1 Appendix D.2: Mapping Supporting Information

1.1 Introduction

This document provides supporting information to Appendix A: mapping of all sources of flood risk across the SFRA study area. Appendix A is presented as interactive GeoPDFs. The information in this document lists the mapping layers contained in Appendix A and the approaches used to derive the mapping layers.

An accompanying User Guide is provided with the GeoPDFs in Appendix D.3. This provides step-by step instructions on how to navigate to data and how to use the interactive GeoPDFs.

Important: The 2017 SFRA has been developed using the best available information at the time of preparation, taking into account the latest flood risk data and the current state of national planning policy. This relates both to the current risk of flooding from fluvial, tidal, pluvial, groundwater, sewers and reservoirs as well as the potential impacts of future climate change.

At the time of preparing the 2017 SFRA, there were several on-going flood modelling studies being undertaken by or on behalf of the Environment Agency. In a number of cases, the flood modelling studies involve updating existing hydrology and hydraulic models and re-running the models for a suite of return periods. The Environment Agency regularly reviews their hydrology, hydraulic modelling and flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific Flood Risk Assessment.

Once a layer is selected in the interactive GeoPDFs, the associated data will display. If no data is shown in the area / grid-tile being viewed, this does not necesserily mean that there is no risk in the areas and could simply mean that there is no data available. Developers are advised to refer to Appendix D and Section 5 of the main SFRA reports which provides an overview of the approaches used and the key limitations.

1.2 Appendix A mapping layers

1.2.1 Administrative Area

The local authority admistrative area boundary.

1.2.2 Study Area

This shows the boundary of the combined study area and covers a consortium of Norfolk Local Planning Authorities adminstrative boundaries including Broadland District Council, Great Yarmouth Borough Council, the Borough Council of King's Lynn and West Norfolk, North Norfolk District Council, Norwich City Council, South Norfolk Council and the Broads Authority. These authorities comissioned this 2017 SFRA.

1.2.3 River networks

Main Rivers are based on the Environment Agency's Statutory Main River layer.

Ordinary Watercourses are based on the Lead Local Flood Authority's Detailed River Network (DRN) layer.

1.3 The Broads

The Broads Authority Executive Area for which they are the Local Planning Authority.

1.4 Flood Zones

Flood Zones 2, 3a and 3b shown in Appendix A has been compiled for the study area as part of the 2017 SFRA.

1.4.1 *Flood Zone 3b*

Flood Zone 3b comprises land where water has to flow or be stored in times of flood (the functional floodplain). Flood Zone 3b was mapped for areas covered by existing detailed hydraulic models which were available and supplied by the Environment Agency for use in the assessments.

The mapping in the SFRA identifies this Flood Zone as land which would flood with a 5% chance in each and every year (a 1 in 20-year annual exceedance probability [AEP]), where modelling exists for both river and sea flooding. Where the 5% AEP model outputs are not available, the 4% AEP (a 1 in 25-year AEP) results were used as an alternative. The presence of defences is considered when mapping Flood Zone 3b.

Appendix D.1 provides a full list of detailed models used in the 2017 SFRA and where the 1 in 20-year or the 1 in 25-year results have been used to prepare Flood Zone 3b.

1.4.2 Indicative extent of Flood Zone 3b

In the absence of detailed hydraulic model information, a precautionary approach has been adopted with the assumption that the extent of Flood Zone 3b would be equal to Flood Zone 3a (i.e. termed 'indicative extent of Flood Zone 3b'). For example, the BESL model is due to be updated in 2019 and therefore the precautionary approach has been adopted to represent Flood Zone 3b.

If a proposed development is shown to be in indicative Flood Zone 3b, further investigation should be undertaken as part of a detailed site-specific Flood Risk Assessment to define and confirm the extent of Flood Zone 3b. This may require detailed hydraulic modelling.

Approaches to mapping the functional floodplain:

The functional floodplain was not mapped along the North Norfolk coastline. The results of the Wells-next-the-Sea coastal model, prepared under the Environment Agency's 2017 Anglian Coastal Modelling package, will define the functional floodplain in this area. As the modelling was not available at the time of preparing this SFRA, Flood Zone 3b and indicative Flood Zone 3b was not mapped.

In Great Yarmouth town specifically, the Environment Agency were consulted to define the extent of Flood Zone 3b and indicative Flood Zone 3b. The new 2017 hydraulic modelling represents the tidal flood risk only and the fluvial hydraulic models (i.e. the updated BESL model) were not available to define the extent of Flood Zone 3b. The BESL model is due to be updated in 2019 and therefore the precautionary approach has been adopted to represent the indicative Flood Zone 3b in areas covered by the BESL model.

1.4.3 Flood Zones 2 and 3a

Flood Zone 2 comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Flood Zone 3a comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year. Developers and the local authorities should seek to reduce the overall level of flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.

Flood Zones 2 and 3a are taken from the Environment Agency's Flood Maps for Planning. Where new 2017 model results are available:

- the undefended 100-year fluvial results have been spliced into Flood Zone 3a and the undefended 1,000-year fluvial results have been spliced into Flood Zone 2.
- the combined maximum extent of the undefended and defended 200-year tidal results have been spliced into Flood Zone 3a and the combined maximum extent of the undefended and defended 1000-year tidal results have been spliced into Flood Zone 2

Where new models have been included to update Flood Zone 2 and Flood Zone 3, there may be some minor discrepancies with the Environment Agency's Flood Map for Planning (Rivers and Sea). In these instances the developer should contact the Environment Agency for further clarification.

Appendix D.1 provides a full list of detailed hydraulic models used in the 2017 SFRAs and which 2017 model results were used to update Flood Zones 3a and 2.

Notes on Flood Zone mapping:

The Flood Zones, whilst generally accurate on a large scale, are not provided for land where the catchment of the watercourse falls below $3km^2$. There are a number of small watercourse and field drains which may pose a risk to development (e.g. some ordinary watercourses and / or drains managed by Internal Drainage Boards). Therefore, whilst these smaller watercourses may not be shown as having flood risk on the flood risk mapping, it does not necessarily mean that there is no flood risk. As part of a site-specific FRA the potential flood risk and extent of flood zones should be determined for these smaller watercourses.

1.5 Surface Water

Mapping of surface water flood risk has been taken from the Flood Map for Surface Water (RoFfSW) published online by the Environment Agency. The RoFfSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water. The different levels of flood risk are shown in the below table.

Category	Definition
High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chances in any given year (annual probability of flooding 3.3%)
Medium	Flooding occurring as a result of rainfall of between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any given year.
Low	Flooding occurring as a result of rainfall of between 1 in 1,000 (0.1%) and 1 in 100 (1%) chance in any given year.
Very Low	Flooding occurring as a result of rainfall with less than 1 in 1,000 (0.1%) chance in any given year.

Although the RoFfSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

1.6 Climate change

1.6.1 Fluvial climate change

Climate change is expected to increase the frequency, extent and impact of flooding, reflected in peak river flows. Wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff and there may be increased storm intensity in summer. Increased river levels may also increase flood risk.

Fluvial climate change mapping provides a strategic assessment of climate change risk. Developers should undertake detailed modelling of climate change allowances as part of a site-specific FRA, following the guidance set out in the SFRA and Environment Agency guidance.

In the 2017 SFRA, climate change modelling for the watercourses in the combined study area was undertaken using the new climate change guidance (see Section 4 and 5 of the main SFRA report). Where appropriate existing Environment Agency hydraulic models were run for the following allowances:

- 25% (Central) climate change allowance for the 0.1% AEP defended scenario
- 35% (Higher Central) and 65% (Upper End) climate change allowance for the 1% AEP defended scenario

When defining the scope of this commission, the Environment Agency recommended that the above allowances were used in this assessment, to assist with forward planning across the combined study area. The climate change allowances reflect the allowances most commonly used by developers i.e. for residential development, classified as 'More Vulnerable' under Table 2 of the NPPG. The epoch selected i.e. the total potential change anticipated for the '2080s' (2070 to 2115), generally reflects the anticipated lifetime for residential development (i.e. 100 years), as stated in Paragraph 026 of the NPPG.

1.6.2 Tidal climate change

Environment Agency climate change modelling of parts of the Norfolk coastline was supplied for use in this study. The Norfolk coastal climate change modelling was undertaken in line with the revised climate change guidance and was agreed as part of a separate commission to the 2017 SFRA. The Norfolk coastal climate change modelling followed the guidance relating to sea level increases. In the wave models, a 5% allowance for increases in wind speed for the 2050s epoch and a 10% allowance for increases in wave height for the 2115 epoch, were used.

1.6.3 Alternative mapping approaches

Alternative mapping approaches have only been applied in instances where advances in 1D mapping techniques have created inconstancies with the Environment Agency's Flood Zones.

In instances where standard mapping techniques have produced inconsistencies with the Environment Agency Flood Zones, the level and flow data of the 100-year plus 65% climate change (Upper End) results were compared to the existing 1,000-year results provided by the Environment Agency. In all cases, the levels and flows found during the 1,000-year event were suitably similar to provide an indication of the extent of flooding which would occur in the 100-year plus 65% climate change (Upper End) scenario. For these models, no data is provided for the 100-year plus 35% (Higher Central) and 1,000-year plus 25% (Central) scenarios.

Details of where this alternative mapping approach has been applied can be found in Appendix D.1.

Additional notes on fluvial and tidal climate change mapping:

Within Great Yarmouth borough, the fluvial hydraulic models were not available to be re-run, and consequently no fluvial climate change modelling was undertaken. The updated BESL model was not available at the time of preparing this SFRA and as such, associated climate change modelled extents were not mapped. At such locations developers should undertake further investigations as part of a site-specific Flood Risk Assessment to ensure that fluvial climate change allowances are adequately considered.

In coastal areas, there will be no fluvial climate change extents shown in the Appendix A interactive GeoPDFs where the hydraulic models represent the tidal flood risk. In such instances, climate change extents will be shown under the tidal climate change layers, rather than the fluvial climate change layers, where detailed models exist, and the outputs were supplied and available at the time of preparing the SFRAs.

1.6.4 Surface Water Climate Change

Climate change modelling for surface water was undertaken based on the new climate change guidance. The Risk of Flooding from Surface Water model was rerun for the 1% AEP event plus a 40% increase for climate change. When defining the scope of this commission, the LLFA advised that a 40% (Upper End) allowance was to be used in the climate change assessment for surface water.

1.6.5 Using climate change allowances

To help decide which allowances to use to inform the selection of flood levels for flood risk management measures at a development or development plan allocation, the following should be considered:

- likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s)
- vulnerability of the proposed development types or land use allocations to flooding
- 'built in' resilience measures used, for example, raised floor levels

- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

The Environment Agency has produced a guidance document called "Flood risk assessment: Climate Change allowances" which details the application of the allowances, local considerations in East Anglia and the local precautionary allowances for potential climate change impacts, that can be used in basic assessments in absence of the updated, detailed modelling (i.e. areas covered by the BESL model). This document is available to download from: These documents are available from: https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers

1.7 Reservoir flooding

Mapping indicating flooding from reservoir sources has been developed based on Environment Agency supplied National Inundation Reservoir Mapping dataset. Please note that the reservoir inundation outlines shown in the mapping are made up of reservoirs which are located outside the SFRA study area of interest. For further information please see the main SFRA report.

1.8 Groundwater

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater (AStGWf) dataset. The AStGWf dataset is a strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWf data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

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1.9 BESL Model

The BESL hydraulic model outputs were not available at the time of preparing the 2017 SFRA. The 2008 BESL model extent is shown on the Appendix A mapping. The BESL model covers several Norfolk authority administrative areas and notably covers much of the Broads Authority Executive Area. The Environment Agency's Flood Map for Planning (Rivers and Sea) and Flood Zones extents, may be subject to change in this area, following completion of the BESL hydraulic modelling. This further reinforces the importance of approaching the Environment Agency, to determine where updated (more accurate) information is available prior to commencing a site-specific FRA.

1.10 Dry Islands

Dry islands are areas which are identified as being in Flood Zone 1 but are completely surrounded by areas at a higher risk of flooding i.e. surrounding areas which fall within Flood Zones 2. Dry islands can present specific hazards, primarily the provision of safe access and egress during a flood event.

The threshold used to determine the presence of dry islands is: land areas of 0.5 hectares or greater in size, identified as being in Flood Zone 1 and completely surrounded by land which falls within Flood Zones 2. The 0.5 hectares threshold was selected as this reflects one of the criteria used to define "major development".