Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment

Final Report

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www.jbaconsulting.com

Babergh & Mid Suffolk District Councils
Endeavour House
8 Russell Road
Ipswich
IP1 2BX

JBA Project Manager

Lucy Archer-Lock BSc
JBA Consulting
Arlington House
Park Five
Harrier Way
Sowton
EXETER
Devon
EX2 7HU

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This report describes work commissioned by Matt Deakin, on behalf of Babergh & Mid Suffolk District Councils, by an email 1st July 2020. Lucy Archer-Lock and Phil Emonson of JBA Consulting carried out this work.

Prepared by .... Lucy Archer-Lock BSc

Analyst

Reviewed by .... Phil Emonson BSc MSc MCIWEM C.WEM MEPS

Technical Director

Purpose

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JBA Consulting has no liability regarding the use of this report except to Babergh & Mid Suffolk District Councils.

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JBA Consulting would like to thank Babergh & Mid Suffolk District Councils, the Environment Agency, Anglian Water and Suffolk County Council for their assistance with the preparation of this report.

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Executive summary

Introduction and Context

This Level 2 Strategic Flood Risk Assessment (SFRA) document undertakes a Level 2 assessment of site options identified by Babergh and Mid Suffolk District Councils. It builds upon the Level 1 SFRA completed in August 2020.

This Level 2 SFRA involves the assessment of 8 proposed development sites.

SFRA Objectives

The Planning Practice Guidance (PPG) advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

- Level One: where flooding is not a major issue in relation to potential development sites and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
- 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.

Level 2 SFRA Outputs

The Level 2 assessment includes detailed assessments of the proposed site options. These include:

- An assessment of all sources of flooding including fluvial flooding, surface water flooding, groundwater flooding, reservoir flooding, mapping of the functional floodplain and the potential increase in fluvial flood risk due to climate change.
- Reporting on current conditions of flood defence infrastructure, where applicable.
- An assessment of existing flood warning and emergency planning procedures, including an assessment of safe access and egress during an extreme event.
- Advice and recommendations on the likely applicability of sustainable drainage systems for managing surface water runoff.
- Advice on whether the sites are likely to pass the second part of the Exception Test with regards to flood risk and on the requirements for a site-specific FRA.

As part of the Level 2 SFRA, detailed site summary tables have been produced for the proposed sites, covering the above. To accompany each site summary table are mapped flood risk outputs.

Summary of the Level 2 SFRA

Babergh and Mid Suffolk District Councils (BMSDC) initially provided a list of 312 sites for review. These sites were screened against the following flood risk datasets to assess how many should be carried forward for Level 2 assessment:

- Fluvial flood zones
- The 100 year fluvial event with an allowance for climate change
- The Risk of Flooding from Surface Water map
- The proximity to a Main River or other watercourse

Of the 8 sites assessed in the Level 2 SFRA:

- 3 sites required detailed modelling and hydrological assessment to understand fluvial flood risk (SS0065, SS1198, SS1223)
- 2 sites required updating the existing River Gipping model to 1D-2D (SS0711, SS1223)
- 4 sites have existing fluvial modelling and required no additional flood modelling except running the latest climate change allowances (SS0264, SS0902, SS0668, SS0861).

Each site specific summary table produced sets out the flood risk to each site based on a range of flood risk datasets and the strategic or detailed flood modelling completed as part of this study. Each table sets out the NPPF requirements for the site as well as guidance for site-specific FRAs. A broadscale assessment of suitable SuDS options has been provided, giving an indication where there may be constraints to certain types of SuDS techniques. To accompany each site summary table, there are mapped flood risk outputs per site.

The following points summarise the Level 2 assessment:

- The majority of the sites assessed as part of this Level 2 SFRA are at fluvial flood risk. The degree of flood risk varies, with some sites being only marginally affected along their boundaries, and other sites being more significantly affected within the site. Sites significantly affected by fluvial flooding will require more detailed investigations to inform a sequential approach to site layouts, SuDS possibilities, safe access and egress etc, as part of a site specific Flood Risk Assessment taken forward by a developer.
- The majority of sites at fluvial risk are also at risk from surface water flooding, with areas of ponding in the higher return period events across some sites and the access roads surrounding them. Surface water tends to follow topographic flow routes, for example along the watercourses or isolated pockets of ponding where there are topographic depressions. Site SS0861 for example is at very low fluvial flood risk but has a large surface water flow path running through the site. The impact of surface water flooding sites such as this will need more detailed investigations undertaken as part of a site specific Flood Risk Assessment at a later stage.
- The modelling completed as part of this SFRA made allowances for the impact of climate change. For the 1 in 20, 100 and 1000-year events, the 2080s period was used, and 35% and 65% allowance categories were modelled. Modelling indicates that flood extents will increase as a result of climate change and therefore, the depths, velocities and hazard of flooding are also seen to increase. The increases seen are more significant on some sites compared to others. Site-specific FRAs should confirm the impact of climate change using latest guidance.
- Structures and culvert locations have been identified where the structure upstream, downstream or within the site could have an impact on flood risk. This impact of blockages on flood risk needs to be considered further as part of a site-specific FRA.

- For some sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles.
- A strategic assessment was conducted of SuDS options using regional datasets. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.

Table 1 - Sites Carried Forward to a Level 2 Assessment

Site Code	Site Name	Reason for Level 2; source of flood risk	Updated Flood Zones %*				Risk of flooding from surface water %		
			FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr
SS0065	Land south of Glebe Way, Mendlesham	Fluvial	1.4%	2.6%	5.8%	94.2%	1.8%	3.2%	16.5%
SS0264	Ashes Farm, Stowmarket	Fluvial Reservoir	7.3%	10.9%	12.0%	88.0%	1.1%	2.5%	11.6%
SS0668	Land south of Creeting Road West, Stowmarket	Surface water	0.0%	0.0%	0.0%	100%	5.2%	19.1%	55.6%
SS0711	Land east of Loraine Way, Sproughton	Fluvial	0.00%	0.05%	4.0%	96%	0.0%	0.0%	0.1%
SS0861	Land south of Church Lane, Claydon	Surface water	0.0%	0.0%	0.0%	100%	5.9%	11.2%	23.5%
SS0902	Land south of Low Road, Debenham	Fluvial, Surface Water, Groundwater	10.9%	15.3%	21.4%	78.6%	12.3%	16.9%	32.1%
SS1198	Land north of Laxfield Road, Stradbroke	Surface water, Fluvial	2.40%	6.90%	10.40%	89.6%	13.0%	16.6%	50.5%
SS1223	Land at Mill Lane, Stowmarket	Fluvial, Reservoir	10.40%	11.90%	14.00%	86%	2.8%	5.0%	15.0%

- *Flood Zones updated using latest modelling data; hence these may differ from the EA's Flood Map for Planning Flood Zones.
- The Flood Zone values quoted show the percentage of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone. For example: If 50% of a site is in the Flood Zones, taking each Flood Zone individually, 50% would be in Flood Zone 2 but say only 30% might be in Flood Zone 3a and only 10% in Flood Zone 3b. This would be displayed as stated above, i.e. the total % of that particular Flood Zone in that site. Flood Zone 1 is the remaining area of the site outside of Flood Zone 2, so Flood Zone 2 + Flood Zone 1 will equal 100%.

At the planning application stage and as part of a Flood Risk Assessment, developers will need to undertake detailed hydrological and hydraulic assessments of watercourses to verify flood extent, depth, velocity and hazard (including considering the latest **climate change allowances**), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.

For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the Exception Test. At planning application stage, the Developer must design the site so that it is flood resistant and resilient in line with the recommendations in National and Local Planning Policy and supporting guidance and those set out in this SFRA.

For developments that have not been allocated in the Local Plan, developers must undertake the Exception Test and present this information to the Local Planning Authority for approval. The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should look into in more detail to inform the Exception Test for windfall sites.

It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific Flood Risk Assessment and drainage strategies with both the Local Planning Authority and the LLFA, to identify any potential issues that may arise from the development proposals.

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Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
DTM	Digital Terrain Model
EA	Environment Agency
Exception Test	Set out in the NPPF, the Exception Test is 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.
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.
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).
FWA	Flood Warning Area

Term	Definition
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a 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.
Greenfield	Undeveloped parcel of land
Ha	Hectare
JBA	Jeremy Benn Associates
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
m AOD	metres Above Ordnance Datum
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NRD	National Receptor Database
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 for maintenance.
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.
ReFH	Revitalised Flood Hydrograph
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.
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.
SFRA	Strategic Flood Risk Assessment
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.
URBEXT	Urban extent catchment descriptor, describing the level of urbanisation in a catchment.

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

JBA Consulting were commissioned by Babergh and Mid Suffolk District Council to prepare a Level 1 Strategic Flood Risk Assessment (SFRA) in February 2020. Following on from this, a Level 2 SFRA was commissioned in July 2020, to provide detailed assessments of the Council´s preferred allocations.

This Level 2 SFRA will be used to inform decisions on the location of future development and the preparation of sustainable policies for the long-term management of flood risk.

This document should be considered in conjunction with the Level 1 SFRA (published in 2020).

1.2 Levels of SFRA

The **Planning Practice Guidance**[1] (PPG) identifies the following two levels of SFRA:

- **Level 1:** where flooding is not a major issue in relation to potential site allocations and where development pressures are low. The assessment should be of sufficient detail to enable application of the Sequential Test.
- **Level 2:** where land outside Flood Zones 2 and 3 cannot appropriately accommodate all 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 the requirements of a **Level 2** SFRA.

1.3 SFRA Objectives

The objectives of the Level 2 SFRA are to:

1 Screen preferred potential allocations to determine which sites are at the highest risk of flooding and require a detailed Level 2 assessment.
2 Provide individual flood risk analysis for site options using the latest available flood risk data.
3 Using available data, provide information and maps presenting flood risk from all sources for each site.
4 Consider the cumulative impact of development.

1.4 Context of the Level 2 assessment

The BMSDC Level 1 SFRA was undertaken by JBA Consulting in 2020. This report appraised flood risk from all sources.

JBA Consulting were provided with a list of preferred sites from BMSDC, which were screened against flood risk information to provide a summary of flood risk to each site. In total, 8 sites were identified as requiring Level 2 assessment. The sites assessed in the Level 2 SFRA are shown in Table 1-1.

1 Planning Practice Guidance – Flood Risk and Coastal Change - Paragraph: 012 Reference ID: 7-012-20140306

Table 1-1: Sites assessed in Level 2 SFRA

Site Code	Site Name	Site area (Ha)	Reason for Level 2; source of flood risk
SS0065	Land south of Glebe Way, Mendlesham	5.28	Fluvial
SS0264	Ashes Farm, Stowmarket	22.76	Fluvial Reservoir
SS0668	Land south of Creeting Road West, Stowmarket	0.88	Surface water
SS0711	Land east of Loraine Way, Sproughton	3.45	Fluvial
SS0861	Land south of Church Lane, Claydon	6.25	Surface water
SS0902	Land south of Low Road, Debenham	0.97	Fluvial, Surface Water, Groundwater
SS1198	Land north of Laxfield Road, Stradbroke	1.95	Surface water, Fluvial
SS1223	Land at Mill Lane, Stowmarket	78.95	Fluvial, Reservoir

1.5 Consultation

SFRAs should be prepared in consultation with other Risk Management Authorities (RMAs). The following parties, external to BMSDC, have been consulting during the preparation of the Level 1 and Level 2 SFRA:

- Environment Agency
- Anglian Water
- Suffolk County Council

1.6 How to use this report

Table 1-2 SFRA User Guide

Section	Contents	How to use
1. Introduction	Outlines the purpose and objectives of the Level 2 SFRA	For general information and context.
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.	Users should refer to this section, which directs to the Level 1 SFRA for any relevant policy which may underpin strategic or site-specific assessments.
3. Planning policy for flood risk management	Provides an overview of both national and existing Local Plan policy on flood risk management	Users should use this section to understand and follow the steps required for the Sequential and Exception Tests.
4. Impact of climate change	Outlines the latest climate change guidance published by the Environment Agency and how this was applied to the SFRA Sets out how developers should apply the guidance to inform site	This section should be used to understand the climate change allowances for a range of epochs and conditions, linked to the vulnerability of a development.

	specific Flood Risk Assessments	
5. Sources of information used in preparing the Level 2 SFRA	Summarises the data used in the Level 2 assessments and mapping	Users should refer to this section in conjunction with the summary tables and mapping to understand the data presented. Developers should refer back to this section when understanding requirements for a site-specific FRA.
6. Level 2 Assessment Methodology	Summarises the sites requiring Level 2 assessment and the outputs produced for each of these sites.	This section should be used in conjunction with the site summary tables and mapping to understand the data presented.
7. Flood risk management requirements for developers	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Refers to relevant sections in the L1 SFRA for mitigation guidance.	Developers should use this section to understand requirements for FRAs and what conditions/ guidance documents should be followed. Developers should also refer to the L1 SFRA for further information on flood mitigation options.
8. Surface water management and SuDS	An overview of any specific local standards and guidance for Sustainable Drainage Systems (SuDS) from the Lead Local Flood Authority. Refers back to relevant sections in the L1 SFRA for information on SuDS and surface water management.	Developers should use this section to understand what national, regional and local SuDS standards are applicable. Hyperlinks are provided. Developers should also refer to the Level 1 SFRA for further information on types of SuDS, the hierarchy and management trains information.
9. Cumulative impact of development and strategic solutions	Looks at the cumulative impact of development on flood risk for the River Gipping catchment and Debenham.	Planners should use this section to help develop policy recommendations for the sites specified.
10. Summary of Level 2 assessment and recommendations	Summarises the results and conclusions of the Level 2 assessment, and signposts to the L1 SFRA for planning policy recommendations.	Developers and planners should use this section to provide an overview of the Level 2 assessment. Planners should use this section to identify which potential site allocations have the least risk of flooding. Developers should refer to the Level 1 SFRA recommendations when considering requirements for site-specific assessments.
Appendix A: Level 2 Assessment - Site Summary Tables	Provides a detailed summary of flood risk for sites requiring a more detailed assessment. The section considers flood risk, emergency planning, climate change, broadscale assessment of possible SuDS, exception test requirements and requirements for site-specific FRAs.	Planners should use this section to inform the application of the Sequential and Exception Tests, as relevant. Developers should use these tables to understand flood risk, access and egress requirements, climate change, SuDS and FRA requirements for site-specific assessments. Planners and developers should use these maps in conjunction with the site summary tables to understand the nature and location of flood risk.

Appendix B: SS0065 modelling	Provides technical information on the model completed as part of this SFRA.	For technical background information.
Appendix C: SS1198 modelling	Provides technical information on the model completed as part of this SFRA.	For technical background information.
Appendix D: SS1223 modelling	Provides technical information on the model completed as part of this SFRA.	For technical background information.
Appendix E: Updated River Gipping modelling (SS1223 and SS0711)	Provides technical information on the model completed as part of this SFRA.	For technical background information.

Hyperlinks to external guidance documents/websites are provided in **green** throughout the SFRA.

Advice to users has been highlighted in **amber boxes** throughout the document.

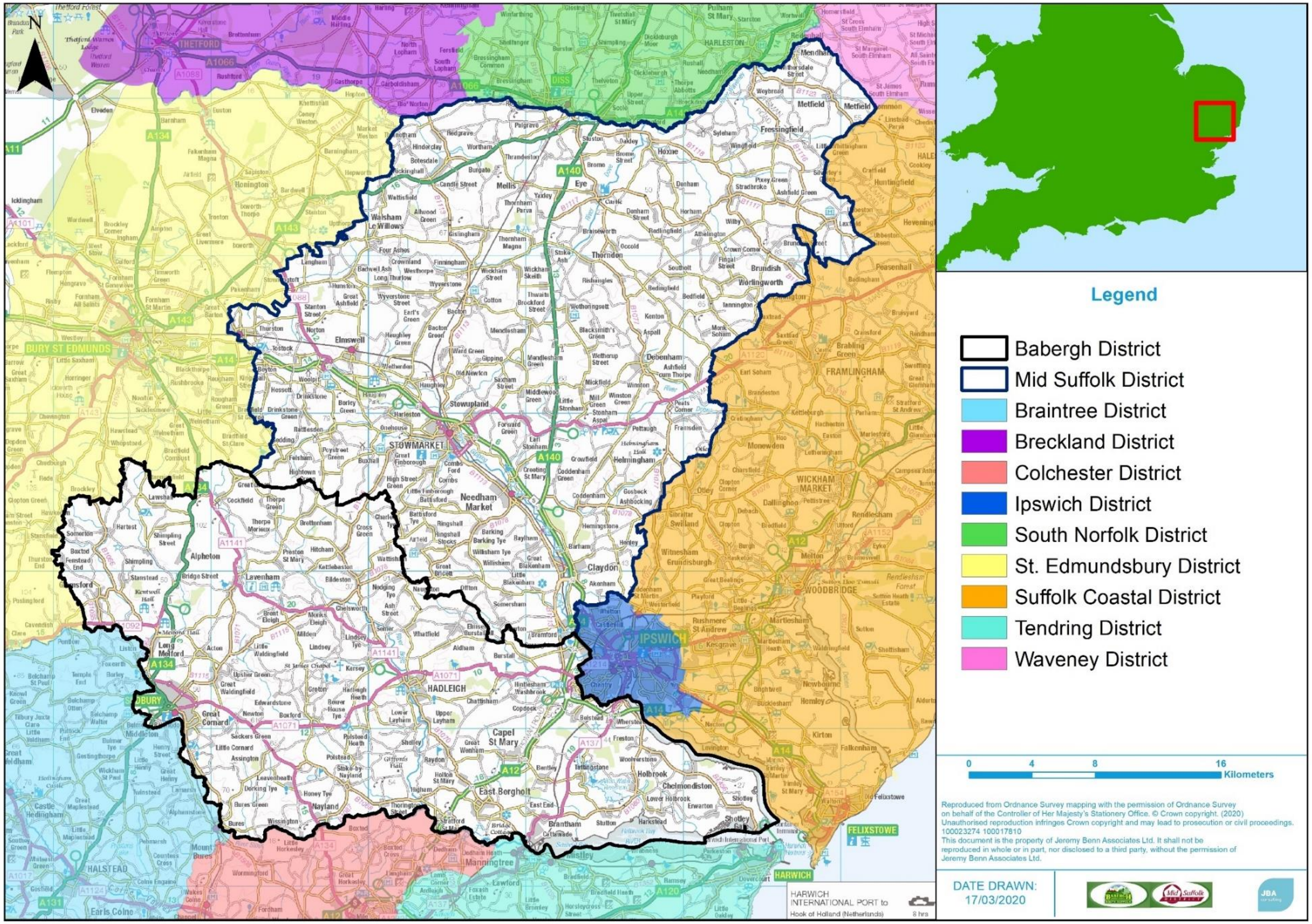


Figure 1-1: Study Area

2 The Planning Framework and Flood Risk Policy

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. Users should refer to section 2 of the Level 1 SFRA which provides an overview of the planning framework, flood risk policy and flood risk responsibilities, given the changes since the previous SFRA publications. In preparing the subsequent sections of this SFRA, appropriate planning and policy amendments have been acknowledged and taken into account.

SFRAs contain information that should be referred to in responding to the Flood Risk Regulations and the formulation of local flood risk management strategies and plans. SFRAs are also linked to the preparation of Catchment Flood Management Plans (CFMPs), Surface Water Management Plans (SWMPs) and Water Cycle Strategies (WCSs).

3 Planning Policy for Flood Risk Management

3.1 National Planning Policy Framework and Guidance

The revised National Planning Policy Framework (**NPPF**) was published in February 2019, replacing the 2012 version. The NPPF sets out Government's planning policies for England. It must be taken into account in the preparation of local plans and is a material consideration in planning decisions. The NPPF defines Flood Zones, how these should be used to allocate land and flood risk assessment requirements. The NPPF states that:

"Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards"

Planning Practice Guidance on flood risk was published in March 2014 and sets out how the policy should be implemented. **Diagram 1 in the NPPG** sets out how flood risk should be considered in the preparation of Local Plans.

3.2 The Risk Based Approach

The NPPF takes a risk-based approach to development in flood risk areas.

3.3 The Flood Zones

The definition of the Flood Zones is provided below. The Flood Zones do not consider defences. This is important for planning long term developments as long-term policy and funding for maintaining flood defences over the lifetime of a development may change over time.

The Flood Zones do not consider surface water, sewer or groundwater flooding or the impacts of canal or reservoir failure. They do not consider climate change. Hence there could still be a risk of flooding from other sources and that the level of flood risk will change over time during the lifetime of a development.

Table 3-1 Fluvial Flood Zone Summary

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 (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) as 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 (>1.0%) 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 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. SFRAs should identify this Flood Zone in discussion with the LPA and 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. Infrastructure must also not increase flood risk elsewhere.
		All developments in this zone require an FRA.

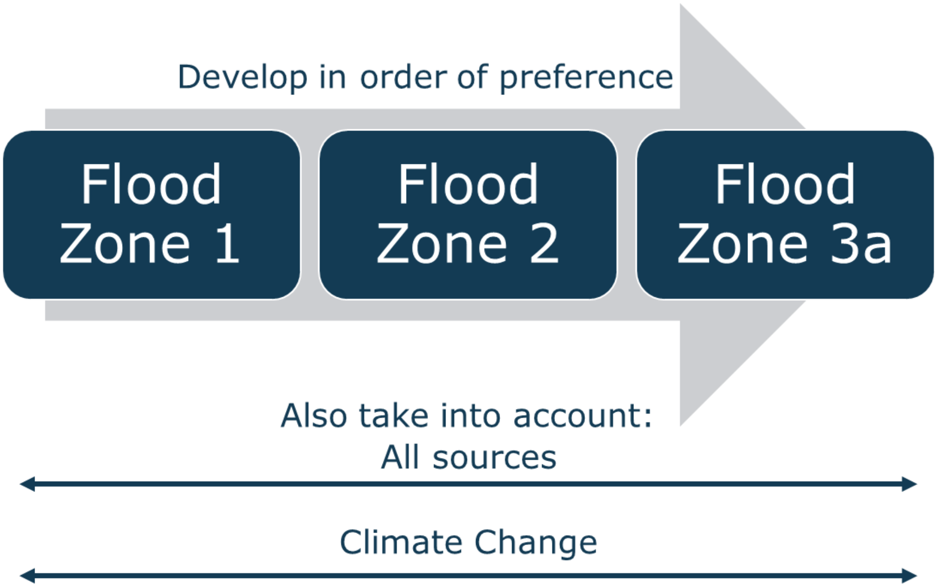
3.4 The Sequential Test

Firstly, land at the lowest risk of flooding and from all sources should be considered for development. A test is applied called the 'Sequential Test' to do this. Figure 3-1 summarises the Sequential Test. The LPA will apply the Sequential Test to strategic allocations. For all other developments, developers must supply evidence to the LPA, with a Planning Application, that the development has passed the test.

The LPA should work with the Environment Agency to define a suitable area of search for the consideration of alternative sides in the Sequential Test. 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.

Whether any further work is needed to decide if the land is suitable for development will depend on both the vulnerability of the development and the Flood Zone it is proposed for. **Table 2 of the NPPG** defines the vulnerability of different development types to flooding. **Table 3 of the NPPG** shows whether, having applied the Sequential Test first, that vulnerability of development is suitable for that Flood Zone and where further work is needed.

Figure 3-1: The Sequential Test

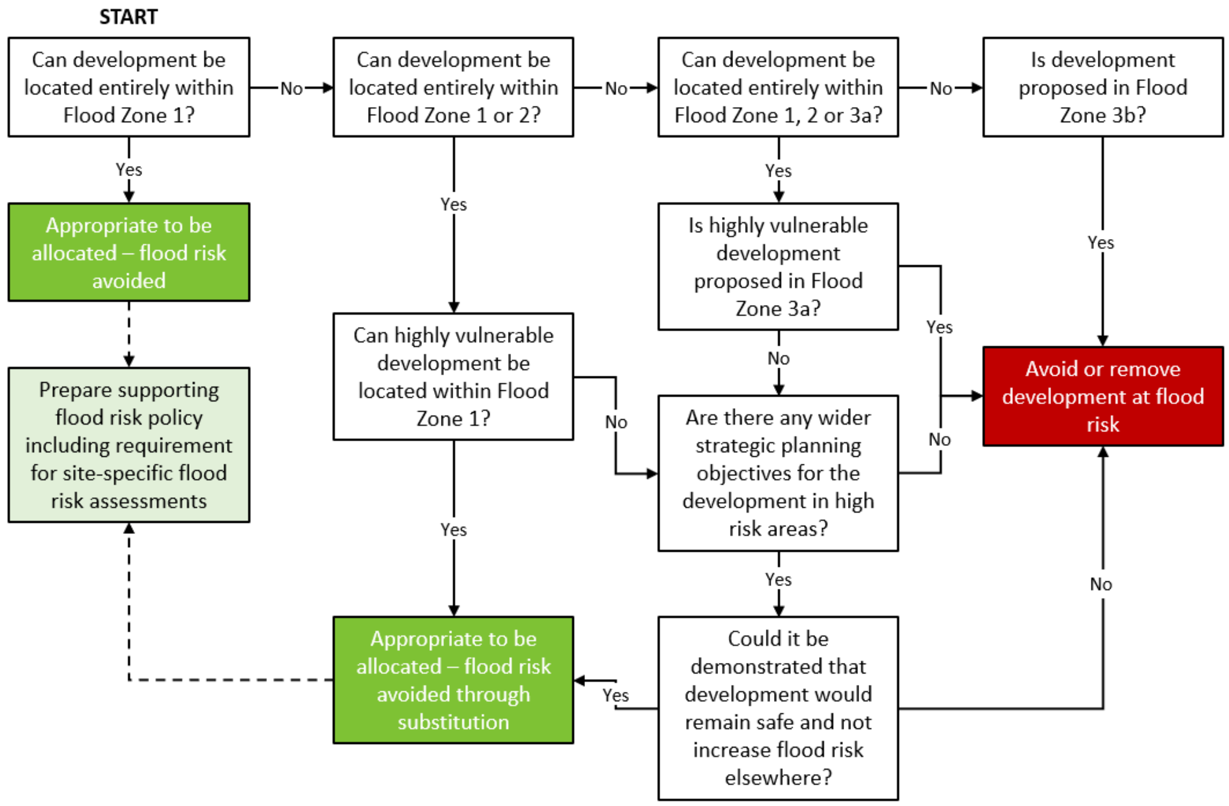


The figure above illustrates the Sequential and Exception Tests as a process flow diagram using the information contained in this SFRA to assess potential development sites against the EA's Flood Map for Planning flood zones and development vulnerability compatibilities.

This is a stepwise process, but a challenging one, as a number of the criteria used are qualitative and based on experienced judgement. The process must be documented, and evidence used to support decisions recorded.

In addition, the risk of flooding from other sources and the impact of climate change must be considered when deciding which sites are suitable to allocate.

Figure 3-2: Local Plan Sequential Approach to Site Allocation



3.5 The Exception Test

It will not always be possible for all new development to be allocated on land that is not at risk from flooding. To further inform whether land should be allocated, or Planning Permission granted, a greater understanding of the scale and nature of the flood risks is required. In these instances, the Exception Test will be required.

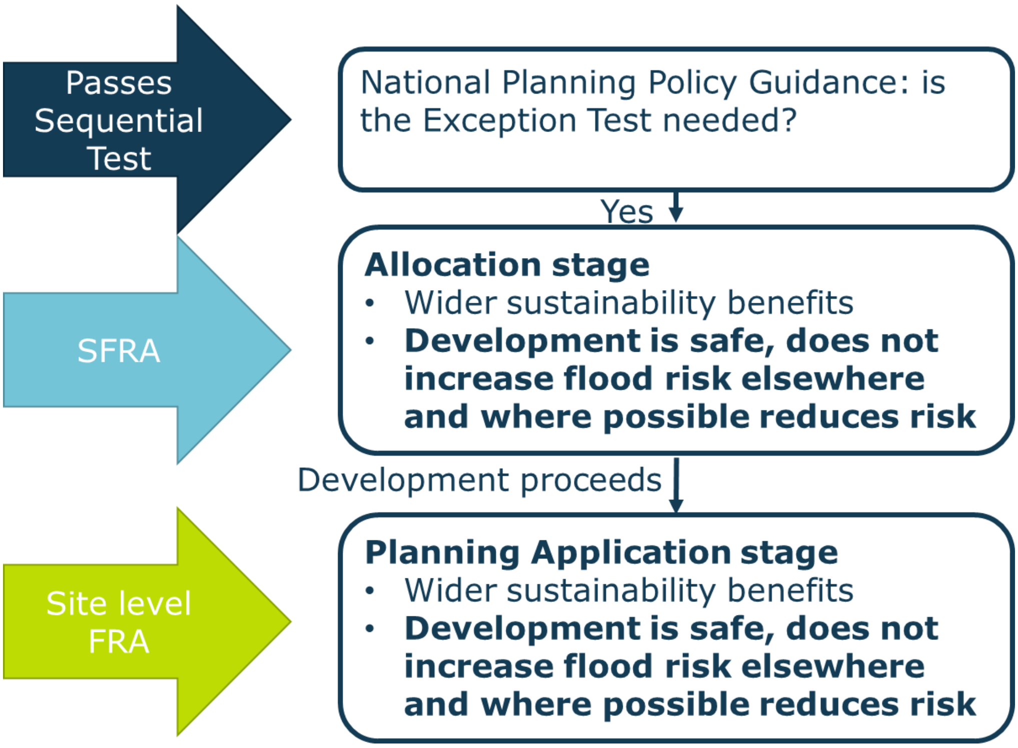
The Exception Test should only be applied following the application of the Sequential Test. It applies in the following instances:

- More vulnerable in Flood Zone 3a
- Essential infrastructure in Flood Zone 3a or 3b
- Highly vulnerable in Flood Zone 2 (this is NOT permitted in Flood Zone 3a or 3b)

The figure below summarises the Exception Test. For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the Exception Test. At planning application stage, the Developer must design the site so that it is flood resistant and resilient in line with the recommendations in National and Local Planning Policy and supporting guidance and those set out in this SFRA. This should demonstrate that the site will still pass the flood risk element of the Exception Test based on the detailed site level analysis.

For developments that have not been allocated in the Local Plan, developers must undertake the Exception Test and present this information to the Local Planning Authority for approval. The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should look into in more detail to inform the Exception Test for windfall sites.

Figure 3-3: The Exception Test



There are two parts to demonstrating a development passes the Exception Test:

1 Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk

- Local planning authorities 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 Local Planning Authority 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.
- At the stage of allocating development sites, Local Planning Authorities should consider wider sustainability objectives, such as those set out in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.
- The Local Planning Authority should consider the sustainability issues the development will address and how doing so will outweigh the flood risk concerns for the site, e.g. by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

2 Demonstrating 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.

- A Level 2 SFRA is likely to be needed to inform the Exception Test in these circumstances for strategic allocations. At Planning Application stage, a site-specific Flood Risk assessment will be needed. Both would need to consider the actual and residual risk and how this will be managed over the lifetime of the development.

3.6 Making a Site Safe from Flood Risk over its Lifetime

Local Planning Authorities will need to consider the actual and residual risk of flooding and how this will be managed over the lifetime of the development:

- The actual risk is the risk to the site considering existing flood mitigation measures. The fluvial 1% chance flood in any year event is a key event to consider because the National Planning Policy Guidance refers to this as the 'design flood' against which the suitability of a proposed development should be assessed and mitigation measures, if any, are designed.
- Safe access and egress should be available during the design flood event. Firstly, this should seek to avoid areas of a site at flood risk. If that is not possible then access routes should be located above the design flood event levels. Where that is not possible, access through shallow and slow flowing water that poses a low flood hazard may be acceptable, but preferably with evacuation prior to flooding based on appropriate flood warning.
- Residual risk is the risk that remains after the effects of flood defences have been taken into account and/ or from a more severe flood event than the design event. The residual risk can be:
- The effects of an extreme 0.1% chance flood in any year event. Where there are defences this could cause them to overtop, which may lead to failure if this causes them to erode, and/ or
- Structural failure of any flood defences, such as breaches in embankments or walls.

Flood resistance and resilience measures should be considered to manage any residual flood risk by keeping water out of properties and seeking to reduce the damage it does, should water enter a property. Emergency plans should also account for residual risk, e.g. through the provision of flood warnings and a flood evacuation plan where appropriate.

In line with the NPPF, the impacts of climate change over the lifetime of the development should be considered when considering actual and residual flood risk.

3.7 The Sequential Test and Exception Test and Individual Planning Applications

3.7.1 The Sequential Test

Developers are required to apply the Sequential Test to all development sites, unless the site is:

- A strategic allocation and the test has already been carried out by the LPA, or
- A change of use (except to a more vulnerable use), or
- A minor development (householder development, small non-residential extensions with a footprint of less than 250m^2), or
- A development in Flood Zone 1 unless there are other flooding issues in the area of the development (i.e. surface water, ground water, sewer flooding).

The SFRA contains information on all sources of flooding and taking into account the impact of climate change. This should be considered when a developer undertakes the Sequential Test, including the consideration of reasonably available sites at lower flood risk.

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 e.g. school catchments, in other cases it may be identified by other Local Plan policies. For some sites e.g. regional distribution sites, it may be suitable to widen the search area beyond LPA administrative boundaries.

The sources of information on reasonably available sites may include:

- Site allocations in Local Plans
- Site with Planning Permission but not yet built out
- Strategic Housing and Economic Land Availability Assessments (SHELAAs)/ five-year land supply/ annual monitoring reports
- Locally listed sites for sale

It may be that a number of smaller sites or part of a larger site at lower flood risk form a suitable alternative to a development site at high flood.

Ownership or landowner agreement in itself is not acceptable as a reason not to consider alternatives.

3.7.2 The 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 required (as set out in Table 3 of the NPPG). Developers are required to apply the Exception Test to all applicable sites.

The applicant will need to provide information that the application can pass both parts of the Exception test:

- Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk
- Applicants should refer to wider sustainability objectives in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.
- Applicants should detail the suitability issues the development will address and how doing out will outweigh the flood risk concerns for the site e.g. by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.
- Demonstrating 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 FRA should consider actual and residual risk and how this will be managed over the lifetime of the development, including:
    - The design of any flood defence infrastructure;
    - Access and egress;
    - Operation and maintenance;
    - Design of the development to manage and reduce flood risk wherever possible;
    - Resident awareness;

- Flood warning and evacuation procedures, including whether the developer would increase the pressure on emergency services to rescue people during a flood event; and
- Any funding arrangements required for implementing measures.

4 The Impact of Climate Change

4.1 Introduction

The Climate Change Act 2008 creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050.

The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. 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 C**limate Change Act 2008** creates a legal requirement for the UK to put in place measures to adapt to climate change and to reduce carbon emissions by at least 80% below 1990 levels by 2050.

Climate change modelling was undertaken as part of the Level 1 SFRA where potential development sites were in existing Environment Agency models. These were run for the 2080s period for the upper end and higher central allowances.

4.2 Revised Climate Change Guidance

The Environment Agency published **updated climate change guidance** in July 2020 on how allowances for climate change should be included in both strategic and site specific FRAs. The guidance adopts a risk-based approach considering the vulnerability of the development. Whilst the guidance was updated in 2020, fluvial allowances are still to be updated from those in the original 2016 guidance.

In 2018, the government published new UK Climate Projections (UKCP18). The Environment Agency are currently using these to further update their climate change guidance for new developments with regards to updated fluvial and rainfall allowances. Developers should check on the government website for the latest guidance before undertaking a detailed Flood Risk Assessment. At the time of writing this report, this was likely to be due in late 2020, but is not yet released.

Note that the method in the SFRA was based on the Environment Agency climate change guidance update from December 2019. In late July 2020 the Environment Agency updated their guidance to say that the sensitivity of significant urban extensions and new settlements to the extreme H++ scenario should be considered in SFRAs. Due to this late change the H++ scenario has not been considered for the urban extensions in this SFRA. The Council are advised to use the Upper End allowances to consider sensitivity to flood risk when allocating sites. Within each site specific summary table, sensitivity to climate change has been assessed and recommendations for future site specific assessments made. Associated mapping also shows how climate change could impact the flood extents and depths across each site. The council are also advised to encourage developers to account for the H++ scenario for the 100-year design event when master planning and ensure a development is resilient to flooding in the extreme 1000-year event with the H++ scenario.

4.3 Applying the Climate Change Guidance

To apply the climate change guidance, the following information needs to be known:

- The vulnerability of the development – see the **NPPG**
- The likely lifetime of the development – in general 60 years is used for commercial development and 100-years for residential, but this needs to be confirmed in a FRA
- The River Basin that the site is in – Babergh and Mid Suffolk is situated in the Anglian River Basin District.

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

4.3.1 Relevant Allowances for Babergh and Mid Suffolk

Table 4-1 shows the peak river flow allowances and Table 4-2 shows the peak rainfall intensity allowances that apply to Babergh and Mid Suffolk.

Table 4-1 Peak River Flow Allowances by River Basin District

River Basin District	Allowance category	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Anglian	Extreme (H++)	25%	40%	80%
	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%

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%

4.4 Representing Climate Change in a Level 2 SFRA

For this Level 2 SFRA, the Level 1 climate change modelling was used where this aligned with sites being assessed. Where models were produced as part of the Level 2 study, climate change allowances were also modelled, and impacts assessed. Two scenarios were previously modelled to reflect the upper end and higher central climate change allowances for the '2080s' timeframe in the Anglian River Basin District, therefore the 20-year defended scenario, 100-year and 1000-year undefended scenario plus 35% and 65%.

The 1,000-year surface water extent was also used as an indication of surface water risk with allowance for climate change.

Developers will need to undertake a more detailed assessment of climate change as part of the planning application process when preparing FRAs, using the percentage increases which relate to the proposed lifetime and the vulnerability classification of the development.

The site tables in Appendix A details what datasets have been used to inform the assessment of each site. Climate change mapping is available in site summary table mapping in Appendix A.

4.5 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; and
- Identifying no or low-cost responses to climate risks that also deliver other benefits, such as green infrastructure that improves adaptation, biodiversity and amenity, for example by leaving areas shown to be at risk of flooding as public open space.

5 Sources of information used in preparing the Level 2 SFRA

This chapter discusses all the datasets used in the Level 2 SFRA to assess the sites against flood risk. Several different sets of data may have been used to inform the extent, depth, hazard and velocity for each site.

5.1 Flood Zones

The data used to prepare the fluvial mapping for this study is based on the results from hydraulic models, either provided by the Environment Agency or prepared for the purposes of this SFRA.

Detailed modelling has been undertaken for sites SS0065, SS1198 and SS1223 using survey data collected as part of this SFRA and hydrology derived for this study. The existing River Gipping model has been updated to 1D-2D for sites SS0711 and SS01223. Existing EA models were used for SS0264 and SS0902, and these models have used climate change modelling carried out as part of the Level 1 and Level 2 SFRA. Additional detail on the 1D-2D modelling developed for this SFRA can be found in Appendix B, C, D and E.

The modelling datasets completed for this SFRA have not been incorporated into the Environment Agency's Flood for Planning and as a result, flood extents vary between the two datasets.

5.2 Surface water

Mapping of surface water flood risk in Babergh and Mid Suffolk has been taken from the Environment Agency's Risk of Flooding from Surface Water (RoFfSW) mapping, which is a slightly more detailed resolution than that published online by the Environment Agency. Surface water flood risk is subdivided into the following four categories:

- **High:** An area has a chance of flooding greater than 1 in 30 (3.3%) each year.
- **Medium:** An area has a chance of flooding between 1 in 100 (0.1%) and 1 in 30 (3.3%) each year.
- **Low:** An area has a chance of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%) each year.
- **Very Low:** An area has a chance of flooding of less than 1 in 1,000 (0.1%) each year.

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 required to more accurately illustrate the flood risk at a site-specific scale. Such an assessment will use the RoFfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

5.3 Climate change

The mapping provides a strategic assessment of climate change risk; developers should undertake detailed modelling of climate change allowances as part of a site-specific FRA, following the Climate Change Guidance set out by the Environment Agency.

This would include the Higher Central (100-year +35%) and Upper End (100-year +65%) climate change allowances for the 2080s epoch, for the Anglian basin's 2080s epoch. The sensitivity to the extreme H++ scenario should be assessed for significant urban extensions as part of a site specific flood risk assessment if required by the EA.

5.4 Groundwater

The JBA Groundwater Flood Map provides a detailed assessment of the risk of groundwater emergence in a 1 in 100-year event at a 5m resolution. The risk is scaled between 0 and 4, with 0 indicating no risk and 4 identifying groundwater levels either at or very near (within 0.025m of) the ground surface. The groundwater levels are compared against ground surface levels to determine the head difference in metres, with 0m suggesting artesian discharge of groundwater at the ground surface.

The JBA Groundwater Flood Map should be used in combination with other information, such as local data or historic data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. The data can however help to identify areas for further assessment at a local scale, where finer resolution datasets may exist or more data could be gathered.

5.5 River networks

Main Rivers are represented by the Environment Agency's Statutory Main River layer. Ordinary Watercourses are represented by the Environment Agency's Detailed River Network Layer. Caution should be taken when using these layers to identify culverted watercourses which may appear as straight lines but in reality, are not. Developers should be aware of the need to identify the route of, and flood risk associated with culverts and model these/use CCTV where necessary.

5.6 Flood Warning and Flood Alert

Flood Warning and Flood Alert Areas are represented by the Environment Agency's GIS datasets.

5.7 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been identified from the **Environment Agency's Long Term Flood Risk Information website.**

This shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. The maximum flood depths and speed are also available on the website. An indication of the hazard to people has been calculated using the below formula as suggested in Defra's FD2321/TR2 "Flood Risk to People". The different hazard categories are shown in Table 5-1.

5.8 Historic flooding

Historic flooding was assessed using the Environment Agency's Historic Flood Map and Recorded Flood Outlines datasets. In addition, historic flooding records have been supplied by BMSDC (which includes SCC records) and Anglian Water.

5.9 Flood Defences

Flood defences are represented by Environment Agency's Asset Information Management System (AIMS) Spatial Defences data set. Their current condition and standard of protection are based on those recorded in the tabulated shapefile data. None of the sites being assessed are formally protected by a flood defence.

5.10 Residual risk

The residual flood risk to sites is identified as where potential blockages or overtopping/ breach of defences could result in the inundation of a site, with the sudden release of water with little warning.

Potential culvert blockages that may affect a site were identified on OS Mapping and the Environment Agency's Detailed River Network Layer to determine where watercourses flow into culverts or through structures (i.e. bridges) in the vicinity of the sites. Any potential locations were flagged in the site summary tables. These will need to be considered by the developer as part of a site-specific Flood Risk Assessment.

Residual risk from breaches to flood defences, whilst rare, needs to be considered in Flood Risk Assessments. Considerations include the location of a breach, when it would occur and for how long, the depth of the breach (toe level), the loadings on the defence and the potential for multiple breaches. There are currently no national standards for breach assessments and there are various ways of assessing breaches using hydraulic modelling. Work is currently being undertaken by the Environment Agency to collate and standardise these methodologies. It is recommended that the Environment Agency are consulted if a development site is located near to a flood defence, to understand the level of assessment required and to agree the approach for the breach assessment.

5.11 Depth, velocity and hazard to people

The Level 2 assessment seeks to map the probable depth and velocity of flooding as well as the hazard to people during the defended fluvial 100-year event. The 100-year flood event has been investigated in further detail because the Level 2 assessment helps inform the Exception Test and usually flood mitigation measures and access/ egress requirements focus on flood events lower than the 1,000-year event (e.g. the 100-year or 100-year plus climate change events). As part of a site-specific FRA, developers may need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood depth, velocity and hazard based on the relevant 100-year plus climate change event as part of a site-specific FRA, using the relevant climate change allowance based on the type of development and its associated vulnerability classification. Not all of this information is known at the strategic scale.

Depth velocity and hazard information was derived from detailed modelling where this exists.

The depth, hazard and velocity of the 100-year surface water flood event has also been mapped and considered in this assessment. Hazard to people has been calculated using the below formula as suggested in Defra's FD2321/TR2 "Flood Risk to People". The different hazard categories are shown in Table 5-1.

Table 5-1 Defra's FD2321/TR2 "Flood Risks to People" classifications

Description of Flood Hazard Rating	Flood Hazard Rating	Classification Explanation
Very Low Hazard	<0.75	Flood zone with shallow flowing water or deep standing water
Danger for some (i.e. children)	0.75 - 1.25	Danger: flood zone with deep or fast flowing water
Danger for most	1.25 - 2.00	Danger: flood zone with deep fast flowing water
Danger for all	>2.00	Extreme danger: flood zone with deep fast flowing water

5.12 Note on SuDS suitability

The hydraulic and geological characteristics of each site were assessed to determine the constraining factors for surface water management. This assessment is designed to inform the early-stage site planning process and is not intended to replace site-specific detailed drainage assessments.

The assessment is based on catchment characteristics and additional datasets such as the JBA Groundwater map and British Geological Survey (BGS) Soil maps of England and Wales which allow for a basic assessment of the soil characteristics on a site by site basis. LIDAR data was used as a basis for determining the topography and average slope across each development site. Other datasets were used to determine other factors. These datasets include:

- Historic landfill sites
- Groundwater Source Protection Zones
- Detailed River Network
- Flood Zones derived as part of this L2 SFRA

This data was then collated to provide an indication of particular groups of SuDS systems which might be suitable at a site. SuDS techniques were categorised into five main groups, as shown in Table 5-2. This assessment should not be used as a definitive guide as to which SuDS would be suitable but used as an indicative guide of general suitability. Further site-specific investigation should be conducted to determine what SuDS techniques could be used on a particular development, informed by detailed ground investigations.

Table 5-2 Summary of SuDS categories

SuDS Type	Technique
Source Controls	Green Roof, Rainwater Harvesting, Pervious Pavements, Rain Gardens
Infiltration	Infiltration Trench, Infiltration Basin, Soakaway
Detention	Pond, Wetland, Subsurface Storage, Shallow Wetland, Extended Detention Wetland, Pocket Wetland, Submerged Gravel Wetland, Wetland Channel, Detention Basin
Filtration	Surface Sand filter, Sub-Surface Sand Filter, Perimeter Sand Filter, Bioretention, Filter Strip, Filter Trench
Conveyance	Dry Swale, Under-drained Swale, Wet Swale

The suitability of each SuDS type for the site options has been described in the summary tables, where applicable. The assessment of suitability is broadscale and indicative only; more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. SCC as LLFA should be consulted at an early stage to ensure SuDS are implemented and designed in response to site characteristics and policy factors. Developers should refer to the SCC **SuDS guide**.

6 Level 2 Assessment Methodology

6.1 Site screening

BMSDC supplied JBA with site options. All 312 sites were screened against a suite of available flood risk information and spatial data to provide a summary of risk to each site as part of the Level 1 SFRA.

The screening has helped to identify where a site required a Level 2 assessment, and where a site may not require a Level 2 assessment but where the implications and recommendations for flood risk to the site could be considered as part of this SFRA.

The site screening assessed the following:

- The proportion of the site in each Flood Zone
- Whether the site is shown to be at risk in the Risk of Flooding from Surface Water map, and the proportion of the site in each surface water category
- Whether the site is within 100m of a Main River or watercourse identified in the Environment Agency's Detailed River Network (DRN) layer.

The screening was undertaken using JBA in-house software called "FRISM". FRISM is an internal JBA GIS package that computes a range of flood risk metrics based on flood and receptor datasets, giving a clear spatial picture of flood risk. The site boundaries were queried using FRISM against the flood risk information including Flood Zones, surface water and historic flood map.

The results of the screening provide a quick and efficient way of identifying sites that are likely to require a Level 2 Assessment, assisting BMSDC with Sequential Test decision-making so that flood risk is taken into account when considering allocation options.

The screening also provides an opportunity to identify sites which have an ordinary watercourse flowing through or adjacent to them but for which no Flood Zone information is currently available. Note: although there are no Flood Zone maps available for these watercourses, it does not mean the watercourse does not pose a risk, it just means no modelling has yet been undertaken to identify the risk.

The Flood Zones are not provided for specific sites or land where the catchment of the watercourse falls below 3km^2. For this reason, the Flood Zones are not of a resolution to be used as application evidence to provide the details of possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site.

6.2 Sites Taken Forward to Level 2 Assessment

The sites were screened to identify those sites that had greater than 10% of the area at risk of fluvial flooding (including climate change on the 1% AEP event), surface water flooding (1 in 100-year event) and groundwater flooding to consider which sites are at high risk of flooding and may need to go forward to a Level 2 SFRA. This identified that there are 41 sites with >10% of the area at risk of flooding from at least one of these sources. Of these 41 sites, the 8 sites which are currently identified as preferred allocations without base post planning permission (PBPP) were taken forward to a Level 2 SFRA.

Table 6-1 Sites Carried Forward to a Level 2 Assessment

Site Code	Site Name	Reason for Level 2	Updated Flood Zones %*				Risk of flooding from surface water %		
			FZ3b	FZ3a	FZ2	FZ1	30yr	100yr	1,000yr
SS0065	Land south of Glebe Way, Mendlesham	Fluvial	1.4%	2.6%	5.8%	94.2%	1.8%	3.2%	16.5%
SS0264	Ashes Farm, Stowmarket	Fluvial Reservoir	7.3%	10.9%	12.0%	88.0%	1.1%	2.5%	11.6%
SS0668	Land south of Creeting Road West, Stowmarket	Surface water	0.0%	0.0%	0.0%	100%	5.2%	19.1%	55.6%
SS0711	Land east of Loraine Way, Sproughton	Fluvial	0.0%	0.05%	4.0%	96%	0.0%	0.0%	0.1%
SS0861	Land south of Church Lane, Claydon	Surface water	0.0%	0.0%	0.0%	100%	5.9%	11.2%	23.5%
SS0902	Land south of Low Road, Debenham	Fluvial, Surface Water, Groundwater	10.9%	15.3%	21.4%	78.6%	12.3%	16.9%	32.1%
SS1198	Land north of Laxfield Road, Stradbroke	Surface water, Fluvial	2.4%	6.9%	10.4%	89.6%	13.0%	16.6%	50.5%
SS1223	Land at Mill Lane, Stowmarket	Fluvial, Reservoir	10.4%	11.9%	14.0%	86%	2.8%	5.0%	15.0%

*Flood Zones updated using latest modelling data; hence these may differ from the EA's Flood Map for Planning Flood Zones.

The Flood Zone values quoted show the percentage of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone. For example: If 50% of a site is in the Flood Zones, taking each Flood Zone individually, 50% would be in Flood Zone 2 but say only 30% might be in Flood Zone 3a and only 10% in Flood Zone 3b. This would be displayed as stated above, i.e. the total % of that particular Flood Zone in that site. Flood Zone 1 is the remaining area of the site outside of Flood Zone 2, so Flood Zone 2 + Flood Zone 1 will equal 100%.

6.3 Recommendations for Site Not Taken Forward to Level 2

Some recommendations are stated below for consideration at the site-specific Flood Risk Assessment stage:

- For sites not represented in the Environment Agency's Flood Zones, or where Flood Zones do exist but no detailed hydraulic modelling is present, it is recommended that developers construct detailed hydraulic models at these sites as part of a site-specific FRA using channel, structure and topographic survey, to confirm flood risk.
- Where detailed Environment Agency models exist, it is recommended the developer embeds site survey, such as topography into the model domain to refine the understanding of flood risk to the site as well as test options to mitigate flood risk. The developer may also need to review the model hydrology and run additional climate change scenarios based on the latest EA guidance.

- Where relevant, blockages of nearby culverts will need to be simulated in a hydraulic model to confirm residual risk to the site.
- Surface water risk should be considered in terms of the proportion of the site at risk in the 30-year, 100-year or 1,000-year events, whether the risk is due to isolated minor ponding or deeper pooling of water, or whether the risk is due to a wider overland flow route.
- Surface water risk and mitigation should be considered as part of a detailed site-specific Flood Risk Assessment and Surface Water Drainage Strategy.
- Access and egress should be considered at the site, but also in the vicinity of the site, for example, a site may have low surface water risk, but in the immediate locality, access/ egress to and from the site could be restricted for vehicles and/ or people

6.4 Site Summary Tables

As part of the Level 2 SFRA, detailed site summary tables have been produced for the sites listed above in Table 6-1. The summary tables can be found in Appendix A.

Readers should refer to Chapter 5 for detailed information on the datasets used to inform the site summary tables.

Where available, the results from existing detailed Environment Agency hydraulic models were used in the assessment to provide depth, velocity and hazard information.

Using the model information combined with the Flood Zones, climate change and Risk of Flooding from Surface Water (RoFfSW) extents, detailed site summary tables have been produced for the site options (see Appendix A). Each table sets out the following information:

- Basic site information
- Area, type of site, current land use (greenfield/brownfield), proposed site use
- Sources of flood risk
    - Existing drainage features
    - Fluvial – proportion of site at risk including description from mapping/modelling
    - Surface Water – proportion of site at risk including description from RoFfSW mapping
    - Reservoir
    - Groundwater
- Flood History
- Flood risk management infrastructure
    - Defences – type, Standard of Protection and condition (if known), and description
    - Description of residual risk (blockage scenarios)
- Emergency Planning
    - Flood Warning and Flood Alert Areas
    - Access and egress
- Climate change
    - Summary of climate change allowances and increase in flood extent compared to Flood Zones

- Description of implications to the site
- Requirements for drainage control and impact mitigation
  - Broadscale assessment of possible SuDS to provide indicative surface water drainage advice for each site assessed for the Level 2 SFRA.
  - Groundwater Source Protection Zone
  - Historic Landfill Site
- NPPF Planning implications
  - Exception Test requirements
- Requirements and guidance for site-specific FRA (including consideration of opportunities for strategic flood risk solutions to reduce flood risk)
- Mapping information – description of data sources for the following mapped outputs:
  - Flood Zones
  - Climate change
  - Surface water
  - Fluvial depth, velocity and hazard mapping
  - Surface water depth velocity and hazard mapping
  - Groundwater

7 Flood Risk Management Requirements for Developers

7.1 Introduction

The report provides a strategic assessment of flood risk in Babergh and Mid Suffolk. Prior to any construction or development, site-specific assessments will need to be undertaken so all forms of flood risk and any defences at a site are considered in more detail. Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), to inform the sequential approach within the site and prove, if required, whether the Exception Test can be satisfied.

A detailed Flood Risk Assessment (FRA) may show that a site is not appropriate for development of a particular vulnerability or even at all. However, a detailed Flood Risk Assessment undertaken for a windfall site[2] may find that the site is entirely inappropriate for development of a particular vulnerability, or even at all. The Sequential and Exception Tests in the NPPF apply to all developments and an FRA should not be seen as an alternative to proving these tests have been met.

7.2 Principles for New Developments

Apply the Sequential and Exception Tests

Developers must provide evidence that the Sequential Test has been passed for windfall developments. If the Exception Test is needed, they must also provide evidence that all parts of the Test can be met for all developments, based on the findings of a detailed Flood Risk Assessment.

Developers should also 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 layout?
- 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 the statutory consultees at an early stage to understand their requirements

Developers should consult with the EA, BMSDC, SCC as LLFA and Anglian Water and Essex and Suffolk Water as the water and sewerage companies, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling and drainage assessment and design.

Consider the risk from all sources of flooding and that they are using the most up to date flood risk data and guidance

The SFRA can be used by developers to scope out what further detailed work is likely to be needed to inform a site-specific Flood Risk Assessment. At a site level, Developers will need to check before commencing on a more detailed Flood Risk Assessment that they are using the latest available datasets. Developers should apply the 2020 Environment Agency climate change guidance and ensure the development has taken into account climate change adaptation measures.

Ensure that development does not increase flood risk elsewhere and in line with the NPPF, seeks to reduce the causes and impacts of flooding

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2 'Windfall sites' is used to refer to those sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan.

The Level 1 SFRA sets out these requirements for taking a sustainable approach to surface water management. Developers should also ensure mitigation measures do not increase flood risk elsewhere and that floodplain compensation is provided where necessary.

Ensure the development is safe for future users

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. Developers should consider both the actual and residual risk of flooding to the site.

Further flood mitigation measures may be needed for any developments in an area protected by flood defences, where the condition of those defences is 'fair' or 'poor', and where the standard of protection is not of the required standard.

Enhance the natural river corridor and floodplain environment through new development

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 an amenity and recreational purposes. Development that may adversely affect green infrastructure assets should not be permitted. Where possible, developers should identify and work with partners to explore all avenues for improving the wider river corridor environment.

Consider and contribute to wider flood mitigation strategy and measures in Babergh and Mid Suffolk and apply the relevant local planning policy

Wherever possible, developments should seek to help reduce flood risk in the wider area e.g. by contributing to a wider community scheme or strategy for strategic measures, such as defences or natural flood management or by contributing in kind by mitigating wider flood risk on a development site. Developers must demonstrate in an FRA how they are contributing towards this vision.

7.3 Requirements for Site-Specific Flood Risk Assessments

7.3.1 When is a FRA 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 such as non-residential extensions, alterations which do not increase the size of the building or householder developments 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.

An 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 evidence of historical or recent flood events have been passed to the LPA
- In an area of significant surface water flood risk.

7.3.2 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 will be at risk of flooding, from all sources, both now and in the future, taking into account climate change;
- 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 local planning authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Babergh and Mid Suffolk District Councils. 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** (NPPF PPG, Defra).

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

7.4 Local Requirements for Mitigation Measures

The Level 1 SFRA provides details on the following mitigation measures in Section 10.4 of the SFRA Report and should be referred to alongside this report:

- Layout and Design (10.4.1)
- Making Space for Water (10.4.2)
- Raised Floor Levels (10.4.3)
- Development and Raised Defences (10.4.4)
- Modification of Ground Levels (10.4.5)
- Developer Contributions (10.4.6)

7.4.1 Flood Storage Compensation

For any development (both major and minor), that results in built volume below the design flood level (100-year plus climate change flood level), mitigation shall be required for loss in floodplain storage volume.

7.4.2 Resistant and Resilient Measures

The consideration of resistance and resilience measures should not be used to justify development in inappropriate locations.

Having applied planning policy, there will be instances where developments, such as those that are water compatible and essential infrastructure are permitted in high flood risk areas. The above measures should be considered before resistance and resilience measures are replied on. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system and the use of back up pumping to evacuate water from a property as quickly as possible. 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 following measures are available:

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, automatic airbrick replacements 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.

Resilience Measures: 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 can include electrical circuitry installed at a higher level and water-resistant materials for floors, walls and fixtures.

7.5 Reducing Flood Risk from other Sources

Section 10.7 of the Level 1 SFRA Report discusses how to reduce flood risk from other sources, such as groundwater, surface water and sewer flooding.

7.6 Duration and Onset of Flooding

The duration and onset of flooding affecting a site depends on a number of factors:

- The position of the site within a river catchment, with those at the top of a catchment likely to flood sooner than those lower down. The duration of flooding tends to be longer for areas in lower catchments.
- The principal source of flooding. Where this is surface water, depending on the intensity and location of the rainfall, flooding could be experienced within 30 minutes of the heavy rainfall event e.g. a thunderstorm. Typically, the duration of flooding for areas at risk of surface water flooding or from flash flooding from small watercourses is short (hours rather than days).
- The preceding weather conditions prior to the flooding. Wet weather lasting several weeks will lead to saturated ground. Rivers respond much quicker to rainfall in these conditions.
- Whether a site is defended, noting that if the defences were to fail, a site could be affected by very fast flowing and hazardous water within 15 minutes of a breach developing (depending on the size of the breach and the location of the site in relation to the breach).
- Catchment geology. Chalk catchments talk longer to respond than typical clay catchments for example.

7.6.1 Flood Warning and Emergency Planning

Emergency planning covers three phases: before, during and after a flood. Measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding. National Planning Policy takes this into account by seeking to avoid inappropriate development in areas of flood risk and considering the vulnerability of new developments to flooding.

The NPPF (paragraph 163) requires site level Flood Risk Assessments to demonstrate that:

"d) any residual risk can be safely managed; and

e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan."

Certain sites will need emergency plans:

- Sites with vulnerable users, such as hospitals and care homes.
- Camping and caravan sites.
- Sites with transient occupants e.g. hostels and hotels.
- Developments at a high residual risk of flooding from any source e.g. immediately downstream of a reservoir or behind raised flood defences.
- Situations 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).

Emergency Plans will need to consider:

- The characteristics of the flooding e.g. onset, depth, velocity, hazard, flood borne debris.
- The vulnerability of site occupants.
- Structural safety.
- The impact of the flooding on essential services e.g. electricity, drinking water.
- Flood warning systems and how users will be encouraged to sign up for them.
- Safe access and egress for users and emergency services.
- 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.
- A safe place of refuge where safe access and egress and advance warning may not be possible, having discussed and agreed this first with emergency planners. Proposed new development that places an additional burden on the existing response capacity of the Councils will not normally be appropriate.

The Environment Agency and the Association of Directors of Environment, Economy, Planning and Transport (ADEPT) have produced joint guidance on **flood risk emergency plans for new development** aimed at local authority planners to help identify when they should be asking for planning applications to be supported by flood risk emergency plans, and what should be included in them. It encourages local planning authorities to produce their own guidelines and set up local consultation arrangements to ensure emergency plans are fit-for-purpose and receive proper scrutiny. It also provides a framework for them to appraise emergency plans in the absence of such local arrangements.

8 Surface Water Management and SuDS

8.1 Sustainable Drainage Systems

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 and can also provide amenity and biodiversity benefits. 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 most spaces. For example, permeable paving could be used in parking spaces or rainwater gardens as part of traffic calming measures.

It is a requirement for all new major development proposals to ensure that sustainable drainage systems for management of runoff are put in place. Likewise, minor developments should also ensure sustainable systems for runoff management are provided. 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 current drainage arrangements is essential.

Users should refer to Section 11 if of the Level 1 SFRA which provides information on SuDS and advice on managing surface water runoff and flooding.

8.2 Sources of SuDS Guidance

8.2.1 C753 CIRIA SuDS Manual (2015)

The **C753 CIRIA SuDS Manual** (2015) provides guidance on planning, design, construction and maintenance of SuDS. 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.

8.2.2 Non-statutory Technical Guidance, Defra (March 2015)

Non-Statutory Technical guidance provides non-statutory standards on the design and performance of SuDS. It outlines peak flow control, volume control, structural integrity, flood risk management and maintenance and construction considerations.

8.3 Other Surface Water Considerations

8.3.1 Groundwater Vulnerability Zones

The Environment Agency have published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise of the underlying bedrock. The map shows the vulnerability of groundwater at a location based on the hydrological, hydro-ecological and soil propertied within a one-kilometre grid square.

The groundwater vulnerability maps should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas. Groundwater vulnerability maps can be found on **Defra's interactive mapping**.

8.3.2 Groundwater Source Protection Zones (GSPZ)

The Environment Agency also defines Groundwater Source Protection Zones (SPZs) near groundwater abstraction points. These protect areas of groundwater used for drinking water. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. Groundwater Source Protection Zones can be viewed on the Defra website.

There is a Source Protection Zone covering Babergh and Mid Suffolk and most of the Level 2 assessment sites fall within this area.

8.3.3 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as 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 NVZ coverage can be viewed on **the Environment Agency's online maps.**

9 Cumulative Impact of Development and Strategic Solutions

9.1 Introduction

Under the NPPF, strategic policies and their supporting Strategic Flood Risk Assessments (SFRAs), are required to 'consider cumulative impacts in, or affecting, local areas susceptible to flooding' (para. 156), rather than just to or from individual development sites.

When allocating land for development, consideration should be given to the potential cumulative impact of the loss of floodplain storage volume, as well as the impact of increased flows on flood risk downstream. Whilst the loss of storage for individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe.

All developments are required to comply with the NPPF and demonstrate they will not increase flood risk elsewhere. Therefore, providing developments comply with the latest guidance and legislation relating to flood risk and sustainable drainage, in theory they should not increase flood risk downstream.

The Level 1 SFRA assessed all the catchments within the districts to determine which catchments are at the highest risk from the cumulative impact of development and made recommendations based on the results. The assessment ranked catchments as high, medium or low risk based on the number of properties within the catchment at risk of surface water flooding, the number of historic flooding events within a catchment.

For the Level 2 SFRA, the amount of proposed development within the catchment, based on the BMSDC proposed allocations have been taken into account. This highlighted that a significant proportion of the proposed development is considered for the River Gipping catchment, notably through and downstream of Stowmarket. 86 of the 312 potential allocations are located in the modelled River Gipping catchment. Therefore using the existing model of the River Gipping, a strategic assessment has been undertaken to look at the potential cumulative impact in the catchment.

The Environment Agency have also highlighted that in Debenham, care must be taken to ensure that the benefit provided by a potential Natural Flood Management (NFM) scheme is not compromised by surface water discharge from proposed development and its discharge does not coincide with the flood peak thereby increasing flood risk. The existing hydraulic model being used for the NFM project has therefore been run to show how potential development in Debenham may change flood risk.

These assessments only provide a high level assessment as there are many assumptions that have been made. The final list of development sites is not known, so all development sites within the catchments have been included in the assessment. Where a site will discharge to is not yet known, this should be considered at a site-specific stage.

As part of a site-specific assessment, it is recommended that more detailed modelling is undertaken by the developer to ascertain in more detail the storage needs and potential at each site.

9.2 Strategic flood risk solutions

BMSDC has a vision for the future management of flood risk and drainage in the district. This concerns flood risk management, alongside wider environmental and water quality enhancements. Strategic solutions may include upstream flood storage, integrated major infrastructure/ FRM schemes, new defences and watercourse improvements as part of regeneration and growth and enhancing green infrastructure, with opportunities for natural flood management and retrofitting sustainable drainage systems. The Local FRM Strategy and Anglian River Basin District Flood Risk Management Plans set out specific actions for the Districts.

The Level 1 SFRA details Strategic flood risk solutions in Section 12, including flood storage schemes, promotion of SuDS, catchment and floodplain restoration, structure removal, re-naturalisation and flood defences.

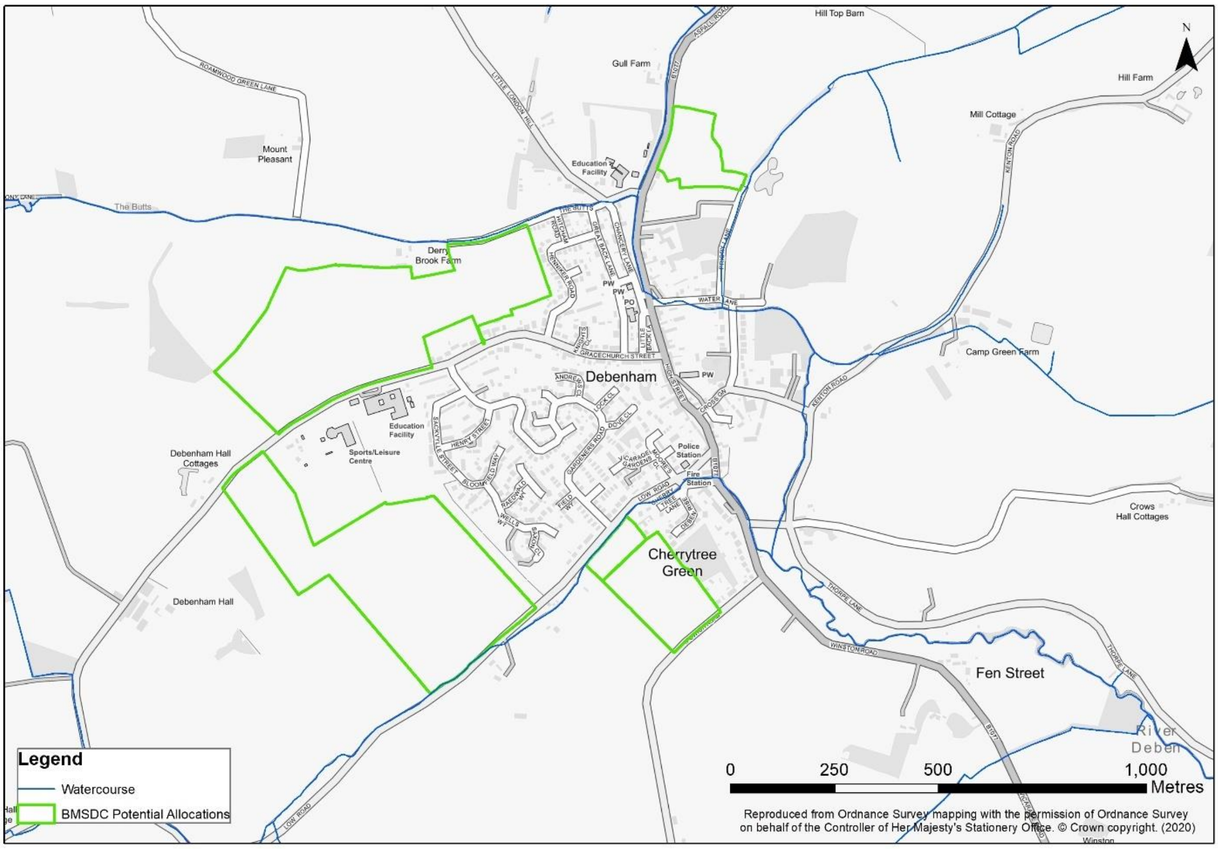

Figure 9-1: Location of potential allocations in Debenham

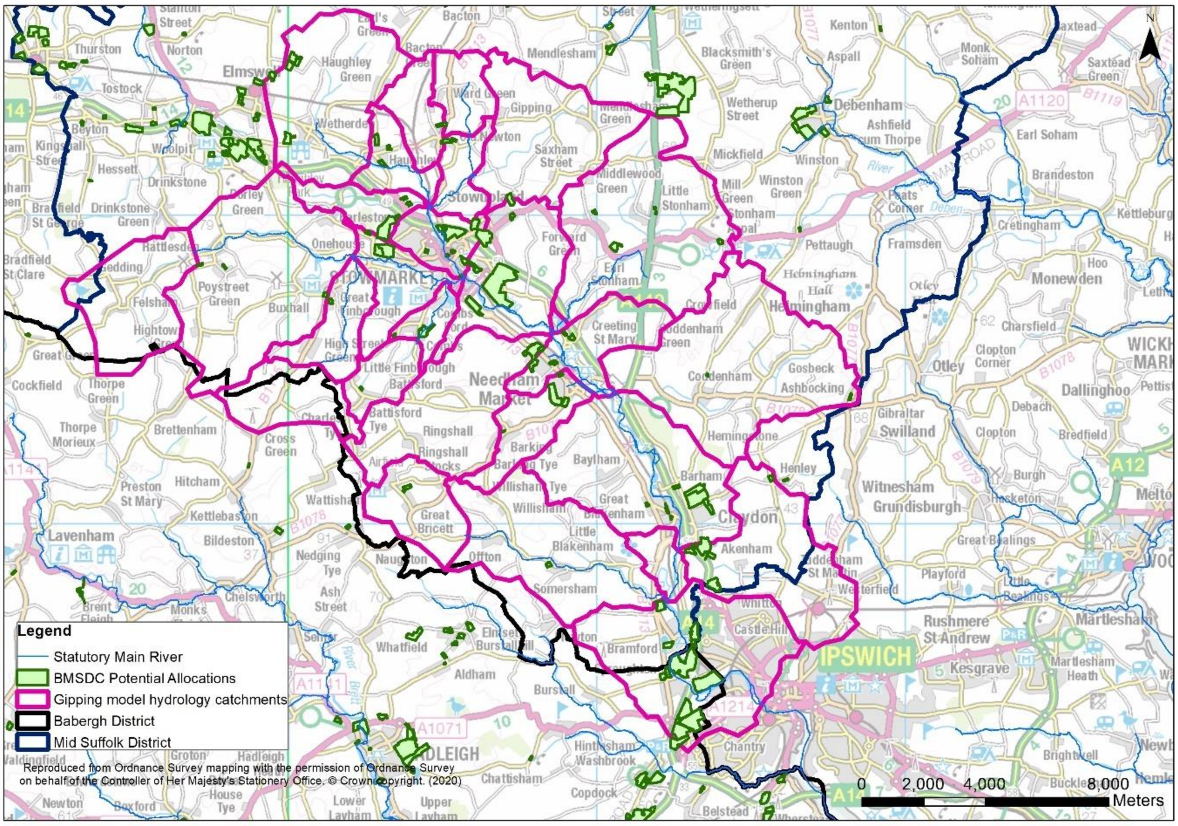

Figure 9-2: Location of proposed allocations in the River Gipping catchment

9.3 Methodology for high level cumulative impact assessment

Confirm development sites within model inflow catchment

Calculate increase in urban area and adjust hydrographs showing watercourse response to rainfall

Use these to model the post development scenario

Compare pre and post development model results

Develop policy recommendations

9.3.1 Potential impact of the proposed development in the River Gipping

An existing Environment Agency hydraulic model of the River Gipping (originally developed by JBA Consulting in 2012) was available for use in the cumulative impact assessment.

To ascertain the impact of the proposed development on downstream flows, the existing hydrology, derived using ReFH1 units fitted to statistical peaks was amended to reflect proposed development in the catchment. In order to be able to adjust the urban extent, for the purposes of this assessment a pre development and post development scenario has been generated using ReFH1, using a storm duration of 9.9 hour for a 100-year event, winter seasonality, using the defended model. ReFH1 with urban divisions was used where URBEXT1990 > 0.125. URBEXT for the urban portion of the catchment has been set to give an urban Tp value of 0.75 of the rural Tp value, in line with the default scaling factor in ReFH2.3.

Therefore the hydrology in this cumulative impact assessment differs from the existing model meaning that this assessment looks at how much change in flooding new development could generate, rather than being concerned that the flood outline is as good as it can be and providing an accurate flood outline for the 100-year event.

For the pre development scenario, URBEXT 1990 was updated to 2020 to reflect the current level of development. For the post development scenario, the URBEXT 1990 (urban extent) value was increased in line with the total area of development proposed in the catchment. As agreed with BMSDC, 75% of the site area was assumed to be developable for residential sites, and 85% for employment sites. FEH catchment boundaries from the existing model were available which showed the catchments for the model inflows. The potential development in each of these FEH catchments was calculated, using the site shapefiles provided by BMSDC, and then the urban fraction and URBEXT 1990 value in ReFH1 was updated accordingly.

An example of how this changes the flood hydrograph is shown in Figure 9-3.

For catchments where the URBEXT value has been increased, this generally causes the hydrograph to have a steeper rising limb, a small increase in the peak flow, and the flood peak occurs slightly earlier.

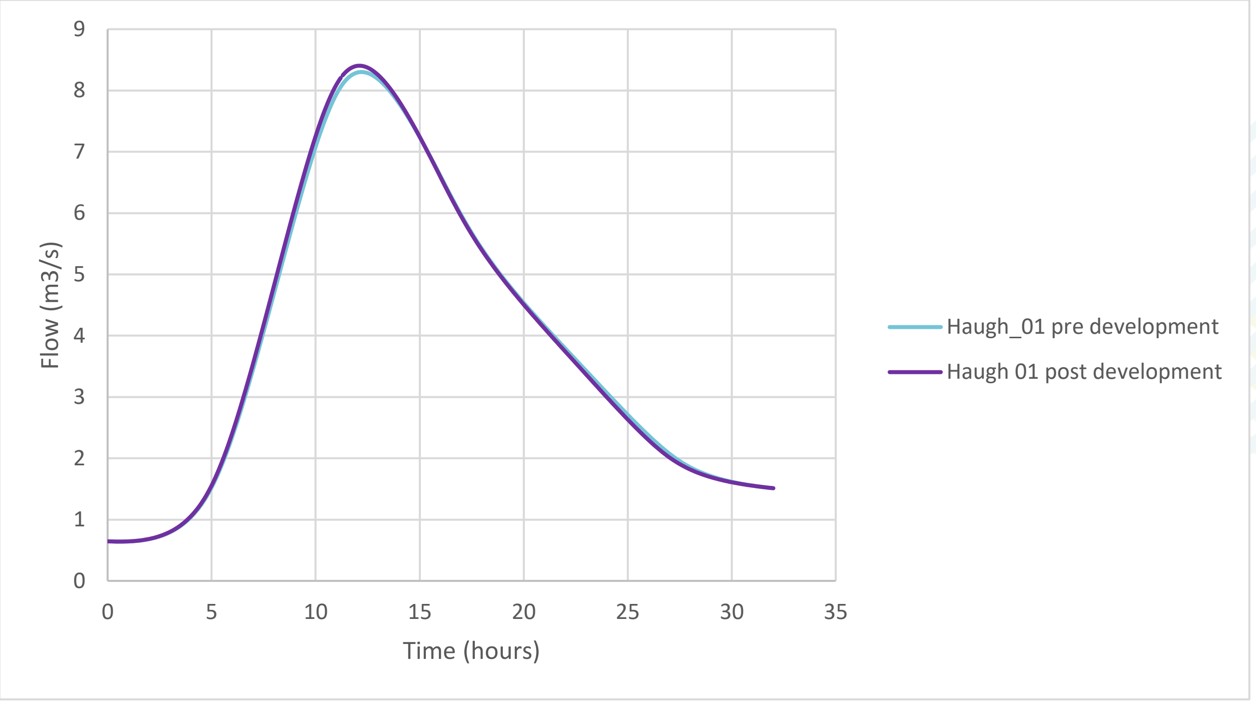

Figure 9-3: Pre and post development inflows for model inflow Haugh_01

9.3.2 Assumptions of method

The method used to generate a post development scenario, using ReFH1 as in the existing hydrology, only provides a strategic assessment of how much more flooding there might be despite the efforts of developers to mitigate it.

The formula used in ReFH1 to estimate parameters on urban catchments are calibrated to real urban catchments, which include mitigation measures. Therefore, it is important to note that the urban adjustment represents the net effect of urbanisation, i.e. it includes the consequences of flood mitigation works. This is because it is developed from flood peak data recorded from real urban catchments, most of which include a certain amount of SUDS, flood storage ponds, etc. For this reason, the model must not be used to project the runoff from future developments; it would substantially underestimate the scale of alleviation works required.

Therefore the post development scenario generated includes the assumption that some mitigation measures, such as SuDS, are in place in the new developed areas (although no more SuDS etc than are present in existing development, which for older parts of urban areas, would be hardly any).

This assessment has only been modelled on one return period and one storm duration. This assessment also looks at the magnitude of change in impact from current to future development, rather than being accurate in the actual flooding.

The study has also included all potential development sites. As this is only a strategic assessment, this would therefore need to be considered by the developer in more detail as part of a site-specific flood risk assessment. Where a site will discharge to is not yet known, this should be considered at a site-specific stage. The assumptions are considered appropriate as this assessment is only providing a strategic assessment of cumulative impact in the River Gipping catchment.

9.3.3 Cumulative impact within Gipping Catchment

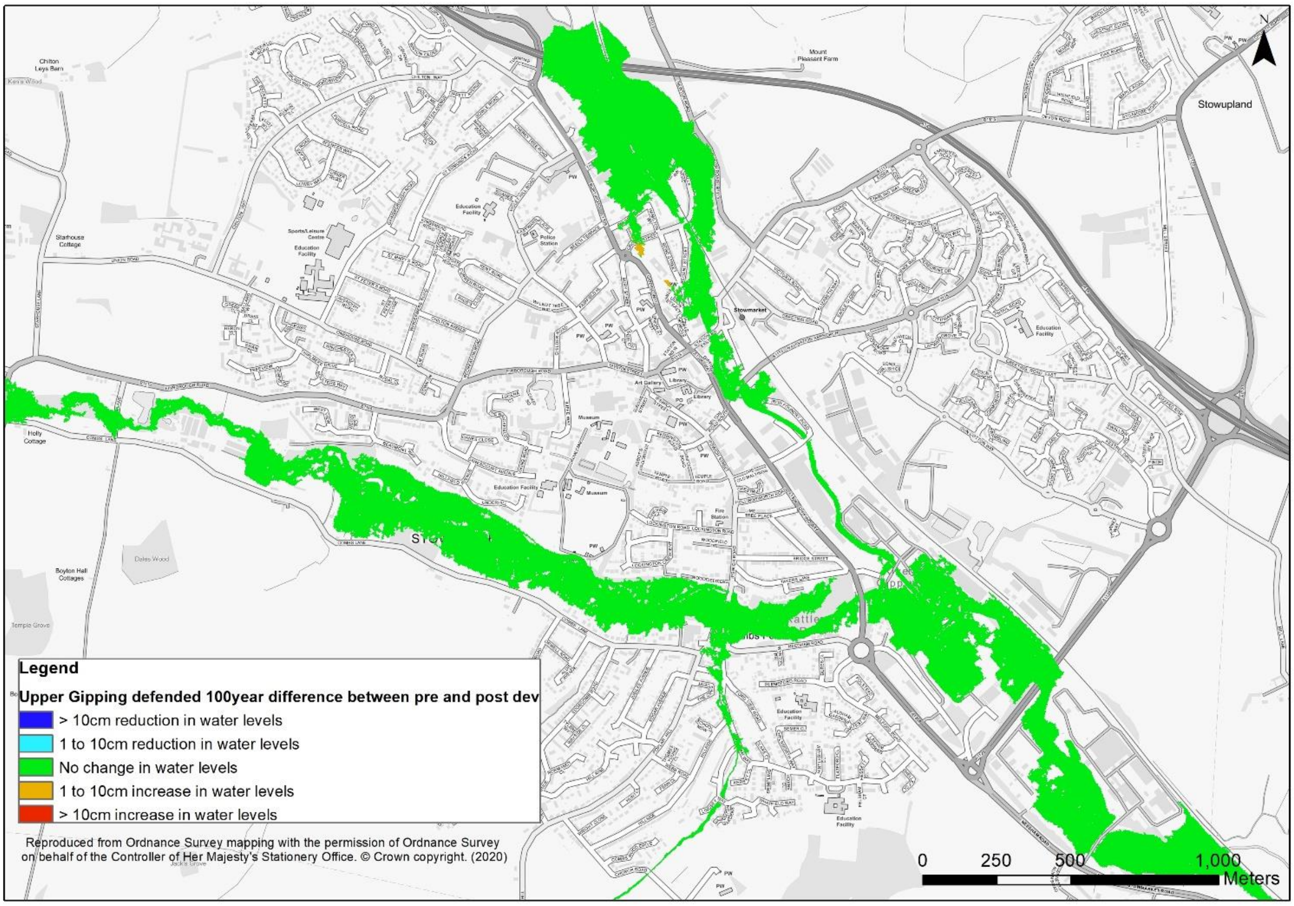

Figure 9-4: Pre and post development potential difference in water levels in Stowmarket

As shown in Figure 9-4, in Stowmarket, it can be seen that the model generally does not show any significant change in water levels (less than 1cm difference) in the 2D model domain. However, there are some small increases in the flood extent in places in the post development scenario. Across the rest of the model changes are also small and comparison of the 1D model nodes shows that changes in water level are less than 1cm. Comparison of model nodes indicates that development may also cause small differences in the timings of the peak.

It is recommended that more detailed modelling is undertaken by the developer to ascertain in more detail the storage needs and potential at each site. The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates.

New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects.

Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate.

9.3.4 Potential impact of the proposed development in Debenham

An existing Environment Agency hydraulic model of Debenham (developed by Jacobs in 2017) was available for use in the cumulative impact assessment. As part of an ongoing project, SCC and the EA are looking at the potential impacts of implementing NFM storage measures on three watercourses that flow into Debenham. The Environment Agency have also highlighted that in Debenham, care must be taken to ensure that the benefit provided by a potential NFM scheme is not compromised by surface water discharge from proposed development and its discharge does not coincide with the flood peak thereby increasing flood risk. The existing hydraulic model being used for the NFM project has therefore been run to show how potential development may change flood risk.

As with the Gipping model, to ascertain the impact of the proposed development on downstream flows, the existing hydrology, derived using ReFH1 units was amended to reflect proposed development in the catchment. In order to be able to adjust the urban extent, for the purposes of this assessment a pre development and post development scenario has been generated using ReFH1. The existing storm duration of 7.75 hours has been used as in the existing hydrology and the model was run for the 100-year event.

The pre development scenario remains the same as the baseline model generated for the NFM project. In the post development scenario, the URBEXT 1990 (urban extent) value was increased in line with the total area of development proposed in the catchment. As agreed with BMSDC, 75% of the site area was assumed to be developable for residential sites, and 85% for employment sites.

BMSDC have 5 potential allocations in Debenham. Sites have been assumed to drain into the nearest model inflow. The potential development in each of these FEH catchments was calculated, using the site shapefiles provided by BMSDC, and then the urban fraction and URBEXT value was updated accordingly.

In reality, a site will generally discharge all to one catchment and as where a site will discharge to is not yet known, this should be considered at a site-specific stage. The assessment has also assumed that both proposed developments south of Low Road (SS902 and SS0031) and SS0642 would drain into the Cherry Tree Brook. Only about half of site SS0031 sits in the Cherry Tree Brook catchment, based on the FEH Webservice, and therefore this may be an overestimation of the increase in flow to the Cherry Tree Brook. This is considered appropriate as this assessment is only providing a strategic assessment of cumulative impact to Debenham.

The pre and post development scenario has been run on a baseline scenario without the potential NFM storage, and also with a high level representation of storage on the three watercourses (12,000m^3 on Derry Brook and The Guls and 14,000m^3 on the Cherry Tree Brook). As the Debenham NFM project is ongoing, and the model is not finalised at time of writing this report (October 2020), this is only providing a strategic assessment.

9.4 Cumulative impact within Debenham Catchment

Results in Figure 9-5 show that the cumulative effects of development in the catchment have the potential to increase flood depths along the Cherry Tree Brook as the flood peak is increased. Across the rest of the model no significant change is shown. However as discussed above, both developments south of Low Road have been assumed to drain into the Cherry Tree Brook which may not occur in reality.

Increased peak flow from development may reduce the benefits of any NFM storage measures that are implemented. However it is important to note this is only a strategic assessment, and changes shown are relatively small and would not completely remove the benefits provided by storage when the results are compared to the baseline scenario.

The developer will therefore need to ensure there is no increase in runoff from the development sites. It is recommended that more detailed modelling is undertaken by the developer at site-specific Flood Risk assessment stage to ascertain in more detail the storage needs and potential at each site so that development does not increase flood risk downstream. Care must also be taken to ensure any development does not remove the benefits of existing and proposed NFM storage features. Care must also be taken with the timings of the peaks, so that SuDS implemented on the Cherry Tree Brook does not delay the flood peak to coincide with the peak of the River Deben, as the Cherry Tree Brook peaks before the River Deben, and this could increase flood risk downstream. Additional storage may be required to ensure that any additional flow from the development site occurs after the peak of the River Deben.

It is recommended that more detailed modelling is undertaken by the developer to ascertain in more detail the storage needs and potential at each site. The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates.

New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects.

Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate to ensure that the benefit provided by NFM scheme is not compromised by development.

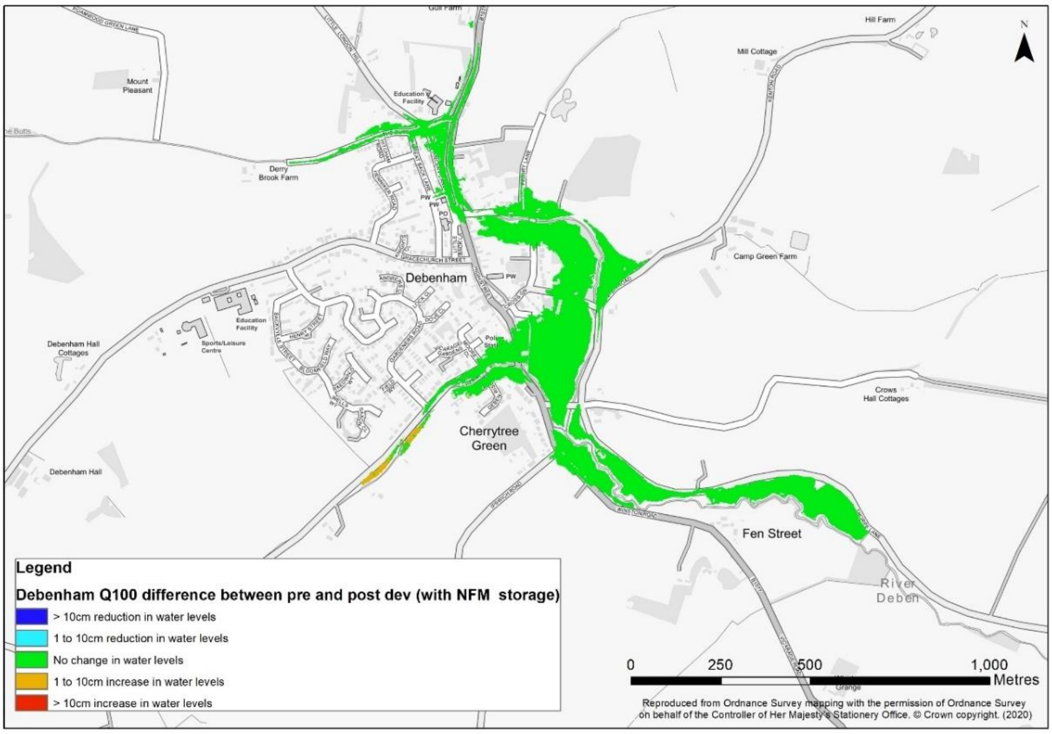

Figure 9-5: 100-year event with 12000m³ storage on Derry Brook and The Guls, 14000m³ on the Cherry Tree Brook – potential difference in flood depths pre and post development

10 Summary of Level 2 assessment

10.1 Assessment methods

As part of the Level 2 SFRA, detailed site summary tables have been produced for 8 of the original 312 considered; these sites are shown to be at risk of fluvial, surface water, groundwater or reservoir flood risk.

The summary tables set out the flood risk to each site, including Flood Zone coverage, maps of extent, depth and velocity of flooding as well as hazard mapping for the 100-year defended event. Climate change mapping has also been produced for each site to indicate the impact which different climate change allowances may have on the site. Each table also sets out the NPPF requirements for the site as well as guidance for site-specific FRAs. A broadscale assessment of suitable SuDS options has been provided giving an indication where there may be constraints to certain sets of SuDS techniques. This assessment is indicative and more detailed assessments should be carried out during the site planning stage to confirm the feasibility of different types of SuDS. It may be possible that those SuDS techniques highlighted as possibly not being suitable can be designed to overcome identified constraints.

It is important to recognise that a number of different sets of data have been used to represent the Flood Zones. Mapping shown in the detailed site summary tables shown in Appendix A as part of the Level 2 assessment may differ to the Environment Agency Flood Zones and 'Flood Map for Planning', as the flood risk from ordinary watercourses flowing through site options has been included in the summary table mapping. Where there are detailed models present, the Flood Zones in this SFRA have been derived from these models.

10.2 Summary of key site issues

The following points summarise the Level 2 assessment:

- The majority of the sites assessed as part of this Level 2 SFRA are at fluvial flood risk. The degree of flood risk varies, with some sites being only marginally affected along their boundaries, and other sites being more significantly affected within the site. Sites significantly affected by fluvial flooding will require more detailed investigations to inform a sequential approach to site layouts, SuDS possibilities, safe access and egress etc, as part of a site specific Flood Risk Assessment taken forward by a developer.
- The majority of sites at fluvial risk are also at risk from surface water flooding, with areas of ponding in the higher return period events across some sites and the access roads surrounding them. Surface water tends to follow topographic flow routes, for example along the watercourses or isolated pockets of ponding where there are topographic depressions. Site SS0861 for example is at very low fluvial flood risk but has a large surface water flow path running through the site. The impact of surface water flooding sites such as this will need more detailed investigations undertaken as part of a site specific Flood Risk Assessment at a later stage.
- The strategic and detailed modelling completed as part of this SFRA made allowances for the impact of climate change. For the 1 in 20, 100 and 1000-year events, the 2080s period was used, and 35% and 65% allowance categories were modelled. Modelling indicates that flood extents will increase as a result of climate change and therefore, the depths, velocities and hazard of flooding are also seen to increase. The increases seen are more significant on some sites compared to others. Site-specific FRAs should confirm the impact of climate change using latest guidance.

- Structures and culvert locations have been identified where the structure upstream, downstream or within the site could have an impact on flood risk. This impact of blockages on flood risk needs to be considered further as part of a site-specific FRA.
- For some sites, there is the potential for safe access and egress to be impacted by fluvial or surface water flooding. Consideration should be made to these sites as to how safe access and egress can be provided during flood events, both to people and emergency vehicles.
- A strategic assessment was conducted of SuDS options using regional datasets. A detailed site-specific assessment of suitable SuDS techniques would need to be undertaken at site-specific level to understand which SuDS option would be best.

At the planning application stage and as part of a Flood Risk Assessment, developers will need to undertake detailed hydrological and hydraulic assessments of watercourses to verify flood extent, depth, velocity and hazard (including considering the latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed.

For sites allocated within the Local Plan, the Local Planning Authority should use the information in this SFRA to inform the Exception Test. At planning application stage, the Developer must design the site such that is appropriate flood resistant and resilient in line with the recommendations in National and Local Planning Policy and supporting guidance and those set out in this SFRA.

For developments that have not been allocated in the Local Plan, developers must undertake the Exception Test and present this information to the Local Planning Authority for approval. The Level 1 SFRA can be used to scope the flooding issues that a site-specific FRA should look into in more detail to inform the Exception Test for windfall sites.

It is recommended that as part of the early discussions relating to development proposals, developers discuss requirements relating to site-specific Flood Risk Assessment and drainage strategies with both the Local Planning Authority and the LLFA, to identify any potential issues that may arise from the development proposals.

10.3 Exception Test considerations

All the sites taken forward to Level 2 will require the application of the Sequential Test prior to the Exception Test being applied. The Exception Test has two parts:

1. Demonstrating that the development would provide wider sustainability benefits to the community that outweigh the flood risk
2. Demonstrating 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.

Table 5-1 below shows an overview of the type of development that is appropriate by Flood Zone, subject to the Sequential Test being passed. Residential development is classified as 'More Vulnerable'' and employment development is classified as 'Less Vulnerable'. The table shows in which instances the Exception Test would need to be passed (e.g. Residential in Flood Zone 3a).

Table 10-1 Flood risk vulnerability and Flood Zone 'compatibility' from the NPPF

Vulnerability Classification		Essential infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zones	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test	✓	✓
	Zone 3a	Exception Test	✓	✗	Exception Test	✓
	Zone 3b	Exception Test	✓	✗	✗	✗
Source: Table 3, NPPF Guidance - Flood risk and coastal change						

10.3.1 Wider sustainability benefits

At the stage of allocating development sites, Local Planning Authorities should consider wider sustainability objectives, such as those set out in Local Plan Sustainability Appraisals. These generally consider matters such as biodiversity, green infrastructure, historic environment, climate change adaptation, flood risk, green energy, pollution, health, transport etc.

The Local Planning Authority should consider the sustainability issues the development will address and how doing so will outweigh the flood risk concerns for the site, e.g. by facilitating wider regeneration of an area, providing community facilities, infrastructure that benefits the wider area etc.

10.3.2 Making a site safe from flood risk over its lifetime

Local Planning Authorities will need to consider the actual and residual risk of flooding and how this will be managed over the lifetime of the development:

- The actual risk is the risk to the site considering existing flood mitigation measures. The fluvial 1% chance flood in any year event is a key event to consider because the National Planning Policy Guidance refers to this as the 'design flood' against which the suitability of a proposed development should be assessed and mitigation measures, if any, are designed.
- Safe access and egress should be available during the design flood event. Firstly, this should seek to avoid areas of a site at flood risk. If that is not possible then access routes should be located above the design flood event

levels. Where that is not possible, access through shallow and slow flowing water that poses a low flood hazard may be acceptable.

- Residual risk is the risk that remains after the effects of flood defences have been taken into account and/ or from a more severe flood event than the design event. The residual risk can be:
- The effects of an extreme 0.1% chance flood in any year event. Where there are defences this could cause them to overtop, which may lead to failure if this causes them to erode, and/ or
- Structural failure of any flood defences, such as breaches in embankments or walls.
- Flood resistance and resilience measures should be considered to manage any residual flood risk by keeping water out of properties and seeking to reduce the damage it does, should water enter a property. Emergency plans should also account for residual risk, e.g. through the provision of flood warnings and a flood evacuation plan where appropriate.

In line with the NPPF, the impacts of climate change over the lifetime of the development should be taken into account when considering actual and residual flood risk.

At a planning application stage and to pass the second part of the Exception Test, the developer will need to be able to demonstrate that:

- within a site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
- the development is appropriately flood resistant and resilient;
- the development incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

At an allocation stage and to pass the second part of the Exception Test, the Local Planning Authority will need to be able to consider the same points using the strategic information on flood risk available in the Level 2 SFRA. This does not mean the developer does not also need to apply the Exception Test, but that the Local Planning Authority will have demonstrated in principle that the Exception Test can be passed when allocating a site.

10.3.3 Considering the Exception Test for the proposed sites in Babergh and Mid Suffolk

In principle, it is possible for all sites assessed in the Level 2 SFRA to pass the flood risk element of the Exception Test, for example by:

- Siting development away from the highest areas of risk into Flood Zone 1 (in the majority of sites assessed, the risk is along a site boundary, so steering away from this is advised),
- Considering safe access/ egress in the event of a flood (from all parts of the site, if say the site is severed by a flood flow path),
- Using areas in Flood Zone 2 for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. Residential development should not be permitted in Flood Zone 3 and no development at all should be permitted in Flood Zone 3b (aside from essential infrastructure, such as a bridge crossing the lowest points of a site),

- Testing flood mitigation measures if these are to be implemented, to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another),
- Considering space for green infrastructure in the areas of highest flood risk.
- If the strategic sites are split in future into smaller land parcels for development, and some of those parcels are in areas of flood risk, the Exception Test may need to be re-applied by the Developer at the planning application stage.

10.4 Planning Policy Recommendations

The planning policy recommendations found in Chapter 14 of the Level 1 SFRA still stand for the site allocations and any windfall development that comes forward. Recommendations made in the Level 1 SFRA cover:

- Site specific flood risk assessments
- Sequential and exception tests
- Windfall sites
- Drainage strategies and SuDS
- Cumulative impact of development and cross boundary issues
- Residual risk
- Safe access and egress
- Future flood management

Further site-specific recommendations have been made in the Level 2 regarding Cumulative Impact Assessment. These are made in Chapter 9.

10.5 Use of SFRA Data and Future Updates

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The 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 Babergh and Mid Suffolk District Councils, Suffolk County Council, Anglian Water and the Environment Agency. Such information may be in the form of:

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

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

Appendices

A Level 2 Assessment – Site summary tables and mapping

B SS0065 modelling

C SS1198 modelling

D SS01223 modelling

E Updated River Gipping (SS01223 and SS0711) modelling

JBA consulting

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Coleshill
Doncaster
Dublin
Edinburgh
Exeter
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Saltaire
Skipton
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Thirsk
Wallingford
Warrington

Registered Office
1 Broughton Park
Old Lane North
Broughton
SKIPTON
North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
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Jeremy Benn Associates Limited

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JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007

Site name	SS0065 Land south of Glebe Way, Mendlesham
Site area (ha)	5.28

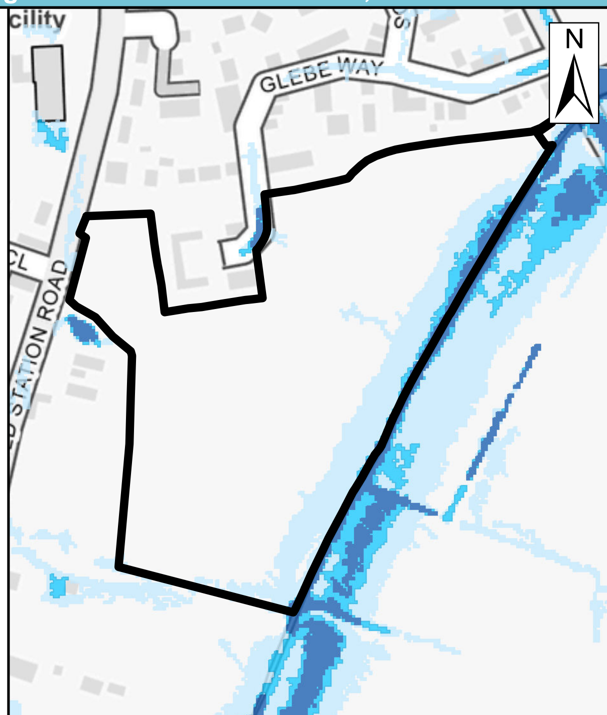
Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 50 100 Metres



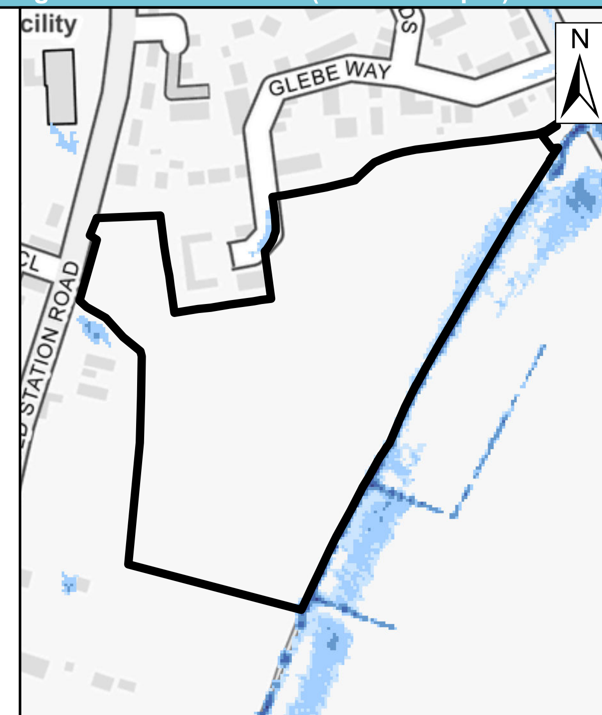
Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 50 100 Metres



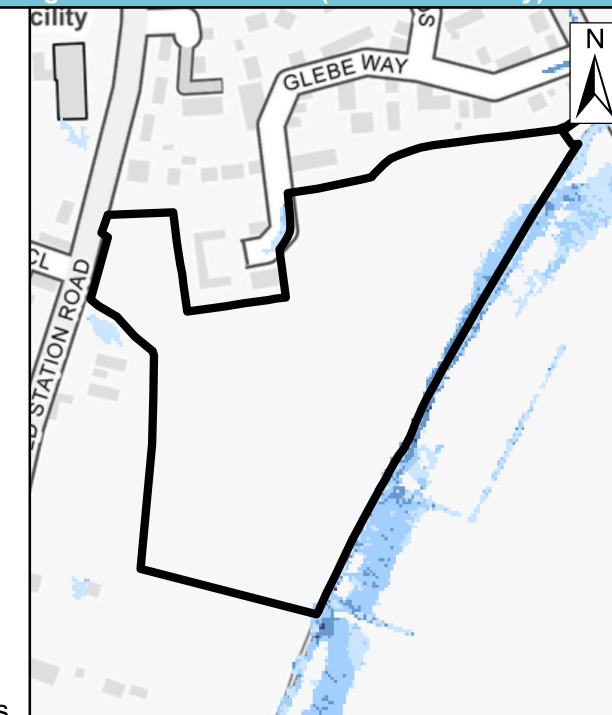
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 50 100 Metres



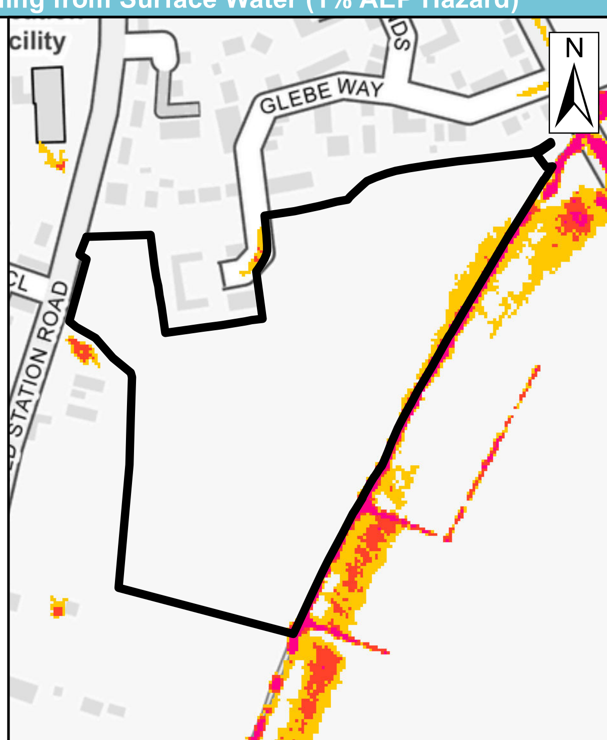
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 50 100 Metres



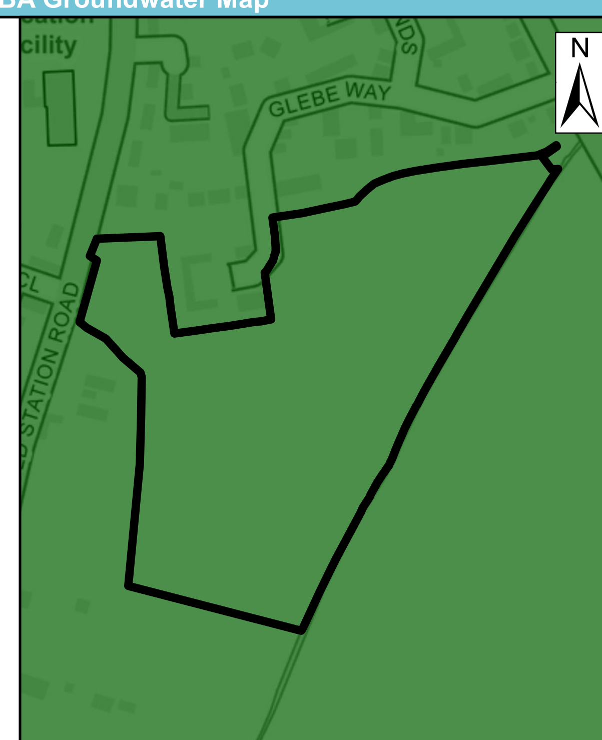
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 50 100 Metres



Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 50 100 Metres

Site name	SS0065 Land south of Glebe Way, Mendlesham
Site area (ha)	5.28

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

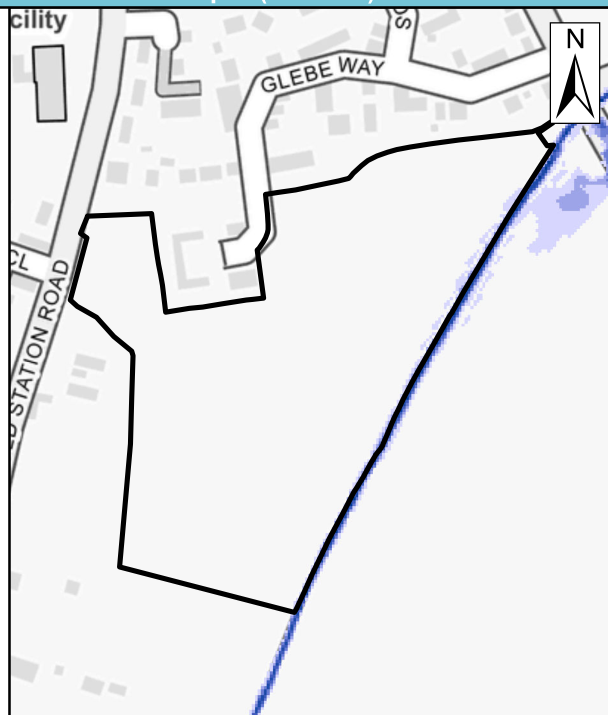
Fluvial Flood Depth (1% AEP)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 50 100 Metres



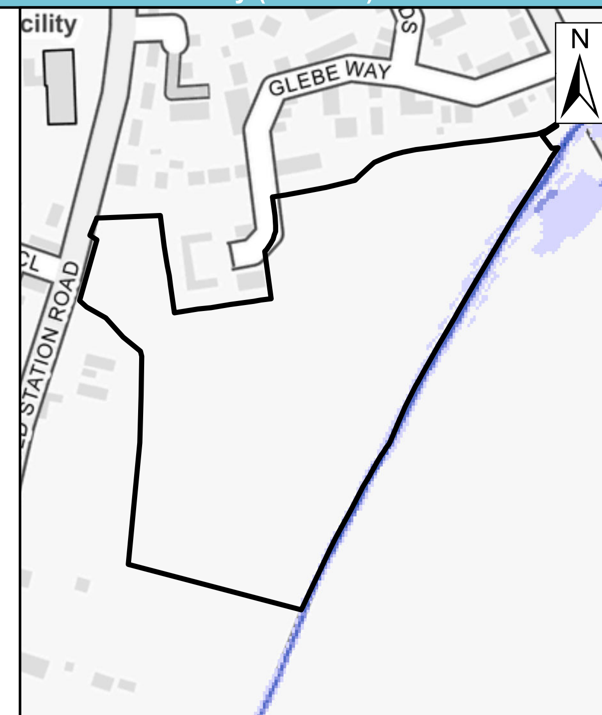
Fluvial Flood Velocity (1% AEP)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 50 100 Metres



Fluvial Flood Hazard (1% AEP)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 50 100 Metres

Fluvial Flood Climate Change (1% AEP)

Legend

- 1% AEP flood extent
- 1% AEP+ 35% CC flood extent
- 1% AEP+ 65% CC flood extent

0 50 100 Metres

Fluvial Flood Climate Change (5% AEP)

Legend

- 5% AEP flood extent
- 5% AEP + 35% CC flood extent
- 5% AEP + 65% CC flood extent

0 50 100 Metres

Fluvial Flood Climate Change (0.1% AEP)

Legend

- 0.1% AEP flood extent
- 0.1% AEP +35% CC flood extent
- 0.1% AEP +65% CC flood extent

0 50 100 Metres

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details		
	Site Code	**SS0065**
	Address	Land south of Glebe Way, Mendlesham
	Area	5.28ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential

Sources of flood risk

Location of site within catchment	The site is contained within the River Dove catchment. The River Dove flows along the eastern boundary of the site in a north-easterly direction to its confluence with the River Waveney.
Existing drainage features	The River Dove runs along the eastern boundary of the site. The watercourse is classified as an ordinary watercourse alongside the site boundary, and becomes a designated Main River at the north-east corner of the site. It flows in a north easterly direction and converges with a smaller watercourse north-east of the site.

Fluvial

Proportion of Site at Risk			
FZ3b	**FZ3a**	**FZ2**	**FZ1**
1.4%	2.6%	5.8%	94.2%

Highest Zone of Risk (Risk of Flooding from Rivers and Sea)

Majority of the site – Very Low
Eastern edge of site adjacent to River Dove – Medium to High

The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)

Available Data: An existing model of the River Dove (the River Waveney Model developed by JBA Consulting in 2012) was provided by the Environment Agency. This model was extended upstream as part of this SFRA to include the development site and converted to a 1D-2D Flood Modeller – TUFLOW model. The model has been run for the current 20-year, 100-year and 1000-year events and with 35% and 65% climate change allowances.

Flood Characteristics:

Fluvial flood risk is shown along the eastern boundary of the site, where the River Dove sits along the site boundary. The majority of the site is not at risk of fluvial flooding. In the 20-year event (Flood Zone 3b), flood extents are constrained along the eastern site boundary, where depths are up to 1m. In the 100-year event, the flood extent increases slightly further into the site, but is still constrained along the boundary. Flood depths of up to 1.2m and velocities of up to 1m/s are found along the site boundary. In the 1000-year event, flood depth increases and depths of up to 1.5m are found along the site boundary. In the north east of the site the flood extent increases further into the site, but depths in this area are less than 0.3m. It is still only a small portion of the site that is at risk of flooding.

Surface Water

Proportion of site at risk (RoFfSW)		
30-year High Risk	**100-year Medium Risk**	**1,000-year Low Risk**
1.8%	3.2%	16.5%
Max depths (m)		
<0.3m	<0.3m	<0.3m
Max velocity (m/s)		
>0.25	>0.25	>0.25

The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).

<table>
<tr><td rowspan="5"></td><td></td><td colspan="3">Description of surface water flow paths:
There are surface water flow paths corresponding with the River Dove, along the eastern boundary of the site. It is likely that the surface water mapping is picking up the flood plain of the River Dove.
In the 30-year event, a small portion of the eastern boundary is at risk of flooding, with depths of below 0.3m. There are no other areas at risk of surface water within the site, however there are small areas of ponding just beyond the boundaries to the north, at the end of Glebe Way, and east opposite Middy Close.
In the 100-year event, surface water flood risk coincides with the River Dove, again extending along the eastern boundary with flood depths of 0.3m. The small areas of pooling mentioned in the 30-year event are also present, although the extent has increased.
In the 1000-year event, the surface water flooding is along the River Dove, extending into the eastern boundary. In the northern section, the depths increase to between 0.3-0.9m, however further south depths are less than 0.3m. Along the south eastern corner more surface water flooding is present along the south boundary of the site, with a depth of less than 0.3m. The northern isolated pool on Glebe Way has extended into the site, with depths of less than 0.3m.</td></tr>
<tr><td>Reservoir</td><td colspan="3">The site is not shown to be at risk of reservoir flooding from the available online maps.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. The site is at no risk of groundwater flooding.</td></tr>
<tr><td>Flood History</td><td colspan="3">There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset.
Flood history provided by BMS (collated from SCC records) shows no records of historic flooding on the site, however the is a record of flooding adjacent to the site on Old Station Road in 2017.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="4">Flood risk management infrastructure</td><td rowspan="3">Defences</td><td>Defence Type</td><td>Standard of Protection</td><td>Condition</td></tr>
<tr><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">There are no known flood defences on or near to the site.</td></tr>
<tr><td>Residual risk</td><td colspan="3">Oak Farm Lane Bridge is just downstream of the site. If the structure was to become blocked, there is potential for increased surface water and fluvial flooding across the site. There is also a structure upstream of the site at Wash Lane. It is recommended that the potential for blockage on all structures affecting the site should be considered as part of any future site-specific assessment.</td></tr>
<tr><td rowspan="2">Emergency planning</td><td>Flood warning</td><td colspan="3">The eastern side of the site is covered by the River Waveney from Diss and the River Dove to Elingham flood alert area.</td></tr>
<tr><td>Access and Egress</td><td colspan="3">The site is bound by the River Dove to the east, with the top north east corner next to Oak Farm Lane. Although it is not bordering this road, if access was created from this road to the site, it would have to cross the River. The central north section of the site follows the curve of Glebe Way, a residential road off Oak Farm Lane. The west edge of the site it is bordered by Old Station Road.
In terms of fluvial flood risk, flood risk is contained to the vicinity of the River Dove, so the site is accessible from Old Station Road and Glebe Way as these are not at risk of fluvial flooding. To the north east of the site, Oak Farm Lane is at risk of flooding in the 100-year event and above.
In terms of surface water flood risk, surface water flooding impacts the site and some of the surrounding road network in the 100 and 1000-year flood events. It is worth noting that significant flows are present on the junction for Oak Farm Lane and Brockford Road in the 30-year flood event, with depths of over 0.9m. The northern corner of the site is opposite this junction, therefore if access was to be created here, flooding would potentially cause an issue for this.
In the 100-year event, the turning onto Glebe Way from Oak Farm Lane experiences flooding, and therefore access could be an issue there, although the depths are only below 0.3m. Further down Glebe Way at the end, there is a section of pooling, with depths of below 0.3m. This area could cause an issue with access and egress.</td></tr>
</table>

		Likewise, along the border of the site against Old Station Road, there are small depths of roughly 0.3-0.9m in the 100-year and 1000-year events.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity, hazard and frequency of fluvial flooding from the River Dove and surface water flooding across the site. • As part of the detailed modelling study completed for the Level 2 SFRA, modelling has included allowances for climate change. The 35% and 65% allowances have been run on the 20-year, 100-year and 1000-year events to define future Flood Zone 3b, 3a and 2. When climate change allowances are modelled, there is an increase in flood depth and extent but flood risk is still constrained to the eastern portion of the site adjacent to the River Dove. • Climate change also needs to be considered for surface water events; at the site-specific Flood Risk Assessment stage. The 100-year event with a 40% allowance for climate change should be considered as part of surface water drainage strategies, or surface water modelling. • The current day 1,000-year surface water extent provides an indication of the possible increase in extent of the 100-year event. It is likely that, as a result of climate change, surface water flood risk across the site will increase in the vicinity of the River Dove. • The impact of climate change on surface water flood risk will require a detailed FRA to assess the site layout and design. • Developers should consider SuDS strategies to reduce the impacts of climate change from surface water in a detailed site-specific FRA.
Requirements for drainage control and impact mitigation	**Broad scale assessment of possible SuDS**	Geology at the site consists of: • Bedrock: Neogene to quaternary rocks (gravel, sand silt and clay) • Superficial: Till (diamicton) Soils at the site consist of: • Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. As such infiltration techniques should only be used where there are suitable levels of treatment although it is possible that infiltration may not be permitted. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. The site is not designated by the Environment Agency as previously being a landfill site. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. • Most source control techniques are likely to be suitable. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk from groundwater. • Infiltration is likely to be suitable. Mapping suggests a low risk of ground water flooding however, site investigations should be carried out to assess potential for drainage by infiltration. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone. • Detention features may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required. • Filtration features may be suitable provided site slopes are <5%. If the site has contamination or groundwater issues; a liner will be required. • All forms of conveyance are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; mitigation measures will be required. Developers should refer to the Suffolk County Council SuDS guide as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.

<table>
<tr>
<td rowspan="2">NPPF and Planning Implications</td>
<td>Exception Test Requirements</td>
<td>The Local Authority have carried out the Sequential Test in line with national guidance. This has supported this site being taken forward for further consideration, including considering if the Exception Test would apply.

Residential development is classified as ‘More Vulnerable’. As the site is partially covered by Flood Zone 3 and is proposed for residential development, the Exception Test will need to be applied to the site.

A sequential approach to site layout will contribute towards passing the flood risk element of the Exception Test, this means that the least vulnerable type of development (in terms of Table 2 of the Flooding section of the NPPG) should be located in the higher flood risk parts of the site.

In no instances should highly vulnerable development be located in Flood Zones 3a and 3b. More vulnerable development (such as dwellings) should be located outside Flood Zone 3 whenever possible. Development in the high flood risk parts of the site should be designed such that it is flood resilient and resistant. It is anticipated that proposed development will be sequentially located within Flood Zone 1 on this site.</td>
</tr>
<tr>
<td>Requirements and guidance for site-specific Flood Risk Assessment</td>
<td>Flood Risk Assessment:
• At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare.
• The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance; BMSDC Local Plan policies, and Suffolk County Council SuDS guide.
• Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage.
• All sources of flooding, particularly the risk of fluvial, surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment.
• Although modelling has been completed as part of this SFRA, detailed modelling of the site will still be required as part of the site-specific FRA to confirm both fluvial and surface water flood risk and flow paths. Detailed modelling would require topographic survey of the site and well as any additional asset survey needed to refine the model further. In addition, the latest guidance on climate change allowances would need to be considered and any mitigation measures would need to be tested through modelling. The residual risk from culvert blockage should be assessed and suitable mitigation proposed.
• The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG.
• Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF.
• Development in FZ3 may require floodplain compensation and this should be confirmed with the EA at FRA stage.

Guidance for site design and making development safe:
• The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF’s policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG).
• Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk.
• Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures.
• The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure both fluvial and surface water flows can pass through the site is essential.</td>
</tr>
</table>

		• The River Dove is classified as a Main River immediately downstream of the site, therefore an Environmental Permit may be required from the Environment Agency. • For any culverts (old or new), the developer must set out who is adopting and maintaining those culverts throughout the lifetime of the development. The design of the development must take into account the residual risk of blockage e.g. properties should not be placed in the area that could flood if a culvert blocks and the exceedance flows from such an event should be built into the site masterplan. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.
Key Messages		The flood risk element of the Exception Test is likely to be passed if: • Development is limited to the 94.2% of the site located outside of the Environment Agency's Flood Zone 2 and 3. There is also a risk of surface water flooding which must be considered to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere. • Areas in Flood Zone 1 and then 2 are used for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. • If flood mitigation measures are implemented then they are tested to ensure they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another) • Space for green infrastructure should be considered in the areas of highest flood risk. • Safe access and egress routes must not be in the areas of high surface water risk or the 100-year fluvial design flood event (taking into account climate change). Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the detailed model of the River Dove developed for this SFRA and the Risk of Flooding from Surface Water map. It should be noted that the outputs of the detailed modelling may vary to the Environment Agency's Flood Map for Planning.

Flood Zones	Flood Zones 2 and 3 have been taken from the detailed model of the River Dove developed for this SFRA.
Climate change	35% and 65% climate change allowances have been run as part of this SFRA.
Fluvial depth, velocity and hazard mapping	Fluvial depth, velocity and hazard mapping has been taken from the detailed completed as part of the Level 2 SFRA. This should be explored further at site-specific stage.
Surface Water	The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping	The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.

Site name	SS0264 Ashes Farm, Stowmarket
Site area (ha)	22.76

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Babergh Mid Suffolk District Working Together

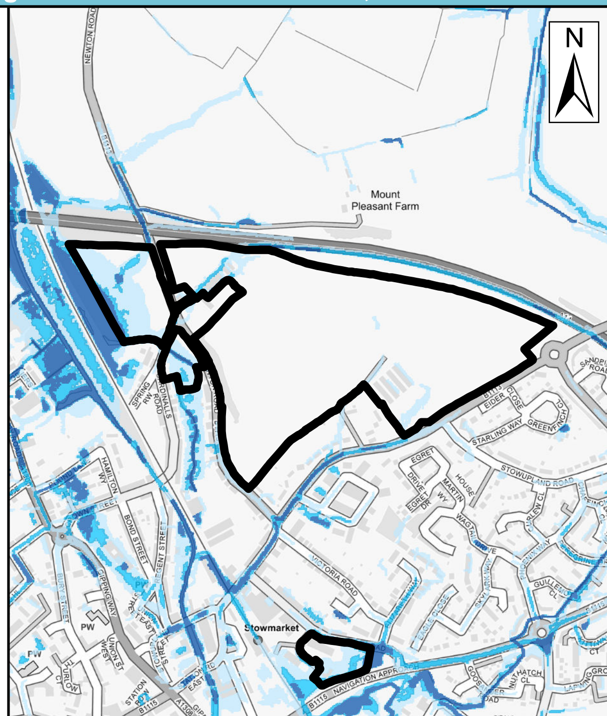
JBA consulting

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 150 300 Metres



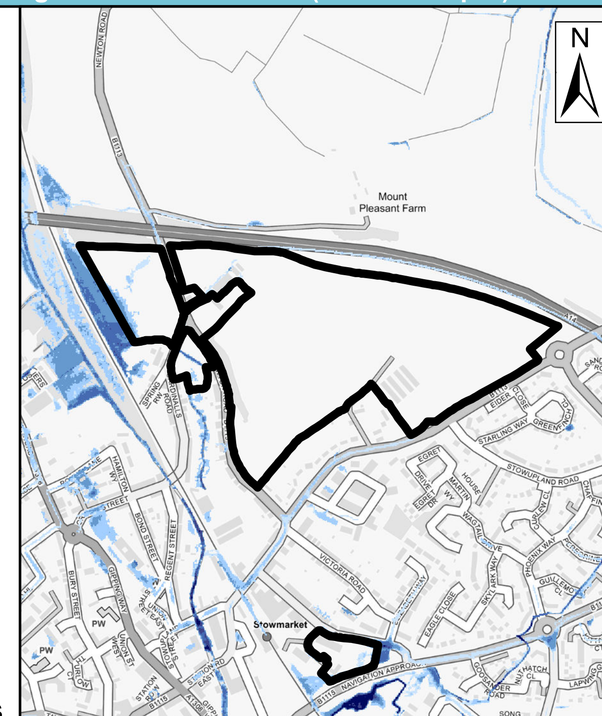
Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 150 300 Metres



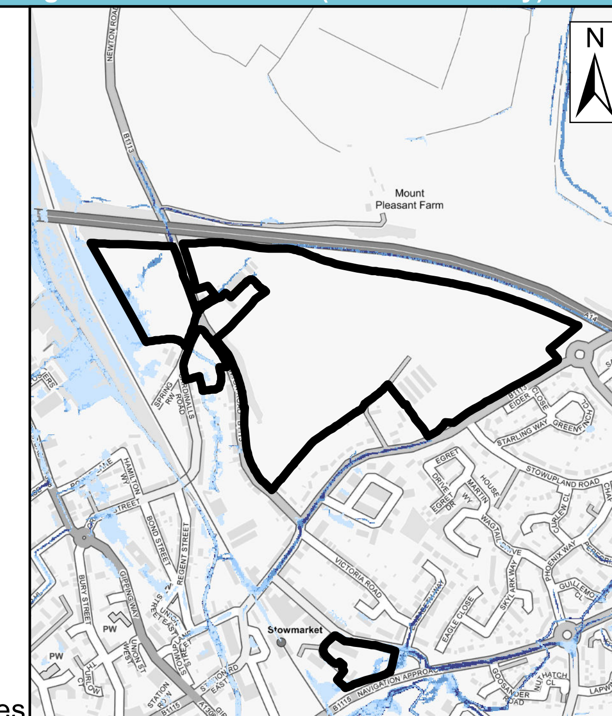
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 150 300 Metres



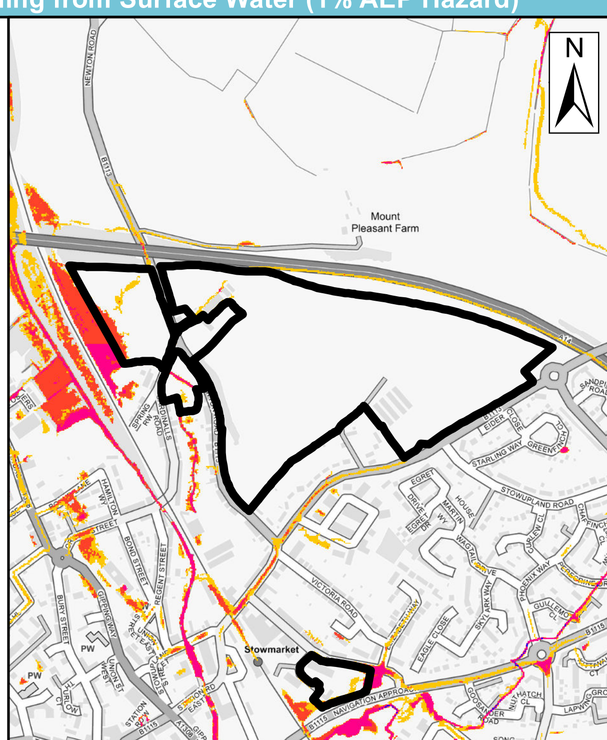
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 150 300 Metres



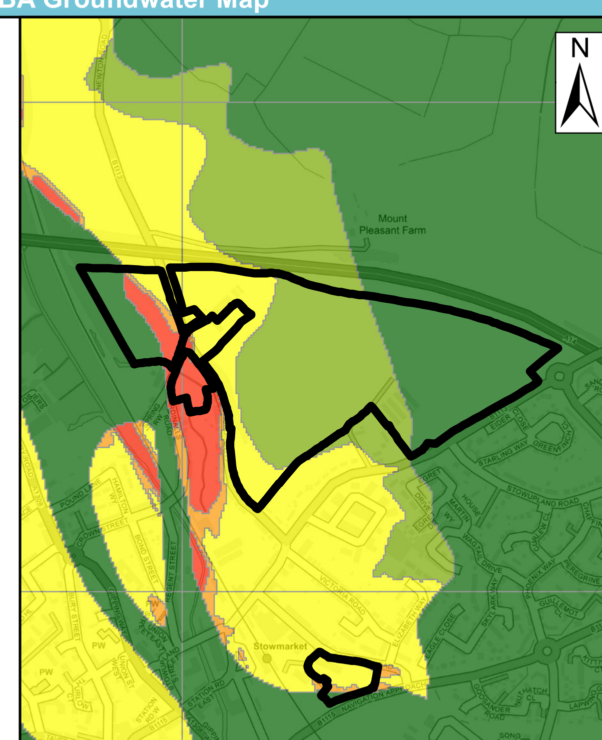
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 150 300 Metres

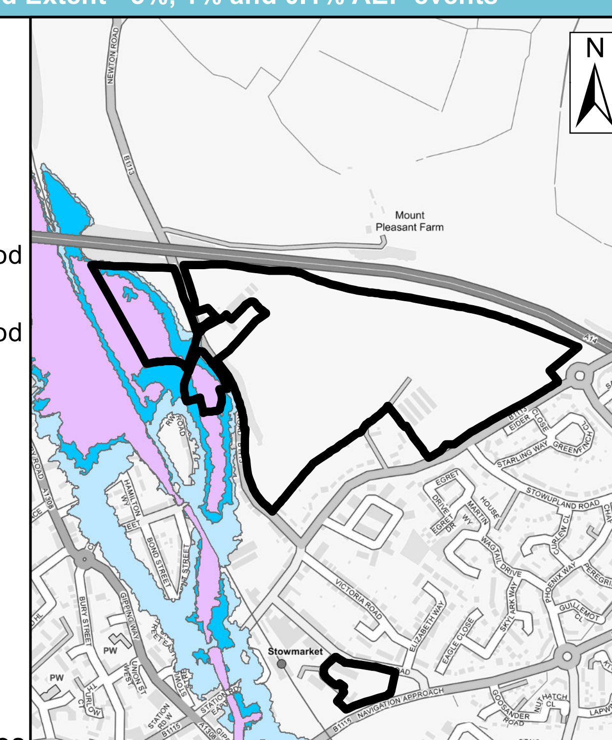


Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 150 300 Metres



Site name	SS0264 Ashes Farm, Stowmarket
Site area (ha)	22.76

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

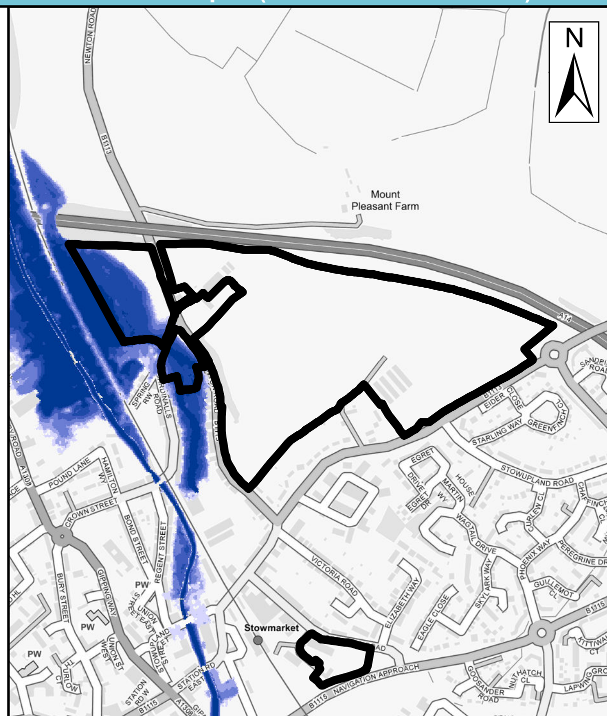
Fluvial Flood Depth (1% AEP undefended)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 150 300 Metres



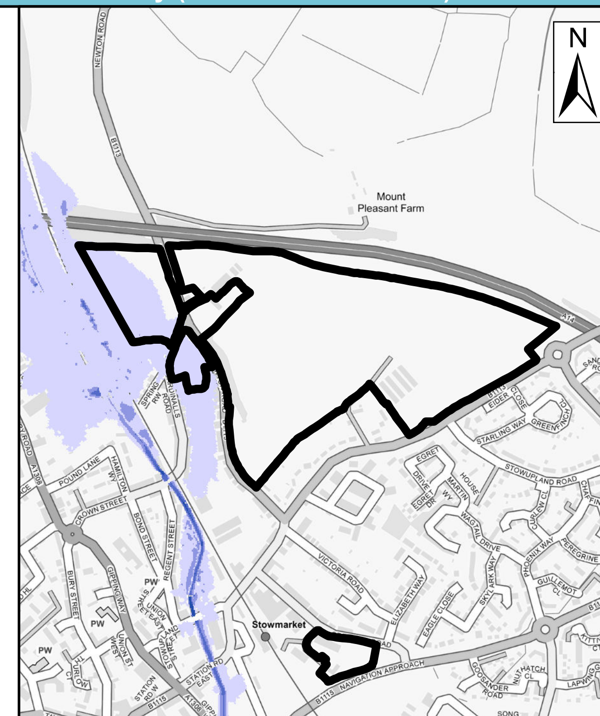
Fluvial Flood Velocity (1% AEP undefended)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 150 300 Metres



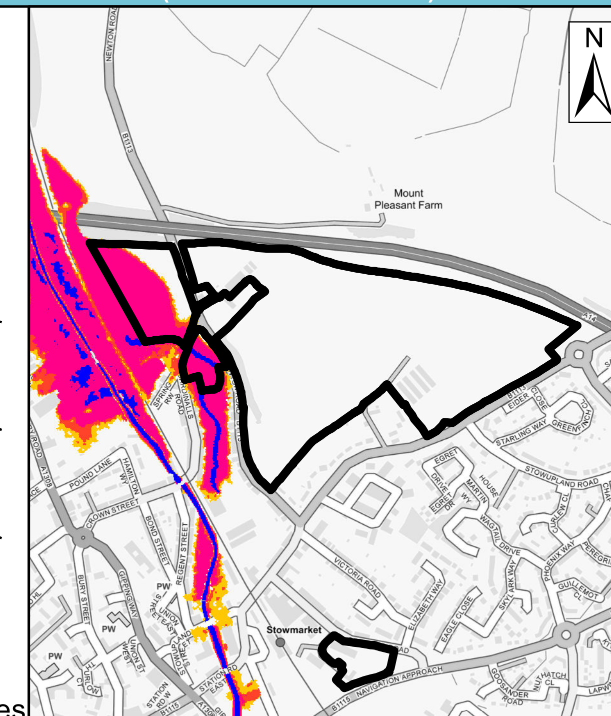
Fluvial Flood Hazard (1% AEP undefended)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 150 300 Metres

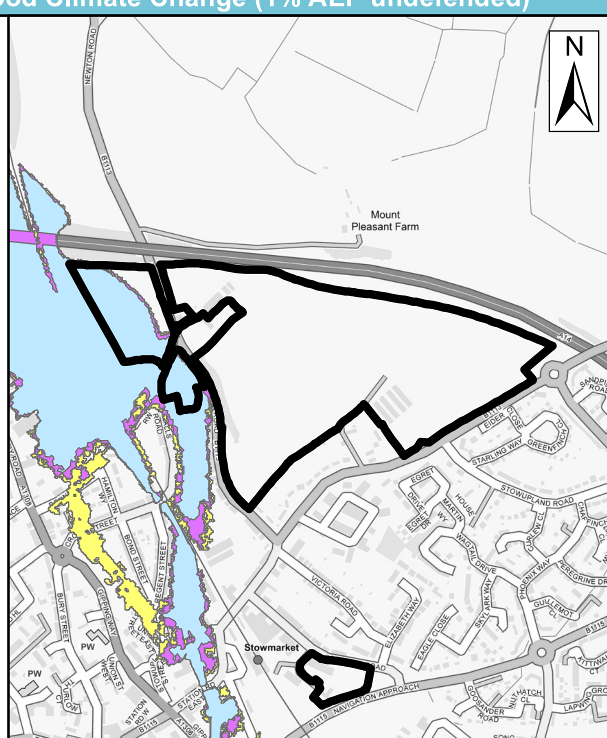


Fluvial Flood Climate Change (1% AEP undefended)

Legend

- 1% AEP flood extent (undefended)
- 1% AEP+ 35% CC flood extent (undefended)
- 1% AEP+ 65% CC flood extent (undefended)

0 150 300 Metres

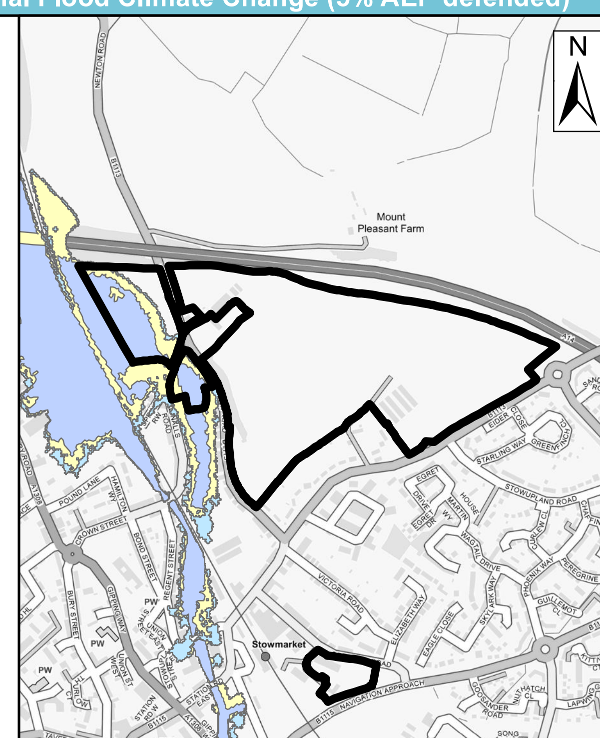


Fluvial Flood Climate Change (5% AEP defended)

Legend

- 5% AEP flood extent (defended)
- 5% AEP + 35% CC flood extent (defended)
- 5% AEP + 65% CC flood extent (defended)

0 150 300 Metres

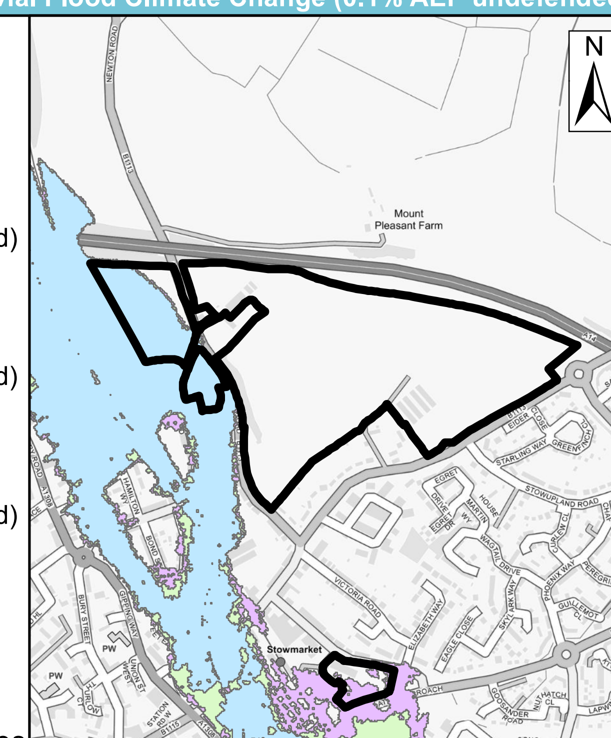


Fluvial Flood Climate Change (0.1% AEP undefended)

Legend

- 0.1% AEP flood extent (undefended)
- 0.1% AEP +35% CC flood extent (undefended)
- 0.1% AEP +65% CC flood extent (undefended)

0 150 300 Metres



Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

Site details		
	Site Code	**SS0264**
	Address	Ashes Farm, Stowmarket
	Area	22.8ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential

Sources of flood risk

Location of site within catchment	The site is located within the River Gipping. The River Gipping flows in a south easterly direction, approximately 200m east of the site, through Stowmarket.
Existing drainage features	The River Gipping converges just north of the site, with a flood storage area to the west of this, and flows south easterly adjacent to the north west of the site. There is a smaller watercourse, the Cardinall Road Drain, which flows through the north western portion of the site, and is then culverted under the railway line where it re-joins the River Gipping.

Fluvial

Proportion of Site at Risk			
FZ3b	**FZ3a**	**FZ2**	**FZ1**
7.3%	10.9%	12.0%	88%

Highest Zone of Risk (Risk of Flooding from Rivers and Sea)

Majority of site - Very Low
Area around the River Gipping - Medium to High

The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)

Available Data:

For this site, the existing detailed Flood Modeller-TUFLOW River Gipping model (2012) was available, which is 1D-2D at the location of this development site. This model is included in the EA flood zones. As part of the Level 1 SFRA, this model has been run with the 35% and 65% climate change allowances on the 20-year defended, and 100 and 1000-year undefended models.

Flood Characteristics:

The detailed modelling shows that the north western portion of the site is impacted by fluvial flooding from the River Gipping. There is no difference in the defended and undefended outlines at the site.

In the 20-year event (Flood Zone 3b), flooding is shown along the north west corner of the site, with extents halfway to Newton Road. Depths of up to 2m are found along Cardinall Road Drain and velocities are less than 0.2m/s.

The flood extents slightly increase in the 100-year event, and a greater proportion of the west of the site is within them, although still not extending beyond Newton Road. Depths over 2m are found along Cardinall Road Drain and velocities are less than 0.4m/s

In the 1000-year event, flood depths and extent increase. Flooding does not extent east of Newton Road. Depths over 3m are found along Cardinall Road Drain. Velocities are less than 0.5m/s.

Surface Water

Proportion of site at risk (RoFfSW)		
30-year High Risk	**100-year Medium Risk**	**1,000-year Low Risk**
1.1%	2.5%	11.6%
Max depths (m)		
0.3-0.9	0.3-0.9	>0.9
Max velocity (m/s)		
<0.25	>0.25	>0.25

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0264**
	Address	Ashes Farm, Stowmarket
	Area	22.8ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).
		Description of surface water flow paths: There are surface water flow paths corresponding with the River Gipping which flows south eastward adjacent to the site, and the Cardinall Road Drain which goes though the west of the site before it is culverted, although the mapping is likely not to be picking up this culverted section. There is also water across the north of the site, where the site is shown to flood between the River Gipping and the A14. In the 30-year event, there is a small isolated area of surface water south east of the existing development, with depths less than 0.3m. The area in the north west corner of the site, there is a larger section of surface water pooling, which then flows down to the unmarked watercourse which runs through the site. This has depths between 0.3 and 0.9m. In the 100-year event, there is greater water to the south east of the existing development, but also north of them, with depths of 0.3m. There are greater extent of water in the north west corner which has depths between 0.3 and 0.9m, with a small area of isolated water slightly further in with a depth of below 0.3m. The 1000-year event is again, an extension on the existing areas of flooding in the 30 and 100-year events. A small section of the southern area of the north west extent is greater than 0.9m, however the majority of the other areas varies between 0.3m – 0.9m.
	Reservoir	The western edge of the site, the area between the River Gipping and Newton Road, is shown to be at risk of reservoir flooding from the available online maps. The maximum extent of reservoir flooding is shown from downstream of Spikes Lane and this extends beyond the site boundary through Stowmarket. The online maps show that reservoir flooding could cause flood depths on the site of between 0.3 and 2m in the area west of Newton Road. Flood velocities on the site are shown to be below 0.5m/s. As exact depths and velocities are not available, it is not possible to make an exact estimate of flood hazard, however it is possible to estimate this based on the range of values available. As a conservative approach, taking the maximum depth of 2m, velocity of 0.5m/s and debris factor of 1, using the U.K. Hazard Rating formula D*(V+0.5)+DF (D= depth, V=velocity and DF = debris factor) this would give a hazard of 3, which would count as an extreme hazard and a danger for all. Taking a low range of values, so a depth of 0.3m, velocity of 0.1m/s and debris factor of 1 would give a hazard of 1.18, so a moderate hazard and danger for some. Given the potential risk of reservoir flooding in the area between the River Gipping and Newton Road, development should be steered away from this area to avoid any potential loss of life or damage to buildings in the event of dam failure. In the event of emergency drawdown of the reservoir, river levels may become artificially raised above normal levels.

<table>
<tr><td colspan="5">Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table</td></tr>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="3">SS0264</td></tr>
<tr><td>Address</td><td colspan="3">Ashes Farm, Stowmarket</td></tr>
<tr><td>Area</td><td colspan="3">22.8ha</td></tr>
<tr><td>Current Land Use</td><td colspan="3">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="3">Residential</td></tr>
<tr><td rowspan="2"></td><td>Groundwater</td><td colspan="3">The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. They are as follows:
The eastern end of the site, alongside the far west section are considered no risk. The middle portion of the site is considered to have groundwater at least 5m below the ground surface so is at low risk of groundwater flooding. The western middle section, either side of Newton Road, has groundwater levels between 0.5 and 5m below the ground surface and so this area is at medium to low risk of groundwater flooding during a 1% AEP event. A small section along the eastern top corner of the site has a strip of groundwater between 0.025m and 0.5m so is at medium to high risk, and a strip of groundwater either at or very near 0.025m which is at high risk. Within high risk areas, there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots.
This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site specific FRA stage.</td></tr>
<tr><td>Flood History</td><td colspan="3">There are no records of historic flooding at the site from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset. There is one flood event recorded in the BMSDC records on the B1113, adjacent to the south of the site. This was in December 2019, and was caused by a drain on the footpath.</td></tr>
<tr><td rowspan="4">Flood risk management infrastructure</td><td rowspan="3">Defences</td><td>Defence Type</td><td>Standard of Protection</td><td>Condition</td></tr>
<tr><td>Reservoir embankment</td><td>25 years</td><td>2/3</td></tr>
<tr><td colspan="3">The Environment Agency Spatial Flood Defences layer shows there is a reservoir embankment, north of the A14, with a design standard of 25 years. This is approximately 250m north of the site.</td></tr>
<tr><td>Residual risk</td><td colspan="3">There is a culvert which may impact the site if blockages were to occur. It is located under the railway to the south west of the site, and if it was blocked, there is potential for increased surface water and fluvial flooding across the site. It is recommended that the potential for blockage on all structures affecting the site should be considered as part of any future site-specific assessment.
The site is at risk of flooding due to reservoir breach. The Environment Agency online mapping shows that maximum extent of flooding from the reservoirs upstream of the site on the River Gipping would affect the site to the west of Newton Road.</td></tr>
<tr><td rowspan="2">Emergency planning</td><td>Flood warning</td><td colspan="3">The western side of the site, east of Newton Road, is covered by the Rattlesden River and River Gipping Flood Alert Area, through and including Stowmarket and Needham Market, and the Flood Warning Area for the River Gipping from the A14 at Stowmarket to upstream of Needham Market.</td></tr>
<tr><td>Access and Egress</td><td colspan="3">The south of the site runs along the Stowupland Road (B1113), and there is a small residential road which enters the site roughly a third of the way along the B1113 from the left. To the north and east, the site is bordered by the A14. To the west of the site, Newton Road (B1113) boarders the site to about halfway up. North of this, the site crosses Spring Row, and is the bound by the railway line.
In terms of fluvial flood risk, the model results show flooding across Spring Row in all return periods, due to the presence of the Cardinall Road Drain. This flow path would impact access and egress along this road to the site, and then further south to Cardinalls Road. The fluvial flood path doesn't encroach onto the A14</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0264**
	Address	Ashes Farm, Stowmarket
	Area	22.8ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		to the north and east, and the Stowupland Road (B1113) to the south-east. Newton Road (B113) is partially affected to the west of the site. In terms of surface water risk, the flow paths cross again across Spring Row in all return periods, and would impact access and egress to the site. Newton Road (B1113) to the south experiences surface water flooding, and this could impact the residential road to the south of the site. There is also water along this road in the 1000yr return period. Stowupland Road is at risk of surface water flooding south of the site, but the site could be accessed from the east where there is very low risk of flooding.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity, hazard and frequency of fluvial flooding from the River Gipping and surface water flooding across the site. • 1D-2D detailed modelling was available for the River Gipping, including allowances for climate change that were run for the Level 1 SFRA. The 20-year defended and 100-year and 1000-year undefended scenarios were uplifted by 35% and 65% to allow for climate change. The extent increases in both scenarios and slightly more into the site, however the change is small and suggests that the site has low sensitivity to climate change. When including climate change, flood risk is still constrained to Newton Road and the area of the site to the west of this. • Climate change also needs to be considered for surface water events; at the site-specific stage. The 100-year event with a 40% allowance for climate change should be considered as part of surface water drainage design strategies, or surface water modelling. • The current day 1,000-year surface water extent provides an indication of the possible increase in extent of the 100-year event. It is likely that surface water flooding will impact a larger portion of the site in the future. The surrounding road networks are also likely to be affected more frequently. A detailed FRA would be required to assess the site layout and design in relation to the impact of climate change of surface water flooding. • The impact of climate change on surface water flood risk will require a detailed FRA to assess the site layout and design. • Developers should consider SuDS strategies to reduce the impacts of climate change from surface water in a detailed site-specific FRA.
Requirements for drainage control and impact mitigation	**Broad scale assessment of possible SuDS**	<u>Geology</u> at the site consists of: • Bedrock: Neogene to Quaternary Rocks (Gravel, sand, silt and clay). • Superficial: Till (Diamicton) <u>Soils</u> at the site consist of: **East Site**: Slowly permeable seasonally wet slightly acid but base rich loamy and clayey soils **West Site**: Lime rich loamy and clayey soils with impeded drainage The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. Proposed

		SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints. The site is not designated by the Environment Agency as previously being a landfill site. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development In the **eastern and far western** portions of the site: • Most source control techniques are likely to be suitable. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk from groundwater. • Infiltration may be suitable. Mapping suggests a low risk of ground water flooding however, site investigations should be carried out to assess potential for drainage by infiltration. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone. • Mapping suggests that the site slopes are suitable for all forms of detention. If the site has contamination or groundwater issues; mitigation measures will be required. • A filtration feature is probably suitable provided site slopes are <5% and the depth to the water table is >1m. If the site has contamination or groundwater issues; mitigation measures will be required. • All forms of conveyance, such as swales, are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. Mitigation measures may be required to prevent the egress of groundwater. In the **middle sections** of the site: • Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater. • Mapping suggests that there is a high risk of groundwater flooding at this section of the site, therefore it is likely infiltration techniques will not be suitable. This should be confirmed via site investigations to assess the potential for infiltration. If possible, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone. • Detention features may be suitable, provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required. • Filtration features may not be suitable, due to the water table being within 1m of the ground surface. If the site has contamination or groundwater issues; mitigation measures will be required. • All forms of conveyance are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; mitigation measures will be required. Developers should refer to the Suffolk County Council SuDS guide as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning
NPPF and Planning Implications	**Exception Test Requirements**	The Local Authority have carried out the Sequential Test in line with national guidance. This has supported this site being taken forward for further consideration, including considering if the Exception Test would apply. Residential development is classified as 'More Vulnerable'. As the site is partially covered by Flood Zone 3 and is proposed for residential development, the Exception Test will need to be applied to the site. A sequential approach to site layout will contribute towards passing the flood risk element of the Exception Test, this means that the least vulnerable type of development (in terms of Table 2 of the Flooding section of the NPPG) should be located in the higher flood risk parts of the site. In no instances should highly vulnerable development be located in Flood Zones 3a and 3b. More vulnerable development (such as dwellings) should be located outside Flood Zone 3 whenever possible. Development in the high flood risk parts of the site should be designed such that it is flood resilient and resistant. It

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

JBA consulting

Site details	**Site Code**	**SS0264**
	Address	Ashes Farm, Stowmarket
	Area	22.8ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		is anticipated that proposed development will be sequentially located within Flood Zone 1 on this site.
	Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance; BMSDC Local Plan policies, and Suffolk County Council SuDS guide. • Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage. • All sources of flooding, particularly the risk of fluvial, reservoir, surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment. • Although modelling has been completed as part of this SFRA, detailed modelling of the site will still be required as part of the site-specific FRA to confirm both fluvial and surface water flood risk and flow paths. Detailed modelling would require topographic survey of the site and well as any additional asset survey needed to refine the model further. In addition, the latest guidance on climate change allowances would need to be considered and any mitigation measures would need to be tested through modelling. • The residual risk from culvert blockage should be assessed and suitable mitigation proposed. • The residual risks associated with failure of reservoir must be addressed so that proposed development is safe. Site design should consider recommendations made in the Suffolk Flood Response Plan. The site-specific FRA will need to consider any existing emergency plans in place related to the reservoir. • The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF. • The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. • Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF. • Development in FZ3 may require floodplain compensation and this should be confirmed with the EA at FRA stage. **Guidance for site design and making development safe:** • The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0264**
	Address	Ashes Farm, Stowmarket
	Area	22.8ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure both fluvial and surface water flows can pass through the site is essential. • The River Gipping and Cardinal Drain is classified as a Main River, therefore it is likely an Environmental Permit will be required from the Environment Agency. • If existing culverts are to be kept, a full CCTV condition survey is required to ensure the culvert will be sound for the lifetime of the proposed development. Improvements should be sought, such as trash screens compliant with the latest Environment Agency guidance and relining where this is appropriate and sustainable option. • For any culverts (old or new), the developer must set out who is adopting and maintaining those culverts throughout the lifetime of the development. The design of the development must take into account the residual risk of blockage e.g. properties should not be placed in the area that could flood if a culvert blocks and the exceedance flows from such an event should be built into the site masterplan. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

JBA consulting

Site details	**Site Code**	**SS0264**
	Address	Ashes Farm, Stowmarket
	Area	22.8ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential

Key Messages	The flood risk element of the Exception Test is likely to be passed if: • Development is limited to the 88% of the site located outside of the Environment Agency's Flood Zone 2 and 3. This is land to the east of Newton Road. It is recommended that no development is undertaken between the River Gipping and Newton Road as this area of the site is at risk of fluvial and reservoir flooding. There is also a risk of surface water flooding which must be considered to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere. • Areas in Flood Zone 1 and then 2 are used for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. • If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another) • Space for green infrastructure should be considered in the areas of highest flood risk. • Safe access and egress routes must not be in the areas of high surface water risk or the 100-year fluvial design flood event (taking into account climate change). Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the outputs from the existing 1D-2D model of the River Gipping (re-run as part of this SFRA for climate change) and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.

Flood Zones	Flood Zones 2 and 3 have been taken from the existing 1D-2D model of the River Gipping.
Climate change	Environment Agency 35% and 65% climate change allowances were modelled as part of detailed hydraulic modelling study completed for the Level 1 and Level 2 SFRA.
Fluvial depth, velocity and hazard mapping	Fluvial depth, velocity and hazard mapping has been taken from the detailed hydraulic model developed as part of the Level 2 SFRA. This information should be explored further at site-specific stage.
Surface Water	The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping	The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.

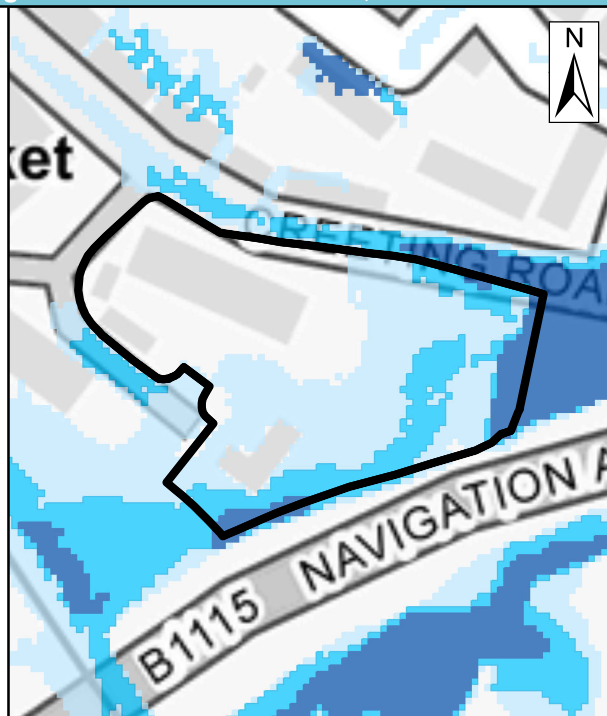
Site name	SS0668 Land south of Creeting Road West, Stowmarket	Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping
Site area (ha)	0.88	

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 25 50 Metres



Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 25 50 Metres

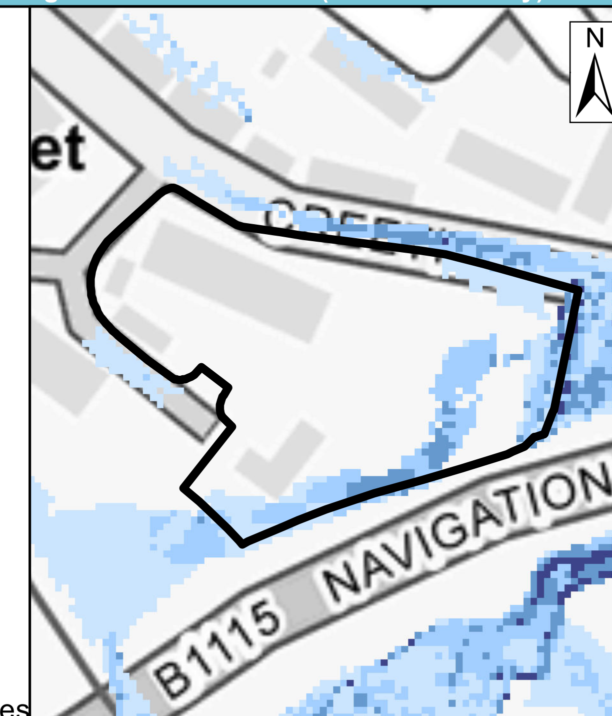
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 25 50 Metres



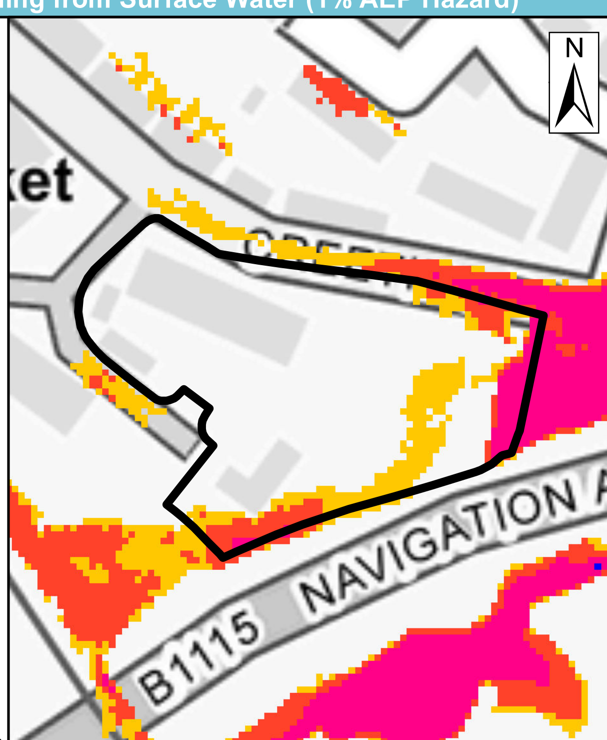
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 25 50 Metres



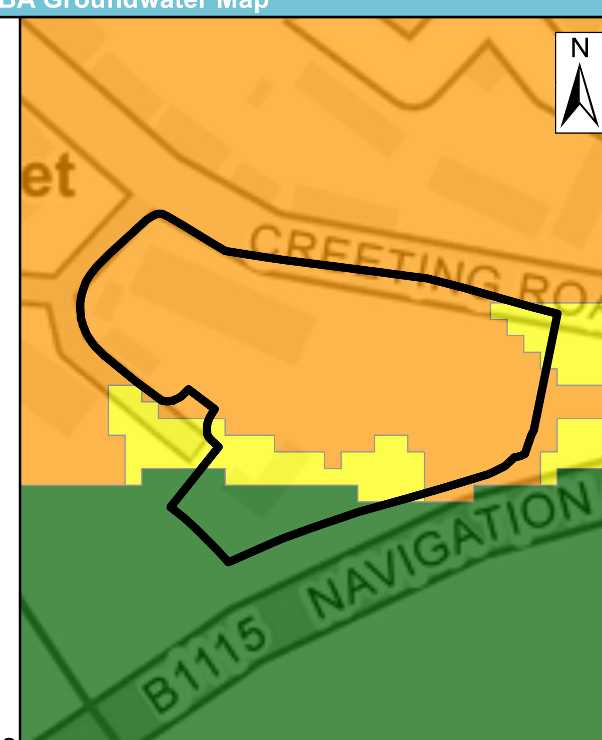
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 25 50 Metres

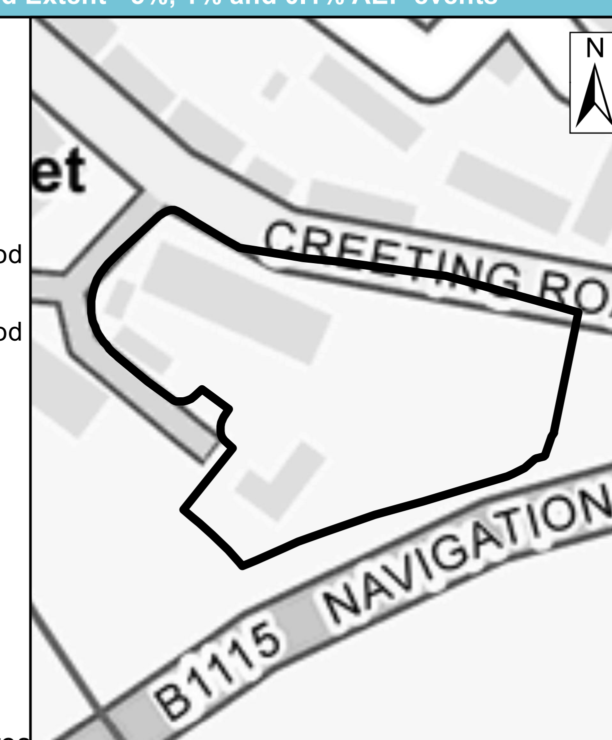


Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 25 50 Metres



Site name	SS0668 Land south of Creeting Road West, Stowmarket
Site area (ha)	0.88

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Fluvial Flood Depth (1% AEP undefended)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 25 50 Metres

Fluvial Flood Velocity (1% AEP undefended)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 25 50 Metres

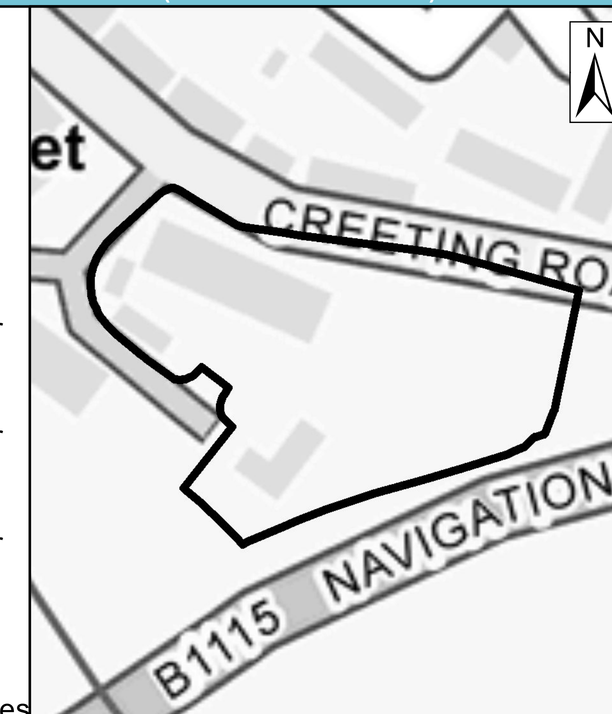
Fluvial Flood Hazard (1% AEP undefended)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 25 50 Metres



Fluvial Flood Climate Change (1% AEP undefended)

Legend

- 1% AEP flood extent (undefended)
- 1% AEP+ 35% CC flood extent (undefended)
- 1% AEP+ 65% CC flood extent (undefended)

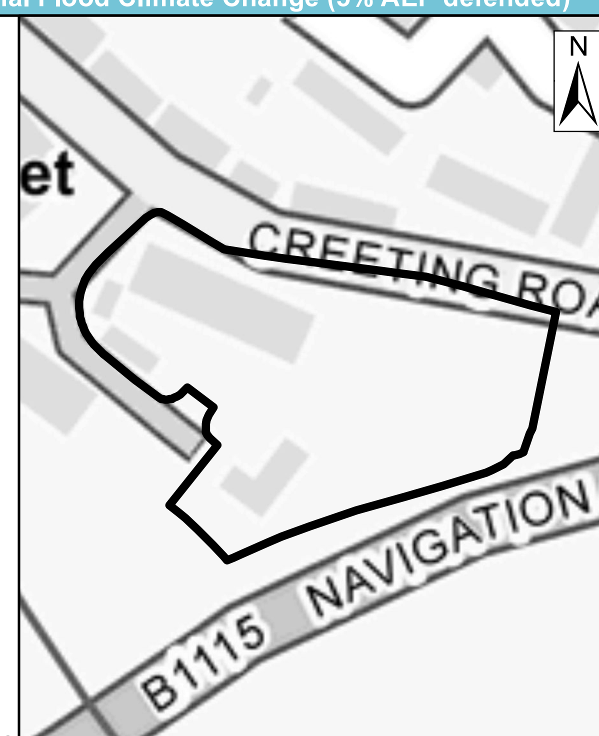
0 25 50 Metres

Fluvial Flood Climate Change (5% AEP defended)

Legend

- 5% AEP flood extent (defended)
- 5% AEP + 35% CC flood extent (defended)
- 5% AEP + 65% CC flood extent (defended)

0 25 50 Metres

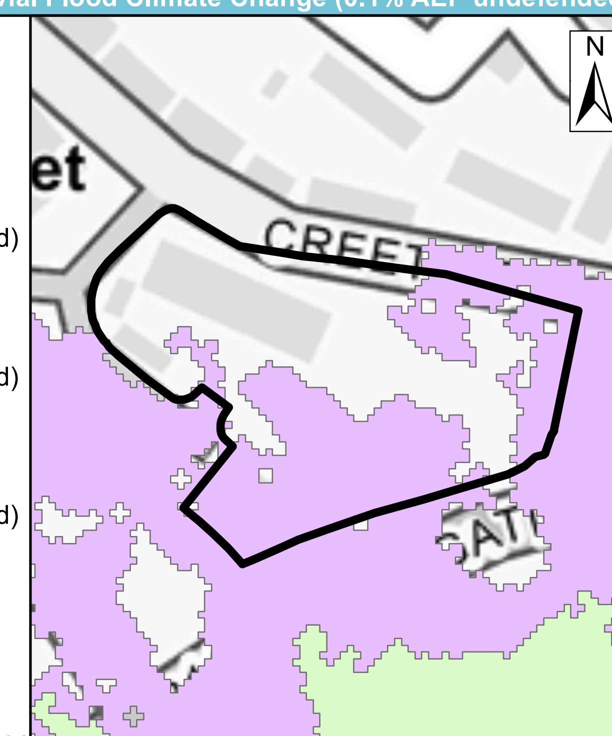


Fluvial Flood Climate Change (0.1% AEP undefended)

Legend

- 0.1% AEP flood extent (undefended)
- 0.1% AEP +35% CC flood extent (undefended)
- 0.1% AEP +65% CC flood extent (undefended)

0 25 50 Metres



Babergh and Mid Suffolk District Councils
Level 2 Strategic Flood Risk Assessment
Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="4">SS0668</td></tr>
<tr><td>Address</td><td colspan="4">Land south of Creeting Road West, Stowmarket</td></tr>
<tr><td>Area</td><td colspan="4">0.88ha</td></tr>
<tr><td>Current Land Use</td><td colspan="4">Industrial</td></tr>
<tr><td>Proposed Land Use</td><td colspan="4">Residential</td></tr>
<tr><td rowspan="20">Sources of flood risk</td><td>Location of site within catchment</td><td colspan="4">The site is located in the River Gipping catchment, and is approximately 200m east of the River Gipping.</td></tr>
<tr><td>Existing drainage features</td><td colspan="4">There is a small tertiary watercourse on the opposite side of Creeting Road to the site, approximately 60m east, which then joins another smaller watercourse and is culverted under the railway for approximately 300 metres until it joins the River Gipping along Iron Foundry Road. Just north of where the culverted waterway joins the River Gipping, and west of the site across the railway, there is a small section of raised wall acting as a flood defence.</td></tr>
<tr><td rowspan="7">Fluvial</td><td colspan="4">Proportion of Site at Risk</td></tr>
<tr><td>FZ3b</td><td>FZ3a</td><td>FZ2</td><td>FZ1</td></tr>
<tr><td>0%</td><td>0%</td><td>0%</td><td>100%</td></tr>
<tr><td colspan="4">Highest Zone of Risk (Risk of Flooding from Rivers and Sea)</td></tr>
<tr><td colspan="4">All of the Site – Very Low</td></tr>
<tr><td colspan="4">The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)</td></tr>
<tr><td colspan="4">Available Data:
For this site, the existing Environment Agency 1D-2D Flood Modeller-TUFLOW River Gipping model (2012) was available. This model has been run with the 35% and 65% climate change scenarios on the 20-year defended and 100 and 1000-year undefended scenarios.
The site is contained within Flood Zone 1, therefore it is not at risk of fluvial flooding.
Flood Characteristics:
The model results shows that the site is located in Flood Zone 1. The site is not at risk of flooding in the 20, 100 or 1000-year flood events.</td></tr>
<tr><td rowspan="9">Surface Water</td><td colspan="4">Proportion of site at risk (RoFfSW)</td></tr>
<tr><td>30-year High Risk</td><td colspan="2">100-year Medium Risk</td><td>1,000-year Low Risk</td></tr>
<tr><td>5.2%</td><td colspan="2">19%</td><td>55.6%</td></tr>
<tr><td colspan="4">Max depths (m)</td></tr>
<tr><td>0.3-0.9</td><td colspan="2">0.3-0.9</td><td>0.3-0.9</td></tr>
<tr><td colspan="4">Max velocity (m/s)</td></tr>
<tr><td><0.25</td><td colspan="2">>0.25</td><td>>0.25</td></tr>
<tr><td colspan="4">The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).</td></tr>
</table>

Babergh and Mid Suffolk District Councils
Level 2 Strategic Flood Risk Assessment
Detailed Site Summary Table

Site details	**Site Code**	**SS0668**
	Address	Land south of Creeting Road West, Stowmarket
	Area	0.88ha
	Current Land Use	Industrial
	Proposed Land Use	Residential
		Description of surface water flow paths: In the 30-year flood event, there is a small isolated pool of surface water in the eastern edge of the site which is toward the junction between Creeting Road and the B1115. The depth here is between 0.3 – 0.9m. There is also a small portion of water in south west corner of the site, along the boundary, with a depth of less than 0.3m. In the 100-year event, there is a greater extent of water in the areas in the 30-year event. Along the eastern edge flood water is shown to extend along the boundary of the site up Creeting Road, with a depth of less than 0.3m. The water is shown to extend further along the south of the site, and nearly joins the isolated pool in the east of the site. This route is a depth of less than 0.3m. In the 1000-year event, the south and east of the site is at risk of flooding, with approximately 50% of the site in the surface water flood extent. This water now links to the flows along the railway line, and down the B1115. The southern boundary and the eastern edge have depths of 0.3 - 0.9m. The surface water encroaching into the centre of the site has a depth of less than 0.3m.
	Reservoir	The site is not shown to be at risk of reservoir flooding from the available online maps.
	Groundwater	The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. They are as follows: The south-western corner of the site is not at risk of groundwater flooding. Just north of this there is a band of the site where groundwater levels are between 0.025m and 0.5m below the ground level, and therefore this area is at medium to high risk of groundwater flooding in the 1% AEP event. There is also a small area at the north eastern edge of the site which is also at risk of groundwater flooding 0.025m to 0.5m below the ground. The rest of the site has groundwater levels between 0.5 and 5m below ground surface and therefore is at medium to low risk of groundwater flooding. This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site-specific FRA stage.
	Flood History	There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset. There is one flood event in BMSDC records on Creeting Road, adjacent to the north of the site. This occurred in June 2017, and was caused by a blocked drain.

Flood risk management infrastructure		**Defence Type**	**Standard of Protection**	**Condition**
	Defences	-	-	-
		This site is not protected by any formal flood defences. However, the Environment Agency spatial flood defences dataset (AIMS data) shows that there is raised brick flood defence on the River Gipping, opposite the site, on Station Road East.		
	Residual risk	There is a culvert approximately 200m south of the site, which if blocked, could cause a risk to the small watercourse at the south east of the site. It is recommended that the potential for blockage on all structures affecting the site should be considered as part of any future site-specific assessment.		

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table		JBA consulting
Site details	**Site Code**	**SS0668**
	Address	Land south of Creeting Road West, Stowmarket
	Area	0.88ha
	Current Land Use	Industrial
	Proposed Land Use	Residential
Emergency planning	**Flood warning**	The western side of the site is covered by the Rattlesden River and River Gipping flood alert area, through and including Stowmarket and Needham Market, and the Flood Warning Area for the River Gipping from the A14 at Stowmarket to upstream of Needham Market.
	Access and Egress	The south of the site runs along Navigation Approach (B1115), and the north east edge of the site is along Creeting Road, which joins the B1115 at the bottom east corner of the site. The west of the site is bounded by the railway line, and the north is a small road which leads to the station. In terms of fluvial flood risk, the model results show there is no flooding on the site, or along the section of roads that border the site. In terms of surface water, there are flow paths across Creeting Road in all return periods, with depths of 0.3-0.9m in all return periods. The southern half of the site experiences surface water flooding, and therefore this will need to be considered for access and egress around the site, and not just on and off the site. The north west of the site is not shown to be at risk of surface water flooding and therefore may be the most appropriate position to access the site.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity, hazard and frequency of surface water flooding across the site. • Detailed modelling has been completed for the River Gipping, including allowances for climate change. The 20-year defended and 100-year and 1000-year undefended scenarios were uplifted by 65% and 35% to allow for climate change. The extent increases in both scenarios for each return period. There is still no flood risk to the site when climate change is taken into account for the 20-year and 100-year events, but in the 1000-year +65% climate change scenario there is shown to be a risk of flooding to the site. • As part of a site-specific Flood Risk Assessment, latest EA climate change allowances will need to be considered in a detailed hydraulic model, to confirm the impact in the site. • Climate change also needs to be considered for surface water events; at the site-specific stage. The 100-year event with a 40% allowance for climate change should be considered as part of surface water drainage strategies, or surface water modelling. • The present day 1000-year surface water extent provides an indication of the possible increase in extent of the 100-year event. It is likely that surface water flooding will impact a larger portion of the site in the future, this is especially true for the southern portion of the site. The surrounding road networks are also likely to be affected more frequently. A detailed FRA would be required to assess the site layout and design in relation to the impact of climate change on surface water flooding. • Developers should consider SuDS strategies to reduce the impacts of climate change from surface water in a detailed site-specific FRA.
Requirements for drainage control and impact mitigation	**Broad scale assessment of possible SuDS**	Geology at the site consists of: • Bedrock: Neogene to Quaternary Rocks (undifferentiated) • Superficial: Till (Diamicton) Soils at the site consist of: Lime-rich loamy and clayey soils with impeded drainage. The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. As such

Site details	**Site Code**	**SS0668**
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<table>
<tr><td></td><td></td><td>
infiltration techniques should only be used where there are suitable levels of treatment although it is possible that infiltration may not be permitted. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints.
The site is not designated by the Environment Agency as previously being a landfill site.
Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development
The majority of the site:

Most source control techniques are likely to be suitable. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater.
Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and underlying soils may be permeable. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable it should be avoided in areas where the depth to the water table is <1m, so specifically in the eastern edge and the south west edge of the site. Additionally, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone.
Detention features may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required.
Filtration features are probably suitable provided site slopes are <5%. If the site has contamination or groundwater issues; mitigation measures will be required.
All forms of conveyance are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access . Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; mitigation measures will be required.

Developers should refer to the Suffolk County Council SuDS guide as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.
</td></tr>
<tr><td>NPPF and Planning Implications</td><td>Exception Test Requirements</td><td>
The Local Authority have carried out the Sequential Test in line with national guidance. The Sequential Test will need to be passed before the Exception Test is applied.
Residential development is classified as ‘More Vulnerable’.
The Exception Test will need to be applied if:

More Vulnerable and Essential Infrastructure development is located in FZ3a and for Highly Vulnerable development located in FZ2.
Highly Vulnerable infrastructure is not be permitted within FZ3a and FZ3b.
More Vulnerable and Less Vulnerable Infrastructure should not be permitted within FZ3b.

No part of the site is within the national Flood Zones that show fluvial flooding. However, there is a significant risk of surface water flooding that must be considered further to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere.
</td></tr>
</table>

Babergh and Mid Suffolk District Councils
Level 2 Strategic Flood Risk Assessment
Detailed Site Summary Table

Site details	**Site Code**	**SS0668**
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	Current Land Use	Industrial
	Proposed Land Use	Residential
	Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare. A Flood Risk Assessment is also required if a development is less than one hectare and in Flood Zone 1, if there is a change of use in development type to a more vulnerable class, or where the development could be affected by sources of flooding other than rivers and the sea (for example surface water drains). • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance, BMSDC Local Plan policies, and Suffolk County Council SuDS guide. • Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage. • All sources of flooding, particularly the risk of surface water flooding, should be considered as part of a site-specific flood risk assessment. • The residual risk from culvert blockage should be assessed and suitable mitigation proposed. • The development should be designed using a sequential approach. Development should be steered away from surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. **Guidance for site design and making development safe:** • The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure surface water flows can pass through the site is essential. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0668**
	Address	Land south of Creeting Road West, Stowmarket
	Area	0.88ha
	Current Land Use	Industrial
	Proposed Land Use	Residential
		modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.
Key Messages		• The site is entirely located in Flood Zone 1 and therefore the Exception Test does not need to be applied. However, there is a significant risk of surface water flooding that must be considered further to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere. • A detailed model of surface water flooding and the existing drainage system using topographical and asset survey should be constructed by the developer at the FRA stage to determine the risk from surface water flooding further and to ensure that surface water overland flows do not overwhelm proposed sustainable drainage features. • Safe access and egress needs to be outside of the areas of surface water flood risk in the east and south of the site. It may be preferential to access the site from the north west where the risk of flooding from surface water is lower. Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the modelling outputs from the River Gipping model and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.

Flood Zones	Flood Zones 2 and 3 have been taken from the Environment Agency's River Gipping model. However the site is located entirely in Flood Zone 1.
Climate change	35% and 65% climate change was modelled as part of this SFRA on the River Gipping. The site was not shown to be at risk of fluvial flooding when considering climate change in the 20-year and 100-year events, however the site was shown to be at risk of flooding in the 1000-year + 65% climate change scenario.
Fluvial depth, velocity and hazard mapping	Fluvial depth, velocity and hazard mapping has been taken from River Gipping model. However the site is located entirely in Flood Zone 1.
Surface Water	The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping	The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.

Site name	SS0711 Land east of Loraine Way, Sproughton
Site area (ha)	3.45

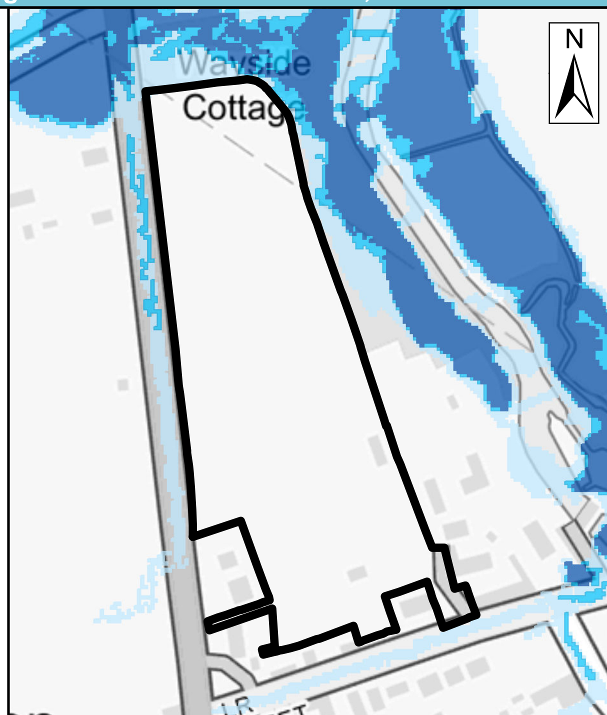
Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 45 90 Metres



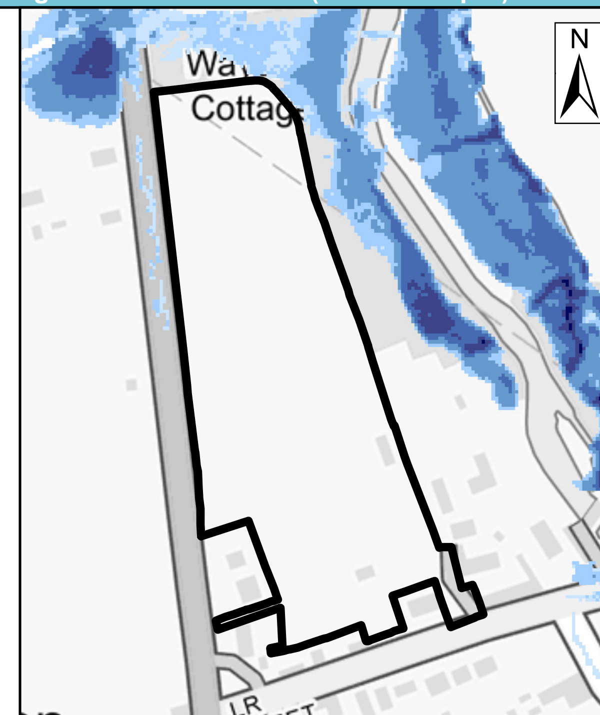
Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 45 90 Metres



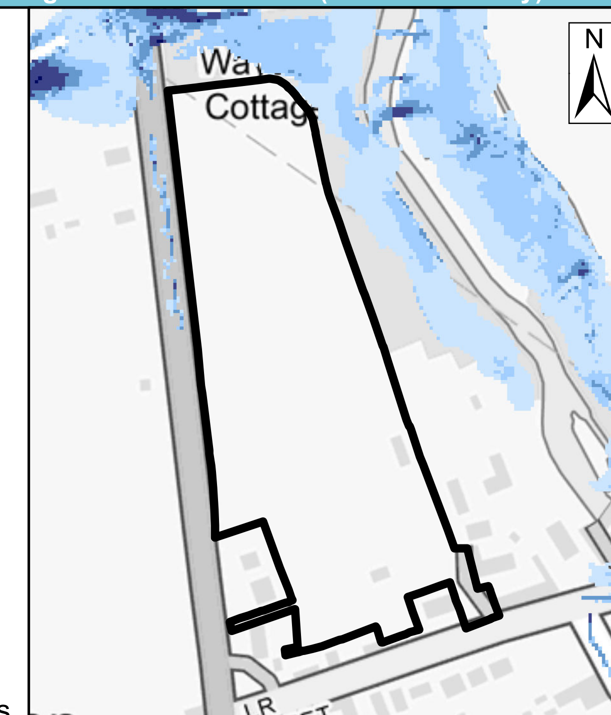
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 45 90 Metres



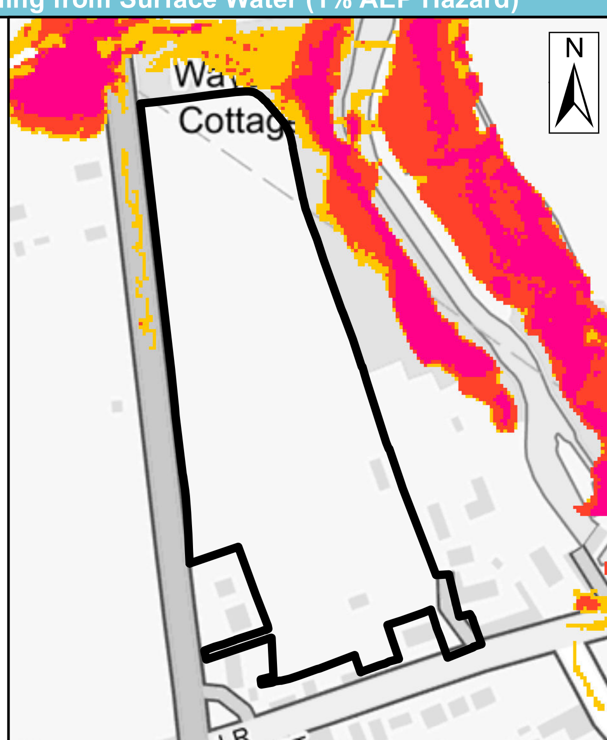
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 45 90 Metres



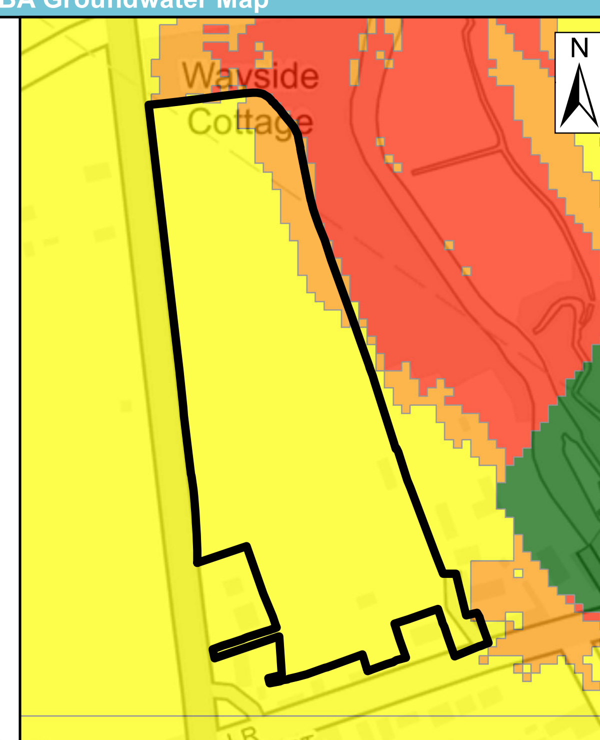
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 45 90 Metres

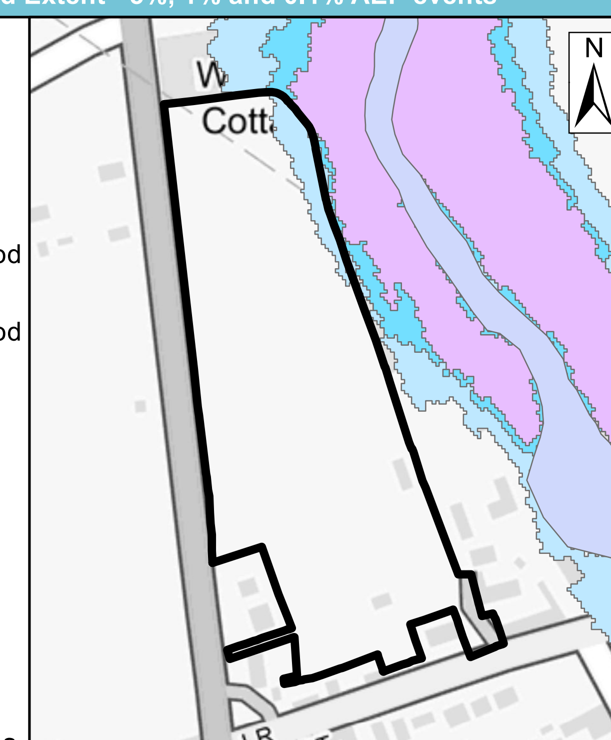


Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 1D Channel
- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 45 90 Metres



Site name	SS0711 Land east of Loraine Way, Sproughton
Site area (ha)	3.45

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

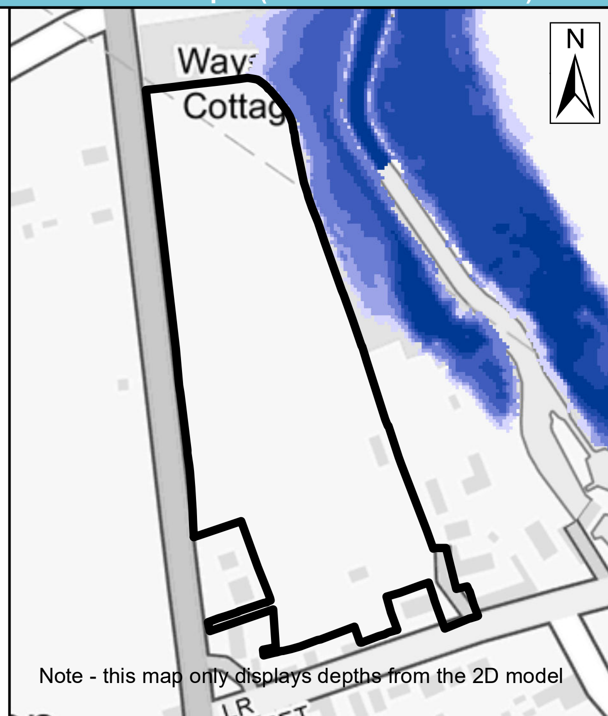
Fluvial Flood Depth (1% AEP undefended)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 40 80 Metres



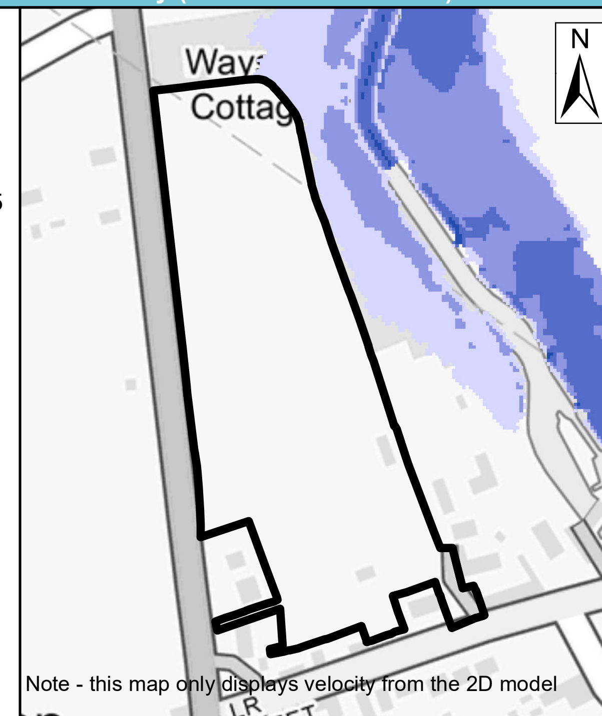
Fluvial Flood Velocity (1% AEP undefended)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 40 80 Metres



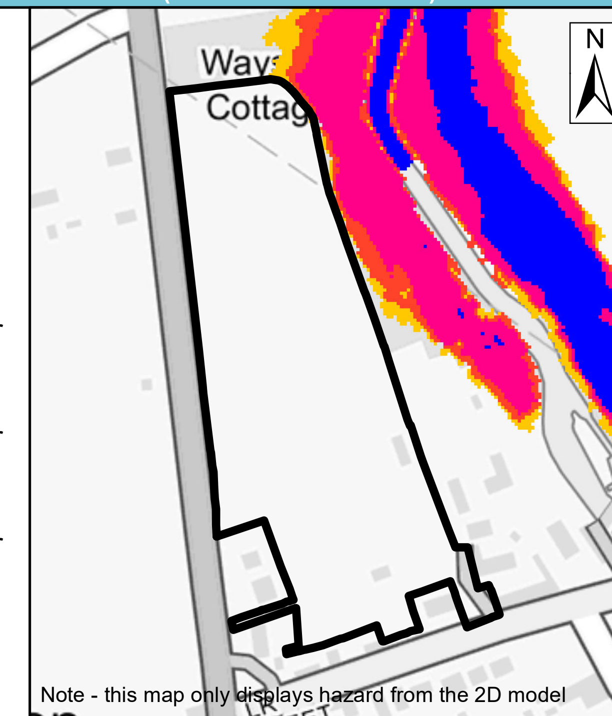
Fluvial Flood Hazard (1% AEP undefended)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 40 80 Metres

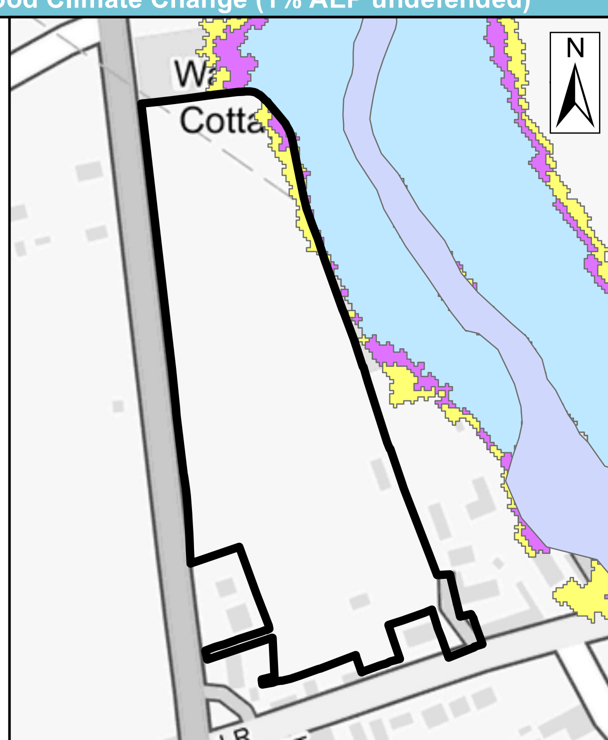


Fluvial Flood Climate Change (1% AEP undefended)

Legend

- 1D Channel
- 1% AEP flood extent (undefended)
- 1% AEP+ 35% CC flood extent (undefended)
- 1% AEP+ 65% CC flood extent (undefended)

0 40 80 Metres

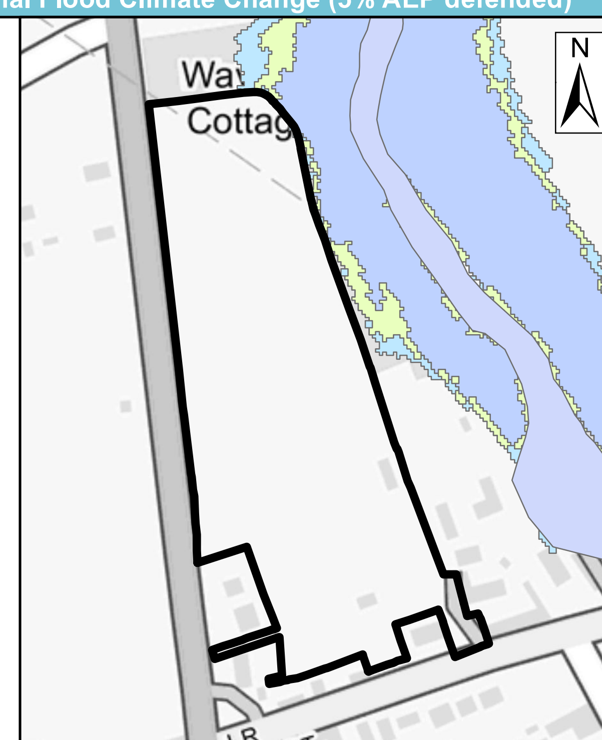


Fluvial Flood Climate Change (5% AEP defended)

Legend

- 1D Channel
- 5% AEP flood extent (defended)
- 5% AEP + 35% CC flood extent (defended)
- 5% AEP + 65% CC flood extent (defended)

0 40 80 Metres

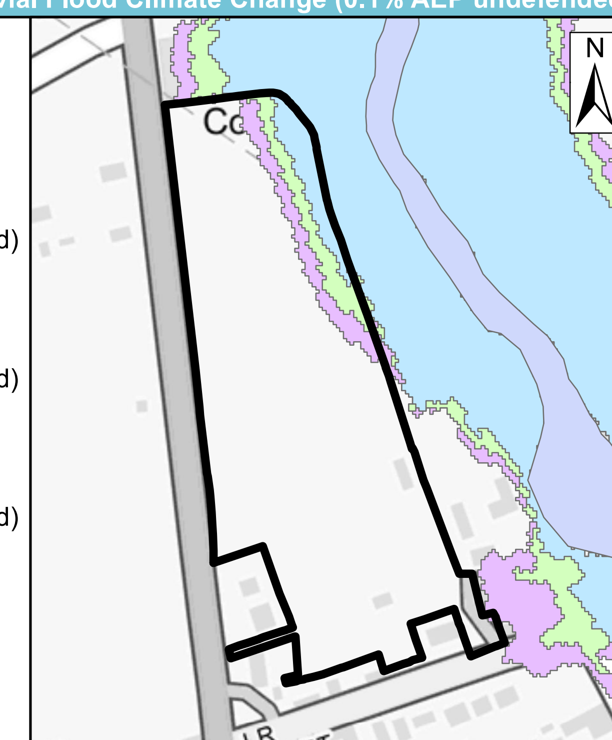


Fluvial Flood Climate Change (0.1% AEP undefended)

Legend

- 1D Channel
- 0.1% AEP flood extent (undefended)
- 0.1% AEP +35% CC flood extent (undefended)
- 0.1% AEP +65% CC flood extent (undefended)

0 40 80 Metres



Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="4">SS0711</td></tr>
<tr><td>Address</td><td colspan="4">Land east of Loraine Way, Sproughton</td></tr>
<tr><td>Area</td><td colspan="4">3.45ha</td></tr>
<tr><td>Current Land Use</td><td colspan="4">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="4">Residential</td></tr>
<tr><td rowspan="10">Sources of flood risk</td><td>Location of site within catchment</td><td colspan="4">The site is contained within the River Gipping catchment.</td></tr>
<tr><td>Existing drainage features</td><td colspan="4">The River Gipping is 30m to the east of the site, and flows in a south-easterly direction. There is a small tertiary watercourse to the north of the site, which joins the River Gipping. There is high ground that confine the River Gipping adjacent to the southern portion of the site. There are some walls south east of the site at Lower Street, however these do not have a design standard of protection.</td></tr>
<tr><td rowspan="8">Fluvial</td><td colspan="4">Proportion of Site at Risk</td></tr>
<tr><td>FZ3b</td><td>FZ3a</td><td>FZ2</td><td>FZ1</td></tr>
<tr><td>0.001%</td><td>0.05%</td><td>4.0%</td><td>96.0%</td></tr>
<tr><td colspan="4">Highest Zone of Risk (Risk of Flooding from Rivers and Sea)</td></tr>
<tr><td colspan="4">Majority of site - Very Low
Area around the River Gipping - Medium to High</td></tr>
<tr><td colspan="4">The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)</td></tr>
<tr><td colspan="4">Available Data:
For this site, the existing detailed FM-TUFLOW River Gipping model (2012) was used. The model has been run with the 35% and 65% climate change allowances on the 20-year defended and 100-year and 1000-year undefended scenarios. As the model was 1D only in the area of interest around the development site, the model has been updated to a 1D-2D model around the development site and re-run for the Level 2 SFRA in order to obtain depth, flow and velocity outputs. There is a difference in level at the site between the 1D only and 1D-2D model, caused by changing from 1D to 2D representation at the structure complex just near the site where the channel splits. On the left bank the original model schematisation does not allow for flow to bypass the sluice at GIPP_4600wu - although the sections are extended there is no way around the structure on the left (only via the right hand channel). In the 1D-2D model flow now goes past here on the left in the 2D which keeps levels lower and so the flood extent on the site is smaller.
Flood Characteristics:
The modelling shows that the north eastern corner of the site is impacted by fluvial flooding associated with the River Gipping.
The 20-year event does not cause fluvial flooding in the site, the 1D-2D model result differs from the 1D only model results previously created for this location. The flood extent sits along the north-eastern site boundary. In the 100-year event, a small section of the north east boundary of the site experiences fluvial flooding, to a depth of 0.1m. The velocity is below 0.1m/s. There is very little difference in the extent of the defended and undefended scenarios. The 1000-year event extent increases on the 100-year event, and a greater proportion of the north east corner is at risk of flooding, although it is still only a small section, increasing to a depth of up to 0.7m.</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="3">SS0711</td></tr>
<tr><td>Address</td><td colspan="3">Land east of Loraine Way, Sproughton</td></tr>
<tr><td>Area</td><td colspan="3">3.45ha</td></tr>
<tr><td>Current Land Use</td><td colspan="3">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="3">Residential</td></tr>
<tr><td rowspan="14"></td><td rowspan="11">Surface Water</td><td colspan="3">Proportion of site at risk (RoFfSW)</td></tr>
<tr><td>30-year
High Risk</td><td>100-year
Medium Risk</td><td>1,000-year
Low Risk</td></tr>
<tr><td>0%</td><td>0%</td><td>0.1%</td></tr>
<tr><td colspan="3">Max depths (m)</td></tr>
<tr><td>-</td><td>-</td><td><0.25</td></tr>
<tr><td colspan="3">Max velocity (m/s)</td></tr>
<tr><td>-</td><td>-</td><td><0.25</td></tr>
<tr><td colspan="3">The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).</td></tr>
<tr><td colspan="3">Description of surface water flow paths:
There is a surface water flow path north of the site which flows eastwards towards the River Gipping. In the 30 and 100-year return periods this does not extend onto the site. In the 1000-year event. only a small section of the flow path (less than 0.1% of the site area) is over the site, along the northern boundary.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Reservoir</td><td colspan="3">The site is not shown to be at risk of reservoir flooding from the available online maps.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site.
Most of the site is covered by groundwater levels between 0.5 and 5m below the ground surface and therefore is at medium to low risk of groundwater flooding. In the north east corner of the site, there is a section which has levels of between 0.025 and 0.5m below the ground surface which is at medium to high risk of groundwater flooding.
This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site specific FRA stage.</td></tr>
<tr><td>Flood History</td><td colspan="3">There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset. There are two flooding events shown in the BMSDC records, one on Lower Street and one on High Street, but both are outside the site boundary. The event on Lower Street was caused by the river overflowing and pooling in the street in 2015. The 2018 event on High Street is flooding on the road, although the cause of flooding is unknown.</td></tr>
<tr><td rowspan="3">Flood risk management infrastructure</td><td rowspan="3">Defences</td><td>Defence Type</td><td>Standard of Protection</td><td>Condition</td></tr>
<tr><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">There are no known flood defences on the site. There is high ground and walls that confine the River Gipping adjacent to the southern portion of the site. The identified raised ground along the River Gipping is likely to act as an informal flood defence on the site. Survey and assessment of these banks would be required as part of a site specific FRA to determine the standard of protection they provide.</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0711**
	Address	Land east of Loraine Way, Sproughton
	Area	3.45ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
	Residual risk	There are several structures near the site along the River Gipping, including a sluice gate and bridge at Lower Street, which may impact the site if blockages were to occur. If it was blocked, there is potential for increased surface water and fluvial flooding across the site. It is recommended that the potential for blockage on all structures affecting the site should be considered as part of any future site-specific assessment.
Emergency planning	**Flood warning**	The western side of the site is covered by the Flood Warning and Flood Alert area of the River Gipping from downstream of Needham Market to upstream of London Road Bridge, Ipswich, including riverside areas at Great Blakenham, Bramford and Sproughton.
	Access and Egress	The site is bound by the River Gipping to the east, as well as fields and a small tertiary watercourse to the north. To the west of the site is Loraine Way, or the B1113, which intersects Lower Street at the south west corner of the site. Lower Street is located along the southern boundary of the site. There are no roads crossing through the site. In terms of fluvial flood risk, the B1113 does not experience any fluvial flooding in all three return periods, and therefore access and ingress to the site on the western side is unaffected. Lower Road to the south of the site is bridged over the River Gipping, and therefore in all three return periods there is water on the road along this section east of the site. Although this section is not immediately south of the site, it could influence traffic and access across the whole road. Additionally, the north east corner of the site does experience fluvial flooding, and therefore any access and ingress to this particular part of the site would be affected in all return periods. As for surface water flood risk, there is no water directly on the site. In the 30-year flood event, surface water crosses the B1113 in the north west corner of the site, and across Lower Street where the bridge is to the south-east of the site. Both of these areas, when blocked, would impact access and ingress to the site. In the 100 and 1000-year events, the extent of water increases and flows down the B1113 and along Lower Street, which could potentially increase the issues of access and egress. In the 1000-year event the depths on Lower Street and High Street adjacent to the site are below 300mm. In the south-west corner of the site High Street is not at risk of surface water flooding, so access may be suitable here.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity, hazard and frequency of fluvial flooding from the River Gipping and surface water flooding across the site. • 1D-2D modelling has been completed for the River Gipping, including allowances for climate change. The 20-year defended and 100-year and 1000-year undefended scenarios were uplifted by 35% and 65% to allow for climate change. The extent increases in both scenarios and slightly more into the north-east of the site. • As part of a site-specific Flood Risk Assessment, latest EA climate change allowances will need to be considered in a detailed hydraulic model, to confirm the impact in the site. • The current day 1,000-year surface water extent provides an indication of the possible increase in extent of the 100-year event. Only the northern boundary of the site is shown to be at risk of surface water flooding. The surrounding road networks are likely to be affected more frequently. A detailed FRA would be required to assess the site layout and design in relation to the impact of climate change of surface water flooding. Developers should consider SuDS strategies to reduce the impacts of climate change from surface water in a detailed site-specific FRA.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td>SS0711</td></tr>
<tr><td>Address</td><td>Land east of Loraine Way, Sproughton</td></tr>
<tr><td>Area</td><td>3.45ha</td></tr>
<tr><td>Current Land Use</td><td>Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td>Residential</td></tr>
<tr><td>Requirements for drainage control and impact mitigation</td><td>Broad scale assessment of possible SuDS</td><td>
Geology at the site consists of:

Bedrock: South-West: Thames Group, North-West: Lambeth Group, and the West: White Chalk Subgroup
Superficial: Alluvium

Soils at the site consist of: Freely draining slightly acid loamy soils. This should be confirmed through infiltration testing, with the use of infiltration maximised as much as possible.
The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.
The site is not designated by the Environment Agency as previously being a landfill site.
Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development
The majority of the site:

Most source control techniques are likely to be suitable. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater.
Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and underlying soils may be permeable. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable it should be avoided in areas where the depth to the water table is <1m. Additionally, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone.
Detention features may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required.
A filtration feature is probably suitable provided site slopes are <5% and the depth to the water table is >1m. If the site has contamination or groundwater issues; mitigation measures will be required.
All forms of conveyance, such as swales, are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access . The slopes are less than 5%. If the site has contamination or groundwater issues; mitigation measures will be required.

Small section along the north east boundary:

Most source control techniques are likely to be suitable. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater.
Mapping suggests that there is a high risk of groundwater flooding at this location, therefore it is likely infiltration techniques will not be suitable. This should be confirmed via site investigations to assess the potential for infiltration. If possible, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone.

</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0711**
	Address	Land east of Loraine Way, Sproughton
	Area	3.45ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		• Detention features may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required. • Infiltration is not suitable in this section, as although the slopes are <5%, the depths of the water table are <1m. • All forms of conveyance are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access. The slopes are less than 5%. If the site has contamination or groundwater issues; a liner will be required. Developers should refer to the Suffolk County Council SuDS guide as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.
NPPF and Planning Implications	**Exception Test Requirements**	The Local Authority have carried out the Sequential Test in line with national guidance. This has supported this site being taken forward for further consideration, including considering if the Exception Test would apply. Residential development is classified as 'More Vulnerable'. As the site is partially covered by Flood Zone 3 (although only 0.05% of the site) and is proposed for residential development, the Exception Test will need to be applied to the site. A sequential approach to site layout will contribute towards passing the flood risk element of the Exception Test, this means that the least vulnerable type of development (in terms of Table 2 of the Flooding section of the NPPG) should be located in the higher flood risk parts of the site. In no instances should highly vulnerable development be located in Flood Zones 3a and 3b. More vulnerable development (such as dwellings) should be located outside Flood Zone 3 whenever possible. Development in the high flood risk parts of the site should be designed such that it is flood resilient and resistant. It is anticipated that proposed development will be sequentially located within Flood Zone 1 on this site.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table		
Site details	**Site Code**	**SS0711**
	Address	Land east of Loraine Way, Sproughton
	Area	3.45ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
	Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance; BMSDC Local Plan policies, and Suffolk County Council SuDS guide. • Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage. • Although modelling has been completed as part of this SFRA, detailed modelling of the site will still be required as part of the site-specific FRA to confirm both fluvial and surface water flood risk and flow paths. Detailed modelling would require topographic survey of the site and well as any additional asset survey needed to refine the model further. In addition, the latest guidance on climate change allowances would need to be considered and any mitigation measures would need to be tested through modelling. • All sources of flooding, particularly the risk of fluvial, surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment. • A detailed hydraulic model will be required to confirm both fluvial and surface water flood risk and flow paths, FZ3b and climate change extents, using channel, asset and topographic survey. The residual risk from culvert blockage should be assessed and suitable mitigation proposed. • The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. • Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF. • Development in FZ3 may require floodplain compensation and this should be confirmed with the EA at FRA stage. **Guidance for site design and making development safe:** • The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0711**
	Address	Land east of Loraine Way, Sproughton
	Area	3.45ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		lengths for essential infrastructure. The need to ensure both fluvial and surface water flows can pass through the site is essential. • As the River Gipping is classified as a Main River, an Environmental Permit will be required from the Environment Agency. • For any culverts (old or new), the developer must set out who is adopting and maintaining those culverts throughout the lifetime of the development. The design of the development must take into account the residual risk of blockage e.g. properties should not be placed in the area that could flood if a culvert blocks and the exceedance flows from such an event should be built into the site masterplan. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.
Key Messages		The flood risk element of the Exception Test is likely to be passed if: • Development is limited to the 96% of the site located outside of the Environment Agency's Flood Zone 2 and 3. • Areas in Flood Zone 1 and then 2 are used for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. • If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another) • Space for green infrastructure should be considered in the areas of highest flood risk. • Safe access and egress routes must not be in the areas of high surface water risk or the 100-year fluvial design flood event (taking into account climate change). Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the detailed 1D-2D hydraulic model of the River Gipping (updated around the development site for this Level 2 SFRA) and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below. It should be noted that the outputs of the 1D-2D modelling vary to the Environment Agency's Flood Map for Planning as this has been based on the outputs where the model was 1D only.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0711**
	Address	Land east of Loraine Way, Sproughton
	Area	3.45ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
Flood Zones		Flood Zones 2 and 3 have been taken from the 1D-2D modelling of the River Gipping which has been updated as part of the Level 2 SFRA as the model was 1D only around the development site. Information on how the model was updated can be found in the technical model report.
Climate change		Environment Agency 35% and 65% climate change allowances were modelled as part of the Level 2 SFRA 1D-2D modelling.
Fluvial depth, velocity and hazard mapping		Fluvial depth, velocity and hazard mapping has been taken from the River Gipping 1D- 2D modelling run as part of the Level 2 SFRA. This should be explored further at site-specific stage.
Surface Water		The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping		The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.

Site name	SS0861 Land south of Church Lane, Claydon
Site area (ha)	6.25

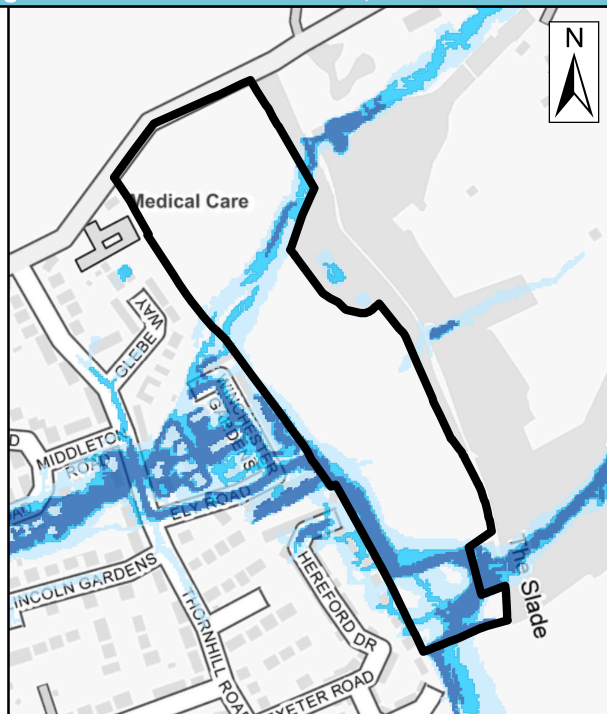
Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 70 140 Metres



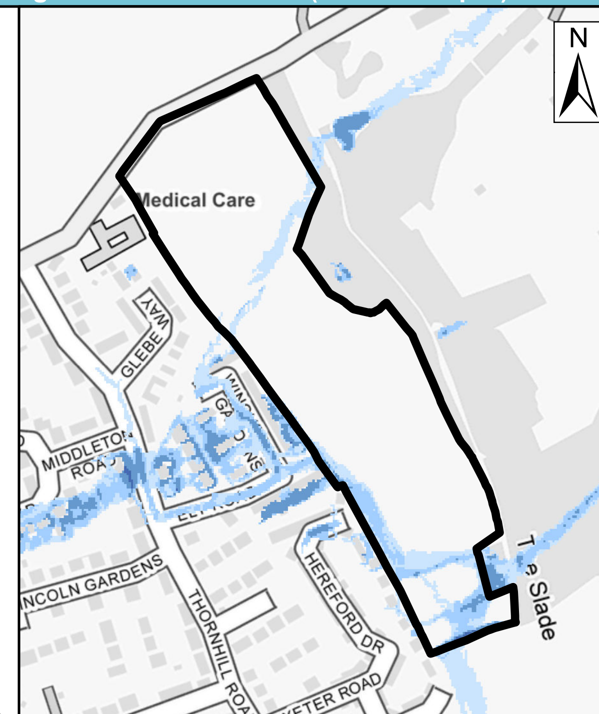
Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 70 140 Metres



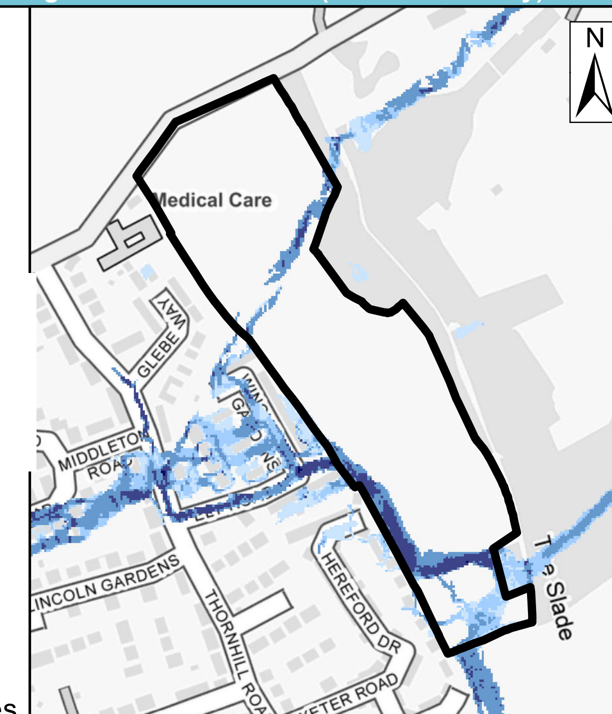
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 70 140 Metres



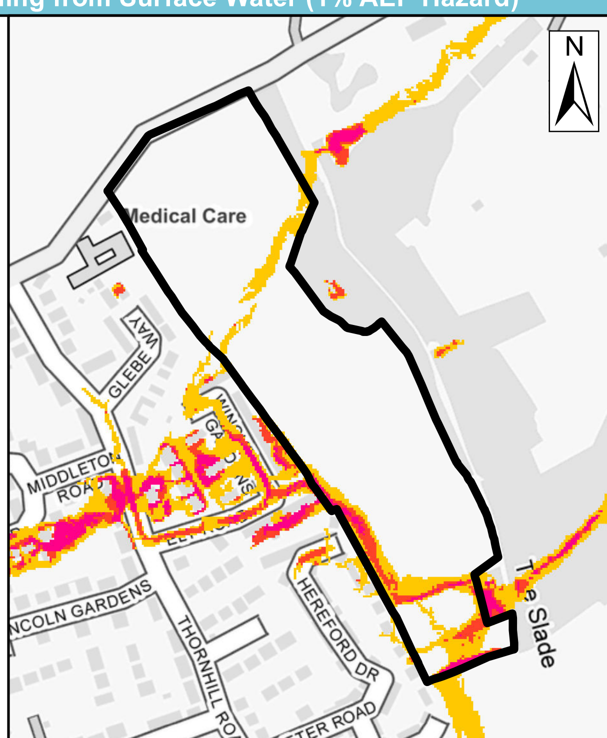
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 70 140 Metres



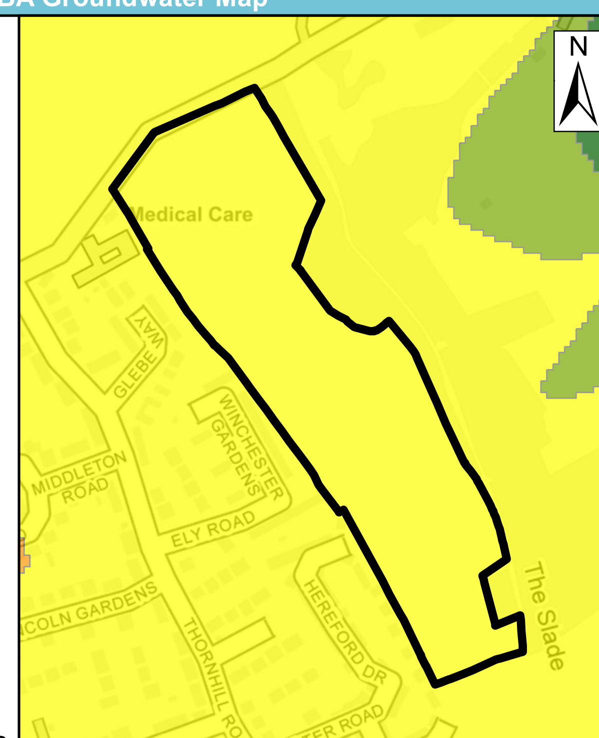
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 70 140 Metres

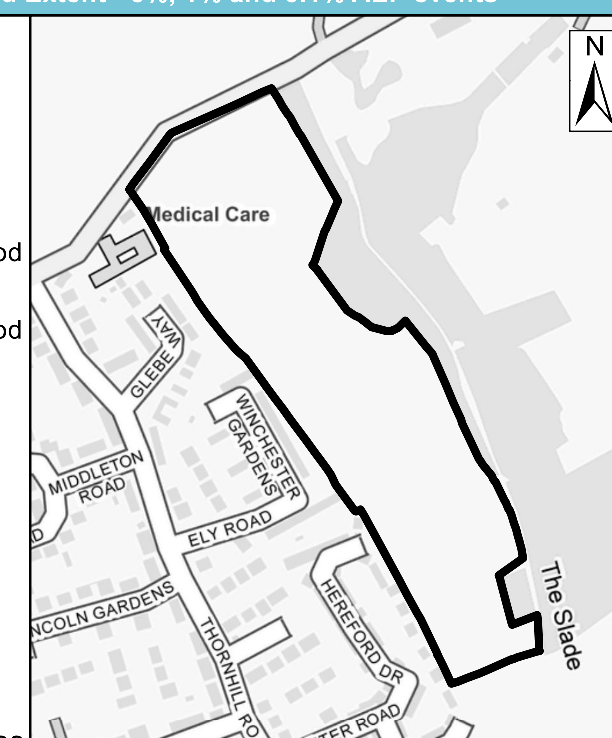


Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 70 140 Metres



Site name	SS0861 Land south of Church Lane, Claydon	Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping
Site area (ha)	6.25	

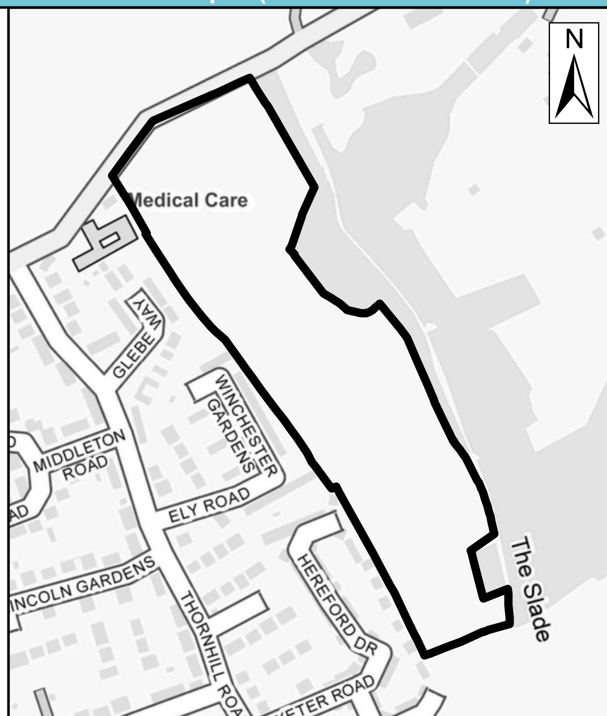
Fluvial Flood Depth (1% AEP undefended)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 70 140 Metres



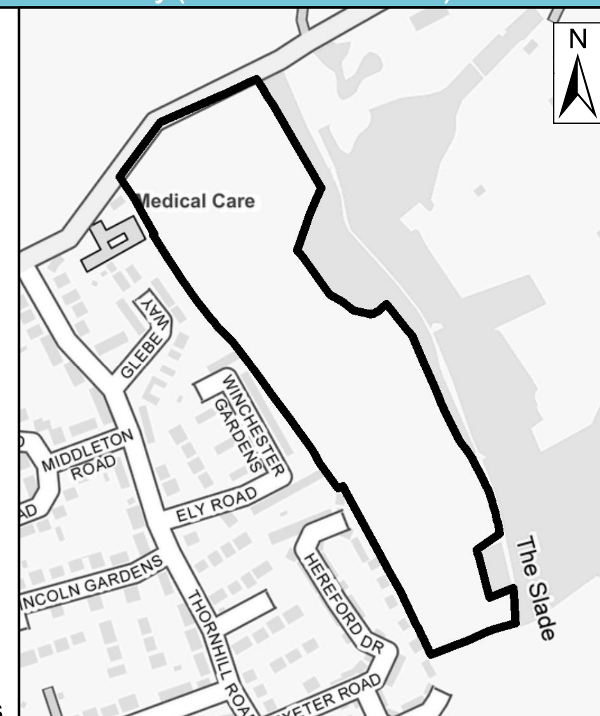
Fluvial Flood Velocity (1% AEP undefended)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 70 140 Metres



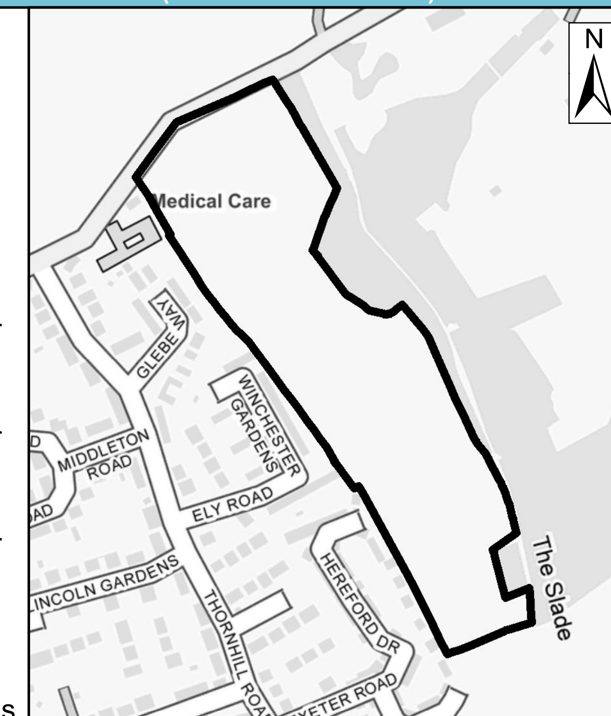
Fluvial Flood Hazard (1% AEP undefended)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 70 140 Metres

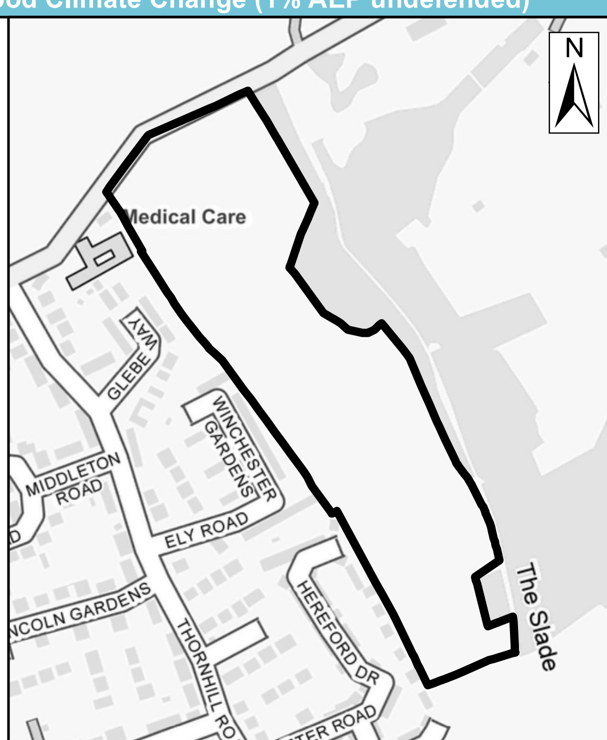


Fluvial Flood Climate Change (1% AEP undefended)

Legend

- 1% AEP flood extent (undefended)
- 1% AEP+ 35% CC flood extent (undefended)
- 1% AEP+ 65% CC flood extent (undefended)

0 65 130 Metres

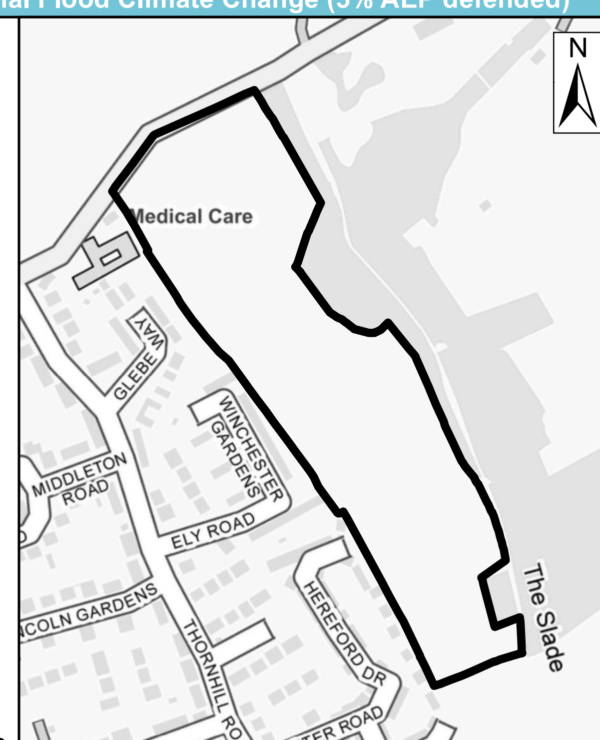


Fluvial Flood Climate Change (5% AEP defended)

Legend

- 5% AEP flood extent (defended)
- 5% AEP + 35% CC flood extent (defended)
- 5% AEP + 65% CC flood extent (defended)

0 70 140 Metres

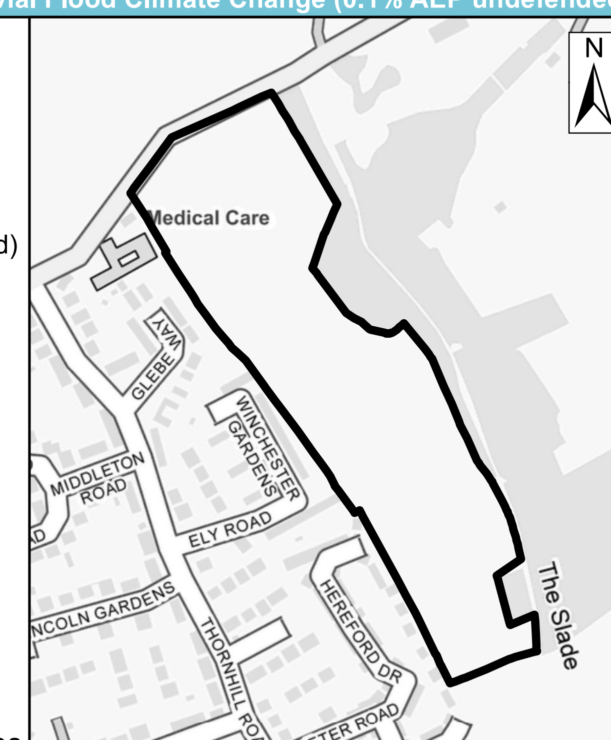


Fluvial Flood Climate Change (0.1% AEP undefended)

Legend

- 0.1% AEP flood extent (undefended)

0 70 140 Metres



Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0861**
	Address	Land South of Church Lane, Claydon
	Area	6.25ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
Sources of flood risk	**Location of site within catchment**	The site is located in the River Gipping catchment, and is approximately 800m east of the River Gipping.
	Existing drainage features	The River Gipping flows in a southerly direction west of the site. This section of the River is bound by sections of high ground either side, with ponds to the east which are bordered to the east by the A14. Just south of Church Lane the River is no longer bound by high ground.

Fluvial

Proportion of Site at Risk			
FZ3b	**FZ3a**	**FZ2**	**FZ1**
0%	0%	0%	100%
Highest Zone of Risk (Risk of Flooding from Rivers and Sea)			
All of the site – Very Low			

The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)

Available Data:

For this site, the existing 1D-2D Flood Modeller-TUFLOW River Gipping model (2012) was available.

35% and 65% climate change allowances are available for the 20-year defended and 100-year undefended scenario.

Flood Characteristics:

The model results shows that the site is located in Flood Zone 1. The site is not at risk of flooding in the 20, 100 or 1000-year flood events, or when climate change is considered for the 20 and 100-year events (35% and 65%).

Surface Water

Proportion of site at risk (RoFfSW)		
30-year High Risk	**100-year Medium Risk**	**1,000-year Low Risk**
5.9%	11%	23.5%
Max depths (m)		
<0.3	<0.3	0.3-0.9
Max velocity (m/s)		
>0.25	>0.25	>0.25

The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="3">SS0861</td></tr>
<tr><td>Address</td><td colspan="3">Land South of Church Lane, Claydon</td></tr>
<tr><td>Area</td><td colspan="3">6.25ha</td></tr>
<tr><td>Current Land Use</td><td colspan="3">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="3">Residential</td></tr>
<tr><td rowspan="4"></td><td></td><td colspan="3">Description of surface water flow paths:
There are 2 main surface water flow paths which cross the site along topographic path towards the River Gipping.
In the 30-year event, the surface water reaches the south east boundary of the site, and splits into two paths; one flows straight across the site and along the western boundary of the site and joins Winchester Gardens, and the other travelling south across and through the site. There is also a small section of the site in the north which has a small isolated section of pooling. All of these areas have depths of less than 0.3m.
In the 100-year event, the flooding is similar to that aforementioned. The flow paths follow the same direction in the south of the site, however the extents of surface water flooding has increased in all directions. The root of these two flows has depths of between 0.3m and 0.9m, however the flow paths are less than 0.3m. Additionally, there is a small area of flooding which joins the two different forks of water to create an isolated section of dry land. The small pool in the north of the site has been extended north east and south west, and now flows in a south westerly direction through the site to join Winchester, with depths less than 0.3m.
In the 1000-year event, the flows are again extended in all directions. In the southern section of the site the extent of surface water flooding increases. There are flood depths of between 0.3 and 0.9m, however depths are mainly less than 0.3m. The northern band continues, and has depths of less than 0.3m. There is also a small section of flooding at the central eastern border of the site which is less than 0.3m in depth.</td></tr>
<tr><td>Reservoir</td><td colspan="3">The site is not shown to be at risk of reservoir flooding from the available online maps.</td></tr>
<tr><td>Groundwater</td><td colspan="3">The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. The site experiences groundwater levels between 0.5m and 5m below the ground surface and therefore is at medium to low risk of groundwater flooding in the 1% AEP event. This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site-specific FRA stage.</td></tr>
<tr><td>Flood History</td><td colspan="3">There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset.
Flood history provided by BMSDC (collated from SCC records) shows no records of historic flooding on the site, however the is a record of flooding adjacent to the site on Thornhill Road in 2012.</td></tr>
<tr><td rowspan="4">Flood risk management infrastructure</td><td rowspan="3">Defences</td><td>Defence Type</td><td>Standard of Protection</td><td>Condition</td></tr>
<tr><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">There are no known flood defences on or near to the site.</td></tr>
<tr><td>Residual risk</td><td colspan="3">There are no recorded culverts within 500m of the site that could potentially cause a residual risk, or any connections that could be found. Therefore there is not considered to be a residual risk to the site from flood risk management structures, however this should be confirmed as part of any future site-specific assessment.</td></tr>
<tr><td>Emergency planning</td><td>Flood warning</td><td colspan="3">The site is outside of the River Gipping from Needham Market to London Road Bridge, Ipswich, including Bramford and Sproughton flood warning or flood alert.</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table		JBA consulting
Site details	**Site Code**	**SS0861**
	Address	Land South of Church Lane, Claydon
	Area	6.25ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
	Access and Egress	The site is bound to the north by Church Lane, and to the east by The Slade, a small public footpath. This footpath also borders the site to the south, and joins Exeter Road in the south-west corner of the site. To the west of the site, Glebe Way, Winchester Gardens and Hereford Drive sit are adjacent to the site. As there is no mapped fluvial flood risk on or immediately adjacent to the site, the impact of access and egress can be seen as negligible. In terms of surface water flood risk, surface water flooding impacts the access and egress to the site. During the 30-year flood event, there is flooding across Winchester Gardens, which could affect accessing site from the west boundary. There is no surface water along Church Lane, therefore the site can be accessed across this road. The 100-year flooding causes a greater extent of water across Winchester Gardens, and also impedes access to the south of the site.
Climate Change	**Implications for the site**	• Increased storm intensities due to climate change may increase the extent, depth, velocity and hazard and frequency of surface water flooding. • Detailed modelling has been completed for the River Gipping, including allowances for climate change. The 20-year defended, and 100-year undefended scenarios was uplifted by 35% and 65% to allow for climate change. The extent increases in both scenarios however there is still no flood risk to the site. • Climate change needs to be considered for surface water events; at site-specific stage, the 100-year event with a 40% allowance for climate change is considered as part of surface water drainage strategies, or surface water modelling. • The present day 1000-year surface water extent provides an indication of the possible increase in extent for the 100-year event. This would require a detailed FRA to assess the site layout and design. In the 1000-year event, surface water flood extents are greater, but still constrained to the two main flow routes through the site and the south and south west of the site. Flood depths could reach 0.3m to 0.9m. Preferential access to the site would be from Church Lane, as Winchester Gardens and Hereford Drive are shown to be at risk of surface water flooding. • The impact of climate change on surface water flood risk will require a detailed FRA to assess the site layout and design. • Developers should consider SuDS strategies to reduce the impacts of climate change from surface water in a detailed site-specific FRA.
Requirements for drainage control and impact mitigation	**Broad scale assessment of possible SuDS**	Geology at the site consists of: • Bedrock: Chalk • Superficial: Glacial sand and gravel Soils at the site consist of: Freely draining, slightly acid, loamy soils The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. As such infiltration techniques should only be used where there are suitable levels of treatment although it is possible that infiltration may not be permitted. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. The site is not designated by the Environment Agency as previously being a landfill site. • Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater. • Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and underlying soils may be permeable. Further

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table		JBA consulting
Site details	**Site Code**	**SS0861**
	Address	Land South of Church Lane, Claydon
	Area	6.25ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable it should be avoided in areas where the depth to the water table is <1m. Additionally, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone. • Detention features may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; a liner will be required. • Filtration measures may be suitable provided site slopes are <5% and the depth to the water table is >1m. If the site has contamination or groundwater issues; a liner will be required. • All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; a liner will be required. • Developers should refer to the **Suffolk County Council SuDS guide** as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.
NPPF and Planning Implications	**Exception Test Requirements**	The Local Authority have carried out the Sequential Test in line with national guidance. The Sequential Test will need to be passed before the Exception Test is applied. Residential development is classified as 'More Vulnerable'. The Exception Test will need to be applied if: • More Vulnerable and Essential Infrastructure development is located in FZ3a and for Highly Vulnerable development located in FZ2. • Highly Vulnerable infrastructure is not be permitted within FZ3a and FZ3b. • More Vulnerable and Less Vulnerable Infrastructure should not be permitted within FZ3b. • No part of the site is within the national Flood Zones that show fluvial flooding. However, there is a significant risk of surface water flooding that must be considered further to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere.
	Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance, BMSDC Local Plan policies, and Suffolk County Council SuDS guide. • Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage. • All sources of flooding, particularly the risk of surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment. • The residual risk from culvert blockage should be assessed and suitable mitigation proposed. • The development should be designed using a sequential approach. Development should be steered away from surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. **Guidance for site design and making development safe:**

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0861**
	Address	Land South of Church Lane, Claydon
	Area	6.25ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		• The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure surface water flows can pass through the site is essential. • As the River Gipping is classified as a Main River, an Environmental Permit will be required from the Environment Agency. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.

<table>
<tr><td colspan="2">Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table</td><td colspan="2">JBA consulting</td></tr>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="2">SS0861</td></tr>
<tr><td>Address</td><td colspan="2">Land South of Church Lane, Claydon</td></tr>
<tr><td>Area</td><td colspan="2">6.25ha</td></tr>
<tr><td>Current Land Use</td><td colspan="2">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="2">Residential</td></tr>
<tr><td colspan="2">Key Messages</td><td colspan="2">• The site is entirely located in Flood Zone 1 and therefore the Exception Test does not need to be applied. However, there is a significant risk of surface water flooding that must be considered further to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere. Development should be steered away from the topographic surface water flow routes shown to run through the site.
• A detailed model of surface water flooding and the existing drainage system using topographical and asset survey should be constructed at the FRA stage to determine the risk from surface water flooding further and to ensure that surface water overland flows do not overwhelm proposed sustainable drainage features.
• Safe access and egress needs to be outside of the areas of surface water flood risk in the south and west of the site.
Refer to the detailed ‘guidance for developers’ section for further information on the measures that are appropriate for this site.</td></tr>
<tr><td colspan="4">Mapping Information</td></tr>
<tr><td colspan="4">The key datasets used to make planning recommendations regarding this site were the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.</td></tr>
<tr><td colspan="2">Flood Zones</td><td colspan="2">Flood Zones 2 and 3 have been taken from the Environment Agency’s River Gipping model. However the site is located entirely in Flood Zone 1.</td></tr>
<tr><td colspan="2">Climate change</td><td colspan="2">35% and 65% climate change was modelled as part of the Level 1 SFRA on the River Gipping. The site was not shown to be at risk of fluvial flooding when considering climate change.</td></tr>
<tr><td colspan="2">Fluvial depth, velocity and hazard mapping</td><td colspan="2">Fluvial depth, velocity and hazard mapping has been taken from River Gipping model. However the site is located entirely in Flood Zone 1.</td></tr>
<tr><td colspan="2">Surface Water</td><td colspan="2">The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.</td></tr>
<tr><td colspan="2">Surface water depth, velocity and hazard mapping</td><td colspan="2">The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency’s Risk of Flooding from Surface Water.</td></tr>
</table>

Site name	SS0902 Land south of Low Road, Debenham
Site area (ha)	0.97

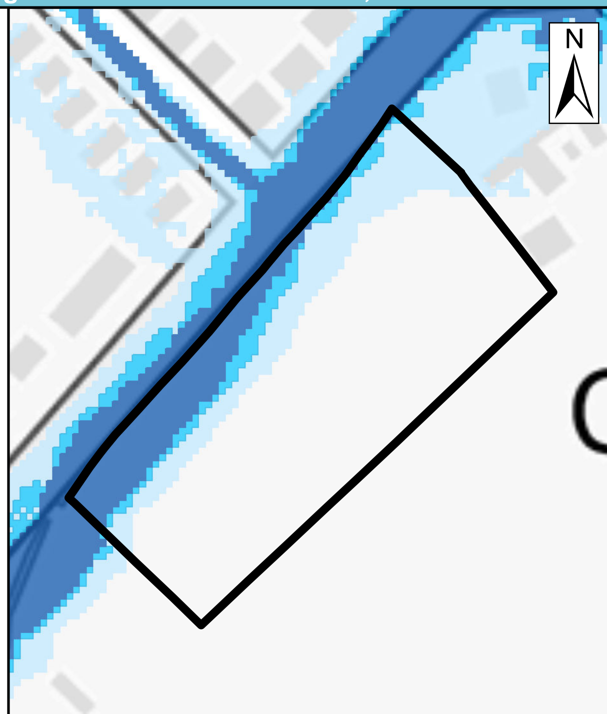
Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 20 40 Metres

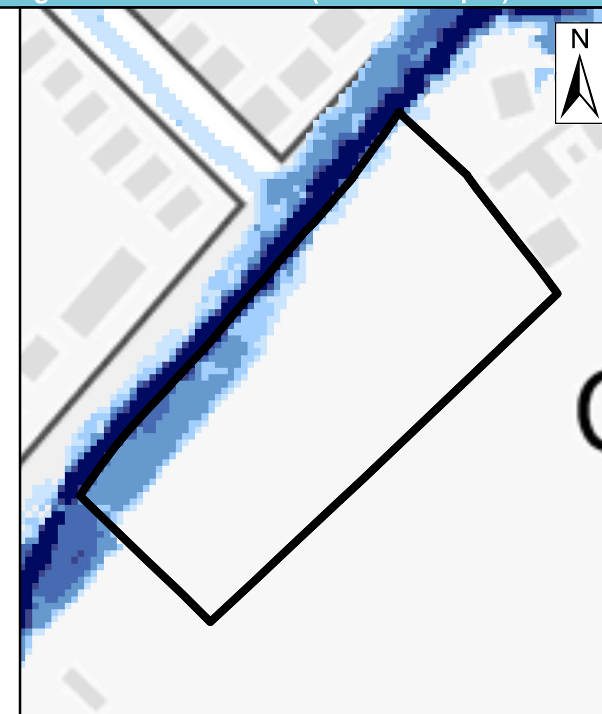


Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)
- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 20 40 Metres

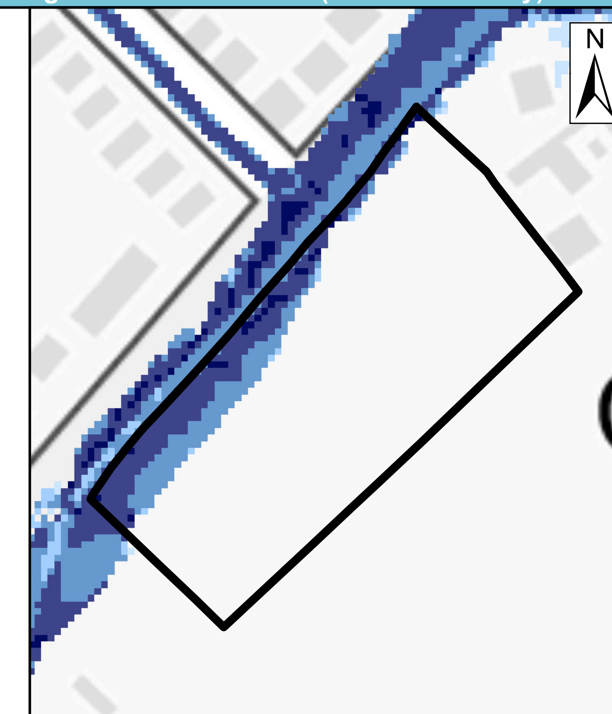


Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)
- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 20 40 Metres

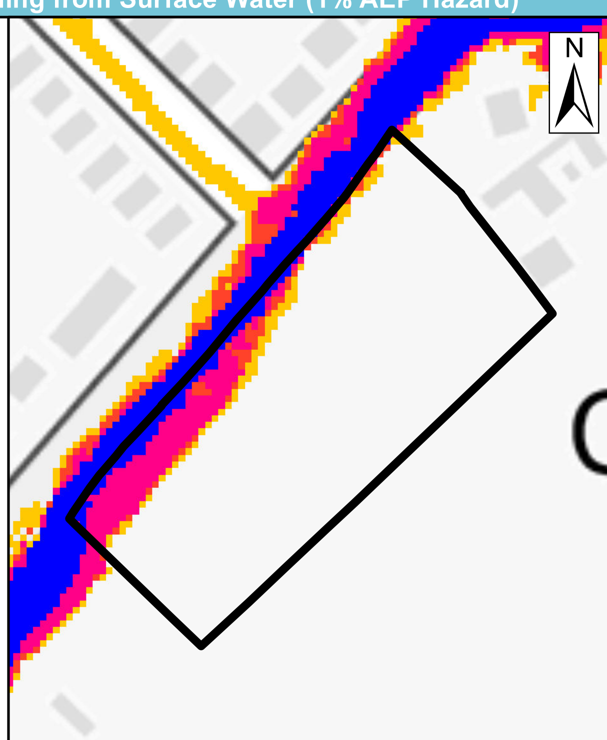


Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard
- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 20 40 Metres

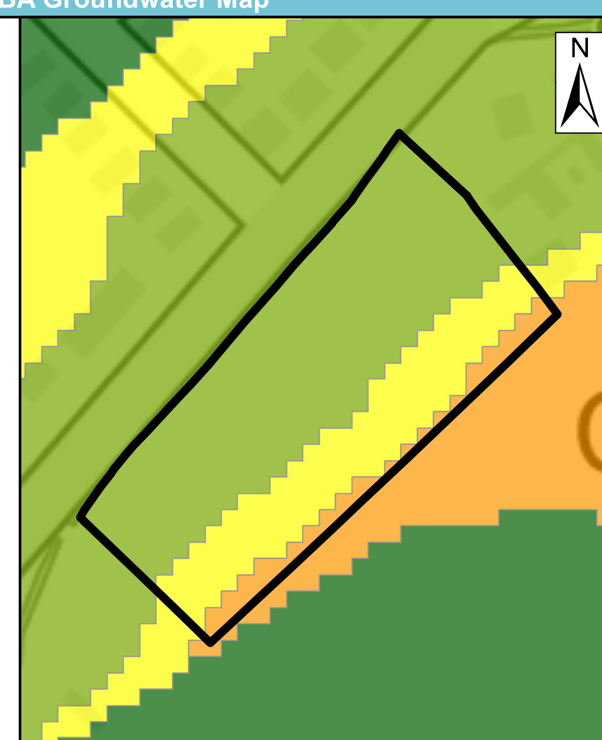


JBA Groundwater Map

Legend

JBA Groundwater Map
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.
- No risk.

0 20 40 Metres



Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 20 40 Metres

Site name	SS0902 Land south of Low Road, Debenham
Site area (ha)	0.97

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

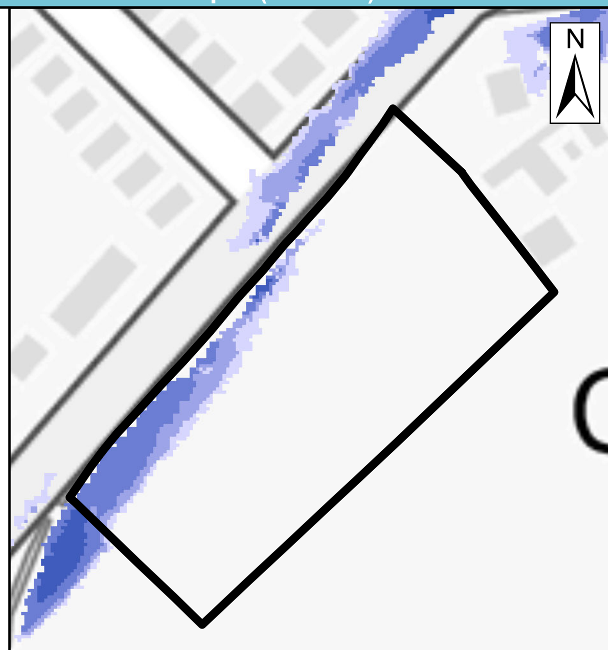
Fluvial Flood Depth (1% AEP)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 25 50 Metres



Note - this map only displays depths from the 2D model

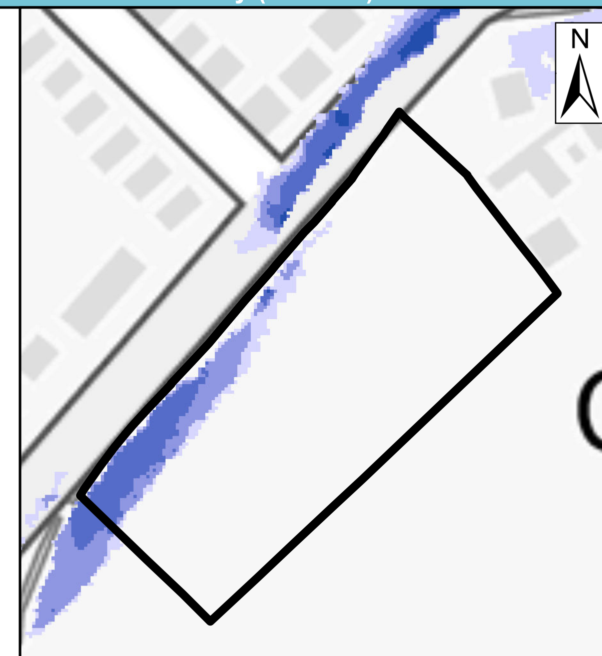
Fluvial Flood Velocity (1% AEP)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 25 50 Metres



Note - this map only displays velocity from the 2D model

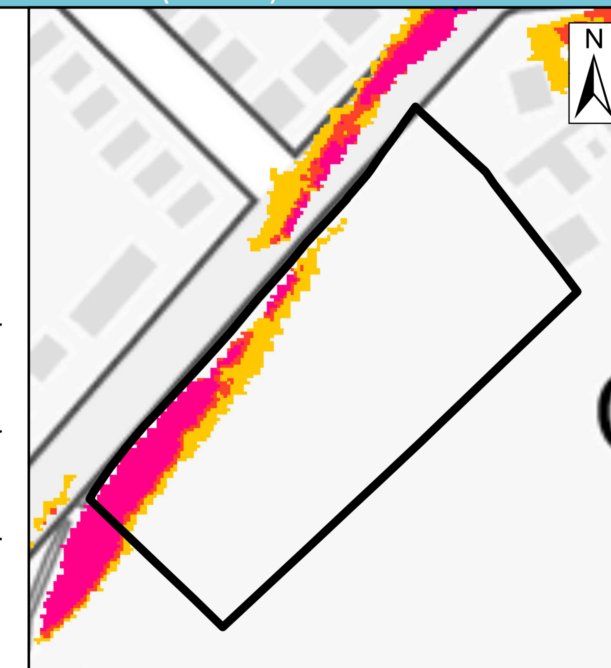
Fluvial Flood Hazard (1% AEP)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 25 50 Metres



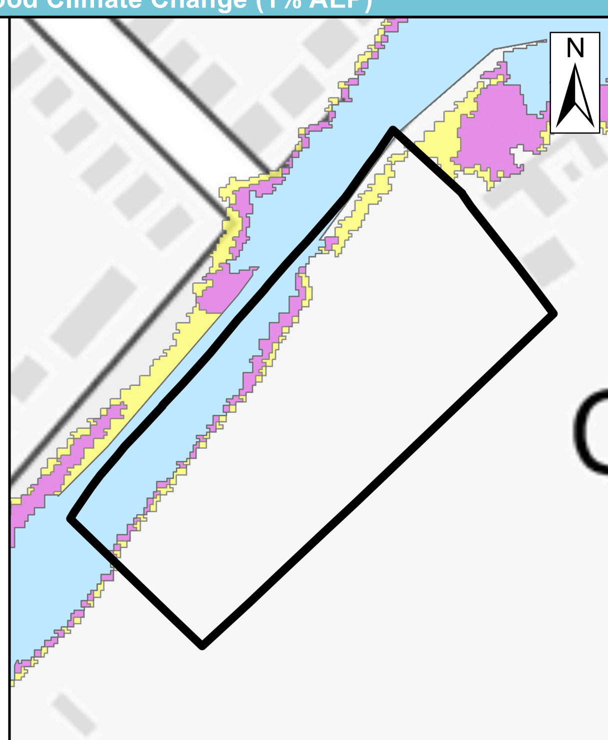
Note - this map only displays hazard from the 2D model

Fluvial Flood Climate Change (1% AEP)

Legend

- 1% AEP flood extent
- 1% AEP+ 35% CC flood extent
- 1% AEP+ 65% CC flood extent

0 25 50 Metres

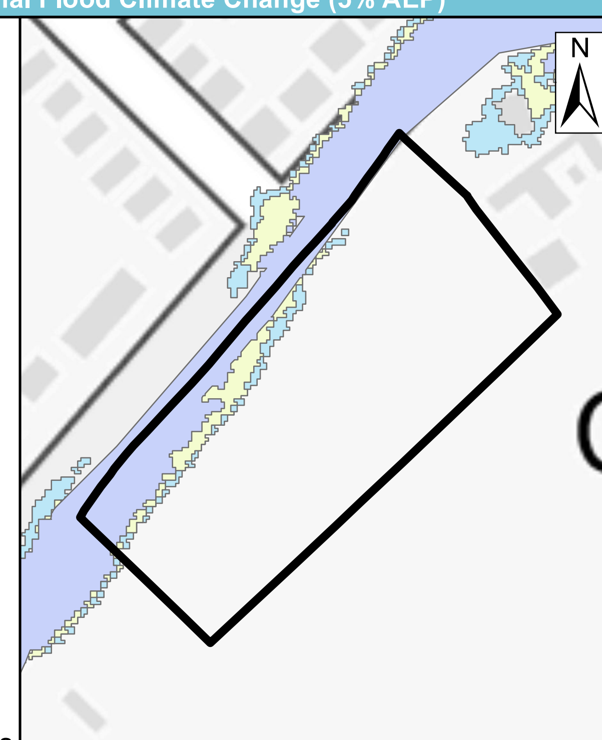


Fluvial Flood Climate Change (5% AEP)

Legend

- 5% AEP flood extent
- 5% AEP + 35% CC flood extent
- 5% AEP + 65% CC flood extent

0 25 50 Metres

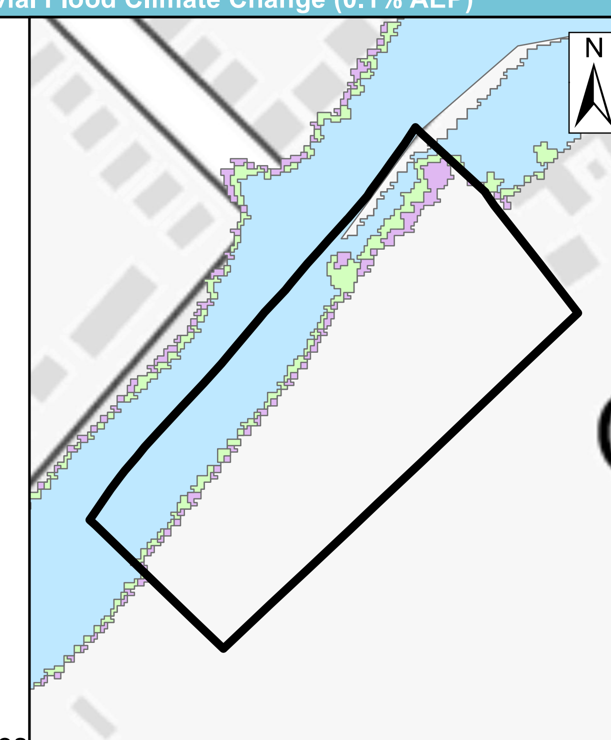


Fluvial Flood Climate Change (0.1% AEP)

Legend

- 0.1% AEP flood extent
- 0.1% AEP +35% CC flood extent
- 0.1% AEP +65% CC flood extent

0 25 50 Metres



Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="4">SS0902</td></tr>
<tr><td>Address</td><td colspan="4">Land south of Low Road, Debenham</td></tr>
<tr><td>Area</td><td colspan="4">0.97ha</td></tr>
<tr><td>Current Land Use</td><td colspan="4">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="4">Residential</td></tr>
<tr><td rowspan="10">Sources of flood risk</td><td>Location of site within catchment</td><td colspan="4">The site is situated to the south of Debenham, south of Low Road. The site is located in the River Deben catchment. The Cherry Tree Brook, a tributary of the River Deben, flows in a north-easterly direction along the north-western boundary of the site.</td></tr>
<tr><td>Existing drainage features</td><td colspan="4">The Cherry Tree Brook is located along the north-western boundary of the site. The watercourse flows in a north-easterly direction along the site and then south-westerly direction towards its confluence with the River Deben approximately 500m downstream.</td></tr>
<tr><td rowspan="8">Fluvial</td><td colspan="4">Proportion of Site at Risk</td></tr>
<tr><td>FZ3b</td><td>FZ3a</td><td>FZ2</td><td>FZ1</td></tr>
<tr><td>10.9%</td><td>15.3%</td><td>21.4%</td><td>78.6%</td></tr>
<tr><td colspan="4">Highest Zone of Risk (Risk of Flooding from Rivers and Sea)</td></tr>
<tr><td colspan="4">Majority of site – Very Low
North-western edge of site adjacent to Cherry Tree Brook – Medium to High</td></tr>
<tr><td colspan="4">The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)</td></tr>
<tr><td colspan="4">Available Data:
An existing model of the River Deben, including the Cherry Tree Brook and other tributaries around Debenham, was available for this assessment. The model is a Flood Modeller-TUFLOW model developed by Jacobs in 2017. The model has been re-run for the 20-year and 1000-year events with the 35% and 65% climate change allowances as part of the SFRA. The 35% and 65% allowances were available for the existing model for the 100-year event.
Flood Characteristics:
Fluvial flood risk is shown along the north-western edge of the site, where the Cherry Tree Brook flows.
In the 20-year event (Flood Zone 3b), flood extents within the site are largely constrained to the north-western boundary, with the extent increasing in the south-west corner. Flood depths range between 0.1m and 0.4m. Along the central part of the boundary, the depths are up to 0.7m. Velocities are below 1m/s in the south west of the site, but could exceed 1m along the central northern boundary.
In the 100-year event, the flood extent increases further into the site, but is still constrained along the boundary and to the south-west corner, with flood depths up to 0.6m. Along the central part of the boundary, the depths are up to 0.9m. In the south west corner the velocity is between 0.5 and 1.0 m/s, but could exceed 1m along the central northern boundary.
In the 1000-year event, flood depths increase compared to the 100-year event up to 1m, with depths up 1.2m along the central part of the boundary.</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0902**
	Address	Land south of Low Road, Debenham
	Area	0.97ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential

	Surface Water	**Proportion of site at risk (RoFfSW)**		
		30-year High Risk	**100-year Medium Risk**	**1,000-year Low Risk**
		12.3%	16.9%	32.1%
		Max depths (m)		
		0.3-0.9	0.3-0.9	>0.9
		Max velocity (m/s)		
		>0.25	>0.25	>0.25
		The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).		
		Description of surface water flow paths: There is one main surface water flow path associated with the Cherry Tree Brook along the north-western boundary of the site and hence the mapping is likely to be picking up the natural floodplain of this watercourse. In the 30-year event, the band of surface water flooding is largely constrained to the area adjacent to the watercourse, with the extent increasing in the south-west corner of the site. Flooding in the 30-year event could reach 0.3 to 0.9m depth. In the 100-year event, the extent of flooding increases further into the site. Flooding in the 100-year event could reach 0.3 to 0.9m in depth. In the 1000-year event, surface water flooding is more extensive into the site, particularly in the north west of the site. The depth of flooding could be >0.9m adjacent to the watercourse and in the south west of the site.		
	Reservoir	The site is not shown to be at risk of reservoir flooding from the available online maps.		
	Groundwater	The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. The majority of the site is shown to be at high risk of groundwater flooding, with levels either at or very near (within 0.025m) of the ground surface. The risk of flooding is slightly lower towards the south eastern boundary of the site, where the levels are between 0.025m and 0.5m below the ground surface and then between 0.5m and 5m below the ground surface along the south eastern boundary. This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site specific FRA stage.		
	Flood History	There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset. Flood history provided by B&MS (collated from SCC records) shows no records of historic flooding on the site, however there is a record of flooding adjacent to the site on Gardeners Road where the road has flooded due to a blocked drain in 2016 and 2019.		
Flood risk management infrastructure	**Defences**	**Defence Type**	**Standard of Protection**	**Condition**
		-	-	-

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS0902**
	Address	Land south of Low Road, Debenham
	Area	0.97ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		There are no known flood defences on or near to the site. An NFM storage feature has been implemented upstream on the Cherry Tree Brook at Mill Green Farm.
	Residual risk	There are no recorded culverts within 500m of the site shown in the detailed river network that could potentially cause a residual risk. There is a small bridge, which is included in the hydraulic model, immediately upstream of the site. If the structure was to become blocked, there is potential for increased surface water and fluvial flooding across the site. It is recommended that the potential for blockage on all structures affecting the site should be considered as part of any future site-specific assessment.
Emergency planning	**Flood warning**	The north-western boundary of the site is in the River Deben and Lark Flood Alert Area. The site is just south of the River Deben from Debenham to Cretingham Flood Warning Area so the site is not included in this.
	Access and Egress	The site is bound by Low Road along the north-west of the site. Ipswich Road sits approximately 230m south east of the development site. In terms of fluvial water flooding, Low Road may be impacted from flooding from the Cherry Tree Brook in the 20, 100 and 1000-year events. Ipswich Road is not shown to be affected by fluvial flooding, except for the far east of the road at the junction with Winston Road. In terms of surface water flooding, Low Road is impacted in all events and flood depths could reach >0.9m in all events adjacent to the Cherry Tree Brook. Ipswich Road is at risk of flooding in all events, but to a lesser extent than Low Road. In the 30-year event there is isolated ponding and depths are <0.9m. In the 100-year and 1000year events surface water flooding is shown to extend further along Ipswich Road, with depths <0.9m. It is proposed for access to be provided via Ipswich Road rather than Low Road to avoid installing access through the floodplain and over the main river, which could potentially exacerbate flood risk in the area.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity and hazard and frequency of fluvial flooding of the Cherry Tree Brook and surface water flooding across the site. • As part of the detailed modelling study completed for the Level 2 SFRA, modelling has included allowances for climate change. The 35% and 65% allowances have been run on the 20-year, 100-year and 1000-year events to define future Flood Zone 3b, 3a and 2. When climate change allowances are modelled, there is an increase in flood depth extent but flood risk is still constrained to the north western and south western portions of the site adjacent to Cherry Tree Brook. • Climate change also needs to be considered for surface water events; at the site-specific Flood Risk Assessment stage. The 100-year event with a 40% allowance for climate change should be considered as part of surface water drainage strategies, or surface water modelling. • The current day 1000-year surface water extent provides an indication of the potential increase in extent of the 100-year event. It is likely that, as a result of climate change, surface water flood risk across the site will increase in the vicinity of the Cherry Tree Brook. • The impact of climate change on surface water flood risk will require a detailed FRA to assess the site layout and design. • Developers should consider SuDS strategies to manage the impacts of climate change from surface water in a detailed site-specific FRA.

<table>
<tr><td colspan="2">Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table</td><td colspan="2">JBA consulting</td></tr>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="2">SS0902</td></tr>
<tr><td>Address</td><td colspan="2">Land south of Low Road, Debenham</td></tr>
<tr><td>Area</td><td colspan="2">0.97ha</td></tr>
<tr><td>Current Land Use</td><td colspan="2">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="2">Residential</td></tr>
<tr><td>Requirements for drainage control and impact mitigation</td><td>Broad scale assessment of possible SuDS</td><td colspan="2">Geology at the site consists of:
Bedrock: Neogene to Quaternary Rocks (Undiffereniated) – gravel, silt, sand and clay
Superficial: Glacial sand and gravel
Soils at the site consist of: Lime-rich loamy and clayey soils with impeded drainage.
The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. As such infiltration techniques should only be used where there are suitable levels of treatment although it is possible that infiltration may not be permitted. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints.
This site does not contain land designated by the Environment Agency as being a landfill site.
Across the site:
Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater. Mapping also suggests that slopes may be unsuitable for selective source control techniques.
Mapping suggests that there is a high risk of groundwater flooding at this location, therefore it is likely infiltration techniques will not be suitable. This should be confirmed via site investigations to assess the potential for infiltration.
Detention is unlikely to be feasible where mapping suggests mean site slopes are > 5%. Feasibility of such options should be assessed as part of a site specific assessment. If this feature is feasible a liner maybe required to prevent the egress of groundwater.
Filtration is unlikely to be feasible where mapping suggests mean site slopes are > 5%. Feasibility of such options should be assessed as part of a site specific assessment. If this feature is feasible it should be located where the depth to the water table is >1m, additionally a liner maybe required to prevent the egress of groundwater.
All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. A liner maybe required to prevent the egress of groundwater.
Developers should refer to Suffolk County Council SuDS guide as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td>SS0902</td></tr>
<tr><td>Address</td><td>Land south of Low Road, Debenham</td></tr>
<tr><td>Area</td><td>0.97ha</td></tr>
<tr><td>Current Land Use</td><td>Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td>Residential</td></tr>
<tr><td rowspan="2">NPPF and Planning Implications</td><td>Exception Test Requirements</td><td>The Local Authority have carried out the Sequential Test in line with national guidance. This has supported this site being taken forward for further consideration, including considering if the Exception Test would apply.

Residential development is classified as ‘More Vulnerable’. As the site is partially covered by Flood Zone 3 and is proposed for residential development, the Exception Test will need to be applied to the site.

A sequential approach to site layout will contribute towards passing the flood risk element of the Exception Test, this means that the least vulnerable type of development (in terms of Table 2 of the Flooding section of the NPPG) should be located in the higher flood risk parts of the site.

In no instances should highly vulnerable development be located in Flood Zones 3a and 3b. More vulnerable development (such as dwellings) should be located outside Flood Zone 3 whenever possible. Development in the high flood risk parts of the site should be designed such that it is flood resilient and resistant. It is anticipated that proposed development will be sequentially located within Flood Zone 1 on this site.</td></tr>
<tr><td>Requirements and guidance for site-specific Flood Risk Assessment</td><td>Flood Risk Assessment:
• At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare.
• The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance; BMSDC Local Plan policies, and Suffolk County Council SuDS guide.
• Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage.
• All sources of flooding, particularly the risk of fluvial, surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment.
• Although modelling has been completed as part of this SFRA, detailed modelling of the site will still be required as part of the site-specific FRA to confirm both fluvial and surface water flood risk and flow paths. Detailed modelling would require topographic survey of the site and well as any additional asset survey needed to refine the model further. In addition, the latest guidance on climate change allowances would need to be considered and any mitigation measures would need to be tested through modelling. The residual risk from culvert blockage should be assessed and suitable mitigation proposed.
• The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG.
• Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF.
• Development in FZ3 may require floodplain compensation and this should be confirmed with the EA at FRA stage.

Guidance for site design and making development safe:
• The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF’s policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained</td></tr>
</table>

Site details	**Site Code**	**SS0902**
	Address	Land south of Low Road, Debenham
	Area	0.97ha
	Current Land Use	Greenfield
	Proposed Land Use	Residential
		effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. It is understood that an application has been made at this site, but this has been rejected on flood risk grounds due to the proposal to culvert the watercourse. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure both fluvial and surface water flows can pass through the site is essential. • As the Cherry Tree Brook is classified as a Main River, an Environmental Permit will be required from the Environment Agency. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Strategic modelling indicates that the effects of cumulative impact of development in Debenham has the potential to increase the flood risk along the Cherry Tree Brook. The developer will therefore need to ensure there is no increase in runoff from the development site. It is recommended that more detailed modelling is undertaken by the developer at site-specific Flood Risk assessment stage to ascertain in more detail the storage needs and potential at each site so that development does not increase flood risk. Additional storage may be required to ensure that any additional flow from the development site occurs after the peak of the Deben. Care must also be taken to ensure any development does not reduce the benefits of existing and proposed NFM storage features. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.

<table>
<tr><td colspan="3">Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Flood Risk Assessment Detailed Site Summary Table</td><td>JBA consulting</td></tr>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="2">SS0902</td></tr>
<tr><td>Address</td><td colspan="2">Land south of Low Road, Debenham</td></tr>
<tr><td>Area</td><td colspan="2">0.97ha</td></tr>
<tr><td>Current Land Use</td><td colspan="2">Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="2">Residential</td></tr>
<tr><td colspan="2">Key Messages</td><td colspan="2">The flood risk element of the Exception Test is likely to be passed if:
• Development is limited to the 78.6% of the site located outside of the Environment Agency's Flood Zone 2 and 3. There is also a risk of surface water flooding which must be considered to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere.
• Areas in Flood Zone 1 and then 2 are used for the least vulnerable parts of the development in accordance with Table 2 in the NPPF.
• If flood mitigation measures are implemented then they are tested to ensure they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another)
• Space for green infrastructure should be considered in the areas of highest flood risk.
• Safe access and egress routes must not be in the areas of high surface water risk or the 100-year fluvial design flood event (taking into account climate change). Site access should be from Ipswich Road rather than Low Road.
Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.</td></tr>
<tr><td colspan="4">Mapping Information</td></tr>
<tr><td colspan="4">The key datasets used to make planning recommendations regarding this site were the Jacobs detailed 1D-2D model of Debenham and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.</td></tr>
<tr><td colspan="2">Flood Zones</td><td colspan="2">Flood Zones 2 and 3 have been taken from the detailed existing model of Debenham.</td></tr>
<tr><td colspan="2">Climate change</td><td colspan="2">35% and 65% climate change allowances were re-run on the existing detailed Debenham model where these were not already available.</td></tr>
<tr><td colspan="2">Fluvial depth, velocity and hazard mapping</td><td colspan="2">Fluvial depth, velocity and hazard mapping has been taken from existing detailed Debenham model. This should be explored further at site-specific state.</td></tr>
<tr><td colspan="2">Surface Water</td><td colspan="2">The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.</td></tr>
<tr><td colspan="2">Surface water depth, velocity and hazard mapping</td><td colspan="2">The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.</td></tr>
</table>

Site name	SS1198 Land north of Laxfield Road, Stradbroke
Site area (ha)	1.95

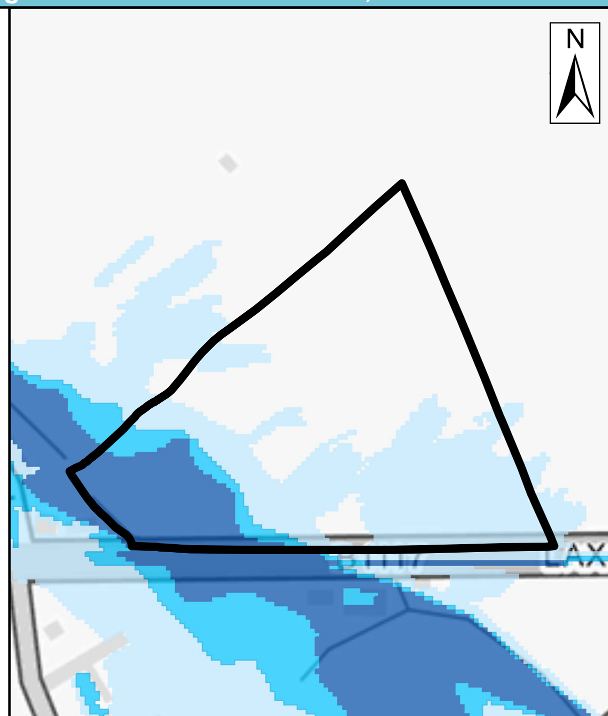
Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 30 60 Metres



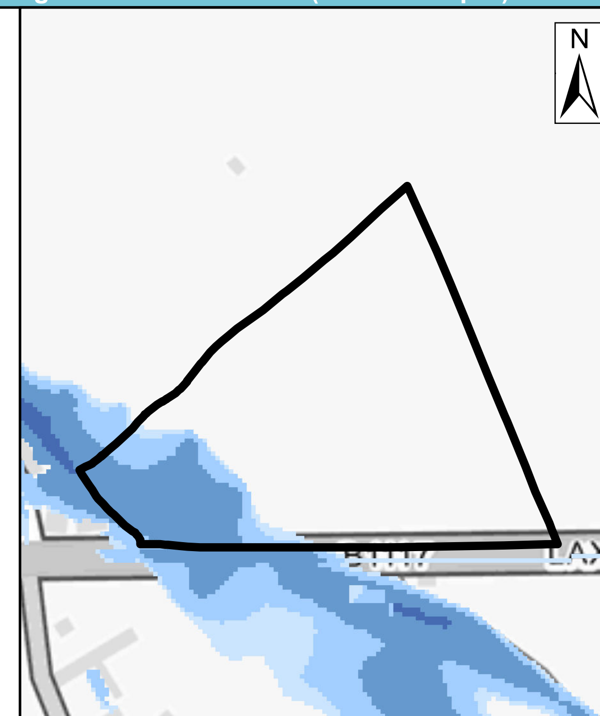
Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 30 60 Metres



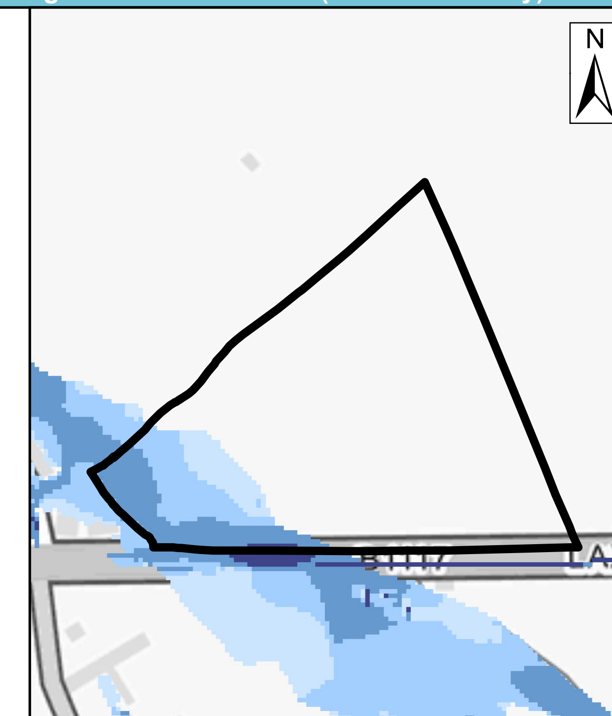
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 30 60 Metres



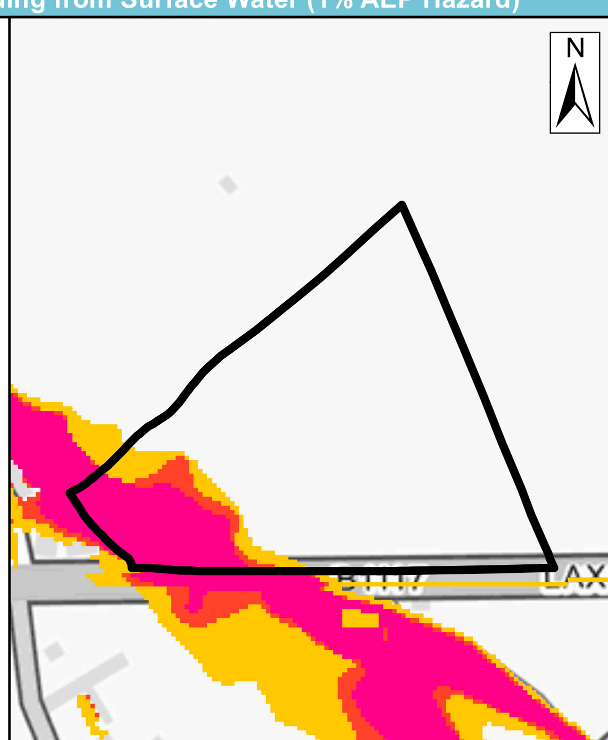
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 30 60 Metres



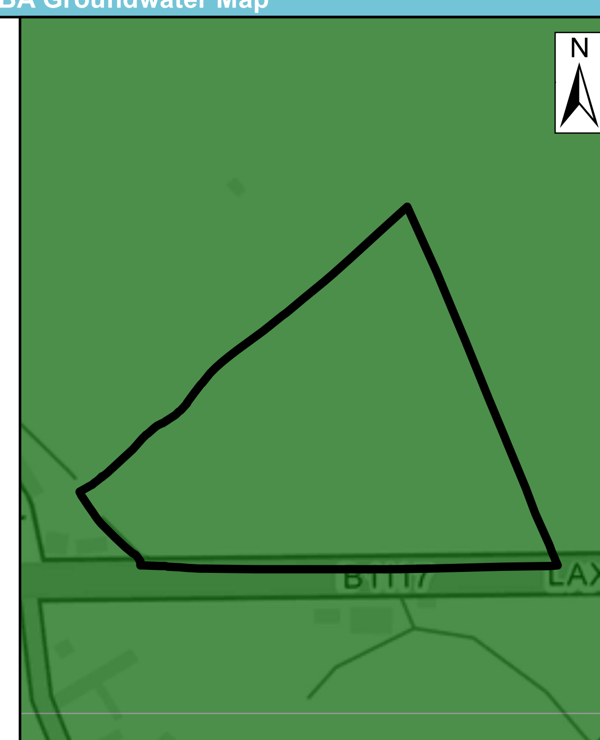
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 30 60 Metres

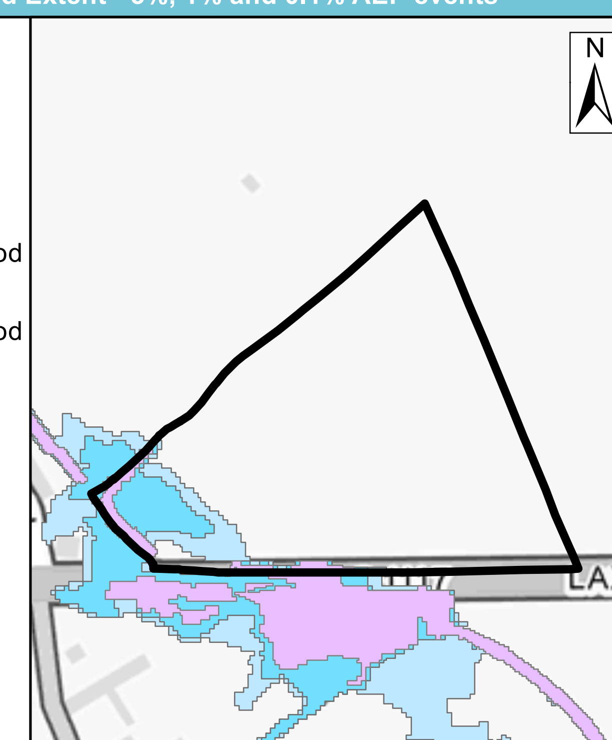


Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 30 60 Metres



Site name	SS1198 Land north of Laxfield Road, Stradbroke
Site area (ha)	1.95

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

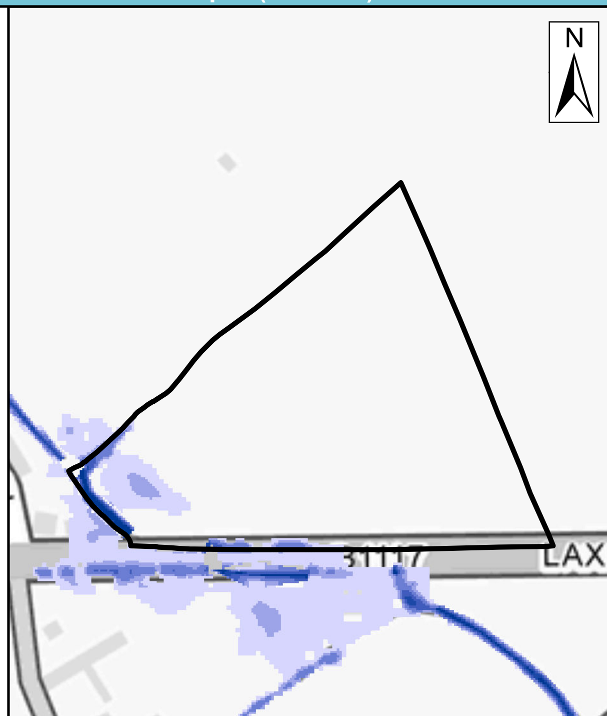
Fluvial Flood Depth (1% AEP)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 30 60 Metres



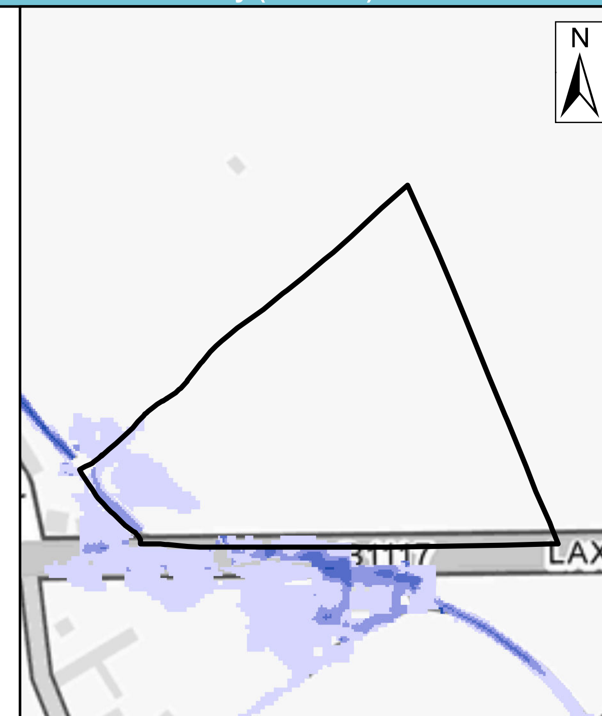
Fluvial Flood Velocity (1% AEP)

Legend

Velocity

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 30 60 Metres



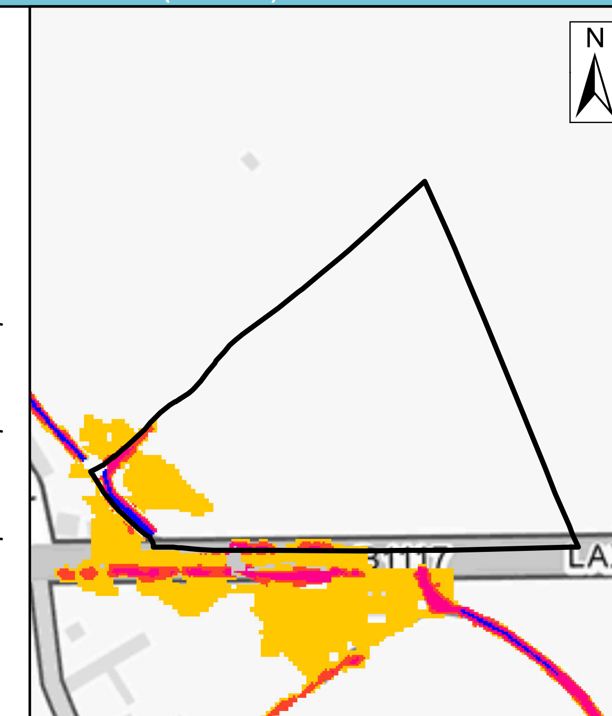
Fluvial Flood Hazard (1% AEP)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 30 60 Metres

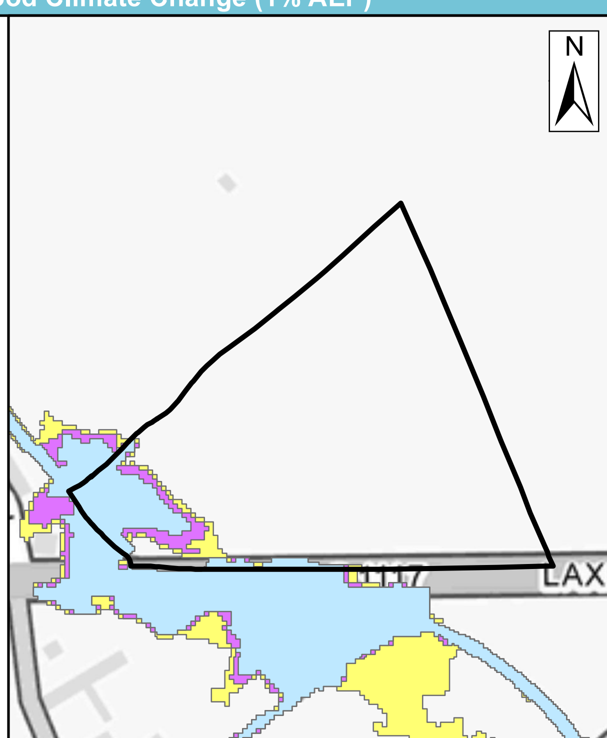


Fluvial Flood Climate Change (1% AEP)

Legend

- 1% AEP flood extent
- 1% AEP+ 35% CC flood extent
- 1% AEP+ 65% CC flood extent

0 30 60 Metres

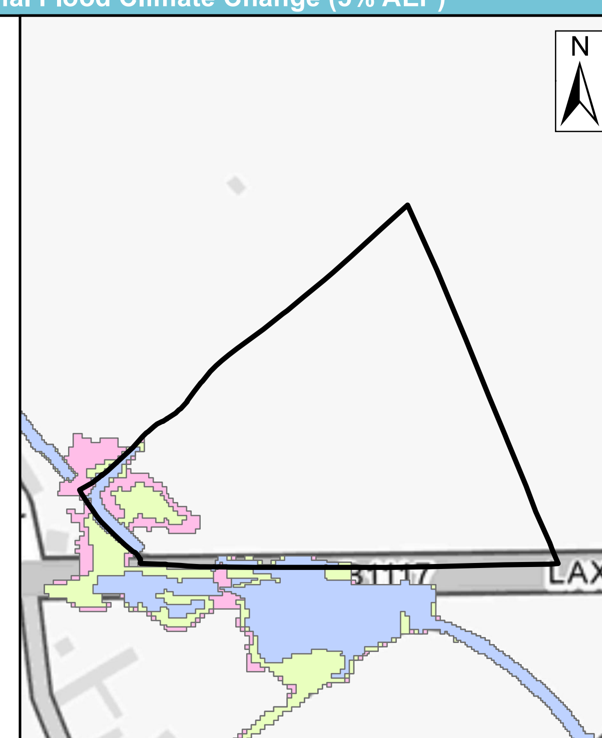


Fluvial Flood Climate Change (5% AEP)

Legend

- 5% AEP flood extent
- 5% AEP + 35% CC flood extent
- 5% AEP + 65% CC flood extent

0 30 60 Metres

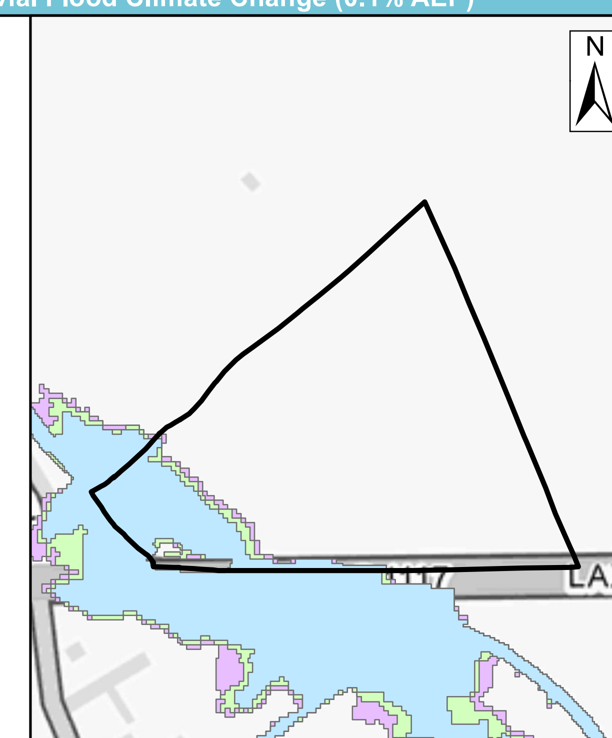


Fluvial Flood Climate Change (0.1% AEP)

Legend

- 0.1% AEP flood extent
- 0.1% AEP +35% CC flood extent
- 0.1% AEP +65% CC flood extent

0 30 60 Metres



Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="4">SS1198</td></tr>
<tr><td>Address</td><td colspan="4">Land North of Laxfield Road, Stradbroke</td></tr>
<tr><td>Area</td><td colspan="4">1.95 Ha</td></tr>
<tr><td>Current Land Use</td><td colspan="4">Agricultural/Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="4">Residential</td></tr>
<tr><td rowspan="18">Sources of flood risk</td><td>Location of site within catchment</td><td colspan="4">The site is located within the River Waveney catchment. The site is located to the south of an unnamed tributary of the River Waveney.</td></tr>
<tr><td>Existing drainage features</td><td colspan="4">There is a tertiary watercourse located along the western and southern boundaries of the site. To the south, the watercourse flows in a westerly direction along the southern boundary of Laxfield Road (B1117) before travelling northwards towards its confluence with the unnamed tributary of the River Waveney, located 850m to the north of the site.
The unnamed watercourse is culverted under Laxfield Road and there is a short section of culvert located adjacent to the western site boundary.</td></tr>
<tr><td rowspan="8">Fluvial</td><td colspan="4">Proportion of Site at Risk</td></tr>
<tr><td>FZ3b</td><td>FZ3a</td><td>FZ2</td><td>FZ1</td></tr>
<tr><td>2.4%</td><td>6.9%</td><td>10.4%</td><td>89.6%</td></tr>
<tr><td colspan="4">Highest Zone of Risk (Risk of Flooding from Rivers and Sea)</td></tr>
<tr><td colspan="4">Majority of the site – Very Low
South edge and west of site adjacent to watercourse– Medium to High</td></tr>
<tr><td colspan="4">The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)</td></tr>
<tr><td colspan="4">Available Data: For this site, a new 1D-2D Flood Modeller-TUFLOW model has been developed as part of this SFRA for the watercourse that runs adjacent to the site, using cross section survey collected for the SFRA. This model has been run with the 35% and 65% climate change allowances on the 20-year, 100-year and 1000-year events.</td></tr>
<tr><td colspan="4">Flood Characteristics: The model results show that there is a risk of flooding from the tertiary watercourse along the western and southern boundaries of the site. In the 20-year event, a small area of the site is at risk of flooding along the central southern boundary, western boundary and north western boundary. Flood depths are highest in the channel along the western boundary, where depths of up to 1.4m are found, and up to 1m on the southern boundary. Velocities are less than 0.5m/s. In the 100-year event, the flood extent increases further into the west of the site and along the southern boundary. Depths also increase, and are up to 1.7m in the channel and over 1m along the southern boundary. Velocities could reach 0.8m/s in the channel, but are generally less than 0.25m/s in the west of the site. In the 1000-year event, the flood extent increases in the west of the site, with flood water flowing from the south of the site in a north westerly direction. Depths are up to 1.8m in the channel, and 1.3m in the south of the site. Velocities in the channel could reach 0.8m/s and up to 0.5m/s on the site.</td></tr>
<tr><td rowspan="8">Surface Water</td><td colspan="4">Proportion of site at risk (RoFfSW)</td></tr>
<tr><td>30-year
High Risk</td><td colspan="2">100-year
Medium Risk</td><td>1,000-year
Low Risk</td></tr>
<tr><td>13.0%</td><td colspan="2">16.6%</td><td>50.5%</td></tr>
<tr><td colspan="4">Max depths (m)</td></tr>
<tr><td>0.3-0.9m</td><td colspan="2">0.3-0.9m</td><td>>0.9m</td></tr>
<tr><td colspan="4">Max velocity (m/s)</td></tr>
<tr><td>>0.25m/s</td><td colspan="2">>0.25m/s</td><td>>0.25m/s</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1198**		
	Address	Land North of Laxfield Road, Stradbroke		
	Area	1.95 Ha		
	Current Land Use	Agricultural/Greenfield		
	Proposed Land Use	Residential		
		The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).		
		Description of surface water flow paths: The site is impacted by surface water flooding in all modelled events. It is likely that the surface water mapping is picking up the flood plain of the unnamed tertiary watercourse along the western site boundary. In the 30-year event, only the western corner of the site is shown to be impacted by surface water flooding. Flooding is also seen across Laxfield Road to the south of the site. During this event, flood depths are largely below 0.3m in depth, however flooding along the western boundary could reach 0.3m to 0.9m in depth. In the 100-year event, surface water flood extents are slightly greater within the site boundary and along Laxfield Road to the south. In this event, a larger area of the site is affected by flood water that could be between 0.3 and 0.9m in depth. In the 1000-year event, surface water flooding is much more extensive across the western and southern portions of the site, reaching the eastern site corner. Depths along the watercourse could be greater than 0.9m and across the site 0.3 to 0.9m flooding could be seen. Flooding in the eastern portion of the site however is likely to be less than 0.3m in depth.		
	Reservoir	The site is not shown to be at risk of reservoir flooding from the available online maps.		
	Groundwater	The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. The site is not at risk of groundwater flooding. This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site specific FRA stage.		
	Flood History	There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset. Flood history information provided by BMSDC also shows no record of historic flooding on or in the immediate vicinity of the site.		
Flood risk management infrastructure	**Defences**	**Defence Type**	**Standard of Protection**	**Condition**
		-	-	-
		This site is not protected by any formal flood defences.		
	Residual risk	There are two main culverts that may impact the site if blockages were to occur. Firstly, where the unnamed watercourse enters a culvert under Laxfield Road to the south of the site and then where there is a short section of culvert adjacent to the western site boundary. If these structures were to become blocked, there is potential for increased surface water and fluvial flooding across the site. The potential for blockage will need to be considered in any future site-specific assessment.		
Emergency planning	**Flood warning**	The site is not covered by an Environment Agency Flood Warning or Alert area. However, the unnamed tributary of the River Waveney, located 850m to the north of the site, is covered by an EA Flood Alert Area.		
	Access and Egress	Currently, the site can only be accessed from Laxfield Road (B1117) to the south.		

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table		
Site details	**Site Code**	**SS1198**
	Address	Land North of Laxfield Road, Stradbroke
	Area	1.95 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Residential
		In terms of fluvial flood risk, the portion of Laxfield Road adjacent to the south-west of the site is affected by flooding in all modelled events. Flood depths on the road could reach 0.5m in the 20-year and 100-year event, and up to 0.6m in the 1000-year event on the road. Velocities on the road could be over 0.5m/s in the 20-year and 100-year events and over 1.5m/s in the 1000-year event. Adjacent to the south-east of the site Laxfield Road is not shown to be at risk of fluvial flooding. In terms of surface water flood risk, the site and Laxfield Road is affected by flooding in all modelled events. In the 30 and 100-year events, the portion of Laxfield Road adjacent to the western site boundary is impacted by surface water flooding. During this event, flood depths could be up to 0.9m on the road. Velocities on the road could be over 0.25 m/s. In the 1000-year event, flooding on Laxfield Road extends along the entirety of the southern site boundary which could impede access and egress. Flooding is shown to be up to 0.9m in depth along the western portion of the southern site boundary but below 0.3m along the eastern portion. Velocities are shown to be over 0.25 m/s along the entirety of the road.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity, hazard and frequency of fluvial flooding from the unnamed watercourse and surface water flooding across the site. • As part of the detailed modelling study completed for the Level 2 SFRA, modelling has included allowances for climate change. The 20-year defended and 100-year and 1000-year undefended scenarios was uplifted by 35% and 65% to allow for climate change. When the climate change allowances are modelled, there is an increase in flood extent and depth in the west of the site. • As part of a site-specific Flood Risk Assessment, latest EA climate change allowances will need to be considered in the detailed hydraulic model once the hydrology has been reviewed, to confirm the impact to the site. • Climate change also needs to be considered for surface water events; at the site-specific Flood Risk Assessment stage. Climate change should also be considered as part of surface water drainage strategies, or surface water modelling. • The current day 1,000-year surface water extent provides an indication of the possible increase in extent of the 100-year extent. It is likely that the risk of surface water flooding across the site and Laxfield Road to the south will increase across the site as a result of climate change. • The impact of climate change on surface water flood risk will require a detailed FRA to assess the site layout and design. • Developers should consider SuDS strategies to manage the impacts of climate change from surface water in a detailed site-specific FRA.
Requirements for drainage control and impact mitigation	**Broad scale assessment of possible SuDS**	Geology at the site consists of: • Bedrock: Neogene to Quaternary Rocks (Undifferentiated) • Superficial: Alluvium - Clay, Silt, Sand and Gravel.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1198**
	Address	Land North of Laxfield Road, Stradbroke
	Area	1.95 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Residential
		Soils at the site consist of: Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. The site is located within a Source Protections Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. The site is not designated by the Environment Agency as previously being a landfill site. • Most source control techniques are likely to be suitable. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk from groundwater. • Infiltration likely to be suitable. Mapping suggests a low risk of ground water flooding however, site investigations should be carried out to assess potential for drainage by infiltration. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone. • Detention features may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required. • Filtration measures may suitable provided site slopes are <5%. If the site has contamination or groundwater issues; mitigation measures will be required. • All forms of conveyance are likely to be suitable. Conveyance features should be located on common land or public open space to facilitate ease of access. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; mitigation measures will be required. Developers should refer to the **Suffolk County Council SuDS guide** as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.
NPPF and Planning Implications	**Exception Test Requirements**	The Local Authority have carried out the Sequential Test in line with national guidance. This has supported this site being taken forward for further consideration, including considering if the Exception Test would apply. Residential development is classified as 'More Vulnerable'. As the site is partially covered by Flood Zone 3 and is proposed for residential development, the Exception Test will need to be applied to the site. A sequential approach to site layout will contribute towards passing the flood risk element of the Exception Test, this means that the least vulnerable type of development (in terms of Table 2 of the Flooding section of the NPPG) should be located in the higher flood risk parts of the site. In no instances should highly vulnerable development be located in Flood Zones 3a and 3b. More vulnerable development (such as dwellings) should be located outside Flood Zone 3 whenever possible. Development in the high flood risk parts of the site should be designed such that it is flood resilient and resistant. It is anticipated that proposed development will be sequentially located within Flood Zone 1 on this site.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1198**
	Address	Land North of Laxfield Road, Stradbroke
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	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Residential
	Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance; BMSDC Local Plan policies, and Suffolk County Council SuDS guide. • Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage. • All sources of flooding, particularly the risk of surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment. • Although modelling has been completed as part of this SFRA, detailed modelling of the site will still be required as part of the site-specific FRA to confirm both fluvial and surface water flood risk and flow paths. Detailed modelling would require topographic survey of the site and well as any additional asset survey needed to refine the model further. In addition, the latest guidance on climate change allowances would need to be considered and any mitigation measures would need to be tested through modelling. • The residual risk from culvert blockage should be assessed and suitable mitigation proposed. • The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. • Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF. • Development in FZ3 may require floodplain compensation and this should be confirmed with the EA at FRA stage. **Guidance for site design and making development safe:** • The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure both fluvial and surface water flows can pass through the site is essential. • If existing culverts are to be kept, a full CCTV condition survey is required to ensure the culvert will be sound for the lifetime of the proposed development. Improvements should be sought, such as trash screens

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1198**
	Address	Land North of Laxfield Road, Stradbroke
	Area	1.95 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Residential
		compliant with the latest Environment Agency guidance and relining where this is appropriate and sustainable option. • For any culverts (old or new), the developer must set out who is adopting and maintaining those culverts throughout the lifetime of the development. The design of the development must take into account the residual risk of blockage e.g. properties should not be placed in the area that could flood if a culvert blocks and the exceedance flows from such an event should be built into the site masterplan. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.
Key Messages		The flood risk element of the Exception Test is likely to be passed if: • Development is limited to the 89.6% of the site located outside of the Environment Agency's Flood Zone 2 and 3. • Areas in Flood Zone 1 and then 2 are used for the least vulnerable parts of the development in accordance with Table 2 in the NPPF. • If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another). • Space for green infrastructure should be considered in the areas of highest flood risk. • Safe access and egress routes must not be in the areas of high surface water risk or the 100-year fluvial design flood event (taking into account climate change). Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the detailed 1D- 2D modelling outputs developed as part of this SFRA and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below. It should be noted that the outputs of the modelling carried out for this SFRA vary to the Environment Agency's Flood Map for Planning.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table		
Site details	Site Code	SS1198
	Address	Land North of Laxfield Road, Stradbroke
	Area	1.95 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Residential
Flood Zones		Flood Zones 2 and 3 have been taken from the detailed modelling completed as part of the Level 2 SFRA
Climate change		Environment Agency climate change allowances were modelled as part of detailed hydraulic modelling study completed for the Level 2 SFRA.
Fluvial depth, velocity and hazard mapping		Fluvial depth, velocity and hazard mapping has been taken from the detailed hydraulic model developed as part of the Level 2 SFRA. This information should be explored further at site-specific stage.
Surface Water		The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping		The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.

Site name	SS1223 Land at Mill Lane, Stowmarket
Site area (ha)	78.95

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

Babergh Mid Suffolk District Working Together

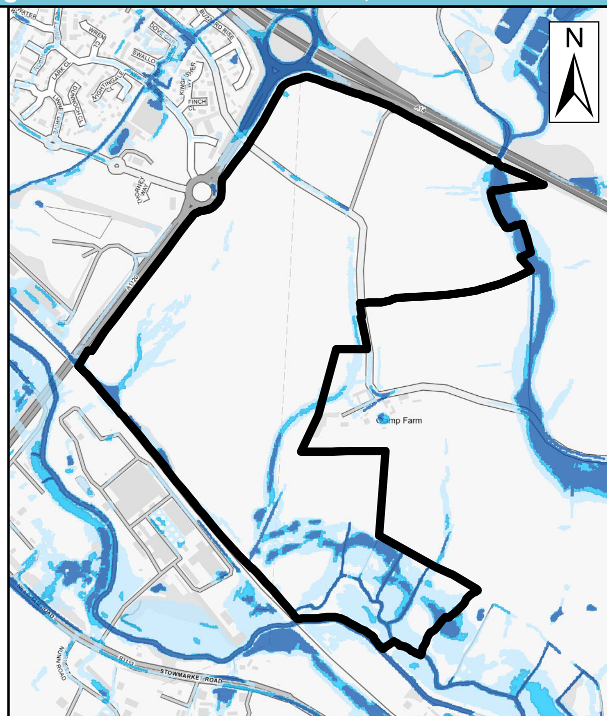
JBA consulting

Risk of Flooding from Surface Water- 3.33%,1% and 0.1%

Legend

- RoFSW 3.3% AEP extent
- RoFSW 1% AEP extent
- RoFSW 0.1% AEP extent

0 200 400 Metres



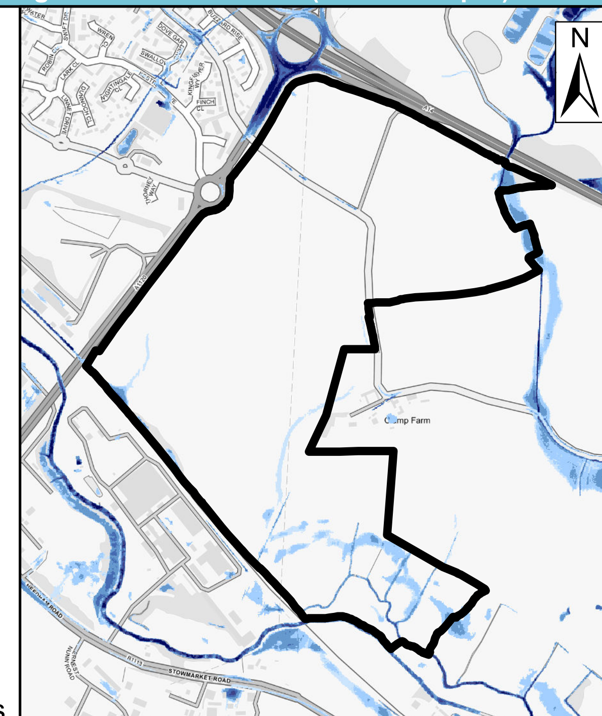
Risk of Flooding from Surface Water (1% AEP Depth)

Legend

DEPTH (Six bands)

- Below 150mm
- 150-300mm
- 300-600mm
- 600-900mm
- 900-1200mm
- Over 1200mm

0 200 400 Metres



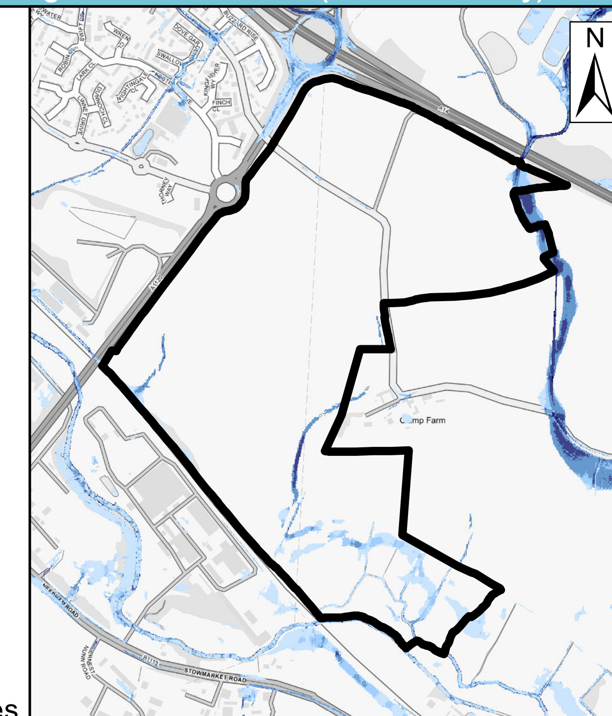
Risk of Flooding from Surface Water (1% AEP Velocity)

Legend

Velocity (Five bands)

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 200 400 Metres



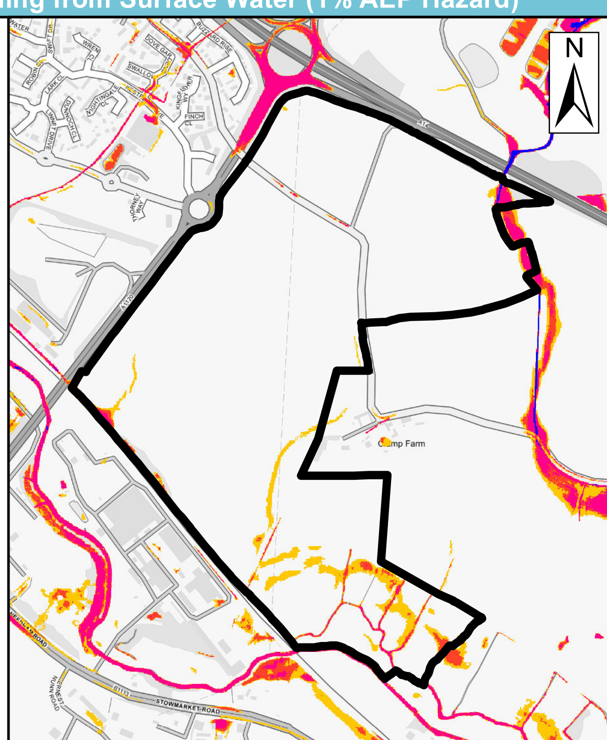
Risk of Flooding from Surface Water (1% AEP Hazard)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

0 200 400 Metres



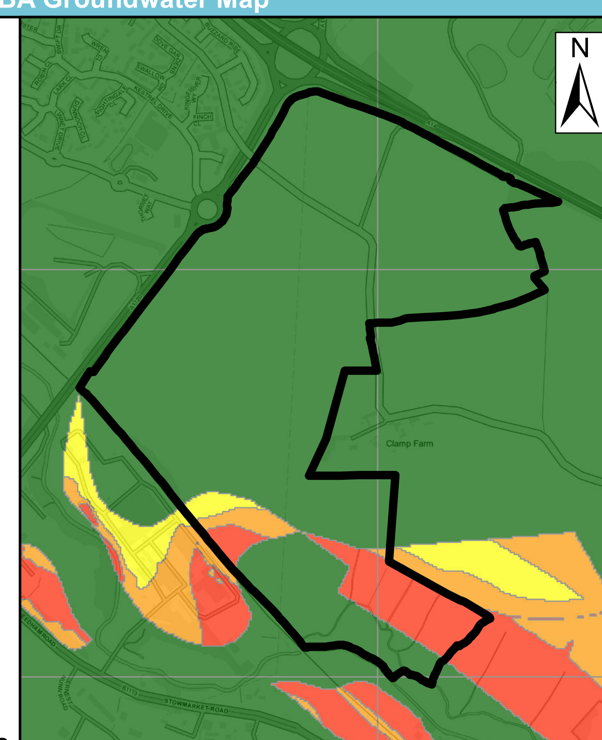
JBA Groundwater Map

Legend

JBA Groundwater Map

- No risk.
- Groundwater levels are at least 5m below the ground surface.
- Groundwater levels are between 0.5m and 5m below the ground surface.
- Groundwater levels are between 0.025m and 0.5m below the ground surface.
- Groundwater levels are either at or very near (within 0.025m of) the ground surface.

0 200 400 Metres

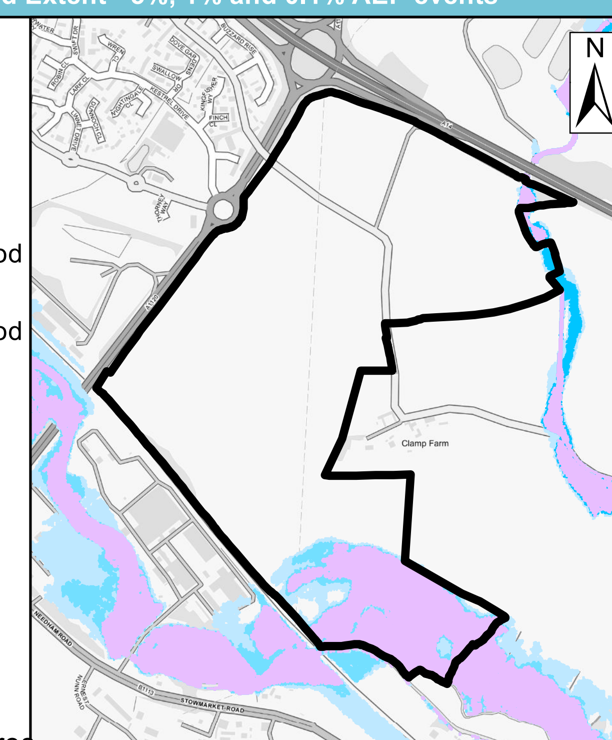


Fluvial Flood Extent - 5%, 1% and 0.1% AEP events

Legend

- 5% AEP flood extent
- 1% AEP flood extent
- 0.1% AEP flood extent

0 200 400 Metres



Site name	SS1223 Land at Mill Lane, Stowmarket
Site area (ha)	78.95

Babergh and Mid Suffolk Level 2 Strategic Flood Risk Assessment Site Summary Sheet mapping

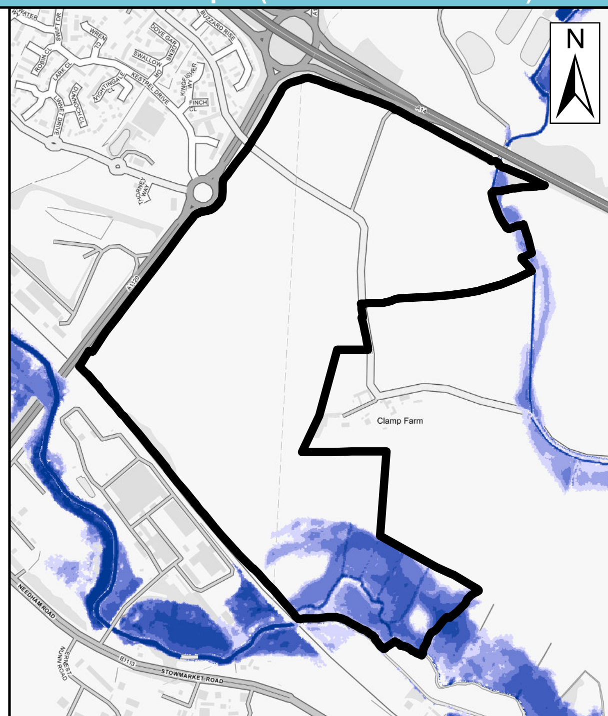
Fluvial Flood Depth (1% AEP undefended)

Legend

Depth

- Below 150mm
- 150 - 300mm
- 300 - 600mm
- 600 - 900mm
- 900 - 1200mm
- Over 1200mm

0 200 400 Metres

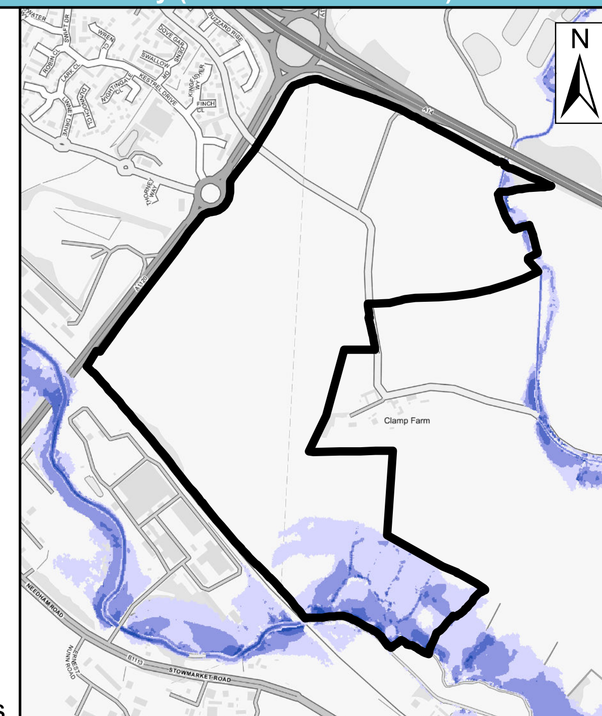


Fluvial Flood Velocity (1% AEP undefended)

Legend

- Less than 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 1.00 m/s
- 1.00 - 2.00 m/s
- Over 2.00 m/s

0 200 400 Metres



Fluvial Flood Hazard (1% AEP undefended)

Legend

Hazard

- 0.50 - 0.75 (Very low hazard)
- 0.75 - 1.25 (Danger for some)
- 1.25 - 2.00 (Danger for most)
- >2.00 (Danger for all)

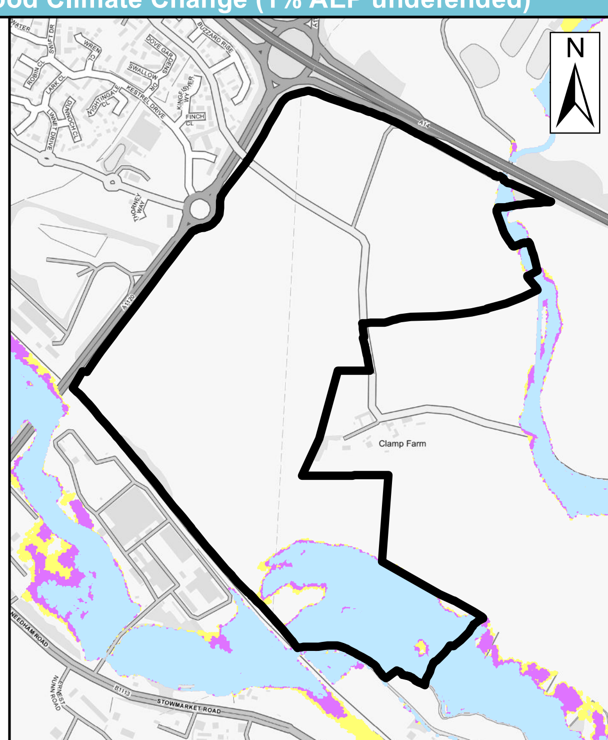
0 200 400 Metres

Fluvial Flood Climate Change (1% AEP undefended)

Legend

- 1% AEP flood extent (undefended)
- 1% AEP+ 35% CC flood extent (undefended)
- 1% AEP+ 65% CC flood extent (undefended)

0 200 400 Metres

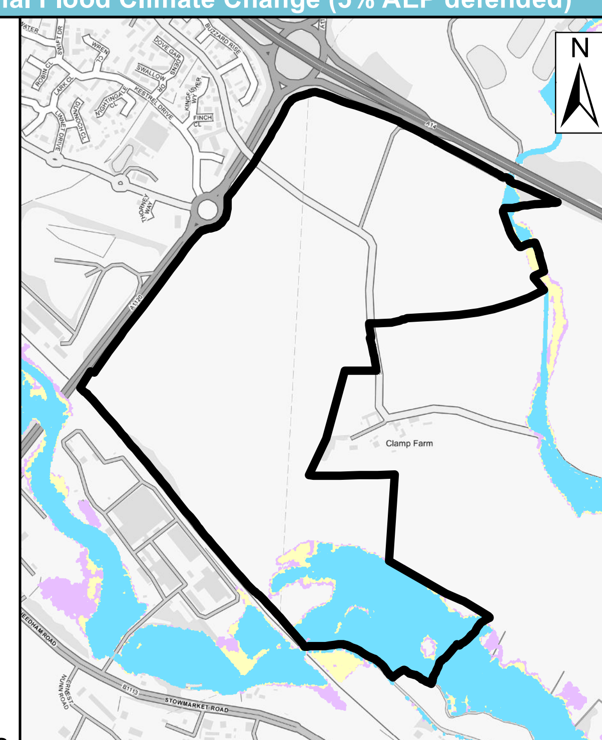


Fluvial Flood Climate Change (5% AEP defended)

Legend

- 5% AEP flood extent (defended)
- 5% AEP + 35% CC flood extent (defended)
- 5% AEP + 65% CC flood extent (defended)

0 200 400 Metres

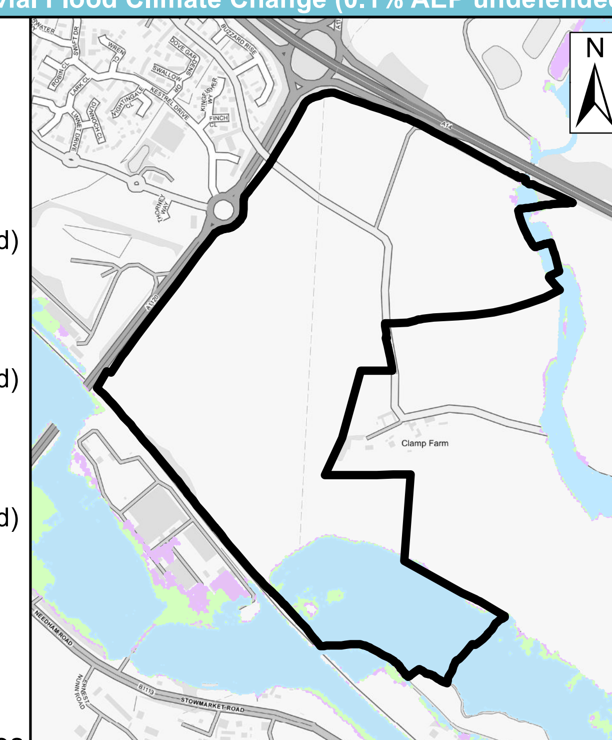


Fluvial Flood Climate Change (0.1% AEP undefended)

Legend

- 0.1% AEP flood extent (undefended)
- 0.1% AEP +35% CC flood extent (undefended)
- 0.1% AEP +65% CC flood extent (undefended)

0 200 400 Metres



Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="4">SS1223</td></tr>
<tr><td>Address</td><td colspan="4">Land at Mill Lane</td></tr>
<tr><td>Area</td><td colspan="4">78.9 Ha</td></tr>
<tr><td>Current Land Use</td><td colspan="4">Agricultural/Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="4">Employment</td></tr>
<tr><td rowspan="9">Sources of flood risk</td><td>Location of site within catchment</td><td colspan="4">The site is located in the River Gipping catchment, adjacent to the left bank of the River Gipping.</td></tr>
<tr><td>Existing drainage features</td><td colspan="4">The site is located directly to the north of the River Gipping which flows in an easterly direction along the western and southern boundaries of the site. Several unnamed drains are located in the southern portion of the site, draining southward into the main river.
Along the north eastern site boundary, an unnamed tributary of the River Gipping flows in a southerly direction towards its confluence with the main river approximately 500m downstream of the site.</td></tr>
<tr><td rowspan="7">Fluvial</td><td colspan="4">Proportion of Site at Risk</td></tr>
<tr><td>FZ3b</td><td>FZ3a</td><td>FZ2</td><td>FZ1</td></tr>
<tr><td>10.4%</td><td>11.9%</td><td>14.0%</td><td>86%</td></tr>
<tr><td colspan="4">Highest Zone of Risk (Risk of Flooding from Rivers and Sea)</td></tr>
<tr><td colspan="4">South east and north east of site: Low to High
Most of site: Very Low</td></tr>
<tr><td colspan="4">The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%)</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td colspan="3">SS1223</td></tr>
<tr><td>Address</td><td colspan="3">Land at Mill Lane</td></tr>
<tr><td>Area</td><td colspan="3">78.9 Ha</td></tr>
<tr><td>Current Land Use</td><td colspan="3">Agricultural/Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td colspan="3">Employment</td></tr>
<tr><td rowspan="10"></td><td></td><td colspan="3">Available Data: For this site, the existing EA detailed Flood Modeller-TUFLOW River Gipping model (2012) was available. The model has been updated so that it is 1D-2D at the location of this development site as it was previously only 1D only. A new detailed model has been built for the watercourse in the north east of the development site as required by the EA. This is also a 1D-2D Flood Modeller-TUFLOW model. Both models have been run with the 35% and 65% climate change allowances on the 20-year defended and 100-year and 1000-year undefended models as part of this SFRA.
Flood Characteristics:
The site is at risk of fluvial flooding from the River Gipping in the south of the site, and from a tributary of the River Gipping in the north east of the site.
The south-east of the site is shown of be a risk of flooding from the River Gipping in all modelled flood events. In the 20-year event, flood depths of up to 2m are found adjacent to the River Gipping and in the network of drainage channels in the site. Velocities are over 2m/s adjacent to the River Gipping.
In the 100-year event, the flood extent and depths increase. Depths in the network of drainage channels exceeds 2m and exceeds 1m in areas adjacent to this, but it is still only the south-east corner of the site that is at risk of flooding. Velocities are over 2m/s adjacent to the River Gipping. There is very little difference in depth and extent in the modelled defended and undefended scenario.
In the 1000-year event, again flood depths and extent increase, to over 2m in channels adjacent to the River Gipping, but it is still only the south-east corner of the site that is at risk of flooding. Velocities are over 2m/s adjacent to the River Gipping.
For the watercourse in the north-east of the site, in the 20-year event, only the watercourse that runs through the site and a very small area of the site adjacent to this is at risk of flooding. Depths in the channel are around 1.5m, and up to approximately 0.5m adjacent to the channel. Velocities in the channel and on the site are less than 1m/s.
In the 100-year event, the depth and extent of flooding from the watercourse increases along the north-east of the site. There are depths of up to 1.75m in the channel, and up to 0.75m adjacent to the channel. Velocities in the channel and on the site are less than 1m/s.
Flood extents and depths increase further in the 1000-year event, but it is still only a small area of the site that is at risk of flooding. There are depths of up to 2m the channel, and up to 1m adjacent to the channel. Velocities are in most places less than 1m/s, but are up to 1.5m/s.</td></tr>
<tr><td rowspan="9">Surface Water</td><td colspan="3">Proportion of site at risk (RoFfSW)</td></tr>
<tr><td>30-year
High Risk</td><td>100-year
Medium Risk</td><td>1,000-year
Low Risk</td></tr>
<tr><td>2.8%</td><td>5.0%</td><td>15.0%</td></tr>
<tr><td colspan="3">Max depths (m)</td></tr>
<tr><td>>0.9m</td><td>>0.9m</td><td>>0.9m</td></tr>
<tr><td colspan="3">Max velocity (m/s)</td></tr>
<tr><td>>0.25m/s</td><td>>0.25m/s</td><td>>0.25m/s</td></tr>
<tr><td colspan="3">The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 100-year includes the 30-year %).</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1223**
	Address	Land at Mill Lane
	Area	78.9 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Employment
		Description of surface water flow paths: The site is impacted by surface water flooding in all modelled events. In the 30-year event, the southern and eastern portions of the site are impacted by surface water flooding. Flooding is seen along the unnamed tributary of the River Gipping which flows through the north eastern corner of the site. It is likely that the surface water mapping is picking up the flood plain of this tributary. Isolated areas of flooding are also seen around the drains in the southern corner of the site and along the south western boundary. The majority of surface water flooding in this event is less than 0.3m in depth but some areas could be up to 0.9m. In the 100 and 1000-year events, surface water flood extents are greater in the north eastern corner of the site. In the south, where isolated areas of flooding were seen in the 30-year event, flood extents are increasingly joined up and greater in extent. Two defined surface water flow paths can be seen, one in the western site corner and the second flowing along Mill Lane and past Clamp Farm. In this event, floods depths remain largely below 0.3m but some areas could still reach greater than 0.9m in depth.
	Reservoir	The available online mapping shows that reservoir flood extents could impact the south east of the site where the range of unnamed drains flow into the main river. The online maps show that reservoir flooding could cause flood maximum depths on the site of between 0.3 and 2m and velocities of up to 0.5m/s. As exact depths and velocities are not available, it is not possible to make an exact estimate of flood hazard, however it is possible to estimate this based on the range of values available. As a conservative approach, taking the maximum depth of 2m, velocity of 0.5m/s and debris factor of 1, using the U.K. Hazard Rating formula D*(V+0.5)+DF (D= depth, V=velocity and DF = debris factor) this would give a hazard of 3, which would count as an extreme hazard and a danger for all. Taking a low range of values, so a depth of 0.3m, velocity of 0.1m/s and debris factor of 1 would give a hazard of 1.18, so a moderate hazard and danger for some. Given the potential risk of reservoir flooding in the south-east of the site, development should be steered away from this area to avoid any potential loss of life or damage to buildings in the event of dam failure. In the event of emergency drawdown of the reservoir, river levels may become artificially raised above normal levels.
	Groundwater	The JBA Groundwater Map 5m dataset was used to inform the groundwater levels at the site. The majority of the site is at no risk of groundwater flooding. However, in the southern portion of the site, there are areas of the following classifications: • **Groundwater levels are between 0.5m and 5m below the ground surface (low risk).** This means there is a risk of flooding to subsurface assets but surface manifestation of groundwater is unlikely. • **Groundwater levels are between 0.025m and 0.5m below the ground surface (medium to high risk)**. Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. There is the possibility of groundwater emerging at the surface locally. • **Groundwater levels are either at or very near (within 0.025m of) the ground surface (high risk).** Within this zone there is a risk of groundwater flooding to both surface and subsurface assets. Groundwater may emerge at significant rates and has the capacity to flow overland and/or pond within any topographic low spots. This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site specific FRA stage.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table				
Site details	**Site Code**	**SS1223**		
	Address	Land at Mill Lane		
	Area	78.9 Ha		
	Current Land Use	Agricultural/Greenfield		
	Proposed Land Use	Employment		
	Flood History	There are no records of historic flooding from the Environment Agency within the recorded flood outlines dataset or historic flooding dataset. Flood history information provided by BMSDC shows some historic incidents of flooding in the vicinity of the site but there are no records within the site boundary. Three incidents of historic road flooding are recorded on the A1120 which runs along the western site boundary.		
Flood risk management infrastructure	**Defences**	**Defence Type**	**Standard of Protection**	**Condition**
		-	-	-
		This site is not protected by any formal flood defences. However, the Environment Agency spatial flood defences dataset (AIMS data) shows that there is raised ground located on the left and right banks of the River Gipping along the entirety of the section of watercourse which passes the site. The identified raised ground along the River Gipping is likely to act as an informal flood defence on the site. Survey and assessment of these banks would be required as part of a site specific FRA to determine the standard of protection they provide.		
	Residual risk	There is a small section of culvert on a section of unnamed channel just outside the southern site boundary that could become blocked during a flood event. There are also structures on the River Gipping which could become blocked during a flood event. This could cause additional water to build up on the site. The potential for blockage will need to be considered in any future site-specific assessment. The site is at risk of flooding due to reservoir breach. The Environment Agency online mapping shows that the south-eastern corner of the site is within maximum extent of flooding from the reservoirs.		
Emergency planning	**Flood warning**	The southern portion of the site is contained within the Flood Warning Area on the River Gipping (054FWFSF4E - A14 at Stowmarket to upstream of Needham Market) In addition, the southern portion of the site and the north eastern corner is contained within the Rattlesden River and River Gipping Flood Alert Area (054WAFSF4DE).		
	Access and Egress	The site could be accessed from the A1129 along the eastern boundary or the A14 along the northern boundary. Mill Lane runs through the centre of the site from east of the A1120 through to Clamp Farm just outside the east site boundary. There is a small unnamed road off Mill Lane which runs from the centre of the site northwards under the A14, providing access to Brazier's Hall. In terms of fluvial flood risk the A1120 (which is raised above the River Gipping and flood outline) and A14 are not shown to be at risk of flooding so would be suitable for access. As there is risk of fluvial flooding in all events between the B1113 and the site, this road is unlikely to provide suitable access. Mill Lane is at risk of flooding east of the site from the tributary, with depths of up to 0.75m in the 100-year event. In terms of surface water flood risk, flooding is seen on the road networks surrounding the site in all events. In the 30 and 100-year events, flooding is shown at the junction between the A14 and the A1120 to the north of the site. Flood depths at this junction could be up to 0.9m in depth. Small areas of flooding are also seen along the A1120 to the west and on Mill Lane within the site boundary. Depths are largely below 0.3m but some isolated areas could reach up to 0.9m.		

Site details	**Site Code**	**SS1223**
	Address	Land at Mill Lane
	Area	78.9 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Employment
		In the 1000-year event, flooding at the junction to the north of the site boundary extends further down the A1120. Some flooding is seen along the rest of the A1120 but flood depths to the south of the junction are shown to be less than 0.3m. Flooding is also more extensive along the Mill Lane, where depths could reach up to 0.9m. Access and egress to the site would probably be most suitable from the A1120 to the south of where Mill Lane crosses the road.
Climate Change	**Implications for the site**	• Increased storm intensity and frequency as a result of climate change may increase the extent, depth, velocity, hazard and frequency of fluvial flooding from the River Gipping and surface water flooding across the site. • As part of the detailed modelling study completed for the Level 2 SFRA, modelling has included allowances for climate change. The 20-year defended and 100-year and 1000-year undefended scenarios were uplifted by 35% and 65% to allow for climate change. When the climate change allowances are modelled, there is an increase in flood extent and depth in from the watercourse in the north east corner of the site, however most of the site is not shown to be at risk of flooding. For the River Gipping, there is also an increase in flood depth and extent when climate change is modelled, but the flood extent is still confined to the south east of the site. • As part of a site-specific Flood Risk Assessment, latest EA climate change allowances will need to be considered in the detailed hydraulic model once the hydrology has been reviewed, to confirm the impact to the site. • Climate change also needs to be considered for surface water events; at the site-specific Flood Risk Assessment stage. Climate change should also be considered as part of surface water drainage strategies, or surface water modelling. • The current day 1000-year surface water extent provides an indication of the possible increase in extent of the 100-year event. It is likely that surface water flood risk, particularly in the south of the site and along Mill Lane will increase as a result of climate change. • The impact of climate change on surface water flood risk will require a detailed FRA to assess the site layout and design. • Developers should consider SuDS strategies to manage the impacts of climate change from surface water in a detailed site-specific FRA.
Requirements for drainage control and impact mitigation	**Broad scale assessment of possible SuDS**	Geology at the site consists of: • Bedrock: Neogene to Quaternary Rocks (Undifferentiated) • Superficial: Lowestoft Formation - Diamicton. Soils at the site consist of lime-rich loamy and clayey soils with impeded drainage The site is located within a Source Protection Zone (SPZ). Zone III defines the total catchment. It is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In the northern portion of the site: • All forms of source control are likely to be suitable. • Infiltration likely to be suitable. Mapping suggests a low risk of groundwater flooding however, site investigations should be carried out to assess potential for drainage by infiltration. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

JBA consulting

<table>
<tr><td rowspan="5">Site details</td><td>Site Code</td><td>SS1223</td></tr>
<tr><td>Address</td><td>Land at Mill Lane</td></tr>
<tr><td>Area</td><td>78.9 Ha</td></tr>
<tr><td>Current Land Use</td><td>Agricultural/Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td>Employment</td></tr>
<tr><td></td><td></td><td>

Detention may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; mitigation measures will be required.
Filtration measures may suitable provided site slopes are <5%. If the site has contamination or groundwater issues; mitigation measures will be required.
All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; mitigation measures will be required.

In the southern portion of the site:

Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater.
Mapping suggests that there is a medium to high risk of groundwater flooding at this location, therefore it is unlikely that infiltration techniques will be suitable. This should be confirmed via site investigations to assess the potential for infiltration. If infiltration is suitable it should be avoided in areas where the depth to the water table is <1m. If possible, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints given that the site is located with a Source Protection Zone.
Detention may be feasible provided site slopes are < 5% at the location of the detention feature. If the site has contamination or groundwater issues; a liner will be required.
Filtration may be suitable provided site slopes are <5% and the depth to the water table is >1m. If the site has contamination or groundwater issues; a liner will be required.
All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination or groundwater issues; a liner will be required.

Developers should refer to the Suffolk County Council SuDS guide as well as the Level 1 SFRA, for information on suitable types of SuDS, the management train and opportunities and constraints in site master-planning.
</td></tr>
<tr><td>NPPF and Planning Implications</td><td>Exception Test Requirements</td><td>
The Local Authority have carried out the Sequential Test in line with national guidance. The Sequential Test will need to be passed before the Exception Test is applied.

Employment development is classified as ‘Less Vulnerable’.

A sequential approach to site layout will contribute towards passing the flood risk element of the Exception Test, this means that the least vulnerable type of development (in terms of Table 2 of the Flooding section of the NPPG) should be located in the higher flood risk parts of the site.

In no instances should less vulnerable development be located in Flood Zones 3b. Development in the high flood risk parts of the site should be designed such that it is flood resilient and resistant. It is anticipated that proposed development will be sequentially located within Flood Zone 1 on this site.
</td></tr>
</table>

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1223**
	Address	Land at Mill Lane
	Area	78.9 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Employment
	Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required if any development is located within Flood Zones 2 or 3 or is greater than one hectare. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance; BMSDC Local Plan policies, and Suffolk County Council SuDS guide. • Consultation with the Local Authority, Local Lead Flood Authority and the Environment Agency should be undertaken at an early stage. • All sources of flooding, particularly the risk of fluvial, reservoir, surface water and groundwater flooding, should be considered as part of a site-specific flood risk assessment. • Although modelling has been completed as part of this SFRA, detailed modelling of the site will still be required as part of the site-specific FRA to confirm both fluvial and surface water flood risk and flow paths. Detailed modelling would require topographic survey of the site and well as any additional asset survey needed to refine the model further. In addition, the latest guidance on climate change allowances would need to be considered and any mitigation measures would need to be tested through modelling. • The residual risk from culvert blockage should be assessed and suitable mitigation proposed. • The residual risks associated with failure of reservoir must be addressed so that proposed development is safe. Site design should consider recommendations made in the Suffolk Flood Response Plan. The site-specific FRA will need to consider any existing emergency plans in place related to the reservoir. • The development should be designed using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. • Development in FZ3b should be avoided unless appropriate use can be demonstrated in line with NPPF. • Development in FZ3 may require floodplain compensation and this should be confirmed with the EA at FRA stage. **Guidance for site design and making development safe:** • The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG). • Safe access and egress will need to be demonstrated in the 1 in 100-year plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Raising of access routes must not impact on surface water flow routes. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. • Resilience measures will be required if buildings are situated in the flood risk area. Raising Finished Floor Levels above the design event may remove the need for resilience measures. • The impact of culvert blockage needs to be fully assessed. Any new culverts proposed as part of access improvements will need to be designed to ensure they do not increase flood risk up or downstream

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

Site details	**Site Code**	**SS1223**
	Address	Land at Mill Lane
	Area	78.9 Ha
	Current Land Use	Agricultural/Greenfield
	Proposed Land Use	Employment
		and will require a Land Drainage Consent outside of the planning process from the LLFA. Culverting should be avoided where at all possible and limited to short lengths for essential infrastructure. The need to ensure both fluvial and surface water flows can pass through the site is essential. • If existing culverts are to be kept, a full CCTV condition survey is required to ensure the culvert will be sound for the lifetime of the proposed development. Improvements should be sought, such as trash screens compliant with the latest Environment Agency guidance and relining where this is appropriate and sustainable option. • For any culverts (old or new), the developer must set out who is adopting and maintaining those culverts throughout the lifetime of the development. The design of the development must take into account the residual risk of blockage e.g. properties should not be placed in the area that could flood if a culvert blocks and the exceedance flows from such an event should be built into the site masterplan. • The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current greenfield rates. • **Areas at risk from fluvial and surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised.** This needs to be modelled to inform the design to ensure that surface water overland flows or fluvial flooding do not overwhelm sustainable drainage features. • New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects. • Betterment on the existing site runoff rate should be sought to ensure that there is no increase in surface water flood risk elsewhere. Surface water runoff must be fully attenuated to the greenfield rate. • Developers should refer to Suffolk County Council SuDS guide and the Level 1 SFRA for background information on SuDS.

Babergh and Mid Suffolk District Councils Level 2 Strategic Flood Risk Assessment Detailed Site Summary Table

<table>
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<tr><td>Address</td><td>Land at Mill Lane</td></tr>
<tr><td>Area</td><td>78.9 Ha</td></tr>
<tr><td>Current Land Use</td><td>Agricultural/Greenfield</td></tr>
<tr><td>Proposed Land Use</td><td>Employment</td></tr>
<tr><td colspan="2">Key Messages</td><td>The flood risk element of the Exception Test is likely to be passed if:
Development is limited to the 86% of the site located outside of the Environment Agency's Flood Zone 2 and 3. It is understood from the proposals for land development that the south-east of the site, which is at risk of flooding from the River Gipping and at risk of reservoir flooding will not be developed. There is also a risk of surface water flooding which must be considered to ensure the development can be made safe from flooding and that it will not increase flood risk elsewhere.
Areas in Flood Zone 1 and then 2 are used for the least vulnerable parts of the development in accordance with Table 2 in the NPPF.
If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another).
Space for green infrastructure should be considered in the areas of highest flood risk.
Safe access and egress routes must not be in the areas of high surface water risk or the 100-year fluvial design flood event (taking into account climate change). Access and egress to the site would probably be most suitable from the A1120 to the south of where Mill Lane crosses the road.
Refer to the detailed 'guidance for developers' section for further information on the measures that are appropriate for this site.</td></tr>
<tr><td colspan="3">Mapping Information</td></tr>
<tr><td colspan="3">The key datasets used to make planning recommendations regarding this site were the outputs from the existing 1D-2D model of the River Gipping (re-run as part of this SFRA for climate change), new modelling developed for this Level 2 SFRA, and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below. It should be noted that the outputs of the modelling carried out for this SFRA vary to the Environment Agency's Flood Map for Planning.</td></tr>
<tr><td colspan="2">Flood Zones</td><td>Flood Zones 2 and 3 have been taken from the River Gipping Model and detailed modelling completed as part of the Level 2 SFRA.</td></tr>
<tr><td colspan="2">Climate change</td><td>Environment Agency 35% and 65% climate change allowances were modelled as part of detailed hydraulic modelling study completed for the Level 2 SFRA.</td></tr>
<tr><td colspan="2">Fluvial depth, velocity and hazard mapping</td><td>Fluvial depth, velocity and hazard mapping has been taken from the detailed hydraulic model developed as part of the Level 2 SFRA. This information should be explored further at site-specific stage.</td></tr>
<tr><td colspan="2">Surface Water</td><td>The Risk of Flooding from Surface Water has been used to define areas at risk from surface water flooding.</td></tr>
<tr><td colspan="2">Surface water depth, velocity and hazard mapping</td><td>The surface water depth, velocity and hazard mapping for the 1 in 100-year event (considered to be medium risk) is taken Environment Agency's Risk of Flooding from Surface Water.</td></tr>
</table>

TECHNICAL NOTE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk Level 2 SFRA
Client	BMSDC
Day, Date and Time	09/10/2020
Author	L Archer-Lock
Reviewer / Sign-off	C Smith
Subject	Mendlesham Model Summary Report

1 Introduction

This report provides a record of information on the hydraulic model of the River Dove which is being developed for the Babergh & Mid Suffolk Level 2 SFRA for the SS0065 (Land south of Glebe Way, Mendlesham) development site.

1.1 Available data

Item	Comments
Hydraulic model	An existing hydraulic model of the River Dove was available, provided by the Environment Agency , developed by JBA Consulting in 2012. This model is 1D only on the River Dove downstream of the development site. The model does not extend far enough to include the development site and therefore the model has been extended for this study, and converted into a 1D-2D Flood Modeller-TUFLOW model. As only Mendlesham is the area of interest, only a small section of the existing model has been used in this study. The 1D existing model has not been changed for this study, except to deactivate cross sections so the 2D model domain could be added.
Cross-section survey	Survey for the River Dove was collected by EDI Surveys in September 2020. Cross sections were derived from the cross section data to represent the 1D domain.
LIDAR & other Topographic data	2m LiDAR (from 2019) was obtained for the full study extent from the Environment Agency open data portal.

1.2 Model build

Item	Comments
What software & reason for choice	A 1D-2D Flood Modeller-TUFLOW model was developed. The use of a 1D-2D modelling approach is preferred for this assessment as there is potential for complex overland routes. Flood Modeller is used to represent the river channel and hydraulic structures along the watercourse, whilst the floodplain is modelled in the 2D TUFLOW domain. TUFLOW version 2018-03-AD-iDP-w64 was used in this project.
General schematisation	The Flood Modeller-TUFLOW model extends along the River Dove from east of Old Station Road to the A140. The 2D TUFLOW domain used a 4m grid with area 2.1km^2. As there are no formal flood defences in the study there is not a defended and undefended model.

TECHNICAL NOTE

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2 Overview

2.1 Model Schematic

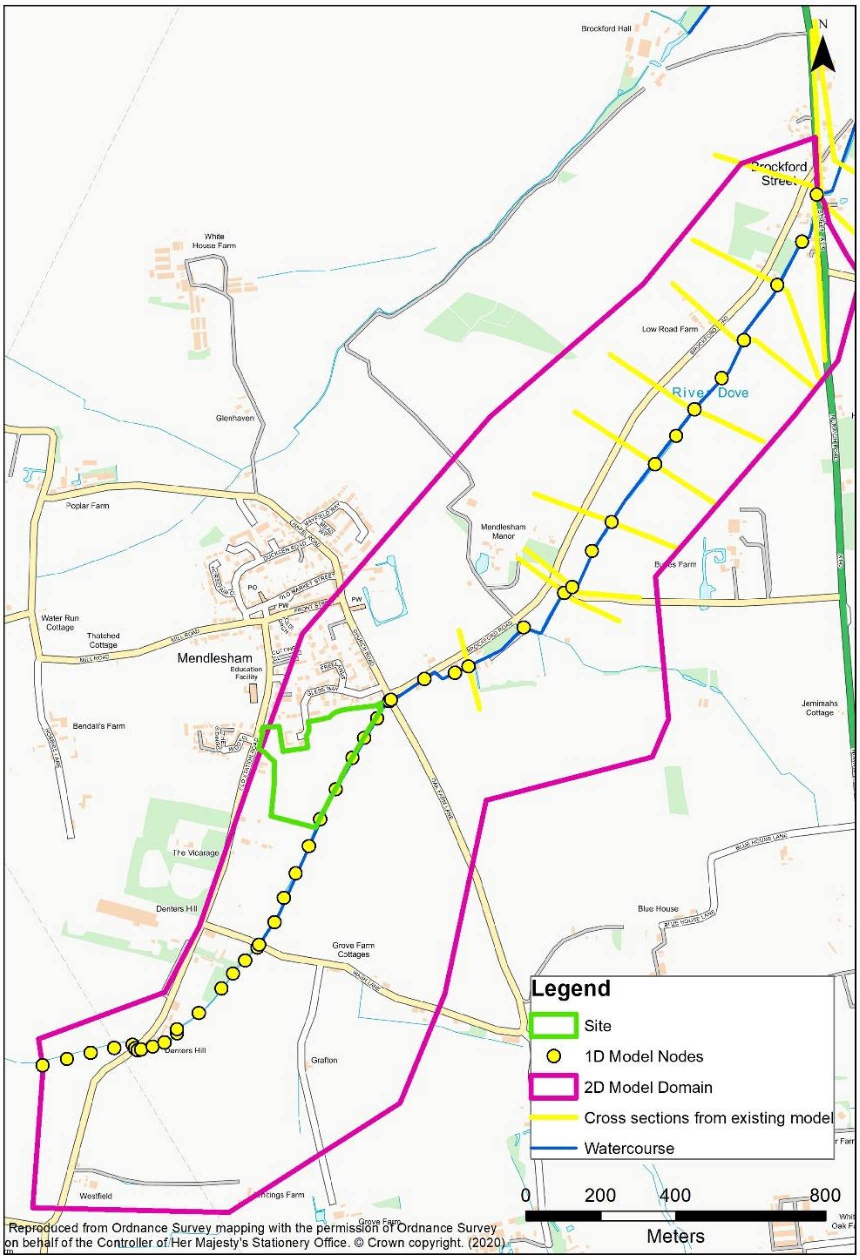

Figure 2-1: Model Extent

TECHNICAL NOTE

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1D model overview	
Inflow boundaries	Hydrological inflows were derived from the assessment undertaken for this study. Inflows were derived for 20, 100 and 1000 year events, including 35% and 65% climate change. More information can be found in DUX-JBAU-XX-XX-RP-HO-0002-S3-P01-SS0065_Mendlesham_hydrology.
Downstream boundary	A normal depth boundary was applied at unit DOVE0116200.
Labelling/ numbering system used	Labelling was kept from the existing model, with chainage added working upstream in line with the new cross section-survey.

2D model overview	
Modification to topography	2d_Mend_Bank_Levels_001 - z-points and z-line to inform bank levels along River Dove. Levels taken from cross section survey
Hydraulic roughness	Manning's n values have been used to represent hydraulic roughness in the 2D domain. The following roughness values were used in the model:

Land Cover	Manning's 'n'
Building	0.300
General surface – multi surface	0.040
General surface – step	0.030
General surface (including agricultural land)	0.040
Glasshouse	0.200
Inland water	0.035
Natural landform	0.050
Landform- slope	0.050
Landform- cliff	0.050
Natural surface/ Scrub/ Non-coniferous trees/ Rough grassland	0.100
Paths	0.030
Rail	0.020
Road or track	0.020
Roadside	0.020
Structure- manmade	0.300
Structure- pylon	0.040
Tidal water – foreshore	0.035

		Tidal water	0.035
		Unclassified	0.300

2.2 1D-2D linking

JBA have adopted the standard approach to linking 1D Flood Modeller and 2D TUFLOW models. Within the 2D domain a lateral spill (HX boundary) is defined for the left and right banks and the channel area in between classified as 'inactive' in the 2D grid. The HX boundaries are linked to the respective Flood Modeller nodes using CN connection lines and are discontinued at bridge and culverts. Along these boundaries, water levels in the channel and floodplain interact dynamically and thus control floodplain wetting and drying.

2.3 1D model Manning's n values

Channel and floodplain roughness values have been represented in the model by Manning's n values. Manning's n values are considered to be a conveyance factor rather than simply a roughness coefficient, and take account of channel meanders (sinuosity), contraction and expansion such as changes in cross sectional area between sections, bed material effects and obstacles, as well as the vegetation of the banks and floodplains. As such, it is appropriate to define values on a reach basis, taking account of the overall features of that reach. A value of 0.04 has been used for the channel and 0.06 for the banks. Although the photos from the survey indicate the channel is highly vegetated, these photos are from summer, when vegetation is higher, whereas the catchment is more likely to flood in winter and therefore this has been represented in the roughness value of 0.06.

2.4 Structures

Structures from the new cross section survey have been entered into the model in 1D based on the new cross section obtained. All structure geometry was entered into the model by hand and any assumptions made in the modelling of structures are recorded in the table below. The remaining structures in the model are from the existing model and therefore as no changes were made to these they are not listed below.

Structure	Model Label	How has structure been modelled?:
Station Road Culvert	DOVE119441	Modelled as circular conduit. Spill modelled for deck overtopping
Culvert	DOVE119391	Modelled as circular conduit. Spill modelled for deck overtopping
Culvert	DOVE119323	Modelled as circular conduit. Spill modelled for deck overtopping
Wash Lane Road Bridge	DOVE118997	Modelled as circular conduit. Spill modelled for deck

		overtopping
Oak Farm Lane Road Bridge	DOVE118251	USBPR Bridge with one opening Spill modelled for deck overtopping

3 Model Results

The model results for the 20, 100 and 1000-year events are shown below at the development site. Flooding is mostly contained along the eastern site boundary which is adjacent to the River Dove. Flood extent increases with return period, and in the 1000-year event, in the north-east of the site there is an increase in the area at risk of flooding. However the majority of the site is not shown to be at risk of flooding.

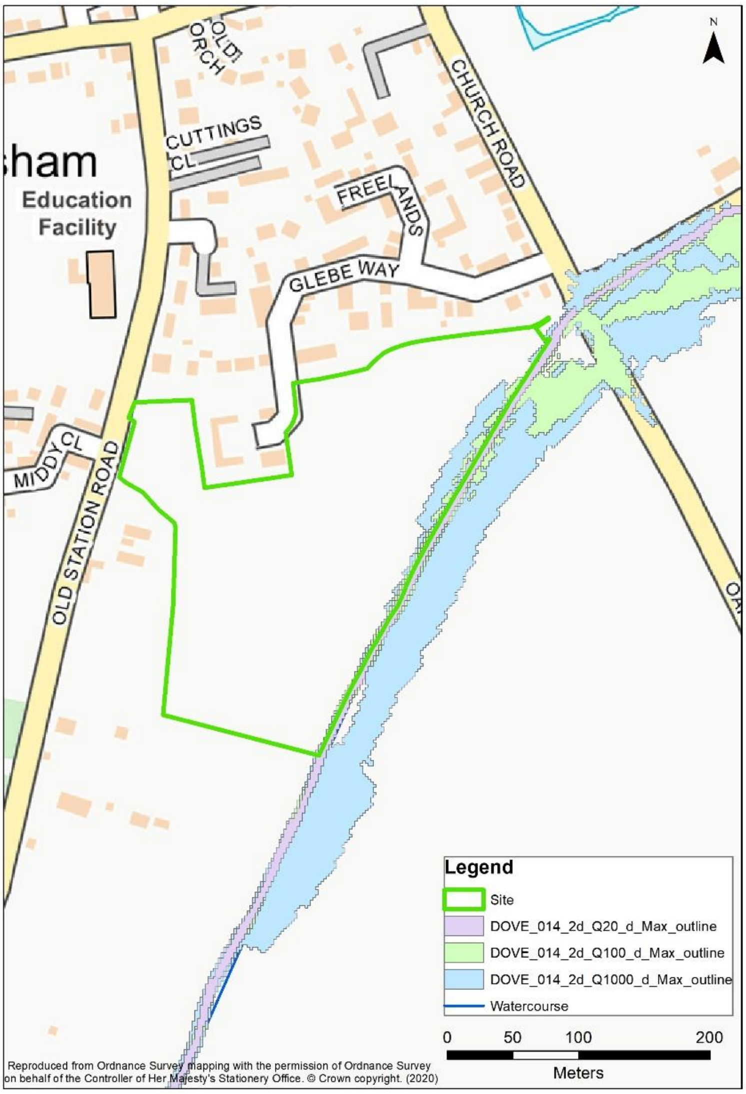

Figure 3-1: Model Results - 20-year, 100-year and 1000-year events

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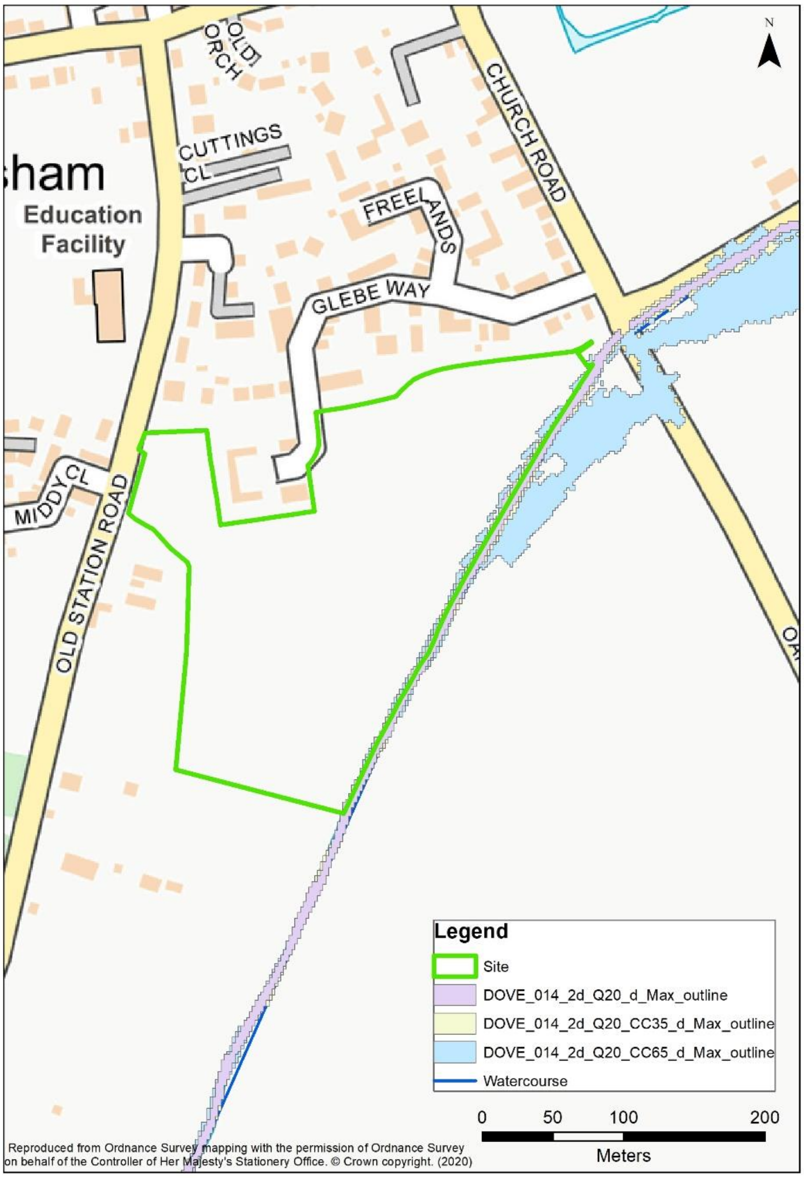

Figure 3-2: Model Results - 20-year event plus 35% and 65% climate change

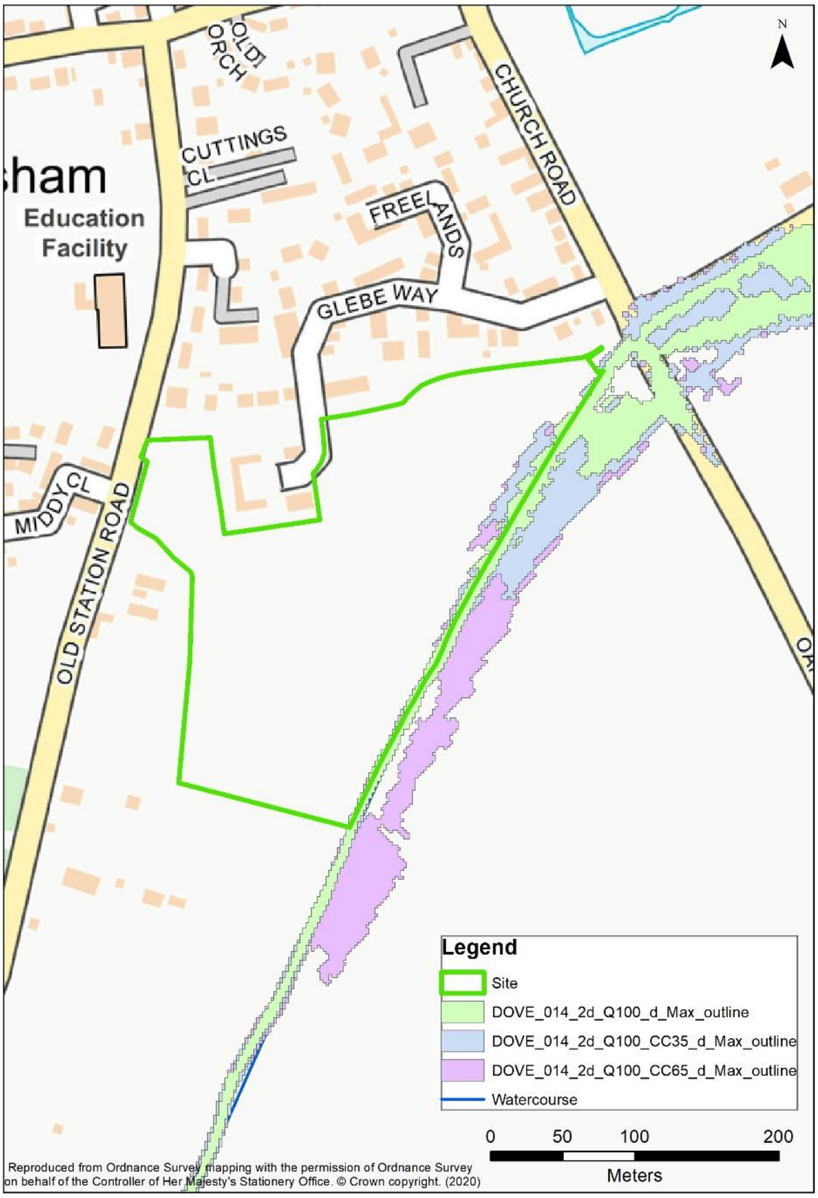

Figure 3-3: Model Results - 100-year event plus 35% and 65% climate change

TECHNICAL NOTE

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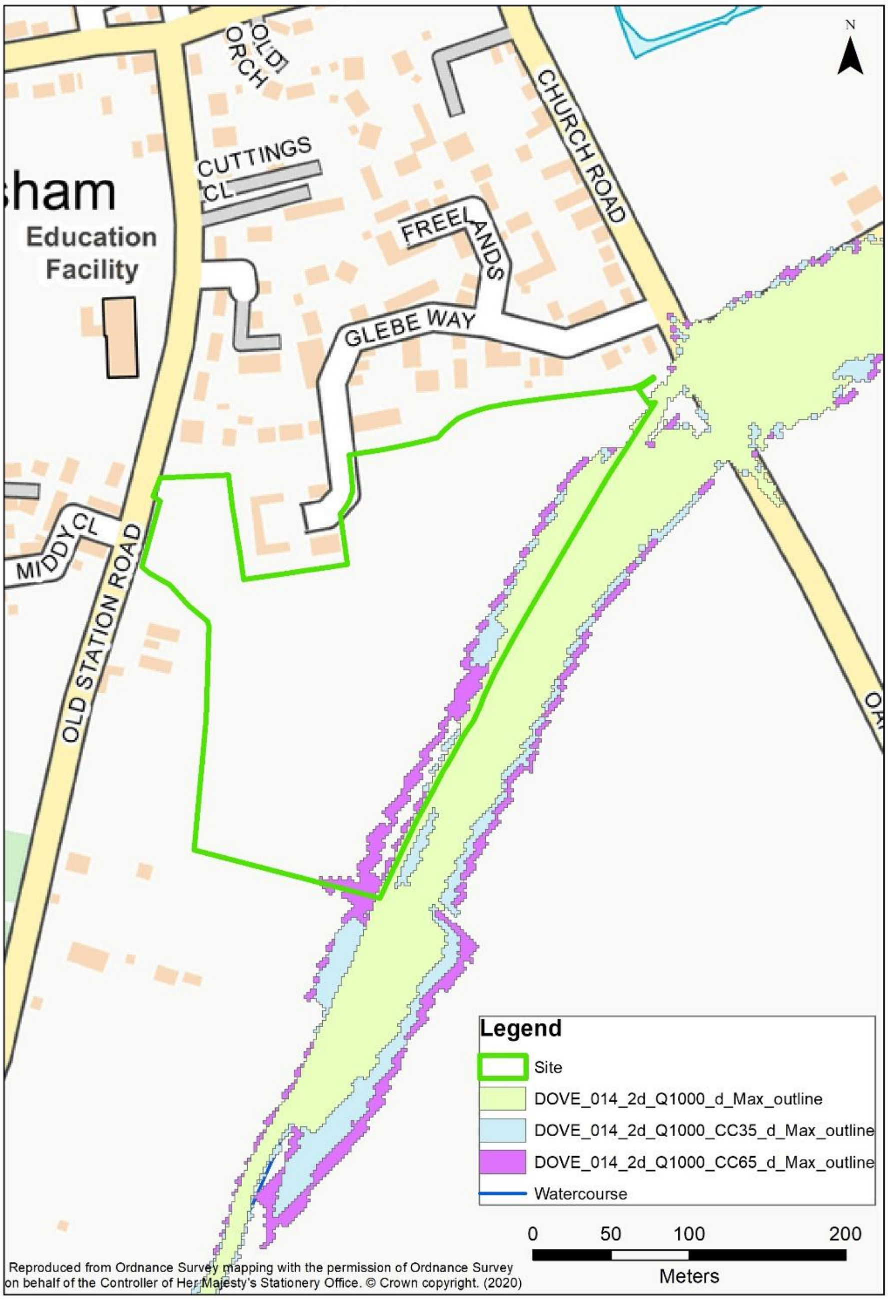


Figure 3-4: Model Results - 100-year event plus 35% and 65% climate change

4 Model limitations, assumptions and uncertainty

Developing a hydraulic model requires the application of simplifications and generalisations. As such a number of assumptions are made when building the model. This can lead to model uncertainties and subsequent limitations of the results.

The scope of the model is a simple model for an SFRA and therefore this is reflected in the level of detail included in the model. The main aim of the model was to produce flood outlines for the development site, and whilst some improvements could be done to the model, this was only done where it would make a difference to the outline at the site.

In terms of model construction, the initial model schematisation and the approach adopted can be a limitation. In this study a linked 1D-2D Flood Modeller-TUFLOW model was developed. This schematisation allows a detailed representation of the channel and structure capacity to be defined within the 1D model domain and flow paths across the floodplain to be defined within the 2D model domain. The 1D-2D modelling approach was considered to be the most appropriate to represent the risk of fluvial flooding due to the complex flow path and the number of obstructions such as bridges and flood banks within the floodplain.

The main assumption associated with the hydraulic model produced for this commission comes from the flow estimates applied to the model. The hydrology in this study was calculated using the FEH Statistical method.

The base data used to provide a representation of the channel and associated structures may be a limitation of the study. In this case, the channel and topographic survey was carried out for this study for the River Dove. Some of the channel and topographic survey is from the existing models. The age of this survey (pre 2012) is a potential source of uncertainty. It has been assumed that the existing model is fit for purpose.

The LiDAR used to set the base topography in the 2D model domain is a source of uncertainty. The bare earth DTM was filtered to remove the presence of buildings and vegetation. The LiDAR data used for this study is at 2m resolution.

General modelling assumptions relate to the selection of various parameters within the model, for example, the roughness values used within the model, representation of certain structures and their coefficients.

There is a flow reversal at higher flows at unit DOVE0117815i leading to a large negative flow. A stability patch was used which did make some improvements, however as this is downstream of the site of interest, and would have little different to the outline at the site, no further troubleshooting was done for this.

A minimum flow of 0.4m^3/s had to be used in DOVE_01, as when this was lowered the model did not run. Although this is not ideal, as it is greater than the capacity of some culverts, this should not impact the flood peaks as the peak flows are all higher than this.

The flow applied at the top of the model (DOVE_01) was generated for the catchment to Wash Lane. To ensure that this is not over-attenuating flow in the hydraulic model by entering flow, generated downstream of culverts, into the model upstream of the culvert, the flows at the downstream of the site at DOVE_02 were compared to the check flow generated in the hydrological assessment. The modelled flows generally match the hydrological estimates well, and were up to 10% higher than the hydrology, depending on the return period, and therefore this is conservative.

Flood estimation report: SS065 – Land South of Glebe Way Mendlesham

Introduction

This report template is based on a supporting document to the Environment Agency's flood estimation guidelines. It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results.

Contents

Approval

	Name and qualifications	Date
Method statement prepared by:	Lucy Archer-Lock BSc	14/09/2020
Method statement reviewed by:	Claire French BSc (Hons) MSc (Eng) MCIWEM CWEM CSci CEnv	17/09/2020
Calculations prepared by:	Lucy Archer-Lock BSc	14/09/2020
Calculations reviewed by:	Claire French BSc (Hons) MSc (Eng) MCIWEM CWEM CSci CEnv	17/09/2020

Revision History

Revision reference	Date issued	Amendments	Issued to
P01	October 2020	-	Matt Deakin

Abbreviations

AM...........................Annual Maximum

AREA ....Catchment area (km^2)

BFI ....Base Flow Index

BFIHOST ....Base Flow Index derived using the HOST soil classification

CFMP ....Catchment Flood Management Plan

CPRE ....Council for the Protection of Rural England

FARL........................FEH index of flood attenuation due to reservoirs and lakes

FEH ....Flood Estimation Handbook

FSR ....Flood Studies Report

HOST........................Hydrology of Soil Types

NRFA ....National River Flow Archive

POT ....Peaks Over a Threshold

QMED ....Median Annual Flood (with return period 2 years)

ReFH........................Revitalised Flood Hydrograph method

SAAR ....Standard Average Annual Rainfall (mm)

SPR ....Standard percentage runoff

SPRHOST ....Standard percentage runoff derived using the HOST soil classification

Tp(0) ....Time to peak of the instantaneous unit hydrograph

URBAN ....Flood Studies Report index of fractional urban extent

URBEXT1990 ....FEH index of fractional urban extent

URBEXT2000 ....Revised index of urban extent, measured differently from URBEXT1990

WINFAP-FEH ....Windows Frequency Analysis Package – used for FEH statistical method

1 Method statement

1.1 Requirements for flood estimates

Overview	The purpose of this hydrological assessment is to provide inflows to a hydraulic model for a development site off Glebe Way, Mendlesham. The hydraulic modelling is being undertaken as part of a Level 2 Strategic Flood Risk Assessment (SFRA). There is an existing model available of the River Dove, which is being extended upstream for the purposes of this study. The new model will be built in Flood Modeller-TUFLOW. Design peak flow estimates and hydrographs are required at four locations for the following annual exceedance probability (AEP) events (%): 50, 10, 5, 3.3, 1 and 0.1. The effects of climate change will be assessed using the 5, 1 and 0.1% AEP events and accounted for using the latest guidance[1]. The intended climate change factors will be 35% and 65% as the site is located within the Anglian River Basin District.
Project scope	There are no river gauges in the study area, therefore rating reviews and ReFH parameter estimation are not relevant. It is only within the scope of this hydrological study to assess fluvial flows. The scope and level of detail in the assessment is proportionate to the strategic nature of the project.

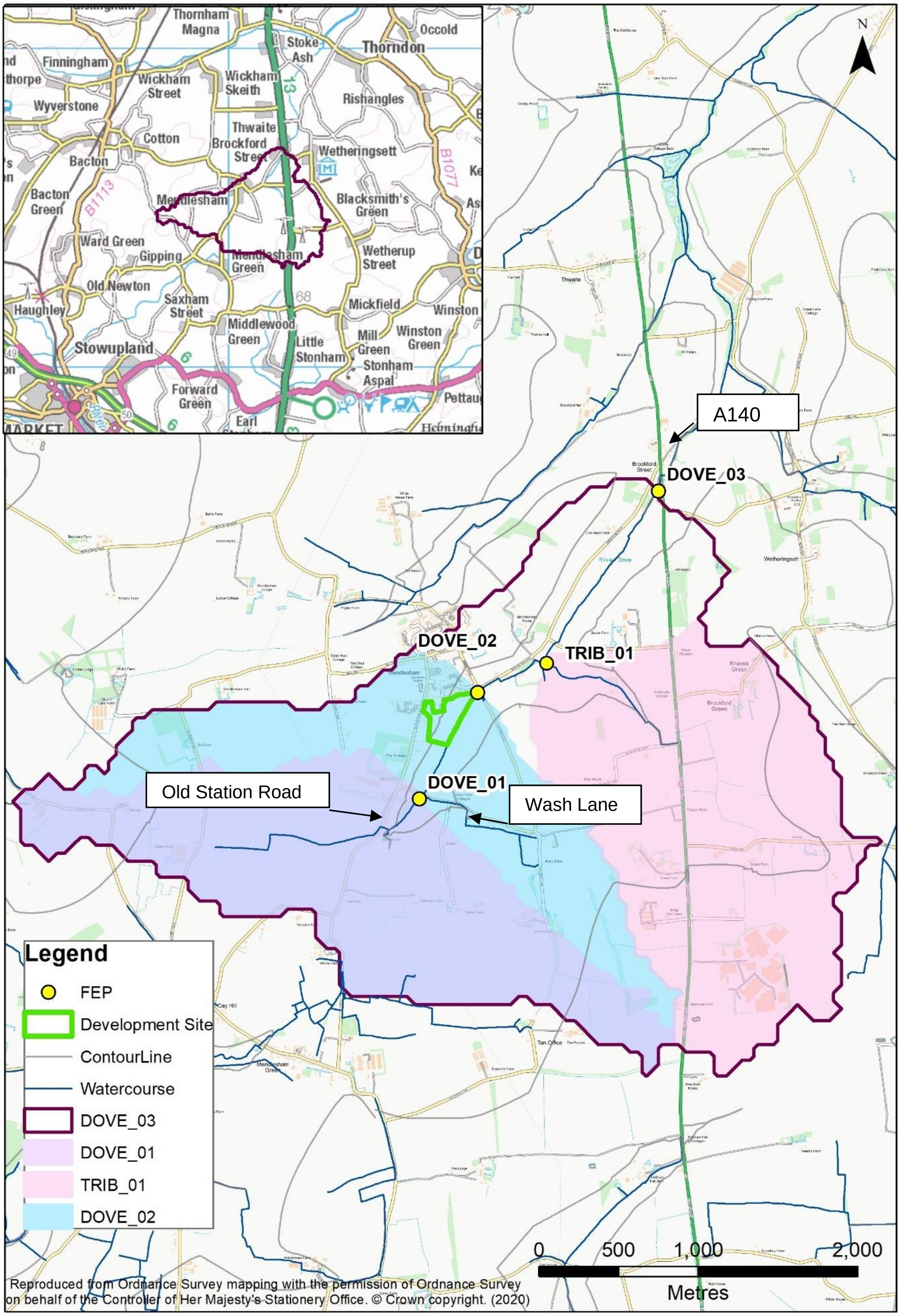
1.2 The catchment

Description Include topography, climate, geology, soils, land use and any unusual features that may affect the flood hydrology.	The proposed development sits to the south of Glebe Way, Mendlesham and is approximately 5.28 hectares. The River Dove rises east of Hoggars Road and flows in a north-easterly direction along the eastern boundary of the development site. The model of the River Dove being developed for this study starts upstream of Old Station Road, with the downstream model extent at the A140. There are several tributaries joining the River Dove in the modelled reach, one at Wash Lane, and a second right bank tributary downstream of the development site south of Brockford Road. The 1:50000 bedrock geology underlying the catchment belongs to the Crag Group and comprises sand[2]. However, borehole scans available for Mendlesham also record the presence of some clay. The soils underlying the catchment are mainly slowly permeable, seasonally wet, slightly acid, but base-rich, loamy and clayey soils. The western and downstream extents of the study catchment are underlain by slightly acid, loamy and clayey soils with impeded drainage. The topography of the catchment is fairly flat. Land use in the catchment is predominantly rural, although the village of Mendlesham lies within the catchment.

[1] Environment Agency (2020), "https://www.gov.uk/guidance/flood-and-coastal-risk-projects-schemes-and-strategies-climate-change-allowances".

[2] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Map (Include river network, catchment boundary and gauging stations)



1.3 Source of flood peak data

Source	NRFA peak flows dataset, Version 8, released September 2019. This contains data up to water year 2017-18.

1.4 Gauging stations (flow or level)

(at or very near to the sites of flood estimates)

Water-course	Station name	Gauging authority number	NRFA number	Catchment area (km²)	Type (rated / ultrasonic / level…)	Start of record and end if station closed
Catchment is ungauged – gauging station on the River Dove (Oakley Park) is significantly downstream of area of interest and has a much larger catchment area.						

1.5 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data	Details
Check flow gaugings	No	N/A	N/A	N/A
Historic flood data	Yes	Yes	BMSDC historic flood records	Babergh & Mid Suffolk District Council (BMSDC) flood records indicate that there are several recorded flood incidents in Mendlesham, including on Old Station Road, Church Road, Chapel Road and Mill Road. These are mainly caused by localised surface water flooding and none of the recorded incidents are noted to have been fluvial flooding from the River Dove.
Flow or river level data for events	Yes	No	N/A	N/A
Rainfall data for events	Yes	No	N/A	N/A
Potential evaporation data	Yes	No	N/A	N/A
Results from previous studies	Yes	Yes	Existing model of River Waveney and River Dove (JBA Consulting 2012) – 2012s6007	Hydrological assessment carried out in 2012 for the model of the River Waveney catchment including the River Dove. FEH Statistical method was chosen as the preferred method – hydrographs were derived using the ReFH method and were scaled to fit

			– JBA FEH calculation record v10	the FEH Statistical peak flows.
Other data or information (e.g. groundwater, tides, channel widths, low flow statistics)	Yes	No	N/A	N/A

1.6 Hydrological understanding of catchment

Outline the conceptual model, addressing questions such as:	The main site of interest is the development site located south of Glebe Way, Mendlesham. Flooding at this location is likely to be caused by peak flows. Although there are some surface water flooding incidents recorded in Mendlesham, only fluvial flooding is being assessed as part of this study.
Any unusual catchment features to take into account?	No

1.7 Initial choice of approach

Is FEH appropriate?	FEH flood frequency methods are considered appropriate, given the catchment area is greater than 0.5km² (the lower limit of applicability of the methods) and is not extremely urbanised.
Initial choice of method(s) and reasons How will hydrograph shapes be derived if needed? Will the catchment be split into sub-catchments? If so, how?	Both the statistical method and the ReFH2 method will be applied. There is no peak flow record available in the study catchment to improve the QMED estimate under the statistical method. Local donors, from outside of the study catchment, will, therefore, be assessed for data transfer suitability. At this stage, there is no strong reason to prefer one method for flood flow estimation over another for this watercourse. The flow estimates from the two methods will be compared and contrasted. Hydrograph shapes will be derived from the ReFH2 model. These will be fitted to the Statistical peaks if this is the preferred method for deriving design peak flow estimates.
Software to be used (with version numbers)	FEH Web Service[3] / WINFAP-FEH v3.0.003[4] / ReFH2.3

[3] CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK.
[4] WINFAP-FEH v3 © Wallingford HydroSolutions Limited and NERC (CEH) 2009.

2 Locations where flood estimates required

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

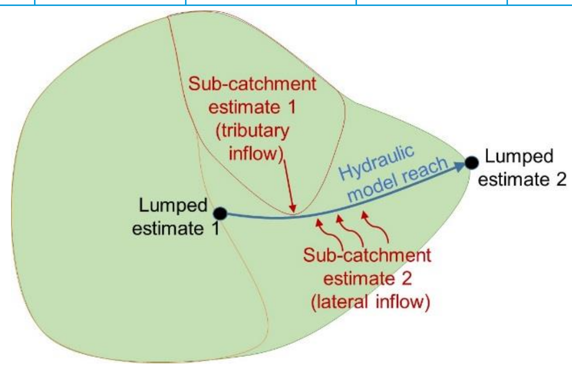
2.1 Summary of subject sites

Site code	Type of estimate L: lumped catchment S: Sub-catchment	Watercourse	Name or description of site	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered
DOVE_01	L	River Dove	Catchment upstream of Wash Lane	610250	264900	3.10	-
DOVE_02	L	River Dove	Downstream of development site	610650	265500	5.23	-
TRIB_01	L	Tributary	Tributary of River Dove	611100	265750	3.68	-
DOVE_03	L	River Dove	Downstream model extent	611750	266800	10.38	-
DOVE_02_IA	S	River Dove	Intervening area between DOVE_01 and DOVE_02	-	-	-	2.13
DOVE_03_IA	S	River Dove	Intervening area between DOVE_02, TRIB_01 and DOVE_03	-	-	-	1.47

Note: Lumped catchments (L) are complete catchments draining to points at which design flows are required.

Sub-catchments (S) are catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system. There is no need to report any design flows for sub-catchments, as they are not relevant: the relevant result is the hydrograph that the sub-catchment is expected to contribute to a design flood event at a point further downstream in the river system. This will be recorded within the hydraulic model output files. However, catchment descriptors and ReFH model parameters should be recorded for sub-catchments so that the results can be reproduced.

The schematic diagram illustrates the distinction between lumped and sub-catchment estimates.



2.2 Important catchment descriptors at each subject site (incorporating any changes made)

URBEXT 2000 values have been updated to 2020

Site code	FARL	PROPWET	BFIHOST	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
DOVE_01	1.00	0.28	0.340	0.352	1.50	10.0	582	0.015	0.293
DOVE_02	1.00	0.28	0.338	0.351	1.96	9.2	582	0.023	0.258
TRIB_01	0.993	0.28	0.312	0.333	1.99	10.0	583	0.034	0.246
DOVE_03	0.994	0.28	0.328	0.344	3.25	11.0	583	0.029	0.227

Site code	FARL	PROPWET	BFIHOST	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
DOVE_02_IA*	-	0.28	0.335	0.350	1.51	8.0	582	0.035	-
DOVE_03_IA*	-	0.28	0.332	0.347	1.24	19.9	587	0.038	-

*Only those catchment descriptors needed for input into the ReFH2 model have been derived for the intervening areas

2.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes	The FEH catchment boundary was compared against Terrain50 and OS 10k mapping. The boundary for the River Dove seems to be incorrect in places. There are a number of field drains in and around the upper catchment. The FEH boundary is picking up some areas where these drains are likely to take flows away from the catchment, while it also looks like there may be areas outside of the FEH boundary that drain into the catchment. These errors will be self-cancelling to a degree. And, since it is not clear from the mapping and topographic data where some of the drains are routed, the original FEH catchment boundaries have been used for this study.
Record how other catchment descriptors were checked and describe any changes.	A qualitative check of the FEH BFIHOST values was undertaken by comparing them to the geology and soils detailed in Section 1.2. The BFIHOST19 values (0.333-0.352) indicate an impermeable catchment. Although the values appear inconsistent with the bedrock geology shown on 1:50k scale mapping (i.e. sand belonging to the Crag Group), borehole scans available for Mendlesham note the presence of some clay. The overlying soils are also described as either slowly permeable or having impeded drainage. The BFIHOST19 and observed BFI values for the Dove catchment downstream at Oakley Park are slightly higher (0.452 and 0.46, respectively), but this catchment includes some freely draining soils. In conclusion, the FEH BFIHOST19 values for the study catchment appear to be a reasonable representation of local base flow conditions and have been retained. The FARL value is 1.00 for DOVE_01 and DOVE_02. The FEH Webservice does not indicate any online lakes within the wider catchment. OS mapping has also been checked, and whilst this shows a few ponds within the catchment, it has been assumed that these do not have a significant flood attenuation effect. There is a small online lake shown on the FEH Webservice in the TRIB_01 catchment, and an additional online lake shown in the DOVE_03 catchment, and therefore the FARL values of 0.993 and 0.994 seem reasonable. A qualitative check of the URBEXT values was made by comparing the FEH values and the urban extent 2000 layer to the current OS mapping. Although the catchments are essentially rural, the FEH values seem low and the urban extent 2000 layer has gaps in it. This particularly applies to the TRIB_01 catchment, which has an FEH value of 0, despite an area of warehouses shown east of the A140 Norwich Road. Therefore, the URBEXT value for all catchments was derived using OS50k mapping and the mapping relationship between URBAN50k and URBEXT2000. This was shown to increase the URBEXT values from the original values, reflecting the current level of development within the catchment.
Source of URBEXT	URBEXT2000
Method for updating of URBEXT	Manually derived URBAN values from OS50k mapping

3 Statistical method

3.1 Overview of estimation of QMED at each subject site

Site code	Initial QMED rural (m^3/s) (from catchment descriptors)	Final method	Data transfer					Urban adjustment factor (UAF)	Final QMED estimate (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Moderated QMED adjustment factor, $(A/B)^a$	If more than one donor			
						Weight	Weighted ave. adjustment		
DOVE_01	0.59	CD	N/A	N/A	N/A	N/A	N/A	1.014	0.60
DOVE_02	0.93	CD	N/A	N/A	N/A	N/A	N/A	1.021	0.95
TRIB_01	0.70	CD	N/A	N/A	N/A	N/A	N/A	1.030	0.72
DOVE_03	1.67	CD	N/A	N/A	N/A	N/A	N/A	1.026	1.71

Are the values of QMED spatially consistent?	Yes, QMED increases downstream
Method used for urban adjustment for subject and donor sites	WINFAP v4[5]

Parameters used for WINFAP v4 urban adjustment if applicable

Impervious fraction for built-up areas, IF	Percentage runoff for impervious surfaces, PR_{imp}	Method for calculating fractional urban cover, URBAN
0.3	70%	OS50k mapping

Notes

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer (with urban adjustment); CD – Catchment descriptors alone (with urban adjustment); BCW – Catchment descriptors and bankfull channel width (add details); LF – Low flow statistics (add details).

The QMED adjustment factor A/B for each donor site is given in Table 3.2. This is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial estimate from catchment descriptors.

[5] Wallingford HydroSolutions (2016). WINFAP 4 Urban adjustment procedures.

3.2 Search for donor sites for QMED (if applicable)

Comment on potential donor sites Include a map if necessary. Note that donor catchments should usually be rural.	There are no river flow gauging stations within the study catchment. Gauging stations in the wider Dove catchment, as well as adjacent hydrometric areas, were, therefore, assessed for suitability for data transfer to the study watercourse. There are 15 rural NRFA stations within 30km of the study area, based on the distance between catchment centroids. Comparison of $QMED_{obs}$ and $QMED_{cds}$ shows there is no consistent trend among the donor stations. Recommendations from current research[6] (and new research[7] to be published soon) indicate that the geographically closest station to the study site tends to produce the best results. The latest research highlights that descriptors, such as AREA, are included in the regression equation for QMED, so the donor adjustment process accounts for the differences in values between the donor and subject catchments. It also explains that the overarching pattern of QMED model residuals across the UK follows a smooth spatial pattern, hence the recommendation to choose donors by proximity. The closest station to the study sites is 34007 (Dove @ Oakley Park). This is situated on the River Dove downstream from the catchment of interest, and therefore is the most appropriate station to be considered as a donor. However, observed QMED for this station (12.845 m^3/s) is only slightly higher than QMED from catchment descriptors (12.69 m^3/s). Therefore, once the urban adjustment is considered, the final adjustment would be 1.000, and therefore use of this station does not have any impact on QMED so it has not been applied.

3.3 Donor sites chosen and QMED adjustment factors

NRFA no.	Reasons for choosing	Method (AM or POT)	Adjust-ment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjust-ment ratio (A/B)
34007	Closest station geographically and on the watercourse of interest downstream	AM	No	12.845	12.69	1.01

[6] Kjeldsen, T.R., Jones, D.A. and Bayliss, A.C. 2008. Improving the FEH statistical procedures for flood frequency estimation. Science Report SC050050, Environment Agency.
[7] Stewart, Lisa, Duncan Faulkner, Giuseppe Formetta, Adam Griffin, Tracey Haxton, Ilaria Prosdocimi, Gianni Vesuviano and Andy Young (TBC). Estimating flood peaks and hydrographs for small catchments (Phase 2). Report – SC090031/R0, Environment Agency.

3.4 Derivation of pooling groups

Several subject sites may use the same pooling group.

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
DOVE_02	DOVE_02	No	Reviewed and retained: • 27073 (Brompton Beck @ Snainton Ings) • 76011 (Coal Burn @ Coalburn) • 27051 (Crimple @ Burn Bridge) Removed: • 49005 (Bolingey Stream @ Bolingey Cocks Bridge) – only 8 years of data Added: • 44008 (South Winterbourne @ Winterbourne Steepleton) – as group had less than 500 years of data	L-CV: 0.260 L-skew: 0.243

Note: Pooling groups were derived using the procedures from Science Report SC050050 (2008).

3.5 Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape after adjustments)	Growth factor for 100-year return period
DOVE_01	P	DOVE_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Scale: 0.259 Shape: -0.246	3.21
DOVE_02	P	DOVE_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Scale: 0.258 Shape: -0.247	3.20
TRIB_01	P	DOVE_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Scale: 0.255 Shape: -0.249	3.20

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape after adjustments)	Growth factor for 100-year return period
DOVE_03	P	DOVE_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Scale: 0.256 Shape: -0.248	3.20

Notes

Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis

A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters.

Urban adjustments are all carried out using the WINFAP 4 urban adjustment procedures.

Growth curves were derived using the procedures from Science Report SC050050 (2008).

3.6 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following AEP (%) events					
	50	10	5	3.3	1	0.1
DOVE_01	0.60	1.1	1.3	1.4	1.9	3.4
DOVE_02	0.95	1.7	2.0	2.2	3.0	5.4
TRIB_01	0.72	1.3	1.5	1.7	2.3	4.1
DOVE_03	1.71	3.0	3.6	4.0	5.5	9.7

4 Revitalised flood hydrograph 2 (ReFH2) method

4.1 Catchment sub-divisions for ReFH2 model

Site code	Area (km^2)			
	Rural or un-developed	Paved	Only relevant if significant transfers of water via sewers crossing catchment boundaries…	
			Paved with sewers draining out of topographic catchment	Paved outside topographic catchment with sewers draining into catchment
DOVE_01	3.071	0.029	N/A	N/A
DOVE_02	5.155	0.075	N/A	N/A
TRIB_01	3.602	0.078	N/A	N/A
DOVE_03	10.191	0.189	N/A	N/A
Sources of information for creating sub-divisions	$URBAN_{50k}$		**Sewer capacity** (return period / rainfall intensity / flow rate) and source of information	N/A

4.2 Parameters for ReFH2 model

Site code	Method	Tp_{rural} (hours)	Tp_{urban} (hours)	C_{max} (mm)	PR_{imp} % runoff for impermeable surfaces	BL (hours)	BR*
DOVE_01	CD	4.96	3.72	289.72	70	32.17	0.94
DOVE_02	CD	5.94	4.46	288.96	70	34.05	0.92
TRIB_01	CD	5.83	4.37	275.76	70	33.09	0.79
DOVE_03	CD	7.49	5.62	283.76	70	37.56	0.86
DOVE_02_IA	CD	5.34	4.00	288.21	70	32.12	0.91
DOVE_03_IA	CD	3.57	2.68	285.98	70	30.58	0.92
Brief description of any flood event analysis carried out (further details should be given in the annex)				N/A			
Methods: OPT: Optimisation, BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details)							
*As BFIHOST<0.5, BR varies with storm event, the BR value displayed in this table relates to the 1% AEP event.							

4.3 Design events for ReFH2 method: Lumped catchments

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours:minutes)
DOVE_01	Rural	Winter	07:30
DOVE_02	Rural	Winter	09:00
TRIB_01	Rural	Winter	09:00

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours:minutes)
DOVE_03	Rural	Winter	11:00
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?			Yes, a uniform storm duration and ARF will be applied to the model. A storm duration of 9:30 (based on the critical duration of 9:00 at DOVE_02 but allowing for a timestep of 00:30) was selected. The storm duration ARF for DOVE_02 was used as the development site is the main area of interest.

4.4 Flood estimates from the ReFH2 method

Note: This table is for recording results for lumped catchments. There is no need to record peak flows from sub-catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system.

Site code	Flood peak (m^3/s) for the following AEP (%) events					
	50	**10**	**5**	**3.3**	**1**	**0.1**
DOVE_01	0.85	1.41	1.67	1.84	2.52	4.65
DOVE_02	1.27	2.09	2.46	2.72	3.73	6.85
TRIB_01	0.97	1.60	1.89	2.08	2.85	5.24
DOVE_03	2.21	3.60	4.23	4.66	6.43	11.71

5 Discussion and summary of results

5.1 Comparison of results from different methods

This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods.

Site code	Ratio of peak flow to FEH Statistical peak	
	Return period 2 years	Return period 100 years
	ReFH2	ReFH2
DOVE_01	1.42	1.33
DOVE_02	1.34	1.24
TRIB_01	1.35	1.24
DOVE_03	1.29	1.17

Figure 5-1 Comparison of growth curves between the FEH Statistical and ReFH2 methods for DOVE_02

5.2 Final choice of method

Choice of method and reasons	FEH Statistical is the preferred method for generating the design peak flow estimates for the study catchment. The comparison of design flows presented in Section 5.1 shows that the Statistical method gives lower flows than the ReFH2 method. The difference between the methods comes from the 2-year estimates, with Figure 5-1 showing that the FEH Statistical method gives a higher growth curve than the ReFH2 method. Consideration of local donor sites lends confidence to the Statistical QMED estimate. The Oakley Park gauging station, located further downstream on the River Dove, indicates that the QMED catchment descriptor equation performs well on this catchment, with an adjustment ratio of 1.01. The FEH Statistical method is, therefore, considered the most appropriate choice. This method is also based on a larger dataset of flood events and has been more directly calibrated to reproduce flood frequency on UK catchments.

	Although the statistical method is preferred here over the ReFH2 model, there can be significant uncertainties associated with applying it to events beyond the 200-year return period, due to the typically short length of river gauge records. To reduce these uncertainties, a hybrid approach can be taken to deriving the 1000-year return period flows. The ReFH2 0.1%/1% AEP growth factors will be applied to the 1% FEH Statistical method flows.
How will the flows be applied to a hydraulic model?	For upstream model inflows, ReFH2 hydrographs, scaled to fit the statistical peaks, will be applied to the model – DOVE_01 will be applied at the upstream model extent. TRIB_01 will be applied at the location the tributary joins the River Dove. For the intervening areas, ReFH2 hydrographs will be applied to the model. DOVE_02_IA and DOVE_03_IA will be applied to the intervening area between DOVE_01 and DOVE_02, and DOVE_02, TRIB_01 and DOVE_03, respectively. These intervening area flows will be distributed across the modelled reach according to catchment area.

5.3 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	The main assumptions are: • The catchment boundary is representative of the topographic catchment • BFIHOST19 can be used in the FEH Statistical method • The BFIHOST19 value for the catchment is correct despite the geology shown to underly the catchment on 1:50k scale mapping. • The pooling group used to define the growth curve in the FEH Statistical method is representative of the catchment
Discuss any particular limitations	The main limitation is the lack of river flow gauge data specific to the study area. There are no river flow or level gauges on the watercourse at or near the area of interest and, therefore, the catchment response is unknown.
Give what information you can on uncertainty in the results	It is not possible to directly quantify the uncertainty for the ReFH2 method. There is no method provided in the FEH for estimating uncertainty for the common situation of an ungauged catchment, pooled growth curve and QMED estimated from catchment descriptors. The uncertainty will depend on many factors, for example, how unusual the study catchment is relative to the pooling group, and the uncertainty in flow measurement at other gauges. A UK average measure of uncertainty is presented in a technical guidance report generated by a R&D project into the FEH, local data and uncertainty (Environment Agency funded consortium of JBA, CEH and others). The report presents results for rural catchments (URBEXT2000 <0.03) and moderately urbanised catchments (0.03 ≤ URBEXT2000 < 0.15). The 95% confidence limits for a 1% AEP flood estimate for a rural catchment are: • Without donor adjustment of QMED: 0.45 – 2.23 times the best estimate.

<table>
<tr><td></td><td>

With donor adjustment of QMED (one donor): 0.47 – 2.12 times the best estimate.

The 95% confidence limits for a 1% AEP flood estimate for a moderately urbanised catchment are:

Without donor adjustment of QMED: 0.33 – 3.01 times the best estimate
With donor adjustment of QMED (one donor): 0.34 – 2.94 times the best estimate.

</td></tr>
<tr><td>Comment on the suitability of the results for future studies</td><td>The design peak flow estimates and hydrographs were derived for the purposes of this modelling study. If peak flow estimates and hydrographs are required for a different purpose it is recommended that, at a minimum, a review of the results is carried out.</td></tr>
<tr><td>Give any other comments on the study</td><td>There is a lack of hydrometric data within the catchment. Confidence in flow estimates and understanding of catchment response could be improved with local hydrometric data collection.</td></tr>
</table>

5.4 Checks

<table>
<tr><td>Are the results consistent, for example at confluences?</td><td>Yes, QMED increases downstream.</td></tr>
<tr><td>What do the results imply regarding the return periods of floods during the period of record?</td><td>There is no local flow data (within the study area) against which to compare the design peak flow estimates.</td></tr>
<tr><td>What is the range of 100-year growth factors? Is this realistic?</td><td>The 1% AEP growth factor range for the methods is:

FEH Statistical: 3.2
ReFH2: 2.9-3.0

The typical range is 2.1 to 4.0. The growth factors for both methods are within this range.</td></tr>
<tr><td>If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?</td><td>The 0.1%/1% AEP growth factor range for the methods is:

FEH Statistical: 1.8
ReFH2: 1.8

</td></tr>
<tr><td>How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.</td><td>The results from this study have been compared with the final results from the JBA 2012 study and are shown in the table below. The FEPs are not at the same location, however DOVE_01_UB (area 5.42km²) from the JBA 2012 study lies close to DOVE_02 (area 5.23km²). The results from the current study are higher, and are preferred as they use the latest data, software and methods, and are targeted at the Glebe Way development site.
<table>
<tr><th rowspan="2">Study</th><th rowspan="2">FEP</th><th rowspan="2">Area (km²)</th><th colspan="3">Flow (m³/s by AEP)</th></tr>
<tr><th>5%</th><th>1%</th><th>0.1%</th></tr>
<tr><td>JBA 2012</td><td>DOVE_01_UB</td><td>5.42</td><td>2.00</td><td>2.66</td><td>4.82</td></tr>
<tr><td rowspan="2">JBA 2020</td><td>DOVE_02 (ReFH2)</td><td>5.23</td><td>2.46</td><td>3.73</td><td>6.85</td></tr>
<tr><td>DOVE_02 (FEH Stat)</td><td>5.23</td><td>2.00</td><td>3.04</td><td>5.40</td></tr>
</table>
</td></tr>
<tr><td>Are the results compatible with the longer-term flood history?</td><td>There is no local flow data against which to compare the design flow estimates.</td></tr>
</table>

Describe any other checks on the results	Modelled levels and flood extents will be sensibility-checked to ensure that flow inputs result in realistic outputs.

5.5 Final results

Site code	Flood peak (m^3/s) for the following AEP (%) events					
	50	10	5	3.3	1	0.1
DOVE_01	0.60	1.1	1.3	1.4	1.9	3.6
DOVE_02	0.95	1.7	2.0	2.2	3.0	5.6
TRIB_01	0.72	1.3	1.5	1.7	2.3	4.3
DOVE_03	1.71	3.0	3.6	4.0	5.5	10.0

If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, hydraulic model, or reference to table below)	DUX-JBAU-XX-XX-CA-HO-0002-S3-P01-SS0065_Mendlesham_hydrographs_for_model (Note: Decimal time is used in the spreadsheet for compatibility with hydraulic modelling software, rather than the hours and minutes format adopted in ReFH2.)

6 Annex

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
27073 (Brompton Beck @ Snainton Ings)	0.764	37	0.82	0.2	0.047	1.427
76011 (Coal Burn @ Coalburn)	2.89	41	1.84	0.165	0.315	1.142
27051 (Crimple @ Burn Bridge)	2.896	46	4.539	0.219	0.148	0.523
26802 (Gypsey Race @ Kirby Grindalythe)	3.017	19	0.109	0.309	0.183	0.352
45816 (Haddeo @ Upton)	3.11	25	3.456	0.306	0.399	1.297
25019 (Leven @ Easby)	3.121	40	5.384	0.343	0.378	0.779
28033 (Dove @ Hollinsclough)	3.275	43	4.205	0.231	0.369	0.8
36010 (Bumpstead Brook @ Broad Green)	3.327	51	7.5	0.372	0.184	2.57
72014 (Conder @ Galgate)	3.382	50	16.465	0.233	0.162	0.232
47022 (Tory Brook @ Newnham Park)	3.401	25	6.18	0.273	0.149	1.233
73015 (Keer @ High Keer Weir)	3.452	27	12.33	0.205	0.281	0.355
27010 (Hodge Beck @ Bransdale Weir)	3.453	41	9.42	0.224	0.293	0.245
41020 (Bevern Stream @ Clappers Bridge)	3.455	49	13.66	0.203	0.181	1.531
44008 (South Winterbourne @ Winterbourne Steepleton)	3.469	39	0.448	0.411	0.328	1.515
Total		533				
Weighted means				0.26	0.243	

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Wallingford
Warrington

Registered Office
1 Broughton Park
Old Lane North
Broughton
SKIPTON
North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
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TECHNICAL NOTE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk Level 2 SFRA
Client	BMSDC
Date	15/10/2020
Author	F Haine
Reviewer / Sign-off	C Smith
Subject	Stradbroke Model User Report

1 Introduction

This report provides a record of information on the hydraulic model for an unnamed tributary of the River Waveney which is being developed for the Babergh & Mid Suffolk Level 2 SFRA for the SS1198 (Land north of Laxfield Road, Stradbroke) development site.

1.1 Available data

Item	Comments
Cross-section survey	Survey for the unnamed tributary collected by EDI Surveys in September 2020. Model cross sections were derived from the cross section data to represent the 1D domain.
LIDAR & other Topographic data	2m LiDAR from 2019 was obtained for the full study extent from the Environment Agency open data portal.

1.2 Model build

Item	Comments
What software & reason for choice	A 1D-2D Flood Modeller-TUFLOW model was developed. The use of a 1D-2D modelling approach is preferred for this assessment as there is potential for complex overland routes. Flood Modeller is used to represent the river channel and hydraulic structures along the watercourse, whilst the floodplain is modelled in the 2D TUFLOW domain. TUFLOW version 2018-03-AD-iDP-w64 was used in this project.
General schematisation	The Flood Modeller-TUFLOW model extends along the unnamed tributary from south-east of Neaves Lane to south of the confluence with another unnamed tributary of the River Waveney at TM 23565 74843. The 1Km^2 2D TUFLOW domain used a 2m grid resolution. As there are no formal flood defences in the study there is not a defended and undefended model.

TECHNICAL NOTE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk Level 2 SFRA
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Date	15/10/2020
Author	F Haine
Reviewer / Sign-off	C Smith
Subject	Stradbroke Model User Report

2 Overview

2.1 Model Schematic

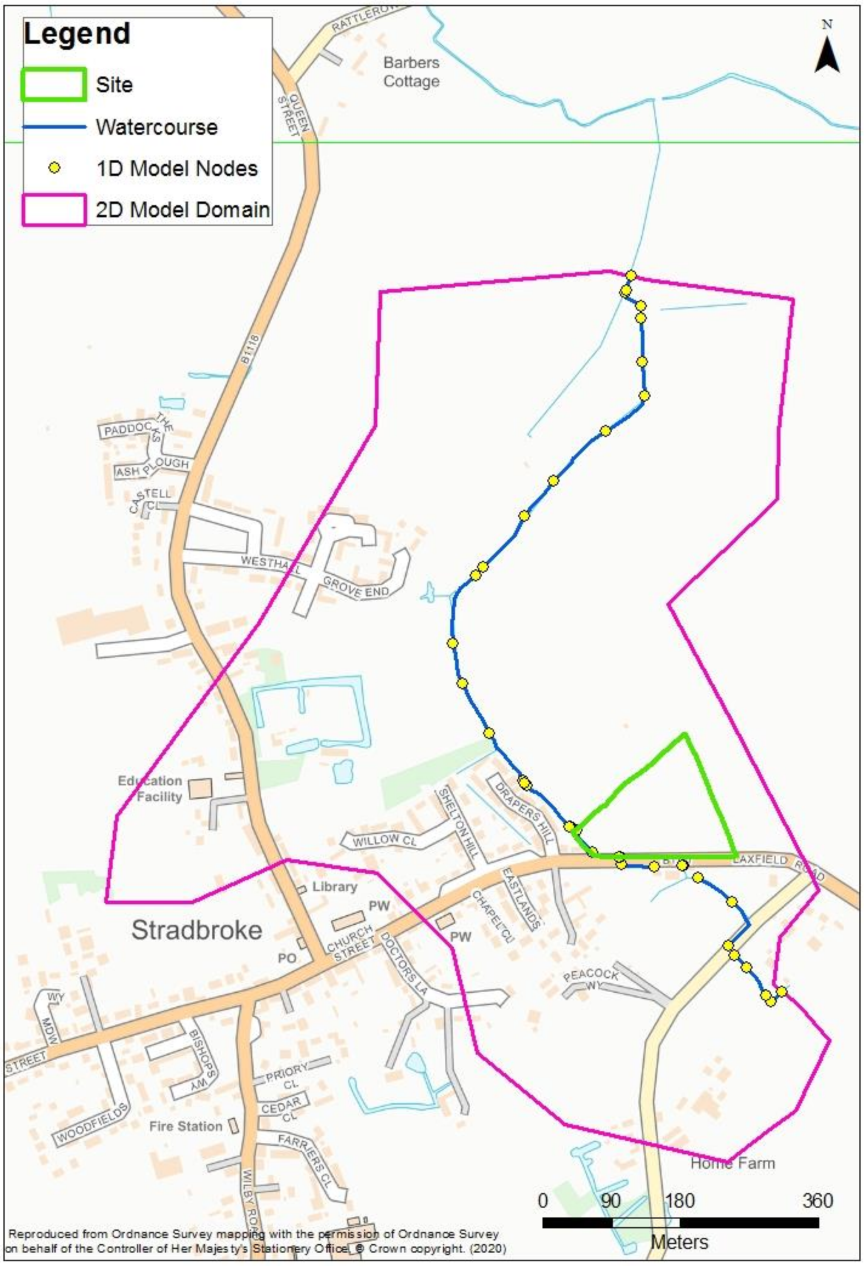

Figure 2-1: Model Extent

TECHNICAL NOTE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk Level 2 SFRA
Client	BMSDC
Date	15/10/2020
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1D model overview	
Inflow boundaries	Hydrological inflows were derived from the assessment undertaken for this study[1]. Inflows are required for 20, 100 and 1000 year events, including 35% and 65% climate change.
Downstream boundary	A normal depth boundary was applied at unit ST01588.
Labelling/ numbering system used	Labelling was kept in line with the new cross section-survey, with chainage added working upstream.

2D model overview	
Modification to topography	2d_strad_bank_levels_002 - z-points and z-line to inform bank levels along the unnamed tributary of the River Waveney. Levels taken from cross section survey
Hydraulic roughness	Manning's n values have been used to represent hydraulic roughness in the 2D domain. The following roughness values were used in the model:

Land Cover	Manning's 'n'
Building	0.300
General surface – multi surface	0.040
General surface – step	0.030
General surface (including agricultural land)	0.040
Inland water	0.035
Landform- slope	0.050
Natural surface/ Scrub/ Non-coniferous trees/ Rough grassland	0.100
Paths	0.030
Road or track	0.020
Roadside	0.020
Structure- manmade	0.300
Unclassified	0.300

1 DUX-JBAU-XX-XX-RP-HO-0001-S3-P01-SS1198_Stradbroke_hydrology.pdf

2.2 1D-2D linking

JBA have adopted the standard approach to linking 1D Flood Modeller and 2D TUFLOW models. Within the 2D domain a lateral spill (HX boundary) is defined for the left and right banks and the channel area in between classified as 'inactive' in the 2D grid. The HX boundaries are linked to the respective Flood Modeller nodes using CN connection lines and are discontinued at bridge and culverts. Along these boundaries, water levels in the channel and floodplain interact dynamically and thus control floodplain wetting and drying.

2.3 1D model Manning's n values

Channel and floodplain roughness values have been represented in the model by Manning's n values. Manning's n values are considered to be a conveyance factor rather than simply a roughness coefficient, and take account of channel meanders (sinuosity), contraction and expansion such as changes in cross sectional area between sections, bed material effects and obstacles, as well as the vegetation of the banks and floodplains. As such, it is appropriate to define values on a reach basis, taking account of the overall features of that reach. A value of 0.04 has been used for the channel and 0.06 for the banks. Although the photos from the survey indicate the channel is highly vegetated, these photos are from summer, when vegetation is higher, whereas the catchment is more likely to flood in winter and therefore this has been represented in the roughness value of 0.06.

2.4 Structures

Structures from the new cross section survey have been entered into the model in 1D based on the new cross section obtained. All structure geometry was entered into the model by hand and any assumptions made in the modelling of structures are recorded in the table below.

Structure	Model Label	How has structure been modelled?:
Culvert	ST01540	Modelled as circular conduit. Spill modelled in 1D/2D for deck overtopping
Neaves Lane Culvert	ST01470	Modelled as circular conduit. Spill modelled in 1D/2D for deck overtopping
Culvert	ST01320	Modelled as circular conduit. Spill modelled in 1D/2D for deck overtopping
Culvert	St01303	Modelled as circular conduit. Spill modelled in 1D/2D for deck overtopping
Laxfield Road Culvert	ST0122	Modelled as circular conduit. Spill modelled in 1D only for deck overtopping
Footbridge	ST01189	USBPR Bridge with one opening Spill modelled in 1D only for deck overtopping
Culvert	ST01133	Modelled as circular conduit. Spill modelled in 1D only for deck overtopping
Footbridge	ST01043	USBPR Bridge with one opening Spill modelled in 1D only for deck overtopping

Culvert	ST00727	Modelled as circular conduit. Spill modelled in 1D only for deck overtopping
Culvert	ST00297	Modelled as circular conduit. Spill modelled in 1D only for deck overtopping
Footbridge	ST00263	USBPR Bridge with one opening Spill modelled in 1D only for deck overtopping

3 Model Results

The model results for the 20, 100 and 1000-year events are shown below at the development site. Flooding occurs in the south-western corner of the site, which is adjacent to the unnamed tributary of the river Waveney. Flood extent increases with return period, and in the 100-year and 1000-year event, along the southern boundary there is an increase in the area at risk of flooding. However, the majority of the site is not shown to be at risk of flooding. The same pattern is seen with the climate change scenarios, with extent increasing with the climate change event.

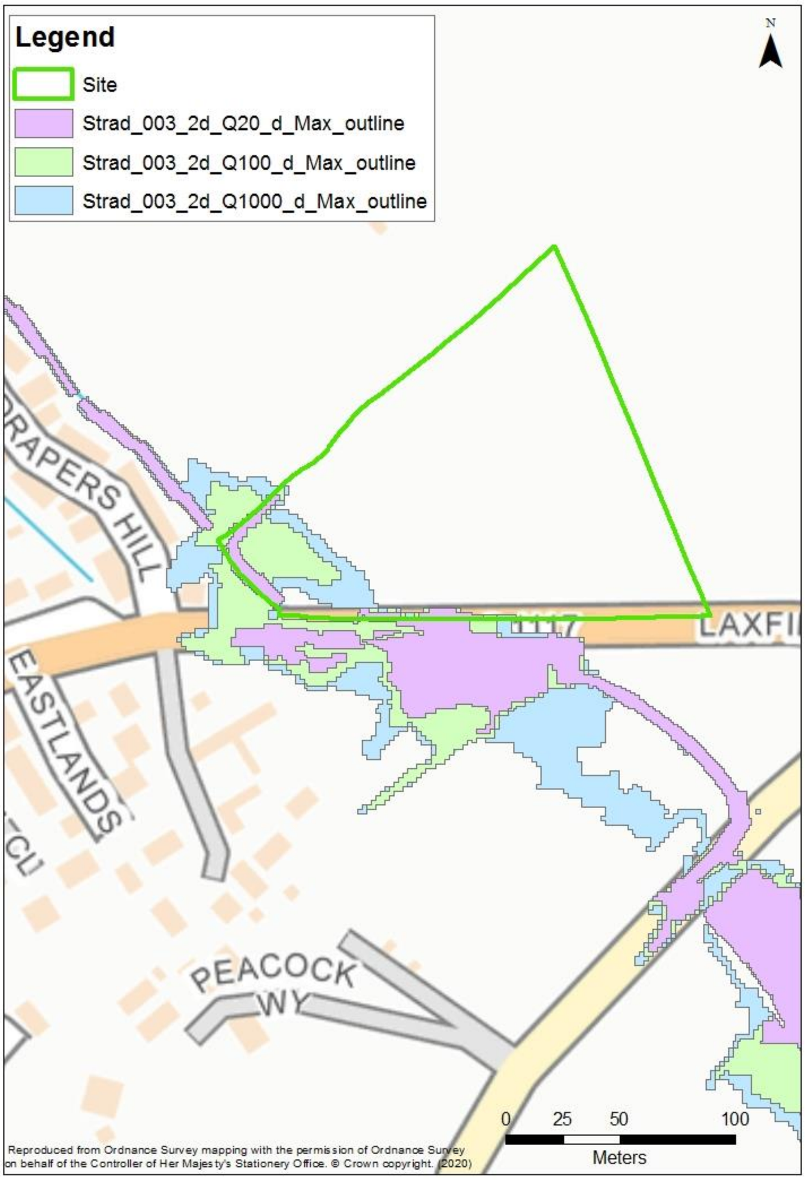

Figure 3-1: Model Results - 20year, 100-year and 1000-year events

JBA Project Code	2020s0908
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Date	15/10/2020
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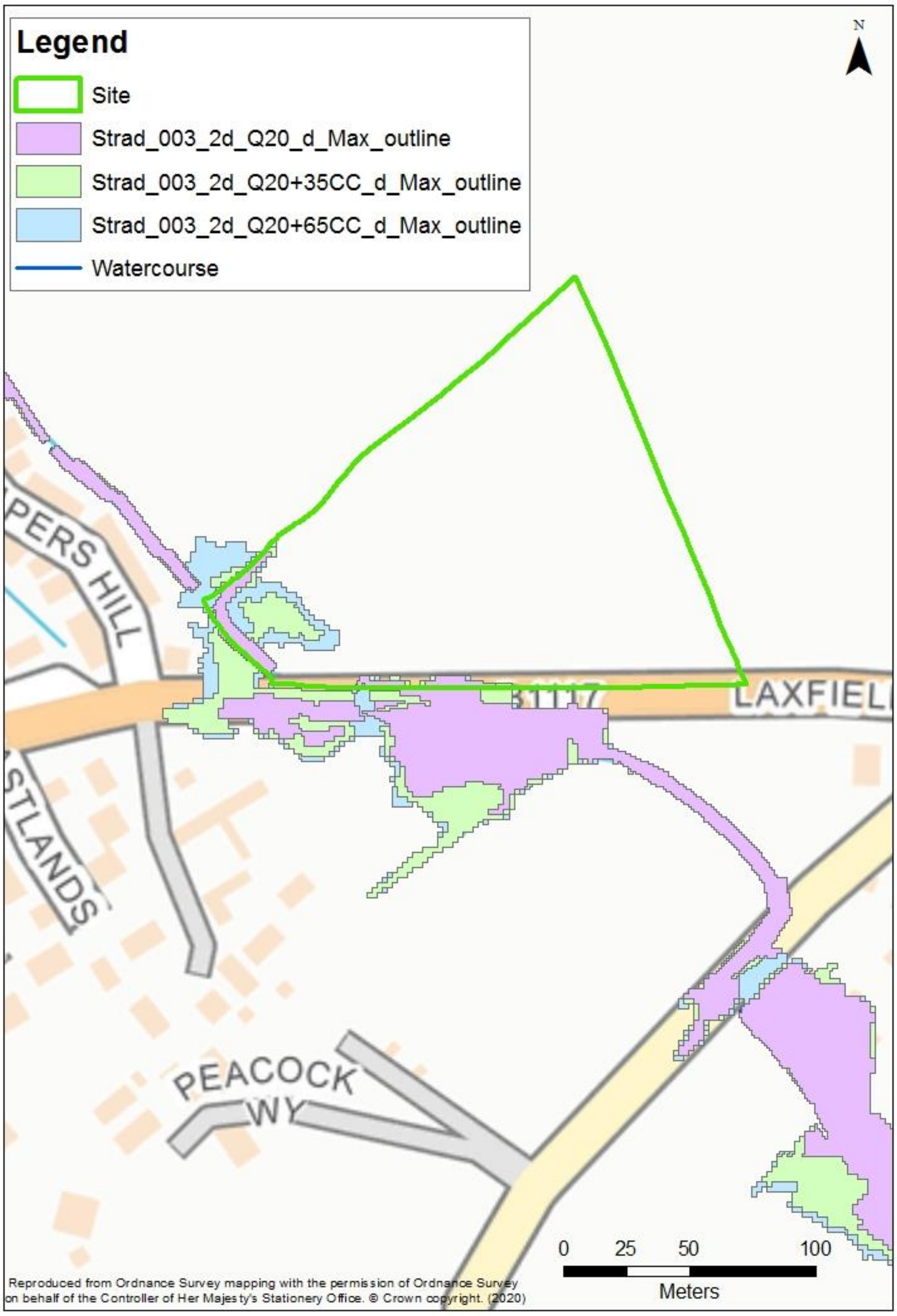

Figure 3-2: Model Results - 20 year event plus 35% and 65% climate change

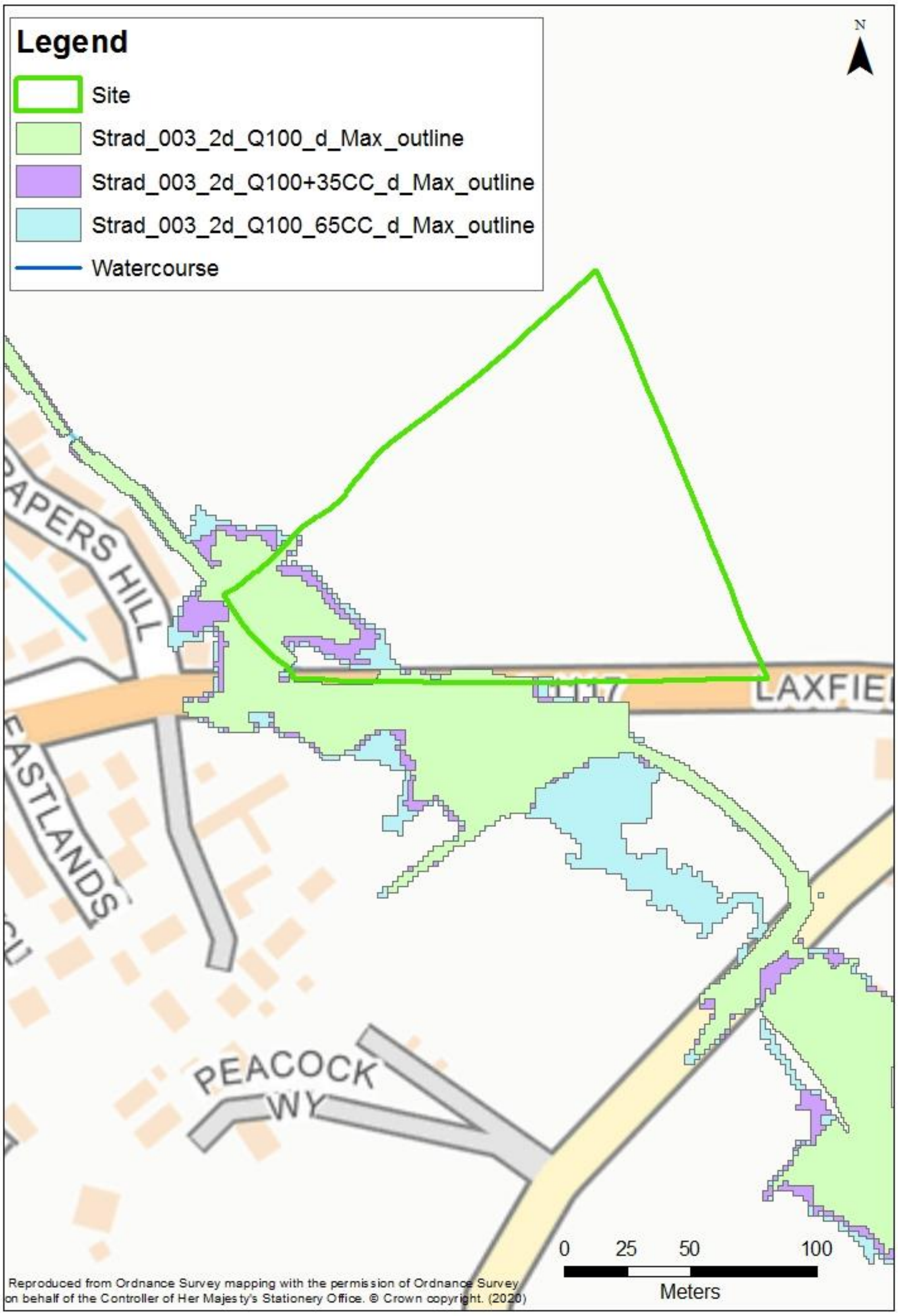

Figure 3-3: Model Results - 100 year event plus 35% and 65% climate change

JBA Project Code	2020s0908
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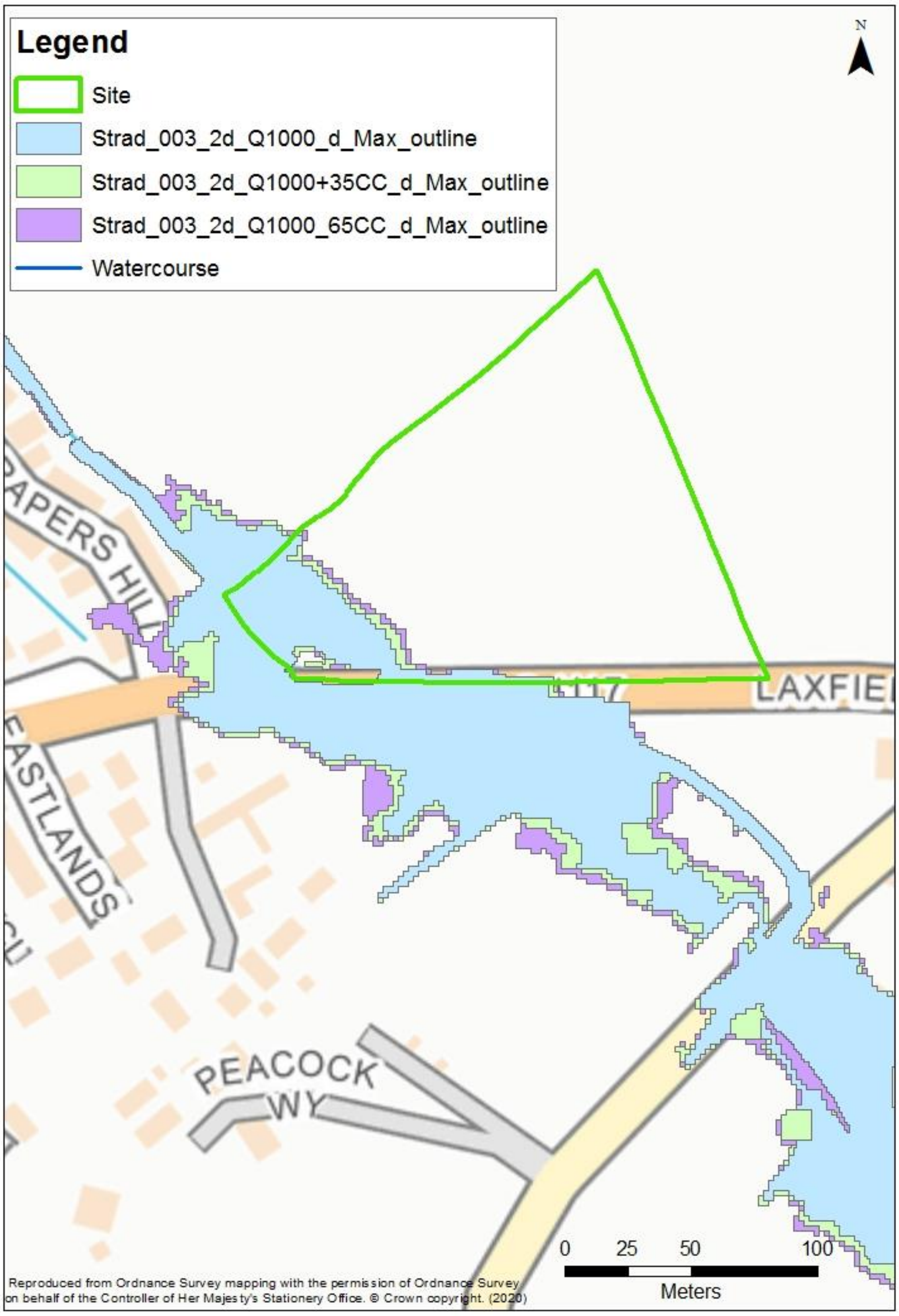

Figure 3-4: Model Results - 1000-year event plus 35% and 65% climate change

JBA Project Code	2020s0908
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4 Model limitations, assumptions and uncertainty

Developing a hydraulic model requires the application of simplifications and generalisations. As such a number of assumptions are made when building the model. This can lead to model uncertainties and subsequent limitations of the results.

The scope of the model is a simple model for an SFRA and therefore this is reflected in the level of detail included in the model. The main aim of the model was to produce flood outlines for the development site, and whilst some improvements could be done to the model, this was only done where it would make a difference to the outline at the site.

In terms of model construction, the initial model schematisation and the approach adopted can be a limitation. In this study a linked 1D-2D Flood Modeller-TUFLOW model was developed. This schematisation allows a detailed representation of the channel and structure capacity to be defined within the 1D model domain and flow paths across the floodplain to be defined within the 2D model domain. The 1D-2D modelling approach was considered to be the most appropriate to represent the risk of fluvial flooding due to the complex flow path and the number of obstructions such as bridges and flood banks within the floodplain.

The main assumption associated with the hydraulic model produced for this commission comes from the flow estimates applied to the model. The hydrology in this study was calculated using the ReFH2 Statistical method.

The LiDAR used to set the base topography in the 2D model domain is a source of uncertainty. The bare earth DTM was filtered to remove the presence of buildings and vegetation. The LiDAR data used for this study is at 2m resolution.

General modelling assumptions relate to the selection of various parameters within the model, for example, the roughness values used within the model, representation of certain structures and their coefficients.

The flow applied at the top of the model (ST01588) was generated for the catchment to the confluence with another unnamed tributary of the River Waveney. To ensure that this is not over-attenuating flow in the hydraulic model by entering flow, generated downstream of culverts, into the model upstream of the culvert, the flows at the downstream of the model at ST00233 were compared to the check flow generated in the hydrological assessment. The modelled flows generally match the hydrological estimates well, and were up to 10% higher than the hydrology, depending on the return period, and therefore this is conservative.

Flood estimation report: Stradbroke modelling – Site SS1198

Introduction

This report template is based on a supporting document to the Environment Agency's flood estimation guidelines. It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results.

Contents

Approval

	Name and qualifications	Date
Method statement prepared by:	Lucy Archer-Lock BSc	02/09/2020
Method statement reviewed by:	Claire French BSc (Hons) MSc (Eng) MCIWEM CWEM CSci CEnv	11/09/2020
Calculations prepared by:	Lucy Archer-Lock BSc	02/09/2020
Calculations reviewed by:	Claire French BSc (Hons) MSc (Eng) MCIWEM CWEM CSci CEnv	11/09/2020

Revision History

Revision reference	Date issued	Amendments	Issued to
P01	October 2020	-	Matt Deakin

Abbreviations

AM........................Annual Maximum

AREA ....Catchment area (km^2)

BFI ....Base Flow Index

BFIHOST ....Base Flow Index derived using the HOST soil classification

CFMP ....Catchment Flood Management Plan

CPRE ....Council for the Protection of Rural England

FARL........................FEH index of flood attenuation due to reservoirs and lakes

FEH ....Flood Estimation Handbook

FSR ....Flood Studies Report

HOST ....Hydrology of Soil Types

NRFA ....National River Flow Archive

POT ....Peaks Over a Threshold

QMED ....Median Annual Flood (with return period 2 years)

ReFH........................Revitalised Flood Hydrograph method

SAAR ....Standard Average Annual Rainfall (mm)

SPR ....Standard percentage runoff

SPRHOST ....Standard percentage runoff derived using the HOST soil classification

Tp(0) ....Time to peak of the instantaneous unit hydrograph

URBAN ....Flood Studies Report index of fractional urban extent

URBEXT1990 ....FEH index of fractional urban extent

URBEXT2000 ....Revised index of urban extent, measured differently from URBEXT1990

WINFAP-FEH ....Windows Frequency Analysis Package – used for FEH statistical method

1 Method statement

1.1 Requirements for flood estimates

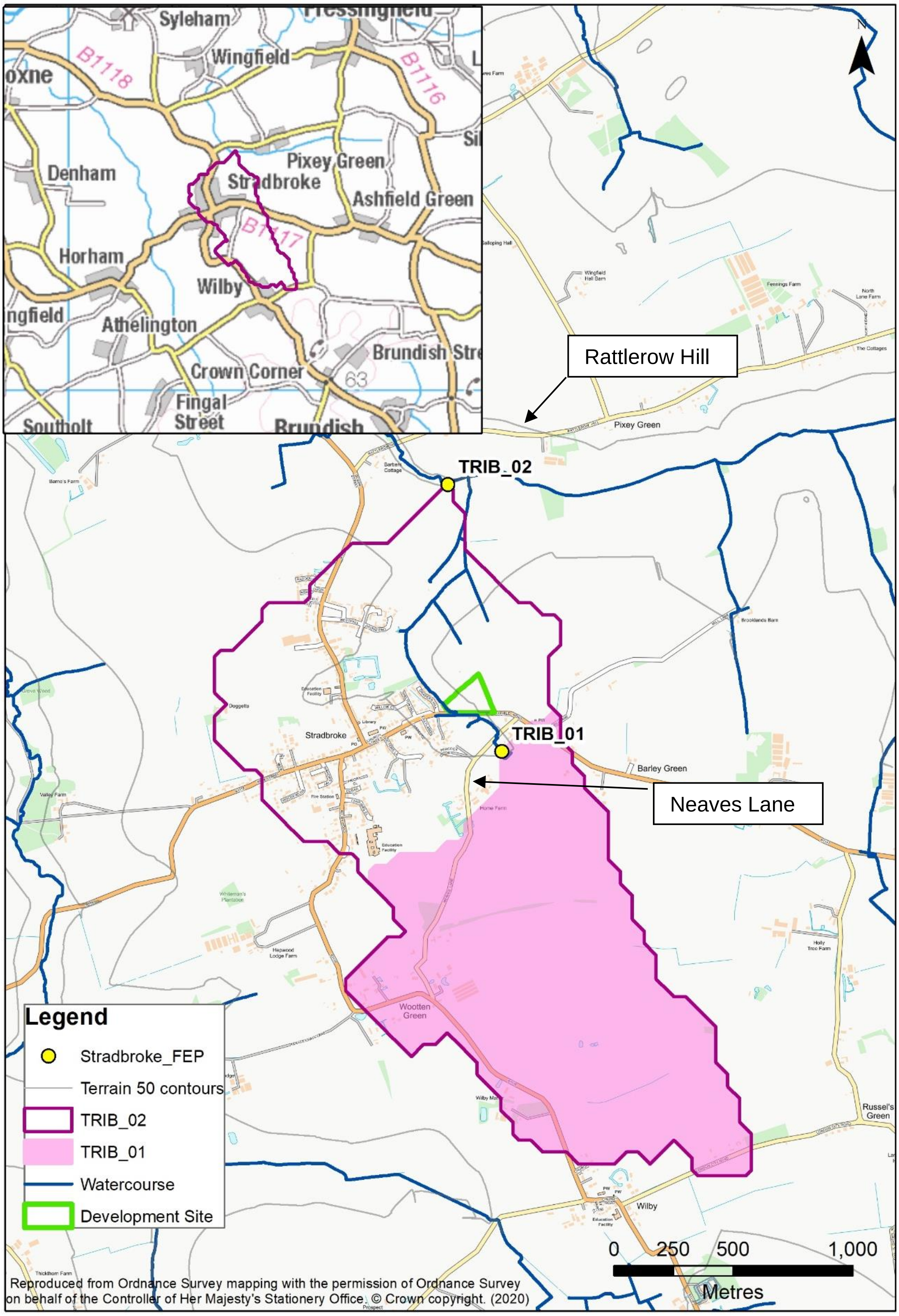
Overview	The purpose of this hydrological assessment is to provide inflows to a hydraulic model for a development site off Laxfield Road, Stradbroke. The hydraulic modelling is being undertaken as part of a Level 2 Strategic Flood Risk Assessment (SFRA). A new hydraulic model is being built for this study using Flood Modeller-TUFLOW. Design peak flow estimates and hydrographs are required at two locations for the following annual exceedance probability (AEP) events (%): 50, 10, 5, 3.3, 1 and 0.1. The effects of climate change will be assessed using the 5, 1 and 0.1% AEP events and accounted for using the latest guidance[1]. The intended climate change factors will be 35% and 65% as the site is located within the Anglian River Basin District.
Project scope	There are no river gauges in the study area, therefore rating reviews and ReFH parameter estimation are not relevant. It is only within the scope of this hydrological assessment to consider fluvial flows. The scope and level of detail in the assessment is proportionate to the strategic nature of the project.

1.2 The catchment

Description	The proposed development site is approximately 1.95 hectares and sits to the north of Laxfield Road in Stradbroke. There is a small watercourse which runs along the western boundary of the site. This watercourse rises to the south-east of Neaves Lane and flows generally in a northerly direction to its confluence with another ordinary watercourse just south of Rattlerow Hill. The proposed model extent starts near the northern end of Neaves Lane, upstream of where the road crosses the watercourse. The 1:50,000 surface geology map shows that the bedrock geology underlying the catchment belongs to the Crag Group and comprises sand[2]. However, borehole scans available for Stradbroke also record the presence of some clay. The soils underlying the catchment are slowly permeable, seasonally wet slightly acid but base-rich loamy and clayey soils[3]. The topography of the catchment is relatively flat. Land use in the upper parts of the catchment is predominantly rural. The village of Stradbroke lies within the lower catchment and therefore the catchment, overall, is classified as moderately urbanised.

[1] Environment Agency (2020), “https://www.gov.uk/guidance/flood-and-coastal-risk-projects-schemes-and-strategies-climate-change-allowances”.
[2] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[3] http://www.landis.org.uk/soilscapes/

Map (Include river network, catchment boundary and gauging stations)



1.3 Source of flood peak data

Source	NRFA peak flows dataset, Version 8, released September 2019. This contains data up to water year 2017-18.

1.4 Gauging stations (flow or level)

(at or very near to the sites of flood estimates)

Water-course	Station name	Gauging authority number	NRFA number	Catchment area (km²)	Type (rated / ultrasonic / level...)	Start of record and end if station closed
Catchment is ungauged						

1.5 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data	Details
Check flow gaugings	No	N/A	N/A	N/A
Historic flood data	Yes	Yes	BMSDC historic flood records	Historical flood records provided by Babergh & Mid Suffolk District Council (BMSDC) show that there have been several recorded flood incidents in Stradbroke, including a few records of blocked drains on Queen Street, Church Street and Doctors Lane. The ditch along Laxfield Road is also reported to have flooded in 2016.
Flow or river level data for events	Yes	No	N/A	N/A
Rainfall data for events	Yes	No	N/A	N/A
Potential evaporation data	Yes	No	N/A	N/A
Results from previous studies	Yes	No	N/A	N/A
Other data or information (e.g. groundwater, tides, channel widths, low flow statistics)	Yes	No	N/A	N/A

1.6 Hydrological understanding of catchment

Outline the conceptual model, addressing questions such as:	The main site of interest is the development site, located to the north of Laxfield Road, Stradbroke. Flooding at this location is likely to be caused by peak flows.
Any unusual catchment features to take into account?	No

1.7 Initial choice of approach

Is FEH appropriate?	FEH flood frequency methods are considered appropriate, given the catchment area is greater than 0.5km² (the lower limit of applicability of the methods) and is not extremely urbanised.
Initial choice of method(s) and reasons How will hydrograph shapes be derived if needed? Will the catchment be split into sub-catchments? If so, how?	Both the statistical method and the ReFH2 method will be applied. There is no peak flow record available in the catchment to improve the QMED estimate under the statistical method. Local donors, from nearby catchments, will, therefore, be assessed for suitability for data transfer. At this stage, there is no strong reason to prefer one method for flood flow estimation over another for this watercourse. The flow estimates from the two methods will be compared and contrasted. Hydrograph shapes will be derived from the ReFH2 model. These will be fitted to the Statistical peaks if this is the preferred method for deriving design peak flow estimates.
Software to be used (with version numbers)	FEH Web Service[4] / WINFAP-FEH v3.0.003[5] / ReFH2.3

[4] CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK.

[5] WINFAP-FEH v3 © Wallingford HydroSolutions Limited and NERC (CEH) 2009.

2 Locations where flood estimates required

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

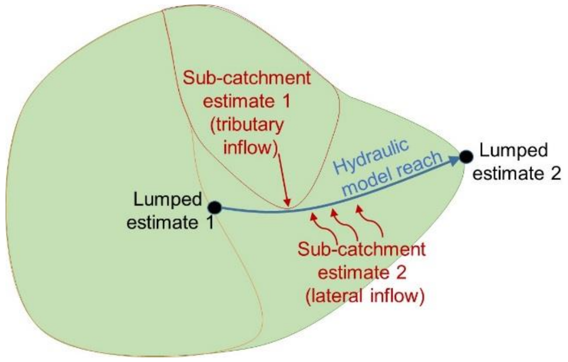
2.1 Summary of subject sites

Site code	Type of estimate L: lumped catchment S: Sub-catchment	Watercourse	Name or description of site	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered
TRIB_01	L	Un-named Tributary	Upstream model extent	623750	273900	1.65	-
TRIB_02	L	Un-named Tributary	Downstream model extent	623500	275000	3.08	-
TRIB_02_IA	S	Un-named Tributary	Intervening area between TRIB_01 and TRIB_02.	-	-	-	1.42

Note: Lumped catchments (L) are complete catchments draining to points at which design flows are required.

Sub-catchments (S) are catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system. There is no need to report any design flows for sub-catchments, as they are not relevant: the relevant result is the hydrograph that the sub-catchment is expected to contribute to a design flood event at a point further downstream in the river system. This will be recorded within the hydraulic model output files. However, catchment descriptors and ReFH model parameters should be recorded for sub-catchments so that the results can be reproduced.

The schematic diagram illustrates the distinction between lumped and sub-catchment estimates.



2.2 Important catchment descriptors at each subject site (incorporating any changes made)

URBEXT 2000 values have been updated to 2020

Site code	FARL	PROPWET	BFIHOST	BFIHOST 19	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
TRIB_01	1.000	0.26	0.312	0.333	1.41	10.5	582	0.031	0.297
TRIB_02	1.000	0.26	0.312	0.333	2.15	13.6	583	0.115	0.197
TRIB_02_IA*	-	0.26	0.312	0.333	1.21	17.2	584	0.213	-

*Only those catchment descriptors needed for input into the ReFH2 model have been derived for the intervening area

2.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (add maps if needed)	The FEH catchment boundary was compared against Terrain50 and OS contour mapping. The catchment boundary generally seems reasonable and therefore has not been changed. The downstream boundary of TRIB_02 is not in the correct place, and is further west than in reality. However, this does not have a significant effect on the catchment area, just the position of the catchment, and therefore this has not been updated as it is not thought to significantly affect any of the catchment descriptors.
Record how other catchment descriptors were checked and describe any changes. Include before/after table if necessary.	A qualitative check of the FEH BFIHOST19 value was undertaken by comparing it to the geology and soils detailed in Section 1.2. The FEH value (0.333) indicates an impermeable catchment. Although this value appears inconsistent with the bedrock geology shown on 1:50k scale mapping (i.e. sand belonging to the Crag Group), borehole scans available for Stradbroke note the presence of some clay. The overlying soils are also described as slowly permeable. As a further check, the BFIHOST19 and observed BFI values for the geographically nearest gauged catchment (35003 Alde at Farnham) have been compared. This gauged catchment is also underlain mostly by the Crag Group and has an FEH BFIHOST19 value of 0.364 and a similar observed BFI of 0.36. In conclusion, the FEH BFIHOST19 value for the study catchment appears to be a reasonable representation of local base flow conditions and has been retained. The FARL value is 1.00. The FEH Webservice does not indicate any online lakes within the wider catchment. OS mapping has also been checked, and whilst this shows a few ponds within the catchment, it has been assumed that these do not have a significant flood attenuation effect. The FARL value is, therefore, considered appropriate. A qualitative check of the URBEXT value was made by comparing the FEH value and the urban extent 2000 layer to the current OS mapping. The urban extent 2000 layer provides a reasonable representation of developed areas within the study catchment. The FEH value for TRIB_02 is higher than TRIB_01 since the village of Stradbroke sits within the downstream catchment. The URBEXT values have been updated to 2020.
Source of URBEXT	URBEXT2000
Method for updating of URBEXT	CPRE formula from 2006 CEH report on URBEXT2000

3 Statistical method

3.1 Overview of estimation of QMED at each subject site

Site code	QMED (rural) from CDs (m^3/s)	Final method	Data transfer					Urban adjust-ment factor UAF	Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Moderated QMED adjustment factor, $(A/B)^a$	If more than one donor			
						Weight	Weighted ave. adjustment		
TRIB_01	0.36	CD	N/A	N/A	N/A	N/A	N/A	1.027	0.37
TRIB_02	0.62	CD	N/A	N/A	N/A	N/A	N/A	1.105	0.68

Are the values of QMED spatially consistent?		Yes, QMED increases downstream
Method used for urban adjustment for subject and donor sites		WINFAP v4[6]
Parameters used for WINFAP v4 urban adjustment if applicable		
Impervious fraction for built-up areas, IF	Percentage runoff for impervious surfaces, PR_{imp}	Method for calculating fractional urban cover, URBAN
0.3	70%	From updated URBEXT2000

Notes

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer (with urban adjustment); CD – Catchment descriptors alone (with urban adjustment); BCW – Catchment descriptors and bankfull channel width (add details); LF – Low flow statistics (add details).

The QMED adjustment factor A/B for each donor site is given in Table 3.2. This is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial estimate from catchment descriptors.

[6] Wallingford HydroSolutions (2016). WINFAP 4 Urban adjustment procedures.

3.2 Search for donor sites for QMED (if applicable)

Comment on potential donor sites	There are no river flow gauging stations within the study catchment. Gauged catchments within the hydrometric areas surrounding the study catchment were, therefore, assessed for suitability for data transfer to the study watercourse. There are 15 rural NRFA stations within 40km of the study area, based on the distance between catchment centroids. Comparison of $QMED_{obs}$ and $QMED_{cds}$ shows there is no consistent trend among the donor stations. Recommendations from current research[7] (and new research[8] to be published soon) indicate that the geographically closest station to the study site tends to produce the best results. The latest research highlights that descriptors, such as AREA, are included in the regression equation for QMED, so the donor adjustment process accounts for the differences in values between the donor and subject catchments. It also explains that the overarching pattern of QMED model residuals across the UK follows a smooth spatial pattern, hence the recommendation to choose donors by proximity. However, the NRFA stations closest to TRIB_02 display marked variation in QMED adjustment factor. The geographically closest station, 34006 Waveney @ Needham Mill, shows that the catchment descriptors overestimate QMED. The second geographically closest station, 35003 Alde @ Farnham, only 0.2km further away, shows that catchment descriptors significantly underestimate QMED. The third and fourth closest stations have QMED adjustment factors close to 1, while the remaining potential donor stations lie 23 km or more away from the study catchment and the effect of any adjustment will be small. It has, therefore, been decided not to use a donor for data transfer to the study watercourse.

3.3 Donor sites chosen and QMED adjustment factors

NRFA no.	Reasons for choosing	Method (AM or POT)	Adjust-ment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjust -ment ratio (A/B)
No suitable donors						

[7] Kjeldsen, T.R., Jones, D.A. and Bayliss, A.C. 2008. Improving the FEH statistical procedures for flood frequency estimation. Science Report SC050050, Environment Agency.
[8] Stewart, Lisa, Duncan Faulkner, Giuseppe Formetta, Adam Griffin, Tracey Haxton, Ilaria Prosdocimi, Gianni Vesuviano and Andy Young (TBC). Estimating flood peaks and hydrographs for small catchments (Phase 2). Report – SC090031/R0, Environment Agency.

3.4 Derivation of pooling groups

Several subject sites may use the same pooling group.

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
TRIB_02	TRIB_02	No	Reviewed and retained: • 27073 (Brompton Beck @ Snainton Ings) • 76011 (Coal Burn @ Coalburn) • 27051 (Crimple @ Burn Bridge) Removed: • 49005 (Bolingey Stream @ Bolingey Cocks Bridge) – only 8 years of data	L-CV: 0.258 L-skew: 0.269
Note: Pooling groups were derived using the procedures from Science Report SC050050 (2008).				

3.5 Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape after adjustments)	Growth factor for 100-year return period
TRIB_01	P	TRIB_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Shape: -0.275 Scale: 0.251	3.31
TRIB_02	P	TRIB_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Shape: -0.290 Scale: 0.235	3.26

Notes
Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis
A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters.
Growth curves were derived using the procedures from Science Report SC050050 (2008).

3.6 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following AEP (%) events					
	50	**10**	**5**	**3.3**	**1**	**0.1**
TRIB_01	0.37	0.65	0.79	0.89	1.23	2.30
TRIB_02	0.68	1.18	1.43	1.60	2.23	4.23

4 Revitalised flood hydrograph 2 (ReFH2) method

4.1 Catchment sub-divisions for ReFH2 model

Site code	Area (km²)			
	Rural or un-developed	Paved	Only relevant if significant transfers of water via sewers crossing catchment boundaries…	
			Paved with sewers draining out of topographic catchment	Paved outside topographic catchment with sewers draining into catchment
TRIB_01	1.618	0.032	N/A	N/A
TRIB_02	2.856	0.224	N/A	N/A
Sources of information for creating sub-divisions	URBEXT2000		**Sewer capacity** (return period / rainfall intensity / flow rate) and source of information	N/A

4.2 Parameters for ReFH2 model

Site code	Method	Tp_{rural} (hours)	Tp_{urban} (hours)	C_{max} (mm)	PR_{imp} % runoff for impermeable surfaces	BL (hours)	BR*
TRIB_01	CD	5.13	3.85	280.1	70	31.74	0.75
TRIB_02	CD	6.01	4.51	280.1	70	34.8	0.76
TRIB_02_IA	CD	4.02	3.02	280.1	70	30.7	0.78
Brief description of any flood event analysis carried out (further details should be given in the annex)				N/A			
Methods: OPT: Optimisation, BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details)							
*As BFIHOST<0.5, BR varies with storm event, the BR value displayed in this table relates to the 1% AEP event.							

4.3 Design events for ReFH2 method: Lumped catchments

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)
TRIB_01	Rural	Winter	9:00
TRIB_02	Rural	Winter	9:00
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?		No. A uniform storm duration and ARF will be applied to the model. As the ReFH2 storm durations are the same for both catchments, the ARF from TRIB_02 will be applied to TRIB_01.	

4.4 Flood estimates from the ReFH2 method

Note: This table is for recording results for lumped catchments. There is no need to record peak flows from sub-catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system.

Site code	Flood peak (m^3/s) for the following AEP (%) events					
	50	10	5	3.3	1	0.1
TRIB_01	0.50	0.84	1.01	1.12	1.61	2.83
TRIB_02	0.87	1.45	1.73	1.94	2.77	4.85

5 Discussion and summary of results

5.1 Comparison of results from different methods

This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods.

Site code	Ratio of peak flow to FEH Statistical peak	
	Return period 2 years	**Return period 100 years**
	ReFH2	**ReFH2**
TRIB_01	1.35	1.31
TRIB_02	1.28	1.24

Figure 5-1 Comparison of growth curves between the FEH Statistical and ReFH2 methods

5.2 Final choice of method

Choice of method and reasons	There is no clear choice of preferred method for generating the design peak flow estimates for the study catchment. There are no flow gauges in the catchment that can be used to update QMED. Both of the methods applied herein have been based on catchment descriptors alone. The comparison of design flows presented in Section 5.1 shows that the Statistical method gives lower flows than the ReFH2 method. However, Figure 5-1 shows that the two methods give similar growth curves, for return periods of between 2 and 100-years. The difference between the methods for these events comes mainly from the 2-year estimate. It is worth noting that the ReFH2 estimates are roughly equivalent to those obtained by adjusting the Statistical QMED estimate using the second geographically-nearest NRFA station (Alde at Farnham). The growth curves given by the two methods diverge for the 1,000-year event, with the Statistical method giving larger growth factors than the ReFH2 model. It is recommended at this stage of the study that ReFH2 model is adopted as the preferred method for this catchment. This takes forward the most conservative estimates for use in the hydraulic model. This approach is considered valid given the uncertainty in an

	appropriate QMED adjustment factor. It is recommended that the hydraulic model is used to validate the choice of method, and if the flood extents seem too large compared to the flooding history, then consideration can be given to applying the results from the FEH Statistical method (no donor).
How will the flows be applied to a hydraulic model?	ReFH2 hydrographs will be applied to the model – TRIB_01 will be applied at the upstream model extent and TRIB_02_IA will be applied to the intervening area between TRIB_01 and TRIB_02, distributed across the modelled reach according to catchment area.

5.3 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	The main assumptions are: • BFIHOST19 can be used in the FEH Statistical method • The BFIHOST19 value for the catchment is correct, despite the geology shown to underly the catchment on 1:50k scale mapping • Catchment area for TRIB_02 is correct even though the FEH boundary is not in the correct location at the downstream end • The pooling group used to define the growth curve in the FEH Statistical method is representative of the catchment.
Discuss any particular limitations	The main limitation is the lack of river flow gauge data specific to the study area. There are no river flow or level gauges on the watercourse and, therefore, the catchment response is unknown.
Give what information you can on uncertainty in the results,	It is not possible to directly quantify the uncertainty for the ReFH2 method. There is no method provided in the FEH for estimating uncertainty for the common situation of an ungauged catchment, pooled growth curve and QMED estimated from catchment descriptors. The uncertainty will depend on many factors, for example, how unusual the study catchment is relative to the pooling group, and the uncertainty in flow measurement at other gauges. A UK average measure of uncertainty is presented in a technical guidance report generated by a R&D project into the FEH, local data and uncertainty (Environment Agency funded consortium of JBA, CEH and others). The report presents results for rural catchments (URBEXT2000 <0.03) and moderately urbanised catchments (0.03 ≤ URBEXT2000 < 0.15). The 95% confidence limits for a 1% AEP flood estimate for a rural catchment are: • Without donor adjustment of QMED: 0.45 – 2.23 times the best estimate. • With donor adjustment of QMED (one donor): 0.47 – 2.12 times the best estimate. The 95% confidence limits for a 1% AEP flood estimate for a moderately urbanised catchment are:

	• Without donor adjustment of QMED: 0.33 – 3.01 times the best estimate • With donor adjustment of QMED (one donor): 0.34 – 2.94 times the best estimate.
Comment on the suitability of the results for future studies,	The design peak flow estimates and hydrographs were derived for the purposes of this strategic modelling study. If peak flow estimates and hydrographs are required for a different purpose it is recommended that, at a minimum, a review of the results is carried out.
Give any other comments on the study	There is a lack of hydrometric data within the catchment. Confidence in flow estimates and understanding of catchment response could be improved with local hydrometric data collection.

5.4 Checks

Are the results consistent, for example at confluences?	Yes, peak flow estimates increase at successive points in a downstream direction.
What do the results imply regarding the return periods of floods during the period of record?	There is no local flow data (within the study area) against which to compare the design peak flow estimates.
What is the range of 100-year growth factors? Is this realistic?	The 1% AEP growth factor range for the methods is: • FEH Statistical: 3.3 • ReFH2: 3.2 The typical range is 2.1 to 4.0. The growth factors for both methods are within this range.
If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	The 0.1%/1% AEP growth factor range for the methods is: • FEH Statistical: 1.9 • ReFH2: 1.8
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	There are no known hydrological studies available to compare the results with.
Are the results compatible with the longer-term flood history?	There is no local flow data against which to compare the design flow estimates.
Describe any other checks on the results	Modelled levels and flood extents will be sensibility-checked to ensure that flow inputs result in realistic outputs.

5.5 Final results

Site code	Flood peak (m^3/s) for the following AEP (%) events					
	50	10	5	3.3	1	0.1
TRIB_01	0.50	0.84	1.01	1.12	1.61	2.83
TRIB_02	0.87	1.45	1.73	1.94	2.77	4.85

If flood hydrographs are needed for the next stage of	DUX-JBAU-XX-XX-CA-HO-0001-S3-

the study, where are they provided? (e.g. give filename of spreadsheet, hydraulic model, or reference to table below)	P01-SS1198_Stradbroke_hydrographs_for_model (Note: Decimal time is used in the spreadsheet for compatibility with hydraulic modelling software, rather than the hours and minutes format adopted in ReFH2.)

6 Annex

6.1 Final Pooling Group

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
27073 (Brompton Beck @ Snainton Ings)	1.478	37	0.82	0.2	0.047	1.694
76011 (Coal Burn @ Coalburn)	2.034	41	1.84	0.165	0.315	1.113
27051 (Crimple @ Burn Bridge)	2.57	46	4.539	0.219	0.148	0.545
45816 (Haddeo @ Upton)	2.734	25	3.456	0.306	0.399	0.749
28033 (Dove @ Hollinsclough)	2.963	43	4.205	0.231	0.369	0.726
26802 (Gypsey Race @ Kirby Grindalythe)	2.992	19	0.109	0.309	0.183	0.415
25019 (Leven @ Easby)	3.053	40	5.384	0.343	0.378	0.74
47022 (Tory Brook @ Newnham Park)	3.31	25	6.18	0.273	0.149	0.855
25011 (Langdon Beck @ Langdon)	3.362	32	15.533	0.235	0.334	2.585
25003 (Trout Beck @ Moor House)	3.392	45	15.12	0.167	0.302	0.652
27010 (Hodge Beck @ Bransdale Weir)	3.436	41	9.42	0.224	0.293	0.214
71003 (Croasdale Beck @ Croasdale Flume)	3.482	37	10.9	0.212	0.323	0.351
44008 (South Winterbourne @ Winterbourne Steepleton)	3.486	39	0.448	0.411	0.328	1.466
36010 (Bumpstead Brook @ Broad Green)	3.505	51	7.5	0.372	0.184	1.896
Total		521				
Weighted means		521		0.258	0.269	

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Warrington

Registered Office
1 Broughton Park
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North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
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TECHNICAL NOTE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk Level 2 SFRA
Client	BMSDC
Day, Date and Time	Wednesday 14 October 2020
Author	James Jones
Reviewer / Sign-off	Chris Smith
Subject	Creeting St Mary Model Summary Report

1 Introduction

This report provides a record of information on the hydraulic model of the Gipping Channel which is being developed for the Babergh & Mid Suffolk Level 2 SFRA for the SS1223 (Land at Mill Lane, Stowmarket) development site.

1.1 Available data

Item	Comments
Hydraulic model	No existing model was available for the reach required.
Cross-section survey	Survey for the Gipping Channel was collected by EDI Surveys in September 2020. Cross sections were derived from the cross section data to represent the 1D domain.
LIDAR & other Topographic data	2m LiDAR from 2019 was obtained for the full study extent from the Environment Agency open data portal.

1.2 Model build

Item	Comments
What software & reason for choice	A 1D-2D Flood Modeller-TUFLOW model was developed. The use of a 1D-2D modelling approach is preferred for this assessment as there is potential for complex overland routes. Flood Modeller is used to represent the river channel and hydraulic structures along the watercourse, whilst the floodplain is modelled in the 2D TUFLOW domain. TUFLOW version 2018-03-AD-iDP-w64 was used in this project.
General schematisation	The Flood Modeller-TUFLOW model extends along the Gipping Channel from Creeting Lane, north of Creeting St Peter to the confluence with the River Gipping. The 2D TUFLOW domain used a 4m grid and has a total area of 3.6km^2.

TECHNICAL NOTE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk Level 2 SFRA
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Author	James Jones
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Subject	Creeting St Mary Model Summary Report

2 Overview

2.1 Model Schematic

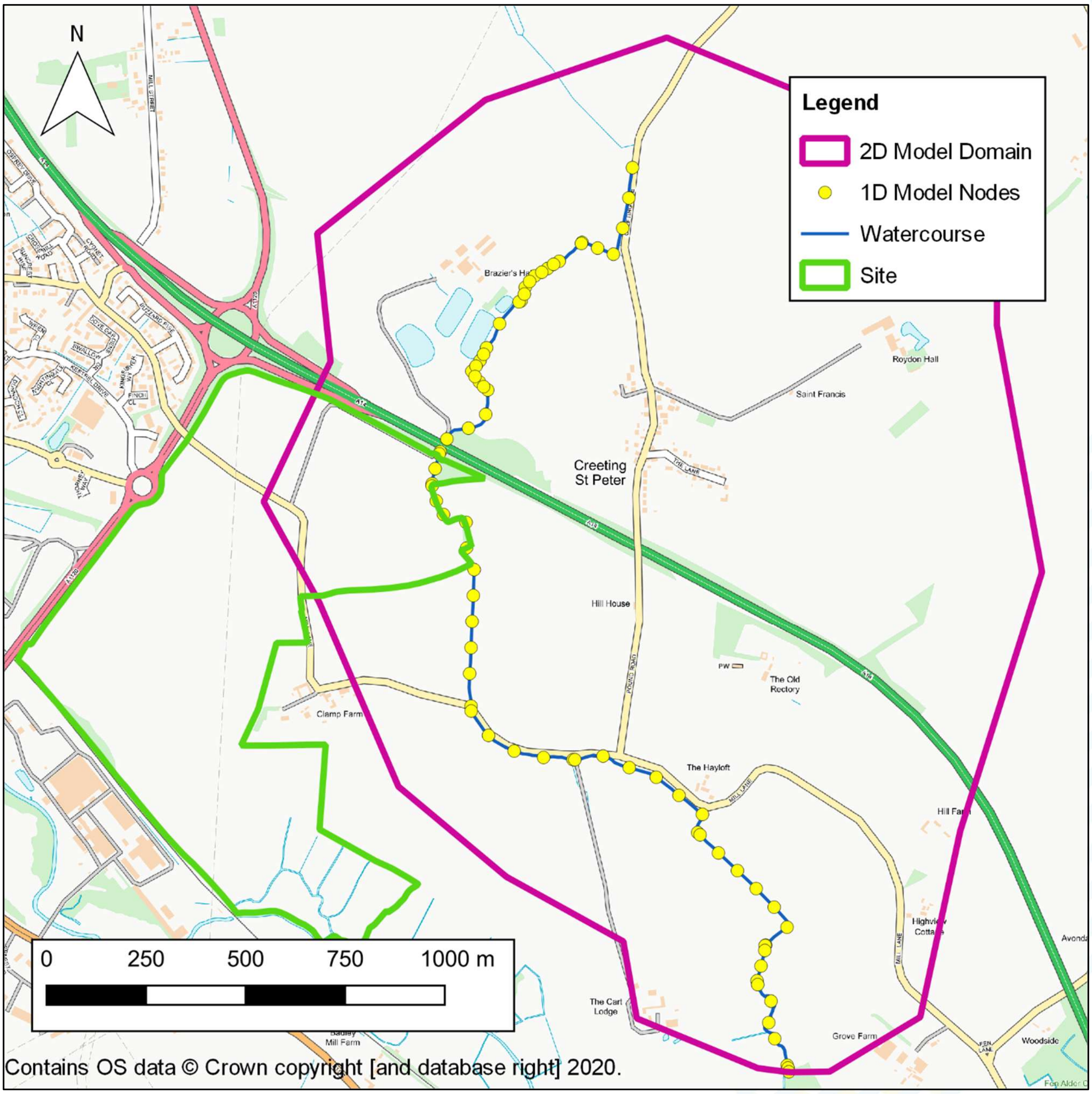

Figure 2-1: Model Extent

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1D model overview	
Inflow boundaries	Hydrological inflows were derived from the assessment undertaken for this study[1]. Inflows are required for 20, 100 and 1000 year events, including 35% and 65% climate change.
Downstream boundary	A normal depth boundary was applied at unit DS_Bdy, immediately downstream of CREE_0000e.
Labelling/ numbering system used	Labelling was based on chainages from the available survey, with 0 chainage at the upstream end of the most downstream culvert.

2D model overview	
2D domain	Area - 3.6km^2 Resolution - 4m DTM data source - LIDAR (2m)
Modification to topography	2d_zsh_CREE_R_004 - z-shape to correct road level of A14 where it passes over the Gipping Channel.
Hydraulic roughness	Manning's n values have been used to represent hydraulic roughness in the 2D domain. The following roughness values were used in the model:

Land Cover	Manning's 'n'
Building	0.300
General surface – multi surface	0.040
General surface – step	0.030
General surface (including agricultural land)	0.040
Glasshouse	0.200
Inland water	0.035
Natural landform	0.050
Landform- slope	0.050
Landform- cliff	0.050
Natural surface/ Scrub/ Non-coniferous trees/ Rough grassland	0.100
Paths	0.030
Rail	0.020
Road or track	0.020

1 DUX-JBAU-XX-XX-RP-HO-0003-S3-P01-SS01223_Creeting_hydrology.pdf

		Roadside	0.020
		Structure- manmade	0.300
		Structure- pylon	0.040
		Tidal water – foreshore	0.035
		Tidal water	0.035
		Unclassified	0.300

2.2 1D-2D linking

JBA have adopted the standard approach to linking 1D Flood Modeller and 2D TUFLOW models. Within the 2D domain a lateral spill (HX boundary) is defined for the left and right banks and the channel area in between classified as 'inactive' in the 2D grid. The HX boundaries are linked to the respective Flood Modeller nodes using CN connection lines and are discontinued at bridges and culverts. Along these boundaries, water levels in the channel and floodplain interact dynamically and thus control floodplain wetting and drying.

2.3 1D model Manning's n values

Channel and floodplain roughness values have been represented in the model by Manning's n values. Manning's n values are considered to be a conveyance factor rather than simply a roughness coefficient, and take account of channel meanders (sinuosity), contraction and expansion such as changes in cross sectional area between sections, bed material effects and obstacles, as well as the vegetation of the banks and floodplains. As such, it is appropriate to define values on a reach basis, taking account of the overall features of that reach.

Due to the highly vegetated state of the channel, relatively high Manning's values have generally been used (often up to 0.07). However, in some locations lower values have been used, where there is evidence of less weed growth.

2.4 Structures

Structures from the new cross section survey have been entered into the model in 1D based on the new cross section obtained. All structure geometry was entered into the model by hand and any assumptions made in the modelling of structures are recorded in the table below. All structures include a spill unit based on bridge deck and ground level from cross section and long section survey.

Structure	Model Label	How has structure been modelled?:
Culvert under farm track	CREE_2936	Sprung-arch conduit. Based on survey long section and photos as no cross section survey at the culvert.
Culvert under farm track	CREE_2717	Circular conduit. Based on cross section survey.
A14 road bridge	CREE_2249	USPBR1978 bridge with cross section downstream to represent bridge length. Based on cross section survey
Footbridge	CREE_2126	USBPR1978 bridge. Based on survey long section and photos as no cross section survey at the footbridge.

Mill Lane road bridge	CREE_1481	Sprung-arch conduit. Based on upstream and downstream cross section survey. Not modelled as bridge due to long length relative to cross section.
Minor road bridge	CREE_1167	Full-arch conduit. Based on upstream and downstream cross section survey. Not modelled as bridge due to long length relative to cross section.
Culvert under farm track	CREE_0746	Sprung-arch conduit. Based on survey long section and photos as no cross section survey.
Channel under farm access	CREE_0253	USBPR1978 bridge. Based on survey long section and photos as no cross section survey.
Culvert under farm track	CREE_0000	Sprung-arch conduit. Based on upstream cross section survey. Lower half of culvert assumed to be silted up based on channel bed level upstream.

3 Model Results

The model results for the 5%, 1% and 0.1% AEP events are shown below at the development site. Flooding is mostly contained along the eastern site boundary which is adjacent to the Gipping Channel. Some flooding occurs adjacent to the short reaches where the site boundaries protrude eastwards. However, the majority of the site is not shown to be at risk of flooding from this watercourse.

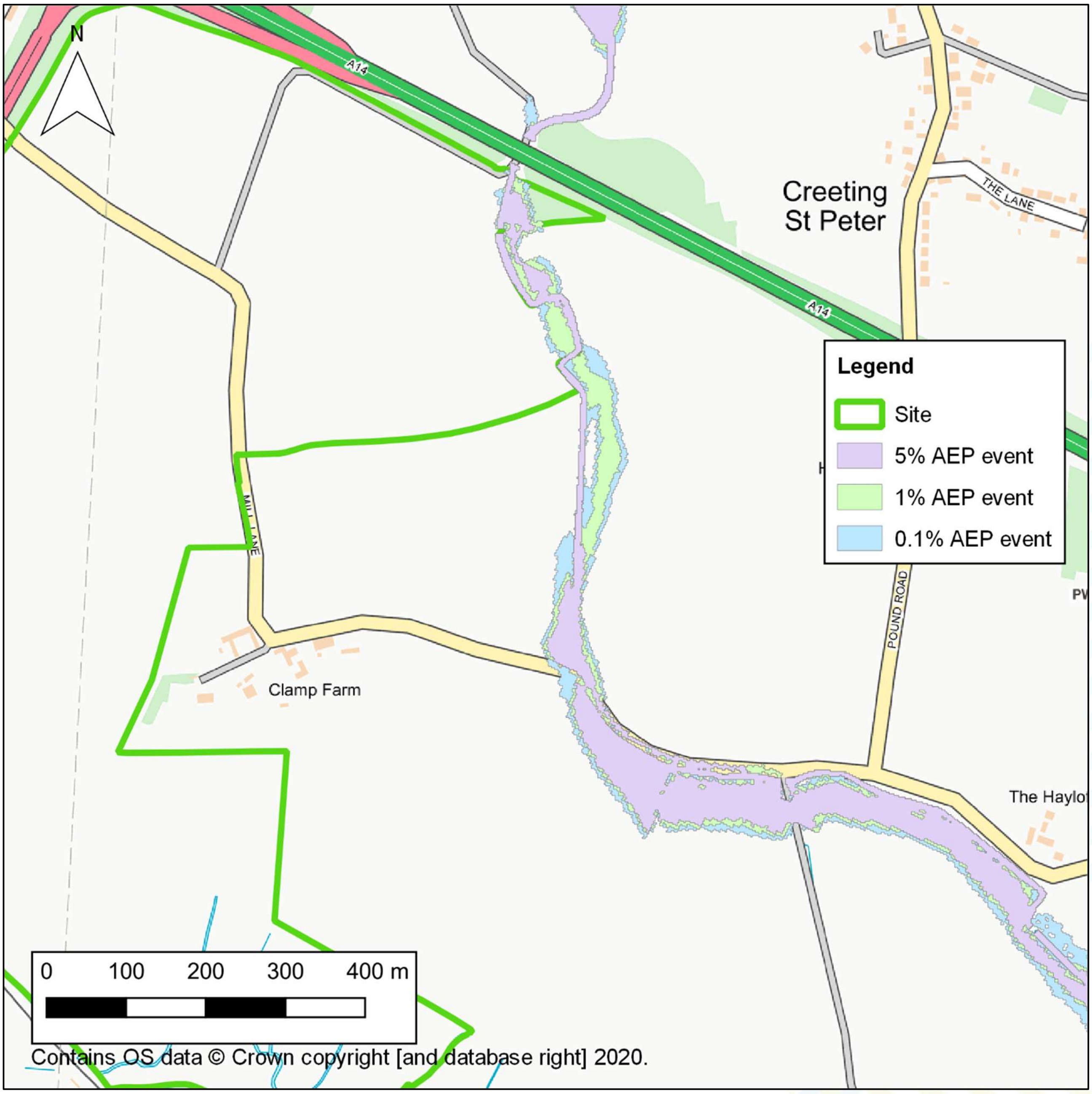

Figure 3-1: Model Results - 5%, 1% and 0.1% AEP events

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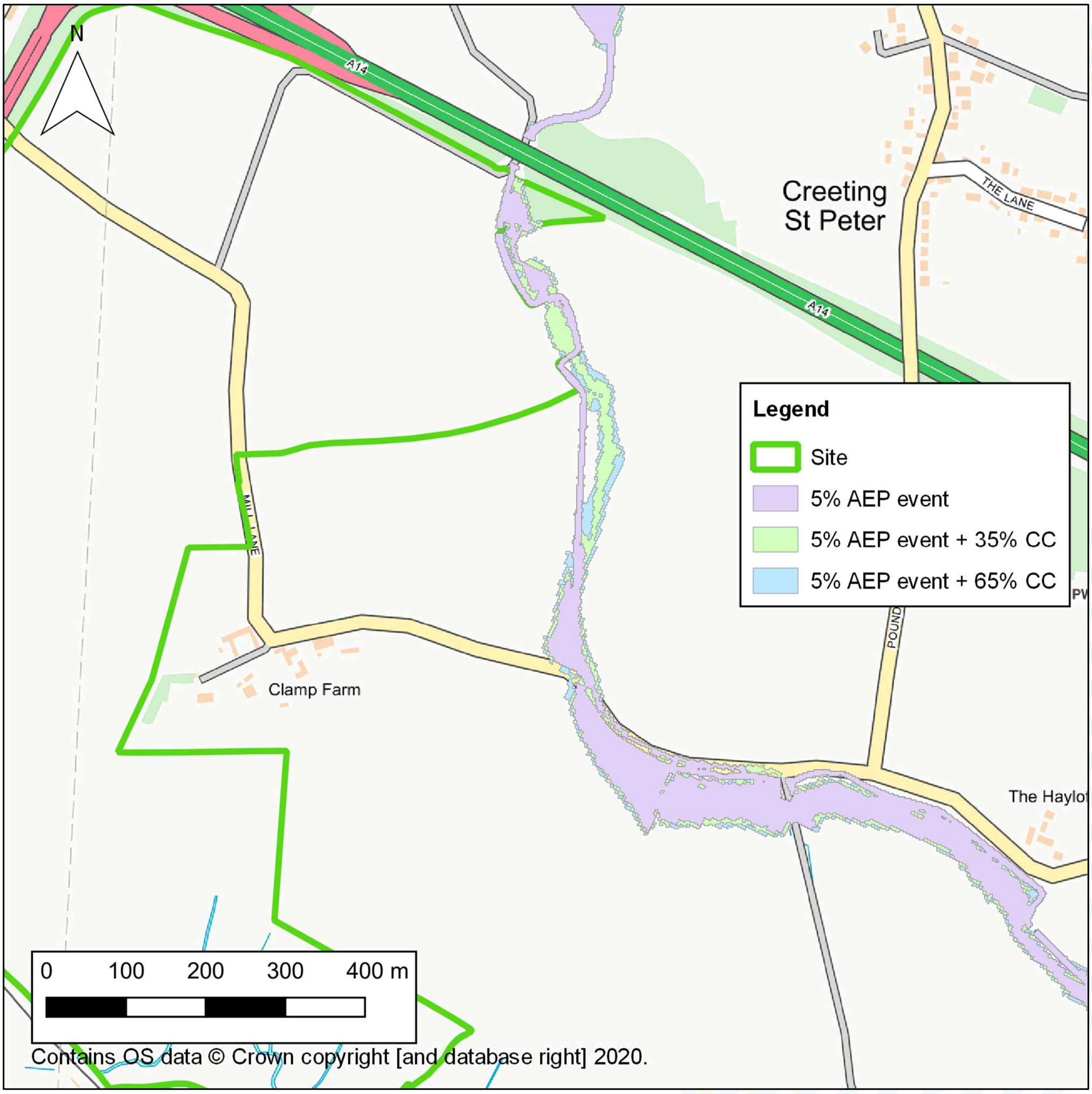


Figure 3-2: Model results - 5% AEP event plus 35% and 65% climate change

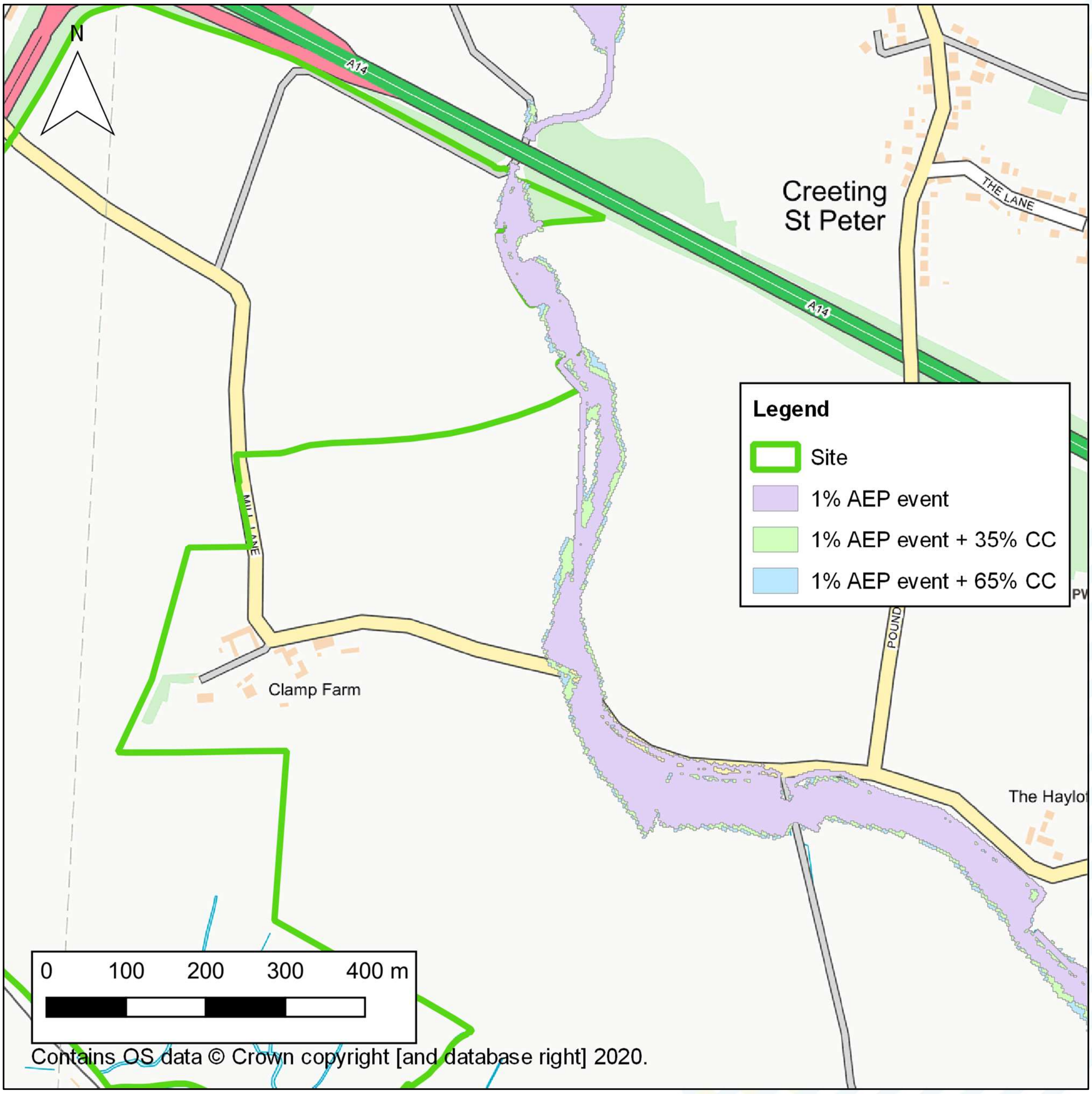


Figure 3-3: Model results - 1% AEP event plus 35% and 65% climate change

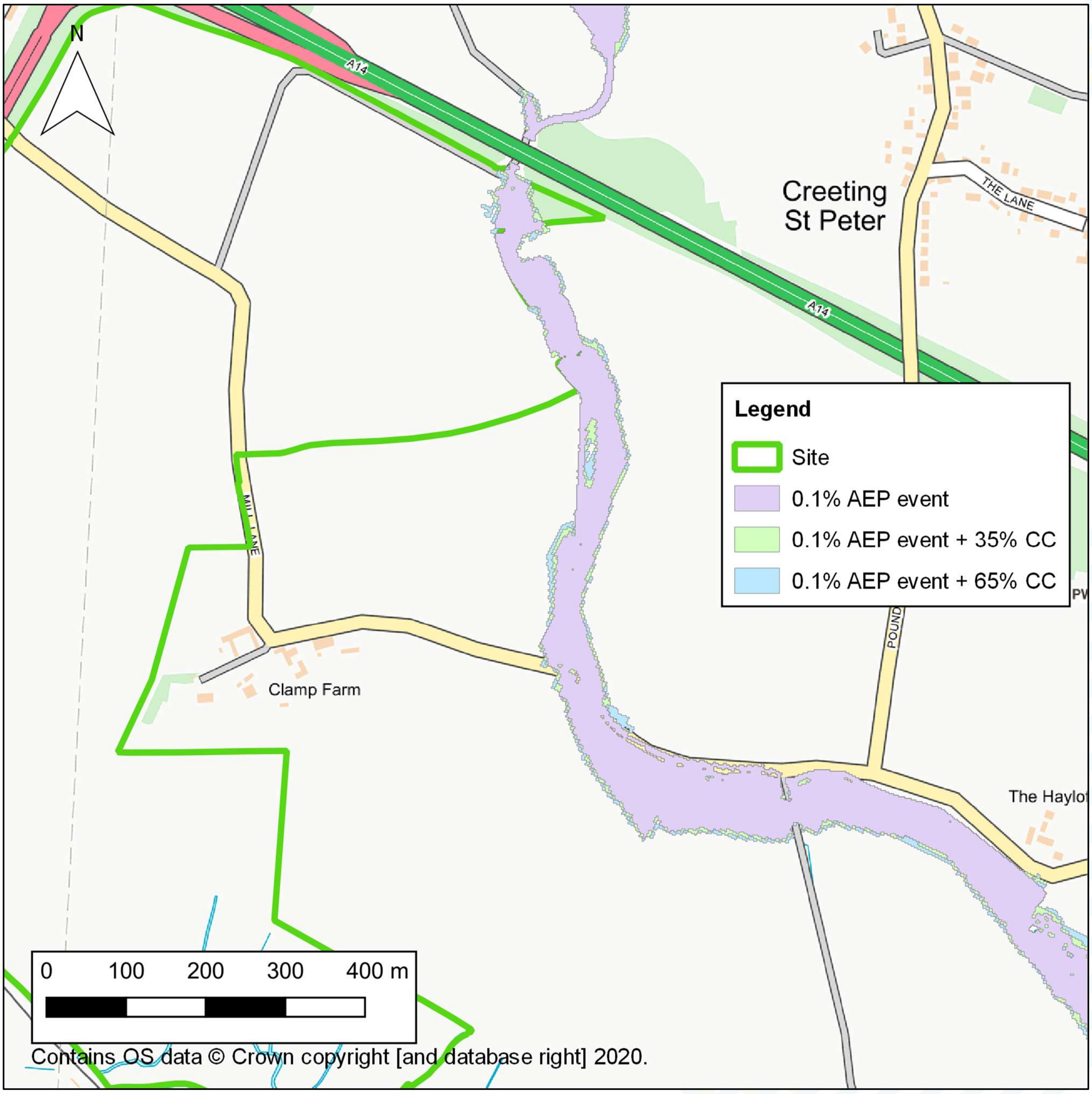


Figure 3-4: Model results - 0.1% AEP event plus 35% and 65% climate change

4 Model limitations, assumptions and uncertainty

Developing a hydraulic model requires the application of simplifications and generalisations. As such a number of assumptions are made when building the model. This can lead to model uncertainties and subsequent limitations of the results.

The scope of the model is a simple model for an SFRA and therefore this is reflected in the level of detail included in the model.

In terms of model construction, the initial model schematisation and the approach adopted can be a limitation. In this study a linked 1D-2D Flood Modeller-TUFLOW model was developed. This schematisation allows a detailed representation of the channel and structure capacity to be defined within the 1D model domain and flow paths across the floodplain to be defined within the 2D model domain. The 1D-2D modelling approach was considered to be the most appropriate to represent the risk of fluvial flooding due to the complex flow path and the number of obstructions such as bridges and flood banks within the floodplain.

The main assumption associated with the hydraulic model produced for this commission comes from the flow estimates applied to the model. The hydrology in this study was calculated using the FEH Statistical method (although 1000-year flows have been determined by scaling up the FEH statistical 100-year flows by a ratio of the 1000-year to 100-year ReFH2 estimates).

The base data used to provide a representation of the channel and associated structures may be a limitation of the study. In this case all the channel and topographic survey was carried out for this study for the Gipping Channel. Cross sections are not available at some structures and these have been based on information provided in the long section. These are not in key areas, except for a footbridge adjacent to the site, which has been incorporated with known soffit and bridge deck levels. The impact of this is minor.

The LiDAR used to set the base topography in the 2D model domain is a source of uncertainty. The bare earth DTM was filtered to remove the presence of buildings and vegetation. The LiDAR data used for this study is at 2m resolution.

General modelling assumptions relate to the selection of various parameters within the model, for example, the roughness values used within the model, representation of certain structures and their coefficients.

Negative flows in the 1D channel are present for the larger events (0.1% AEP event with and without climate change allowance and 1% AEP event with 65% climate change allowance) and locations upstream and downstream of the site. However, these are not in the immediate vicinity of the site of interest and the effects will be limited as these only occur where alternative flow paths in the 2D domain are present.

Flood estimation report: 2020s0908 – Babergh District Council – Level 2 SFRA – Mill Lane, Stowmarket

Introduction

This report template is based on a supporting document to the Environment Agency's flood estimation guidelines. It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results.

Contents

Approval

	Name and qualifications	Date
Method statement prepared by:	Louise Morgan BSc (Hons)	20/08/2020
Method statement reviewed by:	Claire French BSc (Hons) MSc (Eng) MCIWEM CWEM CSci CEnv	01/09/2020
Calculations prepared by:	Louise Morgan BSc (Hons)	15/09/2020
Calculations reviewed by:	Claire French BSc (Hons) MSc (Eng) MCIWEM CWEM CSci CEnv	01/10/2020

Revision History

Revision reference	Date issued	Amendments	Issued to
P01	October 2020	-	Matt Deakin

Abbreviations

AM............................Annual Maximum

AREA ....Catchment area (km^2)

BFI ....Base Flow Index

BFIHOST ....Base Flow Index derived using the HOST soil classification

CFMP ....Catchment Flood Management Plan

CPRE ....Council for the Protection of Rural England

FARL.........................FEH index of flood attenuation due to reservoirs and lakes

FEH ....Flood Estimation Handbook

FSR ....Flood Studies Report

HOST........................Hydrology of Soil Types

NRFA ....National River Flow Archive

POT ....Peaks Over a Threshold

QMED ....Median Annual Flood (with return period 2 years)

ReFH.........................Revitalised Flood Hydrograph method

SAAR ....Standard Average Annual Rainfall (mm)

SPR ....Standard percentage runoff

SPRHOST ....Standard percentage runoff derived using the HOST soil classification

Tp(0) ....Time to peak of the instantaneous unit hydrograph

URBAN ....Flood Studies Report index of fractional urban extent

URBEXT1990 ....FEH index of fractional urban extent

URBEXT2000 ....Revised index of urban extent, measured differently from URBEXT1990

WINFAP-FEH ....Windows Frequency Analysis Package – used for FEH statistical method

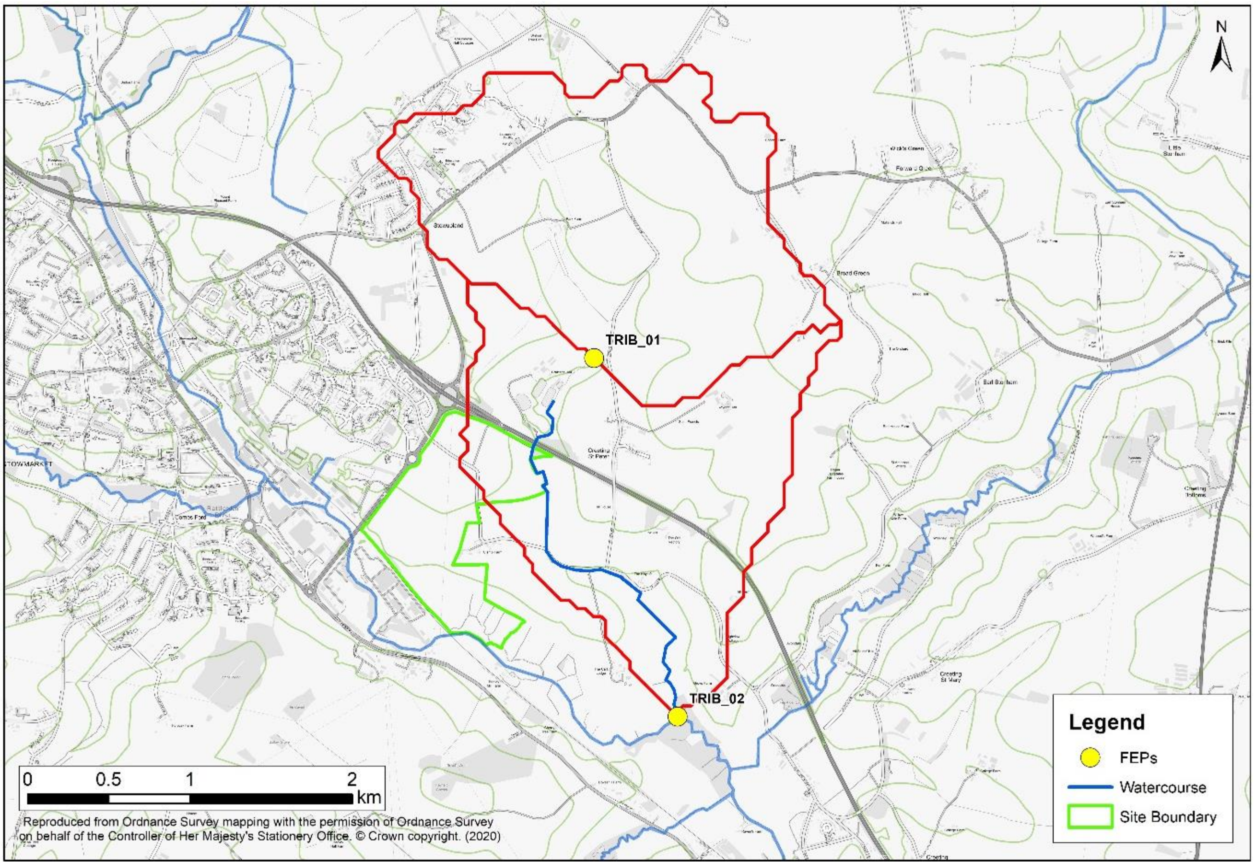
1 Method statement

1.1 Requirements for flood estimates

Overview	The purpose of this hydrological assessment is to provide inflows for a hydraulic modelling study in relation to a development site off Mill Lane, Stowmarket. An existing hydraulic model of the River Gipping and tributaries, developed by JBA Consulting on behalf of the Environment Agency in 2012, is being used as the basis of this study. The model is being extended upstream to include the watercourse to the north-east of the development site. Design peak flow estimates and hydrographs are required at two locations for the following annual exceedance probability (AEP) events (%): 50, 5, 3.3, 1 and 0.1. The effects of climate change will be assessed using the 5, 1 and 0.1% AEP events and accounted for using the latest guidance[1]. The intended climate change factors will be 35% and 65%, since the site is located within the Anglian River Basin District.
Project scope	There are no river gauges in the study area, therefore rating reviews and ReFH parameter estimation are not relevant. It is only within the scope of this hydrological study to assess fluvial flows. The scope and level of detail in the assessment is proportionate to the strategic nature of the project.

1.2 The catchment

Map



[1] Environment Agency (2020), "https://www.gov.uk/guidance/flood-and-coastal-risk-projects-schemes-and-strategies-climate-change-allowances"

Description Include topography, climate, geology, soils, land use and any unusual features that may affect the flood hydrology.	The proposed development site is approximately 78.9ha (0.79km^2) in size, and is located at the intersection of the A1120 and the A14 in Stowmarket. The River Gipping lies close to the site's southern boundary, while a left bank tributary clips the site's north-eastern boundary. From Stowmarket, the River Gipping continues in a general south-easterly direction to Ipswich where it becomes the tidal River Orwell. This hydrological assessment focuses on the left bank tributary. The topography of the site, as well as the catchment of the left bank tributary, is relatively flat. Land use within the catchment is predominantly rural, although Creeting St Peter and part of Stowupland lie within the catchment boundary. The British Geological Survey website[2] 1:50,000 geology mapping shows the geology to mainly comprise sand belonging to the Crag Group. The southern half of the catchment is underlain by lime-rich loamy and clayey soils with impeded drainage, while the north of the catchment has slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils[3]. There is a gauge (35008 Gipping @ Stowmarket) approximately 1km from the study catchment, which has a flashy response catchment.

1.3 Source of flood peak data

Source	NRFA peak flows dataset, Version 8, released October 2019. This contains data up to water year 2017-18.

1.4 Gauging stations (flow or level)

(at or very near to the sites of flood estimates)

Water-course	Station name	Gauging authority number	NRFA number	Catchment area (km²)	Type (rated / ultrasonic / level...)	Start of record and end if station closed
Study catchment is ungauged						

1.5 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data	Details
Check flow gaugings	No	N/A	N/A	N/A

[2] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[3] http://www.landis.org.uk/soilscapes/

Historic flood data	Yes	Yes	BDMSC historic flood records	Historical flood records provided by Babergh & Mid Suffolk District Council (BMSDC) show that there have been several recorded flood incidents in Stowupland and Creeting St Mary, the most recent being in 2019. There are also records of overflowing drains, including 5 records on Church Road in Stowupland.
Flow or river level data for events	Yes	No	N/A	N/A
Rainfall data for events	Yes	No	N/A	N/A
Potential evaporation data	No	N/A	N/A	N/A
Results from previous studies	Yes	No	N/A	N/A
Other data or information (e.g. groundwater, tides, channel widths, low flow statistics)	Yes	No	N/A	N/A

1.6 Hydrological understanding of catchment

Outline the conceptual model, addressing questions such as:	The main site of interest is the development site, located off Mill Lane, Stowmarket. Flooding at this location is likely to be caused by peak flows.
Any unusual catchment features to take into account?	No

1.7 Initial choice of approach

Is FEH appropriate?	FEH flood frequency methods are considered appropriate, given the catchment area is greater than 0.5km^2 (the lower limit of applicability of the methods) and is not extremely urbanised.
Initial choice of method(s) and reasons How will hydrograph shapes be derived if needed? Will the catchment be split into sub-catchments? If so, how?	Both the statistical method and the ReFH2 method will be applied. There is no peak flow record available in the catchment to improve the QMED estimate under the statistical method. Local donors, from nearby catchments, will, therefore, be assessed for suitability for data transfer. At this stage, there is no strong reason to prefer one method for flood flow estimation over another for this watercourse. The flow estimates from the two methods will be compared and contrasted. Hydrograph shapes will be derived from the ReFH2

	model. These will be fitted to the Statistical peaks, if this is the preferred method for deriving design peak flow estimates.
Software to be used (with version numbers)	FEH Web Service[4] / WINFAP-FEH v3.0.003[5] / ReFH2.3

[4] CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK.

[5] WINFAP-FEH v3 © Wallingford HydroSolutions Limited and NERC (CEH) 2009.

2 Locations where flood estimates required

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

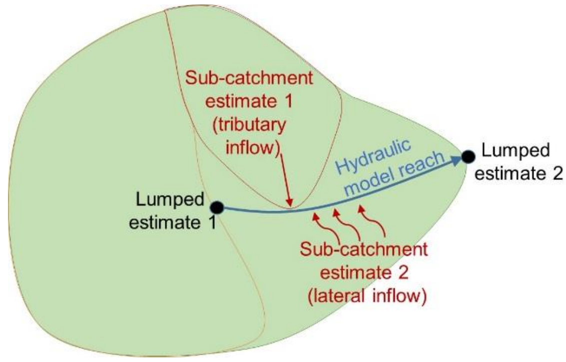
2.1 Summary of subject sites

Site code	Type of estimate L: lumped catchment S: Sub-catchment	Watercourse	Name or description of site	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered
TRIB_01	L	Un-named tributary	Upstream model extent	607700	258800	3.58	-
TRIB_02	L	Un-named tributary	Downstream model extent / Confluence with River Gipping	608200	256600	6.74	-
TRIB_IA	S	Un-named tributary	Intervening area between TRIB_01 and TRIB_02	608200	256600	-	3.15

Note: Lumped catchments (L) are complete catchments draining to points at which design flows are required.

Sub-catchments (S) are catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system. There is no need to report any design flows for sub-catchments, as they are not relevant: the relevant result is the hydrograph that the sub-catchment is expected to contribute to a design flood event at a point further downstream in the river system. This will be recorded within the hydraulic model output files. However, catchment descriptors and ReFH model parameters should be recorded for sub-catchments so that the results can be reproduced.

The schematic diagram illustrates the distinction between lumped and sub-catchment estimates.



2.2 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
TRIB_01	1	0.28	0.331	1.41	18.5	584	0.018	0.074
TRIB_02	1	0.28	0.342	3.25	22	585	0.010	0.065
TRIB_IA	-	0.28	0.355	1.88	26	586	0.001	-

FARL and FPEXT were not derived as they are not used in ReFH2

2.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes	The FEH catchment boundaries were compared to LiDAR, Ordnance Survey (OS) and contour lines and found to be representative of the natural topographic catchments. There is a small watercourse that is included in the catchment boundary but drains northward, away from the study watercourse (around NGR TM 07100 60525). The error is small and amendment of the boundary is not considered necessary. No changes were made to catchment boundaries.

Record how other catchment descriptors were checked and describe any changes.	A qualitative check of the FEH BFIHOST19 values was undertaken by comparing them to the geology and soils detailed in Section 1.2. The values are supported by the soils shown to underlie the catchment and have not been changed. The FEH FARL for TRIB_01 and TRIB_02 is 1.000. Creeting Lakes, located at NGR TM 07429 58532, are within the catchment. However, they don't appear to be online and their attenuation effect it not deemed to be significant. They have, therefore, been ignored for the purposes of this assessment. A qualitative check of the URBEXT values was made by comparing the FEH values and urban extent 2000 layer to current OS Mapping. The urban extent 2000 layer includes Stowupland, and the URBEXT2000 values, updated to 2020, are considered reasonable. The intervening area catchment descriptors were derived using the area-weighting method. The area, BFIHOST, DPSBAR, PROPWET, SAAR and URBEXT2000 values were altered using this method. Additionally, DPLBAR was calculated using equation 7.1 from the FEH Vol. 5.
Source of URBEXT	URBEXT2000
Method for updating of URBEXT	CPRE formula from 2006 CEH report on URBEXT2000

3 Statistical method

3.1 Overview of estimation of QMED at each subject site

Site code	QMED (rural) from CDs (m^3/s)	Final method	Data transfer					Urban adjust-ment factor UAF	Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Moderated QMED adjustment factor, $(A/B)^a$	If more than one donor			
						Weight	Weighted ave. adjustment		
TRIB_01	0.71	DT	35008	5.933	1.072	N/A	N/A	1.016	0.77
TRIB_02	1.19	DT	35008	6.036	1.072	N/A	N/A	1.009	1.29

Are the values of QMED spatially consistent?	Yes, QMED increases downstream
Method used for urban adjustment for subject and donor sites	WINFAP v4[6]

Parameters used for WINFAP v4 urban adjustment if applicable

Impervious fraction for built-up areas, IF	Percentage runoff for impervious surfaces, PR_{imp}	Method for calculating fractional urban cover, URBAN
0.3	70%	From updated URBEXT2000

Notes

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer (with urban adjustment); CD – Catchment descriptors alone (with urban adjustment); BCW – Catchment descriptors and bankfull channel width (add details); LF – Low flow statistics (add details).

The QMED adjustment factor A/B for each donor site is given in Table 3.2. This is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial estimate from catchment descriptors.

[6] Wallingford HydroSolutions (2016). WINFAP 4 Urban adjustment procedures.

3.2 Search for donor sites for QMED (if applicable)

Comment on potential donor sites Include a map if necessary. Note that donor catchments should usually be rural.	There are no river flow gauging stations within the study catchment. Gauged catchments within the hydrometric areas surrounding the study catchment were, therefore, assessed for suitability for data transfer to the study watercourse. There are 20 rural NFRA stations within 40km of the study area, based on the distance between catchment centroids. Comparison of $QMED_{obs}$ and $QMED_{cds}$ shows there is no consistent trend among the donor stations, although the two stations with a BFIHOST of less than 0.4 show the catchment descriptor equation to be under estimating QMED. Recommendations from current research[7] (and new research[8] to be published soon) indicate that the geographically closest station to the study site tends to produce the best results. The latest research highlights that descriptors, such as AREA, are included in the regression equation for QMED, so the donor adjustment process accounts for the differences in values between the donor and subject catchments. It also explains that the overarching pattern of QMED model residuals across the UK follows a smooth spatial pattern, hence the recommendation to choose donors by proximity. Therefore, the geographically closest station, 35008 Gipping @ Stowmarket has been selected for data transfer to the study watercourse. This station has a similar BFIHOST value to the subject sites and gives a comparable adjustment factor to those stations with a BFIHOST of less than 0.4 but which are located further away. According to the NRFA website, high flows on the Gipping at Stowmarket have been significantly affected by a flood relief scheme built in the late 1980s. It has been assumed that QMED has not been affected by the scheme. This assumption is supported by visual inspection of the AMAX record, which shows no long-term decrease in QMED despite the flood relief scheme including two reservoirs designed to reduce the amount of water in the River Gipping.

[7] Kjeldsen, T.R., Jones, D.A. and Bayliss, A.C. 2008. Improving the FEH statistical procedures for flood frequency estimation. Science Report SC050050, Environment Agency.

[8] Stewart, Lisa, Duncan Faulkner, Giuseppe Formetta, Adam Griffin, Tracey Haxton, Ilaria Prosdocimi, Gianni Vesuviano and Andy Young (TBC). Estimating flood peaks and hydrographs for small catchments (Phase 2). Report – SC090031/R0, Environment Agency.

3.3 Donor sites chosen and QMED adjustment factors

NRFA no.	Reasons for choosing	Method (AM or POT)	Adjust-ment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjust-ment ratio (A/B)
35008	Geographically closest station.	AM	No (55-year record length)	14.30	11.86	1.205

3.4 Derivation of pooling groups

Several subject sites may use the same pooling group.

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
TRIB_02	TRIB_02	No	Reviewed and retained: • 27051 (Crimple @ Burn Bridge) • 26802 (Gypsey Race @ Kirby Grindalythe) • 25019 (Leven @ Easby) Removed: • 49005 (Bolingey Stream @ Bolingey Cocks Bridge) – only 8 years of data	L-CV: 0.27 L-skew: 0.237
Note: Pooling groups were derived using the procedures from Science Report SC050050 (2008).				

3.5 Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape after adjustments)	Growth factor for 100-year return period
TRIB_01	P	TRIB_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Shape: -0.240 Scale: 0.270	3.27
TRIB_02	P	TRIB_02	GL – gives acceptable fit and is recommended distribution for UK catchments	Urban Adjustment (WINFAP v4)	Location: 1.000 Shape: -0.239 Scale: 0.272	3.27

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution (location, scale and shape after adjustments)	Growth factor for 100-year return period
Notes Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters. Urban adjustments are all carried out using the method of Kjeldsen (2010). Growth curves were derived using the procedures from Science Report SC050050 (2008).						

3.6 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following AEP (%) events				
	50	**5**	**3.3**	**1**	**0.1**
TRIB_01	0.8	1.7	1.9	2.5	4.5
TRIB_02	1.3	2.8	3.1	4.2	7.5

4 Revitalised flood hydrograph 2 (ReFH2) method

4.1 Catchment sub-divisions for ReFH2 model

Site code	Area (km^2)			
	Rural or un-developed	Paved	Only relevant if significant transfers of water via sewers crossing catchment boundaries…	
			Paved with sewers draining out of topographic catchment	**Paved outside topographic catchment with sewers draining into catchment**
TRIB_01	3.54	0.04	N/A	N/A
TRIB_02	6.69	0.04	N/A	N/A
Sources of information for creating sub-divisions	URBEXT 2000		**Sewer capacity** (return period / rainfall intensity / flow rate) and source of information	N/A

4.2 Parameters for ReFH2 model

Site code	Method	Tp_{rural} (hours)	Tp_{urban} (hours)	C_{max} (mm)	PR_{imp} % runoff for impermeable surfaces	BL (hours)	BR*
TRIB_01	CD	3.94	2.96	274.33	70	30.58	0.87
TRIB_02	CD	6.01	4.51	282.29	70	37.42	0.95
TRIB_IA	CD	4.17	3.13	291.98	70	33.97	0.98
Brief description of any flood event analysis carried out (further details should be given in the annex)				N/A			
Methods: OPT: Optimisation, BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details) *Note: the BR value relates to the 100 year storm event							

4.3 Design events for ReFH2 method: Lumped catchments

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Storm Duration (hours)
TRIB_01	Rural	Winter	06:30	09:00
TRIB_02	Rural	Winter	09:00	
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?			Yes. The FEP specific storm durations have been used to generate peak flow estimates for comparison with the FEH Statistical method estimates. For application to the hydraulic model, a uniform storm duration and areal reduction factor (ARF) will be used.	

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Storm Duration (hours)
			The duration of 9.5 hours has been used with a 0.5 hour time step as the site of interest is in TRIB_02 catchment. Apply this duration and ARF from TRIB_02 to all hydrographs.	

4.4 Flood estimates from the ReFH2 method

Note: This table is for recording results for lumped catchments. There is no need to record peak flows from sub-catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system.

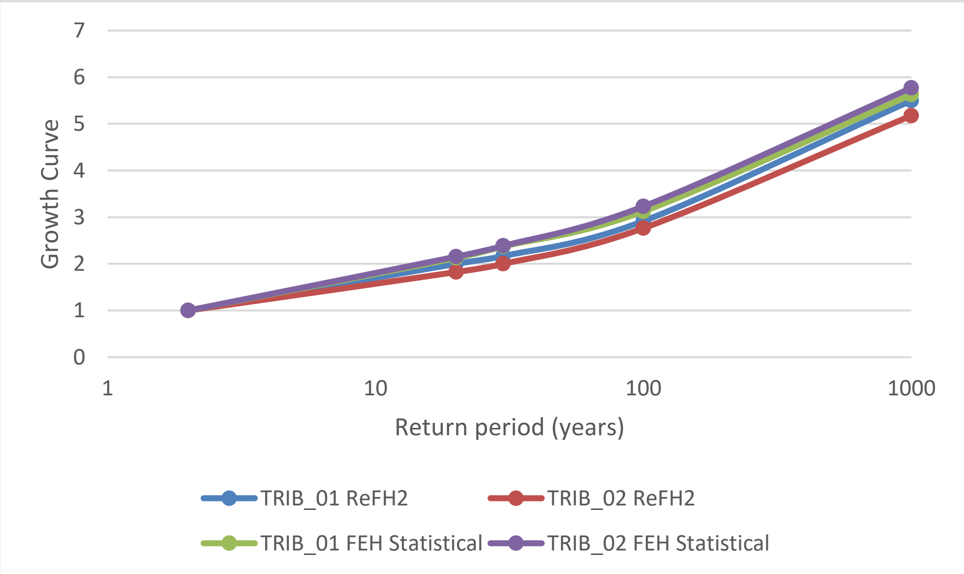
Site code	Flood peak (m^3/s) for the following AEP (%) events				
	50	**5**	**3.3**	**1**	**0.1**
TRIB_01	1.2	2.4	2.6	3.5	6.7
TRIB_02	1.7	3.1	3.4	4.7	8.8

5 Discussion and summary of results

5.1 Comparison of results from different methods

This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods. Blank cells indicate that results for a particular site were not calculated using that method.

Site code	Ratio of peak flow to FEH Statistical peak	
	Return period 2 years	Return period 100 years
	ReFH	ReFH
TRIB_01	1.50	1.40
TRIB_02	1.31	1.12



5.2 Final choice of method

Choice of method and reasons Include reference to type of study, nature of catchment and type of data available.	The FEH statistical method is preferred for generating the design peak flow estimates on the study catchment. Although there are no flow gauges in this catchment, the FEH statistical method has made use of a local donor, on the River Gipping, to adjust QMED. ReFH2 has been based on catchment descriptors alone. The comparison of design flows presented in Section 5.1 shows that the statistical method gives lower flows than the ReFH2 method. However, Figure 5-1 shows that the ReFH2 growth curves are slightly flatter than the statistical growth curves. The difference between the results comes mainly from the 2-year estimates. Since the statistical QMED estimates have been enhanced using data transfer from a local gauge (and a couple of hydrologically similar gauges, located further away, give a similar QMED adjustment ratio), the FEH statistical method is considered the most appropriate choice. Although the statistical method is preferred here over the ReFH2 model, there are significant uncertainties associated with applying it to events beyond the 200-year return period, due to the typically short length of river gauge records. To reduce these uncertainties, a hybrid approach has been taken to deriving the 1000-year return period flows. In particular, the 100-year peak flows from the statistical method have been scaled up using the ratio of the 1000-year and

	100-year peak flows from ReFH2. It is recommended that the hydraulic modelling results are used to sense-check and validate the choice of method.
How will the flows be applied to a hydraulic model?	Trib_01 will be entered into the upstream end of the hydraulic model, while Trib_IA will be apportioned across the modelled reach according to catchment area.

5.3 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	• Observed QMED on the Gipping at Stowmarket is not affected by the flood relief scheme. • The pooling group used to define the growth curves in the FEH Statistical method is representative of the catchment.
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed.	• The main limitation is the lack of river flow gauge data specific to the study area. There are no river flow or level gauges on the watercourse and, therefore, the catchment response is unknown. • BFIHOST19 has been used for the subject sites, however the statistical method has not yet been recalibrated for this new descriptor value (although research has shown that it gives better results overall with the existing equations than the original BFIHOST value). • The QMED adjustment factor has been calculated using BFIHOST values, and not the latest BFIHOST19 values.
Give what information you can on uncertainty in the results, e.g. confidence limits from Kjeldsen (2014).	There is no method provided in the FEH for estimating uncertainty for the common situation of an ungauged catchment, pooled growth curve and QMED estimated from a donor catchment. The uncertainty will depend on many factors, for example, how unusual the study catchment is relative to the pooling group and donor catchment, and the uncertainty in flow measurement at other gauges. A UK average measure of uncertainty is presented in a technical guidance report generated by a R&D project into the FEH, local data and uncertainty (Environment Agency funded consortium of JBA, CEH and others). The report presents results for rural catchments (URBEXT2000 <0.03) and moderately urbanised catchments (0.03 ≤ URBEXT2000 < 0.15). The 95% confidence limits for a 1% AEP flood estimate for a rural catchment are: • Without donor adjustment of QMED: 0.45 – 2.23 times the best estimate. • With donor adjustment of QMED (one donor): 0.47 – 2.12 times the best estimate,
Comment on the suitability of the results for future studies, e.g. at nearby locations or for different purposes.	The design peak flow estimates and hydrographs were derived for the purposes of this modelling study. If peak flow estimates and hydrographs are required for a different purpose it is recommended that, at a minimum, a review of the results is carried out.
Give any other comments on	There is a lack of hydrometric data within the catchment.

the study, e.g. suggestions for additional work.	Confidence in flow estimates and understanding of catchment response could be improved with local hydrometric data collection.

5.4 Checks

Are the results consistent, for example at confluences?	Yes, flows increase between TRIB_01 and TRIB_02.
What do the results imply regarding the return periods of floods during the period of record?	There is no local flow data (within the study area) against which to compare the design peak flow estimates.
What is the range of 100-year growth factors? Is this realistic?	The 1% AEP growth factor range for the methods is: • FEH Statistical: 3.3 • ReFH2: 2.8 – 2.9 The typical range is 2.1 to 4.0. The growth factors for both methods are within this range.
If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	The 0.1%:1% AEP growth factor range for the methods is: • FEH Statistical: 1.8 • ReFH2: 1.9
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	There are no known hydrological studies available to compare to the current study.
Are the results compatible with the longer-term flood history?	There is no local flow data against which to compare the design flow estimates.
Describe any other checks on the results	Modelled levels and flood extents will be sensibility-checked to ensure that flow inputs result in realistic outputs.

5.5 Final results

Site code	Flood peak (m^3/s) for the following AEP (%) events				
	50	5	3.3	1	0.1
TRIB_01	0.8	1.7	1.9	2.5	4.8
TRIB_02	1.3	2.8	3.1	4.2	7.9

If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, hydraulic model, or reference to table below)	CreetingStMary_Hydrographs v2.xls

6 Annex

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
27051 (Crimple @ Burn Bridge)	0.966	46	4.539	0.219	0.148	0.392
26802 (Gypsey Race @ Kirby Grindalythe)	1.35	19	0.109	0.309	0.183	0.245
25019 (Leven @ Easby)	1.406	40	5.384	0.343	0.378	0.759
45816 (Haddeo @ Upton)	1.513	25	3.456	0.306	0.399	0.654
28033 (Dove @ Hollinsclough)	1.732	43	4.205	0.231	0.369	0.903
27010 (Hodge Beck @ Bransdale Weir)	1.857	41	9.42	0.224	0.293	0.326
44008 (South Winterbourne @ Winterbourne Steepleton)	1.939	39	0.448	0.411	0.328	1.375
36010 (Bumpstead Brook @ Broad Green)	1.983	51	7.5	0.372	0.184	1.37
27073 (Brompton Beck @ Snainton Ings)	1.983	37	0.82	0.2	0.047	1.198
47022 (Tory Brook @ Newnham Park)	2.019	25	6.18	0.273	0.149	0.611
25011 (Langdon Beck @ Langdon)	2.054	32	15.533	0.235	0.334	1.683
26014 (Water Forlornes @ Driffield)	2.299	20	0.431	0.297	0.127	0.679
76011 (Coal Burn @ Coalburn)	2.319	41	1.84	0.165	0.315	1.303
206006 (Annalong @ Recorder)	2.355	48	15.33	0.189	0.052	2.502

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Registered Office
1 Broughton Park
Old Lane North
Broughton
SKIPTON
North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
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NOTE TO FILE

JBA Project Code	2020s0908
Contract	Babergh & Mid Suffolk District Council Level 2 SFRA
Client	Babergh District Council
Day, Date and Time	15 October 2020
Author	Fran Haine
Reviewer / Sign-off	Chris Smith
Subject	River Gipping Model Report

1 Upper Gipping Model

One of the eight sites of interest highlighted through the Strategic Flood Risk Assessment process is located on the Upper Gipping model within the 1D only section. To accurately represent the flood risk on the site, the downstream extent of the Upper Gipping model will be converted to a 1D-2D model.

1.1 Study extent

The site of interest (SS1223) on the Upper Gipping model that is outside of the current 2D extent is located to the south of Stowmarket off Mill Lane.

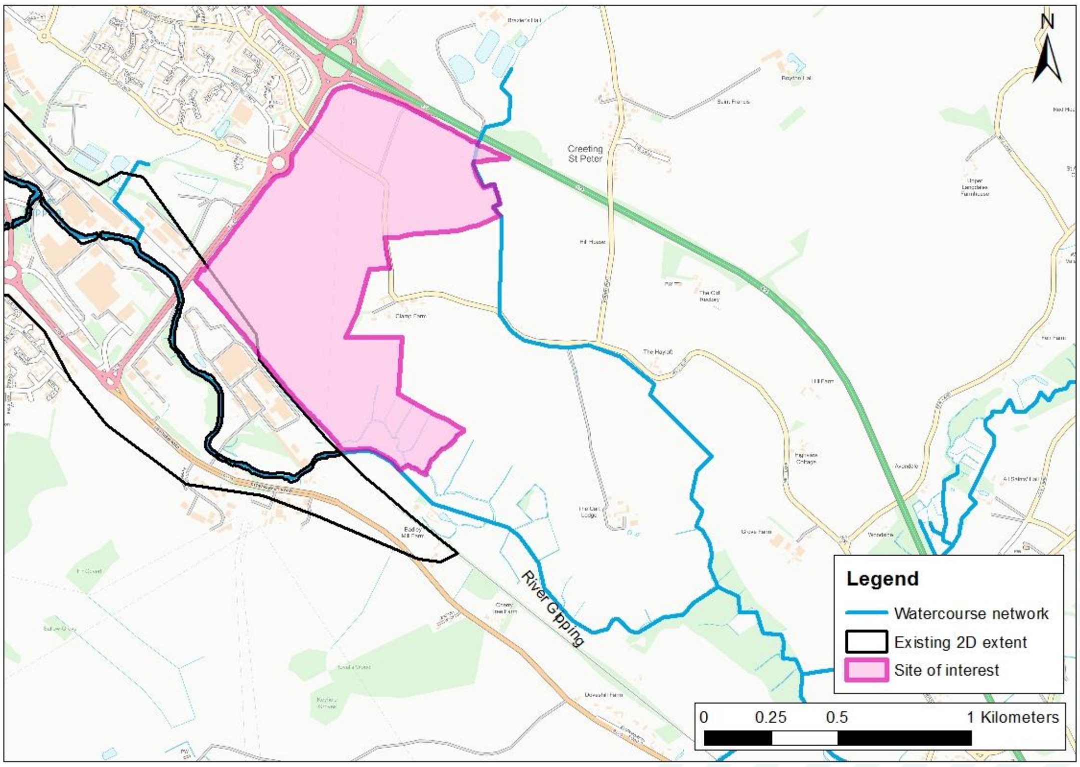

Figure 1-1: Upper Gipping model existing 2D extent and the site of interest (SS1223)

1.2 Input Data

1.2.1 Previous studies and Existing Models

In 2012 JBA Consulting undertook an update to the River Gipping Flood Risk Study. The study included a topographical survey and updating the 1D-2D ISIS-TUFLOW and 1D only model. This model was used and updated in the modelling of Stowmarket in this commission.

1.2.2 1D Model Changes and updates

To accurately represent the flood risk at the site of interest (SS1223), the 1D-2D section of the model is being extended downstream, past the site area. To do this, the 1D ISIS model was altered for this SFRA commission, by cropping the cross-sections to top of bank, from the current 1D-2D model end, to the downstream extent of the 1D model.

1.2.3 2D Model Changes and updates

1D nodes and Network

The 1D nodes and network files were updated to include the downstream cross-sections to the downstream extent of the Upper Gipping model.

1D-2D connections

The 1D-2D connection is established by CN-HX lines that were extended downstream to the end of the model extent. The Bradley tributary and River Gipping channels run parallel for a section of the extended 1D channel. The area between the two channels is continued to be represented within the 1D model by spill units, shown in Figure 1-2.

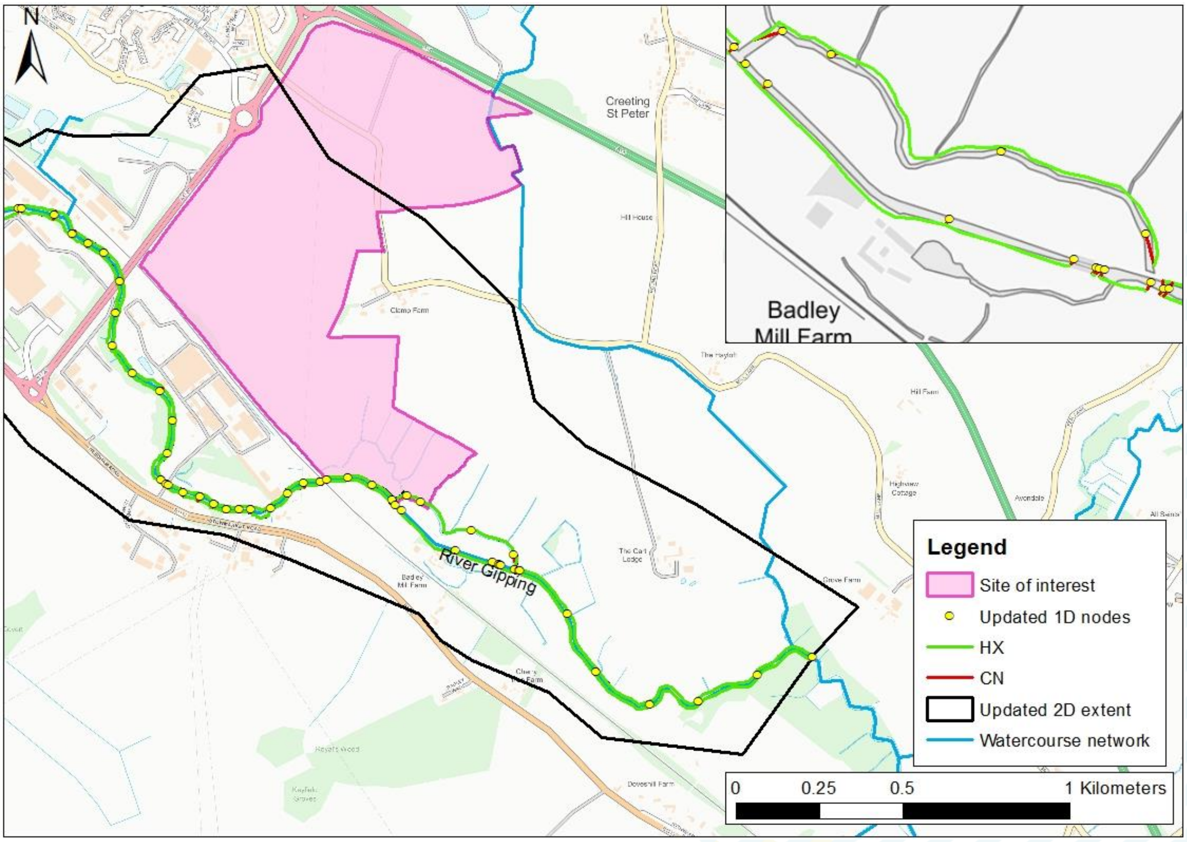

Figure 1-2: Upper Gipping model updated 2D extent and the site of interest (SS1223)

2D zone

The 2D zone was extended downstream to the end of the 1D extent, incorporating the neighbouring floodplain and valley floor.

Downstream Boundary

A downstream boundary was added into the Upper Gipping Model to represent flow out of the model extent into the floodplain.

1.3 Final Design Runs

This section provides details of the model design and scenario runs and a summary of results of the model runs. An explanation is provided regarding the understanding of flood risk as a result of the modelling process.

A list of the final design runs for the study is provided in Table 1-1.

Table 1-1: Final Design Runs

Run	% AEP					
	5%	5%+CC	1%	1%+CC	0.1%	0.1%+CC
Defended	✓	✓✓	✓			
Undefended			✓	✓✓	✓	✓✓

The results for site SS1223 show that flooding occurs for all return periods in the south-eastern corner of the site, with the flood extent increasing with return period. The majority of the site is not impacted by flooding. The comparison between undefended and defended scenarios shows that flood defences do not impact the site of interest. The 1D only 'island' is not inundated for any return period, therefore, is correctly mapped in the figures below.

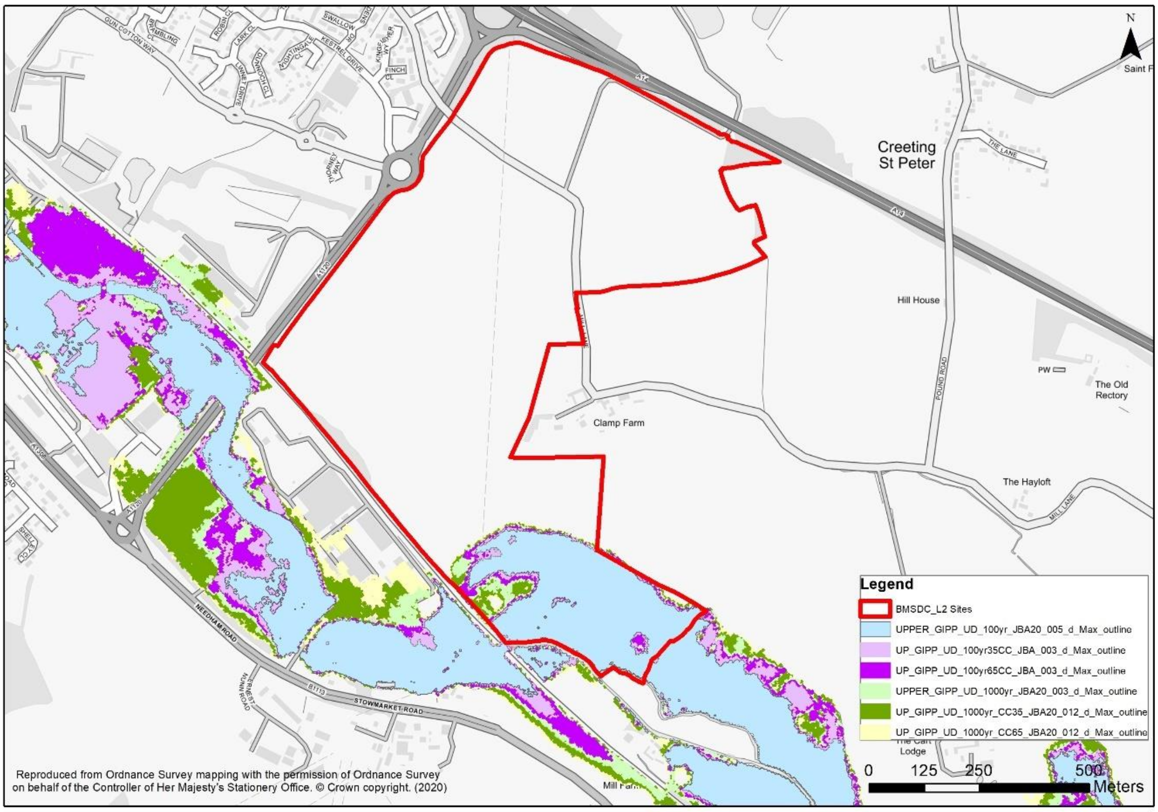

Figure 1-3: Undefended model results -100yr and 1000yr events plus 35% and 65% climate change

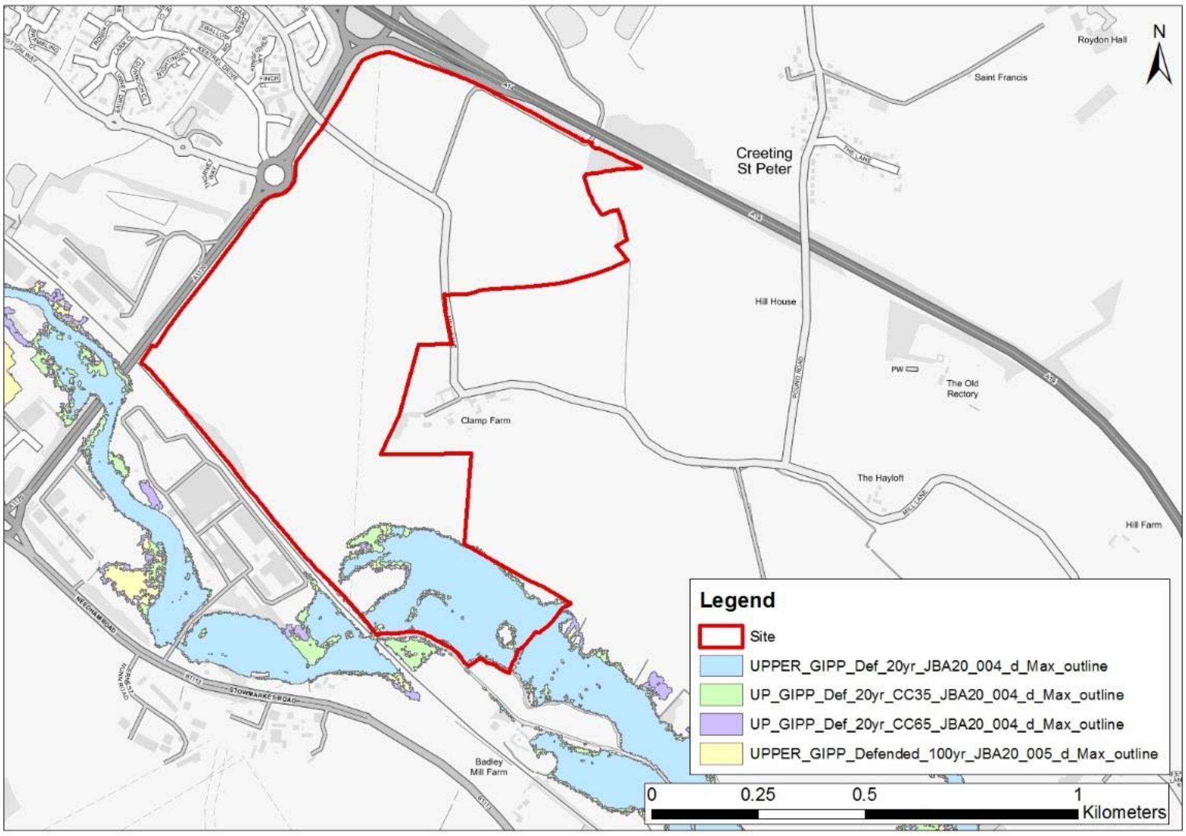

Figure 1-4: Defended Model results - 20year plus 35% and 65% climate change and 100yr events

1.3.1 Climate Change scenarios

The impact of climate change was assessed for fluvial events, based on the 5%, 1% and 0.1% AEP event using the latest Environment Agency guidance on climate change for the 2080s Anglian river basin district using the anticipated potential change factors of 35% (higher central) and 65% (upper end).

The flood extents show the south-eastern corner of the site is inundated by flooding with the flood extent increasing with climate change. The majority of the site is not impacted by flooding. Another 1D-2D model has been developed as part of this SFRA to represent flooding to the site from the watercourse in the north-eastern corner .

1.4 Model limitations, assumptions and uncertainty

Developing a hydraulic model requires the application of simplifications and generalisations. As such a number of assumptions are made when building the model. This can lead to model uncertainties and subsequent limitations of the results.

The scope of the model is a simple model for an SFRA and therefore this is reflected in the level of detail included in the model. The main aim of the model was to produce flood outlines for the development site, and whilst some improvements could be done to the model, this was only done where it would make a difference to the outline at the site.

The base data used to provide a representation of the channel and associated structures may be a limitation of the study. In this case, the channel and topographic survey is from the existing models. The age of this survey (pre 2012) is a potential source of uncertainty. It has been assumed that the existing model is fit for purpose.

Advanced parameters were generally kept from the existing model. In order to get the model to run for the 0.1% AEP + climate change runs, some of the advanced parameters had to be altered (Dflood to 5 and theta to 1) from the existing model set up due to the high flow and instabilities in the model when trying to run this. A stability patch was also required for these events near node GIPP_21265d where there were instabilities in the model.

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Contract	Babergh & Mid Suffolk District Council Level 2 SFRA
Client	Babergh District Council
Day, Date and Time	15 October 2020
Author	Fran Haine
Reviewer / Sign-off	Chris Smith
Subject	River Gipping Model Report

2 Lower Gipping Model

One of the eight sites of interest highlighted through the Strategic Flood Risk Assessment process is located on the Lower Gipping model within the 1D only section. To accurately represent the flood risk on the site, the downstream area of the Lower Gipping model, from the current 1D-2D downstream extent to the A14 bridge at Sproughton, will be converted to a 1D-2D model.

2.1 Study extent

The site of interest (SS0711) on the Lower Gipping model that is out of the current 2D extent is located to the north of Sproughton, east of Loraine Way.

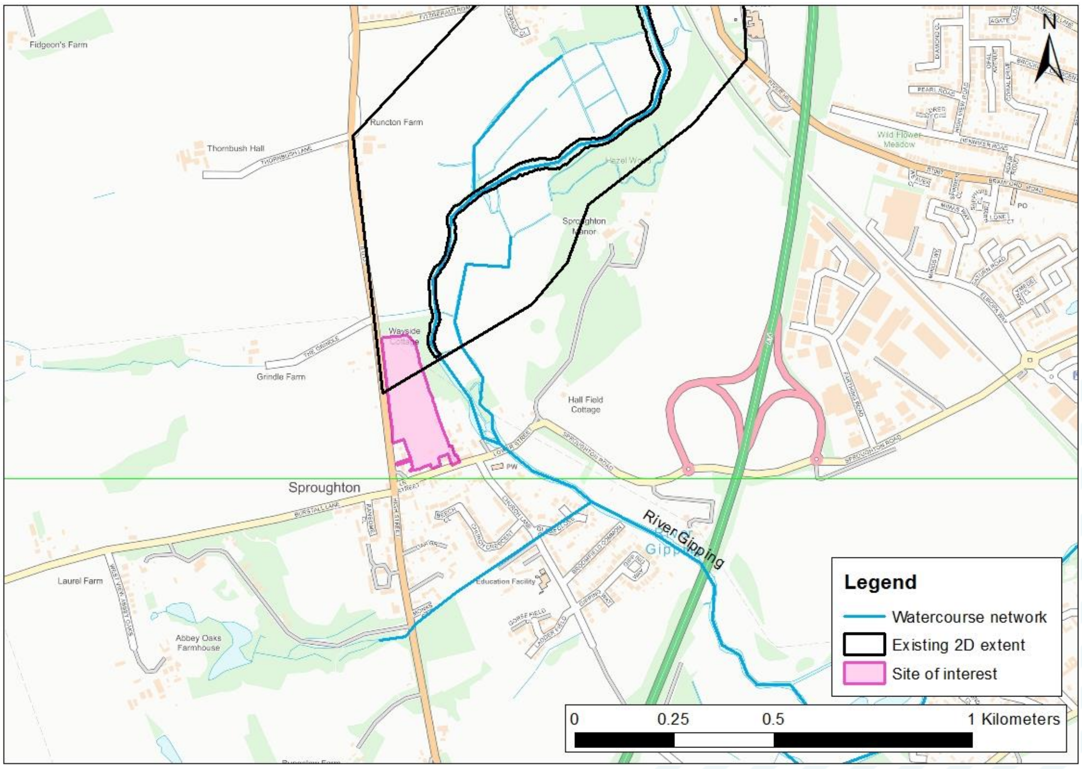

Figure 2-1: Lower Gipping model existing 2D extent and the site of interest (SS0711)

2.2 Input Data

2.2.1 Previous studies and Existing Models

In 2012 JBA Consulting undertook an update to the River Gipping Flood Risk Study. The study included a topographical survey and updating the 1D-2D ISIS-TUFLOW and 1D only model. This model was used and updated in the modelling of Stowmarket in this commission.

2.2.2 1D Model Changes and updates

To accurately represent the flood risk at the site of interest (SS0711), the 1D-2D section of the model is being extended downstream, past the site area. To do this, the 1D ISIS model was altered for this SFRA commission, by cropping the cross-sections to top of bank, from the current 1D-2D model end, to the A14 road bridge.

2.2.3 2D Model Changes and updates

1D nodes and network

The 1D nodes and network files were updated to include the downstream cross-sections to the A14 road bridge.

1D-2D connections

The 1D-2D connection is established by CN-HX lines that were extended downstream to the A14 road bridge. The Mill Stream and River Gipping channels run parallel for a section of the extended 1D channel. The area between the two channels is continued to be represented within the 1D model by spill units, shown in Figure 2-2.

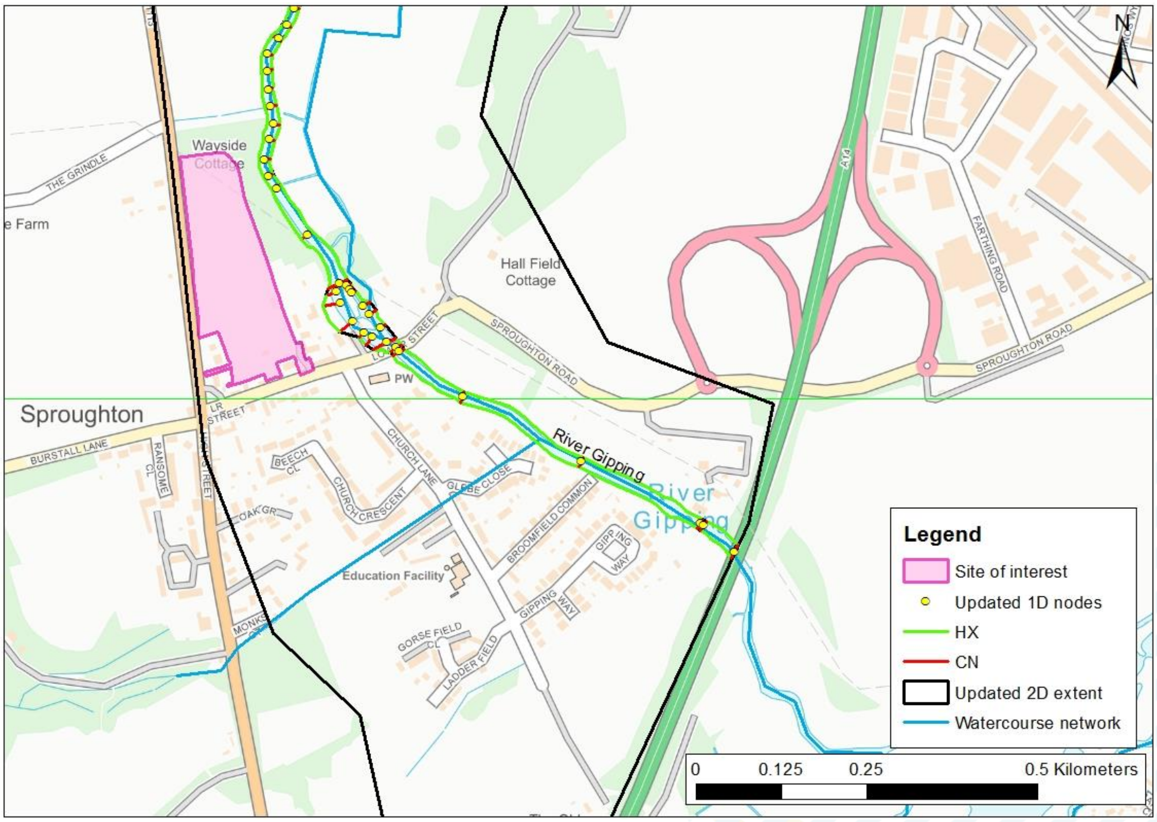

Figure 2-2: Lower Gipping model updated 2D extent and the site of interest (SS0711)

2D zone

The 2D zone was extended downstream to the A14 road bridge, incorporating the neighbouring floodplain and valley floor.

LiDAR

The extended model is outside of the current LiDAR extent, the 2019 1m DTM was added to the model to update the LiDAR for the Bramford 2D zone. No 2D downstream boundary was required as the water levels do not exceed the A14 embankment level represented within the LiDAR.

2.3 Final Design Runs

This section provides details of the model design and scenario runs and a summary of results of the model runs. An explanation is provided regarding the understanding of flood risk as a result of the modelling process.

A list of the final design runs for the study is provided in Table 2-1.

Table 2-1: Final Design Runs

Run	% AEP					
	5%	5%+CC	1%	1%+CC	0.1%	0.1%+CC
Defended	✓	✓✓	✓			
Undefended			✓	✓✓	✓	✓✓

The results for site SS0711 show that flooding occurs for all return periods in the north-eastern corner of the site, with the flood extent increasing with return period and climate change. The majority of the site is not impacted by flooding. A comparison of the defended and undefended scenarios was undertaken, no difference between the extents was seen, therefore, flood defences do not impact this site.

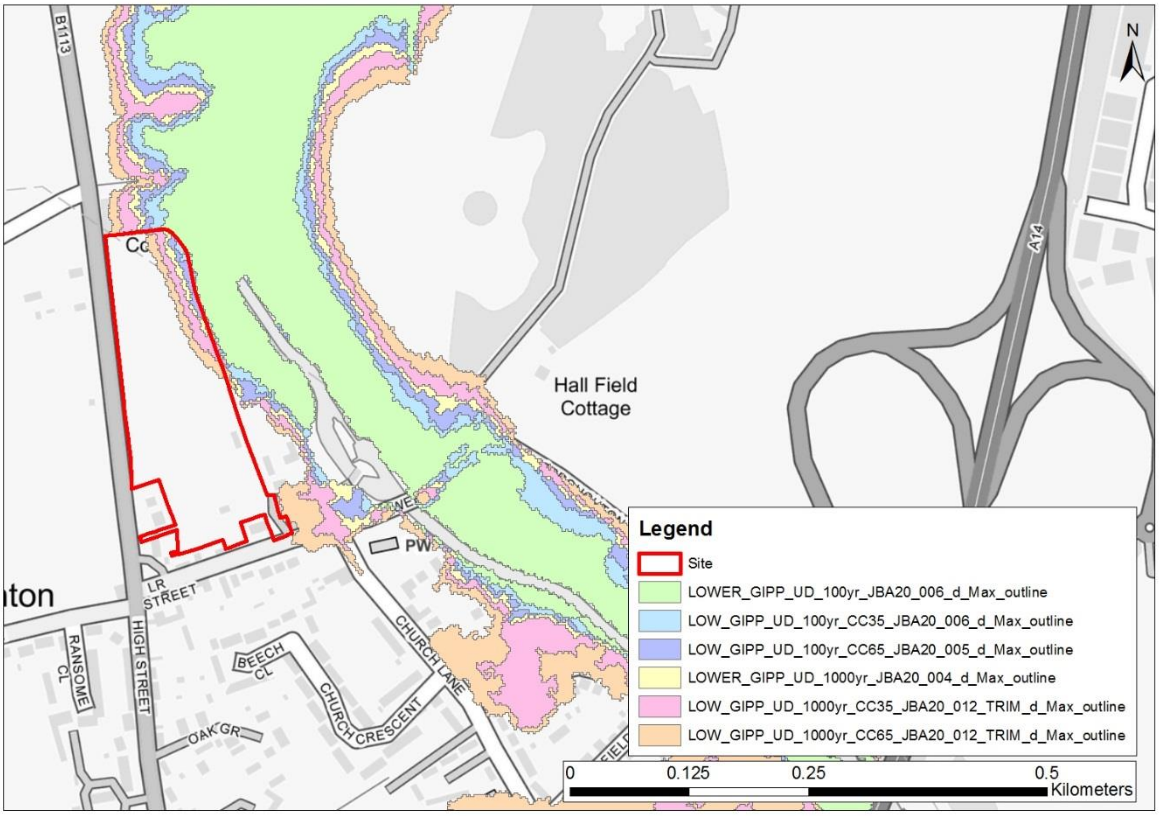

Figure 2-3: Undefended model Results - Model results -100yr and 1000yr events plus 35% and 65% climate change

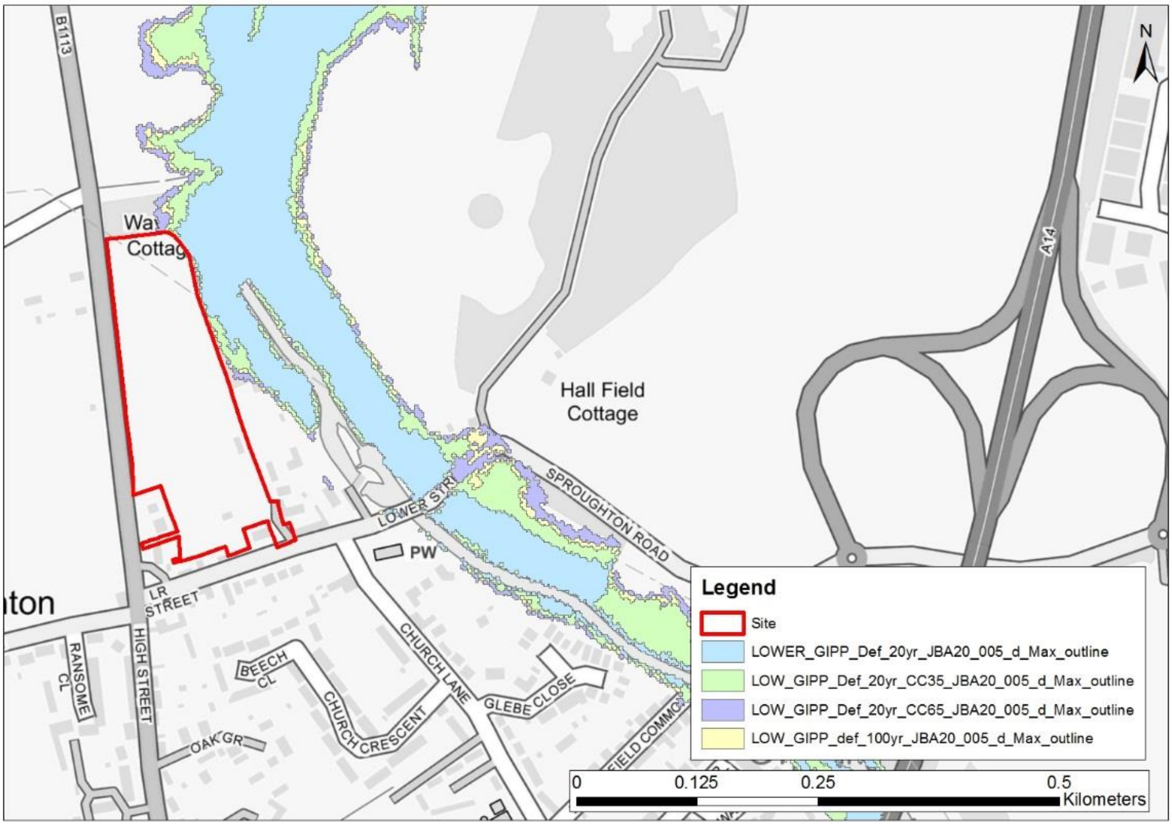

Figure 2-4: Defended model results - 20year plus 35% and 65% climate change and 100yr events

2.3.1 Climate Change scenarios

The impact of climate change was assessed for fluvial events, based on the 5%, 1% and 0.1% AEP event using the latest Environment Agency guidance on climate change for the 2080s Anglian river basin district using the anticipated potential change factors of 35% (higher central) and 65% (upper end).

The flood extents show the south-eastern corner of the site is inundated by flooding with the flood extent increasing with climate change. The majority of the site is not impacted by flooding.

2.4 Model limitations, assumptions and uncertainty

Developing a hydraulic model requires the application of simplifications and generalisations. As such a number of assumptions are made when building the model. This can lead to model uncertainties and subsequent limitations of the results.

The scope of the model is a simple model for an SFRA and therefore this is reflected in the level of detail included in the model. The main aim of the model was to produce flood outlines for the development site, and whilst some improvements could be done to the model, this was only done where it would make a difference to the outline at the site.

The base data used to provide a representation of the channel and associated structures may be a limitation of the study. In this case, the channel and topographic survey is from the existing models. The age of this survey (pre 2012) is a potential source of uncertainty. It has been assumed that the existing model is fit for purpose. However, due to the updated model representing the site in 1D/2D, the flood levels have reduced as a result of the flow bypassing the structure near the site on the left bank in 2D, which wasn't possible in the 1D only model.

In order to get the model to run for the 0.1% AEP + climate changes events, the model had to be trimmed down to run these events to the area of interest, as instabilities at the top of the model meant the model failed in these events. The model was trimmed down to only include the 2D domain with the development site in, and was started at node GIPP_9400d which is in the 1D only section upstream of this. The results were extracted for the node at the top of the model (GIPP_9400d) for the 1000-year event, and then this was applied as the inflow at the top of the model with the climate change allowances.