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**Broadland District Council**

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**Broadland, North Norfolk, and  
South Norfolk District Councils,  
Norwich City Council and the  
Broads Authority  
Strategic Flood Risk  
Assessment**

**Stage 1 Inception and Terms of  
Reference for Stage 2**

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**October 2006**

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**FINAL REPORT**

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## REVISION HISTORY

Revision Ref./ Date Issued	Amendments	Issued to
Draft Inception Report 10 July 2006 Ver 1.0	Draft	Broadland, South Norfolk, North Norfolk District Councils, Broads Authority, Environment Agency
Revision 2.0 7 September 2006	Revision following progress meeting and comments clarifying council requirements and including Norwich City	Broadland, South Norfolk, North Norfolk District Councils, Broads Authority, Environment Agency Norwich City
Revision 3.1 8 September 2006	Revision following project meeting	As 2.0
Revision 3.2 October 2006	Modifications for Greater Norwich Policy Area, addition of 2 options for North Norfolk. Minor corrections.	As 2.0

## CONTRACT

This report describes work commissioned by Broadland District Council under your order of 28 April 2006. Broadland District Council representative for the contract was Roger Burroughs. Ian Ringer, Hannah Burgess and Tony Green of JBA Consulting carried out the work.

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## PURPOSE

This document has been prepared solely as a Stage 1 report for Broadland, South Norfolk, North Norfolk District Councils, Norwich City Council and the Broads Authority. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

## ACKNOWLEDGMENTS

Data has been made available through the district councils and from the Environment Agency. Useful discussions were also had with Anglian Water and Great Yarmouth Borough Council. A significant number of people have made information available and we also acknowledge the approval of the Environment Agency to make available data collected previously by JBA for Broadland Rivers and North Norfolk Catchment Flood Management Plan Studies.

## EXECUTIVE SUMMARY

### Extent of the SFRA

The SFRA covers the planning areas of Broadland, North Norfolk and South Norfolk District Councils, Norwich City Council and the Broads Authority.

### Data Review

A wide range of information is available particularly from the Environment Agency that enables quantification of flood risk from main rivers for a strategic flood risk assessment in much of the study area. The total area covered by the SFRA is extensive (2578 km<sup>2</sup>) and there are a large number of watercourses. Sources of flood risk include main rivers, ordinary watercourses, internal drainage board systems, surface water sewers, and tidal rivers or direct flooding from the sea.

For many of the main rivers, existing model results are available and GIS flood outlines have been produced for different return periods. In the past attention has been focussed on the 100 year flood outline only and revue of the existing plotting of different flood extents will be needed. In previous studies, climate change has also typically been assessed using an increase in flows of 20% as considered appropriate in current guidance (PPG25). The draft PPS25 indicates that 30% increase should be considered, however, and if this is needed then a significant amount of extra work will be required to rerun models and plot outlines. This is probably unjustified as the existing runs should be adequate to show effects of climate change.

In the Broads, which is of a different nature to other areas, plotting of flood extents for different events is not available. Flood risks are significant and overtopping of banks can occur for fluvial and tidal events. The effect can be simulated in an existing model for which suitable outputs are available, however some additional runs and comprehensive mapping of flood extents to delineate flood zones for current and future conditions is needed. Use of the Broads model (which is developed by Broadland Environmental Services (BESL) will be required to refine critical events in light of recent studies on the Bure and Waveney catchments. Access to this model will be through BESL who will need to be reimbursed for their time and for carrying out additional simulations needed.

Detailed topographic information is available suitable for analysis of breaches of sea defences within the North Norfolk District Council area and for overtopping or breach simulations within the Broads.

Surface water drainage issues are significant. Part of the area is underlain by boulder clay and thus has poor natural drainage and would not be suited for some typical SUDS techniques. There are also groundwater protection zones that should be considered. The surface and foul water system operated by Anglian Water is at capacity in some locations (such as in Wymondham) and Anglian Water have indicated that they would comment on these issues in areas being considered for significant development and the timing of work that would be required to relieve these pressures.

### Issues in each planning area

The housing allocations envisaged in the draft East of England plan for the wider Norwich area are for a total number of new houses of 12,200 in Broadland District Council, 11,200 in South Norfolk and 10,600 in Norwich City along with creation of an appropriate number of jobs for which tourism within the Broads is a key economic driver. North Norfolk which is not included in the wider Norwich area has an allocation of 8000 houses. Actual allocations may be higher for the total area (particularly if the Norwich area attains growth point status) but is not yet allocated to specific authorities.

A panel report on the draft East of England Plan was recently published. This includes some significant implications for the Norwich Policy Area - notably the Panel effectively declined to give a clear indication as to where strategic level growth should occur e.g. NE Norwich or Wymondham area. The Panel wanted to

see greater co-operation and co-ordination between Broadland, South Norfolk and Norwich City Councils to define where strategic level growth is best accommodated and to co-ordinate growth. The SFRA must inform this process. An important component of the SFRA is thus to give a strategic overview of flooding issues in the Norwich Policy Area.

Each of the planning bodies have specific issues that require special emphasis for the SFRA:

**Broadland District Council:** Large developments are planned north of Norwich and Broadland DC need the SFRA to differentiate between preferred areas for SUDS and to indicate the proportion of development that might be set aside for SUDS. For the planned expansion of the main settlements outside Norwich, it is expected that any new developments will be outside of Flood Zone 2 or 3. There are few raised defences that pose a flood hazard and thus no requirement for breach analysis.

**North Norfolk District Council:** Development is on a more modest scale and preferred sites have been identified for the local development framework. These are largely outside of EA Flood Zone 2 or 3. SUDS are an issue although drainage is not as constrained due to more favourable soil and topography. Residual flood hazard for existing developments in low lying areas along the coast will be quantified through breach analysis at three locations.

**South Norfolk District Council:** Significant developments are expected in the existing urban areas especially close to Norwich. Development outside EA flood zones is envisaged although drainage issues are significant in terms of the Anglian Water network and use of SUDS in poorly drained soils.

**Norwich City Council:** Significant development including redevelopment and infill is expected. There are 5,900 outstanding consents and allocations within the current Local Plan of which 77% are on previously developed sites although many are small. There are sites within the Flood Zone 2 particularly. The council would like indication of where SUDS is suitable and are particularly concerned that flood risk in the Greater Norwich area is being considered strategically. At a future date it is expected that a more detailed drainage study will be completed separate to the SFRA.

**Broads Authority:** There are no new housing allocations in the Broads but conversion of existing property and provision for business and tourism is an issue. Flood risk to existing property is significant and delineation of defended areas, functional floodplain and flood hazard for present and future conditions is wanted. Simulation of breaches of banks within the Broads is not expected although consideration of a breach of the sea defences near Bramble Hill/Winterton Ness to define flood hazard along the floodplain of the River Thurne.

## **Stage 2 of the SFRA**

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There are few significant raised defences within Norwich City, South Norfolk and Broadland District Councils' planning areas and detailed hydraulic models of the major rivers have been developed under previous studies.

Broadland DC have identified 24 settlements for which delineation of Flood Zones 1, 2, 3a and 3b (as defined in the draft PPS25) is required. Similarly South Norfolk have also identified 14 primary and secondary settlements for Flood Zone delineation. The flood risk for the majority of these settlements can be defined by the Environment Agency flood zone maps and from existing model results but a methodology for defining the split between zone 3a and 3b for the unmodelled areas is required. Within Norwich City existing modelling and flood mapping has been completed although this is older than most studies so needs to be reviewed to account for developments in the City.

North Norfolk District Council will ask consultants to price two options for their part of the SFRA. For their Option 1 they have identified 18 settlements for Flood Zone 3 delineation whereas for Option 2 only 4 settlements are included. Breach analysis at three sites on the coast is also envisaged to help define higher risk areas in these settlements. The areas currently under consideration for the LDF are (for the most part) outside of Flood Zone 2 and 3.

Within the Broads the situation is complex and even though housing allocations are not used, for the SFRA it is necessary to assess the flood risk for a large number of communities. The overlap with Great Yarmouth SFRA does not reduce workload significantly. Use of results from existing runs of the BESL model is possible but some further work is needed including extra model runs to delineate between Flood Zone 3a and 3b, to take account of climate change and to define the functional floodplain. The hazard of flooding from the coast between Winterton and Sea Palling needs to be included through breach modelling. The effect of IDB drainage system should also be considered.

The SFRA will be produced to provide both written outputs, mapping and GIS layers that can be used by councils covering the main flood risk issues in each authority and to provide a properly supported strategic analysis of flood risk and future development in the Greater Norwich area. This will include reporting on the relative merits of major developments in terms of flood risk and any mitigation measures.

For the main potential development areas identified by councils it is necessary to show that these follow the sequential test (or the exception test) for flood risk from main rivers. The issues for the SFRA also cover local drainage concerns and ensuring no increase in floods downstream. The SFRA should indicate likely constraints and flood risk management measures required.

## CONTENTS

	<b>Page</b>
<b>REVISION HISTORY</b>	<i>i</i>
<b>CONTRACT</b>	<i>i</i>
<b>PURPOSE</b>	<i>i</i>
<b>ACKNOWLEDGEMENTS</b>	<i>i</i>
<b>EXECUTIVE SUMMARY</b>	<i>iii</i>
<b>CONTENTS</b>	<i>iv</i>
<b>1 INTRODUCTION -----</b>	<b>1</b>
1.1 Background.....	1
1.2 Study Area.....	1
1.3 Scope.....	2
1.4 Structure of this report.....	2
<b>2 DATA COLLECTED AND INITIAL REVIEW-----</b>	<b>4</b>
2.1 Introduction.....	4
2.2 Topography.....	4
2.3 GIS Data.....	6
2.4 Hydraulic Models.....	11
2.5 Reports.....	12
2.6 Historic Flooding Records.....	19
2.7 Drainage Issues.....	22
2.8 Potential Breach Locations.....	22
2.9 Mapping of Functional Floodplain.....	23
2.10 Cost Estimates.....	26
2.11 Scheduling of Outputs.....	27
<b>3 INITIAL ASSESSMENT OF ALLOCATION AREAS-----</b>	<b>28</b>
3.1 Review of Preferred development Areas.....	28
3.2 North Norfolk District Council.....	28
3.3 South Norfolk District Council.....	28
3.4 Broadland District Council.....	29
3.5 Norwich City Council.....	29

### APPENDICES:

#### APPENDIX A: - TERMS OF REFERENCE FOR STAGE 2 OF SFRA

## LIST OF FIGURES

Figure 1.1 Local Planning Authorities within the study area .....	3
Figure 3.1 Parishes in the Norwich Policy area being considered as part of options for future development. Parishes to the north of the River Wensum catchment boundary line drain towards the River Bure. ....	29

## LIST OF TABLES

Table 2.1 Summary of GIS data obtained .....	7
Table 2.2 Available Hydraulic Models .....	13
Table 2.3 Summary of Reports available for the study. ....	16
Table 2.4 Historic flooding in the study area.....	20
Table 2.5 Model Coverage of North Norfolk Settlements within Flood Zones .....	24
Table 2.6 Model Coverage of South Norfolk Settlements within Flood Zone .....	24
Table 2.7 Model Coverage for Broadland DC Settlements within Flood Zone.....	25
Table 2.8 Summary of Existing Model Availability for Delineation of Flood Zone 3 .....	25
Table 2.9 Estimated Costs of SFRA broken down between partners .....	26

## ABBREVIATIONS

CFMP	Catchment Flood Management Plan
LDF	Local Development Framework
LIDAR	Light Detection and Ranging
PPG	Planning Policy Guidance
PPS	Planning Policy Statement
SFRA	Strategic Flood Risk Assessment

# 1 INTRODUCTION

## 1.1 Background

The draft Planning Policy Statement 25 (PPS25) entitled 'Development and Flood Risk' was published by the Office of the Deputy Prime Minister in December 2005. This policy statement sets out the need for Local Planning Authorities to assess the potential impact of flooding so that this may be fully taken into account in the urban development policies and land allocations in their development plans. PPS25 is still in draft form but is expected to be finalised in Autumn 2006 and will then replace the older guidance (PPG25 issued in 2001). The timing of the change from PPG25 to PPS25 may thus be expected to occur during Stage 2 of the Strategic Flood Risk Assessment (SFRA).

The East of England is the driest region in England but also contains many low lying areas (some below sea level) that are at risk from flooding. River floodplains are found throughout the region and many areas along the extensive coastline are also at risk from flooding. The vulnerability of the region to coastal and river flooding is likely to increase as a result of climate change. This makes a thorough understanding of the risks from flooding and the implications for Local Development Frameworks essential.

Therefore the Strategic Flood Risk Assessment (SFRA) is necessary to satisfy several requirements:

- To provide a reference and policy document to inform Local Development Frameworks and any subsequent plans
- To ensure that the Planning Authorities meet their obligations under the latest planning guidance (PPG25 is the current although this may be replaced by PPS 25 during stage 2 of the SFRA)
- To provide a reference and policy document to advise and inform private and commercial developers of their obligations under the latest planning guidance.

An important aspect of stage 2 of the SFRA is to provide a delineation of the Flood Zone 3 for planning purposes between zone 3a (high probability) and zone 3b (functional floodplain) using an agreed definition of functional floodplain.

## 1.2 Study Area

The study area for the SFRA comprises and is confined to the five local planning authority areas (comprising of Broadland District Council, North Norfolk District Council and South Norfolk District Council, Norwich City and the Broads Authority). The study area and the local planning Authority areas are shown in Figure 1.1.

The study area is 2578km<sup>2</sup> and falls entirely within the Anglian Region of the Environment Agency. The Broads makes up 303km<sup>2</sup> of the total study area. Where the Broads overlap with the District Council boundaries, the Broads Authority is the planning body. The area of the Broads that is within the North Norfolk, South Norfolk and Broadland District Council and Norwich City Council boundaries is 205km<sup>2</sup> and the remainder is within other councils' boundaries (Waveney District and Yarmouth Borough Councils).

The major rivers draining into the Broads include the Yare draining the western and southern areas and the Bure draining the North. South Norfolk and Broadland District Councils planning areas cover the upper reaches of these main rivers and their tributaries (including the Waveney, Wensum, Tiffey and Tas) whilst the Broads Authority covers the lower tidal river sections and the areas most at risk from tidal or combined tidal and fluvial flooding. North Norfolk District Council covers some of the Upper Bure and a number of smaller rivers which flow north to the Sea and is more at risk from tidal flooding. In Norwich City the Rivers Wensum and Yare are the main sources of fluvial flood risk.

The SFRA area does not include Great Yarmouth (covered by Great Yarmouth Borough Council) or the Dereham area (Breckland District Council) which already have their own SFRA in place. Waveney District Council is also in the process of commissioning an SFRA in conjunction with Suffolk Coastal District council.

### **1.3 Scope**

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The general scope of the work that is required for the SFRA is set out in the Environment Agencies guidance note entitled 'Strategic Assessment of Flood Risk – Guidance for Local Planning Authorities', and is available in either electronic or hard copy upon request.

The Study is to be carried out in 2 stages. These are as follows:

- Stage 1 (this report): An inception report which provides details on the information available and the specific issues facing each authority. The inception report will form the basis for procurement of a separately tendered SFRA.
- Stage 2: The Strategic Flood Risk Assessment (SFRA). The SFRA main stage shall be composed of two separate components, a principal SFRA study which will be a single unified assessment covering all five areas without regard to administrative boundaries and a subsidiary component consisting of five separate studies covering each of the Local Authority Areas.

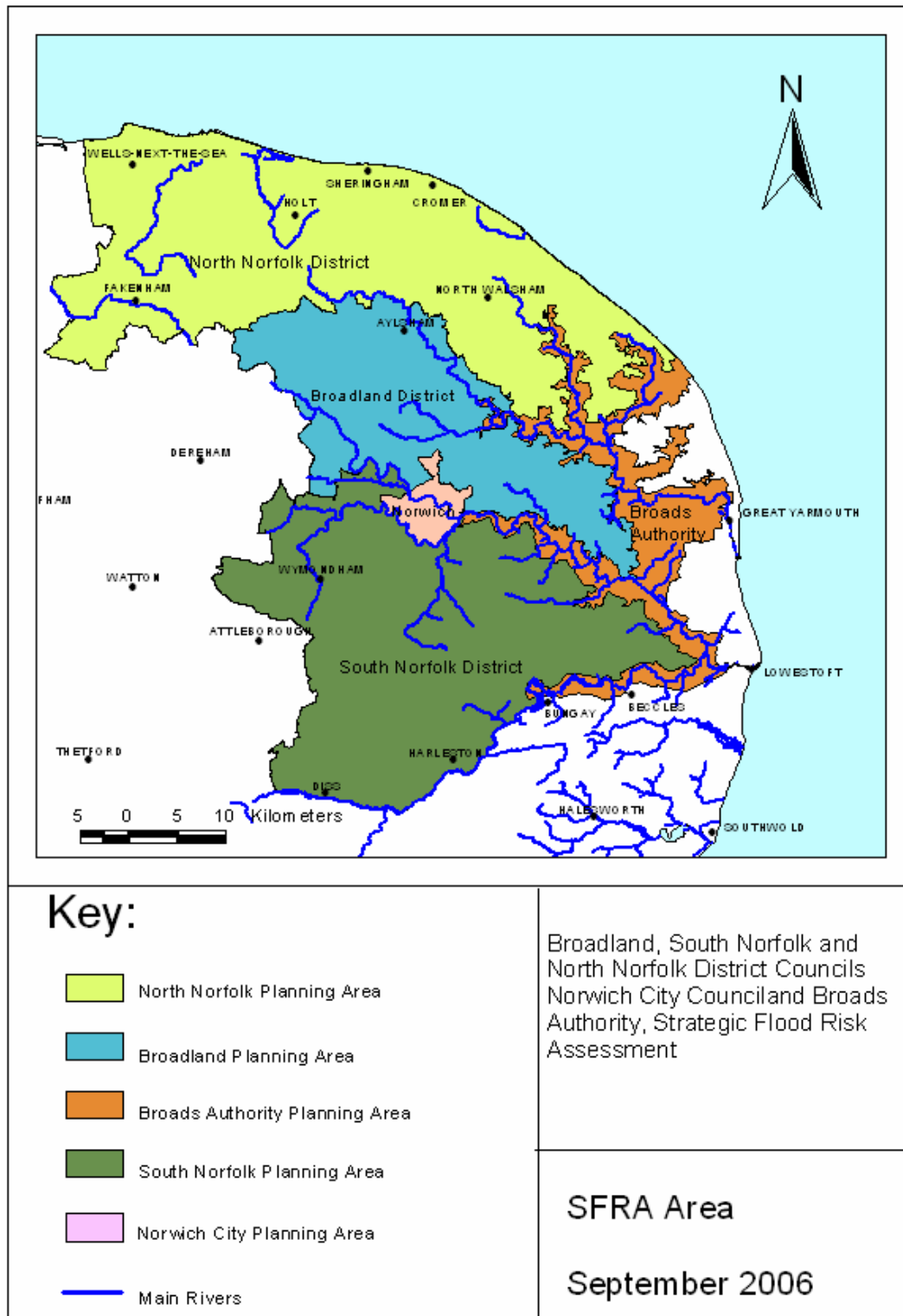
### **1.4 Structure of this report**

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This report is divided into three sections and an Appendix:

- Section 1 (this section) provides an introduction to the report
- Section 2 summarises the data collected and provides a review of the data and its comprehensiveness. Gaps in the data are identified and the agreed datasets to be used in the project are identified. It also provides the reasoning behind the requirements for breach analysis within the SFRA and a summary of any major gaps in the data.
- Section 3 provides a preliminary analysis of areas being considered for the LDF for the councils.
- Appendix A provides a brief for the main stage of the SFRA. This includes the general outputs required and the requirements specific to each local planning authority. It also provides the timescales and contacts for the main stage of the SFRA.

Figure 1.1 Local Planning Authorities within the study area



## 2 DATA COLLECTED AND INITIAL REVIEW

### 2.1 Introduction

A substantial quantity of data and understanding of local issues is required for the SFRA. Much of the data available was already identified by JBA through their work on flood studies for the Upper Wensum, Waveney and Yare and for the Broadland Rivers and North Norfolk Catchment Flood Management Plans (CFMPs) for the Environment Agency. Additional data has been provided by the five local planning authorities and gathered from others.

The data available from the Environment Agency includes a number of Hydraulic Modelling reports, various GIS layers (including flood zones and topographical data). Additional sources of information include the Kings Lynn Internal Drainage Board (IDB) consortium, (and the Lowestoft IDB consortium), Norfolk County Council, Anglian Water, Breckland District Council and Great Yarmouth Borough Council.

Broadland Environmental Services Limited (BESL) developed a detailed model of the Broads area. This model has been used in the CFMP and data derived from the model was used for the Great Yarmouth SFRA. Requests for existing or additional model outputs require specific agreement with BESL and the time taken to prepare this will need to be reimbursed.

It was necessary to undertake a screening process to decide which datasets were most appropriate to use on a strategic project of this nature to complete it within the limited time period available.

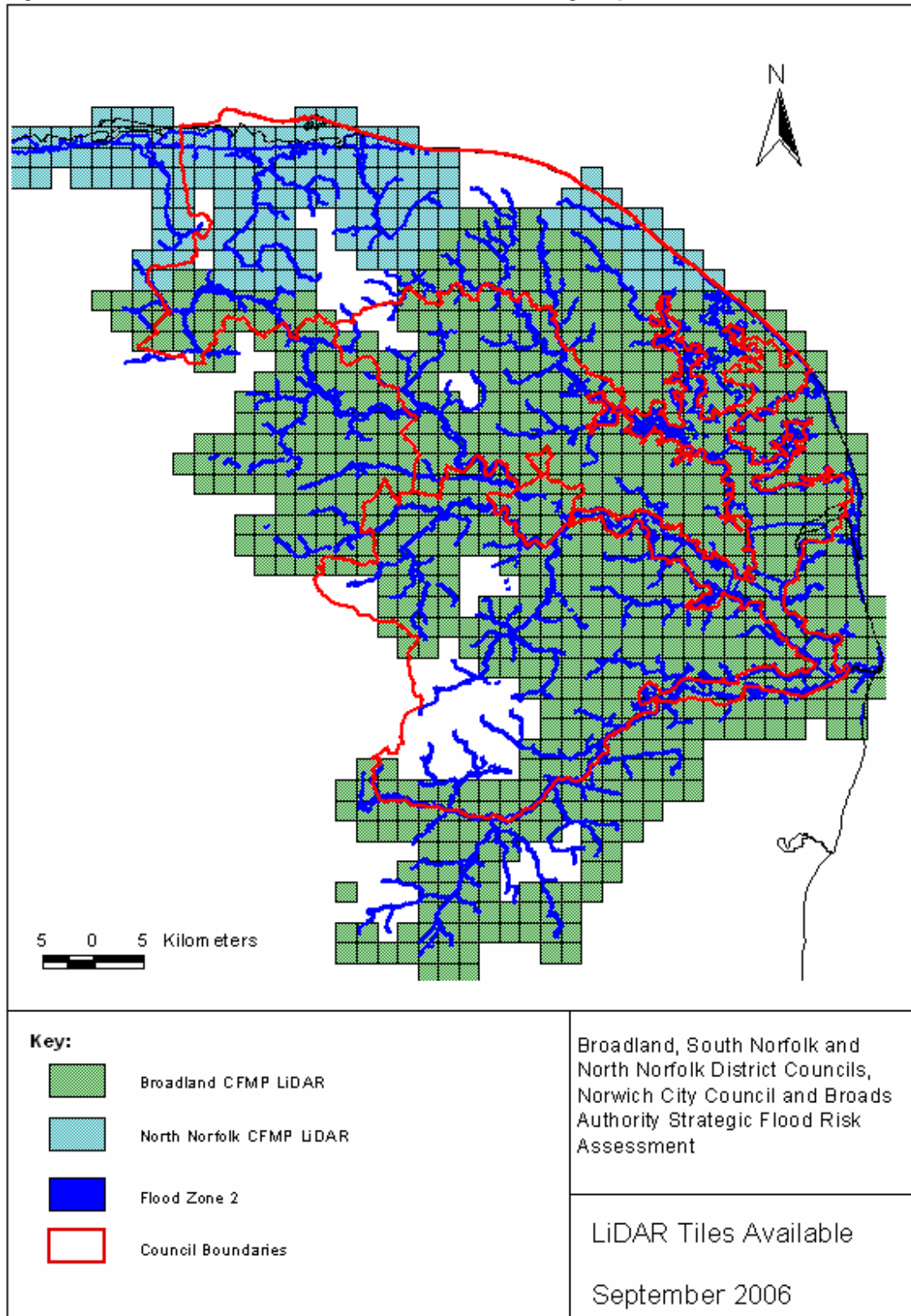
### 2.2 Topography

An accurate Digital Elevation Model (DEM) is an essential tool for providing greater resolution in flood risk. Light Detection and Ranging (LiDAR) data is available for the majority of the project area (Figure 2.1).

The LiDAR data has an expected vertical accuracy of 0.15m or better whereas the vertical accuracy of the SAR is of 1m. The LiDAR data covers the most important parts of the study area (ie the Broads Authority, and the potential development areas for the other Local Authorities where there is a flood risk), a relatively high degree of accuracy in the description of the topography can be achieved. There are a few examples of incomplete LiDAR tiles where a flight has not covered the full land area. In all the cases investigated such gaps could be filled by earlier versions of a LiDAR flight which are also available. Some tiles are covered to a different extent by up to four LiDAR flights.

LiDAR is available in both filtered and unfiltered formats. The unfiltered data includes buildings, vehicles and most vegetation. In the filtered LiDAR most buildings and some of the vegetation have been removed from the Digital Elevation Model. This provides a much more realistic representation of the bare earth topography. Earlier filtering may have a coarse effect for removal of trees and buildings that adds to inaccuracies.

**Figure 2.1 Lidar tiles available from the Environment Agency**



The availability of a comprehensive dataset enables a satisfactory DEM to be constructed across the floodzones in the project area for flood plotting and for breach analysis. The data set is however sizeable and detailed.

### **2.3 GIS Data**

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GIS data layers were provided by the Environment Agency (Eastern Area) and the five Local Planning Authorities for the study area.

Only relevant GIS layers were used in the assessments including: flood zones, previous flood mapping, flood defences, river centrelines, infrastructure, council boundaries, existing allocations and proposed development areas.

Table 2.1 reviews the various GIS layers obtained and gives an assessment of:

- each data set and its suitability for use on the study;
- whether it were to be used in the study and, if so, how;
- any gaps in the datasets; and
- any licensing or copyright issues

Mapping outputs for flood outlines at different return periods are available in either Mapinfo or Arcview formats. It should be noted that the modelled outputs are less extensive than the full flood zone results which may include simulation of smaller watercourses. Because the studies for these flood outlines was completed at different times over the last eight years, the outputs can vary, for example 1:25 year event is considered in earlier studies whereas a 1:20 year event is mapped in the most recent mapping for the Rivers Bure and Ant carried out by Haskoning in 2006.

**Table 2.1 Summary of GIS data obtained**

Source	Data Type	Notes	Review	Use in SFRA	Licensing
<b>Environment Agency – Anglian Region  (Eastern Area)</b>	Hydrology	Flood Zone 2	Information publicly available on the EA Website.	Flood Zones used to carry out initial screening of proposed developments	To be provided and licensed by the Environment Agency for the study. Update just released dated June 2006. Standard licensing to consultants does not include delineation of tidal and fluvial risk though this is in the GIS data files.
		Flood Zone 3	Currently ABD do not represent a fully consistent dataset	Yes	
		Areas Benefiting from Defences (ABD)	Generally catchments are more difficult to define in Urban areas	No	Licensing to be obtained from the Environment Agency
		River Catchments	Based on the 50k OS map. Slightly inaccurate in places. Contains main rivers only	Used for identifying sources of flooding	Licensing to be obtained from the Environment Agency
		Main River Networks	Appear to be covered comprehensively	Yes	Licensing to be obtained from the Environment Agency
		Reservoirs	Available for Rivers Bure, Ant, Yare, Wensum, Waveney, Tat, Tud, Tiffey, Chet, Stiffkey, Glaven, Spring Beck and Mun and BESL model. The form of the data is variable as these models have been developed over a number of years during which specifications for mapping have evolved.	Yes model outputs are required to help define functional floodplain. Additional model runs likely to be needed in Broads area. See separate table for Hydraulic Models	Only licensed for this study. Licensing to be obtained from the Environment Agency and separate agreement needs to be reached with BESL for the Broads Model data.
		Lakes/Broads	Weybourne in North Norfolk. None in Broadland. 10 in South Norfolk. Little data available	Yes locations should be noted.	Licensing to be obtained from the Environment Agency

Source	Data Type	Notes	Review	Use in SFRA	Licensing
	Groundwater	Groundwater Protection Zones	Data sets appear to be accurate.	Yes- Groundwater data used to provide advice on SUDS	Licensing to be obtained from the Environment Agency
	Solid and Drift Geology	Individual sheets produced by British Geological Survey	At 1:50k scale there are many sheets and inconsistent labelling of geological layers.	No - too expensive for each authority to set up initial license for data	Each Authority would need to acquire its own separate license to use the data from the BGS. This is unreasonable for the likely requirement.
	Structures and Defences	Defences and Structures provided nation wide in the form of Arcview and Mapinfo layers	Several GIS layers are available including defences and defended areas. Now includes embankments in Broads	Defence lines to be used to show protected areas Yes	Only licensed for this study. Licensing to be obtained from the Environment Agency and extracted from NFCDD.
<b>Environment Agency – Anglian Region (Eastern Area)</b>	Administrative Boundaries	County Boundaries District Boundaries Parish Boundaries	Accurate Representation	Yes	Only licensed for this study. Licensing to be obtained from the Environment Agency
	Environment Agency Infrastructure	Flood Warning Areas Flood Watch Areas CFMP and SMP boundaries Defences	Background information. Defences and asset information can be extracted from NFCDD	Yes	Only licensed for this study. Licensing to be obtained from the Environment Agency. NFCDD data now includes Broads banks.
	Other Layers	Soils, Waste sites, monitoring (water quality), Landcover, Environmentally designated areas	Not reviewed	Background information soil types are relevant to SUDS assessment	Only licensed for this study. Licensing to be obtained from the Environment Agency
	Properties	National Property Dataset	Good coverage of study area, updated for 2006 MDSF version only includes ground floor properties	Not required	Only licensed for this study. Licensing to be obtained from the Environment Agency
<b>Environment Agency (Ipswich)</b>	Digital Elevation Model Information	LiDAR (filtered, unfiltered, mask)	Good coverage though filtering may have	Yes	Only licensed for this study. Licensing to be obtained from the Environment Agency

Source	Data Type	Notes	Review	Use in SFRA	Licensing
<b>North Norfolk District Council</b>	Ordnance Survey Information	10k and masterrmap OS tiles	No Review needed	Yes	Only licensed for this study. Licensing to be obtained directly from individual local Authorities.
	Development Areas	Preferred Development Areas	Proposals are primarily outside of Flood Zones 3 or 2	Yes	None for use on SFRA
<b>South Norfolk District Council</b>	Ordnance Survey Information	10k OS tiles	No Review needed	Yes	Only licensed for this study. Licensing to be obtained directly from individual local Authorities.
<b>Broadland District Council</b>	Ordnance Survey Information	10k OS tiles	No Review needed	Yes	Only licensed for this study. Licensing to be obtained directly from individual local Authorities.
<b>Norwich City Council</b>	Ordnance Survey Information	10k OS tiles	No Review needed	Yes	Only licensed for this study. Licensing to be obtained directly from individual local Authorities.
<b>Broads Authority</b>	Ordnance Survey Information	10k OS tiles	No Review needed	Yes	Only licensed for this study. Licensing to be obtained directly from individual local Authorities.
	Boundary of the Broads Authority Planning area	There are a number of versions of the boundary of the Broads so obtain correct version from Broads Authority		Yes	Obtain from Broads Authority
<b>Great Yarmouth Borough Council</b>	GIS outputs of SFRA for all Great Yarmouth area. 1:100 fluvial, 1:200 coastal, fluvial, tidal and coastal residual risk. 3 breach simulations	For currently draft SFRA layers of mapping.	Residual risks associated with overtopping differ from CFMP. Fluvial risk purely from Bure.	Yes if permission given.	Request has been made to Great Yarmouth Council especially for Broads Authority area and it was indicated that this should be acceptable.
<b>Breckland District Council</b>	SFRA report & drawings	Completed in June 2005 prior to PPS25 consultation. Includes GIS layers and 25 maps for existing condition at main settlements and a further 25 maps for climate change to 2055. Sewer outfalls considered.	Defines flood risk in using flood zones and for functional floodplain using 1:10 year event where models available.	Yes if permission given	Licensed to Breckland District Council
<b>Anglian Water</b>	DG5 Register	Register of properties affected by internal flooding on parish basis	Very few in project area. Could indicate where drains are overloaded but	Probably no.	Will need to obtain agreement from Anglian Water if required

Source	Data Type	Notes	Review	Use in SFRA	Licensing
			direct contact with AW preferable.		
<b>Kings Lynn Consortium IDB</b>	Main drains	GIS map of main board drains	No sizes of drains given so limited use in hydraulic calculations	Yes	Obtain from Kings Lynn Consortium
<b>Lowestoft Consortium IDB</b>	Main drains and pump stations	Not readily available		Yes if available	Will need to approach Lowestoft consortium and payment may be required.

## **2.4 Hydraulic Models**

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A number of Hydraulic models are available from previous studies covering most of the major water courses within the study area. These are summarised in table 2.2.

The models available for use within the SFRA were as follows:

- Upper Bure
- Upper Ant
- Upper Yare and Tass
- Tud
- Upper Wensum
- Broads (BESL model)
- Upper Waveney
- River Stiffkey
- River Glaven
- Spring Beck
- River Mun

The model review was limited to the suitability of the models for use on the study and focussed on the areas where hydraulic modelling outputs would be used to derive tidal and fluvial conditions and water levels. In general the available hydraulic models are appropriate for the scope and scale of this study and it should not be necessary to rerun and plot flood outlines for most of the available hydraulic models.

Outputs in the form of flood mapping at different return periods are available (with the exception of the BESL model of the Broads area). The flood mapping at lower return periods is typically a direct output of a mapping package whereas the outline for a 100 year event will have been checked and anomalies corrected. Some time for checking and modifying outlines (in consultation with the Environment Agency) may thus be required if these are used for flood zone delineation.

The BESL model of the Broads is a detailed and comprehensive model that includes spill areas (flood cells) that are not the same as compartment cells and some interpretation is required for flood mapping where one section of bank spills and an adjacent cell does not.

Most models have not been run for an extreme 1000 year flood event but given that defences will be overcome at much lower events the Flood Zone 2 map should adequately represent extreme flood risk. In most previous modelling the effect of climate change is taken into account in terms of fluvial risk by considering a 20% increase in flood flows. The draft PPS mentions a need to consider a 30% increase in flows though this is not supported by analysis and may be changed in the final version. If it is required by the final version of PPS25, it may be necessary to undertake further modelling and flood mapping.

More details on the hydraulic models review can be found in Table 2.2.

## **2.5 Reports**

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A significant number of technical reports can be obtained from the Environment Agency covering flood mapping and strategy studies on watercourses within the study area. The main reports are listed and reviewed Table 2.3.

The emergency response plan for Norfolk is available for consultation at the Wymondham Police Station.

**Table 2.2 Available Hydraulic Models**

Source	River Catchment	Model Information	Comment	Review	Model Outputs Available	Mapping Available	Licensing
<b>BESL</b>	Broads	ISIS Hydraulic model developed by Halcrow Very large model 4163 nodes.	Developed by Halcrow for BESL which is a partnership between Nutall, Halcrow and the Environment Agency.	Needs an ISIS license for >4000 node models. Model runs well though is complex due to large range of different events possible. Georeferenced schematic but not flood cells. Likely to need review of fluvial flows used following recent studies on the Bure and Waveney.	Fluvial events 7,10,20,50, 100 for Bure or Yare. Tidal to 200. Fluvial data used may need to be updated to recent studies on Waveney, Ant and Bure.	Not available through BESL although some done in CFMP and Great Yarmouth SFRA	Model or model outputs must be obtained by agreement with BESL. Allowance must be made to reimburse for BESL to provide specific model outputs.
<b>Environment Agency – Anglian Region (Eastern Area)</b>	Coastal Flooding	Extreme Flood Outline (EFO) model believed derived from TUFLOW	Awaiting EA response as to variables and events available.	Sample data obtained. Gives additional information on the undefended case.	Grid of maximum water levels for 0.5% event	Used for flood zone mapping	Output Data could be obtained from the Environment Agency not model files. Sample provided by J Bloomfield at Stage 1
	Upper Waveney	ISIS Hydraulic model	Four part model developed by JBA for the Waveney FR Study in 2006. Right bank of Waveney may not be within study area	Model used to refine flood zones as part of flood risk study. Lower model is probably adequate for SFRA	1:5, 1:10, 1:25, 1:50,1:100, 1:100+20% 1:200, 1:1000	1:5, 1:10, 1:25, 1:50,1:100, 1:100+20% 1:200, 1:1000	Licensing to be obtained from the Environment Agency
	Upper Wensum	ISIS Hydraulic model	Single model developed by JBA for the Upper Wensum Strategy Study(JBA/Babtie)	Lower return period events only produced in draft, less accurate due to use of extended sections. 1000 year event added after	100, 100+20% 10, 20, 50 and 1000 year	1:100 100+20%	Licensing to be obtained from the Environment Agency

Source	River Catchment	Model Information	Comment	Review	Model Outputs Available	Mapping Available	Licensing
Environment Agency – Anglian Region	Norwich ( lower parts of Wensum, Tud, Tas, Yare)	ISIS Hydraulic model	Norwich Strategy (JBA/Babtie)	Only lower parts are of interest, overlaps with Yare and BESL models	100, 100+20% 1000	1:100, 1:1000	Licensing to be obtained from the Environment Agency
	Yare & Tas	ISIS Hydraulic model	JBA model	Note 1:25 year simulation rather than 1:20 year	1:100 +20% 1000 1:10, 1:25, 1:50	1:100 +20% 1000 1:10, 1:25, 1:50	Licensing to be obtained from the Environment Agency
	Tud	ISIS Hydraulic model			1:100 +20% 1000	1:100 +20% 1000 1:10, 1:25, 1:50	Licensing to be obtained from the Environment Agency
	Tiffey	ISIS Hydraulic model	Single model developed by JBA for the Tiffey flood mapping study	Mapping of 1:5 – 1:20 only covers Wymondham	1:100, 1:100 +20%	100, 100 +20% For Wymondham only 1:5, 1:10, 1:20, 1:50 year	Licensing to be obtained from the Environment Agency
	Upper Bure	ISIS Hydraulic model	Model developed for North Norfolk Rivers Flood Risk Study by Haskoning	Recently completed (April 2006). Limited calibration and sparse cross sections	1:5, 1:10, 1:25, 1:75, 1:100, 1:100+CC 1:1000	Depth Grids for runs as models but agreed flood extents only for 1:100	Licensing to be obtained from the Environment Agency
	Upper Ant (North Walsham and Dilham Canal)	ISIS Hydraulic model	“	“	“	“	Licensing to be obtained from the Environment Agency
	Spixworth and Stone Becks	ISIS Hydraulic model	“	“	“	“	Licensing to be obtained from the Environment Agency
	River Stiffkey	ISIS Hydraulic model	“	“	“	“	Licensing to be obtained from the Environment Agency
	River Glaven	ISIS Hydraulic model	“	“	“	“	Licensing to be obtained from the Environment Agency

Source	River Catchment	Model Information	Comment	Review	Model Outputs Available	Mapping Available	Licensing
Environment Agency – Anglian Region	Spring Beck, Weybourne	ISIS Hydraulic model	Model developed for North Norfolk Rivers Flood Risk Study by Haskoning	Recently completed (June 2006). Limited calibration and sparse cross sections	1:5, 1:10, 1:100, 1:100+CC 1:1000	Depth Grids for runs as models but agreed flood extents only for 1:100	Licensing to be obtained from the Environment Agency
	River Mun	ISIS Hydraulic model	”	”	”	”	Licensing to be obtained from the Environment Agency

**Table 2.3 Summary of Reports available for the study.**

Source	Report Information	Date	Review	Use in SFRA	Licensing/Copying
<b>Halcrow</b>	Sheringham to Lowestoft Ness Shoreline Management Plan 3b Review 2004	2004	The proposals for change in the defence line and possible erosion in this draft are not adopted policy but inform the SFRA.	Yes	Publicly available
<b>Mouchell</b>	Snettisham to Sheringham Shoreline Management Plan 3a	1996	Description of study area and SMP policies	Yes	Licensing to be obtained from the Environment Agency
<b>Binnie Partners Consulting Engineers</b>	A Flood Alleviation Strategy for Broadland	March 1994	Description of study area and flood defence strategy. Prior to BFAP/BESL project hard copy only.	No	-
<b>National Rivers Authority</b>	River Yare Catchment Management Plan	January 1994	Review of study area and recommendations	Yes	Licensing to be obtained from the Environment Agency
<b>JBA</b>	River Waveney Flood Risk Study Report	2006	Describes main river flood issues, models and updating of flood zones. Hydrology and Flood Mapping, Options Appraisal, Flood Warning and Summary Report	Yes	Available from Environment Agency
<b>Babtie, Brown and Root</b>	Norwich Comprehensive Flood Study Volumes 1 and 2	2002	Minor changes in flood protection within Norwich are proposed. Mapping covering small parts of Broadland and South Norfolk Councils and Broads Authority areas on the fringe of Norwich.	No	Available from Environment Agency
<b>JBA</b>	River Tiffey Flood Mapping Study	2003	Provides modelling information for ISIS model	Yes	Available from Environment Agency
<b>Babtie, Brown and Root</b>	River Wensum Strategy Study	2003	Provides modelling information for ISIS model	Yes	Available from Environment Agency

Source	Report Information	Date	Review	Use in SFRA	Licensing/Copying
<b>Babtie, Brown and Root</b>	River Yare Fluvial Study (May 2004)	2004	Provides modelling information for ISIS model	Yes	Available from Environment Agency
<b>Halcrow/BESL</b>	Broadlands model report	2002	Provides modelling information for ISIS model	Yes	Available from BESL
<b>Broads Authority</b>	Broads Authority Plan	2002	Provides detailed commentary on planning issues in Broads and at specific locations.	Yes	Available through Planning Portal
<b>Postford Duvivier</b>	Great Yarmouth Flood Defences strategy Review	2000	Background information. Relevant to Great Yarmouth.	No	-
<b>Postford Duvivier</b>	Estuarial Standards of protection Norwich	2000	Background information. Superseded by Norwich strategy studies and BESL.	No	-
<b>Halcrow</b>	River Defence Standards of Protection Norwich	2000	Background information. Superseded by Norwich strategy studies.	No	-
<b>Environment Agency</b>	Broads LEAP		Background Information only	No	Available from Environment Agency
<b>Great Yarmouth Borough Council</b>	Great Yarmouth SFRA (Draft)	2006	Nearing completion and available only in draft. Cover some of Broads and uses BESL model to map fluvial risk at 1% level. 3 breach scenario results given. No delineation of functional floodplain or of climate change impacts.	Yes	Permission from Great Yarmouth BC will be required.
<b>Environment Agency</b>	North Norfolk LEAP		Background Information only	No	Available from Environment Agency
<b>Breckland District Council</b>	SFRA	2005	Completed in June 2005 prior to PPS25 consultation. Includes GIS layers and 25 maps for existing condition at main settlements and a further 25 maps for climate change to 2055. Sewer outfalls considered but inconclusive. Basic assessment of ordinary watercourses.	Yes for areas bordering Breckland DC.	Permission from Breckland DC will be required.

Source	Report Information	Date	Review	Use in SFRA	Licensing/Copying
<b>Environment Agency/JBA</b>	Broadland Rivers Catchment Flood Management Plan Draft for Consultation	2006	Indicates likely policies proposed throughout catchment	Yes – for reference only.	Consultation Report available through EA or website
<b>Environment Agency</b>	Norfolk Sea Defences	-	Asset information in note form for sea defences compiled by Stan Jeavons	Yes	Supplied by Environment Agency
<b>Environment Agency/JBA</b>	North Norfolk CFMP Inception report	2006	Background on flood risk and data availability	Yes	Supplied by Environment Agency
<b>Environment Agency/ Royal Haskoning</b>	North Norfolk Rivers Flood Risk Study	2006	Modelling of North Norfolk Rivers and mapping of 100 year flood envelope	Yes	Supplied by Environment Agency

## **2.6 Historic Flooding Records**

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Records of past flooding are useful for looking at the sources, seasonality, frequency and intensity of flooding. Historical records are mostly anecdotal and incomplete, but are useful for providing background information. More recent gauged records and registers of flooded properties are more valuable for estimating flood frequency and severity at different locations.

An examination of the historic record over the last 900 years shows that there have been many storm surges and very heavy rainfall events that have occurred in Norfolk. Table 2.4 details the most severe floods in the study area, some of which have had devastating effects.

The historic flood records show that:

- there is a long history of flooding in Norwich;
- flooding due to breaches between Eccles-on-Sea and Winterton-on-Sea happened more often in the past, particularly in the 15<sup>th</sup> and 16<sup>th</sup> centuries. This could be because of strengthened sea walls and/or changes in wave and sea level conditions off the coast;
- there is a long history of tidal surge flooding. Water levels have been higher at Haddiscoe in the Broads on several occasions since 1953. This is due to the widespread flooding of defended areas in 1953 that took water out of the river network and lowered water levels;
- in many events, combined fluvial and tidal flooding has affected the upper tidal Broads, most recently in 1959, 1965, 1979, 1984 and 1988;
- melting snow can cause significant and widespread flooding, such as in 1571, although this is rare;
- short, intense rainfall (thunderstorms) on the North Norfolk Rivers can cause frequent flooding.

**Table 2.4 Historic flooding in the study area**

Date	Source	Rivers affected	Areas affected	Impacts
1236	Tidal surge	All	Tidal flood plain	"It washed up the ocean in such tremendous waves that the banks gave way and the whole county lay completely exposed to its awful fury".
1287	Breach Eccles-on-Sea to Winterton-on-Sea and surge	Tidal	Tidal flood plain	108 people died.
1608	Breach Eccles-on-Sea to Winterton-on-Sea	Thurne, Bure, Yare	Tidal flood plain	2,000 people needed to mend defences.
1878	Rainfall, melting snow and tide-locking	Yare and Wensum	Norwich	3-4 people died, 3,000 – 6,000 properties flooded
1897	Breach Eccles-on-Sea to Winterton-on-Sea	Tidal	Tidal flood plain	10 foot surge.
1912	Rainfall	All fluvial rivers and parts of Broads	Norwich and parts of Broads	4 people died, over 3,600 properties flooded 0.13 – 0.11% AEP, £100,000 damage Norwich.
1938	Breach Eccles-on-Sea to Winterton-on-Sea	Thurne	Tidal flood plain	Biggest coastal breach for 50 years.
1953	Tidal surge	Tidal	Great Yarmouth, Lowestoft, Broads, North Norfolk	Many people died, over 3,500 properties flooded, 0.57% AEP.
1968	Rainfall	Fluvial	Particularly Waveney and Yare catchments	Estimated <0.1% AEP Waveney 1% AEP Tas. Drains surcharged Norwich. Ipswich – Norwich line railway bridge washed away near Diss
January 1978	Tidal	North Norfolk	Coastal settlements and those near the outfalls of rivers. Particularly Wells-next-the-Sea and Cley-next-the-Sea	Severe tidal flooding Destroyed sea defences

Date	Source	Rivers affected	Areas affected	Impacts
1981	Rainfall	Waveney, Yare, Bure	Fluvial flood plain	Widespread inundation, 2.2% AEP Norwich
1993	Tidal surge	Waveney, Yare, Chet, Bure	Particularly Yare and Waveney valley	5% AEP, 110 properties flooded
1993	Rainfall	Waveney, Yare, Wensum, Bure, North Norfolk rivers	Norwich, parts of Broads and upper river catchments	Some flooding from surface water, property flooding in many locations
2000	Fluvial – very heavy rainfall from storm off North Sea	Mun	Mundesley	Properties flooded
July 2001	Surface water – very heavy rainfall Fluvial	Glaven	Cromer, Sheringham, East Runton	Roads flooded Water ran off hills to the south of Cromer and caused flooding of shops in the high street High water levels on lower part of Glaven
2004	Fluvial	Burn	North and South Creake	Properties flooded
Autumn 2004	Fluvial exacerbated by tide-lock	Stiffkey, Burn	Stiffkey	Properties flooded
October 2005	Fluvial	Stiffkey		Severe flood warning issued
August 2006	Surface Water Runoff		Sheringham	High local rainfall

## **2.7 Drainage Issues**

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### **2.7.1 SUDS**

Use of sustainable urban drainage is desirable, likely to be requested by the Environment Agency when assessing flood risk for planning applications, and a requirement of building regulations where practicable. The effective use of permeable surfaces, soakaways and to a certain extent storage areas is dependent on the surface and near surface geology of the area and groundwater protection requirements.

There have been difficulties in the area with drainage and for those areas feeding into the internal drainage board drains, there may be a preference to balance any changes in runoff within the drainage system rather than for example in an oversized surface water sewer within an estate that is difficult to maintain. The highly impervious boulder clay of south Norfolk in particular has caused drainage problems not necessarily at the site where the new drainage system is installed.

For the SFRA assessment of the suitability of SUDS systems will need to be considered through consideration of ground conditions, available drainage paths, maintenance and policy of the body responsible for the receiving watercourse.

### **2.7.2 Internal Drainage Boards**

There are two consortia of drainage boards in the area, the Kings Lyn consortium which covers parts of North Norfolk and the Wensum valley and the Lowestoft consortium which covers areas of the south Broads and Waveney valley. Maps of the drains are available.

The standard of service for areas served by drainage boards is believed to typically be around the 1:30 year for residential areas though information concerning this may be sparse. For a property behind a flood bank on a main river that is served by internal drainage board system there are thus residual risks of flooding that are not apparent when considering only the main river system. For a development area within an IDB service area some additional analysis may thus be required.

### **2.7.3 Anglian Water**

Anglian Water have ongoing programmes of investment to improve sewage treatment and surface water management especially for combined sewer systems. The recent pace of expansion in a number of existing settlements such as at Wymondham has meant that there are limits to any new connections without additional investment in upgrading of systems. For the SFRA rather than trying to assess the sewer network capacity it is proposed that potential development areas are discussed with Anglian Water who should be able to indicate areas currently limited and the likely timetable and nature of work that will be needed to accept further connections. The DG5 register of properties affected by internal flooding can be accessed to show the parish within which properties affected fall rather than precise locations which could be sensitive.

## **2.8 Potential Breach Locations**

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The residual flood risks at an area defended are dependant on overtopping and the effect of a breach in a raised defence or in the case of the coast a breach in the natural dune system. In South Norfolk and Broadland District Council areas there are some localised raised defences on

the rivers such as at former mills but these pose little threat to people or property so further quantification through breach analysis should not be required. The areas where significant breaches can occur are along the coast and within the Broads.

Potentially significant breach locations along the coast are readily identified from an examination of the topography, flood zones and settlements. There are erosion issues at other locations but the risk of flooding from sudden breaching is concentrated within the North Norfolk District Council area for which further information is needed at:

1. Wells-next-the-sea
2. Blakeney and Morston
3. Sea Palling area

A breach of the coastal defence at Bramble Hill where the Hundred Stream formerly an outfall of the Bure had its outfall is also potentially significant and this also affects areas within the Broads Authority planning area.

## ***2.9 Mapping of Functional Floodplain***

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The Environment Agency flood zone mapping is for 0.1% and 1% flood areas without the effect of defences. In some (but not all) areas defended areas with a standard of protection of 100 years or better are defined by the Environment Agency. These can be used to define Flood Zones 1, 2 and 3 but not to delineate between zones 3a and 3b or to consider climate change. For planning purposes delineation of flood zone 3 is useful where this information is available or can readily be generated. This is therefore agreed as a requirement for the SFRA Stage 2 for settlements which are potentially in or close to a flood zone and a list of potential settlements was provided by each council.

The settlements are divided between primary and secondary, primary being those that are the main focus of growth and secondary those that will be limited to 'local scale' development, small scale infilling and development for local needs.

The location of each settlement was checked against available model data and a summary compiled for the number that have flood mapping already completed sufficiently to define the 'functional floodplain' or Flood Zone 3a/3b delineation and those for which an alternative approach will be needed including possibly some model development.

The settlements for which councils wish to have the functional floodplain delineated are given in Tables 2.5, 2.6 and 2.7 for North Norfolk, South Norfolk and Broadland District Councils. To give an initial indication of whether climate change will significantly affect extent of flooding the difference between Flood Zone 2 and 3 are indicated.

North Norfolk would like consultants for stage 2 of the SFRA to provide estimates for a) Option 1 including floodplain delineation for settlements given in Table 2.5 and b) Option 2 including floodplain delineation only for those settlements with some flood zone 3 area included in preferred options:

1. Wells-next-the-sea
2. Fakenham
3. Blakeney
4. Roughton

The decision to select Option 1 or 2 will be made prior to award of stage 2.

For Norwich City, the Flood Zone 3 delineation is needed as part of the strategic overview of the Greater Norwich Policy Area.

In the Broads Authority planning area, settlements can be expected to be in Flood Zone 3. Most are covered by the existing BESL model though there will not be existing flood extent plotting that can be used.

**Table 2.5 Model Coverage of North Norfolk Settlements within Flood Zones**

Town	Area	Model	Flood Zone 2/3	Additional notes
Wells	Coastal	not modelled	Similar	Breach Model (1) proposed
1 Fakenham	Upper Wensum	modelled	Differences	
2 Hoveton	BESL	modelled	Similar	
3 Stalham	BESL	modelled	Slight difference	
4 Sculthorpe	Upper Wensum	modelled	Differences	Zone 2 extends up drain/tributary
Blakeney	Coastal	not modelled	Same	Breach Model (2) proposed
5 Roughton	Bure Trib	not modelled	Same	
6 Mundesley	Mun	modelled	Similar	
7 Corpusty	Bure	modelled	Similar	
8 Horning	BESL	modelled	Slight difference	
9 Ludham	BESL	modelled	Differences	
10 Thornage	Tributary of Glaven	not modelled	Similar	
Cley	Coastal /Glaven	modelled	Same	no breach required/excluded
Salthouse	Coastal	not modelled	Same	no breach required/excluded
11 Erpingham	Tributary of Bure	not modelled	Slight difference	
12 Gimingham	Mun	modelled	Slight difference	
13 Stiffkey	Skiffkey	modelled	Same	
14 Langham	Tributary to Stiffkey	not modelled	Similar	
15 Potter Heigham	BESL	modelled	Differences	
16 Hickling	BESL	modelled	Differences	
17 Horsey	BESL	modelled	Same	
Sea Palling	Coastal	not modelled	Similar	Breach Model (3) proposed
Lessingham	Thurne/Coastal Breach	not modelled	Differences	To be assessed from breach model (3) results
Ingham	Thurne/Coastal Breach	not modelled	Differences	To be assessed from breach model (3) results
Sutton	Thurne/Coastal Breach	not modelled	Differences	To be assessed from breach model (3) results
18 Ingworth	Bure	modelled	Slight difference	

Red and green depicts likely primary and secondary settlements considered for development. Numbering refers to flood Zone 3 delineation.

**Table 2.6 Model Coverage of South Norfolk Settlements within Flood Zone**

Town	Area	Model	Flood Zone 2/3	Additional notes
1 Wymondham	Tiffey	Modelled	Differences	
2 Diss	Upper Waveney	Modelled	Slight Differences	Waveney tributary possibly not modelled
3 Harleston	Waveney	Part Modelled	Similar	Waveney tributary possibly not modelled
Hingham	Tiffey Tributary	No need for Modelling	n/a	Not in agency floodzone
4 Loddon (and Chedgrave)	BESL	Part Modelled	Similar	Fluvial events may need small extension
5 Long Stratton	Tas	Part Modelled	Slight Differences	
Poringland	SE of Norwich	No need for Modelling		Not in agency floodzone
6 Costessey	Wensum/Tud	Modelled	Slight Differences	Norwich Model or Upper Wensum model
7 Trowse	Yare	Modelled	Slight Differences	
8 Cringleford	Yare	Modelled	Slight Differences	
9 Colney	Yare	Modelled	Slight Differences	
10 Hethersett	Yare Tributary	Not Modelled	Similar	Village not in Agency floodzones
11 Mulbarton	Small Yare Tributary	Not Modelled	Slight Differences	Only a small trib, limited floodzone
12 Newton Flotman	Tas	Modelled	Similar	
13 Roydon	Upper Waveney	Modelled	Similar	
14 Easton	Tud	Modelled	Similar	

Primary settlements for development only in red, possible primary/secondary areas in green

**Table 2.7 Model Coverage for Broadland DC Settlements within Flood Zone**

Town	Area	Model	Flood Zone 2/3	Additional notes
1 Acle	BESL	Modelled	Similar	
2 Aylsham	Bure and Tributary nr Aylsham	Modelled	Similar	
3 Blofield	Yare tributary	Not modelled	Similar	Main area away from floodzone
4 Brundall	Yare	Modelled	Similar	
5 Buxton	Bure and Tributary nr Aylsham	Not modelled	Similar	Main watercourse affecting is unmodelled
6 Cantley	BESL	Modelled	Similar	
7 Coltishall	BESL/Bure	Modelled	Similar	BESL and NN Strategy Bure models
8 Drayton	Upper Wensum	Modelled	Slight Differences	
9 Foulsham	Upper Wensum Tributary	Not modelled	Similar	
10 Gt Witchingham	Upper Wensum (Blackwater)	Modelled	Similar	Small village near Lenwade close to flood zone
11 Hellesdon	Norwich Model	Modelled	Slight Differences	
12 Hevingham	Lower Bure tributary	Not modelled	Similar	Unmodelled tributary of the Bure
13 Horsford	Lower Bure tributary	Not modelled	Similar	Unmodelled tributary of the Bure
14 Horsham St Faith	Lower Bure tributary	Not modelled	Similar	Unmodelled tributary of the Bure
15 Horstead	BESL/Bure	Modelled	Similar	
16 Lenwade industrial area	Upper Wensum	Modelled	Similar	Unmodelled tributary also joins to the North
17 Marsham	Tributary of the Bure	Not modelled	Small Differences	
18 Reedham	BESL	Modelled	Slight Differences	
19 South Walsham	BESL	Modelled	Similar	Part of flood zone not in by BESL compartments
20 Spixworth	BESL	Part Modelled	Slight Differences	Part of flood zone not in by BESL compartments
21 Thorpe St Andrew	Norwich Model/BESL	Modelled	Differences	
22 Upton	BESL	Modelled	Similar	
23 Wroxham	BESL	Modelled	Similar	
24 Honingham	Tud	Modelled	Similar	

These tables were used to help calculate the number of modelled locations and those currently without models for which a different approach would be needed to delineate the flood zone and functional floodplain. Consultants can be asked to propose the method to use for this during the tender.

The number of settlements to be mapped and available modelling is summarised in Table 2.8.

**Table 2.8 Summary of Existing Model Availability for Delineation of Flood Zone 3**

Council	Total Number of Settlements	Settlements where models exist	Unmodelled or part modelled settlement
<b>Broadland</b>	<b>24</b>	<b>17</b>	<b>7</b>
<b>North Norfolk</b>	<b>18</b>	<b>14</b>	<b>4</b>
<b>South Norfolk</b>	<b>14</b>	<b>9</b>	<b>5</b>
<b>Norwich City</b>	<b>1</b>	<b>1</b>	<b>0</b>
<b>Broads Authority</b>	<b>All of Broads</b>	<b>-</b>	<b>-</b>

*Note: because part of a settlement may be in a Council planning area and part within the Broads, 22 Broads settlements are already specified by councils*

The impact of flood extents shown in the mapping should not be limited to current settlement boundaries but should show the impact on the surrounding area for which planning decisions sometimes need to be made. For the Broads Authority the floodplain delineation to be supplied on GIS should not be limited to settlements but can cover the full area as this is geographically well defined and with the exception of coastal risks is within the BESL model area. Proposed and potential nature areas for which banks may be set back should also be considered in the Broads as this is likely to be of growing significance. There is an overlap of settlements requested by the councils with the parts of those settlements which are within the Broads Authority planning areas.

## 2.10 Cost Estimates

The main SFRA stage has been estimated according to the work required for each authority. There is an efficiency saving in combining the study although the requirement for the different councils vary according to the amount of work required.

A significant element of the work required is in providing additional flood delineation for current conditions and taking account of climate change. By far the greatest effort will be required for the Broads Authority if a full SFRA is pursued to define areas of flood risk at 10 year (functional floodplain), 100 year and 1000 year events, the residual risks in terms of overtopping and breach from the sea and the river system. It is envisaged that the delineation of flood risk would be completed for three events for a climate change scenario that will include a sea level rise and increased fluvial flows.

In the Broads area because both of these effects have an impact then model simulations or processing are required for fluvial and tidally dominated events and the higher water levels used.

The estimated cost of the SFRA is given in Table 2.9. This estimate includes an element for use of the BESL Broads model which will be required for defining functional floodplain in the Broads and parts of North Norfolk and Broadland DC areas. BESL have found that because the model is complex it is not feasible simply to supply it to different consultants and thus agreement must be reached following award of the Stage 2 tender for supply of results for existing and new simulations. Assuming that 4 new cases primarily concerned with fluvial flows will be required as well as liaison regarding existing results a provisional sum of £4k should be allowed by tenderers for reimbursement of BESL expenses. Any contract would however, be between the appointed consultant and BESL. This is included in the estimates provided.

**Table 2.9 Estimated Costs of SFRA broken down between partners**

Authority	SUDS	Settlements for delineation of Flood Zone 3	Breach Models	Estimated Cost £k
Broadland DC	Y	24	0	12.9
South Norfolk DC	Y	14	0	10.3
North Norfolk DC Option 1	Y	18	3	13.3
Norwich City	Y	1	0	11.0
Broads Authority	N	all	1	13.0
<b>Total (Option 1)</b>				<b>60.5</b>
North Norfolk DC Option 2	Y	4	3	9.2
<b>Total (Option 2)</b>				<b>56.4</b>

## ***2.11 Scheduling of Outputs***

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The preparation of the individual SFRA reports will give priority to completion of the volumes for North Norfolk and for the Broads Authority. These authorities have requested information for November 2006. North Norfolk District Council submission will be in April 2007.

For Broadland, South Norfolk and Norwich City Councils the November deadline is not as critical as the proper consideration of the strategic aspects of issues within the Greater Norwich area so the completion of the SFRA for these authorities may be later. The later completion will allow more information to be provided on likely development areas and to enable the consultant to ensure that the North Norfolk and Broads Authority requirements can more readily be met.

## 3 INITIAL ASSESSMENT OF ALLOCATION AREAS

### 3.1 Review of Preferred development Areas

North Norfolk District Council is advanced enough in their Local Development Frameworks to be able to provide some areas of which will be consulted on as areas of preferred development. Upon review of this data it was found that the areas proposed were (with three exceptions for part of the area and one area bordering) located totally inside Flood Zone 1. However several sites may need further investigation during the main stage.

South Norfolk has a number of sites that are already within the existing local plan but are not yet developed but are only currently defining preferred settlements for the Local Development Plan as discussed in the previous section.

For Broadland District Council there are a limited number of sites which are within the current Local Plan that are not yet developed, however the SFRA is primarily concerned with the comparative suitability of candidate areas and specific sites have not been identified.

For Norwich City there are a large number of sites with planning permission and not yet developed or that are already within current Local Plan. There are also options being considered as part of the developments associated with Growth Point Status.

Given the current position of the planning authorities in the selection of allocation areas for the Local Development Frameworks there is little that can be done in terms of an initial appraisal for most councils at stage 1 to assist the development of the LDF and this will instead be done at stage 2.

### 3.2 North Norfolk District Council

There are around 40 preferred areas being considered for consultation for LDF planning of which all but three are totally in Flood Zone 1 i.e. for which there is no significant risk of flooding from main rivers or from the sea. These sites may thus be considered to have preferential status according to the sequential test. The sites that are not totally within Zone 1 are employment designations (a) a small section of in Wells Next The Sea, (b) part of a site in Ludham, (c) Roughton. At Blakeney an employment designation borders the flood zone. The site specific proposals document recognises that the part of these sites that are within a flood risk zone should remain undeveloped and used for car parking or landscaping.

The part of the site in Wells that is within Zone 2 is associated with extreme flooding from the sea and may be considered provided an appropriate flood risk assessment is undertaken and mitigation measures are taken. The site is at risk only if the sea defences fail or are overtopped. The residual risks associated with this site should be covered by the specified breach modelling.

### 3.3 South Norfolk District Council

The preliminary assessment of sites and settlements for LDF will be carried out at Stage 2 of the SFRA. The parishes being consider as part of the developments within the Greater Norwich Policy area are given in Figure 3.1 for both South Norfolk and Broadland District Councils.

### 3.4 Broadland District Council

There are no preferred sites at present as options for substantial developments north of Norwich are being considered. All are likely to be in Flood Zone 1 so risk of flood from main rivers will be low and drainage and suitability for use of SUDS is likely to be a significant factor.

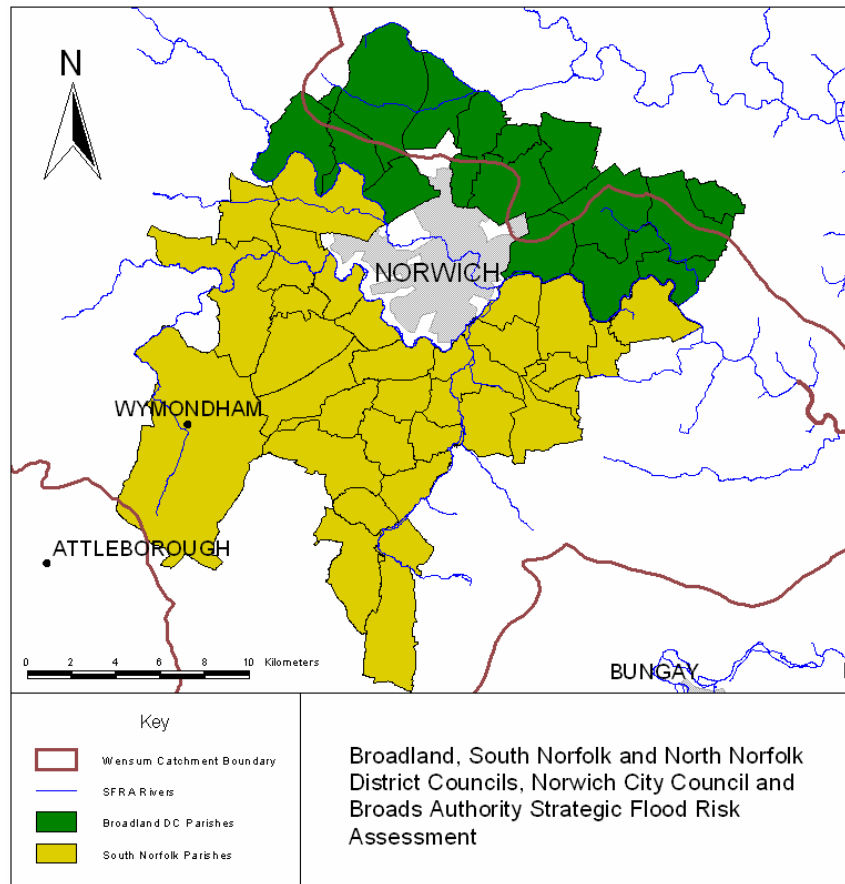
One issue that may influence selection is the drainage route in extreme events taking account of climate change. The river through Norwich is highly constrained and near capacity for existing flood events. Therefore the second stage of the SFRA will need to consider the preference for future developments to drain northwards to the Bure catchment rather than towards Norwich city centre.

### 3.5 Norwich City Council

Norwich City has a large number of existing sites within the current Local Plan some of which have planning permissions and some of which are allocated. Over 75% of these are in areas that are currently developed.

Preliminary screening of potential sites for the LDF will be carried out at an early stage of the Stage 2 SFRA to help give a strategic view of flood risks in the different councils of the Greater Norwich area.

**Figure 3.1 Parishes in the Norwich Policy area being considered as part of options for future development. Parishes to the north of the River Wensum catchment boundary line drain towards the River Bure.**



## Appendix A: - DRAFT TERMS OF REFERENCE FOR STAGE 2 OF SFRA

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## A.1 TERMS OF REFERENCE FOR STAGE 2 OF SFRA

### A.1.1 Introduction

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Broadland District Council in conjunction with North Norfolk District Council, South Norfolk District Council, Norwich City Council and the Broads Authority are carrying out a combined Strategic Flood Risk Assessment (SFRA) in two stages. Stage 1 (Inception and data collation) of the SFRA has already been completed and this brief concerns Stage 2, the main SFRA.

The report for Stage 1 details the flood related information available and the specific issues facing each authority.

Stage 2 (the SFRA) is to be carried out to meet the requirements of the emerging PPS25 currently available in draft form. The SFRA needs to be of a form that informs the preparation of the Local Development Frameworks and will be available to provide the basis for future planning applications and more detailed flood risk assessments and drainage requirements including applicability of SUDS techniques and mechanisms for maintaining these.

The consultant should take account of existing Environment Agency Guidance for SFRAs and any Guidance that is proposed to accompany PPS25 if this becomes available during the study.

### A.1.2 General Study Outputs

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The SFRA will be expected to contain at least:

1. Historic background to flooding in the area.
2. Identify potential flood risk sources
3. Identify current defences, the standard of flood defences and plans for improvement
4. Identify and map areas of high flood hazard through use of breach simulation at specified locations along the North Norfolk coast and for any coastal breach that could affect the Broads.
5. Establish and through use of existing models generate mapping of the functional floodplain and overtopping areas and for the 1:100 year event in fluvial risk parts and 1:200 year for coastal flooding taking account of existing defences. Liaise with the Environment Agency to ensure areas being considered for set aside for flood storage areas in the future are included.
6. For settlements listed in the Stage 1 report that are not currently modelled develop an acceptable (agreed with the Environment Agency) technique to define functional floodplain and provide similar mapping to those areas that are already modelled.
7. Identify and map changes in the above as a result of climate change to both fluvial flooding and tidal flooding for existing (and any proposed changes) defences.
8. Identify where developments may affect flooding at other locations and those downstream sites that are most sensitive to changes in upstream flow.
9. A strategic overview of the issues and relative merits of different locations within the Norwich Policy Area from the point of view of flood risk.

10. For areas identified by authorities for consideration in the LDF assess flood risk in terms of Table D1 of draft PPS25.
11. For the same areas and the Norwich Policy Area identify local drainage issues and develop a matrix of the suitability of different SUDS techniques and the likely proportion of the site area these would require.
12. Identify the broad applicability of SUDS across the study area at a strategic level and illustrate on a map and GIS layer where particular approaches to SUDS would be appropriate.
13. The results from liaison with Anglian Water to determine surface water constraints and timing of works that may be required to overcome development constraints.

The outputs required in respect to the principal component of the study, the Strategic Flood Risk Assessment are as listed below:

- A single report covering the whole of the study area detailing the scope and extent of the work, the processes and methodologies employed in the assessment and mapping of flood risk, to include groundwater, fluvial and tidal sources. The report will also provide an overview of the nature of flood risk in different areas and the strategic assessment of the greater Norwich area. It may be necessary to produce an initial draft of this report initially covering primarily the North Norfolk and Broads Authority planning areas due to the requirement to complete the studies for these bodies prior to full completion of the SFRA.
- A set of maps of suitable scale are required to be presented in the reports covering the areas where delineation of the flood zones is required for planning purposes, where flood hazards have been calculated using breach modelling. This mapping will show categories of actual flood risk numerically equivalent to the PPS25 Flood Risk Zones 1, 2 and 3a and 3b, take into account of the effects of flood defences, drainage channels, road and rail embankments or artificially maintained channels. It is not envisaged that these maps will cover the entire study area.
- For each council and the Broads Authority, GIS layers should be prepared giving flood zones, expected flooding in a 1:100 year event for current and future conditions (taking account of existing defences), areas of high flood hazard (derived from breach modelling for limited areas near the coast only), functional floodplain defined as the area affected in a 1 in 10 year event (or as agreed) for current and future conditions, and applicability of SUDS. The functional floodplain and actual flood risk shall be defined for all areas where existing models are available and for the potential development areas that have been included in the mapping.

Fifteen printed and bound copies of the report and sets of maps will be required. Electronic versions of the report (in Word and pdf formats) and sets of maps will also be required for public access.

A single general presentation of the findings of the report to councillors and officers of the partnership members and officers of the Environment Agency will be made within one month of completion of the project. An executive summary of the report will be required for distribution at the presentation.

Although not part of the scope of this project the contractor must, if required by any member of the partnership, be prepared to give evidence on the findings of the report at planning enquiries.

The GIS layers should be produced in ESRI compatible format which can be used by the Environment Agency, and the five contracting bodies.

### **A.1.3 Specific Study Outputs**

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Outputs which are required in respect of the subsidiary component of this study are as follows:

- Five separate subsidiary reports, one for each Authority, each report covering those elements of the subsidiary component of the study that are relevant to that partnership member. Sufficient supplementary information and guidance, derived from the results of the principal component of the study, should be given in each subsidiary report to enable each Authority to apply the sequential test in PPG25 to developed areas in their Planning Authority Area.
- Where tidal embankment breach analyses have been carried out within a district, although the results of those analyses will have been used to inform the main strategic flood risk assessment, the detailed results of those analyses shall be given within the relevant subsidiary report.
- Where more detailed flood risk assessments have been undertaken for designated potential development areas, the results of those assessments shall be given in the relevant subsidiary report. The assessment must include not only local flood risks (which must be consistent with the strategic assessment) but also an assessment of the effect that development of the area could have on flood risk on land or property outside the area. A summary of the features of each development area should include flood zoning, sequential test and exception test, appropriate SUDS measures and a plan to an appropriate scale. The plan will show all significant sources of flood risk, watercourses (open or culverted), flood defences, hydraulic structures and drainage paths in the proposed development area.

Detailed requirements for each of the five subsidiary reports are given below:

#### **North Norfolk Council**

The specific requirements for North Norfolk Council are:

1. A comprehensive assessment of the areas being considered for the LDF covering the sequential test, drainage issues and likely SUDS requirements. North Norfolk are able to identify specific preferred sites that are expected to be included in the consultation for the LDF but the assessment should include the general areas in the vicinity of these sites. With the exception of part of two sites, all areas being considered are outside of Flood Zone 3.
2. Mapping of the Functional floodplain and delineation of the Flood Zone 3 for each of the 18 settlements for potential development listed in the Stage 1 report.
3. Flood Hazard mapping for 3 locations along the North Norfolk coast (exact location of breach simulations to be agreed with Norfolk Norfolk DC):
  - a) Wells-next-the-sea
  - b) Blakeney and Morston
  - c) Sea Palling area

#### **South Norfolk Council**

The specific requirements for South Norfolk Council are:

1. A surface water drainage assessment of the issues and possible SUDS requirements for the general development areas. The requirements and constraints on surface water management will need particular attention in this area.
2. A comprehensive assessment of the areas being considered for the LDF covering the sequential test, drainage issues and likely SUDS requirements.
3. Mapping of the Functional floodplain and delineation of the Flood Zone 3 for each of the settlements for potential development listed in the Stage 1 report.
4. Strategic Assessment of Flood related issues in the Norwich Policy Area.

### **Broadland District Council**

The specific requirements for Broadland District Council are:

1. A surface water drainage assessment of the issues and possible SUDS requirements for the general development areas.
2. A comprehensive assessment of the areas being considered for the LDF covering the sequential test, drainage issues and likely SUDS requirements
3. Mapping of the Functional floodplain and delineation of the Flood Zone 3 for each of the settlements for potential development listed in the Stage 1 report.
4. Strategic Assessment of Flood related issues in the Norwich Policy Area.

### **Norwich City Council**

The specific requirements for Norwich City Council are

1. A surface water drainage assessment of the issues and possible SUDS requirements for the general development areas.
2. A comprehensive assessment of the areas being considered for the LDF covering the sequential test, drainage issues and likely SUDS requirements
3. Mapping of the Functional floodplain and delineation of the Flood Zone 3 for each of the settlements for potential development listed in the Stage 1 report.
4. Strategic Assessment of Flood related issues in the Norwich Policy Area.

### **Broads Authority**

The specific requirements for the Broads Authority are:

1. Use of the hydraulic model prepared by Halcrow for the BESL contract (and amended as necessary) to define functional floodplain, overtopping flows and affected areas within the Broads for both defended and undefended settlements.
2. As above for future conditions considering climate change.

In general banks have a low standard of protection (5-20 years) and overtopping may occur in rural and built up areas. The likely change in flood regime with climate change and natural subsidence is a particular interest. The planning area of the Broads Authority within the Great Yarmouth council boundaries should also be included so that a consistent output is available for the whole Broads area. This may draw on the results from the Great Yarmouth SFRA which should be made available.

Likely changes due to redevelopment at Great Yarmouth and Lowestoft should be taken into account and the work of the BESL project including bank strengthening, set back and creation of washland areas.

### **Reporting**

Five printed and bound copies of each subsidiary report and associated plans will be required. Electronic versions of each report (in Word 97 and pdf formats) and plans will also be required.

A presentation of the findings of each subsidiary report to councillors and officers of the relevant Authority and officers of the Environment Agency will be made within two months of the completion of the project. An executive summary of the report will be required for distribution at these presentations, which will be separate from the general presentation of the results of the strategic study.

#### **A.1.4 Status of the Final Report**

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The final document will be used as a background document to the five LDFs and in support of subsequent SA/SEA/EIA and appropriate assessment under EU Habitats Directive and or applications for planning permission. The document will be the property of the five Authorities who will retain the copyright for the document.

Data provided for the SFRA will be for single use on the study and will not be available for use on other related studies without appropriate permissions.

#### **A.1.5 Timescale**

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It is envisaged that the contract for Stage 2 of the SFRA will be let in October 2006. Work should be scheduled for completion of the reports for North Norfolk and the Broads Authority in time for their LDF submissions.

Final completion of all reports should be specified by the consultant in his proposal but ideally this should be by the end of December 2006.

A draft of the report dealing with strategic flood risk assessment, including drafts of the flood risk maps, will be submitted to the Lead Authority with sufficient time to allow completion as proposed above. All constituent authorities and associated organisations are aware of the tight timescales and have committed resources to enable completion within the time allowed.

It is imperative that the Broadland District Council, North and South Norfolk and Norwich City and Broads Authority SFRA is completed on time and to budget.

A presentation of the findings of the principal component of the Study will be required to be made to broad audience representing the Broads Authority, Broadland District Council, North and South Norfolk and Norwich City Councils, associated organisations, and elected members of those organisations. Presentation to each of the five constituent authorities comprising the main study outputs and the subsidiary components of the study will be made within one month and two months respectively after completion of the project.

#### **A.1.6 Cost Estimate**

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The consultant should provide a breakdown of costs for each component part of the SFRA (split by authority) for budgetary and planning purposes only. For North Norfolk prices for Option 1 and Option 2 should be given. A provisional sum of £4k should be allowed for provision of modelling outputs and additional model runs by BESL for the Broads area.

### **A.1.7 Data Availability**

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One of the key objectives of the Stage 1 was to obtain and assess information. In the Stage 1 report available data is described and where there are not copyright issues the data collected will be made available to other consultant at the start of the project. The Environment Agency will collate the available Lidar information and copy this to an external hard drive to be supplied by the consultant for this purpose.

### **A.1.8 Contact list**

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The names and telephone numbers of individuals from whom data and information may be sought for the purposes of this project are given below. Although these names have been supplied by each of the organisations concerned, some of the named individuals may no longer be directly employed by that organisation

Where only one individual is named, all requests for data or information from that organisation should be channelled through that individual.

#### **Broadland District Council (Principal Project Contact)**

Project Manager Roger Burroughs, Planning Policy Manager  
Tel: 01603 430558, [roger.burroughs@broadland.gov.uk](mailto:roger.burroughs@broadland.gov.uk)

#### **Broads Authority**

Principal Contact Gillian Morgan  
Tel: 01603 610734 [Gillian.Morgan@broads-authority.gov.uk](mailto:Gillian.Morgan@broads-authority.gov.uk)

#### **North Norfolk District Council**

Principal Contact Polly Wake, Senior Planner  
Tel: 01263 516233 [pwake@north-norfolk.gov.uk](mailto:pwake@north-norfolk.gov.uk)

#### **Norwich City Council**

Principal Contact Michael Burrell [MikeBurrell@norwich.gov.uk](mailto:MikeBurrell@norwich.gov.uk)  
Tel: 01603 212525

#### **South Norfolk District Council**

Principal Contact Richard Cooper  
Tel: 01508 533848 [RBCooper@S-NORFOLK.GOV.UK](mailto:RBCooper@S-NORFOLK.GOV.UK)

#### **Environment agency**

Principal Contact Stewart Rickards, Planning Liaison Officer  
Tel: 01473 706016 [Stewart.rickards@environment-agency.gov.uk](mailto:Stewart.rickards@environment-agency.gov.uk)

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Tel: 01473 706835 [Natalie.newton@environment-agency.gov.uk](mailto:Natalie.newton@environment-agency.gov.uk)

Technical Advisor Jeremy Bloomfield, Mapping and Technical Specialist  
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