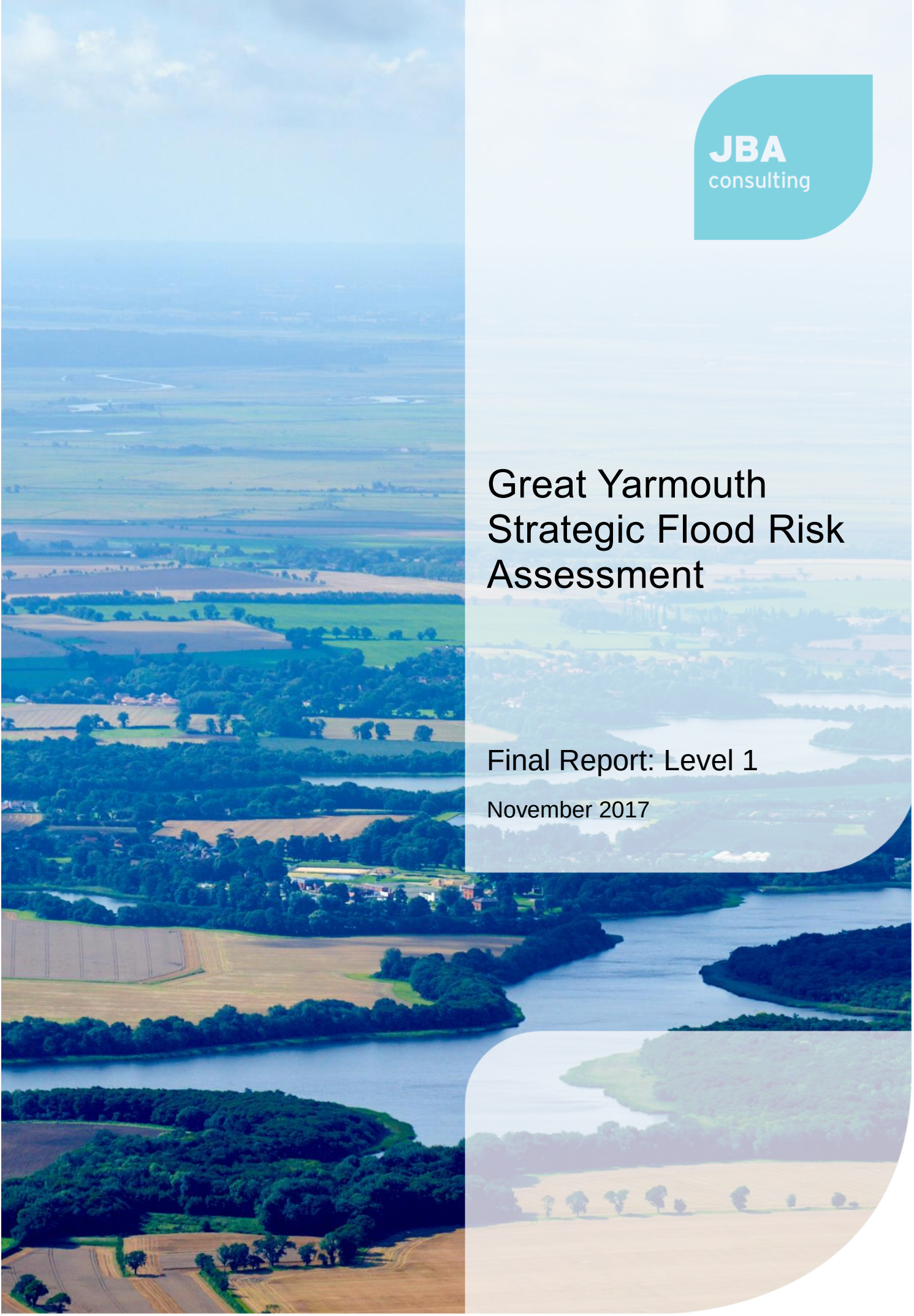

Great Yarmouth Strategic Flood Risk Assessment

Final Report: Level 1

November 2017

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Revision History

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Final Draft rev 2.0 / August 2017	Final DRAFT for comment	SFRA Steering Group
Final rev 1.0 / October 2017	Final Report	SFRA Steering Group
Final rev 2.0 / November 2017	Final Report – updated with minor text amendments	SFRA Steering Group

Contract

This report describes work commissioned on behalf of a consortium of local planning authorities in Norfolk:

- Broadland District Council
- Great Yarmouth Borough Council
- Borough Council of King's Lynn and West Norfolk
- Norwich City Council
- North Norfolk District Council
- South Norfolk Council
- Broads Authority

Each authority was represented as part of a steering group for the SFRA. The steering group's representative for the contract was North Norfolk's Policy Team Leader, Iain Withington. Sophie Dusting, Freyja Scarborough and Ffion Wilson of JBA Consulting carried out this work.

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Purpose

This document has been prepared as a Final Report for Great Yarmouth Borough Council. 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.

JBA Consulting has no liability regarding the use of this report except to the Client.

Acknowledgements

We would like to acknowledge the assistance of:

- All the commissioning authorities;
- The Lead Local Flood Authority (Norfolk County Council);
- Environment Agency;
- Internal Drainage Boards (Water Management Alliance and Waveney IDB);
- Anglian Water;
- Highways England; and,
- Planners at the neighbouring authorities and LLFAs

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Executive Summary

Introduction

Norfolk Local Planning Authorities (LPAs) have a long track record of co-operation and are working together on strategic cross-boundary planning issues, through the emerging Norfolk Strategic Framework. One of the aims of the emerging framework is to inform the preparation of future Local Plans, through shared objectives and strategic priorities.

Strategic Flood Risk Assessments (SFRAs) form part of the evidence base of the Local Plan and can be used to inform the Sustainability Appraisal. The requirement for the preparation of SFRAs is detailed in paragraph 100 of the **National Planning Policy Framework (NPPF)**.

A consortium of Norfolk LPAs, comprising 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, have commissioned new Level 1 SFRAs to inform strategic planning decisions, the preparation of Local Plans and to inform development management decisions. These councils are local planning authorities for their respective administrative areas, with the exception of the Broads Executive Area, where the Broads Authority is the Local Planning Authority.

The 2017 Level 1 SFRAs comprise the following four reports:

- 2017 Greater Norwich Area SFRA, covering the Norwich City Council, Broadland District Council, South Norfolk Council and parts of the Broads Authority administrative areas
- 2017 North Norfolk SFRA covering the North Norfolk District Council and parts of the Broads Authority administrative areas
- 2017 Great Yarmouth SFRA covering the Great Yarmouth Borough Council and parts of the Broads Authority administrative areas
- 2017 King's Lynn and West Norfolk SFRA covering the Borough Council of King's Lynn and West Norfolk

Within this 2017 SFRA report, when reference is made to the '*combined study area*' this is the whole area covered by the four reports listed above.

The 2017 SFRA document is one of a series of SFRAs that will replace the following previous SFRAs:

- The Great Yarmouth and Gorleston SFRA, originally published in 2009 by Great Yarmouth Borough Council
- The joint North Norfolk District Council, Broadland District Council, the Broads Authority, Norwich City Council and South Norfolk Council SFRA, originally published in 2008 by the Partnership of Norfolk District Councils

The main purpose of this 2017 SFRA is to inform the selection of options for the Local Plan allocations and support determination of planning applications for Great Yarmouth borough. The Broads Authority also covers parts of Great Yarmouth borough.

SFRA objectives

The key objectives of the 2017 Strategic Flood Risk Assessment are:

- To provide up to date information and guidance on flood risk for Great Yarmouth borough, taking into account the latest flood risk information and the current state of national planning policy;
- To determine the variations in risk from all sources of flooding in Great Yarmouth borough, taking into account climate change;
- To identify the requirements for site-specific flood risk assessments;
- To consider opportunities to reduce flood risk to existing communities and developments;
- To enable local authorities in Great Yarmouth borough to apply the Sequential Test;
- To aid authorities in identifying when the Exception Test is required and when a more detailed Level 2 SFRA will be required, when determining strategic site allocations; and,

- To inform the Sustainability Appraisal of the authorities' Local Plans, so that flood risk is taken into account when considering strategic site allocations.

SFRA outputs

This report fulfils the Level One SFRA requirement.

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding (see Sections 5 and 6)
- Assessment of the potential impact of climate change on flood risk (see Sections 4 and 5)
- Mapping of all potential sources of flooding including climate change (see Appendix A)
- Mapping of location and extent of functional floodplain (see Appendix A)
- Mapping of "dry islands" (see Appendix A)
- A high-level overview of existing flood risk management infrastructure (see Section 7)
- Mapping of areas covered by Environment Agency Flood Warnings (see Section 6.10.2 and Appendix C)
- Review of opportunities to reduce flood risk to existing communities and development (see Section 10)
- Guidance for developers including requirements for site-specific flood risk assessments and general advice on the requirements and issues associated with Sustainable Drainage Systems (SuDS) (see Sections 8 and 9)
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk (see Section 3).

Summary of the SFRA

Appraisal of flood risk

- There have been a number of recorded flood incidents across the borough, from a combination of sources. The predominant source of flooding is from tidal surges. More recent events investigated by the Lead Local Flood Authority (LLFA) under Section 19 of the Flood and Water Management Act, reviewed the flood incidents that occurred between early May and mid July 2014, across the borough. During this time, 59 properties were flooded internally due to a large number of rainfall events. Section 19 reports are available to download from Norfolk County Council's **website**. A total of seven flood incidents along the A12 highway have been recorded by Highways England since July 2009. Further historic flood information can be found in Section 6.1.
- Tidal flooding is the most significant flood risk in the borough as Great Yarmouth is bound to the east by the North Sea and is entirely located within the tidally-influenced area of the Broadlands River catchment. All three major watercourses, the Rivers Yare, Bure and Waveney, are subject to significant tidal influences at the downstream ends of their catchments, which can cause a 'tide-locking' effect, raising water levels further upstream. A combination of a storm surge (caused by a low-pressure system within the North Sea) coinciding with the arrival of high tide could result in a high risk of tidal / coastal flooding. Tidal flood risk is discussed further in Section 6.5.
- Coastal erosion is expected to be attributable to storm surge tides, combined with large waves. This may result in flooding of the beaches and undefended areas or cause overtopping of defences within the town of Great Yarmouth, as well as affecting the coastal zones to the north and south of the town. Coastal flood risk is discussed further in Section 6.6.
- Fluvial flood risk within the borough is primarily associated with the Rivers Yare, Bure and Waveney and their tributaries. Most of the rivers are embanked and are higher than the adjacent land, which represents a residual risk in the event of a breach or overtopping. Flooding may not be from one watercourse alone. Often the combination of watercourses and the interaction of two or more sources of out of bank flow across the floodplain can

have profound implications for the extent of the risk (i.e. the Rivers Bure and Yare within Great Yarmouth). Fluvial flood risk is discussed further in Section 6.4.

- Watercourses in Internal Drainage Board (IDB) districts are managed for water level and flood risk management. Great Yarmouth borough is partially covered by the Waveney, Lower Yare and Lothingland IDB and the Water Management Alliance. The Water Management Alliance covers five IDBs; the Broads IDB partially covers the borough. The IDB coverage is mapped in Appendix B. The **Broadland Rivers Catchment Flood Management Plan** (CFMP) notes that many settlements are reliant on pumping stations to reduce the risk of flooding including: Martham, Repps, Thurne, Caister, Hemsby, Winterton and Stokesby. The IDB policy statements of flood protection and water level management have been used to determine the general standard of flood protection provided to each IDB District and are summarised as follows:
    - The Waveney, Lower Yare and Lothingland IDB **policy statement** states that the Board will seek to maintain a general standard of protection against flooding of 1 in 25-years for developed areas and 1 in 15-year for agricultural land. The policy statement acknowledges that the standards cannot be taken literally and that some over-spilling from the systems may occur during these events.
    - The Broads IDB **policy statement** states that the Board will seek to maintain a general standard of protection against flooding of 1 in 10-years with 600mm of freeboard to agricultural land and 1 in 100-year with 300mm freeboard to developed areas. The policy statement acknowledges that the standards cannot be taken literally and that some over-spilling from the systems may occur during these events.
- The Risk of Flooding from Surface Water (RoFfSW) dataset shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys, with some isolated ponding located in low-lying areas. The 2013 **Surface Water Management Plan**, prepared for the Great Yarmouth borough, has identified eight Critical Drainage Areas (CDAs). Six CDAs are located within the town of Great Yarmouth; one CDA is located at Caister-on-Sea and another CDA is located at Hemsby. Surface water flood risk is discussed further in Section 6.7.
- The Areas Susceptible to Groundwater flooding (AStGWf) dataset has limited data recorded in the borough. The AStGWf dataset indicates that groundwater emergence is more susceptible in areas to the north and south of the town. Broadscale analysis in the 2009 Waveney District Council and Great Yarmouth Borough Council SFRA identified potential areas in Great Yarmouth and Gorleston as being susceptible to groundwater emergence. In particular, areas to the north and south of the town centre as well as those close to the coast where the tidal influence on groundwater is greatest, are considered among the most susceptible in the study area. The **2009 Water Cycle Study** indicated that the underlying groundwater levels in the Great Yarmouth area are very high. However, the water table in the study area is likely to be kept artificially low through the extensive use of pump infrastructure. As a result, pumping failures could have a potential effect on the water table. Groundwater flood risk is discussed further in Section 6.8.
- Historical incidents of flooding are detailed by Anglian Water in their DG5 register. This database records incidents of flooding relating to public foul, combined or surface water sewers and identifies which properties suffered flooding. A total of 144 recorded flood incidents have been identified on the DG5 register for Great Yarmouth borough. Flood risk from sewers is discussed further in Section 6.9.1.
- There are no records of flooding from reservoirs impacting properties inside the study area. Flooding from reservoirs is discussed further in Section 6.9.2.
- Currently there are five Flood Alert Areas and 16 Flood Warning Areas (FWAs) covering the study area. Flood warning and emergency planning is discussed in Section 6.10.1 and mapping showing the coverage of the Flood Alert Areas and FWAs is provided in Appendix C.
- A high-level review was undertaken to identify the main settlements where flood risks / extents are more prominent; this is shown in Table 6-6. If a settlement is not listed in this table this does not mean that the settlement is not at flood risk. The mapping provided in

Appendix A can be used as a high-level screening exercise, to identify whether a location or site has a potential risk of flooding.

- The mapping of all potential sources of flooding including climate change is provided in Appendix A.

Climate change

The NPPF and accompanying Planning Practice Guidance set out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. The Environment Agency published **updated climate change guidance** on 19 February 2016 (further updated on 3 February 2017), which supports the NPPF and must now be considered in all new developments and planning applications. The Environment Agency has also published guidance to LPAs in the application of appropriate climate change allowances when considering climate change effects (updated April 2016 **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities**).

When defining the scope of this commission, the climate change allowances were agreed by the Environment Agency and LLFA and are intended to assist with future planning across the combined study area. The climate change allowances used in the Strategic Flood Risk Assessment are detailed in Sections 4 and 5. Climate change modelling for watercourses and coastal areas across the combined study area was undertaken where detailed models exist, were available and supplied at the time of preparing this SFRA. Where existing detailed models were not re-run and mapped for climate change, this is documented in Appendix D. It should be noted that in Great Yarmouth borough, fluvial hydraulic models were not available to be re-run and consequently no fluvial climate change modelling was undertaken. Further details and guidance for developers is contained in Section 4 and 8. The mapping of all potential sources of flooding including climate change is provided in Appendix A.

Flood defences

There are a number of Environment Agency assets throughout Great Yarmouth borough. The assets comprise a mixture of embankments, quays, bridge abutments, demountable defences, flood gates and walls. The condition of these assets varies. The flood risk analysis in Section 6 indicates that much of the borough is heavily dependent on flood defences to protect settlements from flooding, particularly from tidal / coastal sources.

Great Yarmouth lies within the Broadland Flood Alleviation Project (BFAP). A critical aspect of the project is to protect and enhance the sensitive wetland areas that are rich in biodiversity, while providing an improved service level in flood defence protection through strengthening and restoring embankments, while making allowances from climate change and settlement of the banks. The BFAP benefits areas surrounding the River Thurne, River Bure and River Yare and their tributaries.

Further information on flood defences and schemes in the borough is provided in Section 7.

Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments (FRAs) are documented in Section 3, along with guidance for planners and developers throughout the report. Links are provided to various relevant guidance documents and policies published by other Risk Management Authorities, such as the LLFA and the Environment Agency.

Dry Islands

In this SFRA, dry islands are defined as an area of 0.5 hectares or greater in size, identified as being in Flood Zone 1 and completely surrounded by land which falls within Flood Zone 2 (i.e. the extreme 1 in 1,000-year extent). The 0.5 hectares threshold was selected as this reflects one of the criteria used to define “major development” (see Section 2.5). Flood Zone 2 was selected as under the NPPG, developers are sometimes required to consider the safety of the site during the extreme flood event including the potential for an evacuation before the extreme flood event.

Dry islands can present specific hazards, primarily the provision of safe access and egress during a flood event.

The results show that there are 42 dry islands in the Great Yarmouth area. These are primarily located towards the northern and central areas of the borough and a few dry islands cross administrative boundaries into neighbouring districts.

Dry islands are discussed in Section 6.10.3; this section expands further on the assumptions used to map dry islands and further considerations. Dry islands are mapped in Appendix A.

Relevant studies

There are many relevant regional and local key studies which complement the SFRA and have been considered, such as the Catchment Flood Management Plan, River Basin Management Plan, the Preliminary Flood Risk Assessment and Local Flood Risk Management Strategies. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management. Relevant policy is discussed in Section 2 and policy considerations have been referenced throughout the report.

Policy Recommendations

The following policy recommendations are to be considered by local planning authorities in Great Yarmouth borough in the development of the Local Plans.

Development and planning considerations

Sequential approach to development

It is recommended that the sequential approach is adopted for all future developments within Great Yarmouth borough.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at a site.

Sequential and Exception tests

The SFRA has identified that areas of Great Yarmouth borough are at high risk of flooding from tidal, coastal, fluvial and surface water sources. Therefore, proposed development sites will be required to satisfy the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Great Yarmouth Borough Council and the Broads Authority should use the information in the 2017 SFRA when deciding which development sites to take forward in their Local Plan.

The Broads Authority administrative area extends beyond Great Yarmouth borough. As such, the Broads Authority should also use the information contained in the 2017 North Norfolk SFRA, the 2017 Greater Norwich Area SFRA and any SFRAs produced for Waveney District Council, when deciding which development sites to take forward in their Local Plan.

Site-specific Flood Risk Assessments

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), to inform the sequential approach within the site and prove, if required, whether the Sequential and Exception Tests can be satisfied (for windfall sites not included in the Plan, evidence on the Sequential Test must be submitted in FRAs).

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.

Where a site-specific FRA has produced modelling outlines which differ from the EAs Flood Map for Planning (Rivers and Sea) then a Flood Map Challenge may need to be undertaken. Where the modelling and results are deemed acceptable to the EA, amendments to the Flood Map for Planning (Rivers and Sea) may take place.

Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

All new development within the 1% Annual Exceedance Probability (AEP) flood extent including an allowance for climate change (for the lifetime of the development) must not normally result in a net loss of flood storage capacity. Annual Exceedance Probability is the probability (expressed as a percentage) of a flood event occurring in any given year. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage. Where proposed development results in a change in building footprint, the developer should normally ensure that it does not impact upon the ability of the floodplain to store or convey water, and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided to ensure that the total volume of the floodplain storage is not reduced.

There are a number of guidance documents which provide information on the requirements for site-specific FRAs:

- **Standing Advice on Flood Risk (Environment Agency);**
- **Flood Risk Assessment for Planning Applications (Environment Agency);** and,
- **Site-specific Flood Risk Assessment: CHECKLIST (NPPG, Defra).**

The Environment Agency has produced a Flood Zone 3 Fact Sheet which provides information on the requirements for site-specific Flood Risk Assessments for sites in Flood Zone 3 and in the East Anglia area. The Environment Agency has also produced a guidance document called "Flood risk assessment: Climate Change allowances" which details the application of climate change allowances and local considerations in East Anglia. These documents are available from: **https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers**

Developers should consult with the relevant LPA (i.e. Great Yarmouth Borough Council or the Broads Authority), Norfolk County Council, the Environment Agency, Anglian Water and, where necessary, relevant IDBs at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. If applications cross administrative boundaries, the neighbouring LLFA, Suffolk County Council may need to be approached.

Further guidance for developers can be found in Section 8.

Surface water management and SuDS

- Planners should be aware of the conditions and local requirements set by Norfolk County Council, the LLFA, for surface water management for major and minor developments and ensure development proposals and applications are compliant with the LLFA's policy.
- Developers should consult Norfolk County Council's guidance for developers: Norfolk County Council, **Lead Local Flood Authority, Statutory Consultee for Planning, Guidance Document (2017).** The guidance provides information on how SuDS proposals for new developments will be considered by the LLFA, when to consult the LLFA, how to screen applications based on local flood risk and records, LLFA standing advice (for Ordinary Watercourse consenting, major development below LLFA thresholds and minor development), the levels of information required for planning applications and technical guidance. The technical guidance is split into the following themes:
    - Local flood risk guidance
    - Drainage hierarchy
    - Infiltration testing guidance
    - Runoff rates
    - Runoff volumes
    - Climate change
    - Management and maintenance
    - Flood exceedance management
- All new development should aim to minimise areas of impermeable ground to reduce surface water runoff. Sustainable drainage systems (SuDS) should be used on all new development.

- Planners should be aware of local conditions and requirements set by the Waveney, Lower Yare and Lothingland IDB and / or the Water Management Alliance. The Water Management Alliance have published application **guidance notes** and a **SuDS adoption policy**. Nicholsons' Law, which administers the Waveney, Lower Yare and Lothingland IDB, has published a number of guidance documents, available to download from their **website**.
- Developers who wish to have their SuDS schemes considered for adoption by Anglian Water should refer to the **Anglian Water SuDS Adoption Manual**[1]. Anglian Water also expect national guidance (i.e. **the CIRIA C753 SuDS Manual**) to be referred to in addition to Anglian Water's guidance.
- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will provide an appropriate standard of protection from surface water flooding to properties and critical infrastructure from flooding from surface water both on and off site. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. The 2015 **DEFRA non-statutory technical standards for sustainable drainage systems** should be followed, alongside the LLFA guidance note and national guidance.
- For proposed developments, geotechnical investigations should be undertaken to determine whether the ground at the site has infiltration potential. This information should be representative of on-site conditions. If the ground at the site is found to have infiltration potential, detailed infiltration testing should be undertaken in line with BRE 365 to establish representative infiltration rates. The LLFA have published information relating to infiltration tests within their **guidance document.**
- There are no Groundwater Source Protection Zones in the borough (see Section 9.4). Where sites lie within or close to aquifers (see Section 6.2), treatment steps may be required ahead of discharge to the ground, sewers etc. Great Yarmouth and Gorleston also have a number of historic industrial sites and as such, there is a heightened risk of groundwater pollution. Development proposals at sites across the area should assess the pollution risk to receiving waterbodies and include appropriate treatment steps ahead of any discharge to surface or groundwaters. The CIRIA C753 SuDS manual provides further guidance on this issue.
- A management and maintenance plan of sustainable drainage and surface water systems covering the lifetime of the development will be required. Consideration must also be given to the residual risks associated with the use of SuDS.

Further information on surface water and SuDS is provided in Section 9.

Council review of planning applications

The Council should consult the Environment Agency's **'Flood Risk Standing Advice (FRSA) for Local Planning Authorities'**, last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding, as well as the **Broads Supplementary Planning Document** on flood risk (where appropriate). The Council will consult the relevant statutory consultees as part of the planning application assessment and they should also contact non-statutory consultees (e.g. IDBs or Anglian Water) that have an interest in the planning application.

Infrastructure and safe access

Finished floor levels and safe access and egress

Finished floor level guidance has been established through consultation with the Environment Agency. Minimum finished floor levels for development should be set to whichever is the higher of the following:

[1] At the time of preparing this SFRA, Anglian Water's current manual is expected to be revised to take account of national guidance published after the manual and Anglian Water's position regarding health and safety matters associated with open SuDS features.

- a minimum of 300mm* above the 1% AEP fluvial event plus an allowance for climate change
- a minimum of 300mm* above the 0.5% AEP tidal event plus an allowance for climate change
- a minimum of 300mm above surrounding ground levels

*A 300mm freeboard is only applicable where detailed modelling is available which is deemed to be reliable. If no detailed and reliable modelling is available, the Environment Agency may require a 600mm freeboard to be applied when setting minimum finished floor levels.

With regards to LLFA guidance and surface water flood risk, finished floor levels are recommended to be set to a minimum of 300mm above the 1% AEP plus an allowance for climate change flood levels (including anticipated flood levels within the drainage system). If there is an uncertainty in flood levels, the freeboard level should be increased from 300mm to 600mm. The LLFA would also expect a minimum of at least 150mm freeboard between proposed external ground levels and the property finished floor level. Further information can be found in the **LLFA guidance document**.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency and / or LLFA will be required to determine the suitability of alternative flood mitigation approaches.

Safe access and egress will need to be demonstrated at all development sites. Ideally, access should be situated 300mm above the design flood level and waterproof construction techniques used. If safe access and egress cannot be achieved, the **Defra/EA Technical Report: FD2320: Flood Risk Assessment Guidance for New Development** should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site.

Emergency vehicular access should be possible during times of flood.

Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential safety of the development, finished floor levels and the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

Resistance and resilience measures will be required if buildings are situated in the flood risk area, and as applicable in all cases of flood risk, opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. Further information is provided in Section 8.5 and 8.6 and in the publications **"Improving the flood performance of new buildings"** and **"Prepare your property for flooding."**

Dry islands

It is recommended that emergency planners at the local authorities review the outputs of the 2017 SFRA and the areas identified as being located in a dry island. A site-specific Flood Risk Assessment and / or Flood Warning and Evacuation Plan may be required if a proposed development is located within a dry island (even for sites less than 1 hectare and in Flood Zone 1).

Residual risk

Residual risk is the risk that remains after mitigation measures are considered. The residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences or circumstances where there is a failure of the defences, e.g. flood banks collapse, reservoir failure etc. The flood risk analysis in Section 6, indicates that much of the borough is heavily dependent on flood defences to protect settlements from flooding, particularly from tidal / coastal sources. The Environment Agency's 2017 coastal breach modelling of the Norfolk coastline indicates breaches along defences in Great Yarmouth borough pose a significant risk; much of Great Yarmouth town is within the modelled breach flood extents. This is discussed further in Section 7.5. Residual risks should be considered as part of site-specific Flood Risk Assessments.

Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed. Further, any developments located within an area protected by flood risk management measures where the standard of protection is not of the required standard, or where the failure of the intended level of service gives rise to unsafe conditions, should be identified.

Future flood management in Great Yarmouth borough

Green Infrastructure and the Water Framework Directive

Developments should demonstrate opportunities to create, enhance and link green assets. Development that may adversely affect green infrastructure assets should not be permitted.

Strategic flood risk solutions

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within Great Yarmouth borough (see Section 10 for further information). Opportunities could consist of the following:

- Catchment and floodplain restoration;
- Flood storage areas;
- Opening up culverts, weir removal, and river restoration; and
- Green infrastructure.

Cross-boundary partnership working

For successful future flood risk management, it is recommended that local planning authorities adopt a catchment partnership working approach in tackling flood risk and environmental management.

Potential modelling improvements

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. For example, the outputs of the updated BESL hydraulic model were not available at the time of preparing this 2017 SFRA and as such, the functional floodplain and climate change extents associated with this model could not be mapped. The 2008 BESL hydraulic model extent is displayed in Appendix A mapping of all sources of flood risk to provide an indication of the model coverage and it is noted that Flood Zone extents in this area may be subject to change when the model is updated.

As part of a separate commission to the SFRA, the Environment Agency were preparing updated modelling of the Anglian coastline. Where the outputs were available at the time of preparing the 2017 SFRA, these were supplied and used in the assessment. The updated coastal modelling concerning Great Yarmouth borough was available, supplied and used in this 2017 SFRA.

Further information on the hydraulic modelling and mapping approaches used in the 2017 SFRA are provided in Appendix D.

It is important that the Environment Agency are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

Use of Strategic Flood Risk Assessment data

SFRAs are high-level strategic documents and, as such, do not go into detail on an individual site-specific basis. The 2017 SFRA has been developed using the best available information, supplied at the time of preparation, taking into account the latest flood risk information 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. It is this data that guidance singles out as the most appropriate for forward planning.

The accompanying SFRA appendices comprise:

- Appendix A: Mapping of all sources of flood risk across Great Yarmouth borough (historic flooding is not included).
- Appendix B: Watercourses in the Great Yarmouth borough and coverage of IDB districts
- Appendix C: Flood Warning and Flood Alert coverage across Great Yarmouth borough
- Appendix D: Technical Summary including a list of all detailed models used in the 2017 SFRA and a map showing the coverage of these models

The SFRA appendices are published separately to the main SFRA report.

Appendix A is presented in interactive GeoPDFs. An accompanying User Guide is provided with the GeoPDFs which provides step-by step instructions on how to navigate to data and how to use the GeoPDFs. The GeoPDFs can be used to perform high-level screening exercises, to identify whether a location or site has a potential risk of flooding. The GeoPDFs primarily display flood extents and are subject to the limitations of the flood risk datasets that are used. If detailed flood risk information is required (e.g. flood level, depth, velocity and hazard to people information), this should be addressed as part of a Level 2 SFRA and / or as part of a site-specific Flood Risk Assessment. Historic flood events are not presented.

It is important that the 2017 SFRA and appendices are read in conjunction with the Technical Summary provided in Appendix D. The Technical Summary provides further information on the hydraulic modelling and mapping approaches used in the 2017 SFRA.

The SFRA is a tool for refining information on river and sea flooding risk shown on the Environment Agency flood maps. The Environment Agency's Flood Zones, on their Flood Map for Planning website, may differ to the maps in the SFRA for a short period of time. The modelled fluvial and tidal flood risk datasets shown in the 2017 SFRA and Appendix A, will be incorporated into the Environment Agency's flood maps in due course.

At the time of writing, this report was developed using the best available information. However, the 2017 SFRA should be a **'living document'** and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. 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 FRA.

The 2017 SFRA was commissioned by a consortium of Norfolk authorities and was produced in conjunction with the LLFA and Environment Agency. The assistance of these organisations and external stakeholders including IDBs, Anglian Water and planners at the neighbouring authorities and LLFAs, is acknowledged.

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Using this document

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Hyperlinks have been provided where there are useful reference points. These are shown as **red bold text.**

Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability – The probability (expressed as a percentage) of a flood event occurring in any given year.
AStGWf	Areas Susceptible to Groundwater flooding
BFAP	Broadland Flood Alleviation Project
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, Main River and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
Cumecs	The cumec is a measure of flow rate. One cumec is shorthand for cubic metre per second; also m^3/s.
Defra	Department for Environment, Food and Rural Affairs
Designated Feature	A form of legal protection or status reserved for certain key structures or features that are privately owned and maintained, but which make a contribution to the flood or coastal erosion risk management of people and property at a particular location.
Design flood	This is a flood event of a given annual flood probability, which is generally taken as: • fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or; • tidal flooding with a 0.5% annual probability (1 in 200 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.
DTM	Digital Terrain Model
EA	Environment Agency
ESWSL	An ESWSL is the level the sea is expected to reach during a storm event for a particular magnitude of flood event as a result of the combination of astronomical tides and meteorological surges.
EU	European Union
Exception Test	Set out in the NPPF, the Exception Test is a method used to demonstrate that flood risk to people and property will be managed appropriately, where alternative sites at a lower flood risk are not available. The Exception Test is applied following the Sequential Test.
FCERM	Flood and Coastal Erosion Risk Management
FCRMGiA	Defra's Flood and Coastal Erosion Risk Management Grant in Aid
FEH	Flood Estimation Handbook
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Map for Planning	The Environment Agency Flood Map for Planning (Rivers and Sea) is an online mapping portal which shows the Flood Zones in England. The Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences and do not account for the possible impacts of climate change.

Term	Definition
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
FWA	Flood Warning Area
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a Main River
FRA	Flood Risk Assessment - A site-specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
FSA	Flood Storage Area
FWMA	Flood and Water Management Act
FWS	Flood Warning System
GI	Green Infrastructure – a network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and urban fringe
Greenfield	Undeveloped parcel of land
Ha	Hectare
IDB	Internal Drainage Board
Indicative Flood Risk Area	Nationally identified flood risk areas, based on the definition of 'significant' flood risk described by Defra and WAG.
JBA	Jeremy Benn Associates
Jflow	2D generalised hydrodynamic modelling software.
LFRMS	Local Food Risk Management Strategy
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
LPA	Local Planning Authority
m AOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers
NFM	Natural Flood Management
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NRD	National Receptor Database
NRIM	National Reservoir Inundation Mapping
NVZs	Nitrate Vulnerability Zones
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity.
PPS25	Planning Policy Statement 25: Development and Flood Risk – superseded by the NPPF and PPG

Term	Definition
RBMP	River Basin Management Plan
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
Riparian owner	A riparian landowner, in a water context, owns land or property, next to a river, stream or ditch.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Risk Management Authority	Operating authorities who's remit and responsibilities concern flood and / or coastal risk management.
RoFfSW	Risk of Flooding from Surface Water (formerly known as the Updated Flood Map for Surface Water (uFMfSW)
Sequential Test	Set out in the NPPF, the Sequential Test is a method used to steer new development to areas with the lowest probability of flooding.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
SPD	Supplementary Planning Document
SPZ	(Groundwater) Source Protection Zone
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
WFD	Water Framework Directive – Under the WFD, all waterbodies have a target to achieve Good Ecological Status (GES) or Good Ecological Potential (GEP) by a set deadline. River Basin Management Plans (RBMPs) set out the ecological objectives for each water body and give deadlines by when objectives need to be met.

1 Introduction

1.1 Consortium of Norfolk authorities Strategic Flood Risk Assessments

Norfolk Local Planning Authorities (LPAs) have a long track record of co-operation and are working together on strategic cross-boundary planning issues, through the emerging Norfolk Strategic Framework. One of the aims of the emerging framework is to inform the preparation of future Local Plans, through shared objectives and strategic priorities.

Strategic Flood Risk Assessments (SFRAs) form part of the evidence base of the Local Plan. The requirement for the preparation of SFRAs is detailed in paragraph 100 of the **National Planning Policy Framework (NPPF):**

> ***"Local Plans should be supported by a strategic flood risk assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change".*** (National Planning Policy Framework, paragraph 100)

The NPPF also requires that Local Plans are based on adequate, up-to-date and relevant data and evidence; since the publication of the previous SFRAs, flood risk datasets and information has developed and planning and flood risk related policy and guidance has been updated.

A flow chart diagram illustrating **how flood risk information should be taken into account in the preparation of a Local Plan** is shown on the National Planning Practice Guidance (NPPG) website and is replicated in Figure 3-1.

A consortium of Norfolk LPAs, comprising 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, have commissioned new Level 1 SFRAs to inform strategic planning decisions, the preparation of Local Plans and to inform development management decisions. These councils are local planning authorities for their respective administrative areas, with the exception of the Broads Executive Area, where the Broads Authority is the Local Planning Authority.

The new Level 1 SFRAs are split into the following four reports:

- 2017 Greater Norwich Area SFRA covering the Norwich City Council, Broadland District Council, South Norfolk Council and parts of the Broads Authority administrative areas
- 2017 North Norfolk SFRA covering the North Norfolk District Council and parts of the Broads Authority administrative areas
- 2017 Great Yarmouth SFRA covering the Great Yarmouth Borough Council and parts of the Broads Authority administrative areas
- 2017 King's Lynn and West Norfolk SFRA covering the Borough Council of King's Lynn and West Norfolk

Within this 2017 SFRA report, when reference is made to the '*combined study area*' this is the whole area covered by the four reports listed above. The combined study area is shown in Figure 1-1.

1.2 Purpose of the Strategic Flood Risk Assessment

The 2017 SFRA document is one of a series of SFRAs that will replace the following previous SFRAs:

- The Great Yarmouth and Gorleston SFRA originally published in 2009 by Great Yarmouth Borough Council; and,
- The joint North Norfolk District Council, Broadland District Council, The Broads Authority, Norwich City Council and South Norfolk Council SFRA originally published in 2008 by the Partnership of Norfolk District Councils.

The main purpose of the 2017 Great Yarmouth Borough Council SFRA is to inform the selection of options for the Local Plan allocations and support determination of planning applications for Great

Yarmouth borough. The Broads Authority also cover parts of Great Yarmouth borough. The SFRA study area is shown in Figure 1-2.

The key objectives of the 2017 SFRA are:

- To provide up to date information and guidance on flood risk for Great Yarmouth borough, taking into account the latest flood risk information and the current state of national planning policy;
- To determine the variations in risk from all sources of flooding in Great Yarmouth borough, taking into account climate change;
- To identify the requirements for site-specific flood risk assessments;
- To consider opportunities to reduce flood risk to existing communities and developments;
- To enable local authorities in Great Yarmouth borough to apply the Sequential Test;
- To aid authorities in identifying when the Exception Test is required and when a more detailed Level 2 SFRA will be required, when determining strategic site allocations; and,
- To inform the Sustainability Appraisal of the authorities' Local Plans, so that flood risk is taken into account when considering strategic site allocations.

1.3 Levels of SFRA

The NPPG advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1. Level One: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
2. Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances, the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This report fulfils Level One SFRA requirements.

1.4 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding;
- Assessment of the potential impact of climate change on flood risk;
- Mapping of all potential sources of flooding including climate change;
- Mapping of location and extent of functional floodplain;
- Mapping of "dry islands";
- A high-level overview of existing flood risk management infrastructure;
- Mapping of areas covered by Environment Agency Flood Warnings;
- Review of opportunities to reduce flood risk to existing communities and development;
- Guidance for developers including requirements for site-specific flood risk assessments and general advice on the requirements and issues associated with Sustainable Drainage Systems (SuDS); and,
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk.

1.5 SFRA user guide

Table 1-1: User guide

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2. The Planning Framework and Flood Risk strategic documents	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
3. The sequential, risk-based approach	Describes the Sequential Approach and application of Sequential and Exception Tests.
4. Climate change	Outlines climate change guidance and the implications for Great Yarmouth borough.
5. Sources of information used in preparing the SFRA	Outlines what information has been used in the preparation of the SFRA.
6. Understanding flood risk in Great Yarmouth borough	Gives an introduction to the assessment of flood risk and provides an overview of the characteristics of flooding affecting the study area. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered.
7. Fluvial and coastal defences	Assessment of residual risk from flood defences, including future protection from climate change.
8. FRA requirements and flood risk management guidance	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the EA and LLFAs that should be followed.
9. Surface water management and SuDS	Advice on managing surface water run-off and flooding.
10. Strategic flood risk solutions	Summary of strategic options that can be considered by commissioning authorities and their partners, to avoid, control, mitigate and / or reduce flood risk in Great Yarmouth borough.
11. Summary	Summary of SFRA findings.
12. Recommendations	Summary of recommendations.
Appendix A: Mapping of all sources of flood risk across Great Yarmouth borough	Interactive GeoPDF mapping of flood risk from all sources including the functional floodplain (Flood Zone 3b) and climate change mapping, to Great Yarmouth borough. Historic flood events are not mapped.
Appendix B: Watercourses in Great Yarmouth borough and coverage of IDB districts	Maps showing the location of watercourses in the borough of Greater Yarmouth including Main Rivers, Ordinary Watercourses and IDB districts.
Appendix C: Flood Alert and Flood Warning coverage across Great Yarmouth borough	Maps showing the extent of the Environment Agency's Flood Warning System.
Appendix D: Technical Summary	A technical summary, providing supporting information on the methodology used in this SFRA. A map showing those watercourses with detailed hydraulic models across the combined study area. A table which lists all detailed hydraulic models supplied for use in this commission and covers the combined study area. This table identifies those models which have been used to inform Flood Zone 3b and the climate change extents across the combined study area; the models listed in this table are those available and supplied at the time of preparing the 2017 SFRA report.

1.6 Consultation

The following parties (external to Great Yarmouth Borough Council and the Broads Authority) have been consulted during the preparation of the SFRA:

- Environment Agency
- Norfolk County Council (as Lead Local Flood Authority [LLFA] and as Highways Authority)
- Anglian Water
- Highways England
- Internal Drainage Boards (IDBs)
- Neighbouring authorities and LLFAs

1.7 Use of SFRA data

1.7.1 SFRA information and updates

It is important to recognise that SFRAs are high-level strategic documents and, as such, do not go into detail on an individual site-specific basis. The 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. It is this data that guidance identifies as being most influential for forward planning.

The accompanying SFRA appendices comprise:

- Appendix A: Mapping of all sources of flood risk across Great Yarmouth borough
- Appendix B: Watercourses in the Great Yarmouth borough and coverage of IDB districts
- Appendix C: Flood Alert and Flood Warning coverage across Great Yarmouth borough
- Appendix D: Technical Summary including a list of all detailed models used in the 2017 SFRA and a map showing the coverage of these models

The SFRA appendices are published separately to the main SFRA report.

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

The datasets shown in GeoPDFs have not been trimmed to the individual SFRA study area; there is some overlap into neighbouring authority areas. This approach was agreed with the commissioning authorities in order to highlight that flood risks cross administrative boundaries and to reinforce the need for continuous partnership working with the consortium of Norfolk LPAs and their partners. It should also be noted that some datasets were supplied showing information clipped to Norfolk County Council's administrative boundary.

The GeoPDFs can be used to perform high-level screening exercises, to identify whether a location or site has a potential risk of flooding. The GeoPDFs show flood extent information and do not show flood levels, depths, velocities or hazard to people information. If flood level, depth, velocity and hazard to people information is required, this should be addressed as part of a Level 2 SFRA and / or as part of a site-specific Flood Risk Assessment.

The GeoPDFs are subject to the limitations of the flood risk datasets, for example:

- 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 (e.g. some ordinary watercourses and / or drains managed by Internal Drainage Boards). As such, whilst a location can be shown to be outside of Flood Zones 2 and 3, this does not necessarily mean that it is not at risk of fluvial flooding, as the lack of flood extent is due to a lack of data rather than indicating there is no risk.
- In certain areas, hydraulic models are in the process of being updated at the time of preparing the 2017 SFRA, e.g. the BESL model is being updated and thus the Flood Zone coverage in this area is subject to change, following completion of the modelling work.

It is important that this SFRA and appendices are read in conjunction with the Technical Summary provided in Appendix D. The Technical Summary provides further information on the hydraulic modelling and mapping approaches used in the 2017 SFRA.

The SFRA is a tool for refining information on river and sea flooding risk shown on the Environment Agency flood maps. The Environment Agency's Flood Zones, on their Flood Map for Planning website, may differ to the maps in the SFRA for a short period of time. The modelled fluvial and tidal flood risk datasets shown in the 2017 SFRA and Appendix A, will be incorporated into the Environment Agency's flood maps in due course.

At the time of writing, this report was developed using the best available information. However, this SFRA should be a **'living document'** and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by the commissioning local planning authorities, Norfolk County Council (including as Highways Authority), Highways England, IDBs, Anglian Water and the Environment Agency. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

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 FRA.

The 2017 SFRA was commissioned by a consortium of Norfolk authorities and was produced in conjunction with the LLFA and Environment Agency. The assistance of these organisations and external stakeholders including IDBs, Anglian Water and planners at the neighbouring authorities and LLFAs, is acknowledged.

Figure 1-1: Combined study area

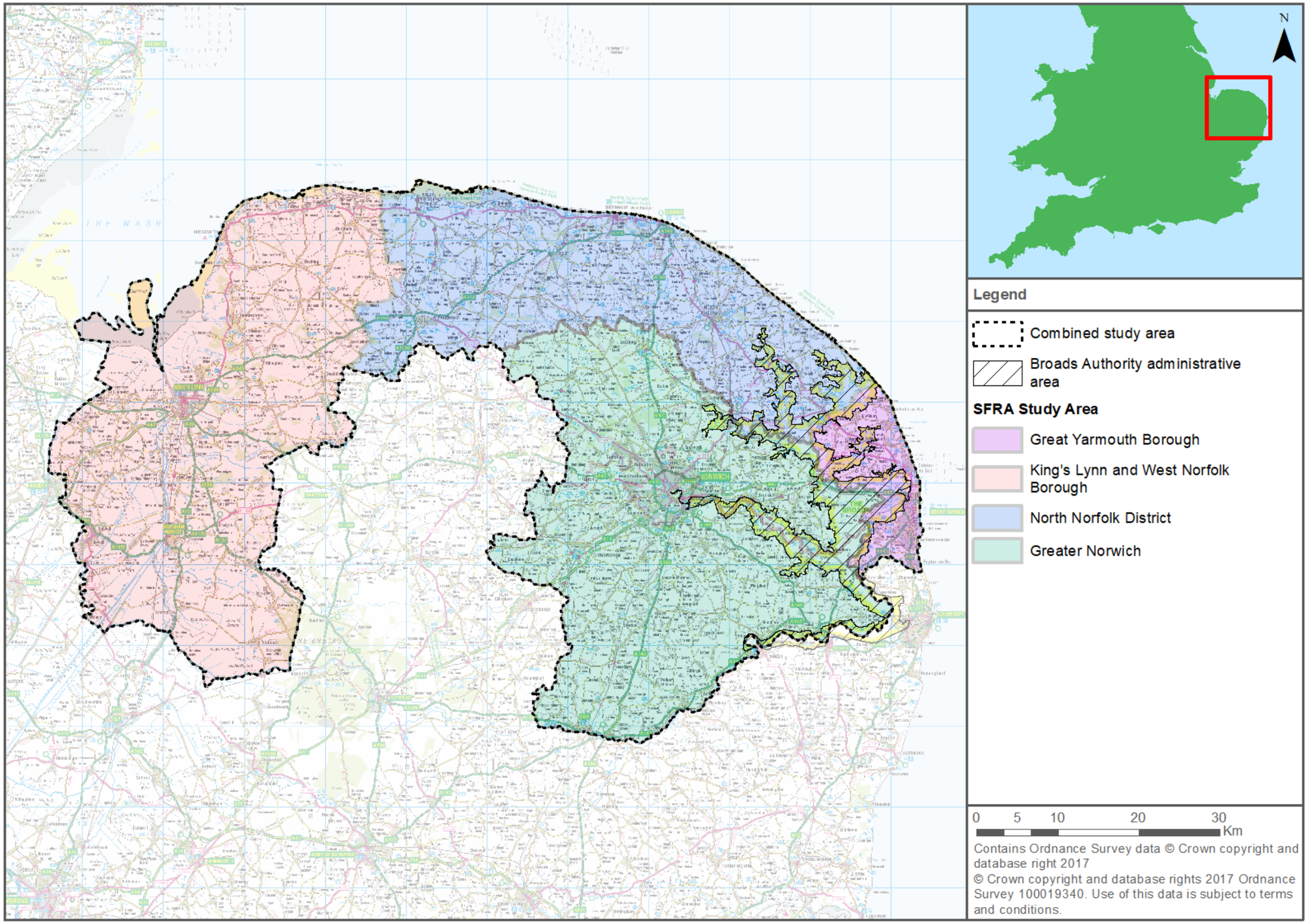
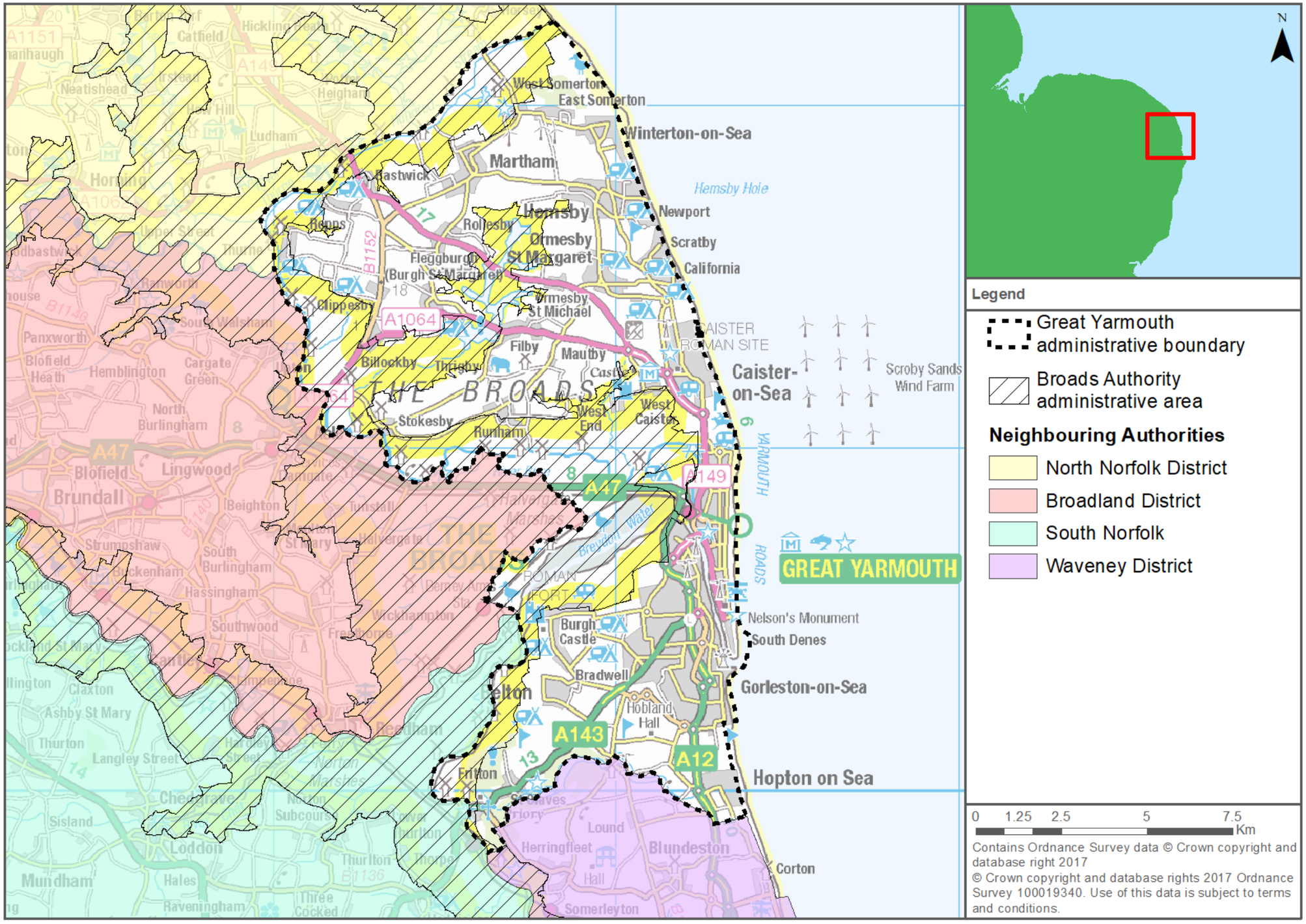


Figure 1-2: Great Yarmouth SFRA study area



2 The Planning Framework and Flood Risk strategic documents

2.1 Introduction

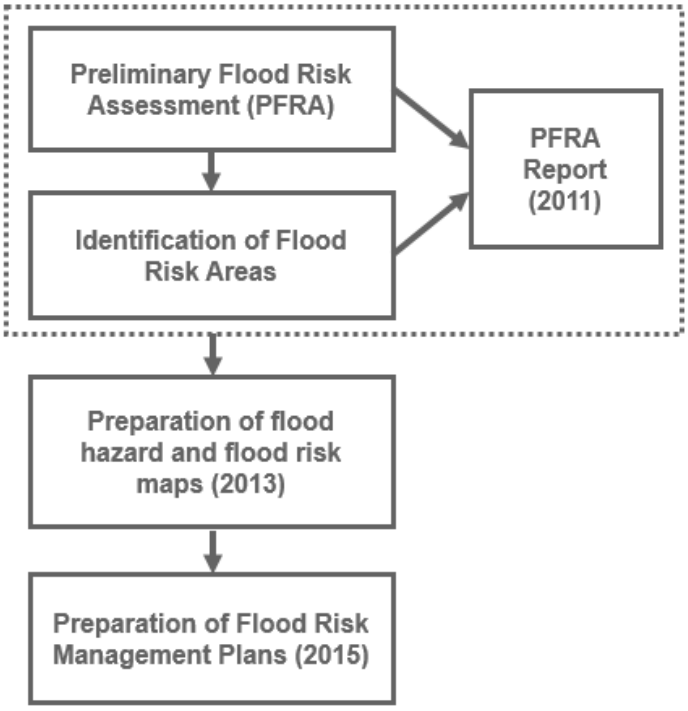
The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and strategic documents and flood risk responsibilities.

2.2 Flood Risk Regulations (2009) and Flood and Water Management Act (2010)

The Flood Risk Regulations (2009) translate the current EU Floods Directive into UK law and place responsibility upon all LLFAs to manage localised flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; however, responsibility for local and all other sources of flooding rests with LLFAs. In the instance of this SFRA, the LLFA is Norfolk County Council. Details on the responsibilities of LLFAs are provided in Section 2.12.3.

Figure 2-1 illustrates the steps taken to initially implement the requirements of the EU Directive in the UK via the Flood Risk Regulations.

Figure 2-1: Flood Risk Regulation Requirements



The next cycle of the Flood Risk Regulations has now begun (2015 – 2021). The Environment Agency issued guidance on the process to be adopted and made provision for LLFAs to prepare updated information by June 2017.

2.2.1 Norfolk County Council Preliminary Flood Risk Assessment (PFRA) (2011)

Under this action plan and in accordance with the Regulations, LLFAs initially had the task of preparing the first Preliminary Flood Risk Assessment (PFRA) report.

PFRAs report on significant past and future flooding from all sources except from Main Rivers and reservoirs, which are covered by the Environment Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Anglian Water). PFRAs are a high-level screening exercise and consider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The **PFRA document** that covers

the study area was published by Norfolk County Council in 2011. The Regulations require the LLFA to identify significant Flood Risk Areas. The threshold for designating significant Flood Risk Areas is defined by Defra and the PFRA is the process by which these locations can be identified.

Of the ten national indicative Flood Risk Areas that were identified by the Defra/Environment Agency, none encroach on the administrative area of Great Yarmouth Borough Council.

However, the PFRA process has acknowledged that there is a high risk of flooding from local sources across the county. Based on national surface water modelling, approximately 37,000 properties in the county are estimated to be at risk of flooding during a rainfall event with a 1 in 200 annual chance of occurring. Through this process, Norfolk was recognised as the 10th most at risk area out of 149 authorities.

As part of the ongoing PFRA second cycle review, the Environment Agency has produced updated Indicative Flood Risk Areas (2016). No new indicative Flood Risk Areas have been identified within Great Yarmouth borough, however, until the final 2017 PFRA report is reviewed and agreed by EA and published by the LLFA, this analysis remains provisional.

2.2.2 Flood Risk Management Plans (FRMPs)

Under the Regulations the Environment Agency exercised an 'Exception' during the initial round of assessment and did not prepare a PFRA for risk from rivers, reservoirs and the sea. Instead they prepared and published a FRMP to meet the requirements of the Regulations. The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations. The **Anglian River Basin District Flood Risk Management Plan** (FRMP) was issued in March 2016 and covers the period of 2015 to 2021. The FRMP draws on policies and actions identified in Catchment Flood Management Plans (Section 2.7) and also incorporates information from Local Flood Risk Management Strategies (Section 2.2.4). The Plan will be updated as part of the new cycle of the Flood Risk Regulations and is due to be published in December 2021.

2.2.3 Flood and Water Management Act (FWMA), 2010

Following the 2007 floods, Sir Michael Pitt was appointed to chair an independent review into the floods. The **final report** was published in June 2008. The **Flood and Water Management Act** (2010) implements many of Sir Michael Pitt's recommendations and aims to create a simpler and more effective means of managing both flood risk and coastal erosion.

The FWMA established Lead Local Flood Authorities (LLFAs). Norfolk County Council is the LLFA for the Great Yarmouth borough. Further information on the LLFA role and responsibilities are provided in Section 2.12.3.

2.2.4 Norfolk Local Flood Risk Management Strategy (LFRMS) (2015)

Norfolk County Council is responsible for developing maintaining, applying and monitoring a **Local Flood Risk Management Strategy** (LFRMS) for Norfolk, which includes Great Yarmouth borough. The Strategy is used as a means by which the LLFA co-ordinates Flood Risk Management on a day to day basis. The Strategy also sets measures to manage local flood risk i.e. flood risk from surface water, groundwater and Ordinary Watercourses.

The aim of the Norfolk LFRMS is:

To work with organisations, businesses and communities to manage flood risk and, where it is practicable, affordable and sustainable to do so, to reduce risk to life, property and livelihoods that may arise from local surface runoff, Ordinary Watercourse and groundwater flooding.

The LFRMS will seek to implement the following strategic objectives:

- **Objective 1**: Determine and communicate Local Flood Risk
- **Objective 2**: Partnership Working
- **Objective 3**: Partnership Programmes and Projects
- **Objective 4**: Riparian Responsibilities
- **Objective 5:** Flood Risk and Development
- **Objective 6**: Water Framework Directive

- **Objective 7:** Support Water and Sewerage Company infrastructure

Norfolk County Council have advised that LFRMS policies UC10 (Planning) and UC11 (Securing Sustainable Drainage (SuDS) apply across Norfolk including the SFRA study area.

2.2.5 The National Flood and Coastal Erosion Risk Management Strategy for England (2011)

The **National Flood and Coastal Erosion Risk Management Strategy** for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. It was prepared by the Environment Agency with input from Defra.

The Strategy builds on existing approaches to flood and coastal risk management and promotes the use of a wide range of measures to manage risk. It describes how risk should be managed in a co-ordinated way within catchments and along the coast, and balances the needs of communities, the economy and the environment.

The strategy encourages more effective risk management by enabling people, communities, business, infrastructure operators and the public sector to work together to:

- ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risk;
- manage flood and coastal erosion risks in an appropriate way, taking account of the needs of communities and the environment;
- ensure that emergency plans and responses to flood incidents are effective and that communities are able to respond effectively to flood forecasts, warnings and advice; and,
- help communities to recover more quickly and effectively after incidents.

2.3 National Planning Policy and Guidance

The **National Planning Policy Framework** (NPPF) was issued in 2012 to replace the previous documentation as part of reforms to make the planning system less complex and more accessible, and to protect the environment and promote sustainable growth. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs) that were referred to in the previous version of the SFRA. The NPPF sets out the Government's requirements for the planning system and provides a framework within which local people and councils can produce distinctive local and neighbourhood plans to reflect the needs and properties of their communities. The NPPF must be taken into account by Local Planning Authorities (LPAs) when preparing Local Plans and for applicants preparing planning submissions.

National Planning Practice Guidance (NPPG) was published in 2014 and sets out how the NPPF should be implemented. **NPPG: Flood Risk and Coastal Change** advises on how planning can account for the risks associated with flooding and coastal change in plan making and the application process. It sets out Flood Zones, the appropriate land uses for each Flood Zone, flood risk assessment requirements, including the Sequential and Exception Tests and the policy aims for developers and authorities regarding each Flood Zone. Further details on Flood Zones and associated policy is provided in Table 3-1 and throughout this report. The Sequential and Exception tests are covered in greater detail in Section 3.

The Sequential Test

"The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones, as refined in the Strategic Flood Risk Assessment for the area, provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required".

(National Planning Practice Guidance, paragraph 019)

The Exception Test

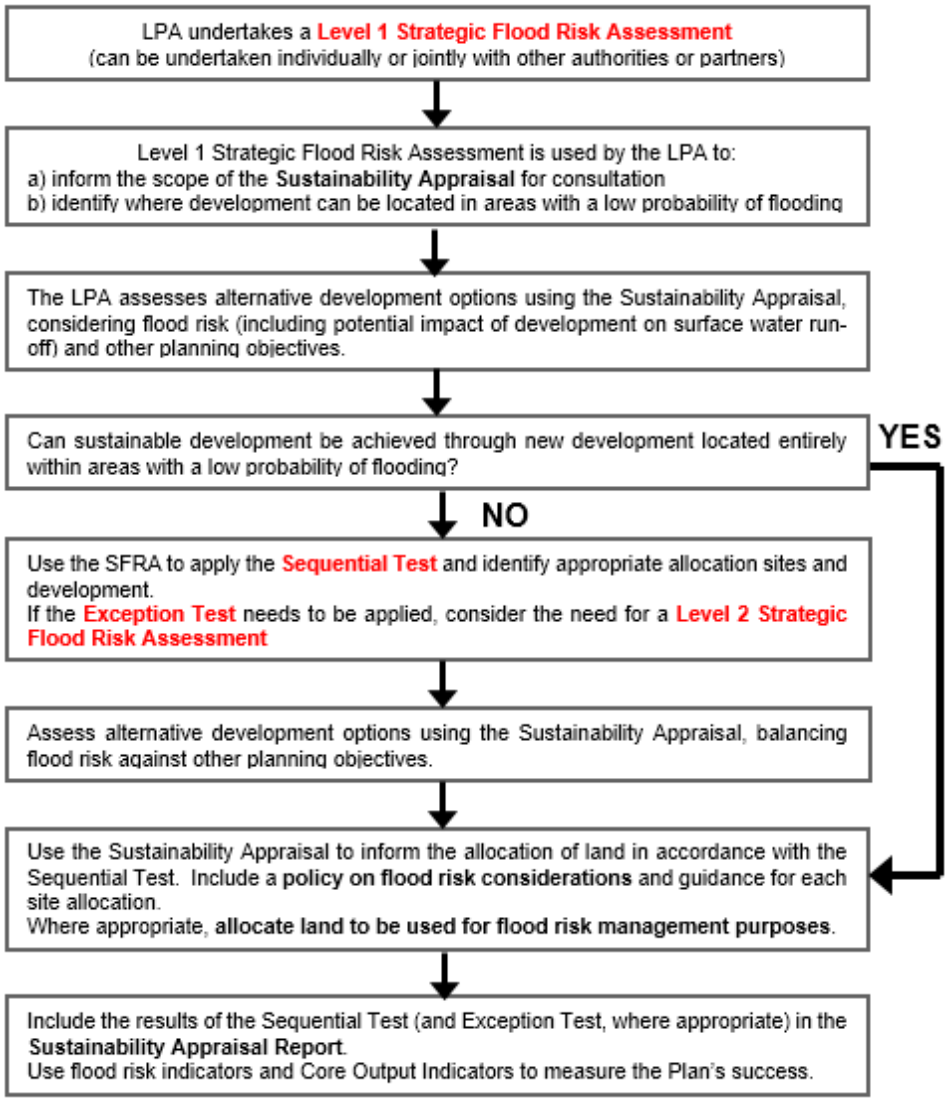
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.".

(National Planning Practice Guidance, paragraph 023)

A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance (Figure 2-2).

Figure 2-2: Flood Risk and the preparation of Local Plans†



† Diagram 1 of NPPG: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

2.4 Broads Flood Risk Supplementary Planning Document

Supplementary Planning Documents (SPDs) are intended to expand upon policy or provide further detail to policies in adopted Development Plan Documents. When adopted, SPDs form part of the Development Plan.

The **Broads SPD** has been prepared by the Broads Authority and covers part of the Great Yarmouth borough. The SPD was adopted in March 2017 and the purpose is to increase awareness of the nature of flood risk in the Broads area, give advice to developers and others about the Authority's approach to the issue of development and flood risk, and stress the need to maintain a high standard of design in new waterside development.

The SPD provides details on understanding flood risk in the Broads area, making and assessing a planning application, reducing the flood risk to development and other important considerations.

2.5 Planning, surface water and SuDS

On 18 December 2014 a **Written Ministerial Statement** laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015.

Major developments are defined as

- Residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more.

When considering major planning applications, LPAs should consult the LLFA on the management of surface water in order to satisfy that:

- the proposed minimum standards of operation are appropriate
- there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

In March 2015, the LLFA was made a statutory consultee which came into effect on 15 April 2015. As a result, Norfolk County Council, is required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Norfolk County Council has published a guidance document regarding their Lead Local Flood Authority role as Statutory Consultee to Planning (2017). In this **document**, there are thresholds where the LLFA will provide bespoke advice; the thresholds are

- Residential development with greater than or equal to 100 properties.
- All developments with an area greater than or equal to 2 hectares.

The guidance document notes that these thresholds are periodically reviewed and thus these are subject to change.

In addition, the LLFA will aim to provide bespoke consultation responses for the following application types:

- *"All residential development applications where the number of units is greater than or equal to the LLFA threshold. This would include individual applications of a multi-phased development that in total would be equivalent to or greater than the LLFA threshold.*
- *All other development applications with an area greater than or equal to the LLFA threshold.*
- *Any major development applications that have a local flood risk and are on an obvious flow route or include extensive surface water or fluvial flooding on the site. Significant ponding of surface water over a large proportion of the site boundary also falls within this category…*
- *Sites adjacent to, or within, areas with records of local flooding (as evidenced and provided by the LLFA)."*

LLFA standing advice is provided in this document for major developments which fall below the LLFA thresholds and for minor development. Further information on this document can be found in Section 2.5.2. The guidance document has also been referred to through Sections 8 and 9.

2.5.1 Defra Non-Statutory Technical Standards for SuDS

On March 23 2015, the Department for Environment, Food and Rural Affairs (Defra) published the **Non-Statutory Technical Standards for SuDS**. The standards should be used in conjunction with the NPPF and NPPG. These standards cover the following

- Flood risk outside the development
- Peak flow control
- Volume control
- Flood risk within the development
- Structural integrity
- Designing for maintenance considerations
- Construction

2.5.2 Guidance on Norfolk County Council's Lead Local Flood Authority role as Statutory Consultee to Planning (2017)

This **document** was published to support the development of Norfolk County Council's LLFA role as a statutory consultee to planning and to inform stakeholders in this process such as LPAs and developers. The document is split into three parts and aims to:

Part A

- Highlight recent changes in planning policy with regard to surface water drainage.
- Explain the role of the LPA in determining Sustainable Drainage Systems (SuDS) proposals on new developments.
- Outline Norfolk County Council's LLFA role as a statutory consultee to planning.

Part B

- Explain how the LLFA will fulfil this function and when it should be consulted

Part C

- Provide guidance for developers on the information required by the LLFA from applicants to enable it to provide responses to major planning applications.

2.5.3 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high-level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

2.5.4 Anglian Water SuDS Handbook

Where developers and applicants are considering applying to Anglian Water to adopt SuDS features, reference should be made to **Anglian Water's SuDS handbook**.

2.6 Surface water management plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken, when required, by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

2.6.1 Great Yarmouth Borough Surface Water Management Plan: Stage 1 and Stage 2 reports (2014)

Stage 1 of the **Great Yarmouth Borough SWMP** involved putting together a steering group to manage the project, gathering all available and relevant data and starting engagement with local resilience groups and councillors.

The steering group consists of officers from Anglian Water, the Broads Authority, the Environment Agency, Great Yarmouth Borough Council, Norfolk County Council and local Internal Drainage Boards.

The report collated all available data and identified gaps. Historic flood events and predicted flood risk from new surface water flood maps were analysed to set the overall objectives of the SWMP, identify the priority settlements for this project and determine the approach and level of assessment for Stage 2 of the SWMP.

Stage 2 of the Surface Water Management Plan involved assessments of all the identified settlements and the construction of flood prediction models for the highest priority areas. This led to the production of flood risk maps and a range of mitigation measures intended to lessen the flood risk or impact of flooding.

2.7 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Policy Units'. These policies are intended to cover

the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The six national policies are:

1. No active intervention (including flood warning and maintenance). Continue to monitor and advise.
2. Reducing existing flood risk management actions (accepting that flood risk will increase over time).
3. Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline).
4. Take further action to sustain the current level of flood risk (responding to the potential increases in risk from urban development, land use change and climate change).
5. Take action to reduce flood risk (now and/or in the future).
6. Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

2.7.1 Broadland Rivers CFMP (2009)

The study area is covered by the **Broadland Rivers CFMP**. The following policies apply to the Great Yarmouth area:

- **Policy 1 – Breydon Water.** Areas of low to moderate flood risk where action with others to store water or manage run-off (in locations that provide overall flood risk reduction or environmental benefits) will be undertaken.
- **Policy 3 – Fluvial/ Tidal Rivers and Tidal Broads and Buxton.** Areas of low to moderate flood risk where existing flood risk is generally managed effectively.
- **Policy 5 – Great Yarmouth town.** Areas of moderate to high flood risk where further action to reduce flood risk can generally be taken.

The Broadland Rivers CFMP provides proposed actions for each sub-area.

The 2017 SFRA will help support the above policies in the CFMPs by aiding LPAs to make informed decisions about the location of future development, as well as identifying where future flood risk management measures may be required.

2.8 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts. Great Yarmouth borough falls within the Anglian River Basin District.

The updated 2015 **Anglian RBMP** identified a number of pressures on the water environment and significant water management issues.

The RBMP describes how development and land-use planning needs to consider a number of issues relevant to the RBMP including sustainable drainage systems, green and blue infrastructure, sewage treatment options (tertiary phosphate treatments), water efficiency measures, infrastructure and development locations and the reduction of nutrients from diffuse pollution. The RBMP provides a summary of measures to protect and improve the water environment in the river basin district.

2.9 Shoreline Management Plans

Shoreline Management Plans (SMP) form part of Defra's strategy for flood and coastal defence. They provide a large-scale assessment of risks associated with coastal evolution and present the policy framework to address these risks in a sustainable manner. The SMP policies defined by Defra are:

- **Hold the line** – maintain or upgrade the level of protection provided by defences.
- **Advance the line** – build new defences seaward of the existing defence line.
- **Managed realignment** – allowing retreat of the shoreline, with management to control or limit the movement.

- **No active intervention** – a decision not to invest in providing or maintaining defences.

The coastline of Great Yarmouth borough is covered by **SMP 6: Kelling Hard to Lowestoft Ness (2012)**. Further information about the Kelling Hard to Lowestoft Ness SMP can be found in Section 10.1.

2.10 Water Cycle Studies

Climate Change is predicted to present unprecedented new challenges, such as more frequent and extreme rainfall events and rising global temperatures, which are expected to exert greater pressure on the existing infrastructure. Planning for water management therefore has to take these potential challenges into account. A large number of new homes for instance may cause the existing water management infrastructure to be overwhelmed which would result in adverse effects on the environment, both locally and in wider catchments.

Water Cycle Studies assist Local Authorities to select and develop sustainable development allocations so that there is minimal impact on the environment, water quality, water resources, and infrastructure and flood risk. This can be achieved in areas where there may be conflict between any proposed development and the requirements of the environment through the recommendation of potential sustainable solutions.

2.10.1 Water Cycle Strategy Scoping Study (2009)

Waveney District Council and Great Yarmouth Borough Council have produced a **Joint Water Cycle Strategy Scoping Study**. Within the scoping study, provisional baseline capacities for the major constraints to development within Great Yarmouth borough were provided. This indicated that there were significant existing constraints on the environment, flood risk and hydrology. The scoping study also identified constraints on water resources/supply and wastewater treatment capacity which would require further investigation before development could take place. The constraints on the sewer network capacity were to be confirmed.

2.11 Riparian ownership

A riparian owner is the person who owns the land on which, or adjacent to, a watercourse flows through. The law presumes, in the absence of any other evidence, that the land adjoining the watercourse includes the watercourse to its mid-point; therefore, there may be more than one riparian owner of a watercourse.

Anyone with a watercourse in or adjacent to their land has rights and responsibilities as a riparian owner. The Environment Agency, local authority and other risk management authorities have permissive powers to work on watercourses under their jurisdiction, however, they are not required to do so.

Under land drainage law, watercourses cannot be obstructed and the riparian owner must accept water flowing onto their land.

Further information on the rights and responsibilities of riparian owners can be found on:

- Norfolk County Council **website**
- The Environment Agency publication **'Living on the Edge'**[2].

2.12 Roles and responsibilities of Risk Management Authorities

The roles and responsibilities of Risk Management Authorities (RMAs) in Great Yarmouth borough are summarised as follows.

2.12.1 Great Yarmouth Borough Council

As a LPA, Great Yarmouth Borough Council assess, consult on and determine whether or not development proposals are acceptable, ensuring that flooding and other, similar, risks are effectively managed.

[2] At the time of preparing this SFRA, the 'Living on the Edge' Environment Agency publication is in the process of being updated, as the existing publication refers to Flood Defence Consents which are no longer used.

The council will consult relevant statutory consultees as part of planning application assessments and may, in some cases, also contact non-statutory consultees, such as IDBs and Anglian Water, that have an interest in the planning application.

2.12.2 The Broads Authority

The Broads Authority manages the Broads, primarily for the purposes of:

- Conserving and enhancing the natural beauty, wildlife and cultural heritage of the Broads;
- Promoting opportunities for the understanding and enjoyment of the special qualities of the Broads by the public; and
- Protecting the interests of navigation

The Broads Authority is a LPA for the Broads Executive Area and advises developers / planning applicants on flood risk, sustainable building design and development[3].

The Broads Authority will consult relevant statutory consultees as part of planning application assessments and may, in some cases, also contact non-statutory consultees, such as IDBs and Anglian Water, which have an interest in the planning application.

2.12.3 Norfolk County Council

As a LLFA, Norfolk County Council duties include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood Investigations: When appropriate and necessary, LLFAs must investigate and report on flooding incidents (Section 19 investigations). A Section 19 Investigation may be carried out due to the following types of flooding in Norfolk:
    - Any risk to life or serious injury
    - One or more properties flooded internally; and/or one or more properties rendered inoperable or their functions severely compromised due to the access to the premises being impassable
    - Any section of a national category 3 road or above made impassable due to flooding; and/or flooding to priority 1 and 2 gritting routes.

  Section 19 reports are available to download from Norfolk County Council's **website**.
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate, LLFAs will perform consenting of works on Ordinary Watercourses. Standing advice on Ordinary Watercourse consenting is provided in Norfolk County Council's **guidance document** on the Lead Local Flood Authority's role as Statutory Consultee to Planning (2017). Norfolk County Council is a statutory consultee on planning for surface water flooding.

Norfolk County Council is also the Local Highway Authority and manages highway drainage, carrying out maintenance and improvement works on an on-going basis, as necessary, to maintain existing standards of flood protection for highways, making appropriate allowances for climate change. It also has the responsibility to ensure highway projects do not increase flood risk.

2.12.4 Environment Agency

The Environment Agency is responsible for protecting and enhancing the environment as a whole and contributing to the government's aim of achieving sustainable development in England and Wales. The Environment Agency has powers to work on Main Rivers to manage flood risk. These

[3] The Changing Broads? The Broads Climate Adaptation Plan 2016

powers are permissive, which means they are not a duty, and they allow the Environment Agency to carry out flood and coastal risk management work and to regulate the actions of other flood risk management authorities on Main Rivers and the coast.

The EA also has powers to regulate works to Main Rivers and sea defences. Under the Environmental Permitting Regulations (England and Wales) 2016, an environmental permit may be required for flood risk activities for work in, under, over or within 8 metres of any fluvial Main River, flood defence structure or culvert and within 16m of any tidal Main River, flood defence structure or culvert. A permit for works on the floodplain may also be required, beyond the 8/16m distance for work that is likely to divert or obstruct floodwaters, damage any river control works or affect drainage. Application forms and further information can be found on the government's website: **https://www.gov.uk/guidance/flood-risk-activities-environmental-permits.**

The Environment Agency also has a strategic overview role across all types of flooding.

2.12.5 Internal Drainage Boards (IDBs)

IDBs are local public authorities that manage water levels. They are an integral part of managing flood risk and land drainage within areas of special drainage need in England and Wales. Great Yarmouth borough lies within the Water Management Alliance (the Broads IDB) and the Waveney, Lower Yare and Lothingland IDB.

Roles and responsibilities for IDBs include the following:

- IDBs have permissive powers to undertake work to provide water level management within their Internal Drainage District. They undertake works to reduce flood risk to people and property and manage water levels for local needs, this includes the maintenance of rivers, drainage channels, outfalls and pumping stations
- The IDBs input into the planning system by facilitating the drainage of new and existing developments within their districts and advising on planning application. However, they are not a statutory consultee to the planning process
- In some cases, a development meeting the following criteria may be required to submit an FRA to the IDB to support any consent applications:
    - Development within or adjacent to a drain/watercourse, and/or flood defence structure within the area of an IDB
    - Development within the channel of any Ordinary Watercourse within an IDB area
    - Where direct discharge of surface water or treated effluent is proposed into an IDB catchment
    - Any development proposal affecting more than one watercourse in an IDB's area and having possible strategic implications
    - Development in an IDB that is an area of known flood risk
    - Development within the maintenance access strips provided under the IDB's bylaws
    - Any other application that may have material drainage implications
- Some IDBs have other duties, powers and responsibilities under specific legislation

2.12.6 Water and wastewater providers

Anglian Water is the sewerage undertaker for Great Yarmouth borough. Water and sewerage companies including Anglian Water are responsible for managing the risks of flooding from surface water and foul or combined sewer systems.

Anglian Water provides a pre-planning service to provide a feasible water and/or drainage solution for planning application purposes. There is no requirement to request pre-planning report, however Anglian Water encourage developers to make use of our services before submitting a planning application where the site is of a significant scale. Further information can be found on the Anglian Water **website**.

Two different water service providers, Essex and Suffolk Water and Anglian Water, supply potable water to Great Yarmouth borough. Consent, prior to commencing work, is required from the relevant provider if installing water systems, or altering existing systems, is intended

2.13 When to consult authorities in Great Yarmouth borough

Table 2-1 summarises when the different risk management authorities should be consulted.

Table 2-1: When to consult authorities in Great Yarmouth borough

Key Authority	When to consult
Great Yarmouth Borough Council and the Broads Authority	Pre-application consultation is recommended to identify the range of issues that may affect the site and, following on from the Sequential and, if necessary, Exception Test, determine whether the site is suitable for its intended use. Should be consulted where an awarded watercourse runs within or adjacent to proposed development consultation.
Environment Agency	Should be **consulted** on development, other than minor or as defined in the Environment Agency's Flood Risk Standing Advice document within Flood Zone 2 or 3, or in Flood Zone 1 where critical drainage problems have been notified to the LPA. Consultation will also be required for any development projects within 20m of a Main River or flood defence.
Norfolk County Council (LLFA)	Where the proposed work will either affect or use an Ordinary Watercourse or require consent permission, outside of an IDB's rateable area. As of the 15th April 2015 the LLFA should be consulted on surface water drainage proposal for all major developments.
Norfolk County Council (Local Highway Authority)	Where the proposed development will either involve a new access to the local highway network or increase or change traffic movements.
Highways England	When the quality and capacity of the **Highways England** (strategic) road network could be affected.
Historic England	Whilst Historic England are not a RMA, they should be consulted where proposals may affect heritage assets and their settings.
Natural England	**Natural England** has mapped 'risk zones' to help developers and LPAs determine whether consultation is required. This is likely where water bodies with special local or European designations (e.g. SSSI or Ramsar) exists.
Anglian Water	Where **connection to surface water sewers** is required, or where the flow to a public sewerage system may be affected Where new connections to the water supply network are required or if any alterations are made to existing connections. Anglian Water would wish to comment on major planning applications in the area (10 or more dwellings) or 0.5 ha or more for employment where it proposed to connect to the public sewerage network.
Essex and Suffolk Water	Where new connections to the water supply network are required or if any alterations are made to existing connections.
Water Management Alliance (covering Norfolk Rivers IDB and the Broads IDB)	Where proposed development is in, or in close proximity to, an IDB district.
Waveney, Lower Yare and Lothingland IDB.	

3 The sequential, risk-based approach

3.1 The sequential, risk-based approach

This approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible.

The sequential approach can be applied both between and within Flood Zones.

When drawing up a Local Plan, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances, the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale and nature of the flood risks is required.

3.1.1 Flood Zones

Table 1 of NPPG Flood Risk and Coastal Change identifies the following Flood Zones. These apply to both Main River and Ordinary Watercourses. Flood risk vulnerability and Flood Zone compatibility is set out in **Table 3** of the NPPG. Table 3-1 summarises this information and also provides information on when an FRA would be required.

Table 3-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
Zone 2	Medium	This zone 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.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) are appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3a	High	This zone 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.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. LPAs should identify, in their SFRA, areas of functional floodplain, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. They must also be safe for users and not increase flood risk elsewhere. Essential Infrastructure will only be permitted if it passes the Exception Test.
		All developments in this zone require an FRA.

Further definition of Zone 3b:

This Flood Zone comprises land where water has to flow or be stored in times of flood (the functional floodplain). 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), 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 annual probability) results were used as an alternative. In Appendix A, Flood Zone 3b is identified in the Flood Zone mapping.

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. In the Appendix A mapping of all sources of flood risk, this precautionary approach is represented as a separate layer and is termed 'indicative extent of Flood Zone 3b'. If a proposed development is shown to be in Flood Zone 3, 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.

The presence of defences are considered when mapping Flood Zone 3b, but if these defences are overtopped during a flood with a 5% chance in each and every year then the mapping will show that the Zone affects land behind defences. Under climate change conditions this effect can result in the extent of the Zone increasing substantially and in such circumstances decisions on land allocation or planning applications should review and take account of the implications of this effect and whether such land should be regarded as functional floodplain.

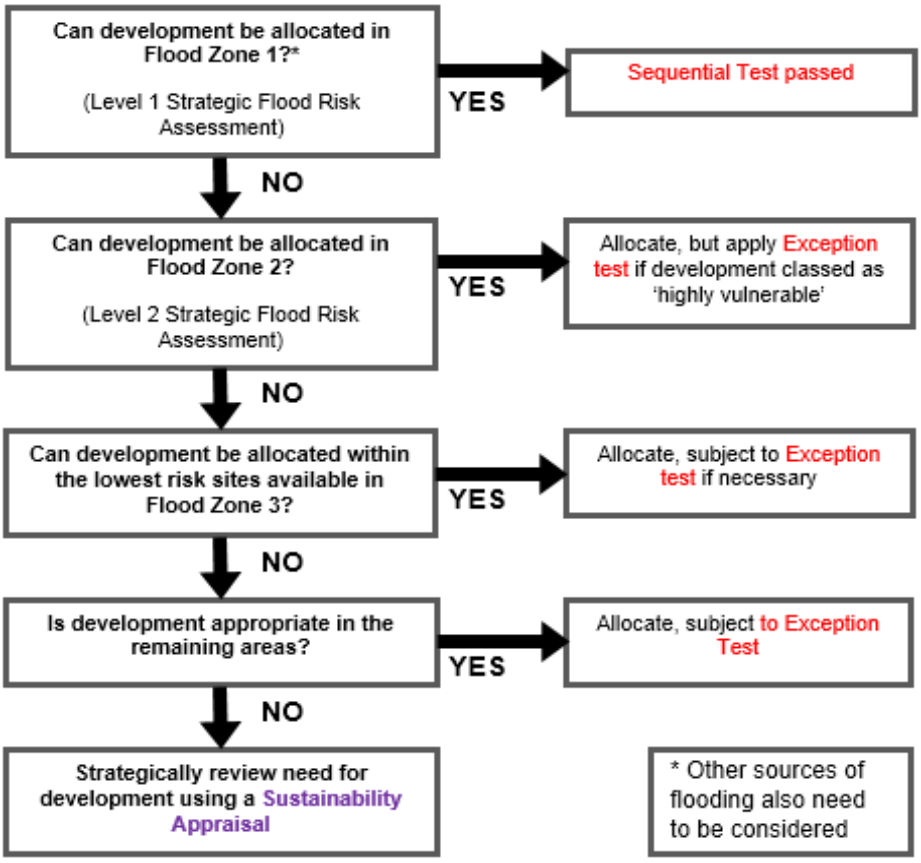
In circumstances where existing development or infrastructure is shown in Flood Zone 3b, where the flooding is a consequence of overtopping of existing defences or where the flooding is a consequence of sea water levels, additional consideration should be given to whether the specific location is appropriate for designation as 'Functional' with respect to the storage or flow of water in time of flood.

3.2 Applying the Sequential Test and Exception Test in the preparation for a Local Plan

When preparing a Local Plan, the LPA should demonstrate it has considered a range of site allocations, using SFRAs to apply the Sequential and Exception Tests where necessary.

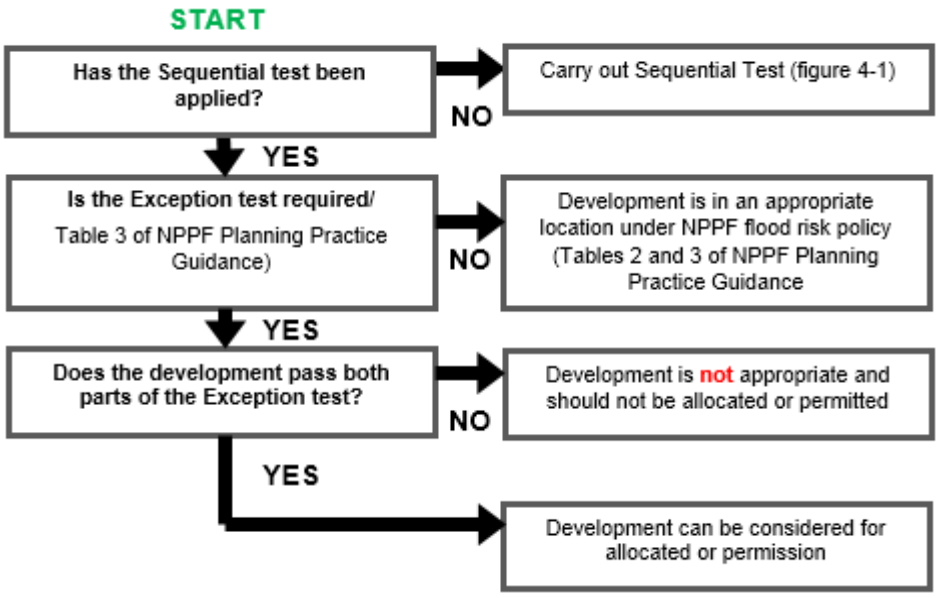
The Sequential Test should be applied to the whole LPA area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPG for Flood Risk and Coastal Change describes how the **Sequential Test should be applied in the preparation of a Local Plan** (Figure 3-1).

Figure 3-1: Applying the Sequential Test in the preparation of a Local Plan



The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPG Flood Risk and Coastal Change. The NPPG describes **how the Exception Test should be applied in the preparation of a Local Plan** (Figure 3-2).

Figure 3-2: Applying the Exception Test in the preparation of a Local Plan



3.3 Applying the Sequential Test and Exception Test to individual planning applications

3.3.1 Sequential Test

Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other Local Plan policies. A pragmatic approach should be taken when applying the Sequential Test.

Great Yarmouth Borough Council and the Broads Authority, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied, and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test.
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site).

It is normally reasonable to presume and state that individual sites that lie in Flood Zone 1 satisfy the requirements of the Sequential Test; however, consideration should be given to risks from all sources and areas with critical drainage problems.

3.3.2 Exception Test

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if deemed appropriate (see **NPPF Table 3: Flood risk vulnerability and flood zone 'compatibility'**). The aim of the Exception Test is to ensure that more vulnerable uses, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the Test to be satisfied, the following two elements have to be accepted for the development to be allocated or permitted:

1. **It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.**

   LPAs will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied, and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the LPA should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused.

2. **A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.**

   The site-specific Flood Risk Assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. The following should be considered:

   - The design of any flood defence infrastructure.
   - Access and egress.
   - Operation and maintenance of defences.
   - Design of the development to manage and reduce flood risk wherever possible
   - Resident awareness.
   - Flood warning and evacuation procedures.
   - Any funding arrangements required for implementing measures.

The **NPPG** provides detailed information on how the Test can be applied and provides a **table** that outlines when the Exception Test is required.

3.4 Actual flood risk

If it has not been possible for all future development to be situated in Flood Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Flood Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) in any year; and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated.
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed.
- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change may reduce the standard of protection afforded by defences, due to increased river flows and levels and sea level rise, and so commitment is needed to invest in the maintenance and upgrade of defences if the present-day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures.
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where a) the consequences of flooding need to be mitigated or b) where it is proposed to place lower vulnerability development in areas of flood risk.

3.5 Impact of additional development on flood risk

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting increase in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream.

Consideration must also be given to the potential cumulative impact of the loss of floodplain as a result of development. The effect of the loss of floodplain storage should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified. Further information on flood plain compensation is provided in Section 8.4.4.

Whilst the increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures.

The cumulative impact of development should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken, within an appropriate FRA, to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk.

Maintenance and upkeep of SuDS have been neglected in the past as a result of lack of clarity over where responsibility for it lies. Therefore, is it important that maintenance and upkeep for mitigation measures, such as SuDS, has been set out as part of a drainage strategy and that management funding for the lifetime of the development has been agreed.

4 Climate change

4.1 Climate change and the NPPF

The NPPF and accompanying National Planning Practice Guidance (NPPG) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. Paragraph 100 of the NPPF, shown in Section 1.1, makes specific reference to considering the impacts of climate change as part of Local Plans. Further, the NPPF and NPPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

The Environment Agency has published guidance to local planning authorities in the application of appropriate climate change allowances when considering climate change effects (**Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities**). This guidance adopts a risk-based approach to the selection of appropriate allowances based on the consequences of flooding, as described by the flood risk vulnerability of the proposed development (see Section 4.4). For proposed development that is highly vulnerable to flooding, it is recommended that the upper end allowance be used when considering climate change (i.e. 100-year +65% flow); conversely for development that is 'water compatible' then the central allowance can be used (i.e. 100-year +25% flow). When assessing the potential effects of climate change in the land allocation process, consideration is given to the vulnerability of proposed development and the potential effect on the Flood Zone on the basis of the application of the appropriate climate change allowance.

Assessing the impacts of climate change and mapping climate change extents is a key objective and outcome of the 2017 SFRA (see Section 1.2 and 1.4). When defining the scope of this commission, the Environment Agency and LLFA recommended that the climate change allowances used in this assessment (see Section 5.2.4), be in line with the revised guidance (discussed in Section 4.2). These allowances reflect those which are most commonly used by developers and will assist in future development matters as part of the local planning process.

4.2 Revised climate change guidance

The Environment Agency published **updated climate change guidance** on 19 February 2016 (and updated on 3 February 2017), which supports the NPPF and must now be considered in all new developments and planning applications. The document contains guidance on how climate change should be taken into account when considering development, specifically how allowances for climate change should be included with FRAs. The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice.

4.3 Climate change allowances

By making an allowance for climate change, it will help reduce the vulnerability of the development and provide resilience to flooding in the future. The 2016 climate change guidance includes climate change predictions of anticipated change for peak river flow and peak rainfall intensity. The guidance also covers sea level rise and wave height. These allowances are based on climate change projections and different scenarios of carbon dioxide emissions to the atmosphere. Due to the complexity of projecting climate change, there are uncertainties attributed to the magnitude of the climate change allowances. As a result, the guidance presents a range of possibilities to reflect the level of uncertainty in the predicted climate change impacts over three periods (epochs).

4.4 Peak river flows

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.

The peak river flow allowances provided in the guidance show the anticipated changes to peak flow for the river basin district within which the subject watercourse is located. Once the river basin district has been identified, guidance on uplift in peak flows are provided for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th

percentiles respectively and reflect the differing levels of uncertainty associated with the respective estimates (i.e. 50th percentile: more certainty in the outcome; 90th percentile: less certainty in the predicted outcome). The allowance category to be used is based on the vulnerability classification of the proposed development and the Flood Zones within which it is to be located.

These allowances are provided in the form of figures for the total potential change anticipated, for three climate change periods:

- The '2020s' (2015 to 2039)
- The '2050s' (2040 to 2069)
- The '2080s' (2070 to 2115)

The time-period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development. Further information on what is considered to be the lifetime of development is provided in the **NPPG**.

Great Yarmouth Borough falls within the Anglian River Basin District. The allowances for the Anglian River Basin District are provided in Table 4-1.

Table 4-1: Peak river flow allowances for the Anglian river basin district

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	25%	35%	65%
Higher central	15%	20%	35%
Central	10%	15%	25%

4.4.1 High++ allowances

High++ allowances only apply in assessments for developments that are very sensitive to flood risk, for example large scale energy generating infrastructure, and that have lifetimes beyond the end of the century. H++ estimates represent the upper limit of plausible climate projections and would not normally be expected for schemes or plans to be designed to or incorporate resilience for the H++ estimate. Further information is provided in the Environment Agency publication, **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.**

4.4.2 Which peak river flow allowance to use?

The Flood Zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. Vulnerability classifications are found in the **NPPG**. The guidance states the following:

Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

4.5 Peak rainfall intensity allowance

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect drainage systems, resulting in increased risk of surface water flooding, due to the increased volume of water entering the systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments. These allowances should be used for small catchments and urban drainage sites. For catchments, larger than 5km^2, the guidance suggests the peak river flow allowances should be used.

For Flood Risk Assessments, both the Central and Upper end allowances should be assessed to understand the range of impact.

Table 4-2: Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

4.6 Sea level allowances

Climate change is predicted to cause sea level rise and increase the rate of coastal risk erosion. The table below shows anticipated sea level rise for each time-period (termed 'epoch'), with cumulative sea level rise in brackets. Guidance on how to calculate the sea level rise (i.e. the cumulative total sea level rise expected over the lifetime of a development), is provided on the government **website**.

Table 4-3: Sea level allowance for each epoch in millimetres (mm) per year, with cumulative sea level rise for each epoch in brackets (use 1990 baseline)

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115 / metres (m)
East	4 (140mm)	8.5 (255mm)	12 (360mm)	15 (450mm)	1.21m

In addition to increased sea levels, wave heights may change due to increased water depths. The severity, duration and frequency of storms may also change. Allowances for wind speed and wave heights have also be **published**, alongside the sensitivity allowances to be used.

4.7 Using climate change allowances

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for 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 and local considerations in East Anglia. This document is available from: **https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers**

When defining the scope of this commission, the Environment Agency recommended that the below allowances were used in this assessment, to assist with forward planning across the combined study area:

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

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**.

4.8 Norfolk County Council guidance

Norfolk County Council has outlined their expectations in using climate change allowances in their guidance document called: **Norfolk County Council, Lead Local Flood Authority, Statutory Consultee for Planning, Guidance Document (2017)**. The document highlights that peak river flow climate change allowances should be considered for Ordinary Watercourses as well as Main Rivers. In addition, the new allowances should be used to update any detailed design at reserved matters or discharge of conditions planning applications following an outline planning approval where the previous allowances may originally have been applied.

4.9 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months. The effect of climate change on groundwater levels for sites in areas where groundwater is known to be an issue should be considered at the planning application stage.

4.10 The impact of climate change in Great Yarmouth borough

4.10.1 Previous studies

The **UK Climate Projection 2009** (UKCP09) predict the following climatic changes in the East England:

- Increased summer temperatures of 2.9°C by 2050
- Increased winter temperatures of 2.5°C by 2050
- Reduced summer rainfall of 18% by 2050
- Increased winter rainfall of 16% by 2050.

Tomorrow's Norfolk, Today's Challenge: A Climate Change Strategy for Norfolk aims to provide the vision and drive for Norfolk to tackle the issue of climate change. It states that Norfolk is particularly vulnerable to climate change as it is a county which is low-lying with a lengthy coastline, it has a large agricultural sector and a growing population. Climate change in the county is expected to result in

- Greater flood risk, both coastal and fluvial
- Water scarcity and drought
- Accelerated coastal erosion.

One of the high-level goals of the strategy is *"to improve Norfolk's resilience to the changing climate, including reduction of the socio-economic and environmental risks associated with flooding and coastal erosion (adaptation)."* The strategy sets out several priorities for local authorities and their partners to manage the risks of climate change.

In addition, the Broads Authority have also published a **Climate Adaptation Plan (2016)**. This notes that water quality and quantity are central to the Broad's ecosystems and services they provide. The largest risk relates to managing flooding and saline intrusion, as 95% of the Broads Authority Executive Area is within the floodplain. There are several potential climate change impacts related to flooding:

- Sea overtopping or breaching defences and / or surging up rivers;
- Excessive rain, which may also be held back by the tide, overtopping and breaching defences;
- Groundwater and surface water flooding; and,
- Extreme weather events in combination.

The Plan proposes a number of possible adaptation options and puts forwards a number of "next step" actions. One of these actions is to continue investigating the impacts of climate change and revisiting coastal flood barriers to review options for retaining their freshwater systems.

4.10.2 SFRA climate change modelling

Fluvial

In the 2017 SFRA, climate change modelling for the watercourses across the combined study area, including Great Yarmouth borough, was undertaken using the new climate change guidance (see Section 4.2). Where appropriate existing Environment Agency hydraulic models were run for the following allowances:

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

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**.

Within Great Yarmouth borough, the fluvial hydraulic models were not available to be re-run, and consequently no fluvial climate change modelling was undertaken. 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. Section 8.2.3 provides further guidance on this.

Tidal (sea)

Climate change modelling of the Norfolk coastline was supplied by the Environment Agency for use in the combined SFRA assessments. This is with exception of the Wells-next-the-Sea model in North Norfolk district and the Wash model in the borough of King's Lynn and West Norfolk as these were not available at the time of preparing the SFRAs. 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 shown in Table 4-3, and used the defended scenario. 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.

Surface Water

Climate change modelling for surface water was undertaken based on the new climate change guidance (see Section 4.2). The Risk of Flooding from Surface Water model (see Section 5.3.1) 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.

Mapping

Climate change mapping covering Great Yarmouth borough is provided in Appendix A. Further information on the climate change approach and methodology can be found in Section 5 and in the Technical Summary provided in Appendix A.

Summary of tidal climate change impacts

Great Yarmouth town is shown to be sensitive to climate change. The 200-year with climate change scenario has a greater flood extent covers a large part of the Great Yarmouth town centre. The 1,000-year with climate change scenario covers large parts of the borough, from Caister-on-Sea, to Great Yarmouth town, to Gorleston-on-Sea along the coast and further inland to Belton. Mapping suggests that un-named watercourses that flow to the north and to the south of the Belton may back up and experience a tide-locking effect when the River Waveney is flooding.

In general, the 100-year with climate change surface water scenario results show similar overland flow routes to the 1,000-year surface water scenario and follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. In general, the 1,000-year surface water extent is larger than the 100-year with climate change surface water scenario across Great Yarmouth borough.

4.10.3 Adapting to climate change

The NPPG sections on climate change contain information and guidance for how to identify suitable mitigation and adaptation measure in the planning process to address the impacts of climate change. Examples of adapting to climate change include:

- Considering future climate risks when allocating development sites to ensure risks are understood over the development's lifetime
- Considering the impact of and promoting design responses to flood risk and coastal change for the lifetime of the development
- Considering availability of water and water infrastructure for the lifetime of the development and design responses to promote water efficiency and protect water quality
- Promoting adaptation approaches in design policies for developments and the public realm for example by building in flexibility to allow future adaptation if needed, such as setting new development back from watercourses
- identifying no or low-cost responses to climate risks that also deliver other benefits, such as green infrastructure that improves adaptation, biodiversity and amenity, for example by leaving areas shown to be at risk of flooding as public open space.

5 Sources of information used in preparing the SFRA

5.1 Hydraulic models used in this SFRA

The Environment Agency supplied detailed hydraulic models for use in the SFRAs for the combined study area. Appendix D lists and displays the coverage of all the supplied detailed hydraulic models and contains information on:

- the date of the model;
- the name of the model;
- whether the model outputs have been used to inform Flood Zone 3b;
- for the 2017 hydraulic models, whether the outputs have been used to update Flood Zones 3a and 2 or whether these are based on the Environment Agency's Flood Map for Planning; and,
- whether the model outputs have been used to inform the climate change mapping.

It is important that the 2017 SFRA and mapping appendices are read in conjunction with the Technical Summary provided in Appendix D. The Technical Summary provides further information on the hydraulic modelling and mapping approaches used in the 2017 SFRA.

5.1.1 New 2017 modelling outputs

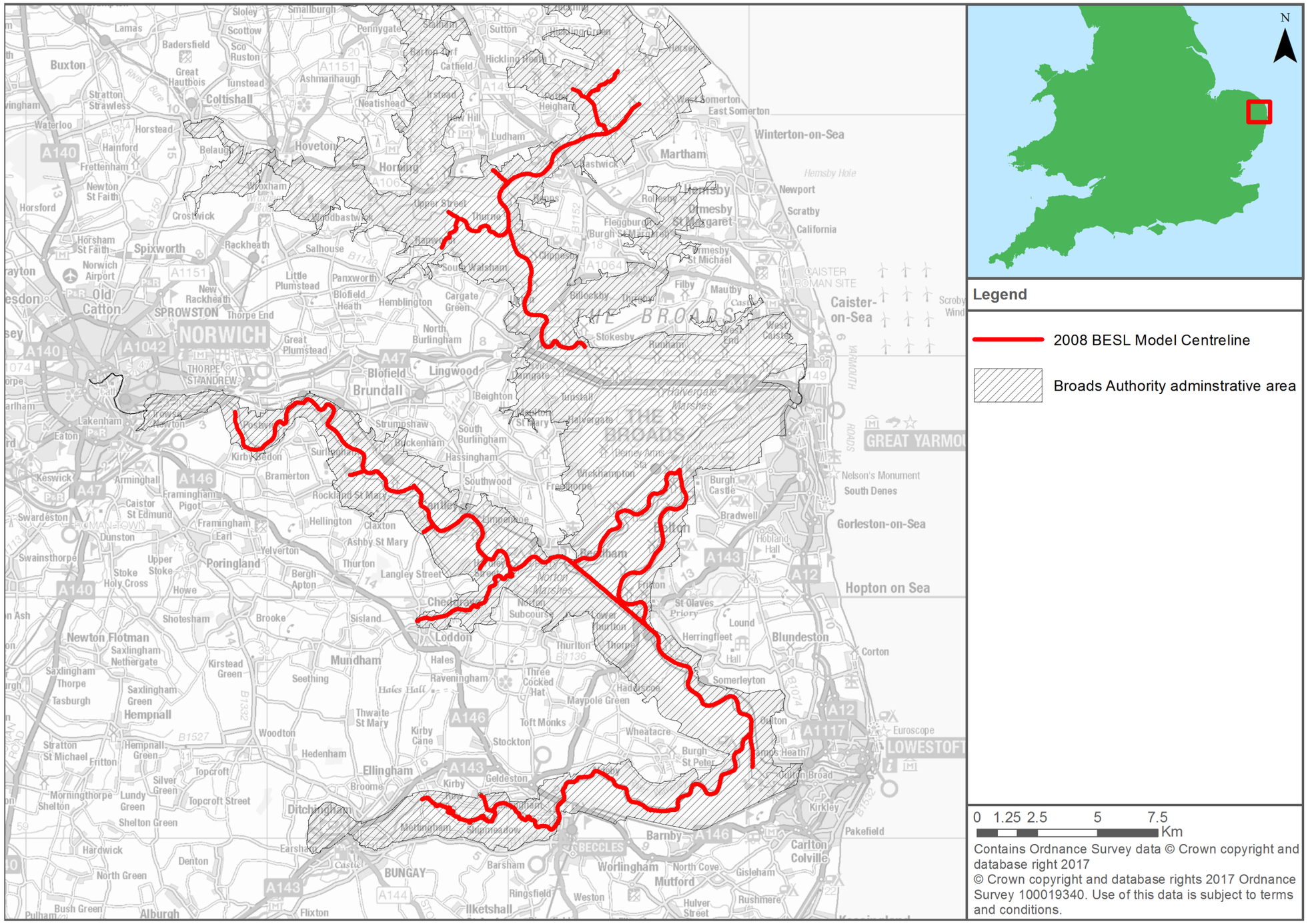
The 2017 SFRAs for the combined study area contains updated hydraulic modelling for a number of watercourses and the coast. As part of a separate commission to the SFRA, the Environment Agency were preparing updated modelling of the Anglian coastline. Where the outputs were available at the time of preparing the 2017 SFRA, these were supplied and used in the assessment. The outputs of two coastal models were not available at the time of preparing the 2017 SFRA; the Wash model and the Wells-next-Sea model. However, the Wash model and the Wells-next-the Sea model do not affect Great Yarmouth borough. The updated coastal modelling concerning Great Yarmouth borough was available, supplied and used in this 2017 SFRA. It should be noted that this modelling represents the tidal flood risk only; the modelling contains no fluvial inflows and does not represent the interaction between the fluvial and tidal flood risks.

5.1.2 Potential modelling improvements

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. It is important that the Environment Agency are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

For example, the outputs of the updated BESL hydraulic model should be available in 2019. The 2008 BESL model extent is shown in Figure 5-1 and covers several Norfolk administrative areas and notably covers much of the Broads Authority administrative area and extends into Great Yarmouth borough. The 2008 BESL hydraulic model extent is also displayed in Appendix A mapping of all sources of flood risk. The Environment Agency's Flood Map for Planning and Flood Zone 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.

Figure 5-1: 2008 BESL model centreline



5.2 Fluvial and tidal modelling

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

Please note that 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.

5.2.1 Flood Zones 2 and 3a

Flood Zones 2 and 3a are taken from the Environment Agency's Flood Maps for Planning (Rivers and Sea). 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.

This is so that the SFRA Flood Zones represent the most up-to-date information. The Environment Agency's Flood Zones on their Flood Map for Planning website, may therefore differ to the maps in the SFRA for a short period of time. The modelled fluvial and tidal flood risk datasets, shown in the 2017 SFRA and Appendix A, will be incorporated into the Environment Agency's Flood Map in due course.

5.2.2 Flood Zone 3b (functional floodplain)

Flood Zone 3b comprises land where water has to flow or be stored in times of flood (the functional floodplain). 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 detailed modelling exists for both river and sea flooding. Where the 5% AEP outputs are not available, the 4% AEP (a 1 in 25-year annual probability) results were used as an alternative. The project scope provided by the commissioning authorities identified that the functional floodplain was to be mapped using the 1 in 20-year event extent. The presence of defences is considered when mapping Flood Zone 3b. In Appendix A, Flood Zone 3b is identified in the Flood Zone mapping.

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'). In Appendix A, if the Flood Zone 3b is indicative, this is highlighted in the GeoPDF mapping layers.

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.

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.

The presence of defences is considered when mapping Flood Zone 3b, but if these defences are overtopped during a flood with a 5% chance in each and every year the mapping will show that the Zone affects land behind defences. Under climate change conditions this effect can result in the extent of the Zone increasing substantially and in such circumstances decisions on land allocation or planning applications should review and take account of the implications of this effect and whether such land should be regarded as functional floodplain.

In circumstances where existing development or infrastructure is shown in Flood Zone 3b, where the flooding is a consequence of overtopping of existing defences or where the flooding is a consequence of sea water levels, additional consideration should be given to whether the specific

location is appropriate for designation as 'Functional' with respect to the storage or flow of water in time of flood.

5.2.3 Internal Drainage Boards

Great Yarmouth borough is partially covered by the Waveney, Lower Yare and Lothingland IDB and the Water Management Alliance. The Water Management Alliance covers five IDBs; Norfolk Rivers IDB covers part of the borough.

The IDB policy statements of flood protection and water level management have been used to determine the general standard of flood protection provided to each IDB district; this is discussed in Section 6.3.3. However, developers in IDB districts should, where appropriate, undertake a detailed assessment to determine the Flood Zone coverage including the extent of Flood Zone 3b, through detailed hydraulic modelling and consultation with the relevant IDB.

5.2.4 Climate change

Fluvial

Climate change modelling for the watercourses in the Greater Yarmouth borough was undertaken based on the new climate change guidance. Existing Environment Agency hydraulic models were run for the following:

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

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) stated in **Paragraph 026 of the NPPG**.

Within Great Yarmouth borough, the fluvial hydraulic models were not available to be re-run, and consequently no fluvial climate change modelling was undertaken. 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. Section 8.2.3 provides further guidance on this.

Tidal (sea)

Climate change modelling of the Norfolk coastline was supplied by the Environment Agency for use the combined SFRA assessments. The Norfolk coastal climate change modelling was undertaken in line with the revised climate change guidance and were 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 shown in Table 4-3. 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.

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.

5.3 Surface water

Mapping of surface water flood risk in Great Yarmouth borough has been taken from the Risk of Flooding from Surface Water (RoFfSW) published online by the Environment Agency. These maps are intended to provide a consistent standard of assessment for surface water flood risk across England and Wales to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk.

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 (Table 5-1).

Table 5-1: RoFfSW risk categories

Category	Definition
High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chance 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, such as the modelling undertaken as part of the SWMPs, to confirm the presence of a surface water risk at that particular location.

5.3.1 Climate change

Climate change modelling for surface water was undertaken based on the new climate change guidance (see Section 4.2). The RoFfSW model was rerun for the 1% AEP event plus a 40% increase for climate change (see Section 4.5). 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.

5.4 Groundwater

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater Flooding (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.

5.5 Sewers

Historical incidents of flooding are detailed by Anglian Water through their DG5 register. The DG5 database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding (on a 4-5 digit post code basis).

5.6 Reservoirs

The risk of inundation because of reservoir breach or failure of reservoirs within the area has been mapped using the outlines produced as part of the National Reservoir Inundation Mapping (NRIM) study.

5.7 Suite of maps

All of the mapping can be found in the appendices to this SFRA and is presented in the following structure:

- Appendix A: Mapping of all sources of flood risk across Great Yarmouth borough (excluding historic flood extents).
- Appendix B: Watercourses in Great Yarmouth borough and coverage of IDB Districts
- Appendix C: Flood Alert and Flood Warning Coverage across Great Yarmouth borough
- Appendix D: Technical summary including a list of all detailed models used in the 2017 SFRA and a map showing the coverage of these models

It is important that the Technical Summary provided in Appendix D is read in conjunction with using or referring to the SFRA mapping appendices. The Technical Summary provides further information on the hydraulic modelling and mapping approaches used in this SFRA.

5.8 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. This information includes:

- **Broadland Rivers Catchment Flood Management Plan (2009)**

  Provides information on the catchment-wide strategy for flood risk management. It should be ensured that any flood risk management measures are consistent with the strategy.
- **Norfolk Local Flood Risk Management Strategy (2015)**

  Provides information on local flooding issues and the plan for managing risk. It should be ensured that development and any flood risk management measures are consistent with the Plan.
- **Kelling Hard to Lowestoft Ness Shoreline Management Plan (2012)**

  Provides large-scale assessment of risks associated with coastal evolution and presents the policy framework to address these risks in a sustainable manner. It should be ensured that any coastline development and flood risk management measures are consistent with the plan.
- **Waveney District Council and Great Yarmouth Borough Council Joint Water Cycle Strategy Scoping Study (2009)**

  Developers and planners should use the WCS as a starting point when considering any water supply, sewerage or water quality constraints on a development.
- **Great Yarmouth Borough Council's Surface Water Management Plan (2014)**

  Provides information on surface water flooding issues for the borough and the plan for managing risk. It should be ensured that any surface water management measures are consistent with the Plan.
- **Anglian Flood Risk Management Plan (2016)**

  Provides information on the catchment-wide strategy for flood risk management. It should be ensured that any flood risk management measures are consistent with the strategy.

6 Understanding flood risk in Great Yarmouth borough

6.1 Historic flooding

Great Yarmouth borough has a history of documented flood events with the main source being from tidal surges.

The historic flood information described below has been taken from:

- The 2009 Partnership of Norfolk District Councils SFRA;
- The 2009 Great Yarmouth and Gorleston SFRA;
- Norfolk County Council's 2015 Local Flood Risk Management Strategy;
- The Environment Agency's Historic Flood Map and Record Flood Outlines datasets;
- An internet search; and,
- LLFA Section 19 reports.

The following historical flood events have been recorded in Great Yarmouth borough:

- In 1608, a coastal breach between Eccles-on-Sea and Winterton caused flooding to the tidal floodplain and the Thurne, Bure and Yare rivers were affected. Two thousand people repaired the defences[4].
- During February 1938, the north of the borough was affected by the Horsey floods which was caused by high tides.
- The East Coast of the UK was hit by a storm surge on the 31st January/ 1st February 1953. As a result, areas of Great Yarmouth borough experienced major flooding, with peak tide levels of 3.28m AOD. The flooding caused 10 deaths. The Environment Agency recorded flooding at Great Yarmouth, Caister-on-Sea and around the Horsey area and noted that the flooding was due to the overtopping of defences.
- In January 1976, a tidal surge affected tidal rivers and Burgh Marshes.
- In February 1983, a tidal surge affected the Rivers Yare and Bure.
- In September 2006, heavy rain caused flash flooding to Great Yarmouth borough. The flooding caused pumping stations in Great Yarmouth to fail and over 50 properties were flooded including six schools in Great Yarmouth[5].
- During a storm surge on the 9th November 2007, low-lying parts of Great Yarmouth were flooded by seepage through the flood defences and water coming up from drains. Flood depths of up to two feet were observed around the Town Hall and South Quay. Great Yarmouth Borough Council reported that a few properties flooded.
- A storm surge hit Great Yarmouth borough in March 2008. Along Riverside Road in Gorleston and the riverside in Bure close to the White Swan Inn, water overtopped at low-lying areas. High tides were unable to drain away before the next high tide due to tide-locking in the Broads.
- In December 2013, a storm surge hit the east coast of the UK. Homes in the borough were evacuated and the army were called in to help fight the floods and to put up temporary barriers. Three properties fell into the sea at Hemsby and four more were "seriously undermined"[6]. Great Yarmouth Borough Council reports that around 20 properties were flooded. The Environment Agency recorded flooding at Great Yarmouth and Gorleston-on-Sea due to overtopping of defences and the river channel capacity being exceeded in areas with no raised defences.
- Torrential rain lasting 90 minutes caused flooding to homes in Gorleston on the 29th August 2016. Drains and pumping systems were unable to cope with the volume of rain[7].

[4] http://www.greaternorwichgrowth.org.uk/dmsdocument/1850
[5] http://www.broads-authority.gov.uk/news-and-publications/publications-and-reports/conservation-publications-and-reports/water-conservation-reports/33.-Norfolk-Flood-Risk-Management-Summary.pdf
[6] http://www.bbc.co.uk/news/uk-england-norfolk-25254808
[7] http://www.bbc.co.uk/news/uk-england-norfolk-37212776

- On the 13th January 2017, Great Yarmouth borough was prepared for the biggest tidal surge to hit the east coast since 2013 and around 6,000 homes were evacuated. However, the tidal surge did not cause as much damage as expected; no damage was caused to any properties[8].
- Norfolk Fire Service received more than 20 calls on the 6th July 2017 to flooding incidents across the county, following heavy thunderstorms. Settlements affected included Great Yarmouth and Caister[9].

Under Section 19 of the Flood and Water Management Act, Norfolk County Council in their role as LLFA, have published Section 19 reports. Where possible, the likely source of the flood event, as noted in these reports, has been listed. One investigation has been carried out for the area; this reviewed the flood incidents that occurred between early May and mid July 2014, across Great Yarmouth borough. During this time, 59 properties were flooded internally due to a large number of rainfall events. Section 19 reports are available to download from Norfolk County Council's **website**.

Highways England have provided details of historic flood information which is listed in Table 6-1. This shows that eight incidents of flooding to the A12 highway have been recorded since July 2009.

Table 6-1: Highways England historic flood information

Date reported	Road	Description of flood event	Initial action	Secondary action
17/07/09	A12	Flooding	Not stated.	Not stated.
25/02/10	A12	Flooding in main carriageway caused by blocked gullies	Not stated.	Not stated.
14/02/13	A12	Flooding - standing water (unknown how deep)	SWAT attended site and cleared drains to alleviate standing water as much as they could.	Place flood warning signs on site.
9/03/13	A12	Standing water on carriageway on northbound approach to Harfreys Road Roundabout	SWAT attended and attempted to clear water. Unable to clear. Flood warnings placed out.	Site monitored and standing water alleviated after rainfall eased.
20/11/13	A12	Flooding in lane 2 and central reservation	SWAT crew lifted gulley heads and cleared to alleviate standing water.	None.
8/05/14	A12	Flooding at A12 Hafreys Roundabout	Attended site and diagnosed issues.	Cleared gully top of detritus.
5/06/15	A12	No information	Not stated.	Not stated.

Historic flood information can be used for:

- Model calibration: This involves checking the model results align with historic flood information.
- The basis of Environment Agency Flood Zone 2 extents: In certain locations, the Flood Zone 2 extents can be based on the Environment Agency's Historic Flood Map rather than hydraulic modelling data.

[8] http://www.greatyarmouthmercury.co.uk/news/immense-relief-as-great-yarmouth-area-escapes-serious-flooding-1-4849197
[9] http://www.edp24.co.uk/news/weather/weather-warning-in-place-as-thunder-is-heard-across-norfolk-1-5094998

- A driver for preparing a site-specific Flood Risk Assessment for a site: If the site is known to be affected by historic flood events, a site-specific Flood Risk Assessment may be required to investigate the risk further.

6.2 Topography, geology and soils

6.2.1 Topography

The topography of Great Yarmouth borough can be seen in Figure 6-1. The west and centre of the study area form part of the Norfolk Broads (i.e. the Broads Authority administrative area) and have comparatively lower elevations, with some parts below sea level. Three distinct areas of higher elevation run latitudinally; two across the north of the borough separated by the Trinity Broads and one is located in the south of the borough. The highest elevation in the study area is located to the west of Caister on-Sea and reaches approximately 24.7m AOD.

6.2.2 Geology and soils

The geology of the catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

Figure 6-2 shows the bedrock (solid permeable) formations in the borough and Figure 6-3 shows the superficial (permeable, unconsolidated (loose) deposits). These are classified as the following:

- Principal: layers of rock or drift deposits with high permeability which, therefore, provide a high level of water storage
- Secondary A: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- Secondary B: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- Secondary undifferentiated: rock types where it is not possible to attribute either category a or b
- Unproductive Strata: rock layers and drift deposits with low permeability and therefore have negligible significance for water supply or river base flow.

The borough is shown to be entirely underlain by a Principal aquifer (bedrock designation) associated with gravel, sand, silt and clay in the east and chalk in the west.

The superficial deposits in the study area comprise predominately of Secondary A (associated with sand and gravel) in the south. Unproductive deposits are prevalent throughout the low-lying Broads area across the centre and west of the borough (associated with clay, sand and silt alluvium deposits). In the north of the study area there is a combination of Secondary A (associated with sand and gravel), Secondary (undifferentiated) and unproductive deposits (both associated with diamicton).

Figure 6-1: Topography of Great Yarmouth borough

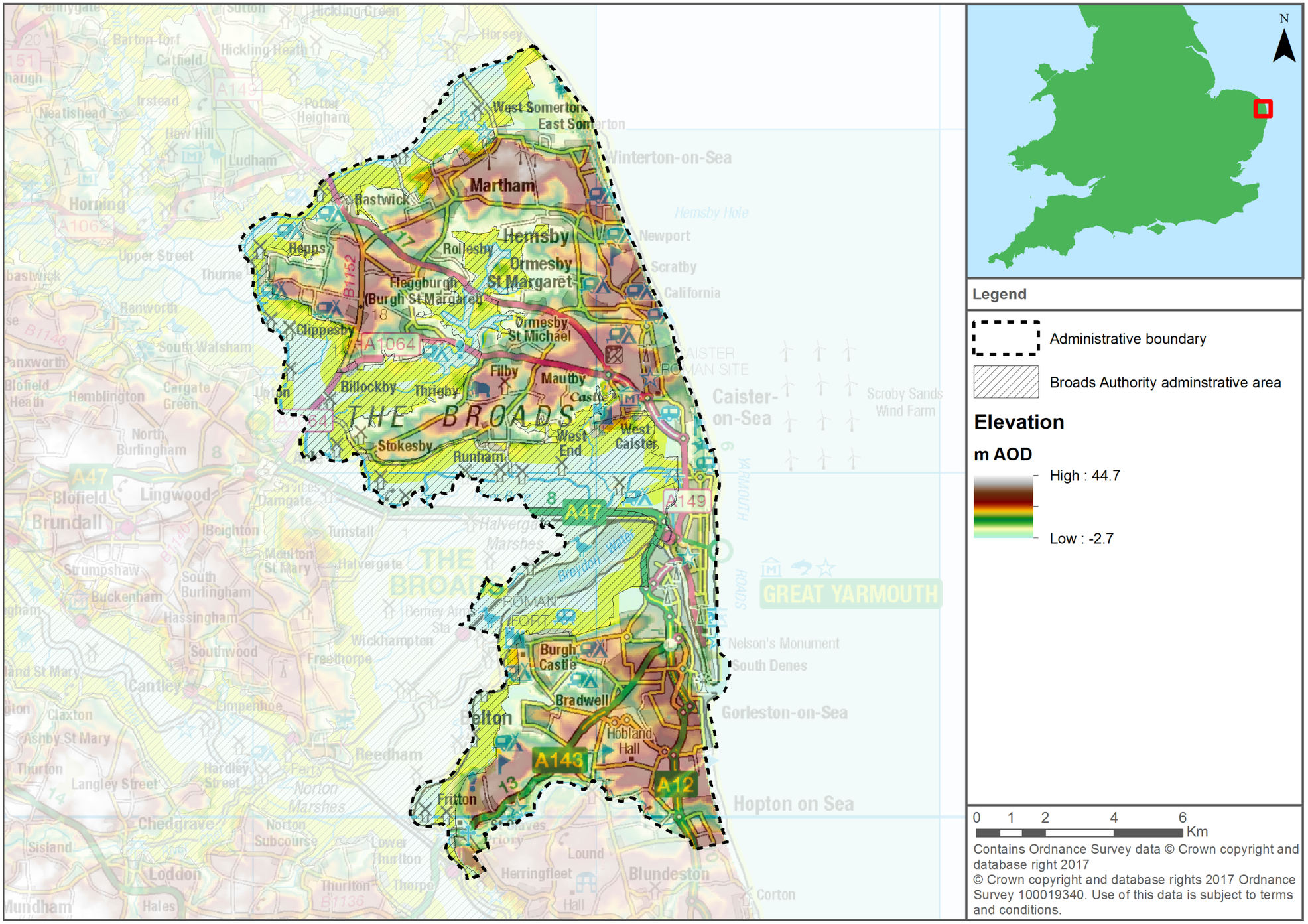


Figure 6-2: Bedrock aquifer classification in Great Yarmouth borough

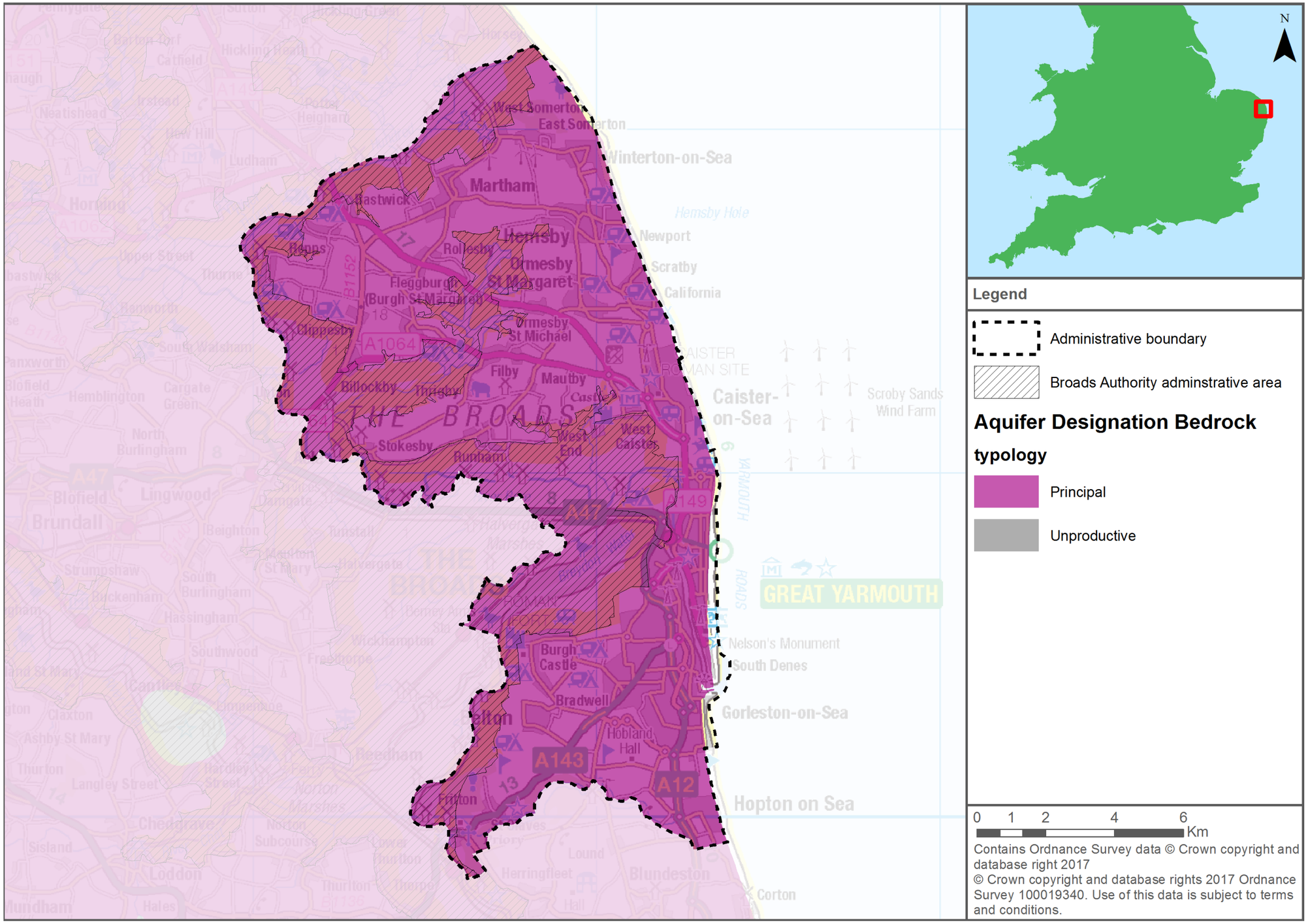
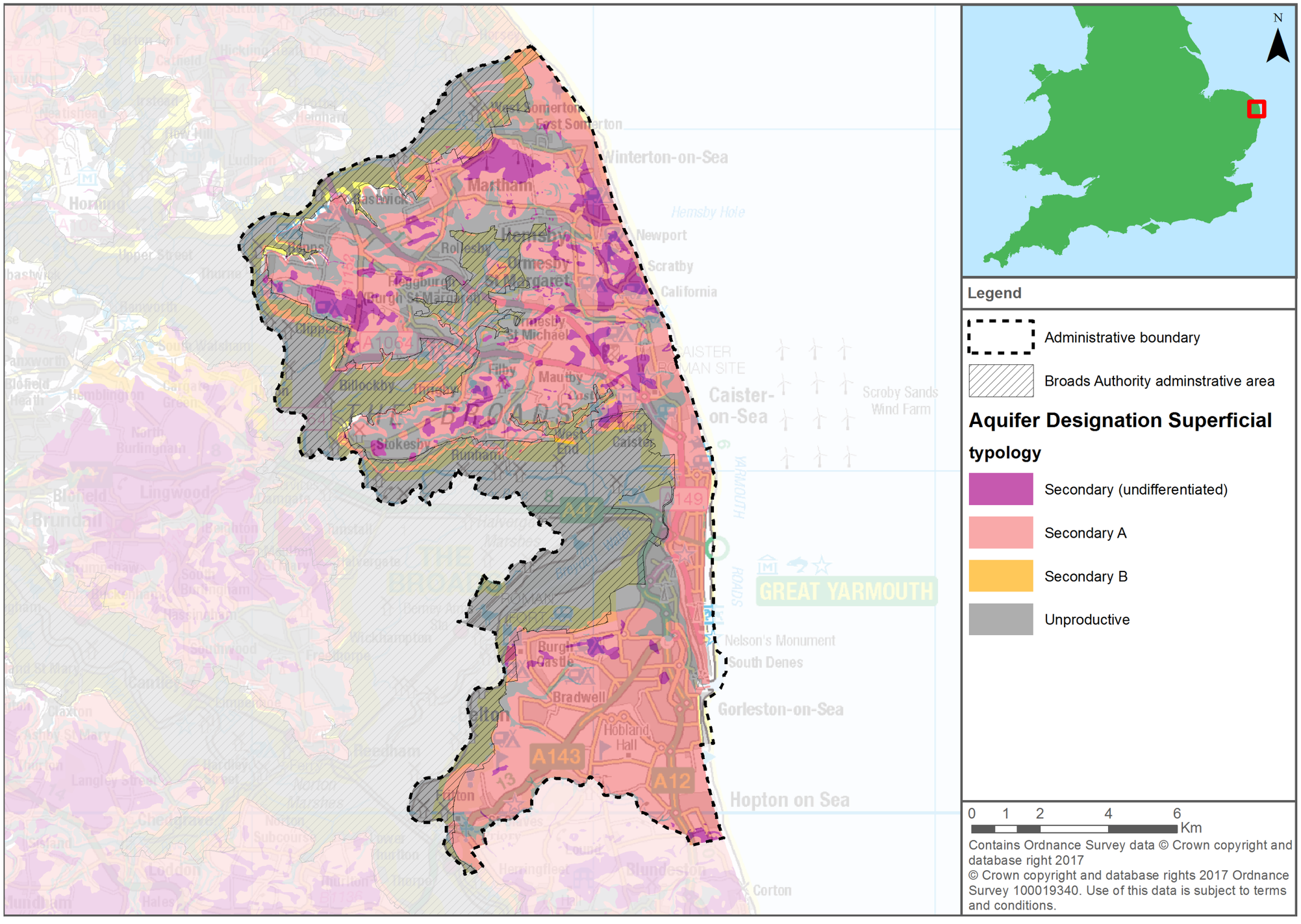


Figure 6-3: Superficial aquifer classification in Great Yarmouth borough



6.3 Watercourses in Great Yarmouth borough

There are numerous watercourses flowing through the study area. These include Main River, Ordinary Watercourses and the IDB watercourses. Appendix B shows the location of Main Rivers and Ordinary Watercourses in Great Yarmouth borough and the coverage of IDB districts.

6.3.1 Main Rivers

These tend to be larger streams and rivers, though some of them are smaller watercourses of local significance. The Environment Agency has permissive powers to carry out maintenance, improvement or construction work on Main Rivers to manage flood risk. Consultation with the Environment Agency will be required for any development projects within 20m of a Main River or flood defence.

6.3.2 Ordinary Watercourses

These are all watercourses not designated as Main River or IDB watercourses. The local authority or IDB has permissive powers to maintain them, but the responsibility lies with the riparian owner.

6.3.3 Internal Drainage Board watercourses and drains

Numerous smaller watercourses and drains are managed by IDBs within Great Yarmouth borough. IDBs operating in Great Yarmouth borough include:

- The Waveney, Lower Yare and Lothingland Internal Drainage Board - this IDB covers an extensive area throughout the south of the study area. Its coverage can generally be described as including all the drainage districts within the authority located to the south of the River Yare, in addition to one above it; Limpenhoe.[10] Their operational area extends to the south and west of the authority.
- The Broads Internal Drainage Board (Part of the Water Management Alliance group) – this IDB operate across much of the Broads situated in the north of the study area. Their coverage can broadly be described as all the drainage districts to the north of the River Yare (excluding Limpenhoe). They continue to operate beyond both the northern and western boundary.[11]

The **Broadland Rivers Catchment Flood Management Plan** (CFMP) notes that many settlements are reliant on pumping stations to reduce the risk of flooding including: Martham, Repps, Thurne, Caister, Hemsby, Winterton and Stokesby.

The IDB policy statements on flood protection and water level management have been used to determine the general standard of flood protection provided to each IDB District and are summarised as follows:

- The Waveney, Lower Yare and Lothingland IDB **policy statement** discusses that the Board will seek to maintain a general standard of protection against flooding of 1 in 25-years for developed areas and 1 in 15-years for agricultural land. The policy statement acknowledges that the standards cannot be taken literally and that some over-spilling from the systems may occur during these events.
- The Broads IDB **policy statement** and the Norfolk Rivers IDB **policy statement** discusses that the Boards seek to maintain a general standard of protection against flooding of 1 in 10-years with 600mm of freeboard to agricultural land and 1 in 100-year with 300mm freeboard to developed areas. The policy statement acknowledges that the standards cannot be taken literally and that some over-spilling from the systems may occur during these events.

6.4 Fluvial flood risk

Fluvial flood risk within Great Yarmouth borough is primarily associated with the Rivers Yare, Bure and Waveney and their tributaries.

Due to the low-lying nature of much of the authority area, fluvial as well as tidal flooding represents a significant risk and the tidal water levels along downstream reaches are strongly influenced by

[10] http://www.nicholsonslaw.com/cms/document/map.pdf
[11] https://www.wlma.org.uk/uploads/BIDB_Watershed.pdf

tide levels (climate change will significantly influence the predicted flood levels as a consequence of changes to mean sea level). Most of the rivers are embanked and are higher than the adjacent land. This represents a residual risk in the event of a breach or overtopping due to fluvial, tidal or combined flood events. Breach / failure events are difficult to predict but the effects are likely to be severe with rapid inundation of land behind the embankments and a severe risk to life to be expected.

Flooding may not be from one watercourse alone. Often the combination of watercourses and the interaction of two or more sources of out of bank flow across the floodplain can have profound implications for the extent of the risk (i.e. the Rivers Bure Yare within Great Yarmouth).

A summary of fluvial flood risk to settlements in the Great Yarmouth borough (as well as other sources of flooding) is detailed in Table 6-6.

6.5 Tidal flood risk

Tidal flood risk is assessed based on Extreme Still Water Sea Levels (ESWSL), plus an allowance for the interaction of wind and waves. An ESWSL is the level the sea is expected to reach during a storm event for a particular magnitude of flood event as a result of the combination of astronomical tides and meteorological surges. It is conventional to assess the magnitude of these events by referring to 'still' water, and then to make additional allowances for the effect of waves, wind and swell. The astronomical tide levels are primarily generated by the gravitational effects of the sun and the moon. Surge events are the result of meteorological conditions where low atmospheric pressure causes the sea level to be increased higher level than during more average or high atmospheric pressure conditions. The wave heights and swells are influenced by the strength, direction and persistence of the wind and the profile of the nearshore.

Tidal flooding is caused by extreme tide levels exceeding ground and/or defence levels. Tidal flooding often also occurs by wave overtopping of defences. Flood Zones 1, 2 and 3 delineate areas at low risk, medium risk and high risk respectively from both tidal and fluvial flooding. Flood Zones do not take into account the effects of flood defences, and as such provides a worst-case assessment of flood risk. Flood Zone 3 and 2 represent the area that would be flooded in the 0.5% AEP and 0.1% AEP tidal event in the absence of defences, respectively. Consideration of how climate change may influence the predicted Flood Zones in the future is indicated within the mapping of Appendix A.

Tidal flooding is the most significant flood risk in the borough as Great Yarmouth is bound to the east by the North Sea and is entirely located within the tidally influenced area of the Broadlands River catchment. There is acute risk of tidal flooding in Great Yarmouth and across the Broads within the study area; the prior has defences to protect up to the 0.5% annual probability tidal flood.[12]

All three major watercourses, the Rivers Yare, Bure and Waveney are subject to significant tidal influences at the downstream ends of their catchments. These tidal influences are powerful enough to reverse the flow of the rivers and hold back water within the surrounding drainage system. This 'tide-locking' effect raises levels further up the catchments and in adjoining tributaries increasing the flood risk over a broad area.[13]

A combination of a storm surge caused by a low-pressure system within the North Sea coinciding with the arrival of high tide could result in a high risk of tidal / coastal flooding. Such conditions could be amplified on a local scale (i.e. as surge conditions at the mouth of the River Yare are amplified in the inner harbour increasing the likelihood of defences being overtopped or worsening the effects of a breach).[14]

The tidal flood risk is managed by an extensive network of flood asset infrastructure. However, there remains residual risk in the event of a breach or overtopping scenario. The consequences of a breach/failure of an asset could be significant and result in widespread inundation of adjacent low-lying land and property, as well as the potential for significant risk to life. Flood defences are discussed further in Section 7.

[12] Environment Agency (2010) Broadland Rivers: Catchment Flood Management Plan
[13] Norfolk County Council (2015) Norfolk Local Flood Risk Management Strategy.
[14] Great Yarmouth Borough Council (2009) Strategic Flood Risk Assessment: Volume 2: Technical Report

A summary of tidal flood risk to settlements in the Great Yarmouth borough (as well as other sources of flooding) is detailed in Table 6-6.

Fluvial and tidal Flood Zones, for Great Yarmouth borough can be found in Appendix A.

6.6 Coastal flood risk

If the coast is eroding, then the potential effect is that tidal flood and erosion defences near to the sea will be lost and flood risk may increase. To maintain an appropriate standard of safety from flooding it is sometimes necessary to implement works to slow down or stop the rate of coastal erosion and so maintain the integrity of the coastal defences. The 2012 **Kelling to Lowestoft Ness Shoreline Management Plan** (SMP) describes the high-level strategy and coastal policies. Coastal erosion is a prominent process along much of the Great Yarmouth coastline directly threatening some settlements and posing an additional threat to coastal defences. Should these defences be compromised there could be the additional risk of inundation to properties behind in areas susceptible to coastal flooding. Coastal flooding can also often occur by wave overtopping of defences.

Within the study area, coastal flood risk is expected to be attributable to storm surge tides combined with large waves. This may result in flooding of the beaches and undefended areas or cause overtopping of defences within the town of Great Yarmouth, as well as affecting the coastal zones to the north and south of the town.[15]

6.7 Surface water flood risk

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours, occurring often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding.

The Risk of Flooding from Surface Water (RoFfSW) dataset shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas. The RoFfSW mapping for Great Yarmouth borough can be found in Appendix A.

The **2013 Surface Water Management Plan**[16] (SWMP) developed for Great Yarmouth borough, serves as a framework to understand the causes of surface water flooding and outline a preferred strategy to manage the surface water flood risk. The plan was developed to cover the whole borough and identified several settlements at risk of flooding during the strategic review, these include

- Martham
- Winterton-on-Sea
- Caister-on-Sea
- Great Yarmouth
- Hemsby
- Ormesby-St-Margaret
- Hopton-on-Sea
- Gorleston
- Bradwell
- Belton

More detailed investigation revealed eight Critical Drainage Areas (CDAs) within the study area where the risk of surface water flooding was most acute.

- Great Yarmouth CDAs:
    - Bradwell
    - Claydon, Southtown and Cobham

[15] Great Yarmouth Borough Council (2009) Strategic Flood Risk Assessment: Volume 2: Technical Report
[16] Great Yarmouth Borough Surface Water Management Plan (2014)

  - Gorleston
  - South Yarmouth
  - Northgate
  - North Yarmouth
- Other CDAs in the study area:
  - Caister on-Sea
  - Hemsby[17]

A Section 19 Flood Investigation Report was prepared in 2015 following extensive flooding in the summer of 2014 that affected 59 properties. The flooding affected properties across eight catchments with the worst affected being Hemsby (28 properties) and Ormesby St. Margaret (17 properties). The flooding affected a wide area. The causes were often complex and multifaceted however, the causes could be summarised as:

- Existing properties located along natural overland flow routes or constructed at low points in the topography where water is likely to concentrate;
- The extreme localised rainfall that exceeded the design strategy of the local drainage systems; and,
- Surface water frequently being managed by multiple organisations and individuals with a lack of computability in design standards, poor maintenance regimes in some areas and a lack of connectivity in some networks due to a loss of historic drainage features.[18]

Section 19 reports are available to download from Norfolk County Council's **website**.

A summary of surface water flood risk to settlements in the Great Yarmouth borough (as well as other sources of flooding) is detailed in Table 6-6.

6.8 Groundwater flood risk

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Under the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on Major Aquifers. However, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high groundwater levels in mudstones, clays and superficial alluvial deposits, very few records are available. Additionally, there is increased risk of groundwater flooding where long reaches of watercourse are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

As part of the SFRA deliverables, mapping of Great Yarmouth borough has been provided showing the Areas Susceptible to Groundwater Flooding (AStGWf). This information is provided in Appendix A. The AStGWf is a strategic-scale map showing groundwater flood areas on a 1km square grid. The data was produced to annotate indicative Flood Risk Areas for Preliminary Flood Risk Assessment (PFRA) studies and allow the LLFAs to determine whether they may be at risk of flooding from groundwater. This data 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, nor does it take account of the chance of flooding from groundwater rebound (rising groundwater levels resulting from a reduction in abstraction rates from groundwater). 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 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. It should be

[17] Great Yarmouth Borough Surface Water Management Plan (2014)
[18] Norfolk County Council (2015) Investigation Report into flooding across Great Yarmouth Borough during the summer of 2014, accessed at: https://www.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/hemsby-and-ormesby-st-margaret-great-yarmouth-2014.pdf

noted that although an area may be designated as susceptible to groundwater flooding, this does not mean that groundwater flooding will definitely be a problem within these areas, rather it provides an indication of potential risk.

The Areas Susceptible to Groundwater flooding (AStGWf) dataset has limited data recorded in Great Yarmouth borough. The AStGWf dataset indicates that groundwater emergence is more susceptible in areas to the north and south of the town. Broadscale analysis in the 2009 Waveney District Council and Great Yarmouth Borough Council SFRA identified potential areas in Great Yarmouth and Gorleston as being susceptible to groundwater emergence. In particular, areas to the north and south of the town centre, as well as those close to the coast where the tidal influence on groundwater is greatest, are considered among the most susceptible in the study area.[19]

The **2009 Water Cycle Study** for Great Yarmouth indicated that the underlying groundwater levels in the Great Yarmouth area are very high. However, the water table in the study area is likely to be kept artificially low through the extensive use of pump infrastructure. As a result, pumping failures could have a potential effect on the water table.[20]

A summary of groundwater flood risk to settlements in Great Yarmouth borough (as well as other sources of flooding) are detailed in Table 6-6.

6.9 Flooding from artificial sources

6.9.1 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration or entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that most new surface water sewers have been designed to have capacity for a 1 in 30-year rainfall event (3.3% AEP), although until recently this did not apply to smaller private systems. This means that, even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding. Existing sewers can also become overloaded as new development adds to the discharge to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

As noted in Section 6.7, the **2013 Great Yarmouth SWMP** identified eight Critical Drainage Areas in Great Yarmouth borough.

The **2009 Broadlands CFMP** states that surface water and sewer flooding within Great Yarmouth and Gorleston was frequently caused by the inadequate capacity of the existing sewage system, or by sewers unable to drain freely into rivers.[21] There is an additional risk of foul sewer flooding as a resulting from misconnections between the surface water drainage and foul sewer.[22]

The **2009 Water Cycle Study** for Great Yarmouth found that historically the sewer network within the urban area of Great Yarmouth had been susceptible to flooding, although efforts were made by Anglian Water, and completed in 2009, to reduce this risk. Further reports of flooding had been made for both the Hemsby and Ormesby areas where sewage had reportedly escaped from the foul system.[23]

Historical incidents of flooding are detailed by Anglian Water in their DG5 register. This database records incidents of flooding relating to public foul, combined or surface water sewers and identifies

[19] Great Yarmouth Borough Council (2009) Strategic Flood Risk Assessment: Volume 2: Technical Report
[20] Great Yarmouth Borough Council (2009) Strategic Flood Risk Assessment: Volume 2: Technical Report
[21] Environment Agency (2010) Broadland Rivers: Catchment Flood Management Plan
[22] Norfolk County Council (2015) Norfolk Local Flood Risk Management Strategy
[23] Great Yarmouth WCS https://www.great-yarmouth.gov.uk/CHttpHandler.ashx?id=1244&p=0

which properties suffered flooding. For confidentiality reasons, this data has been supplied on a postcode basis. The information from the DG5 register is shown in Table 6-2.

The DG5 register indicates a total of 144 recorded flood incidents in the Great Yarmouth borough. The more frequently flooded postcodes are: NR31 8 (52 incidents), NR30 4 (15 incidents), NR31 6 (14 incidents) and NR31 9 (14 incidents). It is important to recognise the DG5 register does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages. Also, the register represents a snap shot in time and will get outdated with properties being added to the register following rainfall events, whilst risk will be reduced in some locations by capital investment to increase the capacity of the network. As such the sewer flooding flood risk register is not a comprehensive 'at risk register'.

Table 6-2: DG5 register for Great Yarmouth borough

Area	Postcode	Number of recorded flood incidents
Filby, Ormesby St Margaret, Scratby	NR29 3	8
Winterton -on-Sea, Hemsby	NR29 4	7
Rollesby, Potter Heigham, Ludham	NR29 5	9
Great Yarmouth	NR30 1	9
Great Yarmouth	NR30 2	1
Great Yarmouth	NR30 3	4
Great Yarmouth	NR30 4	15
Great Yarmouth	NR30 5	9
Great Yarmouth	NR31 6	14
Gorleston	NR31 7	2
Gorleston, Bradwell,	NR31 8	52
Bradwell, Belton, Fritton	NR31 9	14
Total 144		
Note: Based on information supplied on 26/06/2017		

6.9.2 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low. Recent changes to legislation under the Flood and Water Management Act require the Environment Agency to designate the risk of flooding from these reservoirs. The Environment Agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

The risk of inundation to the Great Yarmouth borough as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study. Three reservoirs are located within the Great Yarmouth borough however, there is also one reservoir outside of the area whose inundation mapping is shown to affect the district. Details of the reservoirs are provided in Table 6-3. Maps of the flood extent can be found on the Government's **Long term flood risk information website**.

The Government's maps represent a credible worst-case scenario. In these circumstances, it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

Table 6-3: Reservoirs with potential risk to the Great Yarmouth study area

Reservoir	Location (grid reference)	Reservoir owner	LPA affected by extents
Ormesby Subsidence	646423, 314918	Essex and Suffolk Water Ltd.	Great Yarmouth Borough Council and the Broads Authority
Back of Hall Reservoir	642629, 314929	Billockby Farms Ltd.	Great Yarmouth Borough Council and the Broads Authority
Ormesby Reservoir Wharton Farms	648264, 314313	Wharton Farms Ltd.	Great Yarmouth Borough Council and the Broads Authority
Potter Heigham Reedbed Reservoir	644001, 319393	Norfolk Wildlife Trust	Great Yarmouth Borough Council and the Broads Authority

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate, but it is less likely than flooding from rivers or surface water. It may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

The risk of a reservoir failure is a residual risk. Whilst a residual risk, developers should consider reservoir flooding during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include:
    - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
    - operation: discharge rates / maximum discharge;
    - discharge during emergency drawdown; and
    - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site. The following questions should be considered:
    - can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?
    - can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
    - can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?
- Consult with relevant authorities regarding emergency plans in case of reservoir breach

In addition to the risk of inundation, those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid flood event and check that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

The NPPG states that, where relevant, the LPAs should take advice from reservoir undertakers[24]. LPAs should discuss their proposed site allocations with reservoir undertakers to:

- avoid an intensification of development within areas at risk from reservoir failure, and;
- ensure that reservoir undertakers can assess the cost implications of any reservoir safety improvements required due to changes in land use downstream of their assets.

[24] NPPG, Paragraph: 006 Reference ID: 7-006-20140306, Revision date: 06 03 2014

6.10 Flood warning and emergency planning

6.10.1 Emergency planning

Emergency planning is one option to help manage flood related incidents. From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding.

In development planning, a number of emergency planning activities are already **integrated** in national building control and planning policies e.g. the NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. However; safety is a key consideration for any new development and includes residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.

The Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development to demonstrate that development satisfies the second part of the Exception Test. As part of an FRA, the developer should review the acceptability of the proposed access in consultation with the LPA (where appropriate) and the Environment Agency.

There are circumstances where a flood warning and evacuation plan[25] is required and / or advised:

- It is a **requirement under the NPPF** that a flood warning and evacuation plan is prepared for sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels) and for essential ancillary sleeping or residential accommodation for staff required by uses in this category [water-compatible development], subject to a specific warning and evacuation plan.
- The **Environment Agency and DEFRA's standing advice** for undertaking flood risk assessments for planning applications states that details of emergency escape plans will be required for any parts of the building that are below the estimated flood level.

It is recommended that Emergency Planners at the LPA and / or Norfolk County Council (where appropriate) are consulted prior to the production of any emergency flood plan.

In addition to the **flood warning and evacuation plan considerations listed in the NPPF / PPG**, it is advisable that developers also acknowledge the following:

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a breach.
- Proposed new development that places additional burden on the existing response capacity of the Council will not normally be appropriate.
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.
- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment should be prepared to help develop emergency plans.

The **Norfolk Prepared**, Local Resilience Forum website covering Great Yarmouth borough provides practical advice for residents, communities and businesses on preparing for emergencies (not exclusive to flooding). The LRF website provides a map of **communities with registered emergency plans** and contains emergency plan templates for residents and communities. The agencies which form the Norfolk Local Resilience Forum have also prepared a number of multi-

[25] Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

agency emergency plans to support the flood response; these can be downloaded from their **website**.

Further emergency planning information links:

- **2004 Civil Contingencies Act**
- **DEFRA (2014) National Flood Emergency Framework for England**
- **Sign up for Flood Warnings with the Environment Agency**
- **National Flood Forum**
- **GOV.UK Make a Flood Plan guidance and templates**
- **FloodRe**
- **Local Resilience Forum website covering Great Yarmouth borough**

6.10.2 Flood warnings

Flood warnings can be derived and, along with evacuation plans, can inform emergency flood plans or flood response plans. The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. Flood Warnings are supplied via the Flood Warnings Service (FWS), to homes and business within Flood Zones 2 and 3.

There are currently five Flood Alert Areas and 16 Flood Warning Areas (FWAs) covering significant parts of the borough. These are shown in Appendix C. A list of the Flood Alert Areas in the study area is shown in Table 6-4 and a list of the FWAs in the study area is shown in Table 6-5.

Table 6-4: Flood Alert Areas within Great Yarmouth borough

Flood Alert Code	Flood Alert Name	Watercourse	Coverage
054WACDV2B	The Norfolk coast from Eccles on Sea, to and including, Winterton-on-Sea	North Sea	The Norfolk coast at Eccles on Sea, Whimpwell Green, Lessingham, Sea Palling, Waxham, Horsey, Somerton and Winterton-on-Sea
054WACDV3A	The Norfolk coast from Caister to Gorleston, including Great Yarmouth	North Sea	The Norfolk coast at Caister, north and South Beach at Great Yarmouth, and Gorleston
054WATBT1	The tidal Rivers Bure, Ant and Thurne	Bure, Ant, Thurne	The tidal Rivers Bure from Wroxham Bridge, Ant from Honing and Thurne from Hickling, to Breydon Water
054WATBT2	The tidal River Yare, from Thorpe St Andrew to Breydon Water	Yare	The tidal River Yare, from Thorpe St Andrew to Breydon Water
054WATBT3	The tidal River Waveney from Ellingham to Breydon Water	Waveney	The tidal River Waveney from Ellingham to Breydon Water
054WACDV2B	The Norfolk coast from Eccles on Sea, to and including, Winterton-on-Sea	North Sea	The Norfolk coast at Eccles on Sea, Whimpwell Green, Lessingham, Sea Palling, Waxham, Horsey, Somerton and Winterton-on-Sea
054WACDV3A	The Norfolk coast from Caister to Gorleston, including Great Yarmouth	North Sea	The Norfolk coast at Caister, north and South Beach at Great Yarmouth, and Gorleston

Table 6-5: Flood Warning Areas within Great Yarmouth borough

Flood Warning Code	Flood Warning Name	Watercourse	Coverage
054FWCDV2B	The Norfolk coast from Eccles on Sea, to and including, Winterton-on-Sea	North Sea	The Norfolk coast at Eccles on Sea, Whimpwell Green, Lessingham, Sea Palling, Waxham, Horsey, Somerton and Winterton-on-Sea
054FWCDV3A1	The west bank of the River Yare at Great Yarmouth, including Southtown and Cobholm	North Sea	The west bank of the River Yare at Great Yarmouth, from Ferry Hill to Breydon Water, including Southtown and Cobholm
054FWCDV3A2	The east banks of the Rivers Yare and Bure at Great Yarmouth, including North Quay, Newtown and Bure	North Sea	The east banks of the Rivers Yare and Bure at Great Yarmouth, from South Quay to the race course, including North Quay, Newtown and Bure Park
054FWCDV3A3	The west bank of the River Yare at Great Yarmouth, from Gorleston to Ferry Hill	North Sea	The west bank of the River Yare at Great Yarmouth, from Gorleston to Ferry Hill, including areas around Riverside Road
054FWCDV3A4	The east bank of the River Yare at Great Yarmouth, from South Denes to South Quay	North Sea	The east bank of the River Yare at Great Yarmouth, from South Denes to South Quay, including areas around Southgates and South Denes
054FWCDV3A5	The Rivers Yare and Bure from Runham Vauxhall to Scare Gap, including Vauxhall Holiday Park	North Sea	The Rivers Yare and Bure from Runham Vauxhall to Scare Gap, including Great Yarmouth Railway station, Vauxhall Holiday Park and the Euro Centre industrial Estate
054FWCDV3A6	The seafront at Great Yarmouth, from Salisbury Road to the Pleasure Beach	North Sea	The seafront at Great Yarmouth, from Salisbury Road to the Pleasure Beach
054FWCDV3A7	South Caister from West Road to Freemantle Road, including North Denes	River Bure	South Caister from West Road to Freemantle Road, including areas around the High Street, Yarmouth Road, North Denes, the Golf club and the racecourse
054FWTBT1A	The tidal River Bure from Scare Gap to Acle Bridge	River Bure	The tidal River Bure from Scare Gap to Acle Bridge
054FWTBT1B	The tidal River Bure from Acle Bridge to Hoveton	River Bure	The tidal River Bure from Acle Bridge to Hoveton, including Horning and Wroxham
054FWTBT1C	Riverside properties on the River Thurne including Hickling Broad	River Thurne	Riverside properties on the River Thurne, including Repps, Thurne Bungalows, Martham Ferry and Hickling Broad
054FWTBT1E	Outlying villages on the Bure, Ant and Thurne	River Bure, Ant and Thurne	Outlying villages including Acle, Damgate, Billockby, Bastwick, Martham, Ludham, Hickling, Dilham, and Honing on the Bure, Ant and Thurne

Flood Warning Code	Flood Warning Name	Watercourse	Coverage
054FWTBT1F	Trinity Broads from Billockby to Hemsby	Trinity Broads	Trinity Broads from Billockby to Hemsby
054FWTBT2A	Riverside properties along the tidal River Yare including Cantley, Brundall and Reedham	River Yare	Riverside properties along the tidal River Yare including Cantley, Brundall and Reedham
054FWTBT3A	The tidal River Waveney from Ellingham Marshes to Belton	River Waveney	The tidal River Waveney from Ellingham Marshes to Belton
054FWTBT3B	Isolated low lying properties along the tidal River Waveney	River Waveney	Isolated low lying properties along the tidal River Waveney

6.10.3 Dry Islands

In this SFRA, dry islands are defined as an area of 0.5 hectares or greater in size, identified as being in Flood Zone 1 and completely surrounded by land which falls within Flood Zone 2 (i.e. the extreme 1 in 1,000-year extent). The 0.5 hectares threshold was selected as this reflects one of the criteria used to define "major development" (see Section 2.5). Flood Zone 2 was selected as under the NPPG, developers are sometimes required to consider the safety of the site during the extreme flood event including the potential for an evacuation before the extreme flood event.

Dry islands can present specific hazards, primarily the provision of safe access and egress during a flood event.

The results show that there are 42 dry islands in Great Yarmouth borough. These are located in sporadic locations across the study area and a few dry islands cross administrative boundaries into neighbouring districts.

The identification of dry islands in this SFRA have limitations:

- Dry islands account for the fluvial and tidal flood risk only, as mapped in the SFRA Flood Zone 2. No other sources of flood risk nor a breach of defences have been considered when mapping dry islands.
- A number of the dry islands are located in areas where there are IDB drains; it is not known what influence that the IDB drains will have on the extent of flood risk.
- Other areas may be considered a dry island if all access routes are compromised due to flood waters, regardless of whether the surrounding land is covered by flood waters. Identifying such areas was not practical given the strategic nature of the assessment and that this is a Level 1 SFRA.
- Dry islands are identified based on the SFRA Flood Zone 2 extent. This does not consider flood depths, velocities or flood hazard to people classification.

The concepts listed in the bullet points above can be explored further as part of a site-specific Flood Risk Assessment and / or a Level 2 SFRA.

Mapping which shows these dry islands is contained in Appendix A.

Emergency planning implications

A site-specific Flood Risk Assessment may be required if a proposed development is located within a dry island (even for sites less than 1 hectare and in Flood Zone 1). A site-specific Flood Risk Assessment may also need to be accompanied with a Flood Warning and Evacuation Plan to detail emergency response arrangements. However, it should be noted that evacuation may not always be the most suitable response. Situations may arise where occupants cannot be evacuated or where it is safer to remain "in-situ" (e.g. if a safe evacuation cannot be safely facilitated because flooding obstructs access and egress).

The developer should consult with the LPA (i.e. Great Yarmouth Borough Council or the Broads Authority) if their site is located in a dry island and the requirements for a site-specific FRA and emergency procedures.

6.11 Cross Boundary Considerations

The topography and location of Great Yarmouth borough means that all the major watercourses such as the River Yare, River Bure and River Waveney either flow through the study area or along its boundaries, towards the coast. As such, future development, both within and outside Great Yarmouth borough can have the potential to affect flood risk to existing development and surrounding areas, depending on the effectiveness of SuDS and drainage implementation. Great Yarmouth borough has boundaries with the following Local Authorities:

- North Norfolk District Council
- Broadland District (Greater Norwich area)
- South Norfolk (Greater Norwich area)
- Waveney District Council

Parts of the Broads Authority administrative area also fall outside of the study area and thus, the Broads Authority is also considered to be a neighbouring authority in the content of cross-boundary considerations.

Neighbouring authorities are collectively working together across Norfolk in this SFRA and through the Norfolk Strategic Framework. Information, were available on emerging plans, has been used to assess whether there are any proposed developments that may affect flood risk in the Great Yarmouth borough.

No significant planned developments were found in neighbouring authorities near watercourses that flow into the study area, although several authorities were yet to publish their site allocations. All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments near watercourses in neighbouring authorities comply with the latest guidance and legislation relating to flood risk and sustainable drainage, they should result in no increase in flood risk within Great Yarmouth borough.

Development control should ensure that the impact on receiving watercourses from development in Great Yarmouth borough has been sufficiently considered during the planning stages and appropriate development management decisions put in place to ensure there is no adverse impact on flood risk or water quality. Great Yarmouth Borough Council and the Broads Authority can also work with their partners, together on flood risk issues, as part of the emerging Norfolk Strategic Framework.

6.12 Summary of flood risk to towns and villages in Great Yarmouth borough

Table 6-6 summarises the flood risk to towns and villages in Great Yarmouth borough. A high-level review was undertaken to identify the main settlements where flood risks / extents are more prominent. This has been informed by historic flood risk information and the flood risk datasets shown in Appendix A. It is therefore important that the information contained in this table is read in conjunction with the Technical Summary provided in Appendix D. The Technical Summary provides further information on the hydraulic modelling and mapping approaches used in this SFRA.

The settlements listed in Table 6-6 do not reflect the settlement hierarchy in the Local Authority Core Strategies.

If a settlement is not listed in Table 6-6, this does not mean that the settlement is not at flood risk. The mapping provided in Appendix A can be used as a high-level screening exercise, to identify whether a location or site has a potential risk of flooding.

Table 6-6: Summary of flood risk to towns and villages in Great Yarmouth borough

Settlement	Fluvial / tidal / coastal flood risk	Flood Defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Number of recorded sewer flood incidents on Anglian Water's DG5 Register
				<25%	>=25% <50%	>=50% <75%	>=75%		
Great Yarmouth town and Gorleston-on-Sea	Great Yarmouth town and Gorleston-On-Sea are at risk of tidal / coastal inundation along the sea front. These settlements are also at risk of inundation from a combination of tidal and fluvial sources, on land adjacent to the River Yare and the River Bure. Tidal / coastal inundation along the sea front is shown to affect properties along and in the vicinity of South Beach Parade, Marine Parade and North Drive. Flood Zones show combined tidal and fluvial flooding could affect a significant number of properties in the areas of Runham, Cobholm Island, Southtown, in addition to flooding property to the east of Pier Plain, Blackwall Reach and Beach Road in Gorleston-On-Sea. Tidal locking has the potential to increase levels upstream in the River Yare and River Bure due to the watercourses not being able to discharge effectively during high tide. In addition, high levels in the River Yare may result in the River Bure being unable to discharge effectively, causing levels near the confluence to rise. The defences along the banks of the Yare provide protection in some places in the settlement. However, there remains a residual risk should the defences be overtopped or fail. The Environment Agency's 2017 coastal breach modelling of the Norfolk coastline indicates breaches along defences in Greater Yarmouth pose a significant risk; much of Great Yarmouth town is within the modelled breach flood extents. Historical records show that Great Yarmouth town and Gorleston-on-Sea have experienced flooding from fluvial and tidal (sea) sources, including from overtopping of flood defences.	See section 7.	Mapping shows surface water flood risk to affect large areas of Great Yarmouth town and Gorleston-on-Sea. In the 3.3% AEP event, surface water is generally restricted to roadways and gardens. However, around Burgh Road property is shown to be affected by surface water extents. In the 1% AEP event, surface water extents continue to increase, with additional properties affected throughout the settlements; properties off Wren Drive are notably affected. In the 0.1% AEP event, surface water flooding is shown to be widespread across the settlements with the areas shown to be most at risk including properties off Oxford Avenue, Yallop Avenue , Primrose Way, Lord's Lane as well as numerous other locations across the settlements. Historical records show that Great Yarmouth town and Gorleston-on-Sea have been affected by heavy rainfall events which cause pumping systems to fail and the drainage capacity to be exceeded. The 2013 SWMP for Great Yarmouth borough identified six Critical Drainage Areas across Great Yarmouth town.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				These settlements are not shown to be located within reservoir inundation extents.	52 incidents have been recorded in Great Yarmouth, two incidents have been recorded in Gorleston-on-Sea and 52 further incidents have been recorded in a four digit post that is located in Gorleston and Bradwell.
Bradwell	Mapping does not suggest that the settlement of Bradwell is at risk of fluvial or tidal flooding.	None	Mapping shows surface water flood risk consists predominantly of surface water ponding on roads, gardens and other open spaces throughout the settlement. Property flooding is shown to occur along Primrose Way in the 3.3%, 1% and 0.1% AEP events. Property flooding along Lord's Lane is also shown during these events.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				This settlement is not shown to be located within reservoir inundation extents.	14 incidents have been recorded in a four-digit postcode area which relates to Bradwell, Belton and Fritton.

Settlement	Fluvial / tidal / coastal flood risk	Flood Defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Number of recorded sewer flood incidents on Anglian Water's DG5 Register
				<25%	>=25% <50%	>=50% <75%	>=75%		
Caister-on-Sea	Mapping shows fluvial / tidal flood risk to the settlement of Caister on-Sea appears to be driven by the River Bure to the south of the settlement. Flood Zone extents cover around a third of the town, towards the south. Historical records show that Caister-on-Sea has experienced flooding from tidal (sea) sources via overtopping of flood defences.	None. Caister-on-Sea is reliant on pumping stations to reduce the risk of flooding.	Mapping shows surface water flood risk in the settlement consists predominantly of surface water ponding on roads, gardens and other open spaces throughout the settlement in the 3.3% AEP and 1% AEP events. Properties are shown to be within surface water extents, around Ormesby Road , in the 1% AEP event. In the 0.1% AEP event, surface water flooding is shown to affect properties throughout the settlement. Some of the worst affected areas shown include properties around Tamarisk Drive and Coxswain Read Way in addition to Ormesby Road. The 2013 SWMP for Great Yarmouth borough identified parts of Caister-on-Sea as a Critical Drainage Area. Historical records show that Caister-on-Sea has been affected by heavy rainfall events.		✓			This settlement is not shown to be located within reservoir inundation extents.	None
Hemsby	Mapping does not suggest the settlement of Hemsby is at risk from fluvial or tidal flooding. However, during the December 2013 storm surge, properties fell into the sea and four were seriously undermined at Hemsby. The coastal erosion processes are linked to storm surge events. There is a drain to the west of the settlement of Hemsby, located to the south of Martham Road, that may pose a risk; this watercourse is not currently shown in the Environment Agency's Flood Zones.	See section 7.	Mapping shows surface water flood risk consists predominantly of pockets of water ponding on roads, gardens and other open spaces throughout the settlement. In the 0.1% AEP event, an overland flow route begins to affect properties off The Street and Waters Lane and in the vicinity of Common Lane. There is additional sporadic flooding to properties across the settlement. The 2013 SWMP for Great Yarmouth borough identified parts of Hemsby as a Critical Drainage Area.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				These settlements are not shown to be located within reservoir inundation extents.	Seven incidents have been recorded in a postcode area that relates to Hemsby and Winterton-on-Sea.
Ormesby St. Margaret	Mapping does not suggest the settlement of Ormesby St. Margaret is at risk from fluvial or tidal flooding. There is a drain to the north west of the settlement at the end of Private Road that may pose a risk; this watercourse is not currently shown in the Environment Agency's Flood Zones.	None	Mapping shows surface water flood risk consists predominantly surface water ponding on roads, gardens and other open spaces throughout the settlement in the 3.3% AEP event. In the 1% AEP event surface water flood extents are shown to affect properties around Wapping, as well as properties between Decoy Road and Private Road. In the 0.1% AEP event, flood extents are shown to increase. Properties are shown to be within surface water extents in and around North Road.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				This settlement is not shown to be located within reservoir inundation extents.	Eight incidents have been recorded in a four-digit postcode area that relates to Ormesby St. Margaret, Filby and Scratby.

Settlement	Fluvial / tidal / coastal flood risk	Flood Defences	Surface water flood risk	Susceptibility to Groundwater flood risk				Reservoir inundation risk	Number of recorded sewer flood incidents on Anglian Water's DG5 Register
				<25%	>=25% <50%	>=50% <75%	>=75%		
Belton	Mapping shows fluvial / tidal flood risk to the settlement of Belton appears to be driven by the River Yare to the west of the settlement and two un-named drains / tributaries of the Yare, which flow to the north and west of the settlement. Properties along Station Road, Stephsort and St. Johns Road are shown to be within the Flood Zone extents. High levels in the River Yare may prevent the drains from effectively discharging, raising levels within those watercourses and potentially exacerbating flooding.	None	Mapping shows surface water flood risk consists predominantly of surface water ponding on roads, gardens and other open spaces throughout the settlement. In the 0.1% AEP event, some of the worst affected areas include properties in the vicinity of The Coke and Sharmans Loke and Farman Close.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				This settlement is not shown to be located within reservoir inundation extents.	14 incidents have been recorded in a four-digit postcode area which relates to Belton, Bradwell and Fritton.
Hopton-on-Sea	Mapping does not suggest the settlement of Hopton on Sea is at risk from fluvial or tidal flooding.	None	Mapping shows surface water flood risk consists generally of surface water ponding on roads, gardens and other open spaces throughout the settlement in the 3.3% AEP event. However, properties in the vicinity of Warren Road and The Laurels are shown to be affected by surface water extents. In the 1% and 0.1% AEP events, surface water flood extents continue to increase and affect more properties along Warren Road and The Laurels. A prominent overland flow route develops in the 0.1% AEP event emanating from Groomes Close (and flowing in a south-western direction towards the Mill Water.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				This settlement is not shown to be located within reservoir inundation extents.	None
Martham	Mapping does not suggest the settlement of Martham is at risk from fluvial or tidal flooding. There is a drain to the south east of the settlement at the end of Willow Way that may pose a risk; this watercourse is not currently shown in the Flood Zones.	None	Mapping shows surface water flood risk consists predominantly of surface water ponding on roads, gardens and other open spaces as well as the existing watercourse throughout the settlement in the 3.3% and 1% AEP events. Property flooding is shown to occur sporadically across the settlement in the 0.1% AEP event; however, properties to the east of White Street / Black Lane and to the west and east of Rollesby Road (are shown to be within surface water extents.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				This settlement is not shown to be located within reservoir inundation extents.	None
Winterton-on-Sea	Mapping shows approximately two properties are within Flood Zone 2 in the north of the settlement. Flood Zones are associated with fluvial / tidal influences from the Hundred Stream.	None	Mapping shows surface water flood risk consists generally of pockets of water ponding on roads, gardens and other open spaces throughout the settlement in the 3.3% AEP event. However, property in the vicinity of the village centre is shown to be affected by surface water extents. In the 1% and 0.1% AEP events, surface water extents increase and are shown to affect more properties in the village centre, as well as sporadically across the settlement.	AStGWf dataset displayed no data in this location – susceptibility is therefore unknown.				This settlement is not shown to be located within reservoir inundation extents.	Seven incidents have been recorded in a postcode area that relates to Winterton-on-Sea and Hemsby.

7 Fluvial and coastal defences

Preparation of the SFRA has included a high-level review of available information on flood defences and involved interrogation of existing evidence on flood defence condition and standards of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment, in addition to some supplementary explanation on defence performance. Defences are categorised as either raised flood defences (e.g. walls/embankments) or flood storage areas (FSAs).

The flood defences and their locations are summarised in the sections below.

7.1 Flood defences

One of the principal aims of the SFRA is to outline the present risk of flooding across Great Yarmouth borough including consideration of the effect of flood risk management measures (including flood banks and defences). The modelling that informs the understanding of flood risk within the borough is typically of a catchment wide nature, suitable for preparing evidence on possible site options for development. In cases where a specific site risk assessment is required, detailed studies should seek to refine the results used to provide a strategic understanding of flood risk from all sources.

Flood defences are given a rating based on a grading system for their condition. A summary of the grading system used by the Environment Agency for condition is provided in Table 7-1.

Table 7-1: Defence asset condition rating

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation required.
5	Very Poor	Severe defects resulting in complete performance failure.

Developers should consider the standard of protection provided by defences and residual risk as part of a detailed FRA. The Environment Agency should be contacted for detailed defence information such as crest levels and standard of protection.

Standard of Protection

Flood defences are designed to give a specific standard of protection, reducing the risk of flooding to people and property in flood prone areas. For example, a flood defence with a 1% AEP standard of protection means that the flood risk in the defended area is reduced to a 1% chance of flooding in any given year.

Although flood defences are designed to a standard of protection it should be noted that, over time, the actual standard of protection provided by the defence may decrease, for example due to deterioration in condition or increases in flood risk due to climate change.

It should be noted that the Environment Agency's on-going hydraulic modelling programme may revise flood risk datasets and as a consequence, the standard of protection offered by flood defences in the area, may differ from those discussed in this report.

The condition of existing flood defences and whether they will continue to be maintained and/or improved in the future is an issue that needs to be considered as part of the risk based sequential approach and, in light of this, whether possible site options for development are appropriate and sustainable. In addition, detailed Flood Risk Assessments (FRAs) will need to thoroughly explore the condition of defences, especially where these defences are informal and demonstrate a wide variation of condition grades. It is important that all of these assets are maintained to a good condition and their function remains unimpaired.

The Environment Agency has a dataset called “Areas Benefiting from Defences”. This dataset shows those areas that benefit from the presence of defences in a 1 in 100 (1%) chance of flooding each year from rivers; or 1 in 200 (0.5 %) chance of flooding each year from the sea. This dataset indicates that no areas in the borough of Great Yarmouth, benefit from defences. However, the dataset does not show all areas that benefit from defences as the Environment Agency do not map defences that offer a lower standard of protection than that stated above. It should be noted that the Environment Agency’s on-going hydraulic modelling programme may revise flood risk datasets and as a consequence, the areas benefiting from defences, may differ from those discussed in this report.

A review of the Environment Agency’s supplied raised flood defence information shows that there are defences in the borough of Great Yarmouth. A review of key Environment Agency assets across Great Yarmouth borough and their condition is included in the following sections. There are no FSAs in Great Yarmouth borough shown in the Environment Agency’s dataset.

Note: Authority administrative boundaries are not shown in the figures in 7.2 and 7.3.

7.2 Fluvial and tidal flood defences in Great Yarmouth borough

7.2.1 Great Yarmouth town

Flood defences within Great Yarmouth are predominantly formed of walls, as shown in Figure 7-1. A number of bridge abutments, flood gates and demountable defences are located along the walls. Embankments surround the south-east of Breydon Water. A quay is located along Riverside Road and to the south-west of the port in Great Yarmouth town.

The majority of the defences are in fair condition, with the remaining defences in either very good, good, poor or very poor condition as illustrated in Figure 7-2.

In 2016, the Environment Agency finished the first phase of work to replace over 500 metres of tidal defences, which reduces the risk of flooding to the Southtown and Cobham areas of Great Yarmouth. Over the coming decades, the EA intend to refurbish the tidal defences in 5-year phases. The scheme will reduce the risk of tidal flooding from the River Yare to over 6,000 properties, including 5,000 homes over 12km of flood defences.[26]

[26] Environment Agency (2016) Thousands of properties protected in first phase of flood defence scheme

Figure 7-1: EA flood defence type in Great Yarmouth town

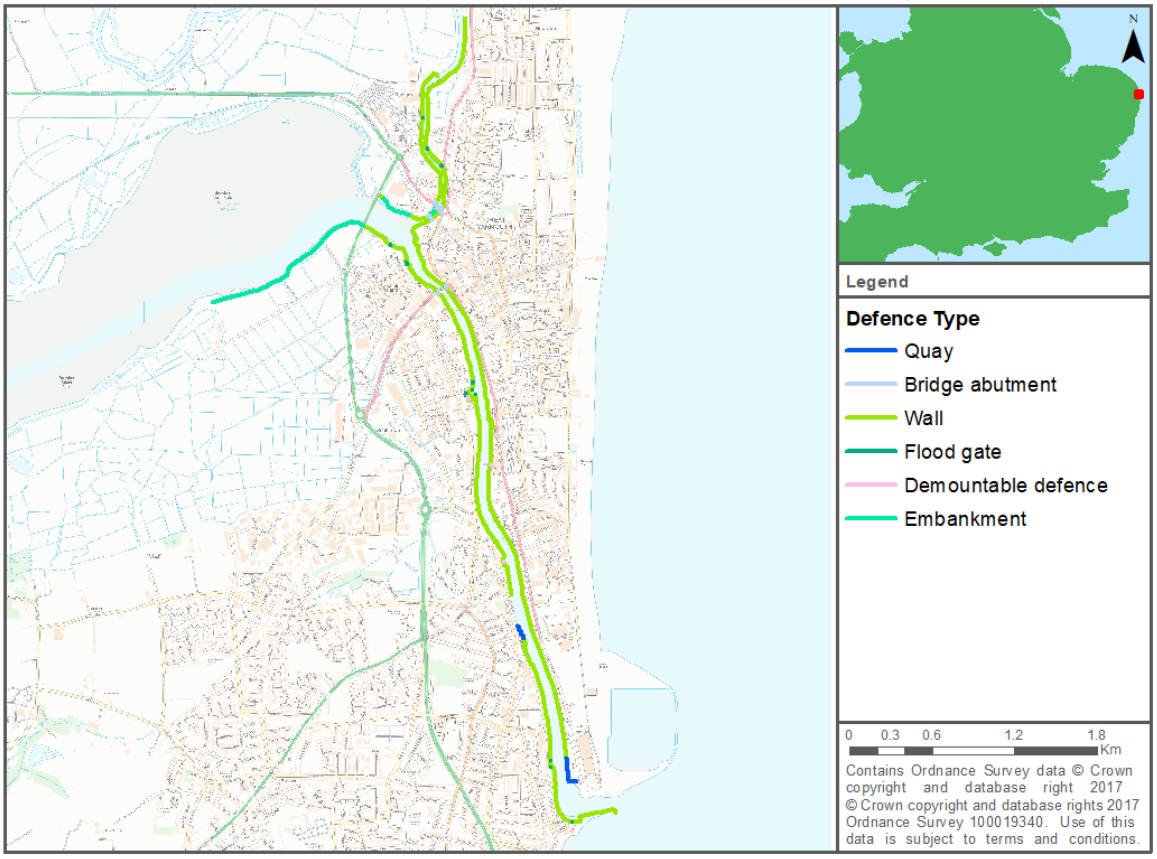
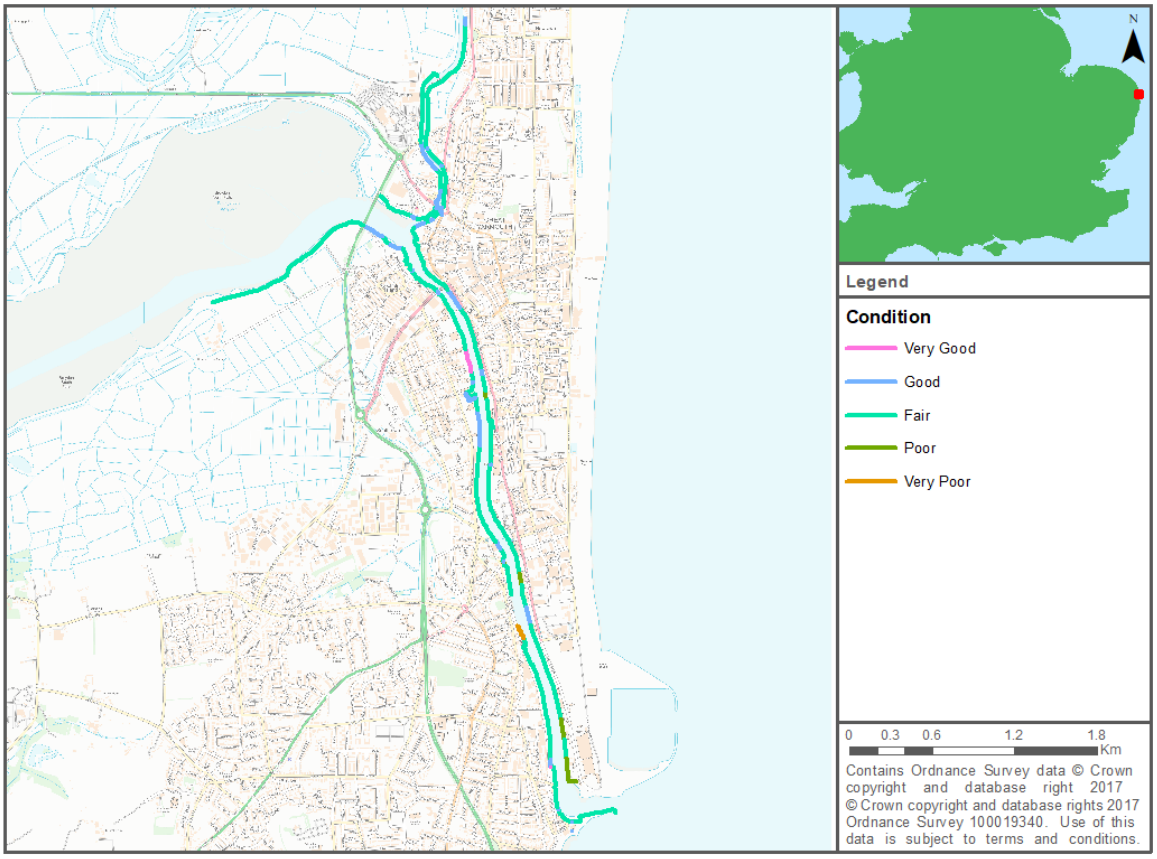


Figure 7-2: EA flood defence condition in Great Yarmouth town



7.3 Coastal defences in Great Yarmouth borough

7.3.1 Winterton Dunes

Along Winterton Dunes lies a series of concrete walls and sand dunes, with two demountable defences (see Figure 7-3). The defences are in fair conditions (see Figure 7-4).

Figure 7-3: EA flood defence type along Winterton Dunes

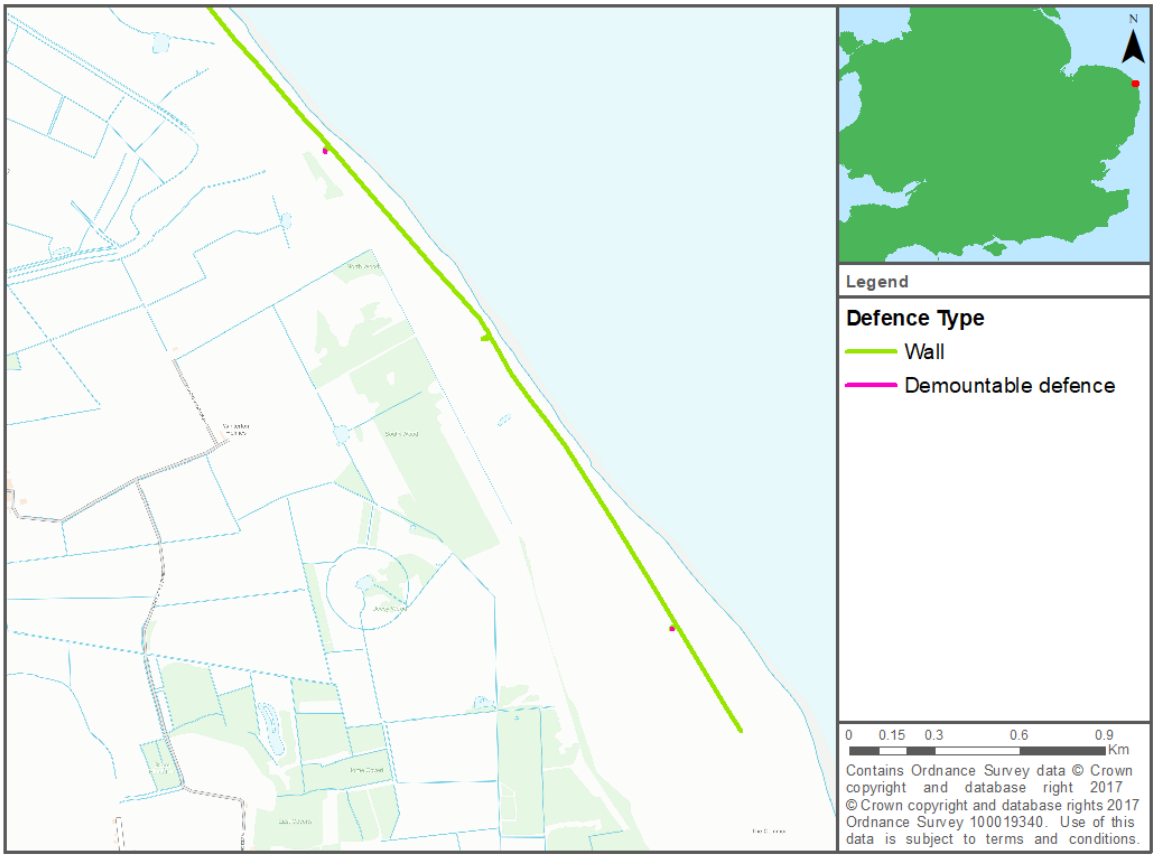
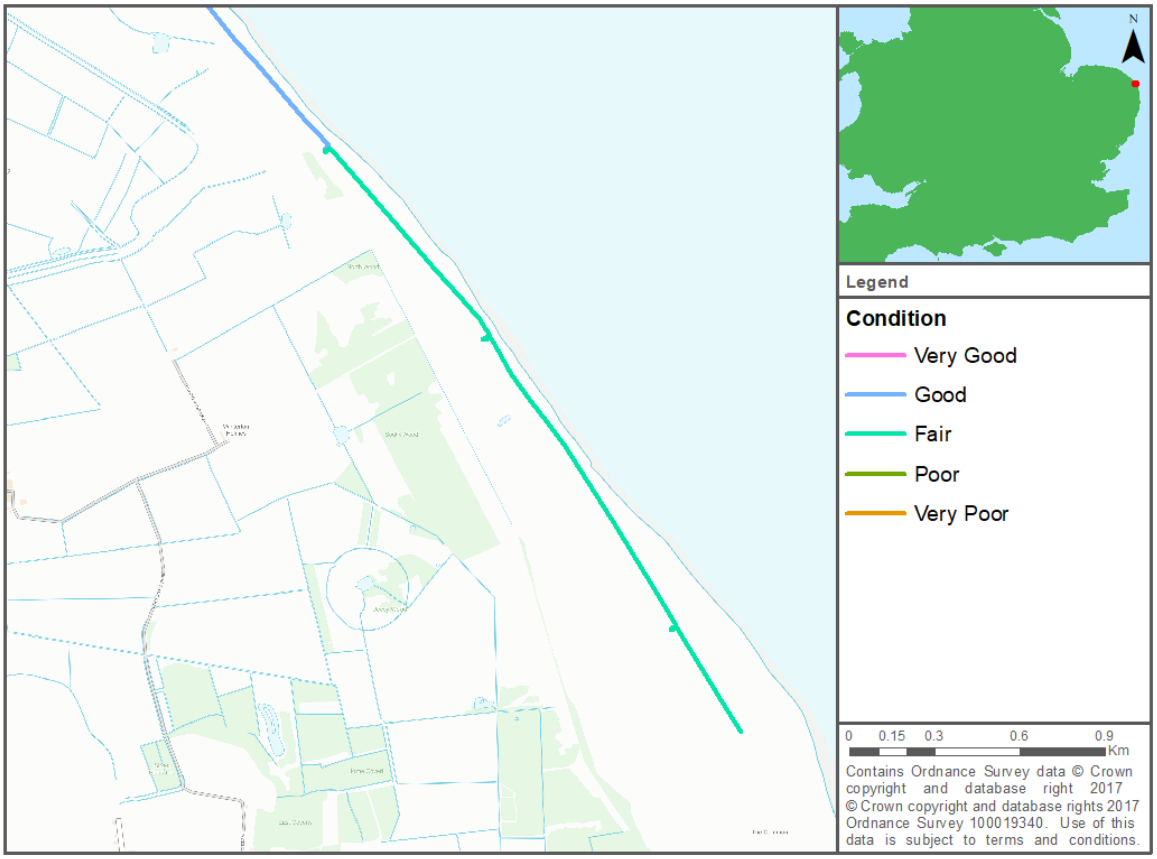


Figure 7-4: EA flood defence condition along Winterton Dunes



7.3.2 Newport to Scratby

In 2016, a coastal protection scheme was carried out which involved a 900m long revetment of about 1,300 gabions (stone-filled and crushed concrete filled cages) from Newport to Little Scratby Crescent.

Three-metre high gabions were positioned at the toe of the soft, sandy cliffs, protecting the low dunes, which are their natural buffer from lapping waves. If left unprotected, these dunes take some years to recover once hit in a storm, meaning they are less effective at reducing erosion to the cliffs if there is another storm soon after. The added protection aims to delay the rate of erosion, giving the community time to adjust to coastal change.

The scheme is designed to help protect 37 homes which are nearest to the cliff edge, over a 25-year period.[27]

7.3.3 Great Yarmouth Harbour

The Great Yarmouth Harbour was constructed in 2007-9. The harbour's breakwaters form a substantial seawards extension to the structures at the mouth of the Yare, with potential for consequential impacts on coastal processes in the vicinity.[28]

7.3.4 Hopton

A rock revetment and rock groynes were completed in 2014 along this frontage to provide protection for at least 30 years; these were paid for entirely by Bourne Leisure Ltd to protect their substantial leisure park assets along the cliff top. The Shoreline Management Plan policy is to "Hold the Line" along this frontage, but for the short term only, through maintenance of existing defences.

[27] Great Yarmouth Borough Council (2016) Environment minister Thérèse Coffey officially commissions Scratby coast protection scheme

[28] Waveney District Council and Great Yarmouth Borough Council (2016) Gorleston to Lowestoft Coastal Strategy

Therefore, although in-keeping with the policy headline, these new defences do not align with the intention of the Shoreline Management Plan, which was to promote managed realignment of this coastline in the medium term onwards.

These defences should provide protection to both cliff top assets and the wider community of Hopton at least into the medium term and have therefore met the aspirations of the local community. The benefits of maintaining the defences currently outweigh the benefits of removing them and it is therefore likely that they will remain for several decades to come.

7.4 Proposed defence schemes

7.4.1 Hemsby Flood Risk Management Project

A Flood Risk Management Project in Hemsby, led by Norfolk County Council, is due to commence sometime between 2017 and 2019 and is due to be completed by April 2021. It is proposed that 90 properties will be better protected from flooding on completion of the scheme.

7.4.2 Great Yarmouth Flood Defences – Stage 2 – 2016 to 2021

The second stage of the Great Yarmouth flood defence scheme is set to commence between 2019 and 2021 and will be completed sometime after 2021. A total of 1,415 homes are expected to be protected from flooding.

The Environment Agency intends to refurbish the tidal defences in 5-year phases over the coming decades. The overall scheme includes 12km of flood defences in Great Yarmouth that reduce the risk of tidal flooding from the River Yare to over 6,000 properties, including 5,000 homes[29].

7.4.3 Gorleston Coast Protection Scheme

The Gorleston Coast Protection scheme is forecasted to start construction after 2021. The Lead Risk Management Authority will be Great Yarmouth Borough Council and the scheme is expected to protect 500 homes from coastal erosion.

7.5 Residual flood risk

Residual risk is discussed during the Level 1 SFRA and is an important consideration when assessing sites. Residual risk refers to the risks that remain in circumstances after measures have been taken to alleviate flooding (such as flood defences). It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be:

- The effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges.
- Failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner or failure of pumping stations.

Defences in Great Yarmouth are shown to be in varying condition. However, in the event of a breach, depending on the extent and magnitude of the breach, water could rapidly inundate areas behind defences with little warning. Although the majority of areas protected by defences are within the Environment Agency's Flood Warning System, the service does not provide a warning in the event of a breach.

There is also the potential that the risk of defences overtopping in the future may increase due to increased flows due to climate change.

7.5.1 Breach modelling

Coastal breach modelling covering the Great Yarmouth and North Norfolk coastline was completed in 2017, to gain an understanding of potential impacts of breach failure from coastal defences at Great Yarmouth town and along the Thurne and Hickling coastline in North Norfolk.

[29] Great Yarmouth Borough Council (2016) Thousands of properties protected in first phase of flood defence scheme

Four breach locations were assessed in Great Yarmouth and two were assessed in North Norfolk. These are recorded in Table 7-2 and Table 7-3 respectively.

Table 7-2: 2017 Great Yarmouth coastal breach modelling – breach locations

Breach	Location
1	Opposite Stone Road / Critten's Road, Great Yarmouth town, right bank of the River Yare, around the vicinity of the River Bure and River Yare confluence
2	Southtown Road, Great Yarmouth town, right bank of the River Yare
3	Opposite the A1243 Southgates Road, near Selby Place, Great Yarmouth town, left bank of the River Yare
4	Adjacent to the A149, opposite Yarmouth train station, Great Yarmouth town, right bank of the River Bure, upstream of the confluence with the River Yare

Table 7-3: 2017 Thurne and Hickling coastal breach modelling – breach locations

Breach	Location
1	Opposite Bush Drive at Eccles-on-Sea in North Norfolk District.
2	At the end of an un-named road, north-east of Horsey Corner in North Norfolk District.

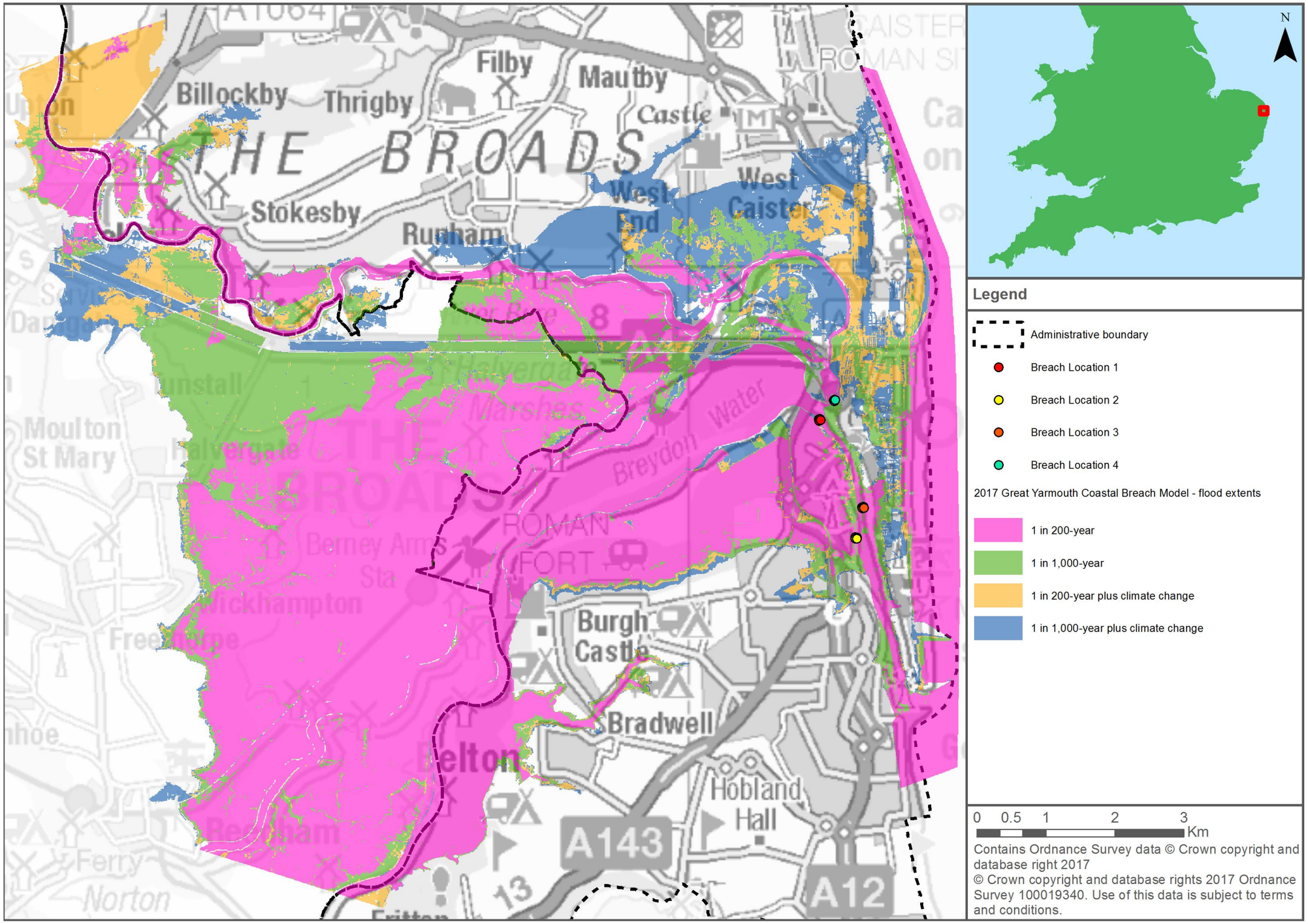
Breach modelling was completed for the defended 200-year, 200-year with climate change, 1,000-year and 1,000-year with climate change scenarios. Standard guidance for breach modelling was adopted, with the breach specified to occur one hour before high tide, with elevations of the defences reducing to the ground level behind the defence.

The breach extents for the 2017 Thurne and Hickling coastal breach modelling partially cover Great Yarmouth borough, to the north of Winterton-on-Sea. From a review of the extents and OS mapping, the extents cover rural, open land and do not affect properties.

The resultant flood extents from the combined breach modelling for Great Yarmouth borough are displayed Figure 7-5. The areas predicted should be seen as indicative of the influence of breaches, as the exact location of the breach, failure type, and event at which the breach occurs all could influence the flooding from such an event.

The breach modelling shows that significant areas of Great Yarmouth town are at risk should the defences breach; it demonstrates that Great Yarmouth town is reliant on defences to protect against tidal (sea) flooding. The risk also extends inland, away from the coast, and covers parts of neighbouring Broadland District and South Norfolk. The model results indicate that the model is quite sensitive to climate change; the 1 in 200-year plus climate change extent is larger in some locations than the 1 in 1,000-year extent.

Figure 7-5: 2017 Norfolk coastal breach modelling at Great Yarmouth



7.5.2 Implications for development

The assessment of residual risk demands that attention be given to the vulnerability of the receptors and the response to managing the resultant flood emergency. In this instance, attention should be given to the characteristics of flood emergencies and the roles and responsibilities during such events. Additionally, in the cases of breach or overtopping events, consideration should be given to the structural safety of the dwellings or structures that could be adversely affected by significant high flows or flood depths.

Developers should include an assessment of the residual risk where developments are located in areas benefitting from defences, including identifying rapid inundation zones. They should consider both the impact of breach, including the effect on safe access and egress, as well as potential for flood risk to increase in the future due to overtopping.

At areas susceptible to breach failure, it is expected that more detailed assessment be completed to evidence the severity of the risk. This more detailed assessment should refine the information prepared as part of SFRA assessment and describe how the residual risk will be safely managed at the development site. This more detailed assessment should at least include consideration of the following elements which may also be included within a site flood risk management plan:

- Extent of flooding
- Depth of flooding
- Velocity of flood water
- Speed of onset of flooding
- Hazard to people
- Duration of flooding
- Warning and evacuation procedures
- Forces on buildings and infrastructure

Any improvements to defences should ensure they are in keeping with wider catchment policy.

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8 FRA requirements and flood risk management guidance

8.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within the Great Yarmouth borough. Due to the strategic scope of the study, prior to any construction or development, site-specific assessments will need to be undertaken for individual development proposals (where required) so all forms of flood risk at a site are fully addressed. It is the responsibility of the developer to provide an FRA with an application.

It should be acknowledged that a detailed FRA may show that a site is not appropriate for development of a particular vulnerability or even at all. Where the FRA shows that a site is not appropriate for a particular usage, a lower vulnerability use may be appropriate.

8.2 Requirements for site-specific flood risk assessments

8.2.1 What are site-specific FRAs?

Site-specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted to LPAs with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

8.2.2 When are site-specific FRAs required?

Site-specific FRAs are required in the following circumstances:

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

A FRA may also be required for some specific situations:

- If the site may be at risk from the breach of a local defence (even if the site is actually in Flood Zone 1);
- Where the site is intended to discharge to the catchment or assets of a water management authority which requires a site-specific FRA;
- Where the site's drainage system may have an impact on an IDB's system;
- Where a site is located 20m from a watercourse that doesn't have an associated Flood Zone;
- Where evidence of historical or recent flood events have been passed to the LPA; and / or,
- In an area of significant surface water flood risk.

In some cases, a development meeting the criteria below may need to submit a FRA to the IDB to inform any consent applications:

- Development being either within or adjacent to a drain/ watercourse, and/ or other flood defence.
- Structure within the area of an IDB.
- Development being within the channel of any Ordinary Watercourse within an IDB area.
- Where a direct discharge of surface water or treated effluent is proposed into an IDB's catchment.
- For any development proposal affecting more than one watercourse in an IDB's area and having possible strategic implications.

- In an area of an IDB that is in an area of known flood risk.
- Development being within the maintenance access strips provided under the IDB's by-laws.
- Any other application that may have material drainage implications.

8.2.3 Objectives of site-specific FRAs

Site-specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature and location of the development. Site-specific FRAs should establish:

- Whether a proposed development is likely to be affected by current or future flooding from any source
- Whether a proposed development will increase flood risk elsewhere
- Whether the measures proposed to deal with the effects and risks are appropriate
- The evidence, if necessary, for the LPA to apply the Sequential Test
- Whether, if applicable, the development will be safe and pass the Exception Test, if applicable

FRAs for sites located in Great Yarmouth borough should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency. Guidance and advice for developers on the preparation of site-specific FRAs include:

- **Standing Advice on Flood Risk (Environment Agency)**
- **Flood Risk Assessment for Planning Applications (Environment Agency)**
- **Site-specific Flood Risk Assessment: CHECKLIST (NPPG, Defra)**

The Environment Agency has produced a Flood Zone 3 Fact Sheet which provides information on the requirements for site-specific Flood Risk Assessments for sites in Flood Zone 3 and in the East Anglia area. The Environment Agency has also produced a guidance document called "Flood risk assessment: Climate Change allowances" which details the application of the allowances and local considerations in East Anglia. This document is available from: **https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers**

Within Great Yarmouth borough, the fluvial hydraulic models were not available to be re-run, and consequently no fluvial climate change modelling was undertaken. 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. The Environment Agency's Climate Change guidance note provides further information on the local precautionary allowances for potential climate change impacts. These allowances can be used in basic assessments for areas covered by the BESL model, in the absence of the updated detailed modelling, alongside other cases where precautionary allowances may be suitable.

Guidance for LPAs for reviewing flood risk assessments submitted as part of planning applications has been published by Defra in 2015 – **Flood Risk Assessment: Local Planning Authorities.**

8.2.4 LLFA guidance note

Part C Technical Guidance of Norfolk County Council's **guidance document** on their Lead Local Flood Authority role as Statutory Consultee to Planning (2017), sets out the expectations of the Council when reviewing flood risk assessments and surface water drainage submissions. It reinforces that all development should consider existing risk of flooding from all sources and that the sequential approach will be supported by the LLFA. Details on the sources of flood risk and drainage information used to assist the LLFA in the review of an application are provided in this document.

The document notes three key criteria which are to be met to protect the public from flooding, on site and downstream:

1. Protection against flooding from watercourses
2. Protection against flooding from the drainage system
3. Protection against flood from overland flows (from sources within or external to the site).

The LLFA will expect the risk to be assessed if sites are at risk of flooding from an Ordinary Watercourse or from a surface water overland flow route and, where appropriate, this may require hydraulic modelling. Further details can be found in the guidance note.

8.2.5 Broads Authority Supplementary Planning Document

The **Broads SPD** has been prepared by the Broads Authority and covers part of Great Yarmouth borough. The SPD was adopted in March 2017 and provides guidance to developers and others about the Authority's approach to the issue of development and flood risk. Developers considering proposals located within the Broads Authority administrative area are advised to consult this document and where necessary approach the Broads Authority at an early stage to discuss flood risk, including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

8.2.6 IDB Guidance

Planners should be aware of local conditions and requirements set by the Waveney, Lower Yare and Lothingland IDB and / or the Water Management Alliance (comprising the Broads IDB and Norfolk Rivers IDB). The Water Management Alliance have published application **guidance notes** and Nicholsons' Law, which administers the Waveney, Lower Yare and Lothingland IDB, has a number of guidance documents available to download from their **website**.

8.2.7 Consultations

Developers should consult with the relevant LPA (i.e. Great Yarmouth Borough Council or the Broads Authority), Norfolk County Council, the Environment Agency, Anglian Water and, where necessary, relevant IDBs at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. If applications cross administrative boundaries, the neighbouring LLFA, Suffolk County Council, may need to be approached.

8.3 Flood Map Challenge

Where a site-specific FRA has produced modelling outlines which differ from the EAs Flood Map for Planning (Rivers and Sea) then a Flood Map Challenge may need to be undertaken. Where the modelling and results are deemed acceptable to the EA, amendments to the Flood Map for Planning (Rivers and Sea) may take place.

8.4 Flood risk management guidance – mitigation measures

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

8.4.1 Site layout and design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from Flood Zones 2 and 3, to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas. However, vehicular parking in floodplains should be based on the nature of parking, flood depths and hazard including evacuation procedures and flood warning.

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

Making space for water

The NPPF sets out a clear policy aim in Flood Zone 3 to create space for flooding by restoring functional floodplain.

All new development close to rivers should normally consider the opportunity presented to improve and enhance the river environment. Developments should normally look at opportunities for river restoration and enhancement as part of the development. Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

The provision of a buffer strip can 'make space for water', allow additional capacity to accommodate climate change and ensure access to the watercourse, structures and defences is maintained for future maintenance purposes.

It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

8.4.2 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood.

Finished floor level guidance has been established through consultation with the Environment Agency. Minimum finished floor levels for development should be set to whichever is the higher of the following:

- a minimum of 300mm* above the 1% AEP fluvial event plus an allowance for climate change
- a minimum of 300mm* above the 0.5% AEP tidal event plus an allowance for climate change
- a minimum of 300mm above surrounding ground levels

*A 300mm freeboard is only applicable where detailed modelling is available which is deemed to be reliable. The additional height that the floor level is raised above the maximum water level is referred to as the "freeboard". If no detailed and reliable modelling is available, the Environment Agency may require a 600mm freeboard to be applied when setting minimum finished floor levels.

Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

With regards to LLFA guidance and surface water flood risk, finished floor levels are recommended to be set to a minimum of 300mm above the 1% AEP plus an allowance for climate change flood levels (including anticipated flood levels within the drainage system). If there is an uncertainty in flood levels, the freeboard level should be increased from 300mm to 600mm. The LLFA would also expect a minimum of at least 150mm freeboard between proposed external ground levels and the property finished floor level. Further information can be found in the **LLFA guidance document**.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency and / or LLFA will be required to determine the suitability of alternative flood mitigation approaches.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when the duration of flooding covers many days.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test.

Safe access and egress will need to be demonstrated at all development sites. Ideally, access should be situated 300mm above the design flood level and waterproof construction techniques used. If safe access and egress cannot be achieved, the **Defra/EA Technical Report: FD2320:**

Flood Risk Assessment Guidance for New Development should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site.

Emergency vehicular access should be possible during times of flood.

8.4.3 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution.

Temporary or demountable defences are not acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe but the time required to install the defences, for example in an overtopping scenario, would be realistic. In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate. The storage and accessibility of such structures must be considered.

Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential safety of the development, finished floor levels and the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

8.4.4 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property; in most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land.

All new development within the 1% AEP flood extent including an allowance for climate change (for the lifetime of the development) must not result in a net loss of flood storage capacity. Where possible, opportunities should normally be sought to achieve an increase in the provision of floodplain storage.

Where proposed development results in a change in building footprint, the developer should normally ensure that it does not impact upon the ability of the floodplain to store or convey water, and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided to ensure that the total volume of the floodplain storage is not reduced.

For compensatory flood storage to be effective and not require hydraulic modelling, it must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it must be in the immediate vicinity, in the applicant's ownership/control and linked to the site. Floodplain compensation should be considered in the context of the 1% annual probability (1 in 100 year) flood level including an allowance for climate change. When designing a scheme flood water must be able to flow in and out unaided. An FRA should demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development. Guidance on how to address floodplain compensation is provided in Appendix A3 of the CIRIA Publication C62430.

Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land or property.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment.

8.4.5 Developer contributions

In some cases, and following the application of the sequential test, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS).

DEFRA's Flood and Coastal Erosion Risk Management Grant in Aid (FCERMGiA)[30] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCERMGiA and therefore any shortfall in funds will need to be found from elsewhere through Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the Council and the Environment Agency.

The appropriate route for the consideration of strategic measures to address flood risk issues is the LFRMS. The LFRMS describes the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

The Environment Agency is also committed to working in partnership with developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions.

8.5 Flood risk management guidance – resistance measures

Measures designed to keep flood water out of properties and businesses.

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 0.1% AEP scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method.

Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system to ensure the measures are deployed in advance of an event. The following measures are often deployed:

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

[30] Flood and coastal defence funding: for risk management authorities (Environment Agency, 2014)

Temporary barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale, temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

Community resistance measures

These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

Non-return valves

Non-return valves can be installed on appliances and sewer pipes to prevent waste water from being forced up bathroom and kitchen plugs, or lavatories.

8.6 Flood risk management guidance – resilience measures

Measures designed to reduce the impact of water that enters property and businesses.

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier. Interior design measures to reduce damage caused by flooding include:

- Electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level.
- Water-resistant materials for floors, walls and fixtures such as tiled floors, with waterproof adhesive and grout.
- Front doors that reduce ingress of water all the time with no further installation required. Such methods must consider hydrostatic pressure and that water may still come in through the floor. Such methods offer time and reduce damage but may not remove flood water from entering the house completely.

8.6.1 Further guidance

Norfolk County Council's **guidance document** on their roles as LLFA Statutory Consultee for Planning, details that the LLFA expect any resistance and resilience measures to be followed where it is agreed that it is not possible for development to be avoided in areas at risk of surface water flooding and not possible to mitigate the risks through the site design.

In relation to fluvial and tidal flood risks, the Environment Agency recommend that consideration is given to flood proofing measures to reduce the impact of flooding when it occurs. To minimise the disruption and cost implications of a flood event, the Environment Agency encourage development to incorporate flood resistance and resilience measures up to the extreme 1 in 1,000-year climate change flood level. Further information is provided in the publication **"Improving the flood performance of new buildings"** and **"Prepare your property for flooding."**

8.7 Reducing flood risk from other sources

8.7.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1% AEP plus climate change event, or where high ground water levels are known. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

Infiltration SuDS can cause increased groundwater levels and increase flood risk on or off of the site. Developers should provide evidence and ensure that this will not be a significant risk.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution.

8.7.2 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. It is important that a surface water drainage strategy shows that development will not make the risk worse, increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk.

When redeveloping existing buildings, the installation of some permanent or temporary floodproofing and resilience measures could protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers, providing they are maintained appropriately. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly, and appropriately, maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.

8.7.3 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) re-create the benefits of natural drainage systems by integrating water management with urban form to create and enhance the public realm, streets and open spaces. The flexibility of SuDS components means that SuDS can apply in both the urban and rural context and in both natural and man-made environments.

SuDS allow the delivery of high quality surface water drainage whilst at the same time supporting urbanised areas in coping with severe rainfall. SuDS generally replace traditional underground, piped systems that gather runoff using grates or storm water drains. They control flows to prevent deluges during times of high rainfall and reduce the risk of flooding whilst also providing benefits for amenity and biodiversity. The SuDS approach keeps water on the surface as much as possible to avoid concentration and acceleration of flows in piped systems while also taking the opportunity to provide valuable amenity assets for local residents and increase the provision of green infrastructure in urban areas. Keeping water on the surface also means that any problems with the system are quicker and easier to identify than with a conventional system and are generally cheaper and more straightforward to rectify.

SuDS provide an opportunity to improve and connect habitats in urbanised environments, as well as playing an important role in delivering and reinforcing wider green infrastructure ambitions. SuDS can also deliver recreation and education opportunities.

The four key principals of SuDS design, as shown in Figure 9-1, comprise water quantity, water quality, amenity and biodiversity. Methods for attenuating water on-site are not always considered to be SuDS. Norfolk County Council's **guidance document** provides the example of piped drainage that conveys water to an attenuation tank which is often proposed as SuDS and states that such systems do not always consider water quality, amenity or biodiversity benefits. The guidance document further states that *"the piped and tanked systems can be put forward for adoption and long-term maintenance by Anglian Water but these will be classed as conventional drainage systems and not SuDS."*

SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. This will assist with the delivery of well designed, appropriate and effective SuDS.

Advice on best practice is available from Norfolk County Council (as LLFA), the Environment Agency and the Construction Industry Research and Information Association (CIRIA). More detailed guidance on the use of SuDS is provided in Section 9.

Developers who wish to have their SuDS schemes considered for adoption by Anglian Water should refer to the **Anglian Water SuDS Adoption Manual**. Anglian Water's current position with relation

to safety is that for any open SuDS features that a developer wants Anglian Water to adopt, will be required to have an independent risk assessment carried out by the Royal Society for the Prevention of Accidents (RoSPA). The recommendations presented in the RoSPA report should be incorporated in the overall design. Further details are provided in Section 9.

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9 Surface water management and SuDS

9.1 What is meant by surface water flooding?

Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall.

Surface water flooding includes:

- **pluvial flooding**: flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- **sewer flooding**: flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood around buildings or in built up areas. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network; and
- **overland flows entering the built-up area from the rural/urban fringe**: includes overland flows originating from groundwater springs.

9.2 Role of the LLFA and LPA in surface water management

From April 2015, local planning policies and decisions on planning applications relating to major development should be made such that clear arrangements for the implementation and long-term management of SuDS are put in place. The approval of SuDS lies with the LPA in consultation with the relevant LLFA. These arrangements are put in place under provisions in the Flood and Water Management Act, 2010.

In April 2015 Norfolk County Council was made a statutory consultee on the management of surface water and, as a result, provide technical advice on surface water drainage strategies and designs put forward for major development proposals. Major developments are defined as:

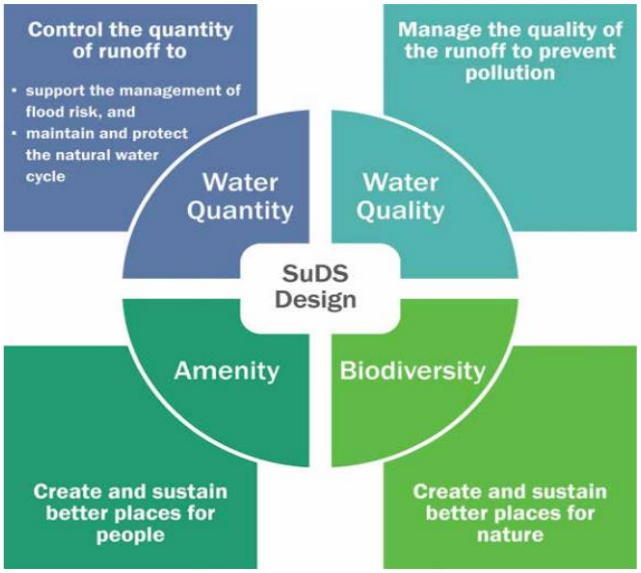
- The winning and working of minerals or the use of land for mineral-working deposits
- Waste development
- The provision of dwelling houses where the number of dwelling houses to be provided is 10 or more; or the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the number of dwelling houses to be provided is 10 or more
- The provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more
- Development carried out on a site having an area of one hectare or more

When considering planning applications, Great Yarmouth Borough Council and the Broads Authority will seek advice from the relevant flood risk management bodies, principally Norfolk County Council (the LLFA) on the management of surface water, to satisfy themselves that the development's proposed minimum standards of operation are appropriate, and to ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the lifetime of the development. Judgement on what SuDS system would be reasonably practicable will be through reference to **Defra's Non-Statutory Technical Standards for SuDS** and the **Guidance on Norfolk County Council's Lead Local Flood Authority role as Statutory Consultee to Planning** and will take into account design and construction costs.

Under Policy CU11 (Securing Sustainable Drainage) in Norfolk County Council's LFRMS, the LLFA shall seek to secure the implementation of SuDS and through voluntary cooperation of landowners, aim to secure adaptation of existing drainage networks to enable SuDS.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These four principles are shown in Figure 9-1.

Figure 9-1: Four principles of SuDS design



Source: **The SuDS Manual (C753) Ciria (2015)**

9.2.1 Norfolk County Council guidance in their LLFA role as Statutory Consultee to Planning

The Norfolk County Council **guidance document** regarding their Lead Local Flood Authority role as Statutory Consultee to Planning (2017) provides information on how SuDS proposals on new developments will be determined, when to consult the LLFA (also discussed in Section 2.5.2), how to screen applications based on local flood risk and records, LLFA standing advice (for Ordinary Watercourse consenting, major development below LLFA thresholds and minor development), the levels of information required for planning applications and technical guidance. The technical guidance relates to local flood risk, SuDS surface water drainage disposal destination, infiltration testing, runoff rate and volume, climate change, Water Framework Directive and water quality, management and maintenance of SuDS and resistance and resilience measures.

There are a series of policies contained in the technical guidance which are summarised as follows:

- **Policy Box 1: Local Flood Risk Guidance** refers to Paragraph 103 of the NPPF and NPPG Paragraph 033 Reference ID: 7-033-20140306. This discusses the requirements for LPAs to consider flood risk when determining planning applications. Norfolk County Council state that the sequential approach is supported, as this is the most sustainable form of flood risk management and describe what sources of flood risk information the LLFA will use to assist with a review of planning applications. Guidance is provided on the assessment of flood risks and mitigation measures relating to Ordinary Watercourses and surface water overland flow routes. Inclusion of opportunities to improve existing local flood risk issues are encouraged.
- **Policy Box 2: Drainage Hierarchy** refers to the NPPG Paragraph 080, Reference ID: 7-080-20150323. Where reasonably practical, the general aim should be to discharge surface runoff as high up the hierarchy of drainage options as possible: 1) into the ground (infiltration), 2) to a surface water body, 3) to a surface water sewer, highway drain or another drainage system, 4) to a combined sewer. How proposals follow this hierarchy should be clearly demonstrated, with adequate evidence and reasoning, to explain why infiltration methods are not considered to be feasible and why methods, lower down the hierarchy, are considered to be feasible.

- **Policy Box 3: Infiltration Testing Guidance** refers to the BRE 365: Soakaway Design (2016). The LLFA expects *"all submitted drainage strategies to include an assessment of the suitability of underlying geology to discharge collected surface water to the ground via infiltration."* Further information regarding infiltration testing and infiltration constraints are provided in the guidance. Section 9.3.4 of this SFRA discusses overcoming SuDS constrains.
- **Policy Box 4: Runoff Rate** refers to the SuDS Non-Statutory Technical Standards (2015), specifically standards S2 and S3 which concern peak runoff rates. In addition, the LLFA state that consideration needs to be given to the catchment area (e.g. where sub-catchments may exist on the site) and any historical flooding or capacity constraints.
- **Policy Box 5: Runoff Volume** refers to the CIRIA SuDS Manual (C735). Two approaches for the consideration of runoff volume from a development site are detailed in the CIRIA SuDS Manual and the LLFA discuss their preferred approach. The LLFA also state that Urban Creep should be considered in any application and detail the allowances to be used in assessments.
- **Policy Box 6: Climate Change** refers to the requirement to consider climate change in flood risk assessments and the government's climate change allowances (see Section 4). The LLFA discuss expectations and allowances in relation to Ordinary Watercourses and where modelling is used to inform the initial design of surface water drainage systems and SuDS.
- **Policy Box 7: Management and Maintenance** refers to the House of Commons Written Statement (HCWS161) on sustainable drainage systems. The LLFA will require *"applicants to provide a management plan and maintenance schedule of work detailing activities required and who will adopt and maintain the surface water drainage features for the lifetime of the development."* The guidance details some of the options available for the adoption and maintenance of SuDS.
- **Policy Box 8: Flow Exceedance Management** refers the British Standard BS8582:2013 Section 5.2.2.6. It discusses how exceedance flows on site should be considered and take into account any residual risks for the site. This section also discusses resistance and resilience measures.

9.2.2 Anglian Water guidance

Developers who wish to have their SuDS schemes considered for adoption by Anglian Water should refer to the **Anglian Water SuDS Adoption Manual**. Anglian Water also expect national guidance (i.e. the CIRIA C753 SuDS Manual) to be referred to in addition to Anglian Water's guidance. It should be noted that at the time of preparing the 2017 SFRA, Anglian Water's SuDS Adoption Manual was expected to be updated to take into account national guidance published after the manual was released and to reflect Anglian Water's position relating to health and safety matters associated with open SuDS features. At the time of preparing the 2017 SFRA, Anglian Water's current position is that any developer that wants Anglian Water to adopt open SuDS features, will be required to have an independent risk assessment completed that satisfies RoSPA requirements and incorporate recommendations from that report into their overall design.

Anglian Water recommend that developers contact Anglian Water's SuDS Team (**SuDS@anglianwater.co.uk**) as early as possible to discuss any SuDS features which they would like to see adopted by Anglian Water (ideally before submitting formal planning applications).

9.2.3 Internal Drainage Board's guidance

Planners should be aware of local conditions and requirements set by the Waveney, Lower Yare and Lothingland IDB and / or the Water Management Alliance IDB. The Water Management Alliance have published application **guidance notes** and a **SuDS adoption policy**. Nicholsons' Law, which administers the Waveney, Lower Yare and Lothingland IDB, has a number of guidance documents available to download from their **website**.

In general, developers who wish to do the following, will require the respective IDB's prior written consent:

- Discharge surface water into any watercourse (managed by the IDB)
- Attenuate surface water run-off arising from development.

9.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are designed to maximise the opportunities and benefits that can be secured from surface water management practices. SuDS provide a means of dealing with the quantity and quality of surface water whilst offering additional benefits over traditional systems of improving amenity and biodiversity. The correct use of SuDS can also allow developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing ground water supplies. SuDS if properly designed can improve the quality of life within a development offering additional benefits such as:

- Improving water quality
- Habitat creation and improvement
- Improving amenity
- Improving air quality
- Helping to regulate building temperatures
- Reducing noise
- Providing education opportunities
- Cost benefits over underground piped systems.

Given the flexible nature of SuDS they can be used in most situations within new developments as well as being retrofitted into existing developments. SuDS can also be designed to fit into the majority of spaces. For example, permeable paving could be used in parking spaces or rainwater gardens into traffic calming measures.

Unless demonstrated to be inappropriate, all new major development proposals should ensure that sustainable drainage systems for management of runoff are put in place and should be given priority, as per the **Ministerial Statement** and paragraph 103 of the NPPF. Likewise, minor developments should also mitigate flood risk, and take a suitable approach to surface water drainage. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

Part C Technical Guidance of Norfolk County Council's **guidance document** details the LLFA's expectations on the SuDS disposal destination and the drainage hierarchy to be followed; any submission should clearly demonstrate how the proposals will follow the drainage hierarchy. Details on runoff rates and volumes are also provided in the technical guidance.

9.3.1 Types of SuDS Systems

There are many different SuDS components that can be implemented in attempts to mimic predevelopment drainage (Table 9-1). The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. **the CIRIA SuDS Manual C753 (2015)**.

Table 9-1: Examples of SuDS techniques and potential benefits

SuDS Technique	Flood Reduction	Water Quality Treatment & Enhancement	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds	✓	✓	✓
Constructed wetlands	✓	✓	✓
Balancing ponds	✓	✓	✓
Detention basins	✓	✓	✓
Retention ponds	✓	✓	✓
Filter strips and swales	✓	✓	✓
Infiltration devices	✓	✓	✓
Soakaways	✓	✓	✓
Infiltration trenches and basins	✓	✓	✓
Permeable surfaces and filter drains	✓	✓	
Gravelled areas	✓	✓	
Solid paving blocks	✓	✓	
Porous pavements	✓	✓	
Tanked systems	✓		
Over-sized pipes/tanks	✓		
Storm cells	✓		

9.3.2 Treatment

A key part of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the "SuDS management train". To maximise the treatment within SuDS, CIRIA recommends the following good practice is implemented in the treatment process:

1. **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.
2. **Treat surface water runoff on the surface:** This allows treatment performance to be more easily inspected and managed. Sources of pollution and potential flood risk is also more easily identified. It also helps with future maintenance work and identifying damaged or failed features.
3. **Treat a range of contaminants:** SuDS should be chosen and designed to deal with the likely contaminants from a development and be able to reduce them to acceptably low levels.
4. **Minimise the risk of sediment remobilisation:** SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than what the feature may have been designed.
5. **Minimise the impact of spill:** Designing SuDS to be able to trap spills close to the source or provide robust treatment along several features in series.

The number of treatment stages required depends primarily on the source of the runoff. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

Further guidance on the treatment stages is provided in the CIRIA SuDS Manual C753 (2015). The manual provides a risk based approach to the treatment of SuDS which is dependent upon the land use and sensitivity of the receiving water body. The manual provides guidance on the treatment steps required for the type of SuDS component / scheme being considered.

9.3.3 SuDS Management

SuDS components should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. SuDS components should be selected based on design criteria and how surface water management is to be integrated within the development and landscaping setting. By using a number of SuDS components in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development.

Part C Technical Guidance of Norfolk County Council's **guidance document** provides further information on the management and maintenance of SuDS and options for the adoption of SuDS. This includes guidance on what could be considered within a management plan and maintenance schedule.

9.3.4 Overcoming SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Table 9-2 details some possible constraints and how they may be overcome and includes information from the SuDS Manual (C753). Guidance should also be sought from the Environment Agency.

Table 9-2: Example SuDS constraints and possible solutions

Constraint	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example, features such as permeable paving and green roofs can be used in urban areas where space may be limited.
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable liner or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table.
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and indicate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should take into account the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Factors such as siltation after a flood event should also be taken into account during the design phase
Future adoption and maintenance	LPA should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

There may be constraints to surface water discharges relating to high water levels in a receiving watercourse, especially those which are tidal, in Great Yarmouth borough.

For proposed developments, geotechnical investigations should be undertaken to determine whether material on site has infiltration potential. This information should be representative of on-site conditions. If material is found to have infiltration potential, detailed infiltration testing should be undertaken in line with BRE 365 to establish representative infiltration rates.

For SuDS components that are designed to encourage infiltration, it is imperative that groundwater levels are low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes.

LLFA requirements for infiltration testing for applications and infiltration constraints are detailed in Part C Technical Guidance of Norfolk County Council's **guidance document**.

9.4 Other surface water considerations

9.4.1 Groundwater Source Protection Zones (SPZ)

In addition to the AStGWf data the Environment Agency also defines Groundwater Source Protection Zones (SPZ) in the vicinity of groundwater abstraction points. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, or for use in the production of commercial food and drinks. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- Zone 1 (Inner Protection Zone) – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- Zone 2 (Outer Protection Zone) – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction
- Zone 3 (Total Catchment) - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source.

No Groundwater SPZs are found within Great Yarmouth borough.

Figure 6-2 shows that the borough is underlain entirely by principal aquifers; thus, water resources may be at risk from development in areas outside of Groundwater SPZs e.g. private supplies may not have an associated Groundwater SPZ.

Where sites are underlain by an aquifer, treatment steps may be required ahead of discharge to the ground, sewers etc. Great Yarmouth and Gorleston also have a number of historic industrial sites and as such, there is a heightened risk of groundwater pollution.[31] Development proposals at sites across the area should assess the pollution risk to receiving waterbodies, and include appropriate treatment steps ahead of any discharge to surface or groundwaters. Chapter 8 of the CIRIA SuDS Manual C753 (2015) provides information and guidance on how to design SuDS in areas with particular constraints. Further restrictions may be applicable and guidance should be sought from the LLFA. Where potentially polluting activities are proposed, the Environment Agency should also be consulted.

9.5 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated to being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies. The level of nitrate contamination will potentially influence the choice of SuDS and should be assessed as part of the design process. The definition of each NVZ is as follows:

[31] Norfolk County Council (2015) Norfolk Local Flood Risk Management Strategy.

- Groundwater NVZ – an area of land where groundwater supplies are at risk from containing nitrate concentrations exceeding the 50mg/l level dictated by the EU's Surface Water Abstraction Directive (1975) and Nitrates Directive (1991).
- Surface Water NVZ – an area of land where surface waters (in particular those used or intended for the abstraction of drinking water) are at risk from containing nitrate concentrations exceeding the 50 mg/l dictated by the EU's Surface Water Abstraction Directive (1975) and Nitrate Directive (1991).
- Eutrophic NVZ – an area of land where nitrate concentrations are such that they could/will trigger the eutrophication of freshwater bodies, estuaries, coastal waters and marine waters.

No Surface Water NVZs are found within Great Yarmouth borough.

The majority of the borough is located within one Groundwater NVZ, with only the far north of the borough unaffected.

A Eutrophic NVZ is located in the north of the borough, with part of a further Eutrophic NVZ located in the south.

Nitrate Vulnerability Zones can be viewed on the governments **What's In Your Backyard website**.

As with Groundwater SPZs, NVZs could affect the type of feature which is appropriate and the level of treatment required.

9.6 SuDS suitability across the study area

The suitability of SuDS techniques is dependent upon many variables, including the hydraulic and geological characteristics of the catchment.

The permeability of the underlying soils can determine the infiltration capacity and percolation capacities. As such, a high-level review of the soil characteristics has been undertaken using BGS soil maps of England and Wales which allow for a basic assessment of the soil characteristics and infiltration capacity. The results of the assessment are shown in Table 9-3; mapping of the soil characteristics is shown in Figure 9-2 and Figure 9-3. This indicates that the soils in the south of Great Yarmouth borough and towards the coastline are permeable and suggests that infiltration techniques, which are at the top of the drainage hierarchy (NPPG Paragraph 080, Reference ID: 7-080-20150323) may be suitable in these areas. However, depending on the proportion of clay in the soil, infiltration techniques may / may not be suitable in other areas, particularly in the Broads Authority administrative area where the predominant soil type is alluvium, which contains clay. A number of other SuDS techniques are also considered to be appropriate based on soil type.

This strategic assessment should not be used as a definitive site guide as to which SuDS would be suitable but rather as an indicative guide of general suitability based solely on soil type. Several other factors can determine the suitability of SuDS techniques including land contamination, the depth and fluctuation of the water table, the gradient of the local topography and primary source of runoff, etc. When considering NVZs and if areas have pollutants, infiltration may only be suitable where treatment measures are provided, prior to any discharge to surface or groundwaters.

Further site-specific investigation should be conducted to determine what SuDS techniques could be utilised at a particular development. The result of this assessment does not remove the requirements for geotechnical investigation or detailed infiltration testing, as discussed in Section 9.3.4 and does not substitute the results of site-specific assessments and investigations. The LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors.

Table 9-3: General application of SuDS in relation to soil types in Great Yarmouth borough

General soil type	Description	Infiltration potential	Appropriate SuDS Techniques	Great Yarmouth Borough	Broads Authority (in Great Yarmouth borough)
Sand	Brown sand	Good, relatively permeable	Living roofs, basins and ponds (depends on depth of water table), constructed wetlands, balancing ponds, detention basins, retention ponds, filter strips and swales, infiltration devices and soakaways (depends on depth of water table), permeable surfaces, porous paving, gravelled areas and filter drains and tanked systems.	✓ - generally found near coastline areas	✓ - generally found near coastline areas
Sand and gravel	Glacial sand and gravel	Good, relatively permeable	Living roofs, basins and ponds (depends on depth of water table), constructed wetlands, balancing ponds, detention basins, retention ponds, filter strips and swales, infiltration devices and soakaways (depends on depth of water table), permeable surfaces, porous paving, gravelled areas and filter drains and tanked systems.	✓ - generally found in areas of high ground towards the north and centre of the borough. Predominant soil type in the south of the borough e.g. around Bradwell, A143 etc.	✓ **-** found in sporadic locations at the top of valleys throughout the Broads Authority administrative area in Great Yarmouth borough and around Ormesby Subsidence Reservoir.
Clay, silt and sand	Alluvium	Variable, mixed permeability	Living roofs, basins and ponds (depends on depth of water table), constructed wetlands, balancing ponds, detention basins, retention ponds, filter strips and swales, porous paving, gravelled areas and filter drains and tanked systems. SuDS techniques which rely on infiltration (e.g. infiltration devices, soakaways and permeable surfaces etc.) may / may not be suitable depending upon the concentration of clay in the soil.	✓ - found at the bottom towards watercourse valleys, adjacent to the Broads Authority administrative area.	✓ - predominant soil type across the Broads Authority administrative area in Great Yarmouth borough, found at the bottom of valleys of watercourses including the River Thurne, River Bure and Muck Fleet
Diamicton	Till (also referred to as Boulder Clay)	Variable, mixed permeability	Living roofs, basins and ponds (depends on depth of water table), constructed wetlands, balancing ponds, detention basins, retention ponds, filter strips and swales, porous paving, gravelled areas and filter drains and tanked systems. SuDS techniques which rely on infiltration (e.g. infiltration devices, soakaways and permeable surfaces etc.) may / may not be suitable depending upon the concentration of clay in the soil.	✓ - a predominant soil type in Great Yarmouth borough, found across large areas to the north and centre of the borough and sections towards the south of the borough.	✓ - found in sporadic locations along the valleys of the River Bure and Muck Fleet

Figure 9-2: Soil Types in Great Yarmouth borough – by general type (ROCK_D)

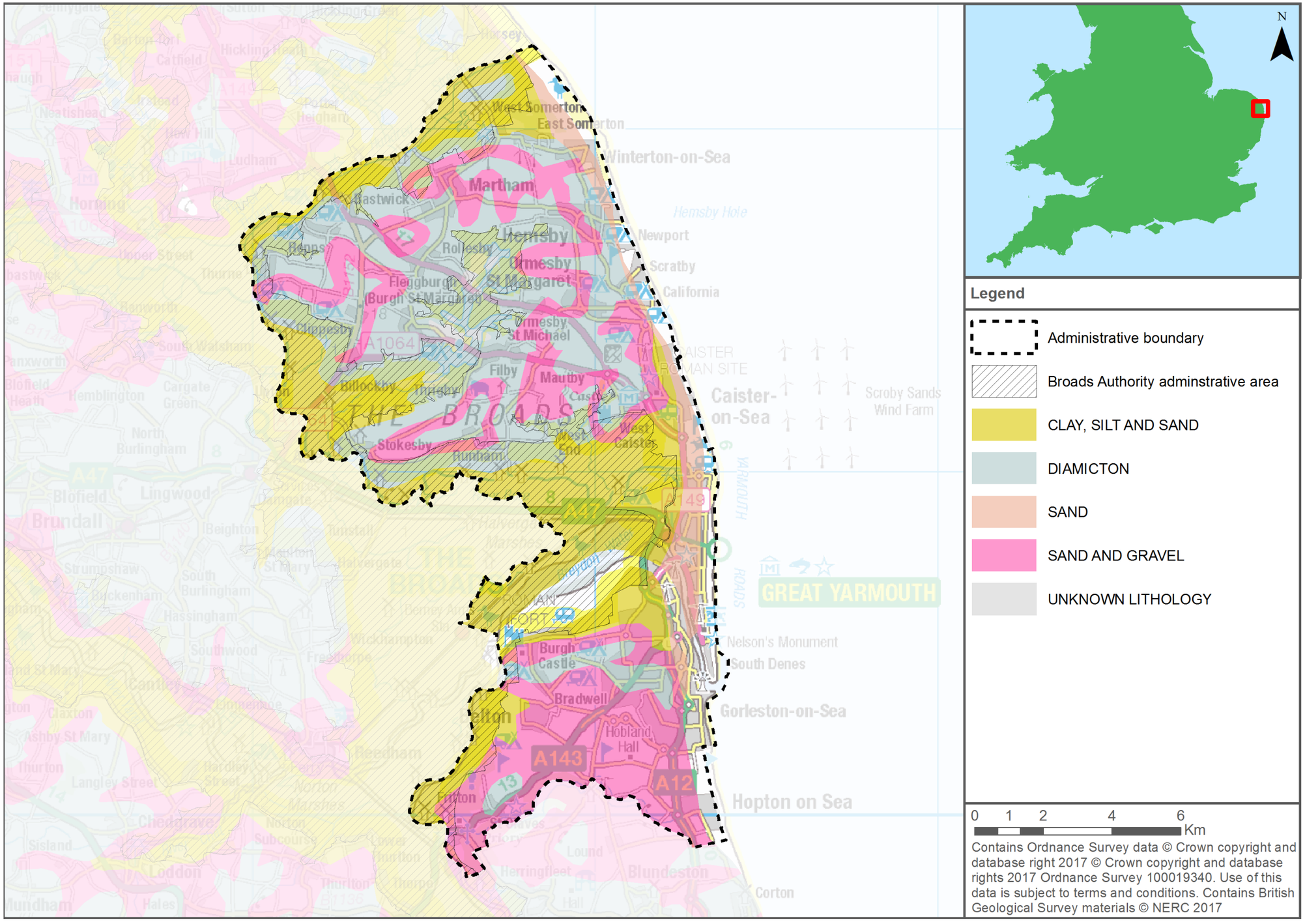
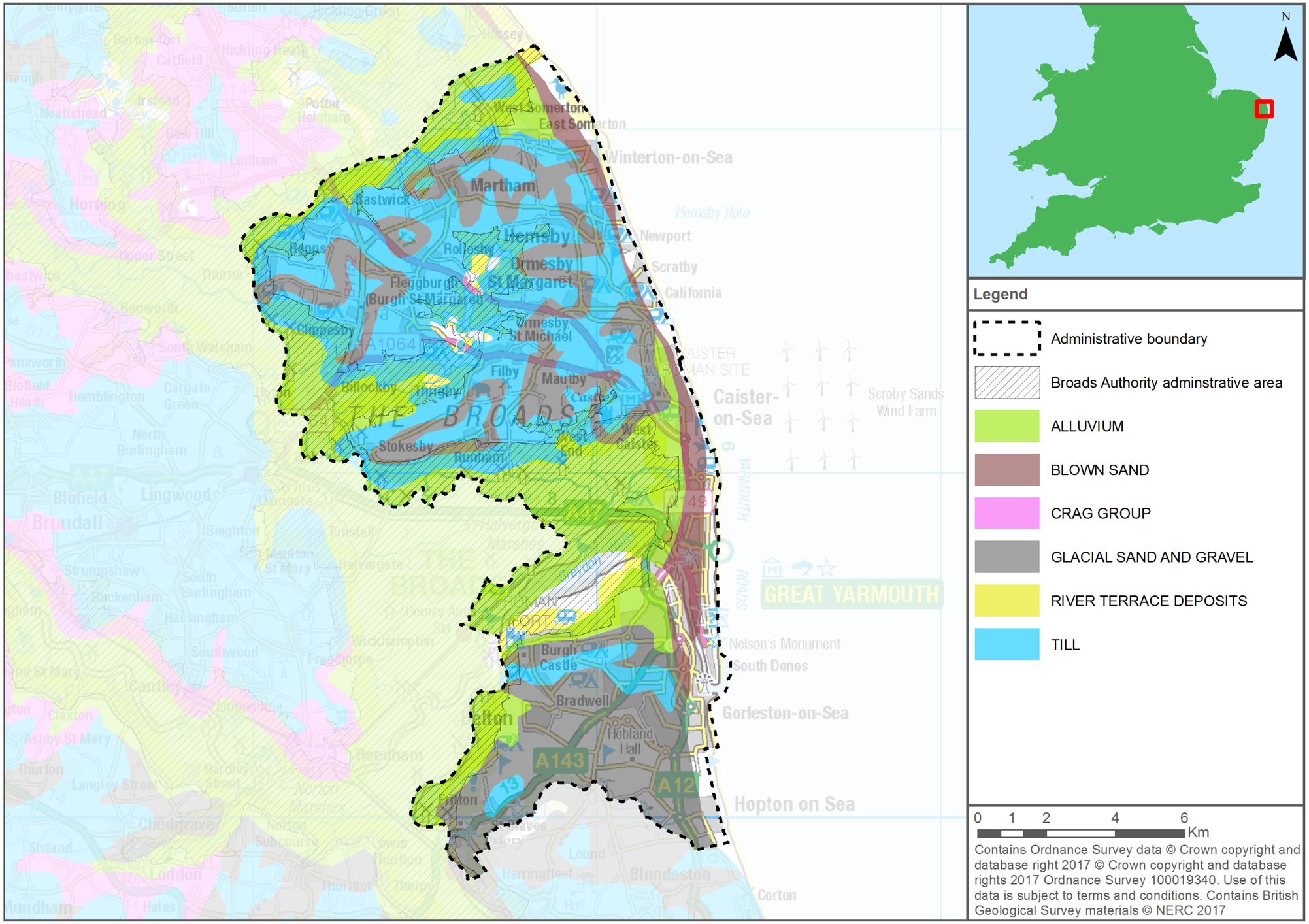


Figure 9-3: Soil Types in Great Yarmouth borough – by description (LEX_D)



10 Strategic flood risk solutions

10.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the borough. As described in Section 2.7, Great Yarmouth borough is covered by 3 sub areas within the 2009 **Broadland Rivers CFMP**, each with difference policies. The three sub areas are:

- **Sub Area 3 Policy Unit - fluvial /tidal rivers and tidal broads**. The flood risk management policy option for the sub area is Policy 3 - areas of low to moderate flood risk where generally there is effective management of the existing flood risk.
- **Sub Area 1 Policy Unit - Breydon Water.** The policy option for this area is Policy 6 - areas of low to moderate flood risk where action will be taken to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.
- **Sub Area 5 Policy Unit – Great Yarmouth.** The policy in this area is Policy 5 - areas of moderate to high flood risk where generally further action can be taken to reduce flood risk.

Specific 'actions' for flood risk management are described for each sub-area within the CFMP.

Further detailed strategic information on proposed strategic measures and approaches is available in the **Anglian River Basin District Flood Risk Management Plan (2015).**

The shoreline along Great Yarmouth borough lies within the **Kelling to Lowestoft Ness Shoreline Management Plan (2012)**. Within the SMP the following plans are outlined.

- **Winterton-on-Sea to Scratby** – The long-term plan is to allow a naturally–functioning coast to develop through allowing the beach and backshore to evolve with minimal intervention. In the long term, there may need to be some soft management of the retreat in response to natural changes.
- **California to Caister-on-Sea** - The long-term plan is to allow retreat of the coastline. In the short term, existing defences will be maintained to continue to provide protection to this frontage.
- **Caister-on-Sea** - The long-term plan is to enable the beach and backshore to evolve more naturally and allow the shoreline position to retreat back to a more natural position. In the short and medium-term the plan is to maintain the existing defences.
- **Great Yarmouth** - The long-term plan is to continue to protect assets within the town from both erosion and from flooding.
- **Gorleston** - The long-term policy is to continue to protect assets through holding the present line of defence
- **Gorleston to Hopton** - The long-term plan for this section of coast is to allow retreat, enabling a naturally functioning coast with minimal human interference.
- **Hopton** - The ultimate policy which will need to be implemented, possibly beyond the timeline of this plan, will be no active intervention. It is recommended that this retreat be managed through continued maintenance of existing defences, whilst technically and economically acceptable.

Strategic flood risk solutions should be in alignment with the objectives and actions detailed in wider strategies such as the CFMPs, RBMPs and SMPs.

When considering strategic flood risk solutions, it is important not only to consider whether a solution provides the most effective way at removing parcels of land from a given magnitude event or Flood Zone, but must also consider many other factors, including:

- Whether the flood risk solution will make the development safe e.g. whether safe access and egress can be achieved
- How the flood risk solution will be managed and maintained for the lifetime of development
- The cost of implementing the solution (and maintaining it)
- Environmental implications of the flood risk solution (both during and after implementation)
- How the flood risk solution could affect the entire catchment

Water Framework Directive (WFD) requirements should also be taken into consideration. The WFD requires that Environmental Objectives be set for all surface and ground waters in England and Wales to enable them to achieve 'Good Ecological Status' (or 'Good Ecological Potential' for Heavily Modified and Artificial Water Bodies) by a defined date. It is important that developments aim to take positive measures to conform to the WFD, which can be impacted as a result of development, for example in terms of 'deterioration' in ecological status or potential.

The following sections outline different options which could be considered for strategic flood risk solutions.

10.2 Flood storage

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[32]:

- enlarging the river channel;
- raising the riverbanks; and/or
- constructing flood banks set back from the river.

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

The construction of new upstream storage schemes as part of upstream catchment-based approaches within Great Yarmouth borough would provide one potential strategic solution to flood risk. Watercourses which are rural in their upper reaches but have high levels of flood risk to urban areas in the downstream reaches are potential candidates, as the open land in the upper reaches can potentially provide the space for an attenuation area, providing benefit to the urban area downstream.

10.2.1 Promotion of SuDS

By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. SuDS should be promoted on all new developments to ensure the quantity and quality of surface water is dealt with sustainably to reduce flood risk. The guidance produced by Defra and Norfolk County Council as LLFA (summarised in Chapter 9), should actively encourage developers to use the information to produce technically proficient and sustainable solutions for drainage.

10.3 Catchment and floodplain restoration

Compared to flood defences and flood storage, floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the watercourse and the floodplain. There are a number of culverted sections of watercourse located throughout the borough which if returned to a more natural state would potentially reduce flood risk to the local area
- Apply the Sequential Approach to avoid new development within currently undefended floodplain.

For those sites considered within the Local Plan and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their

[32] http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter10.aspx?pagenum=2

connectivity to the floodplain. Loss of floodplain connectivity in rural upper reaches of tributaries which flow through urban areas in the borough, could potentially increase flooding within the urban areas. This will also negate any need to build flood defences within the sites. It is acknowledged that sites located on the fringes of urban areas within the borough are likely to have limited opportunity to restore floodplain in previously developed areas.

10.3.1 Structure Removal and / or modification (e.g. Weirs), de-culverting

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers including, alterations to the geomorphology and hydraulics of the channel through water impoundment and altering sediment transfer regimes, which over time can significantly impact the channel profile including bed and bank levels, alterations to flow regime and interruption of biological connectivity, including the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

In the case of weirs, whilst weir removal should be investigated in the first instance, in some cases it may be necessary to modify a weir rather than remove it, for example by lowering the weir crest level or adding a fish pass. This will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

With careful early planning, watercourses can be made a feature of the site and ownership and maintenance should be considered early. De-culverting of a watercourse, to open it up and make it a feature of the site to allow for flood storage and betterment downstream, should be considered for all sites with culverted watercourses within their boundary.

Further information is provided in the **Trash and Security Screen Guide 2009**, published by the Environment Agency/ Defra, which should be used as evidence for any culvert assessment, improvement or structure retention.

10.3.2 Bank Stabilisation

It is generally recommended that bank erosion is avoided where possible and all landowners are encouraged to avoid using machinery and vehicles close to or within the watercourse.

There are a number of techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spiling, can be particularly effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils.

The Broads Authority have published a **River Bank Stabilisation Guide** which gives landowners advice on how to achieve the same high standard that the authority sets for its own work.

10.3.3 Bank removal, set back and / or increased easement

The removal or realignment of flood embankments and walls can allow the natural interrelationship between the river channel and the floodplain to be reinstated. This can be achieved at a small scale within urban areas providing pockets of attractive green spaces along rivers, whilst also improving floodplain storage within confined urban environments at times of flooding.

A detailed assessment would need to be undertaken to gain a greater understanding of the response to the channel modification, including flood risk analysis to investigate flood risk impacts.

An assessment of formal flood defences has been undertaken as part of this SFRA. All formal defences have a role in reducing flood risk, and therefore opportunities for bank removal, set back and / or increased easement will be limited. However, there may be informal artificial structures (embankments, walls) or defences within the borough which are now redundant.

10.3.4 Re-naturalisation

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

10.4 Natural flood management

Developments provide opportunities to work with natural processes to reduce flood and erosion risk, benefit the natural environment and reduce costs of schemes. Natural flood management requires integrated catchment management and involves those who use and shape the land. It also requires partnership working with neighbouring authorities, organisations and water management bodies.

Conventional flood prevention schemes may be preferred, but consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example. With flood prevention schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

10.5 Flood defences

There are a number of formal flood defences present within Great Yarmouth borough (see Section 7 for further information).

Flood mitigation measures should only be considered if, after application of the Sequential Approach, development sites cannot be located away from higher risk areas. If defences are constructed to protect a development site, it will need to be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

10.6 Green Infrastructure

Green Infrastructure (GI) is a planned and managed network of natural environmental components and green spaces that intersperse and connect the urban centres, suburbs and rural fringe and consist of:

- Open spaces – parks, woodland, nature reserves, lakes
- Linkages – River corridors and canals, and pathways, cycle routes and greenways
- Networks of "urban green" – private gardens, street trees, verges and green roofs.

The identification and planning of Green Infrastructure is critical to sustainable growth. It merits forward planning and investment as much as other socio-economic priorities such as health, transport, education and economic development. GI is also central to climate change action and is a recurring theme in planning policy. With regards to flood risk, green spaces can be used to manage storm flows and free up water storage capacity in existing infrastructure to reduce risk of damage to urban property, particularly in city centres and vulnerable urban regeneration areas. Green infrastructure can also improve accessibility to waterways and improve water quality, supporting regeneration and improving opportunity for leisure, economic activity and biodiversity.

10.6.1 Green infrastructure strategies

The following section provides details of the GI studies that have been produced for Great Yarmouth borough.

The Norfolk Green Infrastructure Mapping Project

There is an on-going study called the Norfolk Green Infrastructure Mapping Project (Norfolk GIMP). Flood mitigation is to be a significant element of the project.

Great Yarmouth Infrastructure Plan (2014)

Within the **Great Yarmouth Infrastructure Plan**, Section 6 investigates green infrastructure in the borough. The report sets out the current provision and future schemes for the following areas:

- Designated Sites: Enhancement and management
- Open Spaces: Public parks, ornamental gardens and amenity spaces
- Open Spaces: Play areas
- Open Space: Playing pitches and outdoor sports facilities
- Open Space: Allotments
- Sustainable Drainage Systems (SuDS)

10.7 Engaging with key stakeholders

Where complex flood risk issues are highlighted it is important that all stakeholders are actively encouraged to work together to identify issues and provide suitable solutions. Engagement with riparian owners is also important to ensure they understand their rights and responsibilities including maintaining river beds and banks; allowing the flow of water to pass without obstruction; and controlling invasive alien species e.g. Japanese knotweed. Engagement is also important to determine whether an Environmental Permit is required from the Environment Agency (see Section 2.12.4) or whether consent from the LLFA / IDB is required.

More information about riparian owner responsibilities can be found in the Environment Agency's **Living on the Edge**[33] publication.

[33] At the time of preparing this SFRA, the 'Living on the Edge' Environment Agency publication is in the process of being updated, as the existing publication refers to Flood Defence Consents which are no longer used.

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11 Summary

11.1 Overview

A consortium of Norfolk LPAs, comprising 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, have commissioned new Level 1 SFRAs to inform strategic planning decisions, the preparation of Local Plans and to inform development management decisions.

This Level 1 SFRA delivers a strategic assessment of risk from all sources of flooding in Great Yarmouth borough. It also provides an overview of policy and provides guidance for planners and developers.

11.2 Sources of flood risk

- There have been a number of recorded flood incidents across the borough, from a combination of sources. The predominant source of flooding is from tidal surges. More recent events investigated by the LLFA under Section 19 of the Flood and Water Management Act, reviewed the flood incidents that occurred between early May and mid July 2014, across the borough. During this time, 59 properties were flooded internally due to a large number of rainfall events. Section 19 reports are available to download from Norfolk County Council's **website**. A total of seven flood incidents along the A12 highway have been recorded by Highways England since July 2009.
- Tidal flooding is the most significant flood risk in the borough as Great Yarmouth is bound to the east by the North Sea and is entirely located within the tidally-influenced area of the Broadlands River catchment. All three major watercourses, the Rivers Yare, Bure and Waveney, are subject to significant tidal influences at the downstream ends of their catchments, which can cause a 'tide-locking' effect, raising water levels further upstream. A combination of a storm surge (caused by a low-pressure system within the North Sea) coinciding with the arrival of high tide could result in a high risk of tidal / coastal flooding.
- Coastal erosion is expected to be attributable to storm surge tides, combined with large waves. This may result in flooding of the beaches and undefended areas or cause overtopping of defences within the town of Great Yarmouth, as well as affecting the coastal zones to the north and south of the town.
- Fluvial flood risk within the borough is primarily associated with the Rivers Yare, Bure and Waveney and their tributaries. Most of the rivers are embanked and are higher than the adjacent land, which represents a residual risk in the event of a breach or overtopping. Flooding may not be from one watercourse alone. Often the combination of watercourses and the interaction of two or more sources of out of bank flow across the floodplain can have profound implications for the extent of the risk (i.e. the Rivers Bure and Yare within Great Yarmouth).
- Watercourses in IDB districts are managed for water level and flood risk management. Great Yarmouth borough is partially covered by the Waveney, Lower Yare and Lothingland IDB and the Water Management Alliance. The Water Management Alliance covers five IDBs; the Broads IDB partially covers the borough. The IDB coverage is mapped in Appendix B. The **Broadland Rivers CFMP** notes that many settlements are reliant on pumping stations to reduce the risk of flooding including: Martham, Repps, Thurne, Caister, Hemsby, Winterton and Stokesby. The IDB policy statements of flood protection and water level management have been used to determine the general standard of flood protection provided to each IDB District and are summarised as follows:
    - The Waveney, Lower Yare and Lothingland IDB **policy statement** states that the Board will seek to maintain a general standard of protection against flooding of 1 in 25-years for developed areas and 1 in 15-year for agricultural land. The policy statement acknowledges that the standards cannot be taken literally and that some over-spilling from the systems may occur during these events.
    - The Broads IDB **policy statement** states that the Board will seek to maintain a general standard of protection against flooding of 1 in 10-years with 600mm of freeboard to agricultural land and 1 in 100-year with 300mm freeboard to developed

areas. The policy statement acknowledges that the standards cannot be taken literally and that some over-spilling from the systems may occur during these events.

- The RoFfSW dataset shows that surface water predominantly follows topographical flow paths of existing watercourses or dry valleys, with some isolated ponding located in low lying areas. The 2013 **Surface Water Management Plan**, prepared for the Great Yarmouth borough, has identified eight CDAs. Six CDAs are located within the town of Great Yarmouth; one CDA is located at Caister-on-Sea and another CDA is located at Hemsby.
- The AStGWf dataset has limited data recorded in the borough. The AStGWf dataset indicates that groundwater emergence is more susceptible in areas to the north and south of the town. Broadscale analysis in the 2009 Waveney District Council and Great Yarmouth Borough Council SFRA identified potential areas in Great Yarmouth and Gorleston as being susceptible to groundwater emergence. In particular, areas to the north and south of the town centre as well as those close to the coast where the tidal influence on groundwater is greatest, are considered among the most susceptible in the study area. The **2009 Water Cycle Study** indicated that the underlying groundwater levels in the Great Yarmouth area are very high. However, the water table in the study area is likely to be kept artificially low through the extensive use of pump infrastructure. As a result, pumping failures could have a potential effect on the water table.
- Historical incidents of flooding are detailed by Anglian Water in their DG5 register. This database records incidents of flooding relating to public foul, combined or surface water sewers and identifies which properties suffered flooding. A total of 144 recorded flood incidents have been identified on the DG5 register for Great Yarmouth borough.
- There are no records of flooding from reservoirs impacting properties inside the study area.
- Currently there are five Flood Alert Areas and 16 FWAs covering the study area. Mapping showing the coverage of the Flood Alert Areas and FWAs is provided in Appendix C.
- A high-level review was undertaken to identify the main settlements where flood risks / extents are more prominent; this is shown in Table 6-5. If a settlement is not listed in this table this does not mean that the settlement is not at flood risk. The mapping provided in Appendix A can be used as a high-level screening exercise, to identify whether a location or site has a potential risk of flooding.
- The mapping of all potential sources of flooding including climate change is provided in Appendix A.

11.3 Climate change

The NPPF and accompanying Planning Practice Guidance set out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. The Environment Agency published **updated climate change guidance** on 19 February 2016 (further updated on 3 February 2017), which supports the NPPF and must now be considered in all new developments and planning applications. The Environment Agency has also published guidance to LPAs in the application of appropriate climate change allowances when considering climate change effects (updated April 2016 **Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities**).

When defining the scope of this commission, the climate change allowances were agreed by the Environment Agency and LLFA and are intended to assist with future planning across the combined study area. The climate change allowances used in the Strategic Flood Risk Assessment are detailed in Sections 4 and 5. Climate change modelling for watercourses and coastal areas across the combined study area was undertaken where detailed models exist, were available and supplied at the time of preparing this SFRA. It should be noted that in Great Yarmouth borough, fluvial hydraulic models were not available to be re-run and consequently no fluvial climate change modelling was undertaken. Where existing detailed models were not re-run and mapped for climate change, this is documented in Appendix D. The mapping of all potential sources of flooding including climate change is provided in Appendix A.

11.4 Flood defences

There are a number of Environment Agency assets throughout Great Yarmouth borough. The assets comprise a mixture of embankments, quays, bridge abutments, demountable defences, flood

gates and walls. The condition of these assets varies. The flood risk analysis in Section 6 indicates that much of the borough is heavily dependent on flood defences to protect settlements from flooding, particularly from tidal / coastal sources.

Great Yarmouth lies within the BFAP. A critical aspect of the project is to protect and enhance the sensitive wetland areas that are rich in biodiversity, while providing an improved service level in flood defence protection through strengthening and restoring embankments, while making allowances from climate change and settlement of the banks. The BFAP benefits areas surrounding the River Thunre, River Bure and River Yare and their surrounding tributaries.

11.5 Dry islands

In this SFRA, dry islands are defined as an area of 0.5 hectares or greater in size, identified as being in Flood Zone 1 and completely surrounded by land which falls within Flood Zone 2 (i.e. the extreme 1 in 1,000-year extent). The 0.5 hectares threshold was selected as this reflects one of the criteria used to define “major development” (see Section 2.5). Flood Zone 2 was selected as under the NPPG, developers are sometimes required to consider the safety of the site during the extreme flood event including the potential for an evacuation before the extreme flood event.

Dry islands can present specific hazards, primarily the provision of safe access and egress during a flood event.

The results show that there are 42 dry islands in Great Yarmouth borough. These are primarily located towards the northern and central areas of the borough and a few dry islands cross administrative boundaries into neighbouring districts.

Dry islands are mapped and shown in Appendix A.

11.6 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and FRAs are documented in Section 3, along with guidance for planners and developers throughout the report. Links are provided to various relevant guidance documents and policies published by other Risk Management Authorities, such as the LLFA and the Environment Agency.

11.7 Relevant studies

There are many relevant regional and local key studies which complement the SFRA and have been considered, such as the CFMPs, RBMPs, the PFRA, SMPs and LFRMS. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

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12 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA. Following this, several recommendations have been made for the authorities to consider as part of Flood Risk Management in Great Yarmouth borough.

12.1 Development management

12.1.1 Sequential approach to development

The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within Great Yarmouth borough.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance
- Relocating development to Flood Zones with lower flood risk
- Creating space for flooding
- Green Infrastructure should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space.

12.1.2 Site-specific flood risk assessments

Site-specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), to inform the sequential approach within the site and prove, if required, whether the Sequential and Exception Tests can be satisfied (for windfall sites not included in the Plan, evidence on the Sequential Test must be submitted in FRAs).

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.

Where a site-specific FRA has produced modelling outlines which differ from the EAs Flood Map for Planning (Rivers and Sea) then a Flood Map Challenge may need to be undertaken. Where the modelling and results are deemed acceptable to the EA, amendments to the Flood Map for Planning (Rivers and Sea) may take place.

Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed.

All new development within the 1% AEP flood extent including an allowance for climate change (for the lifetime of the development) must not normally result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage. Where proposed development results in a change in building footprint, the developer should normally ensure that it does not impact upon the ability of the floodplain to store or convey water, and seek opportunities to provide floodplain betterment. Similarly, where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain should normally be provided to ensure that the total volume of the floodplain storage is not reduced.

There are a number of guidance documents which provide information on the requirements for site-specific FRAs:

- **Standing Advice on Flood Risk (Environment Agency);**
- **Flood Risk Assessment for Planning Applications (Environment Agency);** and,
- **Site-specific Flood Risk Assessment: CHECKLIST (NPPG, Defra).**

The Environment Agency has produced a Flood Zone 3 Fact Sheet which provides information on the requirements for site-specific Flood Risk Assessments for sites in Flood Zone 3 and in the East Anglia area. The Environment Agency has also produced a guidance document called "Flood risk assessment: Climate Change allowances" which details the application of climate change allowances and local considerations in East Anglia. These documents are available from: **https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers**

Developers should consult with the relevant LPA (i.e. Great Yarmouth Borough Council or the Broads Authority), Norfolk County Council, the Environment Agency, Anglian Water and, where necessary, relevant IDBs at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design. If applications cross administrative boundaries, the neighbouring LLFA, Suffolk County Council may need to be approached.

At locations reliant on flood risk management measures to provide appropriate levels of safety for communities, special consideration should be given to the assessment of residual risk, particularly in relation to tidal flooding and areas relying on pumped drainage systems. Where residual risks give rise to unsafe conditions, consideration should be given to the introduction of additional measures or identification of tactical responses that can be conducted during an emergency.

12.1.3 Sequential and Exception Tests

The SFRA has identified that areas of Great Yarmouth borough are at high risk of flooding from tidal, coastal, fluvial and surface water sources. Therefore, proposed development sites will be required to satisfy the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Great Yarmouth Borough Council and the Broads Authority should use the information in the 2017 SFRA when deciding which development sites to take forward in their Local Plan.

The Broads Authority administrative area extends beyond Great Yarmouth borough. As such, the Broads Authority should also use the information contained in the 2017 North Norfolk SFRA, the 2017 Greater Norwich Area SFRA and any SFRAs produced for Waveney District Council, when deciding which development sites to take forward in their Local Plan.

12.1.4 Review of planning applications

The Council should consult the Environment Agency's **'Flood Risk Standing Advice (FRSA) for Local Planning Authorities'**, last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding, as well as **the Broads Supplementary Planning Document** on flood risk (where appropriate). The Council will consult the relevant statutory consultees as part of the planning application assessment and they should also contact non-statutory consultees (e.g. IDBs or Anglian Water) that have an interest in the planning application.

12.1.5 Drainage strategies and SuDS

- Planners should be aware of the conditions and local requirements set by Norfolk County Council, the LLFA, for surface water management for major and minor developments and ensure development proposals and applications are compliant with the LLFA's policy.
- Developers should consult Norfolk County Council's guidance for developers: Norfolk County Council, **Lead Local Flood Authority, Statutory Consultee for Planning, Guidance Document (2017).** The guidance provides information on how SuDS proposals for new developments will be considered by the LLFA, when to consult the LLFA, how to screen applications based on local flood risk and records, LLFA standing advice (for Ordinary Watercourse consenting, major development below LLFA thresholds and minor development), the levels of information required for planning applications and technical guidance. The technical guidance is split into the following themes:
    - Local flood risk guidance

  - Drainage hierarchy
  - Infiltration testing guidance
  - Runoff rates
  - Runoff volumes
  - Climate change
  - Management and maintenance
  - Flood exceedance management

- All new development should aim to minimise areas of impermeable ground to reduce surface water runoff. SuDS should be used on all new development.
- Planners should be aware of local conditions and requirements set by the Waveney, Lower Yare and Lothingland IDB and / or the Water Management Alliance. The Water Management Alliance have published application **guidance notes** and a **SuDS adoption policy**. Nicholsons' Law, which administers the Waveney, Lower Yare and Lothingland IDB, has published a number of guidance documents, available to download from their **website**.
- Developers who wish to have their SuDS schemes considered for adoption by Anglian Water should refer to the **Anglian Water SuDS Adoption Manual**[34]. Anglian Water also expect national guidance (i.e. **the CIRIA C753 SuDS Manual**) to be referred to in addition to Anglian Water's guidance.
- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will provide an appropriate standard of protection from surface water flooding to properties and critical infrastructure from flooding from surface water both on and off site. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. The 2015 **DEFRA non-statutory technical standards for sustainable drainage systems** should be followed, alongside the LLFA guidance note and national guidance.
- For proposed developments, geotechnical investigations should be undertaken to determine whether the ground at the site has infiltration potential. This information should be representative of on-site conditions. If the ground at the site is found to have infiltration potential, detailed infiltration testing should be undertaken in line with BRE 365 to establish representative infiltration rates. The LLFA have published information relating to infiltration tests within their **guidance document.**
- There are no Groundwater Source Protection Zones in the borough (see Section 9.4). Where sites lie within or close to aquifers (see Section 6.2), treatment steps may be required ahead of discharge to the ground, sewers etc. Great Yarmouth and Gorleston also have a number of historic industrial sites and as such, there is a heightened risk of groundwater pollution. Development proposals at sites across the area should assess the pollution risk to receiving waterbodies and include appropriate treatment steps ahead of any discharge to surface or groundwaters. The CIRIA C753 SuDS manual provides further guidance on this issue.
- A management and maintenance plan of sustainable drainage and surface water systems covering the lifetime of the development will be required. Consideration must also be given to the residual risks associated with the use of SuDS.

12.1.6 Dry islands

It is recommended that emergency planners at the local authorities review the outputs of the 2017 SFRA and the areas identified as being located in a dry island. A site-specific Flood Risk Assessment and / or Flood Warning and Evacuation Plan may be required if a proposed development is located within a dry island (even for sites less than 1 hectare and in Flood Zone 1).

[34] At the time of preparing this SFRA, Anglian Water's current manual is expected to be revised to take account of national guidance published after the manual and Anglian Water's position regarding health and safety matters associated with open SuDS features.

12.1.7 Residual risk

Residual risk is the risk that remains after mitigation measures are considered. The residual risk includes the consideration of flood events that exceed the design thresholds of the flood defences or circumstances where there is a failure of the defences, e.g. flood banks collapse, reservoir failure etc. The flood risk analysis in Section 6, indicates that much of the borough is heavily dependent on flood defences to protect settlements from flooding, particularly from tidal / coastal sources. The Environment Agency's 2017 coastal breach modelling of the Norfolk coastline indicates breaches along defences in Greater Yarmouth pose a significant risk; much of Great Yarmouth town is within the modelled breach flood extents. Residual risks should be considered as part of site-specific Flood Risk Assessments.

Where the watercourses are embanked, the effect of overtopping and breach must be considered and appropriately assessed. Further, any developments located within an area protected by flood risk management measures, where the standard of protection is not of the required standard, or where the failure of the intended level of service gives rise to unsafe conditions, should be identified.

12.1.8 Finished floor levels and safe access and egress

Finished floor level guidance has been established through consultation with the Environment Agency. Minimum finished floor levels for development should be set to whichever is the higher of the following:

- a minimum of 300mm* above the 1% AEP fluvial event plus an allowance for climate change
- a minimum of 300mm* above the 0.5% AEP tidal event plus an allowance for climate change
- a minimum of 300mm above surrounding ground levels

*A 300mm freeboard is only applicable where detailed modelling is available which is deemed to be reliable. If no detailed and reliable modelling is available, the Environment Agency may require a 600mm freeboard to be applied when setting minimum finished floor levels.

With regards to LLFA guidance and surface water flood risk, finished floor levels are recommended to be set to a minimum of 300mm above the 1% AEP plus an allowance for climate change flood levels (including anticipated flood levels within the drainage system). If there is an uncertainty in flood levels, the freeboard level should be increased from 300mm to 600mm. The LLFA would also expect a minimum of at least 150mm freeboard between proposed external ground levels and the property finished floor level. Further information can be found in the **LLFA guidance document**.

If it is not practical to raise floor levels to those specified above, consultation with the Environment Agency and / or LLFA will be required to determine the suitability of alternative flood mitigation approaches.

Safe access and egress will need to be demonstrated at all development sites. Ideally, access should be situated 300mm above the design flood level and waterproof construction techniques used. If safe access and egress cannot be achieved, the **Defra/EA Technical Report: FD2320: Flood Risk Assessment Guidance for New Development** should be referred to, to determine the hazard to people posed along the access route. This can also be used to inform a Flood Warning and Evacuation Plan for the site.

Emergency vehicular access should be possible during times of flood.

Where development is located behind, or in an area benefitting from, defences, consideration should be given to the potential safety of the development, finished floor levels and the potential for safe access and egress in the event of rapid inundation of water due to a defence breach with little warning.

Resistance and resilience measures will be required if buildings are situated in the flood risk area, and as applicable in all cases of flood risk, opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. Further information is provided in Section 8.5 and 8.6 and in the publications **"Improving the flood performance of new buildings"** and **"Prepare your property for flooding."**

12.1.9 Future flood management

Developments should demonstrate opportunities to create, enhance and link green assets. This can provide multiple benefits across several disciplines including flood risk and biodiversity/ ecology and may provide opportunities to use the land for amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted.

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within the Great Yarmouth borough. Opportunities could consist of the following:

- Catchment and floodplain restoration;
- Flood storage areas;
- Opening up culverts, weir removal, and river restoration; and
- Green infrastructure.

For successful future flood risk management, it is recommended that LPAs adopt a catchment partnership working approach in tackling flood risk and environmental management

12.1.10 Requirement for Level 2 SFRA

This report fulfils Level One SFRA requirement. Following the application of the Sequential Test, where sites cannot be appropriately accommodated in Flood Zone 1, local planning authorities in Great Yarmouth borough may need to apply the NPPF's Exception Test. In these circumstances, a Level Two SFRA may be required, to consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding. Any Level Two SFRA may need to take into account the outputs of any updated fluvial BESL modelling, and have regard to the interaction between fluvial and tidal flood risk.

12.2 Technical recommendations

12.2.1 Potential modelling improvements

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. For example, the outputs of the updated BESL hydraulic model were not available at the time of preparing this 2017 SFRA and as such, the functional floodplain and climate change extents associated with this model could not be mapped. The 2008 BESL hydraulic model extent is displayed in Appendix A mapping of all sources of flood risk to provide an indication of the model coverage and it is noted that Flood Zone extents in this area may be subject to change when the model is update.

As part of a separate commission to the SFRA, the Environment Agency were preparing updated modelling of the Anglian coastline. Where the outputs were available at the time of preparing the 2017 SFRA, these were supplied and used in the assessment. The outputs of two models were not available at the time of preparing the 2017 SFRA; the Wash model and the Wells-next-Sea model. However, the Wash model and the Wells-next-the Sea model do not affect Great Yarmouth borough. The updated coastal modelling concerning Great Yarmouth borough was available, supplied and used in this 2017 SFRA.

Further information on the hydraulic modelling and mapping approaches used in the 2017 SFRA are provided in Appendix D.

It is important that the Environment Agency are approached to determine whether updated (more accurate) information is available prior to commencing a site-specific FRA.

Use of Strategic Flood Risk Assessment data

SFRAs are high-level strategic documents and, as such, do not go into detail on an individual site-specific basis. The 2017 SFRA has been developed using the best available information, supplied at the time of preparation, taking into account the latest flood risk information 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. It is this data that guidance singles out as the most appropriate for forward planning.

The accompanying SFRA appendices comprise:

- Appendix A: Mapping of all sources of flood risk across Great Yarmouth borough (historic flood extents are not included)
- Appendix B: Watercourses in the Great Yarmouth borough and coverage of IDB districts
- Appendix C: Flood Alert and Flood Warning coverage across Great Yarmouth borough
- Appendix D: Technical Summary including a list of all detailed models used in the 2017 SFRA and a map showing the coverage of these models

The SFRA appendices are published separately to the main SFRA report.

Appendix A is presented in interactive GeoPDFs. An accompanying User Guide is provided with the GeoPDFs which provides step-by step instructions on how to navigate to data and how to use the GeoPDFs. The GeoPDFs can be used to perform high-level screening exercises, to identify whether a location or site has a potential risk of flooding. The GeoPDFs primarily display flood extents and are subject to the limitations of the flood risk datasets that are used. If detailed flood risk information is required (e.g. flood level, depth, velocity and hazard to people information), this should be addressed as part of a Level 2 SFRA and / or as part of a site-specific Flood Risk Assessment.

It is important that the 2017 SFRA and appendices are read in conjunction with the Technical Summary provided in Appendix D. The Technical Summary provides further information on the hydraulic modelling and mapping approaches used in the 2017 SFRA.

The SFRA is a tool for refining information on river and sea flooding risk shown on the Environment Agency flood maps. The Environment Agency's Flood Zones, on their Flood Map for Planning website, may differ to the maps in the SFRA for a short period of time. The modelled fluvial and tidal flood risk datasets shown in the 2017 SFRA and Appendix A, will be incorporated into the Environment Agency's flood maps in due course.

At the time of writing, this report was developed using the best available information. However, the 2017 SFRA should be a **'living document'** and as a result should be updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. 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 FRA.

The 2017 SFRA was commissioned by a consortium of Norfolk authorities and was produced in conjunction with the LLFA and Environment Agency. The assistance of these organisations and external stakeholders including IDBs, Anglian Water and planners at the neighbouring authorities and LLFAs, is acknowledged.

Appendices

The SFRA appendices are published separately to the main SFRA report.

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A Mapping of all sources of flood risk across Great Yarmouth borough

The SFRA appendices are published separately to the main SFRA report.

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B Watercourses in Great Yarmouth borough and coverage of IDB districts

The SFRA appendices are published separately to the main SFRA report.

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C Flood Alert and Flood Warning coverage across Great Yarmouth borough

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D Technical Summary

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