Greater Norwich Area Strategic Flood Risk Assessment

Final Report: Level 1

November 2017

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft rev 1.0 / June 2017	DRAFT for comment	SFRA Steering Group
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

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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 (Downham Market Group of IDBs, East Harling IDB, Middle Level Commissioners, Water Management Alliance, 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 cooperation 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 previous joint North Norfolk District Council, Broadland District Council, the Broads Authority, Norwich City Council and South Norfolk Council SFRA, originally published in 2008. 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 Broadland District Council, Norwich City Council and South Norfolk Council (which together form the Greater Norwich area). The Broads Authority also covers parts of the Greater Norwich area.

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 the Greater Norwich area 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 the Greater Norwich area, 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 the local authorities in the Greater Norwich area 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 6.9 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 7.4.2 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 Greater Norwich area, from a combination of sources. Prominent sources of flooding are fluvial, tidal and surface water. More recent events, investigated by the Lead Local Flood Authority (LLFA) under Section 19 of the Flood and Water Management Act, indicates that flood events have been associated with exceedance of the capacity of the sewer network. Section 19 reports are available to download from Norfolk County Council's **website**. Further historic flood information can be found in Section 6.1.
- Fluvial flood risk within the Greater Norwich area is primarily associated with the River Yare, River Bure and River Waveney watercourses and their tributaries. Fluvial flooding can be exacerbated in the upper reaches of the catchment, due to mill structures restricting the flow. 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. Fluvial flood risk is discussed further in Section 6.4.
- Although the Greater Norwich area is landlocked, the **2009 Broadland Rivers Catchment Flood Management Plan** (CFMP) notes that a significant proportion of policy sub-area 3 (Fluvial/Tidal Rivers and Tidal Broads), is located within the study area, where fluvial and tidal interactions influence flooding in the river network. In the east of the study area, along parts of the River Yare (downstream of Norwich) and across the Broads tidal levels are higher than fluvial levels in some places. Combined river and tidal flooding is known to sometimes affect settlements including Wroxham and Brundall whilst high tide levels combined with a storm surge can affect the Norfolk Broads in the east and south of the study area. Additional impacts of tidal influence include rivers not being able to flow freely at high tide. This can affect any locations up to the tidal limit of the rivers in the Greater Norwich area, potentially affecting settlements like Norwich and Wroxham. Tidal flood risk is discussed further in Section 6.5.
- Watercourses in Internal Drainage Board (IDB) districts are managed for water level and flood risk management. The Greater Norwich area is partially covered by the Waveney, Lower Yare and Lothingland IDB and the Water Management Alliance. The Water Management Alliance covers five IDBs; those in the Greater Norwich area include the Broads IDB and the Norfolk Rivers IDB. The IDB coverage is mapped in Appendix B. The 2009 Broadland Rivers CFMP notes that the settlements of Wymondham and Aylsham are

reliant on pumping stations to reduce the risk of flooding. 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** 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** and the Norfolk Rivers IDB **policy statement** states that the Boards 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 2012 **Surface Water Management Plan**, prepared for the Norwich urban area, has identified critical drainage issues at Catton Grove and Sewell, Nelson and Town Close and Drayton. Surface water flood risk is further discussed in Section 6.6.
- Within Norwich city there are areas containing cavities in the underlying chalk strata. Water infiltration in the past has led to the collapse of these cavities resulting in subsidence. There may be limitations in the deployment of particular mitigation measures in areas characterised by this geology. There are a number of locations within South Norfolk identified as being at risk of groundwater flooding including: Poringland, Framingham Earl and Framingham Pigot. Within the Broadland area it is believed pumping from the IDB maintains the water table at a relatively lower level reducing the risk of groundwater flooding. Groundwater flood risk is discussed further in Section 6.7.
- 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 264 recorded flood incidents have been identified in the Greater Norwich area. Flood risk from sewers is discussed further in Section 6.8.1.
- There are no records of flooding from reservoirs impacting properties inside the study area. Flooding from reservoirs is discussed further in Section 6.8.2.
- Currently there are nine Flood Alert Areas and 20 Flood Warning Areas (FWAs) covering the study area. Flood warning and emergency planning is discussed in Section 6.9 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 6-5. 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.

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

Flood defences

There are a number of assets throughout the Greater Norwich area. The assets comprise a mixture of embankments, quays, bridge abutments, demountable defences, flood gates and walls. The condition of these assets varies.

The Greater Norwich area lies partly 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 surrounding tributaries.

Further information on flood defences and schemes in the Greater Norwich area 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 51 dry islands in the Greater Norwich area. These are located in sporadic locations across the study area and a few dry islands cross administrative boundaries into neighbouring districts.

Dry islands are discussed in Section 6.9.3; 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 CFMP, River Basin Management Plan, the Preliminary Flood Risk Assessment, Shoreline Management Plans, Local Flood Risk Management Strategies and the River Wensum Strategy. 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 the Greater Norwich area Partnership in the development of the Local Plan.

Development and planning considerations

Sequential approach to development

It is recommended that the sequential approach is adopted for all future developments within the Greater Norwich area.

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 parts of the Greater Norwich area are at high risk of flooding from both 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. Broadland District Council, Norwich City Council, South Norfolk Council and the Broads Authority should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

The Broads Authority administrative area extends beyond the Greater Norwich area. As such, the Broads Authority should also use the information contained in the 2017 North Norfolk SFRA, the 2017 Great Yarmouth 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 development zoning within the site and prove, if required, whether the Exception Test 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 an 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. Broadland District Council, Norwich City Council, South Norfolk 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, neighbouring LLFAs such as Cambridgeshire County Council and Suffolk County Council may need to be approached.

Further guidance for developers can be found in Section 7.4.2.

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 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**

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.

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.**
- Where sites lie within or close to Groundwater Source Protection Zones (see Section 9.4) or aquifers (see Section 6.2), treatment steps may be required ahead of discharge to the ground, sewers etc. 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:

- 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 Environment Agency's 2017 coastal breach modelling of the Norfolk coastline indicates that whilst the Greater Norwich area is landlocked, breaches along defences in Great Yarmouth pose a risk, specifically to parts of South Norfolk Council, Broadland Council and the Broads Authority administrative areas. Norwich City Council's administrative area is not shown to be affected by the modelled breach flood extents. This is discussed further in Section 7.4. 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 the Greater Norwich area

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

There are on-going strategic schemes that are considering flood risk reduction measures in the Greater Norwich area. The consultation draft **River Wensum Strategy** details the vision for regenerating and enhancing the River Wensum corridor from Norwich City Council's boundary at Hellesdon in the west to Whitlingham Country Park in the east. The measures proposed under this strategy aim to provide multiple benefits including improving the management of the river corridor, enhancing the natural and city environmental and green infrastructure and improving access to and use of the area. Policy 13 under the strategy relates to proposed flood risk reduction measures.

The information provided in the SFRA should be used as a basis for investigating potential strategic flood risk solutions within the Greater Norwich area (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 SFRA and as such, the functional floodplain and climate change extents associated with this model could not be mapped. Results from the 2008 BESL hydraulic model extent are 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 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 the Greater Norwich area.

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 the Greater Norwich area (historic flooding is not included)
- Appendix B: Watercourses in the Greater Norwich area and coverage of IDB districts
- Appendix C: Flood Alert and Flood Warning coverage across the Greater Norwich area
- 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.

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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
FCERMGiA	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.
Flood 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 NPPG

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.

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1 Introduction

1.1 Consortium of Norfolk authorities Strategic Flood Risk Assessments

Norfolk Local Planning Authorities (LPAs) have a long track record of cooperation 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 2-2.

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 combined study area is shown in Figure 1-1.

1.2 Purpose of the Strategic Flood Risk Assessment

This SFRA document is one of a series of SFRAs that will replace the previous joint North Norfolk District Council, Broadland District Council, the Broads Authority, Norwich City Council and South Norfolk Council SFRA, originally published in 2008. The main purpose of this SFRA is to inform the selection of options for the Local Plan allocations and support determination of planning applications for Broadland District Council, Norwich City Council and South Norfolk Council (which together form the Greater Norwich area). The Broads Authority also cover parts of the Greater Norwich area. 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 the Greater Norwich area 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 the Greater Norwich area, 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 the local authorities in the Greater Norwich area 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 Plan, 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 requirement.

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: SFRA 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 Policy	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 the Greater Norwich area.
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 the Greater Norwich area	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. Flood 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. Options to reduce flood risk	Summary of strategic options that can be considered by commissioning authorities and their partners, to avoid, control, mitigate and / or reduce flood risk in the Greater Norwich area.
11. Summary	Summary of SFRA findings.
12. Recommendations	Summary of recommendations.
Appendix A: Mapping of all sources of flood risk across the Greater Norwich area	Interactive GeoPDF mapping of flood risk from all sources including the functional floodplain (Flood Zone 3b) and climate change mapping, to the Greater Norwich area. Historic flood events are not mapped.
Appendix B: Watercourses in the Greater Norwich area and coverage of IDB districts	Maps showing the location of watercourses in the Greater Norwich area including Main Rivers, Ordinary Watercourses and IDB districts.
Appendix C: Flood Alert and Flood Warning coverage across the Greater Norwich area	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 at the time of preparing this report and supplied for use in this commission.

1.6 Consultation

The following parties (external to Broadland District Council, Norwich City Council, South Norfolk Council and the Broads Authority) have been consulted during the preparation of this version 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 the Greater Norwich area
- Appendix B: Watercourses in the Greater Norwich area and coverage of IDB districts
- Appendix C: Flood Alert and Flood Warning coverage across the Greater Norwich area
- 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 this 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.

This 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

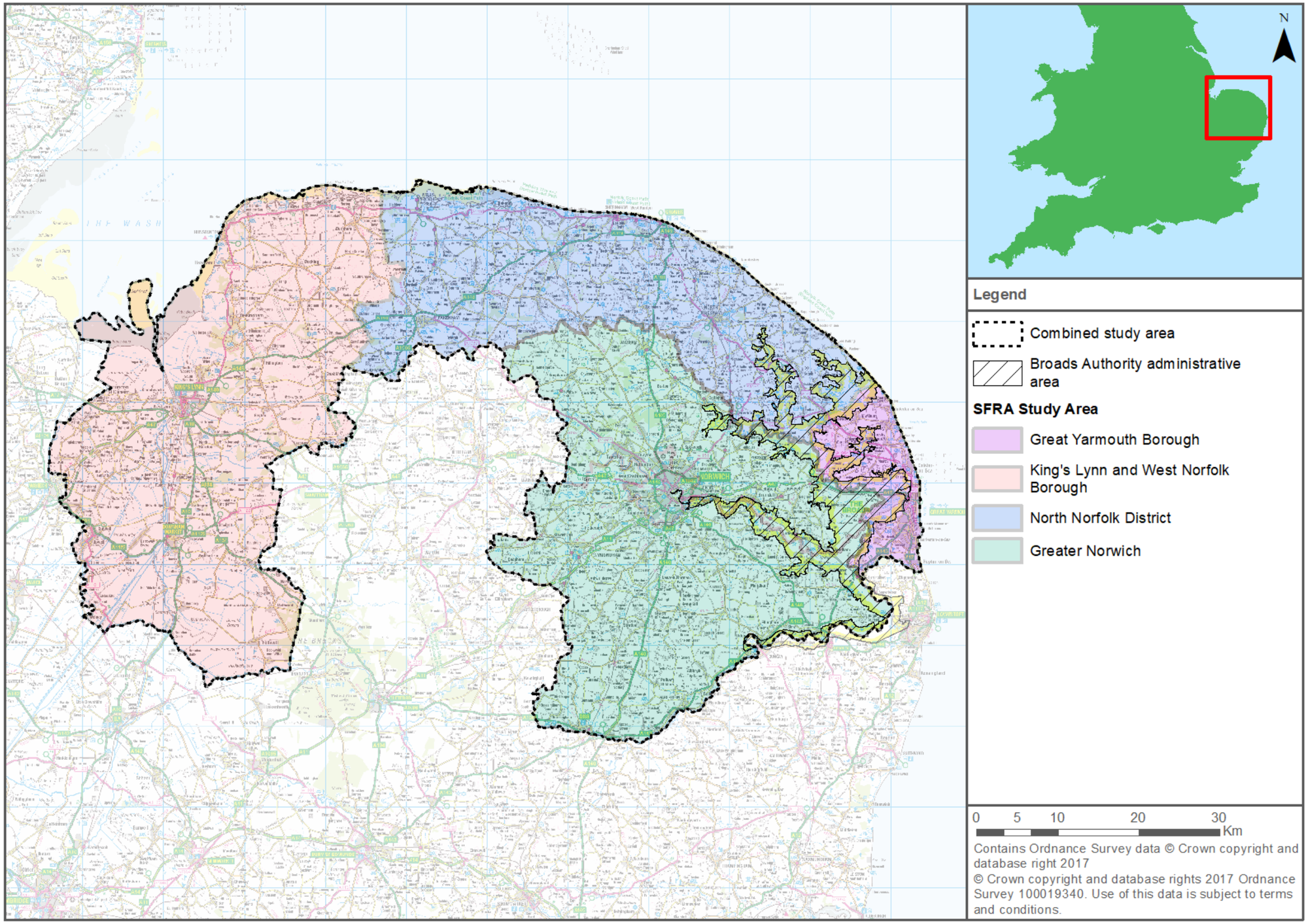
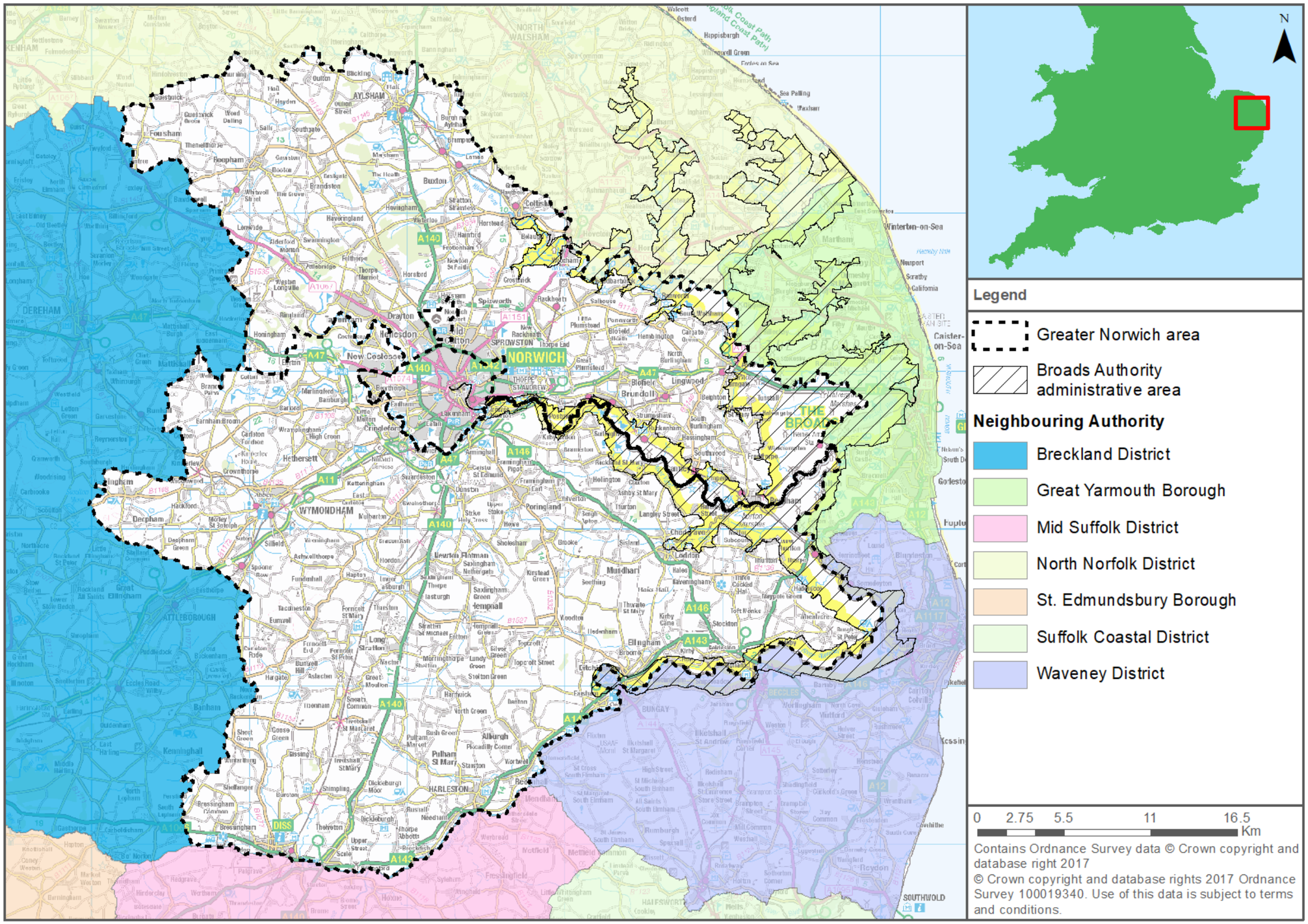


Figure 1-2: Greater Norwich area SFRA study area



2 The Planning Framework and Flood Risk Strategic Documents

2.1 Introduction

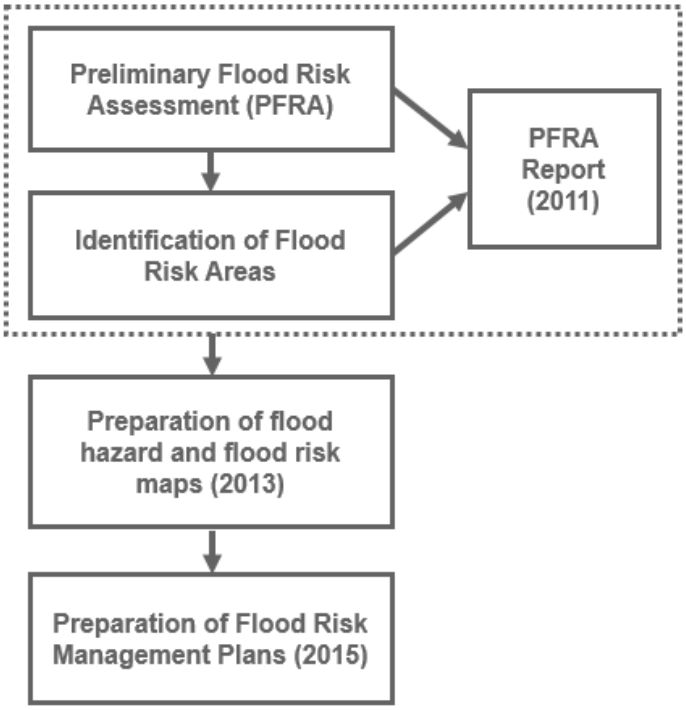
The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and strategic documents 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. Detail on the responsibilities of LLFAs is provided in Section 2.12.3.

Figure 2-1 illustrates the steps taken to 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's Preliminary Flood Risk Assessment (PFRA) (2011)

In accordance with the Regulations, LLFAs had the task of preparing a 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 in the first cycle assessment, none encroach on the administrative areas of the Broadland District Council, Norwich City Council and South Norfolk 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), identifying Norwich city as an Indicative Flood Risk Area (2016). Through consultation with the LLFA, it is understood that Norwich City will be put forward as a Flood Risk Area in the emerging PFRA update, subject to final review and agreement with EA..

2.2.2 Flood Risk Management Plans (FRMPs)

Under the Regulations the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. Instead they had to prepare and publish a FRMP. 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** 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 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 Greater Norwich area. Further information on the LLFA role and responsibilities are provided in Section 2.12.3.

2.2.4 Norfolk Local Flood Risk Management Strategy (2015)

Norfolk County Council is responsible for developing maintaining, applying and monitoring a **Local Flood Risk Management Strategy** (LFRMS) for Norfolk, which includes the Greater Norwich area. 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.

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 (LPA) 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

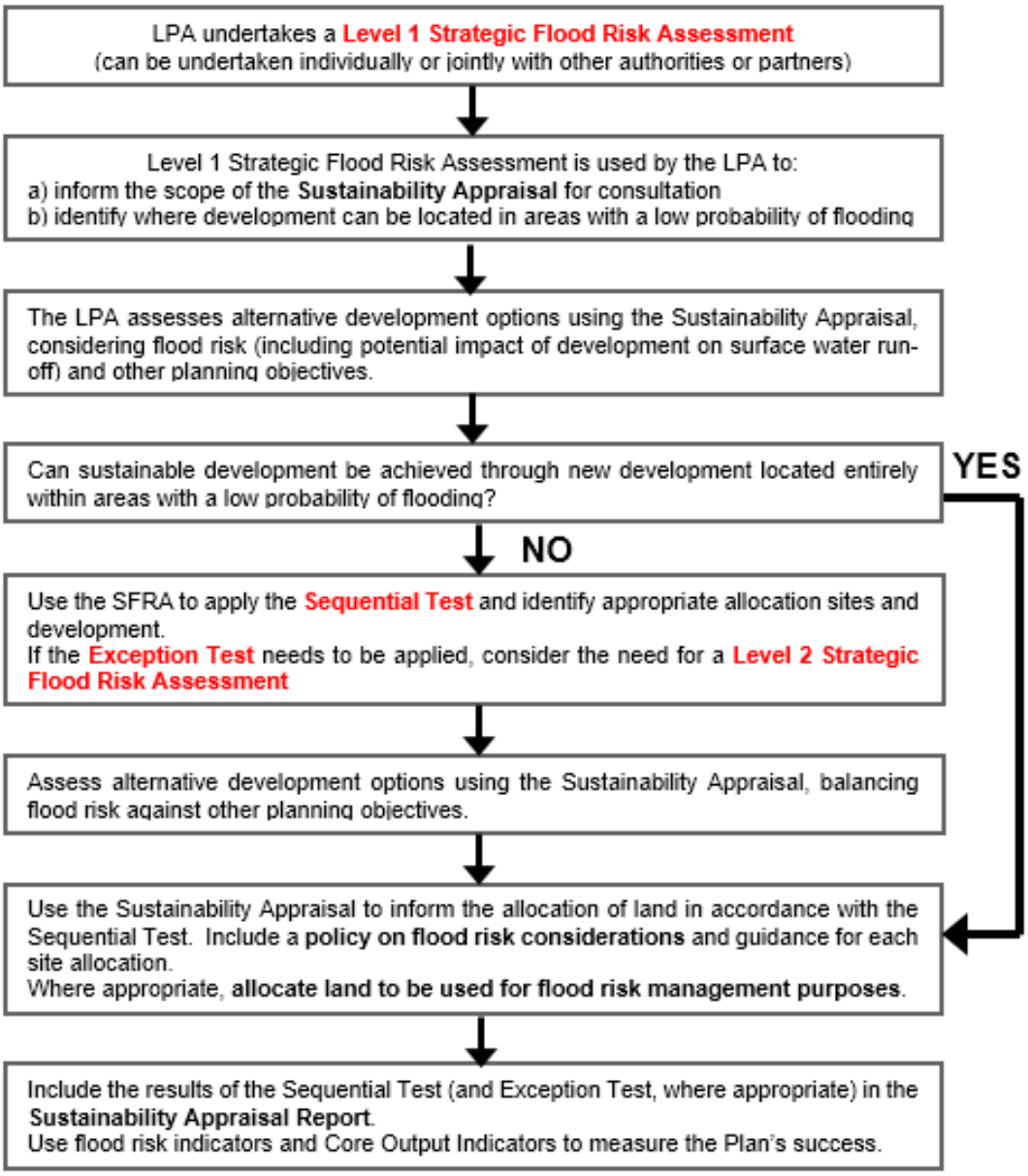
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

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 The 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 Greater Norwich area. The SPD was adopted in March 2017 and the purpose is to increase awareness of the nature of flood risk in the Broads area, to 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 developments.

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 7.4.2 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:

Part A

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

Part B

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

Part C

- Provides 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 LPAs 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 Norwich Urban Area Surface Water Management Plan (2012)

Norfolk County Council worked with Norwich City Council, Broadland Council, South Norfolk Council, the Environment Agency, Anglian Water and consultants URS/Capita Symonds to produce a **Surface Water Management Plan** (SWMP) for the Norwich Urban Area.

The Norwich SWMP commenced in September 2010 and was adopted by the Council in May 2012. Modelling was undertaken for the entire urban area of Norwich and detailed modelling was carried out for the areas deemed most at risk. These areas were identified as 'Critical Drainage Catchments' (CDC).

One of the key outputs from the Norwich Urban Area SWMP was detailed surface water flood risk maps. These maps are being used to prioritise the maintenance of drainage systems, planning policies and help shape funding bids for mitigation works.

Further work on the Norwich SWMP (completed in November 2014) provided more accurate data on the Critical Drainage Catchments and cost benefit analyses of the flood protection measures.

2.6.2 South Norfolk Council Surface Water Management Plan: Stage 1 (2016)

Stage 1 of the **South Norfolk SWMP** was completed in September 2016. Stage 1 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 consisted of representatives from Anglian Water, the Environment Agency, South Norfolk Council, Norfolk County Council and local IDBs.

Historic flood events and predicted flood risk from new surface water flood maps were analysed to identify the priority settlements for the SWMP study.

Norfolk County Council, are in the process of bidding via the Regional Flood and Coastal Committee (RFCC) for funding to take the South Norfolk SWMP forward into Stage 2[2].

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 Greater Norwich area:

- **Policy 2 – Fluvial Rivers.** Areas of low to moderate flood risk where further action to reduce flood risk can generally be taken.
- **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.

2 https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies/surface-water-management-plans/south-norfolk-swmp

- **Policy 5 – Norwich.** Areas of moderate to high flood risk where further action to reduce flood risk can generally be taken.
- **Policy 6 – River Wensum.** 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.

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

This 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. The Greater Norwich area 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 Plan (SMP) forms part of the Defra's strategy for flood and coastal defence. It provides a large-scale assessment of risks associated with coastal evolution and presents 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 Norfolk County is covered by:

- SMP4: The Wash
- **SMP 5: Hunstanton to Kelling Hard (2010)**
- **SMP 6: Kelling Hard to Lowestoft Ness (2012)**

The administrative area of the Broadland District Council, Norwich City Council and South Norfolk Council does not cover any coastlines. However, the SMPs should be considered by the Council's if measures, such as the strategic flood risk solutions proposed in Section 10 interact with coastal communities and processes.

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 Greater Norwich Integrated Water Cycle Study (2007)

The **Greater Norwich Integrated Water Cycle Study** provides initial advice on the best locations for development in relation to waste water infrastructure.

A non-technical report was produced for this study; the non-technical report acts as the principal planning reference for Greater Norwich's' Water Cycle Strategy document. This sets out the key findings of the study in relation to the Development Plan and sets out planning implications of the solutions proposed from the study.

A technical report was also produced which sets out how the strategy was developed. It details the methodology used in the assessments of infrastructure capacity and new infrastructure, discussion on the policy and legislative drivers affecting the assessments, the data used in the study and the key findings. Its aim is to act as the technical reference for the evidence base to the partner authorities' LDFs, showing how the strategy has been developed in more detail.

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, the 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'**[3].

2.12 Roles and responsibilities of Risk Management Authorities

The roles and responsibilities of Risk Management Authorities (RMAs) in the Greater Norwich area are summarised below.

2.12.1 Broadland District Council, Norwich City Council and South Norfolk Council

Broadland District Council, Norwich City Council and South Norfolk Council are individual LPAs. Each Council will assess, consult on and determine whether or not development proposals are acceptable within their respective administrative area, ensuring that flooding and other, similar, risks are effectively managed.

The councils 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.

2.12.2 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[4].

3 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.

4 The Changing Broads? The Broads Climate Adaptation Plan 2016

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. The Environment Agency has powers to work on Main Rivers to manage flood risk. These 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. The

Greater Norwich area lies within the Water Management Alliance administrative area (covering the Broads IDB and Norfolk Rivers 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
- They 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 the Greater Norwich area. 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's **website**.

Anglian Water supply potable water to the Greater Norwich area. Consent, prior to commencing work, is required from Anglian Water if installing water systems, or altering existing systems, is intended.

2.13 When to consult Risk Management Authorities

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

Table 2-1: Roles and responsibilities in the Greater Norwich area

Key Authority	When to consult
Broadland District Council, Norwich City Council, South Norfolk 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.

Key Authority	When to consult
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.
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 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 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.

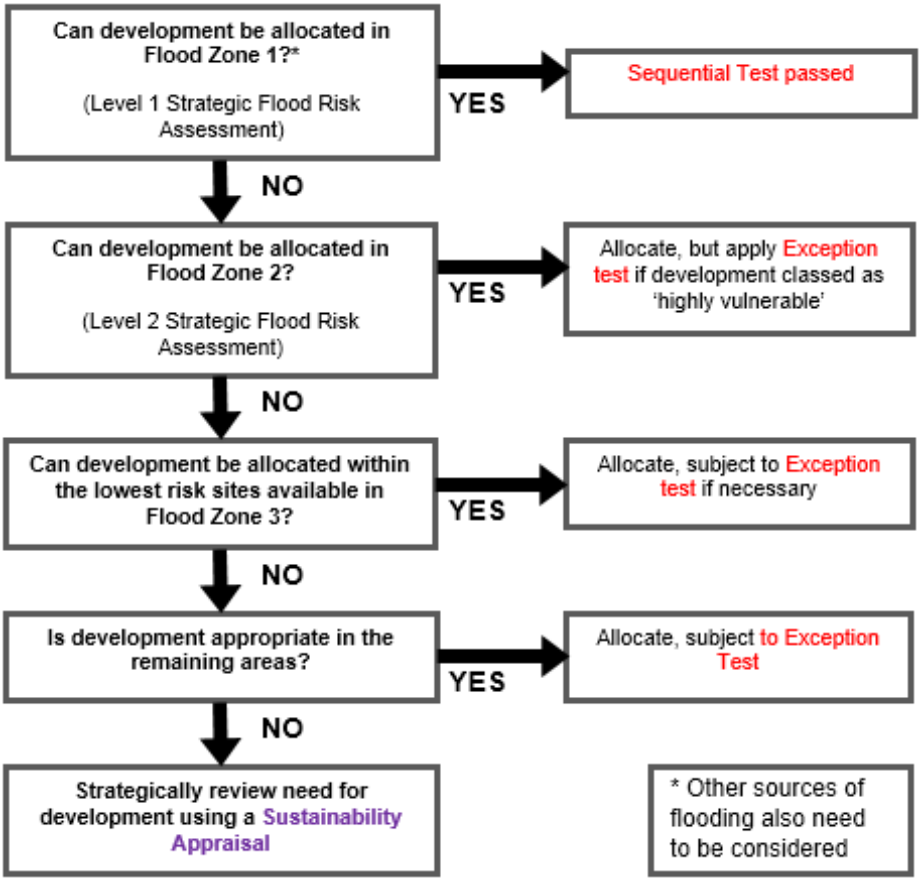
In circumstances where existing development or infrastructure is shown in Flood Zone 3b, where the flooding is a consequence of overtopping of existing defences or where the flooding is a consequence of sea water levels, additional consideration should be given to whether the specific location is appropriate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

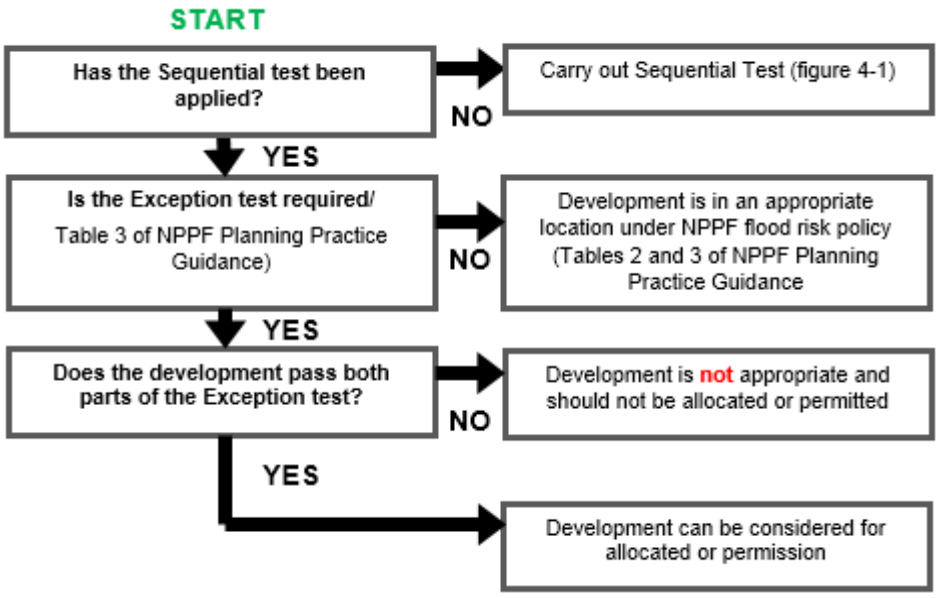
The Sequential Test should be applied to the whole LPA area to increase the likelihood of allocating development in areas not at risk of flooding. The Sequential Test can be undertaken as part of a Local Plan Sustainability Appraisal. Alternatively, it can be demonstrated through a free-standing document, 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.

Broadland District Council, Norwich City Council, South Norfolk 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.

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.

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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**.

The Greater Norwich area 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's **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 increase 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 selection of flood levels for flood risk management measures at a development or development plan allocation, the following should be considered:

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

The Environment Agency have 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 the Greater Norwich area

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 a number of 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 the Greater Norwich area, 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**.

The updated BESL model was not available at the time of preparing this SFRA and as such, associated climate change modelled extents were not mapped. At such locations developers should undertake further investigations as part of a site-specific Flood Risk Assessment to ensure that fluvial climate change allowances are adequately considered. 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. 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 using 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 4.5). The Risk of Flooding from Surface Water model (see Section 5.3) 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 the Greater Norwich area 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 D.

Summary of climate change impacts

- Norwich City: The River Wensum is quite sensitive to increases in flow due to climate change. The River Yare, which flows along the southern boundary of Norwich City, is comparatively less sensitive to the impacts of climate change. Flood extents do not increase greatly in the 100-year with 35% and 100-year with 65% climate change scenarios. Whilst flood extents may not increase significantly, climate change has the potential to increase flood levels, depths, velocities and hazard to people classification.
- South Norfolk: The Rivers Yare, Tiffey, Tas and Tud flood extents do not increase greatly in the 100-year with 35% and 100-year with 65% climate change scenarios. Whilst flood extents may not increase significantly, climate change has the potential to increase flood levels, depths, velocities and hazard to people classification. The notable settlements where climate change extents are shown to increase, are along the River Tiffey at Barford and River Yare at Marlingord and Bawburgh. Towards the north-east of the district, tidal climate change extents cover significant areas. However, the land covered by the tidal climate change extents are predominantly rural.
- Broadland: The Rivers Wensum and Bure flood extents do not increase greatly in the 100-year with 35% and 100-year with 65% climate change scenarios and are similar to the Flood Zone 2 extent. Whilst flood extents may not increase significantly, climate change has the potential to increase flood levels, depths, velocities and hazard to people classification. The notable settlements, where climate change extents are shown to increase, are along the River Wensum at Morton and Lenwade. The tidal climate change extents of the River Yare, towards the east of the district, cover significant areas. However, the land covered by the tidal climate change extents are predominantly rural.

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 the Great Norwich area.

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.

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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. In particular, the following should be noted:

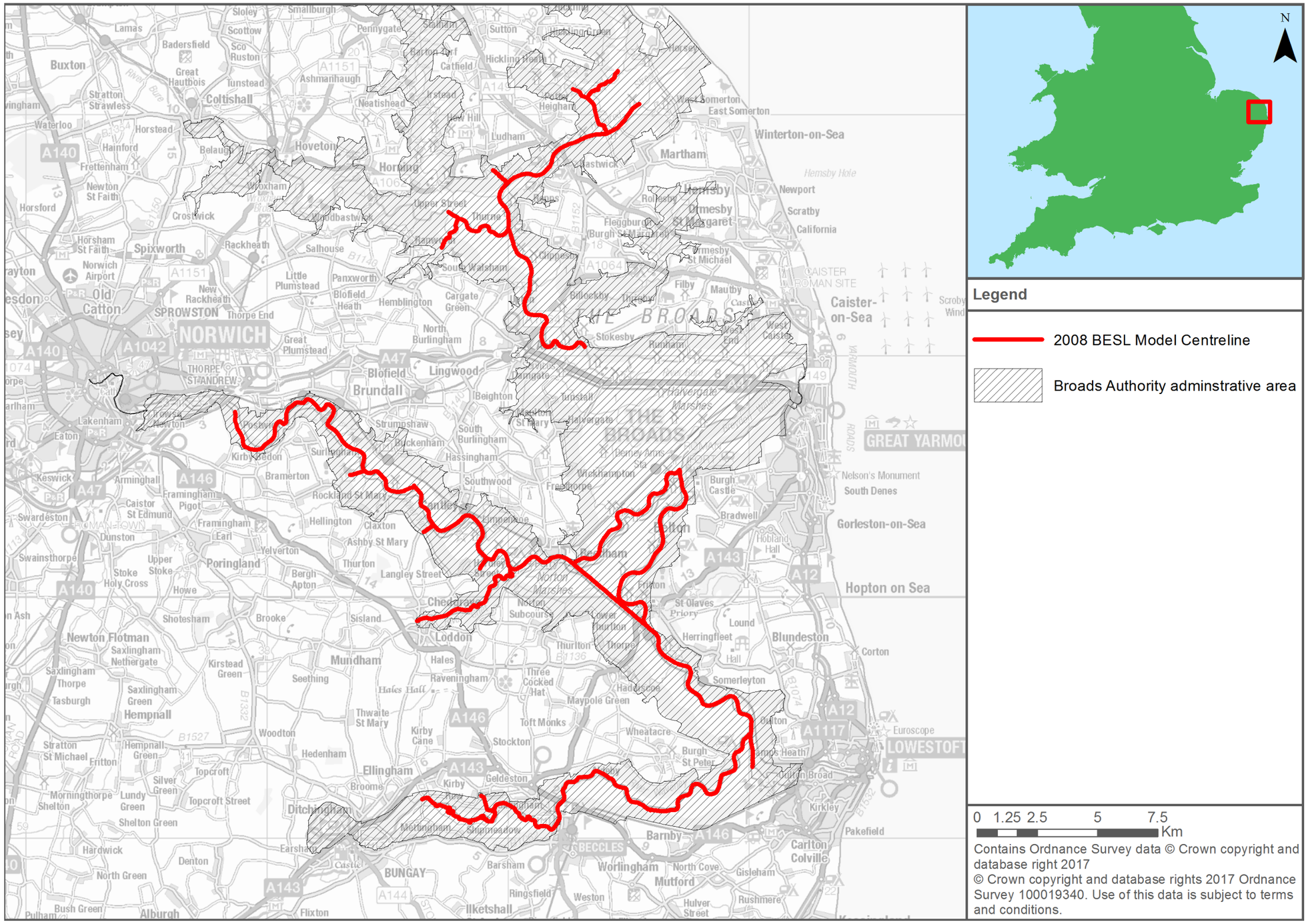
- **2017 Anglian coastline modelling package:** as part of a separate commission to the SFRA, the Environment Agency were preparing updated modelling of the Anglian coastline. Where the outputs were available at the time of preparing the 2017 SFRA, these were supplied and used in the assessment. The 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 the Greater Norwich area. 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.
- **2017 River Wensum modelling package:** as part of a separate commission to the SFRA, the Environment Agency were preparing updated modelling under this package. This modelling package predominantly concerns the Upper Wensum and the River Wensum in Norwich as well as the River Tud. The outputs were available and supplied at the time of preparing this SFRA.

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 by 2019. The 2008 BESL model extent is shown in Figure 5-1 and covers several Norfolk authority administrative areas and notably covers much of the Broads Authority administrative area and extends into the Greater Norwich area. 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 flooding

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'). For example, the BESL model is due to be updated in 2019 and therefore the precautionary approach has been adopted to represent Flood Zone 3b. In Appendix A, if the Flood Zone 3b is indicative, this is highlighted in the GeoPDF.

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.

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

The Greater Norwich area is partially covered by the Waveney, Lower Yare and Lothingland IDB and the Water Management Alliance. The Water Management Alliance covers five IDBs; those in the Greater Norwich area include the Broads IDB and Norfolk Rivers IDB.

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; 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 Norwich area 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**.

Where no hydraulic models exist, no climate change modelling was undertaken. At such locations developers should prepare detailed hydraulic models as part of a site-specific flood risk assessment and account for climate change in the assessment.

The updated BESL model was not available at the time of preparing this SFRA and as such, associated climate change modelled extents were not mapped. At such locations developers should undertake further investigations as part of a site-specific Flood Risk Assessment to ensure that fluvial climate change allowances are adequately considered. Section 8.2.3 provides further guidance on this.

Where alternative approaches have been used to map the extents associated with the climate change scenarios (i.e. where Flood Zone 2 used as a substitute for the 100-year with 65% climate change extent), developers may be required to further investigate the flood risk as part of a site-specific Flood Risk Assessment. Appendix D identifies where surrogate extents were used in the mapping.

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 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 the Greater Norwich area 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 (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 (based on a 4-5 digit post code).

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 the Greater Norwich area (excluding historic flood extents).
- Appendix B: Watercourses in the Greater Norwich area and IDB Districts
- Appendix C: Flood Alert and Flood Warning Coverage across the Greater Norwich area
- 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.
- **Norwich Urban Area Surface Water Management Plan (2012)** and **South Norfolk Council Surface Water Management Plan: Stage 1 (2016)**

  Provides information on surface water flooding issues for Norwich and South Norfolk and the plan for managing risk. It should be ensured that any surface water management measures are consistent with the Plan
- **Greater Norwich Integrated Water Cycle Study (2007)**

  Developers and planners should use the WCS as a starting point when considering any water supply, sewerage or water quality constraints on a development
- **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 the Greater Norwich area

6.1 Historic flooding

The Greater Norwich area has a history of documented flood events with the main sources being from fluvial/tidal and surface water sources.

The historic flood information described below has been taken from:

- The 2009 Partnership of Norfolk District Councils 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 the Greater Norwich area:

- Flooding was recorded in 1273, 1280, 1289, 1361, 1519, 1571, 1614, 1617, 1640, 1646, 1696, 1703, 1706 and 1734.
- 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 were reported to be involved in the repair of the defences.
- From the 24th to the 27th October 1762 a rainfall event affected Norwich and 2,000-3,000 properties were flooded. "Several" people were reported to have died.
- A further flood occurred in Norwich on the 19th November 1770, where there were a higher number of deaths than the 1762 event.
- Rainfall, snowmelt and tide-locking in 1878 caused 3,000-6,000 properties to be flooded in Norwich. The flooding affected the River Yare and 3-4 people died during this event.
- In 1893, a rainfall event affected Norwich.
- In 1897, a coastal breach between Eccles-on-Sea and Winterton caused a 10ft surge along the tidal rivers and tidal floodplain.
- A rainfall event in 1912 caused flooding in Norwich and part of the Broads. Over 3,600 properties were affected and 4 people died. It was estimated that the rainfall event had a return period of 800 to 1,000 years.
- The East Coast of the UK was hit by a storm surge on the 31st January/1st February 1953 which affected the River Yare and the Broads.
- Rainfall events in 1968 caused fluvial flooding which affected the Waveney and Yare catchments. It was estimated that the rainfall event had a return period of 1,000 years.
- In January 1976, a tidal surge affected tidal rivers and Cantley.
- Rainfall caused wide spread inundation of the fluvial floodplains on the Waveney, Yare and Bure rivers in 1981.
- In February 1983, a tidal surge affected the Waveney, Yare and Bure rivers. The Beauchamp Arms, Postwick, New Cut and Breydon North Wall were affected.
- A tidal surge in January 1993 affected the Yare and Waveney Valley and part of the Broads. 110 properties were affected.
- Also in 1993, a rainfall event caused flooding the Norwich and part of the Broads and affected 33 properties. The Waveney and Yare rivers were affected with some flooding due to surface water.
- In June 2001, heavy summer storms caused flash flooding in the Shelfanger area flooding 23 properties.
- A tidal surge in November 2006 affected Brundall, Limpenhoe Marshes, Cantley Marshes, Postwick Marshes, Oulton, Strumpshaw Fen and boatyards on Chet flooded. Two sections of the flood bank were reported to have breached.
- The settlement of Harleston saw flooding to properties recorded in 2006, 2009 and 2014.

- In November 2007, a storm surge affected the Waveney, Yare and Bure river systems. Flooding occurred downstream of Oulton and the Haddiscoe flood bank breached. Several hundreds of homes were evacuated.
- On the 12th August 2008, 41 recorded flood incidents were recorded across Norwich City.
- In August 2009, summer storms caused flash flooding in Barford with 23 homes affected by surface water and three affected by sewer water.
- In December 2013, a storm surge hit the east coast of the UK. Train services were disrupted between Norwich and Diss due to problems with overhead cables[5].
- Heavy rainfall caused surface water and sewer flood in the Greater Norwich area throughout the summer of 2014 and caused damage to a number of properties[6,7]
- Heavy rain and thunderstorms caused flash flooding across Norfolk in June 2016 with South Norfolk being particularly affected. Norfolk Fire and Rescue Service attending 15 incidents of flooding in Diss, Scole and Winfarthing[8].
- On the 13th January 2017, Norfolk 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 and no damage was caused to any properties.[9]
- 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, Hethersett, Earlham and Wymondham.[10]

Under Section 19 of the Flood and Water Management Act, Norfolk County Council in their role as LLFA, have published **Section 19 reports** covering the following communities and flood events. Where possible, the likely source of the flood event, as noted in these reports, has been listed.

- Several incidents occurred throughout 2012 - 2014, at Station Road in Wymondham, caused by surface water flooding and the drainage system capacity being exceeded.
- On 28th January 2013 and 9th - 10th March 2013 flooding occurred at Church of England V.C Primary School, Brooke. A number factors caused the flooding including extreme rainfall, loss of connectivity between drainage features and that the drainage system serving the school was in a poor state of repair and inadequate for the rainfall events.
- Flooding in the Mill Road, Little Melton area occurred on 14th February 2013. Rainfall caused highway drainage systems to be put under pressure.
- On 9th March 2013, Glebe Close and Long Stratton experience flooding. Heavy rainfall was experienced across Norfolk causing many low capacity systems to be exceeded. Snow melt and a frozen saturated landscape exacerbated the event.
- On 7th February 2013, Norwich Road, Strumpshaw experienced flooding. Flooding was caused by a combination of land saturation, exceedance of the capacity of the foul sewer and a collapsed manhole.
- On May – October 2014, heavy rainfall triggered surface water and sewer flooding which caused internal flooding to 77 properties in the Norwich Urban Area.
- On 29th May 2015, Station Road, Ditchingham experienced flooding. Flooding was caused by heavy rainfall along with the highways surface water drainage being partially obstructed. A local sewer pumping station became overloaded causing the public sewer to back up.

Historic flood information can be used for:

- Model calibration: This involves checking the model results align with historic flood information.

5 http://www.bbc.co.uk/news/uk-england-suffolk-25228837

6 http://www.bbc.co.uk/news/uk-england-norfolk-28398013

7 http://www.bbc.co.uk/news/uk-england-norfolk-27585524

8 http://www.dissmercury.co.uk/news/flash-floods-cause-chaos-and-misery-in-many-areas-of-south-norfolk-and-breckland-1-4592395

9 http://www.bbc.co.uk/news/uk-england-38619611

10 http://www.edp24.co.uk/news/weather/weather-warning-in-place-as-thunder-is-heard-across-norfolk-1-5094998

- 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.
- 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 the Greater Norwich area can be seen in Figure 6-1 and is composed of higher elevations in western areas, where elevations reach approximately 72.80m AOD, before decreasing in an easterly direction, towards the coast. Some areas in the east of the study area, particularly in and around the Norfolk Broads (i.e. the Broads Authority administrative area), are below sea level. Three valleys descending from west to east are prominent topographical features within the Greater Norwich area; these are associated with the River Waveney in the south, River Yare in the centre and River Bure in the north.

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 Greater Norwich area 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 majority of the Greater Norwich area is underlain by a Principal aquifer (bedrock designation) associated with gravel, sand, silt and clay in the east and chalk in the west. There is a small area of Unproductive Strata in the vicinity of Cantley associated with an area underlain primarily by clay.

The superficial deposits in the study area are generally of Secondary (undifferentiated) aquifer in the south, north and west (associated with diamicton), whilst Secondary A aquifer is mainly found in the centre (associated mainly with sand and gravel) and unproductive superficial deposits are most common in the east, across most of the Broads Authority administrative area (associated with clay, sand and silt alluvium deposits).

Figure 6-1: Topography of the Greater Norwich area

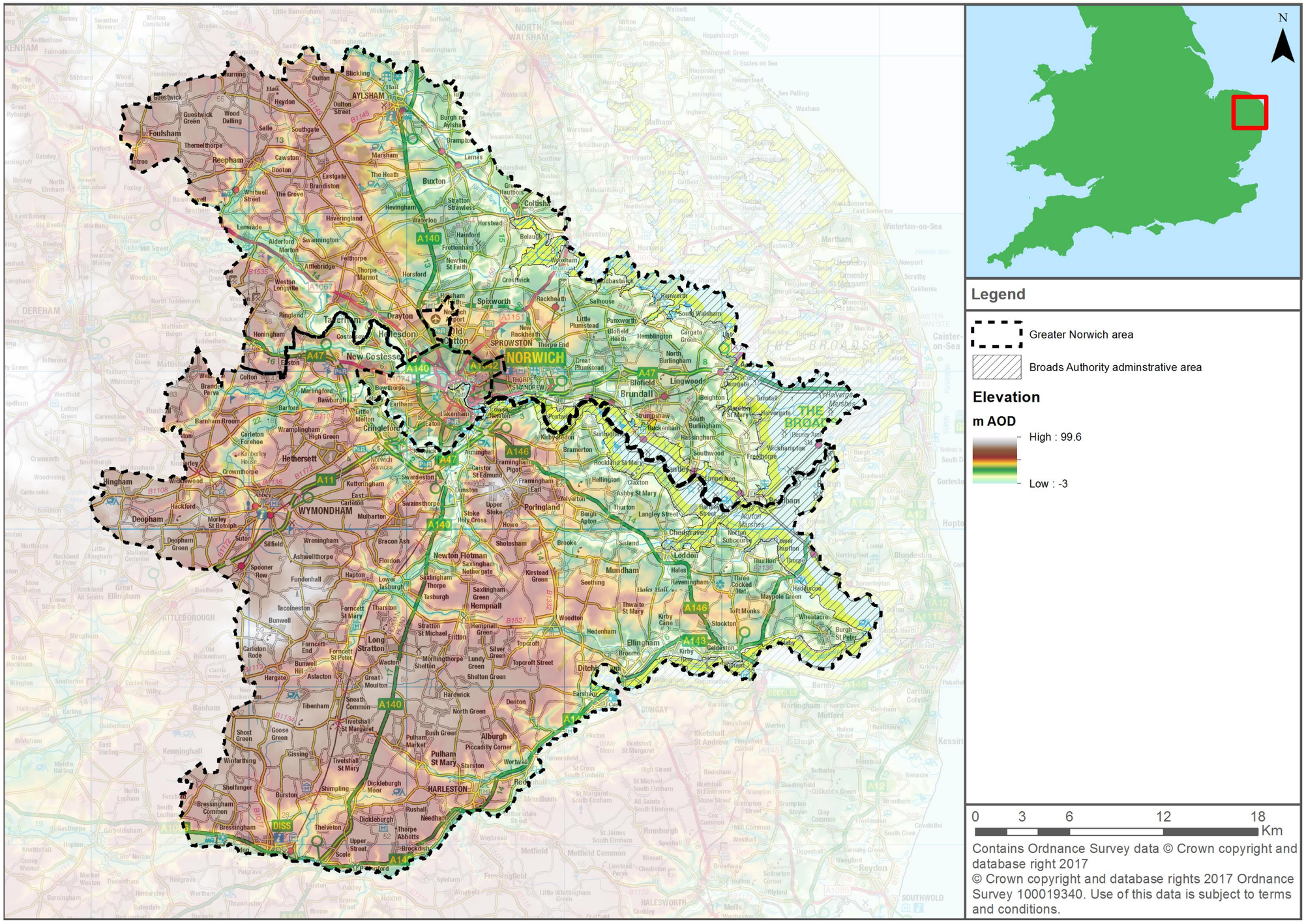


Figure 6-2: Bedrock aquifer classification in the Greater Norwich area

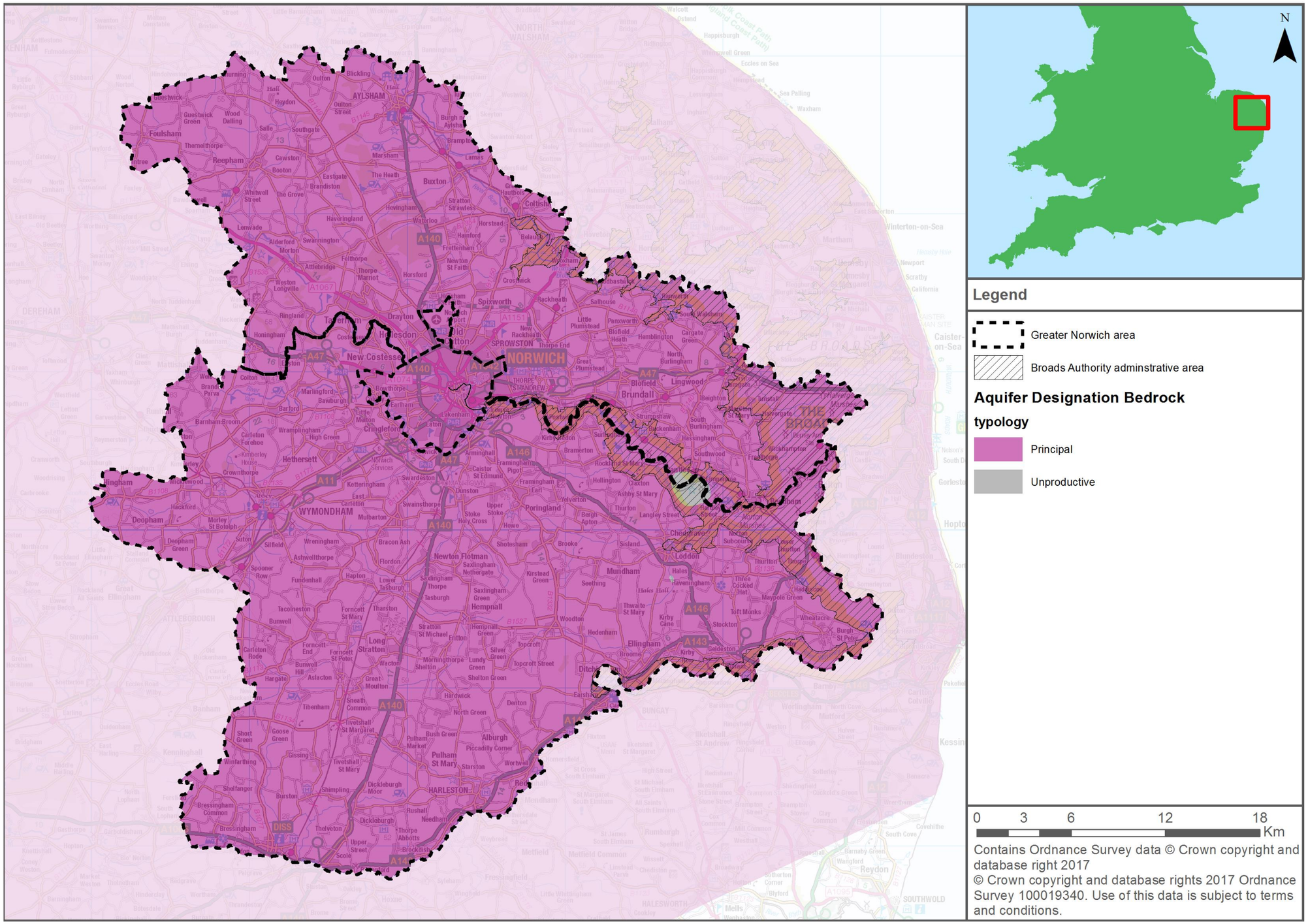
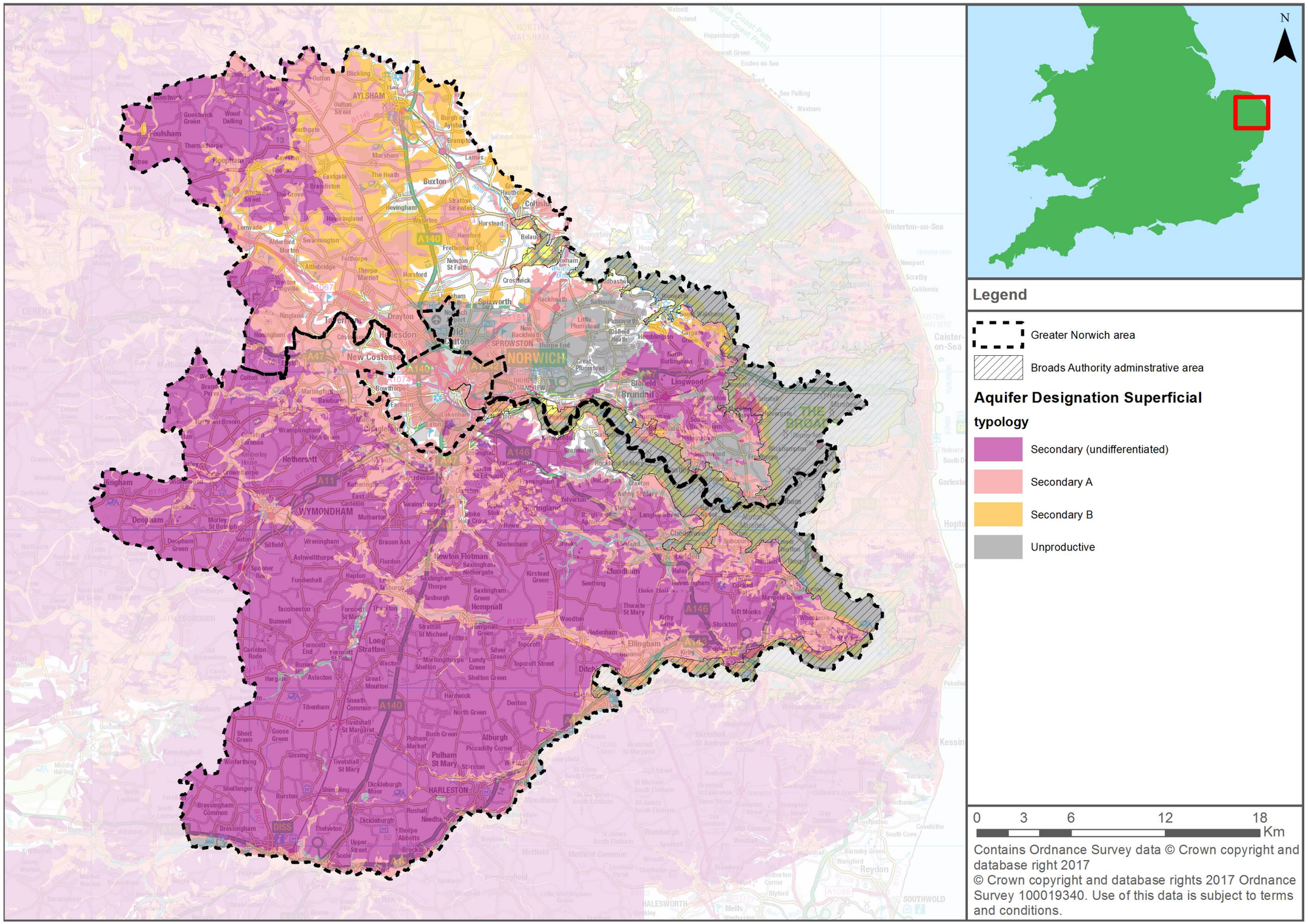


Figure 6-3: Superficial aquifer classification in the Greater Norwich area



6.3 Watercourses in the Greater Norwich area

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 the Greater Norwich area 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 the Greater Norwich area. IDBs operating in the Greater Norwich area include:

- The Waveney, Lower Yare and Lothingland Internal Drainage Board. This IDB covers an extensive part of the Greater Norwich area in the vicinity of the River Yare and River Waveney catchments. Their management area includes watercourses adjacent to the River Yare from as far west as Rockland, the River Chet from Upper Gravitation until its confluence with the Yare and the River Waveney from South Lopham. This IDB manages catchments for both the Yare and Waveney to the eastern extent of the study area and beyond.[11]
- The Norfolk Rivers Drainage Board (part of the Water Management Alliance). This IDB operates extensively throughout the Greater Norwich area including as far north as Long Stratton, as far east as South Walsham. This IDB manages catchments beyond both the north and west of the study area boundary.[12]
- The Broads Internal Drainage Board (part of the Water Management Alliance group). This IDB operates across much of the Broads within the study area. Their coverage starts to the east of Norwich and includes much of Broads in the north east and east of the study area. This IDB manages catchments beyond both the northern and eastern study area boundary.[13]

The **2009 Broadland Rivers CFMP** also notes that the settlements of Wymondham and Aylsham are reliant on pumping stations to reduce the risk of flooding.

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-years with 300mm freeboard to developed areas. The policy statement acknowledges that the standards

11 http://www.nicholsonslaw.com/cms/document/map.pdf
12 https://www.wlma.org.uk/uploads/NRIDB_MapIndexW.pdf
13 https://www.wlma.org.uk/uploads/84-BIDB_drainindex.pdf

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 the Greater Norwich area is primarily associated with the River Yare, River Bure and River Waveney watercourses and their tributaries. Significant tributaries that also contribute to flood risk within the Greater Norwich area include but are not limited to:

- River Yare tributaries - River Wensum, River Chet and the River Tiffey
- River Bure tributaries - Camping Beck, Acle L/S and Spixworth Beck
- River Waveney tributaries - Shelfanger watercourse

Although much of the Greater Norwich area is rural, urban settlements are risk from fluvial flooding from the River Yare, River Bure and River Waveney catchments (as well as other sources of flooding). The Broadland Rivers CFMP identifies that the greatest fluvial flood risk within the Greater Norwich area is from the River Wensum in Norwich (part of the River Yare catchment). The CFMP identifies additional risk from the River Bure and Camping Beck at Buxton. Fluvial flooding can be exacerbated in the upper reaches of the catchment, due to mill structures restricting the flow (i.e. in Horstead).

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 River Wensum and the River Yare within Norwich).

A summary of fluvial flood risk to settlements in the Greater Norwich area (as well as other sources of flooding) is detailed in Table 6-5.

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 to a 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.

Although the Greater Norwich area is landlocked, the **Broadland Rivers CFMP** notes that a significant proportion of policy sub-area 3 (Fluvial/Tidal Rivers and Tidal Broads), is located within the study area, where fluvial and tidal interactions influence flooding in the river network. In the east of the study area, along parts of the River Yare (downstream of Norwich) and across the Broads tidal levels are higher than fluvial levels in some places. Combined river and tidal flooding is known to sometimes affect settlements including Wroxham and Brundall whilst high tide levels combined with a storm surge can affect the Norfolk Broads in the east and south of the study area. Additional impacts of tidal influence include rivers not being able to flow freely at high tide (called tide-locking). This would affect settlements such as Norwich and Wroxham. This can affect any locations up to the tidal limit of the rivers in the Greater Norwich area, potentially affecting settlements like Norwich and Wroxham.

A summary of tidal flood risk to settlements in the Greater Norwich area (as well as other sources of flooding) is detailed in Table 6-5.

Fluvial and tidal Flood Zones, for the Greater Norwich area can be found in Appendix A.

6.6 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 the Greater Norwich area can be found in Appendix A.

A **Surface Water Management Plan**[14] (SWMP) (2012) has been prepared for the Norwich urban area to serve as a framework to understand the causes of surface water flooding outline a preferred strategy to manage the surface water flood risk. Within the report the plan identifies the three areas of the Norwich urban area at greatest risk of surface water flooding, all due to critical drainage issues:

- Catton Grove and Sewell (240 properties)
- Nelson and Town Close (169 properties)
- Drayton (75 properties)

A Section 19 Flood Investigation Report has noted that an area particularly susceptible to surface water flooding is the highway beneath the bridge at Station Road / Silfield Road Railway bridge, Long Stratton.[15] Additional Section 19 Flood Investigation Reports have identified that Glebe Close, Long Stratton (South Norfolk), Mill Road in Little Melton (South Norfolk) and Norwich Road, Strumpshaw (the Broadland) have all suffered surface water flooding.[16] Section 19 reports are available to download from Norfolk County Council's **website**.

A summary of surface water flood risk to settlements in the Greater Norwich area (as well as other sources of flooding) is detailed in Table 6-5.

The RoFfSW mapping for the Greater Norwich area can be found in Appendix A.

6.7 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 the whole of the Greater Norwich area has been provided showing the Areas Susceptible to Groundwater flooding (AStGWf). This information is provided in Appendix A.

Within Norwich city there are areas containing cavities in the underlying chalk strata. Water infiltration in the past has led to the collapse of these cavities resulting in subsidence. There may be limitations in the deployment of particular mitigation measures in areas characterised by this geology.[17]

There are a number of locations within South Norfolk identified as being at risk of groundwater flooding including: Poringland, Framingham Earl and Framingham Pigot. Within the Broadland area

14 Norfolk County Council (2011) Norwich Surface Water Management Plan Stage 2: Final Report

15 Norfolk County Council (2014) South Norfolk, Station Road, Wymondham Flood Investigation Report

16 Norfolk County Council, Flood Investigations https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/flood-investigations

17 Norfolk County Council (2015) Local Flood Risk Management Strategy

it is believed pumping from the IDB maintain the water table at a relatively lower level reducing the risk of groundwater flooding.[17]

Much of the Broads Authority administrative area is shown to have a low susceptibility to groundwater flooding, i.e. within the <25% category. Areas with increased susceptibility tend to be found along the valleys of watercourses including the Rivers Waveney, Yare and Bure. However, for significant parts of the Broads Authority administrative area, there is no data shown in the AStGWf dataset.

A summary of groundwater flood risk to settlements in the Greater Norwich area (as well as other sources of flooding) is detailed in Table 6-5.

The AStGWf mapping for the Greater Norwich area can be found in Appendix A.

6.8 Flooding from artificial sources

6.8.1 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.

The **2007 Greater Norwich Water Cycle Study** identified that sewerage treatment works across the study area ranged from having no spare capacity to considerable capacity. Meanwhile the WCS also noted that the sewerage system within the city centre of the Norwich is at capacity and recommends upgrading the system.[18]

The **Norwich SWMP** identifies the majority of Norwich city as being served by sewers with a 1 in 30-year design standard. However, some smaller parts of the city have drains with a design below 1 in 5-years. The Critical Drainage Areas were identified as Drayton, Catton Grove and Sewell and Nelson and Town Close[19].

A Section 19 Flood Investigation Report was created after heavy rainfall exceeded the capacity of the drainage systems and caused surface water flooding that resulted in approximately 80 properties being flooding in the Norwich Urban Area. A lack of coordination between stakeholders to maintain and clean the drainage system was identified as a key cause.[20] Additional Section 19 Flood Investigation Reports found that flooding primarily due to the exceedance of drainage capacity had taken place at Glebe Close in Long Stratton, High Green Road in Brooke village, and Station Road in Ditchingham, all in South Norfolk. This indicates that some of flooding in South Norfolk is caused or exacerbated by sewer flooding. Section 19 reports are available to download from Norfolk County Council's **website**.

18 Greater Norwich Growth Board (2007) Water Cycle Study, Stage 1, Conclusions, accessed at: http://www.greaternorwichgrowth.org.uk/document-search/SearchForm?Subject=&hidden-Subject=&Title=Water+Cycle+Study&action_doTitleSearch=Search&start=0

19 Norfolk County Council (2011) Norwich Surface Water Management Plan, accessed at: https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies/surface-water-management-plans/norwich-urban-area-swmp

20 Norfolk County Council (2015) Investigation Report into the flooding within the Norwich Urban Area during the summer of 2014 https://www.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/norwich-and-broadland-2014.pdf?la=en

Several historic records relate to sewer flooding. However, for areas where there are re-occurring issues maintenance work may have been undertaken by Anglian Water since the flooding incidents occurred and therefore the risk may have been removed or reduced. As such, the historic record for sewer flooding represents a 'snap-shot' in time and is not necessarily a reflection of the current or future flood risk from sewers.

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. For confidentiality reasons, this data has been supplied on a postcode basis. The information from the DG5 register is shown in Table 6-1.

The DG5 register indicates a total of 264 recorded flood incidents in the Greater Norwich area. The more frequently flooded postcodes are: NR7 9 (40 incidents), NR6 5 (27 incidents), NR7 0 (16 incidents), NR13 4 (14 incidents), NR10 3 (13 incidents) and NR13 6 (12 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 6-1: DG5 register for the Greater Norwich area

Authority	Area	Postcode	Number of recorded flood incidents
South Norfolk	Harleston	IP20 0	1
South Norfolk	Harleston	IP20 9	7
South Norfolk	Diss	IP21 4	4
South Norfolk	Diss	IP22 1	1
South Norfolk	Diss	IP22 4	2
South Norfolk	Diss	IP22 5	1
South Norfolk	Norwich	NR5 0	7
South Norfolk	Costessey	NR8 5	5
South Norfolk	Rockland St. Mary, Poringland, Framlingham Earl	NR14 7	3
South Norfolk	Brooke, Newton Flotman, Tasburgh	NR15 1	3
South Norfolk	Tivetshall St. Mary, Wacton, Aslacton	NR15 2	6
South Norfolk	Ashwellthorpe	NR16 1	1
South Norfolk	Wymondham	NR18 0	5
South Norfolk	Bungay	NR35 2	4
Norwich City/ South Norfolk	Norwich, Cringleford	NR4 6	3
Norwich City/ South Norfolk	Norwich	NR4 7	8
Norwich City	Norwich	NR1 2	1
Norwich City	Norwich	NR1 3	3
Norwich City	Norwich	NR2 3	3
Norwich City	Norwich	NR2 4	2
Norwich City	Norwich	NR3 2	2
Norwich City	Norwich	NR3 3	2

Authority	Area	Postcode	Number of recorded flood incidents
Norwich City	Norwich	NR3 4	1
Norwich City/ Broadland	Norwich, Helleson, Norton Subcourse	NR6 5	27
Norwich City/ Broadland	Norwich, Hellesdon	NR6 6	3
Broadland	Spixworth, Hainford, Horsham St Faith	NR10 3	13
Broadland	Cawston, Felthorpe, Reepham	NR10 4	5
Broadland	Buxton	NR10 5	2
Broadland	Aylsham	NR11 6	4
Broadland	Coltishall	NR12 7	2
Broadland	Wroxham	NR12 8	8
			11
Broadland	Acle, Cantley, Halvergate	NR13 3	5
Broadland	Blofield, Strumpshaw	NR13 4	14
Broadland	Brundall	NR13 5	6
Broadland	Woodbastwick, Rackheath, Salthouse	NR13 6	12
Broadland	Old Catton, George Hill	NR6 7	1
Broadland	Thorpe St. Andrew	NR7 0	16
Broadland	Sprowston	NR7 8	5
Broadland	Norwich	NR7 9	40
Broadland	Taverham, Drayton	NR8 6	8
Broadland	Hingham, Barnham Broom	NR9 4	3
Broadland/ South Norfolk	Lyng, Lenwade, Easton, Honingham	NR9 5	4
Total = 264			
Note: Based on information supplied 26/06/2017			

6.8.2 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 Greater Norwich area as a result of reservoir breach or failure of a number of reservoirs within the area was assessed as part of the National Reservoir Inundation Mapping (NRIM) study. Several reservoirs are located within the Greater Norwich area. However, there are also reservoirs outside of the area whose inundation mapping is shown to affect the

Greater Norwich area. 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 6-2: Reservoirs with potential risk to the Greater Norwich area

Reservoir	Location (grid reference)	Reservoir owner	LPA affected by extents
Ditchingham Lake	632703, 292544	Ditchingham Farms Ltd	South Norfolk Council
Beeston Hall	626631, 314552	EM Dewing and Partners	Broadland District Council and the Broads Authority
Heigham Large Deposit Reservoir[21]	621280, 309653	Anglian Water Services Ltd	Broadland District Council, Norwich City Council, South Norfolk Council and the Broads Authority
South Lake Cantley	639316, 302457	British Sugar Plc	Broadland District Council and the Broads Authority
Reeders Reservoir	639156, 296206	The Trustees of Nr 2 Settlement	South Norfolk Council and the Broads Authority
Blickling Lake	617896, 329593	The National Trust	Broadland District Council
Shrub Farm	611334, 332203	CJC Lee (Saxthorpe) Ltd	Broadland District Council
Melton Constable Lake	603309, 330687	GW Harold and Partners	Broadland District Council
North Lake Cantley	639669, 303106	British Sugar Plc	Broadland District Council and the Broads Authority
Wolterton Lake	616436, 331022	Warpole	Broadland District Council
Holly Heath Farm Reservoir	609373, 330470	GW Harold and Partners	Broadland District Council
Barningham Lake (ID 4)	614994, 335314	Courtland	Broadland District Council
Great Water and Saw Mill Pond	621943, 334194	Martin; Stamp	Broadland District Council
Erpingham Lodge Reservoir	620543, 330090	Mr Ben Macintosh, Erpingham Lodge Farms	Broadland District Council
Church Farm Booton	612234, 323159	Church Farm Booton	Broadland District Council
Quebec Farm	615544, 322155	Quebec Farms	Broadland District Council
Upton Farm	638765, 311139	Hugh Crane Limited	Broadland District Council and the Broads Authority
Colton No 2	609987, 309905	Honingham Farms Limited	Broadland District Council and South Norfolk Council

21 Can also be referred to as the Waterworks Road Reservoir

Reservoir	Location (grid reference)	Reservoir owner	LPA affected by extents
Hill Farm Reservoir Easton Estates	612707, 312046	Honingham Aktieselskab	Broadland District Council, Norwich City Council and South Norfolk Council
Elmerdale Farm Reservoir	613747, 330431	E F Harrold Ltd	Broadland District Council
Haveringland Lake	615843, 320988	Haveringland Hall Country Park Limited	Broadland District Council

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[22]. 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.

6.9 Flood warning and emergency planning

6.9.1 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

22 NPPG, Paragraph: 006 Reference ID: 7-006-20140306, Revision date: 06 03 2014

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 National 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[23] 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 / NPPG**, 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 Councils 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 to help develop emergency plans.

The **Norfolk Prepared**, Local Resilience Forum website covering the Greater Norwich area 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-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**

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

- **FloodRe**
- **Local Resilience Forum website covering the Greater Norwich area**

6.9.2 Flood warnings

Flood warnings, 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 Warning System (FWS) service, to homes and business within Flood Zones 2 and 3.

There are currently nine Flood Alert Areas and 20 Flood Warning Areas (FWAs) covering significant parts of the Greater Norwich area. These are shown in Appendix C. A list of the Flood Alert Areas in the study area is shown in Table 6-3 and a list of the FWAs in the study area is shown in Table 6-4.

Table 6-3: Flood Alert Areas within the Greater Norwich area

Flood Alert Code	Flood Alert Name	Watercourse	Coverage
054WAFNF2	The River Bure, Spixworth Beck and surrounding Becks	Bure, Spixworth Beck	The River Bure, Spixworth Beck and surrounding Becks
054WAFNF3	The upper Rivers Yare, Tiffey, Tas and Wacton	Yare, Tiffey, Tas	The Rivers Yare and Tiffey to Cringleford, and the River Tas and Wacton to Caistor St Edmund
054WAFNF3D	The River Yare at Norwich, from Cringleford to Trowse Newton	Yare	The River Yare at Norwich, from Cringleford to Trowse Newton
054WAFNF4B	The Rivers Tud and Wensum from Fakenham to Costessey, including Wendling Beck	Tud, Wensum, Wendling Beck	The Rivers Tud and Wensum from Fakenham to Costessey, including Wendling Beck
054WAFNF5	The River Wensum from New Costessey to Thorpe Bridge at Norwich	Wensum	The River Wensum from New Costessey to Thorpe Bridge at Norwich
054WAFSF1	The River Waveney from Diss and the River Dove to Ellingham, including Bungay	Waveney	The River Waveney from Diss and the River Dove from Mendlesham, to Ellingham, including Bungay
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

Table 6-4: Flood Warning Areas within the Greater Norwich area

Flood Warning Code	Flood Warning Name	Watercourse	Coverage
054FWFNF2B	The River Bure from Corpusty to Brampton, including Aylsham	Bure	The River Bure from Corpusty to Brampton, including Aylsham and Ingworth

Flood Warning Code	Flood Warning Name	Watercourse	Coverage
054FWFNF2C	The River Bure from Brampton to Wroxham	Bure	The River Bure from Brampton to Wroxham
054FWFNF2D	The Spixworth Beck from Horsham St Faith to Crostwick	Spixworth Beck	The Spixworth Beck from Horsham St Faith to Crostwick
054FWFNF3A	The River Tas through Stoke Holy Cross, to the A47 road bridge at Caistor St Edmund	Tas	The River Tas through Stoke Holy Cross, to the A47 road bridge at Caistor St Edmund
054FWFNF3B	The River Tiffey, from Wymondham to Barford	Tiffey	The River Tiffey, from Wymondham to Barford
054FWFNF3C	The River Yare from Barnham Broom to the A11 at Cringleford	Yare	The River Yare from Barnham Broom to the A11 at Cringleford
054FWFNF3D	The River Yare from the A11 at Cringleford to Trowse Newton	Yare	The River Yare from the A11 at Cringleford to Trowse Newton
054FWFNF4C	The River Wensum from Swanton Morley, to and including Costessey	Wensum	The River Wensum from Swanton Morley, to and including Costessey
054FWFNF4D	The River Tud from East Dereham, to and including New Costessey	Tud	The River Tud from East Dereham, to and including New Costessey
054FWFNF5A	Riverside properties in Norwich, including Bishopgate and the football ground	Wensum	Riverside properties in Norwich, including Bishopgate and the football ground
054FWFNF5B	The River Wensum, through Norwich	Wensum	The River Wensum, through Norwich
054FWFSF1A	The River Waveney from Diss to Bungay	Waveney	The River Waveney from Diss to Bungay
054FWFSF1B	The River Waveney from Bungay to Ellingham	Waveney	The River Waveney from Bungay to Ellingham, including Earsham and Ditchingham
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
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
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
054FWTBT2B	The tidal River Yare from Thorpe St Andrew to Loddon	River Yare	The tidal River Yare from Thorpe St Andrew to Loddon
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

6.9.3 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 51 dry islands in the Greater Norwich area. 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. Norwich City Council, Broadland District Council, South Norfolk Council or the Broads Authority) if their site is located in a dry island to determine the requirements for a site-specific FRA and emergency procedures.

6.10 Cross Boundary Considerations

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

- North Norfolk District Council
- Great Yarmouth Borough Council
- Waveney District Council
- Mid Suffolk District Council
- Breckland 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 Greater Norwich area.

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 the Greater Norwich area.

Development control should ensure that the impact on receiving watercourses from development in the Greater Norwich area 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. Further, the Greater Norwich area is formed of a partnership covering three local authorities which provides opportunities for Norwich City Council, Broadland District Council, South Norfolk Council and the Broads Authority to continue co-operating and working together on flood risk matters and any known cross-boundary issues within the study area, during the preparation of their Local Plans. These authorities can also work with their partners, together on flood risk issues, as part of the emerging Norfolk Strategic Framework.

6.11 Summary of flood risk to cities, towns and village in the Greater Norwich area

Table 6-5 summarises the flood risk to cities, towns and villages in the Greater Norwich area. 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 6-5 do not reflect the settlement hierarchy in the Local Authority Core Strategies.

If a settlement is not listed in Table 6-5 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 6-5: Summary of flood risk to cities, towns and villages in the Greater Norwich area

Settlement	Fluvial \ tidal 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%		
Norwich City	Fluvial flood risk to Norwich stems from the River Yare and the River Wensum and their tributaries which include a number of un-named drains. A significant number of properties in Coslany, The Close and Richmond Hill are within the Flood Zone 2 extent of the River Wensum. However, there are no properties shown to be located within Flood Zones. There are defences within parts of Norwich City i.e. around the Close area. However, there remains a residual risk should the defences breach or fail. Interaction between the two main watercourses has the potential to cause flooding, particularly around Richmond Hill near their confluence. Meanwhile high levels in either of the main watercourses may prevent the tributaries from discharging, causing them to back up and overtop. Tidal locking has the potential to affect Norwich; the River Yare may not be able to flow freely at high tide.	See section 7	Mapping shows surface water flood risk in Norwich is widely dispersed across the city, though largely restricted to roads and gardens as well as the floodplains of existing watercourses. Surface water flood risk is particularly acute in the 1% AEP event. Particularly in several streets in the vicinity of Heigham (, several streets to the west of Coslany, and properties in the New Catton and Mill Hill area.	✓	✓	✓	✓	Norwich is shown to be at risk if the Heigham Large Deposit Reservoir or Hill Farm Reservoir Easton Estates were to fail. However, inundation extents are primarily confined to the banks of the River Wensum through Norwich and few properties are shown to be located within the extents.	55
Taverham	Mapping shows an unnamed watercourse flowing through the north of the town in a south-eastern direction towards its confluence with the River Wensum. This watercourse may present a risk to property within the settlement. Approximately four properties are shown to be within in the Flood Zone 2 extent of the River Wensum in the south of the settlement.	None	Mapping shows surface water flood risk in Tavernham is widely dispersed across the town, though largely restricted to roads and gardens, as well as the floodplain of existing watercourse. An overland flow route is shown to develop in the south of the settlement around Laburnum Avenue and flow south affecting several properties in the 3.3% AEP event.	✓	✓	✓		This settlement is not shown to be located within reservoir inundation extents.	8 (Taverham and Drayton)
Acle and Damgate	Mapping shows fluvial flood risk to the settlements of Acle and Damgate is from the River Bure and its tributaries that flow to east of Damgate. Areas at risk include properties to the east of Damgate, in the vicinity of the New Road / A47 roundabout and to the north east of Acle including Hermitage Close and Fletcher Way. There is also the risk of high levels in the River Bure preventing the tributaries in the vicinity of the Acle from discharging causing it to back up and exacerbate flooding in the town.	None	Mapping shows surface water flood risk in Acle and Damgate consists predominantly of pockets of water ponding on roads, gardens and other open spaces throughout the town. A number of properties along New Road however are shown to be at risk of surface water flooding in the 1% AEP event.	✓				The settlements of Acle and Damgate are shown to be at risk if the Upton Farm reservoir were to fail.	5 (Acle, Cantley and Halvergate)

Settlement	Fluvial \ tidal 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%		
Wroxham	Flood Zones show the main fluvial flood risk is from the River Bure which flows to the north of the town. A number of properties are shown to be a risk of flooding from the River Bure getting out of bank, particularly in the area between Staitheway Road, Northwich Road and Bridge Broad Close. Further properties are also at risk to the east of the settlement along Beech Road. Tidal locking has the potential to affect Wroxham; the River Bure may not be able to flow freely at high tide.	None	Mapping shows surface water flood risk in Wroxham consists predominantly of pockets of water ponding on roads and in gardens and other open spaces throughout the town. A number of properties are at risk from an overland flow route that propagates from the centre of Wroxham in an eastern direction toward the River Bure, starting in the 1% AEP event.	✓				This settlement is not shown to be located within reservoir inundation extents.	8
Wymondham	Flood Zones show the fluvial flood risk in Wymondham is associated with the River Tiffey that flows to the south of the town, and its tributaries. A number of properties in the vicinity of London Road at the White Horse Street junction are shown to be within the Flood Zone 2 extent. Flood risk from a number of watercourses in the north east of the town are not shown in the Environment Agency's Flood Zones.	None	Mapping shows that the town is at risk from surface water in small pockets in the 3.3% AEP event largely restricted to gardens, open spaces and the road network. In the 1% AEP event, overland flow routes and significant ponding is beginning to affect the property in the vicinity of Applegarth and Choseley Crescent South Norfolk Council have reported that properties along Folly Road, Norwich Common and Spinks Lane have been affected by surface water flooding, during historic events. Section 19 reports have recorded flood incidents along Station Road, due to surface water and exceedance of the drainage system.	✓	✓	✓	✓	This settlement is not shown to be located within reservoir inundation extents.	5
Diss	Flood Zones show the fluvial flood risk in Diss is associated with the River Waveney that flows to the south of the town. A number of properties between Rose Lane and Stuston Road are shown to be within the Flood Zone 3 extent. Further properties to the north Ling Road, south of Victoria Road, in the vicinity of Rose Lane, in the vicinity of London Road/ Whitehorse Street junction are shown to be within the Flood Zone 2 extent. Flood risk from a number of watercourses within the town are also not shown in the Environment Agency's Flood Zones.	None	Mapping shows that the town is at risk from surface water however it is mostly confined to gardens and the road network as well as the floodplain of the existing watercourse. There is significant flooding to property from overland flow routes originating from the vicinity of Mount Street and extending in a south-east direction towards Victoria street and then the River Waveney. This however only becomes prominent in the 0.1% AEP event.	✓	✓	✓	✓	This settlement is not shown to be located within reservoir inundation extents.	8

Settlement	Fluvial \ tidal 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%		
Harleston	The fluvial flood risk is Harleston is associated with the unnamed watercourse described as a drain to the north of the settlement. The watercourse itself is a tributary of the River Waveney. Properties are shown to be within Flood Zone 3 in the north east of the settlement, centring on Nelson Close.	None	Mapping shows that the town is at risk from surface water however it is mostly confined to gardens and the road network up as well as the floodplain of the existing watercourse until the 1% AEP event. In the 0.1% AEP surface water flooding is widespread but in particular is shown to inundate properties adjacent to London Road and Redenhall Road. South Norfolk Council have reported that: • properties along Broad Street and London Road can be affected by surface water flooding; • properties and businesses along the Thoroughfare can be affected by surface water flooding; and, • the foul sewer can surcharge during storm events in Redehall.	✓				This settlement is not shown to be located within reservoir inundation extents.	8
Loddon and Chedgrave	Flood Zones show the fluvial flood risk in Loddon and Chedgrave is associated with the River Chet which flows between the two settlements. Meanwhile Loddon is also at risk of fluvial flooding from an unnamed watercourse, described as a drain that is a tributary of the River Chet. Properties within the vicinity of unnamed watercourses are shown to be within Flood Zone 3 and 2 extents around Reeds wat, Brownes Grove and Beccles Road. Meanwhile properties in the vicinity of Wherry Close and Pits Lane in Chedgrave and off Bridge Street in Loddon are shown to be within Flood Zone 3 and 2. Interaction between the River Chet and the unnamed watercourses has the potential to cause meanwhile high levels in either of the main watercourses may prevent the tributaries from effectively discharging, causing them to back up and overtop.	None	Mapping shows that the risk from surface water is largely confined to the watercourses however in the 1% AEP event overland flow routes develop that are shown to inundate properties in the vicinity of Bridge Street in Chedgrave and it is mostly confined to gardens and the road network up until the 1% AEP event. In the 0.1% AEP surface water flooding is widespread but in particular is shown to inundate properties adjacent to London Road and Redenhall Road. In Loddon meanwhile, properties in the vicinity of the High Bungay Road Low Bungay Road junction and those in the north west of the settlement around Filbert Road are the worse affected but really only in the 0.1% AEP.	✓				These settlements are not shown to be located within reservoir inundation extents.	0
Cantley	Flood Zone mapping shows fluvial flood risk to the settlement of Cantley stems from the River Yare that flows to the south of the village, with additional risk associated with its tributaries. The properties at risk of flooding are largely situated in the south of the village. There is also the risk of high levels in the River Yare preventing the tributaries in the vicinity of Cantley from discharging causing it to back up and exacerbate flooding in the village. Tidal surges affected Cantley in 1976 and Cantley Marshes in November 2006.	None	Mapping shows surface water flood risk in Cantley consists mainly of pockets of water ponding on roads and in gardens and other open spaces throughout the village. In the 0.1% AEP event, a number of properties to the west of Church Road are shown to be at risk of surface water flooding.	✓				This settlement is not shown to be located within reservoir inundation extents	5 (Acle, Cantley and Halvergate)

Settlement	Fluvial \ tidal 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%		
Reedham	Flood Zone mapping shows fluvial flood risk to the settlement of Reedham stems from the River Yare that flows to the south of the village, with additional risk associated with its tributaries. The combined flood extents surround the village to the south, east and west and inundate properties on all three sides. The greatest risk of flooding is in the region of Ferry Road/Station Road, Riverside and Church Dam. High levels in the River Yare prevent the tributaries in the vicinity of Reedham from discharging, causing it to back up and exacerbate flooding in the village.	None	Mapping shows surface water flood risk in Reedham consists mainly of pockets of water ponding on roads and in gardens and other open spaces throughout the village. Even in the 0.1% AEP event flooding is generally shown not to be affecting properties beyond a few isolated cases.	✓				Properties in Reedham are not shown to be located within reservoir inundation extents. However, certain roads (e.g. Ferry Road) and the train line to the west of Reedham is shown to be location within the inundation extent of North Lake Cantley Reservoir.	0
Coltishall and Horstead	Flood Zones show the fluvial flood risk in Coltishall and Horstead is associated with the River Bure which flows through the middle of the settlement in a generally north west to south east direction. In addition, there are a number of tributaries of the River Bure that have the potential to present a flood risk, not all of which are shown to have been modelled based on the Flood Zones. A number of properties to the east of Causeway Drive are shown to be within Flood Zone 3 meanwhile additional properties off the High Street, Norwich Road, St Margaret's Close and Wroxham Road are shown to be within Flood Zone 2. High levels in the River Bure prevent the tributaries in the vicinity of Reedham from discharging, causing it to back up and exacerbate flooding in the village. Fluvial flooding can be exacerbated in the upper reaches of the catchment, due to mill structures restricting the flow (i.e. in Horstead).	None	Mapping shows surface water flood risk in Coltishall and Horstead consists mainly of pockets of water ponding on roads and in gardens and other open spaces throughout the village. In the 0.1% AEP event extents are shown to be worst in the Horstead area.	✓	✓			These settlements are not shown to be located within reservoir inundation extents.	2
Buxton	Flood Zone mapping shows fluvial flood risk to the settlement of Buxton stems from the Camping Beck (also known as Hevingham watercourse) that flows through the village in a north-eastern direction, with additional risk associated with its tributaries. Properties along Levishaw Close, Bulwer Road and Brook Street and Drake Loke and Mill Reach are all shown to be within Flood Zone 3. High levels in the Hevingham watercourse could prevent the tributaries in the vicinity of Buxton from discharging causing it to back up and exacerbate flooding in the village.	None	Mapping shows surface water flood risk in Buxton consists mainly of pockets of water ponding on roads and in gardens and other open spaces throughout the village. However, in the 0.1% AEP event flooding is shown to affect a number of properties adjacent to the Camping Beck throughout the settlement.		✓	✓		The eastern peripheries of Buxton are shown to be at risk if the Great Water and Saw Mill Pond Reservoir were to fail.	2

Settlement	Fluvial \ tidal 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%		
Lenwade	Flood Zone mapping shows fluvial flood risk to the settlement of Lenwade stems from the River Wensum that flows through the settlement originally in a northern direction and then in a eastern direction, as well as the Blackwater that flows to the north of the settlement until its confluence with the River Wensum. In addition, there are several tributaries of both watercourses in the vicinity of the site. Properties in the vicinity of Mill Lane in particular are shown to be within the fluvial flood extents. Interaction between the two main watercourses has the potential to cause flooding around their confluence; meanwhile, high levels in either the River Wensum or the Blackwater may prevent the tributaries from discharging, causing them to back up and overtop.	None	Mapping shows the location of the surface water risk tends to correspond with the location of the watercourses flowing through the village and their adjacent floodplains. There is additional surface water ponding in gardens and on the road network. Even in the 0.1% AEP event flooding is generally shown not to be affecting properties beyond a few isolated cases.		✓	✓		Properties in Lenwade are not shown to be located within reservoir inundation extents. However, certain roads (e.g. Heath Lane), to the north of the settlement, are location within the inundation extent of Church Farm Booton Reservoir. .	4 (Lyng, Lenwade, Easton, Hoiningham)
Mulbarton	Fluvial flood risk to Mulbarton stems from two unnamed watercourses described as drains, one flows along the west of the town another flows through the centre in a north-west direction. Whilst the western watercourse is shown to remain confined largely to its floodplain the central watercourse is shown to affect properties in several streets including Birth Gardens, Lakes Avenue, Brindle Drive and Forge Orchards. South Norfolk Council have reported that fluvial flooding can affect properties along Birchfield Gardens, Long Lane and Norwich Road.	None	Mapping shows surface water flood risk in Mulbarton consists mainly of pockets of water ponding on roads and in gardens and other open spaces throughout the village. In the 0.1% AEP event, a significant overland flow route is shown to develop in the vicinity of Pightle Close and flow in a north-west direction towards Forge Orchards affecting a number of properties along the way. South Norfolk Council have reported that surface water flooding can affect properties along Long Lane.	✓				This settlement is not shown to be located within reservoir inundation extents.	0
Long Stratton	Flood Zone Mapping shows that Long Stratton is located in Flood Zone 1. Several un-named drains / watercourses flow through / adjacent to the settlement which are not included in the Environment Agency's Flood Zone 2 and 3 coverage. These un-named drain / watercourses could present a fluvial flood risk.	None	Mapping shows the location of the surface water risk tends to correspond with the location of the un-named drains / watercourses; these are quite prominent flow paths and extents are shown to affect properties during the 0.33% AEP event. There is also an overland flow route leading from the Long Stratton Mill / Mill Road area towards Norwich Road. South Norfolk Council have reported that • there is a surface water flow path along The Street, Start Lane and Swan Lane which has affected properties in Glebe Close and St. Mary's Road; and, • there is the potential for sewers to surcharge in Long Stratton, due to surface water flooding. Section 19 reports indicated that Glebe Close experienced flooding in March 2013 partly due to low capacity systems being exceeded.	✓				This settlement is not shown to be located within reservoir inundation extents.	0

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. 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 asset 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 the Greater Norwich area 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 Greater Norwich area 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.

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 Greater Norwich area 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 Greater Norwich area. A review of key Environment Agency assets across the Greater Norwich area and their condition is included in the following sections. There are no FSAs in the Greater Norwich area shown in the Environment Agency’s dataset.

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

7.2 Flood defences in the Greater Norwich area

7.2.1 The River Wensum at Norwich

There are a number of defences located along the River Wensum, within The Close area of Norwich, as shown in Figure 7-1. The defences comprise walls, embankments, demountable defences and flood gates. The defences are considered to be in very good, good or fair condition as illustrated in Figure 7-2.

Figure 7-1: EA defence type in Norwich

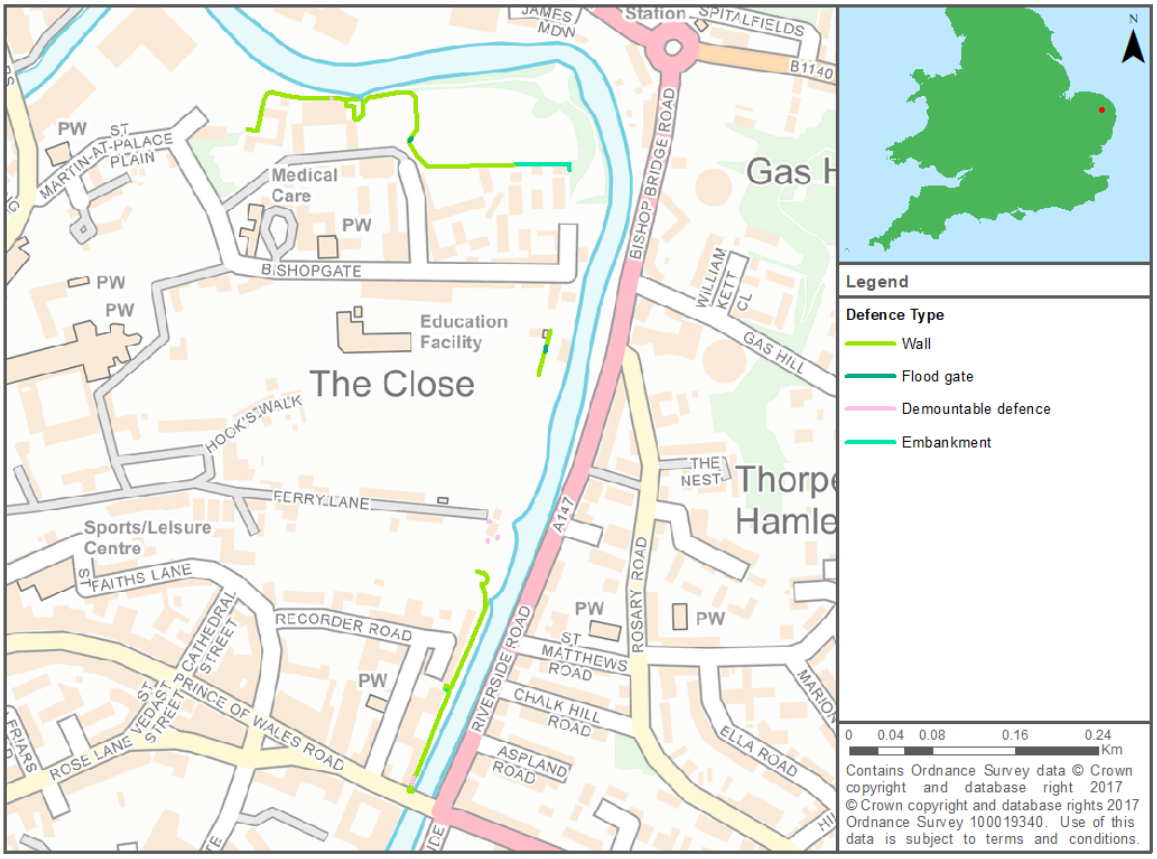
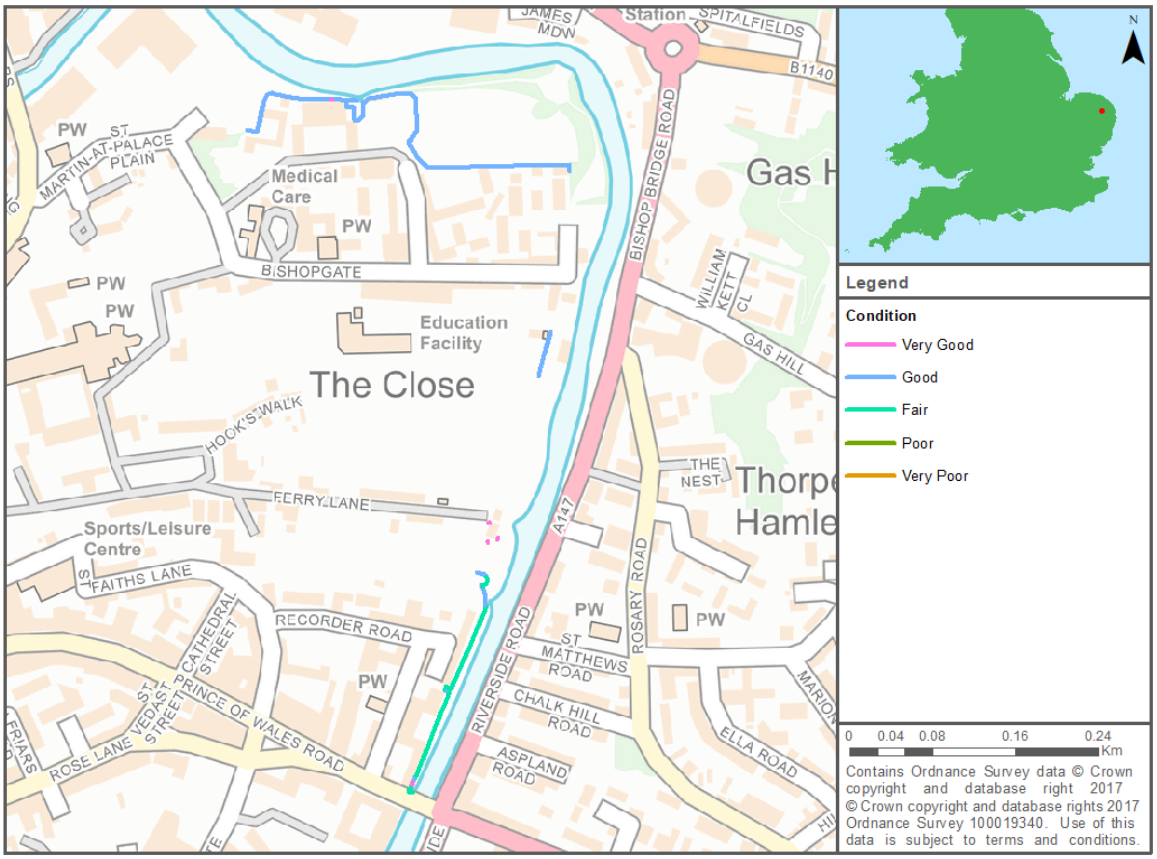


Figure 7-2: EA defence condition in Norwich



7.2.2 The River Bure at Buxton

A series of embankments are located along the River Bure, to the north of Buxton, as shown in Figure 7-3. These defences are in fair condition (see Figure 7-4)

Figure 7-3: EA defence type in Buxton

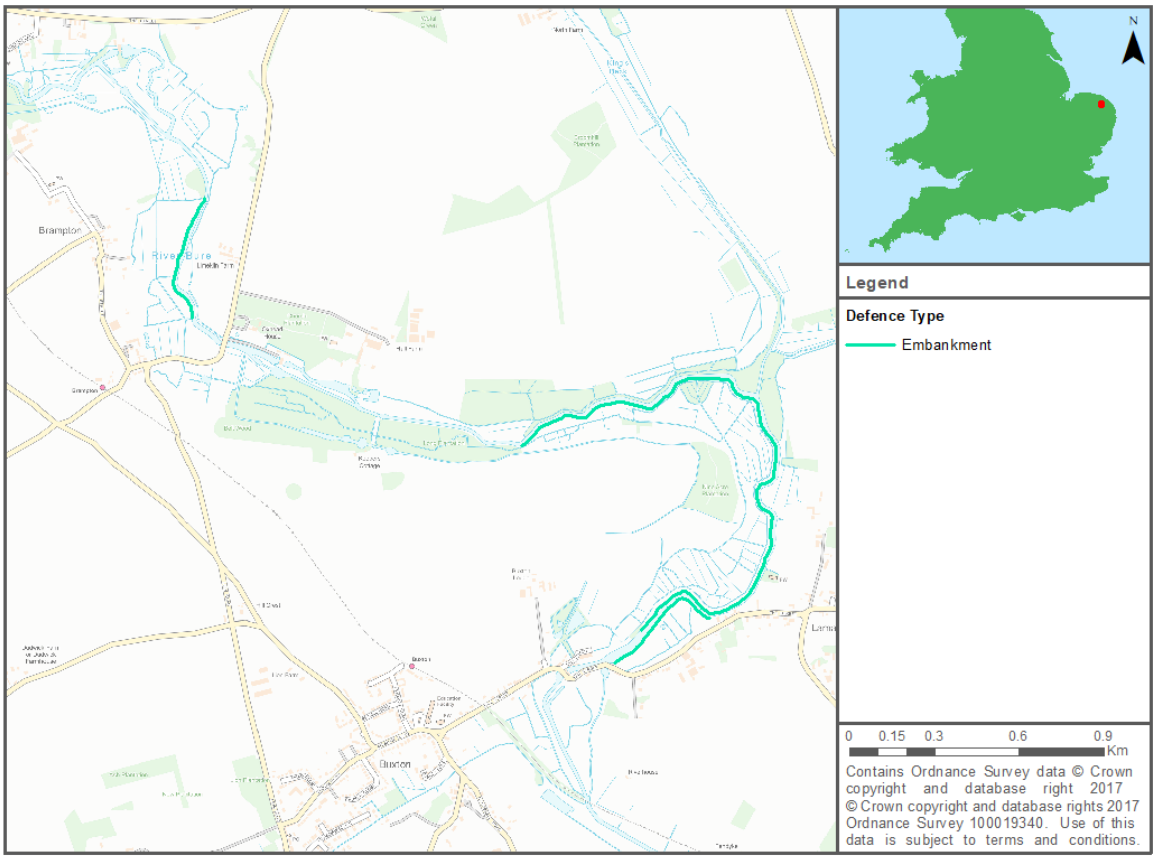
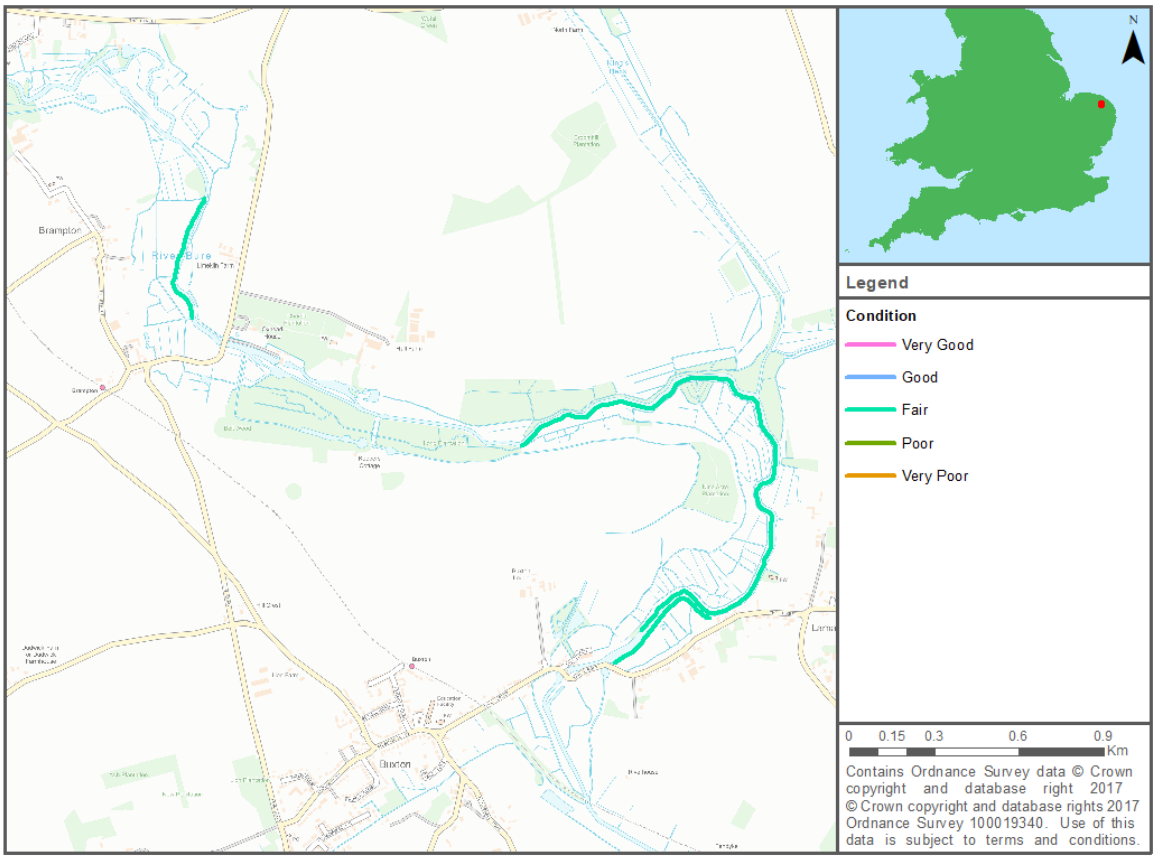


Figure 7-4: EA defence condition in Buxton



7.2.3 River Bure at Pilson Green

There are a series of embankment along the River Bure, to the north of Pilson Green, as shown in Figure 7-5. The defences are in poor condition (see Figure 7-6). Note: defences on the left bank of the River Bure are located outside of the SFRA study area.

Figure 7-5: EA defence type in Pilson Green

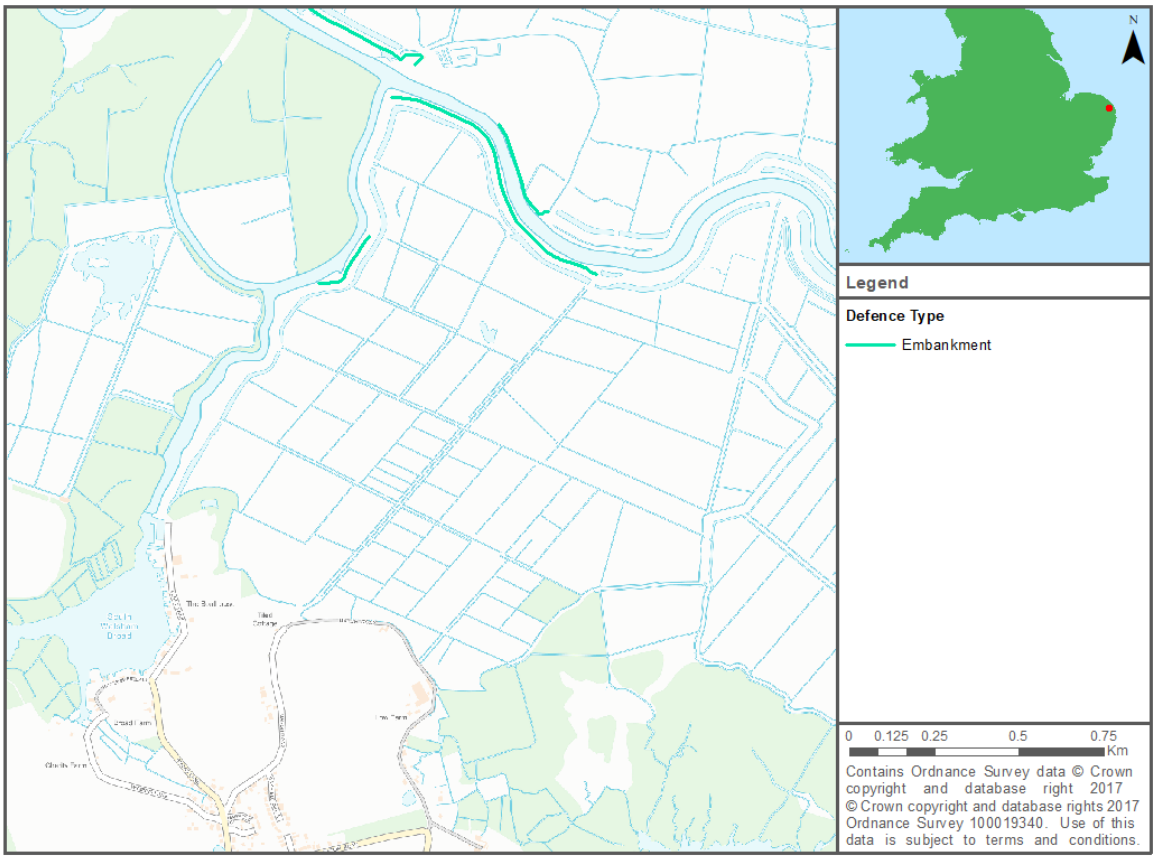
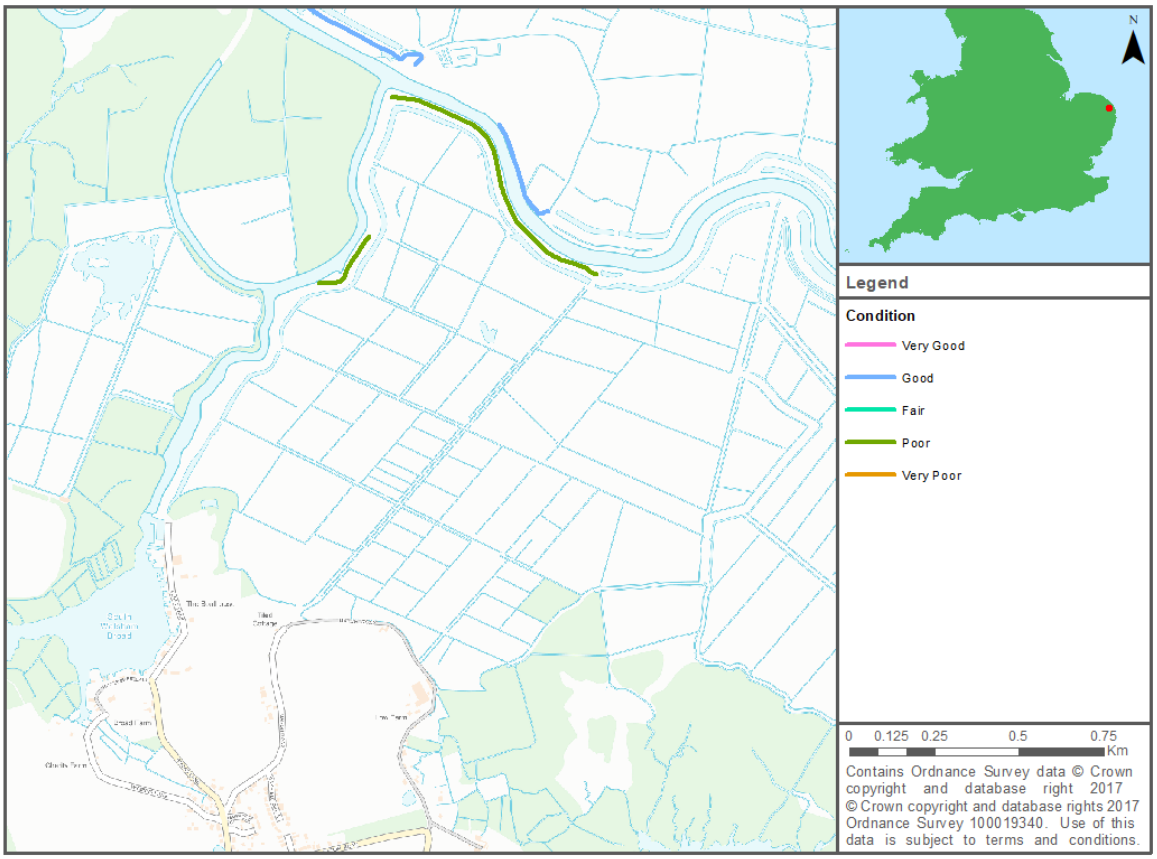


Figure 7-6: EA defence condition in Pilson Green



7.3 On-going flood alleviation schemes

7.3.1 Broadland Flood Alleviation Project

Part of the Greater Norwich area lies within the Broadland Flood Alleviation Project (BFAP). The BFAP is a long-term project to provide a range of flood defence improvements, maintenance and emergency response services within the Norfolk and Suffolk Broads. The BFAP contract was awarded by the Environment Agency in May 2001, to BAM Nuttall Ltd and CH2M (previously known as Halcrow Group Ltd) who work together in a joint venture capacity as Broadland Environmental Services Ltd (BESL). The contract will last until 2021.

The main purpose of the project is to provide a strategic approach to improving the level of flood protection in the Broadland area, while engaging key stakeholders and the local community, which is fundamental to achieving this objective. 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. Currently, the 240km of flood banks protect 1700 properties, 1000 of which are residential, and 24,000 Ha of agricultural land.

The project is divided into 40 hydrologically discrete flood compartments. The works improve the existing embankments through strengthening and restoring them to their 1995 height, while making allowances from climate change and settlement of the banks. Soke dykes, which are linear ditches, are found behind the flood banks. The Soke dykes provide many benefits including counterbalancing the weight of the bank, a source of clay for bank improvements, an integral part of the marshland drainage system and serve as a habitat for flora and fauna.[24]

The BFAP benefits areas surrounding the River Thurne, the River Bure, the River Yare and their surrounding tributaries.

The asset data provided by the EA was divided in to the Broads BESL 1 and the Broads BESL 2.

24 CIRIA (2011) Broadland flood alleviation project

Broads BESL 1

Embankments lie along several sections of the banks of the River Bure; a quay is located in the Upton area and a wall is located to the south-east of Damgate (see Figure 7-7). The assets along the River Bure are considered to be in a good, fair and poor condition (see Figure 7-8

Note: there are a number of defences in the Broads BESL 1 area shown in these figures which are located outside of the SFRA study area.

Figure 7-7: EA defence type in the Broads area BESL 1

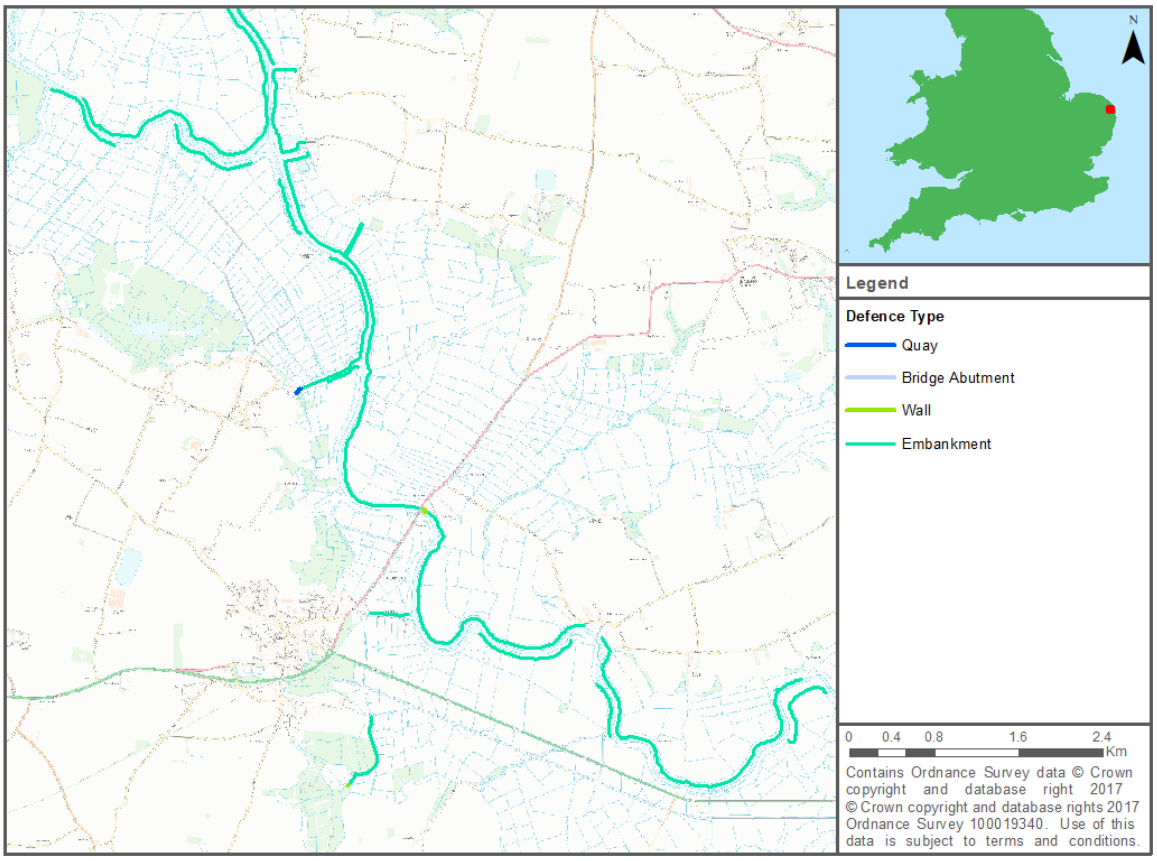
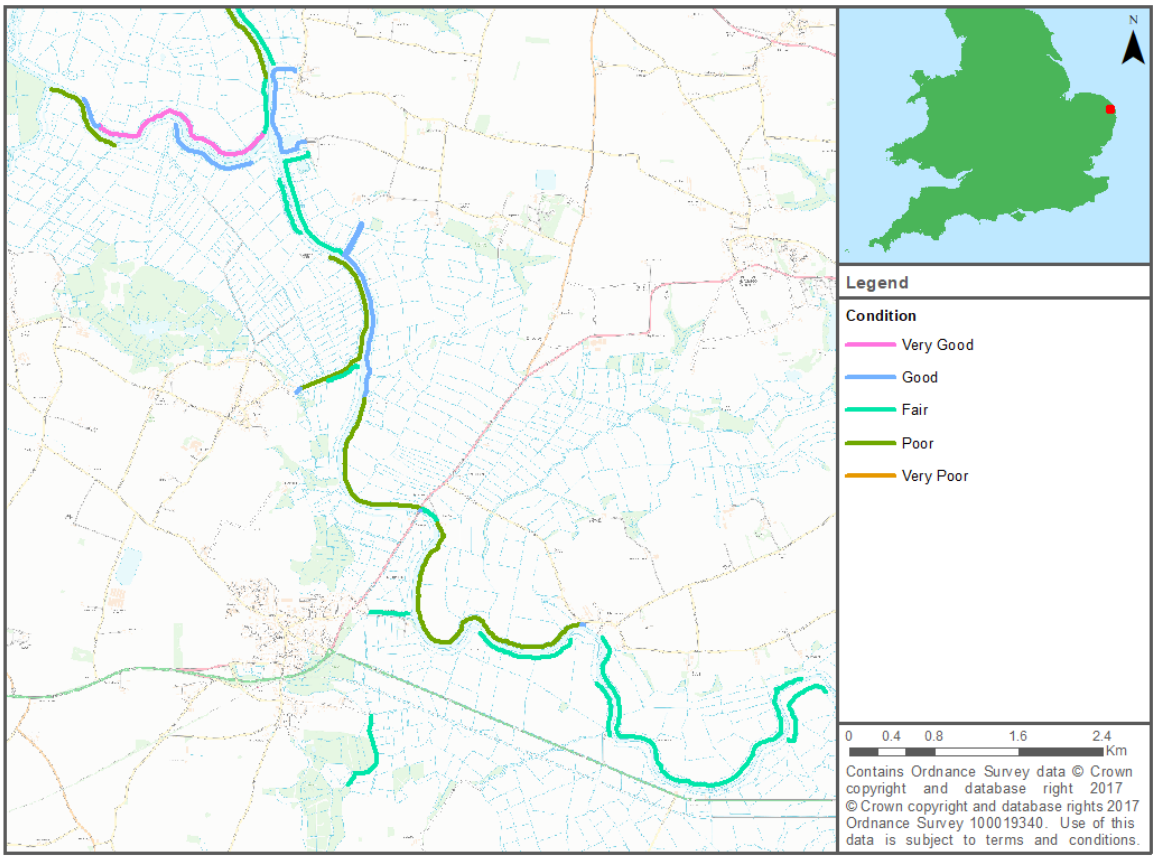


Figure 7-8: EA defence condition in the Broads area BESL 1



Broads BESL 2

The majority of the defences in the Broads BESL 2 area formed of embankments (see Figure 7-9). Flood walls are located in Reedham and close to the Rockland Broad. Figure 7-10 illustrates that the majority of the assets are considered to be in fair condition. A number of assets along the tributaries of the River Yare are considered to be in a good or poor condition.

Note: there are a number of defences in the Broads BESL 2 area shown in these figures which are located outside of the SFRA study area.

Figure 7-9: EA asset type in the Broads area BESL 2

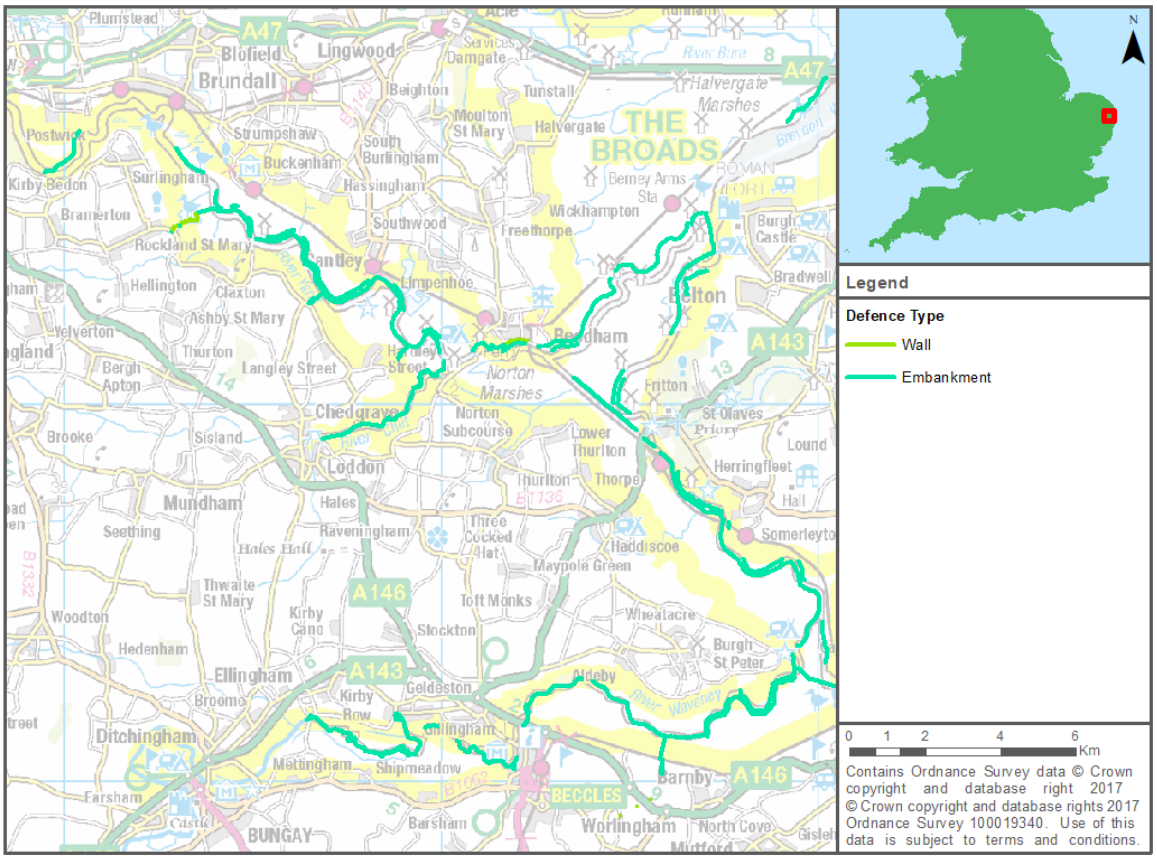
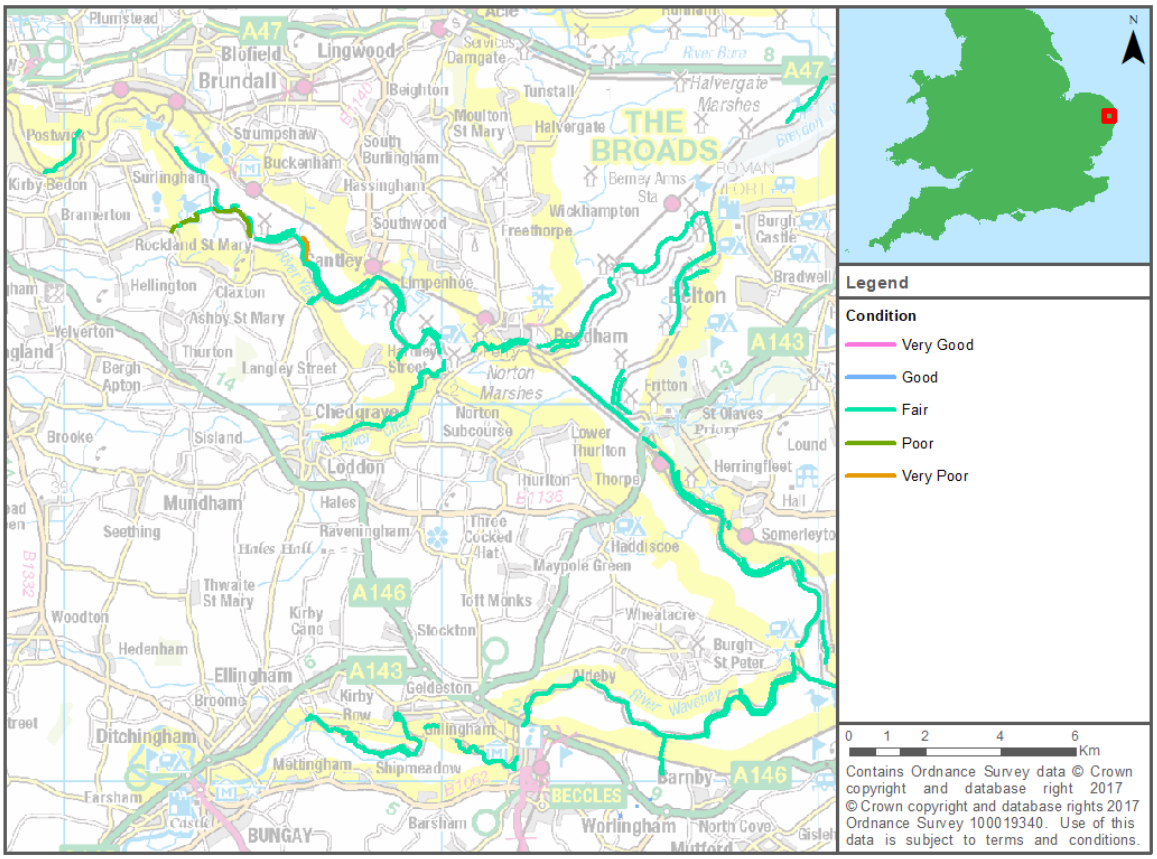


Figure 7-10: EA asset condition in the Broads area BESL 2



7.4 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 the Greater Norwich area 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.

7.4.1 Breach

Coastal breach modelling covering the Great Yarmouth coastline was completed in 2017, to gain an understanding of potential impacts of breach failure from coastal defences at Great Yarmouth town. Four breach locations were assessed. These are recorded in Table 7-2.

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

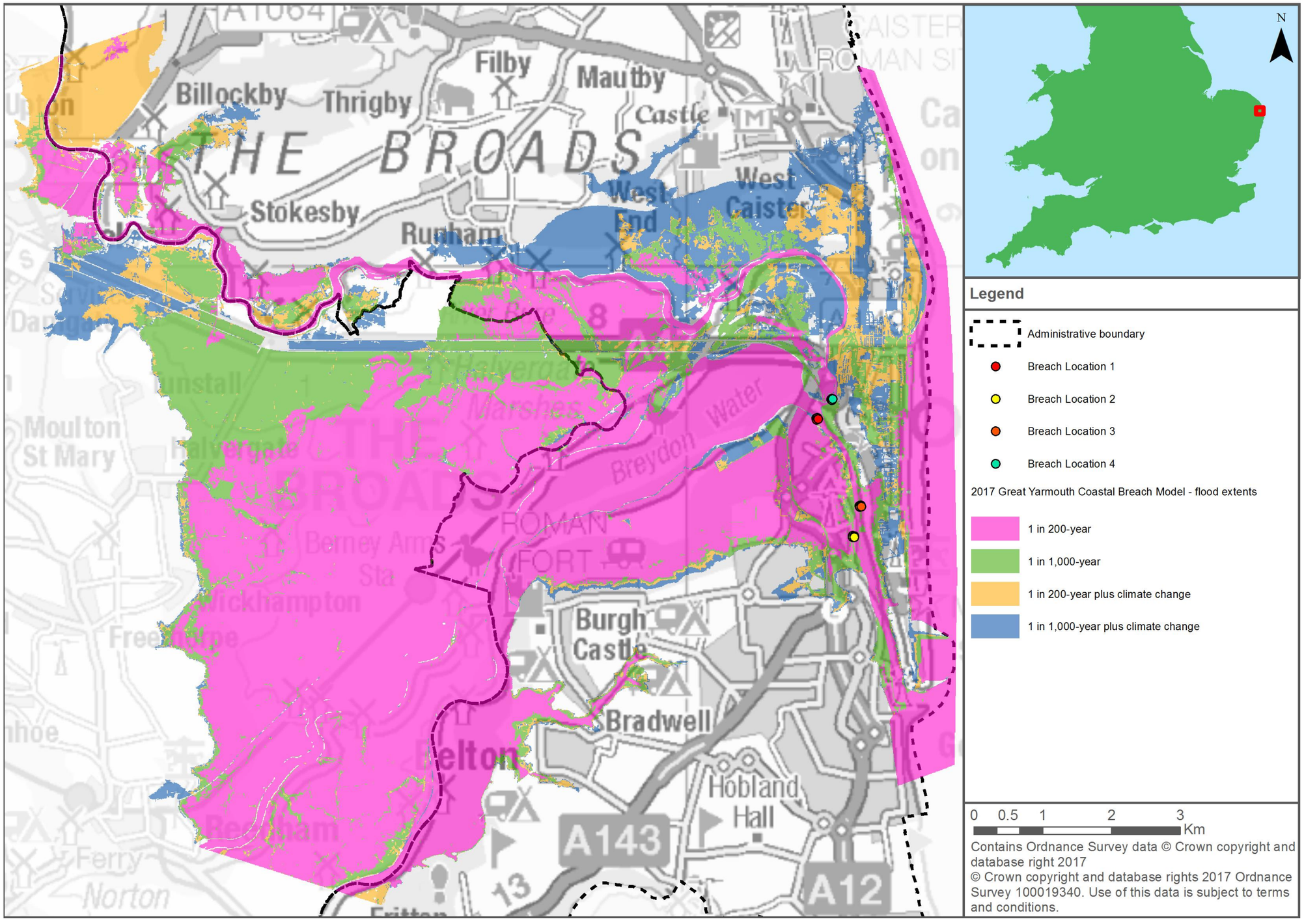
Breach	Location
1	Opposite Stone Road / Critten's Road, Great Yarmouth town, right bank of the River Yare, around the vicinity of the River Bure and River Yare confluence
2	Southtown Road, Great Yarmouth town, right bank of the River Yare
3	Opposite the A1243 Southgates Road, near Selby Place, Great 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

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 combined breach flood extents from all four breaches are displayed Figure 7-11. 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 whilst the Greater Norwich area is landlocked, breaches along defences in Great Yarmouth pose a risk, specifically to parts of South Norfolk Council, Broadland Council and the Broads Authority administrative areas. Norwich City Council's administrative area is not shown to be affected by the modelled breach flood extents. 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 7-11: 2017 Norfolk coastal breach modelling at Great Yarmouth



7.4.2 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 Greater Norwich area. 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 a Flood Risk Assessment (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 an IDB area.
- 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 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 the Greater Norwich area 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 (PPG, 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. These documents are available from: **https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers**

The updated BESL model was not available at the time of preparing this SFRA and as such, associated climate change modelled extents were not mapped. At such locations developers should undertake further investigations as part of a site-specific Flood Risk Assessment to ensure that fluvial climate change allowances are adequately considered. The Environment Agency's Climate Change guidance note provides further information on the local precautionary allowances for potential climate change impacts, that can be used in basic assessments for areas covered by the BESL model, in 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 the Greater Norwich area. 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 has 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. Broadland District Council, Norwich City Council, South Norfolk 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, neighbouring LLFAs, such as Cambridgeshire County Council and 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 and 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)[25] 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 though 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:

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

Permanent barriers

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

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 flood proofing 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 habitat 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 9.2.2.

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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

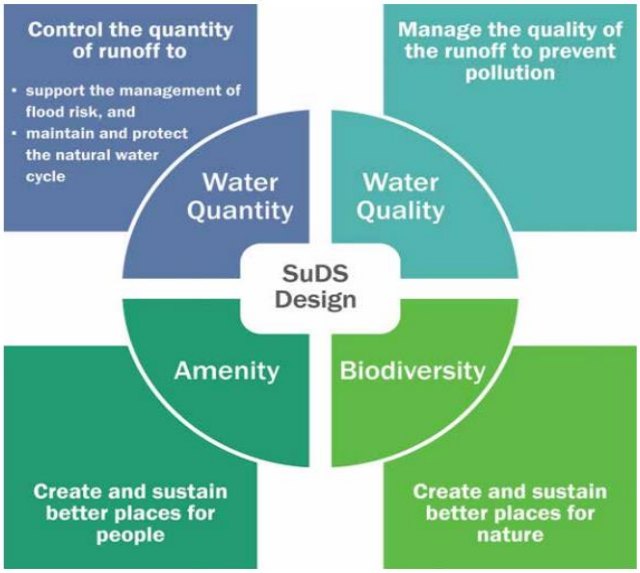
When considering planning applications, Broadland District Council, Norwich City Council, South Norfolk Council and the Broads Authority will seek advice from the relevant flood risk management bodies, principally Norfolk County Council (the LLFA) on the management of surface water, to satisfy themselves 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. Where appropriate, other authorities, such as IDBs, Anglian Water, the Environment Agency and the highways authority, may be consulted. 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 for 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 PPG 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 PPG 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 to 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.

Anglia 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 larger 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 the Greater Norwich area.

For proposed developments, geotechnical investigation 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.

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 (Groundwater 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:

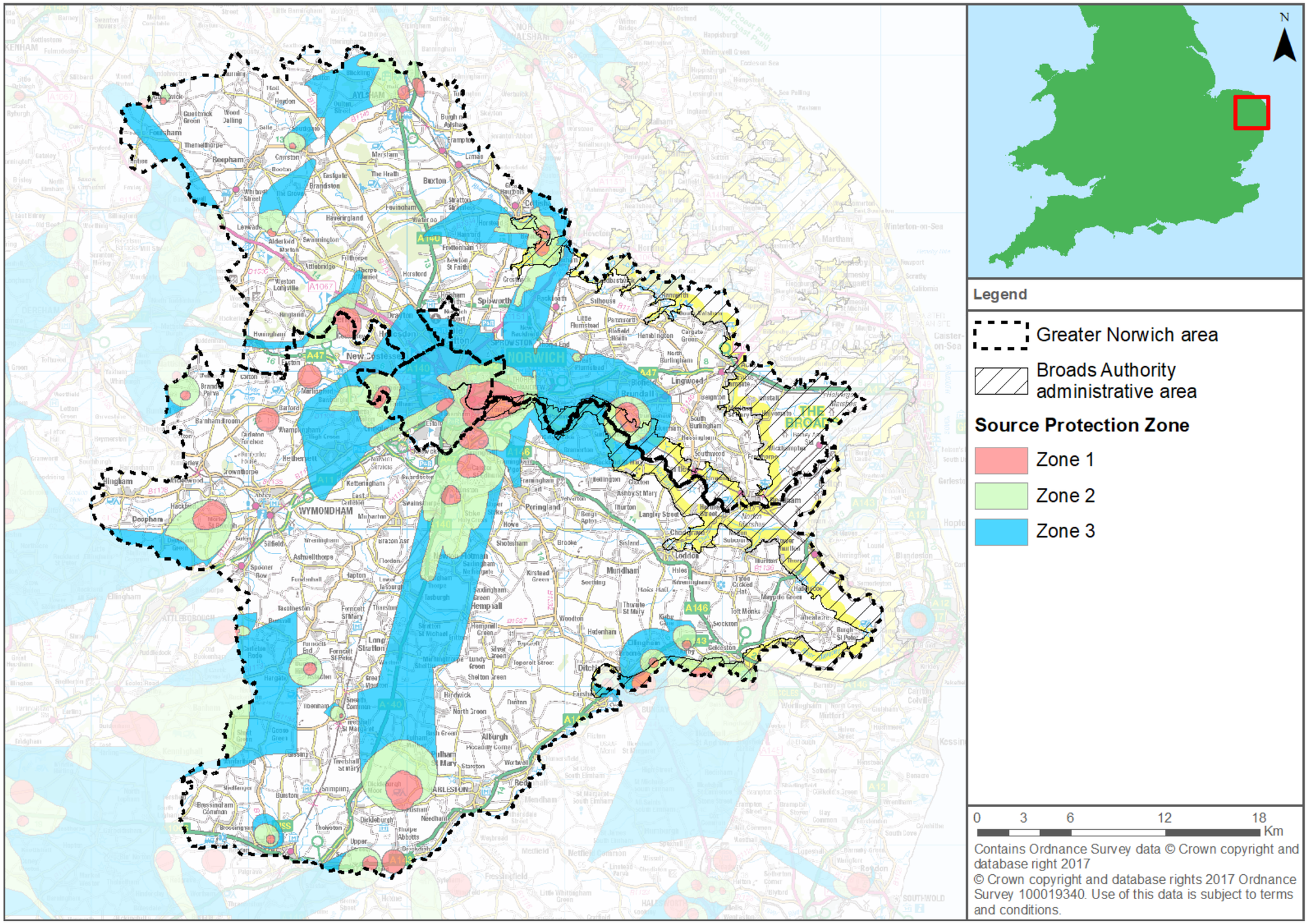
- Zone 1 (Inner Protection Zone) – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- Zone 2 (Outer Protection Zone) – Also sensitive to contamination: defined by a 400-day travel time from a point below 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.

A number of Groundwater SPZs have been identified throughout the Greater Norwich area with the locations of the Groundwater SPZs shown in Figure 9-2. Further, Figure 6-2 shows that much of the Greater Norwich area is underlain entirely by a Principal aquifer; 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 lie within or close to Groundwater Source Protection Zones (Groundwater SPZs) or are underlain by an aquifer, treatment steps may be required ahead of discharge to the ground, sewers etc. 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.

Where development is located in a SPZ, it is recommended that consultation with the relevant stakeholders (e.g. the EA for pollutant matters and the LLFA for SuDS) is undertaken as early as possible.

Figure 9-2: Location of Groundwater Source Protection Zones in the Greater Norwich area



9.4.2 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:

- Groundwater NVZ – water held underground in the soil or in pores and crevices in rock, which has or could have if action is not taken, a nitrate concentration greater than 50mg/l.
- Surface water NVZ – areas of land that drain into a freshwater water body which has, or could have if action is not taken, a nitrate concentration greater than 50mg/l.
- Eutrophic NVZ – bodies of water, mainly lakes and estuaries, that are, or may become, enriched by nitrogen compounds which cause a growth of algae and other plant life that unbalances the quality of the water and to organisms present in the water.

One Groundwater NVZ covers the entire Norwich City area and extends to the north and south covering much of the Broadland District and South Norfolk. Additionally, two further groundwater NVZs lie within the west of the Broadland District.

Seven surface water NVZs occupy or partially occupy the majority of South Norfolk, with one surface water NVZ extending into the Broadland District and a further surface water NVZ extending into Norwich City.

One Eutrophic NVZ lies in the north-east of South Norfolk, with two eutrophic NVZ identified in the centre and north-west of the Broadland District.

The majority of the Broads Authority administrative area is covered by a NVZ; either a groundwater, surface water or eutrophic NVZ.

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

As with Groundwater SPZs, NVZs could affect the suitability of surface water drainage features and the level of treatment required.

9.5 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 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 9-3 and Figure 9-4. This indicates that the vast majority of the Greater Norwich area is underlain by soils which are permeable and suggests that infiltration techniques, which are at the top of the drainage hierarchy (NPPF NPPG Paragraph 080, Reference ID: 7-080-20150323) may be suitable across much of the Greater Norwich area. However, depending on the proportion of clay in the soil, infiltration techniques may / may not be suitable 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, groundwater SPZs (see Section 9.4), the gradient of the local topography and primary source of runoff etc. When considering groundwater SPZs in Figure 9-2, infiltration may only be suitable where treatment measures are provided, prior to any discharge to surface or groundwaters. This is likely to be required across much of Norwich City and surrounding areas in Broadland District and South Norwich, particularly along the A140 corridor, due to the presence of groundwater SPZs in these areas.

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 the Greater Norwich area

General soil type	Description	Infiltration potential	Appropriate SuDS Techniques	Broadland District	Norwich City	South Norfolk	Broads Authority (in Greater Norwich area)
Sand and gravel	Crag Group	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.	✓ - found along the valleys of watercourses including the Rivers Bure and Yare	✓ - found along the valleys the River Wensum	✓ - found along the valleys the River Yare and the Beck	✓ - found along the valleys the River Yare and Bure
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.	✓ - found across large areas of Broadland District and largely associated with areas of high ground	✓ - found across large areas of Norwich City and largely associated with areas of high ground	✓ - generally found in hill side areas or along the headwaters of small tributaries to the Rivers Waveney, Yare and Tiffey	✓ - found in sporadic locations along valleys of the Rivers Bure and Waveney.
Sand and gravel	River Terrace Deposits	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.	**X –** not found in Broadland District	**X –** not found in Norwich City	✓ - generally found along the valley of the Broome Beck and parts of the River Waveney valley	✓ - found in sporadic locations along valleys of the River Waveney.
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 of valleys of watercourses including the Rivers Bure, Tud, Wensum and Yare.	✓ - found at the bottom of River Wensum valley	✓ - found at the bottom of valleys of watercourses including the Rivers Tiffey, Yare, Tud, Tas and Waveney	✓ - predominant soil type across the Broads Authority administrative area in the Greater Norwich area, found at the bottom of valleys of watercourses including the Rivers Yare, Bure and Waveney
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.	✓- found across large areas of Broadland District and largely associated with areas of low ground	✓ - found to the north of Norwich City, around the airport and the New Sprowston areas	✓ - predominant soil type in South Norfolk Council, found across most the administrative area	✓ - found in sporadic locations along the watercourses including the Rivers Yare, Bure and Waveney

Figure 9-3: Soil Types in the Greater Norwich area – by general type (ROCK_D)

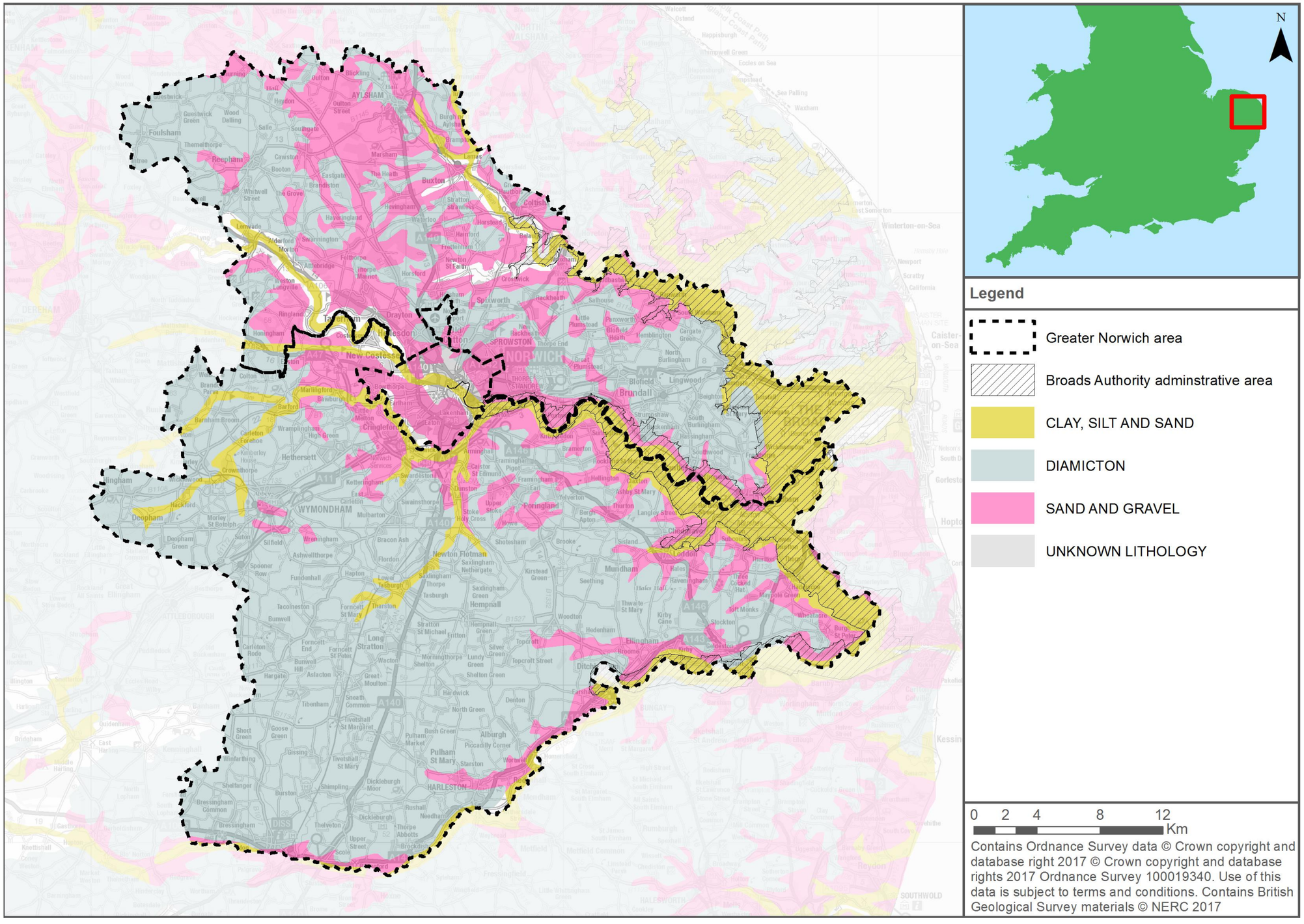
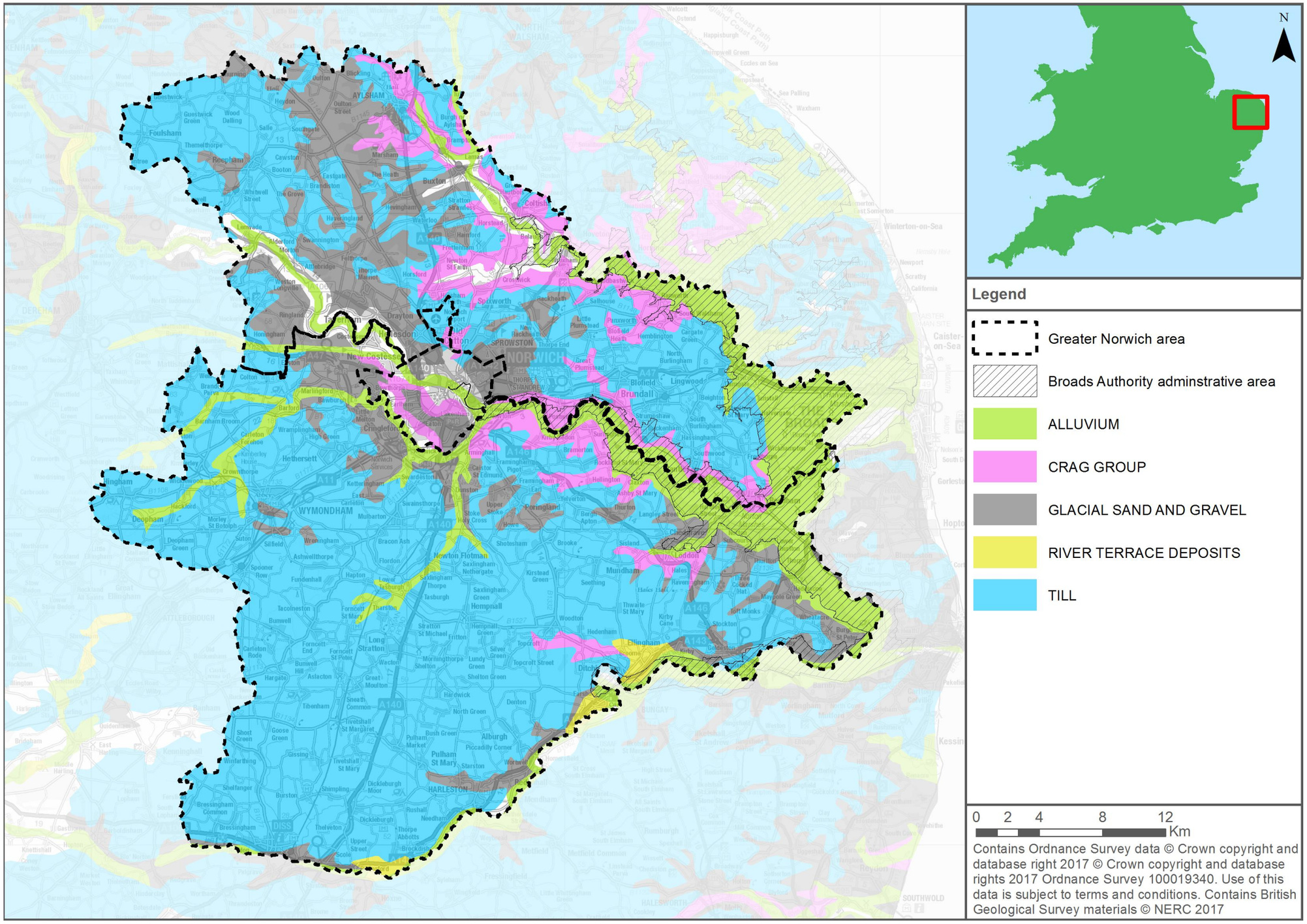


Figure 9-4: Soil Types in the Greater Norwich area – by description (LEX_D)



10 Strategic flood risk solutions

10.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the Greater Norwich area. As described in Section 2.7, the Greater Norwich area is covered by the **Broadland Rivers CFMP** and four policies apply to the area. These are:

- **Policy 2 – Fluvial Rivers.** Areas of low to moderate flood risk where generally there can be a reduction in existing flood risk management actions.
- **Policy 3 – Fluvial/Tidal Rivers and Tidal Broads and Buxton.** Areas of low to moderate flood risk where the existing flood risk is generally being managed effectively.
- **Policy 5 – Norwich.** Areas of moderate to high flood risk where generally further action can be taken to reduce flood risk.
- **Policy 6 – River Wensum.** 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.

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.**

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); and,
- 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[26]:

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

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

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 the Greater Norwich area could 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.

Site allocations that fall within the River Wensum Policy Unit in the CFMP would be an ideal area to consider flood storage schemes as the provision of flood storage would be consistent with the CFMP policy (Policy 6).

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. SuDS can also be retro-fitted to existing developments. The guidance produced by Defra and Norfolk County Council in their role 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 Greater Norwich area 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 connectivity to the floodplain; loss of floodplain connectivity in rural upper reaches of tributaries which flow through urban areas in the Greater Norwich area, could potentially increase flooding within the urban areas. It 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 Greater Norwich area are likely to have limited opportunity to restore floodplain in previously developed areas.

10.3.1 River Wensum Strategy

The consultation draft River Wensum Strategy[27] details the vision for regenerating and enhancing the River Wensum corridor, from Norwich City Council's boundary at Hellesdon in the west to Whitlingham Country Park in the east. The measures proposed under this strategy aim to provide multiple benefits, including improving the management of the river corridor, enhancing the natural and city environmental and green infrastructure and improving access to and use of the area.

Policy 13 under the strategy relates to proposed flood risk reduction measures. This has identified opportunities to consider how development and infrastructure planning for Norwich, can reduce the

27 Draft River Wensum Strategy, July 2017: https://www.norwich.gov.uk/downloads/file/4033/draft_river_wensum_strategy

risk of flooding and maximise habitat for key plants and animals. The design of new development and infrastructure along the river can change the profile of the banks, to encourage the creation of new features, where appropriate. New Mills has been identified as an area where this measure may provide benefits, such as flood risk reduction and improved habitat and biodiversity. The strategy provides further opportunities to review how changes to the river profile and additional flood storage areas can help to mitigate flood risk. The creation of additional storage along the river banks, especially if these are currently piled, is encouraged.

10.3.2 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.

10.3.3 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 spilling, 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.

10.3.4 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 Environment Agency flood assets has been undertaken as part of this SFRA. All 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 Greater Norwich area which are now redundant.

10.3.5 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 flood defences present within the Greater Norwich area (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 the Greater Norwich area.

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.

Greater Norwich Development Partnership Green Infrastructure Project (2007)

The aim of the **Greater Norwich Development Partnership Green Infrastructure Project** is to create a bold vision for the Greater Norwich area and to establish a strategy for green infrastructure

that will complement and support good quality housing and substantial economic growth by: providing high quality, accessible green infrastructure within a comprehensive landscape structure; promoting ecological networks and continuity and links between habitats; improving quality of life; helping to address climate change; improving access to habitats and greenspace; and encouraging community well-being.

- **Part one** of the Green Infrastructure Project examines existing Green Infrastructure provision in the Greater Norwich area.
- **Part Two** of the Strategy sets out a recommended approach and Action Plan that provides a framework for the co-ordinated delivery of Green Infrastructure by a range of partners in the Greater Norwich area.

The project identifies a multi-functional Green Infrastructure Network for the Greater Norwich area. Within the network, key areas are defined where investment in new and enhanced green infrastructure provision should be prioritised. The key areas are split into the following categories:

- **Sub-Regional Green Infrastructure Corridors**. These corridors broadly follow the proposed Green and Blue Ways that formed the Primary Sustainable Movement Network. They also generally follow significant wildlife habitat corridors that formed the proposed Ecological Network.
- **Local Green Infrastructure Corridors.** The Local Green Infrastructure Corridors link up to the Sub-Regional Green Infrastructure Corridors. They broadly follow the Pink Ways and Red Ways that formed the proposed Secondary Network of sustainable movement routes and also follow significant habitat corridors that formed the proposed Ecological Network.
- **Urban Area Green Infrastructure**. These routes demonstrate the priority given to achieving a connected network of green links within and between urban areas.
- **Targeted Environmental and Access Improvements in the Wider Countryside.** These improvements would complement and support the priority areas for investment within the overall Green Infrastructure Network, by focussing environmental land management schemes on addressing needs and opportunities identified for conserving and enhancing the open countryside.

Greater Norwich Green Infrastructure Delivery Plan (2009)

The Greater Norwich Green Infrastructure Delivery Plan built on the Greater Norwich Development Partnership Green Infrastructure Project and focused on the main areas of growth as identified in the emerging Joint Core Strategy at the time. The study area for the Delivery Plan focused on two key geographical areas, south west and north-east Norwich and how they connect into Norwich City. Through this process, the following five Green Infrastructure Priority Areas were identified:

- Five Rivers
- Wymondham to Norwich
- Water City – Rivers Yare and Wensum
- Long Station to Norwich
- Norwich to the Broads

Old Catton, Sprowston, Rackheath and Thorpe St Andrews Growth Triangle Area Action Plan (2016)

The **Growth Triangle Area Action Plan** aims to enable and co-ordinate sustainable strategic scale development to the north east of Norwich in accordance with the requirements of the Joint Core Strategy. Policy GT 2: Green Infrastructure states that sustainable drainage systems will be located and orientated to support the delivery of the identified primary and secondary corridors. Drainage strategies within the Growth Triangle should seek to utilise swales, filter strips and ponds/wetlands in preference of hard engineered solutions, as these are best placed to support biodiversity and improve water quality entering aquifers or watercourses.

Green Infrastructure is also considered in further Area Action Plans such as the **Long Stratton Area Action Plan** and the **Wymondham Area Action Plan**.

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 or IDB is required.

More information about riparian owner responsibilities can be found in the Environment Agency's **Living on the Edge**[28] publication.

28 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.

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 four 2017 Level 1 SFRAs to inform strategic planning decisions, the preparation of Local Plans and to inform development management decisions.

The 2017 Level 1 SFRA delivers a strategic assessment of risk from all sources of flooding in the Greater Norwich area. The Greater Norwich area covers Broadland District Council, Norwich City Council, South Norfolk Council and parts of the Broads Authority's administrative areas. This SFRA 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 Greater Norwich area, from a combination of sources. Prominent sources of flooding are fluvial, tidal and surface water. More recent events, investigated by the LLFA under Section 19 of the Flood and Water Management Act, indicates that flood events have been associated with exceedance of the capacity of the sewer network. Section 19 reports are available to download from Norfolk County Council's **website**.
- Fluvial flood risk within the Greater Norwich area is primarily associated with the River Yare, River Bure and River Waveney watercourses and their tributaries. Fluvial flooding can be exacerbated in the upper reaches of the catchment, due to mill structures restricting the flow. 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.
- Although the Greater Norwich area is landlocked, the 2009 Broadland Rivers CFMP notes that a significant proportion of policy sub-area 3 (Fluvial/Tidal Rivers and Tidal Broads), is located within the study area, where fluvial and tidal interactions influence flooding in the river network. In the east of the study area, along parts of the River Yare (downstream of Norwich) and across the Broads tidal levels are higher than fluvial levels in some places. Combined river and tidal flooding is known to sometimes affect settlements including Wroxham and Brundall whilst high tide levels combined with a storm surge can affect the Norfolk Broads in the east and south of the study area. Additional impacts of tidal influence include rivers not being able to flow freely at high tide. This can affect any locations up to the tidal limit of the rivers in the Greater Norwich area, potentially affecting settlements like Norwich and Wroxham.
- Watercourses in IDB districts are managed for water level and flood risk management. The Greater Norwich area is partially covered by the Waveney, Lower Yare and Lothingland IDB and the Water Management Alliance. The Water Management Alliance covers five IDBs; those in the Greater Norwich area include the Broads IDB and the Norfolk Rivers IDB. The IDB coverage is mapped in Appendix B. The 2009 Broadland Rivers CFMP also notes that the settlements of Wymondham and Aylsham are reliant on pumping stations to reduce the risk of flooding. 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** 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** and the Norfolk Rivers IDB **policy statement** states that the Boards 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 2012 **Surface Water Management Plan**, prepared for the Norwich urban area, has identified critical drainage issues at Catton Grove and Sewell, Nelson and Town Close and Drayton.
- Within Norwich city there are areas containing cavities in the underlying chalk strata. Water infiltration in the past has led to the collapse of these cavities resulting in subsidence. There may be limitations in the deployment of particular mitigation measures in areas characterised by this geology. There are a number of locations within South Norfolk identified as being at risk of groundwater flooding including: Poringland, Framingham Earl and Framingham Pigot. Within the Broadland area it is believed pumping from the IDB maintains the water table at a relatively lower level reducing the risk of groundwater flooding.
- 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 264 recorded flood incidents have been identified in the Greater Norwich area.
- There are no records of flooding from reservoirs impacting properties inside the study area.
- Currently there are nine Flood Alert Areas and 20 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. 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 assets throughout the Greater Norwich area. The assets comprise a mixture of embankments, quays, bridge abutments, demountable defences, flood gates and walls. The condition of these assets varies.

The Greater Norwich area lies partly 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.

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 51 dry islands in the Greater Norwich area. These are located in sporadic locations across the study area 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 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.

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, Shoreline Management Plans, LFRMS and the River Wensum Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management. Policy considerations have been referenced throughout the report.

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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 the Greater Norwich area.

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 the Greater Norwich area.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at a 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), inform the sequential approach within the site and prove, if required, whether the Exception Test can be passed.

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. 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 (PPG, 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. Broadland District Council, Norwich City Council, South Norfolk 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, neighbouring LLFAs such as Cambridgeshire County Council and 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 parts of the Greater Norwich area are at high risk of flooding from both fluvial and surface water sources. Therefore, proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. Broadland District Council, Norwich City Council, South Norfolk Council and the Broads Authority should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

The Broads Authority administrative area extends beyond the Greater Norwich area. As such, the Broads Authority should also use the information contained in the 2017 North Norfolk SFRA, the 2017 Great Yarmouth 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 Councils 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 Councils will consult the relevant statutory consultees as part of the planning application assessment and they should, in some cases, 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. 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**. Nicholson' 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**[29]. 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 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.**
- Where sites lie within or close to Groundwater SPZs or aquifers, treatment steps may be required ahead of discharge to the ground, sewers etc. 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).

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 Environment Agency's 2017 coastal breach modelling of the Norfolk coastline indicates that whilst the Greater Norwich area is landlocked, breaches along defences in Great Yarmouth

[29] 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.

pose a risk, specifically to parts of South Norfolk Council, Broadland Council and the Broads Authority administrative areas. Norwich City Council's administrative area is not shown to be affected by 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 an 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."**

It is recommended that emergency planners at the local authorities review the outputs of this 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).

12.1.9 Future flood management

There are on-going strategic schemes that are considering flood risk reduction measures in the Greater Norwich area. The consultation draft **River Wensum Strategy** details the vision for

regenerating and enhancing the River Wensum corridor, from Norwich City Council's boundary at Hellesdon in the west to Whitlingham Country Park in the east. The measures proposed under this strategy aim to provide multiple benefits, including improving the management of the river corridor, enhancing the natural and city environmental and green infrastructure and improving access to and use of the area. Policy 13 under the strategy relates to proposed flood risk reduction measures.

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 Greater Norwich area. 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, the Councils 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.

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 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 the Great Norwich area.

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

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.

12.2.2 Updates to SFRAs

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 the Greater Norwich area (historic flood extents are not included)
- Appendix B: Watercourses in the Greater Norwich area and coverage of IDB districts
- Appendix C: Flood Alert and Flood Warning coverage across the Greater Norwich area
- 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 the Greater Norwich area

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B Watercourses in the Greater Norwich area and coverage of IDB districts

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C Flood Alert and Flood Warning Coverage across the Greater Norwich area

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D Technical Summary

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