the reader is directed to The SuDS Manual for further information regarding SuDS techniques).

8.6 Alternative Forms of Attenuation

8.6.1 In many situations the development of a site may involve proposals that would inhibit the use of basins or ponds as a means of managing the surface water run-off discharged from the site. This may be due to space limitations, economic feasibility, or other issues such as health and safety etc. In these situations it may be appropriate to use a storage option that is viewed as being more ‘engineered’ than an open basin or pond. Most of these methods involve the provision of storage beneath the ground surface, which may be advantageous with regards to the developable area of the site, however consideration needs to be given to construction methods, maintenance access and to any development that takes place over an underground storage facility. The provision of large volumes of storage underground also has potential cost implications.

8.6.2 Methods for providing alternative attenuation include:

- Deep Shafts
- Geocellular Systems
- Oversized Pipes
- Rainwater Harvesting
- Tanks

- Green Roofs

8.7 Combined Infiltration / Attenuation Systems

8.7.1 In most situations, SuDS systems include both infiltration and storage. Most of the techniques identified above can be used in combination, however dedicated infiltration and attenuation systems include swales and filter strips.

8.7.2 Combined systems often meet all three goals of Sustainable Drainage Systems, whilst also reducing the land take required to accommodate them.

8.8 SuDS Suitability in the Suffolk Coastal and Waveney Areas

8.8.1 The underlying ground conditions of a development site will often determine the type of SuDS approach to be used at development sites. This will need to be determined through ground investigations carried out on-site, however an initial assessment of the suitability of a site to the use of SuDS can be obtained from a review of the available soils/geological survey of the area.

8.8.2 Table 8-1, Table 8-2 and Table 8-3 indicate the types of soils, drift deposits and solid geology that are present in the Suffolk Coastal and Waveney area, and their likely suitability to infiltration measures. This is based on a review of:

- the Soil Survey of England and Wales 1993 – 1:250,000 Soils Maps (Sheets 4 & 6), and
- the Geological Survey of Great Britain (England and Wales) 1:50,000 Series Solid and Drift Edition Sheets 207, 176 (1996), 191 (1996) and Sheets 208 & 225 (2001).

The Soils Map Legend was also consulted as part of this assessment.

8.8.3 The tables present the ground conditions found in the Suffolk Coastal and Waveney areas in terms of their permeability (impermeable, variably permeable and permeable) and the types of SuDS techniques that may be suitable for a site located on these materials. These definitions are based on a review of available information and our experience and should not supersede site-specific data and ground investigations. These tables should be used in conjunction with the SuDS information in the relevant appendices.

8.8.4 In the design of any drainage system and SuDS approach, consideration should be given to site-specific characteristics and where possible be based on primary data from site investigations. The information presented in the following tables (Table 8-1, Table 8-2 and Table 8-3) is provided as a guide and should not be used to accept or refuse SuDS techniques.

TABLE 8-1 : SUFFOLK COASTAL AND WAVENEY DISTRICTS SOIL DEPOSITS & APPROPRIATE SUDS TECHNIQUES

Permeability	Soil Association	Geology	Location	Soil Characteristics	Appropriate SuDS Techniques
Permeable	Sandwich	Dune sand and marine shingle	East of the River Alde on the coast at Orford Ness and other coastal locations	Mainly deep well drained calcareous and non-calcareous sandy soils. Some sparsely vegetated unstable soils. Waterlogged soils in hollows locally. Shingle bars and spite locally extensive. Risk of wind erosion.	Infiltration and Combined Infiltration/Attenuation Systems
	Wick 3	Glaciofluvial and aeolian drift	One deposit north of the River Orwell and one deposit north of Lowestoft and east of the River Waveney	Deep well drained coarse loamy often stoneless soils. Some similar sandy soils. Complex pattern locally. Risk of water erosion.	Infiltration and Combined Infiltration/Attenuation Systems
	Newport 1	Glaciofluvial drift	Found along the River Waveney watercourse in two areas	Deep well drained sandy and coarse loamy soils. Some sandy soils affected by groundwater. Risk of wind and water erosion.	Infiltration and Combined Infiltration/Attenuation Systems
	Newport 2	Glaciofluvial drift over Cretaceous sand or Crag	Found separating marine deposits from inland areas in the southern corner of Suffolk Coastal District	Deep well drained sandy often ferruginous soils. Risk of wind and water erosion.	Infiltration and Combined Infiltration/Attenuation Systems
	Newport 4	Glaciofluvial drift	Most abundant of the Newport group found separating marine deposits from inland areas	Deep well drained sandy soils. Some very acid soils with bleached subsurface horizon especially under heath or in woodland. Risk of wind erosion.	Infiltration and Combined Infiltration/Attenuation Systems
Variably permeable	Newport 3	Glaciofluvial drift and chalky till	Found separating marine deposits from inland areas in northern Suffolk Coastal and Waveney Districts	Deep well drained sandy and coarse loamy soils. Some coarse and fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging. Risk of wind erosion.	Infiltration and Combined Infiltration/Attenuation Systems
	Burlingham 3	Chalky till and glaciofluvial drift	An area found north of Woodbridge, east of the River Deben and west of the River Deben	Deep fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging. Some similar fine or coarse loamy over clayey soils. Some deep well drained coarse loamy over clayey, fine loamy and sandy soils.	Infiltration and Combined Infiltration/Attenuation Systems
	Mendham	Fen peat and river alluvium	Found in river channel locations, e.g. River Blyth, River Waveney and coastal discharging watercourses.	Deep peat soils associated with clayey over sandy soils, in part very acid. High groundwater levels. Risk of flooding.	Infiltration and Combined Infiltration/Attenuation Systems

Permeability	Soil Association	Geology	Location	Soil Characteristics	Appropriate SuDS Techniques
Impermeable	Hanslope	Chalky Till	Found inland around the upper reaches of watercourses	Slowly permeable calcareous clayey soils. Some slowly permeable non-calcareous clayey soils. Slight risk of water erosion.	Attenuation Systems
	Beccles 1	Chalky Till	Abundant in inland upland areas of the districts, thus are found towards the westerly boundaries.	Slowly permeable seasonally waterlogged fine loamy over clayey soils, associated with similar clayey soils.	Attenuation Systems
	Gresham	Aeolian drift and till	Found within Wick 3 deposits north of Lowestoft.	Stoneless slowly permeable seasonally waterlogged coarse loamy soils and silty over clayey soils. Some deep coarse loamy soils affected by groundwater	Attenuation Systems
	Midelney	River alluvium over peat	Found along the upper reaches of the River Deben	Stoneless clayey soils mostly overlying peat. Soils variably affected by groundwater which is, in places, controlled by ditches and pumps. Flay land. Risk of flooding locally.	Attenuation Systems
	Wallasea 1	Marine alluvium	Found in coastal and estuarine locations in the south east of Suffolk Coastal District and around the River Alde	Deep stoneless non-calcareous and calcareous clayey soils. Soils locally have humose or peaty surface horizons. Groundwater controlled by ditches and pumps. Flat land. Slight risk of flooding.	Attenuation Systems
	Windsor	Tertiary clay	A small area west of Felixstowe	Slowly permeable seasonally waterlogged clayey soils mostly with brown subsoils. Some fine loamy over clayey and fine silty over clayey soils and, locally on slopes, clayey soils with only slight seasonally waterlogging.	Attenuation Systems
	Ragdale	Chalky till	A large area located around Saxmundham and to the north west of Saxmundham	Slowly permeable seasonally waterlogged clayey and fine loamy over clayey sols. Some slowly permeable calcareous clayey soils especially on slopes.	Attenuation Systems
	Newchurch 2	Marine alluvium	Found in the estuarine area of the River Waveney	Deep stoneless mainly calcareous clayey soils. Groundwater controlled by ditches and pumps. Flat land. Risk of flooding in places.	Attenuation Systems

TABLE 8-2: SUFFOLK COASTAL AND WAVENEY DRIFT GEOLOGY DEPOSITS & APPROPRIATE SUDS TECHNIQUES

Permeability	Drift Deposit	Location	Characteristics (where available)	Appropriate SuDS Techniques
Permeable	Alluvial Fan Deposits	Found in small deposits in tributary locations of the River Blyth		Infiltration and Combined Infiltration/Attenuation Systems
	Alluvium	Found along river courses e.g. upper reaches of the River Blyth and River Alde	Mainly sand, silt and clay with some gravel	Infiltration and Combined Infiltration/Attenuation Systems
	Brown Sand	These are located along the coast to the north of Lowestoft and around the mouths of Rivers and Estuaries	Fine to medium grained sand	Infiltration and Combined Infiltration/Attenuation Systems
	Chillesford Sand Member (CfC)	Found in southern areas of Suffolk Coastal surrounding the Kesgrave Formation	Sand, yellow brown, fine to medium grained, micaceous, locally shelly (0-20m)	Infiltration and Combined Infiltration/Attenuation Systems
	Crag Group	This deposit is found in coastal areas and estuarine locations e.g. along the coast between Southwold and Kessingland	Includes: Mainly fine grained buff to brown, locally shelly, micaceous sands, with local rounded flint gravels. Chillesford Clay – grey silty mudstones. Red Crag-ferruginous shelly sands	Infiltration and Combined Infiltration/Attenuation Systems
	Glacial Sand and Gravel	Found around rivers and coastal areas. The southern region, from the River Orwell to Martlesham Creek is predominantly Glacial Sand and Gravel. To the north of Martlesham creek, is a fringe area of Glacial Sand and Gravel		Infiltration and Combined Infiltration/Attenuation Systems
	Glaciofluvial deposits	Found in small deposits on the western edge of the River Deben floodplain area and to the east of the River Deben	Sand and gravel	Infiltration and Combined Infiltration/Attenuation Systems
	Kesgrave Formation	Found in southern areas of Suffolk Coastal between the River Deben and River Ore and Alde and south of the River Deben	Sand and gravel	Infiltration and Combined Infiltration/Attenuation Systems
	Red Crag Formation	Found in southern areas of Suffolk Coastal surrounding the Kesgrave Formation	Sand, medium to coarse grained shelly in lower parts, strongly ironstained at surface, green at depth. Basal beds rich in phosphate pebbles (0-31m)	Infiltration and Combined Infiltration/Attenuation Systems
	River Terrace Deposits	Found around rivers and are numbered, e.g. River Waveney, River Blyth	Undifferentiated. Sand and Gravel	Infiltration and Combined Infiltration/Attenuation Systems
	Sand	Found in coastal locations	Marine and coastal zone deposits	Infiltration and Combined Infiltration/Attenuation Systems

Permeability	Drift Deposit	Location	Characteristics (where available)	Appropriate SuDS Techniques
	Sand and gravel	Found in coastal locations, e.g. east of the River Ore	Marine and coastal zone deposits	Infiltration and Combined Infiltration/Attenuation Systems
	Second terrace Deposits	Found around rivers and are numbered, e.g. River Waveney, River Blyth	Sand and gravel	Infiltration and Combined Infiltration/Attenuation Systems
	Shell Marl	(indicated as present on sheet 176 (1996) but not shown)		Infiltration and Combined Infiltration/Attenuation Systems
	Yare Valley Formation	(proved only in boreholes)	Sand and Gravels	Infiltration and Combined Infiltration/Attenuation Systems
Variable Permeability	Coralline Crag Formation	This deposit is found to the north west of Aldeburgh and to the west of the River Ore and a number of other deposits in south Suffolk Coastal	Calcarenite, yellow brown at surface, green at depth, shelly, partly indurated (0-22m)	Attenuation Systems
	Corton Formation	Found in northern areas of Waveney District, between drift associated with watercourses and the till that covers the majority of the inland areas	Mainly sands, some clays and gravels and sandy clay	Attenuation Systems
	Head	Found in deposits fringing Rivers and floodplain areas and upper reaches of watercourses, e.g. River Blyth	Diamiction, stony, sandy clay and clayey sand	Attenuation Systems
	Lacustrine Deposits	Found in isolated areas in the southern region of Suffolk Coastal district, one area is found between Shottisham and Hollesley	Silt and clay, laminated, locally organic rich	Attenuation Systems
	Lowestoft Till Formation	This deposit is found in the majority of inland non riverine areas. The dominant form of which is the mainly chalky, pebbly, sandy clay (till)	Aldeby Sands and Gravels, Haddiscoe Sands and Gravels, Corton Woods Sands and Gravels, Oulton beds – laminated clays and silts, silt, sand and gravel, chalky pebbly sandy clay (till), stony, sandy clay rich in chalk and flint pebbles	Attenuation Systems
	Peat	Peats are found in and surrounding sections of river channels e.g. Minsmere River, River Waveney		Attenuation Systems
	Tidal Flat Deposits	In coastal zones	Muds, sand and sand and gravel. Marine and coastal zone deposits; depositional environments of shoreface and beach, bank, tidal flat, channel and saltmarshes.	Attenuation Systems

Permeability	Drift Deposit	Location	Characteristics (where available)	Appropriate SuDS Techniques
	Norwich Crag Formation	Found in the southern region of Suffolk coastal to the west of the River Alde	Chillesford Clay Member – clay and silt, grey, laminated, locally shelly Chillesford Sand Member - Sand, yellow brown, fine to medium grained, micaceous, locally shelly (0-20m)	Attenuation Systems
Impermeable	Boulder Clay	Found around watercourses		Attenuation Systems
	Brickearth	Found to the north of Martlesham Creek and deposits of glacial sands and gravels and Kesgrave sands and gravels	Clay	Attenuation Systems
	Chillesford Clay Member (CfC)	Found in southern areas of Suffolk Coastal around Sudbourne	Clay and silt, grey, laminated, locally shelly (0-6m)	Attenuation Systems
	Intergalcial Deposits	(Present but not mapped at surface)	Mainly silts and clays	Attenuation Systems
	London Clay	Found in close proximity to river locations		Attenuation Systems
	Mud	Found in marsh and estuarine locations, e.g. River Alde and River Ore estuary and Tinkers Marsh	Marine and coastal zone deposits	Attenuation Systems
	River Terrace Deposits	Found around rivers and are numbered, e.g. River Waveney, River Blyth	Undifferentiated. Clay and Silt	Attenuation Systems
	Silt	Found in riverine locations		Attenuation Systems

TABLE 8-3 : SUFFOLK COASTAL AND WAVENEY SOLID GEOLOGY DEPOSITS & APPROPRIATE SUDS TECHNIQUES

Permeability	Solid Geology	Location	Characteristics	Appropriate SuDS Techniques
Permeable	Carstone sandstone with glauconite	Found under the Upper Chalk		Infiltration and Combined Infiltration/Attenuation Systems
	Crag Group	This deposit is found under drift deposits across extensive areas in both Suffolk Coastal and Waveney. It is underlain by the Thames Group, the Lambeth Group and the Chalk Group.	Includes: Mainly fine grained buff to brown, locally shelly, micaceous sands, with local rounded flint gravels. Chillesford Clay – grey silty mudstones. Red Crag-ferruginous shelly sands	Infiltration and Combined Infiltration/Attenuation Systems
	Upper Greensand Gault	Found under the Upper Chalk	Silty and sandy mudstones	Infiltration and Combined Infiltration/Attenuation Systems
Variably permeable	Lambeth Group	Sandwiched between the Thames group on top and the Ormesby Clay Formation beneath	Mottled mudstones in upper part sands and silts in lower part and mottled clays	Infiltration and Combined Infiltration/Attenuation Systems
	Thames Group	Situated beneath Coralline Crag (where present) and the Crag Group	Comprised of the London clay Formation and the Harwich Formation. Grey sand and clay	Infiltration and Combined Infiltration/Attenuation Systems
	Lambeth Group and Thanet Sand Formation (undifferentiated)	Found over lying the Upper Chalk, beneath the Thames Group	Clay, sand and silt, colour mottled, with a thin flint pebble bed at the base	Infiltration and Combined Infiltration/Attenuation Systems
	Harwich Formation	Situated above the Lambeth Group and Thanet Sand Formation (undifferentiated) and below the Red Crag Formation	Sandy siltstone with abundant volcanic ash layers. Hales clay member – sandy mudstone with rare volcanic ash layers	Infiltration and Combined Infiltration/Attenuation Systems
	Upper Chalk	Thick deposit located under Crag Group and Ormesby Clay Formation (where present)	White and grey chalk, nodular and soft with flint seams in upper part	Infiltration and Combined Infiltration/Attenuation Systems
Impermeable	Mudstone	Situated above the Lambeth Group and Thanet Sand Formation (undifferentiated) and below the Red Crag Formation		Attenuation Systems
	London clay Formation	Situated above the Lambeth Group and Thanet Sand Formation (undifferentiated) and below the Red Crag Formation	Clay, blue gravy, variably silty with thin sand and pebble beds. Clay, silty with ash layers and cementstone nodules and beds. Mudstones and Siltstones	Attenuation Systems
	Ormesby Clay Formation	Found under the Thames Group and Lambeth Group (where present)	Grey Clay	Attenuation Systems

8.9 Further Information

8.9.1 The above information is intended to provide an introduction to the use of SuDS in the Suffolk Coastal and Waveney areas. The options available for the provision of SuDS is not exhaustive and new techniques are frequently developed. The consideration of utilising SuDS as part of a development will depend on many factors such as the underlying geology and drift layers, the depth of the groundwater table, site slopes, run-off quality, site restrictions, maintenance requirements, economical viability, groundwater protection and ecological considerations. The final drainage scheme and SuDS for a site should consider each of these elements in its design.

The following reference documents provide further information on SuDS, their benefits and limitations and how they can be employed:

- BRE. Digest 365. 2003. Soakaway Design. Building Research Establishment.
- British Water. 2005. Technical Guidance, Guidance to Proprietary Sustainable Drainage Systems and Components – SuDS. In partnership with the Environment Agency
- BSRIA Ltd. 1997. Water Conservation: Implications of Using Recycled Greywater and Stored Rainwater in the UK. Report 13034/1. Drinking Water Inspectorate, Department of the Environment.
- CIRIA 625. 2003. Model Agreements for Sustainable Water Management Systems – Review of Existing Legislation. RP664.
- CIRIA 626. 2003. Model Agreements for Sustainable Water Management Systems – Model Agreement for Rainwater and Greywater Use Systems. P Shaffer, C Elliott, J Reed, J Holmes and M Ward.
- CIRIA C521. 2000. Sustainable Urban Drainage Systems - Design Manual for Scotland and Northern Ireland. Sustainable Urban Drainage Scottish Working Party.
- CIRIA C522. 2000. Sustainable Urban Drainage Systems - Design Manual for England and Wales. Department of Environment Transport Regions.
- CIRIA C523. 2001. Sustainable Urban Drainage Systems, Best Practice Manual for England, Scotland, Wales and Northern Ireland.
- CIRIA C539. 2001. Rainwater and Greywater Use in Buildings: Best Practice Guidance. D J Leggett, R Brown, D Brewer, G Stanfield and E Holiday. Department of Trade and Industry.
- CIRIA C609. 2004. Sustainable Drainage Systems, Hydraulic, Structural and Water Quality Advice. S Wilson, R Bray and P Cooper. Department of Trade and Industry.
- Construction Industry Research and Information Association. 1996. Report 156 – Infiltration Drainage – Manual of Good Practice. Roger Bettess. Highways Agency and National Rivers Authority.
- DEFRA/EA 2005 W5-074/A/TR1 Preliminary Rainfall Runoff management for developments.
- English Nature Research Reports. 2003. Number 498. Green Roofs: their existing status and potential for conserving biodiversity in urban areas. EcoSchemes Ltd in association with StudioEngleback. ISSN 0967876X

- Environment Agency. 2003. Sustainable Drainage Systems (SUDS) a guide for developers
- National SuDS Working Group. 2004. Interim Code of Practice for Sustainable Drainage Systems. National SuDS Working Group. ISBN 0-86017-904-4.

9 Conclusions and Recommendations

9.1 Summary

9.1.1 The process of the Sequential Test outlined in PPS25 aims to steer vulnerable development to areas of lowest flood risk. The SFRA for Waveney and Suffolk Coastal District Councils aims to facilitate this process by identifying the variation in flood risk across each District allowing an area-wide comparison of future development sites with respect to flood risk considerations.

9.1.2 The SFRA presents Flood Zone Maps that delineated the Flood Zones outlined in PPS25 as Flood Zone 1, low probability, Flood Zone 2, medium probability and Flood Zone 3a, high probability. In addition, Flood Zone 3b, functional floodplain, has also been mapped. Table D.1 of PPS25 provides information on which developments might be considered to be appropriate in each flood zone, subject to the application of the Sequential Test and either the Exception Test or a site-specific Flood Risk Assessment demonstrating safety.

9.1.3 It is hoped that the further information provided through the hazard maps for both the fluvial and tidal areas, will provide additional information with respect to hazard and flood depths, to provide a better understanding of the spatial variations of flood risk within the Flood Zone 3. This information can then be used to inform the Sequential Test and inform future developers.

9.2 Recommendations

Climate change

9.2.1 This SFRA was completed using the PPS25 climate change recommendations, however during the lifetime of this document it is quite likely that climate change levels may alter. As a result future site-specific flood risk assessments may have to adapt to these changes in line with current guidance in response to changing research into climate change.

A Living Document

9.2.2 The Waveney and Suffolk Coastal SFRA has been completed in accordance with PPS25 and the current guidance outlined in the draft Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft' (Feb 2007). The SFRA has been developed by building heavily upon existing knowledge with respect to flood risk within the study area.

9.2.3 These documents have an intended lifespan of 6-10 years. Therefore it should be noted that although up-to date at the time of production, the SFRA has a finite lifespan and should potentially be upgraded or revised as required by the local authorities.

9.2.4 In summary, it is imperative that the SFRA is adopted as a 'living' document and is reviewed regularly in light of emerging policy directives and an improving understanding of flood risk within each of the Local Authority areas.

Local Planning Authority Approach

9.2.5 At the time of writing this document no site-specific allocations had been finalised, therefore pending the finalisation of the other participating LPA allocations, the development areas were used to identify the flood risks to potential growth and development areas. If on completion of the preferred options there are any allocations that fall outside these growth areas, then the Sequential Test and potential exception test for these sites will need to be explored at that time.

The following recommendations are made by way of an indication of how to proceed with the SFRA process once the preferred options allocations are finalised:

- The LPAs should apply the Sequential Test to the potential development sites and identify those sites they consider will be necessary to apply the Exception Test,
- If sites require the Exception Test the LPAs should provide responses to parts ‘a’ and ‘b’ of the Exception Test for each of the allocation sites.
- Following completion of the Sequential Test and parts ‘a’ and ‘b’ of the Exception test the Environment Agency should be consulted to confirm their acceptance of the LPAs arguments and justification for progressing with sites that require the Exception test. The LPA should then refer future developers to complete an FRA to meet the requirements of part c) of the Exception Test in line with recommendations set out in PPS25.

Policies

- The LPAs should consider the consequences of including SuDS on development sites and the impact these can have on the developable area. In all cases the LPA should assess allocation sites in relation to geology and local issues to enable completion of the Sustainable Drainage Systems summary in Section 8;
- National and local policies should be reviewed against local flood risk issues and objectives identified by the Environment Agency. This will be discussed with relevance to the districts of Waveney and Suffolk Coastal in the relevant appendices.

9.2.6 This SFRA recommends various policies pertaining to specific LA areas and associated flood risks (e.g. flood defense maintenance and the incorporation of SuDS into new developments in Lowestoft and Felixstowe). These have been included in the relevant Appendices A and B.

9.2.7 Through completion of these recommendations the LPAs will be able to transparently manage flood risk and ensure risk to their development sites and communities, now and in the future are mitigated.

9.3 Local Flood Risk Assessment Recommendations

9.3.1 Through preparation of the Level 1 SFRA a number of flooding issues specific to locations within the study area have been identified. The issues warrant special attention related to flood risk assessments for developments in these areas.

9.3.2 Lowestoft

9.3.3 Lowestoft is particularly sensitive to flooding due to the situation of Lake Lothing and the surrounding developed areas. Flooding around the margins of the Lake occurs when gravity outfalls to Lake Lothing become tide locked and is a concern to both present and future developments. Flooding also occurs in the town following heavy rainfall due to limited sewer capacity and the tide locking of sewer outfalls. Developments within Lowestoft should therefore aim to mimic green field runoff rates by incorporating SuDS into development designs to limit runoff to surrounding areas. In addition, steps should be taken to improve the tidal outfall systems to limit tide locking.

9.3.4 If land raising is proposed, detailed studies including modelling may be needed to demonstrate any impacts on the wider flood cell.

9.3.5 Aldeburgh

9.3.6 This town is particularly sensitive to flooding as it is bordered by the North Sea to the east; the River Alde is situated to the south and the Hundred River, the Meare and associated marshlands are found to the north. The Environment Agency's Flood Zone 3 encroaches on the developed area of Aldeburgh to both the north and the south.

9.3.7 Any development within Aldeburgh or on the outskirts of the developed area should take flooding into full consideration – both to the development and to the surrounding area as a result of the development.

9.3.8 Aldeburgh Marshes to the south of Aldeburgh and The Meare and The Fens to the north of Aldeburgh are predominantly undeveloped and consequently risk to life is low. By incorporating suitable policies in the emerging LDF, the Local Planning Authorities can encourage new developments in these areas (to the north and south of Aldeburgh) to incorporate sustainable drainage systems that limit site runoff to greenfield rates, and encourage the development of communal storage areas to reduce runoff onto the Levels. A strategic flood storage area operated by a single authority could also be considered to divert current runoff into local watercourses or the sea.

9.3.9 South Felixstowe

9.3.10 The southern area of Felixstowe is at risk from tidal flooding from the River Orwell and the North Sea. This area has been inundated with flood water on a number of different occasions, including in 1953, 1978 and in 1993 (as outlined in the Level 1 SFRA). Developments in this area should ensure rates and volumes of runoff are no greater than green field runoff rates. Satisfactory surface water drainage systems should be in place to ensure the speedy routing of surface water runoff into appropriate watercourses or the sea.

9.3.11 Woodbridge

9.3.12 The Environment Agency Flood Map indicates that the east of Woodbridge is at risk of flooding. Developments within this area should be subject to flood risk assessments, which should look to ensure that the risk to developments from flooding is assessed and that measures are included to mitigate the risk of flooding.

9.3.13 Southwold and Reydon

9.3.14 These towns are vulnerable to flooding due to their proximity to the coast, the River Blyth and Buss Creek, which runs between Southwold and Reydon. There are a number of commercial and residential properties situated on the unprotected side of the Environment Agency tidal flood defences in Southwold. The Environment Agency flood maps show southern and northern areas of Southwold and southern areas of Reydon as effected by Flood Zone 3. New developments in these areas should mimic Greenfield runoff so as not to increase resultant runoff to surrounding areas. This can be achieved by incorporating SuDS. Surface water should be routed efficiently and swiftly to watercourses.

9.3.15 Leiston/Sizewell

9.3.16 Both the 1993 and 2000 flood events that caused damage to many areas in Suffolk Coastal and Waveney, inundated areas of Leiston and Sizewell. Sizewell is particularly vulnerable to flooding as it is bounded to the east by the North Sea. Flood Risk assessments in this area should ensure that any proposed developments do not exacerbate flooding problems. A suitable flood risk assessment will robustly assess the storm water management for the proposed development, ensure the rates and volumes of run off are no greater than greenfield runoff rates and investigate tidal flooding and storm surge flooding and the status of local tidal flood defences.

9.3.17 Potential future development of the power station should consider flood risk in relation to safe egress and access plus surface water management.

9.3.18 Halesworth

9.3.19 Halesworth is at risk of flooding from the River Blyth. High property densities situated on both sides of the river, which runs through the centre of the Town and the presence of two confluences, one to the west and one to the south west of the town exacerbate flooding situations. There have been efforts to improve channel conveyance but the problem of flooding is still apparent as the area flooded again in 1993.

9.3.20 Developments in Halesworth, particularly within close proximity to the River Blyth should be subject to a flood risk investigation. Runoff rates from new developments within Halesworth should be restricted to greenfield rates to prevent exacerbation of any flooding in the area. Upstream of Halesworth areas could be identified for controlled flooding in times of high flow, i.e. functional floodplain, flood flow pathways and the allocation of open space for controlled flooding in times of high flow. This may be a strategy to limit the amount of flooding downstream in Halesworth. Development in these areas would subsequently be severely limited.

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Annex 1 - PPS25 Extracts

Table D.1: Flood Zones sourced from Annex D, PPS25

Table D.1: Flood Zones

(Note: These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences)

Zone 1 Low Probability

Definition

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Appropriate uses

All uses of land are appropriate in this zone.

FRA requirements

For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Table D.1: contd.

Zone 2 Medium Probability

Definition

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Appropriate uses

The water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this zone.

Subject to the Sequential Test being applied, the highly vulnerable uses in Table D.2 are only appropriate in this zone if the Exception Test (see para. D.9.) is passed.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

Zone 3a High Probability

Definition

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Appropriate uses

The water-compatible and less vulnerable uses of land in Table D.2 are appropriate in this zone.

The highly vulnerable uses in Table D.2 should not be permitted in this zone.

The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this zone if the Exception Test (see para. D.9) is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Table D.1: contd.

Zone 3a High Probability *(continued)*

Policy aims

In this zone, developers and local authorities should seek opportunities to:

i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques;

ii. relocate existing development to land in zones with a lower probability of flooding; and

iii. create space for flooding to occur by restoring functional floodplain and flood flow pathways and by identifying, allocating and safeguarding open space for flood storage.

Zone 3b The Functional Floodplain

Definition

This zone comprises land where water has to flow or be stored in times of flood. SFRAs should identify this Flood Zone (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, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes).

Appropriate uses

Only the water-compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this zone. It should be designed and constructed to:

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

Essential infrastructure in this zone should pass the Exception Test.

FRA requirements

All development proposals in this zone should be accompanied by a FRA. See Annex E for minimum requirements.

Policy aims

In this zone, developers and local authorities should seek opportunities to:

i. reduce the overall level of flood risk in the area through the layout and form of the development and the appropriate application of sustainable drainage techniques; and

ii. relocate existing development to land with a lower probability of flooding.

Table D.2: Flood Risk Vulnerability Classification sourced from Annex D, PPS25

Table D.2: Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
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.[19]
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.[20] • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable	• 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 plants. • Sewage treatment plants (if adequate pollution control measures are in place).

[19] DETR Circular 04/00 – para. 18: *Planning controls for hazardous substances.* www.communities.gov.uk/index.asp?id=1144377

[20] See *Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10* for definition. www.communities.gov.uk/index.asp?id=1500757

Table D.2: contd.

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**.

Notes:

1) This classification is based partly on Defra/Environment Agency research on Flood Risks to People (FD2321/TR2)[21] and also on the need of some uses to keep functioning during flooding.

2) Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

3) The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

Annex 2 Data Collection and Sources

Introduction

A wide variety of data was made available for the SFRA. The Inception Report (Faber Maunsell, 2006) identified the data available for the SFRA and the location of the data and/or key stakeholders. The principle items of data and information have been stored on an External Hard Drive (EHD).

In order to facilitate production of the SFRA, data identified in the Suffolk Coastal and Waveney SFRA Inception report was screened to assess its use in production of the SFRA. Consequently, not all the data identified was used in the production of this SFRA. Further details of the data used in this assessment, how it has been used and the source/provider of the information are presented in Table Annex 2-0-4 Additional tables are provided in the appendices detailing the data used to address specific issues of individual authorities.

Further explanation of the data and its use within the SFRA is provided in the following sections. The data has been grouped into categories relating to its primary use in the production of the SFRA.

The majority of the data was provided by the following organisations:

- Environment Agency
- Waveney District Council
- Suffolk Coastal District Council

Topographic Data/Base Mapping

Topographic data used in the SFRA consists of LiDAR (Light Detection and Ranging) and SAR (Synthetic Aperture Radar) data, provided by the Environment Agency.

The LiDAR dataset consists of tiles, providing coverage of the whole study area of Suffolk Coastal and Waveney, made available from the Environment Agency. The LiDAR data provides elevations on a 2km grid with an elevation accuracy of ±0.3m. Further details of how LiDAR data is collected and processed can be found on the Environment Agency web site, http://www.environment-agency.gov.uk. A recent commission by The Environment Agency of the tidal defences in the Anglian Region will provide a more comprehensive coverage of some of the tidal defences in the area. However, this data is not available for the study area. SAR data is less accurate than LiDAR data with elevations provided on a 5m grid with vertical accuracy of ±0.5m. SAR data is available for the entire study area.

Due to the greater accuracy of the LiDAR data, this was used wherever possible for the generation of the Digital Elevation Model (DEM) on which hydraulic modelling was undertaken. Gaps and anomalies in LiDAR data can occur due to non-reflective land and areas of surface water, (e.g. lakes, ponds, rivers), resulting in null values within the data set. SAR data was used to fill in the areas not covered by LiDAR data. The methodology used for generation of the DEM is presented in Chapter 5.

LiDAR data was provided in two formats. The raw data presents elevations for all reflective surfaces, including features such as buildings and trees. The LiDAR data is also available in a filtered form, presenting the surface of the land excluding buildings and trees. The filtered data was used to create a Digital Elevation Model (DEM) of Waveney and Suffolk Coastal.

LiDAR data only provided surface levels for reflective objects. Therefore an important exercise was to identify areas where bridges, culverts and/or other major floodwater pathways existed. This was achieved by reviewing Ordnance Survey maps for the area, and some ground reconnaissance. Where bridges and/or structures that could significantly influence local flooding were identified, the DEM was manually adjusted during the model construction, to accurately represent the flow paths available to floodwater. This results in a more accurate flood model.

Ordnance Survey 1:50,000 and 1:2500 base mapping was used for the presentation of flood zones and hazard zones throughout the Waveney and Suffolk Coastal study area.

Flood Defences

GIS layers provided by the Environment Agency included 1:10000 mapping of defences and defended areas within the area.

Tidal defences

The nature of tidal flood defences at the breach locations (Chapter 4) identified by Waveney and Suffolk Coastal districts were determined through the use of the DEM, aerial photography, the National Flood and Coastal Defence Database (NFCDD) and knowledge from Local Environment Agency flood defence officers.

Querying the DEM identified the locations of flood defences. The defence type (earth embankment or hard defence) was determined from a review of high-resolution aerial photography (supplied in digital format). Reference was also made to the NFCDD and/or drawings supplied by the Environment Agency that include details of the tidal defences.

It is considered that there are significant gaps in the data regarding the condition of defences and that this should be addressed in any further assessments. Most notably more detailed condition surveys would be required for flood defences, in particular privately owned defences.

Fluvial Defences

There was limited information available regarding fluvial defences for both the Waveney and Suffolk Coastal areas. ‘Standard of Protection’ reports were provided for the following locations:

- Wrentham – Fluvial (Halcrows, 2000)
- Knodishall – Fluvial (Halcrows, 2000)
- Halesworth – Fluvial (Halcrows, 2000)
- Bungay – Fluvial (Halcrows, 2000)
- Aldeburgh – Estuarial (Posford Duvivier, 2000)
- Lowestoft – Estuarial (Posford Duvivier, 2000)
- Walberswick –Estuarial (Posford Duvivier, 2000)
- Woodbridge – Estuarial (Posford Duvivier, 2000)

In addition, local authorities provided several miscellaneous items relating to drainage and flood defence systems in the area. These items do not provide comprehensive coverage of the fluvial defences present in the area.

Drainage

Due to the low-lying nature of much of Waveney and Suffolk Coastal districts and the presence of flood defences, drainage forms an important role in the area.

Several sources of information were made available for the study relating to drainage arrangements for Suffolk Coastal and Waveney Districts.

Anglian Water are responsible for sewage systems within the study area and have supplied large scale plans, (1/1,250), of all public surface water, combined and foul water sewage networks. These have been supplied on the EHD in electronic format. However, there are some culverted watercourses and very large surface water sewers that are not included on the plans as these culverts do not come under the public sewer classification. Where this is the case the location of these culverts may have to be inferred from the plans. Associated with these plans are sewer manhole cover levels, which may be used to supplement Lidar data.

There are significant urban areas in the south docks end of Felixstowe and in the centre of Lowestoft that are reliant on pump-drained surface water sewerage systems.

Records of flooded areas are available on the Flood Records Database. These include details of flooded areas during the extensive flooding events of 1993 and 2000. They also contain details of problematic watercourses/drainage networks that caused flooding or undesirable conditions in these severe events. The tender by Faber Maunsell also provided information on flooding records, which are outlined below in section 4.5 Flood History.

The EHD also contains information on the location of Environment Agency river and stream flow gauging stations and water level monitoring stations. Additional information regarding processed records and gauge data for all these recording stations can be obtained from the Environment Agency.

Information regarding Critical Ordinary Watercourses (COWs) and Internal Drainage Boards (IDBs) has been made available in the Tender by Faber Maunsell and is discussed further below.

Flood History

Areas in each district considered, by the Council's officers, to be problem areas with respect to persistent drainage problems, water logging and minor flooding were identified and information was gathered in the Inception Report details of which are given below.

Waveney District

The Council's Drainage & Coastal Protection Department holds two plans of Lowestoft: one showing the extent of tidal flooding on 31st January 1953 on a 6" to 1mile plan, and one showing the 9ft, 10ft and 12ft OD contours on a 12" to 1mile plan.

The following areas have been identified in the Inception Report as 'problematic' with regard to surface water flooding and drainage.

Coopers Drive, Kessingland

This area is predominantly residential and situated within a flood risk zone. An overloaded combined sewerage system and surface water runoff from roads and fields creates a capacity problem during periods of high flow. In response, the District council have provided a ditch and an embankment as protection from field runoff and Anglian Water have improved the sewage system. The area may still be vulnerable to local surface water flooding events.

Beccles Surface Watercourse

The Council believe this to be an Anglian Water surface water sewer. The system is drained by gravity discharge to the River Waveney but this can become tide locked and the system then has to be pump-drained. A flood storage lagoon and hydro brakes have been incorporated into the system but there has still been widespread internal flooding of property within the catchment.

Leathes Ham, Lothingland

This lagoon to the north of Lake Lothing was isolated from the main lake by the construction of a railway embankment in the nineteenth century. Flooding around the margins of this lagoon can result from the tide locking of the gravity outfall to Lake Lothing. The District Council has recently installed a pumping station but there is still concern about flooding in the area.

Central Lowestoft

Sewer capacity and tide locking of combined sewer outfalls into the harbour has lead to the flooding of low-lying areas of the town, (notably Station Square, Beven Street, Tonning Street and Norwich Road), north of the harbour following periods of heavy rainfall. A major tunnelling project, undertaken by Anglian Water, is intended to reduce the risk of flooding by the sewer. To the south of the harbour, (notably Belvedere Road, London Road, St John's Road and Marine Parade), a similar problem exists. This area is dependent on storm water overflows into the harbour and Anglian Water's harbour Pumping Station which pumps sewage to Ness point.

Central Lowestoft was hit by flooding in November 2006. Inundated areas include: Levington Court on St Johns Road, Around Lowestoft Southern Relief Road and Aldwych Way.

Oulton Road

Flooding used to be persistent to the north (Caldecott Road) and to the south (Boulevard and Bridge Road). The Environment Agency carried out flood defence improvement works about ten years ago whereby sewage is pumped from the south to the north.

North Denes, Lowestoft

The area east of Whapload Road was flooded in January 1953 when the old 'beach village' was demolished. As a result the present sea defences were improved and a return wall was constructed at the north end of the existing defence.

Blackshore, Southwold

There is potential for flood damage to commercial properties, dwellings and a public house, all of which are situated on the wrong side of present tidal flood defences.

Halesworth

The River Blyth inundates areas of Halesworth in a flood event. The Environment Agency has published Preferred Options for the Halesworth Flood Alleviation Scheme.

Suffolk Coastal District

The Council dispatched a questionnaire on flooding and drainage problems to all the towns and parish councils within the district in 1993 and 2000. The responses to these questionnaires and other details of flooding problems in the district have been archived. This information has subsequently been collated into the Flood Records database, the results of which have been analysed and summarised in Appendix B.

Hydrometric Data

Hydrometric data was provided by the Environment Agency and comprises of the locations and alignments of Main Rivers, Critical Ordinary Watercourses (COW's), and catchment areas for the watercourses throughout the Waveney and Suffolk Coastal districts, mapped at a scale of 1:10000 and Local Planning Authority boundaries.

This information has been used in the SFRA to refine flood cells (Chapter 5), where fluvial systems drain through to the coast or into estuaries.

This information has also been used in the production of the Appendices and in responding to the specific issues of the two districts.

A modelling study of the River Waveney was undertaken in 2006 on behalf of The Environment Agency. This detailed study involved hydrological and hydraulic modelling of both the fluvial and tidal reaches of the river. The final report along with a comprehensive selection of data and information associated with the study was supplied by the Environment Agency and made available on the EHD.

Tide level data in the form of *Extreme Tide Levels for use in Section 105 Surveys 2nd Edition (1999), Posford Duviver*, has been supplied by the Environment Agency and stored on the EHD. Tidal defence data is available from the Environment Agency in the form of the NFCDD database. In addition GIS location layers from the *Anglian Region Sea Defence Survey – Level of Protection Assessment (1999) Mott Macdonald*, are available on the EHD and a 'hard copy' of the full report is available from the Environment Agency (Ipswich office).

Main Rivers

The information was provided in GIS layers. The Environment Agency can provide details of the locations of river and stream flow gauging stations and water level monitoring stations that they operate. They can also supply processed records and gauge data for these stations. In addition, the Environment Agency can provide records and data for tide level recorders, rain gauges and climate stations. Recording tide gauges are maintained by the Environment Agency at Oulton Broad, Southwold, Sizewell, Aldeburgh, Woodbridge Quay and Harwich (Cork) and tide gauges are located at Lowestoft and Felixstowe Pier. Proudman Oceanographic Laboratory maintains a reference station in North Norfolk, the Cromer Tide Gauge.

Internet based Flood Maps, provided by the Environment Agency at the 1:50,000 scale, can be accessed on the Agency's website. In addition to presenting the flood zones, these Flood Maps show the location of recent major flood defences and give an estimate of actual flood risk (mainly for insurance industry use and do not represent the flood risk classifications in PPS25), where "significant" indicates an annual probability of flooding greater then 1.33%, "moderate" indicates an annual probability between 0.5% and 1.33% and "low" indicates an annual probability less than 0.5%.

Critical Ordinary Watercourses

All watercourses in the districts of Waveney and Suffolk Coastal designated as Critical Ordinary Watercourses (COW's), have been enmained, as such there are no COWs in the area. Recently enmained COW's in both districts are included in the Main Rivers shown on the Environment Agencies flood risk maps but are not distinguished in any way from rivers and streams previously designated as Main Rivers by the Environment Agency and their predecessors.

Certain waterways were originally designated as COWs by LPA's ad IDB's as a reflection of their importance in draining urban and built up areas. COWs in the Waveney area were identified by the Environment Agency (Table Annex 2-0-1). Some of the COWs in this area are isolated, discontinuous and/or do not connect directly to a Main River. As such, the COW's identified below and adopted as Main Rivers may not correspond exactly with the Main Rivers they are now.

TABLE ANNEX 2-0-1 WAVENEY DISTRICT COWS.

Watercourse	Location	Length (km)	OS Grid Ref. Upstream Limit	OS grid Ref. D/stream limit
Street Watercourse*	Carlton Colville	2.95	TM 516 900	TM 512 897
Bell Farm Watercourse	Carlton Colville	0.52	TM 515 920	TM 536 920
Pakefield Watercourse	Pakefield	0.79	TM 536 906	TM 529 907
Foxglove Close Watercourse*	Worlingham	0.67	TM 435 901	TM 440 902
Bonds Meadow Watercourse	Oulton	0.67	TM 521 937	TM 521 931
Hall Road Watercourse*	Oulton	0.78	TM 514 932	TM 521 931
Ellough Hill Watercourse	Beccles	0.26	TM 435 895	TM 433 896
Beccles Surface Watercourse	Beccles	1.31	TM 426 899	TM 425 910
Holton Watercourse*	Holton	0.84	TM 405 780	TM 420 773

* indicates watercourses that were inspected by an officer of Waveney District Council in March 2005

COWs in the Suffolk Coastal area have been extracted from an official schedule of COWs to be adopted as Main Rivers by the District Council are listed below (Table Annex 2-0-2). Again, they may not correspond exactly with the COWs shown on the Environment Agency plan.

TABLE ANNEX 2-0-2 SUFFOLK COASTAL DISTRICT COWS.

Watercourse	Location	Length (km)	OS Grid Ref. Upstream Limit	OS grid Ref. D/stream limit
Brook Farm Watercourse	Saxmundham	1.20	TM 376 636	TM 386 635
Friston Watercourse	Friston	5.45	TM 412 605	TM 427 571
Melton Watercourse	Melton	1.13	TM 274 499	TM 280 493
Posford Brook	Rendlesham etc	4.35	TM 253 563	TM 294 573

Internal Drainage Boards

Within the study area of Suffolk Coastal and Waveney there are a number of small Internal Drainage Boards (IDB's), identified in the Inception Report. The list below (Table Annex 2-0-3) shows the individual Drainage Districts within the two local authority areas. The IDB's are generally only responsible for the maintenance of minor watercourses in their areas and are not responsible for raised flood defences.

IDB's are administered in a variety of ways; some are administered by the Environment Agency, some individually and some as members of an informal consortium. The Environment Agency can provide a hard copy map of the IDB boundaries.

TABLE ANNEX 2-0-3 INTERNAL DRAINAGE BOARDS

Waveney District	
R4-23	Lower Waveney IDB
R4-24	Lower Waveney 2nd IDB
R4-25	Lower Waveney 3rd IDB
R4-26	Blundeston, Flixton & Oulton IDB
R4-27	Oulton, Carlton Colville & Barnby IDB
R4-28	Lothingland IDB
Suffolk Coastal District	
R4-29	River Blyth IDB
R4-30	Minsmere IDB
R4-31	Upper Alde IDB
R4-32	Fromus, Alde & Thorpeness IDB
R4-33 & 35	Lower Alde IDB
R4-34	River Deben Upper IDB
R4-36	Alderton, Hollesley & Bawdsey IDB
R4-37	River Deben Lower IDB
Felixstowe IDB (R4-39) was abolished about twenty years ago	
IDB land drainage pumping stations are situated at the following locations:	
Hundred River	Kessingland
River Blyth	Reydon
River Alde/Ore	Gedgrave, Butley, Iken, Sudbourne, Chillesford & Boyton
River Deben	Falkenham, Kings Fleet, Bawdsey & Felixstowe Marsh
River Orwell	Trimley (Felixstowe IDB-may now be abandoned or operated by the Suffolk Wildlife Trust)

Principal Surface Water and Combined Flow Sewers

The study area lies completely within the sewerage service area of Anglian Water. Plans showing all the public surface water, combined flow and foul sewer networks are located on the EHD and were obtained from Anglian Water Services during the inception stage. The plans do not show all culverted watercourses or very large surface water sewers, as they are not categorised as public sewers.

Flood Risk

EA Flood Zone Maps

The Environment Agency has supplied GIS layers presenting Flood Zones 2 and 3 for the Waveney and Suffolk Coastal districts, applicable at a 1:10,000 scale. The maps present the Flood Zones for areas at risk of flooding from both tidal sources, (e.g. estuaries and the North Sea), and for fluvial watercourses (main rivers and enmained ordinary watercourses) throughout the study area but do not however make any distinction between these types of flooding. They also ignore the presence of defences or artificial obstructions to flows.

The flood maps have been generated by a combination of techniques. Areas at risk from tidal flooding have been identified by extrapolation of extreme tidal levels over the ground surface until the corresponding levels are achieved. Consequently, anything below the extreme tide level is considered to be within a Flood Zone. This approach does not take into account the presence or effect of defences, flood routes as a result of topography, or the volume of water available for flooding as a result of the tidal cycle.

Flood zones for fluvial river systems have been estimated in a similar manner. Flood levels have been extrapolated across the ground surface to define the flood envelope, however, the flood envelope has also been refined with the results of section 105 hydraulic modelling, historic events and/or observations.

The above methods of extrapolating a tidal/fluvial flood level across the ground surface dose not present a completely accurate estimate of fluvial/tidal flooding. It does however provide comprehensive coverage of the study area.

Additional data provided by the Environment Agency also included flood warning and flood watch areas.

Flood Risk Reports

The Environment Agency and stakeholders have provided several other reports relating to flood risk in the Waveney and Suffolk coastal areas. These include:

- Strategic Flood Risk Assessments for neighbouring areas and
- Catchment Flood Management Plans and Shoreline Management Plans

Extreme Water level/Tides Information

The information used on extreme tide levels in this assessment was provided by the Environment Agency.

Extreme flood levels for the Districts of Waveney and Suffolk Coastal were obtained from Environment Agency, Anglian Region Central and Eastern Areas, Report on Extreme Tide Levels, final edition, (Royal Haskoning, 2007).

The following reports were highlighted in the Inception Report and are available as reference for water levels:

- Strategic Assessment of Flood Risk – Guidance for Local Planning Authorities
- Information from the ongoing Suffolk Estuary Strategy Study by the Environment Agency
- Water Level Management Plans for:
- Southwold Town Marshes
- Minsmere
- Home Covert Marshes
- Tinkers Marsh
- Westwood & Dingle Marshes
- Easton valley

The UK Climate Impacts Programme suggests a maximum rise in surge height along the south east coast of England of up to 1.4m for a scenario of High Emissions (Climate Change Scenarios for UK – *Chapter 6 Future changes in sea level and marine climate*). The south east of England experiences the largest change in surge height due to changes in storms and also experiences one of the largest regional subsidence rates. These levels have been modelled using the Had RM3 and a high-resolution model from the Proudman Oceanagraphic Laboratory and are subject to considerable uncertainty.

Planning Documents

Statutory Planning Documents

Several statutory documents were available for this study, including information and draft reports currently being used in the preparation of Local Documents (LDDs).

Data supplied by the stakeholder councils largely took the form of reports including Local Plan documents for both Suffolk Coastal and Waveney Districts.

Suffolk Coastal Local Plan contains planning policies and proposals that aim to guide the future of the Suffolk Coastal District in the period up to 2006. The District Council adopted this document on 27th February 2001. This will be replaced by a new type of plan, the Suffolk Coastal Local Development Framework that sets out the Councils Vision for the area in 2021 and further into the future.

Waveney District Council Local Plan was adopted in November 1996 as part of the Development Plan for Waveney and provides a development framework for Waveney District up to the year 2006. The policies and proposals within the Plan will be used by Waveney District Council to guide development by both the public and private sectors.

The Waveney Local Plan Revised Draft has superseded Waveney District Local Plan. Work to review this Plan began in 2000, but was not continued to the statutory stages in light of changes to the plan-making system. Following public consultation on the Waveney Local Plan Revised Draft and subsequent amendments, the Waveney Interim Local Plan was approved by the Council for development control purposes in 2004. This is currently being used alongside the Adopted Local Plan for development control purposes. The existing Plans will be replaced by the Waveney Local Development Framework, which looks to 2021 and further into the future.

Other important reference documents used were the relevant Planning Policy Guidance Notes, in particular, PPS25: Development and Flood Risk.

Non-Statutory Planning Documents

Several non-statutory planning documents were also reviewed in the preparation of the SFRA. These present the Government's and/or local government aspirations in several areas that may impact on flood risk in the future, such as Sustainable Communities in the East of England: Building for the Future.

Commentary on Data Gaps

The purpose of a SFRA is to present information for all sources of flooding. However, inevitable gaps in the data include information on secondary and tertiary sources of flooding such as groundwater and surcharge drainage. Although these are not likely to pose a significant risk (compared with resultant flooding from tidal sources), they can potentially be very disruptive. There were also gaps in the LiDAR data. Usually SAR data is used to fill in topographic data where no LiDAR data exists. In one location the SAR data was about 2m above the predicted levels from the surrounding LiDAR data. LiDAR data then had to be interpolated to produce topographic information. More comprehensive information would be required to assess the impacts of secondary and tertiary flooding in Waveney and Suffolk Coastal.

Information on groundwater flooding would be extremely useful as this source of floodwater can cause considerable damage. Dry valleys in particular may be susceptible to ground water flooding and should be considered in order to refine flood risk in specific areas. The Environment Agency is currently in the process of producing groundwater flooding maps for the UK, these should be used to formulate local knowledge and policies on groundwater flooding.

There was limited data regarding the condition, height and maintenance of flood defences, both fluvial and tidal. Site visits were required to confirm many of these details. A comprehensive data set of fluvial and coastal flood defences, their associated condition, height and maintenance details would be helpful for future studies.

While the Flood Records Database supplies information on two flooding events, 1993 and 2000, in the District of Suffolk Coastal this information is very subjective and the database is not comprehensive. No such flooding records exist for the District of Waveney. For future studies it would be extremely helpful if comprehensive and through digital records were compiled, in the case of Waveney District, and kept up to date in the case of Suffolk Coastal and made available.

TABLE ANNEX 2-0-4 DATA SOURCES USED IN PRODUCTION OF THE SFRA

Data Category	Type/reference	Source	Contribution to SFRA
Drainage	Large scale plans of all public surface water, combined flow and foul sewer networks in electronic format (on EHD)	Anglian Water	
Extreme Tides	Extreme Tide Levels for use in Section 105 Surveys (2nd Edition) 1999	Posford Duvivier	Used when considering modelling approach
Extreme Tides	Anglian Region Sea Defence Survey – Level of protection Assessment 1999	Mott Macdonald	Used in modelling methodology and overtopping assessments
Flood Defence	National Flood and Coastal defence Database	Environment Agency	Used in modelling methodology and overtopping assessments
Flood Defence	NFCDD asset condition survey		Used in modelling methodology and overtopping assessments
Flood History	1993 & 2000 flooding and drainage questionnaire and other flooding records	Suffolk Coastal District	Used to create Flood Records Database
Flood Risk	Flood Zone Maps at 1:10,000 scale	Environment Agency	Used to determine Flood Zones
Flood Risk	Broadland Rivers Catchment Flood Management Plan - Draft Report June 2006	Environment Agency	Guidance/Reference Document
Flood Risk	East Suffolk Catchment Flood Management Plan Inception Report march 2006	Environment Agency	Guidance/Reference Document
Flood Risk	East Suffolk Catchment Flood Management Plan v1.0, March 2006	Environment Agency	Guidance/Reference Document
Flood Risk	East Suffolk Catchment Flood Management Plan – Draft Scoping Report, July 2006	Environment Agency	Guidance/Reference Document
Flood Risk	River Waveney Flood Risk Study – Summary Report, March 2006, Final report	Environment Agency, JBA Consulting	Guidance/Reference Document
Flood Risk	Suffolk Coast and Estuaries Coastal Habitat Management Plan, Final Report, 20 October 2002	Posford Haskoning Ltd	Guidance/Reference Document

Data Category	Type/reference	Source	Contribution to SFRA
Hydrometric	Location of river and streamflow gauging stations and water level monitoring stations	Environment Agency	Used when comparing 1 in 20 and 1 in 25 as part of original Functional Floodplain methodology- superseded by revised modelling
Hydrometric	Records of river and tide gauging stations	Environment Agency	Used when comparing 1 in 20 and 1 in 25 as part of original Functional Floodplain methodology- superseded by revised modelling
Hydrometric	Critical Ordinary Watercourses information	Environment Agency	Mapped as part of the GIS waterbody layer
Hydrometric	Internal Drainage Board data	Faber Maunsell in Inception Report 2006	Used to inform flood sources in the study area.
Inception Report	Inception Report for Waveney and Suffolk Coastal SFRA (2006)	Faber Maunsell	Guidance Document
Non - Statutory Planning	Consultation - Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement	DCLG	Planning guidance document
Non - Statutory Planning	Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft	DCLG	Planning guidance document
Non - Statutory Planning	Making Space for Water	DEFRA	Planning guidance document
Non - Statutory Planning	Sustainable Communities in the East of England: Building for the Future	ODPM	Planning guidance document
Non - Statutory Planning	Suffolk Coastal Local Plan incorporating the First & Second Alterations	Suffolk Coastal District Council	Planning guidance document
Statutory Planning	Circular 04/2006: Town and Country Planning (Flooding)(England)	DCLG	Planning guidance document
Statutory Planning	Planning Policy Statement 25: Development and Flood Risk	DCLG	Planning guidance document
Statutory Planning	Planning Policy Statement 3: Housing	DCLG	Planning guidance document

Data Category	Type/reference	Source	Contribution to SFRA
Statutory Planning	East of England Plan: Draft revision to the Regional Spatial Strategy for the East of England	EERA	Planning guidance document
Statutory Planning	Planning Policy Guidance 20: Coastal	ODPM	Planning guidance document
Statutory Planning	Regional Planning Guidance 6 for East Anglia to 2016	Government Office for the East of England	Planning guidance document
Statutory Planning	Planning Policy Statement 1: Delivering Sustainable Development	ODPM	Planning guidance document
Statutory Planning	Suffolk Structure Plan	Suffolk County Council	Planning guidance document
Statutory Planning	Waveney Interim Local Plan	Waveney District Council	Planning guidance document
Statutory Planning	Waveney Local Plan	Waveney District Council	Planning guidance document
Topographic/base mapping	Synthetic Aperture Radar coverage of whole area	Environment Agency	Used as part of the modelling methodology
Topographic/base mapping	Ordinance Survey maps at 1:25,000 of whole area	Environment Agency	Used as base for all mapping
Topographic/base mapping	Ordinance Survey maps at 1:2,500 (Suffolk Coastal) and 1:10,000 (Waveney)	Local Authorities	Used as base for all mapping
Topographic/base mapping	LiDAR data coverage of whole area on 2km grid square format	EA	Used to generate DEM
Topographic/base mapping	County Council boundaries	Environment Agency	Used to define study area and extent

Digital Data

In addition to the printed maps and the main SFRA report, a CD Rom containing the following has been supplied to the local authorities:

Inundating mapping, showing…

- Hazard mapping for the 1 in 200 year, 1 in 1000 year… These include the results for combined flood cells and individual breaches for both Suffolk Coastal and Waveney districts
- Depth mapping for …
- Animations of each breach model

The maps are produced in a GIS format in order to facilitate input to the mapping system to Suffolk Coastal and Waveney district councils. The animations are recorded in *.avi format, which is easily viewed on windows media player, which can be downloaded from the internet at: http://www.microsoft.com/windows/windowsmedia/player/11/default.aspx.

Hard copies of the maps are supplied in the appropriate Appendices. The maps should be used following consultation of the Flood Mapping and Application information found in Section 6 of this SFRA.